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J. H. HAMMOND, JR
MICROPHONE SYSTEM HAVING AUTOMATIC VOLUME
LEVEL SENSITIVITY

2,563,648

Filed May 25, 1948

3 Sheets-Sheet 1

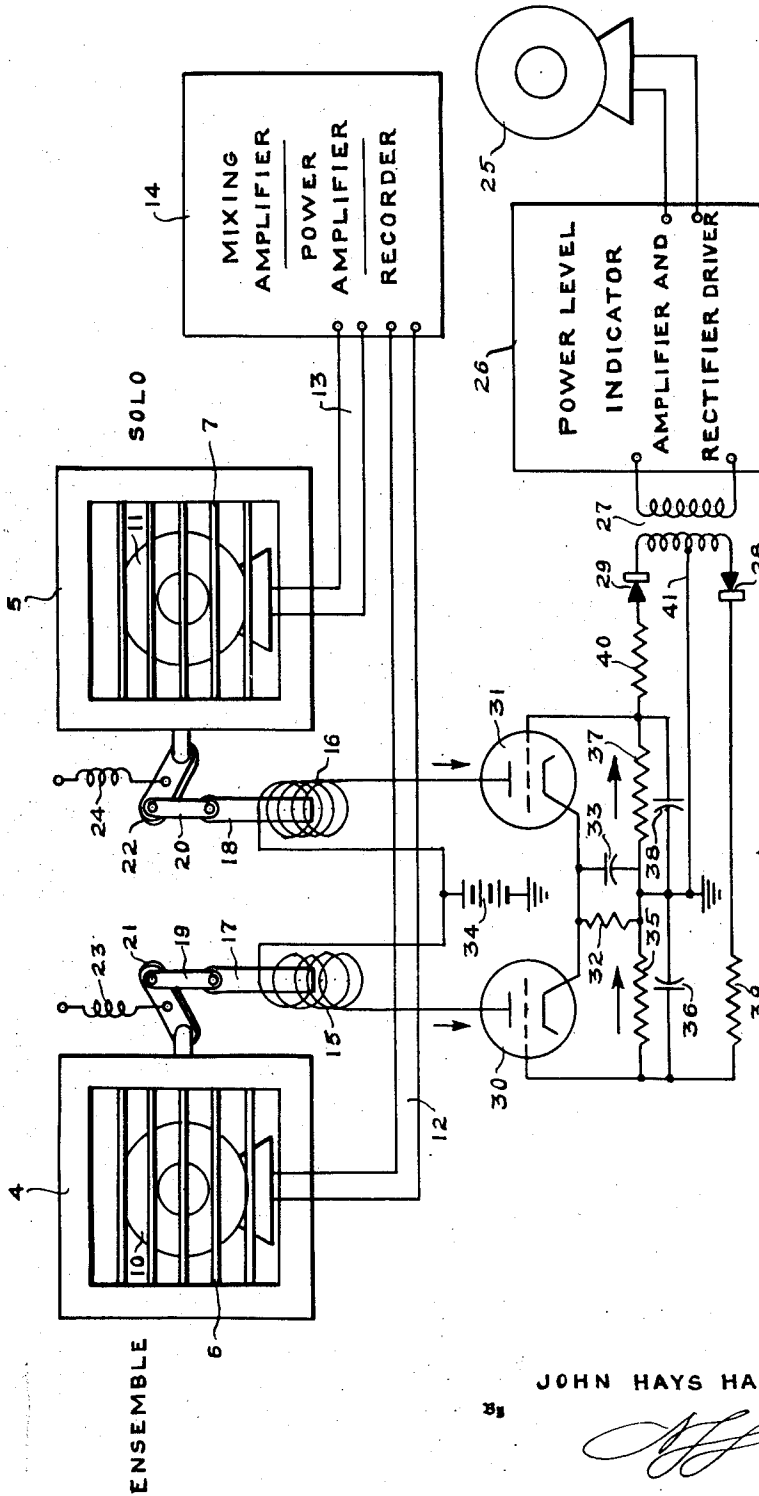


Fig. 1.

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3 Sheets-Sheet 2

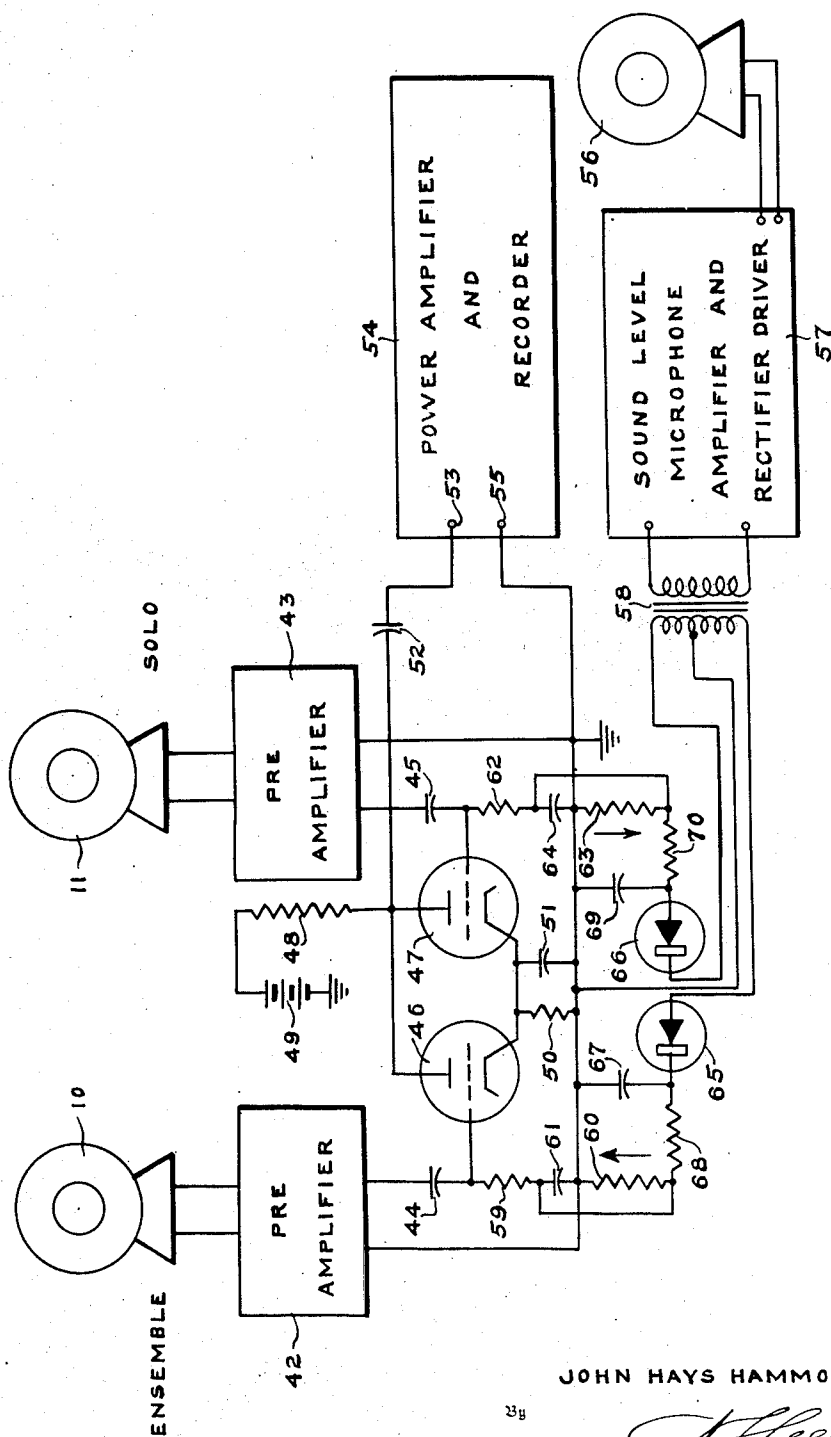


Fig. 2.

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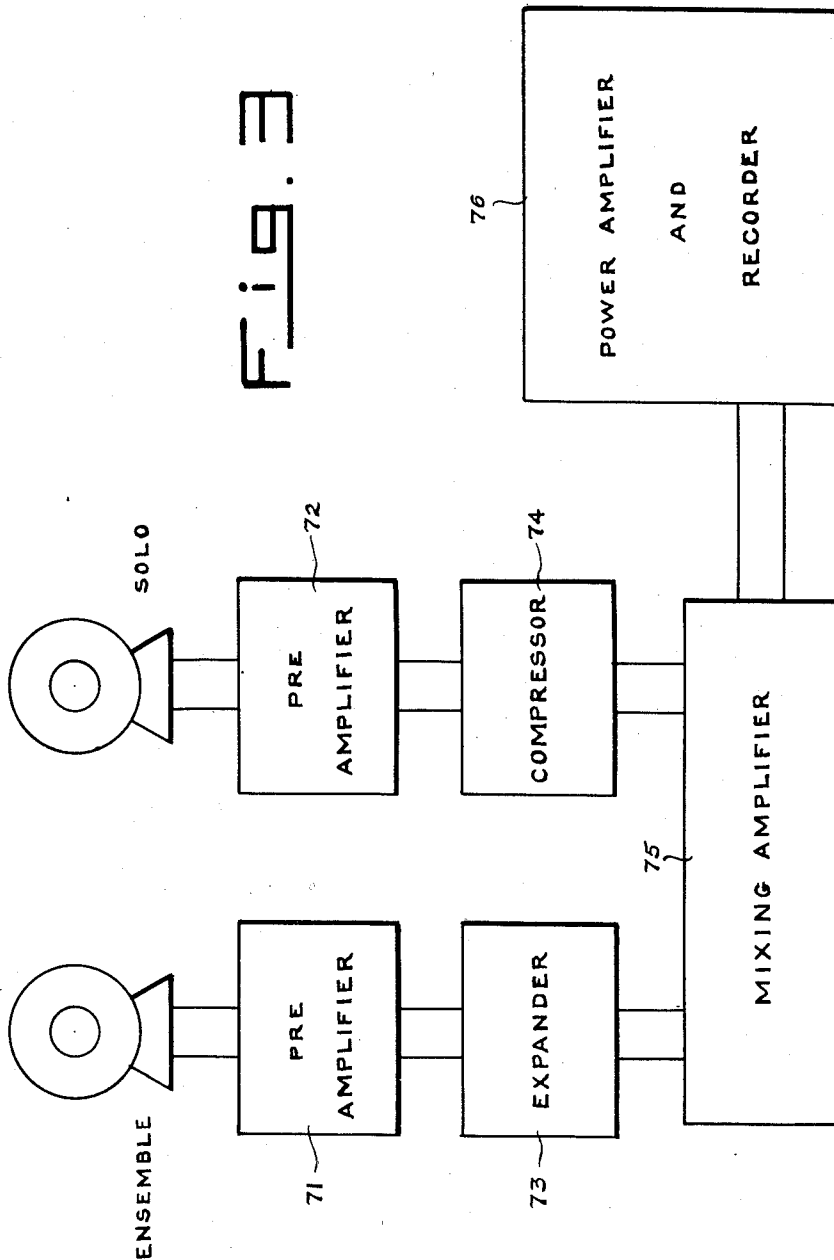
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UNITED STATES PATENT OFFICE

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MICROPHONE SYSTEM HAVING AUTOMATIC
VOLUME LEVEL SENSITIVITY

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10 Claims. (Cl. 179-100.1)

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This invention relates to a pick-up system for the musical output of organs, symphonic orchestras and the like. It provides in general for a system for obtaining suitable dynamic balance and range in the making of sound records, especially when the dynamic range must in effect be compressed in the recording. More specifically I provide for the simultaneous pickup by a plurality of microphones, as for example two microphones, one of which can be termed the "ensemble" microphone, and the other of which can be termed the "solo" microphone. The former may be placed at a distance from the organ or orchestra to pick up the ensemble effect and the latter may be placed nearer to the common source of sound for both microphones so as to pick up solo or individual parts. The relative sensitivities may be controlled by the gain settings of the pre-amplifiers for the two microphones, or in any other manner.

In my invention, I provide for decreasing the sensitivity of the solo microphone as the signal is increased, or for increasing the sensitivity of the ensemble microphone as the signal is increased, up to a certain maximum volume level, or for changing the sensitivities of both microphones simultaneously in the above manners. This provides a system of control which will be automatic to provide best pick up under all conditions.

The nature of the invention will be better understood by referring to the following description, taken in connection with the accompanying drawings in which certain specific embodiments have been shown for purposes of illustration.

In the drawings:

Fig. 1 is a diagrammatical view of a system wherein the sensitivities of the two microphones are controlled mechanically in accordance with the general sound level as established by a third microphone;

Fig. 2 shows diagrammatically a system wherein the electrical outputs of the two microphones are automatically controlled as to gain in accordance with the general sound level as established by a third microphone; and

Fig. 3 shows in block diagram a system wherein the sound level at each microphone automatically controls and adjusts the gain of its output circuit.

In Fig. 1, the ensemble microphone 10 and the solo microphone 11 are both connected by individual lines 12 and 13 to a mixing amplifier, power amplifier and recorder 14. Provisions are made for controlling the sensitivities of these microphones by electromechanical means, as by

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enclosing the microphones in chambers 4, 5 with adjustable shutters 6, 7 respectively. These chambers may be of suitable design such that the quality of the sound is not appreciably disturbed as the shutters are varied. In place of shutters, the control may be upon any mechanical part of the microphones, or upon a volume control device in the microphone output.

As shown, solenoid means using windings 15, 16; plungers 17, 18; links 19, 20; crank arms 21, 22, and springs 23, 24 are provided whereby the amounts of opening of the shutters 6, 7 are increasing functions of the amount of current in the solenoid windings. To control the amount of opening, I provide a microphone 25 suitably exposed to the sound, with a power level indicator, amplifier and rectifier driver 26 including the usual electron tubes connected to produce an output current proportional to the input signal level and operating through a transformer 27 and rectifiers 28 and 29, with connections such that increased sound level at the microphone 25 operates to open the shutters 6 and increase the sensitivity of ensemble microphone 10, and to close the shutters 7 and decrease the sensitivity of the solo microphone 11. For this purpose two triode power tubes 30 and 31 are provided, with cathodes connected in parallel and connected to ground through resistor 32 and capacitor 33. The grid of triode 30 is connected to ground through resistor 35 bypassed by capacitor 36, and through resistor 39 to the cathode of rectifier 28. Similarly the grid of triode 31 is connected to ground through resistor 37, bypassed by capacitor 38, and through resistor 40 to the anode of rectifier 29. The anode of rectifier 28 and the cathode of rectifier 29 are connected to the ends of the secondary of transformer 27, and the center tap 41 of the secondary is connected to ground. This arrangement provides that increased signal level will produce increased rectified control current in resistors 35 and 37 flowing in the directions of the arrows thereby altering the bias on the respective grids to increase the plate current of triode 30 and decrease the plate current of triode 31. This reduces the opening of the shutters 7 for the solo microphone 11, and increases the opening of the shutters 6 for the ensemble microphone 10.

In Fig. 2, the ensemble microphone 10 and the solo microphone 11 are connected through pre-amplifiers 42 and 43, and through blocking capacitors 44 and 45 to the grids of mixing amplifier triodes 46 and 47. The anode plates of these triodes are connected together and through feed

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resistor 43 to the positive end of battery 49, the negative end of which is connected to ground. The cathodes of triodes 46 and 47 are connected through resistor 50 and capacitor 51 to ground. The plates are also connected through blocking capacitor 52 to the input terminal 53 of a power amplifier and recorder 54 the other input terminal of which is connected to ground. It is to be understood that volume controls in the preamplifiers and power amplifier provide for the proper proportioning of the recorded signals from the two microphones when the sound level is low.

To provide for varying the proportioning of the recorded signals to increase the relative pickup from the ensemble microphone and to diminish the relative pickup from the solo microphone, a sound level microphone 56 is provided operating through an amplifier and rectifier driver 57 to supply an audio control signal to the primary of a transformer 58. The grid of triode 46 is connected to ground through resistor 59 from which it receives its microphone signal, and through resistor 60 bypassed by capacitor 61, from which it receives its control signal. The grid of triode 47 is connected to ground through resistor 62 from which it receives its microphone signal, and through resistor 63 paralleled by capacitor 64, from which it receives its control signal. One end of the secondary of transformer 58 is connected to the anode of rectifier 65, and the other end is connected to the cathode of a rectifier 66, while the center tap of the secondary is connected to ground. The cathode of rectifier 65 is connected to ground through capacitor 67, and through resistor 68 to the junction of resistors 59 and 60; the anode of rectifier 66 is connected to ground through capacitor 69 and through resistor 70 to the junction of resistors 62 and 63.

In operation, as the general sound level as determined by the audio output of the rectifier driver 57 increases, the rectified current output of rectifier 65 increases, and flows through resistor 68 in such a manner as to increase the conductance and plate current of triode 46, and the rectified current output of rectifier 66 increases and flows through resistor 63 in such a manner as to decrease the conductance and plate current of triode 45. Constants may be so chosen that the changes of space currents of the triodes 46 and 47 are closely equal and opposite thereby maintaining a constant D. C. component of the current through feed resistor 43, whereby the control signals do not cause corresponding control impulses in the input to the power amplifier 54. Constants may be also chosen and the output of the rectifier driver may be so limited that the changes of operating condition of the triodes 46 and 47 are not excessive, and so that they handle at all times the signals from the microphones without tonal distortion. The triodes 46 and 47 operate as mixing amplifiers, and it is clear that the gain from preamplifier 42 to power amplifier 54 will be an increasing function of the sound level, and the gain from preamplifier 43 to power amplifier 54 will be a decreasing function of the sound level. Therefore in effect, the increase of sound level causes the first channel to be more sensitive, and the second channel to be less sensitive.

In Fig. 3, the ensemble microphone 10 is connected through a preamplifier 71 and a volume expander 73 to an input of a mixing amplifier 75; the solo microphone 11 is connected through a preamplifier 72 and a volume compressor 74 to another input of the mixing amplifier 75. The signals through the two channels are combined

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in the mixing amplifier 75. The output of the mixing amplifier is connected to a power amplifier and recorder 76.

In operation, the volume range of the signal from the ensemble microphone 10 is expanded in its passage to the recorder 76, thereby increasing the effective sensitivity of the channel of the microphone 10 as the general sound level is increased. Correspondingly, the volume range of the signal from the solo microphone 11 is compressed in its passage to the recorder 76, thereby decreasing the effective sensitivity of the channel of the microphone 11 as the general sound level is increased. Hence an increase in volume level decreases the effectiveness of the solo microphone 11 and increases the sensitiveness of the ensemble microphone 10. The volume range of the recorded signal as a whole may be compressed or expanded depending upon the balance selected. The solo microphone being close to the source of sound should have a cut off or limiter to prevent over recording and the ensemble microphone system may have a similar limiter.

The system is particularly adapted to organ recording where the volume range is large and the pianissimo passages may be undercut and the loud passages overcut unless control means as above described is provided. The solo microphone may be made effective for picking up and recording the pianissimo passages but is reduced in effectiveness as the volume increases. The remote or ensemble then becomes sensitive for recording the louder passages with a limiter to prevent overcutting of the record. The system as a whole may be considered as a compressor in that it limits the response at high volumes but is an expander in that it increases the response to the lower volumes.

What is claimed is:

1. In a sound translation system, a plurality of channels each having a sound pick-up device and translating means, a common output channel, means coupling said output channel to said translating means, a pick-up means for monitoring the acoustical energy from said output channel, control means, means whereby said control means is responsive to variations in the volume level picked up by said monitor pick-up means, means for connecting said control means whereby the translation efficiency of each of the respective channels is varied in respectively different degrees.

2. In a sound translating system a pair of channels each having a sound pick-up means and translating means, said channels having different translation efficiencies, a common output channel, means coupling said output channel to said translating means, a pick-up means for monitoring the acoustical energy from said output channel, control means, means whereby said control means is responsive to variations in the volume level picked up by said monitor pick-up means, means for connecting said control means whereby the translation efficiency of the lower efficiency channel is increased and the translation efficiency of the higher efficiency channel is decreased in response to an increase in the volume level picked up by said monitor pick-up means, and vice versa.

3. In a sound translating system a plurality of channels each including sound pick-up means and translating means and having different translation efficiencies, a common output channel, means coupling said output channel to said translating means, a pick-up means for monitor-

ing the acoustical energy from said output channel, control means, means whereby said control means is responsive to variations in the volume level picked up by said monitor pick-up means, means for connecting said control means where-
 by the translation efficiency of at least one of said channels is varied as a decreasing function of said volume level.

4. A system as set forth in claim 1, in which the translation efficiency of at least one of said channels is decreased with increase in volume level picked up by said monitor pick-up means.

5. A system, as set forth in claim 1, in which the output circuit includes a sound recording device.

6. A system, as set forth in claim 1, in which the pick-up means comprise microphones, sound insulated chambers enclosing said microphones and shutters to vary the sound transmitted to the respective microphones, and said control means is connected to control the opening of said shutters.

7. In a system, as set forth in claim 1, a monitor microphone having an output channel including means deriving a control signal proportional to the volume level and means sup-

plying said control signal to actuate said control means.

8. A system, as set forth in claim 1, in which said control means is connected to vary the efficiency of said translating means.

9. A system as set forth in claim 1 in which the control means includes a volume range compressor actuated by one of said pick-up means.

10. A system, as set forth in claim 2, in which the control means includes a volume range expander pick-up means in the less efficient channel and a volume range compressor in the more efficient channel.

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