May 28, 1935. B. F. MIESSNER 2,002,919

ELECTROMAGNETIC TRANSLATING SYSTEM

Filed June 17, 1932 2 Sheets-Sheet 1

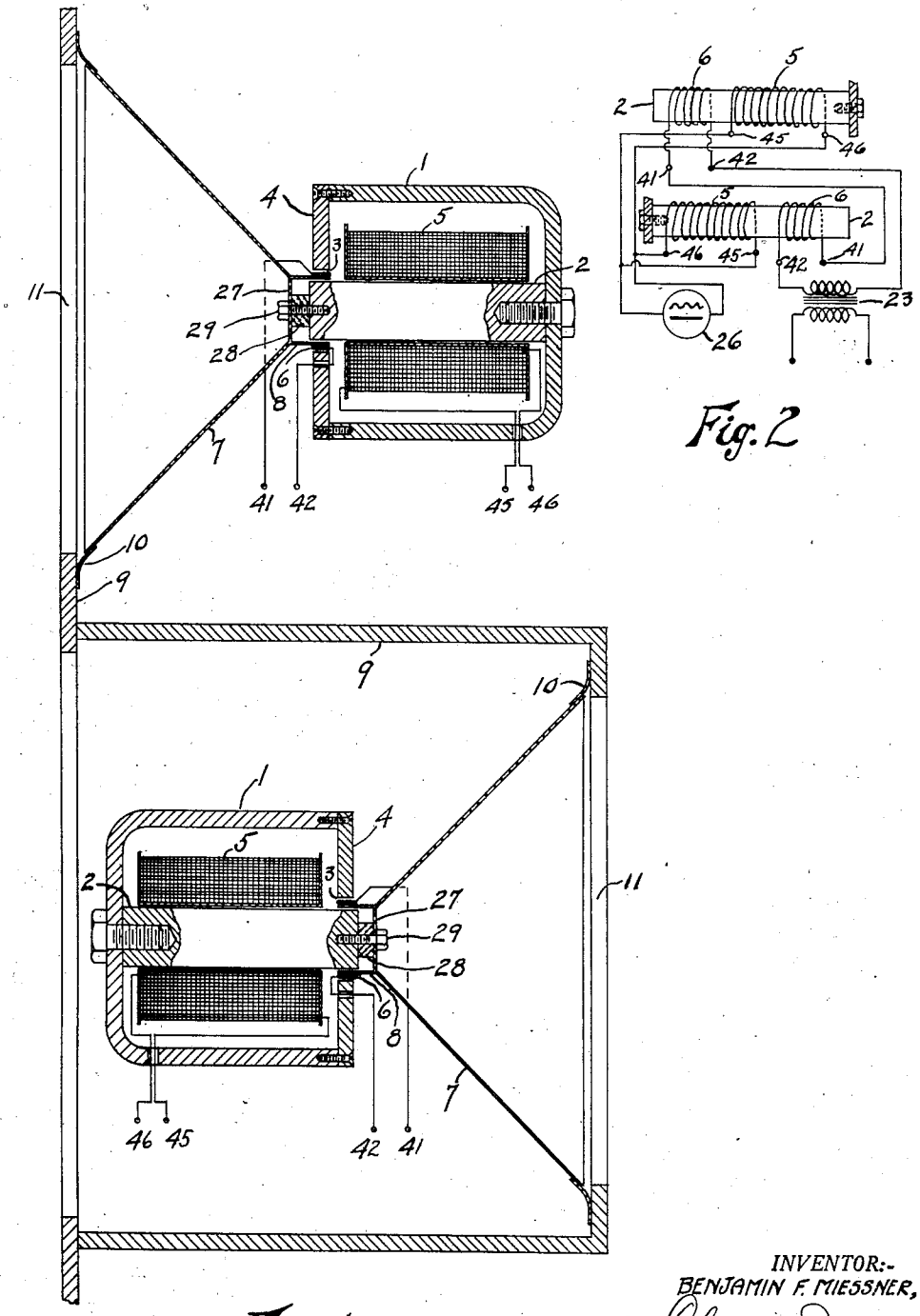


Fig. 1

Fig. 2

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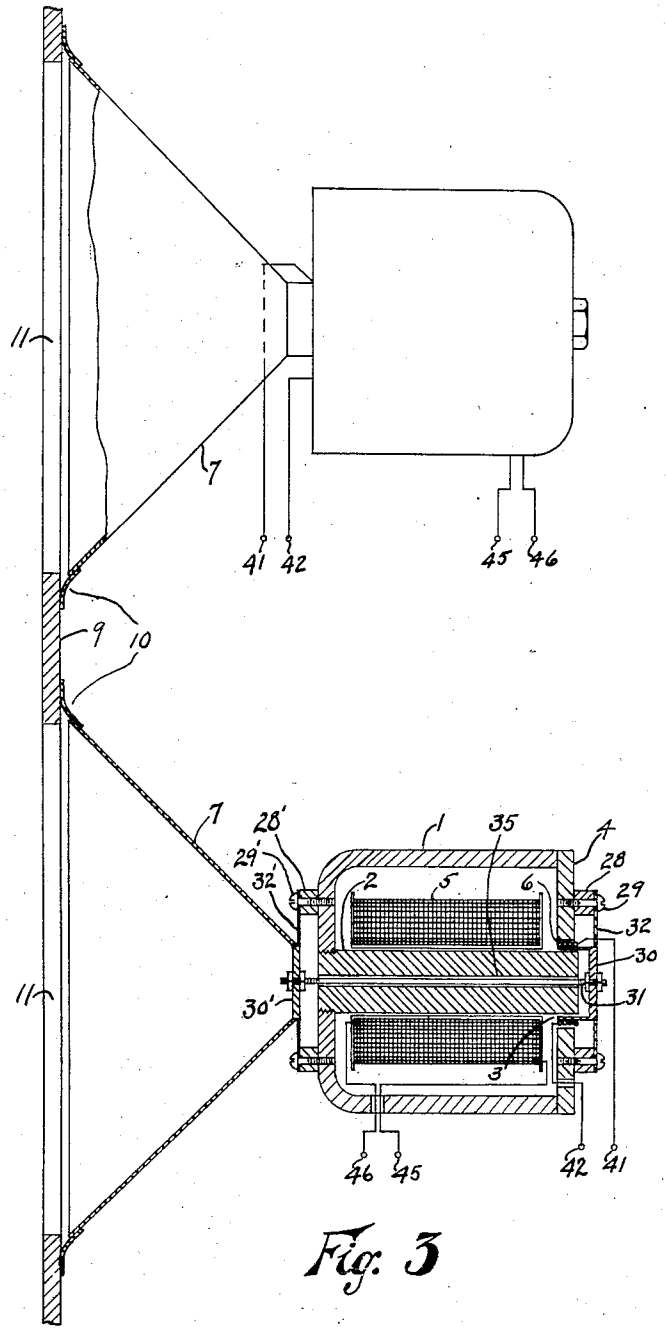


Fig. 3

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ELECTROMAGNETIC TRANSLATING SYSTEM

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7 Claims. (Cl. 179—115.5)

This invention relates to electromagnetic translating systems and more particularly to those systems employing translating devices including a field coil energizable to provide an intense magnetic field, and a dynamic coil positioned in such field and connected to a source or receiver of electric oscillations.

An object of the invention is the provision of a system of one or more of such translating devices whose field coil or coils may be supplied with pulsating direct current, or incompletely filtered rectified currents, without disturbing effect on the dynamic coil or coils. A further object of the invention is the provision of a system comprising a plurality of such devices so positioned, and having field and dynamic coils respectively so interconnected, as to effect efficient translation without producing undesirable hum in their combined acoustic or electric output as a result of pulsations or ripples which may be present in the field energizing current. Other and allied objects will more fully appear from the following description and the appended claims.

While I contemplate no limitation of my invention to sound reproducers, or devices for electro-acoustic translation, these have been selected as representative translating devices of the class described with which to illustrate my invention. Thus in the detailed description of my invention hereinafter set forth, reference is had to the accompanying drawings, of which:—

Figure 1 is a cross-sectional view of one embodiment of my invention employing two suitably arranged sound reproducers;

Figure 2 is a schematic diagram illustrating suitable interconnections of the field and dynamic coils, respectively, of the reproducers of Figure 1; and

Figure 3 is a cross-sectional view of an alternative embodiment of my invention in which a modified form of reproducer is substituted for one of the reproducers of Figure 1.

In Figure 1 I have shown two identical reproducers, each separate one of which may be of conventional design. Thus each may comprise for example a cylindrical element or casing 1 of magnetic material having an integral closure at one end and carrying at the other end removable disc 4, also of magnetic material. While no mounting for casing 1 is shown, it will be understood that it may be supported in a stationary position in any suitable manner. To the center of the integral end of the cylindrical element 1 is tightly affixed central core 2; also of magnetic material, core 2 protruding through a hole in disc 4 and forming therewith a slight annular gap 3. Positioned in the gap 3 may be the dynamic coil 6, wound for example about cylindrical coil form 8, to which may be affixed the diaphragm 7. To the coil form may be attached flexible disc 27; and this may be centrally mounted, as by bolt 29 and spacer 28, to the end of core 2. This manner of support of the dynamic coil 6 is illustrative only, it being understood that other well-known supporting means are available meeting the requirement of permitting relatively unimpeded vibration of the dynamic coil 6 in the direction of the axis of the core 2 while retaining the coil 6 and its support 8 free of contact with core 2 or disc 4, to each of which they are preferably very closely spaced.

Considering the action of a single reproducer such as either of those shown in Figure 1, it will be understood that energization of the field coil with pure unidirectional current will produce a strong magnetic field in the central core 2, in the casing 1, and across the gap 3, there cutting the dynamic coil 6. The interaction with this steady field of the field produced by a current pulse traversing the dynamic coil will produce a motion of the dynamic coil either toward or away from the field coil 5, according to the polarization of the central core 2 and to the direction of the current flow in the dynamic coil. Thus the series of pulses which make up sound representing currents which may be supplied to the dynamic coil produce a corresponding series of motions of the dynamic coil and diaphragm, thus operating the reproducer. It will further be understood that if the field energizing current contains, in addition to pure unidirectional current, a pulsating or ripple component, corresponding voltage pulsations will be induced into the dynamic coil, and corresponding current pulsations will flow therein. The dynamic coil will thereupon execute a vibratory motion in accordance therewith, over and above such motion as it may properly and intendedly execute.

In order to reduce or eliminate this undesired vibratory motion it has been common practice to employ, in series with the dynamic coil of a reproducer of this type, a stationary "bucking" coil, so positioned that there will be induced therein pulsations or ripple voltages of approximately the same amplitude as those induced in the dynamic coil, and so poled with respect to the latter that the pulsations or ripple voltages respectively induced in the two coils will cancel in their common circuit and render the latter free of pulsating currents. Two fundamental

obstacles to perfection of result must always be coped with in the use of such a system. These are, first, the waste in the "bucking" coil of sound representing input power, and secondly, the difficulty of obtaining perfectly similar amplitudes, phases and wave forms of the pulsations respectively induced in the two coils. While I have shown, for example in United States patents to me Numbers 1,859,454 and 1,859,522, highly effective means of coping with these problems, the present invention is directed to their complete circumvention. Thus I show in each of the embodiments of this invention two dynamic coils into which the pulsations induced by field excitation may be entirely similar. These coils are interconnected for mutual opposition or cancellation of these pulsations. Both coils are fully effective, however, in operating the diaphragm or diaphragms of the system.

In Figure 2 I illustrate typical interconnections of the field and dynamic coils, respectively, of the two reproducers shown in Figure 1. The field coils 5 may be connected together either in parallel as shown, or in series, and to their energizing source 26 of pulsating direct current. The dynamic coils 6 may also be connected together in series, and to the secondary of an input transformer 23, the primary of which may be supplied with sound representing currents. The relative poling of the two dynamic coils will depend on the relation in which the field coils have been poled, the criterion being simply that the pulsations induced in each dynamic coil by the associated field excitation mutually cancel in their common circuit. Thus in Figures 1 and 2 the coil terminals of the lower reproducer have been numbered identically with the corresponding coil terminals of the upper reproducer. If now the field coils are connected as shown so that a current pulse from source 26 traverses both field coils 5 from one pair of similarly numbered terminals to the other, the dynamic coils should be connected to effect opposition of voltages at like-numbered terminals of the two respectively. On the other hand, if the field coils be connected so that a current pulse from source 26 traverses the two field coils from one pair of differently numbered terminals to the other, the dynamic coils should be connected to effect opposition of voltages at differently numbered terminals of the two respectively.

In the case of two similar reproducers, interconnections of field and dynamic coils as described above will be found to cause phase opposition of the vibratory motions respectively executed by the two dynamic coils in accordance with sound representing currents from transformer 23, and hence phase opposition of the sound outputs of the reproducers. In other words, the phase of output sound of one reproducer relative to that of the other has been reversed simultaneously with the desired phase reversal of pulsations induced in one dynamic coil relative to that of the pulsations induced in the other. The phase of sound output of one reproducer must therefore be re-reversed relative to that of the other. In Figure 1 I show one method of effecting such re-reversal. This is an acoustic method—the use of the back-side radiation of the diaphragm of the other. Thus the two reproducers may be oppositely directed against opposite sides of baffle 9, holes 11 therein being provided of approximately the respective outside diameters of the diaphragms 7. Limp annular rings 10 have been illustrated secured to the peripheries of the diaphragms and to the baffle 9 around such holes to complete the baffling action; but it will be understood that each reproducers may be provided with a diaphragm-frame and this in turn secured to the baffle if desired.

In Figure 3 I show an embodiment of my invention wherein I again electrically reverse the phases of the induced pulsations and sound output in and from one reproducer, and mechanically, rather than acoustically, reverse the phase of sound output from one reproducer to coincide with that of the other. In this figure the upper-shown reproducer may be entirely similar to either of the reproducers of Figure 1. The lower shown reproducer is modified, however, in the following respects:—

The flexible disc 27 supporting the dynamic coil in Figure 1 may be omitted, and its function otherwise performed, as by three or more flexible flanges 32 extending outwardly from the coil form 8 and each supported at its extremities, as was the flexible disc at its center, by a spacer 28 and bolt 29. A rigid disc 30 may be provided in the position formerly occupied by 27, and to the center of this disc be affixed rod 31 freely passing through axial hole 35 in central core 2. At the other end of the reproducer this rod may be attached to a similar rigid disc 30', which may be flexibly supported in manner similar to the support of disc 30 and coil 6—i. e., by flexible flanges, spacers and bolts designated as 32', 28' and 29'. In this embodiment the electrical interconnections of the coils of the two reproducers may be entirely similar to those shown in Figure 2 for the preceding embodiment of my invention. The phase of the sound output of the lower reproducer having been mechanically reversed, however, the front-side radiation of both diaphragms may be employed.

In both the embodiments of my invention as thus far described, I have shown a series interconnection of the dynamic coils, whereby pulsations therein induced from the field excitation are mutually electrically cancelled. I may, however, alternatively employ a parallel connection, opposing in that terminals of the two respective dynamic coils of opposite instantaneous polarity are connected together. In this case the pulsations will not be electrically cancelled, each diaphragm vibrating in accordance therewith. These undesired vibrations of the diaphragms of the two reproducers will form part of the sound output from each, but will be respectively in phase with each other at the same time that the intended sound outputs are of opposite phase. But upon the above described reversal of phase of total sound output from one reproducer relative to that of the other to obtain phase coincidence of the desired sound output, the undesired vibrations of the two diaphragms become respectively opposite in phase and acoustically cancel, provided the diaphragms of the two reproducers be close together. Thus with the preferred series interconnection of dynamic coils electrical cancellation, and with the parallel interconnection acoustic cancellation, is obtained.

It will be understood that while the description and illustration of the invention has employed sound reproducers as typical electromagnetic translating devices, my invention is equally applicable to other such devices, such for example as moving-coil microphones, or electro-mechanical or mechanico-electric translators similar to such reproducers but without diaphragms, etc.;

and that the scope of my invention is not to be determined by the particularly illustrated embodiments, but rather by the appended claims.

I claim:—

1. In an electromagnetic translating system, the combination of two sound reproducers each including a magnetic circuit wherein is provided an air-gap and including a dynamic coil operatively located in said air-gap and a diaphragm coupled to said coil; a common source of pulsating direct current for exciting said magnetic circuits; a common source of sound representing oscillations for energizing said dynamic coils; electrical interconnections between said two reproducers whereby the pulsations respectively induced in said dynamic coils by said excitation mutually cancel; and a common baffle for the diaphragms of said reproducers, said diaphragms being so disposed with respect to said baffle that their radiations on either one side of said baffle combine in aiding phase.

2. In an electromagnetic translating system, the combination of two substantially similar translating devices each including a magnetic circuit wherein is provided an air-gap and including a dynamic coil operatively located in said air-gap, a diaphragm, and means coupling said diaphragm to said coil; a common source of pulsating direct current for exciting said magnetic circuits; an electrical work circuit connected with both said dynamic coils; electrical interconnections between said two translating devices whereby the pulsations respectively induced in said dynamic coils by said excitation mutually cancel; and a common baffle for the diaphragms of said two translating devices, said translating devices being disposed on respectively opposite sides of said baffle.

3. In an electromagnetic translating system, the combination of two translating devices each including a magnetic circuit wherein is provided an air-gap and including a dynamic coil operatively located in said air-gap, a diaphragm, and means coupling said diaphragm to said dynamic coil, said coupling means in one only of said translating devices including means for reversing the phase of vibration of the diaphragm relative to the dynamic coil of such translating device; a common source of pulsating direct current for exciting said magnetic circuits; an electrical work-circuit connected with both said dynamic coils; electrical interconnections between said two translating devices whereby the pulsations respectively induced in said dynamic coils mutually cancel; and a common baffle for the diaphragms of said two translating devices, said translating devices being disposed on the same side of said baffle.

4. The method of operating two substantially similar electromagnetic reproducers each including a magnetic circuit wherein is provided an air-gap and including a dynamic coil operatively located in said air-gap and a diaphragm coupled to said coil, which comprises exciting said magnetic circuits with similar pulsating direct current to polarize similarly respectively corresponding sides of said two gaps, supplying sound-representing currents from a common source to said dynamic coils in respectively opposite phase, and combining the sound radiations from respectively opposite sides of said two diaphragms.

5. The method of operating two substantially similar electromagnetic sound reproducers each including a magnetic circuit wherein is provided an air-gap and including a dynamic coil operatively located in said air-gap and a diaphragm coupled to said coil, which comprises exciting said magnetic circuits with similar pulsating direct current to polarize oppositely respectively corresponding sides of said two gaps, supplying sound-representing currents from a common source to said dynamic coils in respectively similar phase, and combining the sound radiations from respectively opposite sides of said two diaphragms.

6. The method of operating two electromagnetic sound reproducers each including a magnetic circuit wherein is provided an air-gap and including a dynamic coil operatively located in said air-gap and a diaphragm vibrated by said coil, which comprises exciting said magnetic circuits with similar pulsating direct current to polarize similarly respectively corresponding sides of said two gaps, supplying sound representing currents from a common source to said dynamic coils in respectively opposite phase, reversing the phase of vibration of one only of said diaphragms with respect to its associated dynamic coil, and combining the radiations from respectively corresponding sides of said two diaphragms.

7. The method of operating two electromagnetic sound reproducers each including a magnetic circuit wherein is provided an air-gap and including a dynamic coil operatively located in said air-gap and a diaphragm vibrated by said coil, which comprises exciting said magnetic circuits with similar pulsating direct current to polarize oppositely respectively corresponding sides of said two gaps, supplying sound representing currents from a common source to said dynamic coils in respectively similar phase, reversing the phase of vibration of one only of said diaphragms with respect to its associated dynamic coil, and combining the radiations from respectively corresponding sides of said two diaphragms.

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