

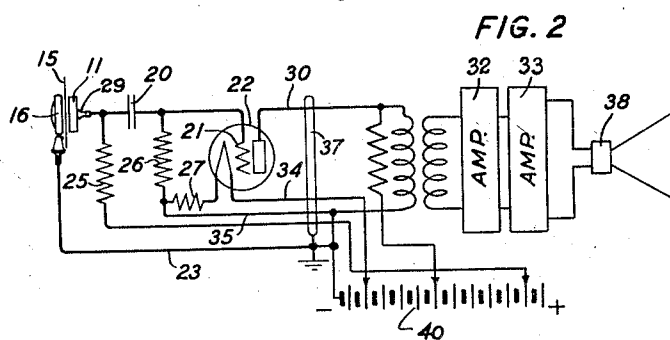
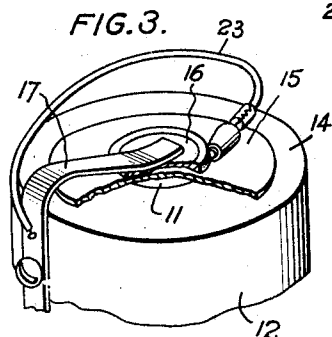
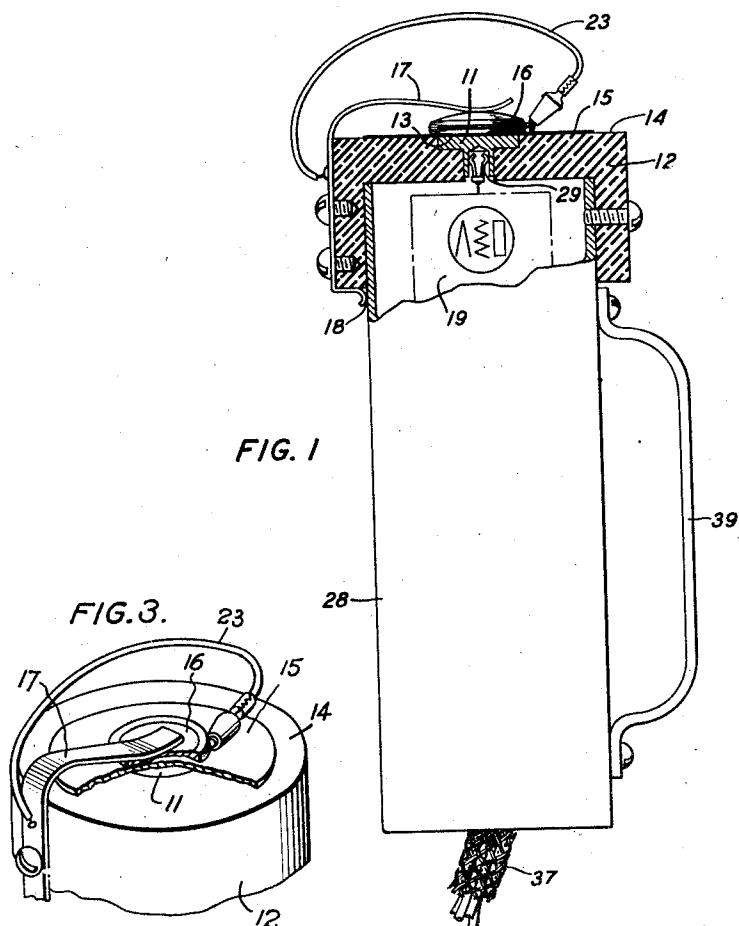
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AMPLIFYING SYSTEM

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## UNITED STATES PATENT OFFICE

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## AMPLIFYING SYSTEM

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This invention relates to vibration translating systems and it is the object of the invention to provide a system suitable for amplifying very faint sounds or mechanical vibrations of very low intensity.

In many cases it is a great convenience, as for instance, when it is desired to study their nature, to be able to amplify very minute vibrations to a very high degree. Since the initial level of such vibrations, which may be the tick of a watch, machinery noises, heart beats or other body sounds, is very low, it is extremely difficult to obtain the desired volume level without seriously distorting the sound and introducing so much background noise that the system is of no practical value. Various arrangements have been proposed heretofore for picking up sounds of low intensity, the most common arrangement being an ordinary transmitter actuated by acoustic vibrations transmitted to it through the air from the sound source. A somewhat better system can be made by using a suitable transmitter in actual contact with the vibrating body so that the diaphragm of the transmitter is actuated mechanically rather than acoustically. It is found, however, that with such a contact arrangement when the sounds or vibrations are amplified sufficiently a great deal of distortion is unavoidable due to resonant vibration of the connecting members or the diaphragm of the transmitter. This type of distortion seriously impairs the naturalness of the amplified sound and renders such systems impractical or entirely useless for many applications.

In accordance with the general features of this invention the sound source or member whose vibrations are to be amplified serves as one electrode of a condenser-transmitter so that the vibrations of the member are translated directly into electrical variations with no intermediate moving parts. With such an arrangement there can be no distortion of the type produced by the resonances referred to above and the noise will be substantially eliminated since the pick-up device will be very insensitive to sound transmitted to it acoustically.

Such a system is very useful to jewellers in repairing very small watches. It is the common practice to analyze the trouble in a watch by listening to the variation in its sound when it is turned into various positions, but in the case of very small watches the sounds are so faint that this procedure is impractical. Most amplifying systems are unsatisfactory for this purpose for the reasons already given but a very natural

sound at any desired volume level can be produced by placing the watch on a thin piece of dielectric material spread over a suitable condenser-transmitter electrode. A voltage of positive polarity is applied to the electrode and the watch itself is grounded so that it will not be damaged by magnetization. The electrode is associated as directly as possible with the grid of the first tube of the amplifying system and the vibration of the watch case will vary the capacity between it and the electrode to produce electrical variations in the amplifier input.

It will be understood, of course, that this arrangement is described merely to illustrate the general principle of the invention and that this principle is equally applicable to other uses as more fully explained below.

In the drawing, Fig. 1 is a general view partly in section of an arrangement according to the invention suitable for use in testing watches;

Fig. 2 is a schematic diagram of the associated amplifying and reproducing system; and

Fig. 3 is a perspective view of the upper portion of Fig. 1.

In Fig. 1 a metal electrode 11 is embedded in an insulating member 12 preferably with its upper face 13 in the plane of surface 14. The electrode is covered by a thin sheet of dielectric material 15 such as one-half mil condenser paper impregnated with phenol and the watch 16 or other vibrating body is held on this sheet directly over the electrode by a spring clip 17 attached to the member 12 and making contact at 18 with the metal casing 28 of the amplifier 19.

In accordance with the usual practice in using condenser transmitters it is necessary to locate the amplifier 19 as closely as possible to the transmitter because of the extremely small output of such a device.

Any amplifier suitable for use with a condenser-transmitter of very small capacity may be used in carrying out this invention. The general problems involved are well understood and are fully explained in such patents as 1,397,862 to Fitch, November 22, 1921 and 1,422,837 to Crandall, July 18, 1922. The circuit connections actually used for this first stage of amplification are shown in detail in Fig. 2 from which it is seen that the back electrode 11 is connected through a condenser 20 of very small capacity to the grid 21 of the tube 22. Since the spring clip 17 contacts the crystal of the watch 16, a detachable conductor 23 is provided to connect the watch to the grounded amplifier casing 28, as shown, and the source of polarizing potential 40 for the electrode

11 has its negative terminal grounded and its positive terminal connected to the electrode by conductor 36 through a very high resistance 25. The input circuit of the tube 22 is shunted by another very high resistance 26 and the grid 21 is maintained at a suitable negative potential with respect to the grid by a low resistance 27. The resistances 25, 26, 27, the condenser 20 and the tube 22 are all located within the casing 28 and are disposed so that the path between the spring connection 29 and the grid 21 is as short as possible.

Due to the considerable gain in the tube 22 the currents in the plate circuit wire 30 are of sufficient magnitude that it is practical to carry them some little distance to a convenient location for the additional amplifiers 32 and 33. In the embodiment shown this wire is grouped together with the battery wires 34, 35 and 36 within a flexible copper shielding 27 extending between the casing 28 and the amplifier 32. This shielding also serves to carry the common ground and plate circuit return connection to the other amplifiers. The output of amplifier 33 may be fed to a loudspeaker 38 or earphones may, of course, be used instead if preferred.

When used for testing watches as already described, it will be convenient to provide a handle 39 so that the device may be readily turned into any desired position or the casing 28 may be mounted in a frame suitable for this purpose.

It should be understood, however, that the invention is not limited to this particular application, for by merely removing the clip 17 and securing the dielectric 15 to the member 12 the device could be used instead of the well known listening stick for studying machinery noises.

Similarly it can be directly applied to the human body as a stethoscope, but in some cases it may be desirable for the patient to lie on a metal table covered with a suitable dielectric when the body sounds are to be studied.

Other applications of this general principle will occur to those skilled in the art and the invention is intended to be limited only by the following claims.

What is claimed is:

1. In a system for amplifying the sounds emitted by a vibrating body, a condenser type translating device in which one electrode of the device is the vibrating body and the other electrode serves as a support for the body, means for polarizing the device, a receiver and an amplifying system connected between the receiver and the translating device.

2. A vibration translating device comprising an electrode, supporting means therefor, means for polarizing the electrode, means for connecting it to an external circuit, a dielectric member for contacting a vibrating body covering the electrode and means for connecting the body contacted to the circuit.

3. In a system for amplifying the ticks of a watch for test purposes, a condenser type translating device in which the electrodes are separated by a thin sheet of dielectric material, the watch under test being one of the electrodes and being supported by the other electrode, means for grounding the watch, means for applying a potential to the other electrode, a receiver and a grounded amplifying system connected between the receiver and the translating device.

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