United States Patent

Rose

[15] **3,678,202**

[45] **July 18, 1972**

[54] LOUDSPEAKER BALANCING SYSTEM

[72] Inventor: **Nelson J. Rose**, 419 E. Willow Grove Ave., Philadelphia, Pa. 19118

[22] Filed: **Nov. 24, 1969**

[21] Appl. No.: **879,151**

[52] **U.S. Cl.** ..... **179/1 AT**, 179/1 MN

[51] **Int. Cl.** **H04r 27/00**

[58] **Field of Search** ..... 179/1 AT, 1 DD, 1 GA, 1 GP, 179/1 J, 1 HN, 1 F, 1 FS, 1 B

[56] **References Cited**

UNITED STATES PATENTS

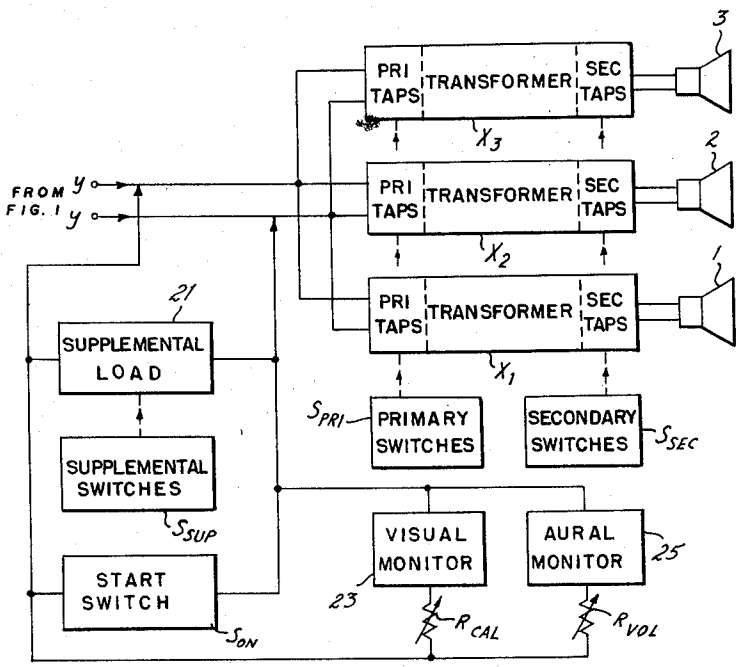
1,587,107	6/1926	Edwards	179/1
2,110,358	3/1938	Dreisbach	179/1
2,149,637	3/1939	Smith	179/1
2,341,706	2/1944	Fields	171/95

Primary Examiner—Kathleen H. Claffy
Assistant Examiner—Horst F. Brauner
Attorney—McClure, Weiser & Millman

[57] **ABSTRACT**

A system is provided for setting up a multiple-speaker assembly, such as in a public address system or the like, to equalize loudspeaker output while total load remains matched to amplifier output and with a minimum of adjustment or readjustment.

10 Claims, 2 Drawing Figures



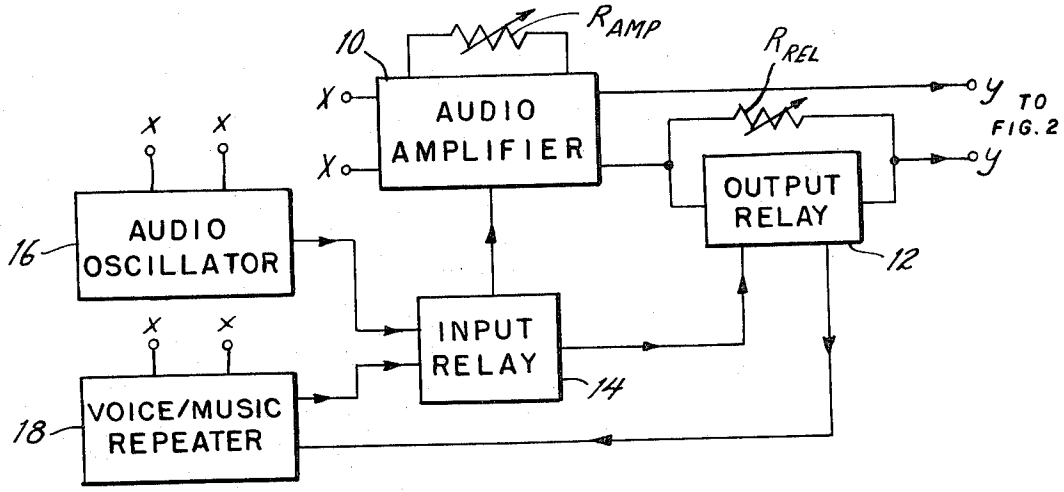


Fig. 1.

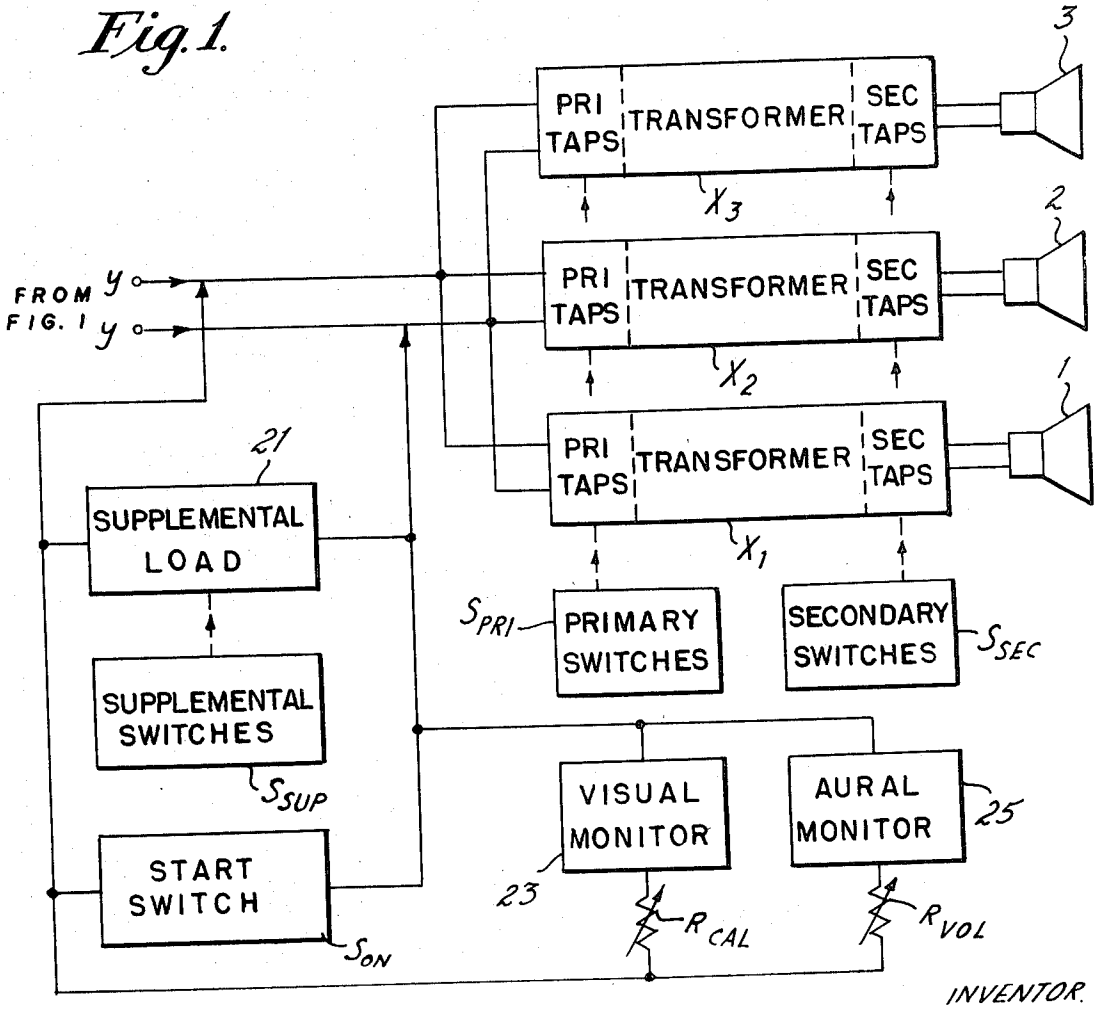


Fig. 2.

INVENTOR.
NELSON J. ROSE
BY McCrary, Weiser & Millman
ATTORNEYS.

LOUDSPEAKER BALANCING SYSTEM

This invention relates to balanced installation of audio systems.

In public address or similar audio systems utilizing several or more speaker locations it becomes increasingly difficult to balance speaker output and to match the total load reasonably well to amplifier output without tedious and time-consuming readjustment of speaker transformer taps. The difficulties are accentuated by variation in equipment characteristics and by non-homogeneity in the environment, whether indoors or outdoors. Mis-estimation of amplifier output requirement may lead to substitution of another amplifier, necessitating tap readjustment throughout, despite previous relative balance, so as to avoid a resulting mismatch and accompanying sound distortion and/or inadequate sound level.

A primary object of the present invention is provision of an improved system for balancing speaker output in multiple-speaker audio installations.

Another object is ready matching of amplifier output and total load in such installations.

A further object is provision of apparatus for accomplishing the foregoing objects.

Other objects of this invention, together with means and methods for attaining the various objects, will be apparent from the following description and the accompanying diagrams.

FIG. 1 is a largely schematic diagram of certain component apparatus arranged according to this invention; and

FIG. 2 is a largely schematic diagram of other component apparatus so arranged to practice the invention.

In general, the objects of this invention are accomplished in a system of balancing loudspeaker output for a multiple-speaker installation fed by a given amplifier and wherein speakers at each of a number of speaker locations are connected thereto through respective transformers whose secondary windings are connected via appropriate taps to the speaker voice coils with proper impedance matching. As practiced the invention includes the steps of monitoring the amplifier output and maintaining the load therefor essentially constant, monitoring the output sound at any given speaker location and adjusting the transformer primary winding taps, and further adjusting the secondary taps if required, to provide a desired output sound level. Each adjustment is made while monitoring preselected voice or music (or both) selections repeatable at will and uniform throughout each repetition. After such procedure has been followed for each and every speaker location an essentially correct sound level should prevail with little or no necessity for tap readjustment.

FIG. 1 shows schematically certain apparatus components and interconnection thereof according to this invention. They are conveniently grouped at a single location and may be referred to as the "fixed" or "home" unit. It will be understood that for installations outdoors such unit usually will be grossly movable, as in a panel truck, to the locale of each installation but that once there it need not be moved to each speaker location, as distinguished from other apparatus components (shown in FIG. 2) that are referred to as the "mobile" unit and discussed hereinafter.

As illustrated, the fixed unit includes audio amplifier **10**, which has associated with it adjustable resistor R_{AMP} as a gain or output control. The amplifier has power input leads from contacts *x,x* to be connected to an external power line or an internal power supply (not shown). The amplifier output leads, one of which contains output relay **12** and adjustable load-compensating resistor R_{REL}, go to contacts *y,y* shown further in the succeeding view. The output relay has a shorting connection discussed further below, from input relay **14**. The input relay itself makes connections to the amplifier to control the signal input thereto. Arranged for alternative connection by the input relay to the amplifier are audio oscillator **16** and voice/music repeater **18**, both of which are adapted to provide audio-frequency output thereto and also have power input from contacts *x,x*. The voice/music repeater has an interconnection from the output relay and conveniently takes the form of a tape player provided with at least one endless loop of recorded voice or music (or both) selections to be monitored during installation of the various speakers in an audio system. More detailed description of these components would be superfluous in view of their largely conventional nature except as noted in discussion of the functioning thereof set forth hereinafter.

FIG. 2 shows schematically apparatus components of the aforementioned mobile unit in conjunction with several speakers by way of example, it being apparent that the number of speakers could be increased practically indefinitely. Speakers **1**, **2**, and **3** are connected in parallel to contacts *y,y* to receive the output from amplifier **10** (shown in FIG. **1**) by way of respective transformers X_1, X_2, and X_3. Each transformer has conventional taps to its primary and secondary windings, indicated as PRI TAPS and SEC TAPS, respectively, at opposite ends within the blocks representing the transformers. Broken lines, with arrows, to the respective winding taps indicate interconnection for tap selection or adjustment by means of two sets of switches shown so connected to the first transformer: primary switches S_{PRI} to the primary taps and secondary switches S_{SEC} to the secondary taps thereof.

Two large vertical arrows in FIG. 2 terminate a pair of leads juxtaposed to the lines from contacts *y,y* to indicate ready connection thereto and disconnection therefrom, which normally takes place at or near each speaker transformer location as will be further apparent from the functional discussion hereinafter. Shown so connected in parallel across this pair of leads are supplemental load **21**, having supplemental switches S_{SUP} associated therewith as indicated by the interconnecting broken line and arrow, start switch (button) S_{ON}, visual monitor **23** in series with adjustable resistor R_{CAL}, and aural monitor **25** in series with adjustable attenuator R_{VOL}.

The supplemental load includes numerous fixed resistors variously connectable by means of the supplemental switches, conveniently multiple-paralleled and calibrated in watts, to set the total load including any connected speakers essentially equal to the amplifier power output, as mentioned further in the functional description hereinafter. The primary switches, also conveniently calibrated in watts, are connected to the taps of the primary winding of the transformer for any given speaker being balanced to permit selection of whatever portion of that primary winding will provide proper speaker output. The secondary switches, which are conveniently calibrated in ohms, are connected to the taps of the transformer secondary winding to permit selection of whatever portion of the secondary winding will match the speaker impedance.

The primary and secondary switches are preferably of rotary type or autonomous self-cancelling bank type (break before make). The visual indicator preferably comprises a high-impedance (negligible loading) highly ballistic meter movement with good frequency response over a range of at least 50 to 8,000 hertz and with an indicator scaled in keeping with transformer primary notation, such as 0 to 100v. for a 70v. line. The aural monitor preferably comprises high-fidelity bridging earphones of circumaural type to negate ambient noise masking. Both monitors facilitate checking on the amplifier output: visually for amplitude output and aurally for undistorted output per type of voice or music input.

Operation of this system to practice the present invention will be readily understood from the foregoing description of the apparatus components and interconnection thereof and the following procedural explanation directed particularly to a first speaker and its transformer. It is assumed that the audio amplifier's gain has been properly set internally, as by adjustment of R_{AMP}, to deliver its rated wattage or required portion thereof, e.g., 80 watts, at appropriate constant voltage, such as the conventional 70.7v. If no speaker is yet connected the supplemental load is the total load and is set by depression of the appropriate supplemental switch(es) in the amount of the amplifier rated wattage. At this stage the system is in "standby" mode, with the audio oscillator (as standby audio means)

providing an input to the amplifier via normally closed contacts of the input relay, but with the output being insufficient to actuate the output relay. Depression of the appropriate secondary switch(es) matches the transformer secondary winding impedance to that of the speaker voice coil, usually 4 ohms or an even multiple thereof. Then the installer or operator estimates the desired wattage of the speaker and depresses the corresponding primary switch(es) to complete the circuit from the amplifier to the speaker.

After making tentative or trial connections to a speaker as just summarized, the operator presses the start switch button, which shorts out such load entirely (i.e., effectively shorting contacts y,y together) so that the entire output voltage appears across R_{REL} momentarily, thereby actuating it the output relay. The closing of the output relay applies power from *x,x* to the tape transport motor (or equivalent means) of the voice/music repeater, and by way thereof the input relay, actuating both. Actuation of the input relay opens its normally closed contacts, thereby removing the audio oscillator output as the amplifier input, and closes normally open contacts to substitute as such input the output of the voice/music repeater. The input relay also closes a pair of normally open contacts flanking the output relay (and parallel resistor R_{REL}) thereby shorting them out of the amplifier output line, whereupon full amplifier power is developed across the intended load.

Notwithstanding release of the start button, the input relay holds until completion of the voice/music tape transmission, thereby providing a preselected period of time, such as from about one-fourth to one-half minute, for primary tap adjustment by means of the primary switches. The holding action, conveniently provided by the tape transport motor potential, is broken at the end of a complete voice/music transmission cycle in any suitable manner, as by presence of a conductive strip at the endpoint on the tape loop, which deenergizes the tape-transport motor and, thus, the input relay. This removes the short in one of the amplifier output leads, to restore the output relay and parallel resistor R_{REL} therein, and restores the audio oscillator to the amplifier input, whereupon the system is back in the standby mode.

Whenever the start button is next depressed the entire cycle just described will repeat itself. If the operator has completed adjustment of the first speaker satisfactorily, he wires into the circuit the taps so selected and moves the mobile unit on to the next speaker and repeats the procedure with its transformer, and so on. As each speaker is added to the line, the operator readjusts the supplemental switch(es) so as to subtract from the setting thereof the wattage load represented by the primary switch setting of the newly connected speaker, as well as the previous speaker loads. Of course, the voice/music repeater may be recycled as often as desired at any single location, until the operator is satisfied with the speaker output at that location. Similarly the operator can return to a previously adjusted speaker transformer and cycle the voice/music transmission to recheck that speaker and to readjust the transformer taps, as may be necessitated by environmental changes, for example.

Notwithstanding description and illustration of a preferred embodiment of this invention hereinabove, various modifications may be made therein, as by adding, combining, or subdividing parts or steps, while maintaining at least some of the advantages and benefits of the invention. The invention itself is defined in the following claims.

The claimed invention is:

1. In a system of balancing loudspeaker output for a multiple-speaker installation fed by a given amplifier and wherein speakers at each of a number of speaker locations are connected thereto through respective transformers whose primary windings are connected via appropriate taps to the amplifier output and whose secondary windings are connected via appropriate taps to the speaker voice coils with proper impedance matching, the improvement comprising monitoring the amplifier output and maintaining the load therefor essentially constant, monitoring the sound output at any given speaker location, and adjusting winding taps of the transformer to provide a desired output sound level.

2. Speaker balancing system according to claim **1**, including the step of providing a repeatable audio transmission having known characteristics to the speakers during such adjustment.

3. Speaker balancing system according to claim **2**, wherein the amplifier output is provided with a supplemental load, which together with the load provided by the speakers equals the rated amplifier output, and including the step of readjusting the supplemental load to compensate for each change in load occasioned by any change in speaker connections.

4. In a system of balancing loudspeaker output for a multiple speaker installation, wherein sound output at each of a plurality of speaker locations is monitored aurally during adjustment of speaker transformer taps, the improvement comprising providing a repeatable voice/music transmission to be so monitored during such adjustment, and including the step of providing a standby output to the amplifier when the repeatable voice/music transmission is absent, the resulting amplifier output being adapted to effect substitution of the repeatable voice/music transmission as the amplifier input upon momentary shorting out the speaker load.

5. Speaker balancing system according to Claim **4**, including the steps of switching manually from the standby input to the repeatable voice/music transmission and switching automatically to the standby input after each repetition of the voice/music transmission.

6. In a loudspeaker balancing system for an audio installation having speakers at a plurality of locations and multitapped audio transformers for use therewith, the combination of an audio amplifying means having an output line across which the tapped primary windings of the speaker transformers are connectable in parallel as the principal load, the secondary windings of the transformers being connected with proper impedance matching to voice coils of the speakers, calibrated audio input means operatively connected to the amplifying means and adapted to provide thereto a repeatable audio transmission having known characteristics, supplemental load means for connection across the output line, and switch means for varying the transformer winding connections and for varying such connection of the supplemental load, including output relay means connected in series in the output line, shorting switch means across the output line at a location between the output relay means and any load across the line, the output relay being responsive to shorting of the output line by the shorting switch means and effective to actuate the audio input means.

7. Speaker balancing system according to Claim **6**, including standby audio input means, input relay means normally connecting the standby audio input means to the input of the amplifying means and responsive to actuation of the calibrated audio input means to disconnect the standby audio input means therefrom and connect the calibrated audio input means thereto until completion of the repeatable audio transmission.

8. Speaker balancing system according to claim **7**, wherein the input relay means also is adapted to short the output line around the output relay means.

9. Speaker balancing system according to claim **7**, wherein the input relay means is adapted to remain in actuated condition regardless of discontinuation of the short across the output line by the shorting switch means and release of the output relay means.

10. Speaker balancing system according to claim **9**, wherein the calibrated audio input means is adapted to deactivate the holding relay means upon completion of one complete transmission of the audio signals therefrom.

* * * * *