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ELECTRON DISCHARGE TUBE

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Fig. 1

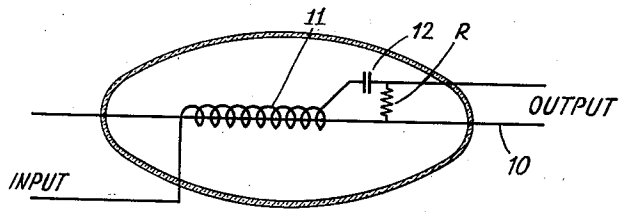


Fig. 2

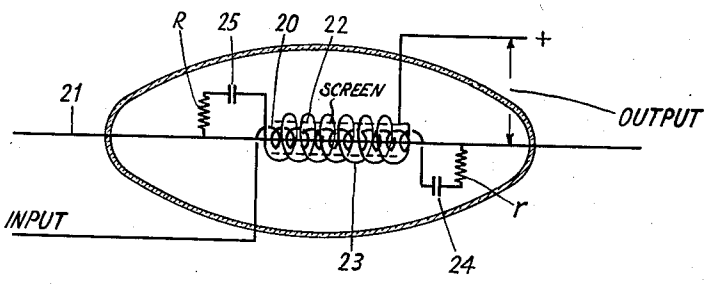
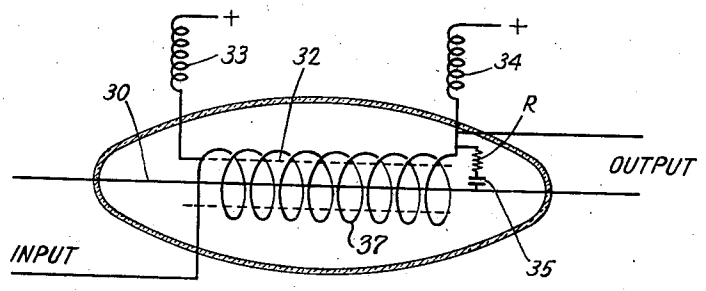


Fig. 3



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ELECTRON DISCHARGE TUBE

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4 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices, and is particularly concerned with devices of this kind which, in operation, are required to handle oscillations extending over a wide range of frequency and which is particularly suited for operation at high frequencies.

In thermionic tube amplifiers in which, for any reason, it is desired to avoid the use of attenuation correction, there is an upper limit to the frequency range over which uniform amplification can be obtained for a given gain per stage of the amplifier. For instance, if in a particular stage of the amplifier g is the mutual conductance of the tube, and c is the total capacity effectively shunting the tube, the limit referred to is dependent upon the ratio of

$$g \text{ to } c \left(\frac{g}{c}\right)$$

the limit being highest for large values of g and for small values of c.

In many amplifiers, as for example, amplifiers for television purposes, it is desirable to provide an amplifier which, although it has a high stage gain, none the less provides substantially uniform amplification over a range of frequency extending to a very high limit. With amplifying tubes at present available, the stage gain for a given frequency range, or alternatively the frequency range of uniform amplification for a given stage gain, is found to be undesirably low for television purposes, for example, and it is one of the objects of this invention to provide an electron discharge tube which is capable of providing more satisfactory operation from the point of view in question.

According to this invention electron discharge devices have at least one electrode in the form of an inductance coil, or an electrode having an inductance coil forming a part thereof and thus may be regarded as reactive systems. The importance of this may be seen from the specification following.

The electrode referred to in the previous paragraph is formed as or comprises an inductance coil which may be helically wound. This coil being inductive in nature and having a certain amount of distributed capacity forms a transmission line.

There is generally a capacity effect existing between the electrodes of a vacuum tube and the electron emitter thereof, said capacity being effectively in shunt with the external circuits of the tube. This inter-electrode capacity taken together with an electrode of the tube formed as an inductance, having distributed capacity, will form a transmission circuit of definite impedance characteristics. If a resistance is connected at the end of the inductive element and joined to the electron emitter in some fashion, as for instance, through a bypass condenser, then a flat amplification will result for a wide band of frequencies according to well known transmission phenomena without frequency discrimination. Furthermore, it can be shown that if the value of the resistance is made such that it does not match or substantially equal the characteristic impedance, the device will favor a desired frequency or band of frequencies. In the case in which there is mis-matching or substantially inequality, the device may be regarded as exhibiting a resonant frequency and this resonant frequency may be adjusted, if so desired, with the aid of reactive elements associated with the leads to the electrodes. Also, stray capacities between the leads may be compensated in a similar fashion. This resistance might, of course, be connected externally to the tube or, as shown in my invention, it may be incorporated within the tube itself.

My invention will best be understood by reference to the accompanying drawing in which:

Figure 1 shows my invention embodied in a diode.

Figure 2 shows an embodiment of my invention in a screen grid tube.

Figure 3 shows an embodiment of my invention in the so-called "Dynatron" tube.

Referring to Fig. 1, there is shown a simple form of discharge device, the well known diode type of tube having a recti-linear cathode **10** arranged within an anode **11** in the form of a helical coil. One end of the cathode and one end of the anode may be connected to an input circuit, while the other ends of the electrodes are connected through a blocking condenser **12** in series with a resistance R, the value of the resistance being such that it is substantially equal to the characteristic impedance of the electrode system, in which case the diode presents a substantially constant impedance to the input circuit at a wide range of frequencies.

Referring to Fig. 2, a screen grid tube is shown constructed according to this invention. The control grid **20** may be helically wound to surround a rectilinear cathode **21**. The screen grid **22** may be formed of wire mesh or the like, while the anode **23** also is formed as a coil, all of the electrodes being substantially co-axial. Connected to one end of the control grid is a block-

ing condenser 24 and a resistance *r* matching or substantially equalling the characteristic impedance of the grid cathode circuit. Connected to one end of the anode is a blocking condenser 25 and a resistor R, the resistance matching or substantially equalling the characteristic impedance of the anode-cathode circuit. It will be appreciated, of course, that these resistors might be supplied externally to the tube or may be supplied as shown in the figure within the envelope of the tube.

Referring to Fig. 3, an electron discharge device for use as a "Dynatron" is shown. This tube contains a rectilinear cathode 30. Either a wire mesh type of screen grid 32 or a helically wound screen grid may be employed and is energized from a positive voltage source, which is higher in value than the anode voltage source (not shown) through a choke coil 33. The anode 23 is wound helically and may be energized by a voltage source (not shown) through a choke coil 34. Connected to the anode is a resistor R and a blocking condenser 35. The resistor matches or substantially equals the characteristic impedance of the anode-cathode circuit. Such a tube would behave as a transmission line with a negative shunt conductance G per unit length and hence would give a negative attenuation which would be independent of frequency over a wide range. The end of the anode, remote from the resistor R, is connected to an input circuit.

In discharge devices, according to this invention, it is found that a wave travels down the inductive electrode and if the terminating resistance is matched or substantially equalled, this wave is absorbed in the resistance. If more than one electrode is inductively wound, it is preferable that the characteristic impedance of all of these electrodes is substantially the same.

The electron discharge tubes, according to this invention, are suitable for connecting in cascade and when so connected, it should be arranged that the impedance of the output circuit of one tube substantially matches or substantially equalled the input impedance of the next. Also, two or more tube stages may be mounted in the same envelope.

Also, a plurality of discharge devices of the form of this invention may be connected together in parallel. In one arrangement of this kind, three screen grid tube arrangements have had their cathodes, control grids, screen grids and anodes respectively connected together so that the various valves are in parallel. Inductance coils were connected in the leads between the anodes of the first and second and the second and third tubes respectively and between the control grids of these tubes. Oscillatory waves were fed to the control grid of the first tube and the control grid of the third tube was connected to the common cathode lead through a terminating resistance and a condenser, while the first anode was connected to the common cathode lead through a condenser and a terminating resistance, the output being taken from the anode circuit of the third tube.

What I claim is:

1. An electron discharge tube including an electrode adapted to emit electrons, a transmission line in said tube in the form of an inductive element, said line forming an electrode of the tube, and resistive means electrically connecting said inductive element to said electron emitting electrode, said resistive means having a value substantially equal to the characteristic impedance of the circuit formed by said inductive element and said electron emitting electrode.

2. An electron discharge tube comprising a cathode, a control electrode, a shield electrode and an anode, said shield electrode and said anode each being in the form of a coil transmission line.

3. An electron discharge tube comprising a cathode, a transmission line forming a control electrode and a transmission line forming the anode, the ratio of the inductance to the capacity per unit length of one of the transmission lines being substantially equal to that of the other.

4. An electron discharge tube comprising electron emitting means, electrode means forming a transmission line, a condenser connected in series with the aforesaid transmission line, and a resistance element connected in series to the emitting electrode and the condenser, said resistance substantially equalling the transmission impedance of the circuit formed by the transmission line, the inter-electrode capacity between the transmission line and the emitting electrode, and the emitting electrode.

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