Oct. 7, 1941. J. C. COE 2,257,731

VOLUME CONTROL FOR RADIO AND INTERPHONE CIRCUIT

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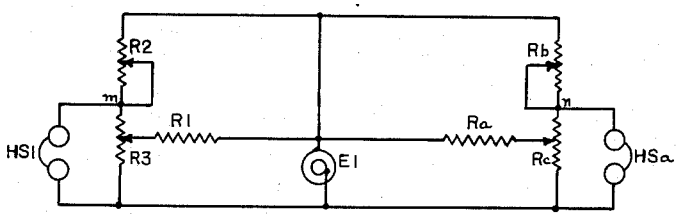


FIG. 1

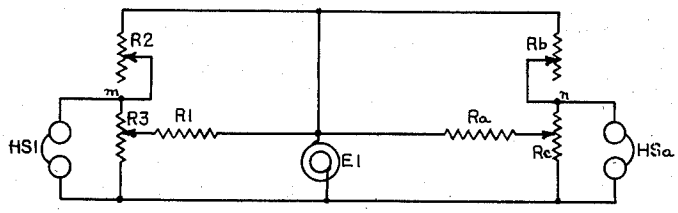


FIG. 2

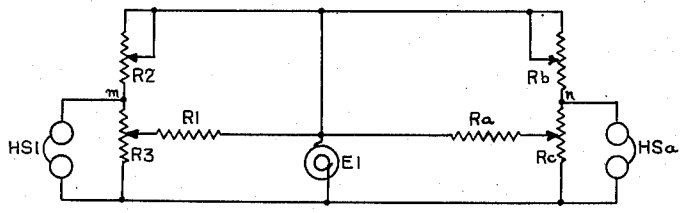


FIG. 3

INVENTOR
JAMES C. COE
BY William Jones
ATTORNEY

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VOLUME CONTROL FOR RADIO AND INTERPHONE CIRCUIT

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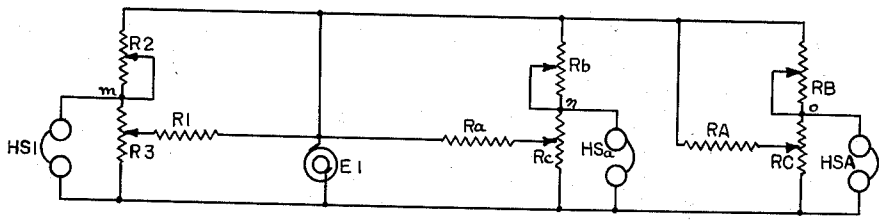


FIG. 4

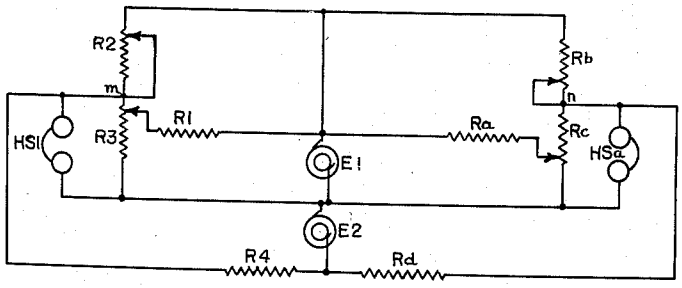


FIG. 5

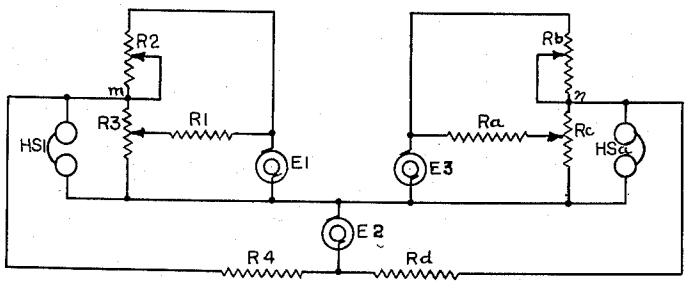


FIG. 6

INVENTOR
JAMES C. COE

BY W. Glenn Jones

ATTORNEY

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VOLUME CONTROL FOR RADIO AND INTERPHONE CIRCUIT

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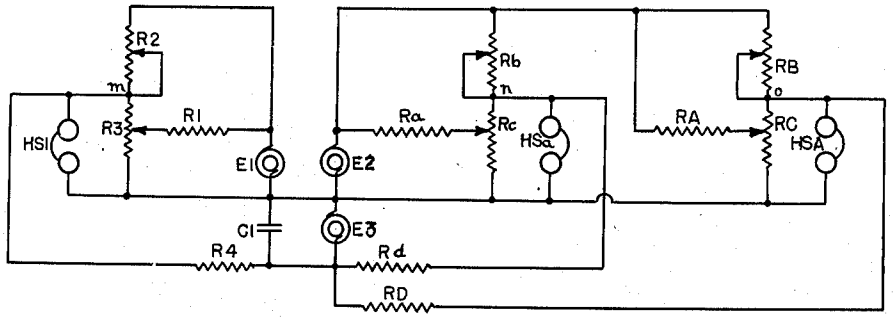


FIG. 7

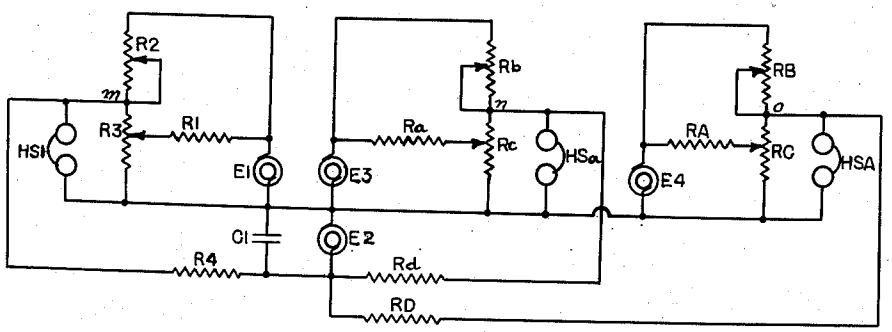


FIG. 8

INVENTOR
JAMES C. COE

BY William Jones

ATTORNEY

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VOLUME CONTROL FOR RADIO AND INTERPHONE CIRCUIT

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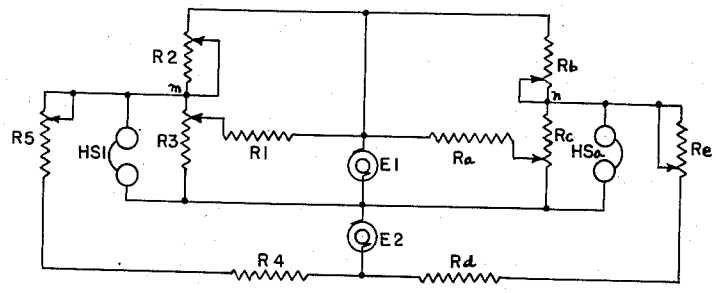


FIG. 9

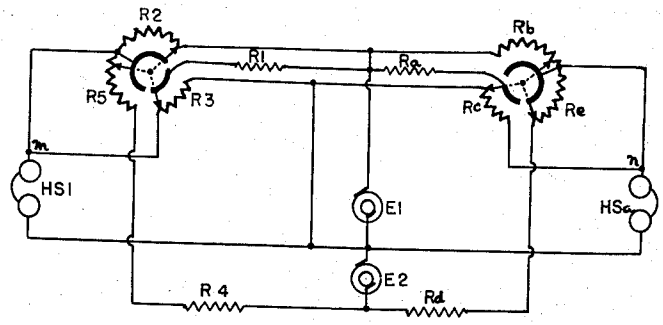


FIG. 9A

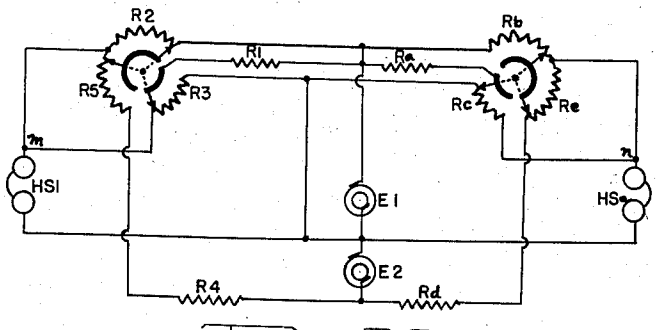


FIG. 9B

INVENTOR
JAMES C. COE
BY William Jones
ATTORNEY

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VOLUME CONTROL FOR RADIO AND INTERPHONE CIRCUIT

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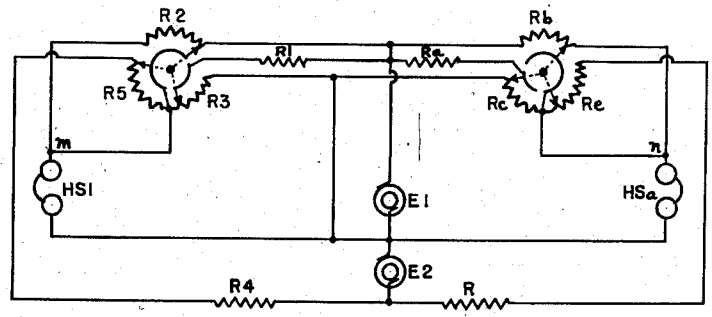


FIG. 9C

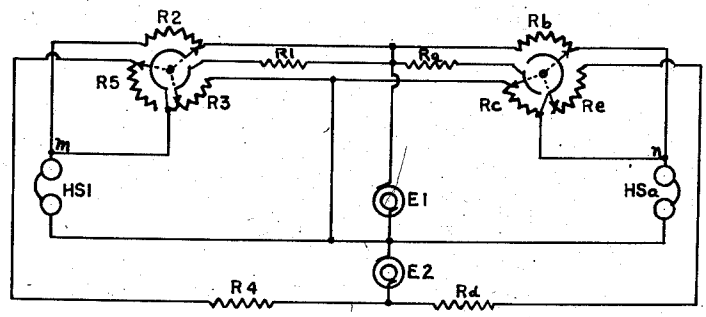


FIG. 9D

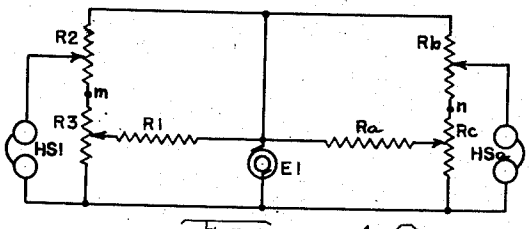


FIG. 10

INVENTOR
JAMES C. COE

BY William Jones

ATTORNEY

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VOLUME CONTROL FOR RADIO AND INTERPHONE CIRCUIT

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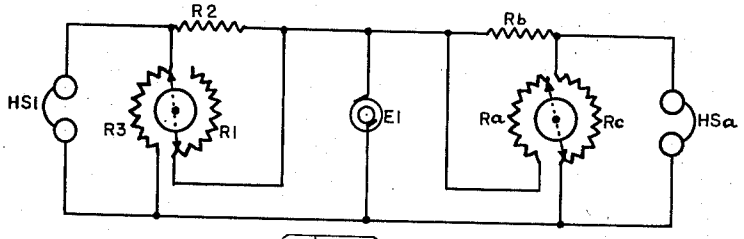


FIG. 11

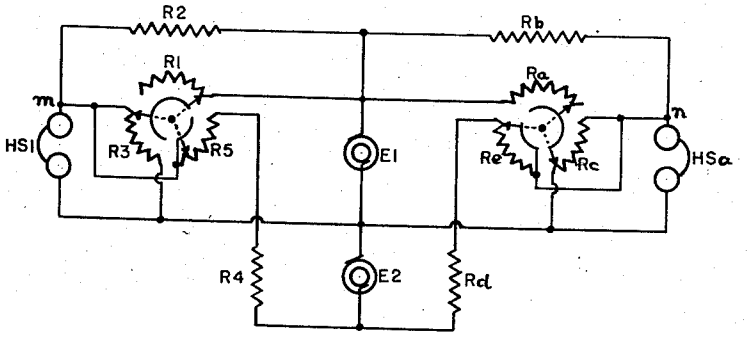


FIG. 11A

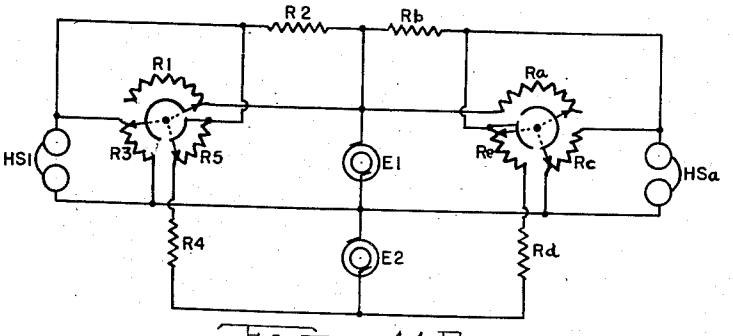


FIG. 11B

INVENTOR
JAMES C. COE

BY William Jones

ATTORNEY

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VOLUME CONTROL FOR RADIO AND INTERPHONE CIRCUIT

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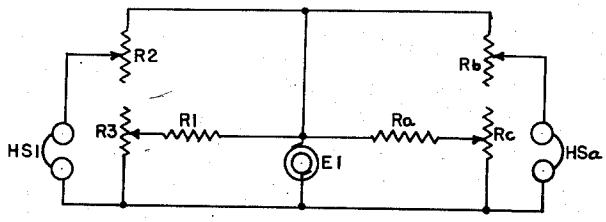


FIG. 12

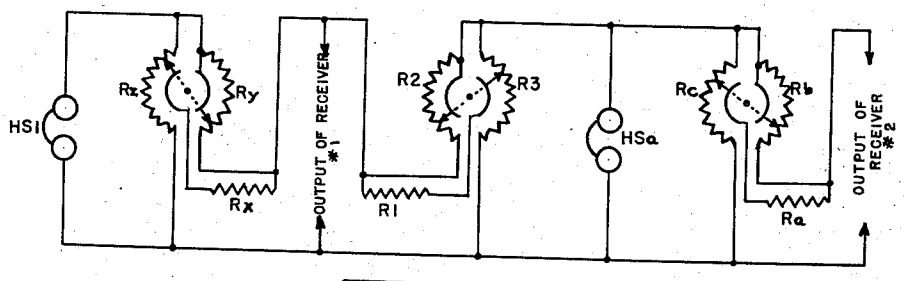


FIG. 13

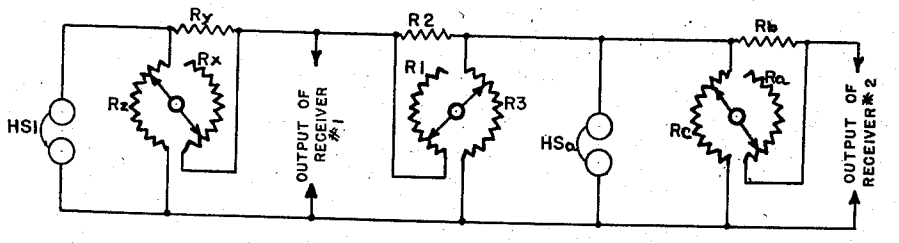


FIG. 14

INVENTOR
JAMES C. COE

BY

ATTORNEY

Patented Oct. 7, 1941 2,257,731

UNITED STATES PATENT OFFICE

2,257,731

VOLUME CONTROL FOR RADIO AND INTERPHONE CIRCUIT

James C. Coe, Arlington, Va.

Application November 2, 1940, Serial No. 363,982

22 Claims. (Cl. 179—1)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

This invention relates specifically to communication systems employing a number of sound reproducing devices and consists particularly of circuit connections wherein a substantially constant impedance network is provided in the volume control circuit for each sound reproducing device, so that independent control may be had to each individual reproducing device without producing a corresponding effect upon the volume level in other reproducing devices connected in parallel therewith through their attenuating network. This invention is intended for use primarily in connection with radio and interphone communication installations for aircraft wherein a number of individual headsets are connected to the common output circuit of the radio receiving apparatus, or interphone communication circuit. At the present time there are a number of attenuation control systems for radio receiving devices or the like, known to the art, which present a constant impedance to the receiver output, but which are undesirable in aircraft installations because of their size and weight. These prior art attenuation control systems are illustrated by the U. S. patents of De Forest, 1,892,935, and Doran, 1,883,624. It is, therefore, an object of the present invention to provide in a communicating system for aircraft having an individual and independent attenuation control system for each sound reproducing device connected thereto of light weight and reduced size so as to be particularly adapted for use in aircraft.

It is a further object of this invention to provide in a communication system for aircraft having superimposed interphone and radio signals, a variable audio attenuator which will permit independent adjustment of the radio level in the various headsets and at the same time permit the reception of the interphone signal in all of the headsets.

It is also an object of my invention to provide a communication system having a plurality of headsets connected to different radio receiving apparatus, each with independent attenuation control, and with a common interphone communication system connected to all the headsets.

It is also a further object of this invention to provide a communication system having superimposed interphone and radio signals with individual volume control of the radio signal to one or more headsets, which will produce no change in the interphone level to the same headset.

It is an object of this invention to provide a system of communication which has at least two independent signal sources, the outputs of which are superimposed upon a number of sound reproducing devices, such as headsets or loud speakers, with an individual audio attenuation control for the reproducing devices in the output circuit of one of said signal sources which permits that signal level in that reproducing device to be varied from a maximum to a minimum without producing any noticeable effect in the signal level from the same source upon the other reproducing devices connected in parallel therewith through their attenuating network, and without interfering with the reception of the signal from the other sources in the same headset, although its level may be affected somewhat.

It is also an object of my invention to provide a communication system having superimposed interphone and radio signals with an individual volume control for the reproducing devices connected thereto, the volume control being arranged so that if the radio signal is increased the interphone signal is automatically decreased, and vice versa.

It is also an object of my invention to provide a communication system having both radio and interphone signal sources, with volume control means which permits the volume to be adjusted so that the level from both the radio and interphone source is increased or decreased together.

It is a further object of this invention to provide a communication system having a plurality of independent signal outputs with plural headsets and individual attenuation controls therefor, arranged so that the signal from both sources may be received in one headset, while the signal from only one source may be audible in the other headset.

With the foregoing and other objects in view, the invention consists in the construction, combination and arrangement of parts hereinafter described and illustrated in the drawings, in which:

Fig. 1 is a wiring diagram showing the connections for a plurality of headsets in parallel with the output of a radio receiver, amplifying device or the like, shown symbolically as collector rings;

Fig. 2 is a wiring diagram showing a modification of Fig. 1;

Fig. 3 is a wiring diagram of a further modification of Fig. 1;

Fig. 4 is a wiring diagram of the connections shown in Fig. 1, illustrating how the circuit may

be expanded to accommodate more than two headsets;

Fig. 5 is a wiring diagram showing the connections illustrated in Fig. 1, with the addition of another signal source indicated generally as collector rings and connected to the same headset loads;

Fig. 6 shows a modification of Fig. 5, wherein independent signal sources are provided for each headset load in place of one of the common signal source illustrated by Fig. 5;

Fig. 7 is a modification of the circuit arrangement shown in Fig. 6, wherein an additional headset load and its volume control circuit is added to the output of one of the signal sources indicated in Fig. 6;

Fig. 8 is a modification of Fig. 7, wherein a separate signal source is added to supply the additional headset load of Fig. 7;

Fig. 9 shows a circuit arrangement similar to Fig. 5, with the adidtion of a variable resistance in the output circuit of the added signal source of Fig. 5;

Fig. 9A shows a modification of the circuit arrangement illustrated in Fig. 9, showing the contact arms of the variable resistance elements connected together mechanically and arranged so that an increase in the series resistance from one signal source, causes a decrease in the series resistance in the output circuit of the other signal source;

Fig. 9B is a further modification of Fig. 9A;

Fig. 9C is a modification of the control circuit illustrated in Fig. 9, arranged so that an increase or decrease in the series resistance from one signal source will also cause an increase or decrease in the series resistance of the other signal source;

Fig. 9D is a modification of Fig. 9C;

Fig. 10 is a modification of Fig. 1;

Fig. 11 is a modification of Fig. 1, showing different variable resistance elements with the contact arms of each connected together mechanically;

Fig. 11A is a modification of Fig. 11, showing the addition of another common signal source with a variable resistance in the output circuit. The contact arms of the series resistance elements in the different sources are connected together mechanically, so that an increase or decrease in one causes a decrease or increase in the other;

Fig. 11B is a modification of Fig. 11, showing circuit arrangements wherein the contact arms to the resistance elements connected in the output circuit of the different sources are arranged so that as the resistance connected in series with one source is increased or decreased, the resistance connected in series with the other source is also automatically increased or decreased;

Fig. 12 is a modification of Fig. 1;

Fig. 13 illustrates circuit connections showing an arrangement wherein the output from two signal sources may be received in single headset, while the output of only one of the signal sources may be audible in the other headset; and

Fig. 14 is a modification of the control circuits of Fig. 13.

This invention in its broadest and most simple form is illustrated generally by Figs. 1, 2, 3, 10, 11 and 12. In Fig. 1 there is shown a suitable source of E. M. F. illustrated diagrammatically as a pair of collector rings; however, in actual practice this E. M. F. source may be any source of power, such as a transformer winding or the output circuit of a radio receiving apparatus, or interphone communicating system. The two controlled load devices shown symbolically in the illustrated embodiments as headsets HS*l* and HS*a*, are each connected to this source of E. M. F. E*l* through a variable series resistor R2 and R*b*, respectively. A second resistor R3 and R*c* is connected in shunt across each headset load HS*l* and HS*a*. These resistors R3, R*c*, R2 and R*b* are all variable resistance elements and may be of the type known to the trade as a "taper potentiometer." In determining the value of resistance R3 or R*c* the designer must take into consideration the characteristics of their particular headset or other load. For example, if the impedance ratio R3 to HS*l* or R*c* to HS*a* is too high, the control characteristics will not be smooth, since the impedance of the network will then vary greatly with different settings of the controls; while if the ratio is too low, an excessive amount of incoming power is wasted in heating the shunt resistance elements R3 and R*c*. The proper impedance ratio is determined between these two extremes to give a fairly constant impedance with small power loss.

The adjustable contact arm to the resistance element R2 is connected to the point *m*, the junction point of the connections to R*l*, HS*l*, and R3. Likewise the adjustable contact arm of the resistance element R*b* is connected to point *n*, which is also the junction point of the connectors for R*b*, R*c* and HS*a*. It is apparent from Fig. 1 that in one extreme position of the contact arm of either resistance element R2 or R, the respective resistance is short circuited.

If resistors R*l* and R*a* were not employed, the contact arms of the variable resistance elements R3 and R*c* would be connected directly to the output terminal of the source of E. M. F. E*l*, so that in one extreme position either of these contact arms would form a direct short across the source E*l*. In order to prevent such a direct short circuit, since it is an object of the invention to obtain a substantially constant impedance network, the padding resistors R*l* and R*a* are connected between the source of supply E*l* and the contact arms of the various resistance elements R3 and R*c*, respectively.

When the contact arms of R2 and R3 are in an extreme position where R2 is entirely shorted out, and where the arm of R3 contacts point *m*, in this position, R*l* will also be shorted out by the contact arm of R2. This constitutes the position of maximum power from E*l* to the headset load HS*l* since a circuit is completed from E*l* to the contact arm of R2, to the parallel circuit consisting of the load HS*l* and the resistance R3. The impedance of such a combination can readily be determined by means of computations known to the art. When the contact arms of R2 and R3 are in the opposite extreme position where the contact arm of R2 contacts point *m* and the contact arm of R3 contacts the resistor R3 at the end opposite the point *m*, in this extreme position, which is the position of minimum power from E*l* to the headset HS*l*, all of the resistance R2 is connected in series with the parallel circuit consisting of the load HS*l* and its shunt resistance R3, while R*l* is connected directly across this series parallel network. The impedance of the network consisting of HS*l*, R*l*, R2 and R3 can be determined by considering the group consisting of HS*l* and R3 in parallel, and this group in series with R2, then with R*l* in parallel with the aforesaid series parallel com-

bination. The impedance of such a combination may be determined by means of computations known to the art. With any intermediate setting the power available to HS1 may be varied between extremes and the impedance of the group may be calculated by applying Kirchhof's laws.

The values of the R1, R2 and R3 may be chosen by means of computation as outlined above, so that the desired conditions of maximum, minimum, or intermediate values of power to HS1 may be obtained without producing excessive change in the impedance presented to E1 due to changing the contacts. Thus it is possible with the value of these resistance elements properly computed to obtain a variation of power to HS1 by changing the controls to R2 and R3 without producing any appreciable effect upon the power available and delivered to HS*a*.

In like respect the resistance elements R*b* and R*c* may be similarly adjusted without producing any appreciable effect upon the power available and delivered to HS1.

It should be understood that R*a* corresponds in function to R1, R*b*, to R2, and R*c* to R3, and what has been set out above concerning R1, R2 and R3 applies also to R*a*, R*b* and R*c*.

The impedance network of Fig. 1, as well as the impedance network of the other embodiments of the invention herein presented, do not necessarily present an absolutely constant impedance network to E1. In fact, it has been found from actual practice that the change in the volume control in headset HS1, for example, from a maximum to minimum may produce a variation in the impedance of the combination HS1, R1, R2 and R3 of 3 to 1 without producing any effect upon headset HS*a*, which would be appreciable to ordinary hearing.

The contact arms to R2 and R3 are in the preferred embodiment of the invention mechanically coupled together so as to be moved in unison, or, in the parlance of the art, they are referred to as being "ganged"; similarly, the contact arms to R*b* and R*c* may also be "ganged."

It is thus apparent that in the network shown in Fig. 1, the values of the resistance elements may be properly selected so that the input to one headset may be adjusted within wide limits without changing the input into the other headset by an amount which would be appreciably noticeable to the average hearing.

The circuit arrangements shown in Fig. 1 may take the form shown also in Figs. 2, 3, 10, 11 and 12, wherein minor variations have been incorporated in each circuit, which consists specifically in details in the connections to the resistance elements comprising the control circuit of each headset load. For example, Fig. 2 is nearly identical with Fig. 1, except that the resistance elements R2 and R*b* are not directly connected to the points *m* and *n*.

In Fig. 3, the control arms for resistance elements R2 and R3 (R*b* and R*c*) do not move in the same direction as they may in the aforementioned embodiment, since in this figure the contact arms for resistances R2 and R*b* are connected to their respective resistances at the end opposite the points *m* and *n*. Thus, in order to short out the resistances R2 and R*b* the respective contact arms of each are moved downwardly to the limit of their movement to point *m* or *n*, while in order to short out resistance element R1 or R*a* the contact arms for resistance elements R3 and R*c*, respectively, must be moved upwardly to the limit of their movement to points *m* and *n* at the same time the other contact arms are at these points. Thus, a different type of coupler must be used to "gang" these resistances than would be provided for the resistance elements in the above embodiments.

In the modification illustrated by Fig. 10, the headset HS1 and the contact arm to resistance R2 are connected directly together without contacting the point *m*. Similarly, HS*a* and the contact arm to R*b* are connected directly together without contacting the point *n*. This circuit presents a somewhat different impedance network from that shown in Fig. 1. For example, when the contact arms are adjusted to the position of maximum power delivery to the headset HS1 the resistance elements R1, R2 and R3 form a series parallel circuit in shunt across the headset load HS1, with R1 and R2 in parallel, and in series with R3. The computations of the impedance network illustrated by the modification may be computed by means set out above.

Fig. 12 differs from Fig. 10 only in that R3 and R2 are not connected together at the point *m*, and similarly R*c* and R*b* are electrically separated at point *n*. The impedance offered by this network for a setting with the maximum power delivered to HS1 may be computed by considering the parallel circuit formed by HS1 in one branch, and R1 and R3 in series in the other branch, with R2 shunted out. In the position for minimum power delivery to HS1, R2 is in series with HS1 and R1 is in shunt with this series circuit.

Fig. 11 presents an arrangement of the various resistance elements wherein the contact arms of R1 and R3, as well as the contact arms of R*a* and R*c* may be tied together electrically as well as mechanically. In the position for maximum power delivery R1 and R2 or R*a* and R*b* are short circuited by the contact arms of resistance elements R1 and R3 or R*a* and R*c*. In any intermediate position a portion of each resistance element R1 and R3 is connected in series and forms with R2 a parallel circuit, the combination being connected in series with HS1. A closed shunt circuit may also be traced from the source E1 through the portion of resistance R1 and through a portion of the resistance R3 not connected in the aforementioned mesh circuit. It is to be noted also that in this arrangement R1 and R3 are variable while series resistor R2 is fixed, distinguishing thereby from Fig. 1.

Fig. 4 presents a modification of the embodiment illustrated in Fig. 1, and differs therefrom in that an additional headset load HSA and its control is provided. This circuit is merely illustrative of the manner in which the circuit diagrams of Figs. 1, 2, 3, 10, 11 and 12 may be expanded to accommodate more than two headset loads. The control for the additional headset load comprises the resistance elements RA, RB and RC, each of which is connected in exactly the same manner as are resistance elements R*a*, R*b* and R*c* of Fig. 1, and each serve the same function. The impedance of each of these elements is also selected so that, as the input to HSA is varied only a minor effect will be produced upon the power delivered to the other loads, which effect is not perceptible to ordinary hearing.

Fig. 5 presents a somewhat different embodiment of the invention, the circuit connections shown herein being similar to those shown in Fig. 1, except that a second source of E. M. F.

E2 is provided, one side of which is connected directly to E1, the other side being connected to each of the headset loads HS1 and HS*a* through the series resistance elements R4 and R*d*, respectively. The two sources of E. M. F. are again illustrated diagrammatically as collector rings, but in one practical application to which this circuit arrangement is particularly adapted, E1 is the output circuit of a radio receiver, and E2 the output of an interphone communicating system.

Since in this modification an additional source of power is provided, it is necessary in order to prevent the adjustment of the attenuation to one load from affecting the power level in the other load to provide isolating resistors in the circuit connecting this source to the load devices. In Fig. 5 (for illustrative purposes only) the contact arms of R2 and R3 are adjusted for maximum power delivery to HS1 while the contact arms of R*b* and R*c* are adjusted for minimum power delivery to HS*a*. In this position of adjustment the voltage drop from E1 to *m* is obviously different than the voltage drop from E1 to *n*, since in the attenuation network for HS1, R1 and R2 are shorted out and the potential of *m* is substantially that of E1; therefore points *m* and *n* are at substantially different potentials.

The conductors connecting E2 to each of the load devices would obviously form a low impedance path for circulating current between points *m* and *n*. With the attenuation to HS*a* high the path for this circulating current would also include HS*a* and any further adjustment of the attenuation to HS1 would change the potential between points *m* and *n*, thereby changing the value of the circulating current and affecting the power level in HS*a*. In order to reduce the value of the circulating current in the closed circuit formed between the points *m* and *n* by the conductors connecting E2 to the respective headset loads, the isolating resistors R4 and R*d* are inserted in series in this closed path, as is apparent from Fig. 5. Were it not for these isolating resistors power from E1 could pass by means of the shunt path around the resistor R2 through the conductors connecting E2 to headsets HS1 and HS*a* onto the headset HS*a*, thereby forming a shunt path around the attenuating network formed by the resistance elements R*a*, R*b* and R*c*, and the power level in HS*a* would be affected by the change in the setting of the attenuation in the circuit to HS1. The circuit formed by R4 and R*d* with E2 comprises a rejection circuit which prevents the power of E1 from reaching HS*a* and R4, R*d* introduce attenuation between points *n* and HS1.

In an actual application wherein E1 is a radio receiver output and E2 is the output of an interphone communicating circuit, the value of the resistance elements are selected so that upon decreasing the level of the radio signal to HS*a* to a minimum, by means of the adjustable contact arms of resistance elements R*b* and R*c*, a greater response from the output of the interphone communicating circuit will be produced in the headset HS*a*. Conversely, increasing the radio receiver response in HS1 by the contact arms to R2 and R3 results in a reduced response in the headset HS1 from the output of the interphone communicating circuit. It should also be apparent that this circuit incorporates the same features of Fig. 1, namely, the adjustment of the output level of either headset will produce no noticeable effect upon the output level to the other headset from E1. In general, it may be stated that an adjustment of the controls which results in a decrease in the radio response to a particular headset, results also in an increase in the interphone response in that headset but produces no perceptible change in the other headsets connected to the radio, and conversely an increase in the radio response in a headset results in a decreased interphone response in that headset, but produces no detectable change to ordinary hearing in other headsets connected to the radio output.

Assuming that the contact arms to R*c* and R*b* are fixed, and that the sliding contacts to R2 and R3 are placed in position so as to result in minimum power delivered to HS1 from E1, in which position R1 is connected to R3 at the end opposite point *m* and all of R2 is inserted between point *m* and E1, the impedance offered E2 by the left-hand portion (Fig. 5) of the circuit consists of the following series parallel arrangement of resistance elements, namely, R4 in series with a parallel circuit comprising the following paths, R2 in series with the parallel circuit comprising E1 and R1, R3 and the headset HS1. It is to be noted that R2 then serves in a measure to isolate E2 from E1 and presents a high impedance circuit to the power source E2 across the terminals of the headset HS1. In this control position the maximum power is delivered from E2 to HS1.

When the sliding arms to R2 and R3 are placed so as to cause E1 to deliver maximum power to HS1, then the power from E2 to HS1 is less, because in this position R1 and R2 are short circuited and the added load presented by E1, R*a*, R*c*, R*b* and HS*a* forms a low impedance shunt path across the headset HS1 when the controls to HS*a* are set for minimum power. The impedance presented to E2 by the lefthand portion of the circuit may be calculated by considering the following series parallel circuit, R4 in series with a parallel circuit comprising the following paths, E1, R3 and HS1, or R*a* when the control to HS*a* is not set for minimum attenuation to E1.

Thus it is evident that adjusting the contact arm to R2 and R3 to give maximum signal level in HS1 from E1 is accompanied by a minimum signal level in HS1 from E2; and, conversely, adjusting the contact arms to R2 and R3 to give a maximum signal level in HS1 from E1 is accompanied by a maximum signal level in HS1 from E2.

The amount of change of interphone response accompanying a change in radio level adjustment, as above described, is dependent upon the relative values of R4 and R*d* to the impedance of E1 since the best regulating characteristics are available when the ratio of external to internal impedance is high; therefore, if R4 and R*d* are of a high value the range of change is greater than for lower values of R4 and R*d*. If these values are too low the rejection characteristics of the R4, R*d* and E2 combination are lessened, and E1 is loaded more heavily thereby. In general, rejection characteristics are improved by lowering the impedance of E2 and increasing R4 and R*d*.

Changing the receiver output E1 by other means such as in the receiver itself without changing the individual volume control has practically no effect upon the interphone response in either headset; however, if the radio receiver output is low such as occasioned by a weak in-

coming signal which necessitates setting the individual volume control so that the attenuation between the receiver output and the controlled headset is a minimum, the interphone level to that headset is not as high as when a much greater receiver output is available, which would permit an intermediate setting of the controls. In the latter event attenuation is introduced between the radio receiver output and the controlled headset in order to reduce the radio signal to a more comfortable level and this is automatically accompanied by an increase in interphone output to that headset.

It should be apparent that the additional source of E. M. F. E2 and the resistance elements R4 and R*d* may also be added to the modifications, as illustrated by Figs. 2, 3, 10, 11 or 12, just as well as to Fig. 1.

Fig. 6 presents a variation of the embodiment illustrated in Fig. 5, where separate E. M. F. sources E1 and E3 are provided for each headset HS1 and HS*a* in place of the single source E1 shown in Fig. 5. The modification herein illustrated has a specific application in aircraft, for example, where the persons wearing headsets may listen to two separate incoming radio signals (E1 and E3) individually adjusted to any level between maximum and minimum and yet both can listen to a common interphone signal, the level of which is relatively independent of the settings of the volume controls which adjust the individual radio signal levels for the separate headsets. However, the circuit may be designed so that as the level of the radio signal to one headset is decreased by its individual control, the level of the interphone to that headset is increased slightly, and conversely, as the radio output is decreased to one headset, the interphone level in that headset is increased, as was explained in connection with Fig. 5. This feature may be of advantage when a weak radio signal is being received because only then would it be necessary to adjust the individual volume level for minimum attenuation of the radio signal, and under those conditions a relatively weaker interphone level is desirable; and conversely, if the volume level is set near maximum attenuation of the radio signal to that headset, the radio receiver output is either very great or not desired at all in that headset, and a greater interphone level is useful.

The proper functioning of the device depends to a certain extent upon proper setting of the receiver output control or receiver sensitivity control, or both, by means not included in the portion of the circuit shown.

The modification illustrated by Fig. 7 includes in addition to the circuit arrangement shown in Fig. 6, an additional headset load HSA and its control circuit which includes the resistance elements RA, RB and RC. This figure is illustrative of how Fig. 6 may be expanded to accommodate additional loads somewhat in the same manner in which Fig. 1 was expanded into Fig. 4. In addition to the control resistors RA, RB and RC, the isolating resistor RD is also provided. This resistor RD serves a function similar to resistors R4 and R*d*, in that it serves to reduce the voltage from E2 to HSA and presents, with R4, a high impedance path between the points *o* and *m*, and thus serves as a rejection circuit. Fig. 7 also differs from Fig. 6 in that a capacitor C1 is connected across the power supply E2. This capacitor is inserted in this circuit to improve its rejection characteristics. As explained above, E2 may be the secondary winding of a transformer having a relatively high impedance to high frequency currents. This is undesirable since, as was pointed out above, the impedance ratio of R4 to E2 should be high in order to give the best rejection. The effect of C1 is to offset the high impedance offered by E2 since the impedance of C1 decreases as the frequency increases. In some applications C1 is replaced by a band pass filter.

The circuit shown by Fig. 7 may be modified to include a separate source of power supply for the headset load HSA; such a modification is illustrated by Fig. 8.

As noted above, this invention was designed primarily for use in aircraft installations where both radio and interphone communications are provided, although it is not particularly restricted to such a narrow field. In such an application, however, a number of headsets are usually provided having a common interphone output, with a variable number of radio receivers, and in such an installation it is important that the number of headsets for each radio receiver be changed as conditions require, without changing the interphone level to any of the other headsets. Furthermore, it is also an important feature of this invention to have adjustments of the attenuation in the output of the radio receiver produce certain desirable changes in the interphone signal level in the common headset load, the said changes being dependent upon the particular installation, that is, in some installations one load station, HS1, for example, may be primarily interested in receiving the radio signal; the interphone signal being only of secondary importance. The operator at the other load station, HS*a* for example, may be more interested in receiving the interphone rather than the radio signal; consequently the variable attenuator must be constructed so that the attenuation to one source will be increased while the attenuation to the other source will be decreased. For example, the audio attenuation to HS1 for radio is reduced so that a weak incoming radio signal may be heard, however, the signal level from the interphone output must be reduced at the same time so that it wont interfere with the reception of the weak radio signal. Under certain other conditions it may be desirable to have the interphone level remain fixed while the attenuation to the radio signal is being adjusted or changed. In certain other installations it is desirable to have the level of the radio signal and interphone signal increase or decrease together by means of a single control. Thus, the signal level in both radio and interphone may be increased or decreased as the noise level at the particular load station changes. The above features may be attained by means of circuit arrangements of Figs. 9 to 9D, inclusive.

Fig. 9 is similar to Fig. 5, except that additional resistance elements R5 and R*e* are provided in the rejection circuit in series with R4 or R*d*, respectively. As in the other modifications, the primary object of R2 and R3 is to permit the adjustment of current to HS1 from E1 without producing any noticeable effect upon the level in HS*a* or other headsets; the primary function of R5 is to provide an adjustment of the impedance in the circuit from E2 to HS1 and also to limit the circulating current from E1 which may reach HS*a* through the resistance elements R4, R*d* and R*e*.

The contact arms of the resistance elements R2, R3 and R5, as well as the resistance elements

Rb, Rc and Re, may be ganged so that when the contact arms for R2 and R3 are set in a position for maximum power delivery to HS1, in which position the resistance elements R2 and R1 are short circuited, the contact arm to the resistance element R5 will also be moved to a position wherein all or substantially all of the resistance remains in series with the headset load HS1 and with R4. This is the position of minimum power delivery from E2 to HS1. It is apparent, therefore, that the resistance elements R5 and Re tend to accentuate the inherent characteristics of the circuit arrangements of Fig. 5, namely, an increase in the output level to a headset from one source, produces a decrease in the output level to that same headset from the other source, and vice versa.

The arrangement shown in Fig. 9A is the same as far as circuit connections are concerned, as the arrangement in Fig. 9, except that the contact arms R2 and R5 are connected together electrically as well as mechanically. The resistance elements R5, R4, Rd and Re, as well as the source of E. M. F. E2, serve as a rejection circuit in the same manner as previously discussed in connection with Fig. 5. With the control to HS1 set for minimum attenuation, and with the control to HSa set for maximum attenuation, the potential differential between points m and n is a maximum. In this position, however, the resistance element R5 is in series with R4 and Rd. The series resistors R5 and R4 reduce the voltage from the source E1 that may appear across E2, and since this source E2 may have a low impedance as compared to the impedance of Rd (and Re) the voltage is still further reduced to HSa. Consequently, with this circuit arrangement the output level from E1 to HS1 may be adjusted to a high value, while the output level from E1 to HSa may at the same time be adjusted to a low value. When the control to HS1 is set for maximum power level from E1, as illustrated, R4 and R5 are in series with HS1 and the voltage from E2 across HS1 is reduced to a minimum; furthermore, R2 is short circuited so that E1 and the control circuit for HSa presents with HSa a substantially constant impedance shunt path across the headset load HS1 for the power delivered from E2. Since R5 is in series with E2 and HS1 the rejection characteristics of E2 are improved because the ratio of R4 and R5 to E2 is increased and the value of the current reaching the shunt path formed by E2 is reduced.

In the position for minimum power delivery from E1 to HSa, Rb is connected to E1 in series with a parallel circuit comprising HSa and Rc. The resistance element Ra is connected directly across E1 in parallel with the above mentioned series parallel connection. The impedance offered to E1 by this circuit is substantially constant but the attenuation to HSa from E1 is maximum. In this control position the contact arm for Re is moved to a position wherein the resistance is entirely short circuited so that the attenuation offered to E2 is a minimum, and the resistance of the control circuit for HSa is high, so that the maximum power delivered by E2 to this portion of the circuit is absorbed in the load device HSa.

It is therefore apparent that the natural inverse effect considered in connection with Fig. 5 is accentuated by the addition of R5 and Re. That is, if the level in HS1 from E1, for example, is increased, the level in HS1 from E2 is decreased further by the addition of R5 together with its control.

The circuit arrangement shown in Fig. 9B appears to be similar to the arrangement shown in Fig. 9A. However, it should be noted that the junction point of R2 and R5, as well as Rb and Re, is not connected to the contact segment of the contact arms for R5, R2 or Rb and Re, respectively. For any intermediate setting, therefore, the radio signal E1 may take a path through all of R2, or through only a portion of R2 in series with a portion of the resistance element R5, or also through R1 and a portion of R3 to m, and similarly the interphone signal E2 may take a path through all of R5 or through only a portion of R5 and a portion of R2, or through the other part of R2, the part of R3 leading to the point m to the headset, or in shunt across the headset through the other portion of R3.

As was pointed out in connection with Fig. 9, the control resistance elements R2, R3 and R5, as well as control resistance elements Rb, Rc and Re, may be adjusted individually. In one extreme position of adjustment R1, R2 and R5 may all be short circuited. This would constitute a position of maximum power in HS1 from E2; while in the other extreme position of the controls HS1 receives minimum power from both E1 and E2. Fig. 9C presents a circuit arrangement wherein the contact arms of these resistance elements may be "ganged" to produce a similar effect. That is, resistance elements R5 and Re in this modification compensate for the inherent inverse effect naturally present in the circuit, rather than to accentuate this effect, as was the case in the embodiment presented by Figs. 9 to 9B, inclusive. The values of the impedance elements may also be selected so that the level from the source E2 will remain substantially constant (or increase and decrease slightly) with an increase or decrease in the level from the source E1.

As illustrated in Fig. 9C, the control arms for the variable attenuator to HS1 are positioned so that R2 and R1 are shorted out by the control arm of R2, and HS1 and R3 form a parallel circuit connected across the source E1. This is the position of minimum attenuation and maximum power delivered from E1 to HS1. The control arm to the resistance element R5 is also moved to a position wherein the resistance of R5 is also shorted, thereby reducing the attenuation introduced in the circuit from E2 to HS1. The reduction of the attenuation introduced in this circuit compensates for the increase in shunt load presented by E1 and Ra, which form a low impedance path across the headset HS1 if the attenuating control to HSa is set for minimum power in HSa from E1. HSa and its control circuit also present an additional load. These loads are in effect isolated from E2 through R4 when the attenuation to HS1 from E1 is maximum, since for this position R2 is connected in series therewith. The effect of the resistance R5 is to compensate for the inherent inverse effect referred to above; that is, as the attenuation from E1 to HS1 is increased the attenuation from E2 to HS1 is also increased; therefore, the signal in HS1 from E2 may remain at a constant level or increase and decrease slightly with an increase and decrease in the signal level in HS1 from E1 by means of the audio attenuator.

Fig. 9D differs from Fig. 9C in that R5 and R3 are not directly electrically connected to HS1 and HSa except through their contact arms. In this circuit power from E2 in order to reach HS1 may go through R2 and R1, as well as R5, except in the extreme position of the contact arms.

This modification is similar to the arrangement shown in Fig. 9B, except that in this arrangement by proper choice of resistor values, the level to HS1 from E1 may be adjusted between extremes without producing any effect in the level in HS1 from E2, and similarly for HSa.

Fig. 11A differs from Fig. 11, as described above, by the addition of another source of power, E2, fixed resistors R4 and Rd, and variable resistors R5 and Re. The contact arm to R5 has a mechanical but not an electrical connection with the contact arms to R1 and R3. The contact arm to Re has a similar mechanical connection to the contact arms Ra and Re. These mechanical connections are shown in dotted lines. The contact arms to R1 and R3 are tied together electrically as well as mechanically; similarly, the contact arms to Ra and Rc are tied together electrically as well as mechanically. When the contact arms to R1, R3 and R5 are adjusted so that maximum power is delivered from E1 to HS1, then minimum power is delivered from E2 to HS1; and, conversely, if these contact arms are adjusted so that minimum power is delivered from E1 to HS1, then maximum power is delivered from E2 to HS1, other conditions remaining fixed. A movement of the contact arms of R1, R3 and R5 in one direction increases the power in HS1 from E1, and decreases the power in HS1 from E2, or vice versa. By changing the position of the contact arms to R1, R3 and R5 the power from E1 to HS1 and from E2 to HS1 is changed, yet the impedance of the load on E1 due to R1, R2, R3 and HS1 may be relatively constant if the values are properly chosen. Resistors Ra, Rb, Rc, Rd, and Re perform the same functions with respect to HSa as the corresponding resistors R1, R2, R3, R4 and R5 perform with respect to HS1.

Fig. 11B differs from Fig. 11A in that R5 and Re are connected in a different manner, such that moving the contact arms to R1, R3 and R5, for example, so as to increase the power delivered to HS1 from E1, also results in an increase in power delivered to HS1 from E2; and, conversely, a movement of the contact arms to R1, R3 and R5, which decreases the power delivered to HS1 from E1, results also in a decrease in the power delivered to HS1 from E2, provided the various values of the resistance elements have been properly chosen, and other conditions remain fixed. In an extreme case, if R5 had practically no resistance, moving the contact arms of R1, R3 and R5 to increase the power from E1 into HS1 would result in a decrease in power available from E2 to HS1, because the effective resistance between E1 and E2 would be lowered and E1 would absorb more power from E2 at the expense of HS1 than when there is a greater value of resistance between E1 and E2. If the contact arms to R1 and R3 were adjusted so as to practically short circuit R2, then HS1 and E1 are practically in parallel and E1 absorbs a maximum of power from E2. Conversely, if the contact arms to R1, R3 and R5 are adjusted for minimum power delivered to HS1 from E1, wherein R2 is in series with HS1, and R1 and R3 each form a shunt path connected in parallel therewith. In this control position E2 would not only have the resistance of R4 between it and E1 but would also have all the resistance of R2, so the power of E2 absorbed in E1 would be less, or E2 would be loaded comparatively lightly. If the value of R5 is properly chosen, the amount of power from E2 into HS1 will remain relatively constant regardless of the power into HS1 from E1, i. e., regardless of the position of the controls to R1, R3 and R5. In other words, R5 acts as a compensating resistor whose contact arm is moved in unison with the contact arms to R1 and R3, the active portion of R5 having just the right value of resistance to compensate for the variable load presented to E2 due to changing power from E1 to HS1. When the load on E2 is the heaviest, the combined resistance of the active portion of R5 and R4 is minimum, thereby maintaining a relatively constant voltage from E2 across HS1, regardless of the voltage from E1 across HS1, or the power into HS1 from E1.

In Fig. 13 there is shown a circuit in which headset HSa is connected to the output of receiver #2 through the control consisting of three resistors Ra, Rb and Rc. The headset HSa also receives power from the output of receiver #1 through the control consisting of resistors R1, R2 and R3. The headset HS1 also receives power from the output of receiver #1 through the control consisting of resistors Rx, Ry and Rz. In aircraft it is often desired to listen to or to monitor two radio receivers simultaneously in one headset, while in a second headset it may be desirable to listen to only one of these two receivers without undue interference from the second receiver. In Fig. 13 the signal from receiver #1 is desired in both headsets HS1 and HSa, while the signal from receiver #2 is desired only in headset HSa. In Fig. 13 the signal level from receiver #2 is less in HS1 than in HSa unless the controls are adjusted for maximum signal, i. e., for minimum attenuation. Frequently the signal available from one receiver is such that it is possible to obtain sufficient volume level where desired, with one control adjusted for more than minimum attenuation. If one control is set for more than minimum attenuation, then the signal strength from receiver #2 is less in HS1, where it is not desired, than in HSa where it is desired. If, however, two or more controls are set for more than minimum attenuation, each one introduces attenuation of the unwanted signal from receiver #2 to the headset HS1. For example, Rb and Rc in combination may be set to attenuate the signal from receiver #2 to HSa, and R2 and R3 may be set to attenuate the signal from receiver #1 to HSa, also Ry and Rz may be set to attenuate the signal from receiver #1 to HS1. In such an arrangement the unwanted signal in HS1, namely, from receiver #2, is attenuated by three sets of controls, whereas the wanted signal is attenuated by only one set, and thus the attenuation of the unwanted signal to HS1 has been attenuated due to each control. The unwanted signal may be attenuated very little to HS1 if the three controls are set for very little attenuation due to weak signals from both receivers, or it may be attenuated very much to HS1 if the three controls are set for considerable attenuation due to strong signals from both receivers. If the output of receiver #1 is high, necessitating the setting of controls between it and the headsets so as to introduce some attenuation, then the unwanted signal from receiver #2 to HS1 is attenuated by both of these controls, and the desired signal is attenuated by only one control. While this variable attenuation of the unwanted signal is not always desirable it is less objectionable than if the receiver outputs were both placed directly in parallel, in which case the attenuation of the unwanted signal to a headset is always the same as

the attenuation of the desired signal. Furthermore, tying the two receiver outputs in parallel causes each one to load down the other at the expense of the audio power available to the headsets. By means of this device the receiver outputs may be separated by means of the controls, one or more of which may be set for more than minimum attenuation, thereby preventing the receiver outputs from being directly in parallel. In Fig. 13 the receiver outputs are directly in parallel only when the two volume controls connected between the receiver outputs are set for minimum attenuation.

As previously indicated, audio attenuating networks which present an absolute constant impedance regardless of their control position are known to the art, also more accurate means for eliminating or reducing the unwanted signal are also known, but these means, as known, cannot be adapted to aircraft communication systems because of their weight and the space required. It is apparent that my invention involves a compromise between attenuators of a constant impedance, requiring additional elements and complicated circuit connections, with the necessity of added weight and additional space, and substantially constant attenuating means involving less weight and space. The means that I have devised has proven, however, to be entirely satisfactory, since in aircraft communication the noise level is high and slight changes in level are not noticeable.

The modification shown in Fig. 14 is similar in functioning to Fig. 13, although differing therefrom in control details. The controls herein employed are similar to the circuit described above and illustrated by Fig. 11.

Other modifications and changes in the number and arrangement of the parts may be made by those skilled in the art, without departing from the nature of the invention, within the scope of what is hereinafter claimed.

The invention described herein may be manufactured and/or used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

I claim:

1. In the output circuit of an aircraft radio receiving apparatus or the like, the combination which includes, a pair of output terminals, a plurality of sound reproducing devices connected thereto, means for varying the volume of at least one sound reproducing device from a maximum to a minimum without causing a variation in the impedance across said output terminals of an amount greater than the ratio of one to three, said means comprising fixed and variable impedance elements, one of said variable impedance elements being connected in series with the sound reproducing device, a second variable impedance element forming a shunt path across the said output terminals and a fixed impedance being connected in series with said variable shunt impedance so that in one extreme position the fixed resistor element will alone form a shunt path across said terminals.

2. In a system of the character described including a sound reproducing device connected across the output circuit of radio receiving apparatus, means for varying the volume of said reproducing device from a maximum to a minimum without varying the impedance across the output circuit an amount greater than the ratio of one to three, said means comprising a plurality of impedance elements, one of said impedance elements being variable and connected in shunt with said reproducing device, the other impedance elements comprising a mesh circuit including a fixed and variable impedance element, said mesh circuit being connected in series with the said reproducing device, and means for shorting out the impedance offered by said mesh circuit for one extreme position of volume control, said last named means comprising the adjustable contact arms for the variable impedance elements.

3. In combination, a plurality of sound reproducing devices each having an output circuit, a variable attenuator in each of said circuits, said attenuator having a single movable element, each of said attenuators comprising an impedance network, including a variable impedance in series with the reproducing device, and a variable impedance in shunt across said output circuit, said single movable element comprising adjustable contact arms for each variable impedance, and means comprising a fixed impedance connected in said network whereby the impedance of said network and reproducing device will remain substantially constant for all control positions.

4. In a communication system for aircraft having an output circuit of a radio receiving apparatus and an output circuit of an interphone communication system, a plurality of isolating resistance elements, a plurality of sound reproducing devices each connected in parallel to the output of said interphone communication system, each reproducing device having in series therewith one of said isolating resistors, a variable attenuator for at least one sound reproducing device connected in the output circuit of said radio receiving apparatus to said reproducing device, said attenuator comprising an impedance network having fixed and variable impedance elements, and means comprising the contact arms of each variable impedance element for changing the level in said sound reproducing device from a maximum to a minimum without producing a change in the combined impedance at the output terminals an amount greater than the ratio of 1 to 3.

5. In a communication system comprising a plurality of audio frequency supply means, a plurality of sound reproducing devices connected in parallel with each of said audio frequency supply means so that each reproducing device has superimposed thereon signals from at least two supply means, an audio attenuator for each reproducing device connected in the output circuit of one of said supply means, an isolating resistor connected in the output circuit of said other supply means, said attenuator comprising an impedance network having variable impedance elements connected therein, and means comprising the adjustable contact arms of said variable impedance elements whereby the impedance of said elements may be adjusted so that the current from said one supply means can be changed from a maximum to a minimum and at the same time produce only a slight inverse effect in the level of said reproducing device from said other supply means.

6. In combination, a plurality of sound reproducing devices, an audio frequency supply means for each sound reproducing device, an audio attenuator connected in the output circuit of the audio frequency supply means for at least one of said sound reproducing devices, a common audio frequency supply means, conductors connecting

each of said reproducing devices to said common supply means and in parallel therewith, an isolating resistor in each of said conductors, said attenuator comprising an impedance network having fixed and variable impedance elements, and means comprising the contact arms of said variable impedance elements whereby the output level from one supply means to said reproducing device can be changed from a maximum to a minimum and at the same time produce only a slightly noticeable inverse effect in the level of said reproducing device from said other supply means.

7. In a communication system for aircraft having an output circuit of a radio receiving apparatus and an output circuit of an interphone communication system, the combination including plural sound reproducing devices connected in parallel with the output circuit of the radio receiving apparatus, a variable audio attenuator connected in the output circuit to each reproducing device whereby the reproducing devices may operate at substantially different levels, conductors connecting each sound reproducing device in parallel with the output of said interphone communication system, and means comprising isolating resistors in the interphone communication system output circuit whereby a high attenuation is offered to a radio signal reaching either reproducing device through a circuit including these conductors although the audio attenuators are set at different levels.

8. In a communication system comprising a plurality of audio frequency supply means, a plurality of sound reproducing devices connected to each of said audio frequency supply means, a variable audio attenuator connected in the output circuit to each reproducing device whereby the reproducing devices may operate at substantially different levels, a common audio frequency supply means, conductors connecting each reproducing device in parallel thereto, a plurality of isolating resistors connected in the output circuit of said common audio frequency supply means and in series with each reproducing device, and means forming a low impedance shunt path to high frequency currents across said common supply means, said last named means and the isolating resistors forming a voltage divider thereby preventing a signal from one independent supply means from reaching a reproducing device connected to another supply means by way of said conductors.

9. In a communication system having a plurality of radio receivers and an interphone communication system, the combination including an output circuit for each radio receiving apparatus, and an output circuit for the interphone communication system, a plurality of sound reproducing devices each connected to an output circuit of a radio receiving apparatus, a variable audio attenuator connected in the output circuit to each reproducing device whereby the reproducing devices may operate at substantially different levels, conductors connecting each sound reproducing device in parallel with the output of said interphone communication system, and means comprising a plurality of isolating resistors connected in the output circuit of said interphone communication system and in series with each sound reproducing device whereby a high attenuation is offered to a radio signal from the output of one receiver reaching a reproducing device connected to a different radio receiver output through a circuit including these conductors.

10. In a communication system having a plurality of sound reproducing devices, an independent audio frequency supply means for each sound reproducing device and a common audio frequency supply means for all of said sound reproducing devices, a variable audio attenuator in the output circuit of the independent audio frequency supply means for each sound reproducing device, said audio attenuator comprising an impedance network having fixed and variable impedance elements which together with the reproducing device offer a substantially constant impedance to each independent audio frequency supply, so that the signal level in each sound reproducing device from the common audio frequency supply source will not be lost as a result of the adjustment of said variable audio attenuator.

11. In a communication system for aircraft having an output circuit of a radio receiving apparatus and an output circuit of an interphone communication system, a sound reproducing device connected across both of said output circuits, means for controlling the attenuation in the output circuit of said radio receiving apparatus, means for controlling the attenuation in the output circuit of said interphone communication system, and means for mechanically coupling the above control means together so that as the attenuation in one circuit is changed the attenuation in the other circuit is also simultaneously changed, whereby the signal level in the sound reproducing device from the output circuit of said interphone communication system is affected primarily by the adjustment of its attenuation control means in its output circuit and secondarily by the adjustment of the attenuation means in the output circuit of said radio receiving apparatus which changes the impedance of the shunt path formed by the attenuation means and said radio receiver output circuit.

12. In a communicating system having two sources of audio frequency supply, a plurality of sound reproducing devices connected in parallel to the output circuit of both of said audio frequency supply sources, a variable audio attenuator connected in the output circuit of one source of supply to at least one reproducing device, said attenuator comprising an impedance network of variable and fixed impedance elements which in combination with the reproducing device offer a substantially constant impedance load to said source of power supply so that the adjustment of the attenuation to one reproducing device will have no noticeable effect in the signal from the same source upon the other reproducing device, and means for maintaining the signal in said reproducing device from said second source constant regardless of the adjustment of the variable attenuator.

13. The invention as defined in claim 12, wherein said last-named means comprises a variable attenuating resistor connected in the output circuit of said second audio frequency supply means.

14. In a communication system having two sources of audio frequency supply, a plurality of sound reproducing devices, a plurality of variable audio attenuators comprising an impedance network having fixed and variable impedance elements, means connecting a variable attenuator in the output circuit of one of said supply means to each reproducing device, a plurality of

isolating resistors connected in the output circuit of said other source of supply and in series with each reproducing device, and means whereby the signal level in said reproducing device from said other source may be adjusted so that its level will not be decreased with an increase in the signal level in the same reproducing device from the first-named source.

15. The invention as defined in claim 14, wherein said last-named means comprises an adjustable resistance element connected in series with each reproducing device and isolating resistor.

16. In a communication system having two sources of audio frequency supply, a sound reproducing device connected to both sources of supply, a variable attenuator connected in the output circuit of one source to said reproducing device, said variable attenuator comprising an impedance network having fixed and variable impedance elements, the variable impedance elements each having adjustable contact arms, a variable impedance element connected in the output circuit of said second source and in series with said reproducing device, said variable impedance also having an adjustable contact arm, means whereby the adjustable contact arms of each variable impedance element may be moved together so that as the attenuation in the output circuit of one source is increased, the attenuation in the output circuit of the other source is also increased.

17. In a communication system having two sources of audio frequency supply, a plurality of sound reproducing devices, means connecting each reproducing device across each source of supply, a variable attenuator in the output circuit of one source of supply to at least one reproducing device, a variable resistor having an adjustable contact arm in the output circuit of said other source of supply to at least the same reproducing device, the variable attenuator comprising variable resistance elements having adjustable contact arms, and means whereby the adjustable contact arms of all the variable resistor elements in the attenuation control for each reproducing device may be moved together so that as the signal in the reproducing device from one source is increased the signal in the same reproducing device from the other source is decreased.

18. In a communication system for aircraft having a plurality of sources of audio frequency supply, a sound reproducing device, means connecting said sound reproducing device to each of said sources so that it may simultaneously reproduce the signal from each, a plurality of variable audio attenuators, each comprising an impedance network having fixed and variable impedance elements, one of said variable attenuators being connected in the output circuit of each supply source to the common reproducing device whereby the output level from each source may be adjusted in the single reproducing device, a second sound reproducing device and means connecting said second sound reproducing device to the output circuit of one of said audio frequency sources, said means including a variable audio attenuator and circuit arrangements whereby a signal from said other source in order to reach said second reproducing device is subjected to the attenuation introduced in each output circuit by each variable attenuator.

19. In a communication system for aircraft having two sources of audio frequency power supply, a plurality of sound reproducing devices, a plurality of variable audio attenuators, means including circuit connections whereby one sound reproducing device may simultaneously receive the signal from each audio frequency supply source through a single variable audio attenuator, means including circuit connections whereby a second sound reproducing device may receive a signal from one of said power sources through a single variable attenuator but the signal from the other source is subjected to the attenuation introduced in each output circuit by each variable attenuator.

20. In a communication system for aircraft the combination of an output circuit of a radio receiving apparatus, an output circuit of an interphone communication system, a sound reproducing device, conductors connecting said sound reproducing device and each output circuits in multiple whereby the sound reproducing device and the output circuit of said radio receiving apparatus comprise a multiple load to the output from said interphone communication system, and a variable attenuator with a movable control means in the conductors connecting said reproducing device to the output circuit of said radio receiving apparatus whereby an increase or decrease in the attenuator to the audio output of said radio receiving apparatus produces a corresponding decrease or increase in the radio signal level in said sound reproducing device and at the same time produces an inverse effect in the interphone signal level in said sound reproducing device by causing an increase or decrease respectively in the impedance of the shunt circuit containing the variable attenuator and the output circuit of said radio receiving apparatus.

21. The invention as defined by claim 20 characterized further by the addition thereto of a second variable attenuator with a movable control means in said conductors connecting the sound reproducing device to the output circuit of the interphone communication system, and means for mechanically coupling said movable control means whereby adjustment providing for an increase or decrease in the signal level from said radio receiver output will cause an accentuated inverse change in the signal level from said interphone communication system output by causing a decrease or increase, respectively, in the attenuation to said sound reproducer.

22. The invention as defined by claim 20 characterized further by the addition thereto of a second variable attenuator with a movable control means in said conductors connecting the sound reproducing device to the output circuit of the interphone communication system, and means for mechanically coupling said control means so that adjustment providing for an increase or decrease in the signal level from said radio receiver output will compensate for the inherent inverse change in signal level from said interphone communication system output whereby the said signal level will remain substantially constant as the signal level from said radio receiver output is increased or decreased.

JAMES C. COE.