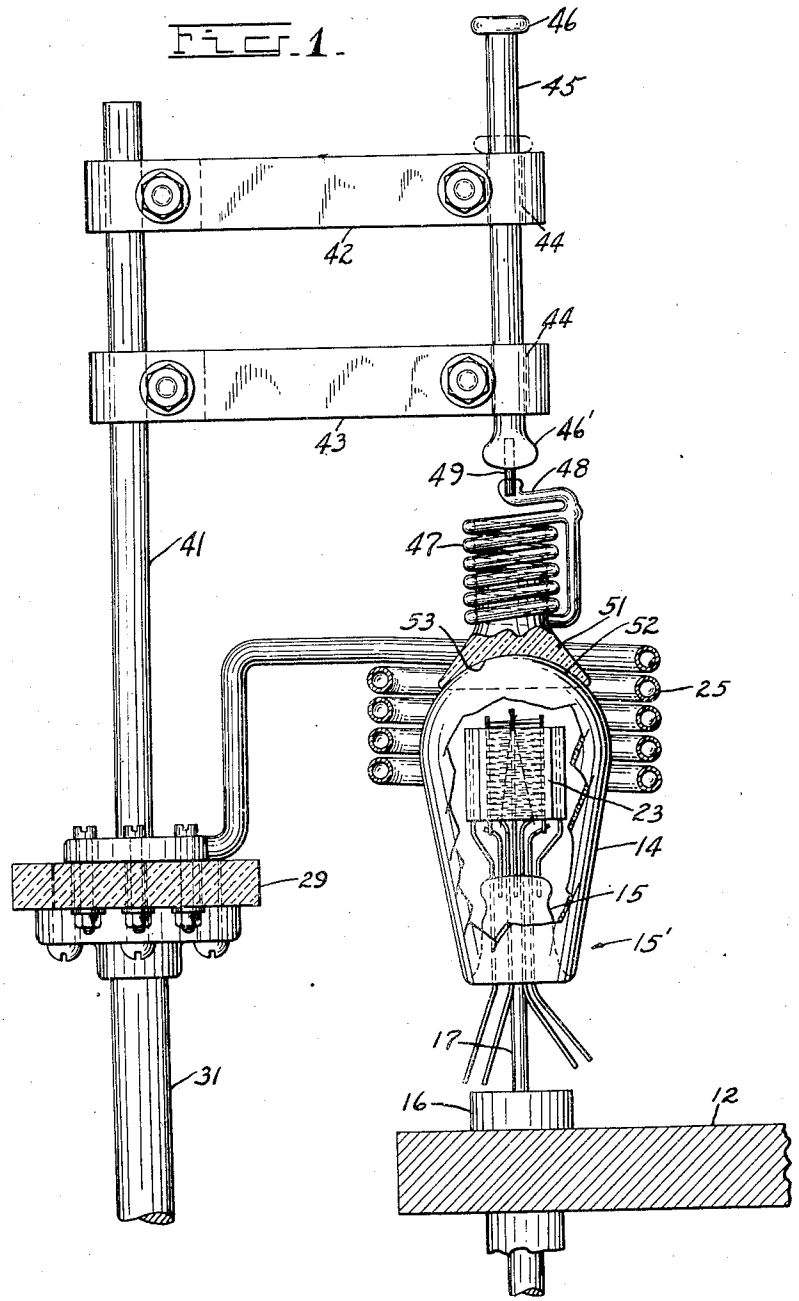
March 5, 1935. D. Y. SMITH 1,993,022

APPARATUS FOR HEAT TREATING ELECTRODES

Filed Oct. 17, 1929 2 Sheets-Sheet 1

Fig. 1.



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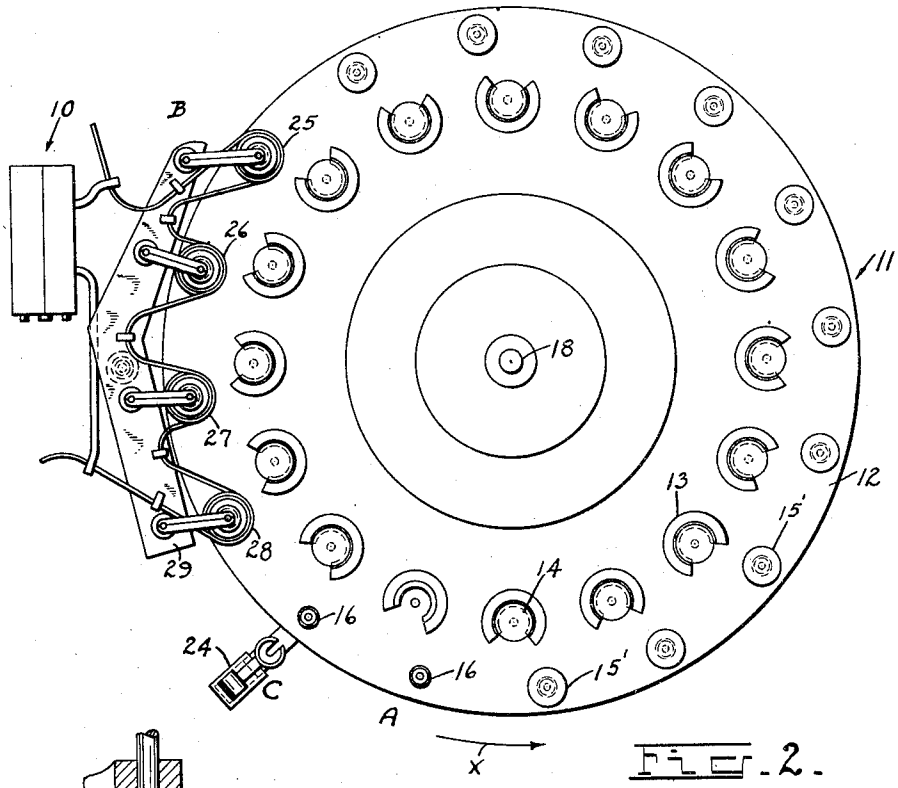

Fig. 2.

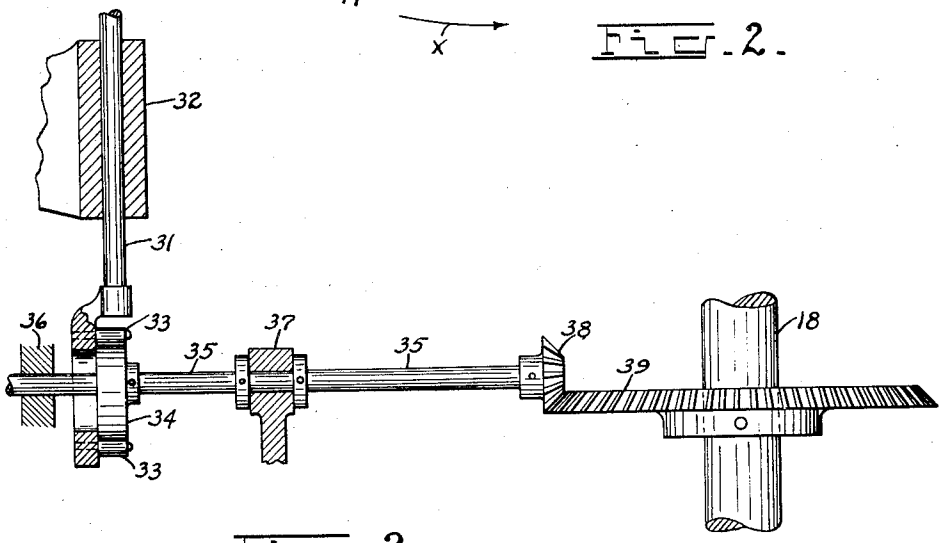

Fig. 3.

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APPARATUS FOR HEAT TREATING ELECTRODES

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Application October 17, 1929, Serial No. 400,308

8 Claims. (Cl. 219—13)

This invention relates to the manufacture of evacuated devices such as radio tubes or the like and relates more particularly to the operation of heat treating the electrodes within the tubes by the use of a high frequency field.

In the manufacture of radio tubes which include several internal electrodes, as for example a cathode, control element or grid and an anode or plate, it is necessary after the device is structurally complete to remove impurities from the electrodes particularly the plate. The removal of impurities is accomplished by a heat treatment and a convenient and practical method of heat treating is attained by disposing a coil of wire about the tube and in passing high frequency current through the coil to create a high frequency field and thus inductively heat the anode sufficiently to drive out the absorbed gases or perform what is termed a degasifying operation.

In order to completely degasify a radio tube it is necessary to subject the tube to a plurality of successive degasifying operations while the tube is connected to an exhaust pump so that the deleterious gases will be drawn from the bulb after each heat treatment. The degasifying operation is therefore performed while the devices are on the exhaust machine and in communication with the vacuum line and in order to attain high speed production a plurality of degasifying devices are employed for simultaneous disposition over a plurality of tubes.

The exhaust machine usually consists of a spider having exhaust ports in which the exhaust tubes of radio tubes are inserted. The spider is moved intermittently and with each movement one radio tube passes from a degasifying position so that with each intermittent movement of the machine a degasified tube is ready for removal to be subjected to other manufacturing operations.

As above set forth it is essential in order to produce devices such as radio tubes at a rate of speed commensurate with other manufacturing operations, to so arrange and organize degasifying devices that they may be disposed over a plurality of tubes simultaneously.

It has been found, however, that in practice it often happens that the operator fails to insert a radio tube into an exhaust port so that when the machine moves it may happen that instead of the total number of tubes being positioned for a degasifying operation, one or more may be missing. Inasmuch as the several coils of the degasifying devices are connected in series with a constant source of high frequency current the total amount of high frequency current must be so regulated as to be sufficient to provide a high frequency field capable of heating a given mass of metal which in the present case would be the total number of plates disposed in the field. If a tube is missing at one of the high frequency positions or fields then an over-load is impressed upon the anodes or other metallic portions of the remaining tubes with the result that the temperature of the parts is elevated above that necessary for degasification and the metallic parts may be burned or rendered otherwise defective for the purpose for which they are intended.

It is an object of the present invention, therefore, to provide a method of stabilizing a constant source of high frequency electrical energy for inductively heating a plurality of metallic bodies.

Another object of the invention is to provide a plurality of high frequency induction fields for inductively heating a given number of metallic bodies and for automatically disposing in place of one of said body, another compensating body capable of absorbing an amount of electrical energy equal to the displaced body.

Other objects and advantages will be evident from the following description together with the accompanying drawing, in which

Fig. 1 is a side elevational view of a portion of a sealing-in and exhaust machine having the present invention applied thereto.

Fig. 2 is a plan view of an exhaust machine shown diagrammatically with a high frequency heater in operative relation therewith, and

Fig. 3 is a fragmentary view of a portion of the exhaust mechanism showing means for causing a vertical reciprocation of a number of helical conductors for movement about the electrodes of radio tubes.

A practical embodiment of the invention may, as shown, comprise a high frequency unit 10 suitably positioned adjacent to the path of movement of a sealing-in and exhaust machine 11.

The sealing-in and exhaust machine may include a conveyor or spider 12 having a plurality of heads or holders 13 to receive a bulb 14 and a stem or mount 15 of a radio tube.

A mount 15 is positioned in a holder and a bulb 14 disposed over the mount, suitable fires being provided to seal-in or unite the bulb neck and mount by fusion. After the bulb and mount have been consolidated and constitute a partially completed electrical device 15' it is transferred to an exhaust port 16. A suitable number of exhaust ports are provided and each port connects with a vacuum pump (not shown). An

exhaust tube 17 of a device is inserted into an exhaust port so that as the conveyor moves the bulbs are evacuated.

The conveyor 12 may be mounted on a central vertical shaft 18 which receives intermittent rotary movement through any suitable mechanism as for example a Geneva drive from any desired source of power as for example a motor (not shown). Mechanism for sealing-in and exhausting bulbs is well known and the present invention is applicable to machines now in common use.

The bulbs and mounts of electrical devices 15' may be loaded on to the conveyor at A and as the conveyor moves in the direction of arrow X, a mount and bulb are positioned in a holder 13. After the mount and bulb have made a complete revolution with the conveyor and have been fused together the device is ready to be positioned in an exhaust port.

The exhaust ports are thus applied with devices and the conveyor moves them to position B or degasifying position at which the electrodes, particularly the anodes or plates 23 are heated to a degasifying temperature by high frequency induction heating, at which time, as above mentioned, the devices are still connected with the vacuum pump and as the gases are driven from the electrodes they are removed from the bulb.

After degasification the devices move to position C where a tipping-torch 24 is provided to seal off the exhaust tubes and close the bulbs from the atmosphere. This operation being well known in the art, a further description has been omitted.

For the purpose of completely degasifying the electrodes it has been found desirable to give each device a plurality of heat treatments and the selected construction shows four positions requiring four helical enclosing conductors 25, 26, 27 and 28. These conductors which may be termed heater-elements are connected in series and to a high frequency source of electrical energy such as the unit indicated by the numeral 10.

The provision of a plurality of heater-elements makes it possible to simultaneously heat treat a number of devices and means are provided for raising and lowering the said elements so that with each movement of the conveyor a completely heat treated device will move from a heater element and a device to be heat treated will enter the high frequency zone or field.

The heater-elements are mounted on a cross-head 29 which is secured to a vertical reciprocable rod 31 movable in a guide bearing 32 and having cam followers 33 on its lower end disposed for engagement with a cam 34 secured to a horizontal shaft 35. The shaft 35 is journaled in bearings 36 and 37 and one end thereof is provided with a beveled gear 38 in mesh with a bevel gear 39 secured to the central shaft 18. The cam and gear mechanism may be so arranged and proportioned that the cross-head 29 is lifted during a movement of the conveyor and lowered during the stationary period of the conveyor.

As above described the present construction provides a plurality of high frequency fields and since these fields are produced from a common source of electrical energy a constant total supply of high frequency current must be provided.

It is obviously essential to furnish sufficient current to heat the four anodes to a temperature at which the gases will be expelled but not an amount of current sufficient to excessively heat the electrodes.

If it happens that one or more devices are not inserted into the exhaust ports then the heater-elements will descend and one or more of the fields created will have no core or body to absorb electrical energy with the result that the electrodes in the remaining heater-elements will be subjected to an excessively powerful field which will heat the electrode or electrodes to a temperature detrimental to usefulness.

For the purpose of avoiding the above condition the present construction provides each heater-element with means for absorbing energy in the absence of a radio tube or other device.

As shown more clearly in Fig. 1 the cross-head 29 is provided with an upright or post 41 disposed adjacent to each heater-element. Each post is provided with bracket arms 42 and 43. These arms extend from the posts and terminate in bearings 44 in which slide rods 45 are disposed. The slide rods may be of insulative material such as glass and are provided with heads 46 at their upper ends and buttons or enlargements 46' at their lower ends. The rods are free to reciprocate vertically on the vertical axis of the heating-elements.

The lower end of each slide rod 45 is provided with an electrical energy absorbing element or member 47. These electrical energy absorbing elements may be of iron or steel or any suitable heat resisting material. A material such as nichrome, for example, has been found to give satisfactory results. As shown in the drawings each member 47 may be in the form of a wire helix having its ends connected to constitute a closed circuit and having a projection 48 suitably connected as by a spud 49 with the lower end of the rod 45. The members 47 may be provided with buffer pieces 51 preferably of an insulative material such as asbestos.

The slide rods 45 being free to move, normally drop by gravity to position the members 47 in the high frequency fields within the heater-elements. The buttons 46 may be so positioned as to serve as stops to limit the downward movement of the members 47 and hold them in proper relative positions to receive the same heat treatment as would be received by the anodes of electrical devices.

When an electrical device such as a radio tube is in position in an exhaust port of the conveyor and the crosshead 29 descends the upper surface 52 of a bulb 14 contacts with a lower curved surface 53 of the buffer member 51 and since the rod 45 is free to move, the bulb 14 prevents the energy absorbing member 47 from entering the high frequency field.

It will be understood that the members 47 may be designed to absorb an amount of energy equal to that which would be absorbed if a device was in place in a heating-element. Thus the high frequency fields are stabilized and the danger of over-heating is removed.

A machine constructed in accordance with the present invention may be operated without the heretofore constant attendance of an operator to adjust the amount of current supply depending upon the number of devices missing at the high frequency stage.

Although a preferred embodiment of the invention may be shown and described herein it will be understood that modifications may be made therein without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. An apparatus comprising means for establishing a high frequency field, means for moving a conductive body capable of absorbing electrical energy into said field, means for supporting another body independent of said first body and capable of absorbing a similar amount of electrical energy and means for positioning one body in said field to the exclusion of the other body.

2. An apparatus comprising means for establishing a high frequency field, means for moving a conductive body capable of absorbing electrical energy into said field, means for supporting above said body another separate body capable of absorbing a similar amount of electrical energy and means for moving one body into said field to the exclusion of the other body.

3. An apparatus comprising means for establishing a high frequency field, means for moving a conductive body capable of absorbing electrical energy into said field, means for supporting another body independent of said first body and capable of absorbing a similar amount of electrical energy, means for normally moving one body toward said field and means for causing the other body to enter said field to the exclusion of the former.

4. An apparatus comprising a conveyor, a plurality of supports on said conveyor to hold vacuum devices, means for establishing a plurality of electro-magnetic fields to receive and inductively heat electrodes in vacuum devices, means for changing the relative positions of said devices and fields to position said devices in said fields, a plurality of individual electrical energy absorbing bodies, means for normally moving said bodies into said fields and means for interrupting the movement of said bodies upon a change in the relative positions of said devices and fields.

5. In a machine for degasifying electrical devices, means for establishing a high frequency field for inductively heating the electrodes of a predetermined number of said devices to a degasifying temperature, and means for absorbing electrical energy from said field when less than the predetermined number of said devices enter said field.

6. In a machine for degasifying electrical devices, means for establishing a high frequency field for inductively heating the electrodes of a predetermined number of said devices to a degasifying temperature and means for moving an electrical energy absorbing element into said field with less than said predetermined number of devices are positioned for a degasifying operation.

7. The method of degasifying an indeterminate number of electrodes by high frequency induction heating which comprises supplying a source of high frequency current and establishing a high frequency field sufficient to degasify a predetermined number of electrodes and in avoiding overheating of electrodes when less than the given number are applied to the high frequency field by substituting for the missing electrodes a body capable of absorbing an amount of electrical energy equal to that which would have been absorbed by the missing electrodes.

8. A machine for inductively heating the electrodes of each of a plurality of vacuum devices for a degasifying operation comprising means for establishing a plurality of high frequency fields, means for changing the relative positions of said devices and fields to dispose devices in certain of said fields, a plurality of electrical energy absorbing elements and means for changing the relative positions of said elements and said fields to position said elements in fields not occupied by said devices.

DOUGLAS YORK SMITH.