July 3, 1951 R. E. H. CARPENTER 2,559,399

POLARIZED ELECTROMAGNETIC RELAY

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FIG. 1.

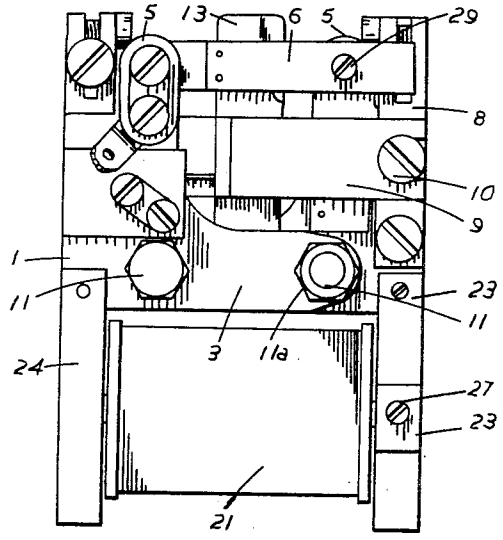

FIG. 2.

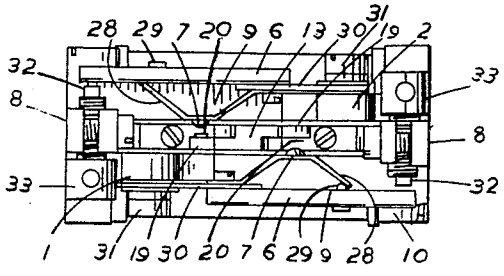

FIG. 3.

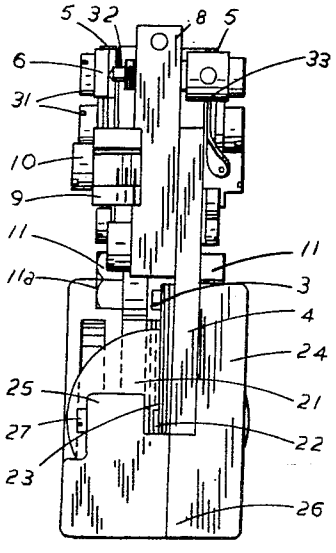

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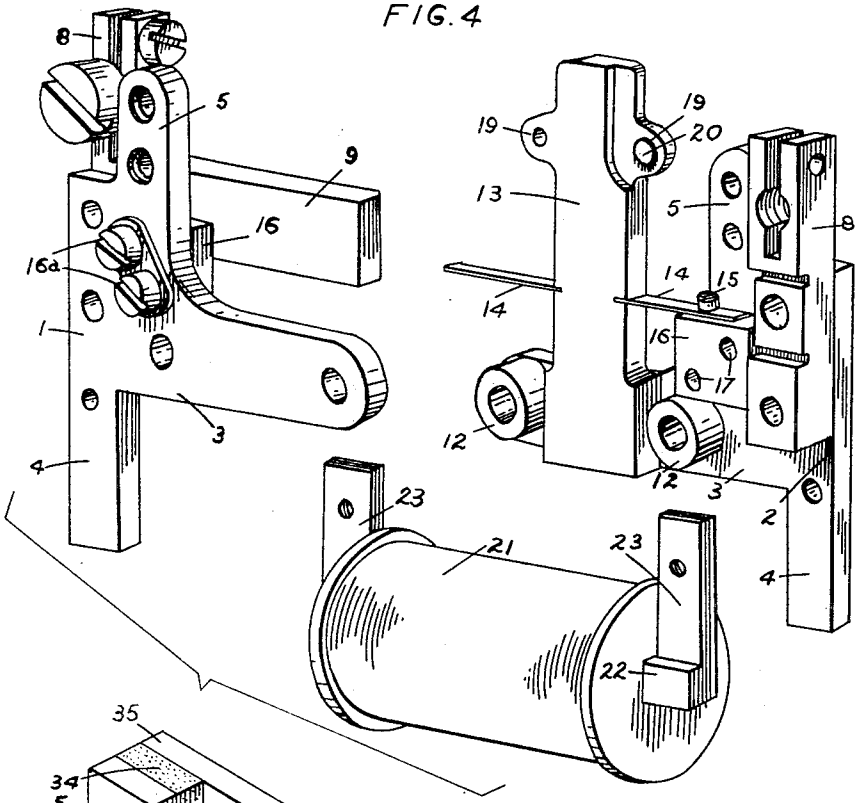
FIG. 4



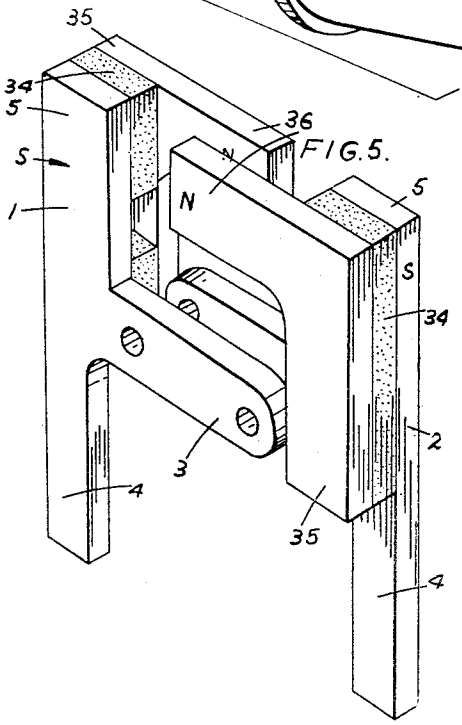


FIG. 5.

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POLARIZED ELECTROMAGNETIC RELAY

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In Great Britain October 2, 1946

5 Claims. (Cl. 175—339)

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This invention relates to polarised electromagnetic relays and like magnetic devices for the interconversion of electrical and mechanical vibrations and one of the chief objects of the invention is to provide a form of relay which is of very small dimensions so as to occupy a small space and to be light in weight without materially sacrificing the efficiency of the instrument. While, however, the invention is valuable in its application to polarised telegraph relays, it is equally applicable to any electromagnetic relays which need to be set up in a relatively small space and in which the minimum of weight is an important consideration.

The qualities outlined above are attained, according to the invention, by employing two magnetic pole-pieces rigidly secured together and having an armature mounted so as to vibrate between them while each pole-piece has three coplanar surfaces of which one constitutes a boundary of the air gap separating the respective pole-pieces from the armature and the other two surfaces are held in contact with spacing members which determine the length of the air gap in which the armature vibrates. It is naturally important to secure accuracy in the length of the air gap and to have the faces bounding the air gap parallel and with devices of small size, this is the more necessary and difficult to attain. The two pole-pieces then conveniently constitute main members of the framework of the relay and serve also to support the permanent magnets, the signals coil and its core and the support for the vibrating armature. The two cooperating members may then consist of flat plates of identical form, being set relatively at 180 degrees instead of being mirror images of one another as has been common previously. The two members may be of opposite magnetic polarity with respect to the alternating or reversals flux set up by the signal currents if the relay has a magnetic circuit according to Patents Nos. 1,826,990 and 2,412,123 or they may be of opposite magnetic polarity with respect to the polarising flux if a permanent magnet is sandwiched between them and the armature vibrates within the signal or input current winding in a magnetic circuit similar to that described in the specification of Patent No. 1,552,676.

The major extensions of the pole-piece members lie substantially parallel to one another and to the axis about which the armature vibrates and on opposite sides of that axis. The armature is suspended to vibrate about an axis near to its centre of gravity and to and from the pole-pieces.

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Since the working gap in which the end or ends of the armature vibrates lies between the pole-pieces of magnetic material, its width may be set accurately by spacing the pole-pieces apart by spacing members which may, in some cases, be permanent magnets. The faces of the parallel pole-pieces may easily be set parallel to one another by accurately forming the spacing members.

The novel form of relay lends itself to the provision of compliant contact mountings as set forth in Patent specification No. 2,219,222. By providing means for connecting the armature to a diaphragm instead of providing relay contacts, any form of the magnetic structure may be used in a loud-speaking or other telephone receiver.

One important feature of the invention is that the two pole pieces are formed of flat plates of soft magnetic material and may be punched from sheet stock.

In order that the invention may be more clearly understood and readily carried into effect, some examples of electromagnetic instruments constructed in accordance with the invention will now be more fully described with reference to the accompanying drawings in which:

Figure 1 is a front elevation of one form of the invention as applied to a polarised telegraph relay;

Figure 2 is a plan of the same; while

Figure 3 is an end elevation of the relay; and

Figure 4 is a perspective view of the chief elements of the relay dismantled; and

Figure 5 is a perspective view showing a modification of the magnetic structure according to Fig. 1.

Referring first to Figs. 1 to 4, the two pole-pieces 1, 2 are identical and each consists of a flat plate with an arm 3 to form the pole-piece proper, a shank 4 at right angles to the arm 3 and a projection 5 opposite the shank 4 for carrying one of the bars 6 which serves as a support for the fixed contacts 7. The pole-pieces 1, 2 are formed of a soft magnetic alloy of low coercivity. A spacing bar 8 of magnetic material is secured to one face of the pole-piece 1 or 2 in line with the shank 4 and the permanent magnet 9 has its rear end fixed to the spacing bar 8 by a screw 10. Thus the permanent magnet 9 extends parallel to the pole-piece 1 or 2 but staggered relatively to it by an amount equal to the thickness of the spacing bar 8. The two pole-pieces 1, 2 are rigidly secured together and set relatively at 180 degrees to one another by a pair of non-magnetic screws 11 passing through both pole-pieces near their ends and each en-

gaged by a nut 11*a* and having a non-magnetic washer 12 around each screw 11 to serve as the spacing members between the two pole-pieces 1, 2. The inner faces of the pole-pieces are ground flat and the two washers are ground or coined so as to be finished accurately to the predetermined thickness, for example, of about a tenth of an inch so that the spacing washers 12 accurately determine the length of the air gap between the pole-pieces which are secured together with their facing surfaces accurately parallel. Although in the example illustrated, the pole-pieces 1, 2 are accurately finished over the whole of their facing surfaces, what is actually important is that the areas of each of the facing surfaces in contact with the spacing washers 12 and that which forms a boundary of the air gap separating the pole-piece in question from the armature are accurately made as three co-planar surfaces with the result that the length of the gap between those parts of the pole-pieces with which the armature co-operates is accurately determined.

Owing to the staggering of the permanent magnets 9 relatively to the respective pole-pieces 1, 2, the magnets 9 are mounted with their outer ends which are of like polarity, parallel to one another but with each relatively on the opposite side of the armature 13 to the corresponding pole-piece 1 or 2. In the example illustrated, the armature 13 consists of a strip of the section at the top seen in Figs. 2 and 4 and has suspension blades 14 let into it in the neighbourhood of its centre of gravity and extending from either side. Each suspension blade 14 is fixed by a screw 15 to a brass block 16, each of which is fixed to the inner face of the respective pole-piece 1 or 2 by screws 16*a*, but which are threaded into holes 17 in the block 16 and holes 18 in the pole-piece 1 or 2. At its upper end, the armature 13 is formed with two offset lateral extensions 19 each of which bears one of the moving contacts 20 of the relay. By this arrangement, the overall effective thickness of the armature is reduced and space is saved. The lower end of the armature is reduced and space is saved. The lower end of the armature 13 lies in the gap between the limbs 3 of the pole-pieces and vibrates between those limbs.

The signals coil 21 embraces a laminated core 22 which abuts against vertical laminations 23 at either end and the latter are pressed against the respective shanks 4 of the pole-pieces 1, 2. This is effected by introducing the shank 4, core 22 and laminations 23 into the space between two uprights 24, 25 of a brass foot-piece 26 and clamping the parts in position by a screw 27, tapped into the upright 25. Thus the two limbs 3 of the pole-pieces 1, 2 are of opposite polarities with respect to the alternating flux produced by the signals current in the case of a relay or by the movement of the armature in the case of a telephone transmitter or phonograph pick-up while the polarising fluxes from the permanent magnets 9 enter the armature from both pole-piece limbs 3, pass in parallel through the armature and return to the magnets 9. It will be seen therefore, that in this example, the magnetic circuit is arranged generally according to patent specifications 1,826,990 and 2,412,123.

The stationary contacts of the relay are seen at 7 on opposite sides of the armature and are carried on bent-out leaf springs 28 fixed at one end to the support bars 6 and having each of the other ends free to rub on an adjustable screw 29 projecting from the bar 6 so that adjustable

damping is applied as in patent specification No. 2,219,222. The bars 6 are rivetted to flat springs 30 which are fixed by screws 31 to the projections 5 of the pole-pieces 1, 2 and are biassed or set to cause the bars 6 to bear on the ends of adjusting screws 32. The latter are screwed in the split ends of the opposite spacing bar 8 and have heads 33 enabling them to be adjusted by small tommy pins. The stationary contacts 7 are thus located to co-operate with the moving contacts 20 carried by the armature as already described.

In the form of magnetic structure shown in Fig. 5, the two pole-pieces 1, 2 are identical flat plates of substantially the same form as in Figs. 1 to 4 with the limbs 3, shanks 4, and projections 5 but in addition to the screws 11 and non-magnetic spacing washers, the pole-pieces are spaced by two permanent magnets 34 from two further pole-pieces 35 having major extensions 36 taking the places of the bar magnets 9. The pole-pieces 1, 2, 35 are all made of a soft magnetic alloy of low coercivity. The permanent magnets 34 are formed of a recent form of magnetic material consisting of grains consolidated by a binder of synthetic resin and having a high coercive force and known under the name "Cassalox." They are magnetised to have unlike poles on their opposite faces so that the extensions 36 present tips of like polarity as marked N. The armature, the relay contacts and the remaining parts are not shown but they are as shown in Figs. 1 to 4.

As shown in Figures 4 and 5 of the drawing, each pole piece is formed of a main limb comprising the shank 4 and the vertical extension thereof which carries the projection 5, and an auxiliary limb 3 extending at right angles to the main limb at a point intermediate the ends thereof.

I claim:

1. An electromagnetic device for the interconversion of electrical and mechanical vibrations comprising, an energizing coil having a magnetic core, a pair of pole pieces formed of two flat plates of soft magnetic material and having main limbs arranged in parallel relation transversely of the axis of said coil, one end of each main limb being magnetically connected with one end of said core, said pole pieces also having auxiliary limbs extending from points intermediate the ends of said main limbs at right angles thereto and in overlapping parallel relation parallel with the axis of said coil, means securing said overlapping auxiliary limbs together in spaced parallel relation including a pair of spacers of equal thickness interposed between said auxiliary limbs at spaced points along their length, the inner faces of said auxiliary limbs between said spacers forming the bounding surfaces of an air gap having a length equal to the thickness of said spacers, and an elongated magnetic armature having one end thereof positioned within said air gap and extending in the space between the outer end portions of said main limbs, and means for pivotally supporting said armature from the outer end portions of said main limbs for vibration about an axis parallel with the axis of said coil.

2. An electromagnetic device according to claim 1 and including a bar magnet secured at one end to the outer end portion of one of said main limbs and extending at right angles thereto in overlapping relation with said armature substantially at the pivotal axis thereof, and a second bar magnet having one end thereof secured to the outer end portion of the other main limb and extending at right angles thereto into

overlapping relation with said armature substantially at the pivotal axis thereof and on the opposite side of said armature from said first magnet, each magnet being positioned on the opposite side of the armature from the auxiliary limb carried by the main limb supporting the magnet.

3. An electromagnetic device for the interconversion of electrical and mechanical vibrations comprising, an energizing coil having a magnetic core, a pair of pole pieces formed of magnetic material of low coercivity and having main limbs arranged in parallel relation transversely of the axis of said coil, one end of each main limb being magnetically connected with one end of said core, said pole pieces also having auxiliary limbs extending from points intermediate the ends of said main limbs at right angles thereto and in overlapping parallel relation parallel with the axis of said coil, means securing said overlapping auxiliary limbs together in spaced parallel relation including a pair of spacers of equal thickness interposed between said auxiliary limbs at spaced points along their length, each of said auxiliary limbs having co-planar surfaces forming seats for said spacers at said points, the inner faces of said auxiliary limbs between said spacers being co-planar with the seating surfaces of said spacers and forming the bounding surfaces of an air gap having a length equal to the thickness of said spacers, and an elongated magnetic armature having one end thereof positioned within said air gap and extending in the space between the outer end portions of said main limbs, and means for pivotally supporting said armature from the outer end portions of said main limbs for vibration about an axis parallel with the axis of said coil.

4. In an electromagnetic device for the interconversion of electrical and mechanical vibrations, the combination of a pair of substantially identical flat pole plates of magnetic material of low coercivity, each plate being formed of a main shank and a transverse arm extending at right angles thereto, means supporting said plates with the shanks thereof in spaced parallel relation and with the transverse arms thereof in parallel overlapping relation, each transverse arm extending from its own shank towards the opposite shank, each of said transverse arms having three co-planar surfaces formed on the face thereof which faces the other transverse arm, the co-planar surfaces on one of said arms being arranged opposite the co-planar surfaces on the other arm, whereby said surfaces are arranged in three pairs of opposed surfaces spaced along said overlapping arms, said means supporting said plates including a pair of spacers of equal thickness interposed between said transverse arms at the two outer pairs of opposed surfaces and engaging said co-planar surfaces, the spaced co-planar surfaces of the central pair of opposed surfaces constituting the bounding surfaces of an air-gap having a length equal to the thickness of said spacers, means connected between said shanks and arranged parallel with said overlapping arms for magnetizing said shanks in opposite polarity, and a magnetic armature positioned within said air-gap and mounted for vibration lengthwise of said gap.

5. In an electromagnetic device for the interconversion of electrical and mechanical vibrations, the combination of a pair of substantially identical flat pole plates of low coercivity, each plate being formed of a main shank and a transverse arm extending at right angles thereto, means supporting said plates with the shanks thereof in spaced parallel relation and with the transverse arms thereof in parallel overlapping relation, each transverse arm extending from its own shank towards the opposite shank, each of said plates having three coplanar surfaces formed on the face thereof which faces the other plate, the co-planar surfaces on one of said plates being positioned opposite the co-planar surfaces on the other plate, whereby said surfaces are arranged in three pairs of opposed surfaces, two of said pairs of opposed surfaces being located respectively adjacent the ends of said arms and the third pair substantially mid-way between said two pairs, said means supporting said plates including a pair of spacers of equal length interposed between said plates at the two outer pairs of opposed surfaces and engaging said co-planar surfaces, the spaced co-planar surfaces of the central pair of opposed surfaces constituting the bounding surfaces of an air-gap having a length equal to the thickness of said spacers, means connected between said shanks and arranged parallel with said overlapping arms for magnetizing said shanks in opposite polarity, and a magnetic armature positioned within said air-gap and mounted for vibration lengthwise of said gap.

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