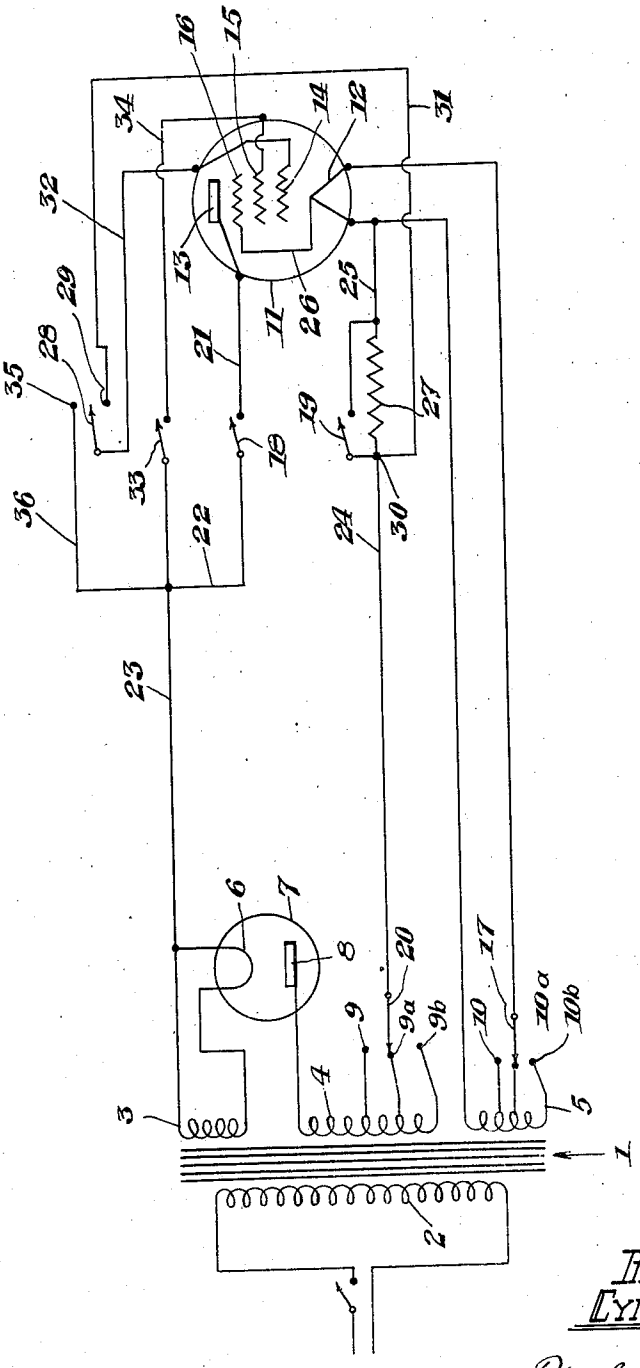
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APPARATUS FOR REACTIVATING RADIO TUBES

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Inventor
Cyril Helliar

BY Fethenstonhaugh & Co.
Attys.

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APPARATUS FOR REACTIVATING RADIO TUBES

Cyril Helliar, Vancouver, British Columbia, Canada

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6 Claims. (Cl. 316—28)

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This invention relates to apparatus for reactivating radio tubes having thoriated tungsten or oxide coated filaments.

Thoriated tungsten filaments are composed of a mixture of tungsten with about 1 to 2% thorium and a little carbon to act as a reducing agent. In normal operation they have a very thin substantially monomolecular thorium coating on the surface, from which electron emission takes place. The normal operating temperature of the filament is such that as the coating is reduced by electron emission, it is replaced by more thorium which comes to the surface. Oxide coated filaments are generally formed by applying barium or strontium carbonates to a metallic core, for example platinum or "Konel" metal, and are originally activated by conversion of some of the carbonate to oxide and some of the oxide to metal, the electron emission taking place from the latter.

A thoriated tungsten or oxide coated filament may cease to operate because of some sudden large flow of electrons which will cause it to lose its metallic emissive coating at such a high rate that the coating is not replaced as quickly as it is lost.

The purpose of reactivation is to reconstitute an emissive metallic coating if any emissive material is left in the filament. The usual method of reactivating a thoriated tungsten filament is first to flash the filament for 10 to 20 seconds at 3 to 3½ times normal filament voltage to drive off from the filament any non-uniform thorium coating, and then to apply about 1½ times normal filament voltage for about an hour for the purpose of heating the filament sufficiently to bring a new thorium coating to its surface. The usual method of reactivating an oxide coated filament is first to apply about twice normal voltage for 2 to 4 minutes in order to convert some of the carbonate to oxide, and then to apply a voltage about 10% above normal for 1 to 2 hours in order to convert some of the oxide to metal.

The difficulty of these normal methods of reactivation is that the condition of the tube to which the method is applied is unknown and can only be ascertained by comparatively elaborate tests. Accordingly, for practical purposes it is necessary to preselect conditions on the basis of an average used tube. If the tube actually under treatment has above average activity, then the filament will be heated above normal operating temperature for too long and deactivation will set in. If, on the other hand, it has below average activity, then the filament will

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not be heated above normal operating temperature for long enough and maximum reactivation will not be obtained. It is in practice impossible with present methods to reach maximum reactivation in any tubes whose activity does not happen to approximate that of the average used tube. In a great many cases reactivation may be almost negligible and in other cases the tube may have less activity after treatment than it had before treatment.

According to the present invention the above-mentioned disadvantages are avoided and an apparatus is provided by means of which maximum reactivation may be automatically obtained without risk of going beyond that maximum to deactivation. The invention depends essentially on applying across the tube a D. C. voltage substantially above normal plate voltage from a source having very low voltage regulation, and supplying substantially normal current in the filament heating circuit.

Apparatus according to the invention for reactivating a radio tube having a filament and a plate and a grid therefore comprises means for supplying substantially normal heating current to the filament, a generator of D. C. voltage substantially higher than the normal plate voltage of the tube, this generator having an internal resistance substantially greater than the normal internal resistance of the tube, and means for connecting this generator across the tube, normally from plate to cathode. The normal internal resistance of the tube means, in this application, the resistance between plate and filament which the tube was designed by the manufacturer to have. Similarly the normal plate voltage is that with which the tube was designed by the manufacturer to operate.

With the apparatus of the invention the extra heating necessary to produce the required emission comes, not as a result of any increased voltage in the filament heating circuit, which cannot be satisfactorily adjusted for the conditions prevailing in the particular tube under treatment, but rather as a result of the electron flow across the tube started by the high plate voltage applied. This plate voltage, however, owing to the low voltage regulation in the generator, automatically decreases as the current through the tube increases and approaches normal. The possibility therefore of carrying the treatment beyond maximum reactivation to deactivation may be substantially eliminated wholly automatically, since the internal resistance of the generator may be so chosen that when

the internal resistance of the tube reaches normal, that is when reactiviation has been completed, the plate voltage will be substantially normal. The rise in current through the tube in reactivation is comparatively slow but the drop in current as deactivation sets in is very sharp (see Morecroft, "Principles of Radio Communication" 2nd ed., p. 444, Fig. 6). If the voltage regulation is high, the time during which the current across the tube is at maximum is extremely short, being reckoned in milliseconds, with the result that deactivation would set in and proceed to a substantial extent before any indicating instrument could warn the operator to disconnect the tube.

The voltage of the D. C. generator is not critical, provided that it is substantially higher than the normal plate voltage of the tube. If it is too low, the reactivation process will take an inordinately long time. The more nearly dead is the tube to be treated, the higher the voltage should be. Satisfactory results may, in many cases, be obtained with a voltage as low as twice normal voltage. Ordinarily, it is preferable that the voltage should be from about three to about six times the normal plate voltage of the tube. The upper limit is simply that the voltage must not be so high as to break down insulation of the tube under treatment.

It is preferable that the generator should give a pulsating D. C. voltage, since such a voltage gives in effect a series of shocks and will start electron flow from the cathode where a constant voltage of the same value might not have the required effect. Accordingly, the preferable D. C. generator is a half wave rectifier which may be supplied through a transformer from an ordinary 110 volt main. A half wave rectifier is preferable to a full wave rectifier because the shock effect of the former is greater and its voltage regulation is lower.

The invention will be described in somewhat more detail by reference to the attached drawing which shows diagrammatically an example of an apparatus according to the invention.

In the drawing, the primary **2** of the transformer **1** is connected to an ordinary electric supply, for instance 110 volts. The transformer has three secondaries, **3**, **4** and **5**. Secondary **3** is in circuit of the cathode **6** of a half wave rectifier **7** to provide heating current for the latter. The plate **8** of the rectifier is connected to the secondary **4**, which is provided with a number of contacts **9**, **9***a* and **9***b*, for the purpose of supplying a variable high voltage for the rectifier circuit. The secondary **5** is likewise provided with a number of contacts **10**, **10***a* and **10***b*. The tube **11** under treatment has a filament **12**, a plate **13**, control grid **14**, screen grid **15**, and a suppressor grid **16** connected to the filament inside the tube. The heating current for the filament **12** is provided by connecting the filament in circuit with the secondary **5** of the transformer through a switch **17** which may be moved to one of the contacts **10**, **10***a* and **10***b*, the purpose of having a number of contacts being to enable the supply of the filament heating current which is substantially normal for the particular tube under treatment. The rectifier **7**, which constitutes the D. C. generator, may be connected across the tube between the plate and filament by closing the switch **18** to establish connection with the plate, and by closing the switch **19** and moving the switch **20** to the appropriate one of the contacts **9**, **9***a* and **9***b* to establish the required plate voltage. The internal resistance of the rectifier **7** is so chosen as to be substantially greater than the normal internal resistance of any tube for the reactivation of which the apparatus is designed. Generally, the internal resistance of the generator should be at least about two or three times as great as the normal internal resistance of the tube to be treated.

In order to avoid a negative space charge in the tube, it may be desirable to apply a positive bias to the control grid **14**. This may be done by opening the switch **19** so that the plate current is then supplied through the resistance **27**, and by closing the switch **28** onto the contact **29**, thus connecting the control grid **14** to the point **30** through the wire **31**, contact **29**, switch **28**, and wire **32**.

In the case of a tube such as that shown, which includes a screen grid, it may sometimes be desirable for the purpose of initiating discharge through the tube to connect the generator initially across the tube between screen grid and filament rather than between the plate and filament. This is provided for in the apparatus shown, where switch **18** may be opened and the switch **33** closed thus connecting the screen grid **15** to the rectifier through the wire **34**, switch **33** and wire **23**. With the apparatus shown it is possible to have both the plate and the screen grid at the same voltage by closing both of the switches **18** and **33**.

If the activity of the tube to be treated is very low it may be desirable to connect the generator initially across the tube between the control grid and filament. In this case a considerably lower voltage must be used than in the case where the connection is between the plate and filament. In the apparatus shown the control grid may be connected to the rectifier by closing the switch **28** onto the contact **35**, the connection then being by the wire **32**, switch **28**, contact **35**, wire **36** and wire **23**. If such a connection is to be made, the switch **20** will first be moved to, say, the contact **9** to give the lowest voltage across the tube. When electron flow has started between the filament and control grid the switch **28** will be opened or closed onto the contact **29**, the switch **20** will be moved to a contact giving a higher voltage across the tube, and the switch **18** will be closed to connect the plate **13** to the rectifier.

It will be appreciated that the apparatus shown in the drawing is merely illustrative of various forms of apparatus which might be used, and that the invention is not confined to the reactivation of pentodes such as that illustrated in the drawing. It may be adapted for the reactivation of any radio tube having a filament, grid and plate. The filament may be either of the type which itself carries the emissive material or of the type which heats an indirectly heated cathode having the emissive material.

This application is a continuation-in-part of my previous application Serial No. 484,264, filed April 23, 1943.

What I claim is:

1. Apparatus for reactivating a radio tube having a filament and a plate and a grid, comprising means for supplying substantially normal heating current to said filament, a source of D. C. voltage substantially higher than the normal plate voltage of said tube, said source having an internal resistance substantially greater than the normal internal resistance of the tube, and means connecting said source across said tube.

2. Apparatus according to claim 1, wherein the

voltage of the source of D. C. voltage is from about three to about six times the normal plate voltage of the tube.

3. Apparatus according to claim 1, wherein the internal resistance of the source of D. C. voltage is about two to three times the normal internal resistance of the tube.

4. Apparatus according to claim 1, wherein the source of D. C. voltage is a half-wave rectifier.

5. Apparatus according to claim 1, comprising

means for connecting the source of D. C. voltage across the tube between the plate and filament.

6. Apparatus according to claim 1, for reactivating a radio tube having a screen grid in addition to a filament and control grid and cathode, comprising means for connecting the source of D. C. voltage across the tube between the screen grid and filament.

CYRIL HELLIAR.