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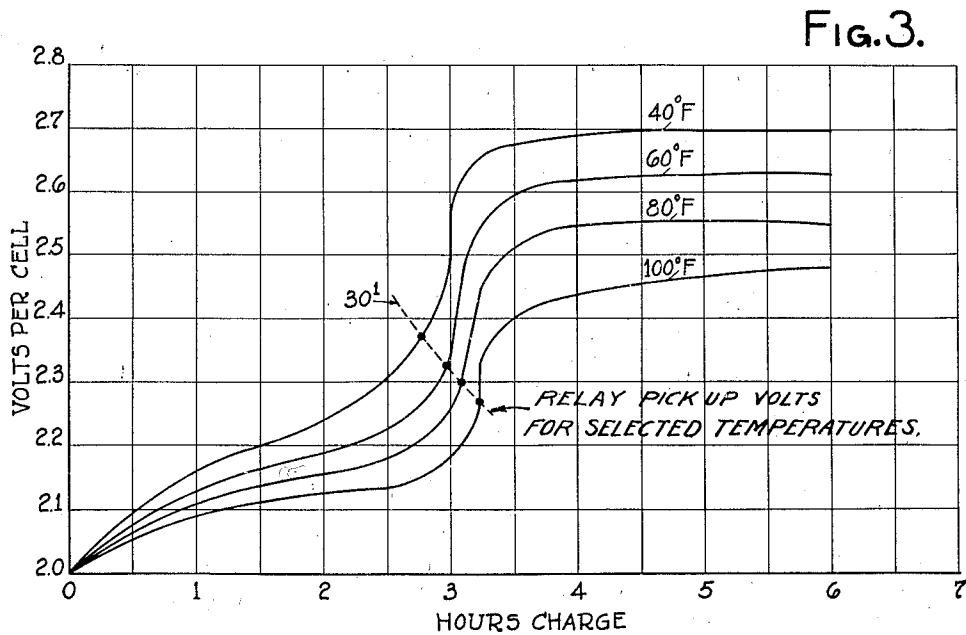
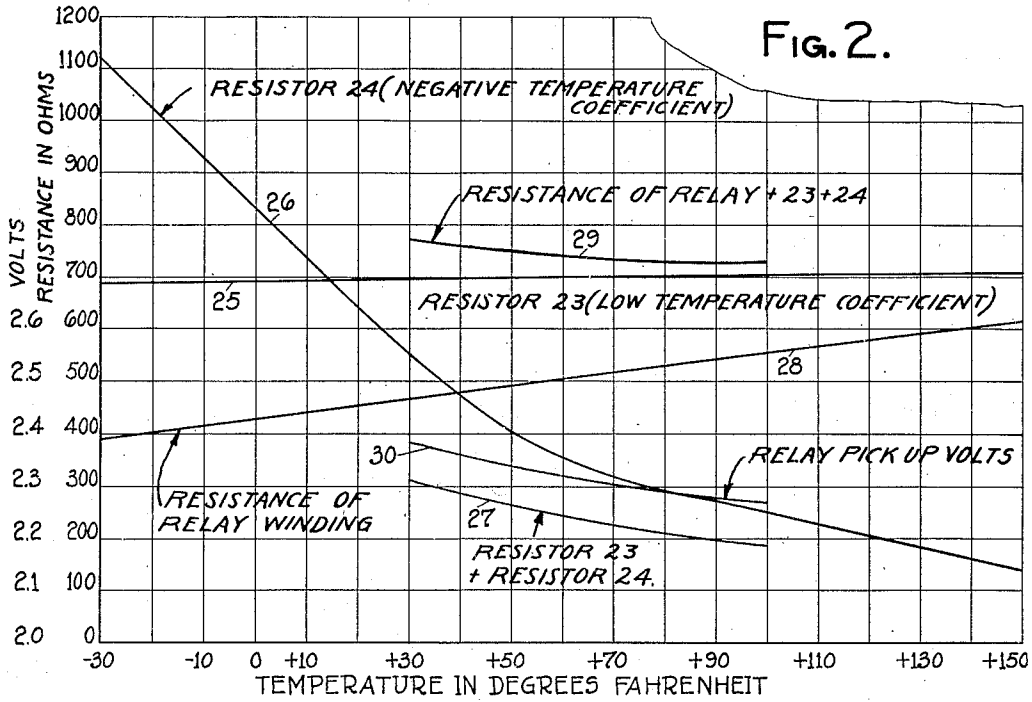
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RELAY TEMPERATURE COMPENSATING MEANS

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RELAY TEMPERATURE COMPENSATING MEANS

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This invention relates in general to relays for railway and other uses, and has more particular reference to temperature compensating means for such relays used in variable rate battery charging systems.

The usual relay of this type includes a winding of copper wire and, hence, it has a positive temperature coefficient so that increase of temperature causes increase of resistance.

In general, the object of the present invention is to provide compensating means for relays so as to impart to the relay and its control circuit temperature coefficient qualities as desired, that is, to produce, for example, a negative temperature coefficient following any desired predetermined form of temperature-resistance curve.

Another specific object of the invention is to provide a relay suitable for use in the automatic control of a two-rate charging system for storage batteries. It is customary at various locations, such as highway crossings and the like, where a heavy load is drawn from a storage battery during occupancy of the track adjacent the location, to automatically shift from a high rate of charging to a low rate of charging. This shift should occur at a charging voltage just below the point where undesirable gassing of the storage battery occurs. Since the internal resistance of a storage battery of the lead type increases with decrease of temperature, an uncompensated relay which operated satisfactorily at one temperature is unsatisfactory at other temperatures, due to the fact that such a relay has a positive temperature coefficient of resistance. This invention provides compensating means whereby the control circuit and relay for such a system has a negative temperature coefficient of resistance of the proper form to operate satisfactorily over a wide range of temperatures.

Further objects, purposes and characteristic features of the invention will appear as the description progresses, reference being made to the accompanying drawings, showing, solely by way of example, and in no way in a limiting sense, two forms which the invention can assume. In the drawings:

Fig. 1 is a diagrammatic illustration of one form of the invention.

Figs. 2 and 3 are sets of curves applicable to the invention of Fig. 1.

Fig. 4 is a schematic view of a portion of a relay particularly adapted to be employed in this invention.

Referring now to Fig. 1, there is here shown a

circuit arrangement for charging a storage battery SB by way of a full-wave rectifier *rec*, from a charging transformer Tr which can receive its energy from any desired source, such as a power line or the like. Connected in series with the input side to the rectifier is an adjustable reactance 20, which is shunted out of the in-put circuit when a contact finger 21 of a relay 22 is in retracted position.

Relay 22 is compensated for temperature to impart to it the desired temperature coefficient characteristics, by means of a multiple arrangement of resistors including a negative temperature coefficient resistor 23 and a substantially zero temperature coefficient resistor 24 which can be made of suitable materials. For example, the negative temperature coefficient resistor 23 may be made of carbon, and thus assume any suitable form, while the resistor 24 can be any suitable material having a very low temperature coefficient, such as nichrome wire or the like, and in some cases such materials will have substantially zero temperature coefficient. This relay 22, in series with the multiple arrangement of resistors, is connected across the terminals of the storage battery SB in series with a contact finger TR and front point thereof. This contact finger TR can be operated in any suitable manner but is preferably the contact finger of a track relay, and, hence, is normally in an attracted position but assumes its retracted position upon occupancy of the section across which the track relay is connected, all, as well understood by those versed in this art.

The storage battery SB can supply any desired load such, for example, as the motor for operating a power operated crossing gate; or highway crossing signals, or the like, associated with the section of track including the relay 22.

Before describing the operation of the arrangement shown in Fig. 1, it is desired first to refer to Fig. 2. In this figure, the resistance-temperature characteristics of resistor 23 is shown by curve 26, and that of resistor 24, by curve 25. The combined series resistance of the multiple arrangement of resistors 23 and 24 is shown by curve 27. The resistance-temperature characteristics of the copper winding of the relay is shown by curve 28. The series combination of curves 27 and 28 gives the curve 29, which is the series temperature-resistance curve of the relay and its control circuit. The pick-up values of voltage for relay 22, for various temperature conditions, is shown by curve 30, and from this, it

can be seen that the relay, and its controlled circuit, has a negative temperature coefficient, and that it picks up at lower voltages as the temperatures increase, and vice versa.

For convenience in understanding the curves of Figs. 2 and 3, the curves of Fig. 2 have suitable legends applied thereto to indicate the characteristics which they represent. All of the curves except the curve 30 represent a plotting of the various resistance values for the various temperatures in degrees Fahrenheit; while the curve 30 is a plotting of the volts at which the relay 22 picks up for a range of temperatures using the left-hand vertical volt scale and the temperature scale at the base of the graph.

Referring now to Fig. 3, there is here shown a set of storage battery charging curves corresponding to different temperature conditions, as 40° F., etc., obtained by plotting, against charging voltage, the hours of charging. Superposed on these curves is a dotted curve 30¹ which is produced by reading the volts pick-up value from curve 30 of Fig. 2 for each of the particular degrees represented by the curves of Fig. 3 and marking points on these curves of Fig. 3 at these voltages. Thus, the dotted line 30¹ is a curve representing the pick-up values of voltage for control relay 22 at the various temperatures 40°, 60°, etc. The line 30¹ is made dotted because it is not a curve using the "hours charge" scale along the base of the graph.

In Fig. 3, as the charging of the storage battery continues, a point is reached where undesired and harmful gassing occurs, and this point on each of the four curves shown, occurs just beyond the point where these curves are crossed by the curve 30¹.

The significance of these curves of Fig. 3 is readily appreciated from a consideration of Fig. 1. In Fig. 1, it can be seen that under normal conditions, as represented in the figure, the storage battery is on a low rate of charge or what is commonly termed, "trickle charge," since the current limiting inductance 20 is included in the input side of the charging circuit.

Upon occupancy of its associated track section, relay contact finger TR releases to open the circuit of relay 22 and allow its contact finger 21 to close on its back point. This shunts out the current limiting inductance 20 to thereby place the battery on the higher charging rate. This continues until relay 22 picks up, which does not occur at least until after contact finger TR makes up its front point, and does not then occur unless the charging voltage across the terminals of the storage battery is sufficiently high.

For example, if the temperature of battery SB be 100° F., relay 22 will pick up when the terminal charging voltage reaches approximately 2.26, thus to place the battery on trickle charge, and avoid undesired gassing while, at the same time, insuring that the battery is fully charged. Should, however, the temperature of the battery be 40° F., the high rate of charging will continue until the terminal charging voltage reaches approximately 2.37° F.

In Fig. 1 the battery SB is shown as having but one cell, but it may as well have any desired number of cells. With more cells in series, the terminal voltage increases, and the relay 22 is controlled by varying the position of its core, which can be withdrawn, for example, as in the Day Patent 1,766,611, granted June 24, 1930.

In connection with this feature of charging various numbers of cells of storage batteries,

there is shown in Fig. 4 a form of relay which is particularly adapted for such use.

In Fig. 4 is shown, in a very schematic manner, a portion of a relay comprising a usual top-plate 40 which carries a magnetic structure comprising two spaced cores 41 and 42—53 magnetically connected together at one pair of ends by a back strap 43 having clamp means 44 and 45. Within the casing, which is closed by the top-plate 40, is an armature 46 pivoted as at 47 and shown in its attracted position in which it is against the pole shoes 48 and 49. The armature carries an operating member 50 which is effective to operate a contact finger or fingers. Carried in any convenient manner, as by connection to back strap 43, is a temperature compensating unit CU which can be constructed in accordance with the units above described for compensating the relay over a wide range of temperatures to follow an energizing current curve of any desired form.

In this relay, one of the cores, as 42—53, is made up of the separate portions 42 and 53 connected as by a stud 54 made of non-magnetic material such as brass or the like. This stud is held against turning in the lower core portion 53, while the upper core portion 42 is provided with a slot or the like 55 whereby the core portion 42 can be turned on stud 54 so as to open up any desired size of air gap between the ends of the two core portions 42 and 53. In this way, a pick-up value of current for the relay can be obtained varying over a very wide range, and thus, with this minor adjustment, the same relay can be employed for charging storage batteries having a wide range of cells, and for other analogous purposes.

From the above, it can be seen that the proper voltages, at various temperatures for insuring full charge of the storage battery while preventing harmful gassing thereof, have been determined, and a relay has been produced so compensated for temperature as to properly control this battery charging.

It can be noted from Fig. 2 that in the case of a battery charging control relay, the multiple compensating means used in series with the relay winding is of a total series resistance which is small as compared to the resistance of the relay winding to thus make for efficiency in operation.

Furthermore, in connection with Fig. 1, with the use of compensating means in accordance with this invention, it has been found practical to employ a relatively high resistance relay whereby to prevent undue leakage of energy from the storage battery as the relay and its associated parts are connected across the storage battery except when contact finger TR is open.

In connection with the above description, and the various curves in the drawings, definite values have been assigned to the various resistance elements employed in this invention. These values, however, can be varied widely so as to bear largely varying relationships to each other without departing from the spirit of this invention.

With regard to the relays that are compensated, it is not necessarily the case that the windings of the relays be composed entirely of copper wire. In some cases, where added resistance is desired, due to the employment of a relatively high operating voltage, and where it is undesired to employ a too fine wire, a varying part of the winding may well be of a wire which has a substantially zero temperature co-

efficient, such as "Ideal" wire. This portion of the winding, which is not of copper, can be small or large relatively depending upon the surrounding conditions. In such event, the complete relay winding, so long as it contains any copper and does not contain too much of any material having a negative temperature coefficient, will still have a positive temperature coefficient, but its curve will be less steep than the corresponding curves referred to above, so that the compensating resistors 23 and 24 must be selected accordingly.

The above rather specific description of one form which the present invention can assume, has been given wholly by way of example and is not intended in any manner whatsoever in a limiting sense. It is to be understood that various modifications, adaptations and alterations may be applied to meet the requirements of practice, without in any manner departing from the spirit or scope of the invention, except as limited by the appended claims.

Having described our invention, we now claim:

1. In a variable rate battery charging organization, a storage battery, means including a source of electrical energy and a series reactance for normally supplying said storage battery with a charge at a relatively low rate, a control relay having contacts for shunting said series reactance when the control relay is dropped away to cause the charging of said storage battery at a relatively high rate, a temperature compensating unit, and circuit means connecting said control relay across the storage battery in series with said temperature compensating unit, said temperature compensating unit including two resistors in multiple one having a relatively low positive temperature coefficient of resistance and the other having a negative temperature coefficient of resistance, their respective resistances being so selected as to vary the current through the control relay dependent upon the various changes in the ambient temperature so that the relay receives effective pick up current at the battery voltages for the various temperatures which are just below the voltages at which excessive gassing of the battery would occur at such temperatures.

2. In a variable rate battery charging organization, a storage battery, a control relay having contacts for changing the rate of charge of said battery from a high rate to a relatively low rate when said control relay is picked up, and a circuit connecting said control relay in multiple with said battery and including the copper winding of said control relay in series with a multiple unit resistance constituting a resistor of carbon in parallel with a resistor of nichrome, the value of the resistance of the copper winding, and that of the two multiple resistors, through a pre-

scribed ambient temperature range, being such as to impart a negative temperature coefficient of resistance to the circuit as a whole, to cause the pick-up values of voltage for said control relay at the different temperatures of the range to pass through those values of battery charge voltages for such temperatures just above which harmful gassing in said storage battery would occur if charging continued at said high rate.

3. In a variable rate battery charging organization, a charge rate controlling relay of the externally adjustable reluctance type having contacts for changing the rate of charge of said battery from a high rate to a relatively low rate when said relay is picked up, and a circuit connecting said relay in multiple with said battery and including the copper winding of said relay in series with a multiple unit resistance constituting a resistor of carbon in parallel with a resistor of nichrome, the value of the resistance of the copper winding and that of the two multiple resistors being such as to impart a temperature coefficient of resistance to said circuit as a whole substantially corresponding to the temperature coefficient of the internal resistance of said battery, whereby said relay may have its reluctance externally adjusted to have at the existing temperature a pick-up value of voltage just below the voltage at which said storage battery would unduly gas at that temperature and thereby be adjusted to pick up to reduce the charging rate at the proper voltage for various ambient temperatures for both battery and relay.

4. In a variable rate battery charging organization, a charge rate controlling relay having contacts for governing the rate of charge of a battery so as to provide a relatively high rate when the relay is dropped away and a relatively low rate when the relay is picked up, a temperature compensating unit connected in series with said relay and comprising a resistor having a relatively low positive temperature coefficient of resistance connected in multiple with a resistor having a negative temperature coefficient of resistance, their respective resistances being such as to impart a negative temperature coefficient of resistance to the series combination as a whole substantially corresponding to the negative temperature coefficient of the internal resistance of a typical lead storage battery, and means associated with said relay for varying its voltage pick up value to correspond with the battery charge voltage for the existing temperature of a selected battery just above that voltage at which harmful gassing in such battery would occur if charging continued at the high rate.

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