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C. M. CREWS

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ELECTRICAL INDICATING SYSTEM

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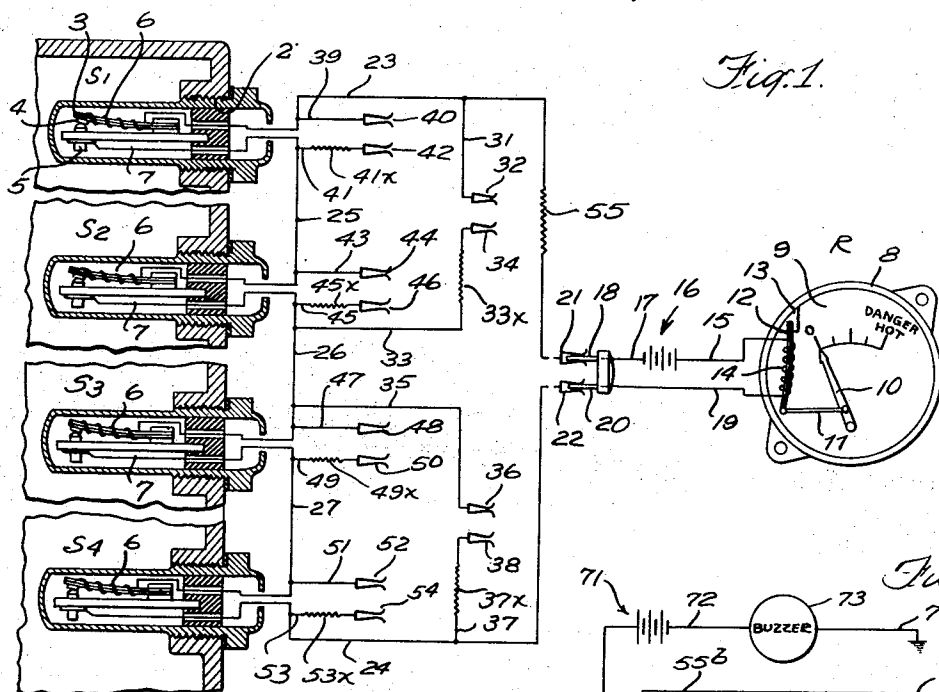


Fig. 1.

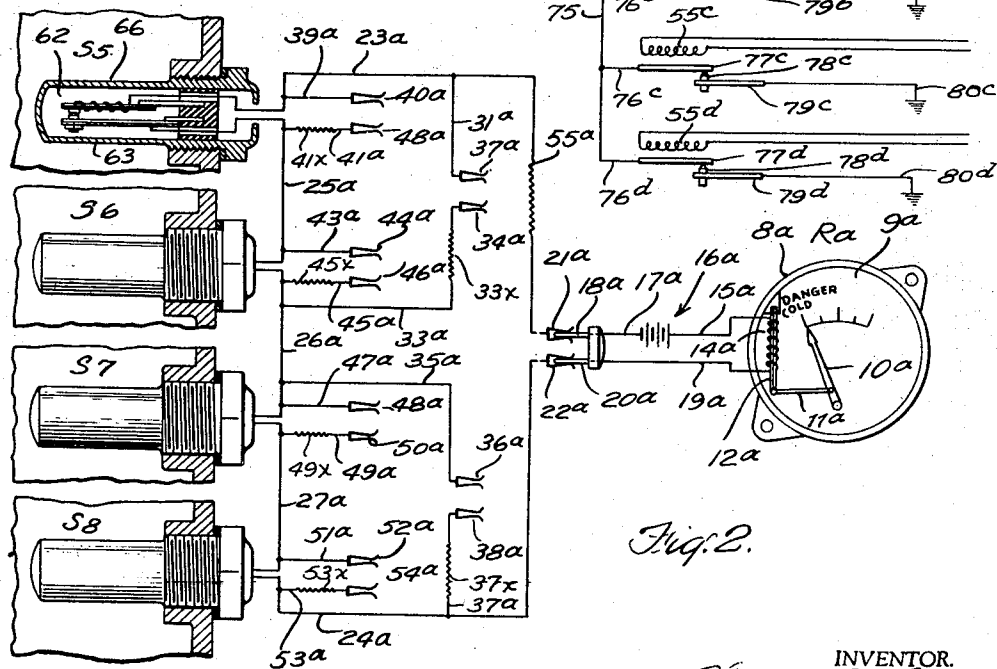


Fig. 2.

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 ATTORNEYS

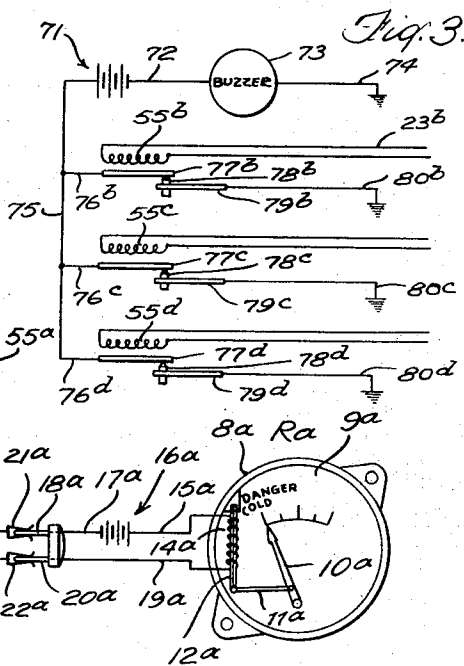


Fig. 3.

UNITED STATES PATENT OFFICE

2,558,736

ELECTRICAL INDICATING SYSTEM

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Continuation of application Serial No. 740,765,
June 17, 1944. This application November 4,
1948, Serial No. 58,189

8 Claims. (Cl. 177—311)

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This invention relates to a novel electrical indicator system in which one or more indicating or controlling instruments, herein called receivers, are made responsive in common to two or more senders located in different environments, the construction and arrangement being such that the receiver or receivers will show always the condition existing in the environment of one or another of the senders depending upon which sender is exposed to a condition most nearly approaching a condition of danger. Such an instrument is of great practical utility, as will be more readily evident if a concrete illustrative example be considered.

On a railway car, a multiplicity of journal boxes is provided. These boxes are loaded with oil soaked cotton waste for lubricating bearing surfaces. At times hot boxes develop through failure of proper lubrication, and these have been known to cause mechanical failures and to result in catastrophic wrecks involving a heavy toll in injury and loss of life. The condition of danger in a railway journal box is a condition of high temperature.

It is not important that the trainman having the matter in charge be continuously informed of the actual operating condition at every journal box on the train, but it is important that he be kept informed of the condition of the hottest journal box. Not only is he in a position when armed with this information to stop the train if the condition becomes truly dangerous, but he is also in a position, when coming into a station, to take appropriate action whenever a condition approaching danger has been observed during the run into the station.

It would be expensive in the matter of first installation, and also in the matter of supervision and repair of equipment, to undertake to provide a separate indicating receiver for every journal box on a train. A separate sender must be provided, but it is very desirable from the standpoint of economy and convenience either that all the senders or a considerable group of them, as for example all the senders on a car, work into a common receiver.

In accordance with the present invention, a way has been contrived for causing a multiplicity of senders to work into a common indicating receiver in such fashion that the sender whose environment most nearly approaches a condition of danger controls the receiver, and causes the condition existing in its environment to be continuously shown by the receiver.

It is a further object of the invention, in an

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instrument of the kind referred to, to provide means for quickly determining, by a process of elimination, which one of the senders is in the most dangerous environment, that is, which one of the senders has produced an indication of danger or an indication showing that the dangerous condition is closely approached.

While the condition of danger in connection with railway journal boxes is one of high temperature, in other situations the condition feared may be dangerously low temperature, as when there is danger of injury arising through freezing. The present invention contemplates dealing with this kind of situation upon exactly the same principle outlined above in connection with railway journal boxes. That is to say, the system is so contrived that the receiver will be controlled by the sender which is in the coldest environment, continuously to indicate the temperature in that environment. The principle of elimination for locating the offending environment is followed in this latter instance the same as in the former.

The salient feature of novelty is the connecting of the senders in series with one another and with one or more receivers, and thereby indicating the temperature of the hottest or the coldest one of the senders. In some installations the senders may be connected in series with more than one receiver, which additional receivers may be connected in parallel with one of the receivers. In any case a receiver may take the form either of an indicating instrument or of a controlling mechanism.

Other objects and advantages will hereinafter appear.

In the drawing forming part of this specification,

Figure 1 is a diagrammatic view illustrating a system in which several senders are connected in common to a single receiver under conditions such that the condition of danger is one of high temperature;

Figure 2 is a view, similar to Figure 1, but illustrating a system in which several senders are connected in common to a single receiver under conditions such that the condition of danger is one of low temperature; and

Figure 3 is a diagrammatic view showing how a number of the multiple sender systems can be made to feed into a single, more comprehensive warning system.

This application is a continuation of application Serial No. 540,765, filed June 17, 1944, en-

titled Electrical Indicating Systems, now abandoned.

In the system of Figure 1, the senders are of the type disclosed in United States Letters Patent to Theodore J. Smulski, No. 1,989,828, granted February 5, 1935, and the receiver is also of the type illustrated in said patent.

There are four senders, S₁, S₂, S₃ and S₄ as illustrated, all connected to a receiver R. The senders are all duplicates of one another so that a description of one will suffice for all. The sender S₁ comprises a casing 1, which is adapted to be threaded into a threaded bore 2, formed in the wall of a journal box or of any other piece of machinery whose temperature is of interest. Within the casing 1 a bimetallic element 3 is anchored at one end and is provided at its opposite end with an electrical contact 4 for cooperative engagement with an adjustable but normally stationary contact 5. An electrical heating element 6 is associated with the bimetallic element 3 for heating it and is connected at one end to the contact 4. The contact 5 is connected to a wire 7.

The receiver R comprises a casing 8, a dial 9, a pointer 10, and an operating link 11 connected to the pointer. A bimetallic strip 12 is anchored at one end in a block 13 forming part of the casing 8, and is pivotally connected at the other end to the link 11 so that the pointer 10 is actuated in response to deformation of the bimetallic strip 12 with changes of temperature.

An electrical heating element 14 is associated with the bimetallic strip 12 for heating it. The heating element 14 is connected through a conductor 15 with one terminal of a battery 16. The other terminal of the battery 16 is connected through a conductor 17 with one terminal prong 18 of the receiver unit. A conductor 19 connects the heating element 14 with the other terminal prong 20 of the battery-receiver unit. The prongs 18 and 20 are adapted to be inserted, respectively, in terminal sockets 21 and 22 of conductors 23 and 24. The conductor 23 is connected to the wire 6 of sender S₁. The wire 7 of sender S₁ is connected through a conductor 25 with the wire 6 of sender S₂. The wire 7 of sender S₂ is connected through a conductor 26 with the wire 6 of sender S₃. The wire 7 of sender S₃ is connected through a conductor 27 with the wire 6 of sender S₄. The wire 7 of sender S₄ is connected to conductor 24. Thus the receiver R, the battery 16, and the four senders S₁, S₂, S₃ and S₄ are connected in a series circuit.

Before undertaking to explain the behavior of the several senders in the circuit described, it is thought desirable to explain briefly the action of a single one of the senders when connected in series with the battery and with the receiver. For this purpose let it be assumed that the wire 7 of sender S₁ is connected directly to conductor 24, and that the senders S₂, S₃, and S₄ do not exist. The battery 16 sends current through the wire 6, contacts 4 and 5, and heater element 14, until the bimetallic element 3 has been bent upward under the combined influence of environmental heat and heat supplied by the element 6 to carry the contact 4 out of engagement with the contact 5. While the bimetallic element 3 is being thus heated by the heating element 6, the bimetallic element 12 is being similarly heated by the heating element 14. When contact 4 leaves engagement with contact 5, however, there is no further electrothermal heating either in the sender or in the receiver, and the element 3 cools and

straightens out until contact 4 again engages contact 5. Again 3 and 12 are heated by the flow of electric current until 4 is again withdrawn from engagement with 5. This process goes on indefinitely. The wattage converted to heat energy by the element 6 of the sender is always exactly proportional to the wattage converted to heat energy by the element 14 of the receiver. The elements being connected in series with one another transmit exactly the same current (measured in amperes), while the voltage drops across the two heating elements 6 and 14 are proportional to the resistances of the respective elements. Whether the energy be designated in watts or calories, the ratio of the electrical energy converted to heat at the sender and at the receiver is constant, and this holds true regardless of possible variations of source voltage, and regardless of the introduction into or withdrawal from the system of other resistance elements in series with the one under discussion.

For a given environmental temperature of the sender, the same number of watt hours will be converted to heat per hour at the receiver regardless of source voltage variations or resistance variations of the circuit. If the voltage drops at 6 and 14 are reduced, the circuit simply remains closed a greater proportion of the time so that an unvarying number of watt hours are converted to heat at the sender and at the receiver per unit of time. The indicator system of the type illustrated may, therefore, be appropriately referred to as of the wattage integrator type.

At the sender the contact 4 will leave engagement with contact 5 at or just below the danger temperature, the contact 5 being so adjusted as to assure that mode of operation. At that temperature the bimetallic element 3 is under no mechanical strain, since its shape and attitude is produced entirely by thermal effects. When the temperature at the sender environment is below the danger temperature, the element 3 is under mechanical strain. The greater the difference between the environmental temperature and the danger temperature, the greater will be the initial mechanical strain of the strip 3, and the greater will be the quantity of electrical energy which must be supplied and converted to heat in order to remove the mechanical strain and permit the contact 4 to stand out of engagement with the contact 5. It will thus be seen that the wattage converted to heat at the element 6 varies with temperature, there being more wattage consumed when the environmental temperature is low and less and less as the environmental temperature becomes higher and higher until the circuit stands constantly open when the danger temperature is reached, so that no wattage is consumed under that condition.

In accordance with the present invention, as many sender units as desired may be connected in series with one another, and for illustrative purposes a system comprising four senders has been chosen.

If, now, the journal box associated with sender S₁ is running hotter than any of the others, the contacts of S₁ will open first. This must be so for the reason that the same electrical energy is being converted to heat at each of the elements 6 of the senders S₁, S₂, S₃ and S₄, but that electrothermal input is being added to the heat representing the highest base temperature at sender S₁. As soon as the contacts 4 and 5 of sender S₁ separate, current ceases to flow in all of the elements

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6 of the senders S_1 , S_2 , S_3 , and S_4 , and all of them cool simultaneously. This cooling will continue until contacts 4 and 5 of sender S_1 become re-engaged. Now the current will flow again through the heating elements of the several senders, but again the sender S_1 has started from a higher temperature than the others, and again it will open first.

It will be seen, therefore, that the sender S_1 will always be the one to have its contacts open and that the temperature of sender S_1 will always be indicated on the receiver R , under the conditions stated, the others having no effect upon the receiver.

Should the environment of sender S_2 become higher than that of sender S_1 , however, the contacts 4 and 5 of sender S_2 will open ahead of the corresponding contacts of sender S_1 . In that event the sender S_1 will become ineffective, and the sender S_2 will take over control of the receiver, the environmental temperature of S_2 being now continuously indicated on the receiver.

Similarly the sender S_3 or the sender S_4 may be the controlling one. The receiver will always indicate the environmental temperature of that sender which is in the hottest environment.

Not only is the operator warned of danger when a dangerous condition exists at any one of the senders, but whenever any one of the senders threatens to approach a dangerously high temperature, the operator is warned of the fact, and is enabled to observe the action on the receiver, and to judge how far he may go safely before taking precautionary measures.

In a system like that of Figure 1, the dangerous condition is represented by a condition of no current flow, and since the senders S_1 , S_2 , S_3 and S_4 are all set to open at the same temperature, at or a little below the danger temperature, any one of the senders is capable of causing the danger indication to be given on the receiver.

Since the receiver R is common to a plurality of senders, the operator cannot know which one of the senders is controlling the receiver, but he only knows either (a) that the environmental temperatures of all the senders are in the normal range, or (b) that the environmental temperature of at least one of the senders is abnormally hot, and threatening to reach the danger temperature, or (c) that a dangerous condition exists in at least one sender environment.

When a condition of danger is indicated by the receiver, or when a condition of threatened danger is indicated under circumstances such that investigation and correction are convenient, steps are taken to ascertain which sender environment is responsible for the abnormal indication, and to correct the condition which has caused the abnormal heating to occur.

As illustrated in Figure 1, there are four senders. This is fewer senders than there are journal boxes on a passenger railway car, but it is a number of senders adequate to illustrate the principle of elimination employed in spotting the responsible sender. In actual practice there would always be one sender for each environment which is of interest.

Conductor 23 is connected through a conductor 31 with a terminal socket 32, while conductor 25 is connected through a conductor 33 with a terminal socket 34. By withdrawing the prongs 18 and 20 of the battery-receiver unit from the sockets 21 and 22, and inserting them in the sockets 32 and 34, the battery-receiver unit is connected in series with senders S_1 and S_2 . If,

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now, the receiver does not indicate an abnormal condition as before, senders S_1 and S_2 are cleared of suspicion. The other half of the senders, namely, senders S_3 and S_4 , may be tested in the same way to confirm the fact that one of them is at fault. Conductor 26 is connected through a conductor 35 with a socket terminal 36 while conductor 24 is connected through a conductor 37 with a socket terminal 38. When the prongs 18 and 20 are placed in the sockets 36 and 38, the same abnormal condition should be shown on the receiver as was shown when all four of the senders were connected in series with the receiver.

This confirmatory test, however, would ordinarily be superfluous if senders S_1 and S_2 were cleared, and the operator could proceed directly to test senders S_3 and S_4 individually. Had it developed that one of the senders S_1 and S_2 was responsible for the abnormal indication, those senders would be tested individually after a preliminary test clearing senders S_3 and S_4 .

Conductor 23 is connected through a conductor 39 with a terminal socket 40, while conductor 25 is connected through a conductor 41 with a terminal socket 42. The prongs of the battery-receiver unit may be inserted in sockets 40 and 42 for testing the sender S_1 individually.

The conductor 25 is connected through a conductor 43 with a socket terminal 44 and conductor 33 is connected through a conductor 45 with a socket terminal 46. The socket terminals 44 and 46 are employed in the manner already indicated when testing sender S_2 individually.

Conductor 35 is connected through a conductor 47 to a socket terminal 48, while conductor 27 is connected through a conductor 49 with socket terminal 50. The socket terminals 48 and 50 are utilized for testing sender S_3 . Conductor 27 is connected through a conductor 51 with a socket terminal 52, and conductor 24 is connected through a conductor 53 with a socket terminal 54. The socket terminals 52 and 54 are utilized for testing sender S_4 individually.

It will be evident that the spotting of the offending sender can be very quickly arrived at. When the battery-receiver unit is plugged into the sockets 32 and 34, that immediately shows that half of the senders are clear, while the remaining half is still implicated. Only the senders of the implicated half need be further considered. The next test eliminates half of those remaining, or, in the case of only four senders, identifies the guilty one. If eight senders were employed, three tests would be necessary in order to identify the individual sender which is responsible. In other words, each test eliminates half of the senders from further consideration. If there are two senders, a single test will suffice. If there are more than two, but not more than four senders, two tests are necessary. If there are more than four, but not more than eight senders, three tests are necessary. If there are more than eight, but not more than sixteen senders, four tests are necessary, etc.

Resistors 33x, 37x, 41x, 45x, 49x, 53x and 55 are desirably provided, respectively, in conductors 33, 37, 41, 45, 49, 53 and 23, the resistance values being so chosen that the total resistance of the effective circuit is substantially the same regardless of the terminal sockets chosen to receive the prongs 18 and 20. In this way the instantaneous value of current flow is caused to be the same for all circuits and is kept as low as practicable under all conditions.

In the illustrative case of a railway train, all

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of the senders on a single car may be connected into a single system to operate a single indicating receiver, there being one sender on each journal box. Further signalling means may be provided for transmitting a signal up to the locomotive whenever an abnormal condition is present on any car, so that the engineer can send a trainman back to identify the receiver responsible for the indication. The car having been identified, the trainman will remain and watch the receiver on that car, signalling to the engineer to stop the train if a dangerous condition occurs, but permitting the train to continue so long as the condition is only one of threatened danger and it seems probable that the train can make a scheduled stop before any harm will result.

The system illustrated in Figure 2 is the same in its basic principles as the system illustrated in Figure 1. In this instance, however, the condition of danger is a dangerously cold condition, not a dangerously hot one, as in the former case. Such a system might be useful, for example, where there is a danger of injury by freezing in any one of a plurality of supervised locations.

Here the senders are designated S_5 , S_6 , S_7 and S_8 . Each sender comprises a casing 61 in which two bimetallic strips 62 and 63 are mounted, the strips being formed with contacts 64 and 65. A heating element 66 is associated with the bimetallic strip 62. The strip 62 is shorter than the strip 63 and both strips tend to be deflected upward in response to rise of temperature.

If it be assumed that the danger temperature is the freezing point of water, and that the contacts 64 and 65 are just barely out of engagement with one another at that temperature, then with rise of environmental temperature the tendency of strip 63 to raise contact 65 with increase of temperature is greater than the tendency of strip 62 to raise contact 64 with increase of temperature. Therefore the higher the environmental temperature the greater is the normal pressure between the contacts 64 and 65.

The external circuits in Figure 2 are the same in all respects as the external circuits of Figure 1, and accordingly corresponding reference characters have been applied to corresponding parts with the subscript a added in each instance, and no extended detailed description will be given.

The receiver R_a differs from the receiver R in that the bimetallic element 12 a tends to move the pointer 10 a toward the right as its temperature is increased, whereas the element 12 of Figure 1 tended to move the pointer 10 toward the left as the temperature of the element 12 was increased. This reversal of law may be brought about simply by reversing the bimetallic element side for side in the receiver.

In Figure 1 less and less wattage was converted to heat at 6 and 14 as the temperature rose, whereas in Figure 2, because of the different sender employed, more and more wattage is converted to heat at 66 and 14 a as the temperature rises.

With the arrangement disclosed in Figure 2, if it be assumed that all senders are located in environments well above the freezing point, all of them will transmit energy to the receiver until the contacts of one of the senders open. This opening will occur in the sender which is located in the coldest environment, for in that sender the strip 62 is stressed the least by the strip 63 and therefore the least electrothermal energy is required to bring about a separation of the contacts 64 and 65 carried by the strip. This sender

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which is in the coldest environment will control the reading of the receiver R_a , and the other sender contacts will not open. Should it develop, however, that the environment of one of the other senders becomes the coldest, then that sender will supersede the first in controlling the indications given by the receiver R_a .

When a condition requiring investigation is observed on the receiver R_a , the elimination principle is followed, the same as has been already described in connection with Figure 1.

Where there are a great number of environmental temperatures to be considered, as in the case of the journal boxes on a railway train, it is not desirable practice to undertake to connect senders at all the journal boxes in series with one another to feed into a common receiver. This would obviously make available a very low voltage drop at each sender, unless a voltage source of very high potential were employed. For mechanical reasons, also, it is more advantageous in such a case to combine all of the senders on a single car into a single system for influencing a single receiver, but to make additional provision for informing the engineer in the locomotive when a condition of danger threatens.

A simple system for conveying warning information to the engineer is diagrammatically illustrated in Figure 3.

Here a battery 71 is provided on the locomotive which is connected through a conductor 72 to one terminal of a buzzer 73. The other terminal of the buzzer is connected through a conductor 74 to ground. The opposite terminal of the battery is connected to a line conductor 75 which through any one of a number of parallel circuit elements may be connected to ground so as to close a buzzer operating circuit.

It will be observed that there is included in Figure 1 a showing of a heater element 55 as a part of the conductor 23, and that a similar heater element 55 a is included in Figure 2 as a part of conductor 23 a . Heater elements corresponding to 6 and 66 respectively are illustrated in Figure 3 and designated, respectively, 55 b , 55 c and 55 d . The conductors in Figure 3 marked 23 b , 23 c and 23 d also correspond to the conductors 23 and 23 a of Figures 1 and 2.

Conductor 75 is connected through a conductor 76 b to a bimetallic strip 77 b which is associated with the heating element 55 b and adapted to be deformed by the heat supplied from the heating element. The conductor 77 b is normally in engagement with a contact 78 b which is threaded into a conductive support 79 b , the latter being connected to ground through a conductor 80 b . The contact 78 b is so adjusted that strip 77 b will be maintained out of engagement with it when the pointer 10 of Figure 1 is operating in the normal range, that is, neither at a dangerous temperature nor at an abnormally high temperature, threatening danger, but so that the circuit will close when the temperature rises to a point which is abnormally high and which does seem to threaten danger.

The parallel circuit elements from conductor 75 to ground, corresponding to the elements 76 b to 80 b , inclusive, are designated, respectively, 76 c to 80 c and 76 d to 80 d . With this kind of arrangement, the heating element 55 of Figure 1 is caused to control one of the parallel paths through which the buzzer sounding circuit may be completed, and each of the additional parallel paths is correspondingly controlled by a like heating element of another like system. Since the

buzzer will sound as soon as an abnormal or threatening temperature range is reached in any one of the circuits, there will be ample time for the engineer to dispatch someone to examine the receivers on the several cars to ascertain which car is responsible for the abnormal indication, and to remain and observe developments if a condition of danger is not so imminent as to demand that immediate corrective steps be taken.

The scheme illustrated in Figure 3 may be applied with equal advantage to a plurality of systems like that illustrated in Figure 1 or like that employed in Figure 2.

I have described what I believe to be the best embodiment of my invention. I do not wish, however, to be confined to the embodiments shown, but what I desire to cover by Letters Patent is set forth in the appended claims.

What I claim is:

1. A continuously operable electrical indicator system comprising, in combination, a transmission circuit, a plurality of senders located in different but similar environments and connected in the circuit in series with one another, each sender being responsive to a temperature condition at each environment and including heat responsive means, a pair of contacts and a heating element associated with the heat responsive means for heating it to move one contact relative to the other contact, a source of electrical potential connected in the circuit in series with the senders, receiver indicating mechanism including an indicator, heat responsive means operatively connected to the indicator and a heating element associated with the heat responsive means for heating it to move the indicator, conductors connecting the heating element of the receiver mechanism in series with the heating elements of the senders, each of said senders being calibrated to cause the indicator to indicate in the receiver a temperature condition existing in the environment of a particular sender, said senders and receiver mechanism being of the wattage integrator type in which the wattages converted to power by the receiver and the controlling sender bear a constant ratio to one another and such wattages vary proportionally with departure of the environmental condition to be indicated from a dangerous temperature condition, the wattage converted to power at the receiver mechanism being controlled by that sender which is in the environment closest to the dangerous temperature condition, so that the receiver mechanism is caused always to indicate the temperature of any sender whose environment is most abnormal.

2. A continuously operable electrical indicator system for warning of, and indicating, abnormally high operating temperatures comprising, in combination, a transmission circuit, a plurality of senders located in different but similar operating environments where they may be exposed to different temperatures and connected in the circuit in series with one another, each sender including heat responsive means, a pair of contacts and a heating element associated with the heat responsive means for heating it to move one contact relative to the other contact, a source of electrical potential connected in the circuit in series with the senders, receiver indicating mechanism including an indicator, heat responsive means operatively connected to the indicator and a heating element associated with the heat responsive means for heating it to move the indicator, conductors connecting the heating element of the receiver mechanism in series with the heating ele-

ments of the senders, each of said senders are being calibrated to cause the indicator to indicate danger in the receiver when a dangerous temperature exists in the environment of a particular sender, said senders and receiver mechanism being of the wattage integrator type in which the wattages converted to power by the receiver mechanism and the controlling sender bear a constant ratio to one another and such wattages diminish proportionally as the temperature of the sender environment rises toward a dangerous temperature, the wattage converted to power at the receiver mechanism being controlled by that sender which is in the hottest environment so that the receiver mechanism is caused always to indicate the temperature of any sender whose environment is the hottest.

3. A continuously operable electrical indicator system comprising, in combination, a transmission circuit, a plurality of senders, each being constructed and arranged to indicate a condition to be indicated and all being located in different but similar environments and connected in the circuit in series with one another, a source of electrical potential connected in the circuit in series with the senders, each sender including heat responsive means, a pair of contacts and a heating element associated with the heat responsive means for heating it to move one contact relative to the other contact, a receiver calibrated in terms of the condition to be indicated, said receiver including an indicator, heat responsive means operatively connected with the indicator and a heating element associated with the heat responsive means for heating it to move the indicator, conductors connecting the heating element of the receiver in series with the heating elements of the senders, each of said senders being calibrated to cause the indicator to indicate danger in the receiver when a dangerous temperature exists in the environment of a particular sender, said senders and receiver being of the wattage integrator type in which the wattages converted to power by the receiver and the controlling sender bear a constant ratio to one another and such wattages vary proportionally with departure of the environment condition to be indicated from a dangerous temperature condition, the wattage converted to power at the receiver being controlled by that sender which is in the environment closest to the dangerous temperature condition so that the receiver is caused always to indicate the condition of the most abnormal environment, the source of electrical potential and the receiver forming a severable unit, and additional circuit means adapted for the application of said unit and adapted when the unit has been so applied to connect different sub-groups of series-connected senders selectively in series with the receiver, and to connect the senders individually in series with the receiver.

4. In an indicator system of the wattage integrator type, in combination, a source of electricity, a plurality of continuously operable temperature senders disposed in different environments, each sender including heat responsive means, a pair of contacts and a heating element associated with the heat responsive means for heating it to cause one contact to move relative to another contact, temperature indicating receiver mechanism, said receiver mechanism including a pointer, heat responsive means operatively connected with the pointer and a heating element associated with the heat responsive means, and con-

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nections electrically connecting the heating elements of said senders in series with one another the heating element of the receiver, and the source of said receiver mechanism in series with the source so that current will flow through all of the senders and receiver subject to the control of the sender which is closest to a dangerous temperature and thereby move the pointer to indicate the temperature of such sender.

5. An indicator system of the wattage integrator type, in combination, a source of electricity, a plurality of continuously operable senders each constructed and arranged to indicate an operating condition which may become dangerous, and each disposed in a different operating environment and including heat responsive means and a heating element, receiver indicating mechanism embodying a pointer, heat responsive means and a heating element, and connections electrically connecting the heating elements of said senders with one another and the heating element of said mechanism in series with the source so that current will flow through all of the senders and receiver subject to the control of the sender which is closest to a dangerous temperature and thereby cause the pointer of the receiver to indicate the temperature of such sender.

6. In an indicator system, in combination, a source of electricity, a plurality of temperature switches of the wattage integrator type disposed in different environments, each of said switches including heat responsive means and a heating element, temperature indicating receiver mechanism embodying heat responsive means and a heating element, and connections electrically connecting the heating elements of said senders and the heating element of said mechanism in series with the source so that current will flow through all of the senders and receiver subject to the control of the sender which is closest to a dangerous temperature and thereby indicate in the receiver the temperature of such sender.

7. An electrical indicator mechanism including a plurality of indicator systems each comprising, in combination, a transmission circuit, a plurality of senders located in different but similar environments and connected in the circuit in series with one another, a source of electrical potential connected in the circuit in series with the senders, a receiver calibrated in terms of a condition to be indicated, connected in series with the senders, said senders and receiver being of the wattage integrator type in which the wattages converted to power by the receiver and the controlling sender bear a constant ratio to one another and such wattages vary proportionally with departure of the environmental condition to be indicated from a dangerous temperature condition, the wattage converted to power at the receiver being controlled by that sender which is in the environment closest to the dangerous tem-

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perature condition so that the receiver is caused always to indicate the condition of the most abnormal environment, each said system including a heater element, and a general warning circuit common to the several systems comprising a warning instrument, a source of operating voltage in series therewith, and a plurality of temperature responsive, circuit closing switches disposed in parallel relation, each associated with, and controlled by, the heater element of one of said systems.

8. A continuously operable electrical indicating system comprising a transmission circuit, a plurality of senders located in different but similar environments and connected in the circuit in series with one another, each sender being responsive to a temperature condition at each environment and set to operate at a predetermined temperature, each sender also including heat responsive means, a pair of contacts and a heating element associated with the heat responsive means for heating it to move one contact relative to the other contact in accordance with the temperature of its environment, a source of electrical potential connected in the circuit in series with the senders, receiver indicating mechanism including an indicator, heat responsive means operatively connected to the indicator and a heating element associated with the heat responsive means for heating it to move the indicator in relation to the temperature at the environment of a sender, conductors connecting the heating element of the receiver mechanism in series with the senders, said senders and the receiver mechanism being of the wattage integrator type in which the wattage is converted to power by the receiver and the controlling sender bear a constant ratio to one another and such wattages vary proportionally with departure of the environmental condition to be indicated from a dangerous temperature condition, the wattage converted to power at the receiver mechanism being controlled by that sender which is in the environment so that the receiver mechanism is caused always to indicate the temperature of any sender whose environment is most abnormal.

CLARENCE M. CREWS.

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