REACTIVATION OF THORIATED TUNGSTEN FILAMENT

THE THORIATED TUNGSTEN FILAMENT - HOW IT OPERATES

The thoriated tungsten filament is used in the following types of Cunningham Radio Tubes: C and CX-299, CX-220, CX-300A, CX-301A, CX-371, CX-310, CX-313 and CX-316B. This filament is not of the coated type, the thorium content being distributed throughout the body of the tungsten wire. In the final factory process, a uniform layer of atomic thorium is built up on the surface of the filament, this layer being responsible for the high emission efficiency of the thoriated filament. When the tube is in use this surface layer of thorium very gradually evaporates, but just as rapidly fresh thorium is continuously supplied from the interior of the filament. This process continues very smoothly maintaining an active surface condition throughout the life of the tube provided the filament voltage is not increased more than 10% above the rated value. When subjected to a voltage overload. this balance between surface evaporation and restoration is upset, the active thorium surface is destroyed and the filament emission rapidly decreases. In operation the tendency is to further increase the filament voltage, thus further overloading the tube until no emission is obtained. The tube filament is then said to be "paralyzed" but can be restored by reactivation.

The end of normal life of the thoriated tungsten filament results from the exhaustion of the thorium content and is indicated by a sudden decrease in filament emission instead of actual failure or burnout of the filament as with other types of filament material.

WHEN TO REACTIVATE

The filament condition of a tube may be most readily judged by an emission test using the circuit shown in Fig. 3, Plate 25. The voltages specified should not be exceeded. Higher voltages will permanently damage the vacuum and may even result in a burnout. If the emission is above the minimum value specified below, the tube is in good condition and does not need reactivation. If equipment for reading emission is not available a simple test for the two most widely used tube types can be made on the customary tube test set which measures plate current. This circuit is shown in Figure. 1, Plate 25.

For C or CX-299 tubes, set the plate voltage at 45 volts with the grid connected to the negative filament, set the filament voltage at 3 volts and read the plate current. Momentarily increase the filament voltage to 3.5 and read the plate current. If the plate current increases more than .2 milliamperes, the filament is not fully active and the tube may be improved by the reactivation process.

For C or CX-301-A tubes, the same value of plate voltage (45) is used but the plate current is read with the filament voltage set at 4 and 6. An increase of more than .2 milliamperes in the plate current indicates that the tube may be improved by reactivation.

Type No.	Filament Voltage	Grid & Plate Voltage	Minimum Emission	Reactivation Voltage	Flashing Voltage
C-CX 299	3.3	50	6 mamp.	4.0	12
CX 220	3.3	50	15	4.0	12
CX 301A	5.0	50	25	7.0	18
CX 300A	5.0	50	12	7.0	18
CX 371	5.0	50	50	7.0	18
CX 310	6.0	100	100	9.0	--
CX 313	4.0	100	50 per anode	6.0	--
CX 316B	6.0	125	100	9.0	--

If the tube will not return to normal after reactivation treatment, it is proof that the tube has either served its normal life or has been so heavily overloaded that the thorium content has been exhausted or the vacuum impaired.

HOW TO REACTIVATE - TWO METHODS

The following methods will generally restore the emission, that is, reactivate, tubes which have been overloaded and also, at times, will reactivate, for short additional usage, tubes that have dropped in emission at the end of normal life. The exact process which gives best results depends upon the nature and extent of the overload to which the tube has been subjected.

Tubes which have been subjected to only a slight overload may be reactivated by a very simple process. This consists in burning the filament, with the plate voltage disconnected, at the voltage listed above under the heading "Reactivation Voltage". This process speeds up the "boiling out" of the thorium from the body of the wire, while at the same time the surface evaporation is very slow when plate voltage is not applied. The length of time required to reactivate a tube by this treatment is one-half to one and one-half hours, depending largely upon the length of time and the extent to which the tube has been subjected to excessive voltage. At the end of thirty minutes burning, test the tube as explained above. If the emission shows improvement continue the treatment until test shows the tube to be above minimum passing limit.

Tubes which have been badly overloaded may not improve under this process, and a "flashing" voltage must be used, as outlined below:

First burn the filament for 10 to 20 seconds at the voltage shown in the table under the heading "Flashing Voltage". Then burn the

filament under the process described above, using the voltage listed as "Reactivation Voltage". Read the emission at the end of 30 minutes and if not restored, continue to burn the filament up to 2 hours, taking readings every 30 minutes. If 2 hours' treatment does not restore the emission, or greatly improve it, it is proof the tube cannot be reactivated.

No plate voltage is ever applied during the reactivation.

The applied voltages should always be controlled by a suitable voltmeter.

A small percentage of tubes reactivated by the use of flashing voltages may be expected to burn out during treatment.

Rapid reactivation, sometimes within ten minutes, can be accomplished by the use of voltages higher than those recommended above. This process very materially shortens the tube life and such reactivation is genarally not permanent. Furthermore, the use of higher voltages greatly increases the percentage of tubes that burn out. Reactivation by the "while you wait" process cannot be recommended.

REACTIVATION EQUIPMENT:

Alternating current from the lighting supply is most convenient and can be stepped down to the proper voltages by a toy or bell ringing transformer, such as, G.E. Type #236093 which is provided with two volt taps from 4 to 22 volts. The circuit diagram is shown in Plate 26 & 27. As A.C. voltmeters require considerable current they should be left permanently in circuit in parallel with the tubes.

If alternating current is not available D.C. supplied by storage batteries may be used. The flashing voltage may be obtained from a storage B battery of the larger sizes. Only one tube should be flashed at a time on a B storage battery and the battery must be left fully charged. The circuit for battery operation is shown in Plates 26 & 27.

FREQUENT REACTIVATION PROOF OF IMPROPER OPERATION

Cunningham Radio Tubes are designed to deliver at full efficiency throughout normal life provided operation is at rated voltages. No reactivation is necessary. This is well illustrated by the curve in Plate 26, showing the mutual conductance of a standard CX-301-A tube on life test at rated voltages. This curve is representative of the life performance of Cunningham Radio Tubes and shows practically no change in performance up to 1500 hours. The test was discontinued at this time since 1500 hours is equal to approximately two years of service

under average conditions. Such life is only obtained from tubes which are not overloaded or abused. The increased life and satisfaction obtainable when rated voltages are used, together with the saving in battery current, justifies the use of a filament voltmeter. This is especially desirable with multiple tube sets using Types C-299, CX-299 and CX-220.

If it is necessary to reactivate tubes each month or at frequent intervals, it is proof that the tubes are being overloaded, and in such cases users of Cunningham Radio Tubes can be assisted to obtain satisfactory service by having their attention called to the following:

1. Do not burn the filament at voltages in excess of the rated filament terminal voltage. Keep the filament rheostat set as low as possible, or use a reliable voltmeter.

2. Do not use high plate voltages unless "C" batteries are provided. With types C-299, CX-299 and CX-301A better life is obtained, and B battery current drain lessened, when a voltage of 67½ volts or less is used in the plate circuit in case no C battery is provided.

3. Be careful when changing battery connections to see that battery polarities are not reversed. If the leads connecting filament heating (A) or grid biasing (C) battery are reversed, signals and music may still be heard, but they will be faint or distorted. Such a reversed condition often causes the operator to turn the filament to a high setting, thus injuring the tubes without appreciably improving results. Always check battery connections after making any changes.

4. If an insensitive tube and a tube in perfect condition are operated from the same rheostat, there will be a tendency to overload the good tube in order to obtain operation from the poorer one. The poor tube should be reactivated or replaced. Here again, the use of a reliable filament voltmeter will save overloading the tubes.

5. If a set without filament voltmeter is equipped with a rheostat volume control which operates by reducing the filament temperature of one or more tubes, this control should always be set to the "Full" or "On" position when adjusting the filament rheostat. If not set to the "Full" position an increase in the filament voltage will increase the audibility of the set at the same time overloading the tubes not controlled by the volume rheostat.

6. When using C-299, CX-299 or CX-220 and a filament voltmeter is not available, the operation of the set may be checked as follows: Connect only two fresh dry cells in series for use as the filament heating (A) battery. The rheostats may now be turned full on, and if the set and tubes are operating correctly, satisfactory reception will be obtained. If results are not satisfactory, check over batteries, battery connections, antenna connections and tubes. When the trouble is located, satisfactory reception will be obtained with the two fresh cells.

GENERAL COMMENT

Many of the standard types of tube rejuvenators use excessive voltage with the frequent result that the tube is permanently damaged or has its useful life shortened. This is especially true with the C-299, CX-299 and CX-220 tubes. With these tubes, the second burning voltage should not exceed 4.0 volts.

The voltages specified in the table are the maximum which should be used. The use of a voltmeter to set the applied voltages to the proper values is essential to obtain proper results.

Tubes which have internal shorts between elements cannot be reactivated and it may be convenient to check for such conditions with a pair of phones and a dry cell. When the tube is not lighted there should be an open circuit between the grid and all other elements, between the plate and all other elements and a closed circuit thru the filament.

Tubes in which the vacuum is impaired cannot be reactivated. This is usually indicated by a filament current reading above rated value. If considerable air is present in the tube, the filament will not light up at all unless the filament voltage is raised well above normal, in which case the filament may burn out.

Cunningham Radio Tubes Type C-11, CX-12, CX-112 and CX-300 do not use the thoriated tungsten filament and cannot be reactivated.