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(73) Proprietor: **Knowles Electronics Company**
Victoria Road
Burgess Hill Sussex RH15 9LP (GB)

(72) Inventor: **Wilton, Raymond John**
35 Braybon Avenue
Patcham Brighton Sussex (US)

(74) Representative: **Wynne-Jones, John Vaughan et al**
Wynne-Jones, Lainé & James 22, Rodney Road
Cheltenham Gloucestershire GL50 1JJ (GB)

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Description

This invention relates to electroacoustic transducers as used in microphones for converting sound energy into electrical current or in loudspeakers or "receivers" for converting electrical currents into sound. The invention is particularly concerned with the type of transducer having a vibrating reed of the class known as "balanced armature".

In a balanced armature transducer a permanent magnet is combined with a pole piece to establish a magnetic field across an air gap and a vibratory reed is mounted with a part fixed and connected to the pole piece and another part capable of vibrating in the gap. The read is surrounded by an electrical coil and the arrangement is such that when the moving part of the read shifts in one direction or another away from a centralised position between the two poles the magnetic flux is caused to flow in one direction or the other along the reed and hence through the coil. The reed is attached to a diaphragm and in this way vibrations of the diaphragm caused by received sound are converted into corresponding currents in the coil, or vice versa.

In such balanced armature transducers it is important that the movable part of the reed should be accurately centralised in the air gap. Many proposals have been made to achieve this, but most prior systems are either inaccurate or extremely difficult to perform. Many such systems rely on bending of part of the pole piece or reed, either in the actual manufacturing process or in a subsequent adjusting stage. A further difficulty then arises from the inescapable movement which follows after adjustment when the stresses induced by bending are relieved.

German Auslegeschrift 1 158 115 illustrates one such instrument in which a pair of spaced magnets 9 are located by a metal yoke 8 carried by a magnetic flux branch 7 to which is attached by a rivet 6 a flexible armature 3 having one end vibratable between the two magnets. In this example the other end of the metal branch 7 is located between the two halves 10 and 11 of the outside casing of the instrument and a hole 13 or a gap 17 is provided to allow a small instrument to be inserted which will distort the housing and thereby act through a diaphragm 1 and the connecting pin 2 on the reed 3, so as to adjust the position of the reed. This example is one of many instances of instruments which incorporate adjustment devices to centralise the reed.

Accordingly, it is an object of the present invention to provide an improved balanced armature transducer which will be relatively simple to manufacture and assemble, with an accurately centralised reed.

The invention is concerned with a balanced armature electro-acoustic transducer, including a pair of permanent magnets spaced apart to define an air gap, a pole piece structure which locates the magnets and forms a magnetic flux circuit which provides a magnetic field across the air gap, a vibratory magnetic reed having one part attached to the pole piece structure, and another part vibratable in the air gap, the fixed and vibratable parts of the reed being flat and coplanar, and a coil surrounding the reed, the arrangement being such that vibration of the reed in the air gap influences a current in the coil and vice versa, and wherein the pole piece structure is formed with abutment surfaces for the reed and the two magnets, and the reed abutment surface lies in a plane passing through the air gap displaced from the central plane of the air gap by a distance approximately equal to half the thickness of the reed, and the pole piece structure is rigid and directly contacts the opposed remote surfaces of the two magnets and the fixed part of the reed.

The present invention consists in a transducer of the type defined in which the pole piece structure is formed of unitary laminations which extend continuously between and whose edges provide the abutment surface for the reed and the mounting surfaces for the magnets, each lamination lying in a plane perpendicular to the plane of the reed, whereby the vibratable part of the reed is accurately centred within the air gap.

Preferably the pole piece structure provides a ring surrounding the air gap and the locating abutment surface is preferably external to the ring. The laminations may extend in planes perpendicular to the vibratory reed, each lamination being of ring shape. Alternatively the laminations may extend parallel with the length of the reed.

In a particular preferred construction the reed is E-shaped with the two outer limbs lying approximately parallel with the central limb, the outer limbs being secured to coplanar abutment surfaces on the pole ring and the central limb vibratable in the air gap.

According to another preferred feature of the invention each of the laminations provides a complete magnetic flux path between opposite poles of the pole pieces and is also connected to the fixed part of the reed.

In all cases the reed is preferably either flat, or bent in such a way that relief of the bending stresses does not influence the position of the vibratable end of the reed.

According to another preferred feature of the invention the magnetic flux path extends through the same reed/pole piece junctions, when the reed vibrates in either direction.

The invention may be performed in various ways and two embodiments will now be described by way of example with reference to the accompanying drawings, in which:—

Figure 1 is a simplified perspective view of one form of transducer according to the invention,

Figure 2 is another perspective view of the same transducer from the end, and

Figure 3 is a perspective view of a second embodiment.

In the first example shown in Figures 1 and 2, the transducer comprises a pole piece stack or assembly 10 formed of a number of parallel flux conductive laminations with rectangular openings 9, assembled together side-by-side to form a central passageway or tunnel. Within this tunnel are located upper or lower permanent magnets 11, 12 secured to the adjacent parts of the laminations and magnetized both in the same direction, vertically as seen in the drawings with the North Pole uppermost. This creates a strong magnetic field extending vertically across the air gap between the magnets, the field then dividing in the parts of the laminations above and below the magnets and looping round towards the further limb of the pole piece.

Each of the laminations is formed with a projecting wing 13 on each opposite side and each of the wings has a flat upper face 14 which is accurately positioned to lie coplanar and parallel with a central horizontal plane through the exact centre of the air gap between the magnets (there will be a deliberate small deviation as will be explained below). It is possible that during manufacture the inside corners of the openings 9 and the wing 13 in the laminations may become radiussed, which could cause small errors in positioning the magnets 11, 12 and the limbs 16, 17 of the curvature. For this reason the corners are preferably formed with small undercuts as shown at 15.

The armature of the transducer is generally of E-shape with two lateral parallel limbs 16, 17 and a central limb 18 which constitutes the vibrating reed. The part 19 of the armature which interconnects the three limbs is bent downwards at 90°, to improve the rigidity and reduce the overall dimensions. The ends of the two fixed limbs 16, 17 are secured, for example, by welding to the flat faces 14 of the wings of the laminations. The tip 20 of the vibratory limb 18 is positioned between the two magnets 11, 12 and the vibrating limb is surrounded by a coil 22 which may be mounted on the base plate 23 of the transducer. The vibrating limb 18 is connected by a link to a diaphragm (not illustrated) and the coil is connected to an amplifier if used as a microphone or to a supply circuit, if used as a receiver.

The three limbs 16, 17, 18 are all carefully and deliberately positioned in a common plane. Since the central limb tip 20 is required to be equally spaced from the two magnets 11, 12 its under surface requires to be positioned by half the thickness of the limb below the mid position. This location is likewise adopted in the position of the face 14 on each pole piece lamination.

It will be noted that each of the limbs 16, 17, 18 is bent with respect to the connecting limb 19, but the bending is in the same direction for each limb. Thus, as the bending stresses are relieved in one limb the same occurs in the others and hence the three limbs remain parallel in a common plane thus holding the tip 20 of the vibrating reed central in the air gap.

It will be noted that the pole piece laminations are not bent during manufacture and assembly as occurs in some prior transducers and the positioning faces 14 are accurately machined or stamped out of the laminations thus providing a positive accurate locating face. Any small inaccuracy in positioning the limbs 16 on the faces would not seriously affect the positioning of the central reed tip 20.

In the second example illustrated in Figure 3, the pole piece assembly 30 is generally of J-shape and again comprises a stack of flux conducting laminations each having a main limb 31 with a hook portion 32 at one end and an anvil 33 at the other end. A pair of permanent magnets 34, 35 are positioned between the hook 32 and the main limb 31, the magnets being polarised in the same direction and spaced apart to form an air gap. The vibrating reed is a simple flat plate 36 secured rigidly at one end to the upper face 37 of the pole piece anvil 33 and with its other end centralised between the two magnets 34, 35. The reed is surrounded by a coil 38 and attached by a link, not illustrated, to an acoustic diaphragm.

For the reasons given it is important that the moving end 40 of the reed should be accurately positioned centrally within the air gap. For this purpose the laminations of the pole pieces are so shaped in manufacture that the upper face 37 of the anvil lies coplanar with the under surface of the reed end 40 when it is centralised. Since the reed is a simple flat plate without bends and the pole piece laminations likewise are not bent in manufacture or assembly, there will be no relieving of stresses to introduce inaccuracies, and the assembly and accurate centralising of the reed require no special adjustment procedures.

It will be noted that in both these embodiments each individual lamination of the pole piece provides a complete flux path between the fixed and moving ends of the armature of reed. Also, it will be noted that when the direction of the magnetic flux along the reed alters, in use, the flux continues to pass in either direction through the same junctions between the armature and the pole piece laminations. Thus any difference in the magnetic qualities of the welds or junctions will not affect the operation of the device.

Claims

1. A balanced armature electro-acoustic transducer, including a pair of permanent magnets (11, 12; 34, 35) spaced apart to define an air gap, a pole piece structure (10; 30) which locates the magnets and forms a magnetic flux circuit which provides a magnetic field across the air gap, a vibratory magnetic reed having one part (16, 17) attached to the pole piece structure, and another part (18) vibratable in the air gap, the fixed and vibratable parts of the reed being flat and coplanar, and a coil (22) surrounding the reed, the arrangement being such that vibration of the reed in the air gap influences a current in the coil and vice versa, and wherein the pole piece structure is formed with abutment surfaces (14, 9) for the reed and the two magnets, and the reed abutment surface (14) lies in a plane passing through the air

gap displaced from the central plane of the air gap by a distance approximately equal to half the thickness of the reed, and the pole piece structure is rigid and directly contacts the opposed remote surfaces of the two magnets and the fixed part of the reed, characterised in that the pole piece structure is formed of unitary laminations which extend continuously between and whose edges provide the abutment surface for the reed and the mounting surfaces for the magnets, each lamination lying in a plane perpendicular to the plane of the reed, whereby the vibratable part of the reed is accurately centred within the air gap.

2. A transducer according to Claim 1, characterised in that the pole piece structure (10) provides a ring surrounding the air gap.

3. A transducer according to Claim 2, characterised in that the reed locating abutment surface (14) is external to the ring.

4. A transducer according to Claim 2 or Claim 3, characterised in that the reed is E-shaped with the two outer limbs (16, 17) lying approximately parallel with the central limb (18), the outer limbs being secured to coplanar abutment surfaces (14) on the pole ring and the central limb (18) vibratable in the air gap, all these limbs lying in a common plane.

5. A transducer according to any of the preceding claims, characterised in that the laminations of the stack extend in planes perpendicular to the vibratory reed (18) and each is of ring shape.

6. A transducer according to any of the preceding Claims 1 to 4, characterised in that the laminations of the stack extend parallel with the length of the reed (18) but perpendicular to the plane thereof.

7. A transducer according to any of the preceding claims, characterised in that each of the laminations of the pole piece structure provides a complete magnetic flux path between opposite poles of the pole piece and also extends to form part of the abutment surface for the fixed part of the reed.

8. A transducer according to any of the preceding claims, characterised in that the magnetic flux path extends through the same reed/pole piece junctions, when the reed vibrates.

9. A transducer according to any of the preceding claims, characterised in that the whole of the reed is flat and coplanar.

10. A transducer according to any of the preceding claims 1 to 8, in which the intermediate part of the reed between the fixed and vibratable parts has two identical bends at the same position.

Patentansprüche

1. Ausgeglichener elektroakustischer Wandler mit einem Paar Permanentmagneten (11, 12; 34, 35), die Abstand voneinander haben und einen Luftspalt freilassen, mit einem Polstückelement (10; 30), welches die Magnete aufnimmt, einen magnetischen Kraftlinienweg bildet und ein magnetisches Feld quer zum Luftspalt hervorruft, ferner mit einer schwingbaren Magnetzunge, von der ein Teil (16, 17) am Polstückelement befestigt ist und ein anderer Teil (18) im Luftspalt schwingbar ist, wobei die befestigten und schwingbaren Teile der Zunge flach ausgebildet und planparallel sind, mit einer die Zunge umgebenden Spule (22) in einer solchen Anordnung, daß die Schwingung der Zunge im Luftspalt einen Strom in der Spule hervorruft und umgekehrt, wobei daß Polstückelement Auflageflächen (14, 9) für die Zunge und die beiden Magnete aufweist, von denen die Auflagefläche (14) für die Zunge in einer Ebene liegt, die den Luftspalt versetzt zur Mittenebene durchdringt mit einem Abstand etwa der Hälfte der Dicke der Zunge und wobei das Polstückelement starr ist und mit den entgegengesetzten entfernten Oberflächen der beiden Magnete und dem festen Teil der Zunge direkt Kontakt hat, dadurch gekennzeichnet, daß das Polstückelement aus einheitlichen Lamellen gebildet ist, die sich ohne Unterbrechung zwischen den Montageoberflächen für die Magnete erstrecken und bei denen die Enden die Auflageflächen für die Zunge bilden, wobei jede Lamelle in einer Ebene senkrecht zur Ebene der Zunge liegt und der schwingende Teil der Zunge genau im Luftspalt zentriert ist.

2. Wandler nach Anspruch 1, dadurch gekennzeichnet, daß das Polstückelement (10) einen Ring um den Luftspalt bildet.

3. Wandler nach Anspruch 2, dadurch gekennzeichnet, daß die Auflagefläche (14) für die Zunge außerhalb des Ringes sich befindet.

4. Wandler nach Anspruch 2 oder 3, dadurch gekennzeichnet, daß die Zunge E-förmig ausgebildet ist mit zwei äußeren Schenkeln (16, 17), welche mit der mittleren Zunge (18) etwa parallel liegen und an planparallelen Auflageflächen (14) des Polstückelementes befestigt sind, wobei die mittlere Zunge (18) im Luftspalt schwingbar ist und alle Teile der Zunge in einer gemeinsamen Ebene liegen.

5. Wandler nach einem der vorgenannten Ansprüche, dadurch gekennzeichnet, daß die Lamellen des Stapels sich in senkrecht zur schwingbaren Zunge stehenden Ebenen erstrecken und daß jede Lamelle eine Ringform hat.

6. Wandler nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß die Lamellen des Stapels sich parallel zur Länge der Zunge (18) aber senkrecht zur Ebene derselben erstrecken.

7. Wandler nach einem der vorgenannten Ansprüche, dadurch gekennzeichnet, daß jede der Lamellen des Polstückelementes einen vollständigen magnetischen Kraftlinienweg zwischen entgegengesetzten Polen des Polstückelementes erzeugt und außerdem derart verlängert ist, daß es einen Teil der Auflagefläche für den festen Teil der Zunge bildet.

8. Wandler nach einem der vorgenannten Ansprüche, dadurch gekennzeichnet, daß der magnetische Kraftlinienweg sich durch dieselben Zungen/Polstück-Verbindungen erstreckt, wenn die Zunge schwingt.

9. Wandler nach einem der vorgenannten An-

sprüche, dadurch gekennzeichnet, daß die Zunge als Ganzes flach und planparallel ist.

10. Wandler nach einem der Ansprüche 1 bis 8, dadurch gekennzeichnet, daß der die Schenkel (16, 17) und die Zunge (18) verbindende Teil (19) in eine Querebene umgebogen ist.

Revendications

1. Transducteur électro-acoustique à induit centré, comprenant deux aimants permanents (11, 12; 34, 35) espacés l'un de l'autre de manière à délimiter un entrefer, une structure formant pièce polaire (10; 30) qui maintient en position les aimants et définit un circuit de propagation d'un flux magnétique, engendrant un champ magnétique à travers l'entrefer, une lame magnétique vibrante dont une partie (16, 17) est fixée à la structure formant pièce polaire et dont une seconde partie (18) est susceptible de vibrer à l'intérieur de l'entrefer, la partie fixe et la partie susceptible de vibrer de la lame étant planes et coplanaires, et une bobine (22) entourant la lame, le montage étant tel que des vibrations de la lame à l'intérieur de l'entrefer induisent un courant dans la bobine et vice-versa, et dans lequel la structure formant pièce polaire est dotée de surfaces d'appui (14, 9) pour la lame et les deux aimants, et la surface d'appui (14) pour la lame s'étend dans un plan qui passe à travers l'entrefer tout en étant décalé par rapport au plan médian de l'entrefer d'une distance approximativement égale à la moitié de l'épaisseur de la lame, et la structure formant pièce polaire est rigide et est en contact direct avec les surfaces opposées des deux aimants, situées de l'autre côté, et avec la partie fixe de la lame, caractérisé en ce que la structure formant pièce polaire est un élément feuilleté constitué de lamelles unitaires qui s'étendent en continu entre les surfaces d'appui et dont les tranches forment ladite surface d'appui pour la lame et les surfaces de montage des aimants, chaque lamelle s'étendant dans un plan perpendiculaire au plan de la lame, ce qui fait que la partie apte à vibrer de la lame est centrée avec précision à l'intérieur de l'entrefer.

2. Tranducteur selon la revendication 1, caractérisé en ce que la structure formant pièce polaire (10) définit un anneau entourant l'entrefer.

3. Transducteur selon la revendication 2, caractérisé en ce que la surface d'appui et de positionnement (14) de la lame est située à l'extérieur de l'anneau.

4. Transducteur selon la revendication 2 ou la revendication 3, caractérisé en ce que la lame présente la forme d'un E dont les deux branches extérieures (16, 17) sont sensiblement parallèles à la branche centrale (18), les branches extérieures étant fixées sur des surfaces d'appui coplanaires (14) ménagées sur la pièce polaire annulaire, tandis que la branche centrale (18) peut vibrer dans l'entrefer, toutes ces branches s'étendant dans un plan commun.

5. Transducteur selon l'une quelconque des revendications précédentes, caractérisé en ce que les lamelles de l'empilage s'étendent dans des plans perpendiculaires à la lame vibrante (18) et chacune d'elle présente une forme annulaire.

6. Transducteur selon l'une quelconque des revendications précédentes 1 à 4, caractérisé en ce que les lamelles de l'empilage s'étendent parallèlement à la direction longitudinale de la lame (18), mais perpendiculairement au plan de cette dernière.

7. Transducteur selon l'une quelconque des revendications précédentes, caractérisé en ce que chacune des lamelles de la structure formant pièce polaire définit un trajet fermé pour le flux magnétique, entre les pôles en vis-à-vis de la pièce polaire, et se prolongent en outre pour former une partie de la surface d'appui pour la partie fixe de la lame.

8. Transducteur selon l'une quelconque des revendications précédentes, caractérisé en ce que le trajet de propagation du flux magnétique traverse toujours les mêmes jonctions lame/pièce polaire, lorsque la lame vibre.

9. Transducteur selon l'une quelconque des revendications précédentes, caractérisé en ce que la lame, prise dans son ensemble, est plane et s'étend dans un plan unique.

10. Transducteur selon l'une quelconque des revendications précédentes 1 à 8, dans lequel la partie intermédiaire de la lame, située entre les parties fixe et apte à vibrer, comporte deux pliures identiques au même endroit.

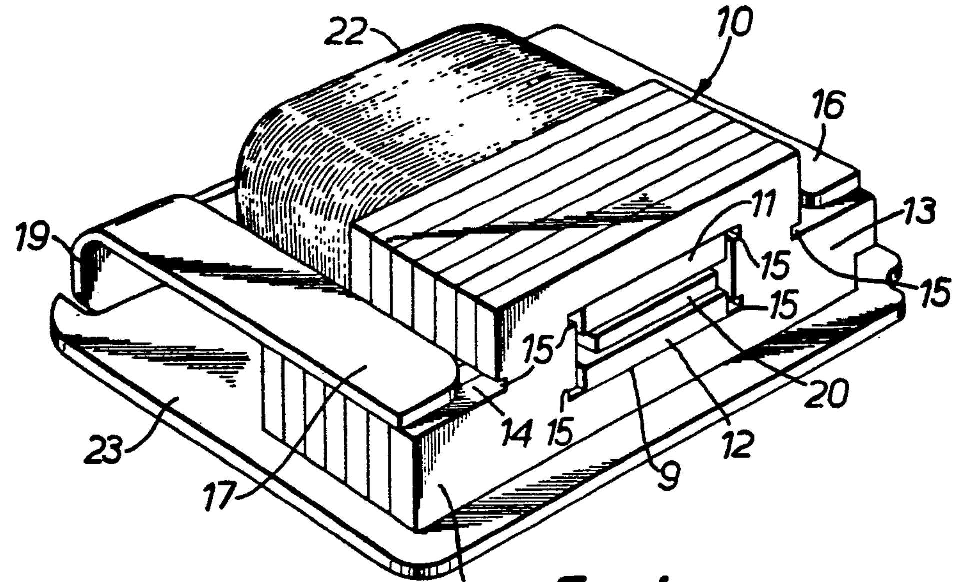
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Fig. 1.

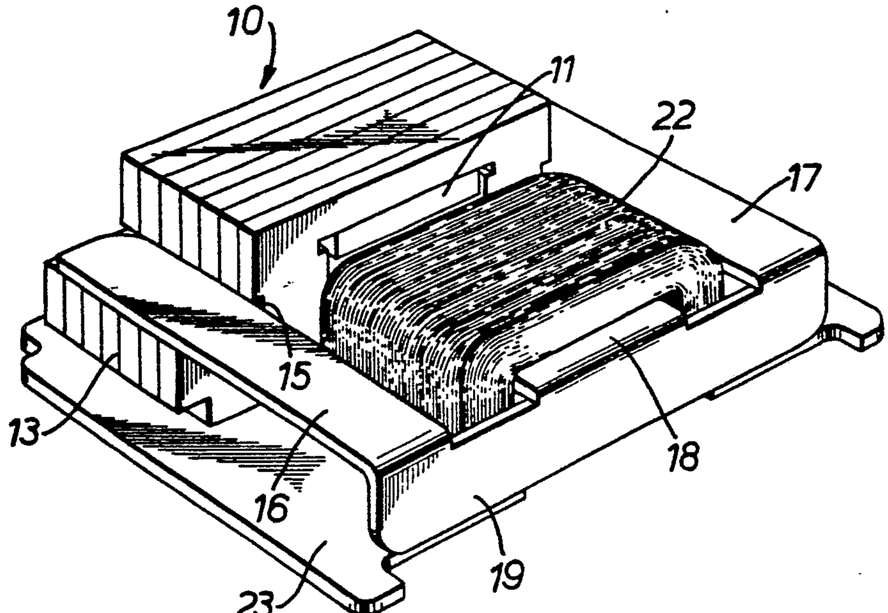
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Fig. 2.

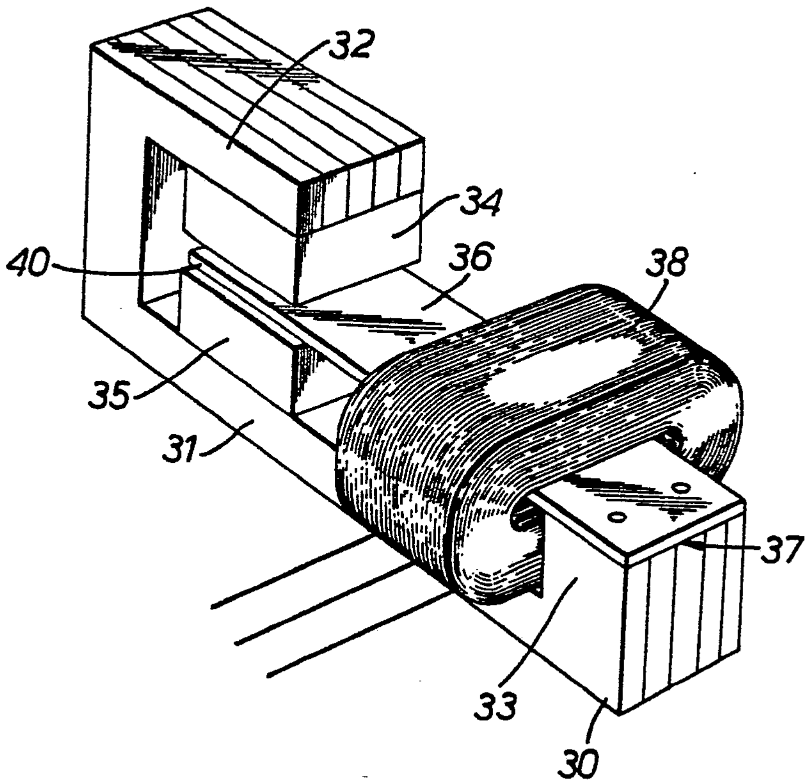

FIG. 3.