

MAGNETIC FASTENER DEVICE

The present invention relates to magnetic fastener devices.

In the manufacture of magnetic fastener devices heretofor, for example as described in British Patent No. 2063343, the permanent magnet employed has usually been chosen for economic reasons to be one of the less expensive sintered magnets such as ferrite or alnico. For the purpose of concentrating the magnetic flux, thereby to intensify the magnetic force of attraction, magnetic pole plates have usually been attached to the respective magnetic poles. To avoid damage to the sintered magnets, which are liable to chip, and to keep the various parts together, the previously proposed magnetic fastener devices included metallic cases in which the parts were mounted. For reasons which are explained below with reference to Fig. 30 of the accompanying drawings, this was not wholly satisfactory. The present invention has arisen from work undertaken to improve upon the previously proposed arrangements.

In accordance with the present invention, there is provided a magnetic fastener device, comprising: first and second means adapted respectively to be attached to first and second members arranged to be held together by the fastener device; the first means comprising a permanent magnet formed with a hole or recess therein open in the region of one magnetic pole thereof and extending towards the other pole thereof, the permanent magnet being made of synthetic resin in which hard magnetic particles are embedded by moulding in situ and further including a first ^{ferro-}magnetic plate attached thereto at said other pole; and the second means comprising a second ferro-magnetic plate; one or both said plates being provided with a projection, and the first and second means being so configured that, on bringing the first and second means together, the second plate is attracted to the said one

pole, and the said projection and the other of the said plates or the two projections are brought into engagement in said hole or recess thereby to complete a magnetic circuit; and the first and second ferro-magnetic plates
 5 being provided with respective coupling means for attachment respectively to the said first and second members.

The invention is hereinafter more particularly described by way of example only with reference to the accompanying drawings, in which:-

10 Fig. 1 is a sectional view through an embodiment of fastener device in accordance with the present invention, with the first and second means inter-engaged;

Fig. 2 illustrates schematically the magnetic lines of force in the first said means in this embodiment;

15 Fig. 3 is an enlarged partial sectional view of the permanent magnet;

Figs. 4 to 16 are sectional views through various alternative embodiments of magnetic fastener device in accordance with the present invention;

20 Fig. 17 is an enlarged sectional view of a rather different arrangement, the two means being shown inter-engaged; and Fig. 18 is one example of a practical embodiment based upon the Fig. 17 construction;

Fig. 19 shows another rather different arrangement
 25 and Fig. 20 is a sectional view of a practical embodiment based upon the arrangement of Fig. 19;

Fig. 21 shows another differing arrangement, with the two means being shown inter-engaged, while Fig. 22 shows the lines of force in the permanent magnet and
 30 associated parts and Fig. 23 shows a practical embodiment based upon the construction of Figs. 21 and 22;

Fig. 24 shows a further alternative arrangement, again here shown with the two means inter-engaged, while Fig. 25 illustrates the lines of force in the permanent
 35 magnet and associated parts and Fig. 26 shows a practical embodiment based upon this construction;

Fig. 27 similarly shows a modified arrangement, Fig. 28 the lines of force, and Fig. 29 a practical embodiment based upon this construction; and

Fig. 30 is illustrative of a prior proposed
5 arrangement of the kind described in the aforementioned British Patent 2063343.

Referring first to Fig. 30, the magnetic fastener device shown therein utilizes the magnetic force of a permanent magnet 100. The device is in two parts, one
10 comprising ferro-magnetic plate 101, and the other comprising ferro-magnetic plate 102 attached to one pole of the magnet 100. A hole 100a is provided in the magnet 100 so that the plate 102 of the female fastener member B and the plate 10 of the male fastener member A make contact via
15 projections 101a and 102a.

In this prior magnetic fastener device, a case 103 was provided for attaching the plate 101 to the permanent magnet 100 as shown in Fig. 30, and also to protect the relatively brittle sintered magnet such as
20 ferrite.

I have found that the use of the case 103 involves a number of disadvantages. When the plate 101 is attached to the magnetic pole of the magnet 100 by means of the case 103, a small space X may remain between the
25 plate 101 and the magnet 100, which space X constitutes a highly reluctant zone in the passage of the magnetic force.

The plate 102 of the male fastener member B to be attracted by the female fastener member B is in effect attracted by the magnetic pole of the magnet 100 via the
30 case 103. Thus, there will again be a space X' forming high magnetic reluctance.

However, it was not possible to omit the use of the case 103 in these prior magnetic fasteners.

The permanent magnet 1 shown in all the embodi-
35 ments of Figs. 1 to 29 in accordance with the present invention is of the type generally known as a "plastic"

magnet. Although the term is not ideal, we shall use it for convenience of explanation.

The plastic magnet is made of hard magnetic particles t such as a powder of ferrite, alnico or rare-earth metals which is mixed with synthetic resin m in a weight ratio of about 90%, heated and moulded before being magnetized.

Synthetic resins useful in the practise of the present invention include polyamide such as nylon 66 or polyester. Other types of resins may also be used.

Although magnetic material of the type described in sheet form may be punched into a disk to obtain the permanent magnet 1, it is preferable to cast the material into a mould thereby to obtain a magnet with precise dimension, to enable a plate to be integrally attached, or to form a skin layer on the surface.

The permanent magnet 1 thus formed is made of hard magnetic powder particles t bound with synthetic resin m. A skin layer m' of synthetic resin tends to be formed on the surface at the mould, and serves to maintain elasticity of the surface.

Thus, the magnet 1 is advantageously resistant against impact while maintaining the magnetic capacity at a reasonable level.

In the general construction of Fig. 1, and in the specific examples of this construction shown in Figs. 4 to 16, the permanent magnet 1 is moulded with the ferro-magnetic plate 2 being incorporated at one of the poles a at the time of casting. A hole 1a is bored at the centre thereof extending between the N, S poles. The plate 2 is provided with a projection 2a to reach the mid point of the hole 1a along its height.

The above construction constitutes the female fastener member, indicated by the letter B in the drawings. The male fastener member A comprises a ferro-magnetic plate 3 adapted to be attracted to the other pole b of the magnet 1, and provided with a projection 3a to come into

contact with the projection 2a at a mid point of the hole 1a along its height.

The plates 2 and 3 concentrate the magnetic flux. Because of low magnetic reluctance of the thick projections 2a and 3a, the magnetic flux is induced to these parts to form a complete magnetic circuit connecting the magnet 1 - plate 2 - projection 2a - projection 3a - plate 3 - magnet 1.

As the magnet 1 and the plate 2 are in complete contact with each other, there will be no magnetically void portion therebetween. There will be no void between the plate 3 and the magnet 1 caused by an interposed non-magnetic case as in the prior art, either, so that there will be little or no magnetic reluctance occurring in the circuit.

The top peripheral edge of the projections 2a and 3a may be rounded with a curvature R. This reduces the contact area of the two projections. This is effective in increasing the intensity of magnetic flux per unit contact area and thus increasing the attracting force.

A plate layer g may be provided on the magnet 1 to protect the skin layer m'. This is effective in improving the impact resistance as well as wear resistance.

The skin layer m' is important in forming the plate layer g. If the layer of hard magnetic powder t is exposed on the surface without the skin layer m', the plating solution would permeate inside, making it difficult to form a uniform coating on the surface. Moreover, the plating solution permeated inside may later erode the plated coating.

Turning now to the practical embodiments of Figs. 4 to 16, in Fig. 4, the plates 2 and 3 are formed integrally with the projections 2a and 3a respectively by means of a press machine. Moreover, very thin projections 2b and 3b are also provided on the other side of the plates, being inserted and pressed into respective small holes 4a made in U-shape legs 4, the prongs of which are for

connecting the male and female parts of the device to respective first and second members designed to be held together by the fastening device.

In the embodiment shown in Fig. 5, the plates 2 and 3 are formed separately from the projections 2a and 3a. Small projections 2b' and 3b' on the opposite side of the projections 2a and 3a respectively are inserted and pressed into small holes 2c and 3c of the plates 2 and 3 and small holes 4a of respective U-shaped legs 4.

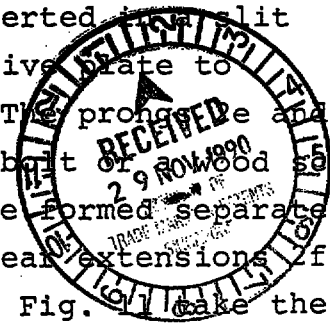
In Fig. 6, the plate 2 is embedded inside the permanent magnet 1 at the pole a. This prevents the plate 2 from slipping out of the magnet.

In Fig. 7, the hole 1a of the magnet is not a through-hole extending between the poles a and b, but a mere recess. The plate 2 is attached to the U-shaped leg 4 by means of a small projection 2b' on the reverse side of the projection 2a which penetrates through the thin layer 1a' of permanent magnet at the foot of the hole 1a.

In Fig. 8, the plane of the permanent magnet in the region of the magnetic pole b of the magnet 1 is concaved while the plate 3 is convexed. This facilitates slipping of the projection 3a into the hole 1a and formation of uniform contact on the concave surface.

Fig. 9 shows a different means for attaching the male fastener member A and the female fastener member B to a handbag and the like without using the prongs of U-shaped legs 4. The illustrated members 2d and 3d are adapted to be inserted in a hole made on the material of a handbag and the like and then pressed as in the case of an eyelet.

In Fig. 10, the plates 2 and 3 have sharp projections 2e and 3e respectively, adapted to be inserted into a slit formed in a washer to join the respective plate to material, for example, of a handbag. The prongs 2e and 3e may alternatively be in the form of a bolt or wood screw. In Figs. 11 and 12, the plates 2, 3 are formed separately from the projections 2a and 3a. The rear extensions 2f and 3f of the projections 2a and 3a in Fig. 11 take the



form of wood screws. The similar extensions 2g and 3g in Fig. 12 take the form of bolts.

In Fig. 13, a thin walled tubular member 5 is provided for joining the respective plates 2 and 3 to members to be fastened by the fastening device. The tubular members 5 have flanges 5a respectively attached to the plates 2 and 3 by moulding or welding. In Fig. 14, a similar thin walled tubular member 6 is held in place by a washer 6a held by the small projections 2b' and 3b'. The washer 6a has its edge turned over to trap the edge of member 6.

In Fig. 15, plurality of holes 1a are provided on the permanent magnet 1. By attaching a chain 7 to a plurality of male fastener members A, the construction can be used as a key holder or the like.

An adhesive tape 8 provided on the female fastener member B makes it possible to attach the fastener to any surface. The embodiment shown in Fig. 16 has only one hole 1a on its permanent magnet 1, but is also coupled to chains 7. This embodiment can be used for necklaces, bracelets and belts. The plate 3 of the male fastener member A is bent to form a portion 3h so that the chains 7 of both the male and female members will be ideally aligned linearly.

Unlike the fasteners shown in Figs. 1 to 16, the general construction of Fig. 17, and the example in Fig. 18 of a practical embodiment based on it, have no projection 2a on the plate 2. The projection 3a of the plate 3 is therefore made longer to directly make contact with the surface of plate 2. The permanent magnet 1 in the fastener means can be made as thin as 2.5 mm without hampering secure engagement of the projection 3a with the hole 1a. The fastener means can therefore be made relatively compact in size.

The general construction of Fig. 19 and the practical embodiment of Fig. 20 on it have the converse arrangement with projection 2a extending as far as the mouth of

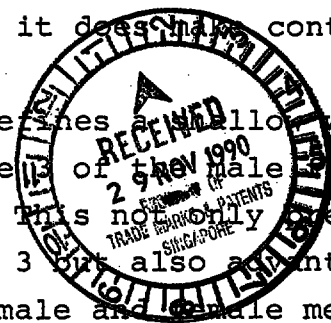
the hole 1a. The magnetic pole plate 3 has no projection. The magnetic flux converges at the top of the projection 2a, so that there is less leakage of flux to the exterior in this arrangement. Since there is no projection 3a on the male fastener member A, there is less tendency for the surface of the magnetic pole b to be scratched. The peripheral edge of the magnetic plate 3 is bent downwardly in Fig. 20 to provide a skirt 31 so that the plate 3 will not readily be displaced sideways from the magnetic pole b.

The embodiments shown in Figs. 21 to 29 all employ a raised edge 1b on the periphery of the permanent magnet 1 to surround the pole b. The raised edge 1b can be easily formed since the permanent magnet 1 is made of plastic. The raised edge 1b has the following functions because of its magnetic flux and the configuration. Firstly the magnet 1 itself is a relatively reluctant material as compared with a ferro-magnetic plate. Magnetic flux is generated between the poles a and b but in the raised edge region becomes extremely small. A field strength of about 500 gauss can be measured at the raised edge when the field strength between the poles a and b is 1200 gauss, for a permanent magnet 1 having a thickness of 4 mm and a raised edge of 1 mm in height.

As a result, a magnetic cash card and the like accidentally coming into contact with the fastener device will not come in direct contact with the magnetic pole b and will not be destroyed even if it does make contact with the raised edge 1b.

The raised edge 1b also defines a well for receiving the ferro-magnetic plate 3 of the male fastener member A or the female member B. This not only prevents lateral displacement of the plate 3 but also advantageously reduces the interval between the male and female members when they are magnetically engaged.

Any magnetic flux in the raised edge 1b is induced towards the plate 3 when the male and female fastener members are attracted to each other so that the magnetic



flux will not leak outside but be converged onto the projections 2a and 3a.

It should be noted that the peripheral edge of the magnet 1 may be circumferentially raised to form in a continuous ring, or it may be crenellated.

The fastener device shown in the general construction of Figs. 24 and 25 and in the specific example of Fig. 26 is a modification of the arrangement of Figs. 21 to 23. A ferro-magnetic plate 9 is embedded in the surface of the permanent magnet 1 at the pole b by moulding with the plate 9 in situ. The raised edge 1b is raised above the plate 9 and serves to hold its edges in place. As a result, the magnetic flux of the magnetic pole b converges in to the plate 9, with any magnetic flux in the raised edge 1b also being attracted to the plate 9, reducing leakage of magnetic flux. The magnet field strength at the edge 1b was measured to be about 350 gauss (under similar conditions to those mentioned above). Thus, there is even less danger of the magnetic recording portion of a cash card or the like being damaged.

The fastener device shown in the general constructions of Figs. 27 and 28 and in the specific example of Fig. 29 is an improvement of the above embodiment. The plate 9 is slightly embedded in the permanent magnet 1. The construction allows formation of a layer 1c of the permanent magnet 1 having a high magnetic reluctance over the plate 9. The magnetic flux of the magnet 1 converges in the plate 9 which effectively acts as the pole b, so that the magnetic field strength on the upper surface of the layer 1c tends to be only about 350 gauss (under the same conditions as before). However, since the magnetic flux passing through the plates 2 and 3 of the male and female fastener members to be converged on the projections 2a and 3a will still pass through the projections 2a and 3a via the plate 9, the attraction will not be decreased.

Thus, even if magnetic cards such as a cash card comes into direct contact with the surface of the permanent

magnet 1, the magnetically recorded data on the card will not be destroyed.

It will be readily appreciated by persons of reasonable knowledge in this art that features of one embodiment illustrated herein can usually readily be used to modify another. For example the various fixture means of Figs. 1 to 16 can be used with various projection arrangements of Figs. 17 to 20 and with a raised edge and ^{the} addition ^{of an} embedded plate 9.



CLAIMS

1. A magnetic fastener device, comprising: first and second means adapted respectively to be attached to first and second members arranged to be held together by the fastener device; the first means comprising a permanent magnet formed with a hole or recess therein open in the region of one magnetic pole thereof and extending towards the other pole thereof, the permanent magnet being made of synthetic resin in which hard magnetic particles are embedded by moulding in situ and further including a first ferro-magnetic plate attached thereto at said other pole; and the second means comprising a second ferro-magnetic plate; one or both said plates being provided with a projection, and the first and second means being so configured that, on bringing the first and second means together, the second plate is attracted to the said one pole, and the said projection and the other of the said plates or the two projections are brought into engagement in said hole or recess thereby to complete a magnetic circuit; and the first and second ferro-magnetic plates being provided with respective coupling means for attachment respectively to the said first and second members.

2. A device according to Claim 1, and of generally cylindrical form, said hole or recess being axially located, wherein the permanent magnet has a circum-extending raised edge about the said one pole defining a shallow well into which a second plate is attracted and received.

3. A device according to Claim 2, wherein the permanent magnet is provided with a ferro-magnetic plate at its surface in the region of the said one magnetic pole, which ferro-magnetic plate is held in place by the said raised edge.

4. A device according to Claim 1 wherein the permanent magnet is provided with a ferro-magnetic plate embedded therein in the region of the said one magnetic pole.



5. A magnetic fastener device substantially as herein-
before described with reference to and as shown in the
accompanying drawings.

