Oct. 7, 1930. G. W. HALE 1,777,433

SIGNALING SYSTEM

Filed Oct. 4, 1924 4 Sheets-Sheet 1

Fig.1.

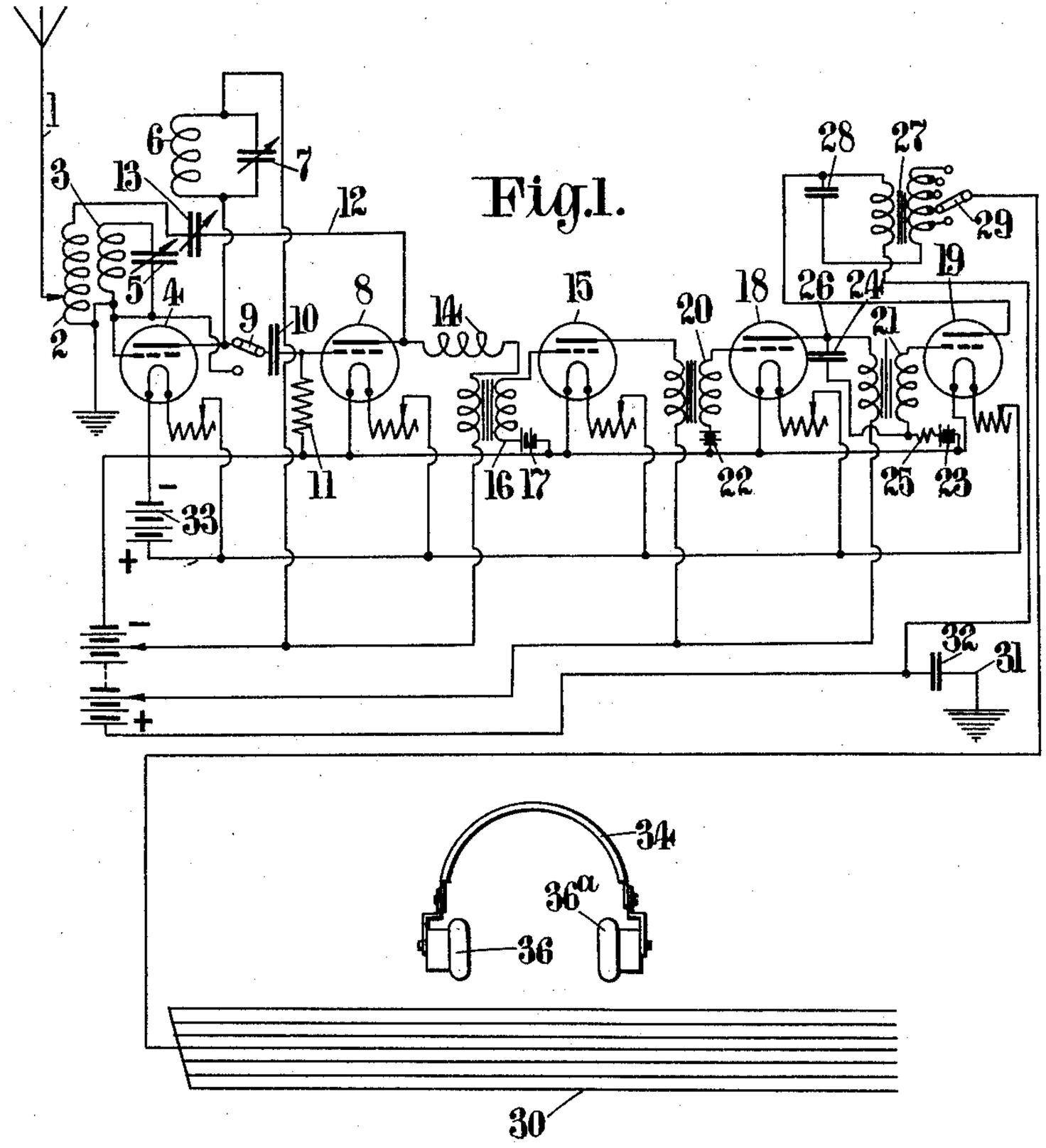
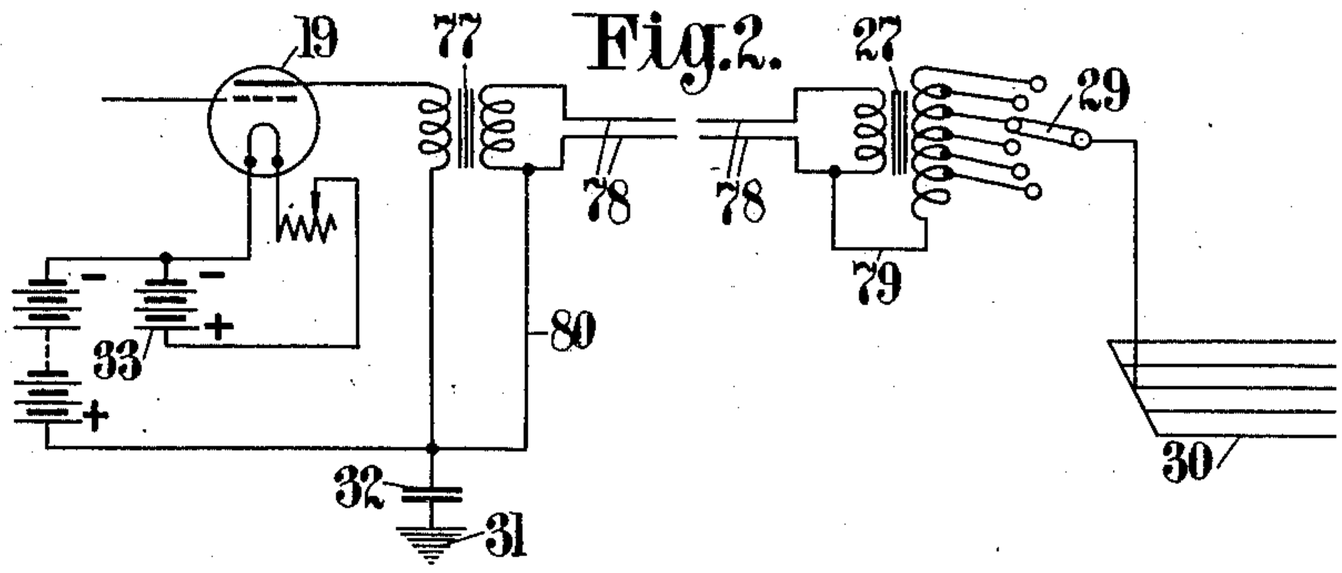


Fig.2.



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SIGNALING SYSTEM

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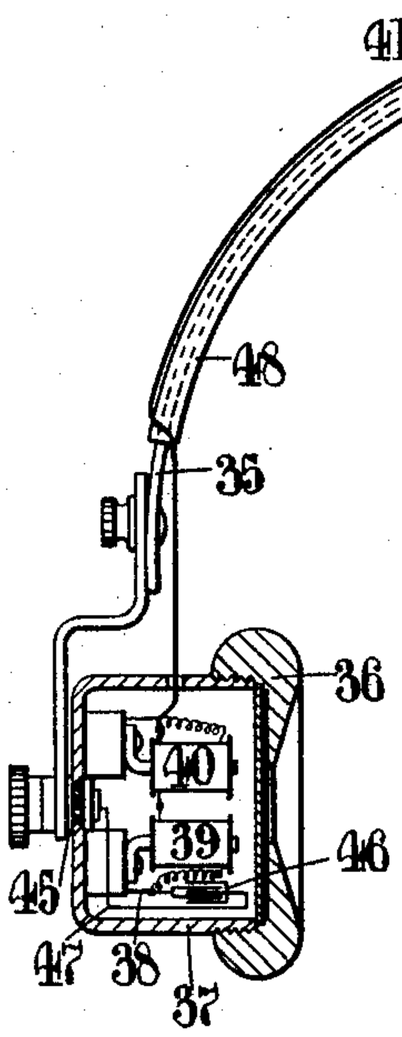


Fig. 3.

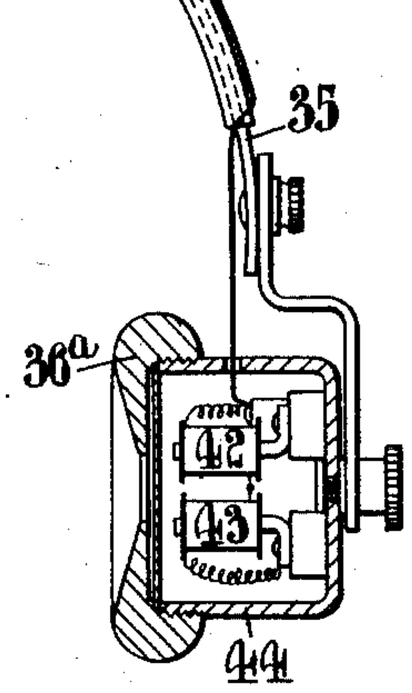


Fig. 4.

Fig. 13.

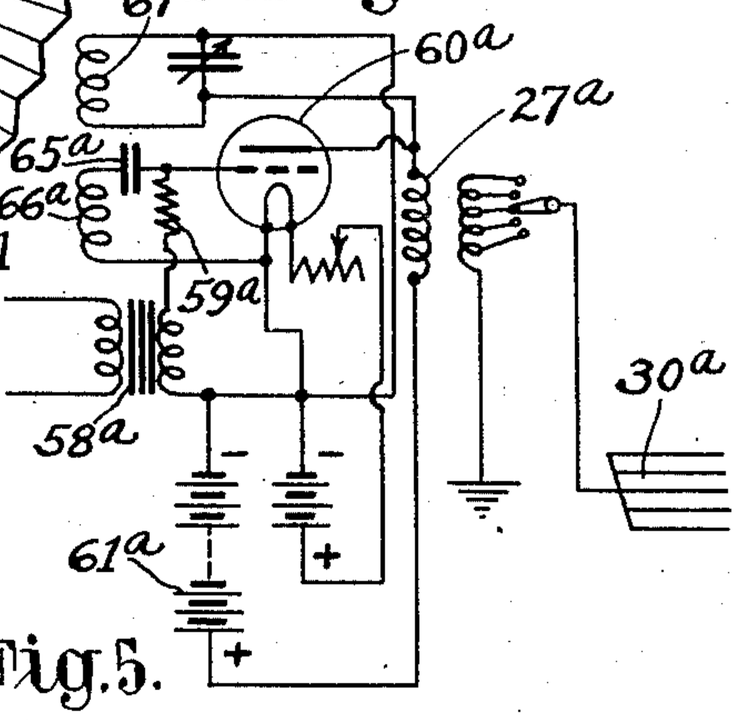
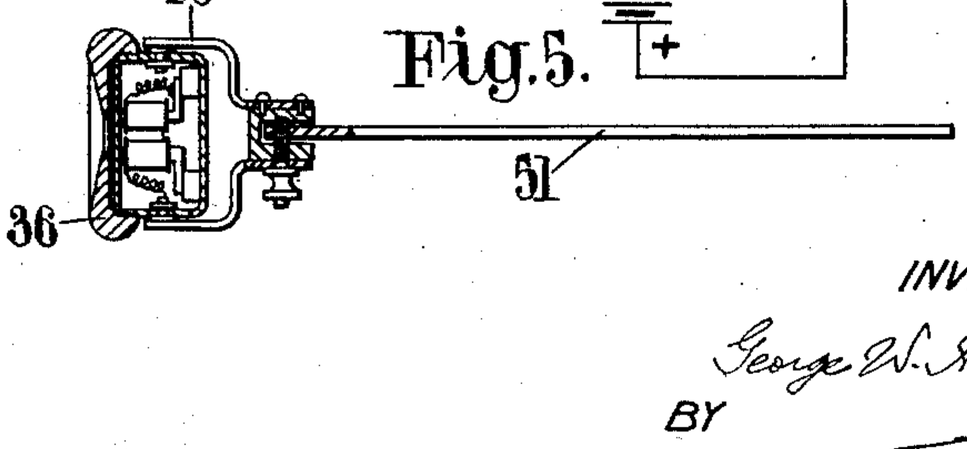


Fig. 5.



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SIGNALING SYSTEM

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Fig.6.

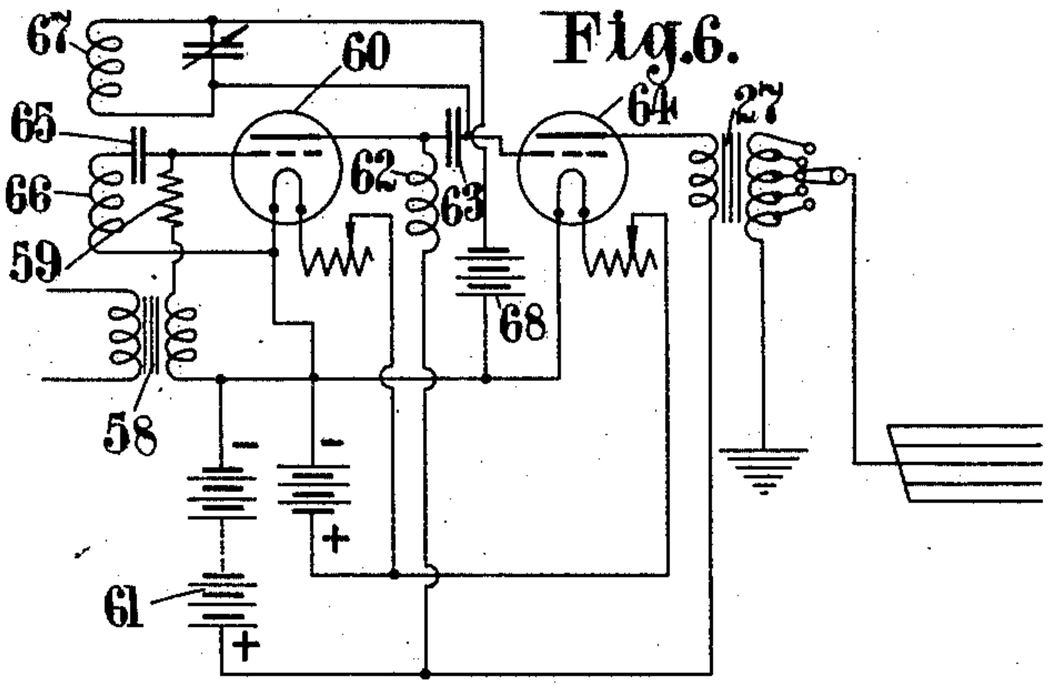


Fig.7.

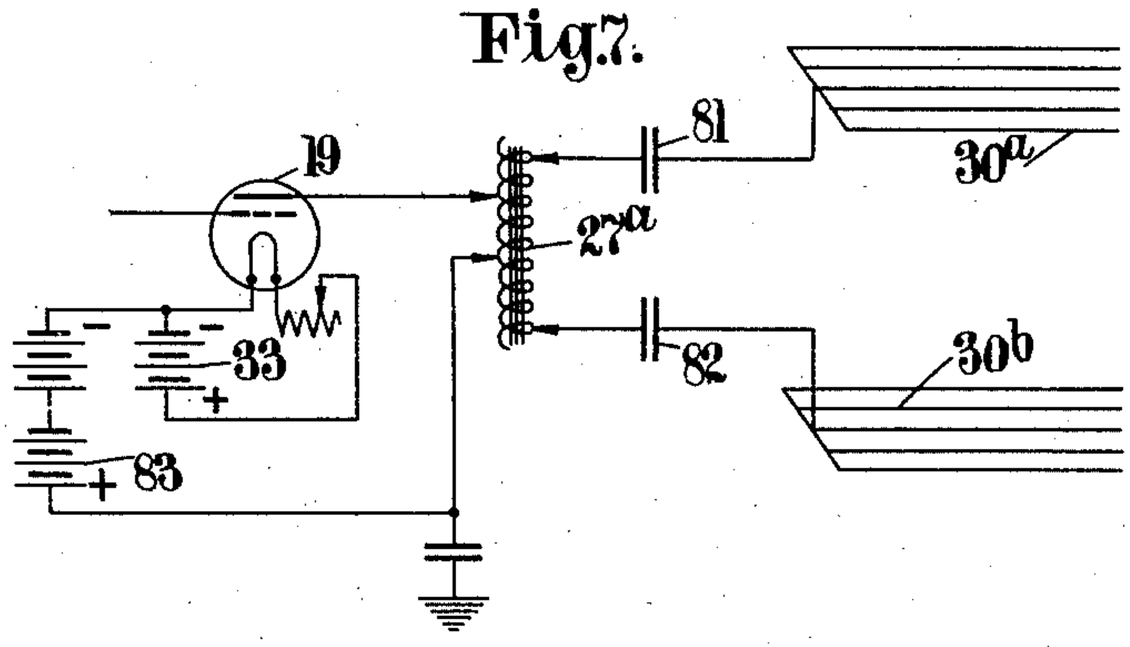
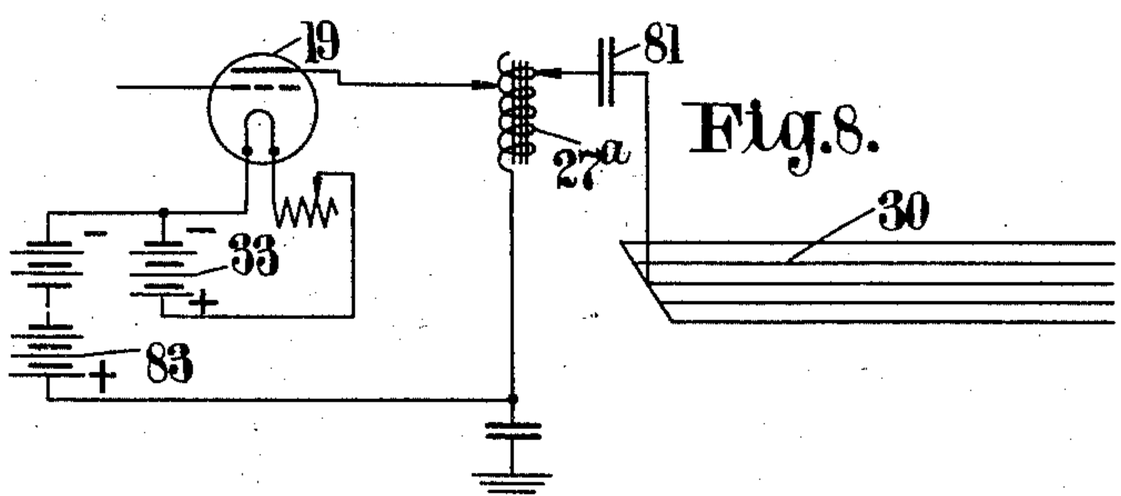


Fig.8.



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SIGNALING SYSTEM

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Fig.9.

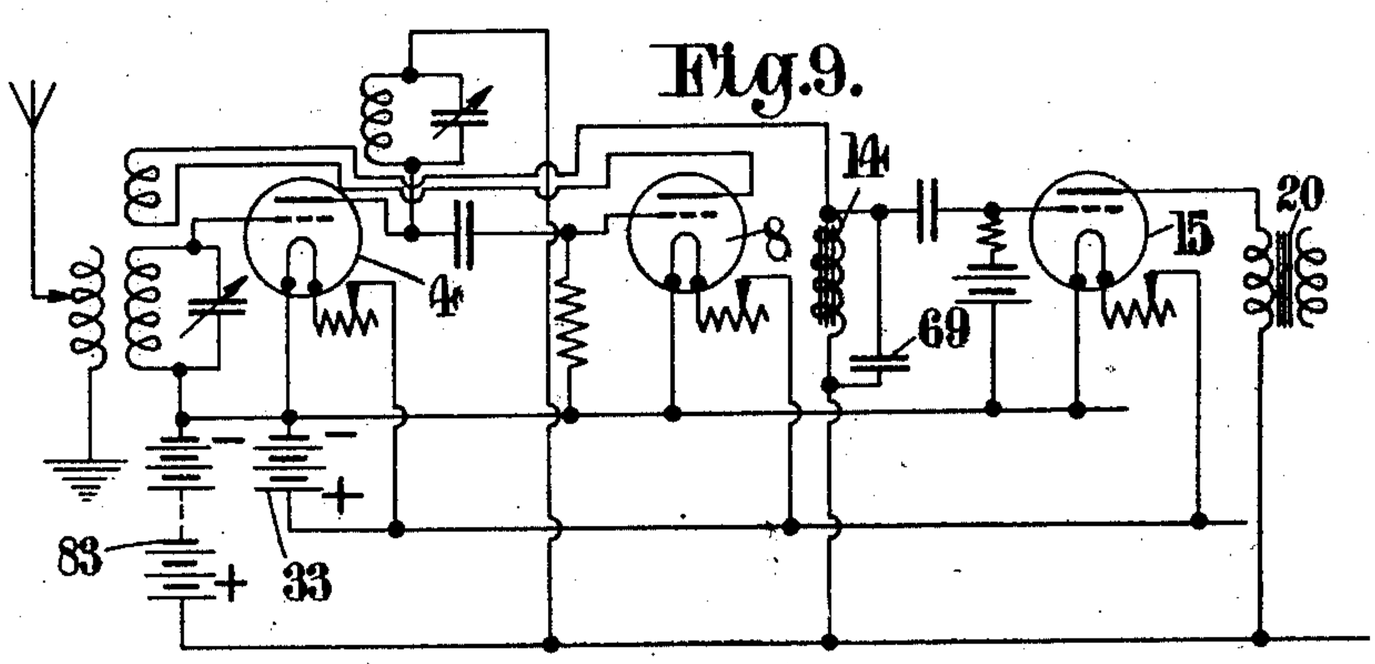


Fig.10.

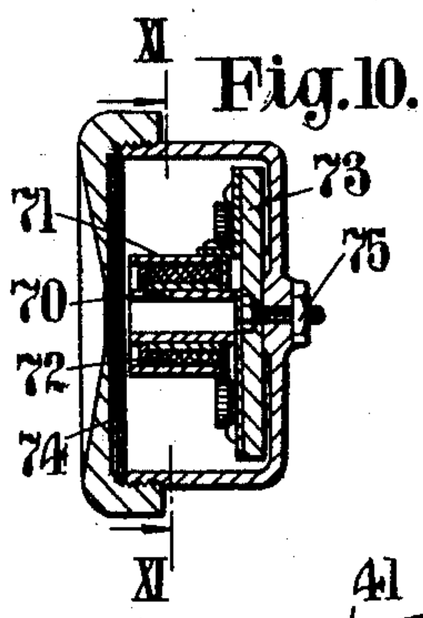


Fig.11.

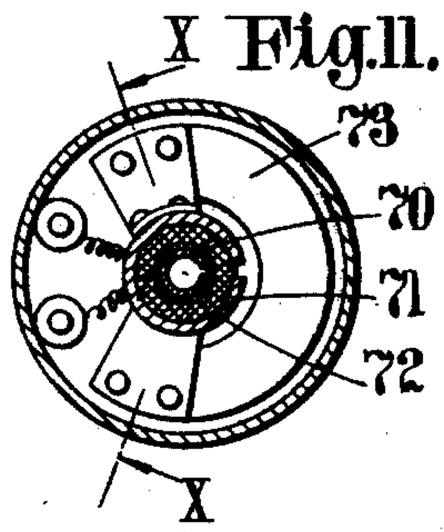
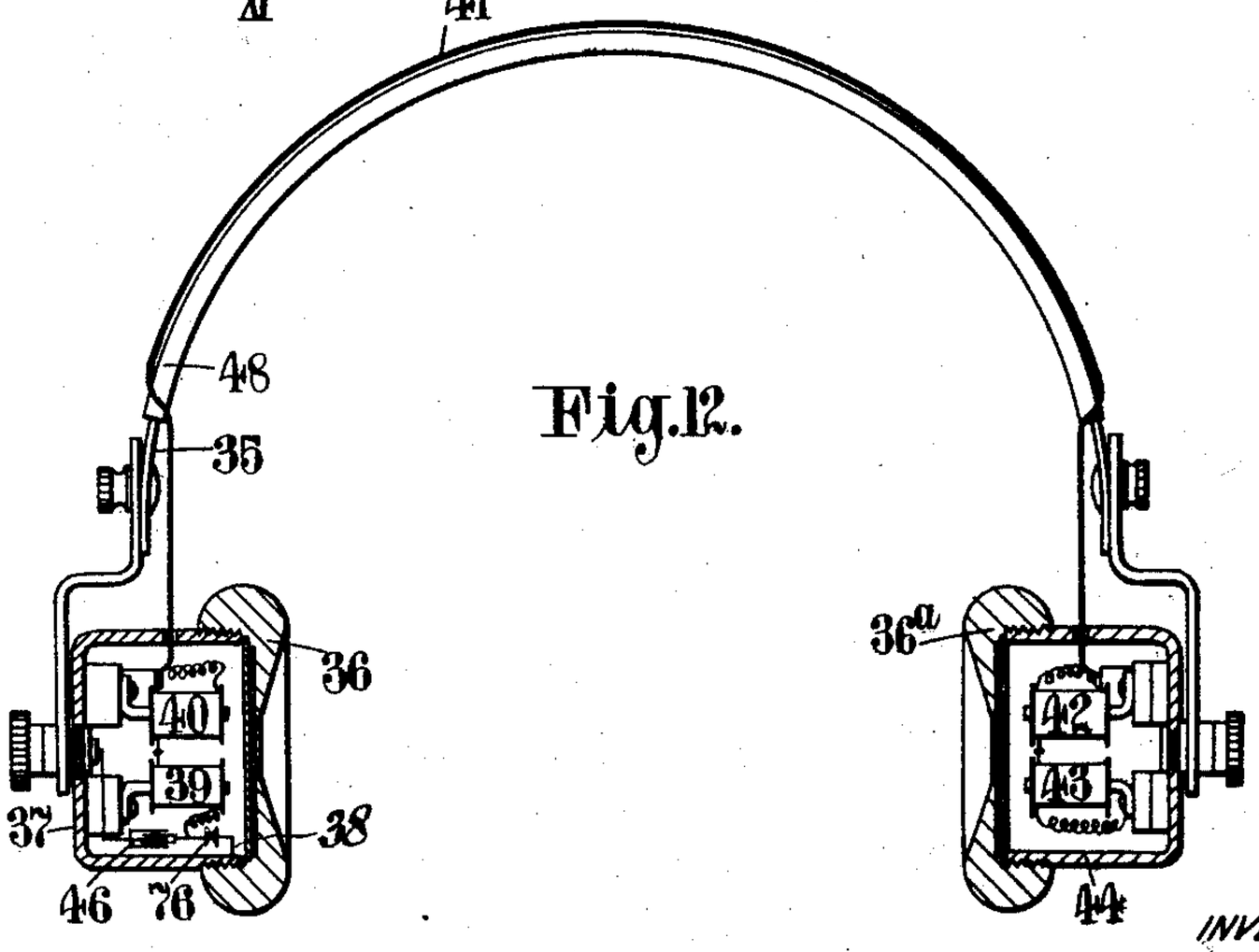


Fig.12.



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Patented Oct. 7, 1930 1,777,433

UNITED STATES PATENT OFFICE

GEORGE WILLIAM HALE, OF LONDON, ENGLAND

SIGNALING SYSTEM

Application filed October 4, 1924, Serial No. 741,636, and in Great Britain August 16, 1924.

This invention relates to apparatus for distributing telephone or telegraph signals arising from radio receiving apparatus or from line signaling systems. The invention is applicable to the distribution of signals, including all kinds of radio telegraph or telephone signals, in the form of speech, conversation and music and so forth, as well as all kinds of matter transmitted by line telephone and telegraph systems. The invention aims at producing an effective system whereby signals of the kind referred to can be received in head telephones or other telephone instruments without a wire connection with the receiving apparatus proper. One advantage of such a system is that one or a number of persons may wear head telephone gear and continue to receive the signals when in any position within the influence of the receiving apparatus and can continue to receive the signals even when moving about and changing their positions.

Broadly defined, the invention consists in a signal distributing system incorporating receiving apparatus wherein currents are set up due to telephone or telegraph signals, a multi-stage vacuum tube amplifier for amplifying the currents and for applying to a distributing grid or network a varying electrostatic field, with a telephone instrument or instruments placed within the influence of that field and arranged so that variations in the electrostatic field set up currents in the coils of the telephone instrument of sufficient magnitude to operate the latter effectively; the invention also includes means for substantially eliminating distortion in the sounds heard in the telephone instrument. In the case of high frequency signals, such as radio signals, the currents may be rectified prior to amplification in the receiving apparatus so that the electrostatic field varies at audio frequency or, on the other hand, the varying electrostatic field may be a high frequency field and rectification will then be carried on in or adjacent to the telephone instrument. The amplifier used may take any one of a number of forms, examples of which will be described hereinafter.

It is believed that the necessity for correcting distortion arises due to the fact that the circuit in which the telephone windings are connected has a comparatively low impedance to induced potentials of relatively high audio frequencies whereas, on the other hand, the impedance is comparatively very great to lower audio frequencies. For example, at a frequency of 5000 the effect produced in the telephones is relatively great compared with the effect produced at a frequency of 200 and this results in the response in the telephones being far from proportional to the variations in the signal currents or to the variations in the electrostatic field. The means employed for correcting this distortion in accordance with the present invention may conveniently be embodied in the structure of the telephone receiver, a condenser of a suitable capacity being connected across the ends of the coils of the receiver and in parallel with the conducting bodies to which said coils are connected. The effect of this is to obtain a more uniform response of the telephones over a wider range of frequency than is possible when the telephones have no such correcting means. If the condenser is chosen of suitable capacity it offers small impedance to currents of high audio frequency, but offers large impedance to currents of the lower audio frequencies. The result of this arrangement is that currents of the higher audio frequencies have a relatively easy passage through the condenser and their effect upon the telephone instrument is considerably reduced; on the other hand the currents of low audio frequencies do not find an easy passage through the condenser and are obliged to pass through the telephone coils so that the total result is to even up generally the response over a large range of frequencies. Furthermore, the use of such a condenser tends to reduce the natural frequency of the winding of the telephone coils so that for this reason also an increased response is obtained at lower frequencies.

When the condenser is connected in parallel to the telephone coils in this way it may be carried on the telephone head pieces, or on the telephone head band, or within the case of the telephone receiver, or in any other

convenient manner and position. However, the distortion liable to arise may also be corrected partially or wholly in the multi-stage vacuum tube amplifier itself. Obviously the distortion can be corrected by producing a converse distortion in the receiving apparatus, that is to say by reducing the impulses of high audible frequency in the amplifier so as to render the proportionality incorrect in that manner. This may be effected by connecting a condenser of a suitable capacity across one or more of the choke coils used for coupling together low frequency tubes of the amplifier or by introducing any other circuits in the amplifier which have the effect of reducing the amount of the impulses of the higher audible frequencies passed on to succeeding tubes.

Several embodiments of the present invention are illustrated in the annexed drawings, wherein:—

Figure 1 is a circuit diagram of one system arranged in accordance with the invention;

Figure 2 is a diagram showng a modification;

Figure 3 is an elevation partly in section showing the telephones used in Figure 1 to an enlarged scale;

Figure 4 is a perspective view, and

Figure 5 a sectional plan of an alternative construction of telephone intended more particularly for ladies' use;

Figure 6 is a circuit diagram showing an alternative form of amplifier;

Figure 7 is a diagram of a part of an alternative system with an auto-transformer and two distributing networks;

Figure 8 is a similar diagram of a further embodiment;

Figure 9 is a circuit diagram showing some stages in an alternative form of the receiving system;

Figure 10 is a section on the line X—X in Figure 11;

Figure 11 is a section on the line XI—XI in Figure 10 showing a preferred form of high impedance telephone for use in connection with the invention;

Figure 12 is a view similar to Figure 3 of a pair of head telephones, wherein a crystal rectifier is employed for use in accordance with the invention; and

Figure 13 is a circuit diagram of a form of amplifier for imposing radio frequency variations upon a distributing net-work.

In carrying the invention into effect a receiving apparatus is employed embodying a vacuum tube amplifier which may take one of a number of forms as will be pointed out in greater detail, hereinafter. In Figure 1 a diagram is shown of a radio receiving system used in conjunction with the present invention. The antenna 1 is connected to a tap on the inductance 2 inductively coupled to the secondary coil 3 in the grid circuit of the high frequency amplifying tube 4, which grid circuit is tuned by the condenser 5. The anode circuit of the tube 4 is tuned to the incoming signals by the inductance coil 6 and variable condenser 7 and is connected to the grid of the second tube 8 through the switch 9, condenser 10 and by means of the high resistance 11, which also serves as a grid leak, is coupled to the second tube 8. The switch 9 in the lower position connects the inductance 3 and condenser 5 direct to the grid of the second tube 8, thereby eliminating when desired the high frequency amplifyng tube 4. There is a connection 12 from the anode of the tube 8 to the inductance 2 containing a variable condenser 13 which thus provides a variable capacity back coupling between the anode of tube 8 and the grid of tube 4, or when the latter is switched out of circuit, the grid of the tube 8. In the anode circuit of the tube 8 there is a high frequency choke coil 14 which ensures that the high frequency oscillations pass through the connection 12. The coupling between the tube 8 and the third tube 15 is by means of the low frequency transformer 16, the grid of tube 15 being provided with bias cells 17. Each of the succeeding low frequency amplifying tubes 18 and 19 is coupled to the preceding tube by low frequency transformers 20 and 21 and each has grid bias cells 22, 23. It will be noted that the secondary winding of the low frequency transformer 21 is connected at its upper end to the grid of the tube 19 and at its lower end is connected through a condenser 24 to the anode of tube 18, that is to say to the high potential end of the primary winding of transformer 21. A grid leak resistance 25 is shown to assist in maintaining the grid of the tube 19 at a suitable negative potential relatively to the filament of the tube 19. Due to this connection through the condenser 24 the audio frequency potential applied to the grid of the tube 19 is the sum of the high potential of audio frequency at the point 26 and the potential electro-magnetically induced in the secondary winding of the transformer 21. The potential at any instant at the point 26, should be in phase with that obtained at the end of the secondary winding to which it is connected through the condenser 24.

A second step-up transformer 27 is connected in the anode circuit of tube 19 and arranged in a similar manner, that is to say the lower end of its secondary winding is connected through a condenser 28 to the anode of tube 19. The secondary winding of transformer 27 has taps taken out to the studs of a rotary switch 29, or other convenient means are employed for varying the ratio of the turns of the primary and secondary windings of the transformer 27. The effect of the two tubes 18 and 19 is to amplify the energy obtained from the incom-

ing signals and to apply through the switch 29 high potentials varying at audio frequency to a wire network or grid or grids 30 connected to the secondary winding of transformer 27 by the switch 29. The point at which the grid 30 is connected to the secondary winding depends upon the area of the grid in use. The latter may be formed of fine gauge wire laid in the form of a grid and placed between india rubber sheets or layers of stout paper securely cemented together and may be concealed beneath carpets, or may be suspended beneath the ceiling of a room, or again may consist of wire woven into carpets or fixed directly to the floors, or arranged in any other convenient manner in those locations at which it is desired to distribute the signals. Although the step-up transformer 27 is indicated in Figure 1 as placed close to the tube 19 it may be arranged locally near the spot at which the signals are to be distributed as shown in Figure 2. A step-down transformer 77 is inserted between the tube 19 and the conductors 78 so that the latter connecting the transformer 77 and the primary winding of the transformer 27 have to deal with relatively low potentials and can therefore be contained in a lead covered cable. The one output terminal of the receiver consists of the arm of the switch 29, the other output terminal 31 which is grounded is shown in Figure 1 as connected through a by-pass condenser 32 to the lower end, that is the low potential end of the primary winding of the transformer 27. On the other hand the terminal 31 may be connected directly to the filament battery 33 of the amplifier. In Figure 2, one terminal of the secondary winding of the transformer 27 is grounded through back connections 79, 80 instead of locally.

The object of using grids or capacity networks such as 30 as herein described, is to set up an electrostatic field which varies at audio frequency and which spreading out from all parts of the grid 30 will induce electrostatic charges of considerable magnitude in any insulated conductive body or bodies placed in the electrostatic field of force which will be of similar audio frequency character to electrostatic charges which are applied to the wire network 30. As already mentioned, in order that the latter shall be raised to as high a potential as possible the ratio of the transformer 27 may be varied by means of the switch 29. The electrostatic field set up by the network 30 tends to induce electrostatic charges and if a pair of insulated and conductive bodies is placed in the field and provided they have not the same capability for collecting electrostatic charges, or have not the same electrostatic capacity to ground, a potential difference will be set up between them capable of creating telephonic currents if they are electrically connected through the coils of a telephone receiver 34 so that a person may listen to telephone or telegraph signals without any connection to the radio receiver. As illustrated in the drawings particularly in Figure 3, the two bodies of different capacity to ground comprise the head band 35 of the telephones and the surface of the body of the person using them. Connection is made to the person's body in the example illustrated in Figures 1 and 3 by the metallic ear cap 36, the other ear cap 36ª being of insulating material. The ear caps 36 and 36ª are screwed on to the bodies of the ear pieces and the body 37 by means of a connection 38 is joined to one end of the telephone coil 39. The coils 39 and 40 are joined in series and by means of a connection 41 passing around but insulated from the head band 35, the coils 39 and 40 are also in series with the coils 42 and 43 of the other ear piece. The coil 43 is connected to the case of the other ear piece 44 which is connected to the head band 35 directly. The head band is shown as insulated from the body of the one ear piece 37 by an insulating bushing 45, so that all four telephone coils are in series between the head band 35 on the one hand and the body of the wearer through the cap 36 on the other hand. Owing to the different capacity of the wearer's body and the head band 35 to ground a current will flow from one to the other through the windings 39, 40, 42, 43 when the telephones are in the varying electrostatic field set up by the network 30 and these currents will be of the same frequency as the electrostatic field and therefore will reproduce in the telephones 34 the signals, either telegraph or speech or music, received in the antenna 1. It is found that with such a connection there is considerable liability for distortion to be set up when receiving telephony which is believed to be due to the comparatively low impedance of the conductive connection between the conductive bodies to induced potentials of relatively high audio frequencies, whereas the impedance is comparatively very great for lower audio frequencies. The result is, for example, that the effect produced at a frequency of say 5000 is relatively great compared with the effect produced at a frequency of 200, with the result that the response in the telephones 34 is far from proportional to the variations in the signaling currents and in the electrostatic field unless steps are taken to correct this distortion. In the embodiment shown in Figures 1 to 3 in order to correct this distortion there is a condenser 46, one end of which is joined by a conductor 47 to the head band 35 and the other end of which is connected to the body 37 of one of the ear pieces and thereby through the cap 36 to the body of the wearer.

The result is that the condenser 46 is effectively connected in a shunt path to the windings 39, 40, 42 and 43 between the conducting bodies formed by the head band 35 and the body of the wearer. The effect of this is to obtain a more uniform response of the telephones 34 over a wider range of frequency than is possible without the condenser 46. If the condenser 46 is chosen of suitable capacity it offers small impedance to currents of high audio frequency, but offers a high impedance to currents of the lower frequencies and therefore currents of the higher audio frequencies have a relatively easy passage through the condenser 46 and their effect upon the telephone instrument is considerably reduced. On the other hand the currents of low frequency do not find an easy passage through the condenser 46 and are obliged to pass through the telephone coils, so that the total result is a general evening up of the response over a large range of frequencies. Furthermore, the use of such a condenser 46 tends to reduce the natural frequency of the telephone windings 39, 40, 42 and 43 so that for this reason also an increased response is obtained at lower frequencies. The telephone 46 is shown diagrammatically carried within one of the telephone head pieces, but in case there is no room for a condenser of the requisite capacity inside the case it may be located upon the head band 35 or in any other convenient position. Clearly the head band 35 needs to be insulated from the conductor 41 and from the head of the wearer and is accordingly encased in an insulating sheath 48 of india rubber, leather or other flexible insulating material.

Although as already described the invention is intended to be used for distributing signals in rooms, it may equally well be used for distributing signals on trains and ships. The grids or networks 30 in the case of trains, for example, may be disposed on the ceilings of the coaches, under seats or behind the backs of seats as may be most convenient. Apparatus such as is shown in Figure 1 may also be installed at railway stations or in signal cabins, the distributing line or lines corresponding to the grid 30 connected to the amplifier being carried on posts or supported on insulators placed along the track. The energy in this distributing line or lines may in known manner be transferred by electrostatic induction to a wire running along the train, which wire is then connected to grids or networks, similar to 30, disposed in the train.

The invention may also be used in conjunction with an ordinary line telephone circuit, in which case the line currents will be amplified before being applied to the network 30 in a similar way to that shown in connection with Figure 1.

In Figures 4 and 5 a modified embodiment of the telephones shown in Figure 3 is illustrated. The telephone consists of a single ear-piece 49 carried upon a handle 50. The body constituted by the head band 35 in Figure 3 is in Figures 4 and 5 formed by a fan 51 which may be of silk and carries a number of radiating wires 52, or may carry any pattern in tinsel, or any metallic material; the fan is intended to fold into a recess 53 in the handle 52. As illustrated connection is made to the wires 52 through the pivot screw 54 to one end of the telephone coils. The other end of the telephone coils is connected to the metallic part 55 of the handle 50 which is intended to be grasped by the user to make the necessary connection to the user's body. The condenser 46 in this case is shown let into a recess in the handle 50 and is connected on the one hand to the metallic part 55 and thence to the user's body and on the other hand by means of a conductor 56 through the pivot 54 to the wires 52, so that the electrical connections are exactly equivalent to those shown in Figure 3. Of course in order to avoid the necessity for a second wire 57 in the handle, the condenser 46 and the metallic part 55 of the handle may be connected to the wires 52 at the lower end of the fan 51 and also in order to enable the telephone to be used, for example, by ladies wearing gloves which may tend to insulate the metallic part 55, there may be an alternative connection of the one end of the telephone windings to the body of the user through the ear cap 36 which would then be made conductive. It is not actually necessary either in Figures 3 or 5 that the actual surface of the ear cap 36 should be conductive. It may contain a thin coating of insulating varnish which in that event would serve as a di-electric so that the current flowing from the head band 35 or fan 51 to the user's body would be a capacity current.

It will be understood that forms of amplifier may be employed in accordance with the invention other than that shown in Figure 1. For example in Figure 6 an amplifier is shown in which the low frequency current from a radio receiver or other source is employed to control the oscillations in a high frequency generator circuit. In Figure 6, audio frequency signals are supplied to the primary winding of a low frequency transformer 58, the secondary winding of which is connected through a grid leak resistance 59 to the grid of the oscillating vacuum tube 60. The anode of the tube 60 is supplied by current from the high tension battery 61 through a high frequency choke coil 62. A by-pass condenser 63 prevents the high tension from reaching the grid of the rectifying tube 64. The grid of the tube 60 has a branch circuit containing a condenser 65 and coil 66, the latter of which is coupled with the anode coil 67 for back coupling purposes in order to produce the oscillations in

tube 60. These oscillations are rectified by the tube 64, the grid of which is maintained at a suitable potential by the battery 68. Low frequency changes in potential of the grid of tube 60 modulate the high frequency oscillations generated, which when rectified by the tube 64 are applied to the high tension output transformer 27 corresponding exactly to the transformer 27 in Figure 1. As a further alternative, distributing grids or networks may be connected to the ends of the secondary winding of the transformer 27, (Figure 1) the middle point of this secondary winding being grounded. In this case, the two grids may be placed under floors one above the other. Yet again an auto-transformer may be employed as shown at 27[a] in Figure 7 instead of the transformer 27. The middle portion of the winding of the auto-transformer 27[a] serves as the primary winding, while the outer portions form the secondary winding. In this case condensers 81, 82 are connected in circuit with the winding of the transformer 27[a] and the distributing grids 30[a], 30[b] and ground to prevent the high tension direct current supplied to the anode of the tube 19 from the battery 83 from finding a path otherwise than through the middle or primary winding of transformer 27[a]. In Figure 8, an autotransformer 27[a] is shown in a system having a single network 30. A condenser 81 is provided for the same purpose as in Figure 7, otherwise the system is the same as shown in Figure 1 and needs no further description.

The distortion liable to arise if the condenser 46 shown in Figures 3 and 4 is omitted can be partially or wholly corrected in the vacuum tube amplifier itself. For example in Figure 9 the amplifier is shown as adapted to produce a converse distortion to that due to the capacity currents in the telephones, that is to say the amplifier is arranged to reduce the impulses of high audible frequency so as to render the proportionality incorrect in that way. In Figure 9 a section of an amplifier is shown with three vacuum tubes 4, 8, 15. The coupling between the rectifying tube 8 and the low frequency tube 15 is by means of a choke coil 14. A condenser 69 is connected across the choke coil 14 and is of such a capacity as to form a fairly easy path for impulses of high audible frequency. The result is that the impulses passed on to the next tube 15 are deficient in these impulses of high audible frequency, with the result that the impulses finally applied to the network 30 are distorted in this way and in the converse manner to the distortion produced by the capacity currents between the head band of the telephones and the body of the user, the net result being that one distortion neutralizes the other and comparatively distortionless speech is heard. The remaining parts of Figure 9 are standard practice and need not be described in detail.

Owing to the smallness of the electrostatic capacity of the head band 35 shown in Figure 3 or the wires 52 shown in Figure 4, it is preferred to use telephone receivers of unusual high impedance and constructed so as to allow a winding to be employed of larger dimensions than is possible with the common form of telephone receiver; such a high impedance instrument is shown in Figures 10 and 11. A central core 70 consists of a hollow cylinder and an outer core 71 consists of a hollow cylinder of about three times the diameter of the inner core 70. The space between the two cylinders is completely filled by the telephone winding 72. The cores 70 and 71 form the polar extensions of a part annular permanent magnet 73. The whole position of the magnet system relatively to the diaphragm 74 may be adjusted by means of a screw 75. The diaphragm 74 is placed a short distance away from the ends of the central core 70 and outer cylinder 71 which are preferably both of the same height. The ends of the winding 72 are carried to a pair of terminals which may be placed either on the case of the receiver or in the interior. The permanent magnet 73 maintains the central core 70 and the outer cylinder 71 at opposite magnetic polarity so that a continuous pull is exerted on the diaphragm 74. The telephone currents create variations in the pull on the diaphragm 74 setting up vibrations therein corresponding to the variations in the telephone current. In this form of receiver the magnetic pull is localized at the centre of the diaphragm resulting in greater sensitiveness owing to the force being applied to the points most easily set in motion, which is not the case in the ordinary type of telephone receiver in which the magnetic pull is applied to points on opposite sides of the centre of the diaphragm. The efficiency of the magnetic circuit is increased by enclosing the winding 72 by the outer cylinder 71 so that advantage is taken of both the inner and outer magnetic fields set up by currents in the winding 72. Both inner and outer cylinders are cut along their sides to prevent the circulation of eddy currents. A condenser such as shown at 46 in Figures 3 and 4 would be required in the case of Figures 10 and 11 for use with a system such as shown in Figure 1. With a system such as shown in Figure 9, however, no condenser is necessary in the telephones if the condenser 69 supplies all the correction desired. If, however, the condenser 69 only partly corrects for distortion a condenser would also be used in the telephones shown in Figures 10 and 11.

Of course low impedance telephones with a telephone transformer may be used in

known fashion in connection with any of the embodiments illustrated.

A further embodiment of suitable head telephones for use in connection with the invention is illustrated in Figure 12. This form of instrument is intended for use with an amplifier which does not embody a rectifier so that the electrostatic field set up by the network 30 may then vary at a frequency above audible frequency. A suitable amplifier for this purpose is shown in Figure 13; it is similar to that shown in Figure 6 but with the rectifying tube omitted. Here, audio-frequency signals are imposed upon the primary winding of the transformer 58ª. The oscillating vacuum tube 60ª has its grid fed from the secondary of said transformer through grid-leak resistance 59ª and is maintained in oscillation by the feed back between anode inductance 67ª and grid coil 66ª. The circuit of the latter also includes a grid condenser 65ª as in Figure 6. The anode circuit of tube 60ª is fed from battery 61ª, through primary of radio-frequency transformer 27ª which couples the output of tube 60ª to the distributing net-work 30ª. In its general details the embodiment shown in Figure 12 is the same as that shown in Figure 3 and corresponding reference numerals have been applied. There is, however, in addition a crystal detector 76 embodied in Figure 12 and it will be seen that it is included in the connection 38 which joins the telephone coil 39 and the condenser 46 to the casing of the telephone receiver and thence to the body of the user. The result of this is that the crystal detector is connected in series with the high frequency currents which pass between the body of the user and the head band from the wires 52 shown in Figure 4. By this means rectification is effected in the telephones themselves instead of in the amplifier. The crystal 76 is shown included in the body of one of the ear pieces, but it might equally well be placed in a small container attached to the head band or in any other suitable position.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:—

1. A signal receiving apparatus comprising in combination, a receiver for radio signals, a distributing conductor connected so as to be charged to a potential varying in accordance with variations in the signal currents in said receiver, a telephone instrument freely transportable independently of said receiver and having its winding adapted to make connection at one terminal point with the body of the listener, a portable insulated conductor having a different capacity to ground from that of the body of the listener and disposed so as to be influenced only by the electrostatic field due to said distributing conductor, said insulated conductor also being connected with the other terminal point of the winding of said telephone instrument, and means for increasing the response of the telephone instrument to the signals of lower audio-frequency relatively to those of higher audio-frequency.

2. A signal receiving apparatus comprissing in combination, a receiver for radio signals, a vacuum tube amplifier connected thereto, a distributing conductor connected to the output of said amplifier so as to be charged to a potential varying at radio frequency, a telephone receiver having an insulated conducting head band or support located within the electrostatic influence of said distributing conductor and having its winding connected to receive currents flowing between said head band or support and the body of the listener, and a wave detector connected to the winding of said telephone instrument to rectify the radio frequency potential differences applied thereto.

3. A signal receiving apparatus comprising in combination, a receiver for radio signals, a vacuum tube amplifier connected thereto, a distributing conductor connected to the output of said amplifier so as to be charged to a potential varying at radio frequency, a portable insulated conductor disposed so as to be influenced only by the electrostatic field due to said distributing conductor, a telephone instrument having its winding connected to receive currents flowing between said insulated conductor and the body of the listener, a wave detector connected in series with the winding of said telephone instrument, and a condenser connected across the terminals of the winding of said telephone instrument.

4. A signal receiving apparatus comprising in combination, a receiver for radio signals, a distributing conductor connected so as to be charged to a potential varying in accordance with variations in the signal currents in said receiver, a portable insulated conductor disposed so as to be influenced only by the electrostatic field due to said distributing conductor, a telephone instrument freely transportable independently of said receiver and having its winding connected at one terminal point to said insulated conductor, a contact member connected to the other terminal point of the winding of the telephone instrument and making contact with the body of the listener and a condenser connected across the terminals of the winding of said telephone instrument.

5. A sound reproducing apparatus comprising in combination a vacuum tube amplifier capable of generating high frequency oscillations, means for applying low frequency current signals to said amplifier, a distributing conductor connected to the output of said amplifier so as to be charged to a potential

varying in accordance with variations in said signal currents, a portable telephone receiver having an insulated conducting support located within the electrostatic influence of said distributing conductor, and having its winding connected to receive currents flowing between said support and the body of the listener, and a wave detector connected to the winding of said telephone instrument.

6. A telephone receiver for receiving signals in the form of variations in an electrostatic field consisting in the combination of a freely transportable electromagnetic telephone, a contact member connected to one end of the windings thereof for making connection to the body of the user, an insulated capacity body connected to the opposite end of the windings, a condenser connected in shunt with said windings and a rectifier connected in circuit with said windings.

In witness whereof, I hereunto subscribe my name this 20th day of September, A. D. 1924.

G. W. HALE.