

SPECIFICATION

Magnetic roller

5 This invention relates to magnet apparatus, particularly although not exclusively to a magnetic roller assembly. Such an assembly may for example be used in apparatus for coupling elevator car doors and hallway doors in order to provide supplemental
10 door closing force to the hallway doors from the car doors and also to actuate car motion control apparatus preventing car movement if the doors are not fully closed.

The hallway doors located on each floor in the
15 typical elevator system are supported on rollers that ride in tracks in the door sill. Typically the hallway doors are closed through the use of springs or weights, but in some installations they are closed with assistance from the car doors through door
20 coupling apparatus.

In some buildings air pressure on the hallway doors may prevent the doors from closing completely. The reason for this is the air pressure forces the door sideways against the tracks and in doing so it
25 may increase the rolling friction and force needed to open and close the doors. For obvious safety reasons the normal door closing force, which is supplied from springs or weights and the like, is small; consequently, this force may be insufficient to
30 overcome those increased frictional forces created by air pressure conditions on the hall doors. Hence, it is possible that under certain operating conditions the hall doors may not close completely.

Car motion control switch apparatus are frequently
35 coupled to the hall doors to prevent further car movement until the hall doors are fully closed. Consequently, incomplete door closure may produce annoying service interruptions.

These door closing difficulties are particularly
40 prevalent in buildings that are air-conditioned and those that are very high. In an air-conditioned building the temperature gradients that may be created between the air-conditioned hallway and the much warmer shaftway may produce significant air
45 pressure forces on the hallway side of the door. These pressures may increase the rolling friction, especially when the door is slightly open (just before full closure). Moreover, at that position there may be significant air flow between the partially opened
50 doors, as the cold air rushes into the warm shaftway. This air flow presents a quasi-rigid column of air between the two oppositely moving doors, and this column, which can obstruct or impede further door movement, acts in conjunction with the increased
55 friction produced by the air pressure to stop the doors.

A similar effect may occur in high buildings as well, where the upper floors are exposed to significantly more wind than the lower floors. As the wind
60 slides across the upper surfaces of the buildings, an air pressure reduction may develop in the shaft. This occurs in the same way that lift is produced on an aircraft wing from air movement across the upper and lower wing surfaces. On an aircraft wing that air
65 movement produces low pressure on the upper

surface and the difference between the air pressure on the upper and lower surface produces lift.

Similarly, a pressure drop in an elevator shaft may create a pressure gradient between the hallway and
70 the shaft, and should that occur, the gradient will produce air pressure on the hallway door, which pressure may bring about the same effects produced by air pressure in an air-conditioned building.

In U.S. Patent 3,638,762, a door coupling apparatus is disclosed for elevators. This apparatus has, as one of its principal objectives providing additional closing force to the hallway doors so as to minimize service interruptions from incomplete door closing. A magnetic roller assembly is disclosed, which is
80 attached to a hallway door. This roller rides on a vane which is attached to one of the car doors. The car doors, of course, are coupled together, as are the hallway doors, so that as one of the coupled doors closes, the other also closes. The magnetic attraction
85 between the vane and the roller provides means for establishing a mechanical connection between the two sets of doors, and as the car doors close, the roller follows the vane, and thus, the car door tends to pull the hall door closed. Through this mechanical
90 connection supplemental door closing force is applied to the hallway doors from the car doors. This supplemental force assists in closing the door against possible increased door closing friction. The mechanical connection between the two sets of
95 doors is interruptable, however, if an object is placed in the path of the hallway doors, they will stop moving, while the car door will continue to close. This occurs because the vane can break contact with the roller.

As disclosed in said U.S. Patent, switch apparatus
100 may be connected to the magnetic roller assembly so that if the door does not close completely, further car movement is stopped until the doors are completely closed.

The magnetic roller disclosed in said patent employs two metal rings; these are magnetized by a smaller diameter magnet, which is sandwiched between the rings. The rings and magnet rotate on an eccentric shaft which is connected to an arm. This
110 arm is pivotally mounted on the hall door to actuate the aforementioned switch apparatus. The supplemental force derived through the roller is transmitted to the door through this arm.

The magnetic pull is derived directly from the two
115 rings as they ride or roll on the vane. The magnitude of the attractive or pulling force is obviously greatest when the two rings are directly on the vane; but if there is a minor misalignment between the roller and the vane (so that only one of the rings contacts
120 the vane), a significant reduction in pulling force may occur. Thus, a magnetic roller of this type is susceptible to misalignment problems which may cause a reduction in pulling force. Still, this apparatus has been exceptionally effective in minimizing service interruptions due to hall door closing problems.

An object of the present invention is to provide a stronger magnetic roller which may for example be
130 used in existing door coupling apparatus. Another object is to provide a door coupling apparatus

through which the pulling force exerted on the hall door is maximized through elimination of the alignment problems frequently associated with the magnetic rollers of the prior art.

5 In accordance with the invention there is provided a magnetic roller assembly comprising an annular ring of magnetizable material adapted to be rotatably mounted on a pin, first and second magnets disposed adjacent respective opposite sides of said
10 ring for magnetizing said ring, and said magnets being disposed relative to each other on said opposite sides of said ring with their like magnetic poles facing each other in opposition with a first portion of said ring therebetween, said ring including a second portion extending from between said
15 magnets, said second portion being magnetized to the same polarity and substantially the combined strength of said like poles.

The assembly may further comprise means
20 adapted to be disposed between said ring and the pin for increasing the reluctance of the magnetic circuit path therebetween. Said means may comprising a bushing constructed of nonmagnetizable material.

25 In a preferred embodiment said first and second magnets are circular, are attached to said ring so as to rotate therewith and have a diameter which is less than the diameter of said ring so that a portion of said ring extends radially outward from between
30 said magnets, said portion being magnetized to the same polarity and substantially the combined strength as said like poles. Thus the ring is essentially sandwiched between these two magnets which rotate together with the ring on a pin or shaft. The
35 two magnets face each other with their like magnetic poles facing. A portion of the ring extends from between these magnets, is magnetized to the same polarity as those like poles and has a magnetic strength which is substantially equal to the combined pole strength of the two magnets.

In addition, the ring's magnetic strength is further enhanced by preventing flux diffusion in the pin or shaft on which the magnets rotate. This is done so that the quantity of flux directed through the pin and
45 then into the ring is insignificant compared to the entire flux which radiates in the path extending through the outer edge of the ring and returning through the magnets to the ring. This path is the preferred flux circuit for maximum pole strength at
50 the outer edge of the ring. In this way the magnetic strength of the ring is enhanced over the strength it would otherwise have and it is significantly increased over the combined strength of the two rings found in prior art rollers. In accordance with the

55 present invention this is accomplished by restricting the magnetic coupling between the ring and the pin.

A feature of the invention is that it may be utilized in fabricating a retrofit magnetic roller for door coupling apparatus already in use but having two
60 metal rings.

As mentioned the invention has particular application to elevator systems. The invention therefore also provides apparatus for coupling a hall door and a car door in an elevator system, comprising a vane
65 mounted on the car door and a magnetic roller

assembly as set forth above, wherein said second magnetized portion is adapted to rest on said vane and exert a magnetic pull thereon. Consequently, the entire pulling force applied to the door vane is
70 exerted through this ring and, thus, the misalignment problems of the two ring type roller are eliminated.

In order that the invention may be readily understood, an embodiment thereof will now be described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a sectional view of a magnetic roller which is part of a door coupling apparatus; and

Figure 2 is an illustration of a door coupling apparatus using a magnetic roller for coupling the
80 hall and car doors in an elevator system.

In *Figure 1* a magnetic roller 10 is rotatably mounted on a pin 12. This pin is attached to an arm 14 and the arm is pivotally attached on the shaft side
85 of one of two coupled hallway doors 16. The roller includes an annular ring 18 which is constructed of magnetizable material, such as iron or steel. The ring rotates about the pin on a bearing 20 which is constructed of nonmagnetic material, i.e. bronze or brass. The ring is magnetized at its outer edge 22 by
90 two small diameter annular ring magnets 24, 25. The outer edge extends for a finite distance from between the magnets. These magnets are affixed alongside the ring and rotate with the ring on the pin. Opposite sides 26, 28 of each magnet are
95 opposite poles (north and south). The magnets are positioned on each side of the ring so that their like poles face each other in opposition: for example, the south pole 30 of each magnet may be placed against the ring, as illustrated. As a result of this, the magnets magnetize the ring in such a way that the
100 ring's outer edge 22 also becomes a south magnetic pole with a strength that substantially equals the combined pole strength of the two magnets. The portion 29 of the ring immediately sandwiched between the magnets becomes a north pole. However, the pole density or magnetic density in this portion 29 is significantly less than it is at the outer edge 22, simply because the available ring volume
105 between the magnets is greater. The magnetic flux lines, which are continuous, extend in a pattern 31 from opposite poles through the outer edge 22.

In some installations, the pin may be made of steel or iron, in which case the pin would have high magnetic permeability. A portion of the flux lines therefore would be shunted or drawn away from the magnets and directed through the pin to the inner edge of the ring. The net effect of this would be that the overall effective pole strength of the ring (its pulling strength) would be reduced somewhat. However, this effect is ameliorated in accordance with the present invention by the nonmagnetic bearing 20, which imposes a high reluctance path between the pin and the inner portion of the ring, thereby lowering the overall permeability of the flux circuit between the pin and the ring. Therefore, less flux is shunted through the pin. On the other hand, if a nonmagnetic pin is utilized, for example one constructed of brass or bronze, such flux shunting
125 obviously will not occur; thus the bearing may be
130

excluded in such an apparatus.

Figure 2 is a top plan view of a portion of an elevator system. It illustrates a simplified door closing apparatus 32 which utilizes the roller apparatus previously depicted and described in Figure 1. A system of this type is shown and described in much greater detail in the aforementioned U.S. Patent 3,638,762, to which reference should be made for a more exhaustive explanation of the operation of such a system.

In Figure 2, a vane 33 constructed of high permeability material such as iron or steel is attached to a car door 34. The magnetic pull from the ring 18 on the roller pulls the ring against the vane when the vane is positioned close by. A car motion switch or interlock apparatus 36 is mechanically connected to the pivoting arm 14. The interlock apparatus is generally depicted, as a more detailed description is available in U.S. Patent 3,638,762. This interlock apparatus serves to prevent car movement if either the hall door 16 or car door 34 are partially open.

As the car door closes, the magnetic pull from the roller holds it against the vane and mechanical connection between the two doors is thus established. Additional pulling force is thereby transmitted from the car door to the hall door as the car door closes and this additional force assists in closing the hall door, especially near its closed position, at which the normal door closing apparatus (not shown) is weakest and the effects from air pressure on the door are greatest.

Only the narrow magnetized ring 22 contacts the vane, and the magnetic force which is applied to the vane is derived exclusively through the ring. Therefore, there is no diminution or lessening in the pulling force applied to the hall door if there is slight misalignment between the roller and the vane such that the plane of the ring is not precisely perpendicular to the contacted surface of the vane. In distinct contrast, however, a prior art roller using two rings (as described in the aforementioned patent) is susceptible to such a reduction in pulling force by such misalignment of the roller because misalignment may cause one of the rings not to contact the vane, in which case a significant reduction in pulling force - as much as fifty percent - may occur.

As the car door closes, the normal hall door closing apparatus pulls it along. A mechanical connection between the doors is established through the door closing apparatus, and additional force is applied to the hall door from the car door through the apparatus to assist in closing the hall door, especially near its closed position. As the car door closes, the hall door will close first and the vane will start to move away from the roller. When this occurs, the roller will start to ride up the vane and cause the arm to pivot on the hall door. This will activate car motion interlock switch to allow car movement when the car door is completely closed.

The ring magnets may be constructed of iron impregnated rubber magnetized to the correct polarity. The advantage to this is that the flexibility it provides assists in achieving a uniform large contact interface between the magnets and the ring. Air gaps between the ring and the magnets decrease the ring

magnetization because they increase the interface reluctance. A good interface is important, therefore, because it minimizes the occurrence of such air gaps and spaces and, therefore, optimizes the magnetic coupling between the magnets and the ring, so as to maximize the ring's magnetization.

The ring must extend radially outward from the pin somewhat further than do the magnets, as shown in Figures 1 and 2, so that a pole can develop there. However, it should not extend out so far that the magnetic pole strength in the outer edge is diffused in a larger area, since diffusion may create a reduction in the overall pole strength along the edge of the ring contacting the vane. Satisfactory results in an elevator door closing apparatus have been achieved by using a ring having a radius which is approximately 1/8th of an inch greater than the nominal radius of the magnets. Other applications and required pulling forces may necessitate smaller or greater extensions, however.

Although the invention has been shown and described with respect to exemplary embodiments thereof, it should be understood by those skilled in the art that various changes, omissions and additions in the form and detail thereof and thereto may be made without departing from the true scope of the invention described in the following claims.

CLAIMS

1. A magnetic roller assembly comprising an annular ring of magnetizable material adapted to be rotatably mounted on a pin, first and second magnets disposed adjacent respective opposite sides of said ring for magnetizing said ring, said magnets being disposed relative to each other on said opposite sides of said ring with, their like magnetic poles facing each other in opposition with a first portion of said ring therebetween, said ring including a second portion extending from between said magnets, said second portion being magnetized to the same polarity and substantially the combined strength of said like poles.

2. A magnetic roller assembly according to claim 1, further comprising means adapted to be disposed between said ring and the pin for increasing the reluctance of the magnetic circuit path therebetween.

3. A magnetic roller assembly according to claim 2, wherein said means comprises a bushing constructed of nonmagnetizable material.

4. A magnetic roller assembly according to claim 1, 2 or 3 wherein said first and second magnets are circular, are attached to said ring so as to rotate therewith and have a diameter which is less than the diameter of said ring so that a portion of said ring extends radially outward from between said magnets, said portion being magnetized to the same polarity and substantially the combined strength as said like poles.

5. A magnetic roller assembly substantially as hereinbefore described with reference to the accompanying drawing.

6. Apparatus for coupling a hall door and a car door in an elevator system, comprising a vane



excluded in such an apparatus.

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Although the invention has been shown and described with respect to exemplary embodiments thereof, it should be understood by those skilled in the art that various changes, omissions and additions in the form and detail thereof and thereto may be made without departing from the true scope of the invention described in the following claims.

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2. A magnetic roller assembly according to claim 1, further comprising means adapted to be disposed between said ring and the pin for increasing the reluctance of the magnetic circuit path therebetween.

3. A magnetic roller assembly according to claim 2, wherein said means comprises a bushing constructed of nonmagnetizable material.

4. A magnetic roller assembly according to claim 1, 2 or 3 wherein said first and second magnets are circular, are attached to said ring so as to rotate therewith and have a diameter which is less than the diameter of said ring so that a portion of said ring extends radially outward from between said magnets, said portion being magnetized to the same polarity and substantially the combined strength as said like poles.

5. A magnetic roller assembly substantially as hereinbefore described with reference to the accompanying drawing.

6. Apparatus for coupling a hall door and a car door in an elevator system, comprising a vane



mounted on the car door and a magnetic roller assembly according to any of the preceding claims wherein said second magnetized portion is adapted to rest on said vane and exert a magnetic pull

5 thereon.

7. Apparatus for coupling a hall door and a car door in an elevator system, substantially as hereinbefore described with reference to the accompanying drawing.

Printed for Her Majesty's Stationery Office, by Croydon Printing Company Limited, Croydon, Surrey, 1983.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.