June 30, 1931. D. MITCHELL ET AL 1,811,954

TRANSMISSION VOLUME CONTROL

Filed Dec. 17, 1928 3 Sheets-Sheet 1

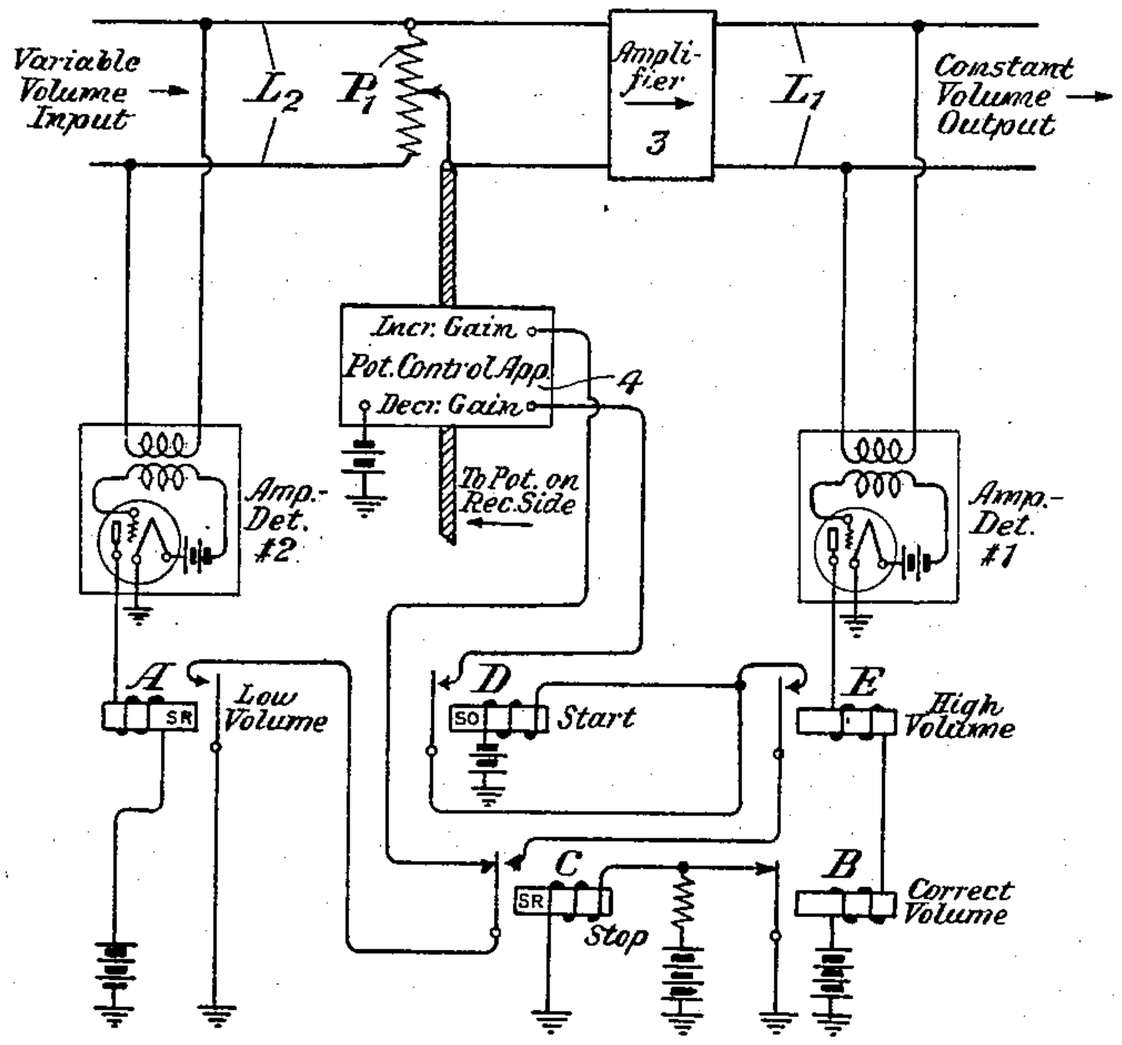

Fig. 1

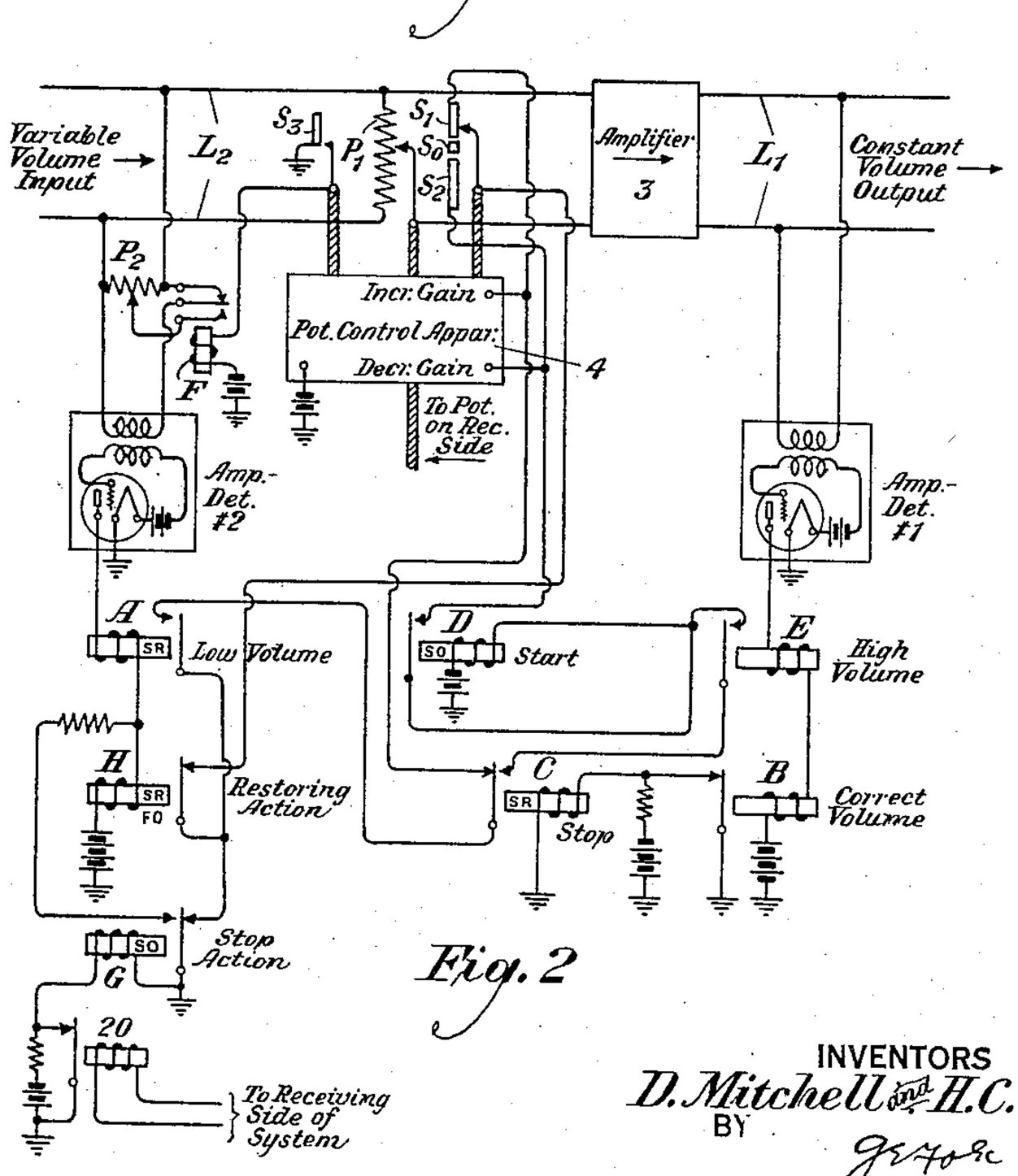

Fig. 2

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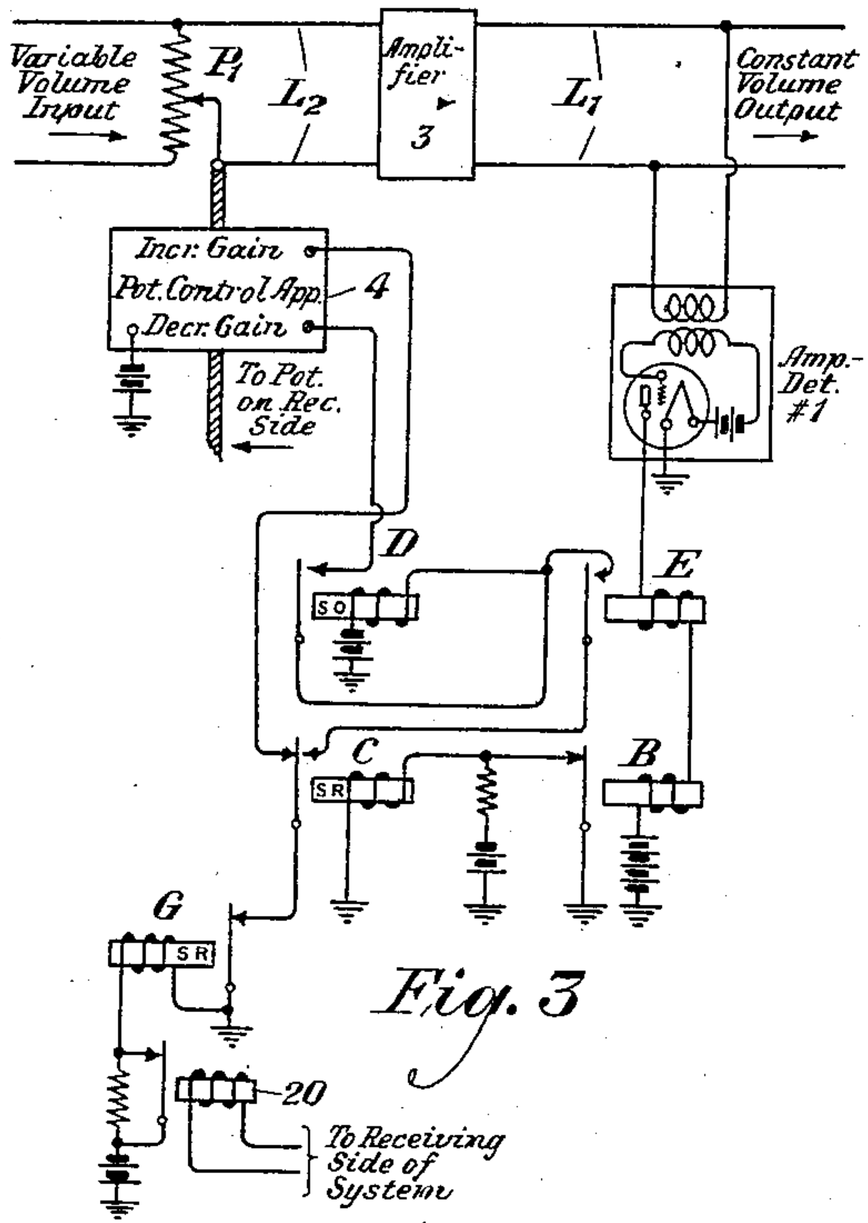

Fig. 3

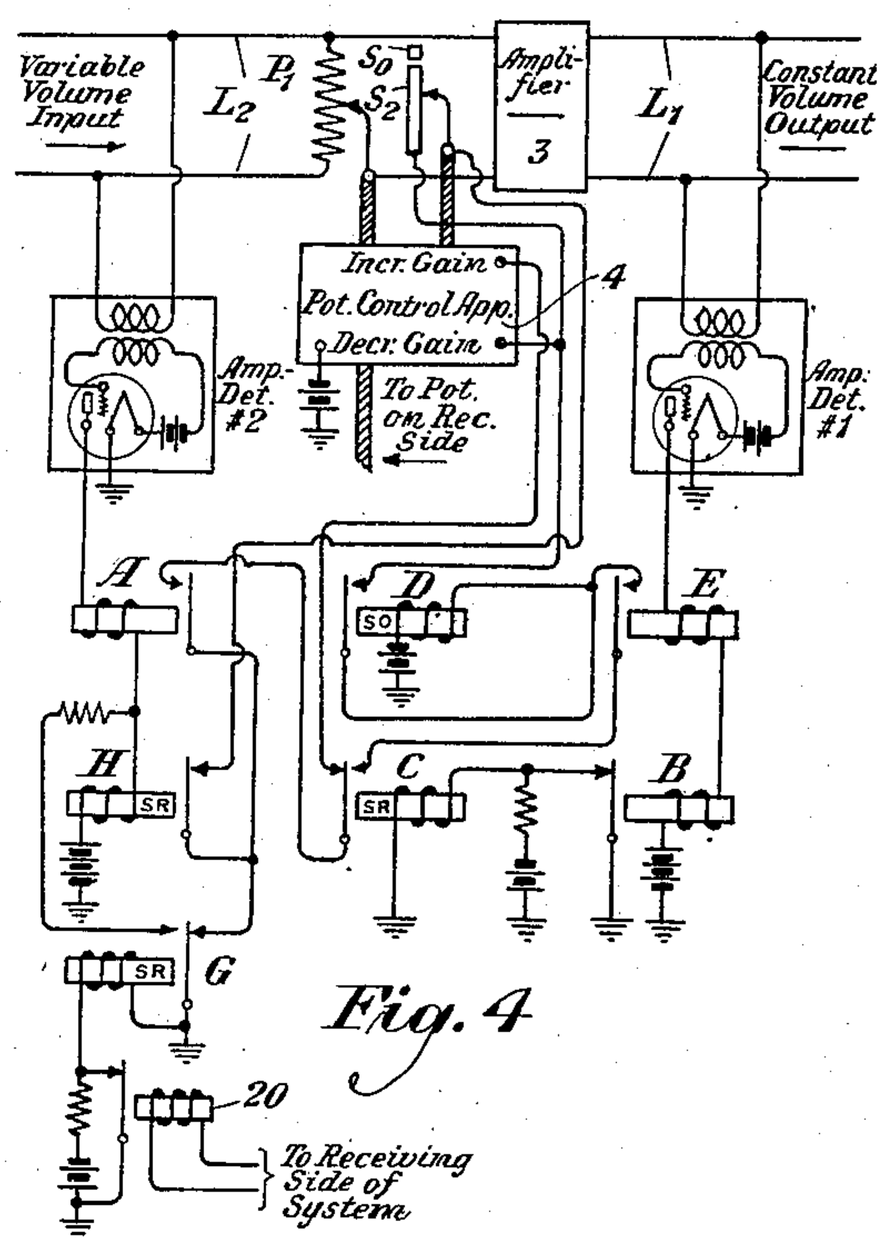

Fig. 4

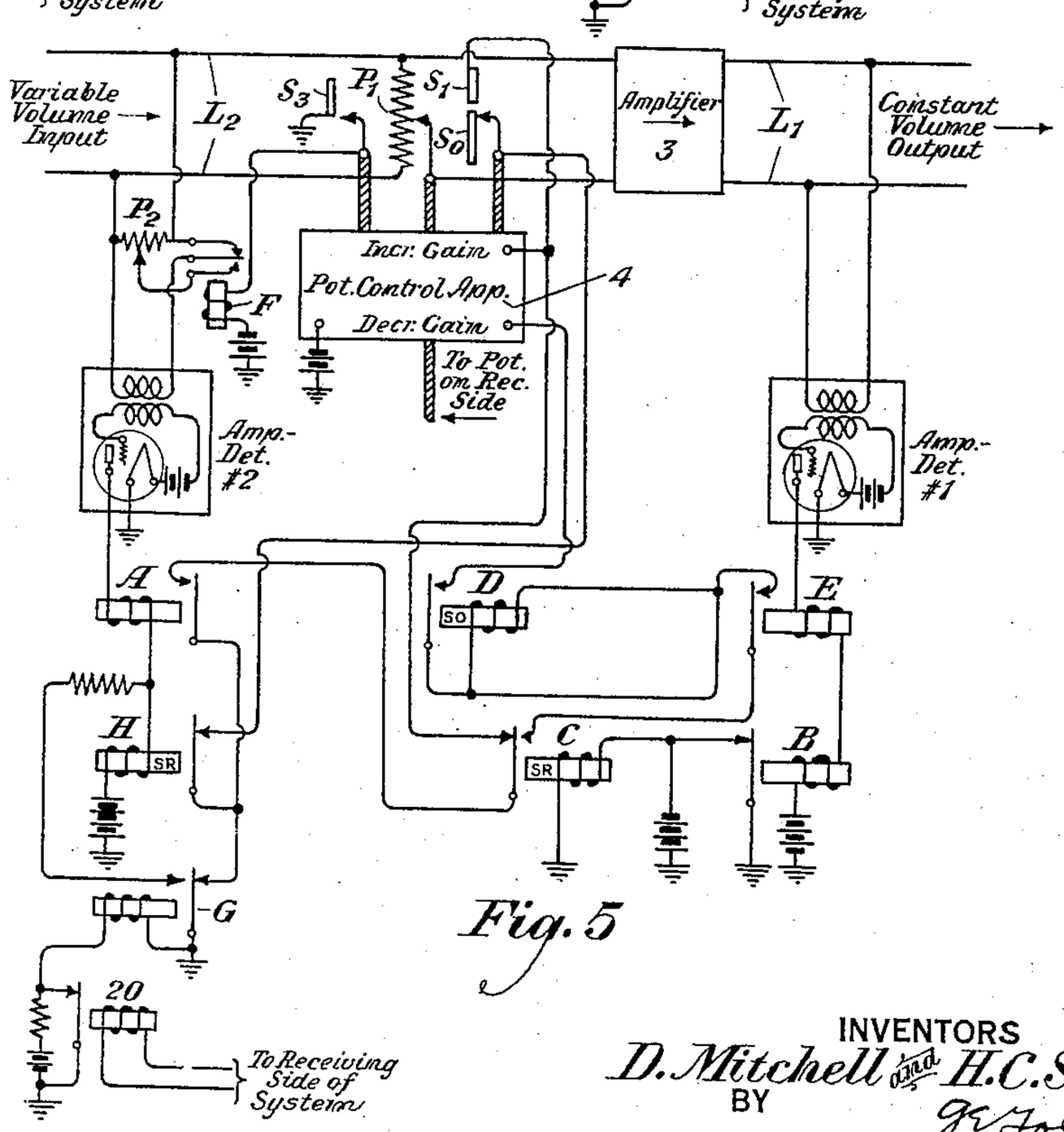

Fig. 5

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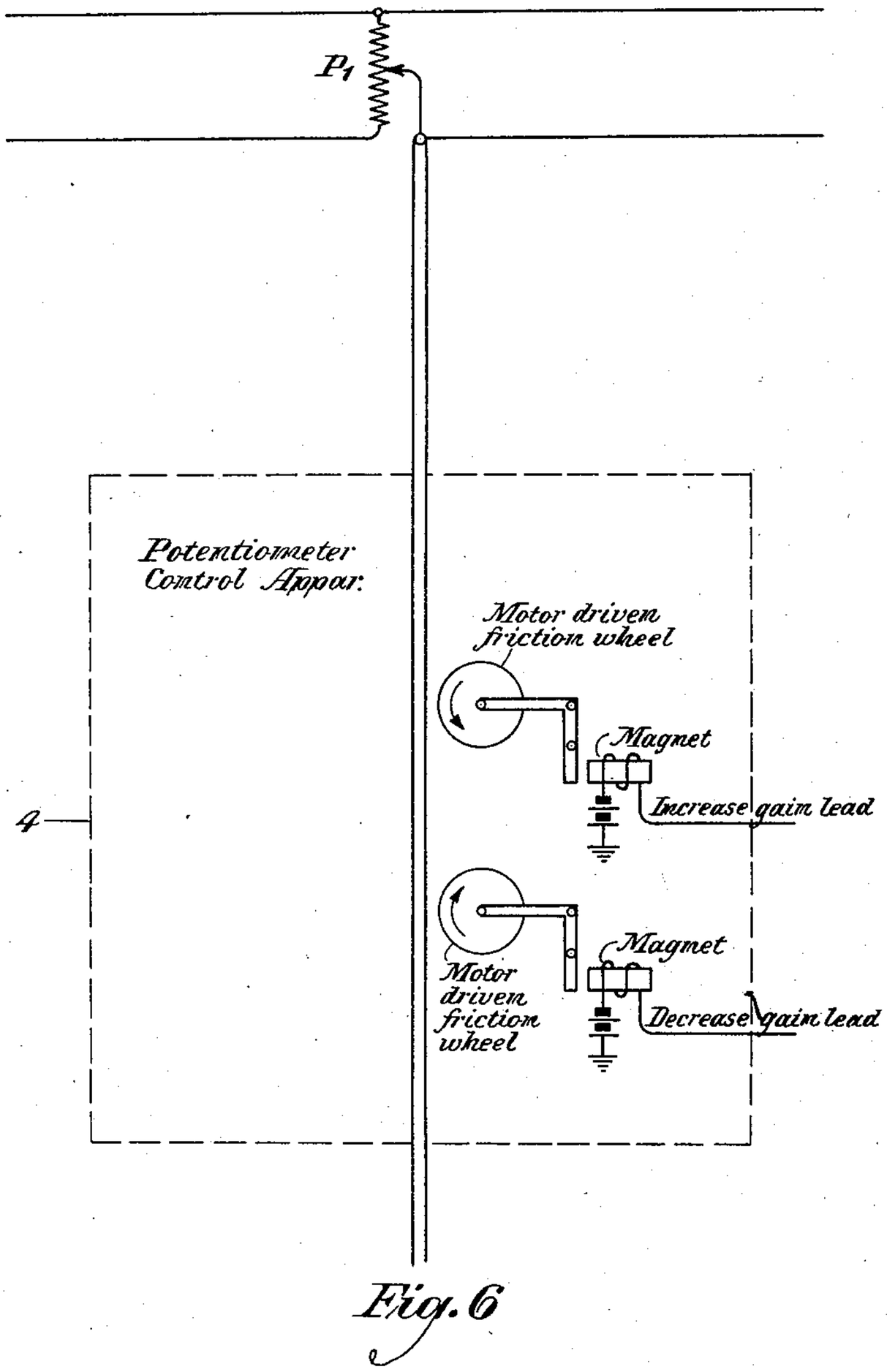

Fig. 6

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UNITED STATES PATENT OFFICE

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TRANSMISSION VOLUME CONTROL

Application filed December 17, 1928. Serial No. 326,597.

This invention relates to transmission systems and more particularly to arrangements for automatically controlling the volume of transmission on such systems.

The arrangements of the invention are particularly applicable to long distance lines or to circuits of the type utilized for transoceanic telephony. On the above types of systems it has been the practice to provide at each end of the line a "technical operator" whose duty is to adjust the volume of the speech entering the line by hand under the guidance of a volume indicator. The arrangements of the invention provide an arrangement of amplifier-detectors and relays whereby the volume may be automatically controlled by the voice or other signals themselves.

When the volume is adjusted by hand there are certain well defined operations to be performed by the technical operator. These operations are as follows: hear the speaker at the near end of the line and be ready to adjust his volume to the proper value; adjust the speaker's volume under the guidance of the volume indicator to the proper value during conversation; make no change in adjustment as long as the volume remains at the correct value; make no change in adjustment when the distant talker speaks; prevent false operation of the voice operated systems by adjusting the regulating networks on the transmitting and receiving side of the line in a complementary manner; and at the conclusion of the conversation to either restore the regulating networks to a normal step or leave them on the step at which the conversation was concluded. The arrangements of the invention by means of a basic relay chain will automatically perform the equivalent of the above operations.

The relay chain arrangements of the invention and modifications thereof may be arranged in several different ways. For example, one form may be termed a full neutral system, remaining on the position taken at the close of the last conversation. Another form may be normally set for the weakest talker (maximum gain) and at the conclusion of the conversation returns to this setting. Another form may be normally set for the strongest talker (minimum gain) and at the conclusion of the conversation returns to this setting. A further form may be normally set at some intermediate position and at the conclusion of the conversation returns to this position. A still further form may be the semi-neutral type having a region of volume adjustment in which the system is neutral, but if this region be exceeded, automatically returns into the neutral region at the conclusion of the conversation. Other forms, objects and features of the invention will appear more fully from the detailed description thereof hereinafter given.

The invention may be more fully understood from the following description together with the accompanying drawings in the Figures 1, 2, 3, 4, 5 and 6 of which the invention is illustrated. Fig. 1 shows the basic relay chain arrangement of the invention. The Figs. 2, 3, 4 and 5 show modifications thereof. In Fig. 6 are shown in detail certain portions of the potentiometer control apparatus. Similar reference characters have been utilized to denote like parts in all of the figures.

In Fig. 1 is shown a portion of a one-way section of a transmission system. Of this there are illustrated two line sections L_1 and L_2, together with amplifier apparatus 3 and a potentiometer P_1 whereby the volume may be controlled. The potentiometer P_1 is under the control of the apparatus 4. This potentiometer control apparatus may be of any convenient form to permit an increase or decrease in the adjustment of the potentiometer P_1. A number of motor driven schemes have heretofore been utilized for the purpose of controlling a potentiometer and, also, relay operated devices have been used. The operating shaft of the potentiometer is extended to connect with a potentiometer on the other side of the line. This is not shown. However, when the shaft operates to increase the gain of P_1 it will operate the other potentiometer to decrease the gain on the other side of the line and vice versa.

In the case where a weak talker begins speaking, causing too low a volume to come

in over line section L_2, the operation of the system is as follows: Bridged across line section L_2 is an amplifier-detector 2 which is set so that the strong peaks of the weakest volume just cause operation of the low volume relay A. Bridged across line section L_1 will be the amplifier-detector 1. The plate circuit of amplifier-detector 1 will include the high volume relay E and the correct volume relay B. Under the above mentioned conditions amplifier-detector 1 may be insufficiently sensitive to operate relays B and E. Ground is therefore fed through the contact of relay A and through the back contact of relay C to the potentiometer control apparatus 4 to cause it to increase gain through adjustment of the potentiometer P_1. It increases gain as long as relay A is operated by the incoming peaks of speech current until amplifier-detector 1 receives sufficient volume to cause its plate current to operate the correct volume relay B. When the volume has reached the proper value relays A and B are operated in such a manner that relay C is held operated. This will remove ground from the increase gain control circuit of apparatus 4 and transfer the ground fed from the contact of relay A to the armature of relay E through the contacts of relay C. Should the volume rise too high the high volume relay E which may be made, for example, 5 T. U. less sensitive than the correct volume relay B, becomes operated. Relay D is operated by relay E and in turn applies ground to the decrease gain circuit of the potentiometer control apparatus 4. This causes a reduction in the potentiometer setting until the volume shall have fallen to such a value as to permit the release of relay E. All gain adjustment then ceases until the volume again requires adjustment. At the conclusion of the conversation all of the relays return to their normal setting without altering the potentiometer setting, and the system waits for further impulses, i. e., it is "full neutral." It is pointed out that the relay arrangement adjusts only when the volume is not correct, remaining at rest as long as the volume is correct or no one is speaking. For this reason any tendency for the control system to hunt is reduced to the minimum or eliminated.

In order that the above actions may be properly effected certain requirements in the time relationships of the relays must be fulfilled. It appears desirable to make relay C slow release and relay D slow operate. Relay A may or may not be a slow release relay but must not remain operated longer than the combined release time of relays C and B. Otherwise, the system will be caused to hunt. It is expected that relays B and E will be fluttering under the action of the voice peaks, relay E fluttering less often than relay B, so that unless the voice reaches a fairly well sustained value relay D, being slow operate, will not be pulled up to cause reduction of the volume. Relay E will be fairly quick release in order to prevent hunting.

In Fig. 2, the arrangements of the invention are shown in the form of a non-neutral system having certain auxiliary functions. The circuit provides for automatic return to any required normal setting, an interlocking action between the transmitting and receiving sides of the system, and certain other features required by these additions. Similar reference characters have been utilized to denote like parts with respect to Fig. 1. The arrangements are substantially similar to those of Fig. 1 in their performance with the following additions: when the system is set for the strongest talker, it is possible that amplifier-detector 2 may be more sensitive than the other voice operated switching devices on the line, such for example as the echo and singing suppressing apparatus. From the standpoint of false operation, this is an undesirable situation since echoes set up by transmission in the receiving side of the system which are too weak to cause false operation of the voice operated switching devices and are therefore not suppressed by the receiving side relays might cause the volume control system to begin adjusting. Accordingly, provision is made for the reduction in the sensitivity of amplifier-detector 2 when certain settings are exceeded in order that this condition shall be corrected. This in turn requires that the device when operated by strong talkers, shall at the conclusion of conversation be automatically returned to a certain setting at which the full sensitivity of amplifier-detector 2 may be employed in order that it shall be ready for the weakest talker at the conclusion of speech.

The reduction in sensitivity is provided by the contact S_3 and its associated contact arm, relay F and the potentiometer P_2. Thus, if the potentiometer P_1 be operated on certain regions, the contact S_3 will be closed. This will complete an operating circuit for relay F. This will reduce the setting of potentiometer P_2 and accordingly reduce the sensitivity of amplifier-detector 2. If desired, S_3 may be increased in number to give successive steps on P_2. If S_3 be made to cover the entire travel of the potentiometer in successive steps, then amplifier-detector 2 may be eliminated and relay A operated directly from amplifier-detector 1.

In order to accomplish the restoring action to the normal setting, where amplifier-detector 2 will have its full sensitivity, contact S_1 has been provided which restores the system to contact S_0 at the conclusion of speech. In order that there shall be no neutral region on S_0 (or a negligible one), contact S_2 has been provided whereby, if the setting be exceeded in the direction opposite

to S_1, the potentiometer will again be returned to S_0. Obviously, S_1, S_2 and S_0 may be made to cover any required portions of the potentiometer setting so that by making S_1 cover the entire potentiometer, a device which is normally set on maximum gain will be obtained. By making S_2 cover the entire potentiometer a device normally set on a minimum gain will be obtained. Any intermediate combinations of these may be employed.

In the system shown in Fig. 2, the operation is as follows: When no speech currents are present in the transmission paths, the potentiometer P_1 will come to rest at the position S_0. If a weak talker is received, the relay H, which may be termed the restoring relay, will be operated and remove the ground from the contact arm cooperating with S_1 and S_2 so that the restoring action will be stopped. Adjustment of volume will then take place in a manner similar to that heretofore described with respect to Fig. 1. A similar gain adjustment will take place for too loud a speaker. At the conclusion of speech, relay H, which is a slow release relay, will remain operated for say 10 seconds and restoration to S_0 will not take place until the conclusion of these 10 seconds. Since it is not desirable to have restoration while the distant speaker is speaking, relay G is provided. This relay is operated by the relay 20 which is connected to the receiving side of the line and is operated when the distant speaker talks. When relay 20 operates, it operates relay G. Thus ground will be removed from the potentiometer control apparatus during the time when the distant talker is speaking. Relay G also causes the operation of relay H and thus prevents the restoring action from starting until 10 seconds after the distant talker finishes speaking. Should the local talker answer the distant speaker before the expiration of the 10 seconds, the action of volume adjustment is not interfered with. Should he fail to reply until after the restoration of relay H the system will return to its normal setting and again adjust volume in the normal manner when the local speaker talks.

In Fig. 3 is shown a modification of the arrangements designed to give a system which is normally set for maximum gain and which returns to that setting when the speaker has ceased talking. Similar reference characters have been utilized to denote like parts with respect to the other figures. Since the system is normally set for maximum gain and the weakest talker, the functions of the low volume relay A may be omitted and consequently, relay A and its associated amplifier-detector, may be eliminated. It is still necessary, however, to retain the interlocking action with the distant speaker. Accordingly, relays G and 20 are retained to prevent restoration when the distant talker is speaking. The actions of the circuit under the impulses of speech are similar to those heretofore described with respect to Fig. 1. At the conclusion of speech, the arrangement restores to the maximum gain setting.

In Fig. 4 is shown a further modification of the invention which is arranged to have minimum gain at its normal setting. In this circuit arrangement, S_1 has been eliminated and S_2 made to cover the entire range of the potentiometer. In order that the weakest talker may be picked up and action initiated, it is necessary to employ amplifier-detector 2 and relay A. In order that the system shall not return to its normal setting when the distant talker speaks or during short-pauses by the local talker, relays G and H are provided. The presence of relays A and H permit adjustment during actual speech by the local talker, but prevent restoration during his pauses unless he stops speaking for, say, ten seconds (the restoration time of H). Since this system is normally set for the strongest talker, it is impossible to employ the actions of S_3, F and P_2, as in other figures, since the system would be unable to find the weakest talker on its normal setting. In other respects the operation of the arrangements are substantially similar to those heretofore described.

In Fig. 5 are shown further modifications of the invention. This arrangement provides a semi-neutral system which returns to an increased gain setting after the loudest speaker but which is neutral after all other speakers. In the circuit arrangements, it will be noted that S_1 has been made to cover the same range of P_1 provided by S_3 and a step of P_2 has been provided which prevents the system being more subject to false operation than the voice operated switching system.

The operation of the arrangements of Fig. 5 is substantially as follows: Normally, with no one speaking, the potentiometer may rest in any position of S_0. If a weak speaker is received, the operation is identical with that of Fig. 1. If a strong speaker is received, a similar action takes place, putting the potentiometer control on to a part of P_1 covered by S_1 and S_3. Closure of the contact S_3 results in a reduction in the sensitivity of amplifier-detector 2 which does not impair the operation of the device as long as the local talker is strong. Closure of the contact S_1 has no effect during speed since relay H is operated. When the strong talker ceases speaking, relay H restores at the end of ten seconds and the potentiometer control apparatus withdraws the contact from S_1, stopping at the end of S_0. If, however, the distant talker begins speaking before the restoration of relay H, he operates relay G to prevent restoration and also relay H to prevent restoration until, say, ten seconds after the conclusion of his speech. If the local talker

then replies before the restoration of relay H, the system continues volume adjustment in the normal manner.

The arrangements have shown certain relay circuits which may be employed for a volume adjusting system controlled by the voice. It may in certain cases be necessary to increase the number of relays in order that the required time actions may be obtained.

The potentiometer control system has been shown without detail in the foregoing figures of the drawing, since there are many systems which would prove satisfactory for this service. However, one suitable form of apparatus is illustrated in Fig. 6. In the arrangements of Fig. 6 there is shown the operating shaft of the potentiometer P_1. There are provided two motor driven friction wheels. These wheels are rotated in opposite directions, as shown by the arrows. Each wheel may be caused to frictionally engage the shaft to move it up or down. This movement of the wheels into frictional engagement with the shaft may be controlled by the pivoted levers controlled by the separate magnets, each of which is controlled by a separate lead, as shown.

By means of the automatic volume adjustment arrangements heretofore disclosed, a closer regulation of the outgoing volume on long transmission lines or transoceanic circuits may be obtained than is now provided by the technical operation where the human element must enter in. If the voice control, by the arrangement of this invention, could be maintained at a more uniform volume than at present, even to the extent of 3 T. U., it would correspond to a doubling of the power at, for example, the radio transmitter of a transoceanic system and represent a corresponding improvement in the service provided by the system.

While the arrangements of the invention have been disclosed as embodied in certain specific forms which are deemed desirable, it is understood that they are capable of embodiment in many and other widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. A transmission system comprising a one-way line section, a device included in said line section for controlling the volume of transmission over said line section, relay means associated with said line section on the incoming and outgoing sides of said device, said relay means being responsive to currents of different values in said line section, and circuit arrangements under the joint control of said relay means for operating said volume control device.

2. A transmission system comprising a one-way line section, an amplifier included in said line section, a potentiometer for controlling the gain of said amplifier, relay means having different marginal adjustments associated with the incoming and outgoing sides of said amplifier and responsive to currents in said line section, and circuit arrangements under the joint control of said relay means for adjusting said potentiometer.

3. A transmission system comprising a one-way line section, an amplifier included in said line section, a device for controlling said amplifier, relay means associated with the incoming side of said amplifier and adjusted to operate on low volume transmission, relay means associated with the outgoing side of said amplifier and adjusted to operate on correct volume transmission, relay means associated with the outgoing side of said amplifier and adjusted to operate on high volume transmission, and circuit arrangements under the joint control of said relays for operating said amplifier control device.

4. A transmission system comprising a one-way line section, an amplifier included in said line section, a device for controlling said amplifier, relay means associated with the incoming side of said amplifier and adjusted to operate on low volume transmission, relay means associated with the outgoing side of said amplifier and adjusted to operate on correct volume transmission, relay means associated with the output side of said amplifier and adjusted to operate on high volume transmission, and circuit arrangements under the joint control of said relays whereby when said low volume relay operates the gain of said amplifier will be increased, whereby when said correct volume relay is operated the gain of said amplifier will be held constant, and whereby when said high volume relay is operated the gain of said amplifier will be decreased.

5. A transmission system comprising a one-way line section, an amplifier included in said line section, a potentiometer for controlling the gain of said amplifier, relay means having different marginal adjustments associated with the incoming and outgoing sides of said amplifier and responsive to currents in said line section, circuit arrangements under the joint control of said relay means for adjusting said potentiometer, another one-way line section for transmission in a direction opposite to that of said first mentioned line section, relay means associated with said second mentioned line section and responsive to currents therein, and means controlled by said last mentioned relay means for rendering ineffective the control of said marginal relays over said potentiometer.

6. A transmission system comprising a one-way line section, an amplifier included in said line section, a potentiometer for controlling the gain of said amplifier, said potentiometer having an arbitrarily chosen normal

setting, apparatus for controlling the setting of said potentiometer, relay means having different marginal adjustments associated with said line section, circuit arrangements controlled by said marginal relay means for causing said control apparatus to increase or decrease the setting of said potentiometer, and relay means associated with said line section for causing said control apparatus to return said potentiometer to its normal setting.

7. A transmission system comprising a one-way line section, an amplifier included in said line section, a potentiometer for controlling the gain of said amplifier, said potentiometer having an arbitrarily chosen normal setting, apparatus for controlling the setting of said potentiometer, relay means having different marginal adjustments associated with said line section, circuit arrangements controlled by said marginal relay means for causing said control apparatus to increase or decrease the setting of said potentiometer, a slow release relay associated with said line section on the incoming side of said amplifier and responsive to currents coming in over said line, and circuit arrangements operative when said relay releases for causing said control apparatus to return said potentiometer to its normal setting.

8. A transmission system comprising a one-way line section, an amplifier included in said line section, control apparatus for increasing and decreasing the gain of said amplifier, an amplifier detector bridged across said line section on the incoming side of said amplifier, a potentiometer in the input circuit of said amplifier detector, marginal relay means associated with the output of said amplifier detector, marginal relay means associated with said line section on the output side of said amplifier, circuit arrangements under the joint control of said marginal relay means for causing said control apparatus to increase and decrease the gain of said amplifier, and means controlled by the increasing of the gain of said amplifier for controlling said potentiometer.

9. A transmission system comprising a one-way line section, a device included in said line section for controlling the volume of transmission over said line section, responsive means having different marginal adjustments, said means being associated with and responsive to current in said line section on the incoming and outgoing sides of said device, and circuit arrangements under the joint control of said responsive means for operating said volume control device in such a manner that the electrical volume of the sound currents at its output is maintained essentially constant.

10. A transmission system comprising a one-way line section, an amplifier included in said line section, relay means having different marginal adjustments, said relay means being associated with and responsive to current in the incoming and outgoing sides of said amplifier, and circuit arrangements under the joint control of said relay means for adjusting the gain of said amplifier.

11. In a signal transmission system, a transmitting channel, impedance varying means in said channel for controlling the volume of the transmitted impulses, and a plurality of control means operated at different energy levels obtaining on said channel for governing said impedance varying means to maintain the volume of the transmitted impulses substantially constant and for jointly insuring against constant hunting when the incoming energy level is substantially constant.

12. In a signal transmission system, a transmitting channel, control means for governing the volume of the transmitted signals, and automatic means controlled from said channel beyond said control means for governing said control means to maintain the volume of the transmitted signals substantially constant and for jointly insuring against constant hunting when the incoming energy level is substantially constant.

In testimony whereof, we have signed our names to this specification this 15th day of December, 1928.

DOREN MITCHELL.
HAROLD C. SILENT.