Nov. 15, 1927. 1,649,778

J. H. HAMMOND, JR., ET AL

MEANS FOR AND METHOD OF CHANGING THE INTENSITY OF SIGNALS IN RADIO DYNAMIC RECEIVING SYSTEMS

Original Filed June 27, 1917

Fig. 1.

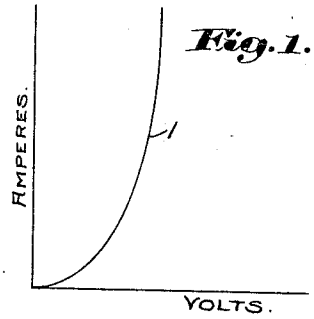


Fig. 2.

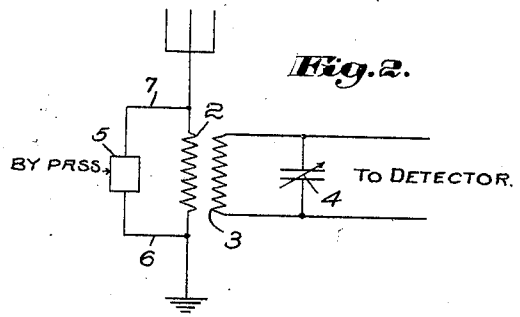


Fig. 3.

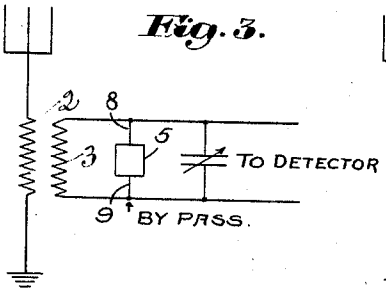


Fig. 4.

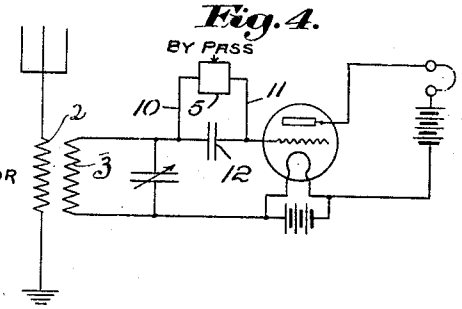


Fig. 5.

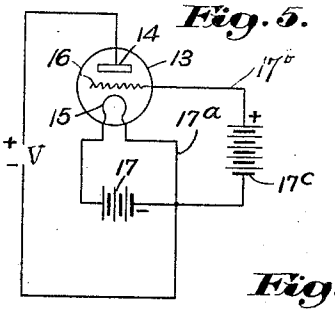


Fig. 6.

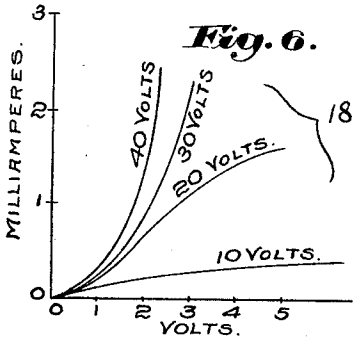
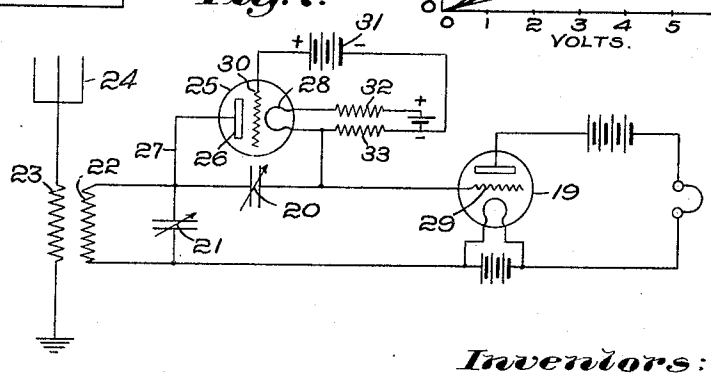


Fig. 7.



Inventors:
John Hays Hammond Jr.
Emory Leon Chaffee
by Emery, Booth, Janney and Varney,
Attys.

Patented Nov. 15, 1927. 1,649,778

UNITED STATES PATENT OFFICE.

JOHN HAYS HAMMOND, JR., OF GLOUCESTER, AND EMORY LEON CHAFFEE, OF BELMONT, MASSACHUSETTS; SAID CHAFFEE ASSIGNOR TO SAID HAMMOND.

MEANS FOR AND METHOD OF CHANGING THE INTENSITY OF SIGNALS IN RADIO DYNAMIC RECEIVING SYSTEMS.

Application filed June 27, 1917, Serial No. 177,202. Renewed May 31, 1924.

This invention relates to means for and methods of reducing the intensity of strong signals produced through or pertaining to radiant energy without reducing the intensity of weak signals. While the invention particularly relates to signals pertaining to radiant energy, it is not so limited in its application. Nevertheless, we shall herein disclose certain forms of means for carrying out our invention and methods for practicing the same, all of which pertain to receiving systems employed in conveying messages or signals through the agency of radiant energy.

In order that the principles of the invention may be readily understood, we will disclose certain forms or adaptations of the invention and the best mode known to us for practicing the same, the characteristics of the means preferably employed being best described in terms of its voltage-current curve.

In the drawings,—

Fig. 1 represents diagrammatically the type of curve essential to the proper operation of means utilized in the practice of the invention;

Fig. 2 represents diagrammatically a radio-dynamic receiving system having a by-pass connected across the inductance of the antenna in accordance with our invention;

Fig. 3 is a similar diagram but representing the by-pass as connected across the secondary inductance of the system;

Fig. 4 represents the by-pass as connected across the stoppage condenser of the system;

Fig. 5 is a diagram representing one form of by-pass device employed in the practice of the invention;

Fig. 6 represents a family of curves illustrating the advantage of a high difference of potential between the grid and the filament of the device shown in Fig. 5; and

Fig. 7 is a diagram disclosing in detail a receiving system wherein the device shown in Fig. 5 is connected across the stoppage condenser.

An important object of the invention is to provide for the reduction of the intensity of strong signals in radio-dynamic work without reducing the intensity of weak signals therein. By the accomplishment of such purpose the interference in the reception of weak signals, due to nearby, powerful transmitting stations or to atmospheric disturbances known as static can be greatly reduced.

In accordance with the preferred embodiment of the invention, means are provided furnishing a leak or by-pass generally analogous to a resistance, but which is much more effective for strong signals than for weak signals. Preferably, for this purpose, means are provided having a resistance which decreases as the potential increases. Such means is effective wherever it be placed in the receiving system to cut down large peaks of potential without affecting the small variations of potential caused by weak signals.

Referring more particularly to the drawings, and first to the diagram designated Fig. 1, I have therein represented at 1 the type of curve essential or important to the successful operation of the by-pass provided in accordance with the invention. In the diagram the ordinates represent current caused to flow through the leak or by-pass device when voltages represented by the abscissæ are impressed across its terminals. A device having such a curve is characterized by the fact that small differences of potential cause very small currents to flow through the device, while large differences of potential cause disproportionately large currents to flow. Such a device is characterized by the fact that the resistance is a function of the potential and is very great for small potentials, but is small when large potentials are impressed across the terminals of the device.

The by-pass employed in the practice of our invention may be connected across any part of a system for receiving radiant energy, providing the part is of such a character that the voltage across its terminals is caused to increase materially by an incoming signal or by static disturbances. In such case the part across which the by-pass is connected will, under predetermined conditions, be more or less discharged, the by-pass being more active for intense signals or disturbances than for weak ones.

The by-pass employed, one form only of which is disclosed herein, may be connected in various ways across parts of the receiving system, and in Figs. 2, 3 and 4 we have represented certain of such ways. It will, how-

ever, be understood that the by-pass or other means within the scope and purpose of our invention may be otherwise suitably connected, and that the invention is not limited either to the particular form of means herein disclosed, or to any of the various ways for connecting said means in receiving systems.

Before describing in detail the form of means herein disclosed for practicing our invention, we will describe certain ways in which such means or other suitable means may be connected in the receiving system. Any suitable receiving system may be employed, that herein represented being merely typical.

In Fig. 2, the primary winding of an oscillation transformer of an open aerial receiving circuit is represented at 2. The secondary winding of a closed oscillatory circuit is represented at 3 and a condenser at 4. The by-pass herein employed in the practice of our invention is represented diagrammatically at 5 and is connected by conductors 6 and 7 across the inductance 2.

In Fig. 3 we have represented the same receiving system having the by-pass device 5 connected by conductors 8 and 9 across the secondary inductance 3.

In Fig. 4, representing the preferred form of the invention, we have shown the device 5 as connected by conductors 10 and 11 across the stoppage condenser 12, thus providing a by-pass in the form of a variable leak which absolutely prevents the paralysis of the receiving audion detector due to excessive charging of the stoppage condenser of the receiving system by intense signals. Such paralysis of the detector is a well known phenomenon in this art, and has been the source of much trouble, which this invention overcomes.

The invention is not limited in its scope to the employment of any particular means for the accomplishment of the object herein stated. Several devices have the essential characteristics shown by the curve of Fig. 1, such for example as crystal contacts and very fine wires, which have a positive temperature coefficient of resistance. While such devices may be employed by us, we preferably use means of the type shown in Fig. 5.

In said figure, we have shown diagrammatically an electron tube 13, which may be of the general form of that of the well known three-electrode audion detector, but functioning wholly differently. Said tube 13 consists of a highly evacuated member into which is sealed a plate 14, an electron emitting filament 15, and a grid 16 situated between the plate and filament. In certain forms of the invention, we may employ a tube or evacuated member having a filament and plate without the grid, but by the use of the grid better results are secured. Preferably, several short filaments are used in parallel, thereby obtaining a large surface of filament with small difference of potential between the ends of each filament.

If the filament 15 is heated in a suitable manner as by a battery 17, so that electrons are emitted by it and a relatively large difference of potential, for example, fifty volts, is impressed between the grid 16 and the negative end of the filament 15, thereby making the grid 16 positive, a large flux of electrons passes from the filament 15 to the grid 16. The grid 16 is connected to the circuit 17^a containing said battery 17, by a circuit 17^b containing the stronger battery 17^c. If now the plate 14 be connected to the negative end of the filament 15, practically no current will pass in the plate circuit. If, however, the plate 14 be made slightly positive in potential with respect to the negative end of the filament 15, a current will pass in the plate circuit, the magnitude depending upon the potential V of Fig. 5, as represented by the curve 1 in Fig. 1. A difference of potential between the plate 14 and the filament 15 of only a volt or so will cause several milliamperes to flow in the plate circuit. The advantage of a high difference of potential between the grid and the filament is illustrated by the family of curves 18 in Fig. 6, each member of which is a plate-voltage, plate-current curve for a certain constant voltage impressed between the grid and the filament. The figures upon the curves in Fig. 6 indicating the number of volts give a rough idea merely of the magnitudes involved.

One manner of connecting the device of Fig. 5 to the receiving circuit in accordance with the preferred method of practicing our invention is represented more in detail in Fig. 7, wherein such device is shown connected across the stoppage condenser thereof.

In said Fig. 7, the ordinary audion of the receiving circuit is represented at 19, it being preferably connected in the usual manner through the stoppage condenser 20 to the oscillatory secondary circuit 21, 22, which in turn is coupled to the inductance 23 of the antenna 24. A tube of the general form shown in Fig. 5 is represented at 25. It there constitutes a by-pass, the plate 26 thereof being connected by the conductor 27 to the common terminals of the parts 20, 21, 22. The negative end of the filament 28 is connected to the junction of the stoppage condenser 20 and the grid 29 of the detector 19. The grid 30 of the tube 25 is polarized in any suitable manner as by the battery 31. The choke coils 32 and 33 are preferably inserted in the heating circuit of the said by-pass in order to confine the variations in potential of the stoppage condenser to the filament of the by-pass.

An electron tube of the general type shown in Figs. 5 and 7 allows a current to pass only in one direction. The stoppage condenser of a radio-dynamic receiving system used with the audion detector charges in one direction only, due to the rectifying action of the detector. The by-pass shown in Fig. 7 is so connected that it discharges the charge of the stoppage condenser 20.

It will be evident from the foregoing description that a by-pass device, such as is shown in Figs. 5 and 7, furnishes a leak analogous to a resistance, that is much more effective for strong signals than for weak signals. A small potential causes a very small current to flow, whereas by doubling the potential the current is increased a great many times, for example, ten or fifteen times. This means that the equivalent resistance in the first case is very high, perhaps several hundred thousand ohms, whereas if the potential becomes two or three times as great, the effective resistance drops to one or two thousand ohms.

The invention herein disclosed is characterized by the phenomenon that a resistance which decreases as the potential increases is effective, substantially wherever it is placed in the receiving system, to cut down large peaks of potential without affecting the small variations of potential caused by weak signals. While the means is effective wherever placed in the receiving system, it is peculiarly effective when placed as shown in Figs. 4 and 7. It then serves a double purpose since it not only cuts down the intensity of the strong signals, but it furnishes the much desired leak on the stoppage condenser necessary for the successful operation of any system using a stoppage condenser.

It will be evident from the foregoing description that the disclosed by-pass is connected across inductances, condensers, or other parts of a receiving system to reduce large potentials produced at the terminals of such parts by interference, such latter potentials being in excess of the potentials produced by the signals.

Having thus described one illustrative embodiment of our invention and the best method known to us for practicing the same, we desire it to be understood that although specific terms are employed, they are used in a generic and descriptive sense and not for purposes of limitation, the scope of the invention being set forth in the following claims.

We claim—

1. A receiving system for radio-dynamic energy including a detector provided with a grid, a stoppage condenser, means joining said detector and said condenser, and means for reducing the intensity of strong signals without substantial reduction of the intensity of weak signals, said last-mentioned means comprising a sealed tube having enclosed therein a plate, a filament and a grid, said filament being connected to the junction of said stoppage condenser and the grid of said detector.

2. A receiving system for radio-dynamic energy including a detector provided with a grid, a stoppage condenser, means joining said detector and said condenser, and means for reducing the intensity of strong signals without substantial reduction of the intensity of weak signals, said last-mentioned means comprising a sealed tube having enclosed therein a plate, a filament and a grid and a battery connected to said last-mentioned grid and the negative end of said filament being connected to the junction of said stoppage condenser and said first-mentioned grid.

3. A receiving system for radio-dynamic energy including a detector provided with a grid, a stoppage condenser, means joining said detector and said condenser, and means for reducing the intensity of strong signals without substantial reduction of the intensity of weak signals, said last-mentioned means comprising a sealed tube having enclosed therein a plate, a filament and a grid and a battery connected to said grid, said filament having connected thereto a circuit including choke coils, and the negative end of said filament being connected to the junction of said stoppage condenser and said first-mentioned grid.

4. A receiving system for radio-dynamic energy having a stoppage condenser and a by-pass therefor, comprising a sealed tube having therein a plate, a filament and a grid, means for heating said filament, and means including a battery connecting said grid to the circuit of said filament.

5. A receiving system for electrical impulses including a condenser connected in series with respect to a portion of said receiving system carrying the received impulses, and a by-pass therefor, comprising a container having therein a plate, a filament and a grid, said plate being directly connected to one side of said condenser, said filament being directly connected to the other side of said condenser, and said grid having a predetermined difference of potential with respect to the filament impressed thereon to determine the functioning voltage of the by-pass.

6. A receiving system for electrical impulses including an oscillatory element connected in series with respect to a portion of said receiving system carrying the received impulses, and a by-pass for said oscillatory element including a container, and a terminal, heating means, and potential gradient changing means arranged in said container, said terminal being directly connected to one side of said oscillatory element, said

heating means being connected with the other side of said element, and said potential gradient changing means having a predetermined difference of potential impressed thereon with respect to one of the other parts arranged in said container to determine the functioning voltage of the by-pass.

7. A receiving system for electrical impulses having a detector, a circuit arranged to control said detector and including an oscillatory element, and a by-pass around said oscillatory element arranged to protect said detector from excessive potentials, said by-pass including a container, and a terminal, electron-discharge means, and potential gradient changing means arranged in said container, said terminal and said potential gradient changing means being connected to opposite sides of said oscillatory element respectively.

8. A receiving system for electrical impulses, having a detector, a circuit arranged to control said detector and including a condenser, and a by-pass around said condenser arranged to protect said detector from excessive potentials, said by-pass including a container, and a terminal, electron-discharge means, and potential gradient changing means arranged in said container, said terminal and said potential gradient changing means being connected to opposite sides of said condenser respectively.

9. A receiving system for electrical impulses including a condenser and a by-pass therefor, comprising a container having therein a plate, a filament and a grid, said by-pass being provided with means arranged to heat said filament and to maintain said grid at a substantially constant potential with respect to said filament when in operation, said plate being connected to one side of said condenser and said filament being connected to the other side of said condenser.

10. A receiving system for electrical impulses including a condenser and a by-pass therefor comprising a container having therein a plate, a filament and a grid, said by-pass being provided with a battery arranged to heat said filament and a battery arranged in a circuit connecting said filament and said grid for maintaining said grid at a substantially constant, positive potential with respect to said filament when in operation, and said plate and filament being connected respectively with the terminals of said condenser.

11. A receiving system for electrical impulses including an oscillatory element and a by-pass shunted around said oscillatory element in series with respect to a portion of said receiving system carrying the received impulses and including a container provided with an anode, a cathode, and a grid, said anode being connected to one side of said oscillatory element, said cathode being connected to the other side of said oscillatory element, and said grid having a predetermined difference of potential impressed thereon with respect to one of the other parts provided in the container to determine the functioning voltage of the by-pass.

12. A receiving system for electrical impulses including an oscillatory element and a by-pass shunted around said oscillatory element and including a container provided with an anode, a cathode, and a potential gradient changing means, said anode being connected to one side of said oscillatory element, said cathode being connected to the other side of said oscillatory element, and said potential gradient changing means being so connected with the cathode as to be held at a substantially constant potential with respect to said cathode while in operation.

13. A receiving system for radiant energy comprising a detector having input and output circuits, a source of energy on the input side of the detector in the form of a transformer having its secondary winding connected with the detector, an impedance element connected in series between said winding and the detector and across which potentials may be induced, and means independent of the output circuit for providing a resistance in shunt with said element which is much less for differences of potential above a predetermined value than for smaller differences of potential.

14. A receiving system for radiant energy comprising a detector having input and output circuits, a closed, oscillatory circuit responsive to electrical oscillations and operatively connected with the input side of the detector, an impedance element connected in series between the oscillatory circuit and the detector and across which potentials may be induced, and means independent of the output circuit for providing a resistance in shunt with said element which is much less for differences of potential above a predetermined value than for smaller differences of potential.

15. A receiving system for radiant energy comprising a detector, a closed, oscillatory circuit responsive to electrical oscillations and operatively connected with the input side of the detector, a condenser connected in series between the closed oscillatory circuit and the detector, and a device permanently connected in shunt to said condenser and having a resistance characteristic of such a nature that it offers a resistance which is much less for differences of potential above a predetermined value than for smaller differences of potential.

16. A receiving system for radiant energy comprising a three-electrode thermionic detector, a closed, oscillatory circuit responsive to electrical oscillations and operatively con-

nected with the input side of the detector, an impedance element connected in series between the oscillatory circuit and the grid of the detector and across which high potentials may be induced, and a thermionic tube connected in shunt with said impedance element and acting to oppose less resistance to the passage of currents at high potentials than at low potentials.

17. A receiving system for radiant energy comprising a detector, a closed, oscillatory circuit responsive to electrical oscillations and operatively connected with the input side of the detector, an impedance element connected in series between the oscillatory circuit and the detector and across which high potentials may be induced, a three-electrode thermionic tube connected in shunt with said impedance device and acting to oppose less resistance to the passage of currents at high potentials than at low potentials, and means for impressing a constant positive potential on the grid of said tube as compared with the filament.

18. A receiving system for radiant energy comprising an impedance element across the terminals of which potentials may be induced, a three-electrode, thermionic tube having its plate and filament connected respectively to the terminals of said element, a source of potential interposed between the grid and filament of said tube for determining the voltages for which the tube will serve as a by-pass for said impedance element, and means for confining the variations of potential of the impedance element to the filament and preventing such variations from affecting the grid.

19. A receiving system for radiant energy comprising an impedance element across the terminals of which potentials may be induced, a three-electrode, thermionic tube having its plate and filament connected respectively to the terminals of said element, a heating circuit for the filament, a source of positive potential with respect to the grid interposed between the grid and filament of said tube for determining the voltages for which the tube will serve as a by-pass for said impedance element, and means for confining the variations of potential of the impedance element to the filament, said means including a choke coil connected in the heating circuit of the filament.

20. A receiving system for radiant energy comprising an impedance element across the terminals of which potentials may be induced, a three-electrode, thermionic tube having its plate and filament connected respectively to the terminals of said element and its grid connected with its filament, and means for confining the variations of potential of the impedance element to the filament and preventing such variations from affecting the grid.

In testimony whereof, we have signed our names to this specification.

JOHN HAYS HAMMOND, JR.
EMORY LEON CHAFFEE.