Feb. 14, 1933. H. F. OLSON ET AL 1,897,732

SYSTEM FOR THE CONVERSION AND TRANSFER OF ENERGY

Filed May 29, 1931

Fig. 1.

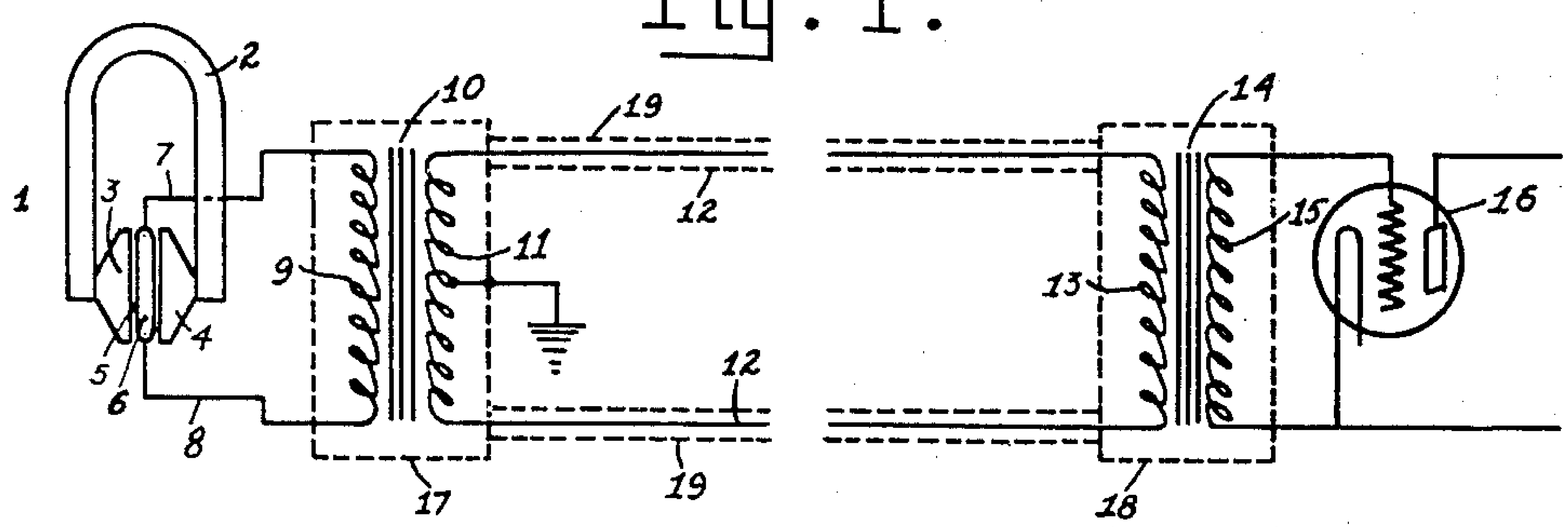
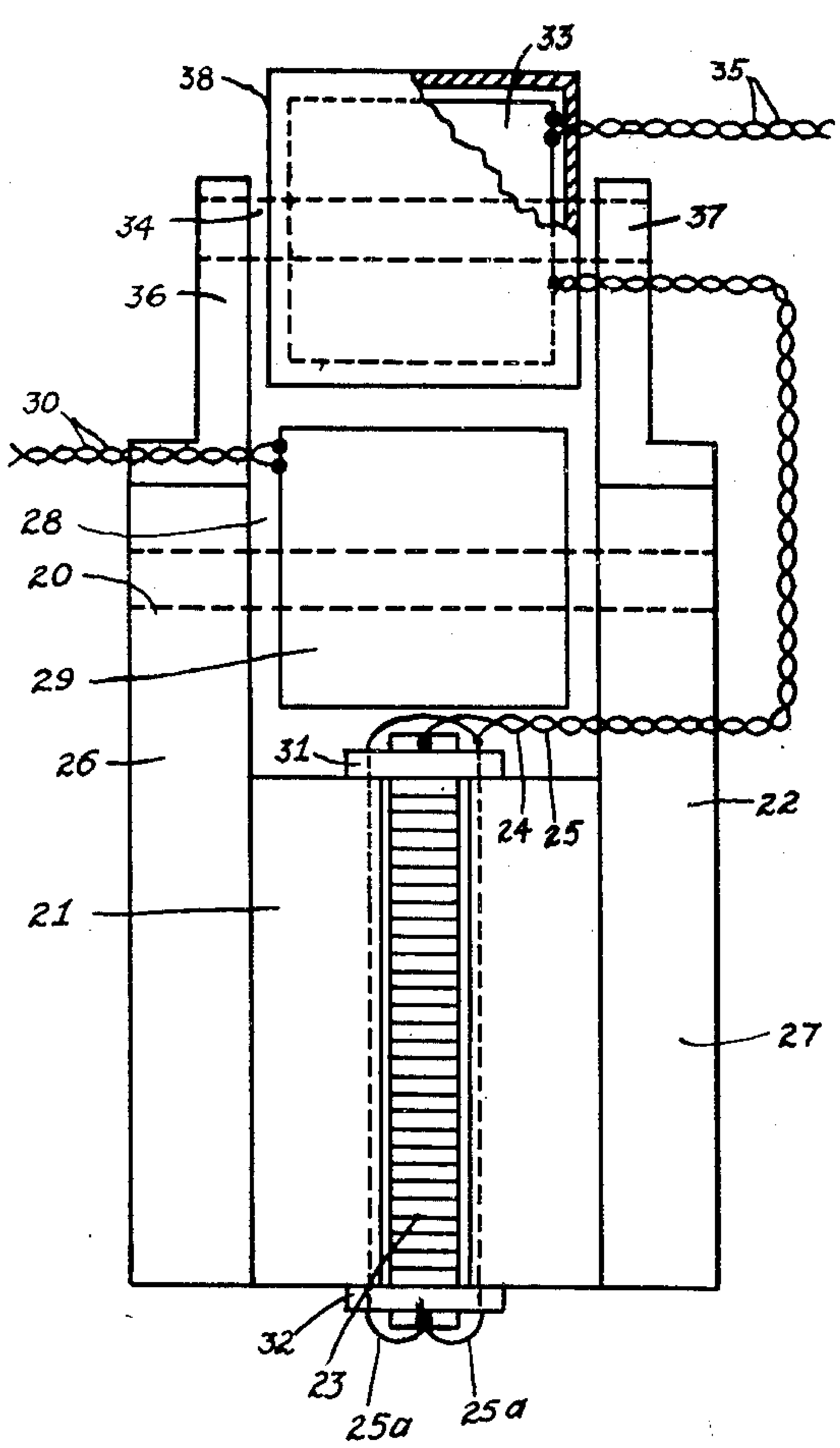



Fig. 2.




INVENTOR
HARRY F. OLSON
BARTON KREUZER
BY H. S. Grover
ATTORNEY

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# UNITED STATES PATENT OFFICE

HARRY F. OLSON, OF NEW YORK, AND BARTON KREUZER, OF ROCKAWAY PARK, NEW YORK, ASSIGNORS TO RADIO CORPORATION OF AMERICA, A CORPORATION OF DELAWARE

## SYSTEM FOR THE CONVERSION AND TRANSFER OF ENERGY

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This invention relates to a system for the conversion and transfer of energy. More particularly the invention relates to a system consisting of apparatus for converting waves of pressure and/or velocity into electrical variations, and means for conveying the electrical variations to some other apparatus. In a specific form the invention relates to an acoustic system consisting of a low impedance microphone and a circuit for transferring energy from the microphone to apparatus such as an amplifier.

Various systems have been designed for the conversion of acoustical energy into electrical energy and for the transfer of the electrical energy to suitable apparatus. Different types of microphones are used in these systems to convert the sound waves into electrical energy, and usually it is necessary to transfer the electrical energy to a vacuum tube amplifier where it is amplified before being recorded or utilized in some other manner. In most instances, such as where a condenser microphone having a very high impedance is used, it is necessary to have the amplifier located immediately adjacent the microphone so that the output of the high impedance microphone can be coupled directly to a vacuum tube amplifier.

For some purposes, however, it has been found undesirable to locate an amplifier adjacent the microphone. It has been found more desirable to have a small and compact microphone structure connected through a simple transmission line to an amplifier located at some point at least several feet from the microphone. It is the object of this invention to provide a system which will include a microphone having all the advantages of the microphones now in general use and which will, at the same time, not require a vacuum tube amplifier connected immediately adjacent the microphone.

The object of the invention is attained by providing a microphone having a very low impedance, and by locating immediately adjacent the microphone structure a relatively small step-up transformer, the input of which is connected with the output of the microphone, and the output of which feeds a transmission line of medium impedance. At the other end of the transmission line there is a second step-up transformer for connecting the transmission line to a high impedance amplifier. A desirable arrangement is to include the first step-up transformer as a part of the microphone structure. As a result of this arrangement the output energy can be transferred over the transmission line to an amplifier located at some distance from the microphone without excessive losses or appreciable distortion.

For a more detailed description of the invention reference may be made to the following specification which should be read in connection with the acompanying drawing in which:

Fig. 1 is a diagrammatical representation of the system constituting one feature of the invention, and

Fig. 2 is a plan view of an approved modification of the microphone and transformer structure.

Referring more particularly to the system shown in Fig. 1 the microphone is indicated diagrammatically at 1. It consists of a magnet 2 having pole pieces 3 and 4 arranged to provide an air gap 5. A thin, flexible ribbon-like conductor 6 is positioned in the air gap 5 and supported for movement by sound waves in a direction to cut the lines of force of the magnetic field across the air gap. Movement of the ribbon in the air gap sets up an electromotive force in the ribbon. The electromotive force may be conveyed by suitable conductors 7 and 8 connected to the ends of the ribbon, to any desired apparatus. For the best results the conductors 7 and 8 should be twisted and otherwise arranged so as to avoid forming an inductive loop. A microphone of this type may be indicated generally as a low impedance microphone due to the comparatively low impedance of the ribbon-like conductor. For a more complete understanding of the microphone and of the manner in which it operates, reference may be made to the co-pending application S. N. 526,598 filed March 31st 1931 in the name of Harry F. Olson.

According to the present invention the output of the microphone is conveyed by means of the conductors 7 and 8 to the primary winding 9 of a step-up transformer, 10. The secondary winding 11 is connected to a medium impedance transmission line 12. The transmission line 12 may be several feet in length or longer and the conductors should be twisted to prevent the transmission line from acting as a loop and picking up energy. The other end of the transmission line is connected to the primary winding 13 of a second step-up transformer 14. The secondary winding 15 of the transformer 14 is connected to the input of the high impedance amplifying tube 16 or to some similar apparatus. By means of this arrangement the energy from the low impedance microphone 1 is stepped-up so that it can be transferred along the medium impedance transmission line 12 to the amplifier 16 located several feet from the microphone, without excessive losses or appreciable distortion.

It would not be feasible to connect a low impedance microphone directly to the transmission line and to locate a step-up transformer adjacent an amplifier positioned several feet from the microphone. In such an arrangement the impedance due to the inductance of the line would be comparable to the impedance of the device itself at the higher frequencies and the line would attenuate high frequencies. It would also not be feasible to connect a high impedance microphone such as a condenser microphone, to an amplifier located several feet from the microphone, by means of a transmission line. In the latter arrangement the disturbed capacity of the line would be such that the high frequencies would be attenuated. A low impedance microphone with a single step-up transformer located immediately adjacent thereto, would be the equivalent of a high impedance microphone, and if connected with an amplifier located several feet from the microphone, would be objectionable for the same reason. In all of the last mentioned cases it is necessary to locate the amplifier immediately adjacent the microphone to avoid losses and distortion. This feature which is sometimes undesirable, is avoided by using the system shown in Fig. 1.

It is usually advisable to shield the transformer 10 by suitable electromagnetic and electrostatic shielding means. For example, the transformer 10 may be enclosed in a suitable container 17. Likewise the transformer 14 may be enclosed in a similar shielding container 18. It may even be desirable, in some instances, to provide electrostatic and electromagnetic shielding 19 for the conductors of the transmission line 12. The shielding means 19 may be in the form of a separate shielding member for each conductor or it may be a single shielding member for both conductors of the transmission line. The shielding members are preferably grounded, as shown, and it is usually desirable to ground the mid-point of one of the transformer windings connected to the transmission line.

Fig. 2 shows in some detail, the structure of an approved form of the combined low impedance microphone and step-up transformer. The microphone consists of a magnet system indicated generally at 20, pole pieces 21 and 22, a ribbon-like conductor 23, and leads 24 and 25 connected to the ends of the conductor 23. The lead 25 is split into two parts 25*a* and 25*b* which are threaded through holes drilled in pole pieces, to the other end of the ribbon-like conductors where they are joined. The two leads 24 and 25 are then twisted, as shown, to prevent the picking up of energy. By splitting the conductor 25 into two parts, 25*a* and 25*b*, two loops are formed with the conductor 23. As these loops oppose each other any energy picked up by the loops will be balanced out.

The magnet system 20 consists of two arms 26 and 27 of magnetic material, a connecting arm 28 of magnetic material and a winding 29 adapted to be energized by means of leads 30 from any source of direct current. The ribbon-like conductor 23 is preferably crimped in order to make it limp so that it will have only a very small restoring force. It is supported by means of suitable supporting members 31 and 32 preferably of non-conducting material. Movement of the ribbon-like member 23 between the pole pieces 21 and 22 sets up an electromotive force in the ribbon which is conveyed by conductors 24 and 25 to suitable apparatus.

The first step-up transformer, which is located immediately adjacent the microphone, is indicated at 33. It consists of a primary winding and a secondary winding surrounding a suitable metallic core 34. The conductors 24 and 25 are connected to the primary winding. Conductors 35 which constitute a medium impedance transmission line, are connected to the secondary winding of transformer 33. The conductors are twisted, as shown, to prevent the picking up of energy. The transformer 33 is equivalent of transformer 10 in Fig. 1, and the conductors 35 are the equivalent of the intermediate impedance transmission line 12 in Fig. 1. The transformer 33 is supported from suitable portions of the microphone structure such as the ends of the arms 26 and 27, by means of two braces 36 and 37. The braces 36 and 37 are preferably made of brass or some other non-magnetic material. The transformer 33 is preferably enclosed in an electromagnetic and electrostatic shielding container 38. The container usually consists of two layers of high permeability material and one layer of high conductivity material. It may also be found desirable to use shielding means for the leads 35.

Various modifications can be made to the system shown in Fig. 1 and to the combined microphone and transformer shown in Fig. 2 without departing from the spirit of the invention. It is therefore to be understood that we do not intend to be limited to the modification shown in the accompanying drawing, but only by the limits of the broadest interpretation of the foregoing specification and by the scope of the appended claims.

What we claim is:

1. A system for the interconversion and transfer of energy of audio frequencies comprising a low impedance device for converting energy variations in other than electrical form into electrical variations, a high impedance device, and an intermediate impedance transmission line for transferring said electrical variations from said low impedance device to said high impedance device.

2. An acoustic system comprising, within audio ranges of frequency, a low impedance microphone, a high impedance device, and an intermediate impedance transmission line for transferring energy from said low impedance microphone to said high impedance device.

3. A system for converting and transferring energy consisting of a low impedance microphone, a step-up transformer connected to said microphone, a medium impedance transmission line connected to said transformer, a second step-up transformer connected to said medium impedance line, and a high impedance amplifier connected to said second step-up transformer.

4. In combination, a low impedance microphone, a step-up transformer connected to the output of said microphone, a medium impedance transmission line, the secondary of said transformer being connected to said transmission line, a second transformer located at the end of said transmission line and some distance from said microphone, and means for utilizing the output of said microphone, said second transformer matching the impedance of the transmission line and that of said means.

5. Acoustic apparatus comprising a low impedance microphone, and a step-up transformer located immediately adjacent the microphone and supported from the microphone structure.

6. Acoustic apparatus comprising a microphone including an energizing winding therefor, a transformer winding positioned immediately adjacent said microphone and a shield interposed between said energizing winding and said transformer winding.

7. Acoustic apparatus comprising an elongated vibratile conductor, means for providing a magnetic field, means for supporting said conductor for vibration in said field, and leads connected to the ends of said conductor, one of said leads being in two parts which are brought back along side of said conductor to its opposite end where the two parts are joined and continue as a single conductor twisted with the other conductor.

8. Acoustic apparatus as set forth in claim 7 in which the means for providing the magnetic field includes pole pieces, and in which the two parts of the conductor are threaded through holes bored in said pole.

9. A system for the inter-conversion and transfer of energy comprising a low impedance device for converting energy variations in other than electrical form into electrical variations, a high impedance device, an intermediate impedance transmission line for transferring said electrical variations in said low impedance device to said high impedance device, and means connected at the opposite ends of said transmission line for matching it respectively with said low impedance and high impedance devices.

10. An acoustic system comprising a low impedance microphone for converting sound waves into electrical energy, a high impedance device, a transmission line of medium impedance for transmitting electrical energy from said microphone to said device, and means connected at opposite ends of said line for matching the impedances of said microphone and said device with the impedance of said line.

11. An acoustic system comprising a low impedance device for converting sound into electrical energy, a high impedance device, a transmission line of medium impedance, a step-up transformer connected between said low impedance device and said transmission line, and a step-up transformer connected between said transmission line and said high impedance device.

12. Apparatus for transferring electrical energy from a microphone to an amplifier located at a distance from the microphone, comprising a low impedance microphone circuit, means for stepping up the energy from the low impedance microphone circuit to an intermediate impedance circuit, an intermediate impedance circuit, a high impedance amplifier circuit and means for stepping up the energy from the intermediate impedance circuit to the high impedance circuit.

HARRY F. OLSON.
BARTON KREUZER.