July 7, 1931. H. F. ELLIOTT 1,813,036

SYSTEM OF NEUTRALIZATION

Filed March 11, 1927

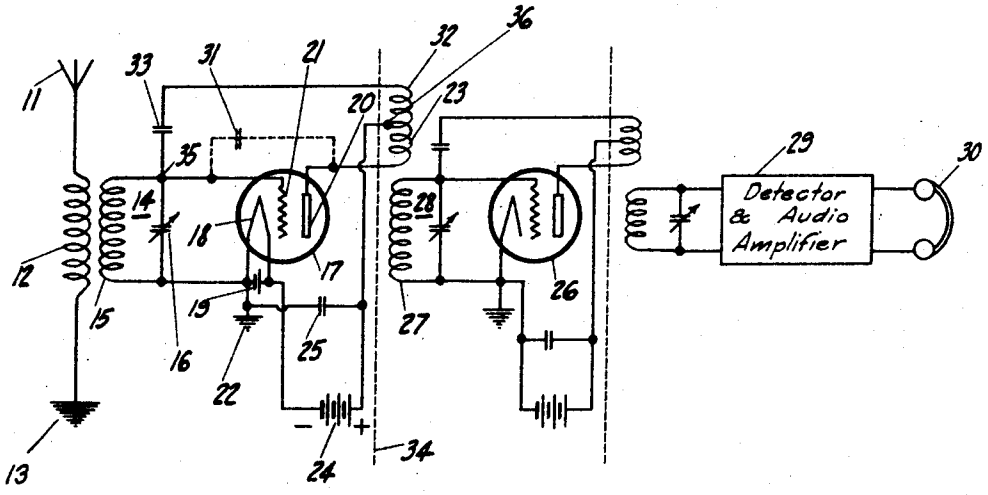


FIG. 1.

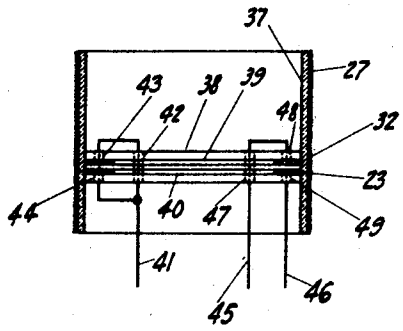


FIG. 2.

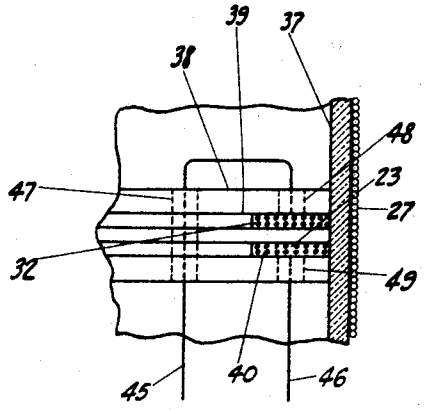


FIG. 3.

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UNITED STATES PATENT OFFICE

HAROLD F. ELLIOTT, OF PALO ALTO, CALIFORNIA, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO VICTOR TALKING MACHINE COMPANY, OF CAMDEN, NEW JERSEY, A CORPORATION OF NEW JERSEY

SYSTEM OF NEUTRALIZATION

Application filed March 11, 1927. Serial No. 174,475.

This invention relates to amplifier systems, and especially those that are adapted for the amplification of minute electrical impulses of high frequency.

Such systems are in extensive use for example in connection with radio receiving systems, for amplifying, at radio frequency, the received signaling impulses. For each stage of amplification, use is made of electronic emission devices, usually termed audions, each comprising an evacuated vessel having a number of electrodes (usually three) sealed therein. One of the electrodes (the cathode) is used to throw off electrons, and is usually in the form of a heated filament in order to secure this function. Another electrode, usually termed the plate or anode, receives the electron discharge which is attracted to it by making its potential positive with respect to the cathode. The "space current" thus formed has been found to be sensitive to potential conditions in the space traversed thereby. This phenomenon is utilized by providing a control electrode, such as a grid, that influences the potential of a point in the space. The grid and filament are connected so that their potential difference is a function of the received impulses; and as this difference varies, the space current is correspondingly varied, the variations being relatively much greater than the potential variations between the grid and filament. A circuit connecting the plate and filament permits variations in this space current to be used as amplified impulses that can be impressed on a succeeding stage.

This amplifying function is now well understood, and requires no further elucidation. The important feature that is to be noted is the fact that such amplifier stages, when used for high frequency currents, as radio frequency, and especially if several are placed in cascade, have a tendency to instability, and to support oscillations that disturb the operation and may destroy the clarity of the signals. This effect is due to the reaction of one part of the system upon another, either capacitively or inductively. One especially annoying reaction is that due to the capacity between the grid and the plate, whereby a feedback is obtained from the output circuit to the input. Furthermore, there may be an undesirable reaction between one stage and the next preceding one through the interstage coupling.

It is one of the objects of my invention to avoid these undesirable effects.

Although schemes for neutralization have been heretofore proposed, I aim to provide a novel and better system for accomplishing that result.

It is another object of my invention to provide an improved instrumentality whereby the neutralization is accurately and easily effected.

My invention possesses many other advantages, and has other objects which may be made more easily apparent from a consideration of one embodiment of my invention. For this purpose I have shown a form in the drawings accompanying and forming part of the present specification. I shall now proceed to describe this form in detail, which illustrates the general principles of my invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of my invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a wiring diagram of one complete stage of amplification utilizing my invention, shown as applied to a radio receiving system with one or more stages of radio frequency amplification;

Fig. 2 is a view, partly in section, of a radio frequency transformer by the aid of which my invention may be practiced; and

Fig. 3 is an enlarged detail thereof.

In Fig. 1 I show a conventional form of pick-up circuit, such as the antenna 11, loading coil 12, and ground 13. This circuit may be inductively coupled to a tunable circuit 14, including the coil 15 coupled to coil 12, and a variable condenser 16. An audion amplifier 17 is provided, having an electron emitting electrode 18 in the form of a filament heated from the battery 19. There is also provided a plate or anode 20, and a control electrode or grid 21. The grid and filament are connected respectively to opposite

terminals of condenser 16, whereby radio frequency impulses received by circuit 14 serve to create corresponding variations in potential difference between the grid and filament. One side of the filament can be grounded, as shown at 22. The output circuit, carrying the amplified impulses, extends from plate 20, through a winding 23, B battery 24, back to the filament 18. A by-pass condenser 25 for the radio frequency currents can be provided around the battery 24, whereby only the steady plate current passes through the battery, the impulses passing through the condenser.

A succeeding stage of amplification, utilizing audion 26, can be coupled to the first stage, as by the aid of a secondary winding 27, forming one element of the tunable circuit 28. This circuit is in turn connected to the input electrodes of the audion 26, and the other connections of this second stage can be made entirely similar to those of the first stage; the radio frequency stages can finally lead to a detector and audio frequency amplifier system 29, which supplies audio frequency currents to a translating device, such as phones 30. Such cascade connections between the stages of amplifiers and the detector are now well known, and needs no further elucidation.

Due to the use of radio frequencies, parasitic capacity effects exist in the audions, such as indicated by capacity 31 between the grid 21 and plate 20. I shall now describe how the deleterious effects of such capacities can be overcome. A coil 32, closely coupled to primary 23 and having identical characteristics as coil 23, is connected at one end to that end of coil 23 which is nearest battery 24. Its other end connects to a small condenser 33, which is in turn connected to grid 21. The capacity of condenser 33 is made substantially equal to the parasitic capacity 31.

The capacities 31, 33 and coils 32, 23 form the four arms of a symmetrical bridge; and coil 32 is arranged to oppose the effect of coil 23. Potentials induced in coil 27 due to currents passing thru coil 23 from the parasitic coupling 31 are opposed and neutralized by the substantially equal and opposite potentials induced therein due to currents passing thru coil 32 via condenser 33. Thus no current can be induced in secondary 27 from the preceding stage other than that which is due to the variations in the electron stream in audion 17. A metal shield 34 is also preferably provided to prevent either inductive or capacitive coupling between the stages.

Now let us consider the effect of the current circulating in circuit 28, upon the preceding stage. This can be shown to be neutralized. Coil 27 induces, in primary coil 23, and neutralizing coil 32, equal and in phase E. M. F.'s that are additive and that cause a circulating current to flow in the bridge circuit 31—33—32—23. Such current however has no effect on the input of tube 17, for the potential difference due to such current across the grid 21 and filament 18 is substantially zero. This is due to the fact that points 35 and 36 of the bridge circuit are equipotential, because of the equality of capacities 31 and 33, the equality of inductances 32 and 23, and the equality of the potentials induced in 32 and 23 by currents in 27. Point 35 is connected to one input electrode 21; and the other electrode 18 is connected to point 36 through a by-pass condenser 25, of such large value as to be practically a short circuit for radio frequency currents. Due to ground connection 22, the points 35 and 36 are at substantially ground potential as regards currents induced from coil 27.

In order to ensure accuracy of neutralization, coils 32, 23 and 27 must be closely coupled and compactly arranged. I show in Figs. 2 and 3 how these results can be very simply provided.

I utilize a tube 37 of insulation such as bakelite, over which I wind the secondary 27. In one instance the tube was about 1¾" diameter and 1⅜" long, the secondary being fine insulated wire of about 85 turns. Disposed in the tube 37 is a disc-like member 38 of insulation in which there are two narrow grooves 39 and 40, of about the proportions shown. In one of the grooves, such as 40, I wind primary 23 (shown in section), in one instance, with about 25 turns. In the other groove 39 is the similarly wound neutralizing coil 32. Both these coils are placed very close together, so that there is tight coupling between them, as well as with secondary 27. Lead 41 is indicated as extending to the common junction point of coils 32 and 23; and to facilitate this, apertures 42, 43 and 44 are provided in member 38. The free ends of coils 32 and 23 are connected to leads 45 and 46 also extending through similar apertures 47, 48 and 49.

Preferably, member 38 is made from a single piece of such material as bakelite, although it is possible to build it up from several pieces. Also, it can be fastened into tube 37 near one end thereof in order to make it easily accessible. The fact that secondary 27 encompasses the other coils closely helps materially in securing the beneficial stabilizing results.

I claim:

1. In combination, an insulation tube, a coil wound on the tube, a disc-like member fixed in the tube, said member having a peripheral slot therein that is closed by the tube, and a coil in said slot.

2. Apparatus of the class described including three coils having coaxial and closely adjacent windings, one of said coils enclosing

the other two coils and said other two coils being axially spaced within the outer coil.

3. Apparatus of the class described including a plurality of coils having coaxial and closely adjacent windings, two of said coils being connected in series and having a common intermediate terminal and another of said coils enclosing both of said two coils.

4. Apparatus of the class described including a tubular supporting element, a coil wound on the exterior thereof, and a pair of axially spaced coils supported within said element and surrounded by said exterior coil.

5. Apparatus of the class described including a plurality of coils having coaxial and closely adjacent windings, a tubular supporting element for one of said coils, and a disk-like supporting element mounted within the tubular element and supporting a plurality of said coils in axially spaced relation to one another.

6. Apparatus of the class described including an insulation tube, a coil wound thereon, and a disk of insulating material mounted within said tube and having a plurality of coils wound on the periphery thereof.

7. Apparatus of the class described including a tubular support, a coil wound thereon, a disk mounted within said tube and having a pair of closely adjacent grooves in the periphery thereof, and a pair of coils one in each of said grooves.

8. Apparatus of the class described including a tubular support, a coil wound thereon, a disk mounted within said tube and having a pair of grooves in the periphery thereof, a pair of coils one in each of said grooves, said pair of coils being connected in series and having a common intermediate terminal, and all of said coils being closely adjacent to provide tight coupling therebetween.

9. Apparatus of the class described including a plurality of coils having coaxial and closely adjacent windings, one of said coils being tubularly wound and the other two coils being of flat annular form and being positioned closely adjacent one another within said tubularly wound coil.

In testimony whereof I have hereunto set my hand.

HAROLD F. ELLIOTT.