

## **Device for sealing a gap between cage door and cage wall in a lift cage**

The invention relates to a device for sealing a gap between cage door and cage wall of a lift cage according to the definition of the patent claims.

In high-speed lift cages the problem exists of sound insulation, because with increasing travel speed the travel and air noises produced in the shaft progressively increase, penetrate through every opening into the cage interior and thus reduce travel comfort. Usual sound insulations with insulating material fillings in double-walled walls and doors, as well as quietly operating ventilation systems, are capable of achieving, in conjunction with vibration damping devices, an appropriate effect. However, acoustic experiments show that the smallest openings admit a considerable amount of sound. With respect to a door this means that a door gap of at least one percent of the entire door opening cross-section lets through a third towards half the volume of sound, which is generated outside this door, to the other side, thus into the cage interior. In the case of an automatic cage door a number of such passages in the form of small gaps between moved and fixed parts is essential. These have to be present in order to avoid direct frictional contact. Such gaps are present at the following locations: between door threshold and lower door panel edges, laterally between door panel surface and entrance side posts, between two door panels in the case of telescopic doors and between entrance header and door panel upper part. The problem can be partly solved by working with tight tolerances and very precise production and assembly in order to reduce these gaps to a minimal dimension. This is an expensive method and not satisfactory in effect.

It is apparent from US Patent Specification No. 3 425 162 that this problem is not usually given any consideration and consequently these gaps are not sealed at all. In Figures 1 to 5 of this patent specification the large passages for sound are readily recognisable at the locations mentioned in the introduction.

Patent EP 0418510 relates to a device for door sealing relative to sound in the case of lift cages with automatic doors. These doors normally have small gaps between door post and door panel, header and door panel, inner door panel and outer door panel in the case of telescopic doors and between door panel underside and door threshold in order to avoid contact between moved and fixed parts during door movements. For sealing and covering these gaps there are present at the door panels, in the closed state of the door, vertical

post seals closing a gap, sliding header seals on the upper side of the door panel, threshold seals in the door threshold and vertical door edge seals at the front edges of the door panel. These seals close off all gaps in encircling manner when the door is closed and thus largely prevent penetration of sound from noises mechanically generated outside the cage.

A disadvantage of this known equipment resides in the substantial mechanical outlay and the large production costs connected therewith. A further disadvantage is the high expenditure on adjustment and maintenance operations.

The present invention now has the object of creating a device which does not have the stated disadvantages and substantially eliminates gaps between door and cage. In particular, there shall be created a sealing device with simple construction which operates independently of the door movement.

This object is fulfilled by the invention characterised in the claims.

According to the invention a device for sealing a gap between cage door and cage wall of a lift cage during cage travel comprises a sealing strip having at least one wall, which wall can be reversibly stretched in front of the gap.

The advantages achieved by the invention are substantially to be seen in that through stretching the wall the different gaps when the cage door is closed are no longer present or no longer have a disadvantageous effect and that a corresponding device can, if need be, still be subsequently installed. Advantageously, the sealing strip is activated only during travel and the wall is stretched in front of the gap.

Advantageously the sealing strip is a resilient hollow body, which hollow body can be loaded by compressed air and/or vacuum. The advantages achieved by this embodiment consist in that the seal is actively sealed only in the closed state, that it is free of contact during door movement, that it is in engagement only during travel (if need be, only from a specific speed) and that it thus has no influence on the door movement, the closing process or the locking of the door.

According to a second embodiment the sealing strip advantageously comprises iron strips and at least one electromagnetic, which is electrically activatable. The advantages achieved by this embodiment are to be seen in that due to the simple construction of the sealing device large savings in technical outlay are achieved and that due to the simple construction there is ensured a minimum susceptibility to fault. A further advantage consists in that due to the independence from the door motion a more rapid mode of operation of the sealing device is possible. A further advantage consists in that the effectiveness of the sealing device is substantially improved.

The invention resolves a long-standing prejudice of the expert world, according to which no additional components are to be arranged at the lift cage in order to save weight and costs. In this specific case, however, hollow bodies or electromagnets are arranged around the cage opening of a lift cage. Moreover, compressed air lines or vacuum lines are required. It has unexpectedly proved that these components are light and economic and enable a significant improvement in travel comfort and a noticeable simplification of the mechanical structures for sound insulation in lift cages.

The invention is explained in more detail in the following on the basis of two embodiments.

There:

Fig. 1 shows a lift entrance/exit with a pneumatic seal, illustrated in outline,

Fig. 2 shows a schematic cross-sectional view of a sealing strip operated by compressed air, in pressure-free and loaded state,

Fig. 3 shows a lift entrance/exit with an electromagnetic seal, illustrated in outline,

Fig. 4a shows a schematic cross-sectional view of a sealing strip operated by electromagnets, in the relieved state, and

Fig. 4b corresponds with Fig. 4a, but in the activated state.

In Figs. 1 to 4 a cage wall is denoted by 2, and a cage door by 3, of a lift cage 1. In Fig. 1 a sealing strip 4 made of resilient material is arranged around the cage opening. The

sealing strip consists of an upper part and a lower part (in the threshold), which have a cross-section illustrated in Fig. 2. In the embodiment according to Fig. 2 the sealing strip 4 consists of a hollow body 8 which has a first wall 41 and a second wall 42 and which stretches in balloon-like manner. The pressure necessary for stretching the hollow body 8 is generated by a pressure source 7 by way of a pressure container 6. The compressed air feed is carried out by way of, for example, the following four variants:

1. A compressor, with the advantage of rapid filling of the container and with the disadvantage of noise.
2. A mechanical pump, which is operated by the door movement, with the advantage of quiet running and that no additional motor or drive is necessary. The forces for the door drive / closing force limiter are used so that for each door movement only one pump volume for filling the pressure reservoir is available and the reservoir is filled only by way of door movements.
3. Utilisation of the pressure difference before and after the cage in the case of high-speed cages or underpressure between cage and shaft doors.
4. Double-acting piston, which is actuated by the acceleration forces during starting off and braking.

A second variant is illustrated in Fig. 1. The air compressed by the pressure source 7 passes into the pressure reservoir 6.

The hollow body 8 shown in Fig. 2 is dimensioned in such a manner in the pressure-free state that a spacing, which is necessary for free opening and closing of the cage doors, from the cage wall 2 is ensured. The compressed air 5 flowing by way of an opening, which is not illustrated, into the hollow body 8 during lift travel expands the resilient hollow body 8 according to Fig. 2 in balloon-like manner so that it is pressed against the cage door 3 and in that case seals off the gap 11 between the cage door 3 and the cage wall 2 in pressure-tight and noise-tight manner.

When the lift cage 1 stops at the stopping point the hollow body 8 is relieved. The resilience to which the material of the hollow body 8 is subject then returns this to the initial

shape according to Fig. 2. The gap between cage door and cage wall is thereby present again, which makes possible a faultless and contact-free motion of the door panel during door opening and closing.

As soon as the lift cage 1 is moved into the stopping point, the lift control electromagnetically brings the directional valves from a first setting, which loads the sealing strip 4 with the feed pressure, to a second setting, which relieves the sealing strip 4. The lift control releases the door opening and closing of the lift cage 1 at the stopping point only when all pressure switches report completion of the relief.

In a further embodiment, instead of relief to the atmosphere the sealing strip 4 can be evacuated. In this case the outlet opening of the directional valves is to be connected with the suction duct of a vacuum source. The evacuation produces a more rapid departure readiness of the sealing strip 4.

A further advantageous embodiment of the invention is explained in Fig. 3, wherein the sealing strip 4 is operated not pneumatically by compressed air, but electromagnetically by an electromagnet 9.

In this embodiment the flexible sealing strip 4 is arranged not at the cage wall 2, but at the cage door 3. Additional iron strips 10 are embedded in the sealing strip 4 and interact with the rod-shaped electromagnet 9 arranged in the cage door frame when the cage doors 3 are closed.

When the cage doors 3 are closed on movement away of the lift cage 1, the electromagnet 9 is activated by an electrical voltage so that attractive electromagnetic forces arise between the electromagnet 9 and the iron strips 10. The sealing strip 4 is thereby drawn into sealing closure against the cage wall 2. Fig. 4b shows the sealing strip 4 in the activated setting when a voltage is applied to the electromagnet 9, the cage doors 3 are closed and the lift cage moves. Fig. 4a shows the sealing strip 4 in the deactivated setting when no voltage is applied to the electromagnet 9 and the cage doors 3 are closed or open whilst the lift cage stands at the storey stop.

The rod-shaped electromagnetic can be replaced by several punctiform electromagnets. Due to the iron rod in the sealing strip 4 the sealing strip 4 will bear tightly with sufficient

stiffness over the entire length. The electromagnetic 9 can also be seated in the doors and the sealing strip in the cage wall. The control of the electromagnet is advantageously carried out by way of the door control.

With knowledge of the present invention numerous possibilities of variation of the illustrated embodiments are available to the expert. Thus, for example, it is also possible to use a piezoelement instead of electromagnet in order to electrically operate the sealing strip.

## Claims

1. Device for sealing a gap (11) between a cage door (3) and a cage wall (2) of a lift cage (1) during cage travel, comprising a sealing strip (4), characterised in that the sealing strip (4) has at least one wall (41, 42), which wall (41, 42) can be reversibly stretched in front of the gap (11).
2. Device according to claim 1, characterised in that the sealing strip (4) is a resilient hollow body (8), which hollow body (8) can be loaded by compressed air (5) and/or vacuum.
3. Device according to claim 1, characterised in that the sealing strip (4) comprises iron strips (10) and/or at least one electromagnetic (9), which iron strips (10) and electromagnet (9) are activatable.
4. Device according to claim 1, characterised in that iron strips (10) are embedded in the sealing strip (4) and at least one electromagnetic (9) is arranged in a cage door frame.
5. Method of sealing a gap (11) between a cage door (3) and the cage wall (2) of a lift cage (1) by a sealing strip (4) during cage travel, characterised in that the sealing strip (4) has at least one wall (41, 42), which wall (41, 42) is stretched in front of the gap (11).
6. Method according to claim 5, characterised in that the sealing strip (4) is pneumatically loaded by compressed air (5) and/or vacuum.
7. Method according to claim 5, characterised in that the sealing strip (4) is magnetically activated by at least one electromagnet (9) and/or iron strips (10).
8. Lift with device according to claims 1 to 4.