

March 14, 1933.

S. LOEWE

1,901,605

MULTIPLE BOOSTER OR MULTIPLE VIBRATION GENERATOR

Original Filed Aug. 26. 1921 2 Sheets-Sheet 1

Fig. 1.

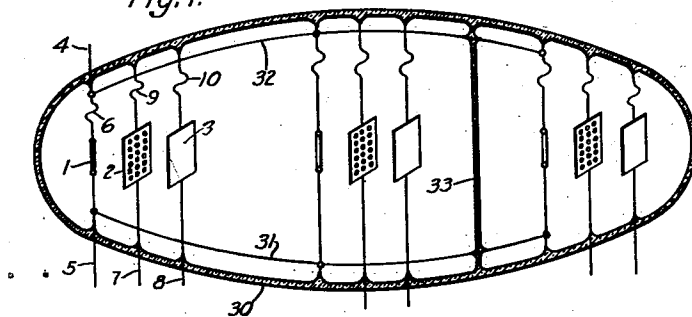


Fig. 2.

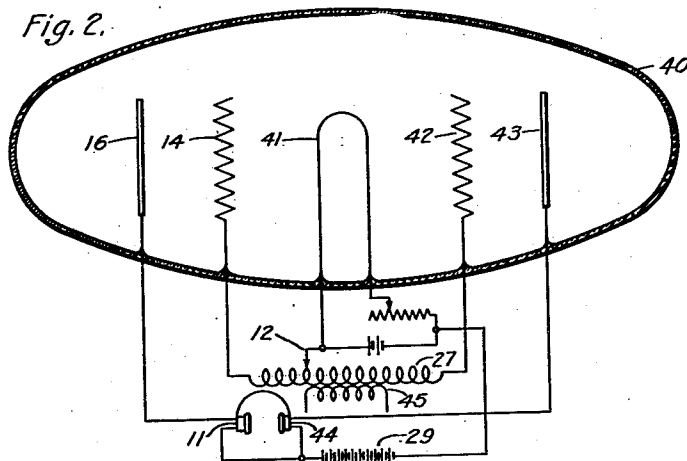
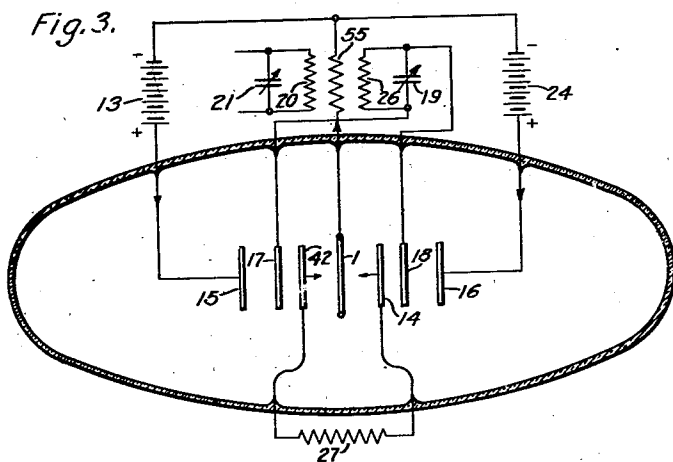


Fig. 3.



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Fig. 4,

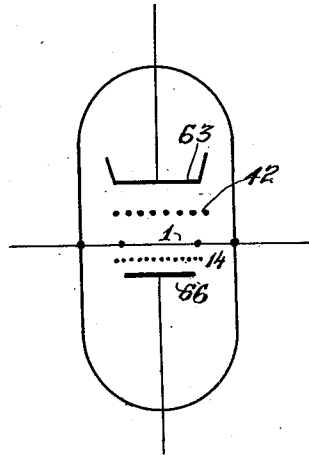
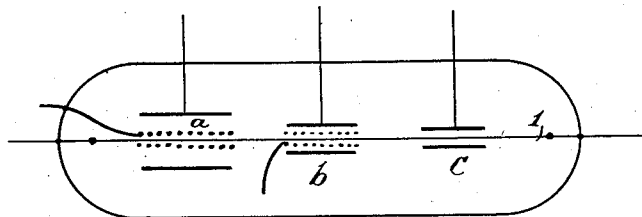


Fig. 5,



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MULTIPLE BOOSTER OR MULTIPLE VIBRATION GENERATOR

Application filed August 26, 1921, Serial No. 495,777, and in Germany March 8, 1917. Renewed July 27, 1932.

(GRANTED UNDER THE PROVISIONS OF THE ACT OF MARCH 3, 1921, 41 STAT. L., 1313)

I have filed applications in Germany March 8, 1917, Patent No. 310,604; in Denmark, Jan. 3, 1920; in Sweden, Dec. 9, 1919; in Switzerland, March 3, 1921, Patent No. 96,397; in Austria, December 20, 1919, and in Great Britain, July 12, 1920.

This invention relates to vacuum-tube devices and the circuits associated therewith. Particularly, it is concerned with systems in which heretofore a plurality of such devices have been used.

One object of this invention is to combine into a single vacuum-tube device arrangements for performing the functions which have heretofore been performed by devices using separate vacuum tubes.

It is a further object of this invention to eliminate the difficulties arising from the difference in degree of vacuum in the several thermionic devices employed in one system.

It is a further object of this invention to embody in a single vacuum device a set of electrodes having the characteristics suitable for an oscillation generator and another set having characteristics suitable for an amplifier.

It is still a further object of this invention to utilize a number of anodes and grids with a single cathode and enclose all of these electrodes in a single evacuated container.

I have illustrated various applications of the invention. One application has for its particular purpose the production of signals in two signalling devices so that the signals shall reinforce one another, although one of them responds to increase of current at the same time that the other responds to a decrease. A single evacuated container, with its enclosed electrodes, is utilized in this application to produce the simultaneous increase of current in one signalling device and decrease in the other.

As a further illustration of the application of the invention, I have shown an arrangement in which the single evacuated tube has associated with its electrodes connections whereby a high-frequency current may be obtained from a current of lower frequency.

Other special applications of the principle of my invention will be apparent to those

skilled in the art, and further disclosure of the objects already mentioned will be obtained from the following specifications and the accompanying drawings:

In the drawings, Figure 1 is a diagrammatic illustration of a plurality of sets of electrodes associated according to this invention;

Fig. 2 is an illustration of another application of the invention;

Fig. 3 is a diagrammatic illustration of another application of the invention;

Fig. 4 is a diagrammatic illustration illustrating one way in which certain features of this invention may be embodied in any of the applications thereof.

Fig. 5 is a further illustration showing how these features of the invention may be repeatedly applied.

In the embodiment of this invention illustrated in Fig. 1, there are shown three sets of electrodes, each set consisting of three electrodes. All of these are enclosed within a single container 30 which is evacuated to a high degree, as is usual in a thermionic device.

The left-hand set of electrodes is described in detail, but it will be understood that, except for the variations pointed out below, all of the several sets of electrodes are like the one described in detail. This includes a cathode 1 of any usual or suitable form but preferably made of a sheet of thin foil of platinum, tantalum, tungsten or other suitable metal capable of withstanding high temperatures. A lead 5 is sealed through the glass wall of the tube for bringing current to this cathode, and a lead 4, sealed through the opposite wall of the tube, is connected to the filament for conducting current away from it. This connection is by means of a spring 6, which acts to keep the foil under proper tension so that it remains fully extended. The current through the leads 4 and 5 serves to heat the cathode 1, and wires 31 and 32 extend within the tube to the other sets of electrodes and connect the respective cathodes in parallel so that all of the heating current can be supplied through one pair of leads.

The electrode 2 is a grid of any standard

or desired form. For controlling the potential of this grid a conductor 7 is sealed through one wall of the tube. A spring 9, anchored to the opposite wall of the tube, is also connected to the grid and serves to hold it in position. In a similar way, the anode 3 is supplied, at one end, with a conductor 8 sealed through one wall of the tube and with a spring 10 at the other end anchored to the opposite wall. The electrodes 1, 2 and 3, forming the set just described, are spaced only a small distance apart. Each of the other sets of electrodes include members spaced only a small distance apart, but the several sets are separated from each other by greater spaces and, if desired, a partition, such as 33, may be used to divide the container into chambers, so that a different degree of vacuum may be maintained around some electrodes, or, if desired, different gases may be present in the different chambers of the container.

These partitions are preferably of glass, as is the container itself, but they are made thinner than the container because the pressure differences which they must withstand are small compared with those which the container itself must withstand. Where the wires 31 and 32 pass through the partition 33, suitable seals must be provided.

The invention is suitable for several amplifier and vibration-generating systems united constructively in the same container and yet working separately from each other. The three systems of Figure 1 can also be connected and used as has been done with three different amplifiers. All the incandescent cathodes can for instance be connected in parallel and supplied by the same current. The arrangement also has the advantage, in addition to its simplicity, that disturbances through noxious capacities and uncontrollable counter influences of the amplifiers are eliminated.

Placing all of the electrodes within one container saves the expense of evacuating a number of containers. It has the further advantage that the same characteristics may be expected at each set of electrodes so that the behavior of the several amplifiers is dependent upon only the sizes and spacing of their electrodes. The problem of making amplifiers of predictable characteristics thus is reduced to the purely mechanical one of predetermining their dimensions. Moreover, enclosing certain of the connections within the tube diminishes the chances of undesirable disturbances arising through body capacity or because of other changeable external conditions.

In the application of my invention illustrated in Fig. 2, a filament 41 serves as a common cathode for each of two sets of electrodes, one of which includes this cathode, the grid 14 and the plate 16. The other includes this

cathode, the grid 42 and the plate 43. A common container 40 surrounds all five of these electrodes.

The cathode 41 is heated in any usual way, for example, by a small battery. The two grids 14 and 42 are connected by coil 27 upon which the signalling energy is impressed. This may be done in any of the usual ways or any desired way; for example, by a signalling coil 45 in inductive relation with the coil 27 and connected into the signal-receiving circuit.

The plates 16 and 43 are connected in parallel to a battery 29. These connections include a pair of telephone receivers 11 and 44 adapted to be simultaneously applied to the two ears of the operator. The other pole of the battery 29 is connected to the cathode 41.

In the operation of this application of my invention, the signalling energy impressed upon the coil 27 causes one of the grids 14 and 42 to rise in potential while the potential of the other is lowered. As a result, the current to one of the plates 16 and 43 is increased while the current to the other one is diminished. The telephone receivers respond either to an increase or a diminution in current, so that the simultaneous changes in current in the two parallel paths give audible results in both telephones. The effect upon the operator of the two simultaneous sounds in the two telephones is considerably greater than if these two telephones were replaced by a single telephone emitting twice the energy. The arrangement, therefore, is an exceedingly sensitive one and the two telephones together form a very effective translating device.

This application of my invention is not limited to two telephones but may be used in any system where an indicating device is controlled by two windings and the indication is to be given either by an increase of current in one winding, a diminution of current in the other, or both. For example, the two windings of a differential relay may be substituted for the two telephone instruments and the relay will then respond to differences in the potentials upon the two grids.

When no signalling energy is impressed upon the coil 27, the current from the cathode 41 divides equally between the two plate circuits, but when signalling energy in the coil 27 causes the grids 42 and 14 to differ in potential the current no longer divides equally between the two plate circuits and, as a result, the translating device is actuated. In order that the division of the current may be properly regulated to produce maximum efficiency in the device, the connection between the cathode 41 and the center of the coil 27 is made adjustable, as shown at 12.

The principle of my invention may be utilized to advantage in an arrangement for securing an increase in frequency. This is il-

illustrated in Fig. 3. In this arrangement, the cathode is again designated 1, and there are two grids, one on each side thereof, designated 14 and 42. These grids are connected to a coil 27 upon which an alternating current is impressed in any desired way. Instead of a single battery for the two plate circuits, two batteries 13 and 24 are provided and the corresponding plates are designated 15 and 16. A common lead from the filament to the two batteries 13 and 24 includes the primary winding 55 of a transformer having a secondary 26. Shunted across the terminals of this secondary is an adjustable condenser 19. These terminals are connected with a pair of grids 17 and 18 adjacent respectively to the grids 42 and 14. The transformer also includes another secondary 20 having across its terminals an adjustable condenser 21.

If an alternating current is created in the coil 27 there will result alternating changes of potential upon the grids 14 and 42. When the coil tends to make the potential of the grid 42 positive, the flow of electrons from the cathode 1 to this grid will be sufficient to raise the potential not merely of the grid but of the whole metallic body composed of grid 42, coil 27 and grid 14, together with the connecting leads. Consequently, the positive potential impressed upon the grid 42 by the current in the coil 27 will have practically no effect in increasing the current from the grid 42 to the cathode 1. On the other hand, the diminution in potential which occurs upon the grid 14 at the same time that the positive potential is impressed upon the grid 42 will result in a diminution of the current from the grid 14 to the cathode 1. Another way of regarding the action may be stated by assuming that at the moment the potential of each grid (42 and 14) changes sign, the current is already at its saturation value, so that the positive charge upon the grid cannot increase this current but the negative charge upon the other grid can diminish the current to that grid.

Tracing the consequence of these considerations, it will be noted that, during the first quarter period, while the potential of the grid 42 changes from a positive maximum to zero, the current from the grid 42 remains constant, but, during the same quarter period, the current from the grid 14 increases to a maximum. During the next quarter period, while the potential upon the grid 42 changes from zero to a negative maximum, the current from the grid 42 sinks from the previous constant value to a minimum, but, during this quarter period, the current from the grid 14 is constant and at a maximum. During the first half period, therefore, the total current from the cathode 1 through the coil 55 has risen from a minimum to a maximum and again fallen to a minimum. Dur-

ing the next half period, similar considerations apply except that events occur on the opposite electrodes so that the total current from the cathode through the coil 55 rises again from a minimum to a maximum, and again sinks to a minimum. It will, therefore, be seen that the period of the changes in the current in the coil 55 is half the period of the potential changes impressed upon the grids 42 and 14 by the coil 27. The current flowing in the coil 55 is, therefore, double the frequency of the energy impressed upon the coil 27.

In order to take advantage of this, a coil 26 is provided in inductive relation with the coil 55 and has a condenser 19 in shunt across its terminal, so that the circuit including the coil 26 and the condenser 19 can be tuned to a frequency double the frequency in the coil 27. The leads from the terminals of the coil 26 may go to any external apparatus which it is desired to operate by this higher-frequency current.

Instead, they may, as illustrated, go to another pair of grids 17 and 18, impressing upon them potential changes having twice the frequency of those upon the grids 14 and 42. The changes upon the grids 17 and 18 will operate to cause an additional doubling of the frequency, as may be seen by an analysis similar to that employed in connection with the discussion of the action of grids 14 and 42. The current in the coil 55, therefore, includes a component having a frequency four times that of the energy in the coil 27. This is utilized by means of the coil 20 in inductive relation with the coil 55 which has a condenser 21 across its terminal. The coil 20 and the condenser 21, being tuned to a frequency four times that of the energy in the coil 27, enables this circuit to segregate this higher-frequency current and it may be delivered by leads, illustrated on each side of condenser 21, going to any external apparatus.

Vacuum-tube devices which are intended to be used as generators of oscillating current should be provided with one style of grid; tubes which are intended to be used as amplifiers are best provided with a different style of grid; while a still different style is best suited for tubes which are to be used as detectors. In general, it may be stated that for each use of a tube there is a style of grid which is best suited to that use. In tubes such as have been above described, where a number of different grids are employed within one tube and where the several sets of electrodes are intended to serve different purposes, it is desirable to have the grids differ in style. This has been illustrated in Figs. 4 and 5. In Fig. 4, two anodes 63 and 66 are illustrated which may be analogous to the anodes 43 and 16 of Fig. 2, or to any other pair of anodes. The difference

in style between the corresponding grids 14 and 42 is represented on the drawings by showing one as of fine mesh and the other as of coarse mesh but it is to be understood that differences not only in mesh but also in size and material are within the scope of this invention. In the particular use illustrated for grids 14 and 42 in Fig. 2, the two grids would ordinarily be alike, but, if the two translating devices or the two windings of one translating device differ in character, a corresponding difference in the style of grids comes within the spirit of this invention.

The several different styles of grid may be spaced longitudinally along one filament as is illustrated in Fig. 5, where *a* represents one style of grid and *b* another style of grid. Fig. 5 also illustrates at *c* the use of a two-electrode device, no grid being employed. In some cases where a thermionic device is used as a rectifier, either for a detector or for other purposes, the absence of any grid is a desirable arrangement. The spirit of the invention includes using such an arrangement in the same tube with the other arrangements described, so that, where different styles of grid are mentioned, it is to be understood as including the case in which no grid at all is used.

In accordance with the provisions of the patent statutes, I have herein described the principle of operation of my invention, together with the apparatus, which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means. Also, while it is designed to use the various features and elements in the combination and relations described, some of these may be altered and others omitted and some of the features of each modification may be embodied in the others without interfering with the more general results outlined, and the invention extends to such use.

I claim as my invention:

1. A vacuum device comprising a plurality of sets of electrodes, each set including a thermal electrode and cold electrodes distinct from the electrodes of the remaining sets, an evacuated container surrounding all of said electrodes and a partition separating part of said sets from the remainder, the parts of said container on opposite sides of said partition having different degrees of vacuum.

2. An electrical discharge device comprising a vacuum-tight container, an incandescible cathode, control grid and anode therefor at one portion of said container, an incandescible cathode, control grid and anode therefor at another portion of said container and insulating means separating said two sets of electrodes.

3. An electrical discharge device comprising a vacuum-tight container, two sets of electrodes in said container, each set including a thermal electrode and a cold electrode to receive electrons from said thermal electrode and said electrodes distinct from the electrodes of the other set and means preventing the electrons from the thermal electrode of one set from reaching the cold electrode of the other set.

4. An electrical discharge device comprising a vacuum-tight container, an incandescible cathode, control grid and anode therefor at one portion of said container, an incandescible cathode, control grid and anode at another portion of said container, conductors for said first-mentioned incandescible cathode, control grid and anode sealed through said container at one portion thereof, conductors for said second-mentioned control grid and anode sealed through said container at another portion thereof, connections within said container between said first-mentioned incandescible cathode and said second incandescible cathode and an intermediate support for said connections comprising a partition extending across said container.

5. An electrical discharge device comprising a vacuum-tight container, an incandescible cathode, control grid and anode therefor at one portion of said container, an incandescible cathode, control grid and anode therefor at another portion of said container and insulating means separating said two sets of electrodes, said insulating means comprising a partition, an electrical connection between the cathodes of each set, said partition being an intermediate support for said connection.

SIEGMUND LOEWE.