Feb. 13, 1934. E. L. KOCH 1,947,049

AMPLIFYING SYSTEM

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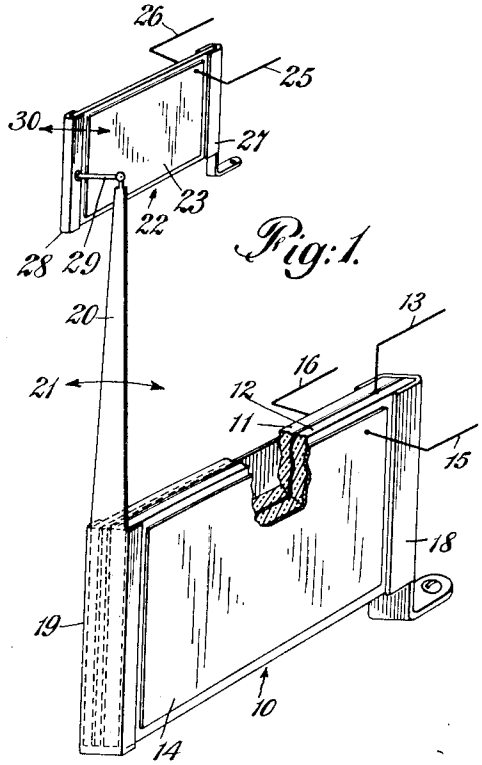



Fig. 1.

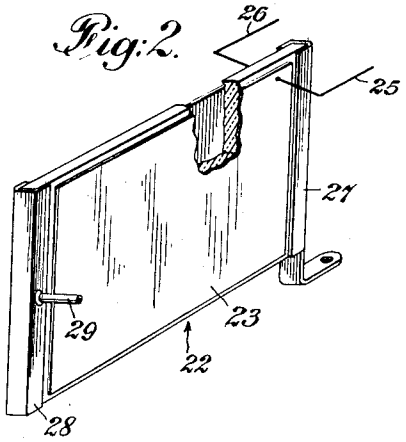
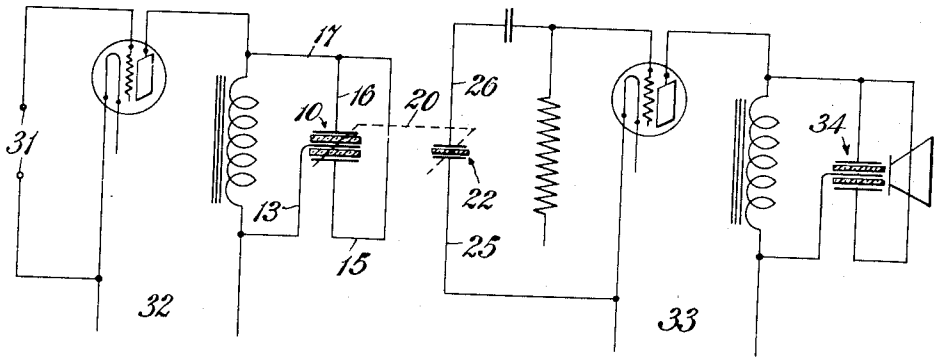



Fig. 2.

Fig. 3.




INVENTOR
Earl L. Koch
BY
H. C. Van Deventer
ATTORNEY

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## AMPLIFYING SYSTEM

Earl L. Koch, Chicago, Ill., assignor, by mesne assignments, to Earl L. Koch Holding Corporation, New York, N. Y., a corporation of New York

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3 Claims. (Cl. 179—171)

This invention relates to improvements in amplifying systems and has for an object the provision of a piezo-electric mechanical means for obtaining voltage gain in an amplifier.

Another object of the invention is the provision of an amplifier using fewer amplifying tubes and giving greater output than the present types of amplifiers.

A further object of the invention is the provision of an amplifier comprising two portions in which there is no electrical connection between the output of one portion and the input of the other portion.

Other objects and advantages will be apparent to those skilled in the art upon reading this specification and the appended claims.

Piezo-electric crystals composed of quartz are well known in the art and it is known that they respond to electrical impulses impressed thereupon. There are a great many other crystalline substances which have properties similar to the quartz crystals in varying degree. The term "piezo-electric crystal" as used herein may apply to any crystalline substance which responds or moves when an electrical potential is impressed thereon.

These crystals also have the property in that when flexed or distorted mechanically they generate a potential. It has been found that with like materials the potential generated is substantially the same although the crystals may be of different physical dimensions, and the potential generated is also proportional to the amount of distortion or flexure of the crystal. An article in "Proceedings of the Institute of Radio Engineers", November 1931, entitled "The Use of Rochelle Salt Crystals for Electrical Reproducers and Microphones" by Sawyer, (pages 2020–2029), describes these crystals.

This invention includes the use of a crystal, operated by a suitable output circuit such as from one or more stages of an amplifier, for mechanically flexing or driving a second, and preferably smaller, crystal and impressing the voltage generated by this second crystal upon the input circuit of one or more succeeding stages of amplification.

Referring to the drawing:

Figure 1 is a view showing a driving crystal and a driven crystal and one method of mechanically transmitting motion from the former to the latter;

Figure 2 is an enlarged view of the driven crystal; and

Figure 3 is a simple circuit diagram of an amplifier embodying one form of the invention.

A twin crystal designated generally by the numeral 10 consists of two crystals 11, 12 cemented together with a sheet of metal foil therebetween. A connection to this foil is shown at 13. A sheet of foil 14 is secured to the outside surface of the crystal 12 and a like sheet of foil (not shown) is attached to the outside of the crystal 11. Connections to these foils are shown at 15 and 16 respectively and these are combined into one lead wire 17.

One end of the combined crystal 10 is clamped into a suitable mounting bracket 18 by means of which the crystal may be rigidly secured to a suitable support.

The other end of the crystal 10 has a clamp member 19 secured thereto having an extended arm 20 associated therewith. When a modulated potential is impressed upon the foil plates of the crystal 10 via the wires 13 and 17 the end of the crystal carrying the member 19 moves the arm 20 as shown by the arrow 21.

A single crystal 22, preferably of smaller dimension and thickness has a foil plate 23 secured to one side thereof and a second foil plate (not shown) on the other side thereof and lead wires 25 and 26 respectively connect to the foil plates.

One end of the crystal 22 is clamped into a suitable mounting bracket 27 by means of which the crystal may be rigidly secured to a suitable support.

The other end of the crystal 22 has a clamp member 28 secured thereto carrying a stud 29, which is secured to the extended arm 20 in any suitable manner.

When a modulated potential is supplied to the crystal 10 as above described and the arm 20 is thereby moved as shown by the arrow 21 this arm drives or flexes the crystal, the motion being indicated by the arrow 30.

This causes a potential to be generated by the crystal 22 in timed relation to the flexure thereof and this potential is fed to the input of one or more stages of the amplifier as shown in the diagram in Figure 2.

The input terminals 31 may be connected to the detector circuit of a radio frequency amplifier or any source of impulses which it is desired to amplify.

These impulses are amplified by the stage 32 and the output therefrom is impressed upon the crystal 10 via the wires 13 and 17, causing the crystal to flex in timed relation to the impulses impressed thereon.

The extended arm 20, which is of long leverage giving an increased motion at the end thereof, via the stud 29 drives or flexes the crystal 22 in timed relation to the movement of the crystal 10 but at greater amplitude (due to the multiplication provided by the length of the arm 20) and impulses of a greater potential are generated by the crystal 22 than is furnished to the crystal 10.

The output of the crystal 22 is impressed via the wires 25 and 26 upon the input of a stage of amplification 33, wherein the voltage gain afforded by the combination of the crystals is further amplified.

The output of the stage 33 may be connected to a loud speaker 34, which may consist of a crystal similar to the crystal 10 with the exception that the arm 20 is arranged to drive a suitable diaphragm.

The two crystals linked together comprise a converter adapted to receive and be driven by impulses from one stage of an amplifier and to generate impulses of similar character to, but higher potentials than, those received. These generated impulses are delivered to a succeeding stage and a gain is effected.

Although a simple embodiment of this invention has been shown and described, many changes and modifications may be made without departing from the scope of the appended claims.

What is claimed is:

1. In an amplifier in combination, an electronic device having a crystal connected to the output circuit thereof, a second electronic device having a crystal connected to the input circuit thereof, said crystals each having one end secured to a rigid support and each opposite end movable, each of said crystals having a flat rectangular formation with flat sides coated with metal foil forming terminals for the crystals whereby the same are connected in the circuits aforesaid and means connecting the movable ends of said crystals.

2. In combination, a rectangular piezo-electric crystal having metal plates secured to the side surfaces thereof, and constituting terminals therefor, a fixed support for said crystal whereby a portion thereof is left free to vibrate, a lever connected to the free vibratory portion of said crystal, a circuit containing a source of current impulses, connections between said plates and said circuit, a second rectangular piezo-electric crystal having metal plates secured to the side surfaces thereof constituting terminals therefor, a fixed support for said last crystal whereby a portion thereof is left free to vibrate, a second circuit, connections between said last plates and said last circuit, and mechanical means connecting the free vibratory part of said last crystal to said lever whereby vibrations of said first crystal will be transmitted to said last crystal.

3. In combination, a circuit having an input end connected to a source of electrical impulses, means in said circuit for amplifying said impulses, a piezo-electric crystal having flat sides, metal plates secured to the flat sides of said crystal, circuit connections between said plates and the output circuit of said amplifying means, a support for said crystal adapted to rigidly support the same while leaving a portion thereof free to vibrate, a lever connected to the free vibratory portion of said crystal, a second crystal having a portion held against vibration and portion free to vibrate, a connection between said lever and the free vibratory portion of said last crystal and means for amplifying the electrical impulses generated by said last crystal.

EARL L. KOCH.