April 7, 1964 F. BUDRECK 3,127,653

MAGNETIC CONNECTOR

Filed April 2, 1962

Fig. 1

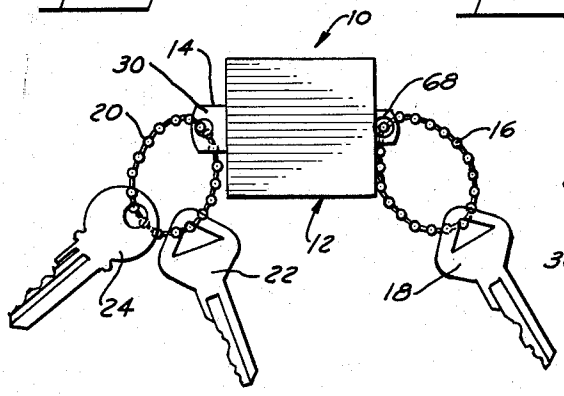


Fig. 6

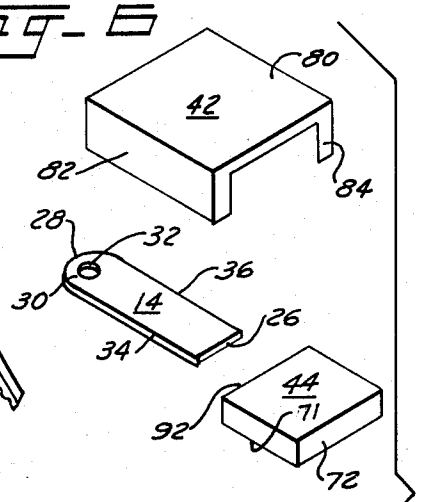


Fig. 2

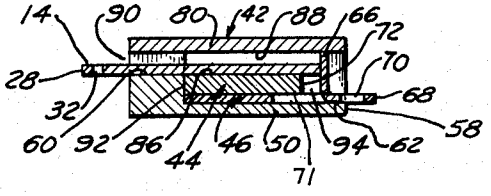
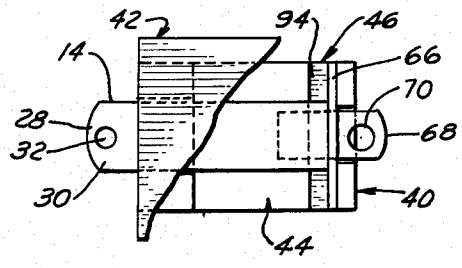


Fig. 3



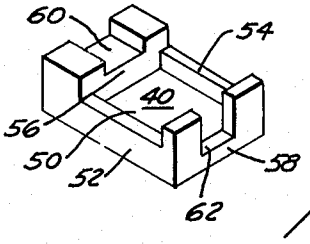


Fig. 5

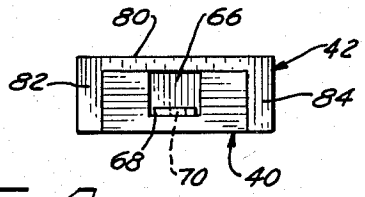


Fig. 7

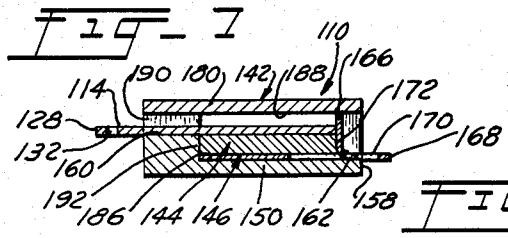
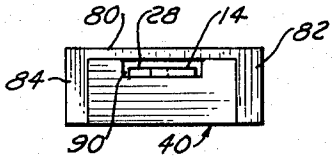


Fig. 4



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3,127,653

MAGNETIC CONNECTOR

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1 Claim. (Cl. 24—201)

The improved separable two-part magnetic connector comprising the present invention has been designed for use primarily as a separable key chain connector for use in connection with the parking or storage of an automobile or other motor vehicle in public parking lots, garages, and the like. Such a separable key chain connector consists of two independent key chains, one of which is adapted to retain a single ignition key and the other of which may retain a reserve ignition key and a glove compartment and trunk key. The two chains are releasably connected together, usually by a push-pull snap connector so that, upon leaving an automotive vehicle in a public parking place, the single ignition key may be left in the ignition lock for use by the attendant, while the chain containing the reserve ignition key and glove compartment and trunk key may be retained by the vehicle owner. The attendant is thus precluded from access to either the glove compartment or the trunk, but he is able to operate the vehicle.

There recently have appeared on the market key chain connectors of this general character or type and in which the releasable connection between the two chains, instead of being a mechanical one, is of a magnetic nature. One such magnetic connector has been disclosed in, and forms the subject matter of, United States Patent No. 2,975,497, granted to me on March 21, 1961 and entitled "Separable Two-Part Magnetic Connector." It is to this type of magnetic connector that the present invention specifically relates.

The present invention presents, in certain respects, specific improvements over the magnetic connector of my aforementioned patent, as well as over other connectors of the same general type. Magnetic connectors according to the principles of the present invention, especially when they are employed as key chain connectors, are possessed of certain advantages which are not inherent in other present-day magnetic connectors.

One decided advantage of the present herein-described magnetic connector, when employed for separably retaining two key chains, resides in the flat shape characteristic of the connector, and another advantage resides in the increased depth of the magnetic field involved, both of these attributes contributing toward a common end in that a more stable article in the pocket of the user results, as will be pointed out in greater detail presently.

The success with which a separable key chain connector of the magnetic type has met upon the market is largely due to the use of barium-ferrite magnetic materials for the magnets of the connector. Magnets of the barium-ferrite type are extremely effective when they are of thin wafer-like design since the magnetic length of such magnets need be but a fraction of that required for the ferrous alloy type of magnets to attain the same degree of attraction or pull. For this reason, as well as by reason of the small sizes which barium-ferrite magnets may assume for any given attractive power, the magnets employed in connection with a separable key chain connector are invariably of the barium-ferrite type and are of wafer-like design. The armatures which are associated therewith are correspondingly flat so that when the magnets and armatures are magnetically coupled, the over-all or complete article is generally flat. To produce maximum coupling strength, the points of attachment of the key chains to the magnets and armatures are made at the

center of the two wafer-like structures. Thus, when one of the keys, for example, an ignition key, is inserted into and supported in the barrel of a lock assembly on the automobile dash panel, the weight of the suspended keys causes the magnetically-coupled flat magnet and armature assembly to assume a horizontal position at a right angle to the plane of the dash panel. This leads to frictional marring of the dash panel as the connector swings or sways in pendulum fashion when the automobile is driven. Furthermore, if one of the key chains is connected in a leather-type folder, the connector assembly does not fit well into the folder since it tends to assume an on-edge position when the key chain loops are aligned. Still further, when the connector is uncoupled and one of the key chains with its attached armature is removed, the remaining magnet has its front pole face exposed so that it attracts adjacent keys or other loose objects in the pocket of the user.

The two-part separable magnetic connector of the present invention is designed to overcome the above-noted limitations that are attendant upon the construction and use of present-day connectors which are employed as key chain connectors and, accordingly, it contemplates the provision of a connector including a flat thin magnet of the barium-ferrite type and a similarly flat thin armature and in which the armature enters and leaves the magnetic field of the magnet end-wise by a sliding motion across the pole face of the magnet. By such an arrangement, it is possible to establish the anchor points for the key chains on the magnet and armature respectively at remote ends of the connector so that when the key chains are placed under tension for purposes of separation, the connector as a whole will lie substantially in the general plane of the thus-tensioned key chains without presenting protruding lateral parts which ordinarily would interfere with proper positioning of the connector on an automobile dash panel or convenient nesting of the connector within a key folder or the like. Furthermore, by causing the armature to move into the magnetic field of the magnet end-wise instead of face-wise, an increased distance range of magnetic coupling between the two parts is attained so that slight movements or displacements of the armature from its home position on the magnet will not completely uncouple the parts. Whereas, in connection with a conventional magnetic connector, a slight separation between the magnet and the armature, as, for example, under the influence of a sharp blow accidentally imparted to one of the parts, will completely uncouple the magnet and the armature, a similar displacement between the magnet and the armature of the present connector will not necessarily effect complete uncoupling of the parts, and after the displacing force has been relieved, the magnet and armature will return to their fully coupled condition.

The provision of a magnetic connector of the character briefly outlined above being among the principal objects of the present invention, it is a further object to provide a connector wherein the pole face of the magnet to which the armature is attracted is physically shielded from contact with extraneous magnetic objects such as might be found in the pocket, purse or pocketbook of the user so that when the armature and its key chain are removed from the assembly, the magnet and its key chain may be pocketed without interference from such magnetic objects.

Still another object of the invention is to provide in a separable magnetic connector of this character a cooperating magnet and armature wherein the armature is in the form of a single unitary one-piece elongated strip of magnetic material, for example, mild steel, the strip being approximately the size of an ordinary automobile key and being similarly elongated so that, when attached to a key chain along with one or more keys, its configuration is conformable to that of the keys, thus resulting in a pack-

age unit which does not depart materially in size, shape, and portability from a conventional group of chain-contained keys.

Finally, it is an object of the invention to provide a novel connector including a magnet assembly and an armature and wherein the magnet assembly is comprised of a minimum number of parts, the parts, with the exception of the barium-ferrite magnet proper, being susceptible to inexpensive manufacturing operations, whether these parts be formed as sheet metal stampings or molded from plastic materials, and wherein the parts are capable of ease of assembly thus contributing to low cost of manufacture.

While the invention has been illustrated and described herein as being in the form of a separable key chain connector, other uses are contemplated. One such use which has been contemplated is as a refrigerator cabinet or other door latch. Another specific use of this nature, of which the present invention is capable, is as a lock for trailer doors, or the doors on other moving vehicles where looseness which may develop in the hinges would ordinarily lead to rattling or squeaking of the door. Because, as will be set forth in detail presently, the present connector makes provision for the prevention of lateral or transverse shifting of the armature with respect to the magnet, any parts which are fixedly attached to the permanent magnet assembly and the armature respectively, will be held against shifting movement with relation to each other in a lateral direction. Furthermore, due to the relatively long path of travel of the armature in moving through the magnetic field of the permanent magnet associated with the magnet assembly, and due to its confinement during such movement, the throw of the armature is comparable to the throw of conventional lock bolts, thus rendering the present connector suitable for use as a lock assembly where the armature performs the function of the usual locking bolt of a conventional lock assembly.

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

In this drawing:

FIG. 1 is a perspective view of a separable key chain-type magnetic connector employing the improved permanent magnet and armature assembly of the present invention;

FIG. 2 is a sectional view taken centrally and longitudinally through the magnet and armature assembly;

FIG. 3 is a top plan view of the connector with a portion of the outer casing broken away in order more clearly to reveal the nature of the invention;

FIG. 4 is an end view of the connector;

FIG. 5 is an opposite end view of the connector;

FIG. 6 is an exploded perspective view of the connector; and

FIG. 7 is a sectional view simlar to FIG. 2 but showing a slightly modified arrangement.

Referring now to the drawings in detail, and in particular to FIG. 1, the separate key chain-type magnetic connector illustrated herein for exemplary purposes has been designated in its entirety by the reference numeral **10** and involves in its general organization a composite permanent magnet assembly **12** and a one-piece armature **14**. The magnet assembly has associated therewith a conventional ball and link key chain **16** carrying an automobile ignition key **18**, while the armature has associated therewith a similar key chain **20** carrying a reserve ignition key **22** and a trunk lock key **24**. As will be described in greater detail presently, the magnet assembly **12** is generally in the form of an elongated, thin, generally flat, sheath for the armature **14**, and is provided with a relatively deep, narrow, pocket therein having a cross-sectional shape conformable to the cross-sectional shape of the armature, and into which pocket the armature is telescopically slidable

to such an extent that it is capable of being almost completely received within the pocket, the only projecting portion of the armature being a small attachment tab for the key chain **16**. The generally flat magnet assembly has associated therewith an internal enclosed and concealed permanent magnet proper having a flat pole face which establishes one side of the narrow pocket for the armature so that as the flat armature is inserted into the pocket designed to receive it, the armature slides across the flat pole face in face-to-face relationship and thus traverses the magnetic field of the magnet. In its home position within sheath-like magnet assembly, the two parts are fully magnetically coupled, and except for the previously-mentioned attachment tab on the armature, the armature is wholly contained within the magnet assembly. As will also be more fully pointed out subsequently, the armature-receiving pocket is relatively deep and the pole face of the magnet is correspondingly long so that, in traversing this pole face and magnetic field associated therewith, the armature travels an appreciable distance. Therefore, an appreciable displacement of the armature from its home position is possible before complete magnetic uncoupling of the parts can be effected.

As best seen in FIGS. 2, 3 and 4, the armature **14** is in the form of a single unitary strip of flat sheet metal stock, preferably mild steel, although other magnetic materials are contemplated. Under certain circumstances, it may be found desirable to form the armature **14** of magnetizable material such as a barium-ferrite material so that the same may itself exhibit attractive magnetic properties. In the form of the invention illustrated herein, the armature will be considered to be formed of a magnetic material which retains little, if any, of its magnetizable characteristics after it has been withdrawn from the magnetic field of the permanent magnet associated with the magnet assembly **12**.

The armature **14** is of elongated design, the forward end region thereof being squared and presenting a straight linear transverse edge **26**, while the rear end region thereof presents a semi-circular edge **28** establishing an attachment tab **30** for the key chain **20**. A small hole **32** extends through the attachment tab **30** and is designed for reception therethrough of the chain **20**. The longitudinal side edges **34** and **36** of the armature extend in parallelism.

The magnet assembly **12** is comprised of four parts, these parts being individually shown in FIG. 6 and comprising a two-part casing or holder consisting of a lower base part **40** and an upper cover part **42**, a permanent magnet **44**, and a pole piece **46**. As will be more apparent presently, when these four parts are assembled upon one another to produce the composite magnet assembly **12**, a sheath-like structure for the flat elongated armature **14** is provided. The two-part casing or holder is formed of a nonmagnetic material, such as a thermoplastic or thermosetting resin which may be molded, or it may be formed of a nonmagnetic sheet metal, such as brass, aluminum, or the like, the parts being shaped by a stamping operation. The pole piece **46** is formed of a magnetic material, such as mild steel. The permanent magnet **44** 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 of 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 **44** 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 influences and evidences very low eddy current losses. Indox is a magnetic material which exhibits extremely high coercive forces, a low remanence and high permea-

bility. Because of the 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 a permanent magnet of this character maintains its magnetic strength despite weakening influences such as contact with extraneous magnetic fields and frequent removal and replacement of the cooperating magnetic armature. Additionally, Indox and like ceramic materials are relatively light as compared to the magnetic alloys such as Alnico and like magnet materials.

The shape characteristics and small sizes which Indox and similar ceramic materials may assume for any given attractive power leave little to be desired as a magnetic material for holding purposes. These materials satisfy the requirements of the present invention when employed as a separable key chain connector or as a door lock where high-holding power is needed and frequent armature attraction and release are encountered. Ceramic magnets of this type are extremely effective even when they are of thin wafer-like design and, accordingly, the magnet 44 illustrated herein is of relatively thin flat construction and its association in the assembly will be more particularly described subsequently.

In the illustrated form of the invention, the magnet assembly is generally of rectangular configuration, it being in the form of a flattened hexahedron. This shape is, of course, controlled by the shape of the composite two-part outer casing 40, 42, but it need not be rectangular since a cylindrical shape having short axial height may be employed if desired. The magnet 44 is of a shape conformable to the over-all shape of the assembly 12 and, accordingly, it is in the form of a flat rectangular plate, the opposite sides of which are oppositely magnetized to produce poles of opposite polarity.

The lower base part 40 of the composite outer casing is of shallow tray-like design and includes a bottom wall 50, side walls 52 and 54 of relatively short height, and end walls 56 and 58 of greater height. The end wall 56 is recessed as at 60 centrally thereof, the recess being shallow, and the end wall 58 is centrally cut away completely as at 62.

The pole piece 46 is preferably but not necessarily of one-piece construction. It is in the form of a strip of magnetic sheet metal, such, for example, as mild steel and is generally L-shape in longitudinal cross section. It includes a flat rectangular bottom plate 64 and an upstanding vertical flange 66 which extends along one end edge thereof. A tongue 68 is struck from the metal of the bottom plate 64 and is turned or bent through an angle of 180° to provide an outwardly projecting attachment ear for the key chain 16. Accordingly, a small hole 70 is provided in the attachment ear and the chain 16 passes through this hole when the magnet assembly is complete. As best shown in FIGS. 2 and 3, the pole piece 46 is adapted to nest within the shallow tray-shaped base part 40 of the composite casing with the bottom plate 64 resting flatly against the bottom wall 50 and with the upstanding flange 66 bridging the cut-away portion 62 of the wall 58. The extent of the bottom plate 64 is such that it completely bridges the distance between the two end walls 56 and 58, with the attachment ear 68 projecting outwardly through the cut-away portion 62 of the end wall 58. The lower pole face 71 of the magnet 44 seats upon the upper face of the bottom plate 64 of the pole piece 46 and is cemented thereon by a suitable adhesive such as any of the adhesives currently employed by magnet manufacturers for attaching pole pieces to magnet pole faces. Among the adhesives suitable for this purpose are several of the epoxy resins, and also the material manufactured and sold under the trade name "Pliobond" by the Goodyear Tire and Rubber Company of Akron, Ohio. The magnet 44 may be positioned so that one edge, such as

the edge 72 thereof (see FIG. 2), remains slightly spaced from the upstanding flange 66 of the pole piece 46, or according to the modified form of the invention shown in FIG. 7, it may be positioned so that the edge 72 abuts this flange. As will be described subsequently, positioning of the magnet 44 shown in FIG. 7 produces a slightly different magnetic effect from the positioning of the magnet as shown in FIG. 2.

The upper cover part 42 of the composite nonmagnetic casing is generally U-shaped in transverse cross section. It consists of a flat top wall 80, and downwardly extending side flanges 82 and 84 (see FIGS. 4 to 6). The cover part 42 is adapted to be telescopically received over the lower base part 40 with the flanges 82 and 84 straddling the side walls 52 and 54 of this latter part. When in position over the base part, the cover part 42 may be cemented or otherwise secured in position thereon.

Reference to FIGS. 2 and 3 will reveal the fact that when the various parts of the magnetic assembly 12 are assembled upon one another in the manner indicated above, the upper pole face 86 of the magnet lies flush with or in the same horizontal plane as the bottom of the recess 60 in the end wall 56 of the lower base part 40. The underneath or inside face 88 of the top wall 80 remains slightly spaced from the upper pole face 86 of the magnet. The opposed faces 86 and 88, in combination with the inside faces of the side flanges 82 and 84 of the cover part 42, provide, in effect, a relatively deep, narrow pocket or void 90 for telescopic reception therein of the elongated flat armature 14.

In the operation of either the form of the invention shown in FIGS. 1 to 6, inclusive, or the form shown in FIG. 7, when the armature magnet assembly are magnetically coupled, the armature 14 is disposed for the most part within the narrow pocket 90 and the underneath face thereof lies flatly against both the bottom of the recess 60 in the end wall 56 and against the upper pole face 86 of the magnet 44, while the linear transverse end edge 26 of the armature 14 abuts against the side of the upstanding flange 66 of the pole piece 46. A closed magnetic path for the magnetic flux will then exist from the bottom plate 64, through the upstanding flange 66, the armature 14, and the magnetically-exposed end edge 92 of the magnet 44. A short section of the armature 14 will bridge the air gap 94 which exists by reason of the spacing between the magnet end edge 72 and the flange 66. In this home position of the armature 14 within the pocket 90, the attraction of the flange 66 for the transverse end edge 26 of the armature and of the pole face 86 for the underneath face of the armature will be great and the armature will be securely held by magnetic attraction within the pocket 90. The magnet assembly 12 thus functions in the manner of a sword-type sheath for the armature 14 which may be projected into or withdrawn from the pocket 90 at will by merely exerting oppositely directed pulling forces on the two key chains 20 and 16 associated with the armature and magnet assembly respectively. It is to be noted at this point that the armature 14 may be projected into the pocket 90 with either side thereof facing upwardly. It is to be further noted that when the armature 14 is in its home position within the relatively deep pocket 90, there is very little clearance between the parts so that lateral shifting or play of the armature is prevented. This renders the connector suitable for use as a door or other lock wherein the armature 14 functions in the manner of a locking bolt while the magnet assembly functions in the manner of the lock housing. In such an instance, the attachment tab 30 and attachment ear 70 for the chains 20 and 16 may be omitted.

Due to the depth of the pocket 90 and the longitudinal extent of the armature 14, an appreciable extent of armature movement is required to move the armature to its home position against the flange 66 after the forward edge 26 thereof has initially been inserted into the open end

of the pocket **90**. Some of this movement is manually impelled, particularly the movement which takes place during initial entry of the forward end of the armature into the pocket. However, much of the movement is assisted by or effected solely by magnetic attraction during passage of the armature end-wise into and through the magnetic field of the magnet **44**, particularly after the forward or leading edge **26** of the armature **14** closely approaches and enters the air gap **94**. The magnetic pull afforded by the upper edge region of the flange **66** at this time is relatively strong and during the final forward movement of the armature **14** in the pocket, manual force is overcome and the armature snaps into its home position and is firmly held in place within the magnet assembly **12**.

An appreciable degree of pull is required to dislodge the armature **14** from its home position, but after the edge **26** thereof has parted from the flange **66**, an appreciably lesser degree of pull is required to withdraw the armature the rest of the way until it is completely removed and detached from the magnet assembly. If, however, at any time before such complete removal from the pocket **90**, the impelling force is discontinued, the armature will either automatically move or slide back to its home position or it will remain static within the pocket and resist further withdrawal. Thus, as is frequently the case when a key cluster is suspended from an ignition key contained within the ignition lock barrel on an automobile dash board, if the key cluster be struck inadvertently by an uncalculated motion on the part of the operator, even though the leading edge **26** of the armature **14** be dislodged from contact with the flange **66**, the armature **14** will not necessarily be completely forced from the pocket. If the displacement is slight, the armature will return to its home position after the dislodging force is discontinued. If the displacement is sufficiently great as to remove the edge **26** appreciably from the flange **66**, magnetic attraction and frictional contact between the flat opposed face of the armature and the pole face **86** of the magnet will maintain the armature and its group of attached keys suspended from the automobile dash board or panel.

It is to be noted that the magnetic pole piece **46** substantially completely covers the bottom pole face **71** of the magnet **44** so that substantially all of the flux on this side of the magnet is confined within the pole piece with little or no flux spreading out beyond the outer surface of the bottom wall **50** of the base part **40**. The magnet assembly **12** presents no attraction for adjacent magnetic objects such as may be found in the pocket, purse or pocketbook of the user. The armature **14** also will present no attraction for magnetic objects inasmuch as it loses its molecular orientation as soon as it is withdrawn from the magnetic field of the magnet. When disposed within the magnetic field of the magnet, it completes a flux path across the pole face of the magnet and confines the flux to this path so that there are no stray external fields outside the confines of the box-like armature casing.

In the form of the invention shown in FIG. 7, the component parts of the connector **110** remain substantially the same as the corresponding component parts of the connector **10**, the only difference between the two connectors being a difference in the position of the magnet **144** with respect to the vertical flange **166** of the pole piece **146**. Thus, to avoid needless repetition of description, similar reference numerals but of a higher order have been applied to the corresponding parts as between the disclosures of FIGS. 1 to 6 and 7, respectively.

In FIG. 7, the magnet **144** is affixed to the upper face of the bottom plate **64** so that the edge **172** thereof is in direct contact with the adjacent side of the upstanding flange **166** of the pole piece **146**, thus eliminating the air gap **94**. Otherwise, the positioning of the parts remains the same as in the previously-described form of the invention. The operation of the connector **110** is substantially the same as that described in connection with the operation of the connector **10** except that during insertion of the armature **114** into the pocket **190**, the final magnetic attraction of the armature by the flange **166** is of shorter duration and the degree of pull exerted by the flange on the armature after contact with the latter is not quite as strong as when the air gap **94** is provided. Assembly operations for the magnet assembly **112** are facilitated inasmuch as the magnet **144** is stable when positioned adjacent to the flange **166** and no special clamps are required for holding the magnet in position while the adhesive, by means of which it is secured to the bottom plate **150**, becomes hardened or set.

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. Therefore, only insofar as the invention has particularly been pointed out in the accompanying claim is the same to be limited.

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

A separable two-part magnetic connector comprising, in combination, a magnet assembly and a cooperating armature, said magnet assembly being in the form of an elongated tubular sheath having a relatively deep pocket extending axially therein, a permanent magnet of the barium-ferrite type having oppositely facing flat pole faces, one of which establishes at least in part one wall of the pocket, an L-shaped pole piece of magnetic sheet material including a flat plate overlying and in substantially coextensive face-to-face contact with the other pole face of the magnet, one edge region of said plate overhanging one end edge of the magnet and having a laterally turned flange projecting completely across the general plane of the magnet and spaced from said one edge so as to define, in combination therewith, a narrow air gap, said laterally turned flange constituting a bottom wall for the pocket, said armature comprising an elongated flat blade-like strip of magnetic material having a cross-sectional shape conformable to the cross-sectional shape of said pocket, said armature being removably and telescopically receivable edgewise within said pocket and when so received within the pocket presenting one flat side thereof to said one pole face in intimate face-to-face contact therewith and having its leading edge region bridging the air gap and its leading edge in engagement with said flange, said flat side of the armature being designed for sliding contact with said one pole face during movement of the armature into and out of the pocket, an attachment tab on the armature at the trailing end thereof, the material of the flat plate having a struck-out portion which is disposed adjacent to said laterally turned flange, is turned through an angle of 180°, projects forwardly of the flange and constitutes an attachment tongue for the tubular sheath as a whole, said tab and tongue being designed for connection to respective key chains or the like.

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