J. W. MILNOR.

AMPLIFIER.

APPLICATION FILED JAN. 17, 1918.

1,415,382.

Patented May 9, 1922.

2 SHEETS—SHEET 1.

Fig. 1.

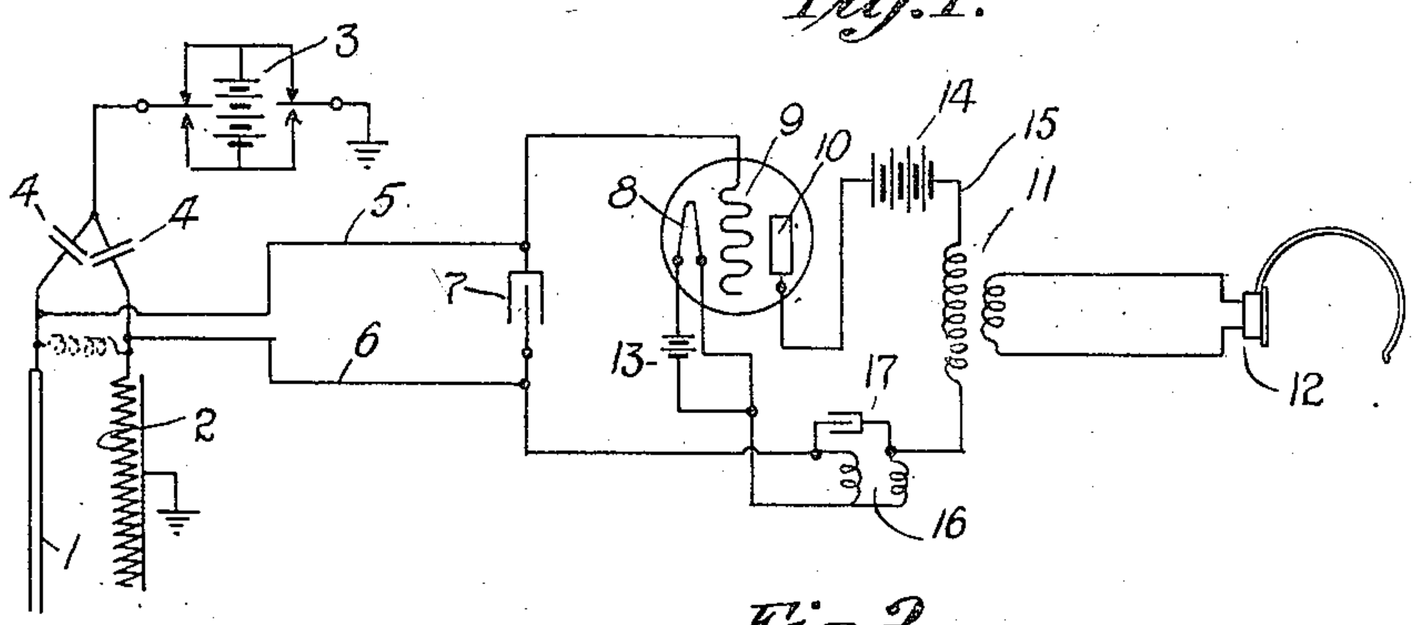


Fig. 2.

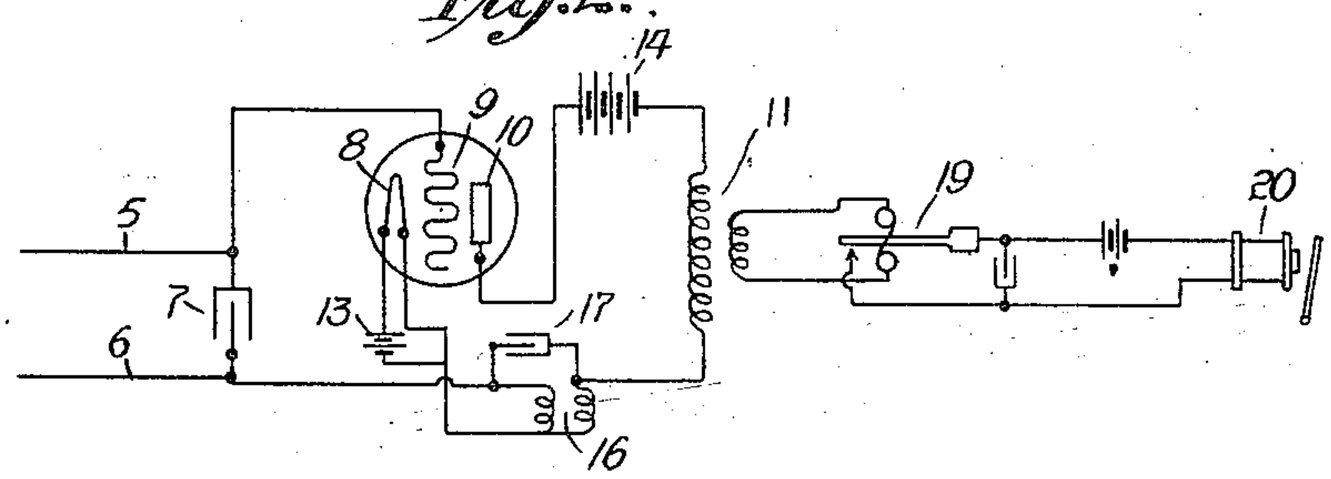


Fig. 3.

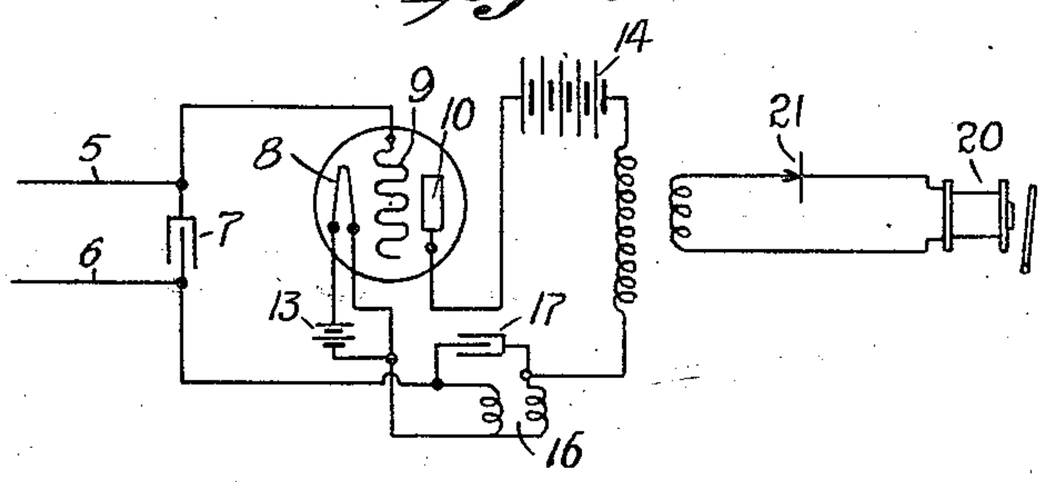
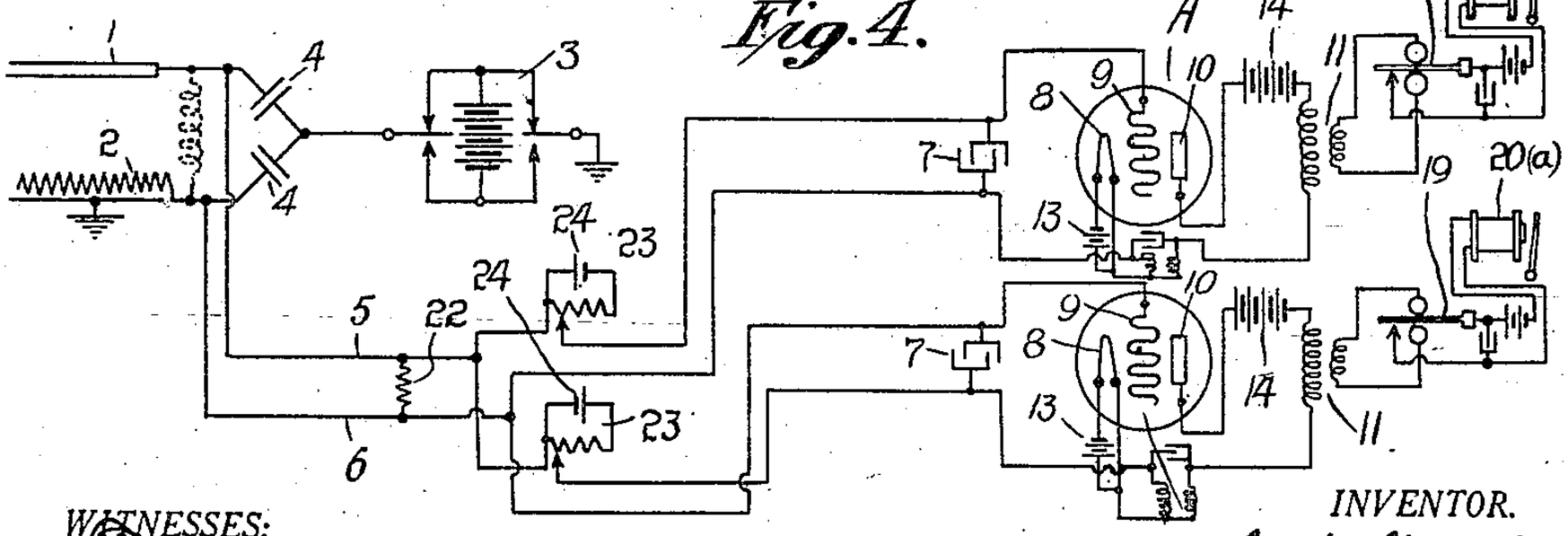


Fig. 4.



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2 SHEETS—SHEET 2.

Fig. 5.

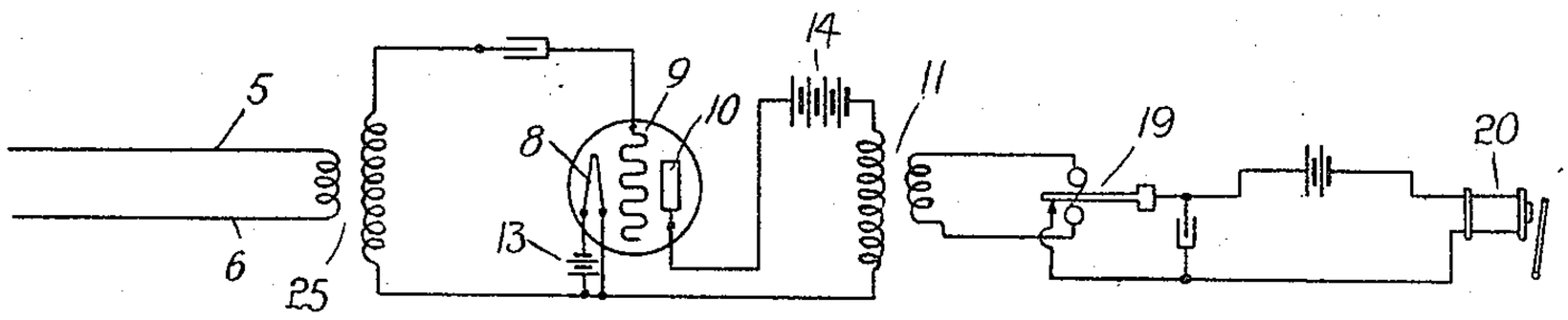
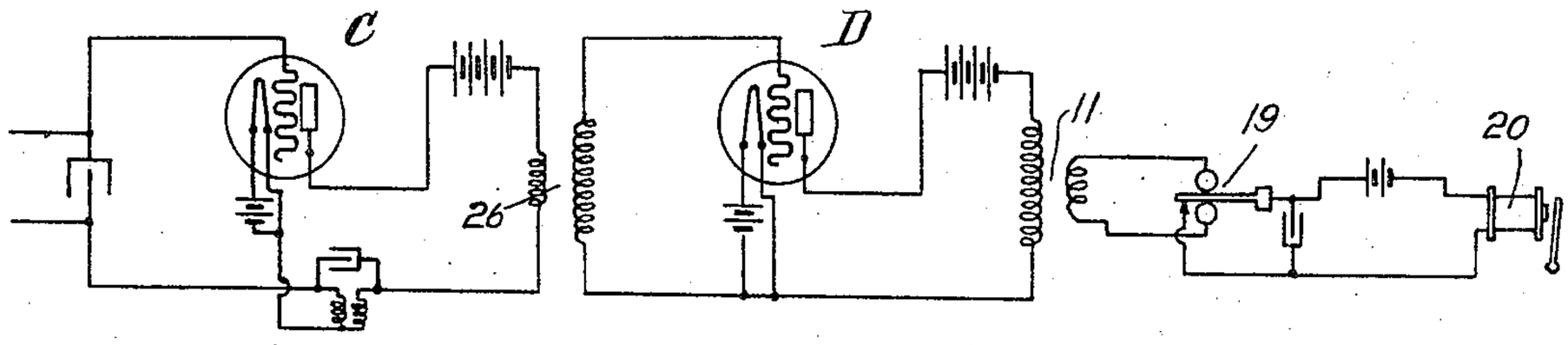


Fig. 6.



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AMPLIFIER.

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To all whom it may concern:

Be it known that I, JOSEPH W. MILNOR, a citizen of the United States of America, and a resident of New York, county of New York and State of New York, have invented certain new and useful Improvements in Amplifiers, of which the following is a specification.

My invention relates to a method of and means for amplifying telegraphic signals, and is particularly adapted and intended for amplification of the signals of submarine cables, but is also applicable to the amplification of the signals of the so-called "wireless" telegraph systems.

According to the present invention, the so-called "audion" or "gas relay" is employed for the amplification of signals. The audion itself is a well-known instrument and is not altered in construction for use according to the present invention. Since the frequency of the signals in a cable circuit may be said to vary from 10 to 20 cycles per second, or thereabouts, (this frequency of course is variable, but is low as compared with usual alternating current frequencies) and since cable signals, if transmitted by the ordinary method (as distinguished from the "true reversal" method) are not true alternating currents, but may comprise several successive impulses of the same direction, and since the audion is best adapted to amplifying signals when the current of those signals is in the form of relatively high frequency, according to the present invention the audion is arranged to oscillate at a definite frequency, preferably in the neighborhood of a few hundred cycles per second. This may be accomplished in various well-known ways, for example, by coupling the grid and plate circuits of the audion in such manner that energy from the plate is returned to the grid, or by causing current or voltage from an outside source to be impressed on the grid. The current amplified by the audion is conducted into a suitable receiving instrument, which may be either a telephone receiver, a "tuned" relay, or a siphon recorder or ordinary relay connected through a rectifier.

Such an amplifying and receiving arrangement as above outlined will serve for the amplification and reception of "wireless" signals, also for the reception of cable and other telegraph signals when a telephone receiver is employed in signal reading. But when submarine cable signals are to be received by a siphon recorder or relay or repeater, it is desirable to be able to distinguish at the receiving end between positive current, negative current, and zero current. The present invention comprises means whereby this may be accomplished.

My invention comprises a method and means whereby telegraph signals are amplified by an audion itself arranged to produce a high frequency current; a method and means whereby the current, as amplified by the audion, is rectified for the benefit of the signal-receiving or signal-repeating apparatus; a method and means whereby distinction is made between positive current, negative current, and zero current; and other features, all as hereinafter described and particularly pointed out in the appended claims.

The objects of my invention are, to provide simple and reliable means for the amplification of cable signals, "wireless" signals, etc.; to avoid, in such amplification, use of parts subject to the disturbing effects of mechanical inertia; to provide an amplifying apparatus possessing the above advantages, and which is devoid of relay contacts and the like which must be completed and broken in the operation of the apparatus; and in general, provide an amplifying apparatus of extreme simplicity and extreme compactness and of a nature such as will be understood readily by telegraph engineers and operators.

I will now proceed to describe my invention with reference to the accompanying drawings, in which certain arrangements embodying my invention are illustrated more or less diagrammatically.

In said drawings:

Figure 1 is a diagram showing one use of an oscillating audion in connection with the amplification of cable signals, the receiving instrument employed being a telephone receiver.

Figure 2 is a fragmentary diagram similar to Figure 1, except that means for operating an ordinary relay, or siphon recorder, or repeater, are shown.

Figure 3 is a diagram similar to Figure 2, except that the use of a rectifier is indicated.

Figure 4 is a diagram in general similar to Figure 2, except that the use of two audions in parallel, arranged respectively one

to amplify positive impulses, the other to amplify negative impulses, are indicated.

Figure 5 is a diagram illustrating the arrangement of apparatus for amplifying wireless signals.

Figure 6 is a diagram showing the joint use of an oscillating audion and an amplifying audion.

Referring first to Figure 1: Submarine cables are usually, though not necessarily, operated "duplex," and in Figure 1 a duplex cable is shown; 1 designates the main cable line, 2 the artificial line, 3 the usual transmitting arrangement, and 4—4 the usual condensers in the main and artificial lines respectively. 5 and 6 designate leads from the main line, and artificial line, respectively, to the audion circuits, and 7 designates a condenser bridged across leads 5 and 6 to act as a path for currents of relatively high frequency, in the audion circuit, while preventing passage of the low frequency currents of the cable circuit. 8, 9, and 10 designate respectively the filament, the grid, and the plate of the audion and 11 designates a step down transformer, the primary of which is in the audion circuit while the secondary of the transformer is in the receiver circuit; 12 designates the receiver. A battery 13 supplies current to the filament of the audion and a battery 14 supplies current to the audion circuit 15, in which amplification occurs; such circuit including the primary of transformer 11. In the conductor 15 there is a transformer 16 bridged by a condenser 17; the connections shown comprising one known means whereby the audion is arranged to itself produce a high frequency oscillation. (It should be explained however that the term "high frequency" is used in contradistinction from the low frequency of the cable circuit proper, and that this high frequency current may be a current of a few hundred cycles per second only).

In Figure 1 the receiving instrument 12 is a telephone receiver; but when it is desired to receive signals by a relay, then, as shown in Figure 2, a tuned vibrating relay 19 is arranged to be operated by the secondary circuit of the step down transformer 11, and this relay is tuned into synchronism with the alternating current produced by the audion, and such relay, by its operation, produces direct current impulses, corresponding to the alternating current impulses of the audion, which direct current impulses operate receiving relay 20. As illustrated in Figure 3, a crystal or other rectifier (for example, an electrolytic rectifier) 21, may be substituted for the tuned relay.

The above circuit arrangements will serve where there is no necessity of distinguishing between positive and negative currents in the cable circuit, or between positive and negative on the one hand, and zero condition on the other. But when receiving and amplifying cable currents, particularly cable currents transmitted in the ordinary manner (as distinguished from the "true reversal" method), it is extremely important to be able to distinguish between positive, negative, and zero conditions. This may be accomplished in the manner and by the means shown in Figure 4 wherein two audion amplifiers A and B are employed, the connections of each being the same as indicated in previous figures, the two amplifiers being connected in parallel with respect to conductors 5 and 6, with a high resistance 22 connected in shunt, across said conductors 5 and 6, and with a potentiometer 23 in circuit with each amplifier; the batteries 24 of the two potentiometers being of relatively reversed signs and the two audions being arranged, one to amplify positive impulses, the other to amplify negative impulses; each audion controlling a tuned vibrating relay 19 from a step-down transformer 11, and so controlling the receiving instrument 20.

It will be understood that the vibrating relays 19 are each tuned to approximately the rate of oscillation produced by the corresponding audion A or B; and being so tuned, will vibrate in step with such oscillations produced by the audion. There are various other connections whereby audions may be caused to generate oscillations of regular character, and I do not limit myself to any particular means of connections for causing the audions to so produce current oscillations.

The amplifying means shown in Figure 4 is applicable not only for use in connection with the code ordinarily employed for cable transmission, but also for use with various other codes, for example the Baudot.

It will be understood that in the operation of the circuit arrangement shown in Figures 1, 2, and 3, the audion, being affected by incoming signals, and being itself producing high frequency current oscillations, in effect not merely amplifies the incoming impulses, but breaks up these incoming impulses each into high frequency oscillations, which, in the arrangement shown in Figure 1, operate the receiver 12 through the transformer 11; in the arrangement shown in Figure 2 operate the tuned relay 19 through the transformer 11, and so operate the receiving instrument 20; and in the arrangement shown in Figure 3 are rectified by the rectifier 21 and so operate the receiving instrument 20. In the arrangement shown in Figure 4, since batteries 24 of the respective potentiometers are of opposite sign, the one audion amplifies positive impulses; the other audion amplifies

negative impulses, both audions breaking up their respective impulses, positive or negative, into high frequency oscillations, which, through the agency of the transformers 11, operate the tuned relay 19, and so the receiving instrument 20.

In some cases it is desirable to employ two separate audions, one mainly for producing oscillations, the other mainly for amplification. Such an arrangement is shown in Figure 6, wherein audion C is arranged for producing oscillations and audion D is arranged for amplification. The signals are transmitted inductively from audion C to audion D through step-up transformer 26, and are transmitted from audion D through step-down transformer 11 to the rectifying device here shown as a tuned relay 19.

The arrangements shown in Figures 2 and 3 are also applicable for the amplification of wireless or radio telegraphy signals, conductors 5 and 6 being connected to the antennæ or other collecting arrangements of the radio system. However, it is preferable, in the case of amplifying wireless signals, to employ a step-up transformer between the antennæ and the audion. This is illustrated in Figure 5, in which such a step-up transformer, 25, is shown; the circuits being in other respects similar to those of Figure 2, except that the transformer 16 is omitted, the audion not being used here to itself generate high frequency impulses, since the impulses of the wireless signals are themselves of high frequency character.

In this arrangement the relay 19 is mechanically tuned so that its free period of vibration is the same as the spark frequency at the wireless transmitting station.

Without intending to limit myself in any way I will state that according to the usual operation of the apparatus illustrated and described, no change in frequency or pitch of the signals, as amplified and thence transmitted to the receiving apparatus, is contemplated; to the contrary, what is intended is that the incoming signals shall be changed as to magnitude of oscillation.

In the arrangement shown in Figures 1 and 2, the oscillations produced by the audion are small or negligible when no signals come in, but are relatively large when signals are coming in. In the arrangement shown in Figure 3, the operation may be as just described with reference to Figures 1 and 2, or, alternatively, the adjustment may be such that the oscillation is moderately large when no signals come in, incoming signals of one sign increasing the amount or magnitude of oscillation, and incoming signals of the other sign decreasing the amount of magnitude of oscillation.

In the arrangement shown in Figure 4, when there are no signals, oscillation in each audion system is preferably small; signals of one sign causing the corresponding audion only to oscillate with greater magnitude, and signals of the other sign causing the other corresponding audion only to oscillate with greater magnitude.

What I claim is:

1. Signal amplifying apparatus such as described, comprising an audion arranged to produce a current of oscillatory character, means for conducting signals to be amplified to the controlling circuit of the audion, and signal receiving means operated by the audion, and comprising a tuned vibrating relay arranged to vibrate in unison with the oscillations produced by the audion and to rectify the oscillatory current produced by the audion.

2. Signal amplifying apparatus such as described, comprising two audions each arranged to produce a current of oscillatory character, one arranged to amplify positive current impulses, the other arranged to amplify negative current impulses, means for conducting current impulses to be amplified to said audions, said audions being connected to said signal conducting means in parallel, and signal receiving means operated by said audions.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

JOSEPH W. MILNOR.

Witnesses:

H. M. MARBLE,
ETHEL JOHNES.