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3,086,268

SEPARABLE TWO-PART MAGNETIC CONNECTOR

Filed April 24, 1961

FIG. 1

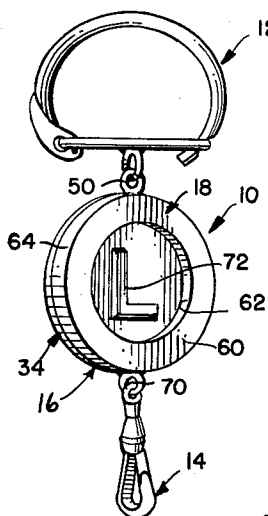


FIG. 2

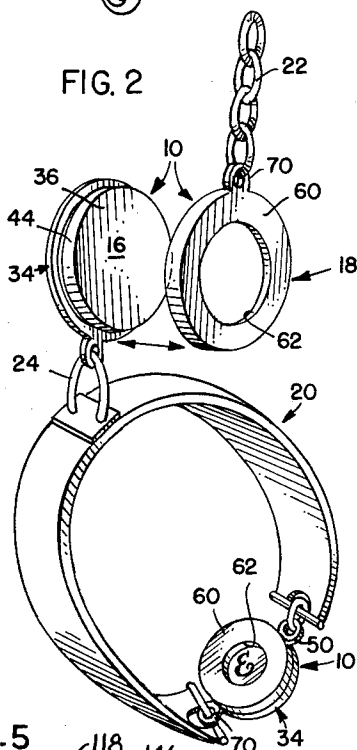


FIG. 5

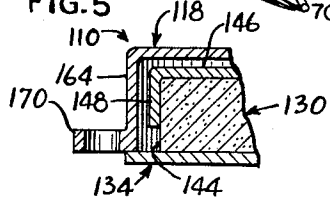


FIG. 3

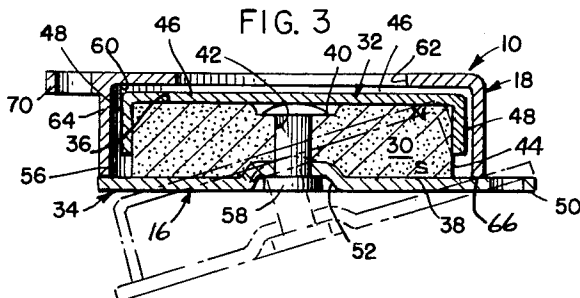
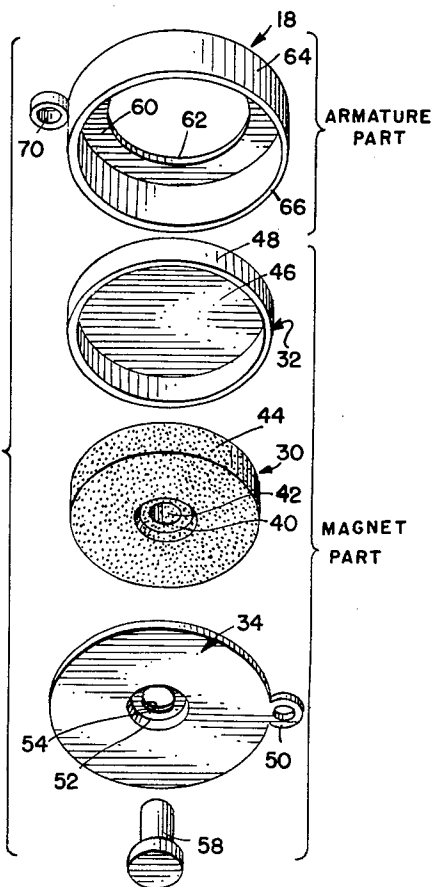


FIG. 4



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SEPARABLE TWO-PART MAGNETIC CONNECTOR
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The improved separable two-part magnetic connector comprising the present invention is versatile in its application and is capable of many uses. Three exemplary uses for the connector have been illustrated herein, but various other uses will suggest themselves when the nature of the invention becomes better understood. One of the uses selected for illustration is that of a separable key chain connector which is designed for use in connection with the parking or storage of automobiles in public parking lots wherein it is necessary to leave an ignition key with the attendant of such lot, while at the same time it is desirable that the owner of the vehicle retain possession of a reserve ignition key or of companion keys associated with the key chain. In this respect, the present invention is designed as an improvement over the separable two-part magnetic connector which is shown and described in United States Patent No. 2,975,497, granted on March 21, 1961.

Another illustrated use for the present separable two-part magnetic connector is as a closure fastener for animal collars, while a still further illustrated use is as a separable fastener by means of which a retention chain or the like may be detachably secured to such an animal collar. The invention is, however, capable of a wide variety of other uses, particularly in the field of ornamental haberdashery, both men's and women's, where the separable magnetic connector may be found useful as a fastener of the belt buckle variety, as a fastener for charm bracelets, necktie clasps, locket chains, watch bands, and the like. Irrespective, however, of the particular use to which the present invention may be put, the essential features thereof are at all times preserved.

There are at the present time several multi-purpose separable magnetic connectors on the market and, in general, are of the type which consists of a flat, circular, disk-like magnet part and an armature part. The uses to which such connectors may be put are limited to situations where, in normal use, the tensional forces which are applied to the articles which are connected together do not exceed the force required initially to separate the magnet parts from the armature parts. This is because the connectors are so designed that the magnetic attraction between the magnet parts and the armature parts constitute in essence the connecting force between the separably connected articles. Any degree of pull greater than this connecting force will result in axial separation of the parts and, consequently, in separation of the articles connected thereby.

A further limitation that is attendant upon the construction and use of a separable connector of the aforementioned type resides in the fact that the force which is required to separate the magnet part from the armature part is applied through the attachment means whereby each part is connected to the article with which it is associated. Thus, a pull tending to separate the two articles which are connected together is a pull counter to the direction of magnetic attraction between the magnet part and the armature part and when the magnitude of this magnetic attraction is exceeded, the magnet and armature parts will become separated. For maximum resistance to separation, it is essential that the attachment means for both the magnet part and the armature part be situated precisely on the respective axes of the parts and, thus, the over-all extent of the connector, including

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the attachment means, can be no less than the combined thicknesses of the magnet, the armature, and the two attachment means. In a transverse direction, i.e., in a direction extending at a right angle to the axis of the connector, the width of the connector is limited to the diameter of the disk-like magnet part. Such a connector, therefore, possesses both appreciable length and transverse width and, as a consequence, it is not suited for many of the uses outlined above and for which the present connector is adapted, particularly in connection with ornamental articles which are adapted to be worn or carried by the connector user.

The present invention is designed to overcome the above-noted limitations that are attendant upon the construction and use of conventional separable magnetic connectors employing thin circular magnet and armature parts and, toward this end, it contemplates the provision of a two-part separable connector wherein the magnet part and the armature part are axially separable in the usual manner of cooperation between such parts, the magnet part is loosely and telescopically receivable within the armature part when the two parts are magnetically coupled and the attachment means for each part is disposed on the periphery of its respective part. By such an arrangement, the two parts may be magnetically coupled in their telescopic, axially aligned relationship in any relative position of radial angularity without thought to circumferential displacement, and when tensional force is applied to the assembled connector through the two attachment means, the magnet part and the armature part will automatically shift to relative positions wherein the two attachment means are diametrically opposed across the assembled connector. Because of the fact that the two circular parts are thin and exist in telescopic relationship when thus magnetically coupled and assembled, and the additional fact that the attaching means for each part extends radially outwardly from the periphery of each part instead of axially outwardly therefrom, the assembled parts assume a thin plaque-like configuration, which, when the connector is employed for fastening the adjacent free ends of a band such as an animal collar or a bracelet, will lie flat against the body of the animal or person to which it is applied and present ornamental characteristics not possible with similar connectors having both axial and transverse width. Finally, because of the fact that the normal tensional forces which are applied to the present improved separable connector in any of the environments with which it may be associated are transversely of the connector rather than axially thereof, a positive interlock between the two telescopically disposed parts will prevent separation between the parts short of rupture of one or the other of the parts or of the attaching means therefor.

The provision of a two-part separable magnetic connector of the character briefly outlined above being among the principal objects of the invention, it is a further object to provide such a connector wherein axial separation of the magnet part and the armature part is made possible by the application of manual force to certain portions of the armature part and other portions of the magnet part in such a manner as to cause the two parts to become axially misaligned with the magnet part tilting on the armature part in a novel manner about a fulcrum point on the latter part, the entire separating operations being easily performed and well within the capabilities of the articulated fingers of the user.

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

In this drawing:

FIG. 1 is a perspective view of a separable key chain assembly employing the improved magnetic connector of the present invention;

FIG. 2 is an exploded perspective view of an animal collar and lead chain therefor and illustrating the use of two individual magnetic connectors in connection therewith;

FIG. 3 is an enlarged sectional view taken substantially diametrically through a separable two-part magnetic connector embodying the present invention;

FIG. 4 is an exploded perspective view of the magnetic connector of FIG. 3; and

FIG. 5 is a fragmentary sectional view similar to FIG. 3, showing a slightly modified form of the invention.

Referring now to the drawing in detail, in FIG. 1, one of the magnetic connectors of the present invention has been designated in its entirety at 10 and is shown as serving detachably to connect a conventional draw-lever type of key ring 12 to a conventional snap-in type of key retainer 14. The assembly of FIG. 1 is designed for automotive use wherein the key ring 12 is adapted to carry an ignition key and a glove compartment or trunk key, together with any desired extraneous keys, such as house keys, while the retainer 14 is adapted to carry a reserve ignition key. The connector 10 is comprised of two principal parts or assemblies, including a magnet part 16 and an armature part 18, the key ring 12 being attached to the magnet part 16 and the retainer 14 being attached to the armature part 18. The magnet part and the armature part are separable from each other and, thus, the armature part, together with its attached retainer and reserve ignition key, may be left with the attendant at a garage or parking lot, while the magnet part, together with its attached key ring and the keys associated therewith may be retained by the automobile owner. In such an instance, the magnet part will be available to the owner as a small pick-up magnet for sundry uses, including that of providing a convenient attachment means whereby the key ring 12 and its contained keys may be suspended from a magnetic surface if it is not desired to carry the same in the user's pocket.

In FIG. 2, one of the magnetic connectors 10 is shown as being employed for the purpose of releasably fastening the adjacent free ends of an animal collar 20 together; and another of the connectors 10 is shown as releasably connecting one end of lead chain 22 to a bail 24 on the bight region of the collar 20. The last-mentioned connector, i.e., the connector between the chain 22 and the bail 24, is shown in exploded fashion, the magnet part 16 being attached to the bail and the armature part 18 being connected to the lead chain.

Referring now to FIGS. 3 and 4, the magnet part 16 is of a composite nature and comprises three principal parts, namely, a permanent magnet proper 30, a pole cup 32, and a flat, disk-like, pole piece 34. The three parts are preferably, but not necessarily generally of circular or cylindrical configuration.

The magnet proper 30 (hereinafter referred to simply as the magnet) is a ceramic magnet of the mixed ferrite type, such a magnet 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 material capable of being employed in connection with the present invention for construction of the magnet 30 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 nonconductive. The material is extremely resistant to demagnetizing forces and evidences very low eddy current losses. Indox is a material which exhibits extremely high coercive force, a low remanence, and high permeability. Because of the characteristics of this permanent magnet material, the

magnetic length thereof need be but a fraction of that required for the ferrous alloy-type magnet 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 influence such as contact with extraneous magnetic fields and frequent removal and replacement of the magnetic armatures. Additionally, Indox and like ceramic materials are relatively light in weight as compared to the magnetic alloys. Ceramic magnets of the type briefly described above are extremely effective even when they are of thin, wafer-like design, and, consequently, the ceramic material Indox is particularly well-suited for use in making the magnet 30 which is of a thin, circular, wafer-like character in conformity with the desired overall plaque-like design of the assembled connector 10. The magnet 30 is provided with oppositely facing pole faces 36 and 38 of opposite polarity as labelled or identified in FIG. 3, and each pole face is formed with a small central socket 40 which surrounds a central bore or opening 42. The latter extends axially through the magnet. The magnet 30 is provided with a short cylindrical side surface 44 so that the magnetic length is correspondingly short.

The pole cup 32 is in the form of a shallow steel cup having a bottom wall 46 and a continuous cylindrical side wall 48 of less height than the length of the axial extent of the side surface 44 of the magnet 30.

The pole piece 34 is in the form of a flat circular disk of steel and is formed with a small integral attaching ear or eyelet 50 which projects outwardly beyond the circular peripheral confines of the disk. The central region of the pole piece 34 is dished as at 52 and embodies a hole 54 therethrough.

In the assembled magnet part 16, the magnet 30 is seated within the pole cup 32 as shown in FIG. 3, and due to the fact that the height of the side wall 48 is less than the axial extent of the magnet 30, a portion of the magnet will project forwardly beyond the open rim of the pole cup. The magnet 30 may be cemented or otherwise secured within the pole cup 32, but due to the magnetic attraction between the pole face 36 of the magnet and the bottom wall 46 of the pole cup, the magnet need not necessarily be cemented to the pole cup.

The flat disk-like pole piece 34 fits flat against the pole face 38 of the magnet 30 and its diameter is slightly greater than the diameter of the pole face so that there is a small peripheral overhang as at 56 (FIG. 3). The dished portion 52 of the pole piece fits within the socket 40 in the pole face 38 of the magnet, and a rivet 58 passes through the hole 54 and the central opening 42 and has its enlarged head portions seated within the dished portion 52 and the socket 40 in the pole face 36. The rivet 58 serves to hold the magnet 30 and the pole piece 34 permanently assembled.

The armature part 18 is of one-piece construction and is in the form of a shallow, cup-shaped, steel ring having an annular bottom wall 60 with a large central opening 62 therethrough, and a cylindrical side wall 64. The axial extent of the side wall 64 is a few thousandths of an inch greater than the combined axial extent of the magnet 30 and its pole cup 32, and the internal diameter of the side wall is slightly greater than the diameter of the side wall 48 of the pole cup 32. Thus, when the magnet part 16 and armature part 18 are magnetically coupled, i.e., when the two parts of the connector 10 are operatively connected together, the armature part 18 completely encompasses the magnet 30 and its associated pole cup 32, while the rim 66 of the side wall 64 seats upon the peripheral overhang 56 of the pole piece 34 and the annular bottom wall 60 remains slightly spaced from the bottom wall 46 of the pole cup 32 and is magnetically attracted thereto. The central region of the bottom wall

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46 of the pole cup 32 is thus exposed through the large central opening 62 in the annular bottom wall 60 of the armature part 18.

The side wall 64 of the armature part 18 is provided with a radially extending attaching ear or eyelet 70 and the latter is similar to the eyelet 50. The eyelet 70 is formed in or near the general plane of the annular bottom wall 60 of the armature part 18 so that the radial pull exerted thereby in use, as will be described presently, is reinforced by reason of the comparative rigidity of the bottom wall 60.

Considering again the several illustrated uses to which the present magnetic connector 10 may be put, when employed as a separable fastener for key retainers as illustrated in FIG. 1, or as a separable fastener for the adjacent ends of an animal collar, as illustrated in FIG. 2, no appreciable amount of oppositely directed radial pull will be applied during normal use to the two attaching ears or eyelets 50 and 70. However, when put to certain other uses, as, for example, the detachable fastening of the lead chain 22 to the bail 24 of the animal collar 20, as also illustrated in FIG. 2, an appreciable degree of radial pull may be applied to the two parts 16 and 18 of the connector. Since these two parts are interlocked against lateral or sidewise displacement by reason of the telescopic relationship between the magnet part and the armature part, and since the axial offset between the two eyelets 50 and 70 is very slight on account of the extreme thinness of the plaque-like connector assembly 10 as a whole, the pull exerted on each eyelet will be approximately radial with practically no lateral components of force being applied to the parts so that the assembly may well withstand any degree of such radial pull short of rupture of the eyelets. Any tendency for axial separation of the two parts 16 and 18 which may arise due to the small axial offset of the two eyelets 50 and 70 would ordinarily be counteracted by the coefficient of friction existing between the sliding surfaces of the two parts. In addition to this frictional restraint against separation of the parts, the relatively powerful magnetic pull between the magnet part 16 and the armature part 18 will more than compensate for any components of axial thrust which may accrue to the parts under the influence of a slightly misaligned radial pull on the two eyelets 50 and 70.

Despite the disinclination of the two parts 16 and 18 to become accidentally separated under the influence of radially and axially applied forces, voluntary manual separation thereof is a relatively simple matter involving the application of but little manual force. It is merely necessary, utilizing either one or two hands, manually to grasp the two eyelets 50 and 70, and then, while maintaining these eyelets steady, to apply inwardly directed force to the exposed central regions of the bottom wall 46 of the pole cup 32 to thus push the magnet part 16 out of the cup-shaped annular armature part 18. Due to the fact that the two eyelets 50 and 70 are held steady by the fingers, a rocking action of the magnet part 16 on the rim of the annular cup-shaped armature part 18 will take place, after which the two parts may easily be completely separated. A similar separation of the two parts 16 and 18 may be effected without resorting to a manual pushing of the magnet part from the armature part by reason of the available access through the enlarged central opening 62. It is contemplated that the bottom wall 60 of the armature part be imperforate and, in such an instance, rocking of the magnet part 16 on the rim of the armature part 18, as previously described, may be effected by merely manipulating the two eyelets 50 and 70 so as to cause appreciable angular misalignment between these members.

When magnetically coupling the two parts 16 and 18, it is not necessary to take pains to insure a diametrical disposition of the two eyelets 50 and 70 at the time the

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magnet part 16 is telescopically placed within the cup-shaped armature part 18. The two parts may be telescopically assembled in any position of circumferential angularity and, after such assembly, the initial pull which is normally exerted in opposite directions upon the two eyelets in actual use will cause the two parts to be rotated relatively to each other so that the eyelets will be pulled, so to speak, to their widely separated diametrically disposed positions, as shown in FIG. 3.

From the above description, it will be seen that magnetic connectors which are constructed according to the principles of the present invention are admirably well-adapted for use where it is desired that the connector lie flat against a surface with the general plane of the same in parallelism with such surface. The connector is thus suitable for use as a utilitarian article of an ornamental nature and personal adornment, as, for example, in separably holding the adjacent ends of watch bands, belts, collars, flaps, and the like, in position. To enhance the appearance of the connector, the exposed region of the bottom wall 46 of the retainer 32 may have applied thereto suitable ornamentation such as is shown at 72 in FIG. 1.

In FIG. 5, a slightly modified form of the invention has been shown. In this view, the attachment eyelet 170, instead of being formed on the armature side wall 164 at or near the general plane of the annular bottom wall 160 as is the case in connection with the previously-described form of the invention, is formed on this side wall at or near the rim 166 where it is more nearly in line with the eyelet 150. Thus, when the two eyelets 170 and 150 are in their diametrically disposed relationship and oppositely directed pulling forces are applied thereto, there will be practically no tendency for the assembly 110 as a whole to become canted. Otherwise, the details of the assembly 110 remain the same as the assembly 10, and, to avoid needless repetition of description, similar reference numerals but of a higher order have been applied to the corresponding parts as between FIGS. 3 and 5.

Whether the armature eyelet be formed on the side wall at or near the plane of the armature bottom wall as in the disclosure of FIG. 3, or whether it be formed on the side wall at or near the plane of the armature side wall rim, as in the disclosure of FIG. 5, is a matter that will be determined according to sound engineering judgment. If a slight amount of canting of the assembly under conditions of load is not objectionable, the eyelet may be positioned at or near the plane of the armature bottom wall. If such canting is objectionable, the eyelet may be positioned at or near the plane of the armature side wall rim. The invention also contemplates that the armature eyelet may assume various intermediate positions between the plane of the bottom wall and the plane of the rim.

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 or scope of the invention. Therefore, 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. A separable two-part magnetic connector comprising, in combination, a magnet part and a cooperating armature, said magnet part comprising a permanent magnet of the ceramic type and in the form of a flat disk presenting oppositely facing pole faces of opposite polarity and a narrow outer rim, and a flat disk-like pole piece of magnetic material coextensive with one pole face of the magnet and fixedly secured in coaxial and face-to-face relationship thereagainst, the over-all extent of the pole piece being slightly greater than the over-all extent of said one pole face whereby the peripheral region of the

pole piece overhangs and projects outwardly a slight distance beyond the outer rim of said one pole face, said armature comprising a cup-shaped member formed of magnetic material and having a bottom wall and a continuous side wall, the axial extent of the armature side wall being slightly greater than the axial extent of the magnet and the internal cross-sectional area of the armature side wall being slightly greater than the over-all extent of the magnet, so that when the magnet part and armature are magnetically coupled to the fullest extent of which they are capable, the magnet will be telescopically received within the armature with a slight freedom of lateral shifting movement therein, the rim of the armature side wall will seat upon the overhanging peripheral region of the pole piece, and the bottom wall of the armature will remain spaced a slight distance from the other pole face of the magnet and lie within the magnetic field thereof, an attachment element on the periphery of the pole piece and disposed radially outwardly of the extended confines of the armature side wall, and an attachment element on the side wall of the armature.

2. A separable two-part magnetic connector as set forth in claim 1 and wherein the attachment element on the side wall of the armature lies substantially in the plane of the armature bottom wall.

3. A separable two-part magnetic connector as set forth in claim 1 and wherein the attachment element on the side wall of the armature lies substantially in the plane of the armature bottom wall, and said bottom wall is formed with a relatively large centrally disposed opening therethrough and through which opening access may be had to the medial region of the adjacent pole face of the magnet for manual forcing of the magnet axially away from the armature.

4. A separable two-part magnetic connector comprising, in combination, a magnet part and a cooperating armature, said magnet part comprising a permanent magnet of the ceramic type and in the form of a flat circular disk presenting oppositely facing pole faces and a narrow outer rim, a pole cup formed of magnetic material and having a bottom wall and a cylindrical side wall, the magnet being nested within said pole cup and being fixedly secured therein, the longitudinal extent of said cylindrical side wall being less than the axial extent of the magnet whereby the portion of the magnet embodying the other pole face projects outwardly beyond the rim of said cylindrical side wall, and a flat circular disk-like pole piece of magnetic material coextensive with said other pole face and fixedly secured in coaxial and face-to-face relationship thereagainst, the diameter of the pole piece being slightly greater than the diameter of said other pole face whereby the peripheral region of the pole piece overhangs and projects outwardly a slight distance beyond the outer rim of said other pole face, said armature comprising a cup-shaped member formed of magnetic material and having a bottom wall and a cylindrical side wall, the axial extent of the armature side wall being slightly greater than the combined axial extent of the magnet and pole cup and the internal diameter of the armature side wall being slightly greater than the external diameter of the side wall of the pole cup, so that when the magnet part and armature are magnetically coupled to the fullest extent of which they are capable, the magnet and pole cup will be telescopically received within the armature, the rim of the armature side wall will seat upon the overhanging peripheral region of the pole piece, and the bottom wall of the armature will remain spaced a slight distance from the bottom wall of the pole cup and lie within the mag-

netic field of the adjacent pole face of the magnet, an attachment element on the periphery of the pole piece and disposed radially outwardly of the extended cylindrical confines of the armature side wall, and an attachment element on the cylindrical side wall of the armature.

5. A separable two-part magnetic connector as set forth in claim 4 and wherein the attachment element on the cylindrical side wall of the armature is in the form of an eyelet and lies substantially in the plane of the armature bottom wall.

6. A separable two-part magnetic connector as set forth in claim 4 and wherein the attachment element on the cylindrical side wall of the armature is in the form of an eyelet and lies substantially in the plane of the armature bottom wall, and said bottom wall is formed with a relatively large central opening therethrough and through which opening access may be had to the medial region of the bottom wall of the pole cup for manual forcing of the magnet axially away from the armature.

7. A separable two-part magnetic connector comprising, in combination, a magnet part and a cooperating armature, said magnet part comprising a permanent magnet of the ceramic type and in the form of a flat circular disk presenting oppositely facing pole faces of opposite polarity and a narrow outer rim, a pole cup formed of magnetic material and having a bottom wall and a cylindrical side wall, the magnet being nested within said pole cup and having one pole face bonded to said bottom wall, the longitudinal extent of said cylindrical side wall being less than the axial extent of the magnet whereby the portion of the magnet embodying the other pole face projects outwardly beyond the rim of said cylindrical side wall, and a flat circular disk-like pole piece of magnetic material coextensive with said other pole face and fixedly secured in coaxial and face-to-face relationship thereagainst, the diameter of the pole piece being slightly greater than the diameter of said other pole face whereby the peripheral region of the pole piece overhangs and projects outwardly a slight distance beyond the outer rim of said other pole face, said armature comprising a cup-shaped member formed of magnetic material and having a bottom wall and a cylindrical side wall, the axial extent of the armature side wall being slightly greater than the combined axial extent of the magnet and pole cup and the internal diameter of the armature side wall being slightly greater than the external diameter of the side wall of the pole cup, so that when the magnet part and armature are magnetically coupled to the fullest extent of which they are capable, the magnet and pole cup will be telescopically received within the armature, the rim of the armature side wall will seat upon the overhanging peripheral region of the pole piece, and the bottom wall of the armature will remain spaced a slight distance from the bottom wall of the pole cup and lie within the magnetic field of the adjacent pole face of the magnet, an attachment element on the periphery of the pole piece and disposed radially outwardly of the extended cylindrical confines of the armature side wall, and an attachment element on the cylindrical side wall of the armature, and lying substantially in the plane of the side wall of the armature.

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