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P. K. BUYS ET AL

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VOLUME CONTROL FOR SOUND REPRODUCTION SYSTEMS

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Fig. 1.

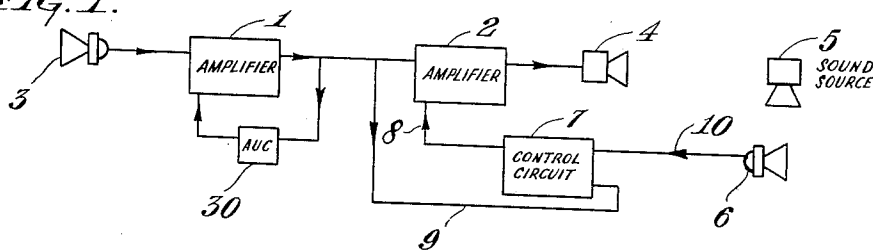


Fig. 2.

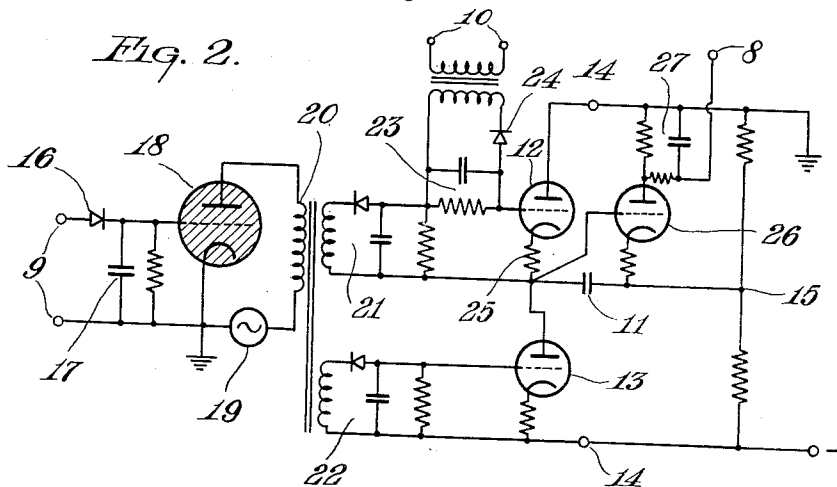
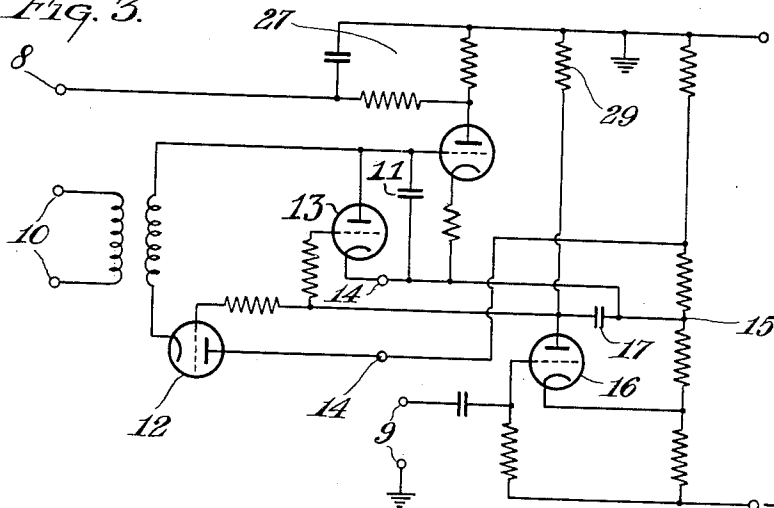


Fig. 3.



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VOLUME CONTROL FOR SOUND
REPRODUCTION SYSTEMS

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6 Claims. (Cl. 179-1)

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The invention relates to an arrangement for automatic adaptation of the amplification factor of a low-frequency amplifier comprising reproducing apparatus to the sound level of the surroundings of this reproducing apparatus. The arrangement is more particularly intended for use as a loudspeaker system on railway yards, where the intensity of sound energy produced by the station loudspeaker with respect to that of the surroundings is required to be a constant number of decibels, for example 40 decibels, higher, since in this case the intelligibility of the sound emitted by the loudspeaker will always be the same.

A known arrangement for this purpose comprises a microphone, an amplifier and a loudspeaker, while in the surroundings of the loudspeaker provision is made of an auxiliary microphone from which a control-voltage is taken which controls the amplification factor of the said amplifier. Such an arrangement entails the difficulty that the auxiliary microphone not only receives the sound of the surroundings but also part of the sound energy of the loudspeaker, so that there is a risk of acoustic back-coupling. In the known arrangement, efforts have been made to solve this problem by deriving the control voltage with the aid of which the amplification factor of the amplifier is controlled from the difference between a voltage derived, by rectification, from the auxiliary microphone and a voltage which is proportional to the amplitude of the current flowing through the microphone in such manner that this difference voltage is only a measure of the sound level of the surroundings. This method ensures that the sound energy produced by the loudspeaker exceeds by approximately 10 decibels that of the surroundings. When aiming at a higher value of this energy ratio, the difficulty is experienced that the two components, the difference between which must yield the control-voltage, have a very high value with respect to this control voltage, so that very small phase-displacements between these two components, provoked, for example, by a variation of the acoustic spacing between the loudspeaker and the auxiliary microphone, may cause acoustic back-coupling.

The invention permits the energy ratio between the sound produced by the loudspeaker and that produced by the surroundings to acquire an arbitrary value, since only during the time in which no acoustic energy is emitted by the loudspeaker will a control voltage which controls the amplification factor of the amplifier be derived from

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the auxiliary microphone. From the instant the loudspeaker emits acoustic energy, this control-voltage acquires a value independent of the voltage set up at the auxiliary microphone.

In order that the invention may be more clearly understood and readily carried into effect, it will now be described more fully with reference to the accompanying drawing, given by way of example, in which Fig. 1 represents in block form the system according to the invention and Figs. 2 and 3 represent embodiments of the invention.

In Fig. 1 the reference numerals 1 and 2 designate two amplification stages with the aid of which the electrical oscillations derived from a microphone 3 are amplified and, by means of reproducing apparatus (for the sake of simplicity represented by a loudspeaker 4) converted into acoustic oscillations. The loudspeaker 4 is housed in a space (for example in a railway yard) where at the same time other sound sources 5 (for example moving trains) are operative. The sound energy produced by the loudspeaker 4 and the sources 5 is picked up by an auxiliary microphone 6 from which, with the aid of a circuit 7, a control-voltage is derived which controls, through a lead 8, the amplification of the amplifier 2.

According to the invention the circuit 7 is controlled in such manner by an alternating voltage supplied through a lead 9 that only if this alternating voltage is equal to zero and, consequently, the energy emitted by the loudspeaker 4 is equal to zero, will the control voltage produced in the lead 8 depend upon the voltage produced by the auxiliary microphone 6. From the instant the alternating voltage of the lead 9 is not equal to zero, for example due to speaking into the microphone 3, the control-voltage produced in the lead 8 is independent of the voltage set up at the auxiliary microphone.

Figs. 2 and 3 show suitable examples of such a circuit 7. They are based on the fact that a condenser 11, having a capacity of a few μf ., through which a voltage controlling the control voltage is produced, is rapidly charged to a voltage corresponding to the sound level of the surroundings and fed to the terminals 10 during the time the alternating voltage set up at the terminals 9 is equal to zero, whereas this condenser is very slowly discharged during the time this voltage is not equal to zero. In order to ensure a very slow discharge of the condenser 11, the circuits comprise a series-circuit which is controlled by a voltage supplied through the lead 10 to the auxiliary microphone 6, this series-circuit comprising the discharge tubes 12 and 13 which pass

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current in the same direction and a source of supply voltage 14. One terminal of the condenser 11 is connected to a point 15 having a potential defined with respect to the source of supply voltage 14, whereas the other terminal is connected to a point of the said series-circuit located between the two discharge tubes, the two discharge tubes 12 and 13 being conductive only if the alternating voltage set up at the terminals 9 is equal to zero. Consequently, the condenser 11 can only be discharged through insulating resistances having a total value of, say 1000 MΩ, so that a very long discharge time constant of several thousands of seconds may be achieved.

According to Fig. 2 the oscillations fed to the terminals 9 are rectified with the aid of a rectifier 16 and smoothing filter 17, whereupon this rectified voltage is sufficient to open the normally nonconductive, gas filled discharge tube 18 which is fed by a source of alternating voltage 19. The alternating voltage produced in the output transformer 20 of the tube 18 is rectified with the aid of the two rectifying circuits 21 and 22, the output voltages of which suffice to cut off the two tubes 12 and 13. The time constant of the circuit 16, 17 is of the order of magnitude of several milliseconds and consequently small enough to prevent any undue acoustic back-coupling phenomena. The discharge time constant of the circuits 21 and 22 is, for example, of the order of magnitude of a few tenths of a second.

If no voltage is produced across the lead 9 the tube 18 is cut off, so that the tubes 12 and 13 are conductive. In the grid circuit of the tube 12 the voltage across a smoothing filter 23 is operative. This is achieved by rectifying the voltage fed to the terminals 10 with the aid of a rectifier 24, owing to which the conductivity of the tube 12 is controlled in accordance with the voltage across the terminals 10 i. e. in accordance with the sound energy of the surroundings. Hence the condenser 11 acquires a potential which is determined by the ratio between the resistance of the tube 12 comprising a cathode resistance 25 and the sum of the resistances of the tube 12 and 13, the time constant for charging the condenser 11 being determined by the product of the value of this condenser and the parallel-resistance of the aforesaid resistance and having, for instance, a value of 50 msec.

The voltage produced across the condenser 11 is amplified with the aid of the tube 26, after which the control-voltage is taken, through the filter 27 having a time constant of some few tenths of a second and effecting a gradual variation of the amplification factor, from the terminal 8.

In the circuit-arrangement shown in Fig. 3 the oscillations supplied through the terminals 9 are amplified and rectified with the aid of the tube 16 comprising a high anode-resistance 29 and a decoupling condenser 17. The voltage produced across the resistance 29 is operative in the grid-circuits of tubes 12 and 13 and renders these tubes conductive only when the alternating voltage set up at the terminals 9 is equal to zero. The time required for charging the condenser 17 (for example of 0.1 μf.) is only 1 msec., since the internal resistance of the tube 13, owing to negative back-coupling, is, for example, only 10 kΩ, the discharging time of this condenser being a few tenths of a second.

In the series-connection of the discharge tubes 12 and 13, a voltage supplied to the terminals 10 through an input transformer is operative

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during the time the tubes 12 and 13 are conductive. This causes the condenser to be charged through the tube 12 to a value corresponding to the amplitude of the voltage fed to the terminals 10, the tube 13 having an anode resistance of, say, 10 kΩ, serving as a discharge circuit. The charging time of the condenser 11 is, for example, 50 msec.

The negative control-voltage taken from the terminal 8 controls, in a known manner, the amplification factor of the amplification stage 2. It affects, for example, the grid adjustment of one or more of the discharge tubes included in the amplification stage 2.

In addition to the control as described it is desirable to provide in the said loudspeaker system a second control which ensures that the amplitude of the input voltage of the amplifier 2 has a substantially constant value, so that the sound energy emitted by the loudspeaker 4 is independent of the distance of the speaker from the microphone 3. This second control may be provided in the form of a well-known automatic gain control (designated 30 in Fig. 1).

The invention is, however, not considered to be limited to such a loudspeaker system and for example, also applies to an arrangement in which the microphone 3 comprising the amplifier 1 and automatic gain control 30 shown in Fig. 1 is replaced, for example, by a gramophone- or a radio-receiving set.

What we claim is:

1. A sound reproduction system of the type adapted to maintain an acoustic energy output at a fixed level above the ambient noise level, comprising in combination: a source of audio frequency electrical impulses including a microphone and an amplifier; a variable gain amplifier connected to said source; at least one loudspeaker connected to the output of said variable gain amplifier; a second microphone located in the acoustic range of said loudspeaker; a condenser; means including a pair of series-connected normally-conductive electron discharge tubes connected to charge said condenser; means coupling said microphone to said first mentioned means whereby said condenser may charge in accordance with the ambient noise level; means including a normally nonconductive thyatron connected between said source and said first mentioned means, and connected to apply a cut off bias to said tubes whenever said thyatron is triggered by said source; and means including a third electron discharge tube connected to amplify the voltage on said condenser and couple the resulting control voltage to said variable gain amplifier whereby the gain of said amplifier is caused to vary in proportion to the ambient noise level whenever said loudspeaker is de-energized.

2. A sound reproduction system of the type adapted to maintain an acoustic energy output at a fixed level above the ambient noise level, comprising in combination: a source of audio frequency electrical impulses including a microphone and an amplifier; a variable gain amplifier connected to said source; at least one loudspeaker connected to the output of said variable gain amplifier; a second microphone located in the acoustic range of said loudspeaker; a condenser; means including a pair of series-connected normally-conductive electron discharge tubes connected to charge said condenser; means coupling said microphone to said first mentioned means

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whereby said condenser may charge in accordance with the ambient noise level; means including a vacuum electron discharge tube connected between said source and said first mentioned means; a resistor in the anode circuit of said tube; means to couple a negative voltage from said resistor to said series-connected discharge tubes to drive said tubes to cut-off whenever acoustic energy is applied to said first mentioned microphone; and means including a fourth electron discharge tube connected to amplify the voltage on said condenser and couple the resulting control voltage to said variable gain amplifier whereby the gain of said amplifier is caused to vary in proportion to the ambient noise level whenever said loudspeaker is de-energized.

3. A sound reproduction system, comprising a source of audio frequency impulses, a variable gain amplifier coupled to said source, sound reproducing means coupled to the output of said amplifier and having a given acoustic range, ambient sound pickup means located in said acoustic range, a control voltage producing device coupled to said sound pickup means, means to apply the output of said control voltage producing device to said amplifier to control the gain thereof in accordance with the ambient sound level in said acoustic range, and means comprising an electron discharge tube having an input circuit coupled to said source of audio frequency impulses and an output circuit coupled to said control voltage producing device to render the output of said control voltage producing device insensitive to ambient sound variations when said audio frequency impulses are applied to said amplifier.

4. A sound reproduction system, comprising a source of audio frequency impulses, a variable gain amplifier coupled to said source, sound reproducing means coupled to the output of said amplifier and having a given acoustic range, ambient sound pickup means located in said acoustic range, a control voltage producing device coupled to said sound pickup means, said control voltage producing device comprising a capacitor, means to charge said capacitor proportional to the ambient sound level in said acoustic range and means to derive an output control voltage from said capacitor, means to apply said output control voltage to said amplifier to control the gain thereof in accordance with the ambient sound level in said acoustic range, and means comprising an electron discharge tube having an input circuit coupled to said source of audio frequency impulses and an output circuit coupled to said control voltage producing device to prevent charging of said capacitor when said audio frequency impulses are applied to said amplifier.

5. A sound reproduction system, comprising a source of audio frequency impulses, a variable gain amplifier coupled to said source, sound re-

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producing means coupled to the output of said amplifier and having a given acoustic range, ambient sound pickup means located in said acoustic range, a control voltage producing device, said control voltage producing device comprising a capacitor, first and second serially-connected normally conductive electron discharge tubes coupled to said capacitor, means to couple said first and second discharge tubes to said sound pickup means thereby to charge said capacitor proportional to the ambient sound level in said acoustic range and means to derive an output control voltage from said capacitor, means to apply said output control voltage to said amplifier to control the gain thereof in accordance with the ambient sound level in said acoustic range, and means comprising a third electron discharge tube having an input circuit coupled to said source of audio frequency impulses and an output circuit coupled to said first and second discharge tubes to render said first and second discharge tubes non-conductive when said audio frequency impulses are applied to said amplifier.

6. A sound reproduction system, comprising a source of audio frequency impulses, a variable gain amplifier, an amplification stage having a substantially constant gain intercoupling said source of audio frequency impulses and said variable gain amplifier, sound reproducing means coupled to the output of said amplifier and having a given acoustic range, ambient sound pickup means located in said acoustic range, a control voltage producing device coupled to said sound pickup means, means to apply the output of said control voltage producing device to said amplifier to control the gain thereof in accordance with the ambient sound level in said acoustic range, and means comprising an electron discharge tube having an input circuit coupled to said source of audio frequency impulses and an output circuit coupled to said control voltage producing device to render the output of said control voltage producing device insensitive to ambient sound variations when audio frequency impulses are applied to said amplifier.

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