July 16, 1935. W. A. MUELLER 2,008,082

RADIO BROADCASTING

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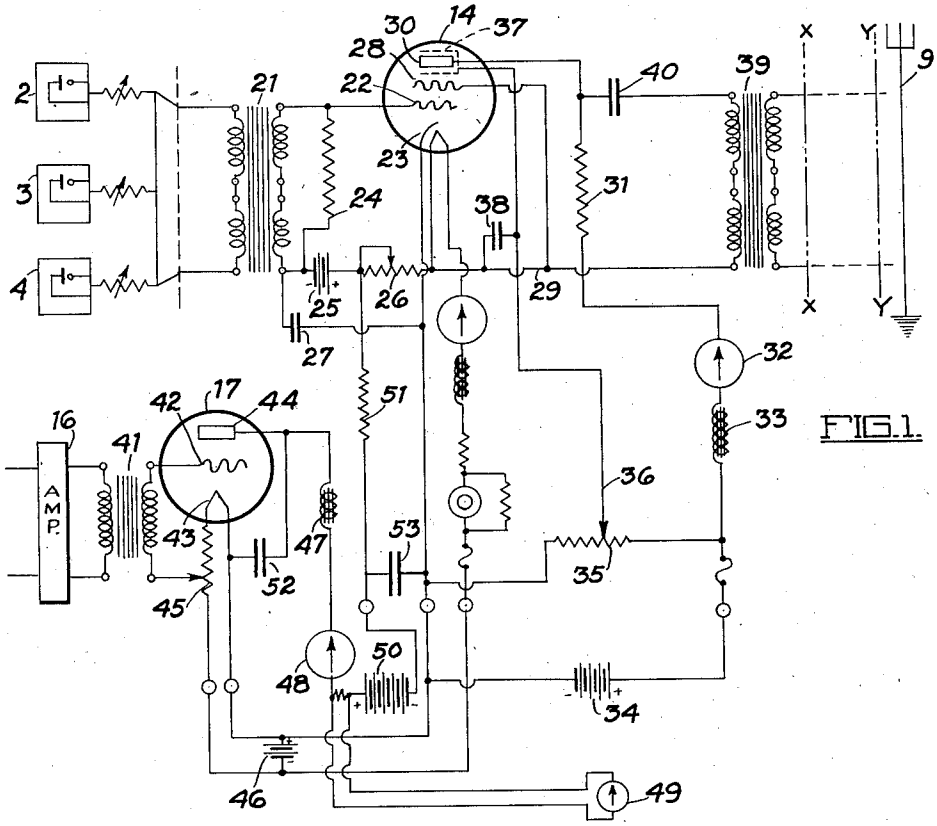

FIG. 1.

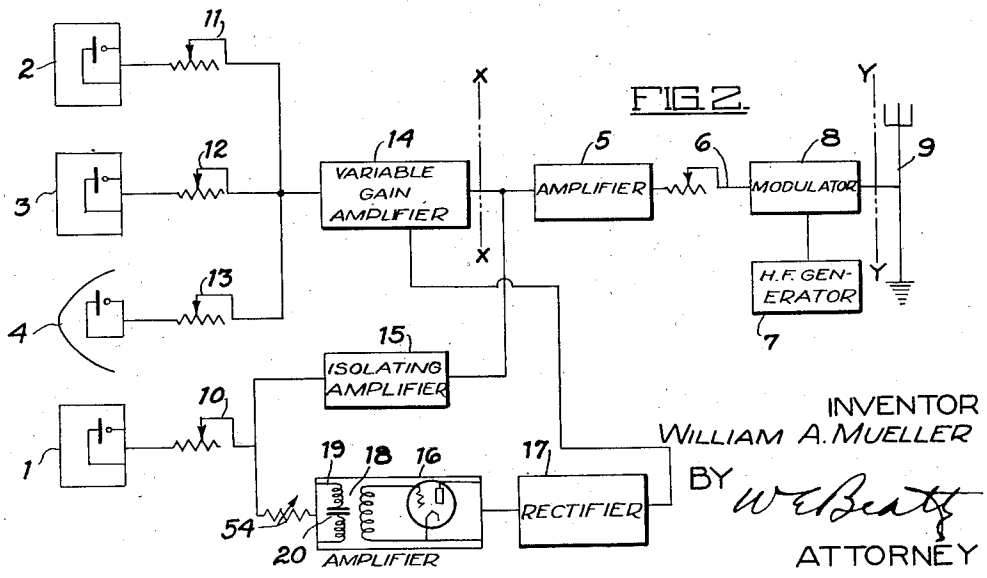

FIG. 2.

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RADIO BROADCASTING

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6 Claims. (Cl. 250—6)

The invention relates to broadcasting, wherein a radio wave is modulated in accordance with the currents from a plurality of microphone circuits.

In broadcasting a football game, for example, use may be made of the folowing microphone circuits; first, the announcer's microphone which is usually installed in a sound-proof booth, and which may be termed the main microphone, and second, one or more auxiliary microphones such as a microphone for the cheering sections, a microphone to reproduce the crowd noise, and a microphone with parabolic or other sound wave concentrator which may be pointed toward the players to selectively pick up a desired portion of the play.

Heretofore in using main and auxiliary microphones as pointed out above, it has been customary for the monitor to manually regulate the volume of the currents in the different microphone circuits. This method of control results in broadcasting an irregular volume of audio current because it is impossible to manually regulate all of the microphone circuits in such a way that the total volume of the current therein shall at all times be constant, and what is more important, the announcer cannot always be understood at the receiving station for the reason that it is not possible for the monitor to instantly suppress the current in the auxiliary circuits when the announcer speaks.

These defects are overcome according to the present invention by providing method and means for automatically and instantaneously regulating the current in the auxiliary microphone circuits in accordance with the current in the announcer microphone circuit, whereby the announcer microphone circuit, when audio currents are present therein, serves to instantly reduce to a desired level the volume of the audio currents in the auxiliary microphone circuits, the currents in the auxiliary microphone circuits instantly being restored to normal upon the cessation of audio currents in the announcer microphone circuit.

While satisfactory results are obtained by controlling the main microphone instantly by the auxiliary microphones, or vice versa, that is without any appreciable delay, it has been found that improved results are obtained by delaying the effectiveness of the controlling arrangement for a very brief interval of time, such as a fraction of a second. Experience has shown that if the volume or level of the current in the auxiliary microphone circuits is varied too rapidly by the current in the main microphone circuit, the change would be noticeable at the broadcast receiving station. Also, if the level is changed too slowly, this would be noticeable. Accordingly, the speed of operation is delayed a selected amount, i. e. for a fraction of a second, whereby the variation in the level of the auxiliary microphone current is not noticeable at the receiving station.

A further object of the invention is to prevent the amplifier in the auxiliary microphone circuit from giving rise to noise currents at times when the auxiliary microphone currents are suppressed by the announcer microphone control. This is accomplished by employing a suppressor grid type tube in the amplifier for the auxiliary microphone. Also, in case the announcer's microphone or other pickup device is not enclosed in a sound-proof booth but is employed in a location where there may be extraneous low frequency sounds, such as door slams or heavy footsteps, such extraneous sounds are prevented from exerting any control on the auxiliary microphone circuit by employing in the control circuit an amplifier which is relatively insensitive to such low frequency sounds, whereby the whole controlling effect is due to the audio currents corresponding to the announcer's voice or the like.

For further details of the invention reference may be made to the drawing, wherein:

Fig. 1 is a diagrammatic view of a preferred circuit arrangement.

Fig. 2 is a schematic view of a radio broadcasting circuit embodying the circuit of Fig. 1.

Referring to Fig. 2, there is provided a main microphone 1 for the use of the announcer. This microphone may or may not be housed in a sound-proof booth as pointed out above. There are also provided one or more auxiliary microphones, such as 2 which may be used for the cheering section, 3 for the crowd noise, and 4 a concentrator microphone which can be pointed to pick up sound waves from a desired source, such as the players.

Current from the microphone 1 and from one or more of the auxiliary microphones 2, 3, and 4, after being amplified by the amplifier 5 is sent over the transmission line 6 to the radio broadcasting station where is located the high frequency generator 7 and a modulator 8 for modulating the radio waves from generator 7 in accordance with the audio frequency currents derived from or furnished by the microphones 1, 2, 3 and 4. The radio wave thus modulated is radiated by antenna 9.

The volume of current from the microphones 1 to 4 inclusive may be manually regulated by

means of the potentiometers or other attenuating devices 10 to 13 inclusive respectively.

In Fig. 2 the auxiliary microphones 2, 3 and 4 are diagrammatically represented as being connected in parallel to the input side of the variable gain amplifier 14, the gain of which is automatically varied in accordance with the current in circuit with the microphone 1.

Audio frequency current from the microphone 1 is amplified by an isolating amplifier 15, the output side of which is connected to the input of amplifier 5. The amplifier 15 is termed an isolating amplifier because it is uni-directional in preventing current from amplifier 14 from being fed into the amplifier 16 and the rectifier 17. The input of amplifier 16 includes a transformer 18, the input coil 19 of which is split and connected through a ½ m. f. condenser 20 in order to provide reduced transmission below a frequency of 250 cycles and normal transmission there-above, for the reasons hereinbefore pointed out.

It will be apparent therefore, that through the parallel relation of amplifiers 15 and 16 some of the audio frequency current from microphone 1 is amplified by amplifier 15 and supplied through amplifier 5 to modulator 8, while another portion of the audio frequency current from microphone 1 is amplified by amplifier 16 and supplied to the rectifier 17. The current thus rectified is supplied to the amplifier 14 in order to suppress the presence or amplification of current from the microphones 2, 3 and 4 when the announcer is speaking in the microphone 1, and to restore the amplification of audio current from the microphones 2, 3 and 4 to normal when the announcer ceases to speak in the microphone 1, as pointed out above.

Details of the arrangement for controlling the amplifier 14 in accordance with the audio frequency current rectified by rectifier 17 are illustrated in Fig. 1, wherein the auxiliary microphones 2, 3 and 4 are also illustrated as being connected in parallel to the input of amplifier 14, the output of which leads to the antenna 9. In Fig. 1 it will be understood that the amplifier 5, transmission line 6, generator 7, modulator 8 and isolating amplifier 15 have been omitted as the details of construction thereof are well understood in the art and form no part per se of the present invention.

In Fig. 1 the microphones 2, 3 and 4 are connected in parallel to the primary coil of transformer 21, the secondary coil of which is connected to the grid 22 and the heater type cathode 23. In shunt to this secondary coil is a high resistance 24 which may be of about 200,000 ohms. The grid 22 is biased negatively by the battery 25 and also by the potential across potentiometer 26, which potential results from rectified audio frequency current in the output circuit of rectifier 17. The battery 25 and the potentiometer 26 are shunted by condenser 27 of about 2 m. f.

The tube 14 is known as suppressor grid variable mu type tube 58 and has the advantage pointed out above that, when the biasing potential at potentiometer 26 is high enough to reduce the amplification of this tube to a negligible quantity, this tube remains substantially noiseless, and in fact it is noiseless also at normal values of grid bias. The suppressor grid 28 is connected to the cathode lead 29.

Plate current is supplied to tube 14 over a circuit including anode 30, high resistance 31, meter 32, choke coil 33, and battery 34, the negative terminal of which is connected to the cathode 23. In shunt to the plate battery 34 is a resistance 35 of about 10,000 ohms, the lead 36 being tapped off from resistance 35 so as to supply a positive potential of about 22 volts to the shield grid 37. Between shield grid 37 and cathode lead 29 is shunted a condenser 38 of about 1 m. f. The output transformer 39 is connected to the cathode lead 29 and to the anode 30 through a stopping condenser 40. The output transformer 39 is connected as illustrated in Fig. 2 which generally represents between the lines *xx* and *yy* the apparatus omitted between these lines in Fig. 1.

The amplifier 16 is suitably coupled, for example through transformer 41 to the rectifier 17, which comprises grid 42, cathode 43 and plate 44. The secondary coil of transformer 41 is connected to the grid 42 and to a suitable point in the resistance 45 in circuit with the cathode 43 to bias the grid 42. The cathode 43 and also the cathode 23 are energized from battery 46 over obvious circuits. The plate circuit of rectifier 17 includes anode 44, choke coil 47, meter 48, local to the rectifier 17, meter 49 at the mixer's position, B battery 50, resistance 51, potentiometer 26 and cathode 43. In shunt between the anode 44 and cathode 43 at opposite sides of choke coil 47 are the condensers 52 and 53. As pointed out above, the choke coil 47 and the condensers 52 and 53 constitute a delay circuit for delaying the control of amplifier 14 by rectifier 17, whereby, for normal amounts of reduction of current in amplifier 14, the variation in level is not noticeable. It has been found that a suitable delay is obtained by using the following values; coil 47—232 h; condenser 52—2 m. f.; condenser 53—2 m. f.

The purpose of resistor 51, which is in the plate circuit of rectifier 17, is to flatten out the rectifier characteristic whereby the rectified current output will be proportional to the input voltage to the rectifier only up to some value, such as 2½ volts, and thereafter a further increase in the voltage on the rectifier will not result in any substantial increase in the rectified output current. Consequently, a soft spoken voice at the microphone 1 corresponding to low input depresses the amplified current from microphones 2, 3 and 4 a desired amount, and a louder sound at the microphone 1 does not needlessly depress the currents from microphones 2, 3 and 4 further. In this operation, therefore, there is heard at the receiving station a small amount of the sounds impressed on microphones 2, 3 and 4, and a normal amount of sounds impressed on the microphone 1 and it follows therefore that the radio wave from generator 7 is modulated simultaneously with currents from the main and auxiliary microphones in balanced relation. It will be understood that the depressing effect on amplifier 14 by rectified currents from rectifier 17 ceases when microphone 1 is not in operation, whereby the currents from microphones 2, 3 and 4 are transmitted at normal level.

As the amplifier 14 overloads at a comparatively low level, in order to prevent harmonic distortion, this amplifier 14 is installed in the circuit at the point of lowest amplification. In other words, as illustrated this amplifier 14 is the first amplifier in the series between the microphones 2, 3 and 4 and the modulator 8.

The amount that the variable gain amplifier reduces the level of the currents from microphones 2, 3 and 4 is controlled by the setting of the potentiometer 26 which may be calibrated at

2 *db.* steps. The current through amplifier **14** can be reduced by the rectified current as much as 20 *db.*, although 8 or 10 *db.* is all that has been found necessary.

The potentiometer **54** in Fig. 2 is placed at the mixer's position so that the mixer can use as much or as little automatic regulation as desired, or cut it out entirely.

Certain of the features disclosed herein, such as the arrangement for delaying the control of the amplifier by rectified current, and the use of an amplifier having a lower gain at low frequencies than at other frequencies, as well as the use of a suppressor grid type amplifier, are useful in sound recording circuits wherein the microphones are replaced by pickup devices for translating sound records into electric currents and wherein the common output from the pickup circuits is led to a recorder. Claims generic to such features, also claims to such features specifically applying to sound recording circuits are presented in applicant's co-pending application S. N. 684,669 filed August 11, 1933 for Method and means for regulating balance between currents in associated circuits.

Having thus described the invention, what is claimed as new and desired to secure by Letters Patent is:

I claim:

1. The method of broadcasting wherein a radio wave is modulated by current from an announcer microphone circuit and from an auxiliary microphone circuit, which comprises controlling the volume of the current in said auxiliary microphone circuit in accordance with and in response to the volume of the current in said announcer microphone circuit, delaying said controlling for a short interval of time, and transmitting over a common carrier wave the modulating impulses from said microphone circuits.

2. The method of broadcasting wherein a plurality of audio frequency circuits are connected to a common modulator, which comprises modulating a high frequency wave in accordance with the current in said plurality of circuits, controlling the volume of the current in one of said circuits in accordance with and in response to the volume of the current in another of said circuits and in delaying the effectiveness of said controlling.

3. Radio broadcasting circuit comprising the combination of a plurality of audio frequency circuits, a common radio output circuit therefor for transmitting a radio wave in accordance with current in said plurality of audio frequency circuits, a rectifier, circuit connections whereby said rectifier is responsive to the current in one of said circuits for controlling the volume of the current in another of said circuits, and a delaying device in circuit with said rectifier for delaying said controlling.

4. Radio broadcasting circuit comprising the combination of a plurality of audio frequency circuits, a common radio output circuit therefor, an amplifier in one of said audio frequency circuits, said amplifier having a lower gain at low frequencies than at other frequencies, a rectifier connected to said amplifier and also connected to supply rectified current to another of said audio frequency circuits for controlling the volume of audio frequency currents in said other circuit.

5. A radio broadcasting circuit comprising an announcer microphone circuit, an auxiliary microphone circuit, a modulator connected to said circuits, a high frequency generator connected to said modulator whereby said high frequency currents are modulated in accordance with audio frequency currents from both of said microphone circuits, means responsive to the audio frequency currents in said announcer microphone circuit for automatically maintaining a balanced relation between the announcer microphone current and the current in said auxiliary microphone circuit, and means for delaying the establishment of said balanced relation.

6. Radio broadcasting circuit comprising the combination of a plurality of audio frequency circuits, a modulator circuit in common thereto for modulating a high frequency wave in accordance with current from said plurality of audio frequency circuits, an amplifier in one of said audio frequency circuits, said amplifier having a lower gain at low frequencies than at other frequencies, and a rectifier connected to said amplifier and also connected to supply rectified current to another of said audio frequency circuits for controlling the volume of audio frequency currents in said other circuit.

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