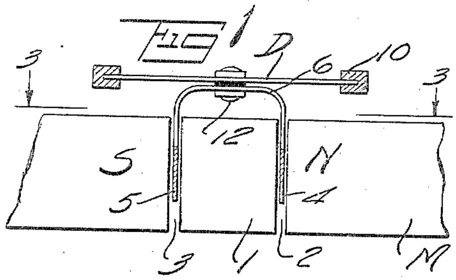
Sept. 4, 1928.

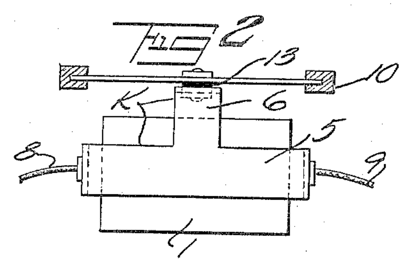
A. A. THOMAS

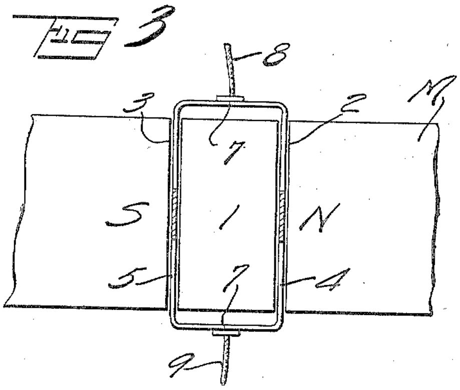
1,682,866

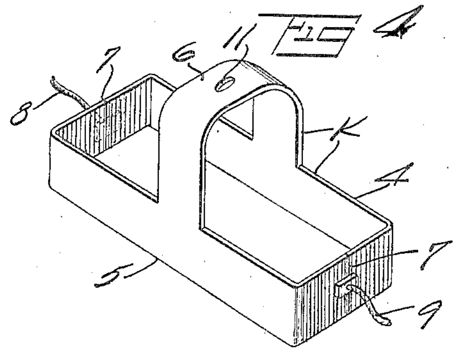
ELECTRICAL INSTRUMENT OF THE TELEPHONE TYPE

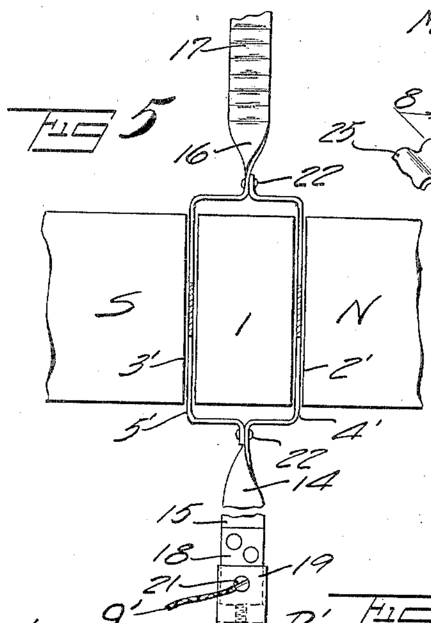
Original Filed Aug. 13, 1924 2 Sheets-Sheet 1

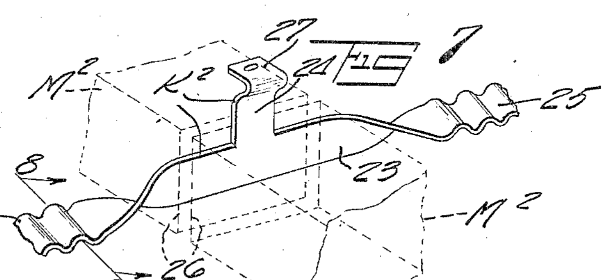


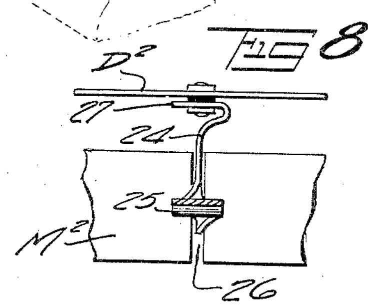


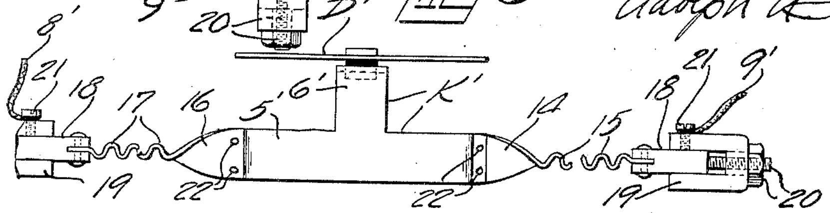












Adolph A Thomas

INVENTOR

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1,682,866

A. A. THOMAS

ELECTRICAL INSTRUMENT OF THE TELEPHONE TYPE

Original Filed Aug. 13, 1924   2 Sheets-Sheet 2

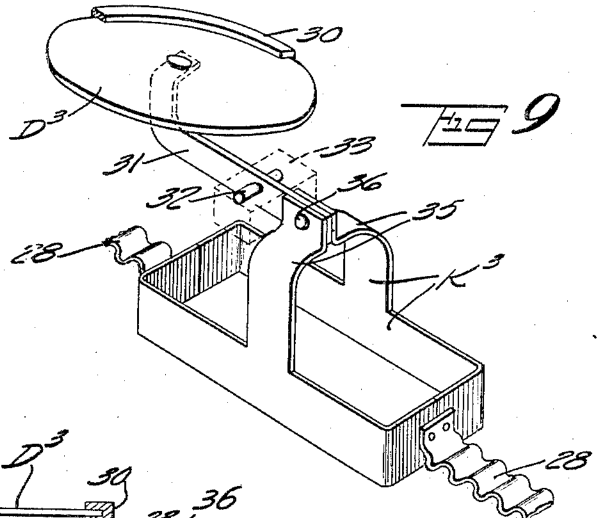


FIG. 9

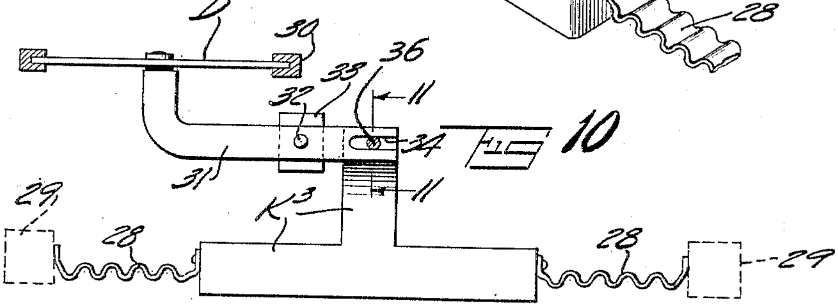


FIG. 10

FIG. 11

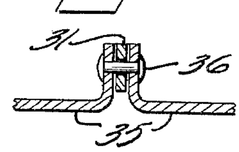


FIG. 12

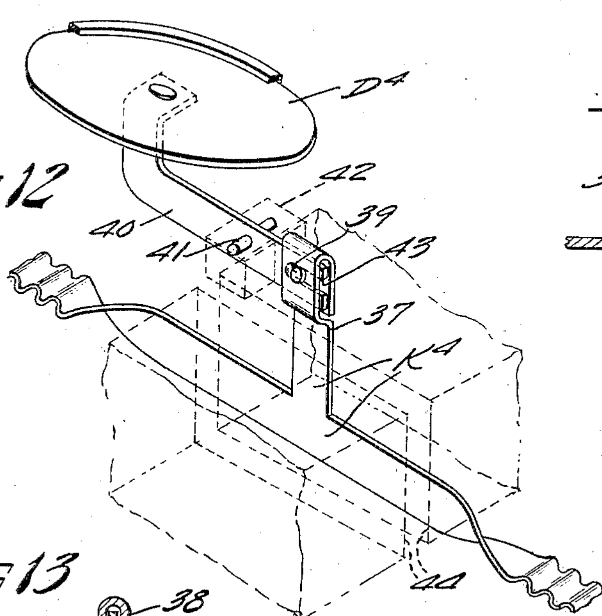
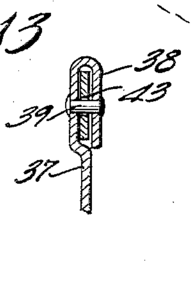


FIG. 13



INVENTOR

Adolph A. Thomas

Patented Sept. 4, 1928. 1,682,866

UNITED STATES PATENT OFFICE.

ADOLPH A. THOMAS, OF NEW YORK, N. Y.

ELECTRICAL INSTRUMENT OF THE TELEPHONE TYPE.

Application filed August 13, 1924, Serial No 731,713. Renewed January 12, 1928.

My invention relates to electromagnetic instruments of the class in which a magnet influences a movable member associated therewith, either to cause movement of the member in accordance with electric current variations, or to generate electric impulses when the member is moved in the magnetic field. As examples of such instruments, I may mention telephone receivers and transmitters, certain types of electric measuring or testing instruments employing a movable conductor in a magnetic field, and other electromagnetic apparatus along the same or similar lines. As will appear later, my invention is especially useful in radio receivers, particularly in loudspeakers.

Since my invention is peculiarly applicable in telephone instruments (but is not limited thereto), I can perhaps best explain its features and advantages by assuming its embodiment in a telephone receiver. The vast development of the radio art has made telephone receivers more or less familiar to the public. There are three general types of receivers on the market: first, those employing a magnetic diaphragm directly acted upon by magnetic poles; second, those in which a vibratory armature is connected to a non-magnetic diaphragm in step-up ratio; and third receivers of the so-called "dynamic" or solenoid type in which the diaphragm is connected to a movable coil operating in a strong magnetic field. While each type of receiver has its good points depending upon its design and manufacture, there are certain inherent faults in those prior devices, no matter how carefully built. For instance, the magnetic diaphragm or armature must be arranged as closely as possible to the magnetic poles in order to secure the maximum effect. But when that is done, the diaphragm or armature is liable to strike the pole pieces under excessive vibrations, such as will occur without warning when an increased current passes through the talking coil. To increase the normal air gap between the magnetic and the diaphragm or armature is to lower the sensitiveness of the instrument. These serious defects are a matter of experience and, as far as I know, are inherently present in all radio receivers of those two types on the market today. A further objection to telephone receivers with a magnetic diaphragm or armature is the constant pull or drag exerted by the magnetic field on one side of the magnetic member, causing the acoustic diaphragm to be drawn out of shape and thereby affecting the quality of tone reproduction. As for those telephone receivers in which a thick movable coil of many turns of fine wire actuates a diaphragm when a variable current passes through the coil, there are certain necessary complications of structure that increase the cost of the instrument. Furthermore, in receivers of that type, where a powerful magnetic field is maintained by direct current of high voltage, any fluctuations or variations in the polarizing current produce induced currents in the telephone coil, and such induced currents interfere with the proper operation of the instrument.

It is the object of my invention to provide an instrument that is free from the foregoing and other faults and defects of prior devices. The operation of my invention is based on the electromagnetic principle that a current-carrying conductor placed in a magnetic field will move in a direction to cut the lines of force. I employ a flat rigid conducting structure of non-magnetic material disposed flatwise in a magnetic airgap and resiliently suspended so as to vibrate bodily in its own plane. This flat conducting structure in its simplest form may be a strip or bar arranged to extend through the air gap of a strong magnetic field. This strip is preferably flat and of sufficient rigidity to act as a frame for actuating or even supporting a diaphragm. The magnetic air gap need be only a trifle wider than the thickness of the flat conducting structure, so that this conductor operates in a magnetic field of minimum reluctance and therefore maximum efficiency. When my invention is applied to a telephone receiver, for example, the flow of variable current through the conducting structure or strip causes the same to vibrate in its own plane in the magnetic air gap. The acoustic diaphragm may be directly mounted on this vibratory conductor, thereby producing a structure of utmost simplicity. In this case no separate clamping ring is necessary for the diaphragm, so that it is free from a natural period of vibration.

As the flat conducting structure of my invention vibrates in its own plane, it may be made comparatively thin and light, yet of requisite strength to actuate or support a diaphragm or whatever operating member may be used. Accordingly, the entire vibratory unit may be made exceedingly light, and this adds to the sensitiveness and efficiency of the instrument.

In a simple form of my invention, the conductor may be a single strip constructed to be resiliently self-supporting and (if desired) directly carrying the diaphragm. Or, the conductor may be in the form of a non-magnetic frame having two or more strips arranged to operate in magnetic air gaps.

By doing away with a magnetic diaphagm and armature, I provide an instrument free from the defects or faults due to the presence of those parts in prior devices. By dispensing with a thick coil of many turns of wire, I not only simplify the entire construction, but also eliminate the disturbing effects of such a coil under certain conditions.

The basic idea of my invention may be mechanically carried out in various ways. In order to explain my invention to those skilled in the art, I have shown several illustrative embodiments in the accompanying drawings, which I will now describe in detail. I want it understood, however, that these constructions are merely by way of example, and not in the nature of restrictions or limitations. In these drawings—

Fig. 1 shows in transverse cross-section an electrical instrument (such as a telephone receiver or transmitter) embodying my invention;

Fig. 2 is a side view of Fig. 1;

Fig. 3 is a top view in section approximately on line 3—3 of Fig. 1;

Fig. 4 is a detached perspective view of the vibratory non-magnetic conducting frame shown in Figs. 1, 2 and 3;

Fig. 5 shows a modification in plan view in which the conducting frame is resilently supported and carries a diaphragm;

Fig. 6 is a side view of the construction shown in Fig. 5;

Fig. 7 is a perspective view of a simplified form of vibratory non-magnetic conductor to support a diaphragm or other operative member;

Fig. 8 is an end view of Fig. 7, approximately on section line 8—8;

Fig. 9 shows in perspective a non-magnetic conducting frame to which the diaphragm is operatively connected in increased transmission ratio;

Fig. 10 is a side view of Fig. 9, certain parts being shown in section;

Fig. 11 is a cross-sectional detail view on line 11—11 of Fig. 10;

Fig. 12 is a perspective view of a simplified form of conductor to which the diaphragm is connected in step-up transmission ratio, and

Fig. 13 is a cross-sectional detail view to show the connection between the vibratory conductor and the lever that actuates the diaphragm in Fig. 12.

I want to make it clear at the outset that the drawings are largely diagrammatic and have been made as simple as possible, without an attempt to show the parts in their proper relative proportions. Only so much of an electrical instrument is shown as is necessary to understand the principle and operation of my invention, without regard to such other details as would go to make up a complete instrument for the market.

In Fig. 1 we have an electrical instrument provided with a magnet M, of which only the pole pieces N and S are shown. The field of magnet M is of sufficient strength to meet the requirements of each particular instrument. This magnet may be a strong permanent magnet, or the magnetic field may be furnished by a battery and magnetizing coils of proper design. In the present instance, the pole pieces of magnet M are separated by a block 1 of suitable magnetic material, such as soft iron or steel, either solid or laminated in the direction of the magnetic flux. For convenience, I will speak of the block 1 as iron, by which I mean any suitable magnetic material. The iron block 1 is separated from the pole pieces N and S by air gaps 2 and 3, which are preferably very narrow as compared with their depth or length. In the air gaps 2 and 3 operates a non-magnetic conductor. In the broader aspect of my invention, this conductor may be constructed in various ways. By way of example, I have shown in Figs. 1–4 a conductor consisting of a non-magnetic frame indicated as a whole by K. This frame may consist of a single strip of suitable metal and may conveniently be cut or stamped in sheet form and then bent into proper shape, as will be clearly understood from Fig. 4. Frame K consists of a pair of side strips 4 and 5 connected by an intermediate cross-arm 6 and bent together at the ends, as indicated at 7. The strips 4 and 5 extend flatwise through the air gaps 2 and 3, so as to vibrate in their own planes, may be seen from Fig. 1. Terminal wires 8 and 9 are connected to the ends of conductors 4 and 5. The circuit of these conductors may be a telephone circuit, or any other circuit where current variations are utilized to produce mechanical movement, or where mechanical movements of the conductors in a magnetic field produce electric currents in the circuit of those conductors.

To the vibratory conducting frame K is

connected a suitable operative member, which in Figs. 1 and 2 is shown as an acoustic diaphragm D, properly supported at its periphery by a clamping ring diagrammatically indicated at 10. The cross-arm 6 has an opening 11 at the top center for receiving a suitable fastening member 12, which may be a small bolt or rivet passing through the center of the diaphragm. If the diaphragm D is of metal, an insulating washer 13 may be interposed, so as to insulate the double conductor 4—5. The acoustic diaphragm D may be of any suitable material, such as mica, corrugated aluminum, reinforced bakelite, fiber, and other substances that have been, or may be, employed for that purpose.

Assuming that the instrument shown in Figs. 1–4 is to be used as a telephone receiver, the conducting strips 4 and 5 are included in the receiving circuit of the system. When a variable or fluctuating current passes through the conducting strips, they will oscillate in their respective air gaps in planes substantially at right angles to the direction of the lines of force across the air gaps. In other words, the flat strips 4 and 5 will vibrate or oscillate in their own planes. The direction of movement of the conducting frame K depends upon the direction of the flow of current through the conductors 4 and 5 at any instance, and the extent or amplitude of vibration depends upon the strength of the current flowing through the conductors. The vibrations of frame K are communicated to the diaphragm D, or whatever operative member may be connected with the frame.

When the instrument of Figs. 1–4 is used as a telephone transmitter, the operation is just the reverse of that described. That is to say, as the conductors 4 and 5 vibrate in their respective air gaps and cut the magnetic force when the diaphragm D is set in vibration by talking against it, a variable or fluctuating current is generated in the circuit of conductors 4 and 5, and that current is caused to operate a receiver at the other end of the line, as will be understood by those skilled in the art.

It will be seen from the foregoing that I have provided a vibratory conducting unit of exceedingly simple construction. Since both the frame K and the diaphragm D may be made exceedingly light—as of aluminum, alloys of aluminum, or like material—the inertia to be overcome in the vibration of this unit is a minimum, whereby the instrument operates with a correspondingly high efficiency.

The conducting strips 4 and 5 are preferably made very thin, so that the air gaps 2 and 3 may be of minimum width. In this way the reluctance of the magnetic field is reduced to its lowest point, whereby the intensity of the magnetic flux across the air gaps is maintained at a maximum, and at the same time the effective life of the magnet is prolonged.

In the particular embodiment above described, the vibratory conducting frame K is resiliently supported by the diaphragm D and, therefore, requires no additional mounting or support. This reduces the construction to utmost simplicity. Since the frame may be made of very light metal, as previously stated, its weight on the diaphragm is practically negligible.

In Figs. 5 and 6, I have shown a modification in which the vibratory frame is resiliently supported and the diaphragm directly mounted on the frame. In this instance, the frame K′ comprises a pair of side strips 4′ and 5′, arranged to extend through and operate in the air gaps 2′ and 3′, respectively, precisely as described in connection with Figs. 1–4. The side strip 4′ is at one end bent at right angles, as indicated at 14, and forms or provides a corrugated extension 15. Similarly, the conducting strip 5′ of frame K′ is bent at 16 into a corrugated extension 17. The free ends of extensions 15 and 17 are secured in suitable supporting pieces 18, which are preferably mounted on blocks 19, so as to be slidably adjusted therein by means of a screw and nut 20. If desired, a set-screw 21 may be used to secure the supporting pieces 18 firmly in adjusted position. The corrugated extensions 15 and 17, which lie in a plane approximately at right angles to the planes of the conducting strips 4′ and 5′, constitute a resilient support for the frame K′ and the diaphragm D′ mounted thereon. It will be understood, of course, that the metal of frame K′ possesses sufficient resiliency for this purpose. There are several aluminum alloys on the market suitable for use in this connection. By sliding the supporting pieces 18 toward or away from each other, the tension of the resilient supporting bands 15 and 17 may be regulated to control the amplitude of vibrations of frame K′ and diaphragm D′. The strips 4′ and 5′ are secured together by any suitable fastening means, such as rivets 22, or otherwise. Diaphragm D′ may be mounted on the cross-arm 6′ in the same way that diaphragm D of Fig. 1 is connected to the cross-arm 6 of frame K, or in any other practical way.

What has been said in connection with Figs. 1 to 4 on the operation of the instrument, is fully applicable to the construction of Figs. 5 and 6, so that I need not repeat that portion of the previous description. Since the supporting extensions 15 and 17 are of good conducting material, they may be included in the circuit of the conductors 4′ and 5′. This makes it a simple matter to connect the vibratory conducting frame K′ in the telephone or other circuit for which it is intended. For the sake of simplicity, the set-screws 21 may be used as binding posts for the circuit conductors 8′ and 9′. This assumes, of course, that the parts 18 and 19 are of conducting material and are properly insulated as against other metallic parts of the instrument.

Attention is called to the fact that the diaphragm D′ of Figs. 5 and 6 is not connected at its periphery to a fixed support. In other words, the diaphragm is not bound, but is entirely free to vibrate at the rate of vibration of the frame K′. This greatly improves the tone reproduction of the instrument when used as a telephone receiver, because the free diaphragm has no natural period of vibration to interfere with the impressed vibrations.

It will be observed that the vibratory frame K′, even when made of comparatively thin strips, is yet of sufficient rigidity to support and operate the diaphragm D′. This is due to the fact that the conducting strips 4′ and 5′ operate in the plane of their maximum mechanical strength. This also applies to the vibratory frames shown in the other figures.

In Figs. 7 and 8, I have shown a more simplified form of vibratory conducting frame K^2 consisting of a single strip 23, having an arm 24 and an integral corrugated extension 25 at each end. These extensions act as a resilient support for the frame K^2, so that the strip 23 may vibrate in its own plane in the narrow air gap 26 of the magnet M^2. The resilient supporting extensions 25 are at their free ends connected to suitable supports, not necessary to show. Those supports may be similar to the adjustable supporting pieces 18 of Fig. 6. Otherwise, what has been said about the function and operation of the resilient supporting strips 15 and 17 of Fig. 6, applies to the corrugated extensions 25 of Fig. 7. The arm 24 of conductor 23 is at its free end bent into a flat lug 27 for connecting a diaphragm D^2, or other operative member, directly to the frame K^2. Diaphragm D^2, like diaphragm D′, is preferably free, that is to say, unbound at its periphery, so that it has no fixed or fundamental period of vibration.

In Figs. 9, 10 and 11, I have illustrated a construction in which the diaphragm is actuated by the vibratory conducting frame through an increased transmission ratio. There is a frame K^3 similar in construction to frames K and K′, and resiliently supported by corrugated bands or strips 28, similar to the strips 15 and 17, previously described. In Fig. 10, I have diagrammatically indicated at 29 any suitable supports for the free ends of the resilient strips 28.

A diaphragm D^3 is mounted in a suitable support 30 and is connected at its center to one end of a lever 31. This lever is pivoted at 32 to a fixed support 33, and its free end has a slot or notch 34. The cross-arm 35 of frame K^3 has a pin 36 arranged to engage in the slot 34. It will be seen that, as the frame K^3 vibrates, the movements thereof are transmitted in increased ratio to the diaphragm D^3. I have not considered it necessary to show any magnet in Figs. 9 and 10, because it will be understood that the arrangement of magnetic air gaps shown in Figs. 1, 3 and 5 is applicable in Figs. 9 and 10.

In Figs. 12 and 13 there is a vibratory conducting frame K^4, which is similar to the frame K^2 of Figs. 7 and 8. Therefore, the detailed description of frame K^2 may be regarded as largely applicable to frame K^4, except that this frame has an arm 37 which terminates in a hook 38 carrying a pin 39. A diaphragm D^4 is connected to a lever 40 pivoted at 41 to a suitable support 42. The free end of lever 40 is provided with a slot or notch 43 through which passes the pin 39. By means of these connections the vibratory movements of frame K^4 in the magnetic air gap 44 are transmitted to the acoustic diaphragm D^4 in increased ratio.

I have not considered it necessary to show or describe any circuit connections for the conducting strips of the vibratory frames, because such connections are well understood by those familiar with the electrical art to which this invention relates. If my invention is embodied in a telephone receiver for use in radio reproduction, it will be properly connected in the talking circuit of a radio set. A telephone receiver built in accordance with my invention may be used either as an earphone, or as a loudspeaker, depending on the way the instrument is designed and on the circuit in which it is used. When the instrument is used as a loudspeaker, a suitable sound amplifier (like a horn) is connected with the diaphragm.

It will be noticed that, by virtue of its resilient suspension at each end, the rigid conductor vibrates in the magnetic airgap with substantially equal amplitude over its entire length. Also, this conductor in its preferred flat form presents a relatively large current area to the magnetic flux. This produces an instrument of high efficiency and sensitiveness. It goes without saying that the different parts should be so proportioned relatively to each other as to effect the best results in any given case. These details lie within the practical skill of the artisan in this particular line of work.

The theory has been advanced that, in sound reproducing apparatus of the kind herein referred to, the best results are obtained when the mass of the diaphragm does not exceed the mass of the volume of air which the vibrations of the diaphragm set in motion. In an instrument built according to my invention, this condition may be fulfilled, or at least closely approximated, because the vibratory unit may be constructed exceedingly light, especially when the diaphragm is supported by the vibratory conductor itself and may be left free or unbound at the periphery. Obviously, a free diaphragm need not be circular, but may be of any shape, size or design suitable for acoustic reproduction.

Although I have herein shown and described certain specific constructions, I want it understood that I have done so merely to explain my invention and not by way of restriction or limitation. The principles of my invention may be mechanically carried out in other ways than herein set forth, without departing from the scope of the invention as defined in the appended claims.

What I claim as my invention is:

1. A telephone instrument comprising a magnet having an air gap, a flat non-magnetic conducting strip extending flatwise through said air gap and arranged to vibrate in its own plane, said strip vibrating in said air gap as a rigid member without bending to cut the magnetc flux across said air gap, an acoustic diaphragm operatively connected with said strip, means whereby said strip and said diaphragm are resiliently supported for vibration, and means for adjusting the degree of resiliency in the vibratory movements of said strip and said diaphragm.

2. In a telephone instrument having a narrow magnetic air gap, a vibratory unit comprising a flat non-magnetic conductor extending flatwise through said air gap and resiliently self-supporting.

3. As a new article of manufacture for use in telephone instruments, a vibratory unit comprising a non-magnetic conductor having resilient end sections and an intermediate rigid section.

4. A telephone instrument comprising a magnet provided with a straight air gap, a flat non-magnetic conductor comprising a flat straight strip extending through said air gap in a plane substantially at right angles to the direction of the magnetic flux across said air gap and adapted to vibrate in its own plane, resilient means extending from the ends of said strip for supporting the same for vibratory movement, and an accoustic diaphragm operatively connected with said strip.

5. A telephone instrument comprising a magnet provided with an air gap, a non-magnetic conductor extending through said air gap and adapted to vibrate in a plane substantially at right angles to the direction of the magnetic flux across said air gap, a transversely corrugated band extending lengthwise from each end of said conductor, said band being of a material suitable for resiliently supporting said conductor to permit vibration thereof in said air gap, and an acoustic diaphragm operatively connected with said conductor.

6. A telephone receiver comprising a magnet provided with an air gap, a flat non-magnetic conducting strip extending through said air gap in a plane substantially at right angles to the direction of the magnetic flux across said air gap, whereby the flow of variable current through said strip causes the same to vibrate in its own plane, resilient means extending from the ends of said strip for supporting the same for vibratory movement, an acoustic diaphragm operatively connected with said strip, and means for adjusting the normal tension of said resilient supporting means.

7. An electrical instrument comprising a magnet provided with an air gap, a non-magnetic conductor extending through said air gap and adapted to vibrate in a plane substantially at right angles to the direction of the magnetic flux across said air gap, the end portions of said conductor being formed as flat integral extensions in a plane approximately at right angles to the plane of movement of said conductor, said extensions being adapted to resiliently support said conductor for vibratory movement in said air gap, and an operative member connected with said conductor.

8. In a telephone instrument having a magnet with an air gap, a non-magnetic rigid conductor extending through said air gap and resiliently supported for vibratory movement in said air gap, and an acoustic diaphragm mounted on said conductor and supported thereby.

9. As a new article of manufacture for use in telephone instruments having a magnet with a straight air gap, a non-magnetic conductor comprising a straight flat strip adapted to extend through said air gap and vibrate in its own plane, said strip being formed with an integral arm intermediate its ends for connection with an acoustic diaphragm.

10. In a telephone instrument, a magnet having two air gaps, a non-magnetic frame having a pair of conducting strips arranged to extend through said air gaps for vibratory movement therein, the opposite ends of said strips projecting beyond said air gaps and the adjacent projecting ends being connected together, a conductor secured to said connected projecting ends for connecting said strips in circuit, and a diaphragm connected with said frame, said frame and said diaphragm being resiliently supported for vibration.

11. In a telephone instrument, a magnet having two air gaps, a non-magnetic frame having a pair of conducting strips arranged to extend through said air gaps, means for

resiliently supporting said frame to permit vibratory movement of said strips in said air gaps, and an acoustic diaphragm mounted on said vibratory frame and supported thereby.

12. In an electrical instrument having a magnet with an air gap, a self-sustained vibratory conductor comprising an intermediate rigid section extending through said air gap for vibratory movement therein, and a pair of resilient end sections for resiliently supporting said intermediate rigid section,

13. In an electrical instrument having a magnet with an air gap, a self-sustained vibratory conductor comprising an intermediate rigid section extending through said air gap for vibratory movement therein, and a pair of resilient end sections for resiliently supporting said intermediate rigid section, said resilient end sections being formed integral with said intermediate section.

14. In a telephone instrument having a magnet with an air gap, a self-sustained vibratory conductor comprising an intermediate rigid section extending through said air gap for vibratory movement therein, a pair of resilient end sections for resiliently supporting said intermediate rigid section, and a diaphragm connected to said intermediate section.

15. In a telephone instrument, a magnet having two straight air gaps, a non-magnetic conducting frame comprising a pair of straight side strips connected together at the ends, said side strips being arranged to extend through said air gaps for vibratory movement therein, an intermediate cross-arm connecting said side strips, and an acoustic diaphragm connected with said cross-arm.

16. As a new article of manufacture for use in electrical instruments of the class described, a non-magnetic conductor comprising a flat band having an intermediate rigid section and a pair of end sections extending in a plane at right angles to the plane of said intermediate section, whereby said end sections act as resilient supports for said intermediate section.

17. As a new article of manufacture for use in electrical instruments of the class described, a non-magnetic conductor comprising a single flat band having an intermediate rigid section and a pair of transversely corrugated end sections extending in a plane at right angles to the plane of said intermediate section, whereby said end sections act as resilient supports for said intermediate section.

18. In an electrical instrument provided with a magnet having an air gap, a vibratory member consisting of a rigid non-magnetic conducting strip resiliently self-supporting and arranged to operate in said air gap to cut the magnetic lines of force.

19. In a telephone instrument provided with a magnet having an air gap, a vibratory unit comprising a rigid non-magnetic conducting strip resiliently self-supporting and arranged to operate in said air gap to cut the magnetic lines of force, and a diaphragm connected with said strip.

20. In an electrical instrument provided with a magnet having a straight air gap, a vibratory unit consisting of a resiliently supported non-magnetic conducting frame having a strip arranged to operate in said air gap to cut the magnetic lines of force, the ends of said strip extending through the opposite ends of said air gap.

21. In an electrical instrument, a magnet having a straight air-gap that is very narrow as compared with its depth, a non-magnetic conductor resiliently supported in said air gap for vibratory movement therein, said conductor comprising a flat strip of metal having a straight rigid section arranged flatwise in said air gap so as to vibrate in its own plane substantially at right angles to the direction of the lines of force across the air gap, said strip extending at its ends through the opposite ends of said air gap and being only slightly narrower than the air gap and of sufficient rigidity in the plane of its movement to be connected with and operate a suitable member, and conductors connected to the oppositely extending ends of said strip.

22. In a telephone instrument, a vibratory acoustic unit consisting of a rigid non-magnetic conductor carrying a free acoustic element.

23. In a telephone instrument provided with a magnet having an air gap, a non-magnetic conducting member resiliently supported to vibrate in said air gap, and a free acoustic element supported by said member for movement therewith.

24. In an electrical instrument, a vibratory unit comprising a rigid central section and a pair of transversely corrugated extensions projecting in opposite directions from said rigid section for resiliently supporting the same for vibratory movement, and a magnet operatively associated with said unit.

25. In an electromagnetic sound reproducer, a magnet provided with pole pieces separated by relatively narrow airgap, a flat rigid conducting structure disposed flatwise in said narrow airgap, means for flexibly mounting said flat conducting structure at opposite ends thereof for bodily vibratory movement in its own plane to cut the lines of force, said conducting structure being energized by variable electric impulses, and a diaphragm operatively connected with said structure, which is supported independently of said diaphragm.

26. A telephone instrument comprising a

magnet having a straight airgap, a flat non-magnetic conducting structure extending flatwise through said airgap and arranged to vibrate in its own plane, said flat structure vibrating in said airgap as a rigid member without bending to cut the magnetic flux across said airgap, an acoustic diaphragm operatively connected with said conducting structure, and means independent of said diaphragm whereby said conducting structure is resiliently supported for vibration.

27. In an electromagnetic sound reproducer, a magnet provided with pole pieces separated by a relatively narrow straight airgap, a flat rigid conducting structure disposed flatwise in said airgap, means at each side of said pole pieces for flexibly suspending said conducting structure, said flexible means consisting of resilient members which permit bodily vibratory movement of said flat conducting structure in said narrow airgap in a plane substantially at right angles to the lines of force across said airgap, and a diaphragm operatively connected with said vibratory structure, which is adapted to be connected in a circuit of variable electric impulses.

28. In an electromagnetic sound reproducer, a magnet having pole pieces separated by a relatively narrow airgap, a flat conducting structure arranged flatwise in said airgap and resiliently supported so as to vibrate bodily in its own plane substantially at right angles to the lines of force in said airgap, said flat vibratory structure being only slightly narrower than the airgap and of sufficient rigidity in the plane of its movement to be connected with and operate an acoustic member, and a diaphragm operatively connected with said structure, which is supported independently of said diaphragm and is adapted to be connected in a circuit of variable electric impulses.

29. In an electromagnetic device, a flat structure comprising non-magnetic conducting material resiliently suspended at opposite ends to vibrate in its own plane in a magnetic airgap with substantially uniform amplitude.

30. In an electromagnetic sound reproducer, a magnet having pole pieces directed toward each other and separated by a straight narrow airgap, a flat conducting structure disposed flatwise in said airgap for vibratory movement in its own plane substantially at right angles to the direction of the magnetic flux across the airgap, and resilient means at opposite ends of said flat structure for suspending the same in a substantially floating condition to vibrate with practically uniform amplitude.

31. In an electromagnetic device, a flat structure of aluminum resiliently suspended at opposite ends to vibrate in its own plane in a magnetic airgap with substantially uniform amplitude, said vibratory aluminum structure being adapted to be connected in circuit.

32. In an electric driving unit, a magnet provided with an airgap, a vibratory member supported in operative relation to said airgap and comprising a tensioned band transversely recessed at opposite ends, and means whereby said recessed end portions are adjustable to regulate the normal tension of the intermediate portion of said band.

33. An electromagnetic sound reproducer comprising a magnetic field system having a pair of substantially parallel airgaps which are relatively narrow, a rigid conducting frame having a pair of flat side members mounted flatwise in said airgaps, means for resiliently supporting said frame to allow said flat members to vibrate in said airgaps in their own planes, and an acoustic diaphragm connected to said members, which are supported independently of said diaphragm.

34. In an electromagnetic sound reproducer, a self-sustained vibratory conductor consisting of a frame having a pair of rigid flat strips adapted to vibrate in a magnetic field in their own planes, and resilient flat extensions on said strips arranged in a plane substantially at right angles to the planes of movement of said strips, whereby said extensions resiliently support said frame for vibratory movement.

35. In an electromagnetic sound reproducer, an electromagnetic field system including a plurality of pole pieces directed toward each other and separated by a narrow airgap, a flat rigid member disposed flatwise in said narrow airgap, and means at each side of said pole pieces for flexibly mounting said member at opposite ends thereof for lateral movement in said airgap in a path substantially normal to said pole pieces, said flexible mounting means holding said member in a substantially floating condition in said airgap so that it vibrates in its own plane with practically uniform amplitude.

ADOLPH A. THOMAS.