Jan. 22, 1935. R. S. DANFORTH 1,988,867

POWER DETECTOR TUBE

Filed July 29, 1932 2 Sheets-Sheet 1

Fig. 1.

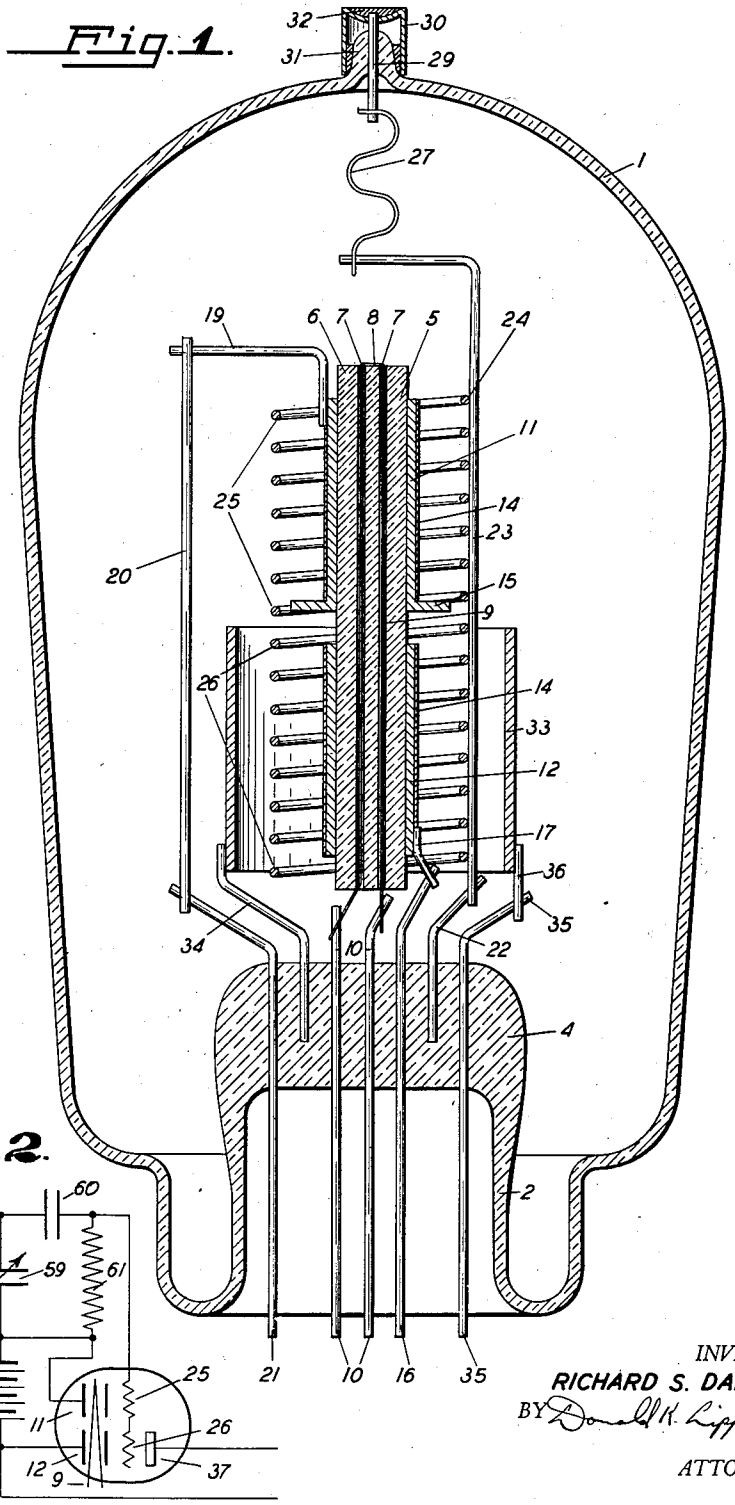


Fig. 2.

INVENTOR,
RICHARD S. DANFORTH.
BY Donald K. Lippincott
ATTORNEY

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Fig. 3.

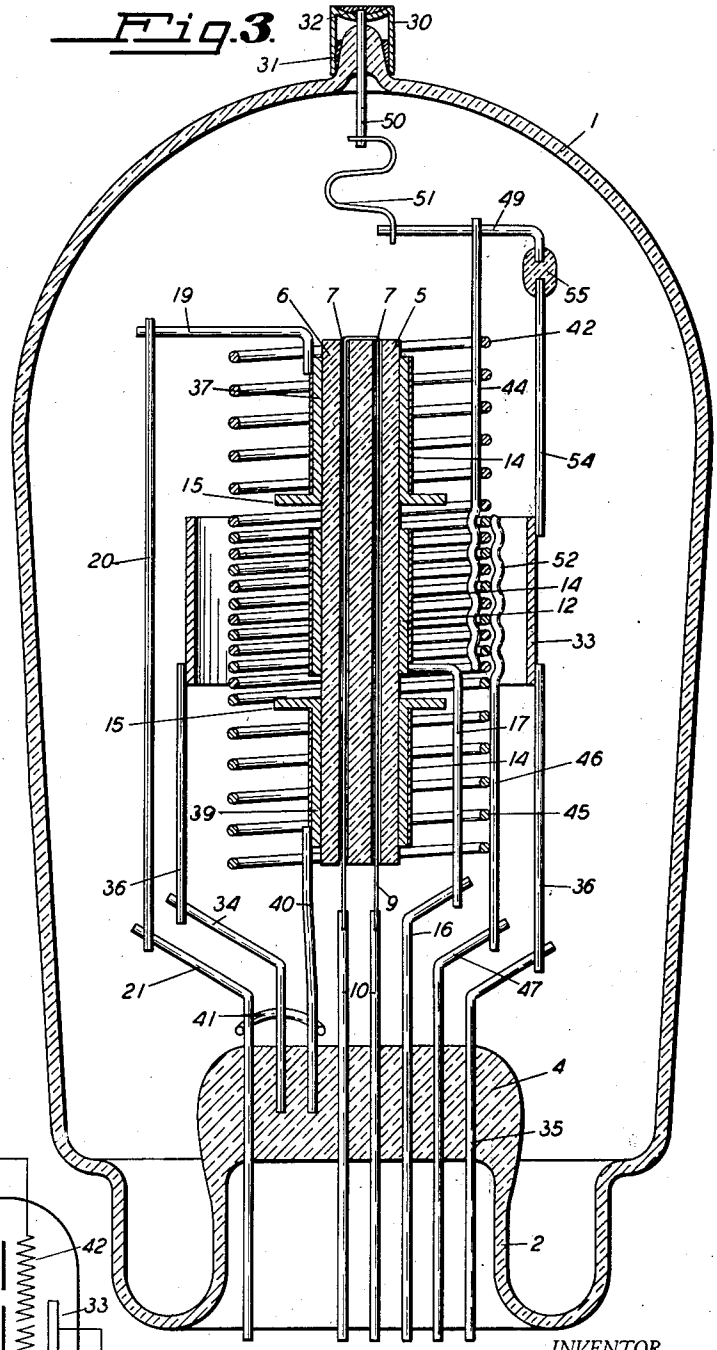
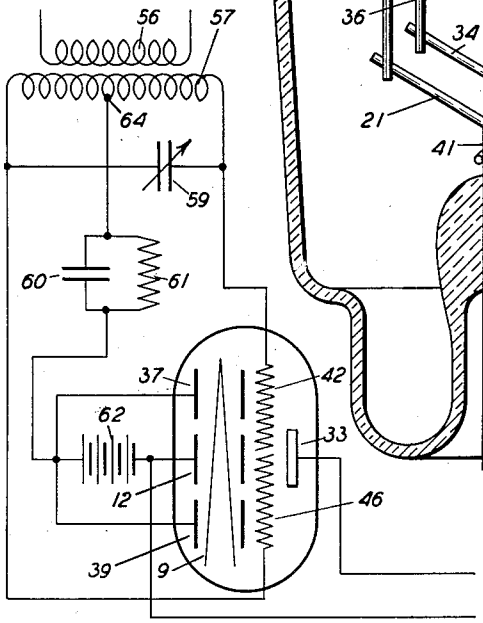


Fig. 4.



INVENTOR,
RICHARD S. DANFORTH,
BY Donald K. Lippincott
ATTORNEY

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POWER DETECTOR TUBE

Richard S. Danforth, San Francisco, Calif.

Application July 29, 1932, Serial No. 625,902

6 Claims. (Cl. 250—27.5)

My invention relates to a power detector tube and more particularly to a tube having separate rectifier and amplifier cathodes maintained at different potentials.

Among the objects of my invention are: To provide an efficient detector tube having minimum distortion; to provide a combined rectifier and amplifier tube in which the biases are proper for their respective actions; to provide a unitary rectifier and amplifier tube in which the rectifier and amplifier actions are at maximum efficiency; to provide an efficient detector and amplifier tube adapted for push-pull circuits; and to provide a detector and amplifier tube having a high power output.

Other objects of my invention will be apparent or will be specifically pointed out in the description forming a part of this specification, but I do not limit myself to the embodiment of my invention herein described, as various forms may be adopted within the scope of the claims.

Referring to the drawings:

Figure 1 is a longitudinal sectional view of the detector tube of my invention, showing the relation of elements.

Figure 2 is a schematic diagram, reduced to its lowest terms, of a circuit in which the tube shown in Figure 1 may be employed.

Figure 3 is a longitudinal view of the detector tube of my invention as adapted to push-pull operation.

Figure 4 is a schematic diagram reduced to its lowest terms of a push-pull circuit in which the tube shown in Figure 3 may be employed.

In the three electrode tube when commonly used as a grid characteristic detector in conjunction with a grid condenser and leak, the tube also acts as an amplifier of the rectified signals. The output of the tube depends on the combined action, and the distortion is contingent on the proper biasing or position of operation on the characteristic curves.

However, I have found that while the bias obtained by the use of a grid condenser and leak may be correct for proper rectification using the grid characteristic, it is not the proper bias for efficient and distortionless amplifier action. I have therefore invented a tube in which the rectification and amplification actions both take place on the proper portion of their respective curves.

In broad terms, my invention comprises a tube which has separate rectifier and amplifier cathodes. The amplifier cathode has the customary anode to receive the emission, and the control electrode inserted between the amplifier cathode and anode is extended over the rectifier cathode to receive the rectifier cathode emission. By operating the rectifier portion with a grid condenser and leak I obtain proper rectification and by inserting an additional source of potential between the rectifier cathode and the amplifier cathode, the adjustment of that source will allow me to operate the amplifier portion at its proper bias for amplification. The two portions are directly coupled as the amplifier grid is the rectifier anode.

I also embody the same invention to produce a tube adapted to push-pull operation, in which tube the anodes of two rectifier portions are meshed in coplanar relationship to control the emission between an amplifier cathode and anode. In this case I maintain the amplifier cathode at a potential differing from that of both of the rectifier cathodes, which are connected together and are at the same potential.

The two rectifier portions may then be connected to a push-pull input circuit to actuate the output of the amplifier portion. In this case all danger of radio frequency anode modulation or rectification is removed.

In the figures illustrating preferred embodiments of my invention, and with reference to Figure 1, a glass bulb 1 is sealed to a reentrant stem 2 through which the various leads are fused in the customary manner at a pinch 4. A heater assembly 5 comprises a cylindrical insulating body 6 having holes 7 formed longitudinally to receive a refractory heater wire 9, usually in hairpin form. This wire is welded to heater leads 10 which supply it with current.

Mounted on the insulating body is a rectifier cathode 11 and an amplifier cathode 12, metal cylinders frictionally applied to the heater assembly and spaced apart. Both cathodes are provided with an oxide coating 14 capable of emitting electrons when heated, and I prefer to mount the rectifier cathode above that of the amplifier. I also prefer to provide the rectifier cathode with a shield 15 extending at right angles to the cathode surface, and uncoated with oxides.

The amplifier cathode is connected to an amplifier cathode lead 16 by a link 17 thus providing the outside connection. The rectifier cathode connection is provided through an elbow wire 19, a riser wire 20, and a rectifier cathode lead 21.

A control electrode dummy wire 22 which does not extend through the pinch supports the grid frame wire 23 to which the grid wires 24 are

welded. These wires surround both the cathodes and for the sake of differentiation the entire structure may be separated into a rectifier anode portion 25 and an amplifier grid portion 26.

While it is obvious that the rectifier anode portion 25 may be a solid metal cylinder, I have found that the grid wires as extended from the amplifier grid portion, are equally efficient in acting as a rectifier anode, and the construction is simplified.

The grid frame wire is extended to the top of the tube, bent toward the longitudinal axis and welded to a grid link 27 which in turn is welded to a grid lead 29 sealed in the top of the tube. It is customary to provide this lead with a cap 30 fastened to the glass by cement 31 and to the lead by weld 32. A cylindrical anode 33 surrounding only the amplifier cathode and the amplifier portion of the grid wires is welded to an anode dummy 34 and to an anode lead 35 to the outside, with an intermediate connection wire 36.

In Figure 3, a push-pull adaptation, the bulb 1 is provided with a stem 2 and pinch 4 as in Figure 1, but the number of leads has been increased The heater assembly 5 is identical with that described above with the exception that it is made slightly longer to accommodate three cathodes, an upper rectifier cathode 37 and a lower rectifier cathode 39, placed above and below the amplifier cathode 12. All of the cathodes have an oxide coating 14 and both rectifier cathodes are provided with shields 15 as in Figure 1.

The lower rectifier cathode is welded to a cathode dummy 40 melted into the pinch, and connected to the rectifier cathode lead 21 by a jumper 41. Connection to the upper rectifier cathode is made by the elbow wire 19 and the riser wire 20 as before. The amplifier cathode is connected to the amplifier cathode lead 16 by the link 17 which, in this tube, has been extended around the lower rectifier cathode.

Two coplanar sets of grid wires are provided, an upper set 42, welded to an upper grid frame wire 44, and a lower set 45, welded to a lower grid frame wire 46. The lower grid frame wire is supported by a lower grid lead 47 in the pinch, and the upper grid frame wire is supported by a bead wire 49, connected to an upper grid lead 50 at the top of the bulb by an upper grid link 51. The cap on the exterior of the bulb is of the same type as that previously described.

The grid wires on the upper grid frame wire extend over the upper rectifier cathode, and also over the amplifier cathode. Those on the lower grid frame wire extend over the lower rectifier cathode and also over the amplifier cathode. Where the two sets of grid wires meet over the amplifier cathode, the wires of one are located between the wires of the other, are coplanar and each of them has equal control over the amplifier emission. The grid frame wires in this location are provided with offsets 52 to prevent them from touching one another and shorting.

That portion of the grid wires opposite their respective rectifier cathode acts to receive the emission of those cathodes, and that portion opposite the amplifier cathode acts to control the emission from the amplifier cathode.

The anode 33 surrounds the interlaced grid wires and the amplifier cathode only and is supported by the intermediate connection wires 36, the anode dummy 34 and the anode lead 35.

An anode bead wire 54 is fused into an insulating bead 55 which in turn supports the bead wire 49.

The tubes are adjusted, evacuated and sealed off, in the approved manner and are ready for use.

The single rectifier type tube as shown in Figure 1 and described above may be employed in conjunction with a circuit such as shown diagrammatically in Figure 2. A primary 56 of a transformer may be energized with alternating current from an antenna, generator or like source. The secondary 57, being shunted by a variable condenser 59 becomes a resonant or tuned circuit and will, when properly adjusted, respond to the impressed energy. The voltage developed is led to the grid wires 25 and 26 through a grid condenser 60 and the bias controlled by a leak resistance 61. The alternations will be rectified by the emission of the rectifier cathode 11 to the rectifier anode portion 25 of the wires.

This rectifying action may be made to take place on the proper portion of the characteristic curve by adjustment of the values of the grid condenser 60 and the leak 61.

The rectifier cathode 11 is connected to the amplifier cathode 12 through a battery or other biasing source 62, which will maintain the amplifier cathode at a different potential to the rectifier cathode, or in other words, will in effect charge the bias on the amplifier grid portion. As the rectifier portion of the grid wires is an extension of, and directly connected to the amplifier portion, the rectified voltage will control the amplifier cathode emission, at a bias determined by the value of the source of potential 62 between the cathodes.

As an example, if rectification properly takes place at a negative bias of 1 volt as determined by the values of the grid condenser and leak, 6 volts negative bias may be necessary for distortionless amplification. The ordinary tube would have to be adjusted to some compromise value, with inferior response, whereas in my invention I adjust the potential difference between the cathodes to 5 volts. I thus obtain maximum efficiency and minimum distortion in power output. The anode 37 is energized in the usual manner.

In Figure 4 I show a push-pull circuit adapted to be used with the double rectifier tube shown in Figure 3.

Here, the secondary 57 is provided with a center tap 64, which leads to the upper and lower rectifier cathodes 37 and 39 through the grid condenser 60 and leak 61. The outer terminals of the secondary 57 lead to the upper and lower sets of grid wires, 42 and 46 respectively. A portion of each of these grid wire sets interlace between the amplifier cathode 12 and amplifier anode 33, and the amplifier cathode is biased from the two rectifier cathodes by the potential source 62.

Here I obtain full wave rectification using the upper and lower rectifiers and amplification of the rectified voltage by the central amplifier assembly, both actions taking place with the proper bias. This circuit has the additional feature of preventing radio frequency from entering the anode circuit, and eliminating the chance of anode rectification.

I have found that with care in bias adjustment I am able to obtain power detection in a single tube without distortion at inputs far beyond the ability of the ordinary tube to deliver.

I claim:

1. A thermionic tube comprising a heater assembly, a plurality of electron-emitting cathodes mounted on said assembly, an anode positioned

to receive the emission from one of said cathodes, and a plurality of control electrodes each having a control portion and an anode portion, each of said control portions being located to control the emission between the first-mentioned cathode and the cooperating anode, and each of said anode portions being positioned to receive the emission from one of the remaining cathodes.

2. A thermionic tube comprising a heater assembly, an upper electron-emitting cathode, a lower electron-emitting cathode and a median electron-emitting cathode all mounted on said heater, an anode positioned to receive the emission from said median cathode, an electrode disposed to control the emission from said median cathode and to receive emission from said upper cathode, and an electrode disposed to control the emission from said median cathode and to receive the emission from said lower cathode.

3. A thermionic tube comprising a heater assembly, an upper electron-emitting cathode, a lower electron-emitting cathode and a median electron-emitting cathode all mounted on said heater, an anode positioned to receive the emission from said median cathode, an electrode disposed to control the emission from said median cathode and to receive emission from said upper cathode, and an electrode disposed to control the emission from said median cathode and to receive the emission from said lower cathode, said electrodes being coplanar.

4. A thermionic tube comprising a heater assembly, a pair of coaxial electron-emitting cathodes mounted on said heater, an intermediate electrode surrounding both of said cathodes, a plate electrode surrounding one of said cathodes and a portion of said intermediate electrode, and means for separating the emissions from each cathode, comprising a flange extended from one of the adjacent ends of said cathodes parallel to the electron flow for separating the emissions from each cathode.

5. A thermionic tube comprising a heater assembly, an upper electron-emitting cathode, a lower electron-emitting cathode and a median electron-emitting cathode all mounted on said heater, an anode positioned to receive the emission from said median cathode, an electrode disposed to control the emission from said median cathode and to receive emission from said upper cathode, an electrode disposed to control the emission from said median cathode and to receive the emission from said lower cathode, and means for separating the emissions from each cathode.

6. A thermionic tube comprising a heater assembly, an upper electron-emitting cathode, a lower electron-emitting cathode and a median electron-emitting cathode all mounted on said heater, an anode positioned to receive the emission from said median cathode, an electrode disposed to control the emission from said median cathode and to receive emission from said upper cathode, an electrode disposed to control the emission from said median cathode and to receive the emission from said lower cathode, and shields disposed to separate the emissions from each cathode.

RICHARD S. DANFORTH.