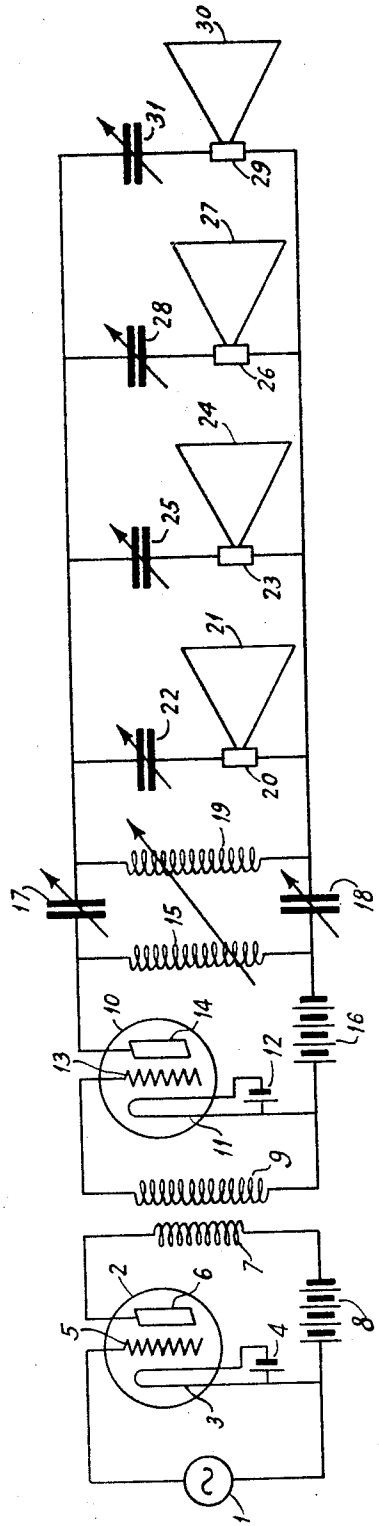
Oct. 17, 1933. A. McL. NICOLSON 1,931,235

SOUND REPRODUCING SYSTEM

Filed April 2, 1927 2 Sheets-Sheet 1

Fig. 1



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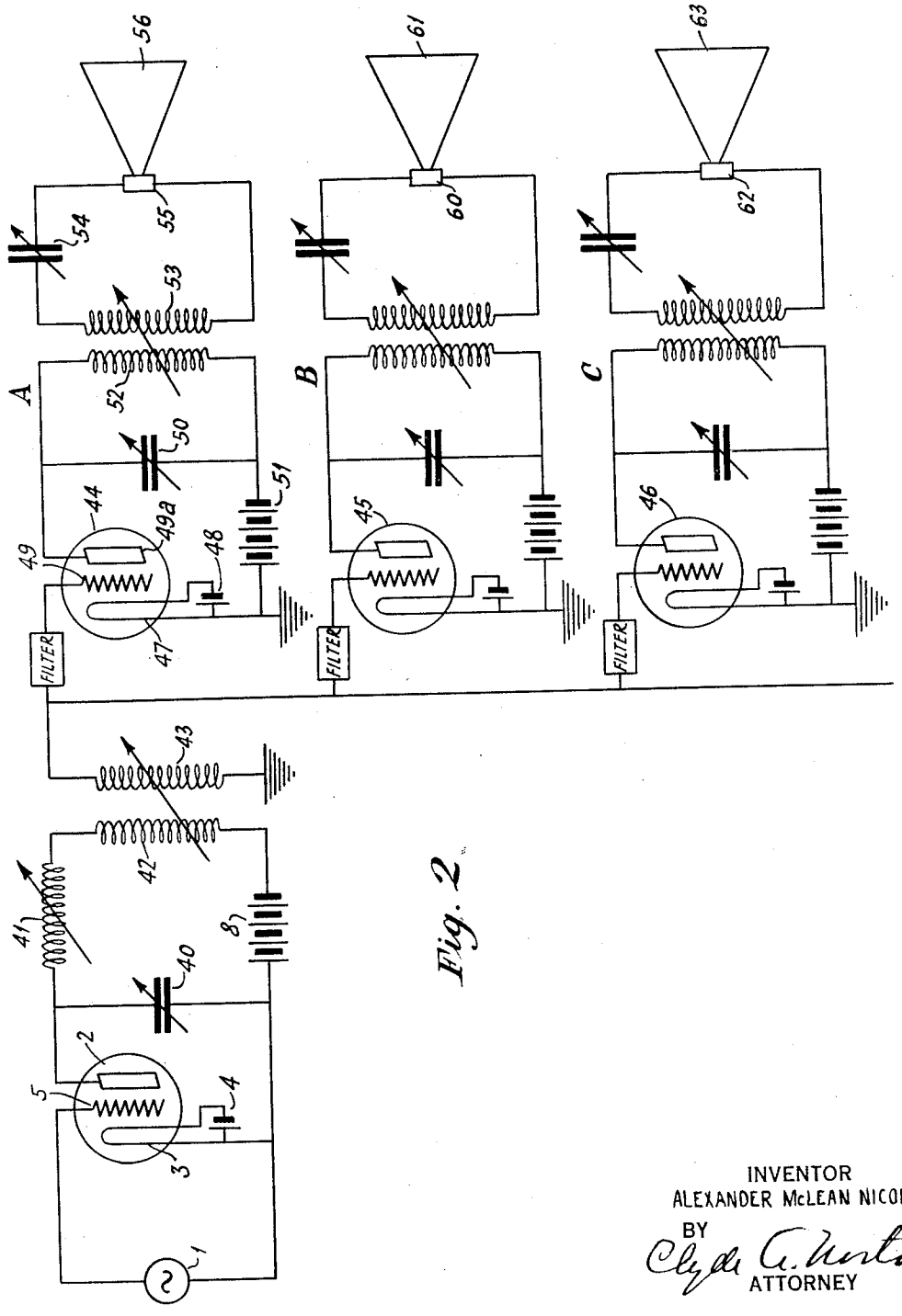


Fig. 2

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UNITED STATES PATENT OFFICE

1,931,235

SOUND REPRODUCING SYSTEM

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Application April 2, 1927. Serial No. 180,420

9 Claims. (Cl. 179—171)

This invention relates to sound reproducing apparatus and more particularly to such apparatus arranged to be operated by electrical oscillations corresponding to the sounds to be reproduced, and adapted to reproduce audible sounds corresponding to speech, music and the like.

It is an object of this invention to provide improved sound reproducing apparatus having a response characteristic which is flexible, so to speak, in that it may be controlled as to any part or parts, by predetermination and design, or by adjustment of the apparatus in operation, or both.

It is a further object of this invention to provide such apparatus by means of which any desired frequency or band of frequencies may be selectively amplified for any desired purpose. Still other objects and advantages of my invention will be apparent from the specification.

The features of novelty which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its fundamental principles and as to its particular embodiments will best be understood by reference to the specification and accompanying drawings, in which:—

Fig. 1 is a diagrammatic view of apparatus according to one form of my invention.

Fig. 2 is a similar view of apparatus according to a modified form of my invention.

In accordance with my invention, I utilize a plurality of sound reproducing units having different natural frequencies disposed within the band of frequencies which it is desired to reproduce. Each sound reproducing unit may comprise means for converting electrical oscillations into acoustic vibrations and an acoustic amplifier adapted to sustain and amplify the acoustic vibrations produced by the unit. A multiplicity of such units are provided and, preferably, each is adapted to respond to a particular frequency or band of frequencies different at least in part from that to which the other units respond. The units may differ in mechanical or electrical tuning, damping, etc., with the ultimate object of reproducing sounds throughout a wider range with greater fidelity than is possible to obtain with a single reproducer.

In accordance with one form of my invention, I may use a common thermionic amplifier arranged to amplify electrically the electrical oscillations to be converted into sound: after the oscillations have been amplified to the extent desired, they may be impressed upon a plurality of sound reproducers as already described.

In accordance with another form of my invention, I may amplify the oscillations to a lesser degree than is desired, after which I may further selectively amplify the oscillations of certain frequencies or bands of frequencies by differing amounts, which amplified oscillations may then be applied to the sound reproducers to be converted into sound.

Referring now more particularly to Fig. 1, 1 designates a source of electrical oscillations which it is desired to convert into sound. This may be the output of a radio receiver, an electric phonograph, a telephone line, a microphone, or the like. For the purpose of amplifying the oscillations, there may be provided a suitable thermionic amplifier 2 having a cathode 3 adapted to be heated by a suitable source of energy such as battery 4 to cause electron-emission. The amplifier 2 also comprises a control electrode or grid 5 and a plate or anode 6 of any suitable type. The amplified currents pass through the inductance 7 and a suitable source of plate potential 8, and thence to the filament. The inductance 7 is coupled to inductance 9, connected in the input circuit of a second thermionic amplifier 10 comprising cathode 11 adapted to be heated by suitable source of energy such as battery 12, control or grid electrode 13, and anode or plate electrode 14 adapted to be energized by suitable plate source 16. An inductance 15 may be provided connected between the positive terminal of the plate battery 16 and the anode: and a second inductance 19 may be connected to the terminals of the inductance 15 through suitable variable capacities 17 and 18.

Connected across the terminals of the inductance 19, I provide a multiplicity of sound reproducing devices, each device comprising a unit or means for converting electrical oscillations into acoustic vibrations and an acoustic amplifier such as a horn or sounding board adapted to sustain and amplify such acoustic vibrations. In this instance, while I have shown four such devices, it is to be understood that this is merely diagrammatic and that it is within the scope and contemplation of my invention to utilize as many such devices as may be found necessary or desirable for the purpose of producing uniform response over the range desired to be covered.

The units are designated as 20, 23, 26 and 29 respectively and the acoustic amplifiers are diagrammatically shown as horns 21, 24, 27 and 30 respectively: associated with each of the reproducers, I may provide a suitable tuning arrangement, diagrammatically shown as variable con-

densers 22, 25, 28 and 31. In the operation of apparatus according to my invention, the oscillations to be converted into sound are amplified by the amplifiers 2 and 10 and impressed upon the terminals of the various sound reproducing devices, which are arranged either by predetermination and design or adjustment, or both, to respond to different frequencies or bands of frequencies. It is possible to control the amplitude of response as well as the frequency of response by varying the damping, either mechanical or electrical, of each of the reproducing devices. The natural frequency or frequency band of each of the devices may be varied, also, either mechanically or electrically, as a result of which it will be understood that it is possible either to raise or to lower the amplitude of response at any particular frequency or band of frequencies to eliminate peaks and valleys in the response curve of the entire apparatus.

Under certain conditions, it may be desired to control the amplification at certain frequencies or band of frequencies, as well as to control the factors already mentioned. For this purpose, I may utilize the apparatus shown in Fig. 2, in which the amplified currents from the amplifier 2 are passed through variable inductance coils 41 and 42 and battery 8 shunted by variable condenser 40. A suitable coil 43 is provided coupled to coil 42, connected on the one hand to ground and on the other hand to the input circuits of the amplifiers 44, 45, and 46 and to any other amplifiers which may be used.

The amplifier 44 may comprise a suitable cathode 47 adapted to be heated by a suitable source such as battery 48 to cause electron emission, a grid or control electrode 49 and a suitable anode or plate electrode 49*a*. The output circuit may be tuned by means of variable inductance 52 and condenser 50 and is energized by suitable battery 51. Inductance 53 is provided coupled to inductance 52 and connected through variable condenser 54, and a sound reproducing unit 55 provided with an acoustic amplifier such as horn 56. Interposed in the input circuit of the amplifier 44, I may provide a suitable filter adapted to pass into the amplifier 44 oscillations of the frequency to which the system is tuned and to exclude from it oscillations of other frequencies.

A series of such amplifiers is provided, the second system comprising amplifier 45 and its associated tuning elements corresponding to variable condensers 50 and 54 and coils 52 and 53. This system comprises a sound reproducing unit 60 and an acoustic amplifier 61. Similarly, the amplifier 46 is provided with tuning elements and its sound reproducing unit 62 and acoustic amplifier 63: each of the said amplifying and sound reproducing systems are preferably tuned to a different frequency or band of frequencies at which they may respond the best, and in each case the filter will be so selected as to permit the oscillations of only those frequencies to be amplified by the corresponding amplifier.

While I have shown only three amplifying systems A, B, and C, it will be understood that as many systems will be provided as are necessary or desirable for the purpose of providing uniform response over the desired range.

It will be understood that the electrical and mechanical tuning of each of the systems may be controlled by predetermination and design or adjustment in operation, or both. Likewise, the degree of damping, both mechanical or electrical, may be controlled, and also the amount of amplification for any frequency or band of frequencies, may be controlled. It will be understood that by the use of this apparatus, it is possible to secure practically any desired type of response: if, for instance, the electrical oscillations of low frequency supplied by the source 1 are of smaller amplitude than they should be, the amplification in the amplifiers handling the oscillations of such frequencies may be increased while that of the other amplifiers is held constant or even decreased, until the desired tonal balance is secured.

It will be understood that any suitable means may be employed for converting electrical oscillations into acoustic vibrations, but for this purpose, I prefer to utilize piezo-electric crystal devices such for example as crystals of Rochelle salt exhibiting the well known "hour-glass" configuration, and provided with suitable electrodes known in the art and such as described in my copending applications entitled, "Composite piezo-electric torsion device," Serial No. 155,899, filed March 11, 1927, and "Internally clamped composite piezo-electric torsion device," Serial No. 155,900, filed December 20, 1926.

While I have shown and described certain preferred embodiments of my invention, it will be understood that modifications and changes may be made without departing from the spirit and scope of my invention as will be understood by those skilled in the art.

I claim:

1. An acoustic system comprising a multiplicity of at least partially resonant sound reproducing units having piezo electric crystals the resonant frequencies of which are so chosen as to be distributed over the band of frequencies to be reproduced, all of said units being connected to be driven by a single source of electrical oscillations and electrostatic means connected to each side of said source for coupling said sound reproducing units to said source, each of said means being independently variable for controlling the potential supplied to said sound reproducing units.

2. An acoustic system comprising a multiplicity of at least partially resonant sound reproducing units, each comprising means including a piezo electric element for converting electrical oscillations into acoustic vibrations and an acoustic amplifier associated therewith for sustaining and amplifying said acoustic vibrations, the resonant frequencies of said units and amplifiers and the amount of damping being so chosen as to give a substantially uniform response characteristic over the response band, all of said units being connected to be driven by a single source of electrical oscillations and electrostatic means interconnecting each side of said source with said units, each of said electrostatic means being independently variable for controlling the potential supplied to said units.

3. An acoustic system comprising a multiplicity of at least partially resonant sound reproducing units each comprising means including a piezo electric element for converting electrical oscillations into acoustic vibrations, and an acoustic amplifier associated therewith for sustaining said acoustic vibrations, all of said units being connected to be driven by a single source of electrical oscillations, a plurality of tuned circuits associated with said units and electrostatic means interconnecting each side of said source with said units, said electrostatic means being independ-

ently variable for controlling the potential impressed upon said units.

4. An acoustic system comprising a multiplicity of at least partially resonant sound reproducing units each comprising means including a piezo electric element for converting electrical oscillations into acoustic vibrations and an acoustic amplifier associated therewith for sustaining said acoustic vibrations, and a plurality of tuned circuits associated with said units, the resonant frequencies of said units and amplifiers and the amount of damping being so chosen as to give a substantially uniform response characteristic over the response band, all of said units being connected to be driven by a single source of electric oscillations and adjustable capacitative means interconnecting each side of said tuned circuits with said source for controlling the potential impressed across each of said tuned circuits.

5. An acoustic system comprising a plurality of at least partially resonant sound reproducing units, each comprising piezo electric means for converting electrical oscillations into acoustic vibrations, a thermionic amplifier associated with each reproducing unit for amplifying electric oscillations within a predetermined frequency range, a tunable output circuit coupling each said amplifier to its respective reproducing unit and means to control the potential impressed upon each said amplifier.

6. An acoustic system comprising a plurality of at least partially resonant sound reproducing units, each comprising piezo electric means for converting electrical oscillations into acoustic vibrations, a thermionic amplifier common to said reproducing units for amplifying said oscillations, an output circuit for said amplifier, individually tunable control circuits for said reproducing units tunably coupled in parallel to said output circuit and means to control the potential impressed upon said circuits for said reproducing units.

7. An acoustic system comprising a source of electrical oscillations, an electron tube amplifier network the control circuit of which is adapted to receive said oscillations, an output circuit for said amplifier network, a plurality of at least partially resonant sound reproducing units having piezo electric crystals the resonant frequencies of which are so chosen as to produce a desired response characteristic over a given band of audio frequencies, and an actuating network comprising tuning elements individually associated with each of said sound reproducing units said actuating network being tunably coupled to said output circuit for said amplifier network.

8. An acoustic system comprising an electron tube amplifier connected to receive variable current corresponding to sound vibrations, an output circuit connected to said amplifier, an inductance in said output circuit, a plurality of partially resonant sound reproducing elements, independent tuning means connected with each of said elements, a parallel connected circuit including said tuning means and said sound reproducing elements, an inductance in said last mentioned circuit variably coupled with the inductance in said output circuit, and variable coupling means connected between said output circuit and said parallel circuit for controlling the potential impressed upon each of said independent tuning means.

9. An acoustic system comprising an electron tube amplifier having input and output circuits, a multiplicity of piezo electric crystal elements of different frequency characteristics disposed in individually tuned circuits, an inductance in said output circuit, and variable coupling means interconnecting points of opposite potential in said inductance with said individually tuned circuits in parallel for impressing variable potential on each of said piezo electric crystal elements for the reproduction of sound over a broad response band.

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