Aug. 18, 1942. S. VASILACH 2,293,372

MEANS FOR AMPLIFYING MECHANICAL VIBRATIONS

Filed Aug. 8, 1939

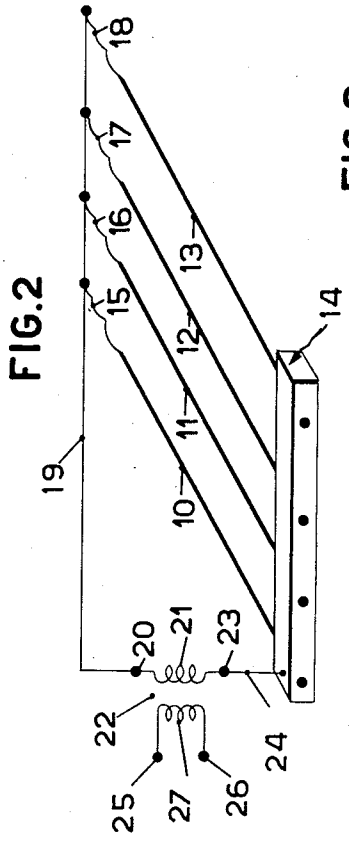

FIG.2

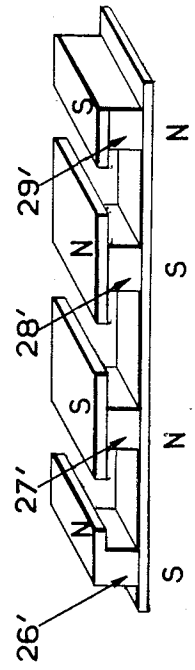

FIG.3

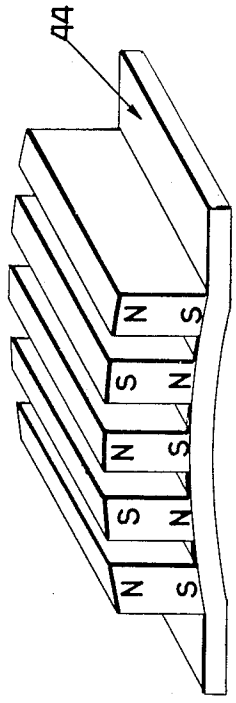

FIG.5

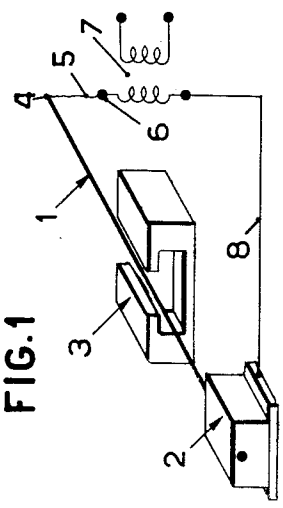

FIG.1

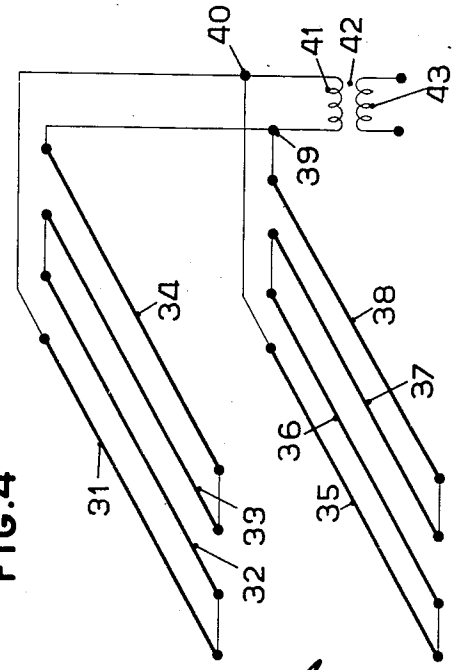

FIG.4

Inventor:
S. Vasilach
By E. F. Wendroth
Atty

Patented Aug. 18, 1942

2,293,372

UNITED STATES PATENT OFFICE

2,293,372

MEANS FOR AMPLIFYING MECHANICAL VIBRATIONS

Serge Vasilach, Paris, France, assignor of three-fourths to Societe des Telephones Picart Lebas, Paris, France, a corporation of France

Application August 8, 1939, Serial No. 289,048
In France August 10, 1938

2 Claims. (Cl. 84—1.14)

The present invention has for its object improvements in devices which enable the mechanical oscillations of vibrating bodies to be converted into electrical oscillations that are capable of being amplified by means of thermionic tubes.

For obtaining this conversion, the devices of the present invention consist in the combination of one or a plurality of vibrating bodies (strings, rods, tubes, etc.) placed in constant magnetic fields which are created by appropriate electromagnets or magnets, the vibrating bodies being on the other hand connected to primary windings of coupling transformers, the secondary windings of which may be connected to the grids of one or a plurality of thermionic tubes.

When the vibrating bodies thus connected in magnetic fields start vibrating, the area of the circuit or circuits, which are closed through said vibrating bodies and the primary windings of the coupling transformer or transformers, varies and produces variations of flux of the same frequency as the mechanical vibrations. Said variations of flux produce induced electromotive forces that can be amplified at will by means of coupling transformers and of one or more thermionic tubes. At the output of these amplifiers, the electric oscillations, thus obtained can be reproduced by means of loud-speakers, or other suitable receiving devices.

The present invention furthermore includes any applications that ensue from its principle, and in particular the applications involving the amplification of the sound waves produced by musical instruments: violins, pianos, harps, bells, chimes or others.

Devices according to the spirit of the invention can furthermore be used for studying in detail the shape and the intensity of the mechanical oscillations of vibrating bodies in general.

The vibrating bodies are set in vibration either by means of bows, (violins, cellos, for example) or by shocks, by striking the bodies in question by means of appropriate hammers (pianos, chimes, bells).

In order to enable the spirit of the present invention to be better understood, several embodiments have been given hereinafter by way of a non-limitative example, which are applicable to the amplification of the waves produced by chimes provided with rods, tuning forks or vibrating tubes, violins or pianos. It is obvious that any other applications may be readily considered with the present devices.

Fig. 1 shows diagrammatically an embodiment comprising a vibrating rod which is embedded at one end and free at the other, a permanent magnet and a transformer which transmits the induced electromotive forces to the grid of a thermionic tube.

Fig. 2 shows the diagram of an embodiment with a plurality of vibrating rods which are embedded at one end and free at the other.

Fig. 3 shows by way of example the shape of a group of magnets for an embodiment with a plurality of vibrating bodies.

Fig. 4 shows diagrammatically the group of vibrating bodies connected in series-parallel across the terminals of the primary winding of a coupling transformer.

Fig. 5 relates to a shape of magnet which is applicable to string instruments.

As shown in the embodiment of Fig. 1, 1 denotes a vibrating metal rod which is embedded at one end in a heavy mass 2 and passes between the two poles of a magnet 3. The free end 4 of the rod is connected by a very flexible wire 5 to one of the terminals of the primary winding 6 of a transformer 7, the other terminal of the primary winding of said transformer being connected to the metallic mass 2 by means of a conductor 8. The secondary winding of said transformer may be connected to the input of a thermionic tube amplifier of any appropriate type.

The method of operation of such a device is as follows: In the normal position, the magnetic flux that passes through the area limited by the contour formed by the rod 1, the mass 2, the conductor 8, the primary winding 6 and the flexible wire 5 is constant.

When the rod 1 is set in vibration, by touching it for example with an appropriate hammer, the area limited by said contour varies, in the region of the contour formed by the vibrating rod 1. The part of said rod between the poles of the magnet 3 thus produces variations of magnetic flux to which there correspond induced electromotive forces whereof the frequencies are the same as those of the mechanical oscillations of the vibrating rod.

Said induced electromotive forces control, by means of the transformer 6, the control grid of the first thermionic tube of any amplifier. At the output of said amplifier, the modulated currents supply either loud-speakers, or any other receivers of electrical energy.

Fig. 2 shows a modification comprising a plurality of vibrating rods (10, 11, 12, 13) which are embedded on the one hand in a metallic mass 14

at one of the ends and are free at the other end. The free ends are connected together by very flexible wires (15, 16, 17, 18) which are joined through a conductor 19 to the terminal 20 of the primary winding 21 of an input transformer 22. The other terminal 23 of the winding 21 is connected to the mass 14 by means of a conductor 24.

The terminals 25 and 26 of the secondary winding 27 of the transformer 22 are connected to the input of an appropriate amplifier. The whole arrangement of Fig. 2 represents an embodiment with a plurality of vibrating rods connected in parallel across the terminals of the primary winding of the same transformer.

Each rod of this group is placed between the poles of a magnet such as the magnet 3 of Fig. 1, or between the poles of a magnetic arrangement shown in Fig. 3. As can be seen in this figure, said magnetic arrangement comprises a plurality of magnets (26', 27', 28', 29') which are fixed on the one hand on the same plate made of magnetic metal 30 by their opposite poles and are provided at the other end with metal plates which limit the air-gaps between which pass the vibrating strings or rods (10, 11, 12, 13, Fig. 2).

The operation of the embodiment shown in Figs. 2 and 3 is the same as that which corresponds to Fig. 1.

Fig. 4 shows a diagram in which the vibrating bodies are formed by groups of any metal strings or rods coupled in series-parallel. Each group comprises a plurality of vibrating bodies connected in series (31, 32, 33, 34 or 35, 36, 37, 38); the corresponding groups being then coupled in parallel to the terminals 39 and 40 of the primary winding 41 of the transformer 42, the secondary winding 43 of which is connected to the input of a thermionic tube amplifier.

The operation of such an embodiment is similar to that of those previously described. The vibrating bodies are placed in magnetic fields produced by magnets such as those shown in Fig. 3.

The strings may be set in vibration either by striking them with appropriate hammers, or by means of bows, bells, chimes, etc.

The same principle applies to the amplification of the sounds emitted by any other types of string and keyboard instruments.

It is quite obvious that the embodiments described above and diagrammatically illustrated in Figs. 1, 2, 3, 4 and 5 of the accompanying drawing, are given by way of a non-limitative example, it being possible to consider any modifications of the whole arrangement and of detail without exceeding the spirit of the present invention.

It is possible, with such devices, to consider the construction of apparatus which are capable of reproducing in a visible form the vibratory state of any metal body. By moving said body relatively to a magnet or the magnet relatively to the vibrating body, it is possible thus to explore the whole extent of the aforesaid body and to localize the nodes and the swells of oscillation and also the amplitude of same, by means of appropriate recording devices (cathode ray oscillographs, for example).

Another example of application of the invention consists in the construction of burglar alarms. Such devices comprise, according to the present invention, one or a plurality of vibrating strings (judiciously mounted in the room or rooms or the regions to be protected) which are coupled either in series or in parallel, or in series-parallel and are finally connected to the terminals of primary windings of one or a plurality of coupling transformers. Each string, which is suitable tensioned, passes between the poles of an or by any other means.

Fig. 5 shows the diagram of a magnetic device which can be fitted on string instruments: violins, cellos, or others. This arrangement is formed by flat magnets which are fixed on the one hand by their opposite poles on a magnetic plate 44 and create at the other end air-gaps for lodging the vibrating strings.

Said strings, which are connected together in series or in parallel, are then connected to the terminals of the primary winding of a transformer, as stated in the embodiments shown diagrammatically in Figs. 1, 2 or 4 of the drawing accompanying the present specification. It would thus be possible to construct violins, cellos or other string instruments without a sounding board, the sound waves being reproduced, after amplification, by a loud-speaker.

For obtaining a system of bells and chimes, the invention consists in a group of vibrating rods which are embedded at one end and free at the other, for example, the free ends being connected by flexible wires to the input terminals of one or a plurality of coupling transformers. The vibrating rods are coupled, either in series or in parallel, or in series-parallel, and are placed in constant magnetic fields. The rods are set in vibration by means of hammers which are controlled by keys on one or a plurality of keyboards. It is thus possible, by means of various combinations of vibrating rods, to obtained the ringing of appropriate magnet. The secondary windings of the coupling transformer or transformers are connected to the input of one or a plurality of thermionic tube amplifiers. In the output circuits of said amplifiers are interposed sensitive relays which are controlled by the modulated thermo-electronic currents which have been previously amplified and rectified.

The operation of such a device is as follows: If, for any reason (shocks, sufficiently loud noises, vibrations of the support or supports of the strings) one or a plurality of strings start vibrating, they produce, as in the previous examples, induced electromotive forces which after amplification, actuate one or a plurality of sensitive relays, it being possible for said relays, which are provided with appropriate contacts, to start the operation of warning signals, either directly, or through the intermediary of secondary relays or switches.

What I claim is:

1. A musical instrument for electrical sound production comprising an electrically conducting member adapted to be mechanically struck, a constant magnetic field in which said member oscillates, induced alternatingly currents being taken from the ends of said member, said member being fixed at one end thereof and a resilient conductor for taking off the induced electrical currents secured to the freely swinging end of said member.

2. A musical instrument as set forth in claim 1 in which said constant magnetic field is formed as a plurality of constant magnetic fields in which a plurality of oscillating members are arranged parallel to one another and said plurality of constant magnetic fields are formed by pole pieces arranged on a common support.

SERGE VASILACH.