Nov. 21, 1961 F. BUDRECK 3,009,225

SEPARABLE TWO-PART MAGNETIC CONNECTOR

Filed Oct. 13, 1959

Fig. 1

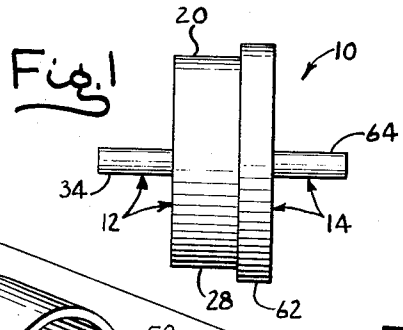


Fig. 2

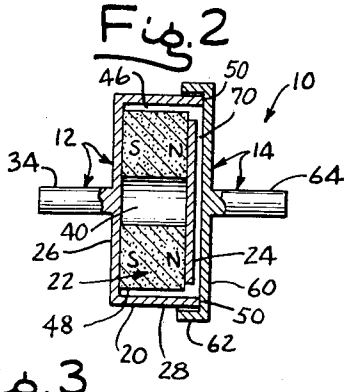


Fig. 3

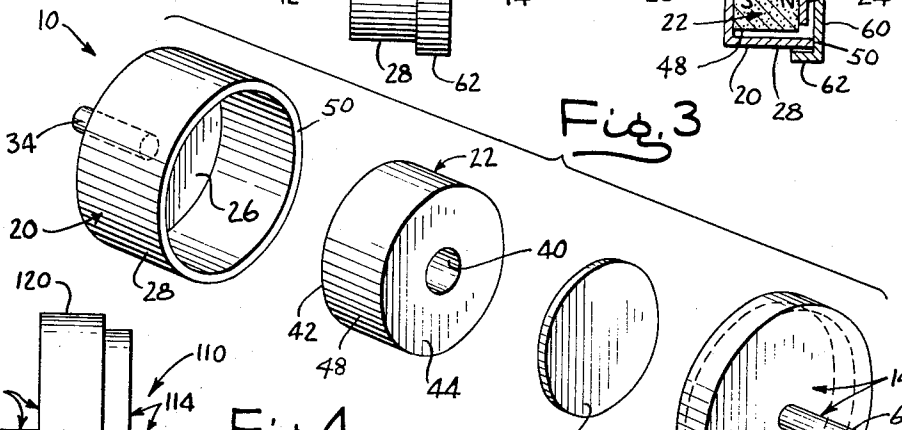


Fig. 4

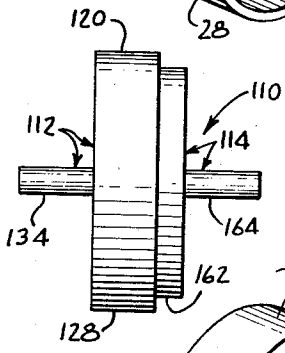


Fig. 6

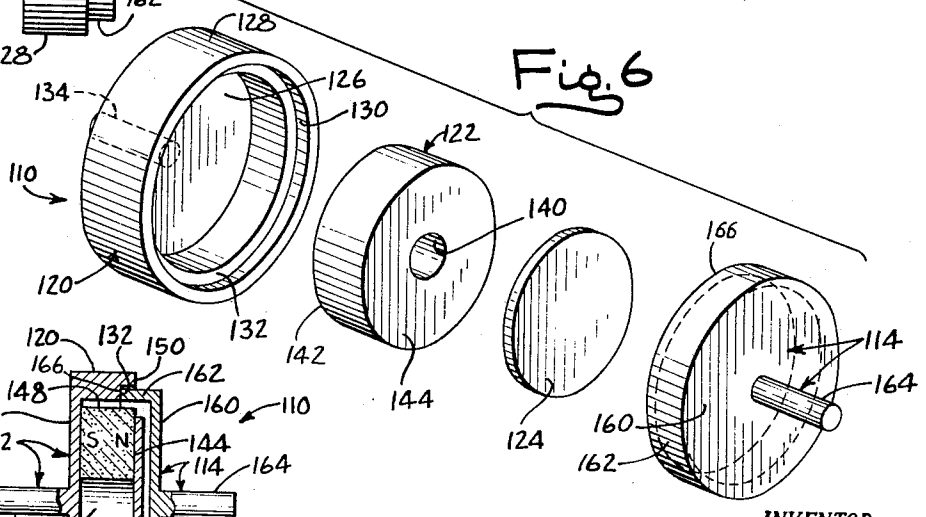
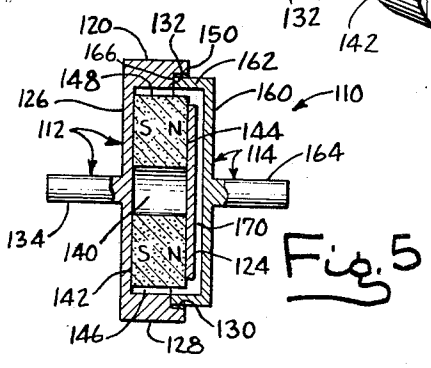


Fig. 5



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United States Patent Office 3,009,225 Patented Nov. 21, 1961

3,009,225
SEPARABLE TWO-PART MAGNETIC CONNECTOR

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Filed Oct. 13, 1959, Ser. No. 846,087
2 Claims. (Cl. 24—201)

The present invention relates to permanent magnets and armature assemblies of the same general type as that shown in my co-pending application, Serial No. 845,026, filed on October 7, 1959, now Patent No. 2,975,497, and entitled "Separable Two-Part Magnetic Connector." The general objects of the present invention are, in the main, substantially the same as those set forth in my co-pending application and are, namely to provide a small, compact, separable magnet and armature assembly including a magnet part and a separate armature part, the two parts being so designed that when the armature part is in its attracted position on the magnet part, the parts are held against transverse shifting movement, each relative to the other, so that there will be no sliding movement of the armature proper across the face of the magnet proper. Stated in other words, it is a general object of the invention to provide a permanent magnet and armature assembly including a generally cylindrical magnet part and a generally cylindrical armature part which are capable of being fully magnetically coupled to each other only when the two parts are in substantial axial alignment but in which such coupling may take place regardless of the relative angular position of the parts throughout the 360° range of turning movement about the common axis of the magnetically coupled parts.

The present permanent magnet and armature assemblies are capable of any of the uses to which the assembly shown in my co-pending application, mentioned above, may be put, and among these are as a separable key chain assembly for automotive use, as a small pocket pick-up magnet and keeper therefor, or as a refrigerator, cabinet, or other door latch. The present invention is particularly well adapted for use in connection with trailer doors or doors on other moving vehicles where looseness may develop in the hinges which ordinarily would lead to rattling or squeaking of the door. Because, as will be set forth in detail presently, the present permanent magnet and armature assembly makes provision for prevention of lateral or transverse shifting of the armature relative to the magnet, any parts which are fixedly attached to the permanent magnet assembly and armature assembly respectively will, when the two parts are magnetically coupled, be held against shifting movement relative to each other in a lateral direction, or in fact, in any direction whatsoever. This prevention of lateral shift between the permanent magnet and its armature is an important feature which is common to all of the forms of the invention illustrated herein, as well as to the assembly shown in my co-pending application.

It is a specific object of the present invention to provide a permanent magnet and armature assembly of the character briefly outlined above wherein, when the magnet part and the armature part are fully magnetically coupled and, therefore, in axial alignment, relative lateral shifting between the parts is prevented without placing any shearing stress, or in fact, any stress whatsoever, on the magnet proper so that the latter exists in its free state, out of contact with any portion of the armature assembly while any stress incident to a tendency for relative shifting movement between the magnet part and the armature part is assimilated by an interlock between the armature part and a portion of the magnet part other than the magnet proper. In carrying out this last mentioned object, the

invention contemplates the provision of a novel form of interlock between the armature proper and a combined magnet pole piece and retainer associated with the magnet part.

With these and other objects in view, which will become more readily apparent as the following description ensues, the invention consists of the novel construction, combination, and arrangement of parts shown in the accompanying single sheet of drawing forming a part of this specification.

In the drawing:

FIG. 1 is a side elevational view of a separable permanent magnet and armature assembly constructed in accordance with the principles of the present invention, and showing the same in their fully coupled condition;

FIG. 2 is a longitudinal sectional view taken substantially centrally through the permanent magnet and armature assembly of FIG. 1;

FIG. 3 is an exploded perspective view of the assembly shown in FIG. 1;

FIG. 4 is a side elevational view of a modified form of permanent magnet and armature assembly;

FIG. 5 is a longitudinal sectional view taken substantially centrally through the permanent magnet and armature assembly of FIG. 4; and

FIG. 6 is an exploded perspective view of the assembly shown in FIGS. 4 and 5.

Referring now to the drawing in detail, one form of the invention has been illustrated in FIGS. 1 to 3, inclusive, while a second form thereof has been illustrated in FIGS. 4, 5 and 6. In the form of the invention shown in FIGS. 1 to 3, inclusive, the permanent magnet assembly illustrated therein has been designated in its entirety at **10** and it includes a composite permanent magnet part **12** and a unitary integral one-piece armature part **14**. The two parts are adapted to be retained in their fully coupled condition solely by magnetic attraction but interlocking means, which will be described presently, are provided for preventing lateral shifting of one part relative to the other.

As best seen in FIGS. 2 and 3, the permanent magnet part or assembly is generally of circular cross sectional shape throughout, although it may assume various external configurations other than circular if desired. The assembly includes three component parts, including an outer, generally cup-shaped, combination magnet shell, retainer or holder and pole piece **20**, a permanent magnet proper **22**, and a second pole piece **24**. The combined retainer and pole piece **20** is preferably of one-piece construction and is formed of a suitable magnetic material such as mild steel. This member **20** has a body portion of cup-shape design including a circular bottom wall **26** and an upstanding cylindrical side wall **28**. A stem or handle portion **34** in the form of a rod-like extension extends rearwardly from the central regions of the bottom wall **26**. This stem **24** may be employed as a handle for manipulation of the part **12**, or it may be provided with suitable fastening means (not shown) whereby the part **14** may be fixedly attached to an object such as a door or a door jamb. Toward this end, if desired, the stem may be threaded for reception thereover of a fastening nut, or it may be so constructed that it constitutes a rivet when the end thereof is beaded over an opening in the part to which the assembly **12** is to be secured.

The magnet **22** is a ceramic magnet of the mixed ferrite type, such magnets being a comparatively recent development in the field of permanent magnet construction and possessing greatly improved magnetic properties over permanent magnets which are constructed of metallic alloys. One such magnetic material capable of being employed in connection with the present invention for construction of the magnet **22** is the material known as

"Indox," a development of the Indiana Steel Products Company of Valparaiso, Indiana. This barium-ferrite material is characterized by the fact that it is electrically non-conductive. The material is extremely resistant to demagnetizing influences and evidences very low eddy current losses. Indox is a magnetic material which exhibits extremely high coercive force, a low remanence and high permeability. Because of these characteristics of this permanent magnet material, the magnetic length thereof need be but a fraction of that required for the ferrous alloys in attaining the same magnetic pull for a given magnet size. Where barium-ferrite ceramic materials are concerned, magnetic stability is pronounced and permanent magnets of this character maintain their magnetic strength despite weakening influences such as contact with extraneous magnetic fields and frequent removal and replacement of the magnet armatures. Additionally, Indox and like ceramic materials are relatively light as compared to the magnetic alloys.

As a magnetic material for holding purposes, the shape characteristics and small sizes which Indox and similar materials may assume for any given attractive power leave little to be desired. For example, such magnetic materials satisfy the requirements of releasable holding devices for refrigerator doors and the like where space is at a premium, where high holding power is required, and where frequent armature attraction and release is encountered. Ceramic magnets of this type are extremely effective even when they are of thin wafer-like design and, accordingly, the magnet 22 illustrated herein is of relatively thin flat construction.

The magnetic length of the cylindrical ceramic magnet 22 is preferably, but not necessarily, provided with a central opening or bore 40 therethrough. The magnet is magnetized as shown in FIG. 2 to provide poles of opposite polarity on the inner and outer faces 42 and 44 thereof, respectively. The inner magnet face 42 is cemented to the bottom wall 26 of the magnet holder 20. A slight annulus or clearance is indicated at 46 between the cylindrical wall 28 of the holder and the cylindrical side surface 48 of the magnet 22, but, if desired, there need be no such clearance and the magnet may be additionally cemented to the side wall 28 interiorly of the latter. The axial extent of the magnet 22 is less than the axial extent of the side wall 28 so that the magnet is wholly disposed within the cylindrical confines of the cup-shaped retainer 20. It is, however, within the scope of the present invention to design the magnet thickness and the height of the wall 28 so that the magnet projects beyond the rim 50 of the side wall 28, or so that the face 42 lies in the plane of the rim 50. Irrespective of these minor details in the construction of the magnet assembly or part 12, the essential features of the invention are not destroyed.

The armature part 14 may be in the form of a casting or it may be machined from a single body of metal. It is provided with a cup-shaped portion having a bottom wall 60 and an upstanding cylindrical side wall 62, together with a rod-like stem or extension 64 which extends from the central region of the bottom wall 60 outwardly of the cup-shaped portion. The internal diameter of the cylindrical side wall 66 is slightly greater than the external diameter of the side wall 28 so that the side wall 62 may be telescopically received over the side wall 28 as shown in FIG. 2 when the two parts 12 and 14 are magnetically coupled. When so coupled, the rim 50 of the side wall 28 seats on the bottom wall 60 of the armature part 14.

The magnetic pole piece 24 is in the form of a flat circular disk, preferably formed of mild steel, which is centered coaxially on the outer face 44 of the magnet and is cemented thereo.

In the form of the invention shown in FIGS. 1 to 3, inclusive, the axial extent of the magnet 22 and its pole piece 24 is slightly less than the axial extent of side wall 28 so that when the parts are coupled a very slight clearance indicated at 70 in FIG. 2 exists

between the outer face of the pole piece 24 and the bottom wall 60 of the armature part 14. This small clearance space establishes a strong magnetic pull between the magnet proper and the bottom wall 60 of the armature part 14.

It is to be noted that a small amount of clearance is provided between the opposed cylindrical surfaces of the side walls 28 and 62 so that it will not be difficult to manually apply the armature part to the magnet part so that when the two parts are employed as a door latch, for example, slight misalignment of the edge of the door relative to the door jamb will not throw the two parts of the assembly so far out of axial alignment that they will not automatically become coupled when the door is closed. The extent of magnetic attraction between the two parts 12 and 14 is materially enhanced by virtue of the fact that the thin rim of the pole piece and magnet retainer 22 effectively concentrates the magnetic flux in a narrow band or annulus. With the parts thus magnetically coupled the small clearance 70 which exists between the outer face of the pole piece 24 and the bottom wall 60 of the armature part creates an additional magnetic pull between the two parts over a fairly wide area.

The form of the invention shown in FIGS. 4, 5 and 6 is similar in many respects to the form of the invention shown in FIGS. 1 to 3, inclusive, as previously described. Therefore, to avoid needless repetition of description, similar characters of reference have been applied to the corresponding parts in the two groups of views. In FIGS. 4, 5 and 6, reference numerals of a higher order are employed.

As best seen in FIGS. 5 and 6, the armature part 114 remains substantially the same as in the previously described form of the invention. The cylindrical side wall 128 of the combined magnet holder and pole piece 120 is provided with an internal recess 130 in the rim region thereof affording a forwardly facing annular shoulder 132 which may be regarded as a forwardly offset portion of the bottom wall 126. The extreme rim 166 of the side wall 162 of the armature part 114 is adapted to be telescopically received within the recess 130 of the side wall 128 so that it may seat against the shoulder 132 when the two parts are magnetically coupled. Toward this end, the external diameter of the rim 166 of the cup-shaped portion of the part 114 is slightly less than the diameter of the cylindrical side wall of the recess 130, thus permitting the parts readily to be coupled magnetically or uncoupled, while at the same time preventing appreciable relative lateral displacement of the two parts 112 and 114 after magnetic coupling has been effected. When the parts are thus magnetically coupled, there is a slight clearance at 170 between the outer face of the pole piece 124 and the bottom wall 160. Otherwise, the construction of the assembly 110 is the same as that of the assembly 10.

From the above description, it will be seen that in the case of either the form of the invention shown in FIGS. 1 to 3, inclusive, or the form shown in FIGS. 4 to 6, inclusive, a physical or mechanical interlock exists between the two principal parts of the assembly when the parts are magnetically coupled. In neither case is an appreciable amount of axial shifting or misalignment between the two parts possible, while at the same time a limited amount of clearance is provided between the side wall structures of the two principal parts to facilitate manual coupling and uncoupling of the parts or proper magnet and armature alignment when the parts are applied to swinging or sliding objects as, for example, a door and its jamb.

The invention is not to be limited to the exact arrangement of parts shown in the accompanying drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit of the invention. Only insofar as the invention has particularly been pointed out in the accompanying claims is the same to be limited.

Having thus described the invention what I claim as new and desire to secure by Letters Patent is:

1. In a separable permanent magnet and armature assembly, in combination, a magnet part and an armature part, each of said parts including a cup-shaped member of magnetic material throughout and having a flat bottom wall, a cylindrical side wall and an open circular rim, the external diameter of the side wall of one of said parts being slightly less than the internal diameter of the side wall of the other part whereby the parts may be telescopically assembled upon each other with the rim of said one part abutting against the bottom wall of the other part, and a thin flat magnet of the barium-ferrite type presenting two oppositely facing pole faces of opposite polarity, said magnet having a magnetic length slightly less than the distance between the bottom walls of the two parts when the latter are in their full telescopic relation, one pole face of said magnet being bonded to the bottom wall of the cup-shaped member associated with the magnet part and having the other pole face opposing the bottom wall of the cup-shaped member associated with the armature part and slightly spaced from

such bottom wall and in parallelism therewith when the two parts are in full telescopic relation, and a flat disk of magnetic material having one face thereof bonded to said other pole face of the magnet, the other face of said disk being parallel to and spaced from the bottom wall of the cup-shaped member associated with the armature part when the two parts are in their full telescopic relation.

2. In a permanent magnet and armature assembly, the combination set forth in claim 1 and wherein said bottom wall of the part against which said rim abuts if formed with a forwardly offset portion providing an annular shoulder against which the rim abuts when the two parts are in their full telescopic relation.

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