

1,325,879.

Patented Dec. 23, 1919.

Fig. 1.

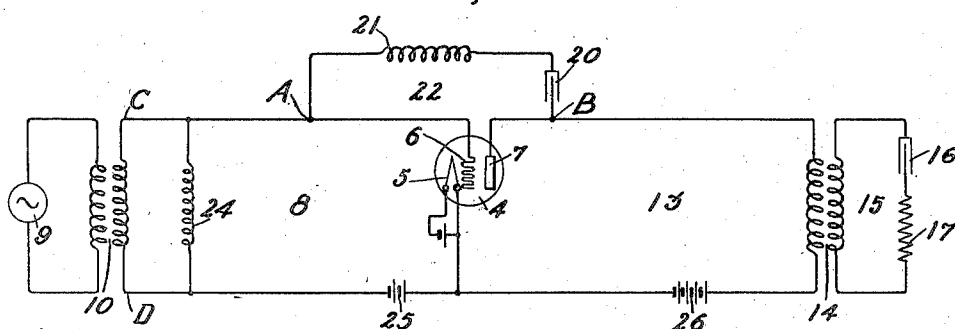
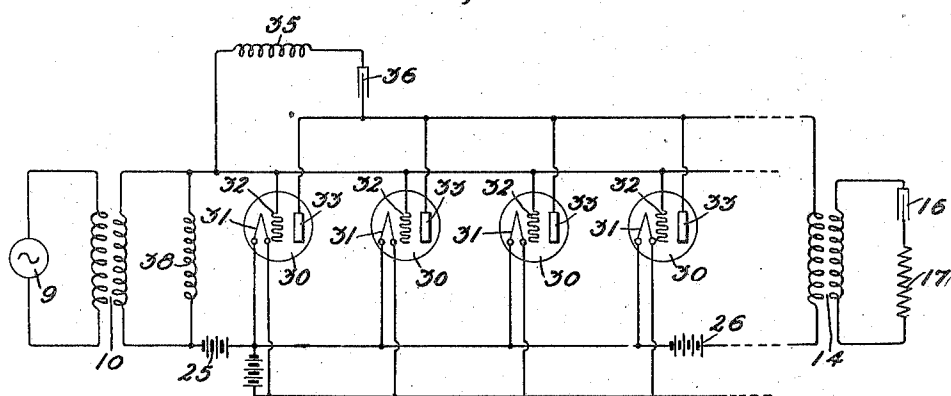


Fig. 2.



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VACUUM-TUBE CIRCUITS.

1,325,879.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, HAROLD WILLIAM NICHOLS, a citizen of the United States, residing at Maplewood, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Vacuum-Tube Circuits, of which the following is a full, clear, concise, and exact description.

This invention relates to vacuum tube circuits.

Its object is to prevent any undesired capacity effects between the electrodes inclosed in a vacuum tube.

In vacuum tubes of the audion type, there are, in general, three electrodes, namely, the filament, the plate and the grid. In view of their relative positions, there will be a certain amount of electrostatic capacity between these members. When a circuit containing such a tube is subjected to an alternating voltage, there will be a flow of current through certain branches of the circuit due to this capacity effect.

For the ordinary vacuum tube, these capacities are exceedingly small, and the displacement currents resulting therefrom, at moderate frequencies, are negligibly small. If the frequencies used in the circuit become high, say of the order of half a million, the capacity or displacement currents may be appreciable.

It has been found that such displacement currents are deleterious in that they decrease the efficiency of operation of the vacuum tube and may, under certain conditions, entirely block the action of the tube. This is particularly true as to the displacement current which may flow between the grid and the plate. In this case the areas of the grid and plate are rather large and the whole alternating voltage of the output circuit is impressed upon them. It is apparent that a comparatively small current flowing from the plate to the grid and through the input circuit may produce a sufficient change in the potential difference between the filament and grid to materially affect the output current.

The object of this invention is to prevent the flow of such current, and the object is attained by adding certain elements to the circuit whereby the capacity between the plate and grid becomes a portion of a circuit which is anti-resonant for that frequency

which is being used in the circuit. By the term "anti-resonant" is meant a circuit which offers high impedance to the passage of currents of the same frequency as that for which the circuit is tuned, but which provides a low impedance path for currents of other frequencies differing from the frequency for which the anti-resonant circuit is tuned.

With sufficiently high frequencies, the capacity or displacement current between grid and filament may also become large enough to be harmful and an arrangement similar to that described above may be resorted to in order to overcome such harmful effects.

The invention will be better understood by reference to the following specification and accompanying drawings, in which Figure 1 shows one embodiment of this invention as applied to a vacuum tube amplifier of the audion type.

Fig. 2 illustrates the invention as applied to a plurality of audion amplifiers in parallel.

Referring to Fig. 1 of the drawing, 4 is a vacuum tube of the audion type containing a filament 5, a grid 6 and a plate 7. The input circuit 8 receives electric oscillations from the generator or source of electric oscillations 9 by means of the transformer 10. These oscillations appear in amplified form in the output circuit 13 and are impressed by means of transformer 14 on any desired circuit 15, which has a capacity 16 and a resistance 17. If the oscillations are of the order of one thousand cycles per second, the capacity effects, due to the electrodes are negligible, but if they are of the order of a million cycles per second, there will be an appreciable capacity effect between the grid 6 and plate 7, and, consequently, a current flow between the input and output circuits. Such being the case, the output circuit would react upon the input circuit and would either materially change the character of the oscillations impressed upon the input circuit or cause them to cease entirely. To avoid this reaction, I propose to insert between the points A and B an inductance 21, which, together with the capacity effect between the grid and plate, is of such a value as to form a circuit 22 that is sharply tuned to the generator frequency. If such is the case, the impedance from point A to point B is infinite in value so that no current can flow

between said points, and circuit 22 becomes "anti-resonant" to the generator frequency. The capacity 20 is a large capacity added to the circuit to prevent a flow of direct current between the input and output circuits from either the input battery 25 or the output battery 26. On account of its size the capacity 20 may therefore be neglected in the tuning of circuit 22; that is, for a given frequency the value of inductance 21 is determined only by the amount of capacity between the grid and the plate.

In the case of high frequency oscillations, the capacity effect across the grid and filament may, as mentioned above, be sufficient to allow an appreciable amount of current to flow in the input circuit 8. This would permit the input circuit to react on the oscillation generator, which reaction should be avoided for reasons previously mentioned, and would also become a diminution of the effective voltage impressed across the input terminals. In order to obtain the condition that the effect of the capacity between the input electrodes shall be inappreciable, I propose to connect an inductance 24 across the input terminals of such a value that, taken with the effective capacity between the grid and filament, it forms a circuit anti-resonant for the given frequency of the generator, thereby making the impedance of the input circuit infinite in value so that no current can flow between the points C and D.

Although the capacity effects may become appreciable in the case of a single tube connected as shown in Fig. 1, the effect becomes much more marked when a plurality of tubes are connected in parallel. Such a circuit is shown in Fig. 2 where a plurality of amplifiers 30 are arranged in parallel so that the capacity between the grids 32 and plates 33, as well as the capacity between the filaments 31 and grids 32, are in parallel. Since these capacity effects are additive, the total effect is much larger than for a single tube. Inductance 35, together with the condenser 36, is of such a value that, taken with the total capacity between the various grids 32 and plates 33, there is formed a circuit anti-resonant to the oscillations present in the system. Condenser 36 is inserted for the same purpose as condenser 20 of Fig. 1, and, in general, is so large as to have no appreciable effect on the impedance of the circuit. Inductance 38, together with the total capacity between the various filaments 31 and grids 32, is of such a value as to form another circuit anti-resonant to the frequency of the oscillations in the system, thereby reducing to zero the undesired current flow in the secondary of transformer 10, and thus preventing any reaction effects, as well as loss of effective voltage.

It is obvious that this invention, as set forth in the appended claims, may be ap-

plied for the elimination of undesired capacity effects between the electrodes of any number of vacuum tubes connected in any desired manner.

Furthermore, although the invention has been described in connection with a three-element audion, it is to be understood that it is equally applicable to any electrical discharge tube with two or more electrodes in which it is desired to prevent the effects due to the capacity or displacement current between any two electrodes.

What is claimed is:

1. A source of oscillations of an ultra audio frequency, a vacuum tube device having electrodes, means for impressing said oscillations upon said device, a circuit containing said electrodes, said circuit offering a path of high impedance to said oscillations while being lower in value for other frequencies, thereby preventing said device from reacting upon the source of oscillations.

2. A source of oscillations, a vacuum tube device having electrodes, means for impressing said oscillations upon said device, means for preventing said device from reacting upon said source, said means comprising a plurality of circuits each anti-resonant to the frequency of the oscillations of said source associated with said electrodes.

3. A vacuum tube device having an input and an output circuit, a source of oscillations of an ultra audio frequency, means for impressing said oscillations upon said device, means for preventing the reaction of said output circuit upon said input circuit for said frequency, said means comprising a circuit anti-resonant to said frequency.

4. A vacuum tube device having input and output circuits, a source of oscillations of an ultra audio frequency for said input circuit, means for preventing a flow of current between said circuits, said means comprising a circuit sharply tuned to said oscillations.

5. A vacuum tube device having input and output circuits, a source of oscillations of an ultra audio frequency and means comprising an impedance, high in value for said frequency and low in value for others, interlinked between said circuits, whereby any appreciable flow of current between said circuits of said frequency is prevented.

6. A vacuum tube device having an input electrode and an output electrode, a source of oscillations of an ultra audio frequency, input and output circuits, means comprising an inductance in a circuit shunted across said electrodes for providing a high impedance for said frequency between said input and output circuits.

7. A vacuum tube device having an input electrode and an output electrode, input and output circuits, a source of electric oscillations

tions of an ultra audio frequency for said input circuit giving rise to a capacity effect between said input and output electrodes, an inductance and capacity in a circuit shunted across said electrodes, said inductance and capacity in connection with the capacity effect between said electrodes forming a circuit anti-resonant to said oscillations, thereby preventing any appreciable flow of current between said circuits.

8. A vacuum tube device having an input circuit and input electrodes, a source of oscillations of an ultra audio frequency, means for impressing said oscillations upon said input circuit, means for making the impedance of said input circuit high in value, said means comprising a circuit including said electrodes, said last mentioned circuit being anti-resonant to said frequency.

9. A vacuum tube device having input electrodes, an input circuit, a source of oscillations of an ultra audio frequency, means for impressing said oscillations upon said input circuit, giving rise to a capacity effect between said input electrodes, an inductance in a circuit shunted across said electrodes, said inductance and capacity forming a circuit anti-resonant to said oscillations, thereby preventing said input circuit from reacting upon said source of oscillations.

10. A vacuum tube device having input and output electrodes, and an input circuit and an output circuit, a source of oscillations of an ultra-audio frequency, an anti-resonant circuit for said oscillations having a portion thereof shunted around said electrodes, thereby preventing said output circuit from reacting upon said source.

11. The combination with an evacuated vessel containing a cathode, an auxiliary electrode and an anode, of a source of oscillations of an ultra audio frequency and means for neutralizing the capacity effect at said frequency between said auxiliary electrode and said anode.

12. The combination with an evacuated vessel containing a cathode, an auxiliary electrode and an anode, of a source of oscillations of an ultra audio frequency and a local circuit including said auxiliary electrode and said anode for neutralizing the capacity effect at said frequency between said auxiliary electrode and said anode.

13. The combination with an evacuated vessel containing a cathode, an anode and an auxiliary electrode, of a circuit over which

impulses are transmitted to said electrodes and an auxiliary circuit comprising an inductance and a condenser in circuit with said auxiliary electrode and said anode for neutralizing the capacity between said auxiliary electrode and said anode.

14. The combination with an evacuated vessel having a plurality of electrodes, of a source of oscillations of an ultra audio frequency and means comprising an anti-resonant circuit for neutralizing the capacity effect of said frequency between two of said electrodes.

15. The combination of an evacuated vessel having a plurality of electrodes, of a source of oscillations of an ultra audio frequency and means comprising a circuit anti-resonant to said frequency for neutralizing the effect of the capacity between two of the electrodes for said frequency.

16. The combination with a vacuum tube device having electrodes of a source of oscillations of an ultra-audio frequency and an inductance in a branch of a circuit anti-resonant to said frequency shunted around said electrodes for neutralizing the effect at said frequency of the capacity between two of said electrodes.

17. The combination with a vacuum tube amplifier containing a cathode, an anode and a grid, of a source of oscillations of an ultra audio frequency and a local circuit containing said grid and anode, said circuit having high impedance for currents of said frequency while having a low impedance for currents of frequencies considerably removed from said frequency.

18. The combination with an evacuated vessel containing a cathode, an anode, and an auxiliary electrode, of a circuit over which impulses are transmitted to said electrodes and an auxiliary circuit comprising an inductance and a condenser in series with said auxiliary electrode and said anode.

19. A vacuum tube device having input and output electrodes and an input circuit and an output circuit, a source of oscillations of an ultra-audio frequency, and an anti-resonant circuit for said oscillations comprising a plurality of branches in one of which are said electrodes, thereby preventing said outgoing circuit from reacting upon said source.

In witness whereof, I hereunto subscribe my name this 27th day of December, A. D., 1916.

HAROLD W. NICHOLS.