

"ELECTROMAGNETIC DISC BRAKE FOR ELEVATOR LIFTING APPARATUS"

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The present invention relates to an electromagnetic disc brake for an elevator lifting apparatus.

The conventional electromagnetic disc brake
5 is arranged in such a manner as has been disclosed in Japanese Utility Model Unexamined Publication No. 63-173530 in order to eliminate an unfavorable effect caused by residual magnetism on an armature.

The above-mentioned conventional electromagnetic
10 disc brake has such an operational characteristic as to induce idle running of a cage due to an insufficient release speed (return speed) of the armature at the time of the operation of the brake.

15 One object of the present invention is to provide an electromagnetic disc brake for an elevator lifting apparatus which has improved operational characteristics.

Another object of the present invention is to
20 provide an electromagnetic disc brake for an elevator lifting apparatus which can diminish the noise during the operation.

In order to achieve the above-described objects, an electromagnetic disc brake for an elevator lifting

apparatus of the invention comprises a disc spline-coupled with a rotational shaft; a braking body and an armature disposed to clamp the disc; braking springs for urging said armature against said disc; an iron core which
5 includes inner and outer magnetic poles each facing said armature via a magnetic gap and concentrically formed with respect to said rotational shaft; and an electromagnetic coil which generates magnetic flux in a magnetic path formed by said inner and outer magnetic poles and said
10 armature; wherein said braking springs are disposed in the region of the outer magnetic pole, and the magnetic gap between said outer magnetic pole and said armature is larger than that between said inner magnetic pole and said armature.

15 Further, the braking body can be supported through a sound absorbing member or one side of the armature facing the disc is formed of a sound absorbing member.

Owing to the means for increasing the magnetic
20 gap provided on the side of the outer magnetic pole, attraction force of the outer magnetic pole which has a larger attraction are is decreased, and also, the braking springs disposed on the outer magnetic pole side contribute to smooth and swift release of the armature from the iron
25 core when an area of the armature where there is less attraction force is pressed by the force of the braking springs. Besides, the noise caused by the attraction and release of the armature to and from the iron core is absorbed by the sound

1 absorbing member, whereby the noise can be diminished.

Thus, according to the present invention, the operational characteristic can be improved by reducing the time to start the braking operation, and the noise
5 during the operation can also be diminished.

The present invention will now be described in greater detail by way of example with reference to the accompanying drawings, wherein:-

Fig. 1 is a vertical sectional view showing one embodiment of an electromagnetic disc brake for an elevator lifting apparatus according to the present
10 invention;

Fig. 2 is a vertical sectional view showing the embodiment of Fig. 1 taken along a different line;

Fig. 3 is a side view of the same embodiment;

Fig. 4 is a perspective view showing an
15 armature of the above embodiment;

Fig. 5 is a perspective view showing an iron core of the same embodiment;

Fig. 6 is an explanatory view showing an operating state of the electromagnetic disc brake
20 for the elevator lifting apparatus according to the present invention;

Fig. 7 is a plan view showing an operating state of the electromagnetic disc brake when applied to the elevator lifting apparatus;

25 Figs. 8 through 10 are diagrams respectively showing the characteristics of the electromagnetic disc brake according to the present invention;

1 Figs. 11 through 13 are vertical sectional
views respectively showing configurations of the iron
core of the electromagnetic disc brake according to
the present invention; and

5 Figs. 14 through 16 are vertical sectional
views showing the main portion of the electromagnetic
disc brake respectively provided with noise absorbing
members according to the present invention.

10 One embodiment of an electromagnetic disc
brake according to the present invention will be
described hereinafter with reference to the attached
drawings.

 As shown in Fig. 6, an elevator is provided
15 with a lifting apparatus 3 in a machine room 2 which is
mounted on a top of an elevator passage 1. Also, as
shown in Fig. 7, the lifting apparatus 3 includes a
sheave 4 around which a wire rope 6 is wound for
suspending a cage 7 and a balancing weight 8, an
20 electric motor 9 which drives the sheave 4, and a
parallel axis reduction gears 10 connected between the
electric motor 9 and the sheave 4. An electromagnetic
disc brake 11 according to the present invention is
attached to an input shaft of the reduction gears 10.

25 Referring to Figs. 1 and 2, the input shaft
10S of the reduction gears 10 is protruded through the
outer wall of a reduction gear box 10B, and a braking

1 body 12 defining a through hole 12H in the center and
concentrically formed with the input shaft 10S is
secured to the reduction gear box 10B by means of bolts
13. A spline boss 14 splined on its outer periphery is
5 fitted around the input shaft 10S within the through
hole 12H of the braking body 12. A disc 15 is spline-
coupled with the spline boss 14 so as to move along
the axial direction only. On both sides of an outer
peripheral portion of the disc 15 is attached a lining
10 16, one side of which faces one end surface of the
braking body 12. The braking body 12 is provided with
a plurality of guide pins 17 on its outer periphery
which extend along the axial direction, and these
guide pins 17 serve to guide an armature 18 so that the
15 armature is adapted to move along the axial direction
and to face the other side of the lining 16.

Referring to Fig. 4, the armature 18 has a
disc type configuration with a through hole 18H in the
center through which the input shaft 10S extends.

20 Further, referring to Figs. 1 and 2, through the armature
18 on its outer peripheral portion are bored guide
holes 19 for extending the guide pins 17 and spring
holes 20 for extending biasing springs 34. Also, the
other side of the armature 18 not facing the lining 16
25 are formed with a magnetic pole facing surface 21
opposed to an inner magnetic pole 25 of an iron core 24
and with a recessed surface 22 which is at a slightly
larger distance from the iron core 24 than the magnetic

1 pole facing surface 21 is (see Fig. 4). That is, on the
location facing the magnetic pole facing surface 21
and the recessed surface 22 of the armature 18 is
disposed the iron core 24 which includes the inner
5 magnetic pole 25 and an outer magnetic pole 26 annularly
formed to be concentric with the input shaft 10S.
The inner magnetic pole 25 and the outer magnetic pole
26 are integrally connected at the other side not
facing the armature 18. An annular coil 30 is incor-
10 porated within an annular groove 27 which is defined
by the inner magnetic pole 25 and the outer magnetic
pole 26.

As shown in Fig. 5, a through hole 24H for
extending the input shaft 10S is provided in the center
15 of the iron core 24, and in the vicinity of its outer
peripheral end portion are provided with pin holes 28
for extending the guide pins 17 and spring receiving
holes 29 for receiving braking springs 32. Referring
to Fig. 3, the iron core 24 is securely fixed by extending
20 the guide pins 17 through the pin holes 28 and screwing
nuts 31 onto the tips of the guide pins protruded out
of the holes. Referring to Fig. 1, each braking spring
32 which is a compression spring abuts against the
bottom portion of the spring receiving hole 29 at its
25 one end and also abuts against the outer peripheral
portion of the recessed surface 22 of the armature 18
at the other end, causing the armature 18 to be pressed
onto the lining 16. On the other hand, referring to

1 Fig. 2, each biasing spring 34 within the spring hole
20 of the outer peripheral portion of the armature 18,
which is also a compression spring, abuts against the
outer magnetic pole 26 of the iron core 24 at its one
5 end and abuts against the braking body 12 at the other
end so that the iron core 24 is pressed to be away from
the braking body 12. A reference numeral 33 denotes
each guide pin for guiding the biasing spring 34.

In the electromagnetic disc brake 11 according
10 to the present invention, the armature 18 is usually
pressed against the braking body 12 by the pressing
force of the braking springs 32. Thus, the disc 15 is
held and pressed between the braking body 12 and the
armature 18 through the lining 16. Consequently, the
15 input shaft 10S spline-coupled with the disc 15 will
be stopped from rotating. The cage 7 is stopped in
this state. Then, the inner magnetic pole 25 of the iron
core 24 is separated from the magnetic pole facing
surface 21 of the armature 18 with a slight gap, namely
20 the distance $\underline{g_0}$, and the outer magnetic pole 26 is
separated from the recessed surface 22 with a gap larger
than the slight distance $\underline{g_0}$, namely the distance $\underline{g}$.
The slight distance $\underline{g_0}$ is adjusted by screwing the nuts
31 on the ends of the guide pins 17, that is, the
25 slight distance $\underline{g_0}$ will become even smaller if the nuts
31 are screwed against the pressing direction of the
biasing springs 34, and on the contrary, the slight
distance $\underline{g_0}$ will become larger if the nuts 31 are

1 loosened along the pressing direction of the biasing
springs 34.

On the other hand, when the cage 7 is to be raised or lowered by energizing the coil 30, the
5 armature 18 is attracted toward the iron core 24, and the magnetic pole facing surface 21 of the armature 18 is brought into frictional contact with the inner magnetic pole 25, reducing the slight distance g_0 to zero. As a result, a gap with the same distance as the
10 moving distance of this armature is formed between the armature 18 and the lining 16, which makes the rotation of the disc 15 possible. Accordingly, referring to Fig. 6, the input shaft 10S driven by the electric motor 9 rotates the sheave 4 so that the cage 7 is raised
15 or lowered.

According to the above-described embodiment, by virtue of the recessed surface 22 provided on the armature 18 so as to face the outer magnetic pole 26, the effect of residual magnetism of the outer magnetic
20 pole 26 onto the recessed surface 22 is reduced when the coil 30 is disenergized, and the residual magnetism on the inner magnetic pole 25 which has been closely fitted to the armature 18 only takes effect. Also, owing to the braking springs 32 disposed on the outer
25 peripheral portion which is less affected by the residual magnetism, the armature 18 is easily detached from the iron core 24 by pushing the iron core 24 at a point away from the closely fitted portion, resulting

1 in the swift movement of the armature 18 toward the
lining 16 so as to brake the disc 15. Therefore, the
time can be reduced for the armature 18 to actually
start moving to brake the disc 15 after the command
5 of the disenergization of the coil 30. This is explained
with reference to Figs. 8 through 10. In these diagrams,
 S_1 shows a case where the distance between the outer
and inner magnetic poles of the iron core and the
armature is fixed, S_2 shows the case according to the
10 above-described embodiment where the distance between
the outer magnetic pole and the armature is larger
than the distance between the inner magnetic pole and
the armature, S_3 is a case where the relationship between
the iron core and the armature is the same as the case
15 S_1 while the electromagnetic attractive force itself
is determined lower, and S_4 is a case where the distance
between the inner magnetic pole and the armature is
larger than the distance between the outer magnetic
pole and the armature, the remaining parts of the con-
20 struction being common in all the cases.

First, referring to Fig. 8, the electromagnetic
attractive force at the predetermined distance g_0
deteriorates to some extent according as the distance
 g of the outer magnetic pole has been determined larger.
25 However, the attractive force at the time of attraction
is substantially the same with regard to any cases
except S_3 where the electromagnetic attractive force
itself has been determined lower. On the other hand,

1 the electromagnetic attractive force at the time of
attraction is larger at the outer magnetic pole than
at the inner magnetic pole, so that the electromagnetic
attractive force at the time of disenergization of the
5 coil will become such as illustrated in Fig. 9. The
effect of the electromagnetic attractive force is
reduced faster in the cases of S_2 and S_3 as compared
with the cases of S_1 and S_4 in relation to the effect
of the residual magnetism on the contact surfaces of
10 the iron core and the armature and the location of
application points of the braking springs. As a result,
the time for the brake to start braking will become
shorter in the cases of S_2 and S_3 as compared with t_1
and t_4 in the cases of S_1 and S_4 , as shown in Fig. 10.
15 That is, in those cases, the time period from the
braking command to the start of braking is shortened,
and this will be the best condition as a brake for
an elevator lifting apparatus in which safety is the
most important factor.

20 It should be noted that as far as the time
used for the start of braking is concerned, there is
not any difference between S_2 and S_3 , but that the
electromagnetic attractive force of S_3 at the time of
attraction (brake released time) at the predetermined
25 distance g_0 is remarkably weak, as is shown in Fig. 8,
so that it cannot be employed because of lack in
reliability with regard to the brake release.

Besides, according to the present invention,

1 an impact noise, which is caused by metallic members
such as the iron core 24 and the armature 18 when the
electromagnetic coil 30 is energized to attract the
armature 18 to itself, is heard only on the inner
5 magnetic pole 25. In addition, when the impact noise
is transmitted in the air through the braking device
to the outside, the noise is diminished while traveling
through the gaps of the above-described distances
(g_0 through g), incidentally contributing to diminishing
10 the operation noise of the braking device at the time
of attraction. Experiments show that the effect is
obtained to an extent of 3 to 5 dB (A).

According to the above-described embodiment,
the recessed surface 22 is formed on the armature 18
15 in the portion facing the outer magnetic pole 26 in
order to have a distance g larger. It is also preferable
to provide something of the same function as the recessed
surface 22 on the outer magnetic pole 26 of the iron
core 24. Figs. 11 through 13 show examples in each of
20 which the iron core 24 is treated, while the armature
18 has a plane surface facing the iron core 24. Referring
to Fig. 11, the outer magnetic pole 26 is less protruded
on the side facing the armature 18 as compared with the
inner magnetic pole 25 on the same side, enlarging the
25 distance g between the core 24 and the armature 18.
Fig. 12 shows that an additional member 35 is attached
to the portion where the iron core is less protruded,
and as to a material for the additional member 35, rubber

1 and the like can be used for diminishing the impact
noise caused by the armature 18 and itself, or lead
and the like can be used for magnetic screening. Fig.
13 shows that a large recessed portion 36 is formed on
5 the outer magnetic pole 26 to lessen the magnetic area
and saturate it with magnetism for causing magnetic
flux leakage, so that the effect of residual magnetic
flux will be decreased.

Further, as the time for starting the brake
10 operation after issuing the braking command is shortened,
the impact noise of the armature 18 against the lining
16 may cause uncomfortableness since calmness is
indispensable for an elevator lifting apparatus. In
that case, as shown in Fig. 14, a sound absorbing
15 member 37 can be interposed between the braking body
12 and the reduction gear box 10B, while the remaining
parts have an identical construction with the embodiment
shown in Figs. 1 to 7. As for a material for the sound
absorbing member 37, a shock absorbing material can
20 be employed, for example, a metallic material such as
a damping steel sheet or cast iron or a non-ferrous
material such as shock absorbing rubber. Having the
above-described structure, it is possible to diminish
the impact noise generated when the coil 30 is dis-
25 energized and the armature 18 presses the lining 16
against the braking body 12 by means of the braking
springs 32. This is effected by diminishing the resonance
sound caused when the impact transmitted through the

1 braking body 12 affects the reduction gear box 10B,
and as a result, the operation noise can be diminished
while the electromagnetic disc brake is at work.

It should be noted that the braking body 12
5 and the sound absorbing member 37 in the above embodiment
are made of different materials, but that the braking
body 12 and the sound absorbing member 37 can be
integrally formed by employing a shock absorbing material
such as cast iron.

10 Next, another embodiment in which the operation
noise is diminished will be explained hereinafter with
reference to Fig. 15.

In this case, the armature 18 is composed of
two layers. That is, the side facing the iron core 24
15 is furnished with a magnetic pole plate 39 which is made
of a material having high magnetic permeability such as
carbon steel, and the side contacted with the lining
16 is provided with a braking plate 38 which is made of
a material having both excellent abrasion resistance
20 and shock absorptivity such as cast iron. Both of these
members are securely fastened by fastener bolts 40.

The remaining parts are identical with the embodiments
shown in Fig. 11 and in Figs. 1 to 7. Owing to the
above construction, the impact noise or release opera-
25 tion noise is diminished, which noise is caused at
the time of braking operation of the electromagnetic
disc brake when the armature 18 composed of the magnetic
pole plate 39 and the braking plate 38 is released from

- 1 the iron core 24 to press the lining 16 against the
braking body 12, and at the same time, by virtue of
the high magnetic permeability of the magnetic pole
plate 39 which serves as a magnetic path of the coil
5 30, the capacity of the coil 30 can be reduced.

Fig. 16 is one embodiment which is provided
with the sound absorbing member 37 shown in Fig. 14
and the armature 18 constructed according to Fig. 15
while the remaining parts are identical with the embodi-
10 ment shown in Figs. 1 to 7.

CLAIMS:

1. An electromagnetic disc brake for an elevator
lifting apparatus, comprising a disc spline-coupled
5 with a rotational shaft; a braking body and an armature
disposed to clamp the disc; braking springs for urging
said armature against said disc; an iron core which
includes inner and outer magnetic poles each facing
said armature via a magnetic gap and concentrically
10 formed with respect to said rotational shaft; and an
electromagnetic coil which generates magnetic flux in a
magnetic path formed by said inner and outer magnetic
poles and said armature; wherein said braking springs
are disposed in the region of the outer magnetic pole,
15 and the magnetic gap between said outer magnetic pole
and said armature is larger than that between said
inner magnetic pole and said armature.
2. An electromagnetic disc brake according to
claim 1, wherein a face portion of said armature facing
20 said outer magnetic pole is recessed therefrom so as to
form said larger magnetic gap between said outer
magnetic pole and said armature.
3. An electromagnetic disc brake according to
claim 1, wherein the face of said outer magnetic pole
25 facing said armature is recessed therefrom so as to
form said larger magnetic gap between said outer



magnetic pole and said armature.

4. An electromagnetic disc brake according to claim 1, wherein a recessed portion is formed on the face of said outer magnetic pole facing said armature so as to form said larger magnetic gap between said outer magnetic pole and said armature.

5. An electromagnetic disc brake according to claim 1, wherein a magnetic screening member is mounted on the face of the outer magnetic pole facing said armature so as to form said larger magnetic gap between said outer magnetic pole and said armature.

6. An electromagnetic disc brake according to any one of the preceding claims wherein said inner and outer magnetic poles are each formed annularly.

7. An electromagnetic disc brake according to any one of the preceding claims wherein, said braking body is held on a stationary member of the lifting apparatus through a sound absorbing member.

8. An electromagnetic disc brake according to claim 7, wherein said sound absorbing member is made of a damping steel sheet.

9. An electromagnetic disc brake according to claim 7, wherein said sound absorbing member is made of cast iron.

10. An electromagnetic disc brake according to claim 7, wherein said sound absorbing member is made



of rubber.

11. An electromagnetic disc brake according to any one of the preceding claims wherein each side portion of said armature facing said inner or outer magnetic pole is made of a magnetic plate.

12. An electromagnetic disc brake according to claim 11, wherein said magnetic plate is made of cast iron.

13. An electromagnetic disc brake according to claim 11, wherein said magnetic plate is made of carbon steel.
