Jan. 1, 1935. V. L. RONCI ET AL 1,986,533

APPARATUS FOR COATING FILAMENTARY MATERIAL

Filed Aug. 8, 1929 3 Sheets-Sheet 1

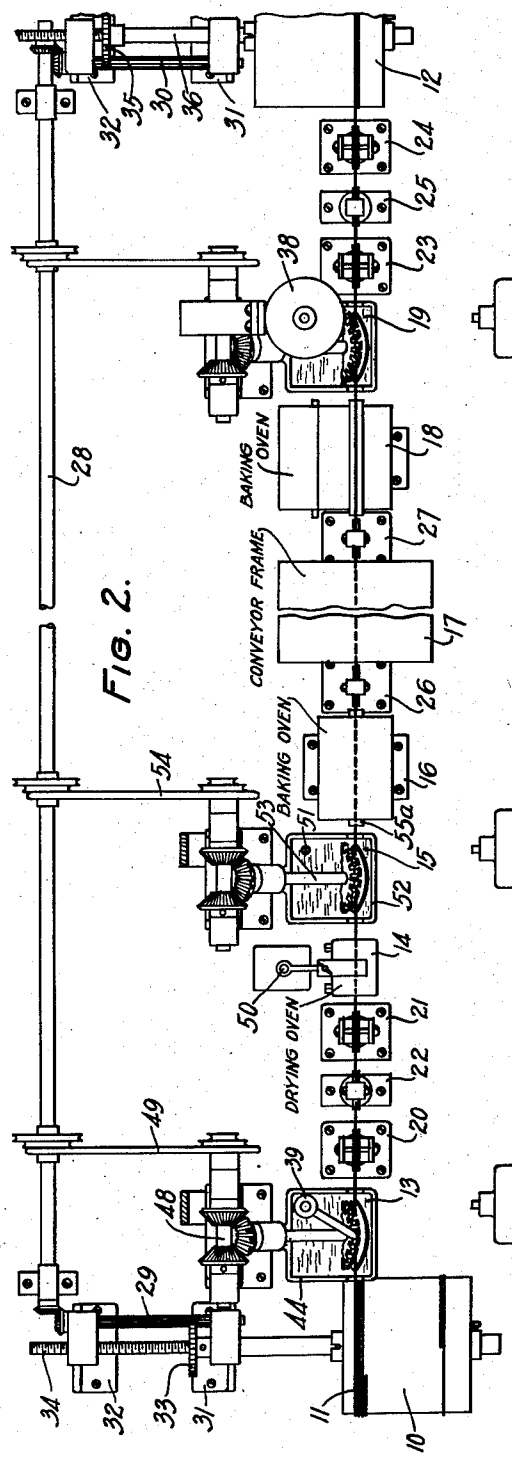

FIG. 2.

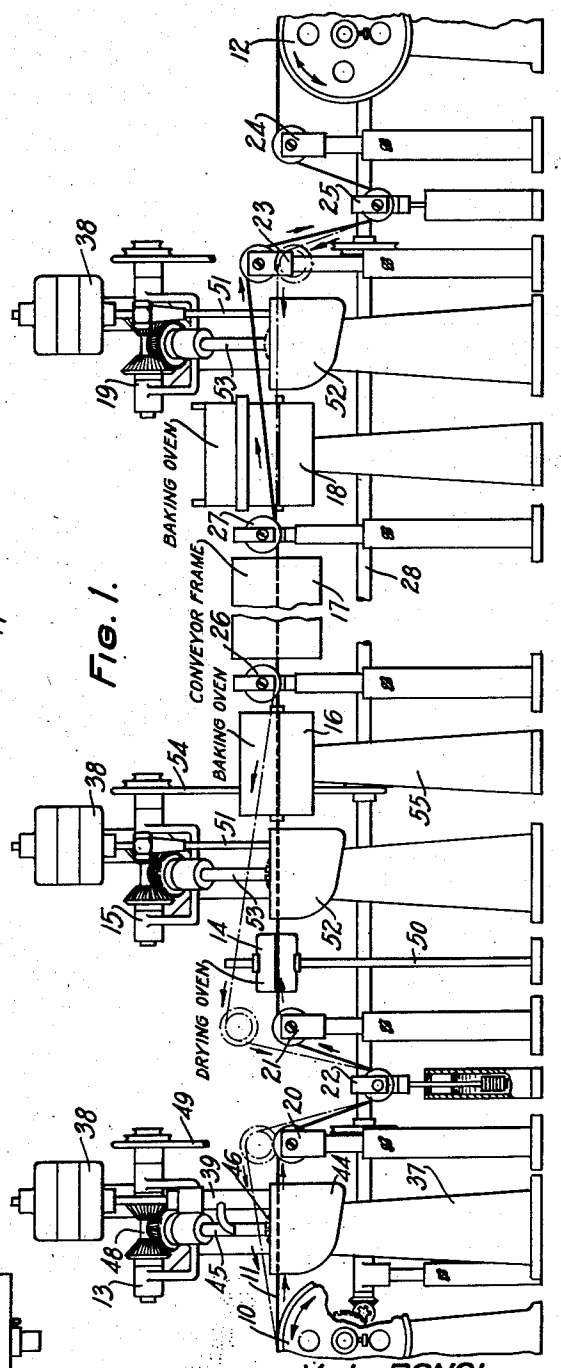

FIG. 1.

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APPARATUS FOR COATING FILAMENTARY MATERIAL

Filed Aug. 8, 1929 3 Sheets-Sheet 2

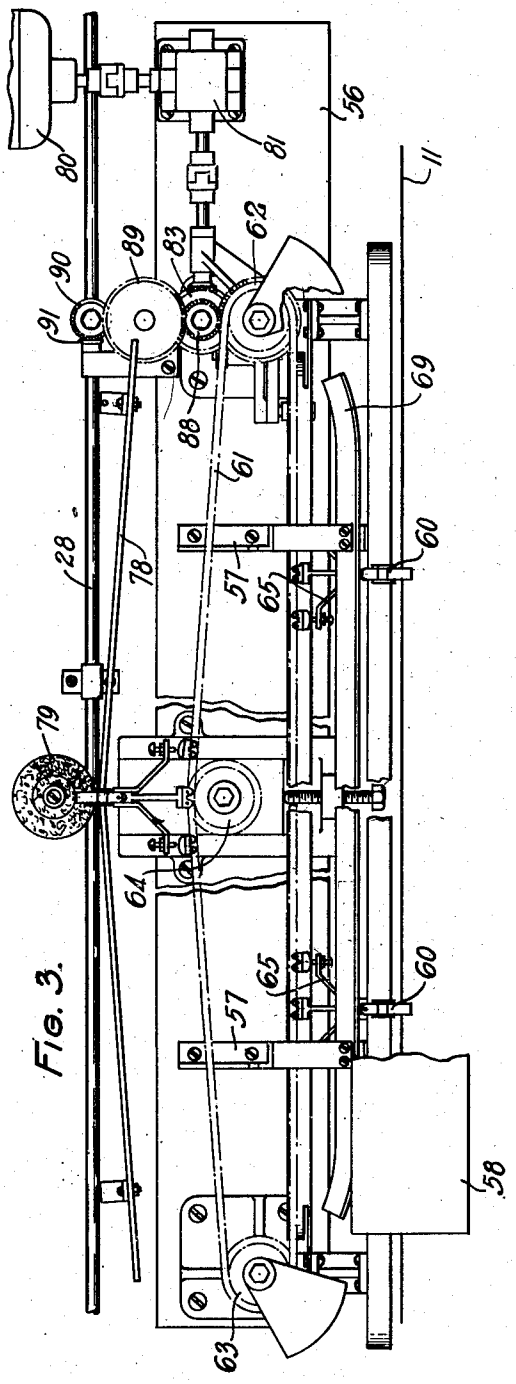

FIG. 3.

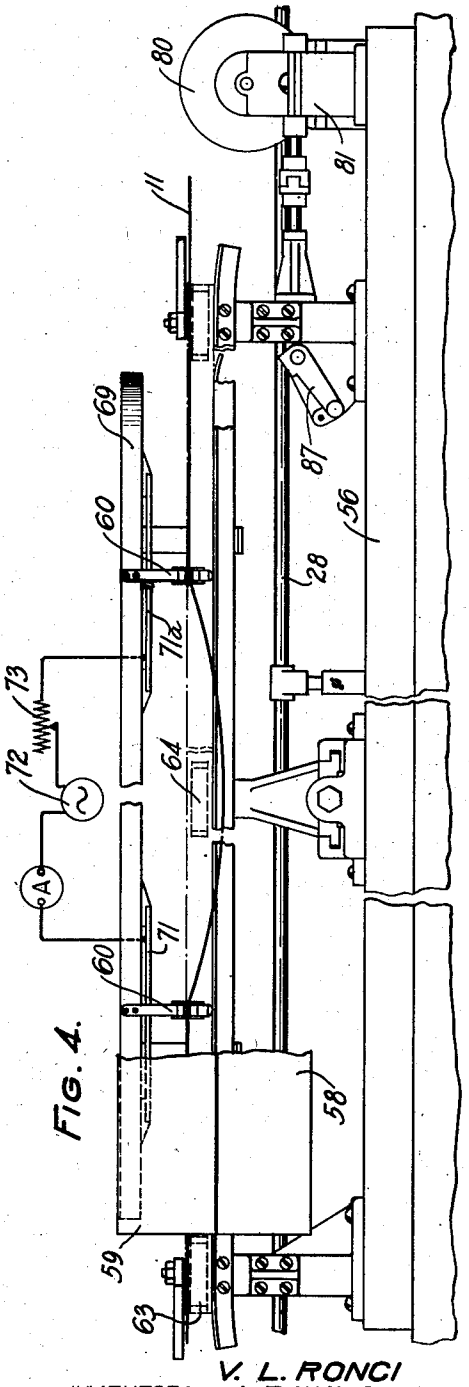

FIG. 4.

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Fig. 5.

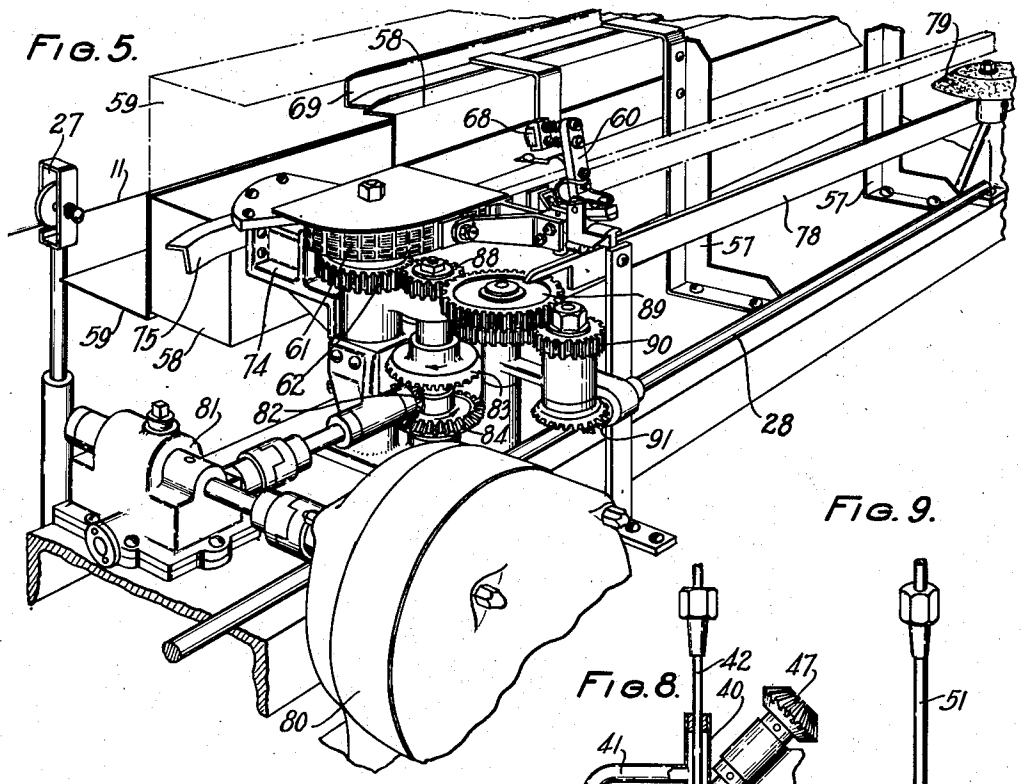


Fig. 9.

Fig. 8.

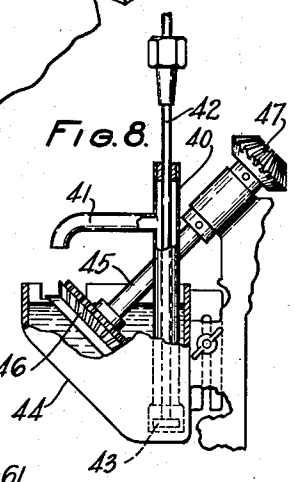


Fig. 6.

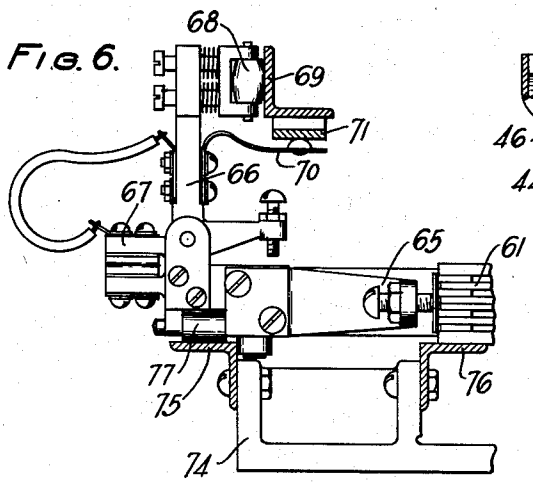
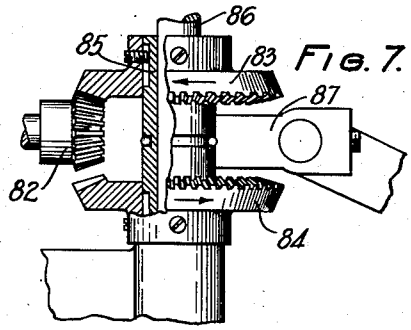


Fig. 7.



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UNITED STATES PATENT OFFICE

1,986,533

APPARATUS FOR COATING FILAMENTARY MATERIAL

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Application August 8, 1929, Serial No. 384,376

9 Claims. (Cl. 91—55)

This invention relates to apparatus for coating material and has particular reference to the coating of filamentary material such as is used for electron emitters in discharge devices.

An object of the invention is to insure uniform coating of filamentary material and to increase its rate of production.

In accordance with this invention the filamentary material is wound on a supply reel and passed through a cleaning bath and drying oven to remove surface matter which is detrimental to the coating material. The filamentary material automatically passes through the coating material, such as alkaline earth compounds, and then enters a baking oven to remove the solvent of the coating material. After leaving the baking oven the filamentary material is automatically gripped by suitably spaced carriers on a continuous conveyer and during the interval of the time the filamentary material is held between two spaced carriers a flashing current is applied to the length of material, to change the coating to thermionically active oxides. After the material is released from the grippers or carriers, it is wound on a take-up reel.

This invention also contemplates applying more than a single coating of thermionically active material to the filament and therefore inserts an additional coating unit and baking oven between the take-up reel and the conveyer frame, so that the cycle of operation described above may be performed in the opposite direction. Any number of subsequent coatings may be applied to the filamentary material simply by reversing the travel of the filamentary material through the series of units. Suitable adjustable guides and tension devices are arranged between the units to maintain the filamentary material in proper position for the various operations.

A feature of the invention relates to the coupling of all the driven units to a single driving mechanism so that the filamentary material is not strained in its travel during the various operations. This is accomplished by driving the supply drum, conveyer and take-up drum at the same speed and advancing the filamentary material from the supply drum instead of drawing the material from the drum.

Another feature of the invention relates to flashing the coated filamentary material while being carried on the conveyer frame and flashing succeeding portions in a continuous manner until the complete length of material has been finished. During the flashing operation the portion of filamentary material on the conveyer frame sags of its own weight, due to expansion under heat, and immediately contracts when the flashing current is discontinued. This operation, however, does not cause strains in the material since the portion which is flashed is held between the spaced carriers on the conveyer frame.

These and other features of the invention will be described in detail in the following description in conjunction with the various figures of the drawings, in which

Fig. 1 shows in elevation, the complete series of units in operative relation to each other, whereby a continuous length of filamentary material may be automatically coated and processed continuously in opposite directions in accordance with this invention;

Fig. 2 corresponds to Fig. 1 and shows the various units in plan view and also the position of the supply drum and take-up drum when the filamentary material is passing through the various units in a direction from left to right, as viewed in Fig. 2;

Fig. 3 is a plan view of the conveyer frame in segmental form to show the assembly of the frame and driving mechanism;

Fig. 4 shows in elevation, the conveyer frame of Fig. 3 and the position of the carriers and the filamentary material during the flashing period;

Fig. 5 is an enlarged perspective view of one end of the conveyer frame and also shows in detail the driving mechanism;

Fig. 6 is an enlarged side view of the carrier or gripper attachment and conveyer chain and shows the carrier in its operated position;

Fig. 7 is an enlarged detail view of the reversing mechanism of the conveyer frame with a portion broken away to show the detailed construction;

Fig. 8 is an enlarged view of elements of the cleaning and coating units partly in cross-section and partly broken away to show the detailed construction; and

Fig. 9 is an enlarged view of the agitator employed in the coating units.

Referring to the drawings, the series of units for mechanically and continuously forming uniform coatings of thermionically active material on a continuous length of filamentary material consist of a supply drum or reel 10, on which the filamentary material 11 is wound and a take-up drum or reel 12 which receives the filamentary material after passing through the series of operations in one direction. Between these drums are located various units for working on the filamentary material as it passes from the supply drum 10 to the take-up drum 12. These units consist of

a cleaning unit 13 closely adjacent, the supply drum 10, the drying oven 14 following the cleaning unit 13, a coating unit 15 following the drying oven, a baking oven 16 succeeding the coating unit and an endless conveyer or flashing frame 17. A baking oven 18 similar to the baking oven 16 and a coating unit 19 similar to the coating unit 15, are positioned between the conveyer frame and the take-up drum. The baking ovens 16 and 18 are located on either side of the conveyer 17 and the coating units 15 and 19 are located between each baking oven and one of the drums. Suitable adjustable guides 20 and 21 are positioned between the cleaning unit 13 and the drying oven 14 to maintain the filamentary material 11 at the proper level for passing through the various units. An oil-damped tension unit 22 is positioned between the two adjustable guides 20 and 21 which are positioned between the cleaning unit 13 and the drying oven 14 and a similar tension device 25 is positioned between the guides 23 and 24 located between the coating unit 19 and the take-up reel 12. Adjustable guides 26 and 27 are positioned on opposite sides of the continuous conveyer 17 to insure proper alignment of the filamentary material 11. The complete assembly of the series of units as shown in Figs. 1 and 2 insures continuous operation of the filamentary material in opposite directions and insures uniform coating and processing of the filamentary material to provide the necessary number of coatings of thermionically active oxides to form an efficient electron emitter for vacuum tubes or other discharge devices.

The filamentary material 11, such as a platinum-nickel alloy or other suitable base material, is of fragile character and precautions must be taken to prevent strains in the material, since these strains have a tendency to disrupt the continuous operation of the machine and also produce bright spots when the filament is mounted in a discharge device. Consequently, it is necessary to advance the filamentary material 11 through the various stages of the coating process without producing strains therein. In accordance with this invention the supply drum 10 and the take-up drum 12 are driven from a common shaft 28, which is coupled to shaft gears 29 and 30, supported in bearings 31 and 32. A gear 33 attached to threaded shaft 34 engages the shaft gear 29 to rotate and advance the drum 10, which is removably attached to the shaft 34. Similarly, a gear 35 attached to threaded shaft 36 engages the shaft gear 30 to rotate and advance the take-up reel 12, which is removably attached to the shaft 36. As shown in Fig. 2, the supply drum 10 is positioned as shown in advanced position, while the take-up reel of drum 12 is shown in the rear position, so that the filamentary material 11 passing through the various units is maintained in true alignment with the guides and the coating units and passes centrally through the ovens ond the conveyer frame. The threaded shafts on which the drums are rotated insure even spacing of adjacent turns of the filamentary material on the drums and the driving means for the drums insure uniform rotation of the drums without placing any strain on the filamentary material since the material is advanced from the supply drum 10 instead of being drawn from the drum.

The cleaning unit 13 adjacent the supply drum 10 comprises a standard 37 supporting a motor unit 38 coupled to a rotary pump 39. This pump is shown more in detail in Fig. 8, in which a tubular casing 40 having a bent nozzle 41 encloses a rotating shaft 42 terminating in an agitator 43. The pump extends into a metallic cup 44, which is filled with acetone or other cleaning solution. The standard 37 also supports a shaft 45, at an angle to rotate a wheel 46 in the cleaning solution. This wheel is slotted and grooved to insure sufficient cleaning solution being carried in the groove of the wheel 46, and together with the cleaning solution poured on the wheel by the rotary pump 39, insures an adequate supply of the cleaning solution being applied to the filamentary material as it passes over the wheel 46 in the cleaning material. The wheel 46 is continuously rotated by spur gears 47 coupled to the shaft 48 carried at the upper end of the frame 37. A belt and pulley arrangement 49 drives the wheel 46 from the main drive shaft 28. The drying oven 14 consists of a standard 50 supporting a hollow electric oven 14 formed of two parts and provided with hinges, so that the unit may be readily removable from around the filamentary material 11.

The coating unit is substantially the same as the cleaning unit 13, except that instead of the rotary pump 39 the motor 38 is coupled to an agitator 51. This agitator is shown more clearly in Fig. 9, in which the shaft is connected to a split disc 51*a*. The agitator 51 is immersed in the coating solution contained in the receptacle 52. The coating solution may be barium and strontium hydroxides dissolved in a suitable solvent. The agitator 51 insures continuous mixing of the compounds in the solution to prevent settlement of the compounds in the bottom of the receptacle and consequent weak solution of the coating composition. The continuously rotating wheel 53 which is similar to the wheel 46 described in connection with the cleaning unit insures an adequate supply of coating material being transferred to the filamentary material 11 passing over the wheel 53. This wheel is continuously rotated by a belt and pulley arrangement 54 coupled to the common drive shaft 28. Immediately following the coating unit is the baking oven 16 supported on a standard 55 and formed of two halves, so that it may be readily opened for purposes to be hereinafter described. This oven is provided with a split cylindrical channel 55*a* which is surrounded by an electrical heating coil within the housing 16.

The baking oven 18 located on the opposite side of the conveyer frame 17 is the same as the baking oven 16 described above and operates in a similar manner, and the coating unit 19 located between the baking oven 18 and the take-up reel 12 is exactly the same as the coating unit 15. The purpose of having an additional coating unit and oven on the opposite side of the conveyer frame is to form coatings on the continuous length of filamentary material in opposite directions without removing the filamentary material from the reels.

The common conveyer frame 17 located intermediate, the drums 10 and 12 consists of a base 56 to which are attached a plurality of L-shaped angle members 57 which support a sheet metal elongated box chamber 58 which comprises the flashing enclosure for the filamentary material 11 as it passes along the conveyer frame. The flashing chamber is provided with a hinged cover 59 to prevent dust particles affecting the filamentary material during the flashing period. As the filamentary material passes through the flashing chamber, it is gripped by movable carriers or grippers 60, as shown in Figs. 3 and 4,

which are carried by an endless gear chain 61, driven by gear 62 at one end of the frame and coupled to idle gears 63 and 64, the idle gear 63 being located at the other end of the frame and the gear 64 being positioned intermediate the driven and idle gears and to the rear of the frame. The endless conveyer chain 61 carries a plurality of normally open grippers 60 which are rigidly coupled to the chain at their midpoint, as shown in Fig. 3 and the outwardly extending arms 65 make contact with links in the chain 61. The center arm of the gripper 60 carries at its outer end a stationary jaw and a pivot joint for supporting the upright member 66, which carries the upper jaw 67 of the gripper. The upright member 66 is also provided with a cushioned wheel 68, which engages a rail 69 extending along the upper edge of the flashing chamber 58. A spring contact 70 attached to the upright member 66 of the gripper engages a bus bar 71, attached to the flashing chamber adjacent, the rail 69, as shown in Fig. 4. When the gripper engages the bus bar 71 current is supplied to the gripper from the generator 72 and the complete circuit may be traced from generator 72, bus bar 71, contact 70, jaw 67, section of filamentary material held between two of the grippers 60, bus bar 71*a*, resistance 73, back to the generator 72.

A frame casting 74 extending from the shaft housing of gear 62 and a similar frame casting extending from the shaft housing of gear 63 located at the other end of the conveyer frame support parallel angle rails 75 and 76, the rail 75 forming a support for the outwardly extending carrier 60 which rides on the rail 75 by means of a roller 77 and the rail 76 forming a guide for the continuous conveyer chain 61. A guide rail 78 is also provided at the rear of the conveyer frame to support the carrier 60 as it moves along the rear of the conveyer frame. A felt disc 79 is positioned opposite the idle gear 64 at the rear of the frame and is provided with a tapered edge, so that as the carriers or grippers pass the felt wheel the normally open jaws of the carrier are cleaned of any coating material deposited on the jaws of the carrier by contact with the filamentary material, to insure good electrical contact when the carrier again engages the filamentary material.

The driving mechanism for the complete series of units is directly coupled to the conveyer frame, as shown in detail in Fig. 5 and comprises a motor 80 coupled to a reduction gear housing 81 which reduces the speed of the motor to a ratio of 200:1. The reduction gear arrangement is coupled to a spur gear 82 which alternately engages a pair of opposed gears 83 and 84, depending on which gear is shifted into engagement with the spur gear 82. This arrangement is shown more in detail in Fig. 7, in which gears 83 and 84 are attached to a sliding collar 85 which is keyed to shaft 86 and controlled by a movable lever 87 to determine the movement of all the units in synchronism in either direction. Attached to the shaft 86 is a gear 88, which is in mesh with driven gear 62 of the conveyer assembly. Gear 88 is also in mesh with an intermediate gear 89 which drives gear 90 coupled to the gear 91 on the main drive shaft 28.

Operation in one direction

When the length of filament is to be coated in accordance with this invention, the filament material is wound on the drum 10 which is coupled to the shaft 34, as shown in Fig. 2 and a lead wire connected to the free end of the filament and passed over the guides 20 and 21 as shown in their normal position in Fig. 1 and under the wheel of the tension device 22. The lead wire is then threaded through the oven 14 through the baking oven 16, under the wheels of guides 26 and 27 in their normal position, as shown, over wheel of guide 23 in its elevated position, as shown in Fig. 1, under tension device 25, over the wheel of guide 24 and wound on the take-up drum 12. During the series of operations in which the filamentary material is coated and processed in a direction from left to right as viewed in Fig. 1, the baking oven 16 is opened, as shown in Fig. 1 and the adjustable guide 23 is raised to prevent the filamentary material entering the coating solution contained in the coating unit 19.

The motor 80 is started to rotate the shaft 28 and the conveyer frame in synchronism to advance the filamentary material 11 from the drum 10, whereupon it passes over the slotted wheel 46 in the cleaning unit 13 and the rotary pump 39 flushes the filamentary material with the cleaning solution as it passes over the grooved wheel 46. The cleaning operation removes deleterious matter such as grease or oxide coating from the fragile filamentary material and as it passes through the drying oven 14 the cleaning solution is dried so that the filament material is cleaned as it advances to the coating bath contained in receptacle 52 of coating unit 15. The continuous rotation of the grooved wheel 53 in the coating unit 15 and the particular arrangement of the slots therein cause an adequate supply of the coating material, such as barium and strontium hydroxide, to be applied to the filament material as it passes over the wheel 53. The filament then advances to the baking oven 16 to remove the solvent of the coating solution and leave as a residue a white precipitate of barium and strontium carbonates on the filament material. As the filamentary material advances toward the conveyer frame, one of the normally open carriers 60 is in position to grasp the filament material 11 as soon as the roller 68 engages the rail 69 on the conveyer frame. The advancement of the carrier 60 along the frame brings a second carrier into position to grasp the filamentary material and these two carriers move along the frame until the springs 70 on the carriers engage the bus bars 71 and 71*a* under the rail 69 of the conveyer frame. As shown in Fig. 4, a flashing current is applied to the section of filamentary material held between the two spaced carriers and during this interval the section of filament sags of its own weight due to expansion and is highly heated to change the barium and strontium carbonates to thermionically active oxides of barium and strontium. The travel of the carriers along the frame eventually cut off the flashing current after the contacts 70 leave the bus bars 71 and 71*a* and as each carrier reaches the end of the frame the closed jaws are opened when the roller 68 is disengaged from the rail 69. The filamentary material is then guided over the oven 18, and coating unit 19 by the extended position of the guide 23 and is then wound on the take-up reel 12.

When the complete length of filamentary material 11 on the supply drum 10 has passed through all the operations hereinbefore described in one direction the driving mechanism is stopped. The guide 21 is advanced to its elevated posi-

tion as shown in dotted outline in Fig. 1 and the guide 23 is lowered to a level similar to the guide 24. In this position the filamentary material is in engagement with the coating wheel of coating unit 19 and the baking oven 18 is closed. The baking oven 16 is opened so that the travel of the filamentary material in the reverse direction is indicated in dotted lines, as shown in Fig. 1. Of course, it is understood that the cleaning unit 13 and drying oven are only necessary during the first run of the filamentary material through the series of units, since deleterious matter will not form on the oxide coating applied to the filament material. For this reason these units may be removed after the first run or the drying oven 14 may be opened and the adjustable guide 20 raised to prevent the filamentary material entering the cleaning bath contained in the cleaning unit 13.

Operation in the reverse direction

When it is desired to reverse the operation of all the units the shift handle 87 is moved up to disengage the gear 83 from the spur gear 82 and bring the gear 84 into engagement with the spur gear 82 and the driving mechanism started to reverse the movement of all the units coupled to the shaft 28 and start the continuous conveyer chain 61 moving in an opposite direction to that described in connection with the previous coating process. It will also be noted that since all the filamentary material is wound from the supply reel 10 and wound on the take-up reel 12, the position of these reels will be reversed to that shown in Fig. 2. In effect, the take-up reel 12 will be in its advanced position and the supply reel 10 will be in its rear position, so that the filamentary material will pass through all the units located between these reels. When the filamentary material which is provided with a single coating of thermionically active oxides is advanced from the take-up reel 12, the position of the adjustable guides 23 and 24 and the tension device 25 causes the filamentary material to pass through the coating unit 19, where a second coating of barium and strontium hydroxide is applied to the first coating. The progress of the filamentary material through the baking oven 18 removes the solvent of the coating solution and the filamentary material is then drawn along to the common conveyer frame 17 where the flashing current is applied to successive sections of the material as the filament passes through the frame in the manner described above. After leaving the conveyer frame the position of the guides 20 and 21 causes the filamentary material to pass over the oven 16 and the coating bath 15 without being conditioned by these units and is then wound on the supply reel 10. Any number of coatings may be applied to the filamentary material successively in opposite directions in accordance with this invention and a heavy uniform coating of thermionically active oxides is applied to the filamentary material.

The assembly of the apparatus as shown in Figs. 1 and 2 produces an efficient product by mechanical operations in which the coatings applied to the filamentary material are evenly distributed thereon. This arrangement also facilitates the production of electron emitters for vacuum tubes or other discharge devices and materially reduces the cost.

While specific apparatus has been shown for performing the various operations on the filamentary material, it is, of course, understood that various modifications may be made in the individual structures and the invention is not to be limited to the specific mechanisms disclosed. The particular elements described in connection with this invention have been found to produce satisfactory results, but the prime function of these elements is to successively and continuously perform the various functions on the filamentary material in opposite directions in which a common conveyer frame is provided for flashing the filament and coating units and baking ovens are arranged on opposite sides of the conveyer frame to operate on the filamentary material in reverse directions. Therefore, the invention is only to be limited within the scope of the appended claims.

What is claimed is:

1. In combination, a machine for coating strand material in which the elements are arranged in a series of units comprising an endless conveyer, a plurality of spaced material carriers on said conveyer, an oven on each side of said conveyer, a coating unit succeeding each oven, a rotatable drum at each end of the series of units and common means connected to said conveyer and drums for driving them in unison, one of said drums serving as a supply drum when the material travels in one direction and the other of said drums serving as a supply drum when the material travels in the opposite direction, said strand material being advanced through the coating unit and baking oven between the supply drum and the conveyer in opposite directions of travel.

2. In combination, a pair of spaced supply reels adapted to wind and suspend a continuous length of filamentary material therebetween, a pair of coating receptacles between said supply reels through which said material is alternately passed in successive opposite directions of travel, a baking oven adjacent each coating receptacle, a flashing frame intermediate the distance between said reels and adjacent said ovens, and driving means coupled to said reels and frame for successively advancing and flashing the filamentary material in opposite directions of travel.

3. In combination, a series of units comprising a pair of spaced supply reels adapted to wind and suspend a continuous length of filamentary material therebetween, a pair of coating receptacles between said supply reels through which said material is alternately passed in successive opposite directions of travel, a baking oven adjacent each coating receptacle, a common flashing frame between the series of units, a common drive for said reels and frames, and guiding means for said material between each two adjacent units.

4. In combination, a pair of spaced supply reels adapted to wind and suspend a continuous length of filamentary material therebetween and advanced from one reel to the other in successive opposite directions, a pair of coating receptacles between said supply reels through which said material is alternately passed in successive opposite directions of travel, a baking oven adjacent each coating receptacle, a common flashing frame intermediate the ovens, common driving means for said reels, coating receptacles and frame, guiding means for said material between said reel and coating receptacle, and a floating tension device intermediate said guiding means.

5. A continuous conveyer for coating machines comprising a frame support, rotatable members on said frame, a conveyer driven by said members, a plurality of normally open grippers attached to said conveyer, means projecting from

said frame and extending substantially over the whole length of said conveyer adapted to be engaged by said grippers for closing said grippers during an interval of movement along said frame, said grippers being adapted to engage and support a traveling filamentary strand therebetween, and means for heating the strand between said grippers.

6. A continuous conveyer for coating filamentary material comprising a frame support, rotatable members on said frame, a conveyer driven by said members, a plurality of normally open grippers carried by said conveyer, a trackway on said frame, said grippers riding on said trackway, a guide rail parallel to said trackway adapted to close said grippers on a section of filamentary material during their travel along said frame, and means for flashing the section of filamentary material between said grippers.

7. In combination, a pair of rotatable drums adapted to wind and suspend a continuous length of filamentary material therebetween, a pair of coating receptacles between said drums through which said material is passed, a flashing frame intermediate the distance between said drums and receptacles, a threaded shaft extending through each of said rotatable drums, a shaft gear coupled to each of said threaded shafts, and a common drive shaft connected to said shaft gears for simultaneous rotative movement of said drums in opposite longitudinal directions.

8. In combination, a pair of rotatable drums adapted to wind and suspend a continuous length of filamentary material therebetween, a flashing conveyer frame between said drums, a receptacle for coating material between each of said drums and said conveyer frame, a coating wheel within said receptacle, an agitator member extending into said receptacle, and means for rotating said wheel and agitator.

9. In combination, a pair of spaced supply reels adapted to wind and suspend a continuous length of filamentary material therebetween, a continuous conveyer frame between said reels adapted to engage said filamentary material in its travel from one reel to another, a coating receptacle on each side of said conveyer frame, a receptacle for a cleaning solution located between one of said reels and coating receptacles, a rotatable carrier dipping into said solution, and rotatable means for pouring the solution on said rotatable carrier.

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