

(19)



(11)

**EP 3 854 940 B1**

(12)

**EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:

**13.09.2023 Bulletin 2023/37**

(51) International Patent Classification (IPC):  
**E01B 7/24 (2006.01)**

(52) Cooperative Patent Classification (CPC):  
**E01B 7/24**

(21) Application number: **21152983.9**

(22) Date of filing: **22.01.2021**

(54) **SWITCH HEATING VALIDATION SYSTEM**

WEICHENHEIZUNG VALIDIERUNGSSYSTEM

SYSTÈME DE VALIDATION DE CHAUFFAGE DE COMMUTATEUR FERROVIAIRE

(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**

(30) Priority: **24.01.2020 NL 2024757**

(43) Date of publication of application:  
**28.07.2021 Bulletin 2021/30**

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**EP 3 854 940 B1**

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## Description

**[0001]** The invention concerns a switch heating validation system for validating the operating state of a railway switch heating system for heating a railway switch, in order to keep railway switches free from snow and ice.

**[0002]** Railway switches comprise switch actuators via which the tips of the switch are operated and moved in position, whereby a rail vehicle can change its direction of travel. This does not mean a forward and return direction, but a change from one track to another, from a main line to a branch line. Switches may be regarded as one of the basic elements of modern rail infrastructure. Modern rail infrastructure, certainly in the dense Dutch railway landscape, comprises a multiplicity of switches.

**[0003]** Not just in the Netherlands but also elsewhere, the density of the railway network is ever increasing. More and more towns and villages are being connected, and alternatively new railway routes are being created. The existing and also the new railway routes are, to an increasing extent, being used ever more intensively. In order to guarantee the required capacity for passenger and goods transport, inter alia, it is necessary to significantly reduce the chance of faults.

**[0004]** An important source of faults is the use of switches in low temperatures when snow and/or ice may occur. If the temperature falls below a specific value, there is an increased chance that the switch tips can freeze onto the rails. To prevent this, switches are equipped with a switch heating system.

**[0005]** A small quantity of snow and/or ice in most cases does not cause any problems because the switch actuators have sufficient strength to change the position of the switch tips even against increased resistance. If the snow accumulates and possibly even freezes, the resistance may reach a level at which the switch actuators have insufficient strength to operate the switch. To prevent faults on switches, it is therefore important to keep switches free from snow and/or ice at all times. This however firstly entails high costs because the switch heating systems are activated often, perhaps more often than necessary. Secondly, there is additional pressure on inspection and maintenance. However, if use of the systems increases, the importance of the operating reliability of the systems also increases. Great resources (manpower and equipment) are used to ensure that the switches remain operational under all circumstances. Despite this however, it appears that, during the cold months of the year, the switches are still always the greatest source of faults and interruptions in the track, and there is therefore a general need for an improved, more reliable and maintenance-friendly switch heating system.

**[0006]** The invention proposes to meet the above-mentioned need and according to the invention, in a first aspect, a switch heating validation system is proposed for validating the operating state of a railway switch heating system for heating a railway switch. Validation in the context of the present description means establishing

whether or not the railway switch heating system is functioning correctly.

**[0007]** As stated, the railway network is used ever more intensively and the density of the railway network is increasing. Single-track railway sections are being extended into multi-track railway sections, new routes are being created and new villages and towns connected.

**[0008]** Railway sections are track portions between two usually larger stations. These railway sections may consist of one track but usually comprise several tracks. If there are several tracks, also known as multi-track sections, trains travelling in opposite directions have their own track, for example double-track sections. This contrasts with single-track sections, wherein trains in both directions must use one and the same track.

**[0009]** As well as single and double tracks, there are also railway sections which have three or sometimes even four mutually parallel tracks, and at least in the Netherlands there are also some six-track sections. The railway sections may be divided into so-called blocks using the block system. Only one rail vehicle may be present in each block, and a section usually consists of various inter-connected blocks, but a short railway section may in principle also consist of a single block.

**[0010]** It appears from research that a large proportion of the faults in railway sections and in yards, and also train failures, are the direct consequence of or at least largely related to switches. Switch faults thus have a great influence on service schedules.

**[0011]** With the increasing pressure on the track and the ever more intensive use, the need for a robust track is also increasing, and there is therefore a need for improved switches in which the chance of faults is lower. One of the most important causes of faults in and the general failure of switches is related to the freezing of the switches or blockage thereof by snow. By means of switch heating systems, the switches can be kept free from snow and ice.

**[0012]** At present, switches are kept free from snow and ice by activating said systems when a specific preset temperature is reached. In practice, it appears that the switch heating often does not function or does not function fully, or it appears that the quantity of snow or ice is greater than that for which the switch heating system was designed. In such cases, the switch heating system will fail and the switch malfunction. To guarantee the correct function, or in other words the operating reliability of the system, at present many maintenance engineers are employed to test and inspect the switch heating system on site in order to establish whether it is providing sufficient heat. If necessary, if it is found this is not the case, the necessary maintenance activities can then be carried out directly or at a later time.

**[0013]** To guarantee the operating reliability of a switch heating system, its correct function must therefore be established. This takes place today by local observation by a maintenance worker. The switch heating systems known at present are not able to establish correct func-

tion, and with such known systems it is simply assumed that they are working correctly, for example because feedback is given that the system is in operation. However, this does not offer any guarantee that the switch is actually being heated. Document DE 198 49 637 C1 discloses a switch heating validation system according to the preamble of independent claim 1.

**[0014]** The switch heating validation system according to the present invention therefore comprises, in a first aspect, a sensor unit, a control interface and a communication interface, via which it can be established with certainty (and therefore validated) that the switch heating system is operating correctly.

**[0015]** The sensor unit of the system is configured for fixing to a rail or a switch tip of the railway switch for measuring a momentary temperature of the railway switch.

**[0016]** The control interface is configured for communication with a control unit of the railway switch heating system, for establishing the operating state of the railway switch heating system, which defines whether one or more heating units of the railway switch heating system are activated or deactivated.

**[0017]** The communication unit is configured for transmitting the momentary temperature and operating state of the railway switch heating system to a remotely located central processing unit. The switch heating validation system is here configured to validate the operating state of the railway switch heating system on the basis of the established momentary temperature and the establishing, via the control interface, of the activation of the railway switch heating system.

**[0018]** In a preferred embodiment, the validation takes place remotely and therefore by the remotely located central processing unit. The momentary temperature and the operating state of the railway switch heating system, which determines whether or not the railway switch heating system is activated, are then perceived locally as sensor data and transmitted to the remotely located central processing unit. The latter interprets the sensor data and establishes whether or not the railway switch heating system is functioning correctly, and hence validates the operating state of the railway switch heating system.

**[0019]** In an alternative example, validation may also take place locally, and therefore the sensor data are processed and interpreted locally. The validated result, and hence the establishing of whether or not the railway switch heating system is functioning correctly, is then transmitted to the remotely located central processing unit.

**[0020]** Remote validation has various advantages. Obtaining sensor data takes less energy than interpreting data, and therefore it is possible to power the sensor and possibly also the control interface by battery. In addition, interpretation of the data may require a great deal of processing capacity, in contrast to obtaining the sensor data. By carrying out interpretation remotely, locally a simpler microcontroller is sufficient, and/or more sensor

data may be obtained or may be obtained more quickly, since the microcontroller in the sensor unit has only one dedicated task to perform, i.e. obtaining the sensor data.

**[0021]** Another important advantage of remote validation is that it is thereby possible to enrich the sensor data and the operating state of the railway switch and/or railway switch heating system further with additional data. Examples of this are the momentary external weather information, weather forecasts, but also data from the rail network such as the state of switches, signals, and operating parameters of trains such as speed, location etc.

**[0022]** The sensor unit and the control interface are preferably accommodated in separate housings, but may also be received in one and the same housing. In the latter example, the sensors are furthermore provided with sensor probes which are attached to the rail or the switch tip of the railway switch.

**[0023]** To measure the temperature and in particular the momentary temperature of the railway switch, the sensor unit must be attached to one or more rails or switch tips of the railway switch.

**[0024]** The control interface of the switch heating validation system is the central control unit of the system, and in one example may be configured firstly to actuate the sensor unit to (temporarily) store the momentary temperature values locally, optionally to process these and transmit them on to a remotely located central processing unit. For this, the system is provided with a wireless communication unit. Secondly, the control interface is configured to communicate with the switch control unit and from this establish whether one or more heating units of the railway switch heating system are activated.

**[0025]** In a further embodiment, the control interface is configured not only to establish the status of the heating unit but also to activate this. This means that via the control interface, via the remotely located central processing unit, a command may be received to activate the processing unit(s). Therefore a possibility is provided for testing the railway switch heating system remotely. In this case, the control interface receives from the remotely located central processing unit a command to carry out a test and activate the heating unit on the basis thereof, whereupon from the sensor data received by the sensor unit it can be established whether the temperature of the switch is increasing.

**[0026]** The sensor unit allows the switch heating validation system to establish a momentary or current temperature of the railway switch. Thus it can not only be determined that the switch heating system is in operation, but also its operating state can be validated.

**[0027]** Validation according to the invention may take place in several ways, for example by comparing the momentary temperature with a previously measured (momentary) temperature, for example the last measured temperature or several last measured temperatures. If a deviation from the trend line can be established here, it is concluded that the switch heating is activated and functioning well (in other words, is in operation). This deviation

preferably exceeds at least one threshold value for improving the fault sensitivity.

**[0028]** In a further embodiment, on the basis of a comparison between the measured momentary temperature of the railway switch and a measured momentary temperature of the immediate environment, it can be established that the switch heating is in operation. To establish this momentary temperature of the immediate environment, the system according to the invention may be provided with a temperature sensor which is mounted in the vicinity of the switch as a weather station. This may measure the ambient temperature and provide this to the switch heating validation system. In another embodiment, the temperature of the environment may also be established by being obtained by means of an interface to an online weather application.

**[0029]** The remotely located central processing unit means a single server, but may also be a server cluster. If it is established that the switch heating system is not in operation, an alarm may be issued.

**[0030]** In a further embodiment, the central processing unit or control interface may be configured to adapt the number of measurements per time unit. In an example, the system may start with a previously entered, fixed time interval between two measurements, which time interval is then adapted depending on whether or not the correct function of the switch heating system is established. Thus the time interval may be gradually extended if, for a predefined number of measurements, it is established that the switch heating system is functioning correctly. This has the advantage that the number of measurements can be reduced, and less data need be transmitted. This has a positive effect on the energy consumption of the system.

**[0031]** With the switch heating validation system, in addition a possibility is created for switching the switch heating system on and off remotely and wirelessly. No physical wiring is necessary for the control. In this way, irrespective of the function and presence of a hard-wired connection, the switch heating system can always be actuated. Also, the status of the switch can be read at all times, even if this cannot be powered.

**[0032]** By providing a wireless communication system in a switch heating validation system according to the invention, the system is made suitable for being centrally actuated and controlled without a change to the service schedule being required. This is however not the case with a non-wireless switch heating system, because a maintenance engineer must physically enter the track in order to check the function of the switch on site. As already indicated above, the switch heating validation system is preferably configured as two separate physical units: on one side, the sensor unit which is in direct contact with the switch, and on the other side, the control interface which is in direct contact with the control unit of the switch and therefore present at some distance from the switch next to the track. Usually, in this control unit or switch box, there is a possibility of providing power to

the control interface of the switch heating validation system. The control interface of the switch heating validation system also comprises a communication unit for communication with the remotely located central processing unit. This communication may be hard-wired via a fixed communication connection of the switch control unit, or preferably wireless by establishing a direct connection with the remotely located central processing unit via a cellular network. Alternatively, the sensor unit and the control interface may also be in direct communication with each other, for example via a local area network, a personal area network or another suitable local communication system. The actual communication with the remotely located central processing unit is then established only by one of the sensor unit or the control interface. In fact, in this way one of the two components functions as a gateway for the other.

**[0033]** A wireless system which can be operated remotely in this way has various advantages over the currently known autonomous powering of a switch heating system. Firstly, the wiring, at least for control, is superfluous, which benefits the robustness and hence the rail infrastructure. Secondly, there are secondary advantages such as the central, remote readout and actuation of the switch heating system.

**[0034]** In an example, the control interface is configured for activating and deactivating the one or more heating units of the railway switch heating system if the momentary temperature of the railway switch, measured by the sensor unit, exceeds a predefined threshold value, wherein one or more of a moment of activation and the moment of deactivation of the one or more heating units of the railway switch heating system, and a number of heating units of the railway switch heating system to be activated or deactivated, can be adjusted via the control interface. Via the threshold value, the control interface provides a hysteresis which prevents an on-off oscillation of the heating units. In addition, according to this example, the control interface may react adaptively to the measured momentary temperature. This means that, for example, depending on the size of the difference between the measured momentary temperature and the ambient temperature, the moment of activation of the heating units can be delayed or advanced. Also, depending on an established necessary heating need, a limited number of heating elements may be activated. This has the advantage that less energy is used in comparison with a simple on/off operating state of the railway switch heating system.

**[0035]** In an example, the adjustment of the control interface is actuated by the remotely located central processing unit.

**[0036]** The adjustment of actuation of the railway switch heating system may also be made by the local control interface, wherein the necessary heat need as described above is established locally, or it may be established remotely by the central processing unit, wherein the latter variant has the advantage that thus less en-

ergy is required locally for calculation.

**[0037]** In an example, the sensor unit or a probe of the sensor unit is configured to be fixed to the rail or switch tip of the railway switch so that direct measurement can be carried out, and it can be established whether the component of the switch to be heated is actually heated by the heating units.

**[0038]** In an example, the sensor unit is received in a closed housing, wherein the closed housing is provided with at least one magnet for fixing to the rail or the switch tip of the switch.

**[0039]** In an example, a communication unit is furthermore configured for interfacing with a control unit of the railway switch, for establishing via the interface the operating parameters of the railway switch.

**[0040]** In an example, the operating parameters comprise at least one or more of the position of the movement rods of the railway switch and the operating state of the railway switch motor.

**[0041]** Various parameters may be established through an interface with the railway switch. Thus for example it may be established whether the movement rods have changed position. If this is not the case and the switch is powered, it must be concluded that the switch has frozen and activation of the switch heating system is desired. Other parameters which may give information on the state of the switch are the parameters of the switch motor. If the motor consumes more power than a predefined normally consumed power, it must also be concluded that the switch is frozen. Also, when a stepper motor is used, it may be established whether the position of the motor is as it should be, and hence on the basis of this, a frozen switch can be concluded.

**[0042]** In an example, the communication unit is furthermore configured for interfacing with a control unit of the railway switch heating system, for establishing via the interface the operating parameters of the railway switch heating system.

**[0043]** In an example, the operating parameters comprise at least one or more of the availability of fuel and the availability of a heat source.

**[0044]** Various parameters may be established through an interface with the railway switch heating system. Thus for example it may be established whether there is sufficient fuel. This applies for example in the case of a railway switch heating system which is provided with a gas burner as a heating unit. Thus for example it may also be established whether there is sufficient supply of electricity. This applies for example in the case of a railway switch heating system which is provided with an electric heating unit.

**[0045]** The system according to the invention is not limited by the type of switch heating, but is designed to be used for all switch heating systems currently available and in use. In particular, this includes the above-mentioned gas burner system but also heating on the basis of a central piped gas supply (CBG), electric heating, ground source heating systems and other forms com-

prising a heat exchanger or other heat transfer means. The system according to the invention measures the object to be heated instead of the heating system itself, which has the advantage that it is thereby suitable for all present and future types of heating systems. In addition, the system according to the invention concerns a retrofit solution, which means that an existing switch with a switch heating system may be made suitable for the existing application without the need to make changes to the original design of the switch and the switch heating system.

**[0046]** In an example, the control interface and the sensor unit are furthermore configured for comprising a grouping identification with which control interfaces and sensor units of a plurality of switch heating validation systems can be grouped, for validating railway switch heating systems in groups.

**[0047]** In another example, the control interface and the sensor unit are furthermore configured for comprising a grouping identification with which control interfaces and sensor units of a plurality of switch heating validation systems can be grouped, for activating and deactivating railway switch heating systems in groups.

**[0048]** By means of the railway switch heating validation system, a railway switch heating system may not only be actuated remotely, but also groups of railway switch heating systems can be formed. In this way, an authorised person may remotely, by means of a single command, simultaneously measure, read but also activate a large group of railway switch heating systems.

**[0049]** In an example, the wireless communication unit is configured for wireless mobile communication over a cellular mobile network, in particular a 2G GSM, 2.5 G GPRS or EDGE, 3G UMTS, HSDPA or LTE, 4G LTE Advanced, 5G, GSM-R or FRMRS network.

**[0050]** The invention will be explained in more detail below with reference to the figures. The drawings show: Figure 1 a switch heating validation system for use in a railway infrastructure.

**[0051]** For better understanding of the invention, in the description of the figures which follows, the corresponding components are designated with identical reference signs.

**[0052]** Figure 1 shows a railway switch 10 which is provided with a switch heating system 16, 18, and a switch heating validation system 17, 19 for establishing the operating state of a railway switch heating system 16 for heating a railway switch 10.

**[0053]** The switch 10 shown in figure 1 consists of a left rail 11 and a right rail 12, and a left switch tip 13 and a right switch tip 14. In order to bring the switch from the one position to the other, the switch 10 is provided with a switch actuator 15. The switch actuator contains the motor and motor control of the switch 10. The motor may in particular be a motor in which features of the control system can be derived from the motor control, such as the consumed power, activation current, deactivation residual current and internal resistance. From these prop-

erties, the function of the switch 10 can be derived directly or indirectly. This means that in normal use, in which there is no ice or snow present on the switch, the motor displays a specific nominal power consumption. The power may increase as the motor encounters resistance in moving the switch tips. This may mean that snow or ice is present. If this is established, it is desired that the heating unit 18 of the switch heating system 16, 18 activates the heating element 16 in order to ensure that one or more of the rails 11, 12 and left and right switch tips 13, 14 are heated. For this, the switch heating system is preferably provided with several heating units 16 or heating elements 16. The heating elements, as shown in figure 1, are electric heating elements, but this may also be a heating system which works with ground source heat or gas burners or other forms of heating. The heat transfer in the case of a gas burner takes place by means of a controlled combustion of a gas/air mixture close to the target on the outside of the (contact) rail 12. The heat is then transferred via radiation and hot combustion gases to the rail 12, 11, and also to the direct environment. The gas may be obtained either from a local gas store or via a pipeline network to which several switch heating systems are connected.

**[0054]** As an alternative to the above-mentioned gas combustion, an indirect heating system with a heat exchanger may also be provided. This is often described as central heating of a heating medium such as water which, after heating in a boiler or along a heat exchanger, is transported to the rails and/or switch tips.

**[0055]** One of the most important reasons for faults in the switch is attributable to the operating reliability of the switch heating system. Therefore, a switch heating system must be subjected to regular inspection and where necessary maintenance. This is a time-consuming, labour-intensive and unsafe activity, since it takes a great deal of time before it can be established that a switch heating system is functioning correctly. Therefore, a maintenance worker or supervisor must go to the site and work in a part of the track which is often not out of service. This creates unsafe and therefore undesirable situations.

**[0056]** The switch heating validation system shown in figure 1 provides a control interface 19, a sensor unit 17 and a communication unit for communication with the remotely located processing unit. The remotely located processing unit is a server or several servers which may be active in a cloud solution in some cases. These are available from the applicant of the present invention and are provided as such in the MT info system with which includes communication, readout and control of track components. For communication with the server or servers, the system according to the invention is provided with a preferably wireless communication unit which is preferably situated in the control interface, but in addition in the sensor unit.

**[0057]** This switch heating validation system solves the above-mentioned problems since, in this way, it can ac-

tually be measured whether the switch heating 16, 18 is functioning. Although a modern switch heater may be configured to give feedback on the state of the system, it can only be concluded from this that the system is powered. But this does not necessarily mean that the switch is being heated. Rather, in practice problems may arise with the heat source, supply, wiring, ignition etc. In such cases, the heating system may indeed be activated but heating does not take place. By fitting sensor units with temperature sensors 17 to the switch tips and/or rails, preferably attached by a magnet, it is possible to establish an actual temperature rise. Thus the control interface or the server may establish that the heating system is functioning correctly.

**[0058]** In figure 1, communication of the control interface and sensors with the server takes place wirelessly. In this case, the sensors are also shown as separate sensor units, and as such are provided with their own power supply. Preferably by means of a battery. In an alternative embodiment, this communication is hard-wired, whereby the sensors may be configured as passive sensor probes. In addition, in another embodiment, also all units according to the invention, i.e. the sensor, control unit and communication unit, may be accommodated in one and the same housing.

**[0059]** By means of the sensor unit, the system is able not only to carry out momentary temperature measurements at fixed or adjustable time intervals, but also by means of the control interface, communicate with the control unit or heating unit 18 of the switch heating system and from this establish the state, and preferably also activate and deactivate these. In this way, the switch heating validation system may continuously monitor or observe the switch heating and hence the status of the switch. If the temperature falls below a specific threshold value to be established, it may be concluded that the switch heating system is not functioning correctly.

**[0060]** In this way, a real-time or near real-time switch heating monitoring system is obtained with which faults in the switch heating system can be established in good time and alarms issued, so that faults and blockades on the railway switch as a result of snow and ice can be prevented.

## Claims

1. Switch heating validation system for validating the operating state of the railway switch heating system 1618) for heating a railway switch (10), the switch heating validation system comprising:

- a sensor unit which is configured for fixing to a rail (11, 12) or a switch tip (13, 14) the railway switch, for measuring a momentary temperature of the railway switch;
- a control interface (19) configured for communication with a control unit of the railway switch

- heating system, for establishing the operating state of the railway switch heating system which defines whether one or more heating units of the railway switch heating system are activated or deactivated; and
- a communication unit configured for transmitting the momentary temperature and the operating state of the railway switch heating system to a remotely located central processing unit, **characterized in that** the switch heating validation system validates the operating state of the railway switch heating system on the basis of the established momentary temperature and the establishing, via the control interface, of the activation of the railway switch heating system.
2. Switch heating validation system according to claim 1, wherein the sensor unit (17) is configured as a stand-alone sensor, furthermore comprising a power supply, a control unit and a communication unit for communication with and transmission of the momentary temperature to the remotely located central processing unit, wherein the control interface is configured as a stand-alone interface, furthermore comprising a control unit and a communication unit for transmitting the operating state of the railway switch heating system to a remotely located central processing unit.
  3. Switch heating validation system according to claim 1 or 2, wherein one or more of the communication unit of the sensor unit and the control interface are designed so as to be wireless, and in particular configured for wireless mobile communication over a cellular mobile network, in particular a 2G GSM, 2.5 G GPRS or EDGE, 3G UMTS, HSDPA or LTE, 4G LTE Advanced, 5G, GSM-R or FRMRS network.
  4. Switch heating validation system according to any of the preceding claims, wherein the remotely located central processing unit is configured for validating the railway switch heating system on the basis of the received momentary temperature and the established operating state of the railway switch heating system.
  5. Switch heating validation system according to any of the preceding claims, wherein the switch heating validation system establishes whether the momentary temperature exceeds a predefined threshold value at the moment that the control interface has established that the railway switch heating system is activated.
  6. Switch heating validation system according to any of the preceding claims, wherein the control interface (19) is configured for activating and deactivating the one or more heating units of the railway switch heating system.
  7. Switch heating validation system according to claim 6, wherein the control interface (19) is configured for adjusting one or more of a moment of activation and the moment of deactivation of the one or more heating units of the railway switch heating system, and adjusting a number of heating units to be activated and deactivated of the railway switch heating system.
  8. Switch heating validation system according to any of the preceding claims, wherein the sensor unit (17) is provided with at least one magnet for fixing to the rail or switch tip of the railway switch.
  9. Switch heating validation system according to any of the preceding claims, wherein the control interface (19) is configured for establishing, via the interface operating parameters for the railway switch.
  10. Switch heating validation system according to claim 9, wherein the operating parameters comprise at least one or more of the position of the movement rods of the railway switch and the operating state of the railway switch motor.
  11. Switch heating validation system according to any of the preceding claims, wherein the control interface (19) is configured for establishing, via the interface operating parameters of the railway switch heating system.
  12. Switch heating validation system according to claim 11, wherein the operating parameters comprise at least one or more of the availability of fuel, electricity, and the availability of a heat source.
  13. Switch heating validation system according to any of the preceding claims, wherein the control interface (19) and the sensor unit (17) are furthermore configured for comprising a grouping identification with which control interfaces and sensor units of a plurality of switch heating validation systems can be grouped, for validating railway switch heating systems in groups.
  14. Switch heating validation system according to claim 6, wherein the control interface (19) and the sensor unit (17) are furthermore configured for comprising a grouping identification with which control interfaces and sensor units of a plurality of switch heating validation systems can be grouped, for activating and deactivating railway switch heating systems in groups.

## Patentansprüche

1. Weichenheizung-Validierungssystem zum Validieren des Betriebszustands des Eisenbahnweichenheizungssystems (16, 18) zum Beheizen einer Weiche (10), wobei das Weichenheizung-Validierungssystem aufweist:
- eine zum Befestigen an einer Schiene (11, 12) oder einer Weichenspitze (13, 14) der Eisenbahnweiche ausgelegte Sensoreinheit (17) zum Messen einer momentanen Temperatur der Eisenbahnweiche;
  - eine zur Kommunikation mit einer Steuereinheit der Weichenheizung ausgelegte Steuerschnittstelle (19) zum Ermitteln des Betriebszustands der Weichenheizung, der definiert, ob eine oder mehrere Heizeinheiten der Weichenheizung aktiviert oder deaktiviert sind; und
  - eine zum Übertragen der momentanen Temperatur und des Betriebszustands der Weichenheizung an eine entfernt gelegene zentrale Verarbeitungseinheit ausgelegte Kommunikationseinheit,
- dadurch gekennzeichnet, dass**  
das Weichenheizung-Validierungssystem den Betriebszustand des Eisenbahnweichenheizungssystems auf der Grundlage der ermittelten momentanen Temperatur und des Ermitteln der Aktivierung des Eisenbahnweichenheizungssystems über die Steuerschnittstelle validiert.
2. Weichenheizung-Validierungssystem nach Anspruch 1, wobei die Sensoreinheit (17) als ein eigenständiger Sensor ausgelegt ist, die darüber hinaus eine Stromversorgung, eine Steuereinheit und eine Kommunikationseinheit zur Kommunikation mit der entfernt gelegenen zentralen Verarbeitungseinheit und Übertragung der momentanen Temperatur an die entfernt gelegene zentrale Verarbeitungseinheit aufweist, wobei die Steuerschnittstelle als eine eigenständige Schnittstelle ausgelegt ist, die darüber hinaus eine Steuereinheit und eine Kommunikationseinheit zum Übertragen des Betriebszustands des Eisenbahnweichenheizungssystems an eine entfernt gelegene zentrale Verarbeitungseinheit aufweist.
3. Weichenheizung-Validierungssystem nach Anspruch 1 oder 2, wobei die Kommunikationseinheit der Sensoreinheit und/oder die Steuerschnittstelle drahtlos ausgebildet und insbesondere für eine drahtlose mobile Kommunikation über ein Mobilfunknetz, insbesondere ein 2G GSM-, 2,5 G GPRS- oder EDGE-, 3G UMTS-, HSDPA- oder LTE-, 4G LTE Advanced-, 5G-, GSM-R- oder FRMRS-Netz, ausgelegt sind.
4. Weichenheizung-Validierungssystem nach einem der vorhergehenden Ansprüche, wobei die entfernt gelegene zentrale Verarbeitungseinheit zum Validieren des Eisenbahnweichenheizungssystems auf der Grundlage der empfangenen momentanen Temperatur und des ermittelten Betriebszustands des Eisenbahnweichenheizungssystems ausgelegt ist.
5. Weichenheizung-Validierungssystem nach einem der vorhergehenden Ansprüche, wobei das Weichenheizung-Validierungssystem ermittelt, ob die momentane Temperatur zu dem Zeitpunkt, zu dem die Steuerschnittstelle ermittelt hat, dass das Eisenbahnweichenheizungssystem aktiviert ist, einen vordefinierten Schwellenwert überschreitet.
6. Weichenheizung-Validierungssystem nach einem der vorhergehenden Ansprüche, wobei die Steuerschnittstelle (19) zum Aktivieren und Deaktivieren der einen oder mehreren Heizeinheiten des Eisenbahnweichenheizungssystems ausgelegt ist.
7. Weichenheizung-Validierungssystem nach Anspruch 6, wobei die Steuerschnittstelle (19) zum Einstellen eines Aktivierungszeitpunkts und/oder des Deaktivierungszeitpunkts der einen oder mehreren Heizeinheiten des Eisenbahnweichenheizungssystems und zum Einstellen einer Anzahl von zu aktivierenden und deaktivierenden Heizeinheiten des Eisenbahnweichenheizungssystems ausgelegt ist.
8. Weichenheizung-Validierungssystem nach einem der vorhergehenden Ansprüche, wobei die Sensoreinheit (17) mit mindestens einem Magnet zum Befestigen an der Schiene oder Weichenspitze der Eisenbahnweiche vorgesehen ist.
9. Weichenheizung-Validierungssystem nach einem der vorhergehenden Ansprüche, wobei die Steuerschnittstelle (19) zum Ermitteln von Betriebsparametern für die Eisenbahnweiche über die Schnittstelle ausgelegt ist.
10. Weichenheizung-Validierungssystem nach Anspruch 9, wobei die Betriebsparameter mindestens die Position der Bewegungsstangen der Eisenbahnweiche und/oder den Betriebszustand des Eisenbahnweichenmotors aufweisen.
11. Weichenheizung-Validierungssystem nach einem der vorhergehenden Ansprüche, wobei die Steuerschnittstelle (19) zum Ermitteln von Betriebsparametern des Eisenbahnweichenheizungssystems über die Schnittstelle ausgelegt ist.
12. Weichenheizung-Validierungssystem nach Anspruch 11, wobei die Betriebsparameter mindestens die Verfügbarkeit von Brennstoff, Elektrizität

und/oder die Verfügbarkeit einer Wärmequelle aufweisen.

13. Weichenheizung-Validierungssystem nach einem der vorhergehenden Ansprüche, wobei die Steuerschnittstelle (19) und die Sensoreinheit (17) darüber hinaus ausgelegt sind, eine Gruppierungskennzeichnung aufzuweisen, mit welcher Steuerschnittstellen und Sensoreinheiten einer Vielzahl von Weichenheizung-Validierungssystemen gruppiert werden können, um Eisenbahnweichenheizungssysteme in Gruppen zu validieren.
14. Weichenheizung-Validierungssystem nach Anspruch 6, wobei die Steuerschnittstelle (19) und die Sensoreinheit (17) darüber hinaus ausgelegt sind, eine Gruppierungskennzeichnung aufzuweisen, mit welcher Steuerschnittstellen und Sensoreinheiten einer Vielzahl von Weichenheizung-Validierungssystemen gruppiert werden können, um Eisenbahnweichenheizungssysteme in Gruppen zu aktivieren und deaktivieren.

#### Revendications

1. Système de validation de chauffage d'aiguillage pour valider l'état de fonctionnement du système de chauffage d'aiguillage de chemin de fer (16, 18) pour chauffer un aiguillage de chemin de fer (10), le système de validation de chauffage d'aiguillage comprenant :
- une unité de détection (17) qui est configurée pour être fixée à un rail (11, 12) ou à une pointe d'aiguillage (13, 14) de l'aiguillage de chemin de fer, pour mesurer une température momentanée de l'aiguillage de chemin de fer ;
  - une interface de commande (19) configurée pour communiquer avec une unité de commande du système de chauffage d'aiguillage de chemin de fer, pour établir l'état de fonctionnement du système de chauffage d'aiguillage de chemin de fer qui définit si une ou plusieurs unités de chauffage du système de chauffage d'aiguillage de chemin de fer sont activées ou désactivées ; et
  - une unité de communication configurée pour transmettre la température momentanée et l'état de fonctionnement du système de chauffage d'aiguillage de chemin de fer à une unité centrale de traitement située à distance, **caractérisé en ce que** le système de validation de chauffage d'aiguillage valide l'état de fonctionnement du système de chauffage d'aiguillage de chemin de fer sur la base de la température momentanée établie et de l'établissement, via l'interface de commande, de l'activation du sys-

tème de chauffage d'aiguillage de chemin de fer.

2. Système de validation de chauffage d'aiguillage selon la revendication 1, dans lequel l'unité de détection (17) est configurée comme un capteur autonome, comprenant en outre une alimentation électrique, une unité de commande et une unité de communication pour communiquer avec et transmettre la température momentanée à l'unité centrale de traitement située à distance, dans lequel l'interface de commande est configurée comme une interface autonome, comprenant en outre une unité de commande et une unité de communication pour transmettre l'état de fonctionnement du système de chauffage d'aiguillage de chemin de fer à une unité centrale de traitement située à distance.
3. Système de validation de chauffage d'aiguillage selon la revendication 1 ou 2, dans lequel une ou plusieurs de l'unité de communication de l'unité de détection et de l'interface de commande est/sont conçue(s) de manière à être sans fil, et en particulier configurée(s) pour une communication mobile sans fil sur un réseau de téléphonie mobile, en particulier un réseau 2G GSM, 2,5 G GPRS ou EDGE, 3G UMTS, HSDPA ou LTE, 4G LTE Advanced, 5G, GSM-R ou FRMRS.
4. Système de validation de chauffage d'aiguillage selon l'une des revendications précédentes, dans lequel l'unité centrale de traitement située à distance est configurée pour valider le système de chauffage d'aiguillage de chemin de fer sur la base de la température momentanée reçue et de l'état de fonctionnement établi du système de chauffage d'aiguillage de chemin de fer.
5. Système de validation de chauffage d'aiguillage selon l'une des revendications précédentes, dans lequel le système de validation de chauffage d'aiguillage établit si la température momentanée dépasse une valeur seuil prédéfinie au moment où l'interface de commande a établi que le système de chauffage d'aiguillage de chemin de fer est activé.
6. Système de validation de chauffage d'aiguillage selon l'une des revendications précédentes, dans lequel l'interface de commande (19) est configurée pour activer et désactiver la ou les plusieurs unités de chauffage du système de chauffage d'aiguillage de chemin de fer.
7. Système de validation de chauffage d'aiguillage selon la revendication 6, dans lequel l'interface de commande (19) est configurée pour ajuster un ou plusieurs d'un moment d'activation et du moment de désactivation de la ou des plusieurs unités de chauffage du système de chauffage d'aiguillage de che-

min de fer, et ajuster un nombre d'unités de chauffage à activer et désactiver du système de chauffage d'aiguillage de chemin de fer.

8. Système de validation de chauffage d'aiguillage selon l'une des revendications précédentes, dans lequel l'unité de détection (17) est munie d'au moins un aimant pour être fixé au rail ou à la pointe d'aiguillage de l'aiguillage de chemin de fer. 5  
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9. Système de validation de chauffage d'aiguillage selon l'une des revendications précédentes, dans lequel l'interface de commande (19) est configurée pour établir, via l'interface, des paramètres de fonctionnement pour l'aiguillage de chemin de fer. 15
10. Système de validation de chauffage d'aiguillage selon la revendication 9, dans lequel les paramètres de fonctionnement comprennent au moins un ou plusieurs de la position des tringles de déplacement de l'aiguillage de chemin de fer et de l'état de fonctionnement du moteur d'aiguillage de chemin de fer. 20
11. Système de validation de chauffage d'aiguillage selon l'une des revendications précédentes, dans lequel l'interface de commande (19) est configurée pour établir, via l'interface, des paramètres de fonctionnement du système de chauffage d'aiguillage de chemin de fer. 25  
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12. Système de validation de chauffage d'aiguillage selon la revendication 11, dans lequel les paramètres de fonctionnement comprennent au moins un ou plusieurs de la disponibilité de carburant, de l'électricité et de la disponibilité d'une source de chaleur. 35
13. Système de validation de chauffage d'aiguillage selon l'une des revendications précédentes, dans lequel l'interface de commande (19) et l'unité de détection (17) sont en outre configurées pour comprendre une identification de regroupement avec laquelle des interfaces de commande et des unités de détection d'une pluralité de systèmes de validation de chauffage d'aiguillage peuvent être regroupées, pour valider des systèmes de chauffage d'aiguillage de chemin de fer en groupes. 40  
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14. Système de validation de chauffage d'aiguillage selon la revendication 6, dans lequel l'interface de commande (19) et l'unité de détection (17) sont en outre configurées pour comprendre une identification de regroupement avec laquelle des interfaces de commande et des unités de détection d'une pluralité de systèmes de validation de chauffage d'aiguillage peuvent être regroupées, pour activer et désactiver des systèmes de chauffage d'aiguillage de chemin de fer en groupes. 50  
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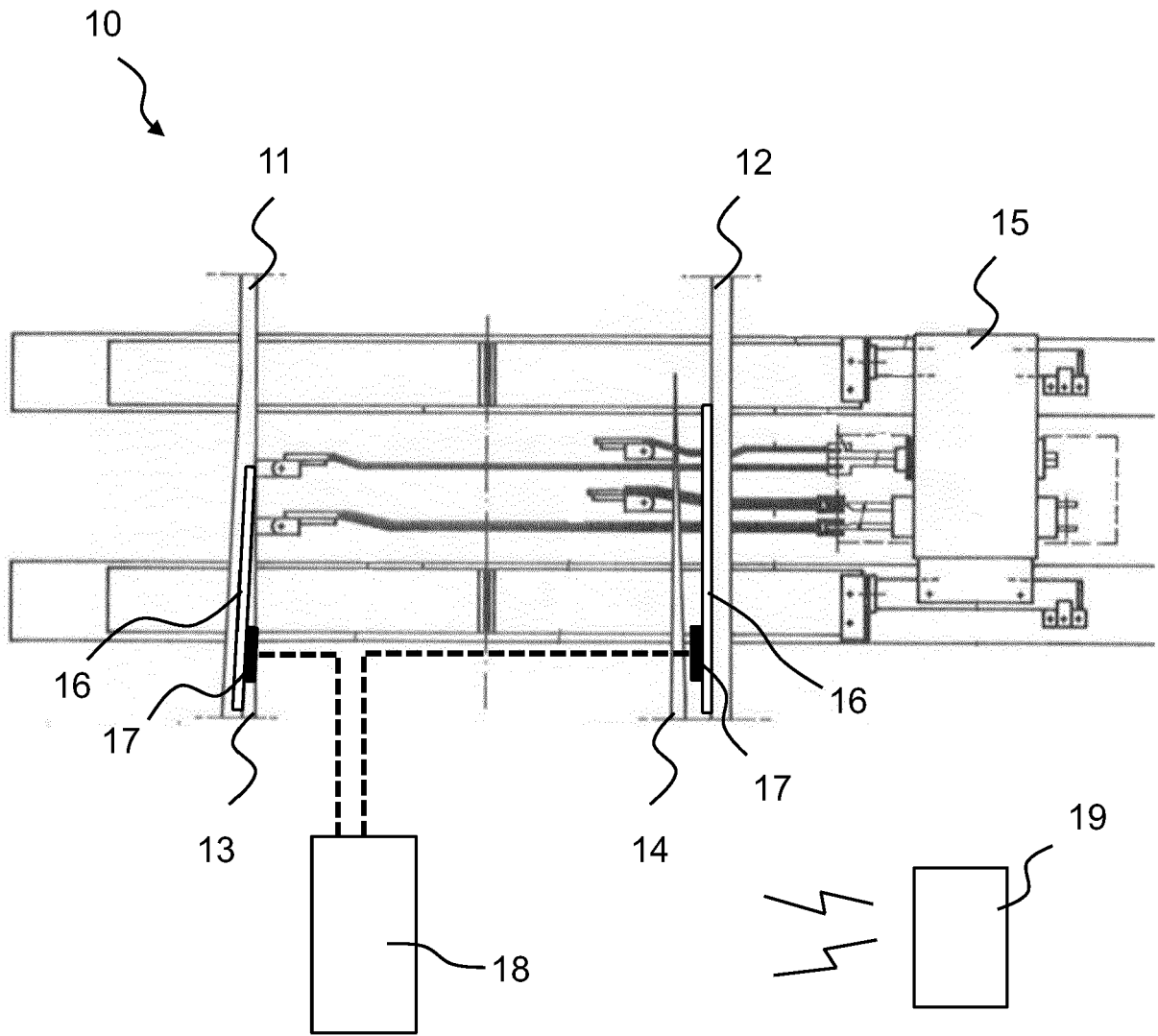


Fig. 1

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

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