May 21, 1935. P. CROSLEY, JR., ET AL 2,002,390

ACOUSTIC DEVICE

Filed Aug. 15, 1932

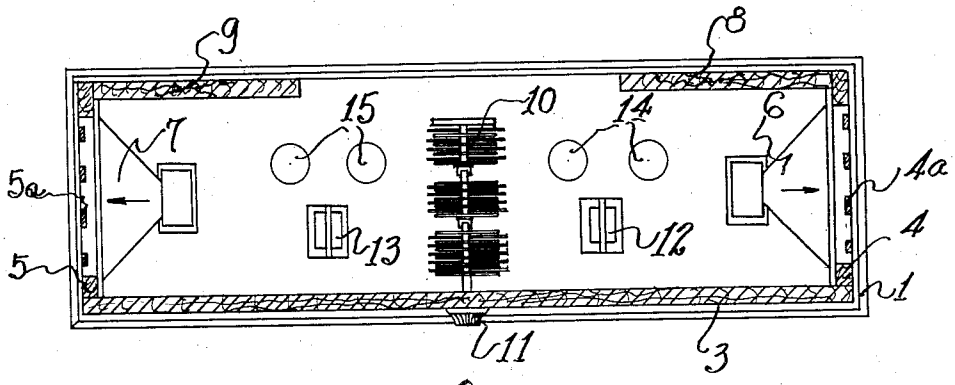


Fig. 1

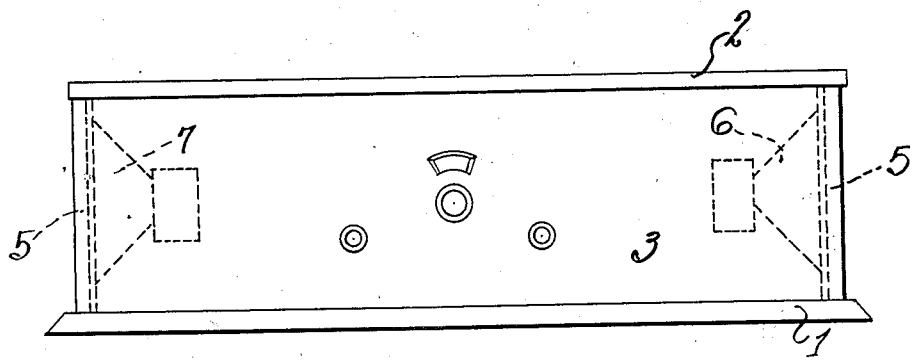


Fig. 2.

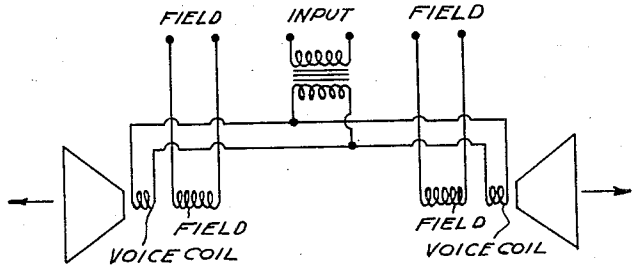


Fig. 3

INVENTORS
Powel Crosley, Jr.
Henry Gest
BY
Allen & Allen
ATTORNEYS

Patented May 21, 1935

2,002,390

UNITED STATES PATENT OFFICE

2,002,390

ACOUSTIC DEVICE

Powel Crosley, Jr., and Henry Gest, Cincinnati, Ohio, assignors to The Crosley Radio Corporation, Cincinnati, Ohio, a corporation of Ohio

Application August 15, 1932, Serial No. 628,815

11 Claims. (Cl. 250—14)

It has been found that in radio sets, or other reproducing devices employing loud speakers, somewhat improved acoustic results may be secured by the employment of more than one loud speaker. There has been some commercial development in equipping radio sets of the most expensive type with two speakers. This development should not be confused with prior suggestions relative to the use of a plurality of speakers which have essentially markedly different characteristics. Thus where speakers do not have relatively flat curves representing reproducing characteristics, but reproduce at most only a limited band of audio frequencies with entire satisfaction, it has been proposed to couple together, say, a speaker which is relatively inadequate to reproduce high frequencies with a speaker which is relatively inadequate to reproduce low frequencies, so as to secure through the combined action of both speakers a somewhat more adequate reproduction of all frequencies. This expedient need not be employed with modern speakers which, when correctly made, reproduce quite satisfactorily the entire range of audio frequencies.

Nevertheless it has been found that improved results may be secured by using two speakers, the characteristics of which are as nearly the same as can be secured by identical design and construction methods. Some of the reasons why this is true are known. Others apparently are not entirely clear. For example, modern speakers usually have a certain resonance in the relatively low frequency range, say, around 90 to 100 vibrations per second. Speakers made to an identical design under the same manufacturing conditions will vary slightly as to the exact frequency of resonance. Hence when two speakers are combined, it is believed that a common curve representative of their combined reproduction, exhibits much less marked a resonance characteristic in the neighborhood of their individual points of resonance. Other effects apparently have to do with interference wave patterns. Some difficulty has attended attempts to use two speakers heretofore, and the results have not been all that could be desired.

The general object of our invention is to improve the acoustic results of the use of more than one speaker, and to eliminate the difficulties heretofore attendant upon such use.

It is a specific object of our invention to employ a construction providing a distinct and pleasing binaural effect, that is, a sensation of the sounds produced, in both ears of the listener. Another object of our invention is so to couple a plurality of speakers to an electric circuit to drive the same, as to secure an enhanced and a more pleasant reproduction. Still another object of our invention is to employ a plurality of speakers in such a way as to neutralize hum. Still another object of our invention is to employ a reproducing device or devices in such a way as to avoid the so-called microphonic effect hereinafter to be discussed.

These and other objects of our invention which will be set forth hereinafter, or will be apparent to one skilled in the art upon reading these specifications, we accomplish by that certain construction and arrangement of parts of which we shall now describe a preferred embodiment, reference being had to the accompanying drawing, wherein:

Figure 1 is a horizontal section of a radio cabinet and associated devices embodying our invention.

Fig. 2 is a front elevation of the same.

Fig. 3 is a diagram of the speaker energizing circuits.

In the specific embodiment of our invention which we will describe herein for purposes of illustration, we employ a radio cabinet of the table model type and of box form. It will be understood that our invention is not restricted to this, and that the principles thereof may be employed in other types of radio cabinets, whether designed for table use or whether of the so-called console type. We prefer to embody our invention in a cabinet which is of considerable length or breadth in some dimension, since for the securing of our effects we prefer so to mount the loud speakers as to send the sound out of the sides or ends of the cabinet, and we also prefer to increase the binaural effect by having as great a distance between the vibrating parts of the speakers as is practicable. We have assumed for purposes of our illustrative disclosure herein, the assumption being based upon modern practices and market demands, that the operating parts of the radio set and the loud speakers will be mounted in a single enclosing casing or cabinet.

We have shown in Figs. 1 and 2 a radio cabinet of box form having a base 1, a top 2, a front panel 3, and end members 4 and 5. The end members may be provided with the usual ornamental grilles 4a and 5a, covered on the inside, if desired, with cloth. Behind each of these grilles we mount loud speakers indicated generally at 6 and 7. A specific description of these speakers is not necessary, since the exact type or character of reproducing devices is not a limita-

tion upon our invention. We prefer, of course, to use dynamic speakers since these have, in the present state of loud speaker development, somewhat better reproducing characteristics than the other common types of acoustic units. It will be noted, however, in Figs. 1 and 2 that these reproducers point in opposite directions and are effectively located at the ends of the cabinet. They are also spaced from each other an appreciable distance to increase the binaural effect. The portions of the end members 4 and 5 adjacent the grilles serve as part of the baffles. The front panel 3 serves as another baffling member, and since it is the practice to leave the rear portion of radio cabinets open, we prefer to provide back portions 8 and 9 as shown in Fig. 1, which extend inwardly from the side members 4 and 5, and serve as additional baffles. The purpose of baffling members is, of course, to increase the power and clarity of reproduction by preventing to a considerable extent the mutual interference of sound waves emitted both forwardly and rearwardly by the cones of the speakers.

Since the speakers are so positioned as to emit sounds traveling in effectively opposite directions, the binaural effect is greatly increased by this fact, and a much more effective sound wave pattern is produced, in a hall or chamber in which listeners are located, than otherwise. Nothing like the same effect is produced by causing loud speakers substantially spaced, or not, to emit sound waves in the same direction. However, we have made still another discovery in connection with the employment of spaced loud speakers oppositely disposed, which is that in order to secure the most pleasant sound reproduction the diaphragms of these speakers must continuously move simultaneously in opposite directions. Another way of saying this is that the diaphragms of the speakers must move together with respect to the speaker construction. When the diaphragm of the speaker 6 is moving forwardly with respect to the chassis thereof, the diaphragm of speaker 7 will preferably be moving forwardly with respect to the chassis of that speaker. This obviously results in a simultaneously opposite movement in space of the speaker diaphragms as respects each other. This appears to give a highly advantageous sound pattern in the room in which the radio set is located, and produces a markedly truer and more brilliant reproduction.

Again the plural speaker arrangement characteristic of our invention appears to have a marked effect upon the elimination of hum. Whether this effect is purely acoustic, or whether it involves other factors, we do not know; but we have found that not only is the hum markedly decreased when the device is listened to from a distance, but also at exceedingly close range. With a radio receiving and amplifying device having appreciable hum characteristics it will be noticed that when both speakers are in operation, the hum practically ceases to be apparent, even when the ear is placed close to the grille behind which one of the speakers is located, even though under these circumstances the other speaker will clearly have much less effect upon the ear. If, however, the other speaker be disconnected, there will be a noticeable increase in the apparent hum. This effect seems dependent upon the arrangement of speakers characteristic of our invention.

Particularly in superhetrodyne radio receivers trouble has, under certain circumstances, been experienced with what is known as microphonism. This is due to the bodily vibration in accordance with sound waves impinging thereon of some current carrying member in the set which is adapted to vary the characteristics of an electric circuit. Michrophonism is now relatively seldom experienced with tubes due to the vibration of the elements thereof. Trouble is sometimes had, however, with the vibration of such elements as the plates of the variable condenser rotors, which frequently have a natural period in the neighborhood of two to three hundred cycles. Where condenser plates are made of vibratile substances they are sometimes set in motion bodily in response to sound waves of the proper frequency, developed by the loud speaker or speakers, impinging upon the condenser plates. When so set in motion, such plates act as condenser microphones, and since the condensers are ordinarily carrying radio frequency currents, the vibrations aforesaid will serve to modulate these currents producing undesirable noises in the loud speaker.

We have shown in Fig. 1 a centrally located condenser or condenser gang 10, controlled by the usual knob 11, preferably by means of some micro-or-vernier drive not shown. It will be seen in Fig. 1 that the condenser gang is not only centrally located between the two speakers, but also that the plates thereof extend generally in a direction parallel to a line drawn between the two speakers. In this arrangement not only are sound waves developed by the speakers broken up to some extent by the various instrumentalities of the radio set, such as transformers 12 and 13 and tubes 14 and 15, but also the condenser gang 10, being centrally located between the speakers, is at a natural node created by the interference of the sound waves developed by each speaker. Moreover, it will be noticed that as respects the sound waves developed by any speaker, the plates of the condenser gang 10 are in such position as to lie parallel with the direction of vibration and travel of said waves. Hence the sound waves do not tend to cause transverse vibrations of the plates of the condenser. Since it is difficult as well as expensive to shield a condenser or condenser gang acoustically, our invention provides a novel and convenient way of eliminating microphonism.

It will be clear not only that the type of cabinet employed by us is not a limitation upon the broader aspects of our invention, but also that our invention may be applied to other devices than a radio set. In general, it will be found of value and utility in its broader aspect in any type of device in which electrical pulsations are to be transferred into sound. Modifications may be made in our invention without departing from the spirit thereof.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent, is:—

1. In a radio set, an elongated cabinet with sides of negligible responsiveness to wave impulses, speakers of the cone type located in the ends thereof and directed away from each other in substantially opposite directions and having sound openings in said ends, said speakers so connected to a source of exciting current as to concurrently emit sound waves in the opposite directions.

2. In a radio set, an elongated cabinet with sides of negligible responsiveness to wave impulses, speakers of the cone type located in the ends thereof and directed away from each other in substantially opposite directions and having

sound openings in said ends, said speakers so connected to a source of exciting current as to concurrently emit sound waves in the opposite directions, the length of said cabinet and its wave baffling properties being sufficient to create a binaural effect.

3. In a radio set, a cabinet of elongated shape, having sides of negligible responsiveness to wave impulses and end members considerably spaced, speakers of the cone type located adjacent the ends of said cabinet and facing in substantially opposite directions and having sound openings directly from the respective speakers out through said end members to the exterior of the cabinet, the front portion of said cabinet being of substantial extent between said ends and substantially continuous in structure, whereby said front portion is adapted to act as a baffle, and baffling members on the rear portion of said cabinet extending inwardly sufficiently from said end portions to provide a baffling effect.

4. In a radio set, a cabinet of elongated shape, having sides of negligible responsiveness to wave impulses and end members considerably interspaced, speakers of the cone type located adjacent the ends of said cabinet and facing in substantially opposite directions and having sound openings in said end members and the front portion of said cabinet being of substantial extent between said ends whereby it is adapted to act as a wave impulse baffle, and baffling members on the rear portion of said cabinet extending inwardly sufficiently from the end portions to provide a wave impulse baffling effect, said speakers connected to a source of exciting current in in-phase oppositely vibrating relationship.

5. In a radio set, spaced loud speakers of the cone type directed substantially oppositely away from each other and connected to a source of exciting current so as to cause their respective cones to move simultaneously in opposite directions.

6. In a reproducing device having a variable condenser, interspaced loud speakers oppositely directed, said condenser being located at a point substantially midway between said loud speakers, the plates of said condenser extending in a plane substantially parallel with a line drawn between the effective centers of said loud speakers.

7. In a reproducing device having a variable condenser, interspaced loud speakers oppositely directed, said condenser being located at a point substantially midway between said loud speakers, the plates of said condenser extending in a plane substantially parallel with a line drawn between the effective centers of said loud speakers, said loud speakers being connected to a source of exciting current so as to emit sound waves having initially opposite effective directions.

8. In a radio set, the combination of a plurality of loud speakers oppositely directed and concurrently oppositely vibrating, and a condenser located at a sound-nodal point between said loud speakers.

9. In a radio set, the combination of a plurality of loud speakers oppositely directed and concurrently oppositely vibrating, and a condenser located at a sound nodal point between said loud speakers, the plates of said condenser being disposed in a plane substantially transverse to the direction of sound waves at said nodal point.

10. In a sound reproducing device, a plurality of acoustic mechanisms of the cone type, said mechanisms being spaced by means of negligible responsiveness to wave impulses and substantially oppositely directed away from each other and connected to a source of exciting current so as to operate in in-phase oppositely vibrating relationship.

11. In a sound reproducing device, a plurality of acoustic mechanisms of the cone type, said mechanisms being substantially oppositely directed away from each other and spaced sufficiently distant from each other to produce a binaural effect, said mechanisms being connected to a source of exciting current so as to operate simultaneously in in-phase oppositely vibrating relationship.

POWEL CROSLEY, JR.
HENRY GEST.