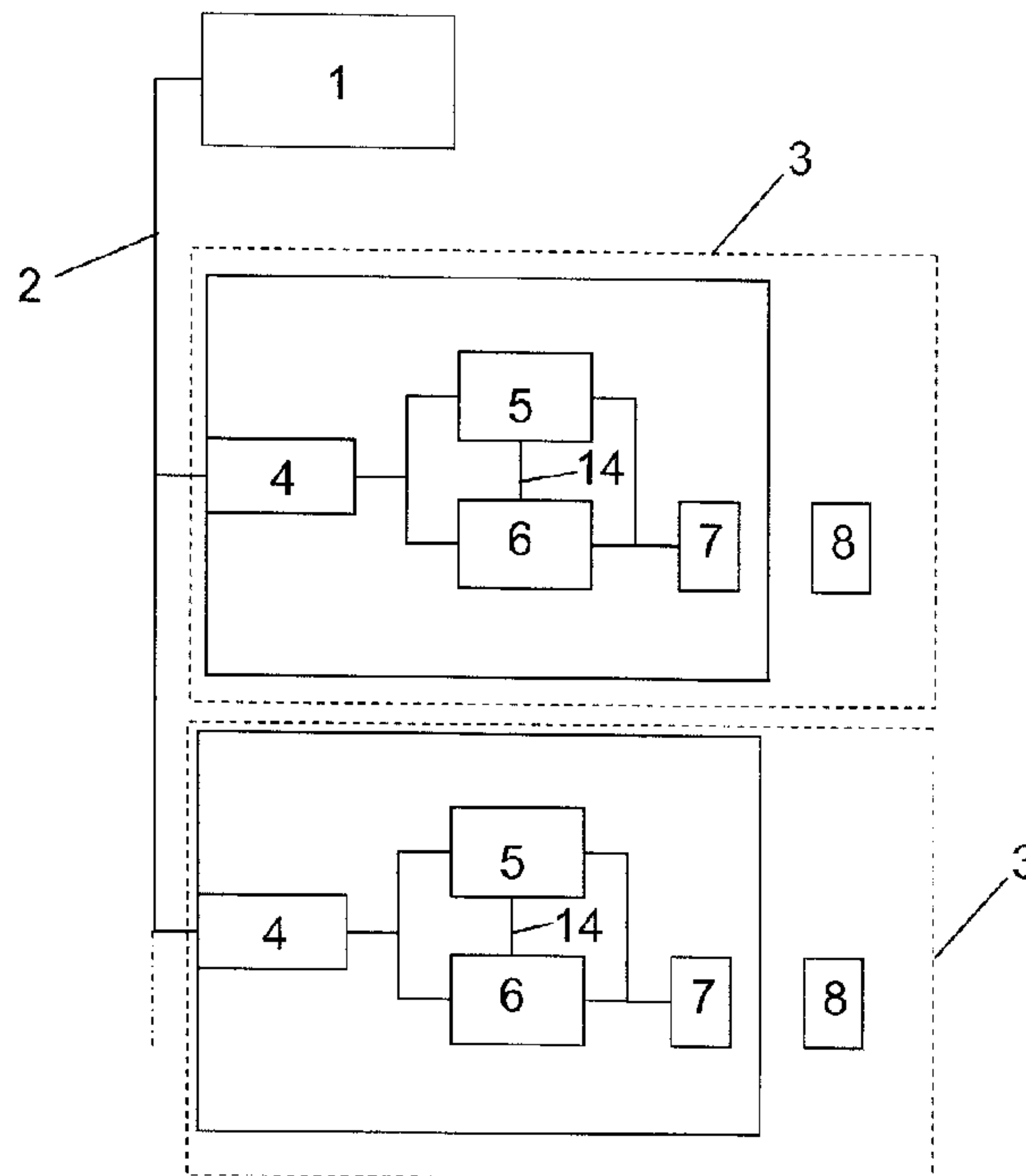




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(57) **Abrégé/Abstract:**

The invention describes a method of checking the functional capability of at least one safety element (3) of a safety circuit of a lift installation, wherein a first processing unit (5) and a second processing unit (6) are used for the at least one safety element (3), wherein the at least one safety element (5) is connected with a control unit (1) by way of a communications network (2). According to the invention at least one signal is provided by the first processing unit (5) on the basis of at least one communication from the control unit (1). The at least one provided signal is detected by the second processing unit (6) connected with the first processing unit (5) and communicated to the control unit (1) by way of the communications network (2). The at least one communicated signal is checked with respect to the validity thereof by the control unit (1).

ABSTRACT

The invention describes a method of checking the functional capability of at least one safety element (3) of a safety circuit of a lift installation, wherein a first processing unit (5) and a second processing unit (6) are used for the at least one safety element (3), wherein the at least one safety element (5) is connected with a control unit (1) by way of a communications network (2). According to the invention at least one signal is provided by the first processing unit (5) on the basis of at least one communication from the control unit (1). The at least one provided signal is detected by the second processing unit (6) connected with the first processing unit (5) and communicated to the control unit (1) by way of the communications network (2). The at least one communicated signal is checked with respect to the validity thereof by the control unit (1).

Description

FUNCTION-MONITORING OF A SAFETY ELEMENT

The invention relates to a method of checking the functional capability of at least one safety element of a safety circuit of a lift installation, wherein a first processing unit and second processing unit are used for the at least one safety element and the at least one safety element is connected with a control unit by way of a communications network.

Conventional lift installations have safety circuits which consist of safety elements connected in series. These safety elements monitor, for example, the state of shaft doors or cage doors. Such a safety element can be a door contact, a lock contact, a buffer contact, a flap contact, a sensor, an actuator, a travel switch, an emergency stop switch, etc. An open contact shows that, for example, a door is open and a potentially impermissible door state has arisen. If with the opened contact an impermissible open state of the door is now identified then the safety circuit is interrupted, which has the consequence that a drive or brake, which influence the travel of a lift cage, bring the lift cage to a stop.

A safety system or a safety circuit for a lift installation is known from the document EP 1638880, which comprises a control unit as well as at least one safety element and a bus as communications network. The bus or safety bus enables communication between the at least one safety element and the control unit. The safety element can, for example, monitor the state of shaft and cage doors. Moreover, the at least one safety element consists of a receiver and a transmitter.

The document EP 1427662 describes a safety system with safety bus. The safety bus is used in order to enable a secure and reliable monitoring of shaft doors of a lift installation.

The document EP 1427660 describes a safety system with safety bus which permits evaluation of the state of cage and shaft doors.

The understanding of bus or bus system is, for example, as described in the book

'Bussysteme, Parallele und serielle Bussysteme, lokale Netze', by Georg Färber, R. Oldenbourg Verlag Munich Vienna, 1987, ISBN 3-486-20120-4.

A safety system or a safety circuit for lift installations with the use of a bus system has to be constructed to be safe. Otherwise, for example, undefined states or faulty interpretations can occur. In particular, the interrogation of the safety elements of the safety system by way of the safety bus has to be absolutely secure and reliable.

For safety elements in safety-sensitive environments, high demands with respect to the fail-safety thereof are imposed so that harm to persons in a lift installation can be prevented. Safety-sensitive environments exist wherever due to a functionally incapable safety element unacceptable risks for the health of persons can arise. The requirements for safety elements are specified in various safety standards such as, for example, in European Norm IEC 61508. European Norm IEC 61508 contains the minimum requirements so that the safety in systems and electrical installations can be increased. For that purpose this Norm defines four so-termed safety integrity stages SIL1 to SIL4 which are applicable as a measure for the operational safety of an installation or a system. The safety integrity stage SIL4 is in that case the highest operational safety stage.

An object of the invention is to propose a simple and efficient method for checking the functional capability of safety elements of a safety circuit of a lift installation.

The invention is fulfilled on the basis of the features of the independent patent claims. Developments are indicated in the dependent claims.

A core of the invention consists in that for checking the functional capability of a safety element of a safety circuit of a lift installation a first processing unit of the safety element provides at least one signal on the basis of at least one communication from a control unit, that a second processing unit detects the provided at least one signal and communicates it to the control unit and that the communicated at least one signal is checked with respect to its validity by the control unit. For that purpose the first and second processing units are connected together.

The at least one safety element is connected with the control unit by way of a communications network. A hardwired or a non-hardwired communications network,

such as, for example, a fixed network, a mobile communications network, a radio communications network, a bus system, etc., can be used as the communications network.

In an advantageous embodiment the first and second processing units of the at least one safety element are directly connected together. A direct connection in that case means that the first processing unit is connected by way of an output of the first processing unit with an input of the second processing unit and/or conversely. Microprocessors, for example, can be used as first and second processing units.

The first and second processing units can in that case have different command sets. By that is meant that the two processing units can have, inter alia, different functionalities, different tasks, etc. Thus, for example, a communication between the first processing unit and the second processing unit could be initiated only by the second processing unit. Moreover, provision can be made for only the first processing unit to be able to provide at least one signal, for example in that the first processing unit creates or generates this signal.

The second processing unit can have, by comparison with the first processing unit and conversely, a different priority for communication with the control unit. A ranking for communication with the control unit is established by the priority. This means, for example, that in the case of a simultaneous communications attempt by the first and second communications unit the control unit communicates with that processing unit which has the higher priority.

The at least one provided signal can be of any form. It can be either digital or analog. In that case, a bit train, a signal with a specific or defined frequency, a tone sequence, a pattern, a message, etc., can be used as the signal.

The at least one signal provided by the first processing unit can be present either in the at least one communication from the control unit or it can be set up or generated by the first processing unit.

The check of the functional capability of the at least one safety element of the safety circuit of the lift installation can be performed in dependence on at least one rule. In that case, the at least one rule to be used can be as desired. Thus, for example, a

frequency, a time instant, a clock time, etc., could, for example, be used as the at least one rule for the check. By frequency there is defined or indicated how often and at which intervals a check is to take place. Obviously, further rules could also be defined. Thus, for example, a further rule could read that after maintenance, after disturbance, etc., of the lift installation a check is carried out.

An advantage of the invention is that it can be established in simple mode and manner whether the safety chain of the lift installation or the at least one safety element of the safety circuit is functionally capable.

A further advantage of the invention is that the method according to the invention and the device according to the invention satisfy the operational safety requirement, which is specified in European Norm IEC 61508, at least in accordance with SIL3.

The invention is explained in more detail on the basis of an embodiment illustrated in the figures, in which:

Fig. 1 shows a simplified example for a safety element of a safety circuit and

Fig. 2 shows a lift installation with a safety circuit and safety elements according to the invention present therein.

Figure 1 shows a simplified example for a safety element 3 of a safety circuit of a lift installation. Components of a lift installation are monitored by a safety element 3, thus, for example, the open or closed state of (shaft) lift doors, the open or closed state of a lift cage door, the position of a lift cage, the cable tension of a support means of the lift installation, the state of a lift brake, etc. The safety elements 3 in that case are arranged at or in the vicinity of the components of the lift installation and are connected with a control unit 1 by way of a communications network 2, wherein a lift control unit of the lift installation or a separate control unit can be used as the control unit 1.

A wire-bound or a non-wire-bound communications network can be used as the communications network 2. Thus, for example, a fixed network, a mobile communications network, a radio communications network, a bus system, etc., could be used.

The safety element 3 comprises at least one first processing unit 5 and second processing unit 6, a transmitting and receiving unit 4 for communication with the control unit 1 and a detection or interrogation unit 7. In this example, a contactless door monitoring unit is used as the safety element 3. A monitored unit 8, such as, for example, a RFID unit or radio frequency identification unit (RFID = radio-frequency identification), a magnet or similar is, for example, mounted on a lift door, a lift cage door, a flap, etc. (not illustrated). The monitored unit 8 is disposed, when the lift door is closed, in the range of the detection or interrogation unit 7, for example a radio-frequency transmitting/receiving unit, of the safety element 3.

If the lift door is opened, the monitored unit 8 moves out of the range of the detection or interrogation unit 7. How the detection or interrogation unit 7 detects that, for example, a door is open is described in, for example, European Patent EP 1638880. The detection or interrogation unit 7 passes on at least one appropriate signal, for example a message, a digital signal, an analog signal, etc., to the second processing unit 6. The second processing unit 6 checks or processes the at least one signal and transmits at least one (alarm) signal, message, digital signal, analog signal, etc., to the control unit 1 by way of the transmitting and receiving unit 4. It is also conceivable for the second processing unit 6 to pass on the signal, which is obtained by the detection or interrogation unit 7, to the control unit 1 without checking or processing by way of the transmitting and receiving unit 4 and for the control unit 1 to undertake the checking or processing of the signal. The checking or processing serves to establish whether an unsafe state prevails, thus whether, for example, the lift door is open, a sensor unit has detected safety-critical data, an overrun switch of the lift cage of the lift installation was overrun, etc. How this checking or processing by the control unit 1 or by the second processing unit 6 is carried out depends on the obtained at least one signal. Thus, for example, it would be possible for, inter alia, a comparison with existing signals to be carried out, a difference to be calculated, etc.

However, in order that it is ensured that the safety element 3 is in a position of communicating to the control unit 1 a signal detected by the detection or interrogation unit 7 or to report an unsafe state as a consequence of a check or processing of the signal in the second processing unit 6 the functional capability of the safety element 3 has to be able to be checked or tested.

For that purpose at least one communication is sent from the control unit 1 to the

first processing unit 5. The first processing unit 5 provides at least one signal on the basis of this at least one communication. The provided signal can in that case be as desired. Thus, use can be made of a digital signal, an analog signal, etc. A bit sequence, a pattern, a tone sequence, an image sequence, a signal with a frequency, etc., can, for example, be used as the signal. The communication can also be as desired. Thus, a digital signal, an analog signal, a signalling message of a communications network, a text message, etc., could, for example, be used as communication.

The first processing unit 5 can, for example, obtain from the control unit 1 the at least one communication with the requirement, as in this embodiment, to provide a signal with a specific frequency.

The at least one provided signal with the frequency from the first processing unit 5 can in that case either be set up or generated by the first processing unit 5 or be present in the at least one communication from the control unit 1.

The at least one provided signal is detected by the second processing unit 6 connected with the first processing unit 5. In that case, the first processing unit 5 and the second processing unit 6 can be directly connected together by the connection 14. The first processing unit 5 is connected by way of an output and/or input (not illustrated) via the connection 14 with an input and/or output (not illustrated) of the second processing unit 6. The connecting unit 14 can be hardwired or non-hardwired.

Detection of the at least one signal by the second processing unit 6 can, for example, be carried out in that the second processing unit 6 obtains transmission of the at least one signal from the first processing unit 5 automatically and/or without request or interrogates the first processing unit 5, i.e. the first processing unit 5 behaves passively. However, the detection can also be carried out in that the second processing unit 6 transmits a request communication to the first processing unit 5 and the first processing unit 5 thereupon communicates the at least one signal to the second processing unit 6.

The at least one signal detected by the second processing unit 6 is communicated to the control unit 1 by way of the communications network. The control unit 1 checks the at least one communicated signal with respect to the validity thereof, i.e. the control unit 1 compares the at least one communicated signal with the signal requested in the at least one communication to the first processing unit 5 or signal contained in this

communication. If the signals do not correspond with one another, i.e. the at least one communicated signal is invalid, the control unit 1 could infer therefrom that the communication between the at least one safety element and the control unit 1 via the communications network is faulty and the safety chain is thus functionally incapable. In addition, the control unit 1 could infer therefrom that the safety element 3 is faulty or functionally incapable.

The afore-described functional check of the at least one safety element 3 can be carried out in dependence on at least one rule. The at least one rule can be as desired. Thus, for example, the frequency, time instant and/or clock time for the functional check can be regulated as the at least one rule. A rule could also read that after maintenance or conversion or modernisation of the lift installation a functional check is to be carried out.

A microprocessor, a circuit or similar can be respectively used, for example, as the first processing unit 5 and second processing unit 6. In that case, the two processing units 5, 6 can have different command sets. By that is meant that the first processing unit 5 by comparison with the second processing unit 6 and conversely has either less functions or different functions. Thus, for example, only the first processing unit 5 could have the function of creating the at least one signal. In addition, for example, the first processing unit 5 could have no function for communicating at least one signal to the control unit 1.

Moreover, the first processing unit 5 and the second processing unit 6 can have or be allocated different priorities for communication with the control unit 1. Thus, for example, a communication or signal from the second processing unit 6 could be preferentially handled by the control unit 1.

Figure 2 shows a lift installation with a safety circuit and safety elements 3 according to the invention, which are present therein, for performance of the method as is described in Figure 1.

The method according to the invention can be used in any lift installation such as, for example, a hydraulic lift, a drive-pulley lift, etc. In this example a drive-pulley lift is illustrated. A lift cage 13 moves vertically by means of a motor 10 in a lift shaft 12. In that case the lift cage 13 is suspended at a support means 9. A counterweight 11 moves in

opposite sense to the lift cage 13 and is connected with the lift cage 13 by way of the support means 9, for example a cable, a wire cable with round cross-section, a belt with rectangular cross-section, a belt with round or oval cross-section, etc. The lift cage 13 travels to the individual storeys 0. SW to 4. SW.

In addition, the lift installation comprises at least one control unit 1. Safety elements 3 are connected by way of a communications network 2 with the control unit 1, which is termed safety circuit. In this example, a safety bus with a star-shaped network architecture is used as the communications network 2. A safety bus or a bus system with a serial network architecture is obviously also conceivable. The individual safety element 3 can in that case be arranged at the lift doors (not illustrated) on the individual storeys 0. SW to 4. SW, in the lift cage 13, at the motor 10 and in the shaft 12.

CLAIMS:

1. A method of checking the functional capability of at least one safety element of a safety circuit of a lift installation, wherein a first processing unit and a second processing unit are used for the at least one safety element and wherein the at least one safety element is connected with a control unit by way of a communications network , comprising:

at least one signal is provided by the first processing unit on the basis of at least one communication from the control unit, the at least one provided signal is detected by the second processing unit connected with the first processing unit and communicated to the control unit by way of the communications network and the at least one communicated signal is checked with respect to its validity by the control unit, wherein the at least one communicated signal is compared by the control unit with the signal provided by the first processing unit and wherein the at least one communicated signal is invalid and a functional incapability is present if the signals do not correspond with one another.

2. The method according to claim 1, wherein a digital or an analog signal is used as the at least one provided signal.

3. The method according to claim 2, wherein at least one of a bit sequence, a message, a signal with a frequency, a tone sequence and a pattern is or are used as the at least one signal.

4. The method according to any one of claims 1-3, wherein a different command set is used for the first processing unit than for the second processing unit .

5. The method according to any one of claims 1-4, wherein a different priority for communication with the control unit is assigned to the first processing unit than to the second processing unit .

6. The method according to any one of claims 1-5, wherein the provided signal is present either in the at least one communication from the control unit or is set up by the first processing unit .

7. The method according to any one of claims 1-6, wherein the check of the functional capability of the at least one safety element is performed in dependence on at least one rule.

8. The method according to claim 7, wherein at least one of a frequency, a time instant and a clock time is or are used as the at least one rule.
9. The method according to any one of claims 1-8, wherein a hardwired communications network is used as the communications network .
10. The method according to any one of claims 1-8, wherein a non-hardwired communications network is used as the communications network.
11. A device for checking the functional capability of a safety element of a safety circuit of a lift installation, comprising:
 - at least one first processing unit and a second processing unit connected with the first processing unit , wherein the first processing unit provides at least one signal on the basis of at least one communication from a control unit connected by way of a communications network with the at least one safety element , the second processing unit connected with the first processing unit detects the at least one provided signal and communicates it to the control unit by way of the communications network , and the control unit checks the at least one communicated signal with respect to the validity thereof, wherein the control unit compares the at least one communicated signal with the signal provided by the first processing unit and wherein the at least one communicated signal is invalid and a functional incapability is present if the signals do not correspond with one another.
12. The device according to claim 11, wherein the first processing unit and the second processing unit are directly connected together.

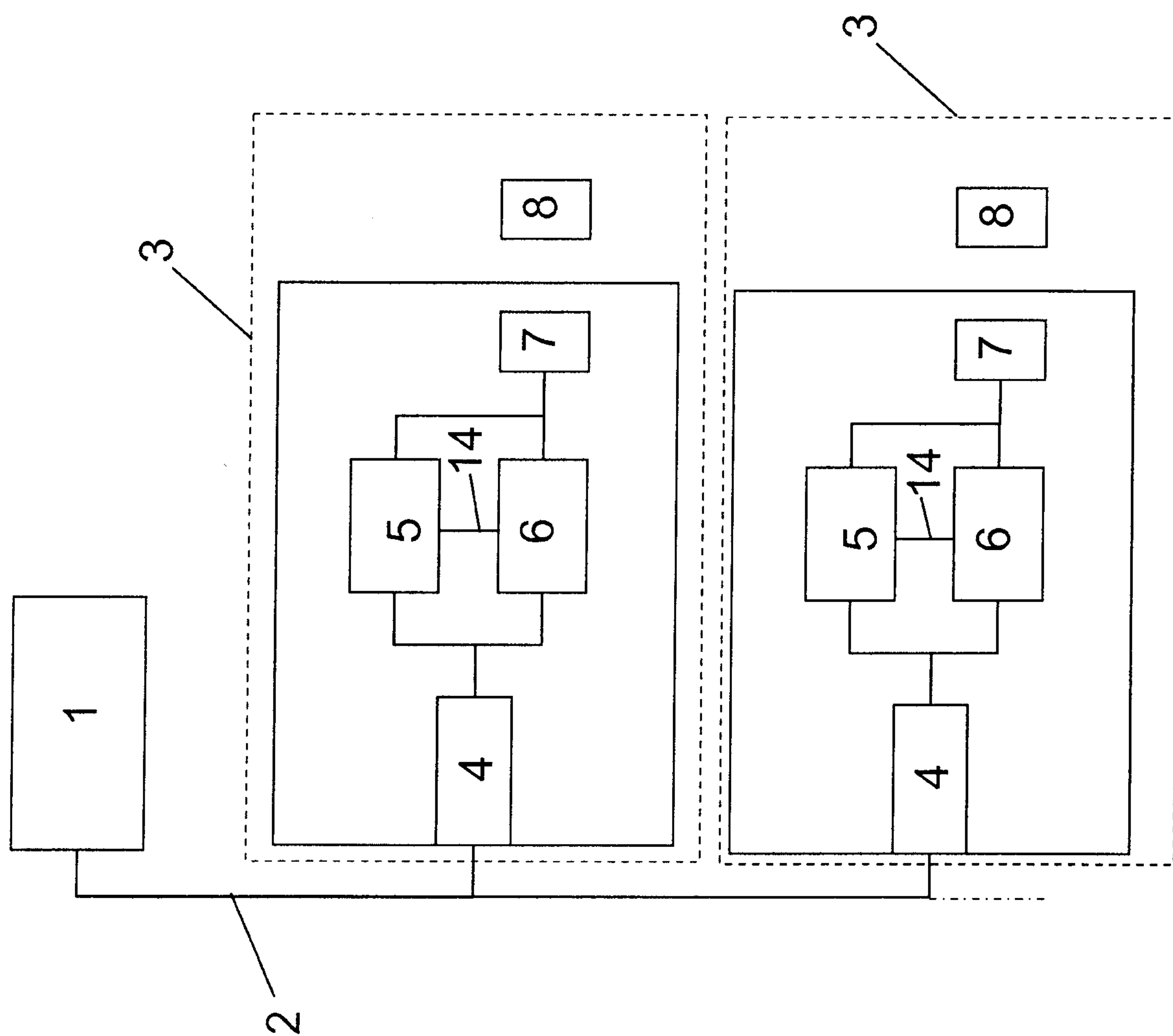


Fig. 1

