

MAGNETIC LOCK DEVICE

The present invention relates to a magnetic lock device that makes use of the attracting action of the magnetism.

A conventional magnetic lock device comprises two parts, one of which provides the magnetically attracting action and includes a permanent magnet having a center bore therethrough and having a first side for providing one polarity and a second side opposite the first side for providing the opposed polarity, a first ferromagnetic plate rigidly attached to the first side of the permanent magnet, and a nonmagnetic enclosure having a center bore aligned with the center bore of the permanent magnet and for packaging the permanent magnet and enclosure into one unit (which may be referred to as the "magnetically attracting part"), and the other of which is magnetically attracted by the magnetically attracting part and includes a second ferromagnetic plate detachably to be attached to the magnetically attracting part (which may be referred to as the "magnetically attracted part"). The first ferromagnetic plate may have a rod of ferromagnetic material extending therefrom or not, and the second ferromagnetic plate has a rod of ferromagnetic material extending therefrom which can meet the first ferromagnetic plate or its rod when the rod of the second ferromagnetic plate is inserted into the center bores through the enclosure and permanent magnet. The magnetic lock device may

be used as attachments for handbags, baggage, and other similar bags or wear, belts, and other similar articles.

The conventional magnetic lock device is constructed such that a magnetic circuit may be concluded by the permanent magnet, and first and second ferromagnetic plates when the two parts are to be coupled together. In the magnetic circuit, the magnetic lines of force from the permanent magnet may be centered onto the rods that meet each other or the rod that directly engages the corresponding ferromagnetic plate inside the bores. Thus, the powerful magnetic attraction may be provided.

The conventional magnetic lock device is based on the principle of operation in which the magnetic lines of force that emanate from one pole of the permanent magnet pass through the magnetic circuit toward the opposed pole. Specifically, those magnetic lines of force pass through the first and second ferromagnetic plates, centering onto the rod or rods through which they are directed to the point at which the rods meet or the rod directly engages the corresponding plate. This way, the magnetic flux density may be increased at that meeting point.

According to the conventional magnetic lock device, each of the first and second ferromagnetic plates is made of iron which is usually one (1) mm thick so as to meet the reduced-size requirements. Because of its reduced thickness, the plate will tend to reach its saturation point of magnetization prematurely, above which point no more magnetic lines of force can be transmitted to its rod. Those magnetic lines of force will be lost as external magnetic leaks. A more powerful permanent magnet may be used to compensate for the loss, but the magnetic attraction cannot be increased because the magnetization is saturated prematurely.

In light of the above described problems, it would be desirable to be able to provide a magnetic lock device that can make full use of the magnetic lines of force provided by the permanent magnet so that all of the magnetic lines of force can be transmitted through the plates toward the respective rod or rods without being magnetically saturated.

The invention provides a magnetic lock device comprising: a first element comprising a permanent magnet having a central bore traversing it and having a first side for providing one polarity and a second side opposite to the first side for the opposite polarity, a first ferromagnetic plate rigidly attached to the said first side of the permanent magnet, and a non-ferromagnetic enclosure packaging the permanent magnet and the first ferromagnetic plate into one unit and having a central bore aligned with the central bore of the permanent magnet; and a second element comprising a second ferromagnetic plate detachably attached to the said second side of the permanent magnet; and the second ferromagnetic plate having a rod of ferromagnetic material extending therefrom and disengageably engaging the first ferromagnetic plate directly, or indirectly through a rod of ferromagnetic material extending from the first ferromagnetic plate, via the said bores; in accordance with the invention as set forth in each of the independent claims, means are provided for enhancing the magnetism provided by the permanent magnet, at the point where at least one of the first and second ferromagnetic plates is connected to the associated ferromagnetic rod, for increasing the cross-sectional area of a magnetic path.

Specifically, as set forth in the independent claims, this means may take several forms. One form may include an additional ferromagnetic plate that is attached to either of the first and second ferromagnetic plates. For another form, a diametrically enlarged portion may be provided on the rod of either of the first and second ferromagnetic plates so that it can engage the first or second ferromagnetic plate flatly. Still another form may include a fastening member made of ferromagnetic materials

that is attached to the back of the first or second ferromagnetic plate.

The means for enhancing the magnetism provides the increased cross section through the magnetic path at the connecting point of the first or second ferromagnetic plate and ferromagnetic rod thereon, thereby avoiding the magnetic saturation that would otherwise occur when the magnetic lines of force are travelling through the magnetic path and are then centered onto the rod. Thus, all of the magnetic lines of force from the permanent magnet can be directed to the rod.

Preferred features and advantages of the present invention may be understood from the detailed description of several preferred embodiments that follows with reference to the accompanying drawings, in which:

Fig. 1 illustrates the cross section of a device according to a first preferred embodiment;

Fig. 2 illustrates the cross section of the device in Fig. 1, with some portions shown on an enlarged scale;

Fig. 3 illustrates the cross section of the device in Fig. 1, with the two parts A and B coupled together;

Fig. 4 illustrates the cross section of a device according to a second preferred embodiment, with some portions shown on an enlarged scale;

Fig. 5 illustrates the cross section of a device according to a third preferred embodiment, with some portions shown on an enlarged scale;

Fig. 6 illustrates the cross section of a device according to a fourth preferred embodiment, with some portions shown on an enlarged scale;

Fig. 7 (a) illustrates the bottom view of a device according to a fifth preferred embodiment, and Fig. 7 (b) illustrates the cross section of the same device, with some portions shown on an enlarged scale;

Fig. 8 (a) illustrates the cross section of a device according to a sixth preferred embodiment, with some portions shown on an enlarged scale, and Fig. 8 (b) illustrates the bottom view of the same device; and

Fig. 9 (a) illustrates the exploded cross section of a device according to a seventh preferred embodiment, and Fig. 9 (b) illustrates the cross section of the same device as assembled together.

Referring to Fig. 1, a magnetic lock device according to a first preferred embodiment comprises a part A which provides the magnetic attracting action, and a part B which is magnetically attracted by the part A. The part A includes a cylindrical permanent magnet 1 having a center bore 5 therethrough and having a first side for providing one polarity and a second side for providing the opposed polarity, a first ferromagnetic plate 2 made of iron and rigidly attached to the first side of the permanent magnet 1, and an enclosure 3 made of nonmagnetic material

such as brass. The enclosure 3 is formed like a cylindrical shape closed at the top and open at the bottom. It has a center bore 7 at the top that is aligned with the bore 5 of the permanent magnet 1, and a plurality of nails 4, 4 extending inwardly from the peripheral bottom edge. Those nails 4, 4 engage the peripheral bottom edge of the first ferromagnetic plate 2. Thus, the permanent magnet 1 and first ferromagnetic plate 2 are packaged by the enclosure 3 into one unit.

The center bore 7 on the top of enclosure 3 is formed such that it includes a skirt 6 extending downwardly that is fitted into the center bore 5 in the permanent magnet 1, and through which the bores 5 and 7 communicate with each other.

The first ferromagnetic plate 2 has a rod 8 made of iron extending upwardly from the center of the plate 2 as viewed from Fig. 1. The rod 8 has the diameter that is slightly smaller than the bore 5 in the permanent magnet 1, and has the height or depth nearly equal to half the thickness of the permanent magnet 1. The rod 8 includes a connecting shaft 9 extending downwardly therefrom as viewed from Fig. 1. This connecting shaft 9 extends through the center bore 10 formed in the first ferromagnetic plate 2. The first ferromagnetic plate 2 is backed by an additional plate 11 of any ferromagnetic material. The additional plate 11 and a fastening member 12 to be described later are affixed to the plate 2 by means of the bottom end of the connecting shaft 9.

The additional plate 11 is made of iron, and is shaped like a disc having the diameter and thickness which are substantially equal to half those of the first ferromagnetic plate 2, respectively, and having a center bore 13 into which the connecting shaft 9 is passed. The fastening member 12 includes a base 15 and a pair of legs 14 extending downwardly from the base. The base 15 has a center bore 16 into which the connecting

shaft 9 is passed. The connecting shaft 9 passes through the first ferromagnetic plate 2 and then through the additional plate 11 and fastening member 12. The bottom end of the connecting shaft 9 that is exposed from the fastening member 12 is pressed like a rivet 17 which couples all those parts together.

The part B includes a second ferromagnetic plate 18 made of iron which is magnetically attracted toward the second side of the permanent magnet 1 when the part B is brought closer to the enclosure 3. The second ferromagnetic plate 18 is formed like a disc shape, and has an iron rod 19 extending downwardly therefrom as viewed from Fig. 1. The plate 18 is backed by an additional ferromagnetic plate 11. The rod 19 has the diameter that is slightly smaller than the diameter of the skirt 6, and has the height or depth sufficient to permit the rod to reach or abut against the first ferromagnetic plate 2 or its rod 8 when the second ferromagnetic plate 18 is placed on the enclosure 3. Like the rod 8 for the first ferromagnetic plate 2, the rod 19 has a connecting shaft 9 which is inserted through the second ferromagnetic plate 18, additional ferromagnetic plate 11, and a fastening member 12, all of which are coupled together by pressing the bottom end like a rivet.

In the embodiment of the magnetic lock device described above, when the part A and the part B are coupled together as shown in Fig. 3, the second ferromagnetic plate 18 engages the top surface of the enclosure 3, with the rod 19 on the plate 18 through the bores 5 and 7 engaging the rod 8 on the first ferromagnetic plate 2 at the respective ends 19a and 8a thereof.

As coupled together as shown in Fig. 3, a magnetic circuit is created in which the magnetic lines of force emanate from the first side of the permanent magnet 1 (assuming that the first side provides the

N pole), traveling through the first ferromagnetic plate 2 and then centering onto the rods 8 and 19 meeting together, from which they go through the second ferromagnetic plate 18 as they are radiating radially. Finally, they return to the second side of the permanent magnet 1 that provides the S pole. It may be understood that when the magnetic lines of force are passing from the first ferromagnetic plate 2 to the second ferromagnetic plate 18, they are centered onto the respective rods 8 and 19 between the plates 2 and 18 so that the magnetic flux density is increasing gradually from the respective peripheral marginal edges toward the respective centers of the plates.

It may be possible that the magnetic flux density will reach its saturation point about the respective center areas of the first and second ferromagnetic plates 2 and 18, but those respective magnetic lines of force which exceed the saturation point can be directed through the additional plate 11 to the rod 8, and through the rod 19 to the additional plate 11.

Thus, all of the magnetic lines of force from the permanent magnet 1 can be directed to the respective ends 8a, 19a of the rods 8, 19 without causing any external magnetic leaks, thereby providing the powerful magnetic attracting action.

In the embodiment described above, the bore 13 of the additional plate 11 for each of the first and second ferromagnetic plates 2 and 18 may be formed so that it includes a skirt portion (as shown in Fig. 9).

A variation of the means for enhancing the magnetism is shown in Fig. 4. As seen from Fig. 4, a center bore 10 is provided on the first ferromagnetic plate 2 by means of a press. The center bore 10 is formed to include an expanded portion 22 like a funnel, and the rod 8 is also formed to include an expanded portion 23 that conforms to the expanded

portion 22.

Another variation of the means for enhancing the magnetism may be provided as shown in Fig. 5. In this variation, the first ferromagnetic plate 2 has a rod 8 formed like a trapezoidal shape 24 in cross section, and the permanent magnet 1 has a center bore 5 that includes a tapered portion 25 that conforms to the portion of the trapezoidal shape 24 of the rod 8 for accepting it.

Another variation of the means for enhancing the magnetism may be provided as shown in Fig. 6. In this variation, the first ferromagnetic plate 2 has a rod 8 having a diametrically enlarged portion 26, and the permanent magnet 1 has a center bore 5 including the corresponding diametrically enlarged portion 27 that conforms to the shape 26 of the rod 8 for accepting it.

In each of the above variations, each respective diametrically enlarged portion 23, 24, or 26 engages each corresponding first ferromagnetic plate 2 at the respective meeting ends, so that the magnetic lines of force can travel from the respective first ferromagnetic plate 2 and through the respective meeting ends to the respective the ferromagnetic rod 8, without being magnetically saturated. For any of the those variations, the means for enhancing the magnetism as described with reference to the variations may also be provided between the second ferromagnetic plate 18 and the rod 19.

Fig. 7 shows a variation of the means for enhancing the magnetism that is provided in the form of a fastening member. As seen from Figs. 7 (a) and (b), the fastening member 28 includes a disc plate 29 made of iron having a center bore and whose diameter is smaller than that of the first ferromagnetic plate 2, and a pair of legs 30, 30 formed from the disc plate 29 such that it extends like the U shape in cross section as

viewed from Fig. 7 (b). The disc plate 29 is rigidly attached to the first ferromagnetic plate 2 by means of the connecting shaft 9 of the rod 8.

According to the variation shown in Figs. 7 (a) and (b), the magnetic lines of force travel from the peripheral edge area toward the center area of the first ferromagnetic plate 2. The remaining part of the magnetic lines of force that have been saturated at the center area can be directed to the rod 8 through the disc plate 29. Thus, the magnetic flux density can be increased before the saturation point is reached. This concept may also be implemented on the part B. It should be understood that an additional disc plate of iron may be provided between the plate 2 and disc plate 29, thereby increasing the cross section through the magnetic path.

Referring to Fig. 8, there is another preferred embodiment in which the fastening member 12 is backed by an additional disc plate 31 that provides the means for enhancing the magnetism. The additional plate 12 is made of iron, and has the diameter which is slightly smaller than that of the first ferromagnetic plate 2. It includes a rectangular recess 32 at the center that accepts the base 15 of the fastening member 12 attached to the back of the first ferromagnetic plate 2, the rectangular recess 32 having openings 32a on the lateral sides thereof through which the pair of legs 14 can be inserted.

The means for enhancing the magnetism described with reference to Figs. 1, 2, and 3 for the part A or B or both is not limited to those embodiments where its constituent parts are previously assembled as described, but may be varied as shown in Fig. 9. As seen from Fig. 9 (a), it may include a rod 8, an additional plate 33, and a backing washer 34 which are separately provided and may be mounted to the first ferromagnetic plate 2 in the sequence given above. In this case, the rod 8 has a

connecting shaft 9 which is longer than those in the preceding embodiments. The additional plate 33 is made of iron, formed like a disc, as in the preceding embodiments, and has a center bore 35 formed from a barring. The back washer 34 has the disc form like the additional plate 33, and has a center bore 36 therethrough. The back washer 34 may be made of nonmagnetic or ferromagnetic materials.

According to the embodiments described above, the additional plates 31, 33 may be mounted to the back of the first ferromagnetic plate 2 when the device is actually used on an article such as a handbag. This fastening process is explained by referring to Fig. 8. For example, when the part A is fastened to the article, the pair of legs 14 of the fastening member 12 is pierced into the article, and is then folded over behind the article, thereby coupling the additional plate 31 and first ferromagnetic plate 2 together. This process may apply to the part B.

For the embodiment shown in Fig. 9, the fastening process may be accomplished in the similar manner. With the connecting shaft 9 of the rod 8 being mounted to the center bore 35 of the additional plate 33 as shown in Fig. 9 (b), the connecting shaft 9 is inserted through the article 37, and then the back washer 34 is mounted to the portion of the connecting shaft 9 that is exposed behind the article 37. Then, the bottom end of the connecting shaft 9 is pressed to provide a rivet 38. This rivet 38 secures the part A to the article 37, with the first ferromagnetic plate 2 and the additional plate 33 coupled together.

It may be appreciated from the various preferred embodiments and the respective variations thereof that the means for enhancing the magnetism allows the magnetic lines of force to pass through the magnetic circuit without being saturated. As such, the magnetic force provided by the permanent magnet can be utilized fully without causing any external

magnetic leaks. Thus, the powerful magnetic attraction can be provided.

Although the present invention has been described in full detail with reference to the embodiments, it should be understood that various changes and modifications may be made without departing from the scope of the invention as defined in the appended claims. In particular, it will be appreciated that the features of different embodiments may be combined.



Claims:-

1. A magnetic lock device comprising:

a first element comprising a permanent magnet having a central bore traversing it and having a first side for providing one polarity and a second side opposite to the first side for the opposite polarity, a first ferromagnetic plate rigidly attached to the said first side of the permanent magnet, and a non-ferromagnetic enclosure packaging the permanent magnet and the first ferromagnetic plate into one unit and having a central bore aligned with the central bore of the permanent magnet;

a second element comprising a second ferromagnetic plate detachably attached to the said second side of the permanent magnet;

the second ferromagnetic plate having a rod of ferromagnetic material extending therefrom and disengageably engaging the first ferromagnetic plate directly, or indirectly through a rod of ferromagnetic material extending from the first ferromagnetic plate, via the said bores; and

an additional ferromagnetic plate attached to one of the first and second ferromagnetic plates at the point where the said one ferromagnetic plate and the associated ferromagnetic rod are connected, the additional ferromagnetic plate overlapping the area of the permanent magnet, thereby increasing the cross-sectional area of a magnetic path and enhancing the magnetism provided by the permanent magnet.

2. A magnetic lock device as claimed in claim 1, including a further additional ferromagnetic plate attached to the other of the first and second ferromagnetic plates.

3. A magnetic lock device as claimed in claim 1, including a diametrically enlarged portion of the rod associated with the other of the first and second ferromagnetic plate, the said portion engaging the associated ferromagnetic plate.

4. A magnetic lock device as claimed in any preceding claim, including a fastening member made of ferromagnetic material attached to the back of the first or second ferromagnetic plate.



5. A magnetic lock device comprising:

a first element comprising a permanent magnet having a central bore traversing it and having a first side for providing one polarity and a second side opposite to the first side for the opposite polarity, a first ferromagnetic plate rigidly attached to the said first side of the permanent magnet, and a non-ferromagnetic enclosure packaging the permanent magnet and the first ferromagnetic plate into one unit and having a central bore aligned with the central bore of the permanent magnet;

a second element comprising a second ferromagnetic plate detachably attached to the said second side of the permanent magnet;

the second ferromagnetic plate having a rod of ferromagnetic material extending therefrom and disengageably engaging the first ferromagnetic plate directly, or indirectly through a rod of ferromagnetic material extending from the first ferromagnetic plate, via the said bores; and

a diametrically enlarged portion of the ferromagnetic rod associated with one of the first and second ferromagnetic plates, at the point where the said one ferromagnetic plate and the associated ferromagnetic rod are connected, the enlarged portion engaging the associated ferromagnetic plate and overlapping the area of the permanent magnet, thereby increasing the cross-sectional area of a magnetic path and enhancing the magnetism provided by the permanent magnet.

6. A magnetic lock device as claimed in claim 5, including an additional ferromagnetic plate attached to the other of the first and second ferromagnetic plates.

7. A magnetic lock device as claimed in claim 5 or 6, including a fastening member made of ferromagnetic material attached to the back of the first or second ferromagnetic plate.

8. A magnetic lock device comprising:

a first element comprising a permanent magnet having a central bore traversing it and having a first side for providing



one polarity and a second side opposite to the first side for the opposite polarity, a first ferromagnetic plate rigidly attached to the said first side of the permanent magnet, and a non-ferromagnetic enclosure packaging the permanent magnet and the first ferromagnetic plate into one unit and having a central bore aligned with the central bore of the permanent magnet;

a second element comprising a second ferromagnetic plate detachably attached to the said second side of the permanent magnet;

the second ferromagnetic plate having a rod of ferromagnetic material extending therefrom and disengageably engaging the first ferromagnetic plate directly, or indirectly through a rod of ferromagnetic material extending from the first ferromagnetic plate, via the said bores; and

a fastening means made of ferromagnetic material attached to the back of one of the first and second ferromagnetic plates, at the point where the said ferromagnetic plate and the associated ferromagnetic rod are connected, thereby increasing the cross-sectional area of a magnetic path and enhancing the magnetism provided by the permanent magnet.

9. A magnetic lock device as claimed in claim 8, including an additional ferromagnetic plate attached to the first or second ferromagnetic plate.

10. A magnetic lock device as claimed in claim 8 or 9, wherein a diametrically enlarged portion of the rod associated with the first or second ferromagnetic plate engages the associated ferromagnetic plate.

11. A magnetic lock device as claimed in any of claims 8 to 10, including a further fastening member made of ferromagnetic material attached to the back of the other of the first and second ferromagnetic plates.

12. A magnetic lock device as claimed in claim 4, 7, 8, or 11, wherein the fastening member has a base portion attached to the associated ferromagnetic plate and a pair of legs extending



- 16 -

from the base portion, to provide a U-shaped cross section, the base portion having the shape conforming to the shape of the ferromagnetic plate to which the base portion is attached.

13. A magnetic lock device substantially as described with reference to any of the embodiments illustrated in the accompanying drawings.
