No. 854,120. PATENTED MAY 21, 1907.

J. S. STONE.

DEVICE FOR AMPLIFYING ELECTRICAL CURRENTS.

APPLICATION FILED MAY 23, 1906.

2 SHEETS—SHEET 1.

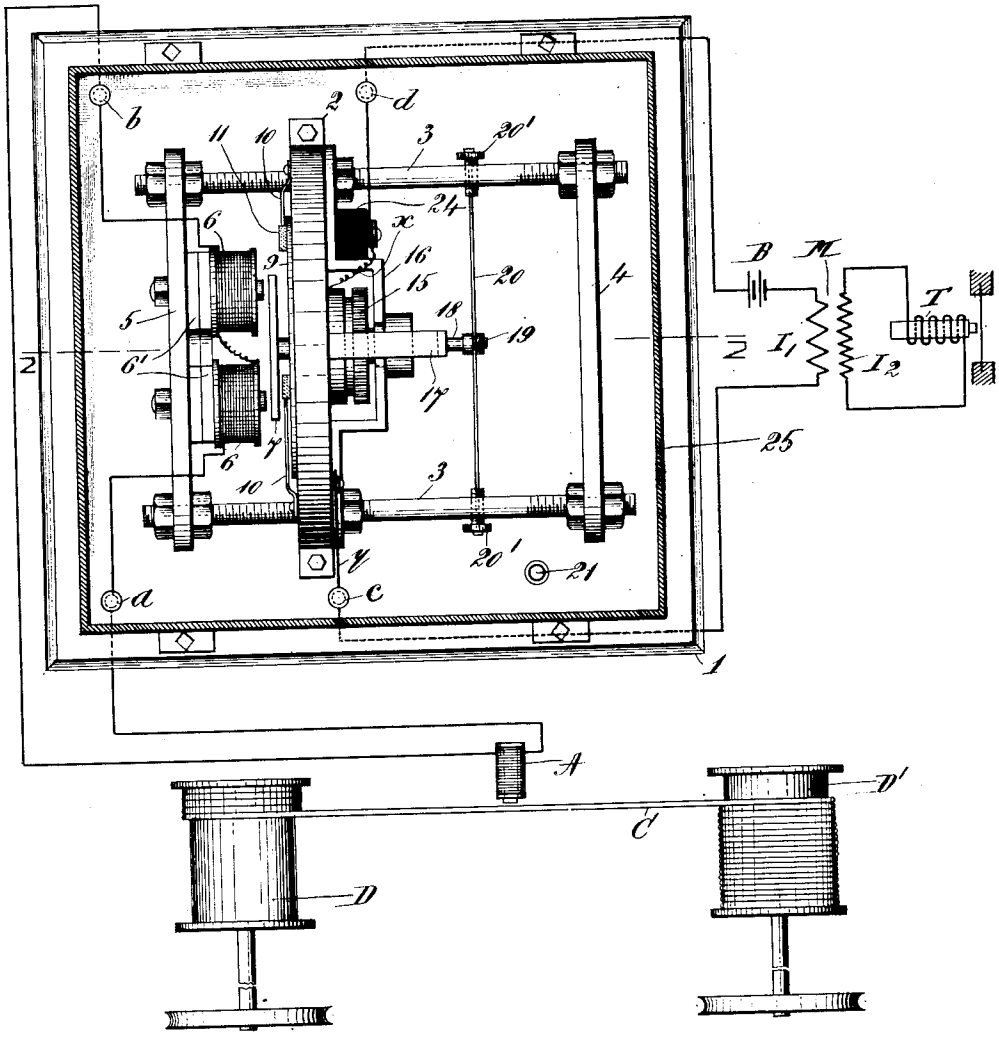

Fig. 1.

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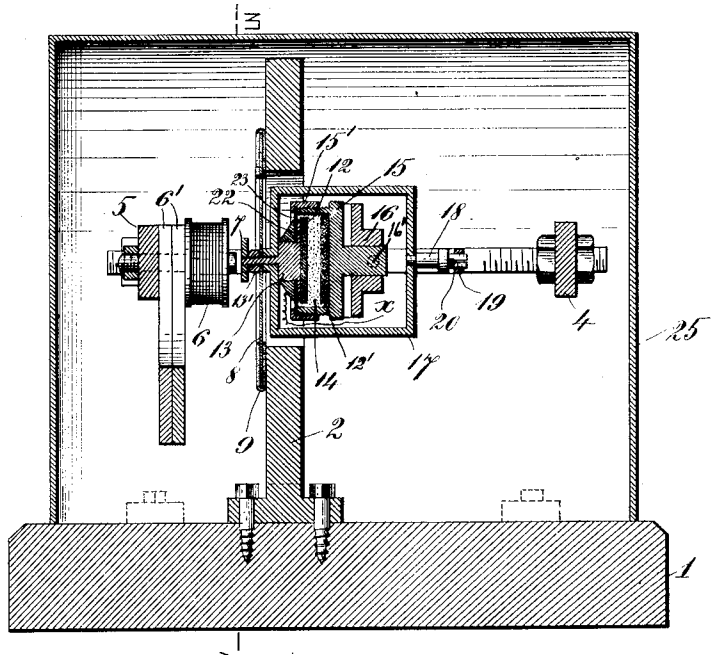

Fig. 2.

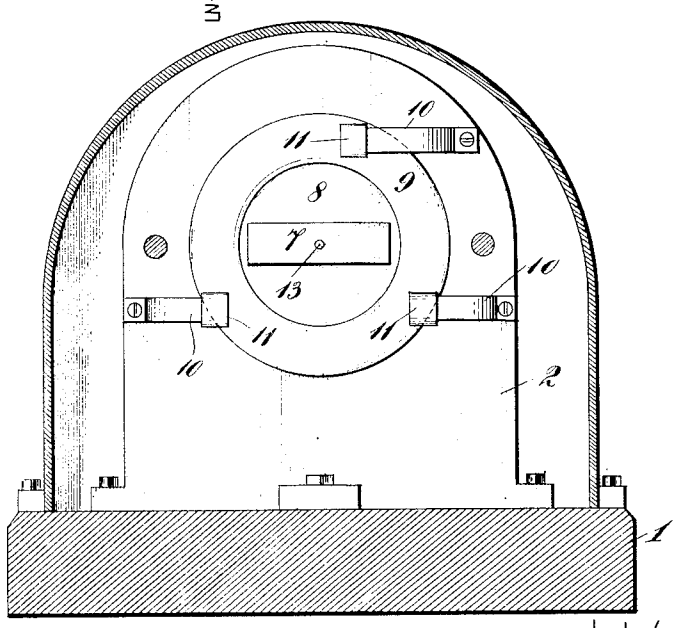

Fig. 3.

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UNITED STATES PATENT OFFICE.

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DEVICE FOR AMPLIFYING ELECTRICAL CURRENTS.

No. 854,120. Specification of Letters Patent. Patented May 21, 1907.

Application filed May 23, 1906. Serial No. 318,305.

To all whom it may concern:

Be it known that I, JOHN STONE STONE, a citizen of the United States, and a resident of Cambridge, in the county of Middlesex and State of Massachusetts, have invented a new and useful Improvement in Devices for Amplifying Electrical Currents, of which the following is a specification.

My invention relates to devices for amplifying electrical currents, however produced, which vary in accordance with the sonorous vibrations accompanying vocal or other sounds, and it relates more particularly to devices of such character which are adapted to amplify without distortion the currents, and hence the sounds produced by telegraphones.

The primary object of my invention is to produce a device for amplifying such electrical currents, in which the diaphragm or armature which is actuated by said currents and which in turn serves to actuate the movable electrode of a microphonic transmitter is maintained in a condition of stable equilibrium; and a secondary object of my invention is to provide a device for amplifying without distortion the currents, and hence the sounds, produced by telegraphones.

With these objects in view my invention consists in a device for amplifying electrical currents, in which a diaphragm or armature and the movable electrode of a microphonic transmitter are maintained in a condition of stable equilibrium between a magnetic force and an opposing mechanical force which varies for all positions of said diaphragm and electrode directly as said magnetic force, and such mechanical force may, with a sufficient degree of approximation, be applied by an elastic member the tension of which increases as the square of its deflection.

My invention may best be understood by having reference to the drawings which accompany and form a part of this specification, and which illustrate one form of apparatus and arrangement of circuits whereby the hereinbefore mentioned objects may be carried into effect, although it is to be understood that I do not limit myself to the particular embodiments therein illustrated inasmuch as many modifications may be made both in the apparatus and in the circuit arrangements without departing from the principle of my invention.

In the drawings, Figure 1 is a plan view of my invention, showing the circuit arrangements in diagram. Fig. 2 is a longitudinal section taken on the line 2—2 of Fig. 1. Fig. 3 is a cross section taken on the line 3—3 of Fig. 2.

In the drawings, D D′ represent rollers on which the magnetizable wire C is wound. By mechanisms which are now well known and which form no part of my invention, the magnetizable wire C has its magnetism modified in accordance with the sonorous vibrations which accompany vocal or other sounds and is moved past the electromagnet A, being maintained always closely adjacent to the core of said electromagnet. As is now well understood by those skilled in the art of telegraphones, the relative motion produced between said magnetizable member C and said electromagnet will produce feeble currents in the circuit of the solenoid which constitutes part of said electromagnet and if a telephone receiver be included in circuit with said solenoid sound waves will be produced corresponding more or less accurately to the original sonorous vibrations whereby the magnetism of the member C originally was varied. These sound waves, however, will be exceedingly minute, and although various attempts have been made to amplify the currents produced by telegraphones and the resulting sounds produced by said currents in telephone receivers, I am advised that as yet no such attempt has been commercially successful.

As shown in Fig. 1, the circuit of the solenoid which constitutes part of the electromagnet A, includes the serially-connected coils 6, 6 which surround cores secured to the permanent magnet 6′, the cores of said coils and said permanent magnet being secured to the cross piece 5 of brass or other non-magnetic metal. In lieu of a telephone diaphragm operated upon by the magnetic flux created by the currents flowing in the coils 6 for reproducing as sonorous vibrations the electric vibrations developed in the circuit of the coils 6 by the motion of the magnetizable member C past the electromagnet A, I cause said flux to produce relative movements between the

electrodes 12 and 12′ of a microphonic transmitter and associate in any suitable manner the sound-producing mechanism with the circuit which includes said electrodes and the carbon granules 14 which separate them.

In the particular embodiment of my invention which is shown in the drawings, the support 2 which may be of brass, is secured to the base 1, which may be of any suitable material, and carries the bolts 3, 3, which may be threaded through said support 2 and held in position by lock nuts. The cross piece 5 is secured to said bolts on one side of said support and the cross piece 4 is secured to the bolts on the other side of said support. The frame 16 to which the fixed electrode 12′ and carbon-containing capsule 15 are secured is bolted to the frame 2 and affords means for connecting said fixed electrode to the binding post *c*. The movable electrode 12 is secured to the screw 13, and the screw 13 and aluminium frame 17 are secured to the diaphragm 8 by means of the nut 13′. The armature 7 of the electromagnet 6, 6 is threaded on the projecting end of the screw 13. A lock nut 15′ is employed to secure the mica diaphragm 23 between the carbon containing capsule 15 and the nut 22. As shown more clearly in Fig. 1, the carbon containing capsule 15 is knurled for purposes of ready adjustment and when adjusted is secured in the frame 16 by a set screw 16′.

The diaphragm 8 may be secured to the support 2 by means of the springs 10 which carry rubber washers on their ends, and as shown the diaphragm 8 may have its periphery covered by a rubber washer 9 or other suitable material for insulating it from said support 2.

The wire *x* is secured to the insulating block 24 and is connected through the binding post *d* to the battery B and the primary I_1 of the transformer M. The wire *y* is connected to the frame 2, which as above stated, is conductively connected to the fixed electrode 12′ through the frame 16. As most clearly shown in Fig. 2, the wire *x* is conductively connected to the movable electrode 12 through the intermediary of the lock nut 22 and the screw 13. The wire *y* is then connected through the binding post *c* to the primary of the transformer M, thus completing the circuit through the two electrodes 12, 12′, the carbon granules 14, battery B and the primary of the transformer M.

In lieu of employing an electromagnet connected in series with the coils 6, 6 for the purpose of retracting the diaphragm 8 and its attached electrode 12, I use a mechanical retracting means consisting of an elastic member 20 so tensioned that the force exerted by it to move the electrode 12 back to its normal position varies directly over a wide range of positions of said electrode approximately as the force exerted thereon by the electromagnets 6, 6. For this purpose a wire 20 secured to the extension 18 of the frame 17 by the nut 19 may be employed, and its tension may be adjusted by the adjusting screws 20′ which are threaded through the bolts 3, 3. When said wire is so constructed and arranged that its tension varies as the square of its deflection, it will be evident that the movable electrode 12 and the moving parts secured thereto are in a condition of stable equilibrium, for the force exerted on said movable electrode by the electromagnets 6, 6 varies inversely as the square of the separation of the armature 7 from the cores of said electromagnets. By thus maintaining the movable electrode in a condition approximating closely that of stable equilibrium during the operation of the apparatus, it will be apparent that during such operation of said apparatus the only work required to be done by the magnetic flux developed in the electromagnets 6, 6 is the overcoming of the inertia of the movable electrode 12 and its connected moving parts as distinguished from the overcoming of the inertia of said parts and a retractile force. In this manner, the variations effected in the resistance of the circuit of the battery B and microphonic transmitter are greatly amplified with the result that the sounds produced by a telephone receiver included in said circuit are much louder than they would be were the usual magnetic retractile force employed in lieu of the member 20 and also distortion is greatly diminished. Instead of connecting the telephone receiver directly in the circuit of the battery B and microphonic transmitter, I prefer to connect said telephone receiver T in series with the secondary I_2 of the step-up transformer M, the primary of which is included in series with the battery B and microphonic transmitter, inasmuch as such arrangement results in a still further amplification.

By inclosing the apparatus in the bell-jar 25 and evacuating said jar, as by an air pump attached to the orifice 21, the movement of the electrode 12 which is effected by the feeble magnetic forces which operate upon the armature 7 may be increased on account of the resulting reduction of friction, and the current variations created in the circuit of the battery B may be correspondingly amplified. For the purpose of maintaining the vacuum in the bell-jar 25, the binding posts *a b c d*, may extend through the base 1 and the external circuits of the magnets 6, 6 and the microphonic transmitter may be connected to the lower ends of said binding posts as indicated in the dotted lines in Fig. 1.

I claim—

1. In an apparatus for amplifying electric currents varying in accordance with sonorous vibrations, a microphonic transmitter com-

prising a fixed and a movable electrode, magnetically operated means for moving said movable electrode in one direction and mechanical means for moving said electrode in the opposite direction, said mechanical means being so constructed that its tension varies as the square of its deflection.

2. In an apparatus for amplifying electric currents varying in accordance with sonorous vibrations, a microphonic transmitter comprising a fixed and a movable electrode and means maintaining said movable electrode in a condition of stable equilibrium during the operation of the apparatus.

3. In an apparatus for amplifying electric currents varying in accordance with sonorous vibrations, an armature, a microphonic transmitter comprising a fixed and a movable electrode, means securing said movable electrode to said armature, magnetic means for actuating said armature, and mechanical means secured to said movable electrode and exerting thereon a force in opposition to the force exerted thereon by said magnetic means, said mechanical means being so constructed that the force exerted thereby on said movable electrode varies for all positions of said electrode directly as the force exerted thereon by said magnetic means.

4. In an apparatus for amplifying electric currents varying in accordance with sonorous vibrations, a microphonic transmitter comprising a fixed and a movable electrode, an armature secured to said movable electrode, magnetic means for moving said movable electrode in one direction, and an elastic member secured to said movable electrode for moving the same in the opposite direction, said elastic member being so constructed that the force exerted thereby on said movable electrode varies for all positions of said electrode directly as the force exerted thereon by said magnetic means.

5. In an apparatus for amplifying electric currents varying in accordance with sonorous vibrations, a microphonic transmitter comprising a fixed and a movable electrode, an armature secured to said movable electrode, magnetic means for moving said electrode in one direction and a wire secured to said movable electrode for moving the same in the opposite direction, said wire being so tensioned that the force exerted thereby on said movable electrode varies for all positions of said electrode directly as the force exerted thereon by said magnetic means.

In testimony whereof, I have hereunto subscribed my name this 17th day of May 1906.

JOHN STONE STONE.

Witnesses:
GEO. K. WOODWORTH,
E. B. TOMLINSEN.