

July 10, 1945.

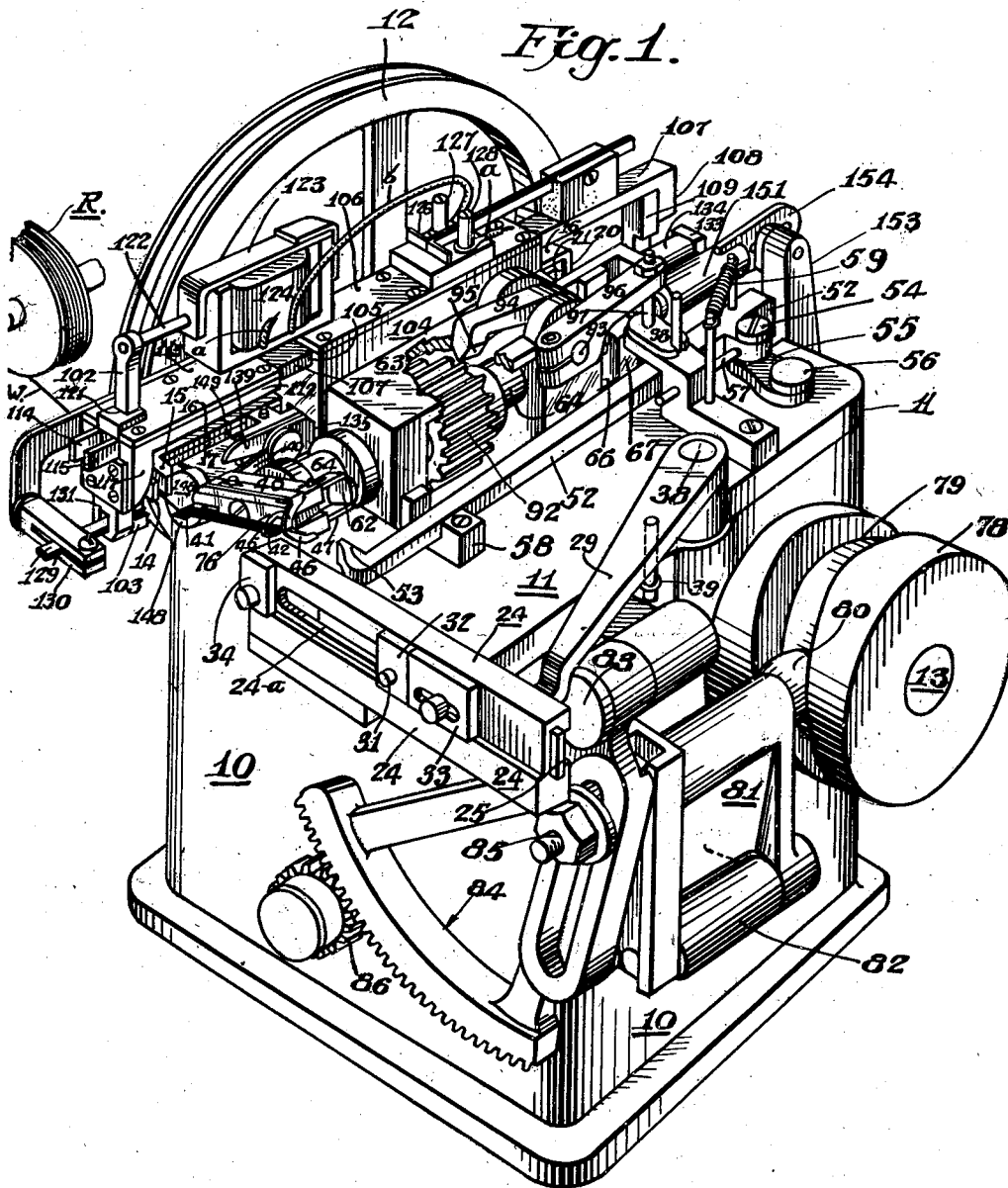
A. LA FRANCE

2,380,320

MACHINE FOR MAKING RADIO TUBE HEATER ELEMENTS

Filed Jan. 20, 1942

6 Sheets-Sheet 1



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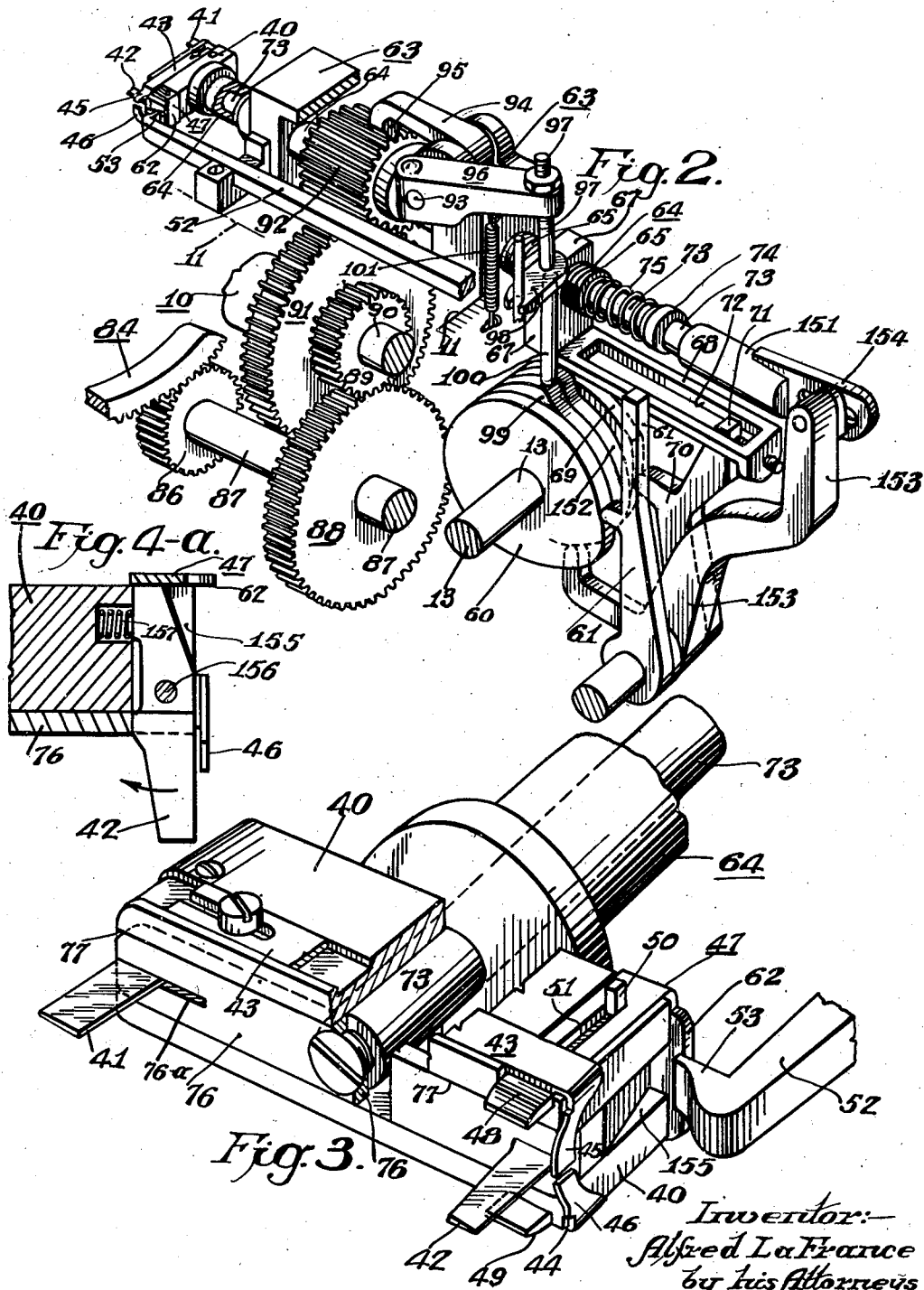
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MACHINE FOR MAKING RADIO TUBE HEATER ELEMENTS

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6 Sheets-Sheet 2



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MACHINE FOR MAKING RADIO TUBE HEATER ELEMENTS

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6 Sheets-Sheet 3

Fig. 18.

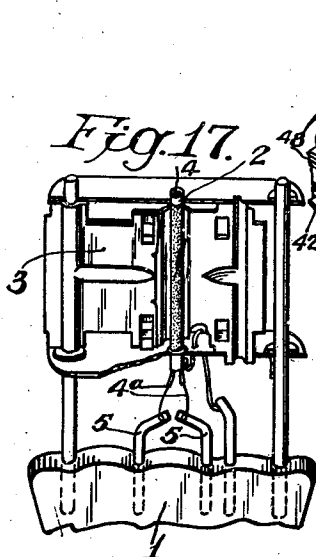
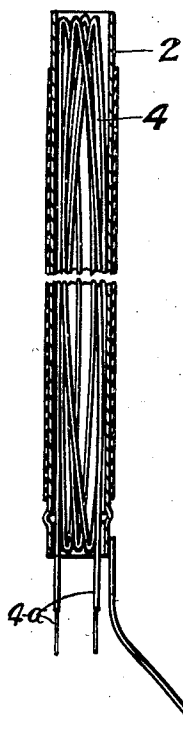


Fig. 9.

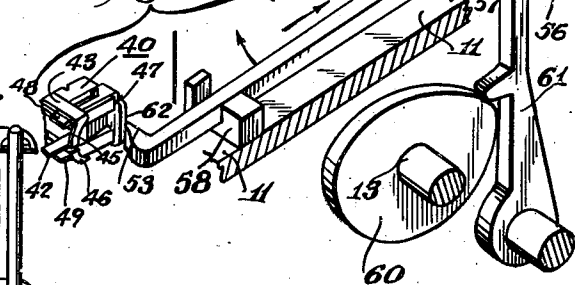
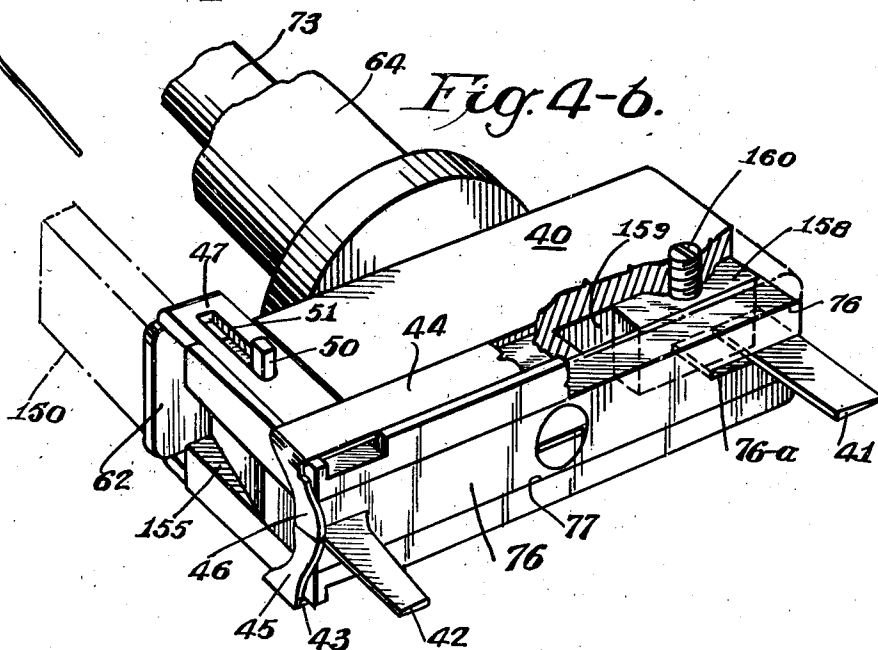


Fig. 4-b.



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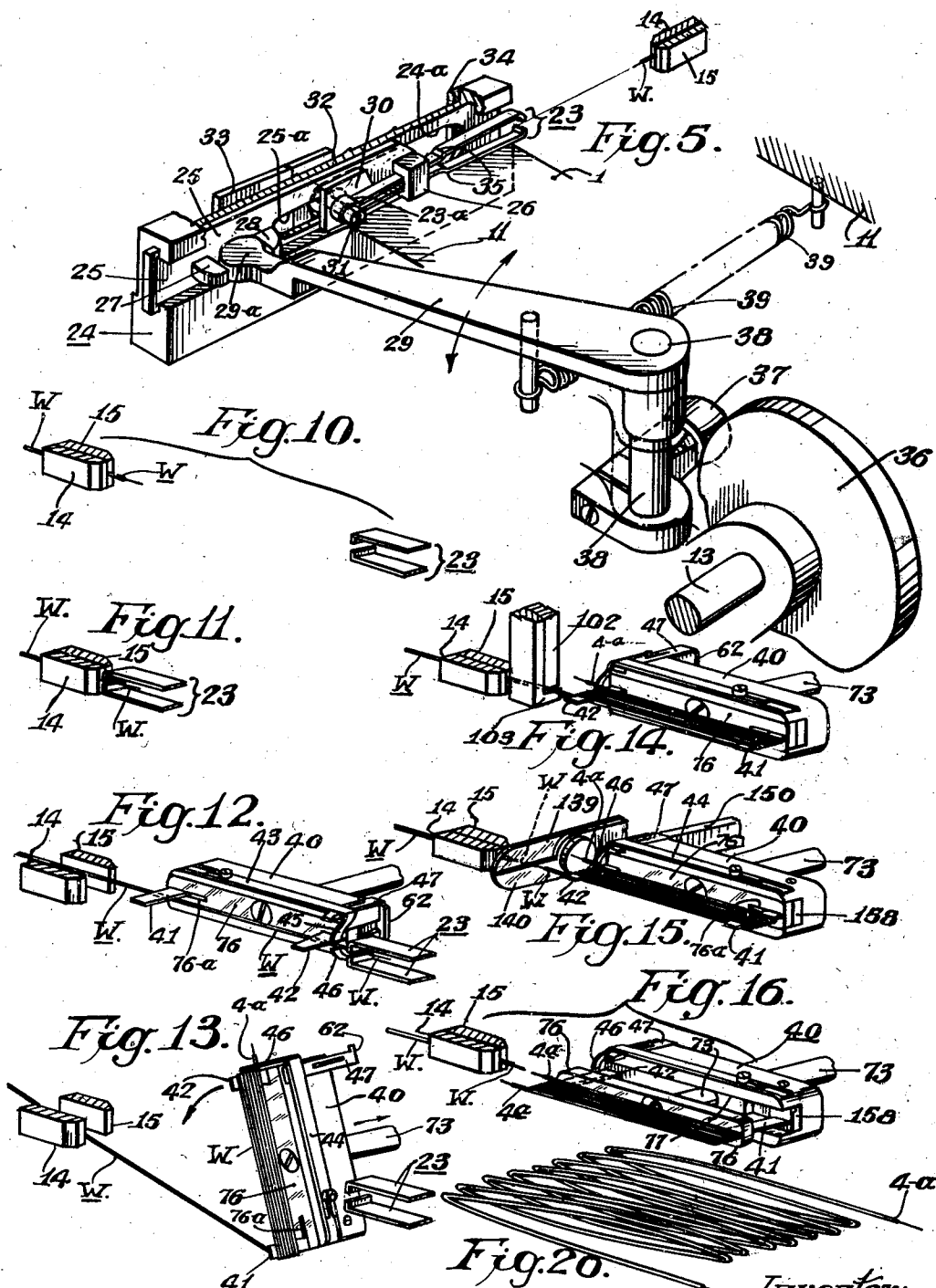
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MACHINE FOR MAKING RADIO TUBE HEATER ELEMENTS

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6 Sheets-Sheet 4



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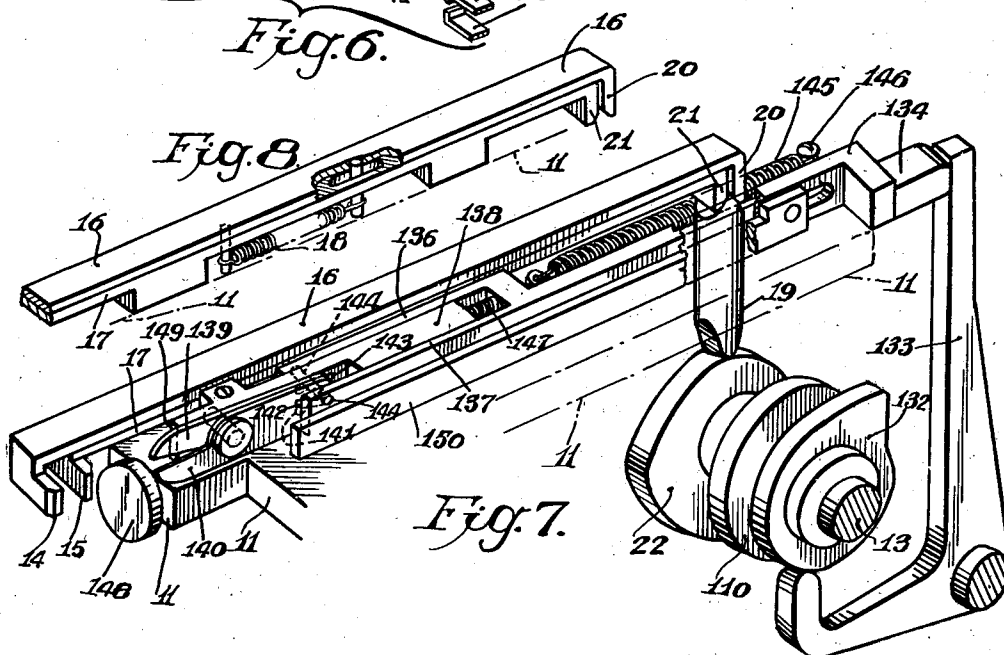
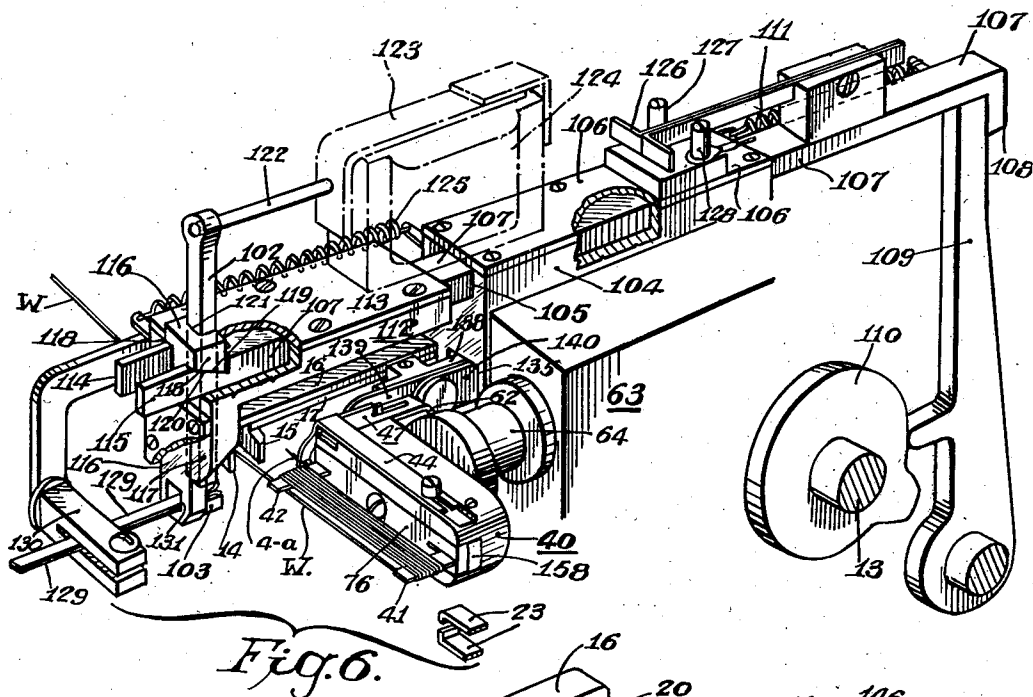
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MACHINE FOR MAKING RADIO TUBE HEATER ELEMENTS

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6 Sheets-Sheet 5



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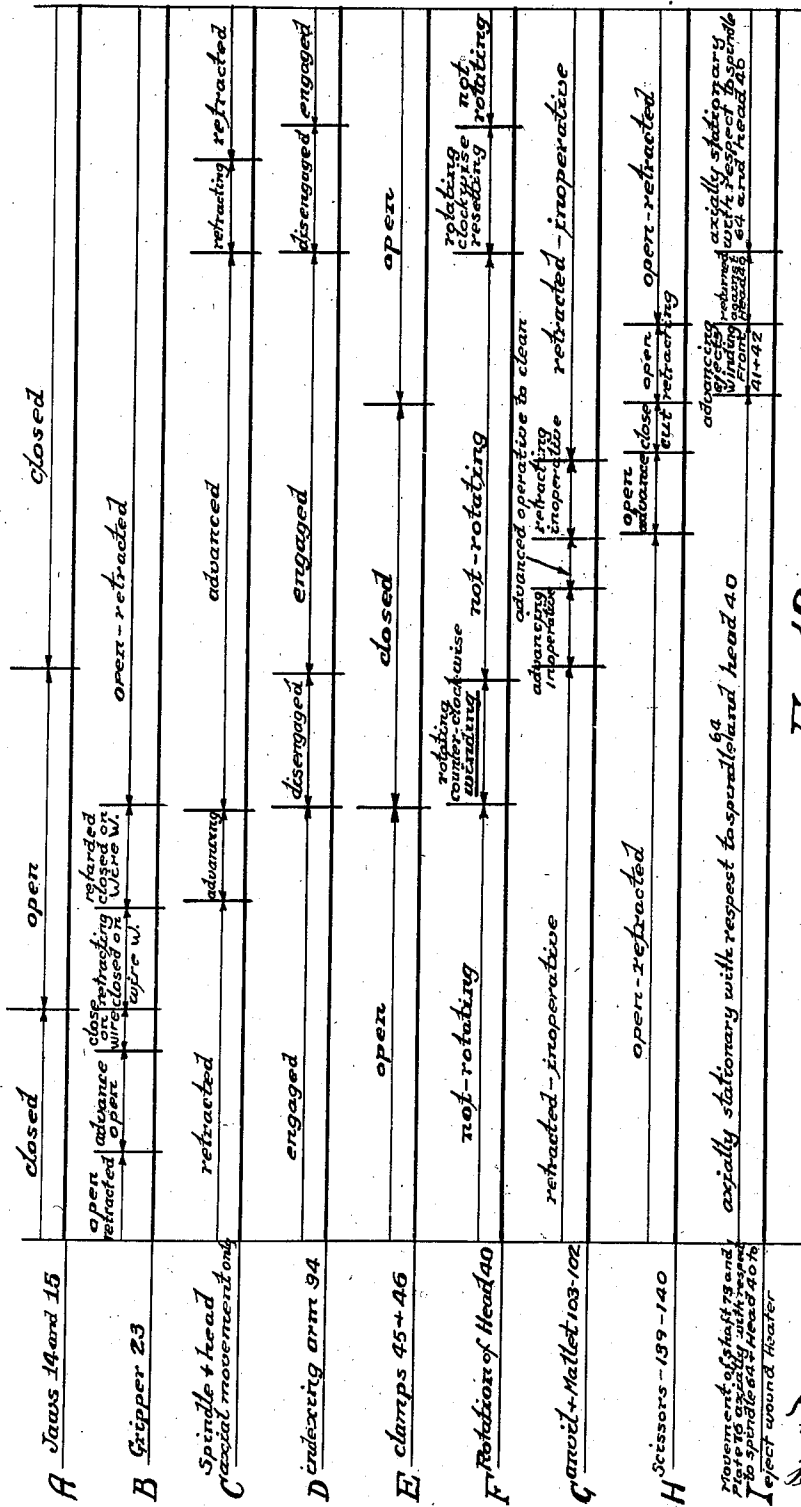
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MACHINE FOR MAKING RADIO TUBE HEATER ELEMENTS

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6 Sheets-Sheet 6



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UNITED STATES PATENT OFFICE

2,380,320

MACHINE FOR MAKING RADIO TUBE
HEATER ELEMENTSAlfred La France, Salem, Mass., assignor to Hy-
tron Corporation, Salem, Mass., a corporation
of Massachusetts

Application January 20, 1942, Serial No. 427,512

44 Claims. (Cl. 140—71)

This invention relates to new and useful improvements in apparatus and methods for folding or winding wire heater elements for radio tubes and more particularly to a method and a completely automatic machine for forming, from a continuous strand of wire, complete heater elements for the common types of radio tubes.

In the manufacture of radio tubes, and particularly those of the cathode type employing a separate heater element for heating the cathode to an electron emitting temperature, the operations heretofore employed for forming the heater elements have been numerous and costly and, due to the almost continuous manual handling of the elements during these forming operations, there has been a considerable waste of material resulting from unavoidable breakage of the delicate heater wire. Normally the heater wire consists of a single strand of tungsten wire approximately two thousandths of an inch in diameter, and because of its stiffness and small diameter such wire is very brittle.

Further, since a heater element normally comprises a number of courses of wire arranged to lie adjacent each other in parallel relation within a sleeve-like container or cathode, the wire normally is covered with a relatively heavy baked-on coating of a suitable pasted frangible insulating material operable to separate and insulate the several courses each from the others. Such insulation may be a coating of aluminum oxide applied by a drag coating process and then baked onto the wire.

With the foregoing in mind, the principal object of the present invention is to provide a machine for performing in succession, and by novel means, the operations necessary to provide a complete folded radio tube heater element.

Another object of the invention is to provide a machine of the type set forth for performing, by novel means, each of the several individual operations required to form radio tube heater elements of the stated type.

Another object of the present invention is to provide a novel method for making radio tube heater elements of the stated type.

Another object of the invention is to provide a machine of the character described that is operable automatically to form complete radio tube heater elements from a continuous strand of suitable insulated wire.

Another object of the invention is to provide a fully automatic machine of the stated character that is operable to form radio tube heater elements of the type having multiple parallel

courses, the end legs of which are longer than the intermediate runs, and wherein the extremities of said longer end legs are free of insulation to provide electrical connection portions.

5 Still another object of the invention is to provide a fully automatic machine of the type described that is operable to form radio tube heater elements of the folded type having multiple parallel courses arranged for insertion in a supporting sleeve or cathode.

10 A further object of the invention is to provide a machine of the stated character embodying means for folding a strand of wire into a folded heater element having a plurality of adjacent parallel courses.

15 A further object of the invention is to provide a machine of the type set forth having novel means for automatically producing heater elements having a plurality of adjacent parallel courses formed from a continuous strand of insulated wire.

20 A further object of the invention is to provide a machine for making folded wire heater elements, which machine is readily adjustable to vary the number of courses of wire therein, the length of such courses, and the lead lengths of said elements.

25 These and other objects and advantages of the present invention and the various features and details of the construction and operation thereof will be clear from the following description of one embodiment thereof. Specifically the present invention resides in the novel radio tube heater element winding machine and in the method of operation and the construction, arrangement and features thereof herein disclosed.

30 In the accompanying drawings:

Figure 1 is a perspective view of a heater element winding machine made according to the present invention;

Figure 2 is a perspective view of the mechanism for controlling the rotatable winding head of the machine;

Figure 3 is an enlarged view, with parts broken away, showing the winding head;

Figure 4a is a detail view of a portion of the winding head;

Figure 4b is a detail view of another portion of the winding head;

Figure 5 is a perspective view of the wire transfer mechanism of the machine;

Figure 6 is a perspective view of the wire clamping and cleaning mechanisms incorporated in the machine;

Figure 7 is a perspective view of the wire

clamping and wire cutting mechanisms incorporated in the machine illustrated;

Figure 8 is a perspective view of a detail of the apparatus of Figure 7;

Figure 9 is a perspective view of the operating mechanism for the winding head wire clamp;

Figures 10 to 16 are diagrammatic views illustrating the operation of the several component mechanisms of the machine illustrated;

Figure 17 is a view of a radio vacuum tube showing one application of the product of the machine herein described;

Figure 18 is a view of a heater and cathode of a radio tube with the cathode shown in section to show the heater element;

Figure 19 is a diagram showing the sequence of the operations of the machine; and

Figure 20 is a view in perspective of a heater element made by the machine of the present invention.

Referring now to the drawings, the machine there shown may best be described by considering first the product of the machine and second, the nature and sequence of the several operations which are performed by said machine.

Radio tube heaters for tubes having tubular cathode sleeve elements normally are formed from a single strand of insulated wire which is folded into multiple parallel courses for insertion into the cathode sleeve. The wire employed usually is of tungsten, and may be about two one-thousandths of an inch in diameter, suitably coated with a frangible insulating covering. The wire preferably is wound on a reel from which it may be fed to or drawn through the folding machine.

In this connection and referring first to Figure 17, there is shown a portion of a radio vacuum tube embodying a heater made in accordance with the present invention. Thus, on a press element 1 there is mounted a suitable supporting structure for the conventional cathode sleeve element 2 and the anode 3 of a two-element or diode vacuum tube. Within this cathode sleeve 2 the wire heater 4 is located, and the leads 4a of said heater may be connected to the wire pin elements 5 of the tube which extend through the press 1 to the conventional tube contact pins (not shown). In Figure 18 the cathode sleeve 2 is shown in section to show the multiple course heater 4 in its normal position, and it will be noted that the lead ends 4a of the end courses of said heater are bare of insulation so that they may be electrically connected to the pin wires 5 of the tube.

Briefly, the operations of the heater folding machine of the present invention are seven in number, each being accomplished in sequence by suitable mechanisms operating in predetermined time relation with respect to one another. Before each cycle of operation of the machine is initiated the filament wire W from reel R is secured by a pair of jaws 14, 15 so that a short length of the free end of said wire W projects horizontally therefrom (see Figure 10). At this time an open gripper 23 is spaced horizontally from the clamped end of the wire W as shown. This gripper 23 then is moved to and closed upon the wire W, as shown in Figure 11, after which the jaws 14, 15 are caused to open and the gripper 23 is then returned to its original position drawing with it the wire W. The gripped end of the wire W is then transferred to the clamps 45, 46 of a rotatable winding head 40 which has previously been advanced to a position overlying said wire W, and the gripper 23 is then released from the wire (see Figure 12). The winding head 40 is

then rotated to wind or fold the wire W about a pair of spaced fingers 41, 42 until the desired number of legs have been provided (see Figure 13), and when this has been completed the insulation is cleaned from a short length of the wire by means of a vibrating mallet 102 which pounds the wire on an anvil 103 so as to knock the frangible insulation therefrom (see Figure 14). Following this, the clamp jaws 14, 15 again close upon the wire W and a small pair of scissors 139, 140 is actuated to cut the wire at the middle of the cleaned length of the wire (see Figure 15), thereby completing the making of the folded heater and severing the heater from the reel of wire. The finished heater is now ejected from the head 40 while the free end of the wire W on the reel is held by the clamp jaws 14, 15 for a repetition of this operating cycle. It may also be noted that during the movement of the gripper 23 as outlined above in connection with Figures 10, 11 and 12, the head 40 is rotated in the reverse direction to that of winding to restore the head to a winding position as more fully described hereinafter. If desired, the folded heater may be arranged to fall onto a small slowly moving conveyor which will carry the heaters to a desired assembly location.

The foregoing general statement of the successive operations involved in the making of complete heater elements will afford an idea of the functioning of the machine of the present invention, one structural embodiment of which is illustrated in the accompanying drawings. Referring now to Figure 1, the machine shown comprises a generally cubical hollow casing 10 which forms a base for the machine, and within this casing 10 are disposed certain actuating and drive mechanisms (later described in detail) while the top of the casing 10 is covered by a top plate 11 upon which the operation performing components of the machine preferably are assembled. In the drawings, Figure 1 will serve and be used as a reference illustration showing the assembled relation of the several mechanisms of the machine while the remaining figures each illustrate a particular mechanism or part thereof.

Before proceeding with a description of any of these, however, some further description of the general machine is in order. Thus, there is shown in Figure 1 a large drive wheel 12 arranged to be driven in a counter-clockwise direction by a suitable motor (not shown). This wheel 12 is mounted on a generally horizontal shaft 13 journaled in the casing 10 (the end of which may be seen in Figure 1), and on this shaft 13 and within the casing 10 there is mounted a series of cams each designed and operable to actuate a cam follower as hereinafter set forth. One revolution of the shaft 13 and the cams thereon operates to perform one complete cycle of operation of the machine.

Starting now at the beginning of a cycle of operation, the heater wire W from its reel R is held by a pair of jaws 14 and 15 and, as seen in Figure 7, these jaws 14 and 15 are respectively a part of one of a pair of relatively superimposed bars 16 and 17 which overlie the top plate 11 and extend rearwardly from the front edge thereof. The jaws 14 and 15 normally are maintained open or relatively separated by means of a spring 18 (Figure 8) which is connected between the bars 16 and 17 and operates to urge them in respectively opposite direction relative to each other. Closing of the jaws 14 and 15 is effected by means of a vertical wedge pin 19 arranged as shown to engage between and sep-

arate the downturned rear ends 20 and 21 respectively of said bars 16 and 17, thus causing relative movement of the latter in opposition to the spring 18 and thereby closing said jaws 14 and 15 upon each other, the pin 19 being actuated by a suitably configured disk cam 22 mounted on and driven by the shaft 13. Preferably jaws 14 and 15 are provided with leather facing pieces (not shown) to prevent damage to the wire W. As shown in Figure 10, the free end portion of the wire W projects a short distance from the jaws 14 and 15 when the latter are closed thereon at the start of the cycle.

To draw the wire W from the reel R, a gripper 23 is provided, and the relation of this gripper 23 to the jaws 14 and 15 is shown in Figures 6, 10 and 11, while the particular construction thereof is shown in detail in Figures 1 and 5. The gripper 23 comprises a pair of fingers, preferably of spring material having a tendency to open said fingers, and this gripper and the associated parts of their assembly is mounted in a channelled block 24. Thus, as shown in Figures 1 and 5, there is fitted into the channelled block 24 a first slide 25 arranged for longitudinal movement and having at one end a yoke 26 through which pass the fingers of the gripper 23. At its other end the slide 25 is provided with a pair of projections 27 and 28 into which extends the head 29a of an operating or actuating arm 29. In front of the slide 25, there is fitted a second slide 30 which supports the closed or base end 23a of the fingers of gripper 23 by means of a stud 31. Both the block 24 and the slide 25 are provided at their central portions with elongated slots 24a and 25a, respectively, and the stud 31 extends through these slots and is secured in a nut 32 at the front face of the block 24, the stud 31 being of such length as to permit of ready relative sliding movement of both of the slides 25 and 30 on the block 24. To limit movement of the slide 30, two relatively adjustable spaced stops 33 and 34 are provided and these lie in the path of movement of the nut 32 thus serving to limit movement thereof and consequently movement of the slide 30 and of the gripper 23. In order to control opening and closing of the fingers of gripper 23, the fingers of said gripper are each provided with an outwardly offset portion 35 located between the base end 23a thereof and the free ends as shown in Figure 5.

Operation of the gripper mechanism is as follows: In Figure 5 the gripper fingers are shown in the open position corresponding to the position thereof in Figure 10, and upon rotation of the shaft 13 a suitably configured cam 36 thereon actuates a follower 37 which, in turn, operates through a shaft 38 to cause the arm 29 to rotate in a clockwise direction against the action of a spring 39 which continuously urges the follower 37 against said cam 36. Thus, rotation of the arm 29 in a clockwise direction as viewed in Figure 5, causes the slide 25 to be moved to the right carrying with it the gripper 23, slide 30, stud 31 and nut 32. During this movement, the gripper 23 will, of course, remain in open position and this movement continues until the nut 32 engages stop 34, whereupon movement of the slide 30 and gripper 23 ceases. This position corresponds to that shown in Figure 11 wherein the fingers of gripper 23 are positioned at respectively opposite sides of the free end of the wire W but with the fingers still open. Further movement of arm 29 in the same direction will now cause the slide 25 to move further to the right

relative to slide 30 and gripper 23 with the result that the yoke 26 on slide 25 also moves relative to the gripper 23 until said yoke reaches the finger offset portions 35, at which time still further movement of slide 25 moves the yoke 26 thereon over said offsets 35 thereby closing the fingers of gripper 23 upon wire W to securely grip the free end thereof.

After the free end of wire W has been gripped by the gripper 23 as just described, clockwise movement of the arm 29 ceases and after a short pause, because of a dwell provided in the contour of cam 36, counterclockwise movement of said arm 29 will begin. During the aforesaid pause in the movement of the arm 29, the cam 22 operates to permit wedge pin 19 to move out from engagement between the rear ends 20 and 21 of the arms 16 and 17 thereby causing spring 18 to open jaws 14 and 15 and release the wire W from said jaws (see Figure 7).

Upon release of the jaws 14 and 15 from the wire W, the cam 36 causes the arm 29 to move in a counterclockwise direction with reference to Figure 5, and this in turn causes the slide 25, and the slide 30 and gripper 23 carried thereby, to move toward the left thereby drawing said wire W from its reel R and across the front of the machine as shown in Figure 12. This leftward movement will continue uniformly until the nut 32 engages the other limit stop 33 and, at this time, the configuration of cam 36 causes the arm 29 to again pause in its movement so that a wire transfer mechanism, hereinafter described, may be brought into position and caused to grip the wire W closely adjacent the point at which it is held by the gripper 23.

Following this second pause, the arm 29 again moves in a counterclockwise direction for a short distance and, during the accompanying movement of the slide 25 toward the left, the slide 30 and gripper 23 are held against movement by engagement of the nut 32 with the stop 33 with the result that there is no relative movement between the gripper 23 and the yoke 26 on slide 25 until said yoke has moved clear of the outwardly offset finger portions 35, thereby permitting the fingers to open and release the end of the wire W. Movement of arm 29, as described, preferably is effected by suitably shaping the disk cam 36 in accordance with conventional practice, and the pauses in the movement of said arm 29 can be obtained by providing circular peripheral edge portions or dwells on cam 36 as desired.

Turning now to the wire transfer mechanism, it will be recalled from Figure 12 that the end of the wire W is transferred from the grippers 23 to a winding head generally designated 40. This is accomplished by mechanism best illustrated in Figures 1, 3 and 9 of the drawings, and referring to Figure 3, the winding head 40 is of generally rectangular shape and carries spaced forwardly projecting winding fingers 41 and 42. Forming a wire holding clamp at one end of the head 40 is a pair of L-shaped spring clamp members 43 and 44 respectively secured to the head with their short legs 45 and 46 extending in coplanar relation across one end of said head so that they are spring urged toward and into closing engagement with each other.

Closing and opening of these legs 45 and 46 is effected by a U-shaped slide member 47 provided with sloping cam faces 48 and 49 on the extremity of each of its legs. As shown in Figure 3, this slide member 47 extends transversely around the end of the head 40 with its leg por-

tions underlying the clamping members 43 and 44 in such fashion that when said slide 47 is in its forward position (Figure 3) the legs 45 and 46 are open, and when the slide 47 is in its rear position (Figure 4b) the clamp legs will be closed. Movement of slide 47 between its forward and rearward positions is limited by means of stop pins 50 which engage within slots 51 in the legs of said slide 47.

Two separate mechanisms are provided to actuate the slide member 47—one for closing the clamp legs 45 and 46, and the other for opening them. The mechanism for closing the clamp legs 45 and 46 comprises an arm 52 arranged to lie adjacent the slide 47 when the winding head 40 is in the horizontal position indicated in Figure 3. This arm 52 has a hooked forward end 53 and, as shown in Figures 1 and 9, said arm 52 extends above the top plate 11 to a pivot 54 carried by a link 55 which is in turn pivoted at 56 to said top plate 11, the arm 52 being normally urged in a generally forward direction (Figures 1 and 9) against a fixed stop finger 57 and a fixed stop 58 on plate 11, by means of a spring 59. To actuate the arm 52 there is provided on the shaft 13 a cam 60 and a cooperating follower 61, the free end of which is engaged with the rear end of said arm 52, as shown in Figure 9, so that when the follower 61 is moved by the cam 60 the arm 52 will be drawn generally rearwardly. However, the initial movement of arm 52 will be rotary in a clockwise direction about the pivot 54 in such manner as to cause the hooked end 53 of arm 52 to engage a lip 62 on the slide member 47. Thereafter, rearward motion of the arm 52 resulting from the action of follower 61 will serve to draw the sloping cam faces 48 and 49 of slide 47 from beneath the clamp members 43 and 44 thereby permitting their legs 45 and 46 to close.

The foregoing operation of the wire transfer mechanism takes place during the second dwell in the operation of the gripper mechanism, and this may be reviewed as follows with special reference to Figure 12 of the drawings. Thus, after the grippers 23 have drawn the wire W across the face of the machine in front of the head 40, the grippers 23 dwell, and by means of suitable mechanism hereinafter described, the head 40 is then advanced toward the wire so that the latter lies beneath the forwardly projecting fingers 41 and 42 and between the open spring clamp legs 45 and 46 as shown. The arm 52 is then actuated as above described to cause the clamp legs 45 and 46 to grip the wire W, after which the gripper 23 is released from engagement with the wire in the manner previously described.

The condition of the apparatus at this time is such that the wire folding or winding operation may be undertaken. This operation is illustrated diagrammatically in Figure 13, while Figures 1 and 2 show the driving linkages for controlling the winding mechanism. Thus, on plate 11 there is provided a housing 63 which supports a hollow tubular spindle 64 provided with relatively fine threads 65 at its rear end and, while the spindle 64 is rotatably journaled in said housing 63 the arrangement is such that the spindle 64 may be moved axially relative to the housing 63. Extending upwardly through a slot 66 in the top plate 11 is a carriage member 67 which is in threaded engagement with the threads 65 on the spindle 64, and this carriage member 67 is arranged for movement in a direction parallel to the axis of the spindle 64. To this end the carriage member 67 is provided with a rearwardly

extending slotted arm portion 68 slidably disposed at the underside of the top plate 11, and to actuate this arm 68 and, of course, carriage 67, a cam 69 is mounted on the shaft 13 and arranged to actuate a follower 70 positioned between said cam 69 and the rearward end of the arm 68 with the upper end 71 of said follower 70 in the slot 72 of said arm 68.

As previously stated, the spindle 64 is hollow or tubular and slidably mounted within said tubular spindle 64 is a shaft 73 of greater length than the spindle so that one end of said shaft 73 projects rearwardly beyond said spindle. Secured on this rearwardly projecting portion of shaft 73 is a collar 74 between which and the rear end of the spindle 64 is disposed a compression spring 75 which serves to urge the shaft 73 rearwardly with respect to the spindle 64, rearward movement of said shaft being limited by means of a plate 76 carried at the forward end of the shaft 73 and arranged to reside in a recess 77 provided in the front face of the winding 40 (see Figure 3).

As shown in the drawings, the winding head 40 is secured on the forward end of the spindle 64, and the cam 69 is suitably contoured so that the carriage 67, spindle 64 and shaft 73 may be caused to move axially as a unit so that the winding head 40 may be accurately positioned relative to the wire W. In addition, and apart from movement of the carriage 67 and its arm 68, the spindle 64, the head 40 thereon, and shaft 73 may be moved axially relative to the carriage 67 by causing said spindle 64 to rotate, with the result that rotation of its threaded portion 65 in said carriage 67 serves to advance or retract said spindle 64, head 40, and shaft 73 with respect to the carriage 67 and the machine as a whole.

For rotating the spindle 64 there is mounted at the rear end of the shaft 13 a barrel cam 78 having a suitably shaped channel 79 in which rides a roller 80 carried by a yoke 81 that is pivoted on the casing 10 as at 82. Extending across the front face of the casing 10 and pivotally mounted therein as at 83 is an arcuate rack 84, and this rack 84 is interlocked with the yoke 81 by an adjustable stud 85 so that oscillation of the yoke 81 by the barrel cam 78 operates to cause a corresponding oscillation of said rack 84. The rack 84 meshes with a pinion 86 on a shaft 87 which also carries a drive gear 88 meshed with a pinion 89 carried by and driving a shaft 90 on which is mounted a larger gear 91 meshed with a drive pinion 92 on the spindle 64.

More particularly, after the wire transfer mechanism previously described has been operated to transfer the free end of the wire W from the gripper 23 to the winding head clamps 45 and 46, the spindle 64 is rotated by driving the gear 92 thereby to fold the wire about the winding fingers 41 and 42 as shown in Figure 13. During this rotation the carriage 67 remains stationary and the spindle 64 and its winding head 40 are moved slightly rearwardly with each revolution thereof by virtue of the engagement of the threads 65 with the threads on said carriage 67 so that the turns of the heater wire wound on the fingers 41 and 42 will be spaced along the latter as illustrated.

After the desired number of revolutions of the spindle 64 have been made, the barrel cam 78 and the rack 84 and its associated drive will pause, thereby stopping rotation of the spindle 64 and head 40, at a time that the said winding head 40 is in a horizontal position and with the wire clamp members 45 and 46 disposed at the side of the

spindle 64 remote from the gripper 23 and toward jaws 14 and 15. This, of course, is done in order that both of the end legs of the heater and their lead wire portions 4a will extend in the same direction from the same end of the head 40 (see Figures 6 and 14).

To maintain the winding head 40 in the aforesaid horizontal position, an indexing arrangement is provided, and to this end there is mounted adjacent the rear end of the housing 63, a short shaft 93 which extends crosswise of the spindle 64 and carries a forwardly extending arm 94 provided with depending beveled end 95. The shaft 93 also carries a rearwardly extending arm 96 having an adjustable pin 97 in its free end. Now, in order to rock the arm 94 into and out of engagement with the spindle gear 92, a lift plate 98 is provided, and this plate is actuated by a suitable cam 99 mounted on the shaft 13, a pin follower 100 working between cam 99 and the lift plate 98, serving to raise and lower the latter in response to the configuration of the cam 99. The lower end of the adjustable pin 97 rests upon the upper face of plate 98 and, therefore, motion of the latter by pin 100 serves to actuate arm 96 and, in turn, arm 94, which is normally urged away from the gear 92 by a spring 101. Thus it will be evident that when it is desired to maintain the winding head 40 in a horizontal position, while the spindle 64 is moved longitudinally of its axis in either direction, the arm 94 may be actuated by cam 99 into engagement with the teeth of the gear 92 thereby to prevent rotation of the spindle 64 and index the head 40 (see Figure 2). The times during the operating cycle of the machine when this indexing mechanism is operated are noted hereinafter.

Having thus described the winding operation of the machine, attention is now directed to the wire cleaning apparatus by which the coating of insulation on the wire W may be cleaned from a short portion or length thereof to provide for the convenient connection of the heater to the tube pins 5. This operation is diagrammatically shown in Figure 14 and has been generally described as the action of a vibrating mallet 102 upon an anvil 103 which has been positioned beneath the wire W. The structural details of this mechanism are shown in Figure 6 while the relation of this part of the apparatus to the whole machine is illustrated in Figure 1.

Referring now to Figure 6, a housing block 104 is positioned on the top plate 11 adjacent and parallel to the previously described spindle housing 63. These housings 104 and 63 are independent of each other and the housing 104 preferably is adjustable laterally with respect to said housing 63. As shown, the upper face of housing 104 is grooved as at 105 and provided with a cover plate 106 thereby forming an enclosed channel through which slidably extends an arm 107. This arm 107 is disposed parallel to the spindle 64, and at its rear end has a depending projection 108 arranged for engagement by a follower 109 which is actuated by a cam 110 mounted on the shaft 13, said cam 110 being suitably contoured to actuate the follower 109 and effect longitudinal movement of arm 107 in a manner hereinafter described. The arm 107 is biased forwardly toward the front of the machine by means of a relatively strong spring 111 connected between the housing 104 and said arm 107, said spring 111 serving also to maintain the follower 109 in contact with the cam 110.

Adjacent its forward end, arm 107 carries a

slide member 112 having a cover plate 113, and when the arm 107 is in its rest position (see Figure 6), the slide 112 is spaced forwardly of the housing 104 as shown. The forward end of arm 107 is formed to provide forwardly extending spaced fingers 114 and 115, between which extends a vertically disposed anvil block 116 carried by the head portion 117 of slide 112 and the block 116 is provided with laterally projecting extensions 118 having cam faces 119 at the underside thereof and arranged to cooperate with corresponding cam faces 120 on said fingers 114 and 115. The anvil block 116 at its lower end carries the rearwardly extending anvil 103 previously mentioned.

The anvil block 116 also has a vertical channel 121 formed in its rear face to receive the mallet 102 which is vertically slidable therein and slidably supported upon a pin 122 that extends generally horizontally from the armature 123 of a vibrator 124 mounted on the housing cover plate 106. The slide 112 is urged continuously toward the housing 104 by a relatively weaker spring 125 connected between housing 104 and slide 112, but it will be noted that movement of the slide 112 under the influence of spring 125 normally is prevented by virtue of the interlock between slide 112, anvil block 116 and fingers 114 and 115 of arm 107.

Having thus described the structure of the wire cleaning apparatus the operation thereof may now be considered. At the time in the rotation of shaft 13 when the cam 110 operates to move arm 107 toward the rear, the slide 112 will move with the arm 107 during the first part of its rearward movement, that is until the slide 112 abuts the housing 104 and this initial movement of slide 112 will, of course, move the anvil 103 and mallet 102 into a position in which the wire W will extend between them. Further rearward movement of the arm 107 causes its fingers 114 and 115 to be drawn into the slide 112, movement of which is prevented by housing 104 and, relative movement of fingers 114 and 115 with respect to the slide 112 causes the anvil block 116 to be raised by operation of the cam faces 119 and 120. Thus, the anvil 103 is raised into underlying contact with the wire W.

During this movement, the mallet 102 moves with the slide 112, its upper end sliding along the length of the pin 122, and at this time the vibrator 124 is energized by the closing of a suitable switch comprising a contact piece 126 which connects or bridges a pair of contact pins 127, 128 when the arm 107 has reached the limit of its rearward movement, the contact 126 being carried by arm 107 and the pins 127, 128 being mounted upon cover 106 of housing 104. The electrical circuit of the vibrator is shown in Figure 1 and it will be understood that the lead wires a and b will be connected to a suitable source of electricity for the vibrator.

As stated hereinbefore, the insulation of the wire W is preferably of a frangible material and accordingly the operation of vibrator 124 causes the mallet 102 to hammer the wire upon the anvil 103 thereby breaking the insulation from the wire for such length thereof as is engaged by the vibrating mallet 102. After the electrical circuit has been completed momentarily, operation of the cam 110 will move the arm 107 forwardly to restore all of the parts to the position shown in Figure 6. If desired, the anvil 103 and mallet 102 may be cleaned of insulation by suitable spring members 129 supported by a bracket 130

so that they extend through an opening 131 in anvil block 116 to a position where their free ends will scrape the anvil 103 and mallet 102 during return movement of the arm 107. It is desirable that during the aforementioned operation of the wire cleaning apparatus the jaws 14 and 15 should be closed so as to support the wire W, and these jaws should remain closed during the wire cleaning and subsequent operations of the machine.

In order to sever the wire heater which has been wound on the fingers 41 and 42 of the winding head 40, a scissors mechanism is provided, and this may be seen in Figure 1 just to the left of the winding head 40, the specific structure thereof being shown in Figure 7. The scissors mechanism is operated from still another cam 132 mounted on the shaft 13, and this cam 132 is arranged to cooperate with an L-shaped follower 133, the free end of which bears against the rear end of a slide member 134 that is fitted into a channel 135 in the lower surface of the housing 104 as indicated in Figures 1 and 6.

As shown in Figure 7, the forward end of the slide 134 is provided with spaced forked portions 136 and 137 to receive therebetween a second and smaller slide member 138. To the forward end of this slide 138 is pivoted a pair of scissors blades 139, 140 and each of these blades has therein an oblique arcuate slot 141, 142 adjacent its rear end, the said arcuate slots extending generally at right angles to each other as illustrated. Through these slots 141, 142, and through a corresponding slot 143 in the slide 138, there extends a pin 144 carried at the front end of the forked portion 136, 137 of slide 134. The slide 134 is urged continuously rearwardly by a spring 145 connected between said slide and a pin 146 on the top plate 11, while the slide 138 is urged continuously forwardly relative to slide 134 by another spring 147 acting between said slides 134 and 138. As shown in Figure 1, the scissors mechanism overlies the top plate 11 and, as shown in Figure 7, a screw 148, projecting from the front edge of said top plate 11, provides a stop against which a forwardly projecting extension 149 of the slide 138 is arranged to abut when the scissors mechanism is moved forwardly by the cam 132.

Considering now the operation of the scissors mechanism it will be observed from Figure 15 that at the time the scissors are operated the wire W will be held between jaws 14 and 15 and head 40. During the first part of the forward movement of the slide 134, slide 138 also moves forwardly under the influence of spring 147 and this motion continues until extension 149 of slide 138 abuts the stop 148, and this stop is adjustably positioned so that when engaged by the slide 138, the open scissors blades 139, 140 extend above and below the wire W. Further movement of the slide 134 (no movement of slide 138 taking place) causes the pin 144 to be carried forward and, by virtue of the slots 141 and 142, the scissors blades are caused to close upon and cut the wire W, the scissors mechanism being disposed relative to the wire cleaning mechanism so as to cut the wire centrally of the cleaned portion thereof in order that both sections of the severed heater wire W may have an end that is free of insulation. Rearward motion of slide 134 merely returns the scissors mechanism to the rest position shown in Figure 7.

The foregoing operations have provided a complete folded heater winding and all that remains to be done is to remove the completed heater

winding from the fingers 41 and 42 of head 40. In this connection, it will be recalled that one end of the heater wire is still secured to the winding head 40 by the clamp members 45 and 46. Hence, it is necessary to open these members 45 and 46, and this is accomplished by causing the slide member 47 to move forwardly on the head 40. Referring to Figure 4b, the slide 47 is shown in its rearward position and immediately behind this slide is the forward end of a bar 150 carried by the slide 134 of the scissors mechanism (see Figure 7). Accordingly, upon actuation of the scissors mechanism by its cam 132, the bar 150 is moved forwardly into engagement with the rear face of the lip 62 of slide 47 thereby moving said slide 47 forwardly to open the clamp members 45 and 46 thus releasing the wire W. (See also Figure 3.)

Removal of the heater winding from the fingers 41 and 42 is depicted in Figure 16, and referring also to Figure 3, as previously stated the winding head 40 has therein a recess 77 in which normally resides the plate 76 carried at the front end of the shaft 73 which is slidably mounted within spindle 64. The rear end of shaft 73 extends into a sleeve 151 arranged for actuation by a cam 152 acting through a suitable follower 153. The cam 152 is mounted on the shaft 13 and the follower 153 is provided at its free end with an adjustable link 154, the arrangement being such that the spring 75 normally maintains plate 76 within its recess 77 in the front face of head 40 as previously described.

Referring again to Figure 3, the two winding fingers 41 and 42 are mounted on the head 40 as shown in Figures 4a and 4b, respectively, the finger 42 being pivotally mounted in a slot 155 in the side of head 40 by means of a vertical pin 156, and a small spring 157 tends to rotate this finger 42 in a clockwise direction although such rotation of the finger normally is prevented by contact thereof with the plate 76. It will be observed, however, that the width of finger 42 is reduced at its inner edge forwardly of plate 76 so that upon forward movement of said plate 76 relative to head 40, upon actuation of shaft 73 by cam 152, the spring 157 causes a slight rotation of finger 42 about its pivot 156. As shown in Figure 4b finger 41 is secured in a small mounting block 158 positioned in a recess 159 in the other end of the head 40 immediately behind the plate 76, and this block 158 is held in position by means of a set screw 160 in such manner that it may be adjusted laterally of head 40 by virtue of a slot 161a provided in plate 76.

Now to remove the completed heater winding from the fingers 41 and 42, cam 69 holds the carriage 67 and spindle 64 against movement while the cam 152 actuates the shaft 73 and plate 76 forwardly relative to spindle 64 and head 40. Upon movement of the plate 76 forwardly out of its recess 77 the finger 42 is permitted to rotate slightly about its pivot 156 as above described, thereby releasing the tension on the courses of the heater winding with the result that further forward movement of said plate 76 operates to push or eject the winding from the fingers 41 and 42.

After the winding has been thus ejected from the fingers 41 and 42, the cam 152 operates to allow spring 75 to move the shaft 73 rearwardly relative to spindle 64 and return plate 76 into its recess 77 in the winding head 40, after which cam 69 operates through its follower 78 to move rearwardly the carriage 67, spindle 64 and head 40, as

well as shaft 73 and its plate 76, to their initial positions with the head 40 removed from the path of the gripper 23 so that the latter can again be advanced to draw a portion of the wire across the machine. Also at this same time, the cam 78 operates to return the rack 84 which causes the spindle 64 to be rotated within the carriage 67 thereby moving the spindle 64 rearwardly with respect to the said carriage so that the spindle 64 is reset for the next heater winding operation.

The timing of the foregoing mechanisms and the operations performed thereby for one complete cycle of operation of the machine are diagrammatically shown in the chart of Figure 19 of the drawings, and briefly summarizing the several operations and their relation to each other with reference to said chart, it will be seen that at the start of each cycle the jaws 14 and 15 (line A, Figure 19) are closed upon wire W the end of which projects a short distance therefrom. The gripper 23 (line B) which is open now advances from the position shown in Figure 10 toward the jaws 14 and 15 where they close upon the end of wire W (see Figure 11). The jaws 14 and 15 (line A) then open and the gripper 23 is returned to its original position carrying with it the wire W which is drawn from its reel R. Upon return of the gripper 23 with wire W to its original position, the spindle 64 and its head 40 is moved axially forward (line C) to position said head 40 adjacent the wire W with the head fingers 41 and 42 overlying said wire, the spindle 64 being held against rotation by arm 94 (line D) with the head 40 horizontally disposed. As the head 40 advances to this position the clamps 45 and 46 (line E) are open and assume positions respectively above and below the wire W (see Figure 12).

At this point arm 52 operates to close clamps 45 and 46 on wire W following which grippers 23 open and release their hold on the wire, after which the spindle 64 is driven through its gear 92 in a counterclockwise direction (see Figure 13) to wind the wire W in a plurality of parallel courses about the fingers 41 and 42 (line F). In this connection it is pointed out that before rotation of the spindle 64 and head 40, the indexing arm (line D) is disengaged from the said gear 92, and as the spindle 64 rotates the threads 65 thereon cooperate with the threads in carriage 67 to slowly advance the spindle and head 40 rearwardly so that the course of wire wound on the fingers 41 and 42 are disposed successively adjacent one another forwardly on said fingers 41 and 42.

Rotation of the head 40 as described continues until the desired number of wire courses are wound thereon, and also until the head reaches a horizontal position with the clamps 45 and 46 remote from gripper 23 and adjacent the jaws 14 and 15 (see Figure 14), at which time the indexing arm 94 (line D) engages gear 92 to hold the spindle 64 and head 40 in such position.

Upon indexing of the head 40, as aforesaid, the cam 110 moves arm 107 rearwardly thereby positioning the anvil 103 and mallet 102, respectively, beneath and above the wire W (line G). Continued movement of arm 107 causes switch contact 126 to close upon pins 127, 128 thereby energizing vibrator 124 to actuate mallet 102 against the wire W upon anvil 103 to clear the insulation from a portion of the length of the wire, after which the anvil 103 and mallet 102 are rendered inoperative and returned to their initial position removed from wire W.

At this time cam 132 operates to move scissors

139, 140 (line H), which are open, to positions respectively above and below the wire W. To accomplish this, cam 132 actuates the slide 134 forwardly, and this carries with it the slide 138 which moves with slide 134 until the forward end 149 of slide 138 engages the screw stop 148, whereupon continued forward movement of the slide 134 operates through the pin 144 to cause the scissors 139, 140 to close and cut the wire W.

Also, at the same time the bar 150, carried by slide 134, engages the rear face of the lip 62 of slide 47 actuating the latter forwardly to open the clamps 45 and 46 (line E) and release the wire W previously held therein.

After opening of the clamps 45 and 46, the shaft 73 and its front plate 76 (in the recess 77 of head 40) are actuated axially forward with respect to the spindle 64 and head 40 (line I) by cam 152 which operates through its follower 153 thereby causing said plate 76 to eject or push the wound heater element outwardly off of, or from, the fingers 41 and 42 on head 40. The shaft 73 and plate 76 are then returned under the action of spring 75 to reseat said plate 76 in the recess 77 of head 40 and the cam 69 then operates to move the carriage 67 and head 40 and spindle 64, as well as the shaft 73 and its plate 76, rearwardly of the machine so that the head 40 is removed from the path of advance of the gripper 23 which now is about ready to again move toward the jaws 14 and 15 and draw another portion of the wire W across the face of the machine to produce another heater winding element in accordance with the foregoing operation.

Coincident with retraction of the spindle 64 and carriage 67, together with their associated elements, the barrel cam 78 operates to cause the rack 84 to move in the reverse direction with the result that the gear 92 and spindle 64, together with its head 40, are rotated in a clockwise direction, with respect to the drawings (line F), thereby to reset the head 40 for the next winding operation and position the clamps 45 and 46 adjacent the retracted position of gripper 23 ready to receive therefrom the next portion of the wire W drawn into the machine by said gripper 23. In this connection it is pointed out that during this clockwise rotation of spindle 64 the threads 65 thereon cooperate with the threads in carriage 67 slightly to advance the spindle and head relative to carriage 67 and return the same to the position that they occupied prior to the slight rearward movement thereof that occurs during counterclockwise winding rotation thereof and which is provided for the purpose of laying the several wound courses of wire successively adjacent one another outwardly along the fingers 41 and 42 of the head 40.

The above described method and machine makes possible the manufacture of vacuum tube heater elements completely automatically and in actual operation it has been found readily possible to manufacture in one hour as many as 400 heater elements each having 16 legs, or courses. Production at this rate is approximately eight times that of a skilled operator working with the best known methods that existed prior to the present invention.

It will be understood also that the several dimensions of heater elements made by the present machine may be readily varied by simple adjustments thereto. For example, the length of the legs, of courses, of the heater element may be varied by adjusting the spacing of the winding fingers 41 and 42 by adjustment of the mounting 158

in the head 40 as previously described (see Figure 4b). Also the number of legs on heater winding may be varied by the adjustment of stud 85 in the slot of rack 84 so as to vary the driving ratio between the yoke 81 and said rack 84. Still further, the length of lead wires of the heater elements may be varied by adjusting the spacing between the spindle housing 63 and the scissors mechanism housing 104, the latter being adjustably mounted on plate 11. Still other adjustments, of course, are within the skill of those working in the art of machine design.

While a particular embodiment of the invention has herein been illustrated and described, it is not intended that the invention be limited to such disclosure but that changes and modifications may be made therein and thereto within the scope of the annexed claims.

I claim:

1. In a machine of the character described, a wire feeding mechanism comprising a support, a first member slidably carried by said support, a yoke on said first member adjacent one end thereof, a gripper having a pair of resilient normally open fingers extending outwardly through said yoke and slidable with respect thereto, said fingers being provided with outwardly offset portions for cooperation with the yoke, a second member slidable with respect to both said support and said first member, a pin connecting the base end of said gripper to said second member and extending through slots in the first member and in the support, a block secured on said pin at the opposite side of the first member from said gripper, actuating means operable to move the first and second members and the gripper as a unit relative to said support in one direction to project said gripper, a stop member positioned for engagement by said block to limit movement of the second member and the gripper relative to the support while permitting the actuating means to continue to move the first member in said one direction relative to the support and the second member and said gripper, thereby to cause the yoke on said first member to engage the offset portions of the gripper fingers to close the latter, the said actuating means thereafter further operating to move the first member, the second member and said gripper as a unit in the reverse direction to retract the gripper, a second stop member positioned for engagement by the block to limit said reverse movement of the second member and said gripper while permitting the actuating means to continue to move the first member in said reverse direction a distance sufficient to disengage its yoke from the offset portions of the gripper fingers thereby opening the latter.

2. In a machine of the character described, a winding head assembly comprising a tubular spindle mounted for rotation, a winding head secured at one end of said spindle, a pair of spaced fingers projecting from the outer face of said winding head and arranged to receive a winding of wire thereon, a shaft slidably journaled in the tubular spindle, a plate secured at the winding head end of said shaft and arranged to seat within a recess in the outer face of said winding head between the fingers thereof; drive mechanism operable to rotate said spindle, head, fingers, shaft and plate in one direction through a predetermined number of revolutions to wind a wire on said fingers; and means operable after completion of rotation of the spindle, head shaft and plate to first move said shaft axially with respect

to the spindle, head and fingers thereby to actuate the plate outwardly of its recess in said head to discharge a winding of wire from said fingers and then to move the shaft in the reverse direction to reseat the plate in said recess.

3. A construction as claimed in claim 2 wherein one of the winding head fingers is spring biased so that its projecting portion is urged radially inward of said head and is held in position against said bias by the plate when seated in the recess of the winding head, the construction and arrangement of said finger and plate being such that upon actuation of the plate outwardly of said recess, the finger is permitted to move inwardly a slight distance under the action of said spring bias.

4. In a machine of the character described, a wire cutting mechanism comprising first and second relatively telescoping extensible slide members, spring means tending to maintain said slide members in a relatively extended position, a pair of scissor elements pivoted intermediate their ends to each other and to said second slide member, the rear end portions of said scissor elements each having a slot therein arranged in generally opposite directions with respect to each other, and said second slide member having a slot therein adjacent the slots in said scissor elements, a pin secured in and carried by the first slide member and extending through the slot in the second slide member and the slots in said scissor elements, cam actuated means operable to move the first and second slide members as a unit in their extended relation in one direction, and a stop member engageable by the second slide member to limit movement thereof while permitting said cam actuated means to continue to move the first slide member in said one direction relative to the second slide member and to position said members in contracted relation with respect to each other, the construction and arrangement of the slots in the scissor elements and the slot in the second slide member being such that when the first and second slide members are in said relatively extended position the pin carried by the first slide member cooperates with said slots to maintain the scissor elements separated, and when the first and second slide members are actuated to said relatively contracted position the pin carried by the first slide member cooperates with said slots to close the scissor elements with respect to each other.

5. In a machine of the character described, a wire feeding mechanism operable to grip the end portion of a wire and draw a portion of the length of said wire across the machine, a rotatable winding head positioned adjacent the wire feeding mechanism and mounted for reciprocation in a direction perpendicular to the wire drawn across the machine by said wire feeding mechanism, a normally open clamp at one end of the winding head, mechanism for advancing said winding head to a position adjacent a wire drawn across the machine by the wire feeding mechanism with said clamp positioned to grip said wire, a member operable to close said clamp on the wire, and drive mechanism operable to rotate the winding head and wind the wire thereon in a predetermined number of successive substantially parallel courses.

6. In a machine of the character described, a wire feeding mechanism operable to grip the end portion of a wire and draw a portion of the length of said wire across the machine, a rotatable winding head positioned adjacent the wire feeding

mechanism and mounted for reciprocation in a direction perpendicular to the wire drawn across the machine by said wire feeding mechanism, a normally open clamp at one end of the winding head, mechanism for advancing said winding head to a position adjacent a wire drawn across the machine by the wire feeding mechanism with said clamp positioned to grip said wire, a member operable to close said clamp on the wire, drive mechanism operable to rotate the winding head and wind the wire thereon in a predetermined number of successive substantially parallel courses, wire cutting means operable upon completion of the winding operation to sever the wire at a point adjacent the winding thereof on the head, and means operable to discharge the winding of wire from said head after severance of the wire by said cutting means.

7. In a machine of the character described, a wire feeding mechanism operable to grip the end portion of a wire and draw a portion of the length of said wire across the machine, a rotatable winding head positioned adjacent the wire feeding mechanism and mounted for reciprocation in a direction perpendicular to the wire drawn across the machine by said wire feeding mechanism, a normally open clamp at one end of the winding head, mechanism for advancing said winding head to a position adjacent a wire drawn across the machine by the wire feeding mechanism with said clamp positioned to grip said wire, a member operable to close said clamp on the wire, drive mechanism operable to rotate the winding head and wind the wire thereon in a predetermined number of successive substantially parallel courses, wire cutting means operable upon completion of the winding operation to sever the wire at a point adjacent the winding thereof on the head, means operable to discharge the winding of wire from said head after severance of the wire by said cutting means, and wire holding means adjacent the opposite side of said winding head from the wire feeding mechanism, said holding means normally engaging said wire and being operable to release the wire subsequent to gripping thereof by said wire feeding mechanism and to reengage the said wire just prior to operation of the wire cutting means.

8. A machine of the character described comprising wire feeding mechanism operable to grip a wire and draw a portion of the length of said wire across the machine, a rotatable winding head positioned adjacent the wire feeding mechanism and mounted for reciprocation in a direction perpendicular to the wire drawn across the machine by said wire feeding mechanism, a normally open clamp at one end of said winding head, mechanism for advancing the winding head to a position adjacent the wire drawn across the machine by the wire feeding mechanism with said clamp in position to grip said wire, a member operable to close said clamp on the wire, drive mechanism operable to rotate the winding head and wind the wire thereon in a predetermined number of successive substantially parallel courses, said drive mechanism being operable to stop rotation of the head when said predetermined number of courses have been wound thereon and when the clamp on said head is in a position opposite that of said clamp prior to rotation of the head, wire cutting means operable upon completion of the winding operation to sever the wire at a point adjacent the winding thereof on the head, a member carried by said cutting mechanism operable to engage

and open the clamp on the winding head and release its grip on the wire at the completion of the wire cutting operation, and a member operable upon opening of the winding head clamp to engage and discharge from the winding head the wire wound thereon, said winding head drive mechanism being operable upon discharge of the wire to rotate the winding head in a reverse direction to reset the same, and the said mechanism for advancing said head operating to retract the same.

9. A machine of the character described comprising wire feeding mechanism operable to grip the end portion of a wire and draw a portion of the length of said wire across the machine, a rotatable winding head positioned adjacent the wire feeding mechanism and mounted for reciprocation in a direction perpendicular to the wire drawn across the machine by said wire feeding mechanism, a normally open clamp at one end of the winding head, mechanism for advancing said winding head to a position adjacent a wire drawn across the machine by the wire feeding mechanism with said clamp positioned to grip said wire, a member operable to close said clamp on the wire, drive mechanism operable to rotate the winding head and wind the wire thereon in a predetermined number of successive substantially parallel courses, wire cutting means operable to sever the wire, and a member operable to discharge the wound wire from the winding head after the wire has been severed by said cutting means.

10. A machine of the character described comprising wire feeding mechanism operable to grip the end of a wire and draw a portion of the length of said wire across the machine, a rotatable winding head positioned adjacent the wire feeding mechanism and mounted for reciprocation in a direction perpendicular to the wire drawn across the machine by said wire feeding mechanism, a normally open clamp at one end of the winding head, mechanism for advancing said winding head to a position adjacent a wire drawn across the machine by the wire feeding mechanism with said clamp positioned to grip said wire, a member operable to close said clamp on the wire, drive mechanism operable to rotate the winding head and wind the wire thereon in a predetermined number of successive substantially parallel courses, wire cutting means operable to sever the wire, a member operable to discharge the wound wire from the winding head after the wire has been severed by said cutting means, and wire holding means adjacent the opposite side of said winding head from the wire feeding mechanism, said holding means normally engaging said wire and being operable to release the wire subsequent to gripping thereof by said wire feeding mechanism and to reengage the said wire prior to operation of the wire cutting means.

11. A machine of the character described comprising wire feeding mechanism operable to grip a wire and draw a portion of the length of said wire across the machine, a rotatable winding head positioned adjacent the wire feeding mechanism and mounted for reciprocation in a direction perpendicular to the wire drawn across the machine by said wire feeding mechanism, a normally open clamp at one end of the winding head, mechanism for advancing said winding head to a position adjacent the wire drawn across the machine by the wire feeding mechanism with said clamp in position to grip said wire, a member operable to close said clamp on the wire,

drive mechanism operable to rotate the winding head and wind the wire thereon in a predetermined number of successive substantially parallel courses, wire cutting mechanism operable to sever the wire, a member operable to engage and open the clamp on the winding head and release its grip on the wire at the completion of the wire cutting operation, and a member operable upon opening of said winding head clamp to engage and discharge from the winding head the wire wound thereon.

12. A machine of the character described comprising wire feeding mechanism operable to grip a wire and draw a portion of the length of said wire across the machine, a rotatable winding head positioned adjacent the wire feeding mechanism and mounted for reciprocation in a direction perpendicular to the wire drawn across the machine by said wire feeding mechanism, a normally open clamp at one end of said winding head, mechanism for advancing the winding head to a position adjacent the wire drawn across the machine by the wire feeding mechanism with said clamp in position to grip said wire, a member operable to close said clamp on the wire, drive mechanism operable to rotate the winding head and wind the wire thereon in a predetermined number of successive substantially parallel courses, said drive mechanism being operable to stop rotation of the head when said predetermined number of courses have been wound thereon and when the clamp on said head is in a position opposite that of said clamp prior to rotation of the head, wire cutting means operable to sever the wire, a member operable to engage and open the clamp on the winding head and release its grip on the wire at the completion of the wire cutting operation, and a member operable upon opening of the winding head clamp to engage and discharge from the winding head the wire wound thereon, said winding head drive mechanism operating upon discharge of the wire to rotate the winding head in a reverse direction to reset the same, and the said mechanism for advancing said head operating to retract the same.

13. A machine of the character described comprising a rotatable winding head, mechanism for engaging and positioning an end portion of a length of wire across said winding head, a clamp carried by the winding head arranged to grip the end portion of said wire and hold the same during rotation of said head, drive means for rotating the head to wind thereon a predetermined number of courses of the wire, cutting means operable to sever the wire, a member carried by said cutting mechanism operable to engage and open the clamp on the winding head and release its grip on the wire at the completion of the wire cutting operation, and means operable upon opening of the winding head clamp to engage and discharge from the winding head the wire wound thereon.

14. In a machine of the character described, a winding mechanism comprising a tubular spindle mounted both for rotation and for axial sliding movement, a winding head secured at one end of said spindle, a shaft slidably journaled in the tubular spindle, a plate secured at the winding head end of said shaft and arranged to seat within a recess in the outer face of said winding head, a spring biasing the spindle and shaft in respectively opposite directions normally to maintain said plate seated in the winding head recess, and cam actuated means operable with said spring to first move said shaft axially with

respect to the spindle and head and thereby actuate the plate outwardly of its recess in said head and then to cause said spring to move the shaft in the reverse direction to reseat the plate in said recess.

15. In a machine of the character described, a winding head assembly comprising a tubular spindle mounted both for rotation and for axial sliding movement, a winding head secured at one end of said spindle, a shaft slidably journaled in the tubular spindle, a plate secured at the winding head end of said shaft and arranged to seat within a recess in the outer face of said winding head, a normally open clamp carried by said winding head for gripping a wire, means operable to close said clamp upon a wire; and drive mechanism operable upon closing of the head clamp to rotate said spindle, head, shaft and plate in one direction for a predetermined number of revolutions to wind the wire thereon, means operable to cause a slight retraction of the spindle, head, shaft and plate during said rotation thereof; means for opening the head clamp upon completion of such rotation; means operable after opening of said head clamp to first move said shaft axially with respect to the spindle and head and thereby actuate the plate outwardly of its recess in said head and then to move the shaft in the reverse direction to reseat the plate in said recess.

16. In a machine of the character described, a winding mechanism comprising a tubular spindle mounted both for rotation and axial sliding movement, a winding head secured at one end of said spindle, a shaft slidably journaled in the tubular spindle, a plate secured at the winding head end of said shaft and arranged to seat within a recess in the outer face of said winding head, a spring biasing the spindle and shaft in respectively opposite directions normally to maintain said plate seated in the winding head and tending axially to advance said spindle and winding head together with said shaft and its plate; a first cam operated mechanism operable in at least one position to hold said spindle, winding head, shaft and plate in a retracted position against the action of said spring and in at least one other position to cause said spring to effect axial movement of the spindle, winding head, shaft and plate to an advanced winding position; and a second cam actuated mechanism operable with said spring in predetermined time relation with said first cam operated means to first move said shaft axially with respect to the spindle and head against the action of said spring and thereby actuate the plate outwardly of its recess in the head and thereafter to cause said spring to move the shaft in the reverse direction to reseat the plate in said recess.

17. In a machine of the character described, a winding mechanism comprising a tubular spindle mounted both for rotation and axial sliding movement, a winding head secured at one end of said spindle, a shaft slidably journaled in the tubular spindle, a member secured at the winding head end of said shaft and arranged to seat within a recess in the outer face of said winding head, a spring biasing the spindle and shaft in respectively opposite directions normally to maintain said member seated in the winding head and tending axially to advance said spindle and winding head together with said shaft and its member; a first cam operated mechanism operable in at least one position to hold said spindle, winding head, shaft and member in a retracted position against the action of said

spring and in at least one other position to cause said spring to effect axial movement of the spindle, winding head, shaft and member to an advanced winding position; drive mechanism operable to rotate said spindle, head, shaft and member in one direction for a predetermined number of revolutions, and a second cam actuated mechanism operable with said spring in predetermined time relation with said first cam operated means to first move said shaft axially with respect to the spindle and head against the action of said spring and thereby actuate the member outwardly of its recess in the head and thereafter to cause said spring to move the shaft in the reverse direction to reseat the member in said recess, said first cam mechanism then operating to cause said spring to move the spindle, head, shaft and member in a reverse direction to retract the same and the said drive mechanism operating simultaneously to rotate said spindle, head, shaft and member in the reverse direction to reset the same.

18. A machine as claimed in claim 17 wherein the spindle is provided with threads cooperable with a member to cause a slight retraction of the spindle, head, shaft and member during rotation thereof in said one direction for a predetermined number of revolutions and upon rotation of said spindle, head, shaft and member in the reverse direction to cause said spindle, head, shaft and member to move to their relative advanced position from the slightly retracted position to which moved by said threads during rotation in the first-named direction.

19. In a wire winding machine, a winding head, drive means for rotating said winding head to wind thereon a portion of a length of insulated wire in a predetermined number of courses with the ends of the winding extending outwardly in the same direction from the head, a housing adjustably mounted adjacent the winding mechanism for movement toward and away from said mechanism and having a plurality of channels therein extending parallel to the axis of rotation of the winding mechanism, wire cleaning mechanism operatively mounted in one of said housing channels for cleaning the insulation from a short portion of a length of wire leading to the winding of wire on the head, and wire cutting mechanism operatively mounted in another of said housing channels to sever the winding of wire from the remainder of the length thereof at a point within the portion of the length from which insulation was removed by said cleaning mechanism, adjustment of the position of said housing with respect to the winding mechanism effecting a corresponding adjustment of the positions of the wire cleaning and cutting mechanisms with respect to said winding mechanism to vary the length of the end lead portions of the winding of wire.

20. In a wire winding machine, a winding head, drive means for rotating said winding head to wind thereon a portion of a length of wire in a predetermined number of courses with the ends of the winding extending outwardly in the same direction from the head, mechanism for cleaning the insulation from a short portion of the length of wire leading to the winding on the head adjacent the latter, wire cutting mechanism adjacent the winding mechanism and positioned to sever the winding of wire from the remainder of the length thereof at a point midway the portion of the length from which the insulation has been removed by said cleaning

mechanism, and means for adjusting the position of said cleaning and cutting mechanism with respect to the winding mechanism to vary the length of the end lead line portions of the winding of wire.

21. In a wire winding machine, a winding head, drive means for rotating said winding head to wind thereon a portion of a length of insulated wire in a predetermined number of courses with the ends of the winding extending outwardly in the same direction from the head, a member mounted adjacent the winding mechanism and adjustable relative thereto, mechanism carried by said member for cleaning the insulation from a short portion of the length of wire leading to the winding on the head, wire cutting mechanism also carried by said member operable to sever the winding of wire from the remainder of the length thereof, and means for adjusting the position of said member to predeterminedly position the cleaning and cutting mechanism with respect to the winding mechanism thereby to vary the length of the end lead line portions of the winding of wire.

22. In a machine of the character described, a winding head mounted for axial sliding movement, a clamp carried by said head, a member engaging said clamp normally to hold the same in open relation, mechanism for moving said winding head axially in one direction to a predetermined winding position, and an element operable upon movement of the head to said winding position to engage and hold said member against movement with the head thereby disengaging the said member from the clamp to effect closing of the latter.

23. A machine of the character described comprising a rotatable winding head mounted for movement axially of its rotational axis, mechanism for engaging and positioning an end portion of a length of wire across the path of axial movement of said winding head prior to the start of each winding cycle, a normally open clamp carried by the winding head for gripping the end portion of said wire and holding the same during rotation of said head, mechanism operable to move said winding head axially to a position adjacent said positioned wire prior to each winding operation of the head, mechanism operable to cause said clamp to be closed upon the positioned wire, drive means for rotating the head to wind thereon a predetermined number of courses of the wire, cutting means operable to sever the wire at the completion of each winding head, and means operable to discharge the winding of wire from said head after the wire has been severed by said cutting means.

24. A machine for winding wire in a plurality of successive substantially parallel courses comprising a rotatable winding head having a pair of winding fingers thereon, mechanism for engaging and positioning an end portion of a length of wire across said winding head and adjacent said fingers thereon, a clamp carried by the winding head adjacent one of said fingers and operable to grip the end portion of said wire and hold the same during rotation of said head, and drive means for rotating the head to wind on the fingers thereon a predetermined number of successive substantially parallel courses of the wire, said drive mechanism being operable to stop winding rotation of the head when said predetermined number of successive parallel courses have been wound on the fingers thereof and when the clamp on said head is in a position diametrically oppo-

site the position of said clamp prior to the rotation of the head, so that the end lead portions of the winding extend outwardly from the head from the same end of the parallel courses of wire wound thereon.

25. In a machine for winding wire in a plurality of successive substantially parallel courses, a rotatable winding head having winding fingers thereon, mechanism for engaging and positioning an end portion of a length of wire across said winding head and adjacent its fingers, a clamp carried by the winding head operable to grip the end portion of said wire when positioned and hold the same during rotation of said head, drive means for rotating the head to wind on the fingers thereof a predetermined number of successive substantially parallel courses of the wire, said drive mechanism being operable to stop winding rotation of the head when said predetermined number of successive parallel courses have been wound on the fingers thereof and when the clamp on said head is in a position diametrically opposite the position of said clamp prior to winding rotation of the head so that the end lead portions of the winding extend outwardly from the head from the same end of the parallel courses of wire wound thereon, cutting means operable to sever the wire at the completion of the winding operation, and means comprising a part of the head operable to discharge the winding of wire from the fingers of said head.

26. In a machine of the character described, a rotatable winding head mounted for movement axially on its rotatable winding head mounted for movement axially on its rotational axis, spaced winding elements projecting from the face of said winding head, wire feed means operable to position a portion of a length of wire across the path of axial movement of the winding head, and mechanism operable to predeterminedly position said head rotationally and to axially move the same to a point adjacent the positioned wire with the winding elements of said head disposed crosswise of said wire.

27. In a machine of the character described, a rotatable winding head mounted for movement axially on its rotational axis, spaced winding elements projecting from the face of said winding head, a wire holding clamp on said head, wire feed means operable to position a portion of a length of wire across the path of axial movement of the winding head, mechanism operable to predeterminedly position said head rotationally and to move the same axially to a point adjacent the positioned wire with the winding elements of said head disposed crosswise of said wire, means operable to close said clamp on said wire, and means for rotationally driving the winding head to wind the wire about the winding elements thereon in a predetermined number of courses.

28. In a machine of the character described, a rotatable winding head mounted for movement axially on its rotational axis, a pair of spaced winding elements projecting from the face of said winding head, a normally open clamp on the winding head in substantial alignment with said winding elements, wire feed means operable to position a portion of a length of wire across the path of axial movement of the winding head, means for predeterminedly positioning said winding head rotationally with the winding elements thereof disposed in a plane substantially parallel to said wire, and mechanism operable to move the winding head axially to a point adja-

cent the wire with said winding elements disposed crosswise of the wire.

29. In a machine of the character described, a rotatable winding head mounted for movement axially of its rotational axis, spaced winding elements projecting from the face of said winding head, a normally open clamp on the winding head in substantial alignment with said winding elements, wire feed means operable to position a portion of a length of wire across the path of axial movement of the winding head, mechanism operable to predeterminedly position said head rotationally and to move the same axially to a point adjacent the positioned wire with the winding elements of said head disposed crosswise of said wire and with the clamp positioned to grip said wire, and means for rotationally driving the winding head to wind the wire about the winding elements thereon in a predetermined number of courses.

30. In a machine of the character described, a rotatable winding head mounted for movement axially of its rotational axis, spaced winding elements projecting from the face of said winding head, a wire holding clamp on said head, wire feed means operable to position a portion of a length of wire across the path of axial movement of the winding head, mechanism operable to predeterminedly position said head rotationally and to move the same axially to a point adjacent the positioned wire with the winding elements of said head disposed crosswise of said wire, means operable to close said clamp on said wire, and means for rotationally driving the winding head to wind the wire about the winding elements thereon in a predetermined number of courses.

31. In a machine of the character described, a wire transfer mechanism; means for actuating said transfer mechanism to draw a wire along a path across said machine; a rotatable winding head mounted for movement toward said path, said head including winding fingers projecting therefrom generally perpendicular to the path; and mechanism operable to predeterminedly position said head rotationally and to axially move the same to a point adjacent to, and with the winding elements of said head disposed crosswise of, said path.

32. A machine for winding wire in a plurality of successive parallel courses comprising a rotatable winding head having a pair of winding fingers thereon, mechanism for engaging and positioning an end portion of a length of wire across said winding head and adjacent said fingers thereon, a clamp carried by the winding head adjacent one of said fingers and operable to grip the end portion of said wire and hold the same during rotation of said head, drive means for rotating the head to wind on the fingers thereof a predetermined number of successive substantially parallel courses of the wire, said drive mechanism being operable to stop winding rotation of the head when said predetermined number of successive parallel courses have been wound on the fingers thereof and when the clamp on said head is in a position diametrically opposite the position of said clamp prior to the rotation of the head, so that the end lead portions of the winding extend outwardly from the head from the same end of the parallel courses of wire wound thereon, and wire holding means normally engaging the wire and being operable to release said wire subsequent to engagement thereof by said positioning mechanism and to reengage the wire at the finish of said winding rotation of the head.

33. In a machine of the character described comprising a rotatable winding head, spaced winding elements projecting from the face of said head, at least one of said winding elements being spring biased so that its projecting portion is urged radially inward of said head, a winding ejector member carried by the head and arranged for movement relative thereto, said member normally holding said winding element against said bias, a clamp carried by the winding head arranged to grip the end portion of a length of wire and hold the same during rotation of said head, drive means for rotating the winding head to wind on the spaced winding element thereof a predetermined number of courses of wire, cutting means operable to sever the wire, a member carried by said cutting means operable to engage and open the clamp on the winding head and release its grip on the wire at the completion of the wire cutting operation, and means operable upon opening of the winding head clamp to actuate said ejector member relative to the head to discharge the winding of wire from the spaced winding elements, the construction and arrangement of the spring biased winding element and the ejector member being such that upon actuation of the latter the winding element is caused to move inwardly by its spring bias to release the tension exerted on the winding of wire by said winding elements.

34. A machine for winding wire in a plurality of successive substantially parallel courses comprising a rotatable winding head, mechanism for engaging and drawing the end portion of a length of wire across the face of said winding head from a point at one side of the head, a clamp on the winding head at the opposite side thereof from said point operable to grip the end portion of the wire drawn across the head and hold the same during winding rotation of said head, and drive means for rotating the winding head through a predetermined number of complete revolutions and an additional one-half revolution so that at the completion of said rotation the end lead portions of the winding of wire extend outwardly of the head from the same end of the parallel courses of wire wound thereon.

35. A machine for winding wire in a plurality of successive substantially parallel courses comprising a rotatable winding head, mechanism for engaging and drawing the end portion of a length of wire across the face of said winding head from a point at one side of the head, a clamp on the winding head at the opposite side thereof from said point operable to grip the end portion of the wire drawn across the head and hold the same during winding rotation of said head, and drive means for rotating the winding head through a predetermined number of complete revolutions and an additional one-half revolution so that at the completion of said rotation the end lead portions of the winding of wire extend outwardly of the head from the same end of the parallel courses of wire wound thereon, and cutting means operable to sever the winding from the length of wire.

36. A machine for winding wire in a plurality of successive substantially parallel courses comprising a rotatable winding head, mechanism for engaging and drawing the end portion of a length of wire across the face of said winding head from a point at one side of the head, a clamp on the winding head at the opposite side thereof from said point operable to grip the end portion of the wire drawn across the head and hold the same

during winding rotation of said head, and drive means for rotating the winding head through a predetermined number of complete revolutions and an additional one-half revolution so that at the completion of said rotation the end lead portions of the winding of wire extend outwardly of the head from the same end of the parallel courses of wire wound thereon, and wire holding means adjacent said one side of the head normally engaging said wire and being operable to release the wire subsequent to engagement thereof by the wire drawing mechanism and to reengage the wire at the finish of winding rotation of the head.

37. A machine for winding wire in a plurality of successive substantially parallel courses comprising a rotatable winding head, mechanism for engaging and drawing the end portion of a length of wire across the face of said winding head from a point at one side of the head, a clamp on the winding head at the opposite side thereof from said point operable to grip the end portion of the wire drawn across the head and hold the same during winding rotation of said head, and drive means for rotating the winding head through a predetermined number of complete revolutions and an additional one-half revolution so that at the completion of said rotation the end lead portions of the winding of wire extend outwardly of the head from the same end of the parallel courses of wire wound thereon, wire holding means adjacent said one side of the head normally engaging said wire and being operable to release the wire subsequent to engagement thereof by the wire drawing mechanism and to reengage the wire at the finish of winding rotation of the head, and cutting means operable to sever the winding from the length of wire.

38. In a wire winding machine, the combination with a rotary winding head, of mechanism for withdrawing a length of wire from a supply source, said mechanism including a wire gripping element retractable from said source in a path remote to said head, mechanism for bringing the said head and wire together into winding relation in a position longitudinally of the wire between the retracted gripping element and the said source, means for transferring the wire from the gripping element to the head, and mechanism for rotating the head to effect winding of the wire upon the head.

39. In a wire winding machine, the combination with a rotary winding head, of mechanism for withdrawing a length of wire from a supply source, said mechanism including a wire gripping element retractable from said source in a path remote to said head, mechanism for bringing the head and wire together into winding relation in a position longitudinally of the wire between the retracted gripping element and the source, a clamp on said head, means for transferring the wire from the gripping element to the clamp, and mechanism for rotating the head to effect winding of the wire upon the head.

40. In a wire winding machine, the combination with a rotary winding head, of mechanism for withdrawing a length of wire from a supply source, said mechanism including a wire gripping element movable between advanced and retracted positions with respect to said source in a path remote to said head, mechanism for bringing the head and wire together into winding relation in a position longitudinally of the wire between the retracted gripping element and the source, mechanism for transferring the wire from the gripping element to the head, mechanism for

rotating the head to effect winding of the wire upon the head, mechanism for severing the wire at a point between the winding head and the source, mechanism for stripping the wound wire from the head, and means for actuating said mechanisms intermittently and in relatively timed cyclic sequence.

41. In a wire winding machine, the combination with a rotary winding head, of mechanism for withdrawing a length of wire from a supply source, said mechanism including a wire gripping element retractable from said source in a rectilinear path, a winding head rotatably intersecting said path at a position intermediate the retracted gripping element and said source, means for transferring the wire from the gripping element to the winding head, mechanism for rotating the head to effect a winding of the wire upon the latter, wire-cleaning and parting means operative at points on said path at a point intermediate the winding head and the source, and means for intermittently actuating said mechanisms and said means in predetermined sequential relation.

42. In a wire processing machine, a supply source for said wire, a winding head, means for advancing the wire into operative association with said head, means for securing said wire to the head at a point adjacent the free end of the wire, means for simultaneously effecting rotational and axial movement of said head to wind the wire thereon in a predetermined number of

substantially parallel courses, and mechanism for parting the wire thus wound from the source, said parting means being adapted to operate when the free end of the wound wire is in substantial parallelism with the run of the wire extending from said source.

43. In a cyclically operable wire processing machine, a supply source for insulated wire, a wire winding head, means for advancing the wire into operative association with said head, gripping means on said head for removably securing the wire thereto, means for effecting simultaneous rotational and axial movement of said head to wind the wire thereon in a predetermined number of substantially parallel courses, means for cleaning the insulation from a zone of the wire in advance of the head, means for severing the wire within the cleaned zone, and means for freeing the wound wire from the head.

44. A machine in accordance with claim 43 wherein said advancing means comprises: a gripper member mounted for reciprocatory movement between advanced and retracted positions with respect to said source, means for advancing said member into gripping engagement with the wire adjacent its free end, and for subsequently retracting the member toward said winding head to draw the wire into operative association with said means, and means for actuating said member to release the wire prior to the winding operation.

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