

May 13, 1930.

H. D. MADDEN

1,758,004

METHOD OF HEAT TREATING ELECTRICAL DEVICES

Filed Oct. 27, 1926

Fig. 1.

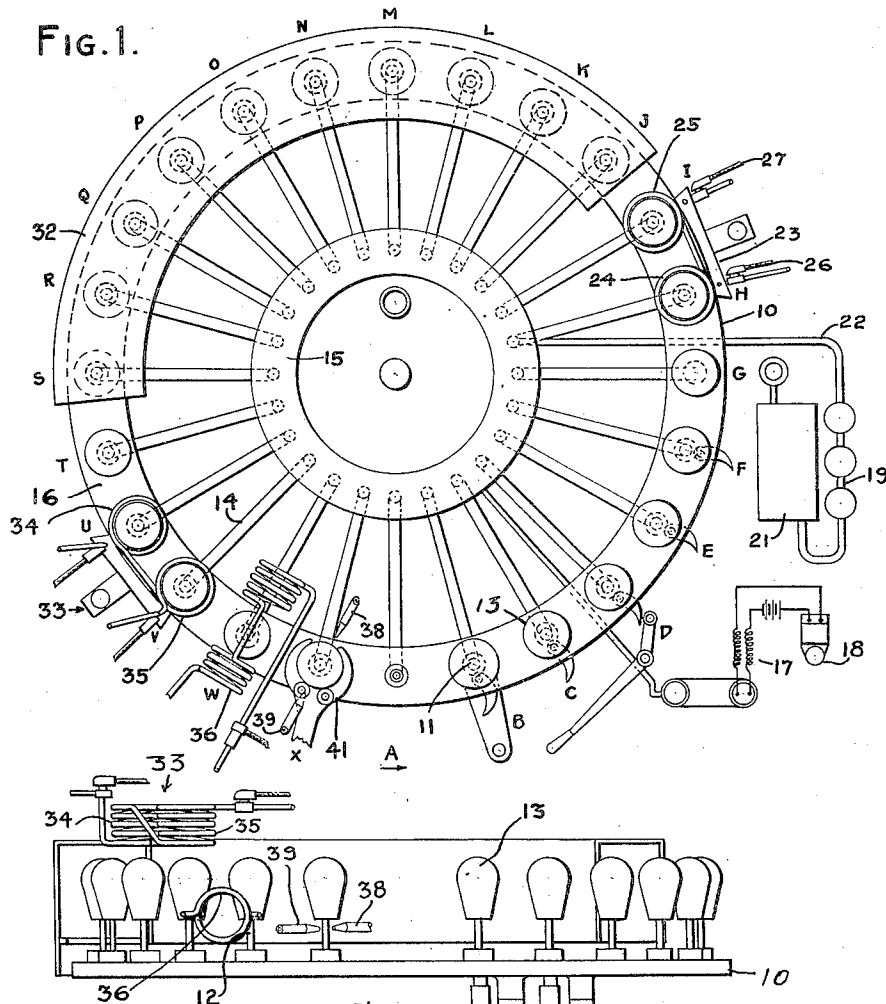


Fig. 2.

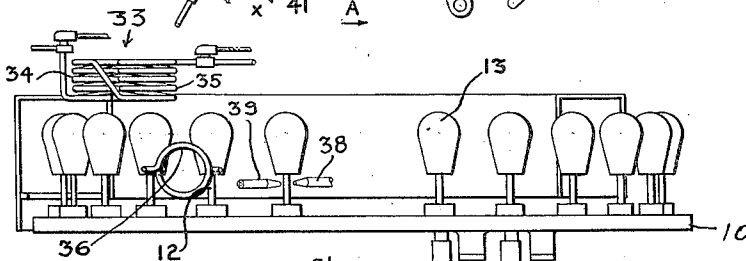
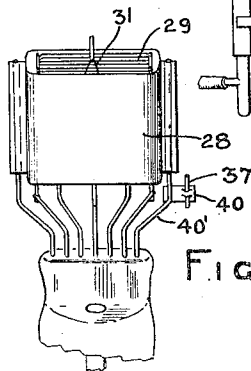


Fig. 3.



INVENTOR
Harry D. Madden

BY *J. J. Esport*
ATTORNEY

UNITED STATES PATENT OFFICE

HARRY D. MADDEN, OF MONTCLAIR, NEW JERSEY, ASSIGNOR TO WESTINGHOUSE LAMP COMPANY, A CORPORATION OF PENNSYLVANIA

METHOD OF HEAT TREATING ELECTRICAL DEVICES

Application filed October 27, 1926. Serial No. 144,500.

This invention relates to the manufacture of electrical devices having the operating elements or electrodes thereof in sealed containers such as glass bulbs or envelopes and relates more particularly to a method and apparatus for treating the elements of such devices.

In the manufacture of certain types of electrical devices such as, for example, a radiotron it is necessary to remove the occluded gases from the several elements or electrodes within the sealed container or bulb, and this operation is usually accomplished by a heat treatment.

The heat treatment generally consists in subjecting the electrodes to high frequency induction heating to bring the electrodes, such as the filament, grid and plate in the case of a radio tube to a relatively high temperature thereby driving out the gases.

Radio tubes are, however, often constructed so that the anode or plate surrounds or partly surrounds the grid. When the high frequency heating is employed to raise the temperature of the electrodes, the plate acts as a shield and protects the grid from the desired heating effect of the electromagnetic field. This results in an insufficient heating of the grid or other inner electrodes and a failure to completely drive out the detrimental gases which when subsequently released have a deleterious effect during the operation of the radiotron or other device, such as causing a change in the characteristics thereof or in acting to reduce the useful life of the device.

An object of the present invention is therefore to provide a method of effectively and efficiently conducting or transferring heat to all the electrodes within a sealed container so that a complete and uniform heat treatment may be obtained in an expeditious and convenient manner and in the provision of apparatus for performing the heat treat-

ment in conjunction with the method of exhausting a sealed container.

Briefly the invention comprises the introduction of a heat conductive gas into a container so that the conducting action will serve to effectively transfer heat to an element such as the grid which may otherwise not be sufficiently heated by reason of a surrounding plate or other element. It has been found that any conductive inert gas such as argon, nitrogen or the like when relatively pure will serve the purpose intended and that when the electrodes of a radiotron or other device are heat treated in an environment of one of said gases or a composition thereof a complete heating action results and the occluded gases are released and may be drawn from the tube to the required degree.

The invention further includes the novel combination of steps such as the exhausting, baking and tipping off operations, which in conjunction with the present step which may be termed a "gas flush" operation, produce a new and useful result in the production of a device of better quality and in which the characteristics are more dependable to produce a uniform product.

Although the present method is applicable to all types of devices wherein it is desirable to heat treat elements in a container the present may be described in connection with a vacuum tube or radiotron for the purpose of setting forth a practical embodiment of the invention.

The invention will be more clearly understood by reference to the accompanying drawings in which Fig. 1 is a diagrammatic plan view of an apparatus for practicing the present invention;

Fig. 2 is an elevational view of the apparatus shown in Fig. 1 and

Fig. 3 a perspective view of a radiotron mount as an example of one type of electrical device adapted for treatment by the present invention.

Referring to the drawing and more particularly to Fig. 1, it will be noted that as shown, an apparatus for practicing the invention may comprise a spider or conveyor

10. This conveyor may be of the usual type known in the lamp art, as an exhaust ring having a plurality of exhaust ports or apertures 11 to receive an exhaust tube 12 of an electrical device such as a radiotron 13 the internal elements of which are shown more clearly in Fig. 3. The exhaust ring illustrated has twenty-four exhaust ports, although any number may be used. The exhaust ports may be connected to mechanical mercury or other types of pumps (not shown) by conduits 14 through a central manifold 15, and the exhaust apertures 11 may have the usual tubular rubbers for making a gas tight connection with the exhaust tubes of bulbs. The spider or conveyor 10 may be operated to index or move intermittently a given number of times for each revolution. In the present apparatus the conveyor moves one twenty-fourth of a complete revolution with each index or actuation of the conveyor. Machines functioning in this manner are well known and mechanism therefor may be readily supplied by those versed in the art.

The twenty-four positions are, in the present machine, divided into groups or stages. At position A the machine is loaded, that is, an exhaust tube 12 of a bulb 13 is inserted into an exhaust port 11. As the bulb is moved with the conveyor to position C it is given a preliminary exhaust. At position C the exhaust ports are closed and at position D a leak detector 17 is provided so that the operator may determine whether or not the bulb is holding a vacuum.

The leak detector may be of any well known construction to actuate a signal as a bell 18 when the vacuum fails within a bulb.

At positions E to G a further exhaust takes place. This is however only a temporary evacuation of the bulb to permit an introduction of an inert gas such as argon into the bulb. Any suitable gas supply system as indicated by the numeral 19 may be provided and may include a purifier 21 containing various oxidizing or catalytic agents after which it is led to a bulb by a conduit 22.

At the position H is a high frequency induction heating element 23. This element may consist of a pair of coils 24 and 25 arranged to enclose a pair of bulbs. Electrical conductors 26 and 27 may supply electrical energy to the coils from any suitable source (not shown). Mechanism may be provided for causing a vertical reciprocation of the heating element to allow one pair of bulbs to be replaced by another pair. The lifting of the heater element can obviously be accomplished by a suitable arrangement of co-related mechanical elements operated by other moving elements constituting part of

the conveyor mechanism and such arrangement may be supplied by a mechanic familiar with this general type of machine.

When the bulbs reach position H the heater element will be in its upper position and after the introduction of the gas the bulb may be subjected to the heating action of a coil 24. This operation is termed "coiling" to bring the elements such as the plate or anode 28 (see Fig. 3), the grid 29 and cathode or filament 31, to the required temperature. As shown the plate 28 surrounds the other elements and ordinarily protects the same from the full heating effect of the coiling operation. The plate in fact serves as a shield and prevents the grid and cathode or other internal electrodes from becoming sufficiently heated by the electromagnetic induction of the high frequency coil.

By reason of the admitted gas, however, the heat is conducted or transferred to the internal electrodes. This transfer of heat may be the result of a circulation of the gas about the inner elements as by convection currents. The heating of the inner electrodes is therefore accomplished and the same are brought to a temperature sufficient to drive out the occluded gases.

The heating operation is performed twice, first by coil 24 and again by coil 25. During the heating the bulb may be cut off from the vacuum line and it is obvious that if desirable more than two coiling operations may be performed.

In positions L to S the bulbs pass through an oven which may be heated by any suitable means such as gas flames or electrically with resistance coils. During their passage through the oven the bulbs are connected with vacuum pumps which begin the final exhaust. This oven heating operates to more completely drive out any gases that may remain in the bulbs. As the bulbs emerge from the oven, they still remain connected to the pumps. At positions U and V the bulbs are again subjected to a coiling operation by a heating element 33 which may comprise coils 34 and 35 and may be similar in construction and operation to the heating element 23. During this last coiling operation a high vacuum is attained by the aid of pumps such as those of the mercury type which operate in connection with the oil pumps.

At position W another high frequency coil 36 is provided to activate a getter or clean up agent 37 shown as carried on a tab 40 mounted on a support wire 40'. This tab is so positioned as to be remote from the electromagnetic field set up during the heating of the electrodes. This final heat treatment gives a high degree of vacuum in the tube by the removal of any residual gas. The clean up agent may be any desired vaporizable material depending upon the character of the device being evacuated.

At position X the bulb is sealed off from the pumps by what is known as a "tipping off" operation which is accomplished by heating the exhaust tube 12 by means of flames from gas nozzles 38 and 39. When a portion of the exhaust tube has been rendered plastic and collapsed, to close the bulb a pair of jaws 41 may be provided to secure the bulb and transfer the same away from the machine. The tipping-off and transfer mechanism is known to those skilled in the art and no further description thereof is believed to be necessary.

The foregoing sets forth an apparatus for practicing the present method in connection with the operation of exhausting the bulbs.

The step of introducing a gas into the bulb has been found to result in a satisfactory heating of all the elements to a temperature sufficient to drive out the gases which, by reason of the pumps, are removed from the bulb.

It will be understood that in the manufacture of electrical devices such as radio tubes a standard of perfection is necessary and all tubes of a given type must be uniform in their various characteristics. If a tube after passing through the exhaust operation becomes gassy the characteristics change, and this often occurs when the elements or electrodes are insufficiently heat treated, such tubes will not meet the requirements of an acceptable product and are therefore discarded at a material loss with a consequent increase in the cost of production.

The present invention is, therefore, an important advance step in the art of manufacturing electrical devices of the above character since a uniform product is attainable and shrinkage losses are greatly reduced.

Although a preferred embodiment of the invention is shown and described herein it is obvious that those versed in the art may modify the same without departing from the spirit and scope of the appended claims.

What is claimed is:

1. The method of heat treating an electron emission device comprising a bulb enclosing a plurality of electrodes which consists in subjecting the electrodes to high frequency induction heating in the presence of an inert gas for obtaining a uniform heating of the electrodes.

2. The method of heat treating a plurality of electrodes in an envelope which comprises subjecting the electrodes to high frequency induction heating in the presence of a heat conductive gas to insure the heating of all the electrodes to a predetermined degree.

3. The method of heat treating one or more electrodes surrounded by another electrode which comprises subjecting the electrodes to a high frequency induction heating while said electrodes are enveloped in a heat con-

ducting medium to bring the surrounded electrodes to a predetermined temperature.

4. The method of driving occluded gases from one electrode surrounded by another, which comprises subjecting the electrodes to high frequency induction heating to drive the occluded gases from the outer electrode and enveloping the electrodes in a gas capable of conducting heat to the internal electrode to a degree sufficient to drive out the occluded gases therefrom.

5. The method of manufacturing an electrical device having a plurality of electrodes disposed in a container which comprises exhausting the container, introducing therein an inert gas subjecting the electrodes to high frequency induction heating, removing the gas and evacuating the container.

6. The method of manufacturing an electrical device having a plurality of electrodes in a container which comprises, exhausting the container, introducing therein an inert gas, heating the electrodes in the presence of said gas to drive occluded gases from said electrodes, evacuating said container and again heating said electrodes.

7. The method of manufacturing an electrical device having a plurality of electrodes in a container which comprises, removing atmospheric air from said container, substituting therefor an inert gas and subjecting the electrodes to a high frequency induction heating.

8. The method of manufacturing an electrical device having a plurality of electrodes, and a clean up agent mounted within a container which comprises removing atmospheric air from said container, introducing therein an inert gas, subjecting the electrodes to high frequency induction heating, partially evacuating while passing the same through an external heat zone, increasing the degree of vacuum in the container while again subjecting the electrodes to high frequency induction heating, flashing the clean up agent and sealing the container from the atmosphere.

9. A machine for manufacturing electrical devices having an envelope containing a plurality of electrodes comprising a conveyor for moving bulbs, exhaust means for removing air from said bulbs, means for introducing an inert gas into said bulbs, a heating element positioned adjacent to the path of movement of said conveyor for heating the bulbs when filled with said gas, means for removing said gas, means for evacuating said bulbs and means for sealing the bulb from the atmosphere.

10. A machine for manufacturing radio bulbs comprising a conveyor, adapted to receive and move bulbs progressively through a plurality of stages, exhaust apparatus connected with said conveyor for evacuating

said bulbs at one or more of said stages, means for introducing an inert gas into said bulbs at another stage, means for subjecting the gas containing bulbs to high frequency induction heating, means for removing the gas, a heat zone in the path of movement of said bulbs, means for exhausting the bulbs while passing through said zone, means for subjecting the bulbs to a second high frequency induction heating, means for activating a clean up agent within the bulb and means for tipping off the bulb.

In testimony whereof, I have hereunto subscribed my name this 26th day of October, 1926.

HARRY D. MADDEN.

20

25

30

35

40

45

50

55

60

65