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

(11) EP 3 974 367 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
30.03.2022 Bulletin 2022/13

(21) Application number: **20198412.7**

(22) Date of filing: **25.09.2020**

(51) International Patent Classification (IPC):
B66B 1/34 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B66B 1/3407; B66B 1/3476

(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:
KH MA MD TN

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

(72) Inventors:
- **Kattainen, Ari**
  00330 Helsinki (FI)
- **Aitamurto, Juha-Matti**
  00330 Helsinki (FI)

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

Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) **METHOD OF CALIBRARING A LOAD WEIGHING DEVICE OF AN ELEVATOR SYSTEM AND ELEVATOR SYSTEM**

(57) The invention relates to an elevator system including a calibration unit (14) receiving car-load information provided from a load weighting device (11, 12), information indicating a position of an elevator car (3), and motor-load information from an elevator drive unit (4, 17). The calibration unit (14) calculates calibration data for the car-load information after launch of a first-elevator run, based on a difference between the car-load information obtained before the first-elevator run and the motor-load information obtained during launch of the first elevator run, and by taking into account an unbalance and an uncompensation at the position of the launch of the first elevator run. The elevator system (1) utilizines the calculated calibration data to correct the car-load information obtained from the load weighting device (11, 12) in connection with subsequent elevator runs.

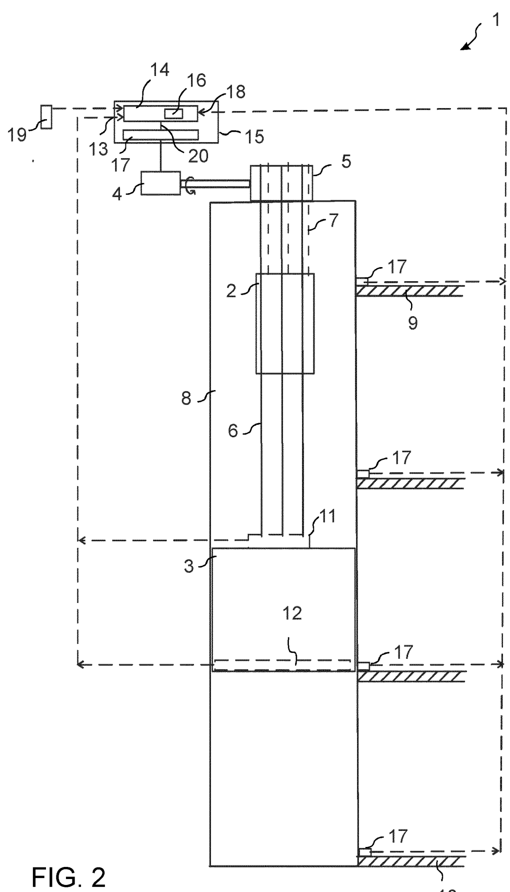

FIG. 2

EP 3 974 367 A1

Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] This invention relates to a solution for operating an elevator system in a safe and efficient way. More particularly, the solution makes it possible to obtain correct information about the status of the elevator system while it is being operated.

DESCRIPTION OF PRIOR ART

[0002] In order to operate an elevator in a safe and efficient way, information is needed about the load of the operated elevator car. This information is needed to ensure smooth movement, but it is also essential for safety. Elevator brakes are dimensioned for a specific full load rating, which should not be exceeded for safety reasons and for the comfort of the passengers. Additionally, elevator systems are utilizing solutions for automatic monitoring and testing of brakes. In order to obtain reliable data from this monitoring and testing it is important to know what the actual load is during the testing of brakes.

[0003] In order to obtain information about the current load, elevator systems are provided with load weighing devices (LWD) to measure the elevator car-load. The car-load information is provided to an elevator control unit, which is provided with a user interface having manual potentiometers or other means facilitating, that service personnel may calibrate the car-load measurement result manually at different elevator-car positions and with different loads. This requires, that different reference weights are loaded to the elevator car in turns, in order to obtain required measurement results for different loads at different positions.

[0004] A drawback with the previously known solution is that it is very laborious and time-consuming, in particular as the calibration occasionally needs to be repeated. This may become necessary in case modifications are done to the elevator car, to the counterweight or to the ropes of the elevator system, for instance.

SUMMARY OF THE INVENTION

[0005] An object of the present invention is to solve the above-mentioned drawback and to provide a simple and efficient solution for obtaining correct information about the status of an elevator system. This object is obtained with a method according to independent claim 1 and an elevator system according to independent claim 5, where calibration data for the car-load information is calculated based on motor-load information by taking into account the unbalance and uncompensation at the position.

[0006] Preferred embodiments of the invention are disclosed in the dependent claims.

BRIEF DESCRIPTION OF DRAWINGS

[0007] 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 is a flow diagram of a method for operating an elevator system, and

Figure 2 illustrates an elevator system.

DESCRIPTION OF AT LEAST ONE EMBODIMENT

[0008] Figure 1 illustrates a method for operating an elevator system which is suitable for use in the elevator system 1 illustrated in Figure 2, for instance.

[0009] In step A the unbalance between the weight of an elevator counterweight 2 and the weight of an empty elevator car 3 is determined. This can be done by measuring motor 4 current, in other words motor-load, during up and down test runs of the empty elevator 3 car before launching said first elevator run (for transportation use) and by storing the determined unbalance information into a memory 16 of the elevator system 1. In praxis the unbalance may be determined for the first time when the elevator system in question is taken into use after installation. If needed, the measurements can be later repeated.

[0010] A solution for determining unbalance of an elevator system is previously known and disclosed in US2019330016A1, especially in equation 1.4. (referred to as elevator system balance m_b therein). Step A can be implemented by utilizing such a solution, for instance.

[0011] In step B the uncompensation of the elevator system masses at different positions of the elevator shaft is determined. Also this step can be done before launching a first elevator run (for transportation use) after installation of the elevator system, at which stage the unbalance information is stored into a memory of the elevator system, such as into a memory 16 of a calibration unit 14.

[0012] The uncompensation of the elevator system depends on the weight difference of hosting ropes 6, 7 hanging on different sides of a traction sheave 5, for instance. When the elevator car 3 and the counterweight 2 move between different positions in the elevator shaft 8, such as between different floors 9 and 10, the uncompensation changes. Consequently, the uncompensation is different when the elevator is at different positions.

[0013] In step B the uncompensation can be determined from US2019330016A1 equation 3.2. (referred to as compensation error ΔB therein). Alternatively or additionally, the measurements may be carried out at at least two different positions with the load weighting device 11 or with other suitable measuring means, such as by means of the motor-load information while holding the elevator car standstill at the positions 9 and 10 during measurement, it is assumed that the uncompensation varies linearly between these positions. This makes it possible to calculate the uncompensation at any point between these positions 9 and 10 by taking into account the distance between these points.

[0014] In some elevator systems so called compensation ropes have been mounted below the elevator car and counterweight to reduce the uncompensation. In case such compensation ropes are in use, it may be sufficient in step B to determine this and that the uncompensation is zero or so small that it can be neglected.

[0015] In step C car-load information is obtained from the load weighting device before launching the first elevator run (for transportation use). In the illustrated example, two different locations of load weighting devices are illustrated by way of example, though in praxis it is sufficient to utilize only one load weighting device for an elevator car. The weighting device 11 is a load cell connected to a rope hitch of elevator hoisting ropes 6, while the second alternative illustrated position for a load weighting device 12 is in connection with the elevator car 3 floor, which may be suspended by springs, for instance, such that it becomes possible to measure the load on the elevator floor. The car-load information may be obtained from the load weighting device 11 or 12 to an input 13 of a calibration unit 14 included in an elevator control 15.

[0016] In step D a check may be performed to ensure that the car-load is below an overload threshold value. This check may be carried out by the elevator control 15. In case the car-load is not below the overload threshold value, a launch of an elevator run may be prevented.

[0017] Elevator systems are manufactured with a rated load and operation of the elevator system should not be allowed in case the car-load is too big. Consequently, the elevator control may maintain in a memory 16 an overload threshold value, which is compared to the obtained car-load information to determine if launch of the elevator run is allowed. In some cases, it may be preferable to set the overload threshold value slightly above the rated load of the elevator system. One alternative is to set the overload threshold value to be 110% of the rated load of the elevator system. In some alternative cases the overload threshold value is set just higher that the rated load but less that the 110 % limit.

[0018] In step E the first elevator run (for transportation use) is launched. At this stage in step F motor-load information is obtained an elevator drive unit 17 based on realized motor current during launch of the first elevator run. The elevator drive unit 17 may be a part of the elevator control 15 and it may include a frequency controller for controlling the electric motor 4 of the elevator system, for instance. One alternative is that, after launch of the first elevator run, the elevator car is kept standstill at the launch position with torque from the elevator drive unit 4, 17. Especially in modern vector-controlled drives, said holding torque is consistent with the motor current. This is in particular the case with synchronous permanent magnet motors.

[0019] In step G calibration data is calculated for the car-load information based on a difference between the car-load information and the motor-load information.

[0020] In order to improve the accuracy of the needed calibration, the determined unbalance and also the uncompensation at the position of the launch of the first elevator run have been taken into account. A highly accurate second value for car load information will be established by substracting these known factors of unbalance and uncompensation from the motor-load information, which second value for car load information may then be used as a reference for the car-load information in generating the calibration data.

[0021] For this purpose the elevator system is provided with one or more position sensors 17 providing an input 18 of the calibration unit 14 with an indication of the position of the elevator car 3. Naturally, the location or type of the position sensor or sensors may vary depending on the implementation.

[0022] In step H the calculated calibration data is utilized to correct car-load information from the load weighting device 11, 12 in connection with subsequent runs, preferably during normal elevator operation. Consequently, an inaccuracy regarding the weight of the loaded elevator car can be minimized and eliminated, which makes the elevator run more comfortable for the user, improves the safety of the brakes during use and also makes automatic testing of the brakes more reliable.

[0023] The illustrated calibration unit may be configured to automatically repeat calculation of the calibration data for the car-load information and take into use the new calculated calibration data. Such calculations may be carried out for each run, or periodically according to a predefined schedule, for instance. Alternatively, the elevator system may be provided with a user interface 19 connected to the elevator control 15 such that maintenance personnel can provide a control command via the user interface 19 to control the calibration unit to repeat the calculation of the calibration data.

[0024] 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. A method of operating an elevator system (1), **characterized in that** the method comprises:

(A) determining an unbalance between an elevator counterweight (2) and an empty elevator car (3),

(B) determining uncompensation of the elevator system masses at different positions (9, 10) of the elevator shaft (8),

(C) obtaining car-load information from a load weighting device (11, 12) before launching a first elevator run,

(F) obtaining motor-load information from an elevator drive unit (4,17) based on realized motor current during launch of the first elevator run, and

(G) calculating calibration data for the car-load information based on a difference between the car-load information and motor-load information by taking into account said determined unbalance and the uncompensation at the position of the launch of the first elevator run, and

(H) utilizing the calculated calibration data in the elevator system (1) to correct the car-load information obtained from the load weighting device (11, 12) in connection with subsequent elevator runs.

2. The method according to claim 1, wherein the motor-load information is obtained by keeping the elevator car (3) standstill at the launch position of the first elevator run with torque from the elevator drive unit (4, 17).

3. The method according to clam 1 or 2, wherein the motor-load is determined based on the motor current.

4. The method according to one of claims 1 to 3, wherein the unbalance is determined by measuring motor-load during up and down test runs of an empty elevator car (3) before launching said first elevator run.

5. The method according to one of claims 1 to 4, wherein the uncompensation is determined by measuring the unbalance at least at two different elevator car positions (9, 10), and by assuming that the unbalance changes linearly between said two different elevator positions (9, 10).

6. The method according to one of claims 1 to 5, wherein
maintaining in a memory (16) an overload threshold value,

(D) the car-load information is compared to the overload threshold value, and
launch of elevator runs are prevented when the car-load information indicates a car-load that exceeds the overload threshold value.

7. The method according to claim 6, wherein the overload threshold value is selected to be 110% of a rated load of the elevator system (1).

8. The method according to one of claims 1 to 7, wherein the elevator system (1) automatically repeats calculation of the calibration data for the car-load information and takes into use the new calculated calibration data.

9. An elevator system, **characterized in that** the elevator system (1) includes a calibration unit (14) comprising:

an input (13) receiving car-load information provided from a load weighting device (11, 12),
an input (18) receiving information indicating a position of an elevator car (3),
an input (20) receiving motor-load information from an elevator drive unit (4, 17), and
a memory (16) maintaining unbalance information indicating an unbalance between an elevator counterweight (2) and an empty elevator car (3), and uncompensation information of the elevator system masses at different positions (9, 10) of the elevator shaft (8), wherein
the calibration unit (14) calculates calibration data for the car-load information after launch of a first-elevator run, based on a difference between the car-load information obtained before the first-elevator run and the motor-load information obtained during launch of the first elevator run, and by taking into account an unbalance and an uncompensation at the position of the launch of the first elevator run, as indicated by the unbalance information and uncompensation information stored in the memory (16), and
the elevator system (1) utilizing the calculated calibration data to correct the car-load information obtained from the load weighting device (11, 12) in connection with subsequent elevator runs.

9. The elevator system according to claim 8, wherein the elevator system (1) comprises a memory (16) maintaining an overload threshold value,
the elevator system compares the car-load information the overload threshold value, and
the elevator system prevents launch of elevator runs when the car-load information indicates a car-load that exceeds the overload threshold value.

10. The elevator system according to claim 8 or 9, wherein the calibration unit (14) automatically repeats calculation of the calibration data for the car-load information and automatically takes into use the new calculated calibration data.

11. The elevator system according to claim 8 or 9, wherein the calibration unit (14) repeats calculation of the calibration data for the car-load information and the elevator unit takes into use the new calculated calibration data in response to a control command from a user interface (19) of the elevator system.

Amended claims in accordance with Rule 137(2) EPC.

1. A method of operating an elevator system (1), **characterized in that** the method comprises:

(A) determining an unbalance between an elevator counterweight (2) and an empty elevator car (3),
(B) determining uncompensation of the elevator system masses caused by a weight difference of ropes hanging on different sides of a traction sheave at different positions (9, 10) of the elevator shaft (8),
(C) obtaining car-load information from a load weighting device (11, 12) before launching a first elevator run,
(F) obtaining motor-load information from an elevator drive unit (4,17) based on realized motor current during launch of the first elevator run, and
(G) calculating calibration data for the car-load information based on a difference between the car-load information and motor-load information by taking into account said determined unbalance and the uncompensation at the position of the launch of the first elevator run, and
(H) utilizing the calculated calibration data in the elevator system (1) to correct the car-load information obtained from the load weighting device (11, 12) in connection with subsequent elevator runs.

2. The method according to claim 1, wherein the motor-load information is obtained by keeping the elevator car (3) standstill at the launch position of the first elevator run with torque from the elevator drive unit (4, 17).

3. The method according to clam 1 or 2, wherein the motor-load is determined based on the motor current.

4. The method according to one of claims 1 to 3, wherein the unbalance is determined by measuring motor-load during up and down test runs of an empty elevator car (3) before launching said first elevator run.

5. The method according to one of claims 1 to 4, wherein the uncompensation is determined by measuring the unbalance at least at two different elevator car positions (9, 10), and by assuming that the unbalance changes linearly between said two different elevator positions (9, 10).

6. The method according to one of claims 1 to 5, wherein

maintaining in a memory (16) an overload threshold value,
(D) the car-load information is compared to the overload threshold value, and
launch of elevator runs are prevented when the car-load information indicates a car-load that exceeds the overload threshold value.

7. The method according to claim 6, wherein the overload threshold value is selected to be 110% of a rated load of the elevator system (1).

8. The method according to one of claims 1 to 7, wherein the elevator system (1) automatically repeats calculation of the calibration data for the car-load information and takes into use the new calculated calibration data.

9. An elevator system, wherein that the elevator system (1) includes a calibration unit (14) comprising:

an input (13) for receiving car-load information provided from a load weighting device (11, 12),
an input (18) for receiving information indicating a position of an elevator car (3),
an input (20) for receiving motor-load information from an elevator drive unit (4, 17), and
a memory (16) for maintaining unbalance information indicating an unbalance between an elevator counterweight (2) and an empty elevator car (3), and uncompensation information of the elevator system masses, caused by a weight difference of ropes hanging on different sides of a traction sheave, at different positions (9, 10) of the elevator shaft (8), **characterized in that**:

the calibration unit (14) is arranged to calculate calibration data for the car-load information after launch of a first-elevator run, based on a difference between the car-load information obtained before the first-elevator run and the motor-load information obtained during launch of the first elevator run, and by taking into account an unbalance and an uncompensation, at the position of the launch of the first elevator run, as indicated by the unbalance information and uncompensation information stored in the memory (16), and
the elevator system (1) is arranged to utilize the calculated calibration data to correct the car-load information obtained from the load weighting device (11, 12) in connection with subsequent elevator runs.

10. The elevator system according to claim 9, wherein

the elevator system (1) comprises a memory (16) for maintaining an overload threshold value, the elevator system is arranged to compare the car-load information the overload threshold value, and

the elevator system is arranged to prevent launch of elevator runs when the car-load information indicates a car-load that exceeds the overload threshold value.

11. The elevator system according to claim 9 or 10, wherein the calibration unit (14) is arranged to automatically repeat calculation of the calibration data for the car-load information and automatically takes into use the new calculated calibration data.

12. The elevator system according to claim 9 or 10, wherein the calibration unit (14) is arranged to repeat calculation of the calibration data for the car-load information and the elevator unit takes into use the new calculated calibration data in response to a control command from a user interface (19) of the elevator system.

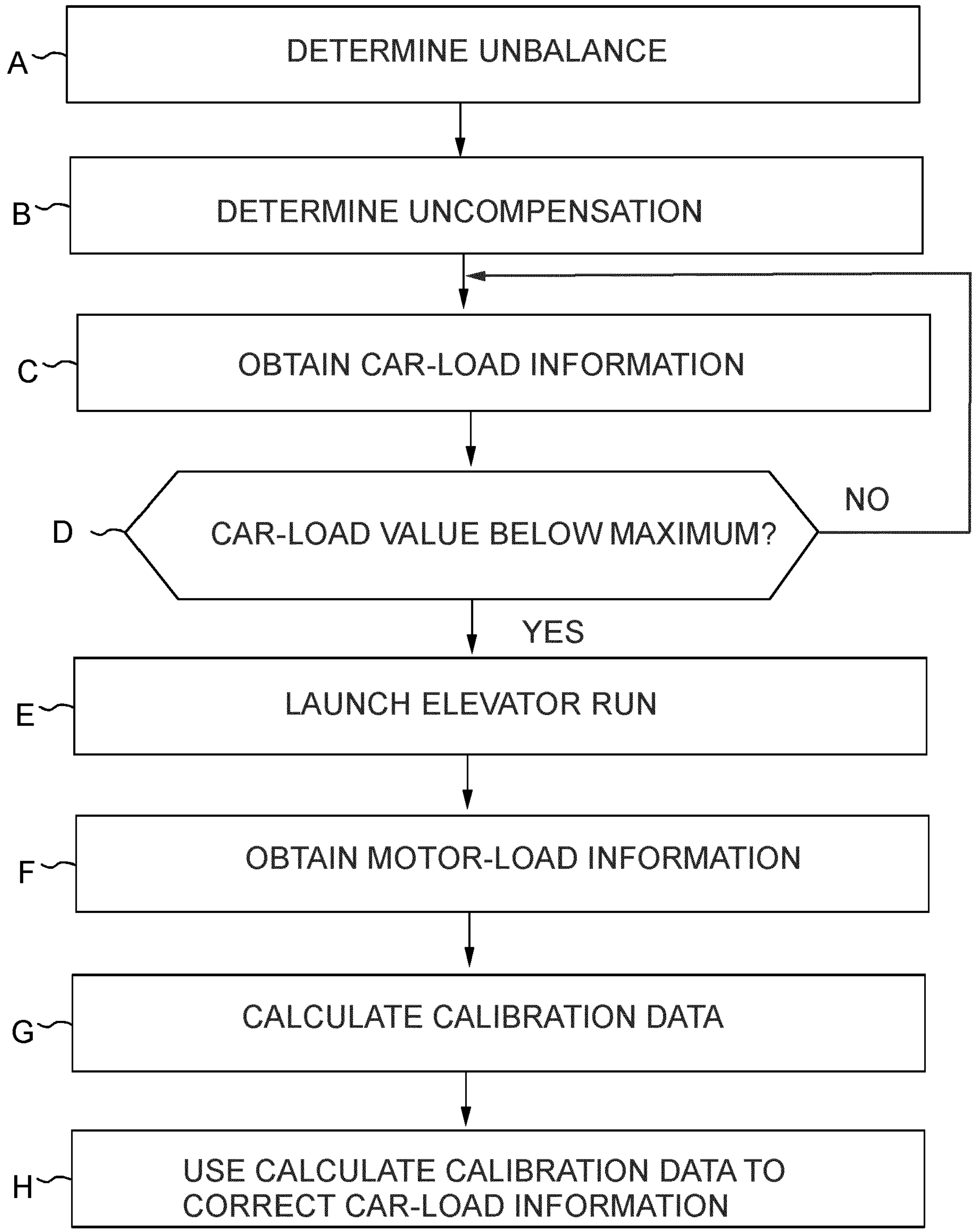
A
DETERMINE UNBALANCE
B
DETERMINE UNCOMPENSATION
C
OBTAIN CAR-LOAD INFORMATION
D
CAR-LOAD VALUE BELOW MAXIMUM?
NO
YES
E
LAUNCH ELEVATOR RUN
F
OBTAIN MOTOR-LOAD INFORMATION
G
CALCULATE CALIBRATION DATA
H
USE CALCULATE CALIBRATION DATA TO
CORRECT CAR-LOAD INFORMATION

FIG. 1

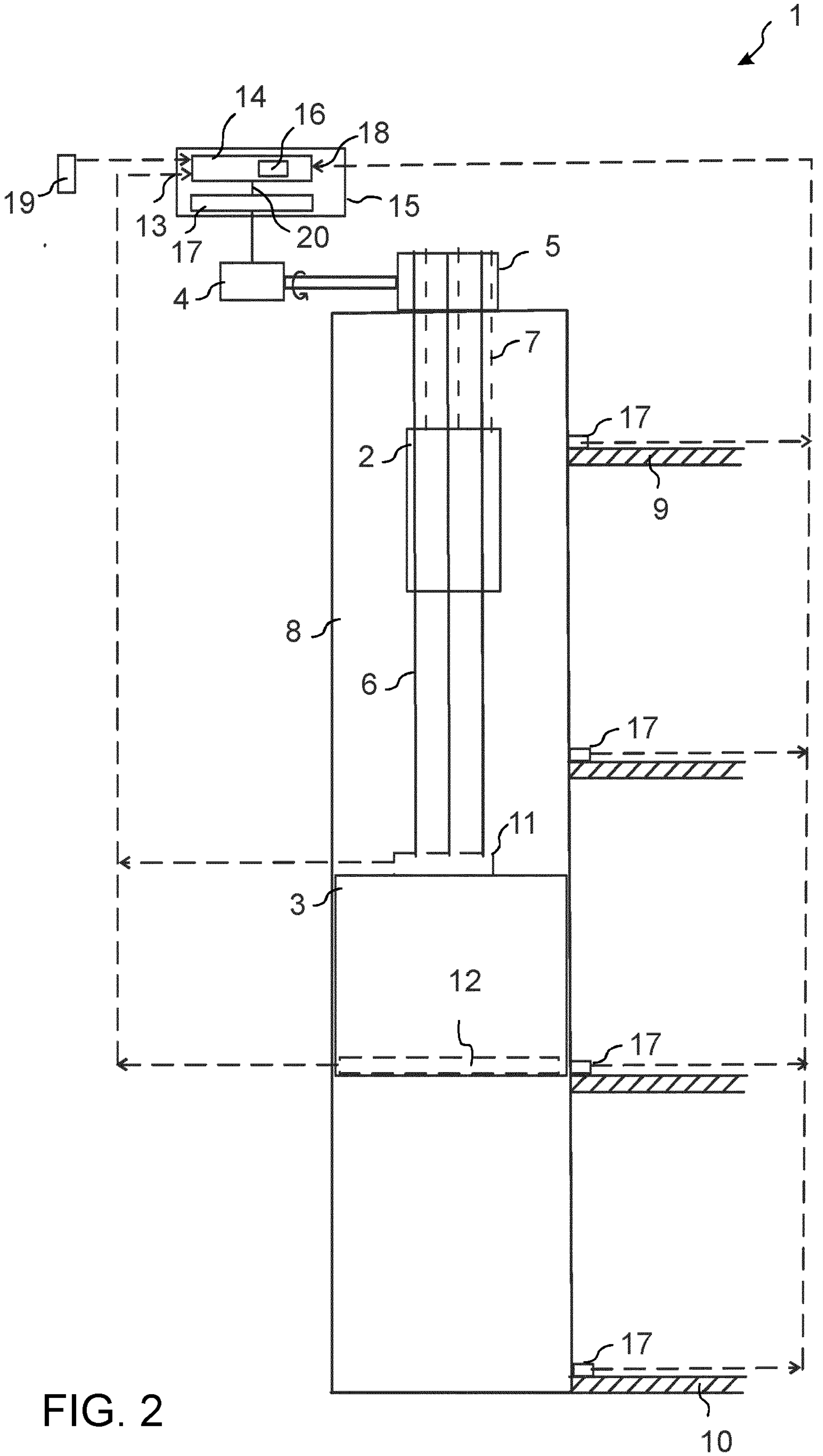

FIG. 2

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 20 19 8412

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2018/083739 A1 (MITSUBISHI ELECTRIC CORP [JP]) 11 May 2018 (2018-05-11) * paragraph [0006] - paragraph [0015]; figure 1 * -----	1-12	INV. B66B1/34
A	US 5 343 003 A (JAMIESON ERIC K [US] ET AL) 30 August 1994 (1994-08-30) * column 2, line 5 - column 6, line 21; figures 1-11 * -----	1-12	
A	EP 2 998 259 A1 (KONE CORP [FI]) 23 March 2016 (2016-03-23) * paragraph [0024] - paragraph [0036] * -----	1-12	
			TECHNICAL FIELDS SEARCHED (IPC)
			B66B

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	5 March 2021	Szován, Levente

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 20 19 8412

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.

05-03-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2018083739 A1	11-05-2018	CN 109890740 A	14-06-2019
		DE 112016007403 T5	11-07-2019
		JP 6667659 B2	18-03-2020
		JP WO2018083739 A1	22-03-2019
		KR 20190051063 A	14-05-2019
		WO 2018083739 A1	11-05-2018
US 5343003 A	30-08-1994	NONE	
EP 2998259 A1	23-03-2016	NONE	

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 2019330016 A1 **[0010] [0013]**