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2,513,207

METHOD OF MAKING MICROWAVE TUBES

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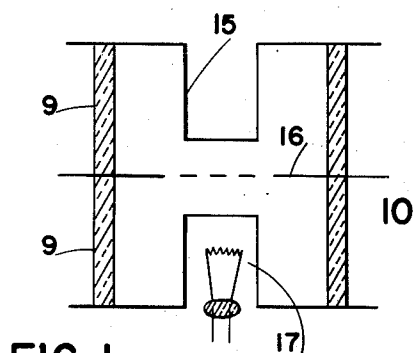


FIG. 1

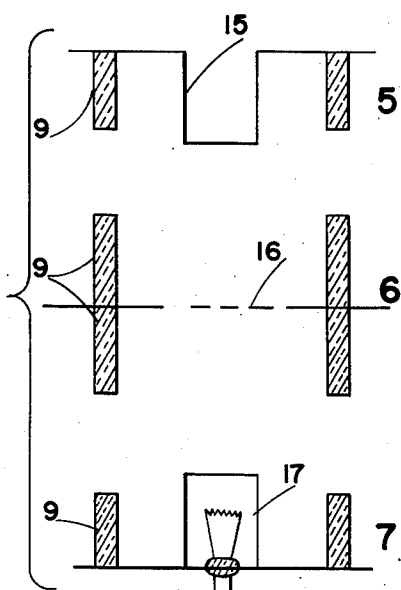


FIG. 2

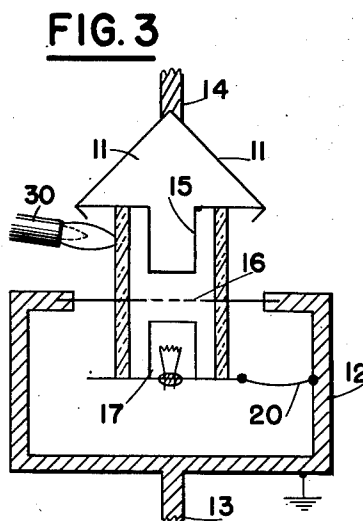


FIG. 3

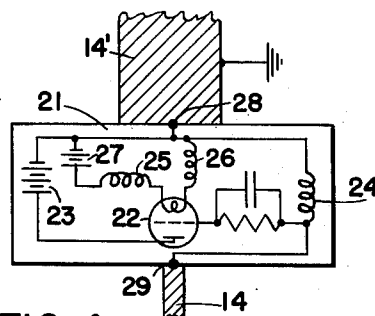


FIG. 4

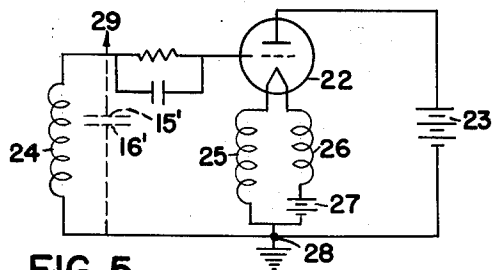


FIG. 5

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METHOD OF MAKING MICROWAVE TUBES

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1 Claim. (Cl. 49—78)

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This invention relates to electric discharge de-
vices and more particularly to an improved
method of adjusting vacuum tube electrodes.

For microwave tubes it is desirable to employ
ring seals and close spacing of electrodes, to-
gether with electrode shapes that form a con-
tinuous part of the "resonant line" or "cavity"
tank circuits cooperating with the electrodes.
However, when ring seals and such electrodes
have been used it has been found difficult to ob-
tain accurate control of the spacings.

It is therefore an object of my invention to
make final adjustment of spacings in accordance
with a continuous indication of interelectrode
capacity.

In the attainment of the foregoing object it is
an important feature of my invention to make use
of the interelectrode capacity of the electrodes
as an indicator of spacing during the actual as-
sembly of the tube.

The phases of this invention which I desire to
protect herein are particularly pointed out in
the appended claim. The invention itself to-
gether with further objects and advantages there-
of can best be understood by reference to the
following description taken in conjunction with
the accompanying drawings of which Fig. 1 is
a cross-section view of a microwave vacuum tube
of the type to which this invention applies; Fig. 2
is a cross-section view showing the component
parts of the tube of Fig. 1; Fig. 3 is a sectional
view of a tube mounted in the adjusting device;
Fig. 4 is a schematic view of the upper end of
the upper shaft of Fig. 3; and Fig. 5 illustrates
a simple triode oscillator.

Referring particularly to Fig. 2, there are shown
the three sections 5, 6 and 7 which when properly
joined together form the tube 10 of Fig. 1. This
tube is seen as having electrodes adapted to ex-
ternal continuation to form resonant cavities and
is well suited to external cooling of the anode.

These sections are each composed of an elec-
trode with glass ring seals. Section 7 with cath-
ode 17 also has a glass bead or two beads with
the heater wires sealed in and an evacuating tip
(not shown). Said cathode 17 has sufficient per-
forations or slits in the thimble-like cathode to
permit evacuation from inside the cathode
thimble.

For proper operation of this method of ad-
justment the sections 5, 6 and 7 when they are
joined together to form said finished microwave
tube 10, the interelectrode spacing should be made
greater than that ultimately desired. In joining
the sections together to form the tube 10, they

are mounted in any suitable apparatus such as
a lathe.

When a lathe is used to obtain the final ad-
justment of parts, the machine is employed as
schematically shown by Figs. 3 and 4. A shaft
13 is adapted to be attached to the headstock of
a lathe, not shown, and carries a chuck 12. A
shaft 14' is also adapted to be supported by the
tailstock of the same lathe, not shown. To shaft
14' is secured a container 21 suitably formed
from insulating material. An electrically con-
ducting extension 14 is attached to the container
21 and a plurality of spring fingers 11 secured to
the extension 14. The chuck 12 and shaft 13
are grounded electrically as schematically shown
in Fig. 3. The electrode being not adjusted, such
as 17 in Fig. 3, is likewise grounded by a ground
clip 20. To obtain accuracy of results, the metal
elements of the tube are accurately machined
or otherwise made up so as to insure the plane
of the electrode when mounted in the chuck 12
being perpendicular to the shaft 13 and accu-
rately centered.

As shown in Fig. 4, which fits immediately
above Fig. 3, the oscillator of Fig. 5 whose tuned
circuit utilizes the interelectrode capacity of the
electrodes being adjusted as the frequency deter-
mining element.

Fig. 5 illustrates a form of a suitable self-con-
tained oscillator for enclosure in container 21.
The ends of the inductance 24 are connected by
leads extending through the container 21 to
points 28 and 29 on the shafts 14' and 14, re-
spectively. It is a simple triode oscillator com-
prising a suitable triode 22, power supplies 23
and 27, filament chokes 25 and 26, grid biasing
network and an appropriate inductance 24. The
necessary capacitance for this oscillator circuit
is the interelectrode capacity of the tube elec-
trodes being adjusted which, in the case of those
being adjusted in Fig. 3, are electrodes 15 and
16. The capacitance of these electrodes appears
across the inductance 24 as schematically shown
by the dotted line of Fig. 5, with the upper and
lower plates 15' and 16', representing tube elec-
trodes 15 and 16, respectively.

Any known type of oscillator may be used, the
only requirement being that the electrodes of
the tube under adjustment be connected to the
oscillator so that their interelectrode capacity af-
fects its frequency. Also in addition to this gen-
eral method, it would be possible to use a sepa-
rate oscillator and to couple this loosely to a
second circuit comprising an inductance and

the interelectrode capacity of the tube being assembled.

As the oscillator frequency is varied, a change in oscillator plate current will be observed as its frequency passes through resonance with said second circuit. The electrode spacings are adjusted until the frequency at which the change of plate current occurs has the certain desired value.

Final adjustment of the interelectrode spacing is to be made as shown in Fig. 3. For instance, the grid-to-anode spacing is adjusted as follows: a chuck 12 on the lower shaft 13 grips the grid 16. The anode disc 15 is gripped by the spring fingers 11 which tend to center said anode 15 and also tends to force the anode to be parallel to the grid 16. This whole arrangement is then mounted in a lathe (not shown), said lathe containing the customary means to provide accurate axially controlled movement of either shaft 13 or 14'. The whole arrangement is now rotated while a gas flame 30 is applied to the desired areas to soften the glass envelope in a ring between the anode 15 and the grid 16. As the glass softens, the spring fingers 11 succeed in what they had only been tending to do and move the anode into exact alignment. The grid-anode spacing is then altered by moving the lathe controls until the oscillator within the insulated container 21 reaches a predetermined frequency, as is evident by its producing a beat frequency with an oscillating receiver. The gas flame 30 is then removed and the proper spacing of the electrodes is maintained by the shafts 13 and 14' while the glass hardens.

The adjustment of the grid-anode spacing having been completed, the tube is reversed and the grid-cathode spacing is similarly adjusted.

Any further shrinkage after the glass hardens can be allowed for by adjusting to a slightly wider spacing than desired in the final product. The amount of allowance necessary will be evident from the behavior of the first few tubes so adjusted.

As an alternative method, the sections 5, 6, 7 may be joined in the lathe. Thus, the spacing would be adjusted and the sealing made all in one operation. In this method the grid section 6 would first be sealed to one of the other sections, then turned over and sealed to the remaining one, each sealing being accompanied by spacing adjustment.

The predetermined frequency is arrived at as follows: a properly spaced similar pair or set of test electrodes (without seals) is put in the lathe.

The oscillator is turned on and the receiver adjusted to zero beat. Then when the electrodes under adjustment are at the same spacing, the oscillator will be heard on the receiver. The same non-visual process determines the setting of the receiver for adjusting grid-cathode spacing.

For extremely close adjustment it may be preferable to avoid vibration by holding the shafts 13 and 14' stationary and playing the gas flame from all sides, or rotating the flame.

While the invention is herein described by reference to particular embodiments thereof, it will be understood that numerous modifications may be made without actually departing from the true spirit and scope of the invention.

I claim:

The method of making a microwave tube having closely spaced tube electrodes ring-sealed in a tube envelope; said method comprising re-spacing said tube electrodes within said envelope after said tube is finished, by adjusting to a properly spaced set of test electrodes; said method including the following steps: forming said tube so that said tube electrodes are spaced apart at a distance greater than that ultimately desired; maintaining a continuous non-visual indication of the interelectrode capacity of tube electrodes by means of an oscillator and a receiver circuit; using said capacity as the capacitance of said oscillator so that said capacity affects the frequency of said oscillator; holding a properly spaced set of un-sealed tube test electrodes in operating connection with said circuit; thereafter adjusting said receiver to zero beat; applying heat to soften a portion of said tube adjacent said tube electrodes; moving said tube electrodes within said softened portion until they attain a re-spaced position at which said oscillator is heard on said receiver; removing said heat from said portion; and retaining said tube electrodes in said re-spaced position until said portion has re-hardened.

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