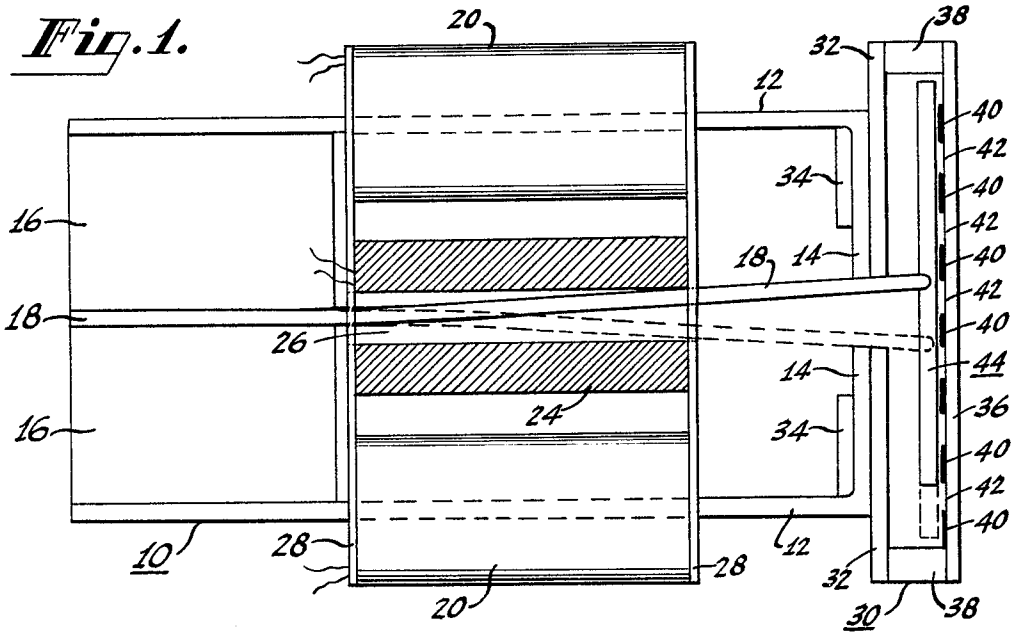
April 30, 1968 E. D. SIMSHAUSER 3,381,291

DISPLAY MODULE HAVING ELECTROMAGNETIC COIL SENSING OF ARMATURE POSITION

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Fig. 1.



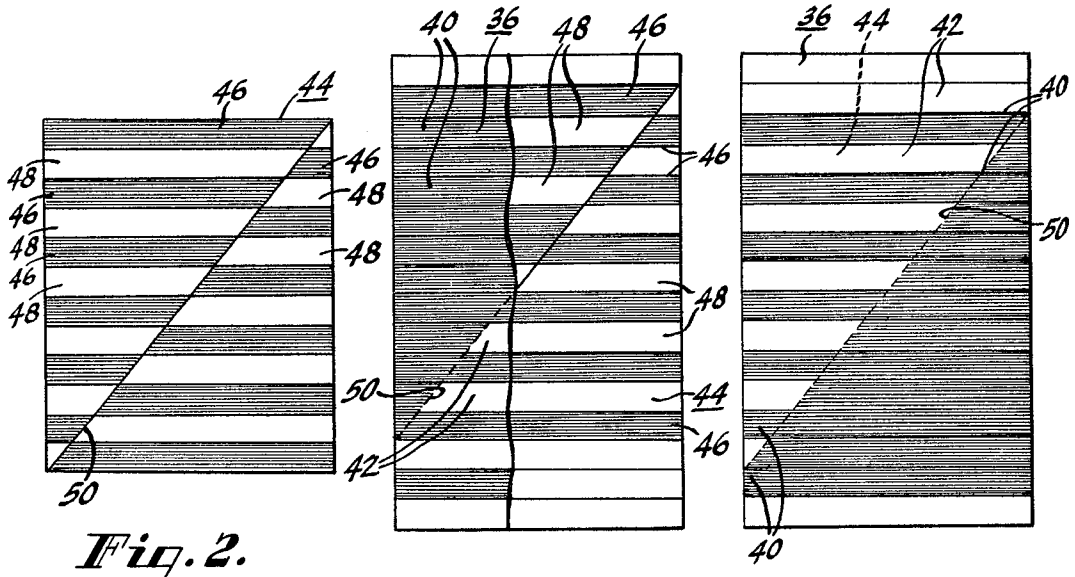


Fig. 2.

Fig. 3.

Fig. 4.

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Fig. 5.

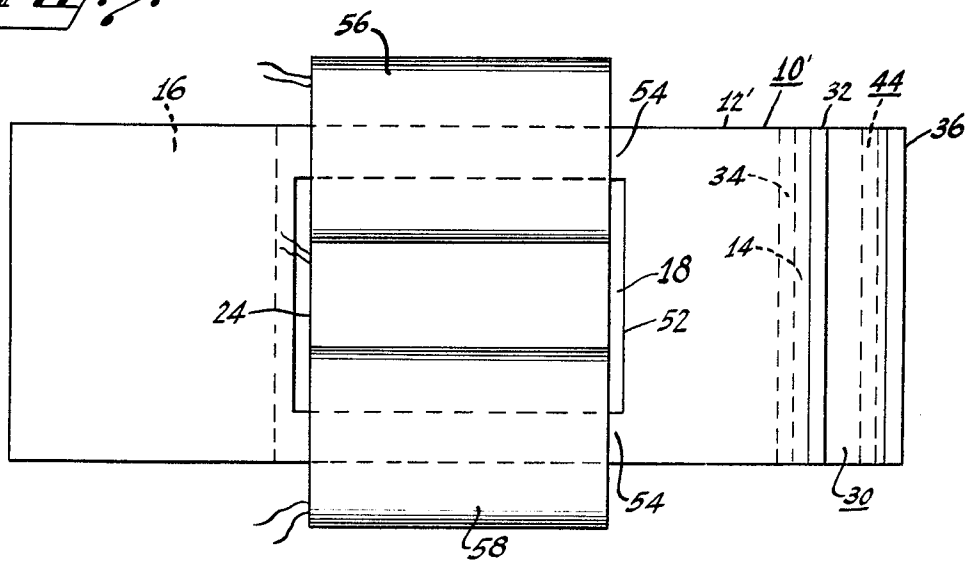
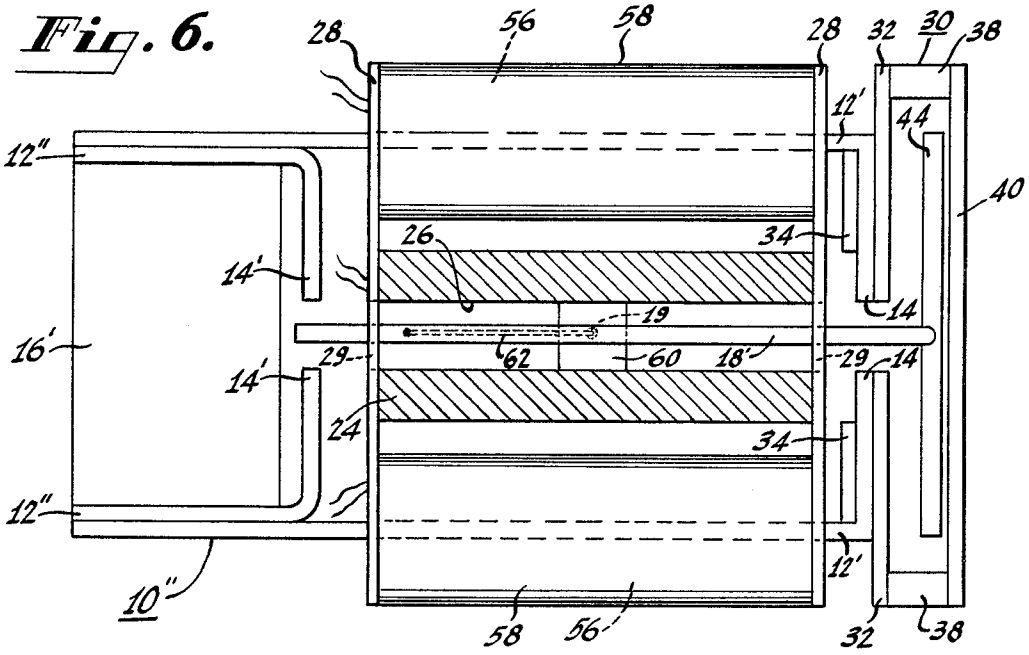


Fig. 6.



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DISPLAY MODULE HAVING ELECTROMAGNETIC COIL SENSING OF ARMATURE POSITION

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This invention relates to magnetically operated display modules.

Many prior art magnetically operated display devices require a substantial amount of power to hold them in one or more of their several positions.

It is an object of this invention to provide an improved magnetically operated display module or device which is operable by a small amount of power.

It is a further object to provide an improved magnetically operated display module which has a plurality of positions of rest and which requires no power to be held in those positions.

Yet a further object is to provide an improved magnetically operated display module, the position of the moving element of which can be ascertained from a distance by the application thereto of an electric pulse or by visual observation.

In accordance with one embodiment of this invention, a magnetic structure is provided having a pair of spaced, oppositely polarized, pole pieces, there being a separate coil wound around the two leg portions of the magnetic structures. The two leg portions are respectively fixed to the pole pieces. A magnetic armature which extends through a third coil and which has high magnetic permeability is so mounted that it can be physically moved to contact either one of the pole pieces. Once in contact with one of the pole pieces, the armature remains in contact with that pole piece until again physically moved. Alternatively, a current may be passed through the coil surrounding the armature in such a direction as to cause the armature to move away from a pole piece into contact with the other pole piece where it will remain until moved by hand or by another current pulse. Therefore, the armature has two positions of rest, one in contact with either pole. Furthermore, the position of the armature can be sensed or determined from a distance by sending a pulse of current through the coils on the legs and by comparing the amount of current passing through the coils. A display device can be fixed to the armature to provide different indications for the two different positions of rest thereof.

In a modification, each leg portion has a slot cut therethrough leaving neck portions that are nearly saturated when the armature is in contact with the pole piece fixed to that leg, the neck portions being less saturated when the armature is in contact with the pole piece fixed to the other leg. A coil is provided surrounding each neck portion of the leg. The position of the armature may be sensed by passing current through one coil associated with one leg and noting the voltage induced in the other coil associated with that leg, which will be higher when the leg is less saturated.

In a still further modification, the magnetic structure can have two pairs of oppositely polarized pole pieces with the armature pivotally mounted and so positioned between the pole pieces that the armature can be tipped

into either of its two positions at which the ends of the armature contact opposite poles of the magnetic structure.

The novel features of the invention both as to its organization and method of operation, as well as additional objects and advantages thereof, will be understood more readily from the following description when read in conjunction with the accompanying drawing in which:

FIG. 1 is the side elevational view of one form of this invention,

FIG. 2 is a front elevational view of a slide comprising a part of the module of FIG. 1,

FIG. 3 is a front elevational view of the module of FIG. 1 with the slide in one of its two positions, a portion of the module being broken away,

FIG. 4 is a front elevational view of the module of FIG. 1 with the slide in the other of its two positions,

FIG. 5 is the plan view of the module of FIG. 1 having however a modified leg structure, and

FIG. 6 is a side elevational view of the module of FIG. 5 in which the magnetic structure and the mounting of the armature is modified.

Similar components in the respective figures are given the same reference numerals with the reference numerals being primed when the components are modified in the manner described.

Referring to FIG. 1, the module **10** comprises a magnetic structure having legs **12**. A portion of each leg **12** is bent at an angle, an end portion of said leg comprising a pole piece **14**. Permanent magnets **16** are provided, clamping between them one end of a flexible armature **18**. The ends of the legs **12** opposite the pole pieces **14** are fixed respectively to the free ends of the magnets **16**, with the pole pieces **14** extending toward each other. The north end of one magnet **16** contacts the flexible armature, and the south end of the other permanent magnet **16** contacts the opposite surface of the flexible armature **18**. The free end of the armature **18** extends through and beyond the gap between the adjacent ends of the pole pieces **14**. The armature **18** is biased by its resilience towards an intermediate position between the pole pieces **14**. A separate coil **20** surrounds and is supported by each of the legs **12**. A further coil **24** surrounds the armature **18**. The last-mentioned coil **24**, which is shown in section, has a hole **26** therethrough large enough to permit free flexing of the armature **18** to either of its extreme positions shown respectively in dotted and in full lines, in which the free end portion of the armature **18** is in contact with one or the other of the two pole pieces **14**. The coil **24** can be supported from the other two coils **20** by non-magnetic end plates **28**. An indicator **30** is provided to indicate the position of the armature **18**.

The indicator **30** comprises a pair of support plates **32**. Each support plate **32** is fixed to a pole piece **14** as by clamp plates **34**. Screws or other mounting means (not shown) can be made to extend through the plates **32**, the pole pieces **14** and into the clamp plates **34**. The indicator **30** also includes a face plate **36** fixed to the support plates **32** by means of spacers **38** at the ends of the faceplate **36** and screws or suitable means (not shown). The faceplate **36** comprises alternate transversely extending parallel opaque portions **40** which may be black, and transparent portions **42**, the transparent and the opaque portions being of the same width, as shown in FIGS. 1, 2, and 3. The indicator further includes a slider **44** fixed to the free end of the armature **18** and moved

thereby parallel to the faceplate 36 between its extreme positions as the armature 18 flexes from contact with one of the pole pieces 14 to the other, as will be explained. As shown in FIG. 2, the slider 44 has alternate black portions 46 and white portions 48 extending thereacross, these portions being of the same width as the opaque and transparent portions 40 and 42 of the plate 36. However, the black portions 46 which begin at the left side, as viewed in FIG. 2, of the slider 44 extend to a diagonal line 50 running from the upper right to the lower left corners of the slider 44. The black portions 46 which begin at the right side of the slider extend to the diagonal line 50 and alternate with the black portions 46 of the slider to the left of the diagonal line 50. In this manner, when the slider 44 is in its extreme upper position as viewed in FIGS. 1 and 3, the indicator 30 shows a solid right triangle having its base at the left and its apex to the upper right and with black lines 40 running to the right from the solid triangle. When the slider 44 is in its extreme lower position, that is, when it is displaced downward, as viewed in FIGS. 1 and 4, by the width of one black portion 46, the base of the right triangle is now to the right with its apex to the lower left. The black portions 40 extend to the left from the triangle. These two indications are shown respectively in FIGS. 3 and 4.

The device of FIG. 1 operates as follows: The armature 18 can be flexed manually until an end portion thereof contacts either the upper or lower pole piece 14 as viewed in FIG. 1, in which case the flux extending along the armature 18 is in the proper direction to cause attraction between the armature 18 and its contacting pole piece 14, and whereby the armature 18 remains in the position to which it is moved. If the armature 18 is moved to contact the other of the pole pieces 14, the flux in the armature 18 reverses in direction and the armature 18 remains in its new position.

The armature 18 can be moved by passing a current through the coil 24 by means of the terminals shown. If a current is sent through the armature coil 24 in a direction to attract the free end of the armature 18 to the upper pole piece 14 (as viewed in FIG. 1) the armature 18 will move into contact with the upper pole piece 14 from its contact with the lower pole piece 14 and remain there. If current is sent through the armature coil 24 in the opposite direction, the armature 18 will move into contact with the lower pole piece 14 and will remain there.

If a pulse of current is sent through both coils 20 from the same source or from sources of current of equal voltage, and the current passing through the two coils 20 are compared, then the coil 20 surrounding the leg 12 whose pole piece 14 does not contact the armature 18 will pass more current. Therefore, the position of the armature 18 and the indication given by the module 10 can be determined from a distance by sending a current through the coils 20.

While a pulse of current sent through either of the coils 20 of FIG. 1 is intended only to give an indication of the position of the armature 18, it can be in such direction and sufficiently strong in itself to move the armature 18 from one of its positions to the other. To prevent such false operation of the module 10, the magnetic structure illustrated in FIG. 5 is provided. In FIG. 5 the armature 18 is the same width as the legs and the coil 24 surrounds the armature 18. In fact, the module 10' of FIG. 5 differs from the module 10 of FIGS. 1–4 only in that a leg 12' of FIG. 5 has a slot 52 therein leaving narrow neck portions 54 in the leg 12' between the magnet 16 and the pole piece 14, and in that a drive coil 56 is mounted on one neck portion 54 and a sense coil 58 is mounted on the other neck portion 54. The material of the leg 12' and the flux density provided by the magnet 16 are so chosen that when the armature 18 contacts a pole piece 14, the neck portions 54 of the corresponding leg 12' are saturated, or nearly saturated, with flux due to the increase of flux therein caused by this contact of the armature 18 and the pole piece 14. The neck portions 54 of the opposite leg 12' (not shown) are not saturated. Therefore using the drive coil 56 as the primary and the sense coil 58 as the secondary of a transformer, an inquiry or drive pulse of current sent into the coil 56 produces a greatly different output of voltage in the sense coil 58 when the armature 18 is in one position than when it is in the other position. Furthermore, the change of flux in one neck portion 54 will be balanced by an equal and opposite change in the opposite neck portion of a leg, whereby an inquiry or drive pulse cannot change the position of the armature 18. Using the modified leg 12' of FIG. 5, only one inquiry or drive coil 56 and only one sense coil 58, both on the same leg, 12', may be necessary, rather than additional coils (not shown) for the opposite leg 12' (not shown) of the magnetic structure. The display position 30 of the device of FIG. 5 is identical to that of FIGS. 1–3 described above.

To save operational energy, a module can be provided in which the armature is pivoted. Referring to FIG. 6, a first pair of legs 12'' of magnetic material contact the opposite ends of a permanent magnet 16'. Each leg 12'' terminates in an inwardly turned pole piece 14', leaving a gap therebetween. A second pair of legs 12' are provided with contact legs 12'' and which are also fixed to the ends of the magnet 16'. The second set of legs 12' are longer than the first set of legs 12''. The ends of the legs 12' are inwardly turned to provide pole pieces 14, a gap remaining between these pole pieces. Two coils 56 and 58 are mounted on each leg 12' of FIG. 6 in the manner described in connection with FIG. 5. A coil 24 which is sectioned to show a hole 26 therethrough is positioned to surround an armature 18' by means of end plates 28 which are fixed to the ends of the coils 56, 58, and 24, there being a bore 29 in each end plate 28 of the same size as and in registry with, the hole 26. An armature 18' having a pair of pivot pins 19 (only one being shown) is pivotally mounted on the coil 24 by means of a pair of blocks 60 only one of which is shown. A wire spring 62 an end of which is fixed to the armature 18' and the other end of which is anchored in a block 60 is provided to bias the armature 18' towards a mid-position in which it is perpendicular to the magnet 16', and in which the end portions of the armature 18' extend respectively midway between the pole pieces 14, 14 and 14', 14'. The end of the armature 18' that is remote from the magnet 16' is fixed to the slider 44. In FIG. 6, as in FIG. 5, the indicator portion 30 of the display module 10'' is identical with the display portion of the display module 10 of FIGS. 1, 2 and 3, whereby no further explanation thereof is given.

In FIG. 5, the armature 18 is clamped at one end and its free end extends between a pair of pole pieces 14, 14. In FIG. 6, the armature 18' is pivoted at its center and the ends of the pivoted armature 18' extend between respective pairs of pole pieces 14, 14 and 14', 14'. However, the operation of the module 10'' of FIG. 6 and 10' of FIG. 5 is substantially identical. Due to the pivotal mounting of the armature 18' and due to the provision of the two pairs of poles 14, 14 and 14', 14' in FIG. 6, less energy is required to operate the module 10'' of FIG. 6 than the module 10' of FIG. 4. In operation, the armature 18' will be in either of its two positions in which the ends thereof will contact either the upper pole piece 14 (as viewed in FIG. 6) and the lower pole piece 14', or the ends of the armature 18' will contact the lower pole piece 14 and the upper pole piece 14'. Furthermore, the armature 18' can be moved from one to the other of its two positions by hand or by sending a current through the coil 24 which surrounds the armature 18' in such a direction as to reverse the flux therein. Furthermore, the position of the armature 18' can be sensed from a distance by sending a current pulse through the drive coil 56 (not shown) in one leg 12' and noting the

voltage developed in the sensing coil 58 of the same leg 12'.

Although only three embodiments of a display module have been described, it will undoubtedly be apparent to those skilled in the art that variations thereof are possible within the spirit of the present invention. For example, any suitable indicator may be substituted for the indicator 30. Hence, it should be understood that the foregoing descriptions are to be considered as illustrative and not in a limiting sense.

What is claimed is:

1. A magnetic device comprising:
a pair of legs, each leg having a pole piece at the end thereof, said pole pieces being spaced,
magnetic means for causing said pole pieces to be oppositely magnetized,
an armature of magnetic material,
means for mounting said armature so that it may assume either one of two positions of rest, said armature being in contact with one of said pole pieces in one of its positions of rest and being in contact with the other of said pole pieces in the other of its positions of rest, said armature being manually moveable from one position of rest to the other of said positions of rest,
means for moving said armature from one position of rest to the other comprising a coil surrounding only said armature and means to cause current to flow through said coil in such a direction as to build up a flux in said armature that repels said armature from its contacting pole piece and attracts the armature to the other of said pole pieces, and
means to sense the position of said armature comprising a coil surrounding at least one of said legs.

2. A magnetic device comprising:
a pair of legs, each leg having a pole piece at an end thereof, said pole pieces being spaced,
an armature of magnetic material,
magnetic means for causing said pole pieces to be oppositely magnetized,
means for mounting said armature so that it can assume either one of two positions of rest, said armature being in contact with one of said pole pieces in one of its positions of rest and being in contact with the other pole piece in its other position of rest, said armature being manually moveable from one position of rest to the other thereof,
means for moving said armature from one of its positions of rest to the other thereof comprising a coil surrounding only said armature,
means to send current through said coil in a direction to buld up a flux that repels the armature from the pole piece with which it is in contact and attracts it to the other pole piece, and
means for sensing the position of said armature including one of said legs, said one leg having a slot therein providing two neck portions extending longitudinally of said one leg and a separate coil mounted on each of said neck portions, the cross section of said neck portions being so chosen that said neck portions are magnetically at least partially saturated only when said armature contacts the pole at the end of said one leg.

3. A magnetic module comprising:
a pair of magnets each having a north and a south pole,
a flexible armature of magnetic material secured between said magnets with the north pole of one magnet and the south pole of the other magnet in contact with opposite sides of said flexible armature, said flexible armature extending laterally away from said magnets,
a leg structure of magnetic material in contact with the south pole of said one magnet and extending laterally away from said magnets,
a second leg structure of magnetic material in contact with the north pole of said other magnet and extending laterally away from said magnets,
said legs and said armature extending in the same direction from said magnets,
one of said legs having a slot therein whereby said one leg is formed with neck portions,
means for sensing the position of said armature including a drive coil and a sense coil on said neck portions,
ends of said legs extending towards each other and providing spaced pole pieces,
the end portion of said armature extending between said pole pieces with said armature having two positions of rest, one position of rest being with said armature flexed to a position where the end portion of said armature contacts one of said pole pieces and the other position of rest being where said armature is flexed to a position where said end portion contacts the other of said pole pieces, and
means for moving said armature from one of its positions of rest to the other of its positions of rest comprising a coil surrounding only said armature.

4. A magnetic module comprising a magnet having poles,
a pair of legs respectively in magnetic contact with said poles and extending laterally of said magnet,
free ends of said legs being bent towards each other and providing a pair of spaced pole pieces,
one of said legs having a slot therein whereby said leg is formed with two neck portions extending laterally of said magnet,
means for sensing the position of said armature including a drive coil on one of said neck portions and a sense coil on the other of said neck portions,
an armature so positioned and mounted that one end portion thereof extends between said pair of pole pieces with said armature having two positions of rest, one of said positions being such that said end portion contacts one pole piece of said pair of pole pieces and the other position of rest being such that said end portion contacts the opposite pole piece of said pair of pole pieces,
means for moving said armature from one position of rest to the other position of rest comprising a coil surrounding only said armature, and
a position indicator having a moveable element connected to said end portion of said armature.

5. A magnetic module comprising:
a pair of magnets having north and south poles,
a flexible armature of magnetic material secured between said magnets with the north pole of one magnet and the south pole of the other magnet in contact with opposite sides of said flexible armature,
said flexible armature extending laterally away from said magnets,
a leg structure of magnetic material in contact with the south pole of said one magnet and extending laterally away from said magnets,
a second leg of magnetic material in contact with the north pole of said other magnet and extending laterally away from said magnets,
said legs and said armatures extending in the same direction from said magnets,
one of said legs having a slot therein whereby said one leg is formed with neck portions,
means for sensing the position of said armature including a drive coil on one neck portion of said one leg and a sense coil on another neck portion of said one leg,
ends of said legs extending towards each other and providing spaced pole pieces,
a free end portion of said armature extending between

said pole pieces with said free end portion of said armature being moveable between said pole pieces.

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