(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 495 302 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.06.2019 Bulletin 2019/24

(51) Int Cl.:
B66B 5/00 *(2006.01)*

(21) Application number: **17206184.8**

(22) Date of filing: **08.12.2017**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD TN

(71) Applicant: **KONE Corporation**
00330 Helsinki (FI)

(72) Inventors:
- **Calcagno, Alessio**
  00330 Helsinki (FI)
- **Jokinen, Risto**
  00330 Helsinki (FI)
- **Kauppinen, Tuukka**
  00330 Helsinki (FI)
- **Stolt, Lauri**
  00330 Helsinki (FI)

(74) Representative: **Kolster Oy Ab**
(Salmisaarenaukio 1)
P.O. Box 204
00181 Helsinki (FI)

(54) ELEVATOR APPARATUS AND METHOD

(57) The invention relates to an elevator apparatus (1), comprising: a drive unit (3), at least a first and a second brake (11, 12), and a control arrangement (10) controlling operation of the hoisting machine (2) and the at least first and second brake (11, 12). In order to test the brakes, the the control arrangement (10) is configured to test operation of the at least the first and second brake (11, 12) in turns during normal operation runs of the elevator car by triggering only one (11) of the at least first and second brakes (11, 12) to brake, decreasing a force (F) provided from the drive unit (3), monitoring movement of the elevator car (4), and triggering an indication of a failed brake (11) in case movement of the elevator car (4) is detected while the triggered brake (11) brakes.

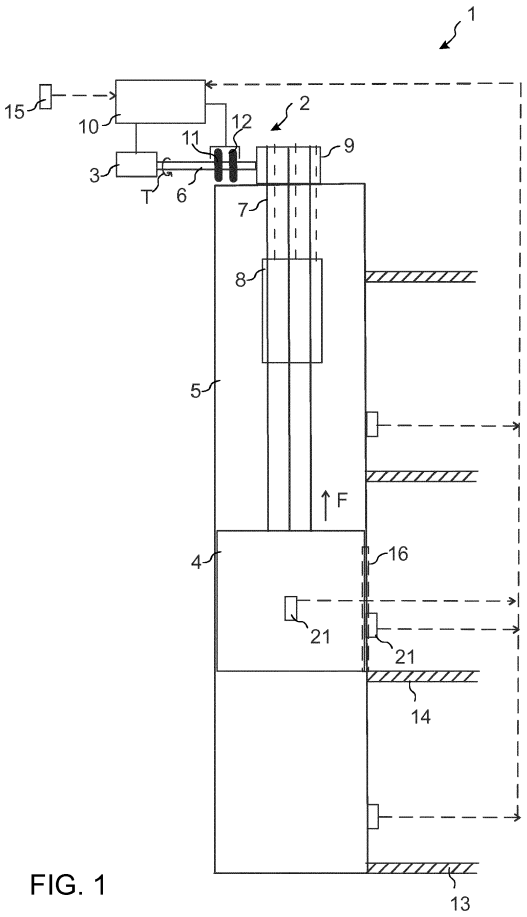

FIG. 1

EP 3 495 302 A1

Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] This invention relates to an elevator apparatus and more particular to a solution for ensuring that brakes of the elevator apparatus remain in a working condition.

DESCRIPTION OF PRIOR ART

[0002] Previously there is known an elevator apparatus with a first and second brake arranged to brake an elevator car. The brakes are dimensioned to stop and hold an elevator car with a predetermined load (such as 25% overload) at standstill in the elevator shaft. These brakes prevent the elevator car from unintentionally moving in the elevator shaft. Therefore it is necessary to ensure that the brakes are operating correctly, which requires testing.

[0003] Testing brakes needs to be carried out in a way which does not disturb persons utilizing the elevator car for normal operation runs between different floors of a building. To avoid this, a common approach is that service personnel utilizes the elevator car for separate test runs carried out without having persons onboard the elevator car during the test.

[0004] A drawback with such a solution is, however, that separate test runs need to be regularly carried out which causes costs due to a need to have maintenance personnel involved, and which also reduces the time that the elevator car is available for normal operation elevator car runs. Additionally, such brake tests with an empty elevator car have the drawback that different load conditions are not tested.

SUMMARY OF THE INVENTION

[0005] An object of the present invention is to solve the above mentioned drawback and to provide a solution which simplifies testing of brakes in an elevator apparatus. This object is achieved with an elevator apparatus according to independent claim 1 and with a method according to independent claim 8.

[0006] When testing of the brakes in an elevator apparatus is carried out during normal operation elevator car runs in such a way that braking of the elevator car is carried out with only one of the available brakes, and when indication of a failed brake is triggered in case the elevator car moves while the triggered brake brakes, it becomes possible to carry out the testing during normal operation of the elevator and without involving service personnel.

[0007] Preferred embodiments of the invention are disclosed in the dependent claims.

BRIEF DESCRIPTION OF DRAWINGS

[0008] In the following the present invention will be described in closer detail by way of example and with reference to the attached drawings, in which

Figure 1 illustrates an elevator apparatus, and
Figure 2 illustrates a method for testing the elevator apparatus of Figure 1.

DESCRIPTION OF AT LEAST ONE EMBODIMENT

[0009] Figure 1 illustrates an elevator apparatus 1 with a hoisting machine 2 including a sheave 9 and a drive unit 3, such as an electric motor, arranged to drive an elevator car 4 in an elevator shaft 5. Figure 1 has by way of example been simplified to show that the drive unit 3 is directly with a shaft 6 connected to a sheave 9 (or sheaves) of the hoisting machine 2 around which the rope 7 (or ropes) runs which is used for moving the elevator car 4 and the counter weight 8 in the elevator shaft. However, instead of connecting the drive unit 3 directly with a shaft 6 to the sheave 9, it is possible to provide a gear between the drive unit and sheave, for instance.

[0010] The elevator apparatus 1 is also provided with a control arrangement 10 which controls the operation of the hoisting machine 2. The control arrangement may be implemented with circuits or a combination of circuits and a computer program, for instance. The control arrangement 10 additionally controls a first brake 11 and a second brake 12, which by way of example are arranged to brake the shaft 6 in order to stop and hold the elevator car 4 at standstill in the elevator shaft 5. It is, however, possible to utilize other types of brakes than the illustrated hoisting machine brakes, in which case the brakes may be located in another part of the elevator apparatus than illustrated in Figure 1.

[0011] The elevator apparatus 1 is provided with electromechanical hoisting machinery brakes 11 and 12 as safety devices to apply braking force to the traction sheave 9 via the rotating shaft 6 of the hoisting machine to brake movement of the hoisting machine and therefore the elevator car 4. There are normally two separate brakes, as illustrated in the figures. The brakes 11 and 12 have to be dimensioned to stop and hold an elevator car with 125% load (25% overload) at standstill in the elevator shaft 5. Additionally, the brakes 11 and 12 are also used in rescue situations and also in emergency braking situations to stop the elevator car 4 if an operational fault occurs, like in an overspeed situation of the elevator car. Further, they are used to protect elevator passengers from unintended car movement at the landing and to provide a safe operating environment for a servicemen who needs to enter to the inside the elevator shaft 5. Therefore it is necessary to ensure that the brakes are operating correctly.

[0012] In the illustrated example the control arrangement 10 is configured to test operation of the at least one

of the first 11 and second 12 brakes during a normal operation run of the elevator car 4. In this context a "normal" operation run refers to a situation where the elevator car is available for ordinary passengers having a need to travel from one floor 13 of a building to another floor 14. Consequently, the tests may be carried out with passengers onboard while the elevator apparatus is in the normal operation mode and it is not necessary to set the elevator apparatus into a test mode, which is the case while maintenance personnel is at the installation site and carry out work with the elevator apparatus and have a need to temporarily take control of the elevator apparatus via a specific operator panel 15 in order to drive the elevator car in a test mode, for instance.

[0013] In order to test the brakes during a normal operation run, the control arrangement 10 triggers only one of the at least first 11 and second brake 12 to brake when the elevator car 4 due to adjustment of the force F from the drive unit 3 has slowed down and arrived to a door 16 at a floor 14 in the elevator shaft 5. At this stage, the elevator car 4 starts to open the door of the elevator car and the landing door 16 to release passengers from the elevator car.

[0014] In the following it will by way of example be assumed that it is specifically the first brake 11 that is tested. In praxis, however, the brakes are preferably continuously tested in turns during different elevator runs with predetermined intervals such that the condition of each brake is regularly checked.

[0015] In the example, once the first brake 11 (which is being tested) has been triggered to brake and a sufficient time for the first brake to engage has passed, the control arrangement 10 decreases the force F provided from the drive unit 3 to the elevator car 4. This decrease in the force F may be achieved by reducing the torque T of the drive unit 3.

[0016] The requirement is that if the first brake 11 is in order, it will alone be able to keep the elevator car 4 standstill in the elevator shaft 5 also then the drive unit 3 no longer provides any force to the elevator car via the rope 7. Consequently, when the force F is decreased, the control arrangement starts to monitor movement of the elevator car 4. This monitoring may be implemented by monitoring the (rotation) speed of the drive unit 3 (such as electric motor), for instance. In case the control arrangement 10 detects that the elevator car 4 moves, it triggers indication of a failed brake. At that stage, the control arrangement 10 triggers braking with also the second brake 12 and also increases the force F provided from the drive unit 3 to the elevator car 4 in order to stop movement of the elevator car as soon as possible.

[0017] Once indication of a failed brake has been triggered, the control arrangement 10 stores in a memory information about the failed brake test. The control arrangement may also send information about the failed brake to a remote service center (where the memory may be located) via a remote connection. Eventually, once a predetermined number of failed tests have been triggered for the same brake, the control arrangement may prevent further normal operation runs with the elevator car 4 in question until a predetermined control command is received. A maintenance person who has arrived to the location and has carried out appropriate service to the failed brake may pass the predetermined control command to the control arrangement 10 via the operator panel 15, for instance. The predetermined number of failed tests needed to prevent further operation of the elevator car may vary case by case. One alternative is that if indication of a failure for the same brake is triggered in three consecutive tests, then further operation of the elevator car is prevented.

[0018] In an embodiment, information about prevention of further operation of the elevator is stored in a non-volatile memory, and further operation of the elevator is prevented based on the information stored in the non-volatile memory.

[0019] However, in case the control arrangement 10 does not detect any movement of the elevator car 4 while the triggered first brake brakes and the drive unit 3 no longer provides any force to the elevator car via the rope 7, the control arrangement determines that the tested first brake is in good working condition. The test result is preferably stored in a memory. Additionally, the test may be ended such that braking continues with both brakes, until it eventually is time for a new test of one of the brakes.

[0020] Figure 2 illustrates a method for testing the elevator apparatus of Figure 1, for instance.

[0021] Line 17 in Figure 2 illustrates the measured motor speed of the drive unit 3 (such as electric motor) and Line 18 illustrates the torque provided by the drive unit 3 at different moments (T0 - T4) of time. The force F provided from the drive unit 3 to the elevator car 4 is dependent on the torque. Additionally, Figure 2 illustrates the status of the first brake 11 with line 19 and the status of the second brake 12 with line 20.

[0022] When the control arrangement 10 of the elevator apparatus 1 determines that it is time to test the first brake 11 and an elevator call is received via a user interface 21 of the elevator apparatus at a door 16 of the elevator shaft 5 or from the inside of the elevator car 4, a normal operation elevator car run is initiated. At this stage the elevator is moved from the first floor 13 with a normal motor speed 17 by means of a normal drive unit torque, as illustrated to the left in Figure 2. At this stage the first brake 11 (line 19) and second brake 12 (line 20) are maintained in a non-engaged position where neither of them brakes.

[0023] At moment T0 the elevator car is approaching the door zone of the landing at floor 14. At this stage the drive unit speed (line 17) and the torque (line 18) is reduced. At moment T1 the elevator has reached the correct level of floor 14, due to which movement of the elevator is stopped with the drive unit such that the drive unit speed (line 17) reaches zero. The opening of the door of the elevator car and of the door 16 in the elevator shaft 5 is initiated. Additionally, the braking with only the

first brake 11 is triggered.

[0024] In praxis there is a significant delay D1 from the moment when the first brake 11 is triggered to brake until this brake actually brakes at moment T2. One reason for such a delay is the inductive energy of an electromagnet in an electromechanical brake. When the brake is triggered to brake, current supply to the coil is first interrupted. The brake engages after the coil current has decreased under a certain value. Because of high inductance of the brake coil, decreasing of the current / applying of the brake requires several hundreds of milliseconds (such as 300 ms) depending on the brake type.

[0025] Once the delay D1 has passed and it can be assumed that the first brake actually is engaged and brakes, the control arrangement 10 decreases the force F provided from the drive unit 3 to the elevator car 4. This is seen in Figure 2 as a rampdown of the drive unit 3 torque (line 18) starting from moment T2. At this stage monitoring of movements of the elevator car is initiated.

[0026] In the illustrated example it is shown that the speed of the drive unit 3 (line 17) increases from moment T2 onwards. Consequently the control arrangement 10 detects movement of the elevator car 4 and triggers indication of a failed brake.

[0027] Immediately when malfunction of the first brake 11 is detected, the control arrangement triggers at moment T3 braking also with the second brake 12. Additionally, the drive unit torque (line 18) is increased such that the force F provided from the drive unit 3 to the elevator car is increased. In this way the elevator car remains still. After the delay D2 the second brake 12 is engaged and a rampdown of the drive unit 3 torque (line 18) is again started from moment T4.

[0028] It is to be understood that the above description and the accompanying figures are only intended to illustrate the present invention. It will be obvious to a person skilled in the art that the invention can be varied and modified without departing from the scope of the invention.

Claims

1. An elevator apparatus (1), comprising:

a hoisting machine (2) with a drive unit (3) driving an elevator car (4) in an elevator shaft (5),
at least a first and a second brake (11, 12) dimensioned to stop and hold the elevator car (4) at standstill in the elevator shaft (5), and
a control arrangement (10) controlling operation of the hoisting machine (2) and the at least first and second brake (11, 12), **characterized in that**
the control arrangement (10) is configured to test operation of the at least the first and second brake (11, 12) in turns during normal operation runs of the elevator car by:
triggering only one (11) of the at least first and second brakes (11, 12) to brake when the elevator car (4) has slowed down and arrived to a door (16) in the elevator shaft (5),
decreasing a force (F) provided from the drive unit (3) to the elevator car (4),
monitoring movement of the elevator car (4), and
triggering an indication of a failed brake (11) in case movement of the elevator car (4) is detected while the triggered brake (11) brakes.

2. The elevator apparatus according to claim 1, wherein the control arrangement (10) is configured to prevent further normal operation runs of the elevator car (4) after an indication of a failed test has been triggered for the same brake during a predetermined number of tests until a predetermined control command is received via a service interface (15) of the elevator apparatus (1).

3. The elevator apparatus according to one of claims 1 to 2, wherein the control arrangement (10) is configured to trigger also the other one (12) of the at least first and second brakes (11, 12) to brake and to increase the force (F) provided from the drive unit (3) to the elevator car (4) in case movement of the elevator car is detected during said monitoring.

4. The elevator apparatus according to one of claims 1 to 3, wherein the control arrangement (10) is configured to decrease the force (F) provided by the drive unit by decreasing the torque (T) provided by the drive unit (3).

5. The elevator apparatus according to one of claims 1 to 4, wherein one or more of the at least first and second brake (11, 12) is a hoisting machine (2) brake.

6. The elevator apparatus according to one of claims 1 to 5, wherein the control arrangement (10) is configured to test each one of the at least first and second brakes (11, 12) in turns during different normal operation elevator car runs.

7. The elevator apparatus according to claim 3, wherein the control arrangement is configured to decrease a force (F) provided from the drive unit (3) to the elevator car (4), when the other one (12) of the at least first and second brakes (11, 12) has been engaged to brake the hoisting machine or elevator car.

8. A method for testing an elevator apparatus, **characterized in that** the method comprises:

initiating a normal operation elevator car run in response to an elevator call received via a user interface (21) of the elevator apparatus (1),
triggering braking with only one (11) of at least a first and a second brakes (11, 12) when the elevator car (4) has slowed down and arrived to a door (16) in the elevator shaft (5),
decreasing a force (F) provided from the drive unit (3) to the elevator car (4),
monitoring movement of the elevator car (3), and
triggering an indication of a failed brake in case movement of the elevator car occurs while the triggered brake (11) brakes.

9. The method according to claim 7, wherein the method comprises:

braking with also the other one (12) of the at least first and second brake (11, 12) and increasing the force (F) provided from the drive unit to the elevator car (4) when movement of the elevator car occurs during braking with the triggered brake.

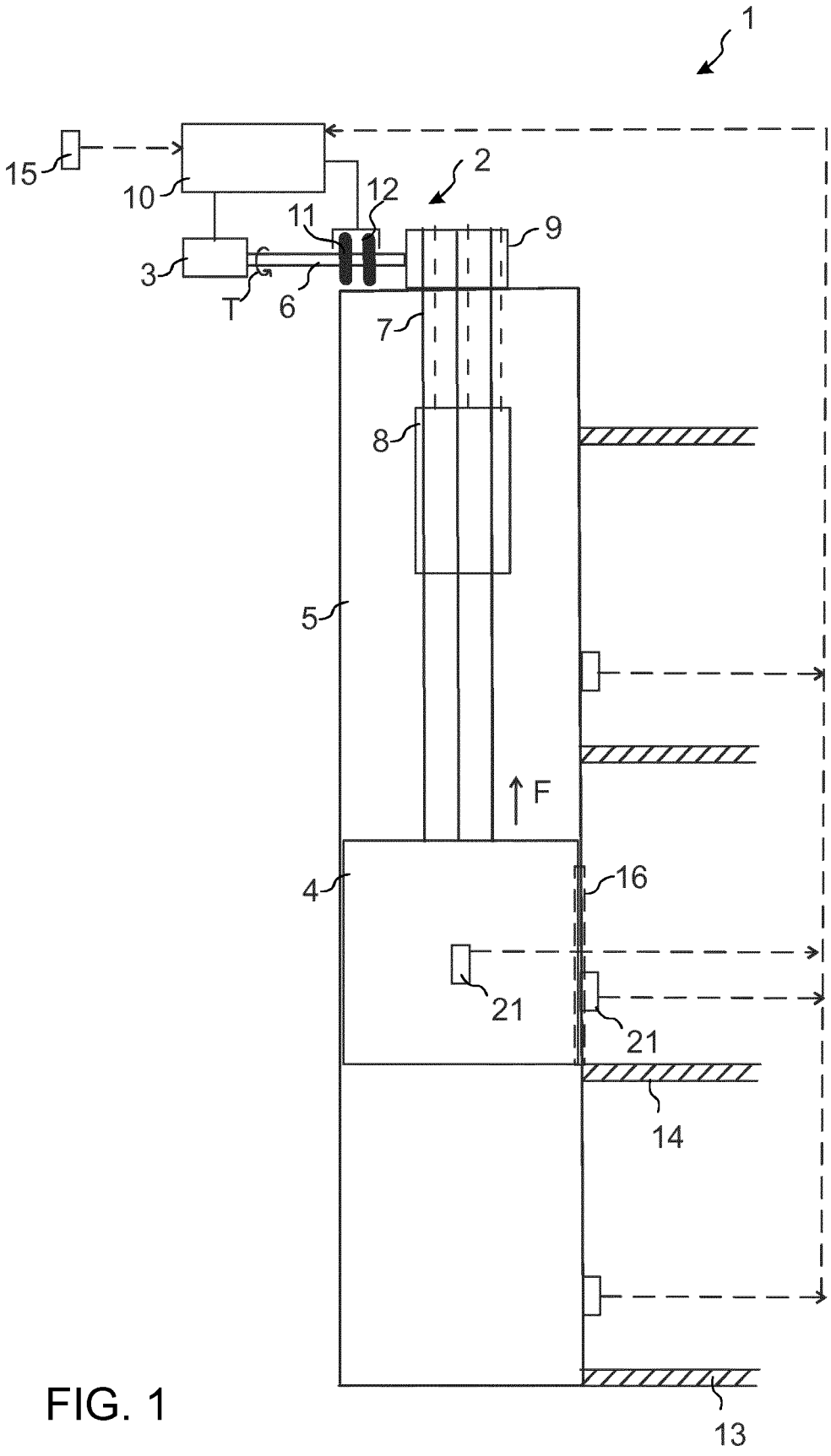

FIG. 1

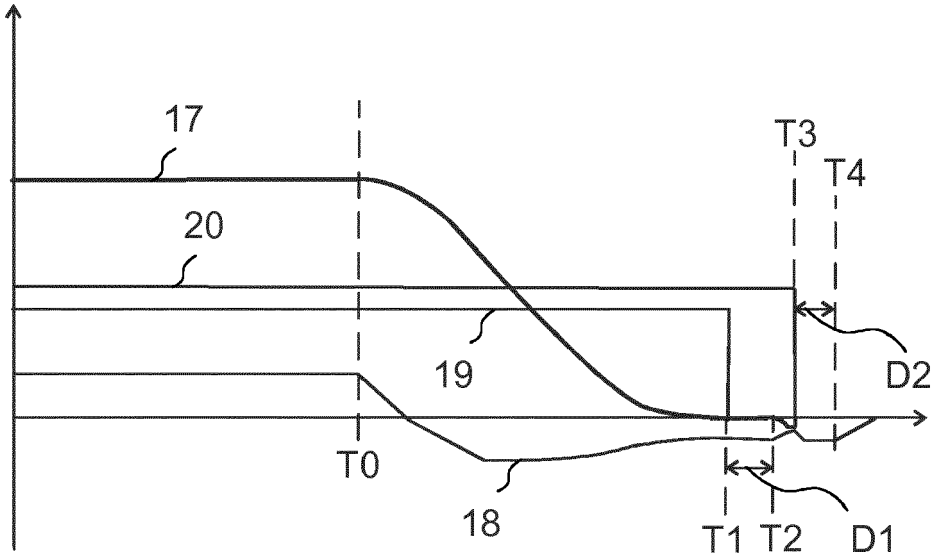

FIG. 2

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 17 20 6184

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2007/020325 A2 (KONE CORP [FI]; OESTERMAN JARI [FI]; SUUR-ASKOLA SEPPO [FI]; MYLLYNEN) 22 February 2007 (2007-02-22)	1,2,4-6, 8	INV. B66B5/00
A	* abstract * * page 3, line 12 - page 12, line 30 * * claims 1-8 * * figure 1 *	3,7,9	
A	EP 3 138 801 A1 (KONE CORP [FI]) 8 March 2017 (2017-03-08) * abstract * * paragraph [0011] - paragraph [0023] * * figures 1-3 *	1-9	

TECHNICAL FIELDS SEARCHED (IPC)
B66B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	29 May 2018	Dijoux, Adrien

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 20 6184

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

29-05-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2007020325 A2	22-02-2007	CN 101243000 A	13-08-2008
		EP 1915311 A2	30-04-2008
		EP 2266910 A1	29-12-2010
		ES 2353331 T3	01-03-2011
		ES 2377293 T3	26-03-2012
		FI 20050840 A	20-02-2007
		HK 1122544 A1	16-08-2013
		JP 5496508 B2	21-05-2014
		JP 2009504538 A	05-02-2009
		US 2008185231 A1	07-08-2008
		WO 2007020325 A2	22-02-2007
EP 3138801 A1	08-03-2017	CN 106495047 A	15-03-2017
		EP 3138801 A1	08-03-2017
		US 2017067943 A1	09-03-2017

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82