Sept. 30, 1947. H. C. DALRYMPLE 2,428,147

ELECTRIC MEGAPHONE

Filed June 1, 1945

Fig. 1

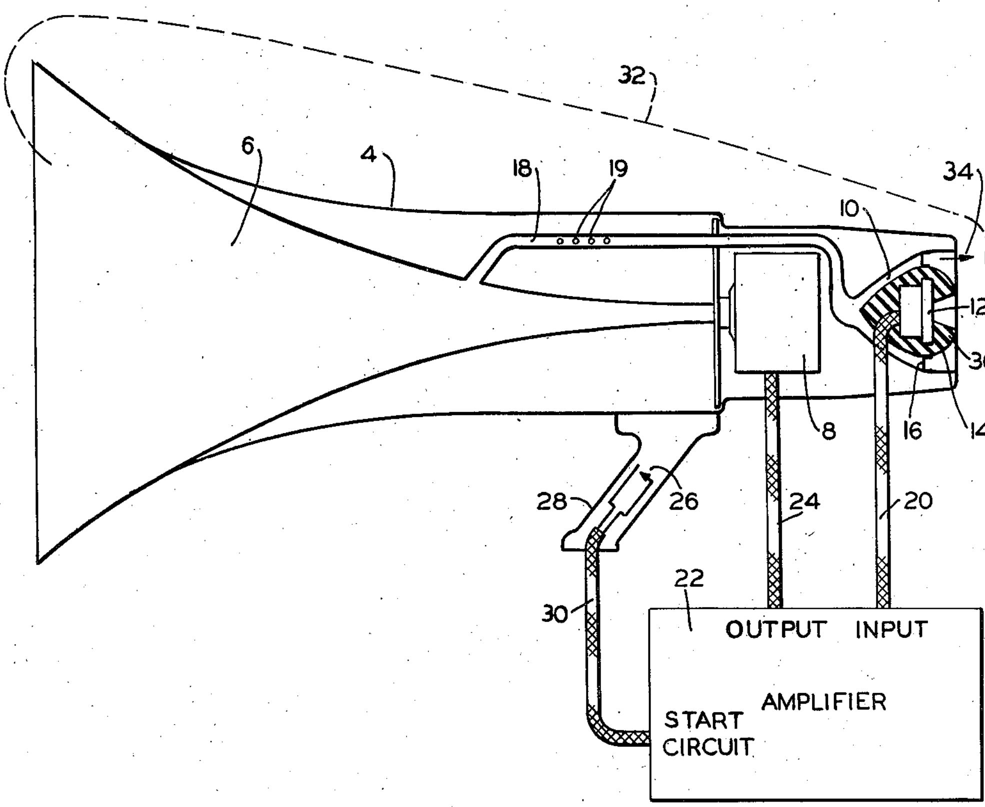
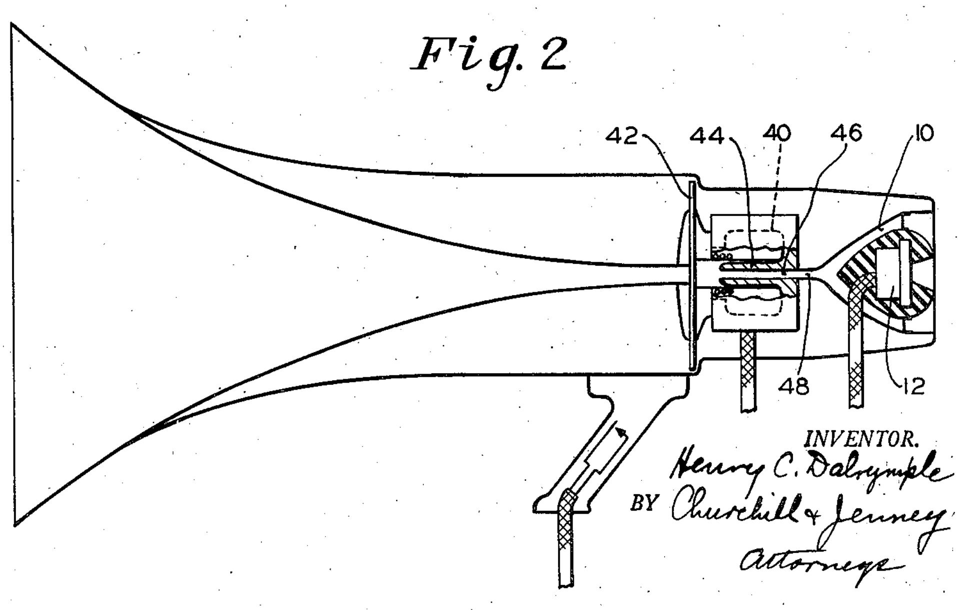


Fig. 2



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ELECTRIC MEGAPHONE

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The present invention relates to electric megaphones and more particularly to means for reducing the tendency of electric megaphones to break into sustained oscillations due to acoustic coupling.

An electric megaphone comprises a loudspeaker, usually in the form of a horn, at the rear of which is mounted a microphone. A suitable amplifier is connected between the microphone and the driving unit of the speaker. Under high gain conditions there is a pronounced tendency for the device to howl because of acoustic feedback. The waves of compression and rarefaction of the air external to the megaphone form what may be termed an acoustic field, which results in impressing a portion of the acoustic energy on the microphone. If a sufficient portion of the acoustic energy at some particular frequency is impressed on the microphone to overcome losses, the megaphone will break into sustained oscillation at that frequency, thus rendering it useless for its intended purpose. In order to permit useful operation of the unit, it is necessary to reduce the gain to such a level that the oscillations will not occur but a gain sufficiently reduced for that purpose may not be adequate for satisfactory loudspeaker output. The frequency at which the oscillations tend to occur is determined by the characteristics of the driving unit, the length and shape of the horn, the characteristics of the microphone and its enclosure, and to the length of the feed-back path over which the acoustic energy travels from the horn back to the microphone. The feedback path in the external acoustic field is not a fixed and determined characteristic because any path over which the acoustic energy can travel, in such a manner as to arrive at the microphone at a sufficiently high intensity and proper phase, is likely to cause howling. In general, the feed-back paths in the immediate vicinity of the unit, are most important because their attenuation at the microphone is relatively small. One difficulty of the problem is, however, that any efforts to prevent oscillations over a narrow frequency band may prove unavailing since there is, in effect, an infinite number of acoustic feed-back paths through which energy may be fed to cause oscillations at one or another frequency.

In accordance with the present invention I provide a negative feed-back channel through which energy is fed from the loudspeaker to the vicinity of the microphone in such intensity and phase relationship as to neutralize a portion of the acoustic energy arriving at the microphone

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through the external field. The microphone is mounted in a secondary horn having its axis displaced 180 degrees from that of the output horn. In one form of the invention acoustic energy is fed from an intermediate portion of the output horn through a tube to the secondary horn. In another form of the invention, the acoustic energy is fed from the back of the diaphragm of the driving unit. In either case, the characteristics of the negative feed-back path are such as to convey a substantial amount of energy in the frequency band within which the megaphone tends to oscillate. For the reasons heretofore noted, the positive feed-back has a relatively wide frequency range and for this reason it is preferable to use a feed-back channel which is sufficiently damped to provide a wide band-pass characteristic.

In the accompanying drawings, Fig. 1 is a sectional elevation of the preferred form of electric megaphone according to the present invention and Fig. 2 is a sectional elevation of a modified form thereof.

The electric megaphone shown in Fig. 1 comprises a casing 4 within which is enclosed a loudspeaker 6, preferably of the exponential type. The horn is energized by a driving unit indicated diagrammatically at 8. The rear of the casing is provided with a secondary horn 10 of flared shape, having its axis coincident with the axis of the primary horn 6. A microphone 12 is mounted within the secondary horn 10. The microphone is preferably mounted within a body of acoustic insulating material 14 which is supported within the horn by suitable spacing means indicated at 16. As herein shown, the secondary horn chamber comprises a passage between the casing and the insulating cone 14. This chamber need not, however, be a complete chamber but may comprise a number of passages extending from the interior of the casing to the exterior, these passages terminating as shown in the drawing somewhat to the rear of the microphone. In any case, the horn passage indicated at 10 is preferably of exponentially increasing section, in accordance with accepted principles of horn construction.

A negative acoustic feed-back path for neutralizing the external feed-back is provided by a tube 18 enclosed within a casing, one end of which is open toward the interior of the output horn 6. The tube is connected to the inner end of the secondary horn 10. The tube is preferably a metal tube of small size (usually between $\frac{1}{16}$ and $\frac{1}{4}$ inch in diameter) capable of carrying acoustic energy from the output horn to the secondary horn. The tube is provided with a corrective acoustic filter, illustrated as a series of small drilled openings 19 for reasons to be presently explained.

An input cable 20 connects the microphone with an amplifier 22, the output of which is connected to the driving unit 8 through a cable 24. A starting switch 26 of conventional form is mounted in the handle 28 of the megaphone and is connected through a cable 30 with the starting circuit of the amplifier.

The operation of the megaphone is described as follows: A portion of the sound energy emanating from the horn 6 will travel back to the microphone by an external path which may be represented diagrammatically by the dotted line 32. This path is indicated in the drawing by way of explanation only and is not intended to represent accurately any actual path or paths which the sound energy may take. It is sufficient to note that energy may be considered as fed back to the microphone through a large body of the air surrounding the horn and that some of the energy in various intensities and phase relationships, depending on the paths of travel, will reach the microphone. Assuming that the indicated path 32 is such as to present to the microphone some acoustic energy in the same phase as the initial disturbance, the energy from the horn will be fortified. If the energy thus fed back is of sufficient intensity to overcome the attenuation around the complete electrical and acoustic circuit, the system would tend to break into oscillation. This tendency to oscillate is countered by the energy fed back from the interior of the horn from the tube 18 of the secondary horn. This energy appears in the vicinity of the microphone as indicated by the arrow 34. By proper choice of the length and transmission characteristics of the tube 18 and the secondary horn, this acoustic energy may be made of such phase and intensity as to neutralize a substantial portion of the energy of the acoustic field in the vicinity of the microphone.

Since the frequency discrimination of a small diameter tube differs from the frequency discrimination of existing paths of transmission in free air, a corrective acoustic filter is introduced in the tubing. Filters of this nature are well known in the art and their characteristics are dependent on the tube length and diameter, the horn design, and the secondary horn design.

Since the megaphone is ordinarily used only for speech transmission, the lower frequencies are suppressed electrically, and it is preferable to limit the negative feed-back transmission to that portion of the frequency spectrum in which the external acoustic feed-back predominates. The holes 19 form a simple corrective filter which has been found satisfactory in many instances.

It is to be noted that the insulating support 14 is provided with flared portions 36 which extend beyond the microphone unit 12. By this construction the tendency for the negative feed-back energy to impinge on the microphone is reduced, that is, it is necessary for the neutralizing energy to travel in a wide path around the flare 36 and thus to subject itself to substantial attenuation before striking the microphone. The neutralization between the external and internal feed-backs is accomplished in the vicinity of the outlet of the secondary horn 10 and not directly at the microphone surface.

The modified form of the invention shown in Fig. 2 is similar to the form shown in Fig. 1 except

that the internal feed-back channel is taken from the back of the diaphragm. The driving unit, which is here shown in detail, comprises the magnet 40 and the diaphragm 42. The central portion 44 of the magnet is provided with an opening 46 connected with a tube 48 leading to the secondary horn 10. The tube 48 is preferably of small size to provide a highly damped transmission over a relatively wide frequency band. The length of the tube is such as to effect substantial neutralization of the energy of the external acoustic field. Since the neutralizing feed-back is of opposite phase to that obtained in the construction of Fig. 1 the feed-back path is necessarily shorter and the immediate connection to the driving unit may thus be used.

In Fig. 1 the point of connection of the tube 18 into the horn and the length of the tube and in Fig. 2 the length of the tube 48 cannot be precisely specified in advance for all conditions. For any given shape and size of horn and any given driving unit, these quantities are best determined by experiment. In general, however, it may be said about the construction shown in Fig. 1, the point of introduction of tube 18 into the horn 6 may be varied between wide limits, if a proper length of tube is used. The tube may be coiled within the unit, if necessary, to provide the proper length. It will be understood also that in Fig. 2 the length of tube 48 may be adjusted by proper design of the length of the rear portion of the megaphone, or again by the use of a coiled tube. The factors determining the size, length and location of the tube, when determined for any particular horn design, may be considered fixed for that design because the characteristics due to the external path do not vary sufficiently with conditions of use to materially affect the stabilization obtained by the present invention.

It will be understood that exact neutralization of positive feed-back at all frequencies at which oscillation might occur, is not to be expected, since the positive and negative paths vary as to length, time of transmission, and frequency characteristics. A sufficiently effective neutralization can, however, be obtained to allow a substantial increase of amplifier gain without bringing the system to the threshold of oscillation.

Having thus described the invention, I claim:

1. An electric megaphone comprising a casing having at the front an output horn, and at the rear a secondary horn, a driving unit for the output horn, a microphone disposed within the secondary horn, and internal acoustic coupling means between the output horn and the secondary horn for feed-back of acoustic energy to the secondary horn in the vicinity of the microphone to neutralize a sufficient part of the external acoustic field to prevent sustained oscillations.

2. An electric megaphone comprising a casing having at the front an output horn, and at the rear a secondary horn, a driving unit for the output horn, a microphone disposed within the secondary horn, and internal acoustic coupling means between the output horn and the secondary horn for feed-back of acoustic energy to the secondary horn in the vicinity of the microphone to neutralize a sufficient part of the external acoustic field to prevent sustained oscillations, said internal coupling means including a corrective acoustic filter.

3. An electric megaphone comprising a casing having at the front an output horn, and at the rear a secondary horn, a driving unit for the output horn, a microphone disposed within the sec-

ondary horn, and internal acoustic coupling means between the output horn and the secondary horn for feed-back of acoustic energy to the secondary horn in the vicinity of the microphone and including a tube leading from a part of the output horn to the secondary horn, to neutralize a sufficient part of the external acoustic field to prevent sustained oscillations.

4. An electric megaphone comprising a casing having at the front an output horn, and at the rear a secondary horn, a driving unit for the output horn, a microphone disposed within the secondary horn, and internal acoustic coupling means between the output horn and the secondary horn for feed-back of acoustic energy to the secondary horn in the vicinity of the microphone, the secondary horn including a body of acoustic insulating material within which the microphone is mounted.

5. An electric megaphone comprising a casing having at the front an output horn, and at the rear a secondary horn, a driving unit for the output horn, a microphone disposed within the secondary horn, and internal acoustic coupling means between the output horn and the secondary horn for feed-back of acoustic energy to the secondary horn in the vicinity of the microphone, the secondary horn including a body of acoustic insulating material within which the microphone is mounted, the body of insulating material having flared portions extending rearwardly beyond the microphone.

6. An electric megaphone comprising a casing

having at the front an output horn, a driving unit for the horn including a diaphragm, a microphone at the rear of the casing, a secondary horn within which the microphone is mounted, and internal acoustic coupling means to neutralize external acoustic feed-back in the vicinity of the microphone, said means including a tube leading from the rear of the diaphragm to the secondary horn.

7. An electric megaphone comprising a casing having at the front an output horn, a driving unit for the horn including a diaphragm, a microphone at the rear of the casing, a secondary horn within which the microphone is mounted the secondary horn including a body of acoustic insulating material forming with the casing a horn passage around the microphone, and internal acoustic coupling means to neutralize external acoustic feed-back in the vicinity of the microphone, said means including a tube leading from the rear of the diaphragm to the secondary horn.

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