

June 21, 1949.

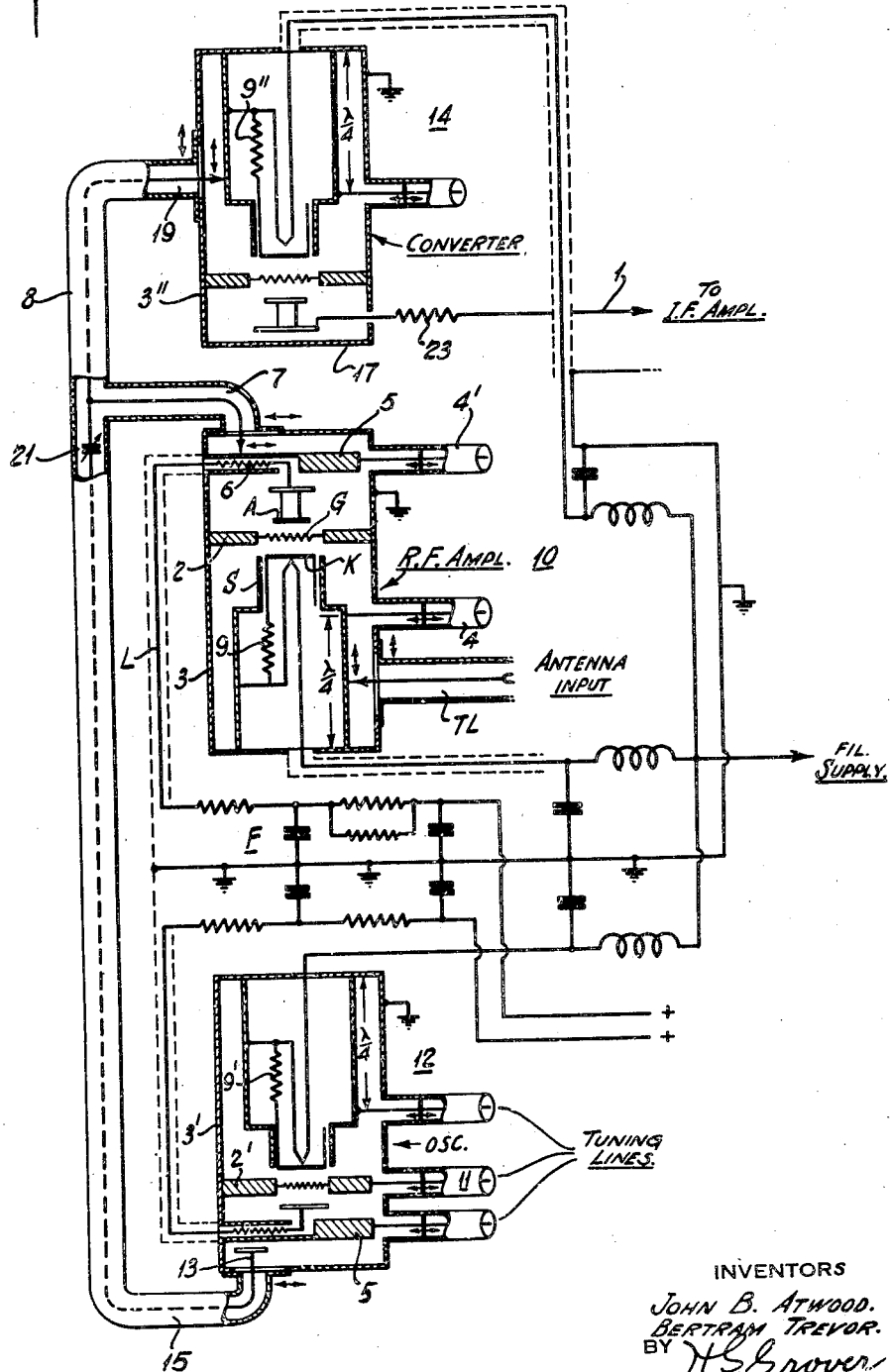
J. B. ATWOOD ET AL
MOUNTING FOR ELECTRON DISCHARGE DEVICE
OF THE HIGH-FREQUENCY TYPE

2,474,026

Filed April 6, 1944

3 Sheets-Sheet 1

Fig. 1.



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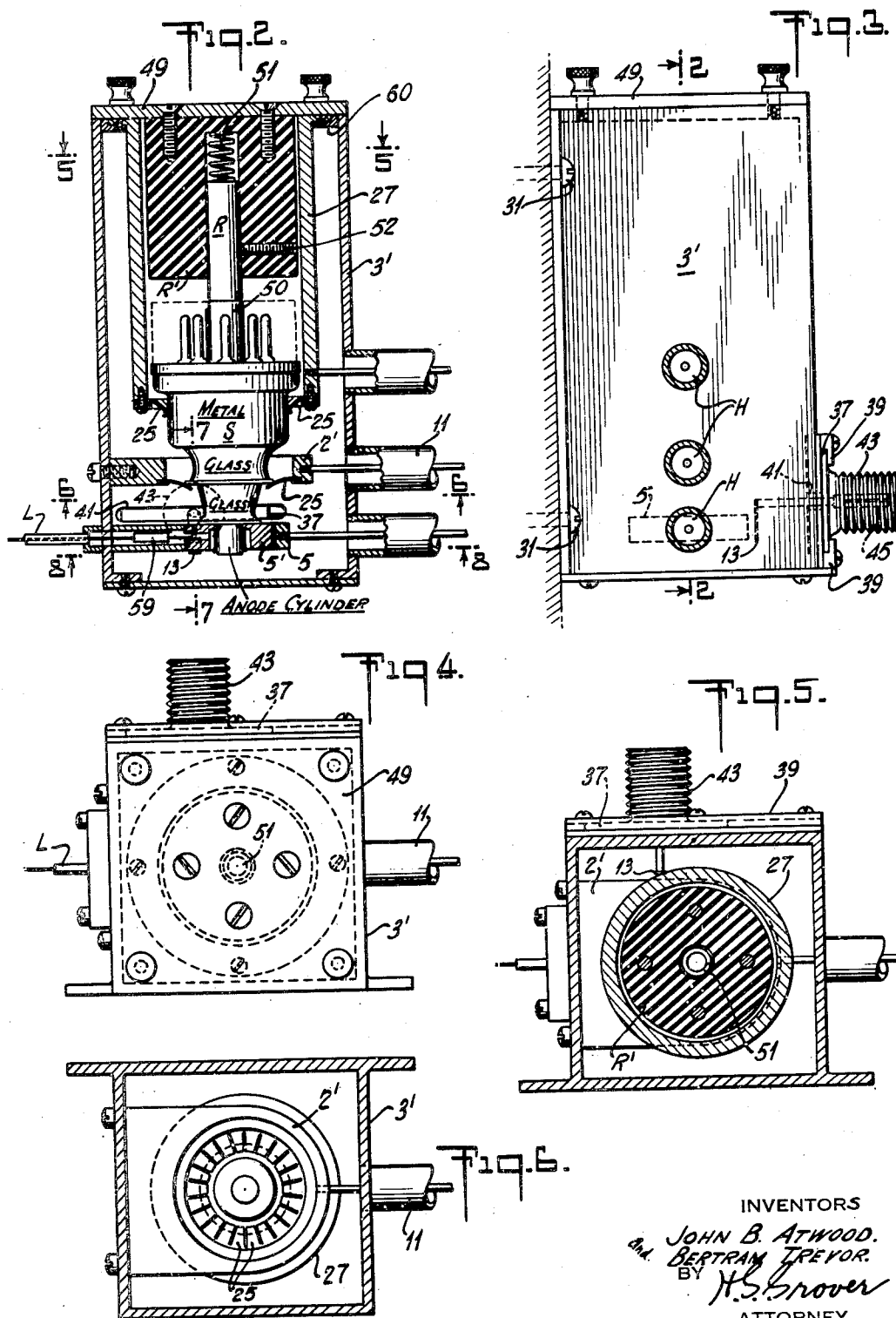
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Fig. 7.

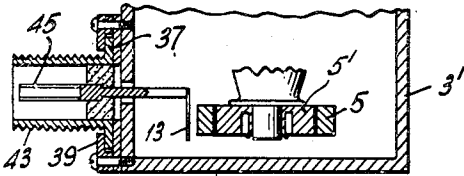


Fig. 8.

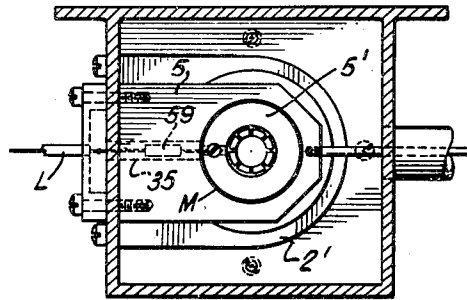


Fig. 10.

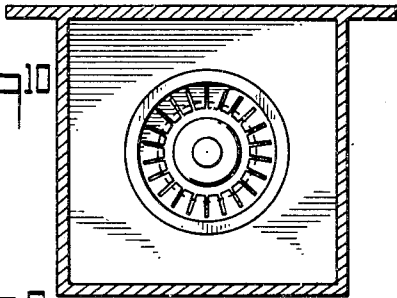


Fig. 12.

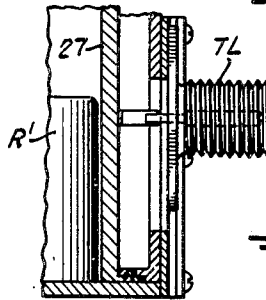


Fig. 9.

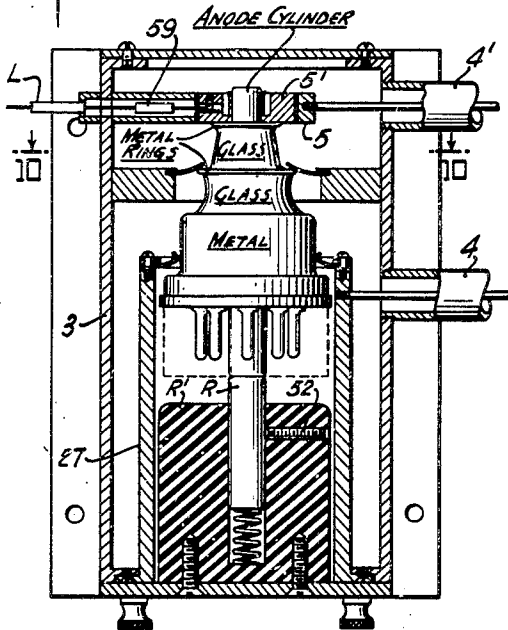
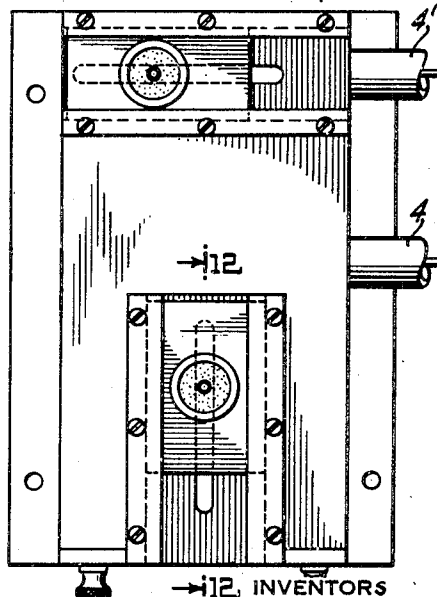


Fig. 11.



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UNITED STATES PATENT OFFICE

2,474,026

MOUNTING FOR ELECTRON DISCHARGE
DEVICE OF THE HIGH-FREQUENCY TYPEJohn B. Atwood and Bertram Trevor, Riverhead,
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Application April 6, 1944, Serial No. 529,716

7 Claims. (Cl. 315—39)

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This invention concerns novel mechanical constructions for accommodating ultra high frequency vacuum tubes of the so-called "lighthouse" type.

In designing radio apparatus for use in the frequency range beyond 1000 megacycles, it has been found advantageous to employ that type of vacuum tube which is now generally referred to as the "lighthouse" tube. In this tube, the grid and anode terminals protrude through the glass envelope in the form of metallic discs or rings which are insulatingly spaced from each other by the glass along the length of the tube. These anode and grid rings are arranged physically parallel to each other, and the anode ring is preferably smaller than the grid ring. The tube includes a metallic shell which is coupled for radio frequencies to the cathode positioned in its interior. In practice, the anode, cathode and grid electrodes within the tube envelope are very close to each other. The anode within the tube envelope forms one end of a metallic cylinder whose other end extends externally of the glass envelope along the longitudinal axis of the tube. The anode ring is connected to this cylinder at a location intermediate its ends. One such "lighthouse" tube, mentioned by way of example, is the General Electric type GL-446 triode.

Among the objects of the present invention are: to provide an ultra high frequency receiver employing "lighthouse" tubes for the oscillator, converter and first radio frequency amplifier stages; to provide novel mechanical constructions for accommodating tubes of the "lighthouse" type; and to provide novel coupling and tuning arrangements for the circuits employing these "lighthouse" tubes.

A more detailed description of the invention follows in conjunction with a drawing, wherein:

Fig. 1 is a view partly schematic and partly mechanical, of the invention as applied to the oscillator, radio frequency amplifier and converter stages of a superheterodyne receiver for receiving ultra high frequency signals in the range above 1000 megacycles;

Fig. 2 is a longitudinal sectional view of mechanical construction of the oscillator stage, including the tube support, electrode coupling elements, and tuning lines. Fig. 2 is a section along the line 2—2 of Fig. 3.

Fig. 3 is a side view of the outer metallic casing of the oscillator stage.

Fig. 4 is a plan view of the outer metallic cas-

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ing of Figs. 2 and 3. This view shows the adjustment feature of the output probe;

Fig. 5 is a cross-sectional view of the construction of Fig. 2 along the line 5—5;

Figs. 6, 7 and 8 are sectional views of Fig. 2 along the lines 6—6, 7—7 and 8—8, respectively;

Fig. 9 is a longitudinal sectional view of the mechanical construction of the radio frequency amplifier stage of Fig. 1;

Fig. 10 is a sectional view of Fig. 9 along the line 10—10; and

Fig. 11 is a front elevation view of Fig. 9,

Fig. 12 is a cross-section of Fig. 11 along the line 12—12.

Referring to Fig. 1 in more detail, there is shown the ultra high frequency portion of a superheterodyne receiver comprising a radio frequency amplifier stage 10 to which incoming energy is supplied over a transmission line TL extending to an antenna (not shown), a heterodyne oscillator stage 12, and a converter stage 14 to which the output of both the radio frequency amplifier and the heterodyne oscillator are fed. The output from the converter 14 is fed over lead 1 to a multi-stage intermediate frequency amplifier (not shown). By way of example only, the receiver may cover an incoming frequency range of 1350 to 1545 megacycles, while the intermediate frequency energy supplied to lead 1 by the converter 14 may have a mid-band frequency of the order of 30 megacycles.

Each of the stages 10, 12 and 14 employs a triode vacuum tube of the so-called "lighthouse" tube referred to above, which may be a GL-446 triode manufactured by the General Electric Company.

The radio frequency amplifier stage 10 comprises a GL-446 lighthouse triode tube having a grid G, an anode A, and a cathode K. The cathode K is capacitively coupled from a radio frequency standpoint to an outer metallic shell S. The grid G is connected to a grid ring or disc which in turn engages a metallic square shaped plate 2 mounted in the interior of and secured at its edges to an outer hollow square shaped metallic housing or box 3. Housing 3 is connected directly to ground as a result of which the grid of the amplifier stage 10 is grounded. The housing accommodates and supports the lighthouse tube of stage 10 and is provided with suitable apertures to enable the input and output connections to be coupled with the circuit.

The line TL is a short coaxial line connector which couples the antenna line (not shown) to

the cathode shell S. The inner conductor of line TL enters the interior of the housing 3 through a vertical slot. To match the impedance of the line to the cathode impedance, the line as a unit is adjustable vertically over housing 3 in combination with the position of the short-length coaxial tuning stub 4. Stub 4 is a coaxial line whose inner conductor is connected to the cathode shell S at a point one-quarter of a wavelength at the mid-frequency from the grounded bottom of the housing. The stub 4 is provided with a tuning slider which short-circuits the inner and outer conductors of the stub and is adjustable in position along the length of the stub.

The anode A is capacitively coupled to a rectangular metallic plate support 5 having a hole drilled in one end thereof for accommodating a 1000 ohm resistor 6 in series with the anode direct current potential supply circuit. The resistor 6 is connected at one end to a filter F before extending to the direct current positive potential supply for the anode. The anode circuit is resonated, like the cathode circuit, by an adjustable coaxial line stub 4' whose inner and outer conductors are short-circuited by a suitable slider. The slider conductor of stub 4' is connected to the anode, from a radio frequency standpoint.

The output of the radio frequency amplifier 10 is obtained from an adjustable tap on the plate support 5 and is fed through a short length of flexible shielded cable 7 (W. E. Co. #KS-8086 type for example) to the cable 8 extending to the converter 14.

The cathode K is provided with a 270 ohm cathode bias resistor 9 mounted on the tube socket and which is connected between the cathode and the shell S, the shell S being grounded for direct current. The resistor 9 is by-passed by the 30 μ f. cathode-to-shell capacity built into the tube.

One side of the filament of stage 10 is also grounded through the shell, while the other side of the filament is filtered before going to the filament heater supply.

The oscillator stage 12 is also provided with a "lighthouse" tube mounted somewhat similarly to the amplifier within a grounded hollow rectangular metal box 3'. This stage 12 differs primarily in four respects from the radio frequency amplifier. First, the cathode bias resistor 9' is higher in value than the cathode resistor 9 of the amplifier in order to limit the anode current. Second, the grid contact plate 2' is fastened at only one edge to the housing 3' and is tuned at another edge by a short length coaxial line stub 11, instead of being grounded thereat. Third, the output is capacitively coupled to the anode plate 5 instead of being conductively coupled as in the case of the amplifier stage, and fourth, the anode voltage is regulated.

The output for the oscillator 12 is obtained from an adjustable capacity probe 13 which connects with the inner conductor of the output coaxial line 15. The probe 13 enters the housing 3' at one end through a horizontal slot, and the entire end of line 15 is adjustable in position horizontally over this slot.

It should be noted that there are individual short-circuiting coaxial line tuning stubs for the cathode, grid and anode circuits of the oscillator stage 12. In the operation of the oscillator in one embodiment, its frequency was adjusted to be 30 megacycles lower than the signal frequency.

The converter stage 14 also includes a "lighthouse" tube positioned within a hollow rectangular

metallic housing or box 3'' which is grounded, and differs from the radio frequency amplifier stage in three respects, essentially. The cathode bias resistor 9'' has a value of 1000 ohms; the anode is by-passed for radio frequency voltages by a built-in 6 μ f. condenser; and there is no anode tuning stub. This condenser is formed by the box cover plate 17 and the anode spring fingers which are supported from the cover plate 17 by three isolantite beads. The energy from the output of the oscillator 12 via cable 15 and the signal energy from the output of the radio frequency amplifier 10 via cable 7 are both supplied to the cathode shell of the converter, as shown, through an adjustable cable terminal 19. The inner conductor of the cable at 19 passes through a vertical slot in the housing 3''.

The outputs of the radio frequency amplifier and the oscillator come together in a T connector just before they are applied to the cathode circuit of the converter 14. This T connector contains an adjustable capacity 21 which is used to couple in the oscillator energy. The output of the radio frequency amplifier can be matched into the converter cathode in the same way that the antenna can be matched in the radio-frequency amplifier cathode. The oscillator coupling capacity can then be adjusted for proper converter excitation which is indicated by an increase in the converter anode current. This coupling capacity can remain fixed over most of the frequency range of the receiver.

The location of the tapping point on the converter cathode shell is made adjustable, but this adjustable feature is not necessary and a fixed tap position can be used.

The anode of the converter is connected to the first intermediate frequency transformer through a 100 ohm resistor 23. The intermediate frequency amplifier (not shown) may comprise 5 stages having a mid-band frequency of 30 megacycles, and whose first three stages have automatic gain control.

Fig. 2 is a cross-section of Fig. 3 along the lines 2-2, and shows in section, the mechanical details of the oscillator stage 12 of Fig. 1. The "lighthouse" vacuum tube within the square housing or box 3' is shown in perspective. The socket for the tube prongs has not been shown for the sake of simplifying the drawing.

The grid plate 2', which is shown in more detail in Fig. 6, comprises a plurality of silver plated beryllium-bronze spring fingers 25 which engage the metallic circular grid disc or ring at all points around the ring. The cathode shell S is connected by means of spring fingers 25 to the end of a quarter wavelength piece of round metallic tubing 27 which surrounds the tube base and the socket (not shown). Tubing 27 is, in turn, supported at its base by a plate 60, over which a cover plate 49 is positioned. The housing 3' is secured by means of screws 31, note Fig. 3, to the panel of the receiver. This housing has three thread holes H for accommodating the coaxial line tuning stubs which tune the cathode, grid and anode circuits.

The anode plate 5 shown in more detail in Fig. 8, has along its axis a circular metallic plate 5' from which it is insulated by a suitable mica spacer M. The circular plate 5' is by-passed to the plate 5 for radio frequency energy through the mica M. This circular plate has a plurality of contact fingers surrounding a hole in the center of plate 5', for accommodating the anode cylinder of the lighthouse tube. The top of plate 5'

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(as seen in Fig. 2) contains the metallic anode disc or ring, while the contact fingers engage the metallic anode cylinder. Plate 5 has a hole 35 drilled in the end which is fastened to the wall of housing 3' for enabling the anode potential lead L to pass therethrough. The hole 35 is sufficiently large to accommodate the small round anode resistor 59. Insulation around the lead L within the hole 35 prevents direct electrical contact between lead L and plate 5. A hole is also drilled through the mica M to permit resistor lead L to be fastened in circular plate 5' and thus supply the anode with positive direct current polarizing potential.

The anode tuning stub in the form of a short section of coaxial line is also shown in Fig. 8, and has its inner conductor screwed into plate 5 at the edge opposite that through which the lead L enters.

The output adjustable tap for the oscillator comprises a movable plate 37 which is movable between the front wall of the housing 3' and a pair of flanges 39. Note Figs. 3, 4 and 7. Movable plate 37 has an aperture through which the probe 13 enters the interior of the housing 3' through a slot 41. The plate 37 also carries a threaded tubular section 43 which cooperates with a spring socket 45 to form a coaxial line stub for enabling the output cable 15 of Fig. 1 to be fastened thereto.

The "lighthouse" tube is maintained in position by pressure from the Bakelite rod R, Fig. 2, one end of which engages the insulation stub at the end of the tube and whose other end is in contact with a spring 51 exerting pressure on rod R. This rod is positioned in a suitable opening in a larger section of Bakelite rod R' which in turn is fastened by means of screws to the metallic cover plate 49 at the top of the housing 3'. The rod R is maintained in position by a screw 52 which enters the larger Bakelite rod R' as shown.

Fig. 9 shows in section the mechanical details of the radio frequency amplifier stage 10. The "lighthouse" vacuum tube within the square housing or box 3 is shown in perspective. As in Fig. 2, the socket for the tube prongs has not been shown.

The details of construction of Fig. 9 are very similar to those of Fig. 2 and their understanding will be apparent from what has been stated above. The grid plate 2 of Fig. 9 differs from the grid plate of Fig. 2 only in extending entirely across the interior of the housing 3 (note Fig. 10). The adjustable output coupling construction of Fig. 9 is similar to that of Fig. 2 except that the probe in Fig. 9 makes direct contact with the anode plate 5 instead of being capacitively coupled as in Fig. 2. The antenna coupling stub identified as TL is also similar in construction to the adjustable coupling structure of Fig. 3, and its similarity is apparent from an inspection of Figs. 11 and 12 showing views of Fig. 9.

We claim:

1. A mounting for an electron discharge device of the type having a pair of spaced grid and anode electrodes each of which has a planar disc-like terminal element which extends transversely of the discharge device is symmetrical with respect to the axis of the discharge device, and a cathode which is surrounded by and coupled to a metallic shell forming part of an enlarged base for said device, the anode terminal element being smaller than the grid terminal element and located near one end of said device; said mount-

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ing comprising a single hollow outer metallic enclosure which is longer than the discharge device and adapted to accommodate and support the discharge device with the longitudinal axis of the enclosure substantially coinciding with the longitudinal axis of the electron discharge device, a first metallic plate in the interior of said enclosure extending transversely of the longitudinal dimension thereof and attached to at least one wall of said enclosure, said plate having an aperture therein and a plurality of contact fingers around the edges of said aperture for engaging the grid terminal element of the discharge device, a second metallic plate in the interior of said enclosure also attached to one wall of said enclosure and parallel to said first plate but spaced therefrom, said second plate having an aperture in a portion thereof and a plurality of contact fingers around the edges of said aperture for coupling to the anode of the discharge device, the aperture of said second plate being smaller than the aperture of said first plate, and a hollow metallic tube completely within said enclosure and adapted to be connected at one end to said enclosure and at its other end adapted to surround at least a portion of and coupled to the metallic shell of the discharge device, said metallic tube and surrounding enclosure forming a line resonator, said enclosure having an aperture lying approximately in the same plane as one of said plate for enabling a line section to be coupled to that electron discharge device electrode which is adapted to be in circuit with said one plate, said enclosure having another aperture lying approximately one-quarter of a wavelength from that end of said metallic tube which is located within and connected to said enclosure for enabling a tuning line stub to be coupled to said line resonator.

2. A mounting for an electron discharge device of the type having a pair of spaced grid and anode electrodes each of which has a planar disc-like terminal element which extends transversely of the discharge device and is symmetrical with respect to the axis of the discharge device, and a cathode which is surrounded by and coupled to a metallic shell forming part of an enlarged base of said device, the anode terminal element being smaller than the grid terminal element and located near one end of said device; said mounting comprising a single hollow outer metallic enclosure which is longer than the discharge device and adapted to accommodate and support the discharge device with the longitudinal axis of the enclosure substantially coinciding with the longitudinal axis of the electron discharge device, a first metallic plate in the interior of said enclosure extending transversely of the longitudinal dimension thereof and attached to at least one wall of said enclosure, said plate having an aperture therein and a plurality of contact fingers around the edges of said aperture for engaging the grid terminal element of the discharge device, a second metallic plate in the interior of said enclosure also attached to one wall of said enclosure and parallel to said first plate but spaced therefrom, said second plate having an aperture in a portion thereof and a plurality of contact fingers around the edges of said aperture for coupling to the anode of the discharge device, the aperture of said second plate being smaller than the aperture of said first plate, and a hollow metallic tube completely within said enclosure and adapted to be connected at one end to said enclosure at its other end adapted to surround at least a portion of and coupled to the metallic shell of the dis-

charge device, said metallic tube and surrounding enclosure forming a line resonator, said enclosure having an aperture lying approximately one-quarter of a wavelength from that end of said metallic tube which is located within and connected to said enclosure for enabling a tuning line stub to be coupled to said line resonator, and a metallic cover for said enclosure at the end adapted to be adjacent the anode terminal.

3. A mounting for an electron discharge device of the type having a pair of spaced grid and anode electrodes each of which has a planar disc-like terminal element which extends transversely of the discharge device and is symmetrical with respect to the axis of the discharge device, and a cathode which is surrounded by and coupled to a metallic shell forming part of an enlarged base of said device, the anode terminal element being smaller than the grid terminal element and located near one end of said device; said mounting comprising a single hollow outer metallic enclosure which is longer than the discharge device and adapted to accommodate and support the discharge device with the longitudinal axis of the enclosure substantially coinciding with the longitudinal axis of the electron discharge device, a first metallic plate in the interior of said enclosure extending transversely of the longitudinal dimension thereof and attached to at least one wall of said enclosure, said plate having an aperture therein and a plurality of contact fingers around the edges of said aperture for engaging the grid terminal element of the discharge device, a second metallic plate in the interior of said enclosure also attached to one wall of said enclosure and parallel to said first plate but spaced therefrom, said second plate having an aperture in a portion thereof and a plurality of contact fingers around the edges of said aperture for coupling to the anode of the discharge device, the aperture of said second plate being smaller than the aperture of said first plate, and a hollow metallic tube completely within said enclosure and adapted to be connected at one end to said enclosure and at its other end adapted to surround at least a portion of and coupled to the metallic shell of the discharge device, said metallic tube and surrounding enclosure forming a line resonator, said enclosure having an aperture lying approximately in the same plane as said second plate for enabling a tuning line stub to be coupled to said anode electrode, said enclosure having another aperture lying approximately one-quarter of a wavelength from that end of said metallic tube which is located within and connected to said enclosure for enabling a tuning line stub to be coupled to the line resonator, and a metallic cover for said enclosure at the end adapted to be adjacent the anode terminal.

4. A mounting for an electron discharge device of the type having a pair of spaced grid and anode electrodes each of which has a planar disc-like terminal element which extends transversely of the discharge device and is symmetrical with respect to the axis of the discharge device, and a cathode which is surrounded by and coupled to a metallic shell, the anode terminal element being smaller than the grid terminal element and located near one end of said device, said mounting comprising a single hollow outer metallic enclosure which is longer than the discharge device and adapted to accommodate and support the discharge device with the longitudinal axis of the enclosure substantially coinciding with the longitudinal axis of the electron discharge device, a

first metallic plate in the interior of said enclosure extending transversely of the longitudinal dimension thereof and attached to at least one wall of said enclosure, said plate having an aperture therein and a plurality of contact fingers around the edges of said aperture for engaging the grid terminal element of the discharge device, a second metallic plate in the interior of said enclosure also attached to one wall of said enclosure and parallel to said first plate but spaced therefrom, said second plate having an aperture in a portion thereof and a plurality of contact fingers around the edges of said aperture for coupling to the anode of the discharge device, the aperture of said second plate being smaller than the aperture of said first plate, and a hollow metallic tube completely within said enclosure and adapted to be connected at one end to said enclosure and at its other end adapted to surround at least a portion of and coupled to the metallic shell of the discharge device, said metallic tube and surrounding enclosure forming a line resonator, said enclosure having a pair of apertures lying approximately in the same planes as said first and second plates for enabling tuning line stubs to be coupled to the grid and anode electrodes, said enclosure having another aperture lying approximately one-quarter of a wavelength from that end of said metallic tube which is located within and connected to said enclosure for enabling a tuning line stub to be coupled to said line resonator, and a metallic cover for said enclosure at the end adapted to be adjacent the anode terminal.

5. A mounting for an electron discharge device of the type having a pair of spaced grid and anode electrodes each of which has a planar terminal element which is generally symmetrical with respect to the axis of the discharge device and extend transversely of the discharge device, and an enlarged base at the cathode portion of the device, said anode electrode having a metal cylinder extending beyond its terminal and externally of said device; said mounting comprising a single hollow metallic enclosure which is longer than the discharge device and adapted to accommodate and support and completely enclose the discharge device, with longitudinal axis of the enclosure substantially coinciding with the longitudinal axis of the electron discharge device, a first metallic plate in the interior of said enclosure extending transversely of the longitudinal dimension thereof and attached to at least one wall of said enclosure, said plate having an aperture therein and a plurality of contact fingers around the edges of said aperture for engaging the grid terminal element of the discharge device, a second metallic plate in the interior of said enclosure also attached to one wall of said enclosure and parallel to said first plate but spaced therefrom, said second plate having an aperture in a portion thereof and a plurality of contact fingers around the edges of said aperture for engaging the anode cylinder, the aperture of said second plate being smaller than the aperture of said first plate, a hollow metallic shell located within and concentric with said enclosure for coupling to the cathode of the discharge device, said shell being supported from one end of said enclosure and constituting with said enclosure a concentric line resonator, the dimensions of said shell being such as to enable the base of the discharge device to rest therein at an appreciable distance from one end of said enclosure, and a cover plate at said one end of said enclosure having means for exerting pressure on the discharge

device to thereby hold said device in position in said enclosure, said enclosure having an apparatus in the plane of the second plate for enabling a direct current polarizing potential to be connected to said second plate.

6. A mounting for an electron discharge device of the type having a pair of spaced grid and anode electrodes each of which has a planar terminal element which is generally symmetrical with respect to the axis of the discharge device and extends transversely of the discharge device, and an enlarged base at the cathode portion of the device, said anode electrode having a metal cylinder extending beyond its terminal and externally of said device; said mounting comprising a single hollow outer metallic enclosure which is longer than the discharge device and adapted to accommodate and support and completely enclose the discharge device, with the longitudinal axis of the enclosure substantially coinciding with the longitudinal axis of the electron discharge device, a first metallic plate in the interior of said enclosure extending transversely of the longitudinal dimension thereof and attached at all edges to the walls of said enclosure, said plate having an aperture therein and a plurality of contact fingers around the edges of said aperture for engaging the grid terminal element of the discharge device, a second metallic plate in the interior of said enclosure attached to at least one wall of said enclosure and parallel to said first plate but spaced therefrom, a portion of said second plate being insulated therefrom and having an aperture therein and a plurality of contact fingers around the edges of said aperture for engaging the anode cylinder, the aperture of said second plate being smaller than the aperture of said first plate, a hollow metallic shell located within and concentric with said enclosure for coupling to the cathode of the discharge device, said shell being supported from one end of said enclosure and constituting with said enclosure a concentric line resonator, the dimensions of said shell being such as to enable the base of the discharge device to rest therein at an appreciable distance from said one end of said enclosure, and a cover plate at said one end of said enclosure having means for exerting pressure on the discharge device to thereby hold said device in position in said enclosure, said second plate having a hole drilled therein from the edge which is attached to said enclosure, and said enclosure having a hole therein registering with the hole drilled in said second plate for enabling a direct current polarizing potential to be connected to that portion of said second plate which is provided with contact fingers.

7. A mounting for an electron discharge device of the type having a pair of spaced grid and anode electrodes each of which has a planar disc-like terminal element which extends transversely of the discharge device and is symmetrical with respect to the axis of the discharge device, and a cathode which is surrounded by and coupled to a metallic shell forming part of the base of said device, the anode terminal element being smaller than the grid terminal element and located near one end of said device; said mounting comprising a single hollow outer metallic enclosure which is longer than the discharge device and adapted to accommodate and support the discharge device with the longitudinal axis of the enclosure substantially coinciding with the longitudinal axis of the electron discharge device, a first metallic plate in the interior of said enclosure extending transversely of the longitudinal dimension thereof and attached to at least one wall of said enclosure, said plate having an aperture therein and a plurality of contact fingers around the edges of said aperture for engaging the grid terminal element of the discharge device, and a hollow metallic tube within said enclosure along the longitudinal axis thereof and adapted to be connected at one end to said enclosure and at its other end adapted to surround at least a portion of and coupled to the metallic shell of the discharge device, said metallic tube and surrounding enclosure forming a line resonator, said enclosure having an aperture along the length of said metallic tube for enabling external connection to said metallic tube, and a metallic cover plate for said enclosure at the end adapted to be adjacent the anode terminal.

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