July 8, 1947. P. G. CHEVIGNY 2,423,819

VACUUM TUBE WITH COUPLING-FEED-BACK-ELECTRODE ARRANGEMENT

Filed Jan. 30, 1943 2 Sheets-Sheet 1

Fig: 1.

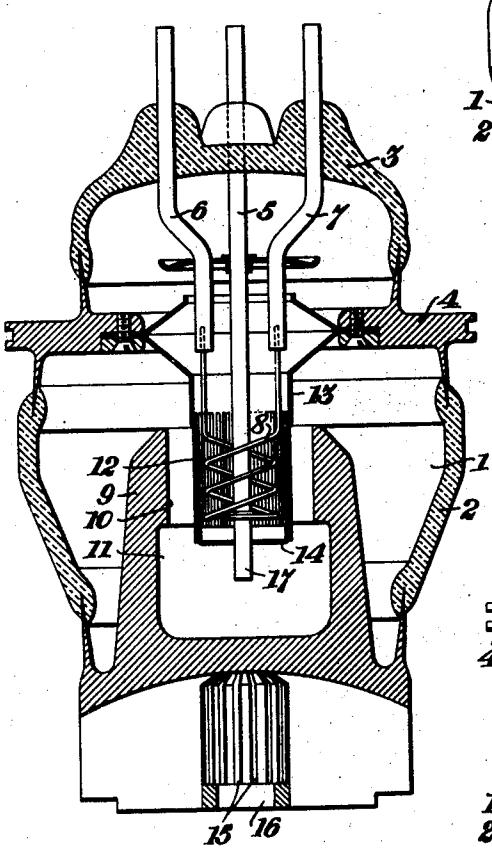


Fig: 4.

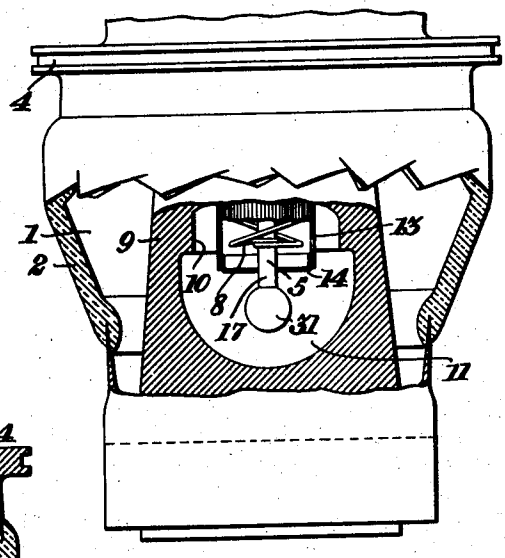
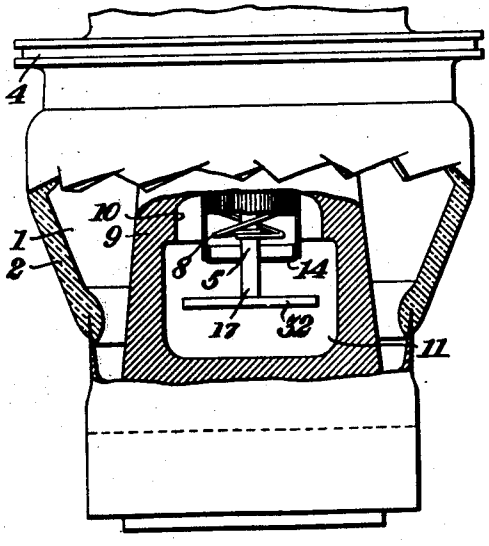


Fig: 5.



INVENTOR.
PAUL G. CHEVIGNY

BY

ATTORNEY

July 8, 1947. P. G. CHEVIGNY 2,423,819

VACUUM TUBE WITH COUPLING-FEED-BACK-ELECTRODE ARRANGEMENT

Filed Jan. 30, 1943 2 Sheets-Sheet 2

Fig:2.

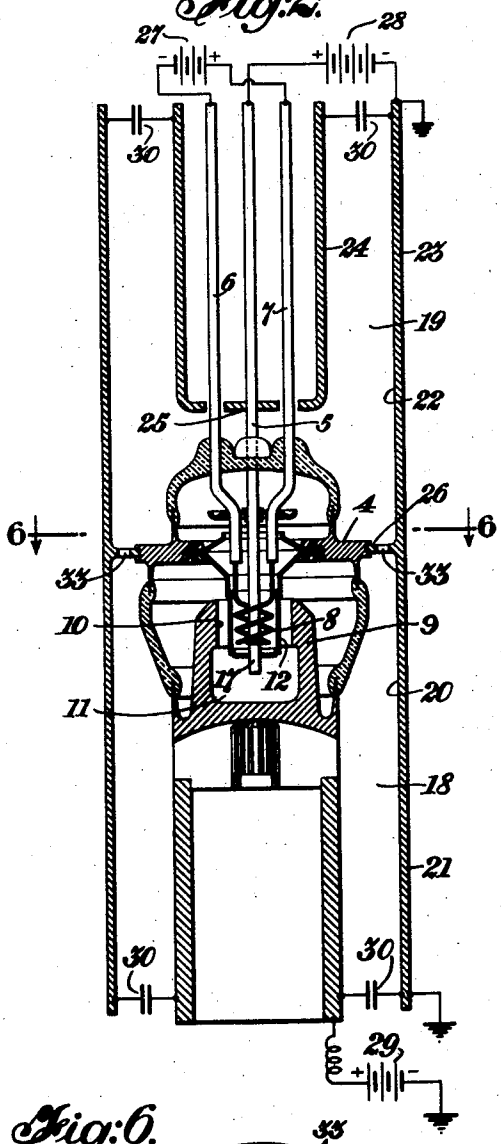


Fig:3.

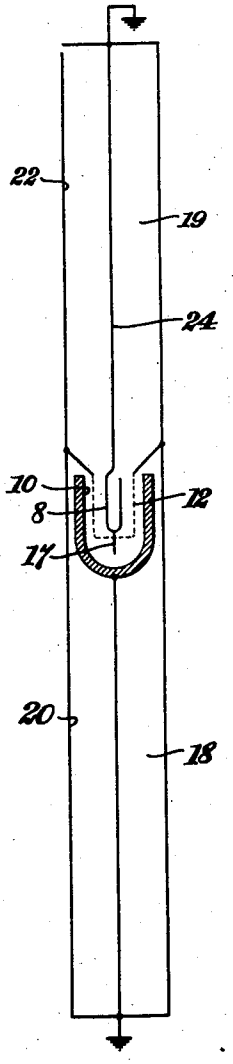
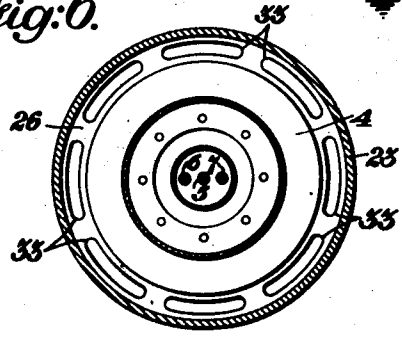


Fig:6.



INVENTOR.
PAUL G. CHEVIGNY

BY

ATTORNEY

Patented July 8, 1947 2,423,819

UNITED STATES PATENT OFFICE

2,423,819

VACUUM TUBE WITH COUPLING-FEED-BACK ELECTRODE ARRANGEMENT

Paul Georges Chevigny, New York, N. Y., assignor, by mesne assignments, to the United States of America, as represented by the Secretary of War

Application January 30, 1943, Serial No. 474,085

8 Claims. (Cl. 250—27.5)

1

This invention relates to vacuum tubes of the electronic type and in particular to a construction and arrangement of electrodes in this type of tube whereby they can be made to operate efficiently and with considerable power output at ultra-high frequencies of the order of 600 megacycles. More specifically, the invention relates to a means for increasing the coupling between certain tube electrodes and their associated circuits and obtaining a feedback voltage having the proper phase for promoting oscillations.

It is, therefore, an object of my invention to devise a vacuum tube having an electrode structure which when associated with suitable circuits is capable of oscillating at ultra-high frequencies.

Another object of my invention is to devise a vacuum tube structure wherein the coupling between the cathode and plate electrodes is increased for permitting the tube to oscillate at frequencies much higher than would otherwise be possible.

Other objects and features of my invention will become apparent as I proceed with the specifications and a description of the drawings, in which:

Fig. 1 is a view of a vacuum tube in partial section showing a preferred embodiment of my invention;

Fig. 2 is a diagrammatic sectional view of the vacuum tube of my invention as it may be incorporated with an oscillating circuit structure;

Fig. 3 is a schematic diagram of the tube and circuits shown in Fig. 2;

Fig. 4 is a sectional view of a vacuum tube electrode structure showing another embodiment of my invention; and

Fig. 5 is a sectional view of an electrode structure illustrating still another embodiment of my invention.

Fig. 6 is a sectional view taken along the line 6—6 of Fig. 2.

Referring to Fig. 1, the general structure of the tube 1 is in some respects similar to that of the tube disclosed in my copending application, Serial No. 441,105, filed April 30, 1942. The insulating portions of the tube envelope consist of a substantially cylindrical portion 2, and a molded disc portion 3. Separating these two portions is a metal member 4 for mounting the grid structure. The member 4 may be of copper and is sealed to the insulating portions 2 and 3 by any suitable means but as shown in Fig. 1, the well known knife-edge type of seal is employed. Passing through and sealed in the disc portion 3 are the cathode support members 5, 6 and 7. The

2

supports 6 and 7 are also employed as current carrying leads for heating the filamentary cathode 8 which is preferably, but not necessarily of the double spiral type. The member 5 supports the far end of the spiral cathode as shown.

The anode electrode 9 may be formed from a solid block of metal, preferably copper. A suitable knife-edge is formed on the outside of the anode structure in order to seal the anode to the other end of the insulating portion 2 and thus complete the tube envelope. The active portion of the anode or that which receives the electron current from the cathode is a cylindrical surface 10 which may be formed by boring a hole in the end of the copper block. The length of the active surface is preferably substantially equal to length of the cathode. Beyond the active surface 10 and preferably of somewhat larger diameter is a recess or cavity 11 which extends further within the copper block. The purpose of this cavity is to decrease the electrostatic capacitance between the anode and grid electrodes as fully described in my copending application above referred to.

Heat dissipation from the anode may be facilitated by cutting a plurality of radial grooves 15 in that portion which is exterior to the tube envelope. These grooves may be formed by boring a central cavity 16 in the copper block and then milling grooves radially between the cavity and the periphery of the block. An air blast directed into the cavity and thence through the grooves dissipates the heat which flows into the fins existing between the grooves.

The grid electrode 12 consists of a plurality of parallel bars welded at one end to a flared tubular support member 13 and at their other end to a spacing and supporting member 14, the completed structure being of substantially circular cross section and lying between the active surface 10 of the anode and the cathode electrode 8. The supporting member 13 is screwed or otherwise fastened to the member 4 for supporting the grid structure.

That part of the tube structure which I believe to be new and novel will now be described. The central cathode support bar 5, in place of terminating at a point directly adjacent the end of the cathode, is made to extend some distance beyond the grid support member 14 and into the cavity 11. Without this extension or projection 17 the cathode 8 is practically completely shielded from the anode surface 10 by the grid electrode 12, the only coupling between the anode and cathode being the small inherent capacitance due to the electrostatic field that penetrates or passes

through the grid electrode. If the bars forming the grid structure are closely spaced, this capacitance may be very small and insufficient to promote strong oscillations when the tube is connected to an oscillation circuit as will be presently described. By extending the support 5, which is electrically connected to and therefore at substantially the same potential as the cathode, into the recess 11 beyond the grid structure, a certain amount of increased coupling is provided between the anode and the cathode electrodes. When a tube having this type of structure is connected with an oscillation circuit of the type shown in Fig. 2, the increased interelectrode coupling provides a means for greatly increasing the tendency of the tube and its associated circuits to oscillate freely. For example, in one particular experiment the addition of the extension 17 to the tube structure resulted in the output of the oscillattor being increased from about 3 watts to about 100 watts. When one considers that the oscillation frequency was of the order of 600 megacycles it is apparent that this represents a tremendous increase in efficiency.

Referring now to Fig. 2, the tube structure of my invention is shown connected to a pair of oscillation circuits 18 and 19 having the form of concentric lines. The circuit 18, known as the anode-grid circuit, extends from the anode surface 10 along the outside of the anode structure 9 to ground and back along the inner surface of the outer conductor 21 to the grid electrode. The circuit 19, or grid-cathode circuit, extends from the grid electrode along the inner surface 22 of the outer conductor 23 to ground and back along the outer surface of the member 24 to the cathode. The member 24 is a tubular shield for the cathode leads and is connected to the cathode support bar 5 at the point 25. This member therefore assumes the same radio frequency potentials that would be assumed by the cathode leads if the shield were absent, as is well understood.

The member 4 is connected to a partition 26 between the surfaces 20 and 22 of the conductors 21 and 23, respectively, and thereby substantially completely isolates the two circuits 18 and 19 one from another, except for the coupling which exists between the anode surface 10 and the cathode extension 17 as above described. Suitable operating potentials are applied to the tube electrodes at points on the oscillation circuits which are at radio frequency ground potentials. The cathode heating source is shown as a battery 27, the grid polarizing potential as obtained from a battery 28, and the power supply to the plate as a battery 29. Other equivalent power and potential sources could obviously be employed. Suitable blocking or radio frequency by-pass capacitors 30 are employed for isolating the direct current potentials.

Fig. 3 is a schematic diagram of the tube and circuit arrangement of Fig. 2 and illustrates just the radio frequency circuits, that is, all potential sources and by-pass capacitors have been omitted. Essential circuit elements are identified by the same reference numerals as in Fig. 2. Fig. 3 is believed to more clearly show the almost complete isolation of the oscillation circuits 18 and 19 with the exception of the coupling extension 17.

While in the above I have indicated that the two oscillation circuits may be completely shielded one from the other, nevertheless in some cases it may be desirable to form small slots in the

partition 26 (see Fig. 2) in order to permit coupling to exist between these circuits. A view taken across sec. 6—6 of Figure 2 is shown in Figure 6. It will be seen from this last figure that a limited number of slots 33 may be formed in the partition 26 without materially weakening the structure. In many cases, however, the coupling which may be produced in this manner is insufficient to cause the vacuum tube and its associated circuits to oscillate efficiently. In these instances, the increased coupling between the anode surface 10 and the projection 17 is highly desirable.

While in Fig. 1, I have illustrated one simple means for increasing the coupling between the anode and cathode electrodes, it has been found that in some cases better results may be obtained by having the extension take the forms such as are shown in Fig. 4 or 5.

Fig. 4 shows a small spherical member 31 connected to the extension 17, and the recess 11 having substantially the form of a hemispherical surface.

Fig. 5 shows a small disc member 32 connected to the end of the extension 17. These variations in the form of the extension 17 apparently improve the coupling action between the electrodes in some cases. Other equivalent forms can be utilized, while the length of the extension 17 is also subject to some variation depending on the oscillation frequency, the optimum length being determined experimentally.

While I have described above the principles of my invention in connection with specific apparatus, and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of my invention as set forth in the objects of my invention and the accompanying claims.

What is claimed is:

1. A vacuum tube structure having an evacuated envelope, an anode, a cathode, and a grid electrode, mounted all within said envelope, a first oscillation circuit connected to said anode and grid electrodes, a second oscillation circuit connected between said grid and cathode electrodes, means electrically isolating said first and second oscillation circuits one from the other except for the coupling between the anode and cathode electrodes, and means for augmenting said coupling between said oscillatory circuits comprising a projection electrically connected to said cathode and in proximity to said anode.

2. A vacuum tube structure having an envelope, an anode, a cathode, a support for said cathode electrically connected thereto, and a grid electrode, all mounted within said envelope, a first oscillation circuit connected between said anode and said grid electrode, a second oscillation circuit connected between said cathode and said grid electrode, means electrically isolating said first and second oscillation circuits one from the other except for the coupling between said cathode and said anode, and means for increasing said coupling between said oscillatory circuits comprising an extension electrically connected to said cathode support.

3. A vacuum tube structure having an evacuated envelope, an anode, a cathode, a support for said cathode, and a grid electrode, all mounted within said envelope, a first oscillation circuit connected between said anode and grid electrodes, a second oscillation circuit connected between said grid and cathode electrodes, and a

plurality of coupling means between said circuits, one of said coupling means comprising a projection connected to said cathode support and in proximity to said anode, the other said coupling means comprising means substantially electrically isolating said oscillatory circuits from each other.

4. A combination in accordance with claim 3, in which another of said plurality of coupling means comprises a perforated partition between said circuits.

5. A vacuum tube electrode structure comprising an evacuated envelope, a grid electrode of substantially uniform lateral dimensions, a cathode electrode and a support for said cathode, all within said envelope, an anode structure comprising a portion disposed within said envelope, the end of said portion having a recess therein, the outer portion of the recess comprising the active surfaces adjacent which the grid electrode is mounted and the inner portion of the recess having lateral dimensions larger than said outer portion thereby disposing the surfaces of said inner portion at a greater distance from the inactive end portion of the grid than the outer surfaces of said outer portion are from the active portion of the grid, and means electrically connected to said support and extending beyond said grid electrode and into said inner portion for increasing the coupling between said anode and said cathode electrode.

6. A vacuum tube electrode structure in accordance with claim 5 wherein said means comprises a substantially spherical member.

7. A vacuum tube electrode structure in accordance with claim 5 wherein said means comprises a disc member.

8. A vacuum tube structure comprising an evacuated envelope, a grid having an active and an inactive end portion, a cathode, a support for said cathode, an anode, all within said envelope, the end of said anode having a recess therein, the outer portion of said recess comprising the active surface adjacent which the active portion of said grid electrode is mounted and the inner portion being disposed at a greater distance from the inactive end portion of said grid than the active surface of said outer portion is from the active portion of said grid, and means electrically connected to said support and extending beyond said grid electrode and into said inner portion for increasing the coupling between said anode and said cathode.

PAUL GEORGES CHEVIGNY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,310,936	Chevigny	Feb. 16, 1943
2,324,766	Chevigny	July 20, 1943
2,020,424	Mouromtseff	Nov. 12, 1935
1,353,976	Stoekle	Sept. 28, 1920
1,550,768	Weinhart	Aug. 25, 1925
2,167,201	Dallenbach	July 25, 1939
2,242,249	Varian et al.	May 20, 1941
2,345,794	Chevigny	Apr. 4, 1944
2,397,854	Glauber	Apr. 2, 1946
2,398,829	Haeff	Apr. 23, 1946