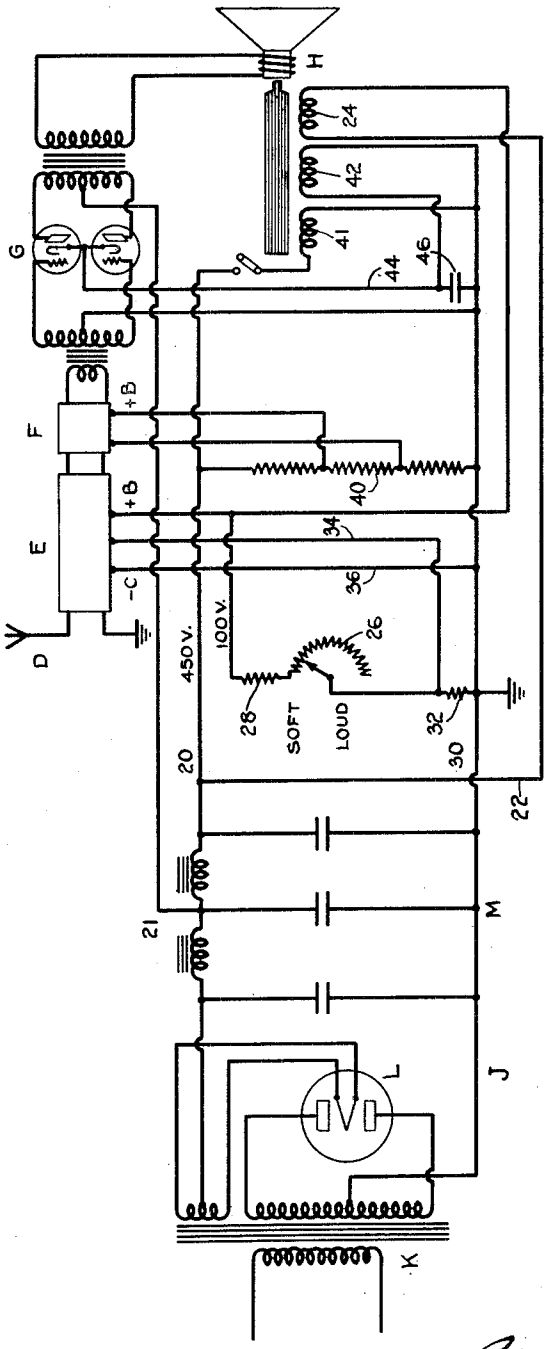
Jan. 5, 1932. L. L. JONES 1,839,968

REPRODUCER

Filed March 28, 1929



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Patented Jan. 5, 1932 1,839,968

UNITED STATES PATENT OFFICE

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REPRODUCER

Application filed March 28, 1929. Serial No. 350,732.

This invention relates to reproducers and more particularly to loud speakers of the electro-dynamic type.

A popular reproducer used with radio receiving sets is the electro-dynamic speaker. This type of speaker employs a field winding through which uni-directional current is passed in order to create an intense and steady magnetic field in which an armature coil carrying the signal current is vibrated. To energize the field of the speaker requires a considerable amount of energy, and for the economical and convenient provision of the necessary field exciting energy, I find it feasible to separate each of a plurality of pulsating signal energies into its steady component and signal components, and to utilize the steady component for energizing the field of the reproducer.

The foregoing method, and the circuits adapted for the practice thereof, are not claimed herein, being disclosed and claimed in a copending divisional application, Serial No. 350,730, filed concurrently therewith.

While the foregoing method may be applied in a number of ways, some of which will be described more in detail later, I am more especially interested in its application to receiving circuits of a common type which employ an audio frequency power stage between the receiver itself and the reproducer. The power stage is usually energized at a direct potential which is considerably higher than that needed to energize the amplifier tubes of the receiver. Inasmuch as it ordinarily is convenient to employ a single source of direct energy for the entire receiving system it then becomes necessary to reduce the voltage of the source before applying it to the anodes of the amplifier tubes. To obtain the desired reduced voltage and to simultaneously energize the field of the reproducer without wasting energy, I feed the anode current from the source to the amplifier through a field coil of the reproducer, thereby obtaining one of the exciting energies.

In a typical receiver the foregoing mode of energization of the reproducer field provides, say, 6 watts of energy. The field needed is so intense that ordinary speakers of this type dissipate, say, 12 watts of energy for field energization. It is possible to provide the necessary field by using an increased number of lower resistance field windings, and so to operate the speaker on 6 watts of energy, but the growth in size, weight, and cost of the speaker is so rapid, when the available energy is decreased, that it is much more desirable and commercially practicable to provide the greater rather than the lesser amount of energy.

A further feature of my invention resides in the provision of even the additional field energy by utilizing waste energy. The power stage of the receiver employs the maximum anode potential available from the direct current source, and requires a correspondingly high bias potential, which heretofore has been obtained from the flow of the anode current of the power stage through a fixed resistance. Instead of wasting this energy, I use it to further excite the speaker field. While a lower potential difference is here available than in the case of the potential reduction applied between the direct current source and the radio frequency amplifier, the current is commensurately larger and an approximately similar quantity of energy, say 6 watts, is available in each case for energizing the speaker field. By utilizing a novel reproducer both waste energies may be employed together, and such a reproducer, especially adapted for use in receiving circuits as previously set forth, constitutes the subject and the object of the present invention.

To the accomplishment of the foregoing and such other objects as will hereinafter appear, my invention consists in the reproducer elements and their relation one to the other, as hereinafter are more particularly described in the specification and sought to be defined in the claims. The specification is accompanied by a drawing showing a wiring diagram for a broadcast receiver employing my novel reproducer.

Referring to the drawing, there is a suitable antenna or signal collecting circuit D, the energy picked up by which is amplified in a radio frequency amplifier E, after which it is rectified in any suitable detector F in order

to make available the audio frequency component thereof, which then may be amplified in an audio frequency amplifier here exemplified by a push-pull power stage G, the output from which is translated in an electro-dynamic reproducer H. The entire receiving system is energized from a source of direct energy generally indicated at J, the latter comprising a power line transformer K, a rectifier L, and a filter M. The details of the radio frequency amplifier and detector, and the wiring for the filament heating currents of the tubes, have all been omitted in order to simplify the diagram.

The power stage G necessitates an anode voltage of the order of magnitude of 250 to 450 volts and, consequently, the power source J is designed to supply this voltage. The tubes in the amplifier E need only be supplied with an anode voltage of the order of magnitude of 100 volts, and it has been customary heretofore to obtain the necessary reduction in voltage by dissipating energy in a fixed resistance. Now, in accordance with my invention, the anode current for the amplifier E is fed from the positive side 20 of the power source, by way of a lead 22, through the field coil 24 of the speaker H, and thence to the amplifier E.

My invention also involves a novel and very effective volume control for the receiver, but this will not be described in detail herein, inasmuch as it is disclosed and claimed in my copending application already referred to. Briefly considered, it may be mentioned that there is a volume controlling circuit including a fixed resistance 28 and a variable resistance 26 connected between the anode supply lead of the amplifier E, and the positive terminal of the biasing resistance 32, the other terminal of which is connected to the negative side 30 of the direct current source. In this manner the volume control circuit forms an additional return path from the speaker coil 24 for field energizing current auxiliary to the anode current. When the resistance of the volume control circuit is lowered the current flow through the coil 24 is increased, and the potential drop thereacross is increased, thereby reducing the anode potential applied to the amplifier, and so reducing its sensitivity. Meanwhile, the total current flow through the reproducer is augmented, rather than diminished as would be the case were no auxiliary magnetizing current provided. The increased total current flows through the biasing resistor 32, and thereby serves to increase the negative bias potential on the tubes of the amplifier, which affects the sensitivity of the amplifier in the proper direction, and at the same time obviates any possibility of a local signal over-running the bias on the control electrodes of the tubes.

It is customary in present receivers to employ electrode potentials on the detector tube which are quite different from those employed on the amplifier tubes. This condition may, if desired, be accommodated by the provision of a potentiometer resistance 40, at suitable tapping points on which leads are taken to the electrodes of the detector tube.

An electro-dynamic speaker requires an intense magnetic field. With a given amount of energy available, it is possible to design the field winding for the proper field strength. However, the number of turns and the cross sectional area of each, and, consequently, the weight, the size, and the cost of the speaker, increase enormously with a decrease in available power. A speaker designed to operate on 12 watts of field energy may be manufactured for about half the cost of a speaker designed to operate on, say 6 watts of field energy. In an average set the field energization obtained by the already described expedient is, say, 6 watts. It is, therefore, desirable to augment the field energization, if possible, and my invention makes this possible by the provision of a reproducer with a field which is excited by a plurality of separate exciting circuits arranged to be independently energized from a plurality of immediate sources of energy. More specifically, I provide an electro-dynamic speaker having a plurality of field windings, instead of a single field winding, so that an additional field winding may be energized directly from the power box, as is indicated by the coil 41 in the wiring diagram, even tho the applied potential is far different from that applied to the winding 24.

However, the primary object of my invention is to make it possible to completely operate an electro-dynamic speaker by the utilization of waste energy. It should be noted that the push-pull power stage G requires direct anode current in excess of that required by the radio frequency amplifier tubes, but it is not desirable to feed this current through a speaker field coil on its way to the power stage G because the maximum voltage obtained from the source J is usually the proper operating voltage for the type of power tube being used. In fact, the anode voltage for the power stage is frequently taken, as is indicated at 21 in the wiring diagram, from an intermediate tap on the filter M.

While the power stage uses an anode voltage which is relatively high, say 450 volts, the control electrodes thereof are biased negatively to a commensurately high value, say 50 volts. This bias potential has heretofore been obtained by passing the steady component of the anode current of the push-pull stage through a resistor on its return path to the negative side 30 of the source J, and then utilizing the potential drop across the re-

sistor for biasing the control electrodes of the power stage. I find that the energy consumed in this resistance is of the order of 6 watts, which is about the order of magnitude of the energy dissipated in the coil 24, despite the much higher terminal voltage difference across the latter. In accordance with my invention the energy which would otherwise be dissipated in obtaining the desired bias potential for the power stage is utilized for energizing the field of the reproducer H.

Referring to the wiring diagram, there is another field coil 42 which is connected in series with the lead 44 from the cathodes of the tubes in the power stage, so that the anode to cathode current of the power stage flows through the coil 42 on its return to the negative terminal of the source J. An audio frequency bypass condenser 46 is arranged in shunt with the coil 42 in order to provide a control electrode to cathode path for audio frequency energy in the power stage, and for the further purpose of shunting audio frequency components in the anode current away from the speaker field coil. It is obvious that the power stage G need not be a push-pull stage, and in such case the necessity for the condenser 46 is, of course, increased. With a push-pull stage the anode current is inherently steadied to a considerable extent, but it is nevertheless desirable to provide the condenser 46 in order to take care of the double audio frequency component which may otherwise be found present in the anode current lead. With windings 24 and 42 I find it is readily possible to dispense with the coil 41, but it is retained in the diagram for the purpose of illustration.

The winding for each of the speaker coils is preferably designed to best accommodate the particular energy with which it is to be excited. Of course, the design of the entire field winding is necessarily a compromise between the desire, on the one hand, for a maximum number of ampere turns for a given amount of available energy, and a desire, on the other hand, to employ a reasonably small amount of material, particularly copper. In the case here considered, the potential across and the current in the windings 24 and 42 are known, and, therefore, the respective desired resistances of these coils is readily ascertained. For example, winding 24 carries a relatively small amount of current, but this current is applied at a high potential, hence this coil is wound of a large number of turns of fine wire. On the other hand, the coil 42 carries a relatively large current which is applied at a relatively low potential, and this coil, therefore, is wound of a fewer number of turns of coarser wire. These remarks refer to the relative magnitudes of the several windings, rather than to their absolute dimensions. As to the latter, little need be said, for the design requirement is simply to obtain the maximum number of ampere turns, (which, in the absence of resistance, might be infinite,) without unduly enlarging the size and cost of the windings.

The structural arrangement of the coils is merely a matter of convenience, and depends to some extent upon the design of the core or magnetic circuit of the particular reproducer. Generally speaking, I consider it preferable to wind each of the coils as an integral unit which just fits into the core structure, and to position the coils alongside of each other, that is, end to end.

In the arrangement here set forth the speaker field is energized by the direct components of the anode currents of the amplifier and of the power stage, and such an arrangement is particularly desirable in practice because some 10 to 12 watts of energy are thus provided, which is sufficient for economical construction without the energy being supplemented by energy fed directly from the same or a different direct current source, for example, the volume control circuit energy in the circuit here illustrated, or the energy in coil 41. However, the utilization of these two waste energies was not only unknown heretofore, but was impossible of accomplishment because there was never available an electrodynamic speaker having two completely independent and unconnected field coils, one consisting of a large number of turns of fine wire, and the other consisting of a small number of turns of coarse wire.

It will be apparent that while I have shown and described my invention in the preferred form, many changes and modifications may be made in the reproducer disclosed without departing from the spirit of the invention, defined in the following claims.

In the claims I shall refer to the windings as adapted to be energized from different immediate sources of energy, although in the very circuit illustrated the energization ultimately is from a single power line because the energies differ in potential and current magnitudes.

I claim:

1. In combination, an electro-dynamic speaker having a movable armature coil adapted for energization by audio frequency energy, and having a plurality of independent stationary field windings one of which consists of a large number of turns of fine wire, while another consists of a small number of turns of coarse wire, an immediate source of direct current at relatively high potential connected to the first winding, and an immediate source of direct current at relatively low potential connected to the second of said windings, said windings each being designed for optimum practical utilization of

the particular energies by which they are excited.

2. In combination, an electro-dynamic speaker having a movable armature coil adapted for energization by audio frequency energy, and having a plurality of independent stationary field windings one of which consists of a large number of turns of fine wire, while another consists of a small number of turns of coarse wire, an immediate source of direct current at relatively high potential connected to the first winding, and an immediate source of direct current at relatively low potential connected to the second of said windings, said windings each being designed for optimum practical utilization and for approximately equal dissipation of the particular energies by which they are excited.

Signed at New York, in the county of New York and State of New York, this 27th day of March, A. D. 1929.

LESTER L. JONES.