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2,322,621

ELECTRO-ACOUSTIC TRANSDUCER

Filed Oct. 2, 1941

FIG. 1.

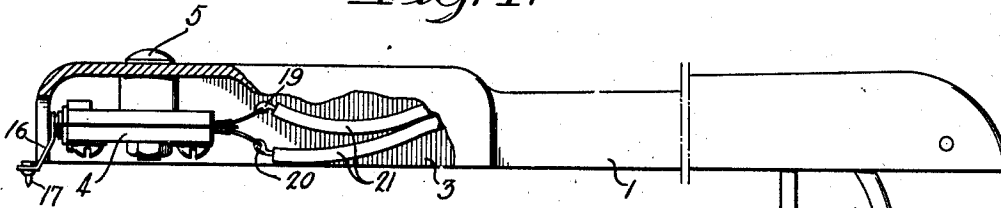


FIG. 2.

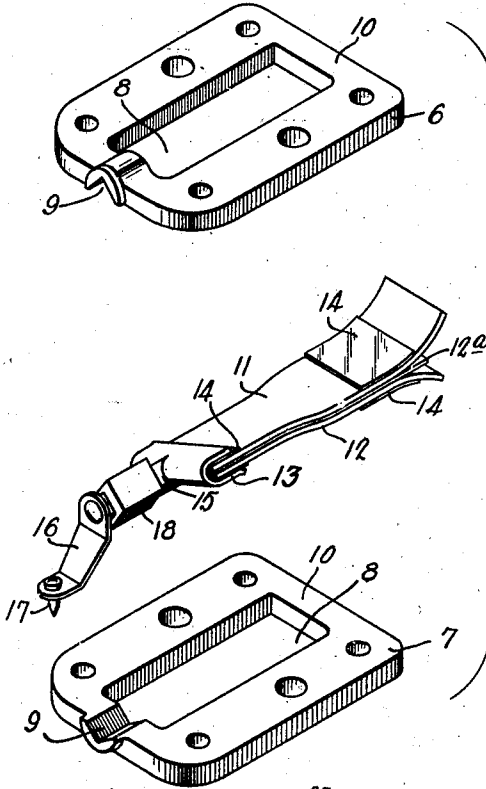


FIG. 4.

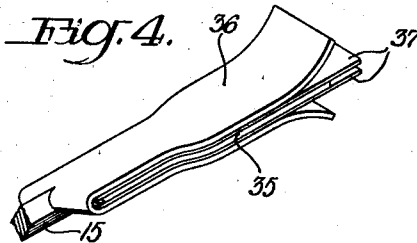
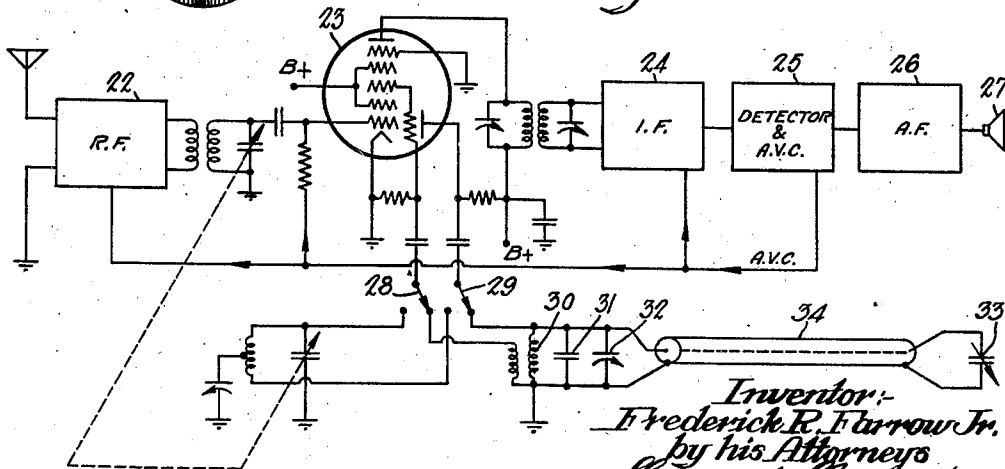


FIG. 3.



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UNITED STATES PATENT OFFICE

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ELECTROACOUSTIC TRANSDUCER

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Application October 2, 1941, Serial No. 413,363

11 Claims. (Cl. 179—100.41)

This invention relates to electro-acoustic transducers of the type adapted when actuated by an acoustic system, such as a phonograph recording, microphone, or like device, to control an electrical system such as an electric wave signal generator or amplifier. The invention is particularly adapted for use in phonograph pickups or microphones in which power supplied from an acoustic system to a transducer operates the same to vary the output signal of a wave signal generator.

An important object of the invention is to provide a novel transducer of simple and compact construction adapted to directly control a wave signal generator.

A further object of the invention is to provide a light weight transducer requiring only a small power input but which is capable of full control of a wave signal generator.

Another object of the invention is to provide a novel variable condenser directly controllable by a suitable acoustic system and adapted to serve as a variable tuning element in a wave signal generator.

Another object of the invention is to provide a novel variable condenser directly operable by the stylus of a phonograph reproducer.

Still another object of the invention is to provide a novel phonograph pickup particularly adapted for association with a wave signal generator capable of generating a frequency-modulated carrier wave.

The invention itself, as well as other objects thereof, may be clearly understood by reference to the accompanying drawing, wherein

Fig. 1 is a side elevation of a tone arm adapted for use in the reproduction of disc recordings, with a portion broken away to show the reproducing element;

Fig. 2 is an exploded perspective view of the reproducing element;

Fig. 3 shows one suitable electrical circuit which may be used with the reproducing element; and

Fig. 4 shows a preferred form of the reproducing element.

Referring to Fig. 1, there is shown a tone arm 1 adapted to be pivotally mounted adjacent a turntable (not shown) for movement thereover during the reproduction of a recording. A vertical post 2 may serve as the tone arm support. At its free end tone arm 1 has an enlarged head portion 3 within which a reproducing element 4 may be secured as by fastening means 5.

The reproducing element is best shown in Fig. 2 wherein the upper and lower halves 6 and 7 of a

frame are shown apart so as to reveal the operative members. Each part 6 and 7 has a rectangular central opening 8, a flat sided front bearing yoke part 9 and a flat rear yoke part 10. The yoke parts 9 form a rectangular or square bearing. The operative members of the reproducer comprise two metallic strips or ribbons 11 and 12 separated throughout their length by a strip of insulating material 12a. When the parts are assembled, the rear ends of ribbons 11 and 12 are clamped in position by the yoke parts 10, while the front ends of ribbons 11 and 12 are held by a U-shaped clamp 13, there being suitable insulating material 14 between the ribbons 11 and 12 and the frame parts 6 and 7 and clamp 13. As shown, clamp 13 is mounted on one end of a rectangular or square shaft 15. An arm 16 is secured to the other end of shaft 15 and has three angularly offset portions such that the free end may carry a stylus 17 adapted to ride in the groove of a recording. The arm 16 may be constructed in accordance with the disclosure in my copending application Serial No. 390,822, filed April 28, 1941. A resilient bushing 18 of rubber or the like surrounds shaft 15 and is clamped in the yoke parts 9 to substantially secure shaft 15 against longitudinal movement, while permitting slight rotational movement. The bushing 18, with yoke parts 9, serves to restore the shaft 15 to its normal angular position whenever it is displaced therefrom. The clamping frames 6 and 7 are secured together by screws or the like, and the assembled reproducer is mounted on the tone arm by bolts 5.

When the parts are assembled, as above described, the arm 16 normally extends substantially downward and clamp 13 is positioned at an acute angle with respect to the rear yoke parts 10 of frames 6 and 7, so that the ribbons 11 and 12 are normally twisted about their longitudinal axes as illustrated. These ribbons may be permanently deformed or they may be retained in their twisted position under initial stress. Electrical contacts 19 and 20 may be secured to ribbons 11 and 12 and wires 21 may extend from these contacts through the tone arm to suitable circuits.

The above described reproducing element constitutes an electrical condenser composed of the two ribbons 11 and 12 spaced by the insulator or dielectric 12a, and when the plates are in their normal position, as shown, they will constitute a condenser of predetermined capacity.

As the stylus 17 traverses the sound groove of a recording, the crank arm 16 will translate the lateral displacement of the stylus by the record

into an oscillatory motion of shaft 15. By virtue of this, the ribbons 11 and 12 will be twisted or torsionally flexed about their longitudinal axes, the oscillations of arm 16 tending when the arm is moving in one direction, to increase the twist of the ribbons, and when moving in the other direction, to decrease their twist. This movement of the ribbons will cause them to move toward and away from each other throughout their length by a very small amount, thus changing the spacing of the ribbons, it being understood that they are not clamped together except at their ends. This movement of ribbons 10 and 11 relative to each other will, of course, vary the capacity of the condenser in accordance with the lateral deflection of the stylus by a recording.

In Fig. 3 there is shown by way of example one suitable electrical circuit for use with the reproducing element above described. The circuit comprises a radio receiver of the superheterodyne type, wherein a common oscillator circuit is employed both as the local oscillator of the superheterodyne during radio reception and as the phonograph pickup oscillator during phonograph operation substantially as disclosed in the application of R. B. Albright, Serial No. 397,986, filed June 13, 1941. The radio receiver may comprise a radio frequency amplifier 22, a detector-oscillator stage including the tube 23, an intermediate frequency amplifier 24, a second detector, and A. V. C. stage 25, an audio frequency amplifier 26, and a loudspeaker 27. When the switches 28, 29 are in their left-hand position, the receiver is adapted for radio reception. When the switches 28, 29 are in the position shown, the phonograph pickup oscillator tank coil 30 is connected to the oscillator grid and oscillator anode of the tube 23. The coil 30 may be tuned to resonate at a desired frequency by a fixed condenser 31, a small adjustable condenser 32, and the condenser 33, which corresponds to the condenser formed by ribbons 11 and 12 of the reproducer 4 above described. Coil 30 is preferably tuned to a frequency above or below the intermediate frequency at a point on the I. F. selectivity characteristic where the characteristic is linear over an appreciable range of frequencies. If now the frequency of the phonograph oscillator is caused to vary about its mean frequency, due to the actuation of condenser 33, the radio frequency output of the I. F. amplifier will vary in amplitude, and the output voltage of the second detector will vary in accordance with the audio frequency signal of the recording. This mode of operation of the receiver circuits is more fully described in the said Albright application and forms no part of the present invention.

Preferably a constant capacity cable, such as the coaxial cable 34, is employed to connect the pickup condenser 33 to coil 30. Since the capacity variations of condenser 33 are very small, it is highly desirable that there shall be no extraneous capacity variations due to the connecting leads. The use of a coaxial cable prevents such extraneous variations.

One embodiment of the present invention applied to a phonograph pickup device employed .005 inch brass condenser ribbons separated by .0025 inch mica insulation, the ribbons being twisted approximately 25 degrees about their longitudinal axes. Other materials or dimensions may be used, such as glass cloth insulation or a resilient insulator, such as latex, and many structural modifications are possible without departing from the invention.

A modified and preferred form of this invention is shown in Fig. 4 wherein the reproducer comprises an inner ribbon 35 and an outer ribbon 36 of U shape folded so as to envelop the inner ribbon 35 as illustrated. Dielectric sheets 37 serve to insulate the two ribbons. With this preferred form of the device, the outer ribbon 36 may contact the frame parts 6 and 7 and is preferably connected to an electrical ground, as by the shielded lead 34, whereby pickup of stray fields is eliminated. Further, in this device, the strip 36 may be attached directly to shaft 15.

A transducer of the type herein described is known as an active transducer and may be defined as one in which the applied power from a recording modulates local power supplied from the oscillator. This type of transducer is, of course, distinct from transducers of the passive type, such as those using piezo-electric crystals in which the output power is derived solely from the applied power. Active transducers or modulators have particular advantages when employed for phonograph reproduction in conjunction with radio receivers, in that they permit the use of the high frequency amplifying circuits of the receiver during phonograph reproduction, and it will be clear that the present invention provides an essentially ideal transducer permitting full advantage to be taken of its inherent characteristics of simplicity, dependability, and quality.

I claim:

1. In an active electro-acoustic transducer, a variable condenser comprising spaced insulated flexible metallic sheet members, said members having substantially rectilinear axes and having a predetermined amount of pre-twist about said axes, and means adapted to torsionally deflect said members about said axes to vary the capacity of said condenser.

2. In an active electro-acoustic transducer, a variable condenser comprising closely-spaced insulated flexible metallic strips pre-twisted about their longitudinal axes, and means adapted to torsionally deflect said strips about said axes to vary the capacity of said condenser.

3. In an active electro-acoustic transducer, a variable condenser comprising spaced insulated flexible flat metallic members, said members having substantially parallel rectilinear axes and having a predetermined amount of pre-twist about said axes, and means comprising a pivotally mounted stylus arm adapted to torsionally deflect said members about said axes to vary the capacity of said condenser.

4. In an electro-acoustic transducer, a variable condenser comprising closely-spaced insulated flexible metallic members normally twisted about their longitudinal axes, and means comprising a pivotally mounted vibratory stylus arm adapted to torsionally deflect said members to vary the capacity of said condenser.

5. In a phonograph pickup device, a tone arm, a pair of oppositely facing frame members secured to said tone arm, said frame members each having a central opening bounded at opposite ends by yoke portions, vibratory means extending into said opening comprising a pair of insulated flexible metallic members each having one end rigidly clamped between one pair of said yoke portions, a resilient bearing secured between the other pair of said yoke portions, a vibratory shaft extending through said bearing, said shaft being secured to the other ends of said metallic members, and means comprising a stylus arm and stylus for actuating said shaft to torsionally de-

fect said members and thus vary the spacing of said members relative to each other.

6. In a phonograph pickup device, a tone arm, a pair of oppositely facing frame members secured to said tone arm, said frame members each having a central opening bounded at one end by a flat yoke portion and at the other end by a recessed bearing-forming yoke portion, vibratory means extending into said opening comprising a pair of closely-spaced insulated flexible metallic members pretwisted about their longitudinal axes, each of said members having one end rigidly clamped between the pair of flat yoke portions, a resilient bearing secured between the other of said yoke portions, a vibratory shaft extending through said bearing into said opening, clamp means secured on said shaft adapted to secure the other ends of said metallic members to said shaft, and a stylus arm and stylus for actuating said shaft to torsionally deflect said members and thus vary the spacing of said members relative to each other.

7. In a phonograph pickup device including a tone arm, a reproducer mounted on said tone arm comprising a condenser formed of two relatively movable long narrow metallic strip elements normally twisted about their longitudinal axes, one of said elements enveloping the other of said elements, and means for deflecting both of said elements relative to each other about said axes in accordance with a recording to vary the capacity of said condenser.

8. In an electro-acoustic transducer, a variable condenser comprising a pair of closely spaced insulated long narrow flexible metallic strips normally twisted about their longitudinal axes, one of said strips enveloping the other of said strips, and means comprising a pivotally mounted vibratory stylus arm adapted to torsionally deflect said strips about said axes to vary the capacity of said condenser.

9. In an electro-acoustic transducer, a variable condenser comprising spaced insulated flexible metallic elements, means for rigidly supporting certain portions of said elements, means for supporting other portions of said elements so as to permit torsional deflection thereof about an axis extending between said portions, said elements having a predetermined amount of pretwist about said axis, and means for torsionally deflecting said elements about said axis to vary the capacity of said condenser.

10. In a phonograph pickup device, a tone arm, a pair of oppositely facing rigid members secured to said tone arm, a variable condenser comprising spaced insulated flexible metallic elements each having a portion rigidly clamped between cooperating parts of said members, means including other cooperating parts of said members for supporting other portions of said elements so as to permit torsional deflection of the latter about an axis extending between the said parts of said members, said elements having a predetermined amount of pre-twist about said axis, and means including a stylus for torsionally deflecting said elements about said axis.

11. In a phonograph pickup device, a tone arm, a pair of oppositely facing rigid members secured to said tone arm, a variable condenser comprising spaced insulated flexible metallic elements each having a portion rigidly clamped between cooperating parts of said members, a non-circular shaft secured to other portions of said elements, a non-circular resilient bushing on said shaft, a yoke formed by other parts of said members adapted to clamp said bushing, said elements when thus supported by said members being twisted about an axis extending between said parts of said members, and a stylus secured to said shaft for torsionally deflecting said elements about said axis.

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