

June 27, 1944.

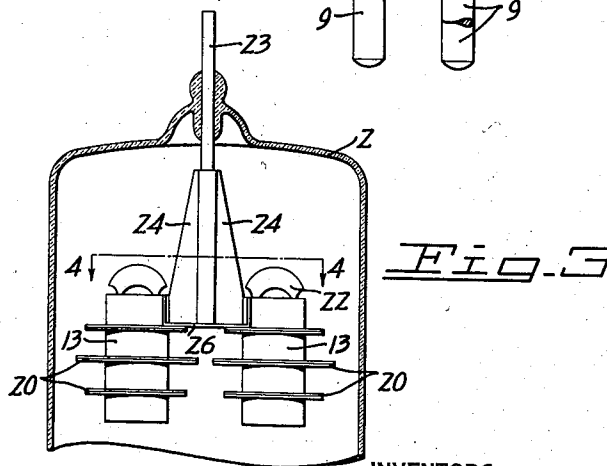
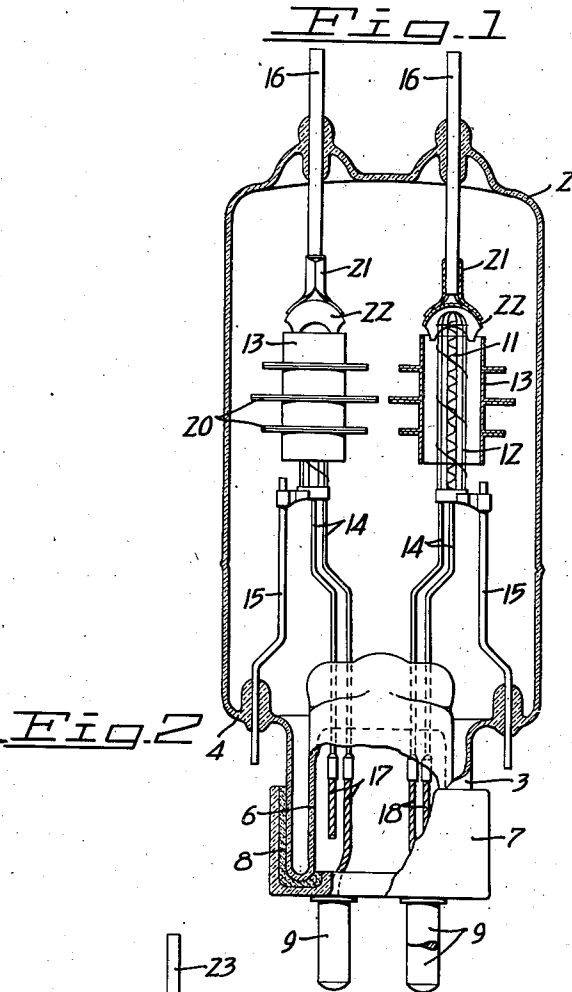
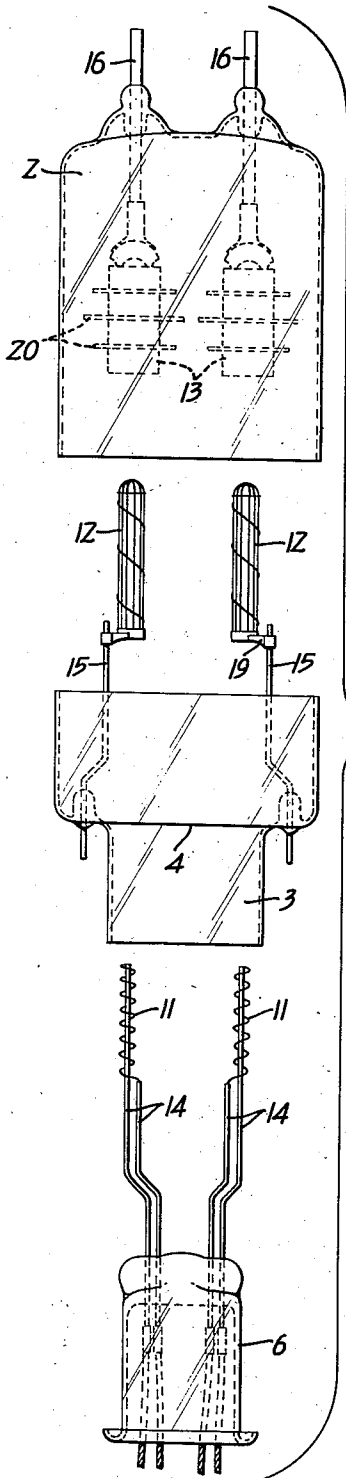
W. W. EITEL ET AL

2,352,522

ELECTRICAL DISCHARGE DEVICE AND METHOD OF MAKING THE SAME

Filed Feb. 14, 1941

2 Sheets-Sheet 1



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Fig. 5

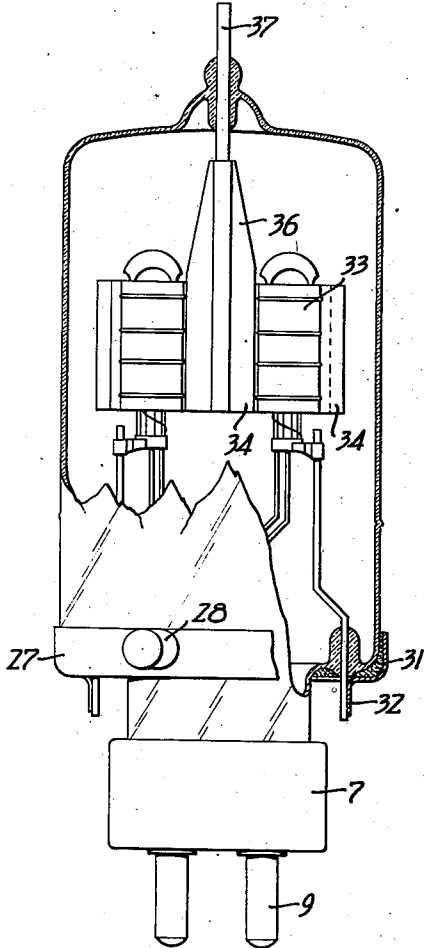


Fig. 6

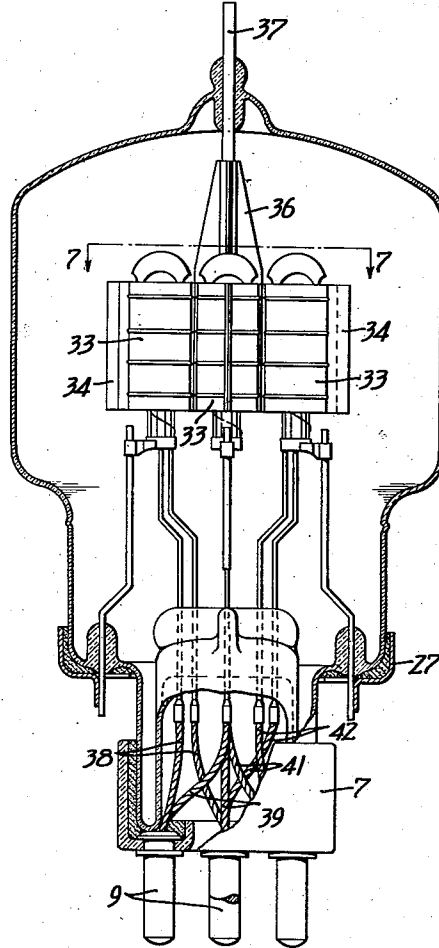


Fig. 7

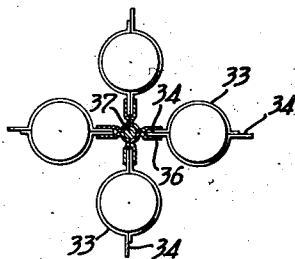
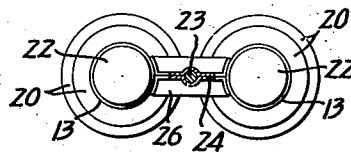


Fig. 4



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ELECTRICAL DISCHARGE DEVICE AND
METHOD OF MAKING THE SAME

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Application February 14, 1941, Serial No. 378,900

9 Claims. (Cl. 250—27.5)

Our invention relates to electron discharge de-
vices; and more particularly to thermionic tubes.

It is among the objects of our invention to pro-
vide an improved multiple-unit tube wherein sev-
eral operative units are assembled within a single
envelope, and in which the individual units are
designed with electrode spacings approximately
the ideal in regard to transit time effects, electron
migration, interelectrode capacity, and thermionic
efficiency.

Another object is to provide a tube of the char-
acter described having a plurality of units adapted
for operation either singly or simultaneously.

Another object is to provide a multiple-unit tube
in which a unit may be brought into operation
after another unit is disabled, thus increasing the
life of the tube; and in which an inactive unit may
be employed for neutralizing capacity.

Still another object is to provide improved
means for connecting like electrodes of the units
in parallel for simultaneous operation.

A further object is to provide improvements in
the anode structure of an electron discharge de-
vice, which improvements may be embodied in an
ordinary single-unit tube as well as in our mul-
tiple-unit tube.

A still further object is to provide an improved
method of assembling tubes to simplify their fab-
rication and insure alignment and accurate spac-
ing of the electrodes.

The invention possesses other objects and fea-
tures of advantage, some of which, with the fore-
going, will be set forth in the following descrip-
tion of our invention. It is to be understood that
we do not limit ourselves to this disclosure of
species of our invention, as we may adopt variant
embodiments thereof, within the scope of the
claims.

Referring to the drawings:

Figure 1 is a side view, partly in section and
partly in elevation, showing a two-unit tube em-
bodying the improvements of our invention; and

Figure 2 is an exploded view of the same illus-
trating the electrodes mounted on the several
envelope sections.

Figure 3 is a fragmentary view showing a modi-
fied construction in which the anodes are unitarily
supported; and

Figure 4 is a horizontal sectional view taken in
a plane indicated by line 4—4 of Figure 3.

Figure 5 is a side view, partly in section and
partly in elevation, showing another modified two-
unit tube; and

Figure 6 is a similar view of a four-unit tube.

Figure 7 is a horizontal sectional view taken in
a plane indicated by line 7—7 of Figure 6.

In terms of broad inclusion, our electrical dis-
charge device comprises a plurality of units
mounted within a single envelope and each in-
cluding a plurality of electrodes such as cathode,
grid and anode. Improved means are provided
for mounting the electrodes of the several units,
and means are provided for establishing connec-
tions with the electrodes for operating the units
either independently or simultaneously. Another
feature of our invention relates to improved means
for radiating heat from an electrode such as an
anode. Our invention also embodies an improved
method of assembling the electrodes in a tube.

In greater detail, and referring to Figure 1 of
the drawings, one type of two-unit tube embody-
ing the improvements of our invention comprises
an envelope of vitreous material such as glass hav-
ing an upper end or dome portion 2, an interme-
diate portion including a reduced neck 3 and a
shoulder 4, and a lower end portion including a re-
entrant stem 6. The base of the tube comprises a
porcelain collar 7 secured to the neck by cement 8
and carrying four terminals or prongs 9 three of
which are shown in Figure 1.

The two units are preferably disposed sym-
metrically about the axis of the tube; and each
comprises a set of electrodes including a cathode
or filament 11, a grid or control electrode 12, and
an anode or plate 13. Cathodes 11 are supported
from stem 6 by conductors 14; grids 12 from
shoulder 4 of the intermediate tube portion by
conductors 15; and anodes 13 from dome portion
2 by conductors 16. These supporting wires are
all sealed in the tube portions indicated and
provide external connections for the various
electrodes. The mounting of the grid supports at
shoulder 4 instead of in the base of the tube
materially reduces the interelectrode capacities
at the base.

Cathodes 11 may be of any suitable form, such
as the coiled filaments illustrated; one filament
being connected to one pair of terminals 9 by
leads 17 and the other filament being connected
to the other pair of terminals by leads 18. Grids
12 are also of optional construction, the type
shown comprising a series of vertical wires with
an outer reinforcing helix all held by a base ring
secured to support 15 by an arm 19.

Anodes 13 may be of any desired construction,
but better results are secured by using the par-
ticular type shown. Our improved anode is hol-
low and preferably cylindrical in shape, and has
a series of say three radiating fins 20 disposed

circumferentially about the electrode and extending transversely of the electrode axis. The axis referred to is the longitudinal axis about which the cathode and grid are also disposed. Our anode is preferably made from drum-like sections having integrally formed, outwardly extending, annular flanges to provide fins of double thickness when the sections are secured together.

Since an anode is subjected to greatest heating at its central portions, we make the central fin wider than the others. In other words, the fins are arranged and proportioned to provide heat radiating surfaces varying in size in accordance with the degree of heat to be dissipated. The use of annular fins makes this arrangement possible. Annular fins have the further advantage of embracing the full diameter of the electrode, thereby giving the most effective heat radiation, particularly along the mid-diameter where the maximum heating occurs. This arrangement of cooling fins is much superior to the longitudinal fins commonly used, and we have materially increased the output of our tubes merely by making this change. It is to be understood that these improvements in the anode structure per se are adaptable for use in ordinary single-unit tubes as well as in our multiple-unit tubes.

The anodes of the tube type shown in Figure 1 are separately supported by the conductors 16, each anode being fastened to its support by a strap 21 secured to a cap 22 of the electrode. These supports being separate from and independent of the heat radiating fins 20 tends to thermally isolate the anode; which is desirable for the purpose of keeping the glass seal at the support from undue heating. Separate external connections can thus be made to each electrode of each unit, so that one unit may be operated independently of the other. When the units are operated singly the life of the tube is doubled, it being only necessary to turn the tube around in the socket to bring another unit into operation when one of the filaments burns out. Another important feature is that the inactive unit may be employed for neutralizing capacity. The two units thereby mutually cooperate in the functioning of the tube, even though only one unit is in actual operation and even though the other unit may be burnt out. If desired, of course, the electrodes having similar function may be connected in parallel to simultaneously operate the units.

For simultaneous operation however the anodes are preferably connected in parallel to a common central support 23 as shown in Figures 3 and 4. In this case a bracket is provided with lateral fins 24 embracing the support and with base flanges 26 secured to the upper fins of the anodes. Fins 24 extend upwardly along the support and decrease in width therealong. These fins aid in radio frequency conduction, and also function to dissipate heat.

Figure 5 shows another two-unit tube having units adapted for simultaneous operation. The grids are connected in parallel by a conducting ring 27 having a terminal button 28 and secured to the shoulder of the envelope by a suitable cement 31; the grid conductors being joined to the ring at lips 32.

Figure 5 also shows a variant type of anode mounting employing anodes 33 having ordinary longitudinal fins 34. Fins 36 of the supporting bracket embrace conductor 37 and lap the inwardly extending fins on the anode so that the

brackets form an extension of the anode fins. Here again the bracket fins taper down toward their outer ends. The base structure and cathode connections of this tube are preferably similar to that shown in Figure 1, since both cathodes may be simultaneously energized by making proper connections with terminals 9.

Figures 6 and 7 illustrate a four-unit tube of a construction similar to that of Figure 5 but embodying four complete units instead of two. The four anodes are all connected in parallel to the common support 37, and the four grids are connected in parallel to ring 27. The cathode connections in this tube are made to the four base terminals 9 by connecting two of the filaments in parallel to a pair of terminals by leads 38 and 39, and connecting the remaining two filaments in parallel to the other pair of terminals by leads 41 and 42.

Another feature of our invention, which is applicable to ordinary one-unit tubes as well as our multiple-unit tubes, relates to a method of assembling the electrode in the envelope to insure accurate alignment and spacing. With reference to the tube type shown in Figure 1, for example, and referring particularly to Figure 2, our method comprises forming the envelope in a plurality of say three separate sections corresponding to the three portions previously referred to herein; namely, an upper end section including dome 2, an intermediate section including neck 3 and shoulder 4, and a lower end section including stem 6. The cathode structure is mounted on the stem section, the grid structure on the intermediate section, and the anode structure on the dome section. By this arrangement the several electrode structures may be readily and accurately fabricated on suitable jigs. The envelope sections are then fused together; the lower and intermediate sections being preferably fused first to enable proper alignment of the cathode and grid structures before the dome section is sealed in place.

Our multiple-unit tubes in which the units operate in unison give excellent results. Many unsuccessful attempts have been made in the past to produce large tubes having the high operating efficiency characterizing tubes of small physical size. In our improved tubes where several small operative units are assembled within a single envelope, the individual units are designed with electrode spacings approximating the ideal in regard to transit time effects, electron migration, interelectrode capacity and thermionic efficiency. Our tubes are extremely easy to drive; provide a high power output at low plate voltage; and the small interelectrode capacities enable them to operate effectively at ultra high frequencies.

We claim:

1. In an electrical discharge device, an envelope, a plurality of cathodes and grids and anodes in the envelope, said envelope having an annular shoulder providing a ledge intermediate the ends of the envelope, conductor means for the cathodes extending through an end of the envelope, conductor means for the anodes extending through the other end of the envelope, and conductor means for the grids extending through said ledge.

2. In an electrical discharge device, an envelope, a plurality of anodes disposed about substantially parallel axes in the envelope, a grid and cathode associated with each anode, said envelope having a reentrant stem at one end there-

of, pairs of cathode leads sealed to the stem, each of the cathodes being connected to a pair of said leads, an anode lead sealed to the envelope adjacent its other end, means for unitarily supporting the anodes on said anode lead, a plurality of grid leads sealed to the envelope intermediate its ends, and means for supporting each grid on one of said last mentioned leads.

3. The method of making an electronic tube having an envelope enclosing a plurality of cathodes and grids and anodes, which comprises forming the envelope in a plurality of sections, including intermediate and two end sections, mounting the cathodes on one end section, mounting the grids on the intermediate section, mounting the anodes on the other end section, and uniting the sections of said envelope.

4. An electronic tube comprising an envelope having a stem at one end thereof, a plurality of anodes and associated grids and cathodes in the envelope, an anode lead sealed to the end of the envelope opposite said stem, means for unitarily supporting the anodes on said lead, conductor means for the grids sealed to the envelope portions intermediate the anode lead and said stem, and conductor means for the cathodes sealed in the stem, said conductor means for said cathodes being joined to connect the cathodes in parallel.

5. An electronic tube comprising a sectional vitreous envelope having a reentrant stem in the lower section thereof, a plurality of tubular anodes in the envelope, conductor means connected to the anodes and sealed to and supported by the upper section of the envelope, a grid associated with each anode and having an upper free end and a lower terminal end, conductor means connected to the terminal ends of the grids and sealed to intermediate portions of the envelope, a cathode associated with each anode, and conductor means connected to the cathodes and sealed in said stem.

6. An electronic tube comprising a vitreous envelope having a reentrant stem at the lower end

and having an annular shoulder intermediate its ends, a plurality of tubular anodes spaced about the axis of the envelope, conductor means connected to the anodes and sealed to the upper portions of the envelope, a grid associated with each anode, conductor means connected to the grids and sealed to the envelope adjacent said shoulder, a cathode associated with each anode, and conductor means connected to the cathodes and sealed to said stem.

7. An electronic tube comprising a vitreous envelope having a reentrant stem at the lower end and having an annular shoulder intermediate its ends, a plurality of tubular anodes spaced about the axis of the envelope, conductor means connected to the anodes and sealed to the upper portions of the envelope, a grid associated with each anode, a plurality of leads each connected to one of the grids and disposed in a circle with their ends sealed to the envelope adjacent said shoulder, a cathode associated with each anode, and conductor means connected to the cathodes and sealed to said stem.

8. An electronic tube comprising a vitreous envelope having portions fused together along a plane intermediate the ends of the envelope, a tubular anode within but distinct from said envelope, a grid and cathode extending within said anode, means supporting the anode on one of the envelope portions, and means supporting the grid and cathode on the other portion.

9. An electronic tube comprising a sectional envelope, a plurality of tubular anodes in the envelope, a seal joining the envelope sections in a plane transverse to the axes of said anodes, conductor means connected to the anodes and sealed to and supported by a section of the envelope lying at one side of said plane, a cathode extending within each anode, and conductor means connected to the cathodes and sealed to and supported by a section of the envelope lying at the opposite side of said plane.

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