May 8, 1928. 1,668,654

C. R. MOORE

DIRECT CURRENT TRANSFORMING APPARATUS

Filed March 23, 1927

FIG. 1.

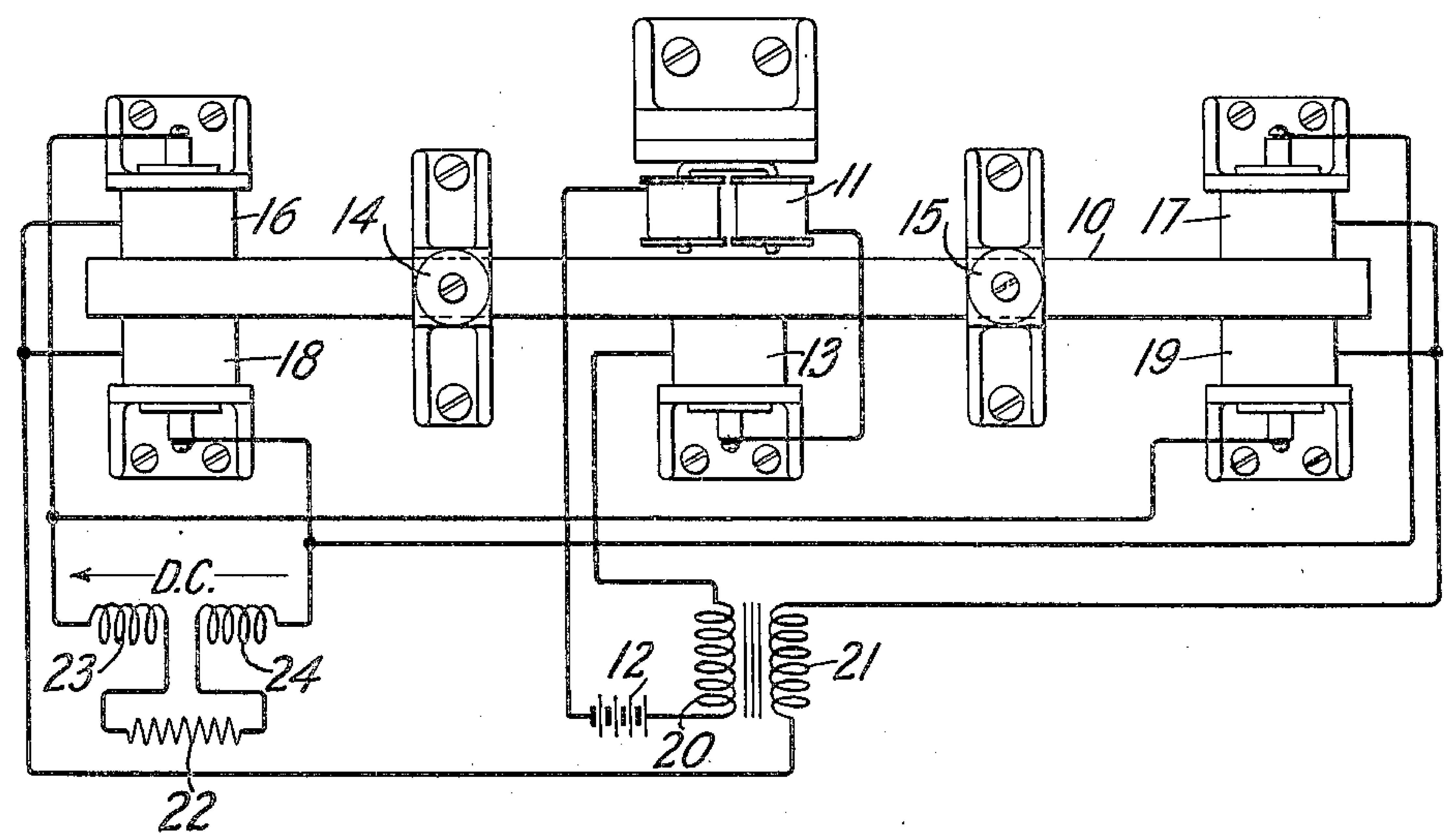


FIG. 2.

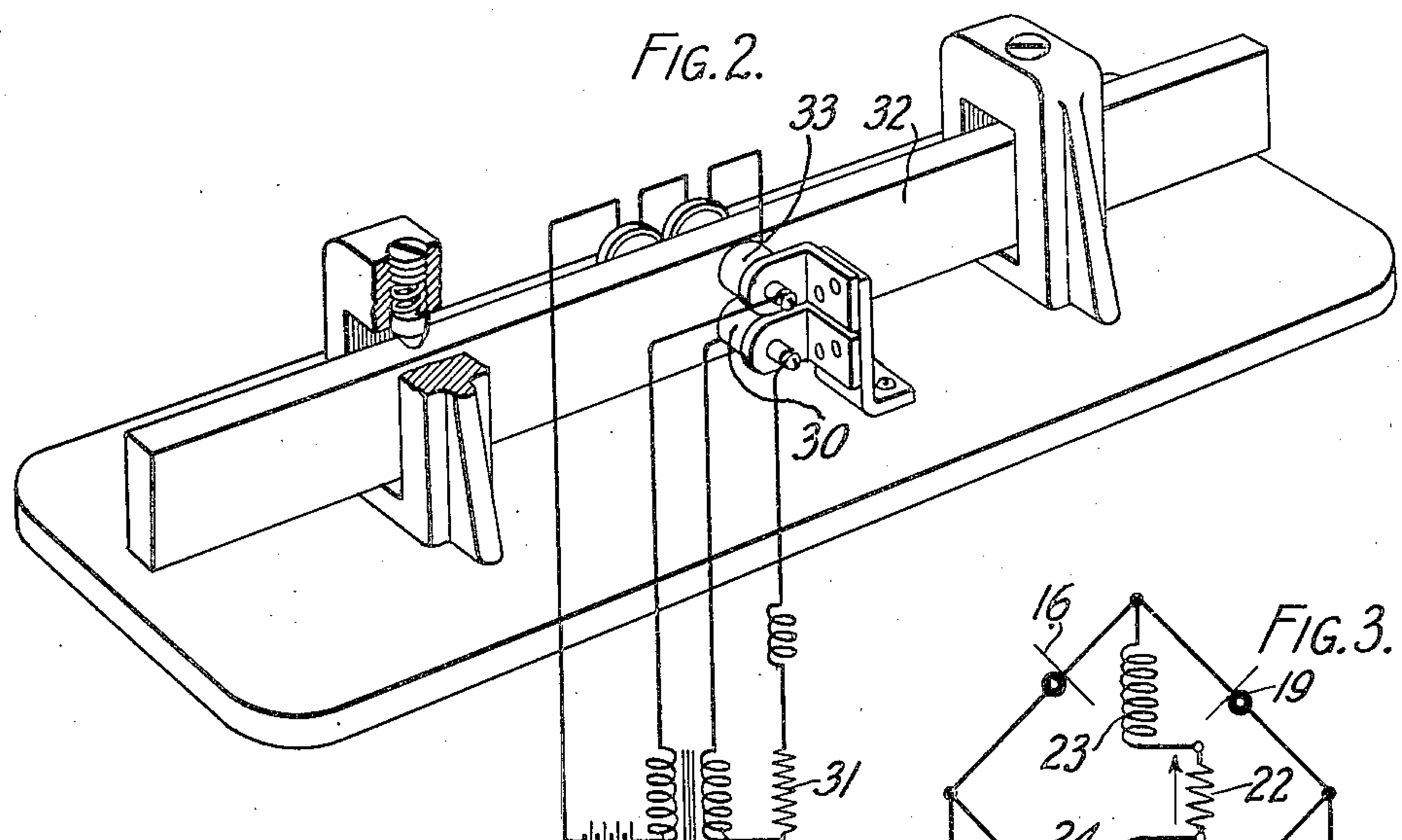
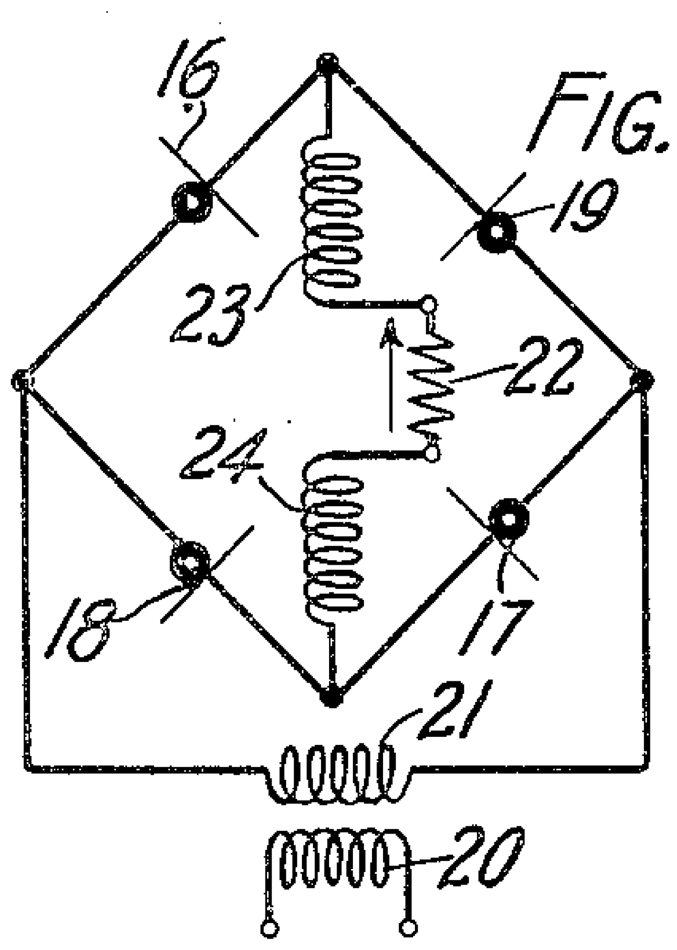


FIG. 3.



INVENTOR:
CHARLES R. MOORE
BY Joel C. R. Palmer
ATTORNEY

Patented May 8, 1928. **1,668,654**

UNITED STATES PATENT OFFICE.

CHARLES R. MOORE, OF MAPLEWOOD, NEW JERSEY, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

DIRECT-CURRENT-TRANSFORMING APPARATUS.

Application filed March 23, 1927. Serial No. 177,510.

This invention relates to direct current transforming apparatus and particularly to a vibro-transformer for transforming unidirectional current from one electromotive force to another.

In a preferred embodiment of the invention there is employed a vibratile bar which is driven so that standing waves are set up therein and which is supported at a plurality of nodal points. A plurality of microphone elements are positioned in proximity to anti-nodal points of the bar so that their resistances are varied in response to the pressure changes on the microphone elements due to the vibration of the bar. One of the microphone elements is connected to a direct current source and a winding of a transformer of the type which is commonly employed for stepping up or stepping down the electromotive force of an alternating current source. The remaining microphone elements are connected in the arms of a Wheatstone bridge circuit in such a way that the resistances of the microphone elements in opposite arms of the bridge are varied simultaneously in the same direction. The secondary winding of the transformer is connected to one pair of bridge terminals while the load through which the transformed direct current is to flow is connected to the conjugate terminals of the bridge. As the bar is vibrated, periodically varying current flows in the primary transformer winding thus inducing an alternating electromotive force in the secondary winding. The resistances of the microphone elements connected in the Wheatstone bridge circuit are also changed periodically in accordance with the frequency at which the bar is vibrated so that the current flowing through the load is always in the same direction.

The invention may be readily understood by referring to the following description and the accompanying drawing in which—

Figure 1 is a diagrammatic view of a direct current transforming device constructed in accordance with the present invention,

Fig. 2 is a perspective view showing a modification of the direct current transforming device shown in Fig. 1, and

Fig. 3 is a diagrammatic showing of a portion of the circuit employed in conjunction with the device shown in Fig. 1.

Referring now particularly to Fig. 1 of the drawing the bar 10 of magnetic material coated with an insulating substance, is driven at a definite frequency by the electromagnet 11 which is energized by current from the battery 12, this current being varied periodically from a maximum value to a value near zero in response to the resistance changes of the microphone element 13. These resistance changes are due to the varying mechanical pressure on the carbon granules of the microphone element caused by the vibration of the bar 10. The bar is pivotally supported at nodal points 14 and 15 located at a distance about one fourth the length of the bar from the ends thereof, respectively. The microphone elements 16 to 19 inclusive are mounted in proximity to anti-nodal points near the ends of the bar 10 the elements 16 and 17 being on one side of the bar and the elements 18 and 19 being on the opposite side. A primary transformer winding 20 is connected in series with battery 12, microphone element 13, and the winding of electromagnet 11. The secondary winding 21 of this transformer is connected to one pair of terminals of the Wheatstone bridge circuit in the arms of which the microphone elements 16 to 19 are connected as clearly shown in Fig. 3. The load 22 is connected to the conjugate terminals of the bridge circuit through the inductance coils 23 and 24.

In considering the operation of the device, assume that the microphone element 13 is in the low resistance state. For this condition a maximum value of current will flow from battery 12 through the winding of the electromagnet 11 and the transformer winding 20. This will cause the bar 10 to be attracted by the electromagnet 11 and the pressure on the carbon granules of microphone element 13 to be decreased, thus increasing its resistance and decreasing the current flowing in the circuit through electromagnet 11 and the primary transformer winding 20. Due to this decrease in current the electromagnet 20 now releases the bar 10 thus increasing the pressure acting on the carbon granules of the microphone element 13, decreasing its resistance, and increasing the current flowing from source 12. This cyclic action is continuous and the rate of change of current through the transformer winding 20 depends upon the frequency of vibration of the bar 10.

As the current through the primary transformer winding 20 is varied, an alternating electromotive force is induced in the secondary winding 21 which electromotive force is impressed upon the Wheatstone bridge circuit. The microphone elements 16 and 17 located on one side of the bar 10 are connected in opposite arms of the bridge circuit. Likewise elements 18 and 19 on the opposite side of the bar are connected in the remaining opposite arms. It is apparent that the resistances of elements 16 and 17 vary simultaneously in one direction and at the same time the resistances of elements 18 and 19, are varied simultaneously in the opposite direction. During the time that the bar 10 is traveling from the electromagnet 11 toward the microphone element 13 the electromotive force induced in winding 21 causes current to flow from transformer winding 21 through microphone element 17, inductance 24, load 22, inductance 23, microphone element 16 and thence back to transformer winding 21. When the bar 10 is being attracted by the electromagnet 11 the resistance of microphone elements 18 and 19 is being decreased and current flows in the opposite direction from transformer winding 21, through microphone element 18, inductance 24, load 22, inductance 23, microphone element 19 and back to the transformer winding 21. It is thus apparent that current always flows in one direction through the load 22.

In Fig. 2 there is shown a device similar to that shown in Fig. 1 in which a single microphone element 30 is employed for rectifying the current flowing through the load 31. The remaining parts of the apparatus are the same as corresponding parts shown in Fig. 1 and need therefore not be described in detail. It will be noted that as the bar 32 vibrates, the resistances of microphone elements 30 and 33 are increased or decreased simultaneously. Due to the resistance changes of microphone element 33 the current through the primary transformer winding 34 varies, thus inducing an alternating electromotive force in the secondary transformer winding 36. Due to the periodic resistance changes of microphone element 30, which changes are in phase with the alternating electromotive force induced in winding 36, current flows in one direction only through the load 31.

What is claimed is:

1. A device for transforming unidirectional current, comprising a vibratile bar, driving means for setting up standing waves in said bar, means for supporting said bar approximately at a nodal point, a source of unidirectional current, means for converting varying current from said source into alternating current, means responsive to the vibrations of said bar for varying the current from said source and means also responsive to the vibration of said bar for rectifying said alternating current.

2. A device for transforming unidirectional current comprising a vibratile bar, driving means for setting up standing waves in said bar, means for supporting said bar approximately at a plurality of nodal points, a source of unidirectional current, means for converting varying current from said unidirectional source into alternating current, and a plurality of resistance elements, the resistance of which is variable in response to the vibrations of said bar, one of said resistance elements being employed for varying the current from said source of unidirectional current and another of said resistance elements being employed for rectifying said alternating current.

3. A device for transforming unidirectional current comprising a vibratile bar, driving means for setting up standing waves in said bar, means for supporting said bar approximately at a plurality of nodal points, a source of unidirectional current, means connected to said current source for converting varying unidirectional current into alternating current, a plurality of microphone elements positioned in proximity to anti-nodal points of said bar, the resistance of said microphone elements being varied in response to vibrations of said bar, one of said microphone elements being employed for varying the current from said unidirectional source, and another of said microphone elements being employed for rectifying said alternating current.

4. A device for transforming unidirectional current comprising a vibratile bar, driving means for setting up standing waves in said bar, means for supporting said bar approximately at a plurality of nodal points, a primary source of unidirectional current, means for converting varying current from said source into alternating current, and a plurality of resistance elements, the resistance of which is variable in response to the vibration of said bar, one of said resistance elements being employed for varying the current from said primary source and a plurality of said resistance elements being connected in the form of a Wheatstone bridge for rectifying said alternating current.

5. A device for transforming unidirectional current comprising a vibratile bar, an electromagnet for setting up standing waves in said bar, supports for said bar at a plurality of nodal points, a primary source of unidirectional current, means for converting varying current from said unidirectional source into alternating current, a plurality of microphone elements positioned in proximity to anti-nodal points of said bar so that

the resistances of said microphone elements are varied in response to the vibration of said bar, one of said microphone elements being employed for periodically varying the current flowing through said means and said electromagnet, other of said microphone elements being connected one in each arm of a Wheatstone bridge circuit so that the resistance of the microphone elements in opposite arms of said bridge are varied in the same direction simultaneously due to the vibration of said bar, said alternating current being impressed upon one pair of terminals of said Wheatstone bridge and the load through which the transformed unidirectional current is to flow being connected to the conjugate terminals of the Wheatstone bridge.

In witness whereof, I hereunto subscribe my name this 21 day of March, A. D. 1927.

CHARLES R. MOORE.