W. K. McIVER.

AUTOMATIC LIGHTING SYSTEM.

APPLICATION FILED APR. 26, 1916.

1,288,947.

Patented Dec. 24, 1918.

Fig. 1.

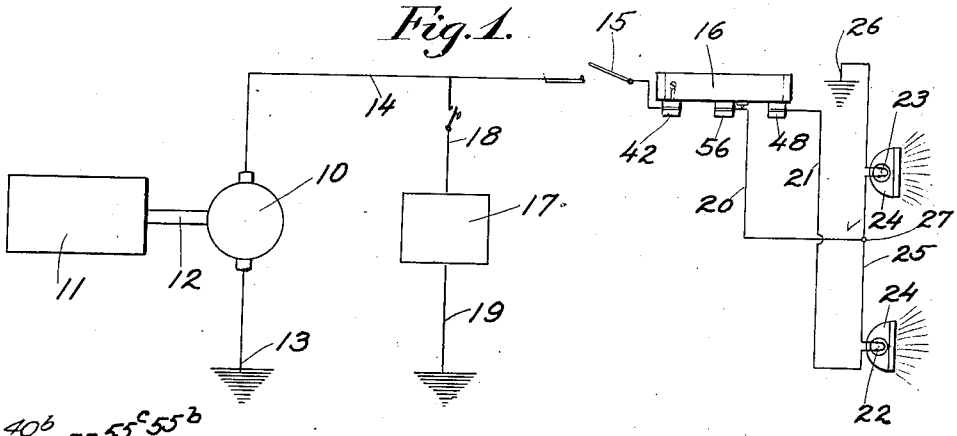


Fig. 2.

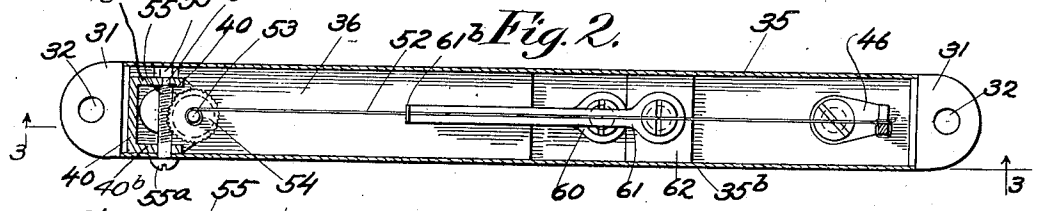


Fig. 3.

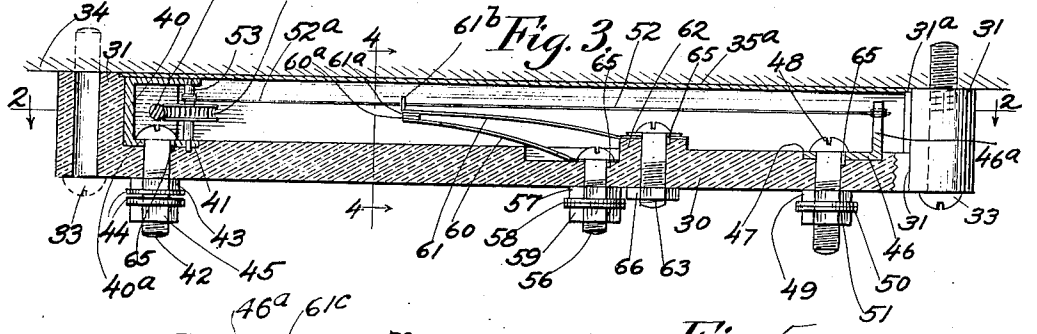


Fig. 4.

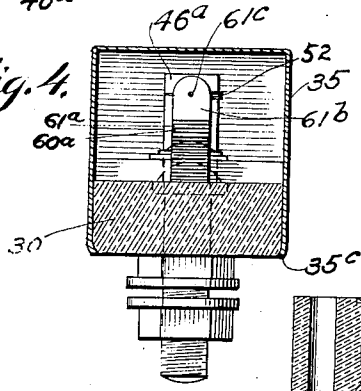


Fig. 5.

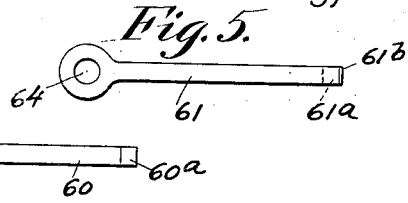
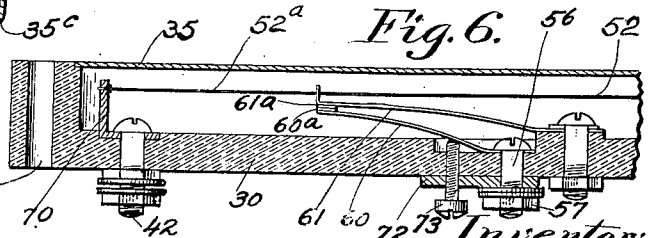


Fig. 6.



Witness:

C. Burnap

Inventor:

William K. McIver

By Sheridan, Wilkinson and Scott, Attys

UNITED STATES PATENT OFFICE.

WILLIAM K. McIVER, OF ELGIN, ILLINOIS, ASSIGNOR TO THE VAN SICKLEN COMPANY, OF ELGIN, ILLINOIS, A CORPORATION OF ILLINOIS.

AUTOMATIC LIGHTING SYSTEM.

1,288,947. Specification of Letters Patent. Patented Dec. 24, 1918.

Application filed April 26, 1916. Serial No. 93,737.

To all whom it may concern:

Be it known that I, WILLIAM K. McIVER, a citizen of the United States, residing at Elgin, in the county of Kane and State of Illinois, have invented certain new and useful Improvements in Automatic Lighting Systems, of which the following is a specification.

This invention relates to electric lighting systems and automatic controllers therefor, and the invention is particularly adapted for use with the lighting systems of automobiles, or the like.

Some automobiles, particularly the less expensive ones, have lighting systems in which the current for operating the head lights is received from the same magneto or generator which furnishes the current for ignition, and since the magneto is driven by the engine, either directly or indirectly, it follows that the voltage impressed on the lighting circuit and the current flowing therein vary according to the speed of the engine which drives the magneto. Thus, when the engine is operating at a relatively high speed the voltage generated by the magneto is relatively high, and a corresponding high voltage is impressed on the lighting circuit, thereby causing the lights included in the circuit to burn brightly. However, when the engine is running slowly, the voltage generated by the magneto is correspondingly low, so that the voltage impressed on the lights is also low, thereby causing them to give a dim and insufficient light.

The principal object of this invention is to provide a lighting system, especially adapted for use with automobiles, or the like, which will operate to cause a brilliant light to be produced, regardless of the voltage impressed on the circuit, or of the engine speed. A further object is to provide improved means for automatically varying the number of lights in the circuit in proportion to the voltage impressed on the circuit. A still further object is to provide a lighting system comprising an electric circuit having lamps connected therein in series, in combination with improved means for automatically varying the number of lights in operation. Another feature is the provision of a lighting system, including a generating element of varying speed and voltage in combination with improved means for controlling the number of lamps operated by this circuit in proportion to the speed of the generating element. A further object is to provide an electric lighting system comprising a plurality of lamps and a shunt circuit for rendering part of said lamps inoperative, in combination with improved means for automatically controlling the operation of said shunt in proportion to the current flowing in the operating circuit. A further object is to provide an improved automatic switch for automatically regulating the operation of the lighting circuit. Another object is to provide an improved electro-thermal switch comprising an expansible member adapted to control electric contacts for regulating the operation of the circuit according to the current flowing in the part of the circuit which is in operation. Still another object is to provide an improved electro-thermal switch comprising adjustable parts adapted to vary the operation of the switch to suit different operating conditions.

These and other objects of the invention will appear more clearly from the following specification, taken in connection with the accompanying drawings, in which certain embodiments of the invention are illustrated.

In the drawings—

Figure 1 is a diagrammatic view showing the circuit connections of the lighting system, and the driving elements coöperating with the electric generating device.

Fig. 2 is a sectional view, taken on the line 2—2 of Fig. 3, showing a plan view of the working parts of the electro-thermal switch.

Fig. 3 is a side elevation of the electro-thermal switch, showing a partial section taken on the line 3—3 of Fig. 2.

Fig. 4 is a sectional view, taken on the line 4—4 of Fig. 3.

Fig. 5 shows detail views of the two movable contact parts; and

Fig. 6 is a partial view, similar to Fig. 3, showing a modified form of the electro-thermal switch.

Referring to Fig. 1 of the drawings, the electrical generating device 10, which is preferably and usually an alternating cur-

rent magneto, is shown operatively connected to an automobile engine, or the like, 11, through suitable driving connections, represented diagrammatically at 12. One terminal of the magneto 10 is connected to one line of the circuit, which in this instance is represented as the frame of the automobile, so that the connection is represented as a ground connection at 13. The other terminal of the magneto is connected through the electric conductor 14, through a manually operated switch 15, with the improved electro-thermal switch 16. In an automobile lighting system of this kind the ignition apparatus 17 may be connected by a conductor 18 with the conductor 14, and by a conductor 19 with the frame of the machine, or the ground which forms the return circuit. The circuit from the automatic switch 16 is normally through parallel or shunt conductors 20 and 21 which lead to suitable terminals of the head lights, or other electric lamps to be operated by the lighting circuit. In this instance the electric lamps 22 and 23 are represented as right and left head lights, respectively, of an automobile, being contained within the usual reflecting casings 24. The two lamps 22 and 23 are connected in series by the conductor 25, and the terminal of the lamp 23, opposite said conductor, is connected to the return circuit, as shown by the ground connection at 26. The conductor 20, leading from the automatic switch 16, is connected to the conductor 25 at a point between the lamps, and the conductor 21 is connected to the terminal of the lamp 22 opposite that to which the conductor 25 is connected.

In the operation of the lighting system, if the shunt 20 is rendered inoperative, the current flowing through the conductor 14 and through the automatic switch 16 will pass through the conductor 21, and thence through the lamps 22 and 23 in series to the return circuit, which is represented by the frame of the automobile. It will be seen that the conductor 20 has relatively low resistance compared with the resistance of the parallel circuit, consisting of the conductor 21 and the lamp 22, and when the shunt is electrically connected to the conductor 14 through the switch 16, the current flowing in the circuit will pass through the shunt to the lamp 23, while the lamp 22 will be inoperative, as hereinafter more fully described. The purpose of the invention as applied to the particular embodiment illustrated is to provide means for causing both of the lamps to be operated when the magneto is driven at a relatively high speed, so that the corresponding voltage impressed upon the circuit will be sufficiently high to cause both of the lamps to burn brightly; and a further feature is to provide means for rendering one of the lamps inoperative when the engine is running at a relatively low speed, so that the voltage developed by the magneto will be impressed upon one light only, thereby causing said light to burn brightly.

The foregoing advantages are obtained in connection with the other features of the lighting system by means of the automatic electro-thermal switch 16. This automatic switch embodies an insulating base or plate 30, constructed of prepared wood, porcelain, or other insulating material not materially affected by moisture, oil, grease, or ordinary weather conditions. The end portions of this plate are provided with integral, transversely-extending lugs 31, the end portions of which are semi-circular in contour. Each of these lugs is provided with an aperture 32 adapted to be engaged by a screw 33, by means of which the base is secured to a supporting member 34, which may be the dash, or other suitable part of the automobile, for instance. A cap or casing 35, formed preferably of stamped metal, or the like, is adapted to be inserted between the insulating base and the supporting member 34, and fits closely the lateral walls of the insulating base. The lugs 31 are provided with undercut shoulders 31^a, which permit the wall 35^a of the cap to lie flush with the end walls of the lugs, and the lateral walls of the base 30 are spaced apart a lesser distance than the width of either lug, so that the lateral walls 35^b of the cap will lie flush with the corresponding edges of the lugs. It will be seen that the shoulders 31^a and 31^b, thus formed at the edges of the lugs, are adapted to hold the cap 35 in rigid position with respect to the base, so that the cap completely incloses the chamber 36 formed between the base and the cap and between the end lugs. The edges 35^c of the lateral walls of the cap are in-turned, as shown, for instance, in Fig. 4, to fit closely the similarly beveled edges of the base, so that when the cap is inserted in position on the base the edges of the cap will snap over the edges of the base, and thus hold the parts in relatively fixed engagement.

In the embodiment of the automatic switch shown in Figs. 2 and 3 a bracket 40 is secured to the insulating base 30 at one end thereof within the chamber 36, the base being provided with a countersunk seat 41, which is adapted to conform to the contour of one of the parallel flanges 40^a of the bracket. This bracket is secured in the position described by means of the screw 42, which passes through the lower flange 40^a and through the insulating base 30, being secured in position by means of a lock nut 43. A pair of washers 44 are placed on the screw adjacent the lock nut, and a nut 45, engaging the screw, is adapted for use in clamping an electric conductor between the washers, whereby the screw and parts car-

ried thereby serve as a binding post for use in forming an electric connection with the conductor 14 of the lighting circuit. Adjacent the other end of the chamber 36 another bracket 46 is seated in a suitable recess 47 formed in the upper wall of the insulating base, held in place by screw 48 being engaged at its lower end by a lock nut 49, washers 50, and clamping nut 51, which coöperate with the screw to form a binding post, by means of which an electric connection may be formed with the conductor 21 of the lighting system above described.

The bracket 46 comprises an upwardly extending flange or post 46^a, which is provided with a relatively small transversely-extending slot adapted to be engaged by a thermally expansible wire 52, which is passed through the slot and around the post, and then soldered or otherwise secured in fixed position. The opposite end of this expansible wire is wound upon the drum or shaft 53, which is provided with reduced ends suitably journaled in the flanges 40^a of the bracket 40. A worm gear 54 is fixed on the shaft or drum 52, and arranged to mesh with the transversely-extending worm or screw 55, which extends through the vertically projecting flanges 40^b of the bracket 40, and through a suitable slot or aperture in the wall of the casing 35, so that the head 55^a thereof may be engaged by a screw driver, or the like, at the outside of the casing to effect the rotation thereof and corresponding rotation of the worm gear, which will operate to wind the expansible wire on the drum, and thereby adjust the tension of the wire, or correct any stretching thereof. The extremity 55^b of the worm 55 is rotatably mounted on the bracket 40, and has secured thereto a nut or washer 55^c, which serves to secure the worm in position. The expansible wire 52 has a relatively small cross sectional area, and it is formed preferably of sterling silver wire, although other suitable material of low specific resistance may be used if desired.

At a point between the binding screws 42 and 48 there is mounted a third binding post 56, carrying a lock nut 57, washers 58, and clamping nut 59, by means of which an electrical connection may be formed with the shunt conductor 20 of the lighting system above described. Each of the binding posts is preferably provided with suitable means, such as a lug 65 engaging a groove in the wall of the corresponding aperture in the base, whereby rotation of the binding screws is prevented when the clamping nuts are being tightened. A spring contact member 60 is clamped beneath the head of the binding post 56, being inserted in a suitable recess formed in the wall of the insulating base. A second spring blade 61, of relatively greater length than the spring contact blade, is mounted within the chamber 36 upon an abutment 62, which is formed upon the insulating base. This spring blade is secured to the base by means of a screw 63, which passes through the aperture 64 formed in the enlarged extremity of the blade, and through a suitable aperture in the base, being engaged at its outer end by a nut 66. The blades or arms of the resilient members 60 and 61 are directed in the same direction parallel to the expansible wire 52, and the extremities of these blades carry contacts 60^a and 61^a, respectively, formed preferably of platinum, or the like, which are adapted to coact with each other when the expansible wire is in its normal taut condition and when the spring blades are in corresponding depressed positions. The extremity of the spring blade 61, adjacent the platinum contact 61^a, is bent transversely to form a projection 61^b, which is apertured at 61^c to be engaged by the thermally expansible wire.

The movable resilient members 60 and 61, which are formed preferably of spring bronze, are so constructed and proportioned that the contacts 60^a and 61^a will remain in electrical connection through a considerable range of movement of the springs corresponding to a transverse flexure of the expansible wire, which is effected by means of the resilient spring 61 when the wire 52 expands under the influence of a current passing therethrough; but the construction and arrangement is such that after a predetermined expansion of the wire the spring 61 will pass out of contact with the spring 60, and thereby break the electrical connection to the conductor 20, which is in the circuit therewith. The point at which the spring 61 breaks contact with the movable contact member 60 may be varied by means of the worm and worm gear, which operate to vary the normal tension of the expansible wire. If the expansible wire is stretched relatively tight, the springs will be depressed in a correspondingly increased degree, so that they will remain in contact through a greater range of movement than in the case where the expansible wire has an initial upward flexure under the influence of the spring 61 before it is expanded under the influence of a current passing therethrough.

Instead of varying the point of separation of the spring 61 with the movable spring contact member 60, by means of the worm and worm gear above described, I may employ the form of construction shown in Fig. 6, in which embodiment of the invention a bracket 70 is substituted for the bracket 40, drum 53, worm gear 54, and worm 55. This bracket is adapted to have secured thereto the extremity of the expansible wire, opposite the bracket 46, the expansible wire being

stretched taut at working atmospheric temperature when the parts of the device are initially assembled, in which condition it will remain when unheated, since it has no appreciable tendency to stretch. The spring blades 60 and 61 are mounted and constructed as in the embodiment above described, but a metal plate 72 is mounted beneath the lock nut 57 of the binding screw 56, and an adjusting screw 73 threadedly engages this plate and passes through the insulating base to coact continuously with the surface of the blade 60 adjacent the binding screw by means of which said blade is secured in position. This adjusting screw may be manipulated to vary the pressure which it exerts upon the under side of the blade 60, so as to alter the normal position which said blade tends to assume by virtue of its resiliency when not restrained by means of the expansible wire 52. This adjusting screw serves, in effect, to vary the attachment of the blade 60 to the insulating base, so that the normal unrestrained position which it assumes by virtue of its resiliency may be varied to vary the point at which the movable contact 60^a, carried by the blade 60, passes out of engagement with the contact 61^a carried by the blade 61.

From the foregoing description it will be seen that the binding post 42 is connected to the conductor 14, the binding post 56 to the conductor 20, and the binding post 48 to the conductor 21, so that a circuit may be formed from the binding post 42 through the entire length of the expansible wire 52 to the binding post 48, and thence through the conductor 21, light 22, conductor 25, and light 23 to the ground connection 26, which represents the return circuit; or when the spring contact member 60 is in engagement with the contact 61^a a shunt connection will be formed through the conductor 20 around the lamp 22, so that said lamp will be rendered inoperative. When the spring blades are in contact the current flows through the portion 52^a only of the thermally expansible member, and as this portion of the expansible wire expands the wire will be given a transverse flexure by the resilient spring 61. As the wire bends transversely and the contact 61^a moves therewith, the contact 60^a, carried by the spring 60, will remain in electrical connection with the contact 61^a during a considerable range of movement; but when the current through the portion 52^a of the expansible wire has increased sufficiently to cause a transverse flexure of the wire which carries the contact 61^a beyond the limit of movement of the spring member 60, the connection through the spring member of the conductor 20 is broken, and the current then flows through the entire length of the wire, and thence through both of the lamps in series. The current then continues to flow through both of the lamps in series until the voltage drops sufficiently to cause a contraction of the expansible wire of such extent as to reëstablish the connection with the shunt circuit.

The point at which the spring blade 61 is connected to the wire is so located that the expansion of the portion 52^a of the wire by the current which flows therethrough when one lamp is in operation, at the instant when the shunt connection is broken, will effect a transverse flexure of the wire, substantially the same or slightly less than the transverse flexure which is caused by the current which flows through the entire wire with two lamps in operation at the instant after the shunt connection is broken. Immediately after the shunt connection is broken the current flowing through the entire expansible wire, and through the two lamps in series, is somewhat less than the current which previously flowed through the portion 52^a with one lamp only in operation; but the flow of the reduced current through the entire wire might cause a greater or a less transverse flexure of said wire than would be caused by the flow of the increased current through a part of said wire, unless the point of contact of the spring 61 with the wire be properly located; and it has been found, in the embodiments of the invention which have been employed, that the portion 52^a of the wire should have a length substantially 31% of the total length of the wire measured between the post 46^a and the drum 53, or bracket 70, to which the other end of the wire is connected. The point of contact of the wire with the extremity of the spring blade 61 may be varied through a considerable range by bending the transversely projecting part 61^b of the spring blade in a direction parallel to the length of the expansible wire, thereby varying the point at which the wire engages the walls of the apertures 61^c; and in order to increase the possible range of this adjustment the aperture 20^c is preferably located a relatively great distance from the adjacent transverse portion of the spring blade.

By means of the construction just described it is possible to locate accurately the point of connection of the contact with the intermediate point of the expansible wire, so that the expansion of the part of the wire through which the current flows when the shunt is closed will produce substantially the same transverse movement of the wire at said intermediate point as is caused by the flow of current which takes place through the entire expansible wire immediately after the shunt connection is broken. This is an important feature of the construction, since it overcomes the possibility of an intermittent action of the switch, which might result if the transverse movement of the entire wire—due to the current

which flows therein after the opening of the shunt—were not sufficient to maintain the wire out of connection with the movable contact spring. Because of this advantageous feature the switch will remain open after being opened by the expansion of that part of the expansible wire through which the current of the shunt circuit flows, until the voltage impressed on the circuit and corresponding current flowing through the entire wire have decreased sufficiently to cause the contact 61^a to reëngage the contact 60^a. In practice, it is found that when the switch operates to break the shunt connection, the contact 61^a moves at once a considerable distance away from the contact 60^a, due to the fact that the portion 52^a of the expansion member is at first heated to a higher degree than the remainder of said member, owing to the relatively larger current which has previously passed therethrough with the contacts closed; but as the portion 52^a contracts, so that its expansion per unit of length is the same as that of the remaining portion, the contact 61^a slowly moves back toward the contact 60^a but stops in a position spaced from said contact, provided the voltage has not fallen below the value which caused the shunt connection to open. It will be seen that this operation causes a quick breaking of the shunt circuit which prevents arcing.

If the voltage and corresponding current continue to increase immediately after the shunt connection is broken, the expansible wire will continue to move transversely under the influence of the spring blade 61, and the brilliancy of the two lights operated by the circuit will continue to increase accordingly within limits depending upon their form and principles of operation. When the speed of the automobile engine decreases, and a corresponding drop in voltage takes place, the expansible wire will contract until it finally reëstablishes a connection with the spring contact member 60, thereby closing the shunt around a part of the circuit and rendering that part inoperative. If the voltage still further decreases thereafter, the wire will continue to contract, thereby depressing both of the springs 60 and 61, which will move together while being depressed, while at the same time maintaining the connection through the shunt.

The point of connection of the contact with an intermediate part of the expansible wire will depend for its location upon the number of lamps in the circuit, their relative capacities, and the number of lamps to be shunted by the shunt circuit, so that in some instances it may be necessary to locate the point of contact differently than is herein described for lighting systems including two automobile head-lights of similar size and rating. The proper size of the expansible wire to be used will also depend upon the current required to operate the incandescent lamps, or other translating devices in the circuit. In certain embodiments of the invention which have been employed in connection with an automobile lighting system including two incandescent lamps rated at 6 amperes and 12 volts, a sterling silver expansible wire having a diameter of approximately five thousandths of an inch has been used with satisfactory results, and the point of connection of the shunt with the expansible wire has been located at a point spaced from the end of the wire a distance substantially equal to 31% of the length of the wire. The expansible wire should of course be of such cross section and specific resistance that it will expand properly under the influence of the currents in the circuit for which the switch is designed. The specific resistance should preferably be relatively low in order that the wire may be reduced in size to secure a relatively large radiating surface per unit of cross-sectional area, thereby causing it to respond quickly to changes in voltage and corresponding changes in current.

If it be found that the connection of the expansible wire with the contacts 60^a is broken before the voltage has increased sufficiently to cause both of the head-lights to burn with the desired brilliancy, the worm and worm gear can be adjusted to increase the initial tension of the expansible wire; or if the form of switch shown in Fig. 6 is used, the adjustment screw 73 may be manipulated to vary the limiting position which the spring blade 60 assumes by virtue of its resiliency, so that the contacts 60^a and 61^a will remain in engagement with each other through a greater range of movement of the expansible wire, that is, until the voltage has increased to a greater extent than in the instance first supposed. It will be apparent that it is an advantage that these adjustments be made from the outside of the casing by manipulating the worm or the adjustment screw. If desired, the means for adjusting the tension of the wire and for varying the normal position of the contact blade 60 may be combined in one structure, so that both adjustments may be employed for the purpose described.

It will be apparent that by means of this invention a lighting system of the class described may be operated to give an efficient light at substantially any voltage and any speed of the driving element. When the speed is relatively high both lights will burn brightly, and when the voltage drops with a fall in speed one lamp is automatically shunted so that the other light burns brightly at the reduced voltage. The opera-

tion of the circuit does not operate at any time to overload the magneto, since the current taken by the translating devices depends on the voltage developed. The circuit is preferably so arranged that the headlight, which is in operation constantly during the operation of the circuit, is located at the left hand side of the vehicle, on which side the driver sits and next to which other vehicles pass. Where an alternating current magneto is used, the improved thermo-electric controller of this invention is of great advantage, since its operation is not affected by changes in frequency of the current which take place as the speed changes, and it therefore operates accurately and efficiently while other circuit-interrupting devices having inductance or capacity would be inoperative. Because of the absence of inductance and any appreciable capacity in the electro-thermal switch, it will be seen that the connection thereof in the circuit does not operate to alter or disturb the wave form of the alternating current generated by the magneto or other generator.

Although I have shown and described a particular embodiment of the invention for purposes of illustration, it will be understood that it may be embodied in other forms without departing from the scope thereof as defined in the appended claims.

I claim:—

1. In a system of the class described, a work circuit including a plurality of translating devices connected in series, a shunt for rendering a part of said devices inoperative, and a switch comprising an electro-thermal wire connected in said circuit for controlling the connection of said shunt, the expansion of a part of said electro-thermal wire by the action of the current passing therethrough being adapted to disconnect said shunt and cause the current to pass through the other part of said electro-thermal wire.

2. In a lighting system, a circuit including an expansible conductor and a plurality of lamps in series, a shunt normally connected to an intermediate point of said conductor and around a part of the lamps to render said part inoperative, and means actuated by the expansion of a part of said conductor due to the current flowing therein for automatically disconnecting the shunt.

3. In a lighting system, a circuit including an expansible conductor and a plurality of lamps in series, a shunt normally connected to an intermediate point of said conductor and around a part of the lamps to render said part inoperative, and means actuated by the expansion of a part of said conductor due to the current flowing therein for automatically disconnecting the shunt, the reëstablishment of the connection of said shunt with said conductor being governed by the expansion of the entire conductor due to the current which flows therein when the shunt connection is broken.

4. In an electric lighting system, a circuit including an expansible conductor and a plurality of lamps in series, a shunt normally connected to an intermediate point of said conductor and around a part of the lamps to render said part inoperative, means tending to produce a transverse flexure of said conductor as the same expands due to the current flowing therein, and a contact adapted to break connection with said conductor to open the shunt after a predetermined movement of the conductor due to the expansion caused by current flowing through the shunt, the flow of current after said shunt connection is broken being through the entire expansible conductor and through all of the lamps in series.

5. In an electric lighting system, a circuit including an expansible conductor and a plurality of lamps in series, a shunt normally connected to an intermediate point of said conductor and around a part of the lamps to render said part inoperative, means tending to produce a transverse flexure of said conductor as the same expands due to the current flowing therein, and a contact adapted to break connection with said conductor to open the shunt after a predetermined movement of the conductor due to the expansion caused by the current which flows through the shunt, the flow of current after said shunt connection is broken being through the entire expansible conductor and through all of the lamps in series, said conductor being adapted to reëstablish a connection with said contact after a predetermined decrease of the current flowing through the entire conductor.

6. In an electric lighting system, a circuit including an expansible conductor and a plurality of lamps in series, a shunt normally connected to an intermediate point of said conductor and around a part of the lamps to render said part inoperative, means tending to produce a transverse flexure of said conductor as the same expands due to the current flowing therein, and a contact adapted to break connection with said conductor to open the shunt after a predetermined movement of the conductor due to the expansion caused by the current which flows through the shunt, the flow of current after said shunt connection is broken being through the entire expansible conductor and through all of the lamps in series, said conductor being adapted to reëstablish a connection with said contact after a predetermined decrease of the current flowing through the entire conductor, the point of connection of said conductor with said shunt being located between the ends of said conductor at such a point that the movement of

the conductor owing to the expansion of a part thereof by the current which flows through the shunt is substantially the same as the transverse movement caused by the expansion of the entire conductor by the current which flows therethrough at the instant after the connection with the shunt is broken.

7. In a lighting system, a circuit including a plurality of lamps and an expansible conductor in series, said conductor being supported at its extremities, means acting to produce a transverse movement of said conductor at an intermediate point thereof when it expands owing to the current passing therethrough, a movable contact adapted to form an electrical connection with said conductor at said intermediate point throughout a predetermined movement of said conductor and to break contact therewith after such predetermined movement, and a shunt connected to said movable contact and around a part of said lamps in the circuit to render said part of the lamps inoperative when the shunt is connected to the intermediate point of said conductor.

8. In a lighting system, a circuit including a plurality of lamps and an expansible conductor in series, said conductor being supported at its extremities, means acting to produce a transverse movement of said conductor at an intermediate point thereof when it expands owing to the current passing therethrough, a movable contact adapted to form an electrical connection with said conductor at said intermediate point throughout a predetermined movement of said conductor and to break contact therewith after such predetermined movement, a shunt connected to said movable contact and around a part of said lamps in the circuit to render said part of the lamps inoperative when the shunt is connected to the intermediate point of said conductor, and means to vary the degree of expansion of said conductor required to effect the breaking of the electric connection with said movable contact.

9. In a lighting system, a circuit including a plurality of lamps and an expansible conductor in series, said conductor being supported at its extremities, a resilient member operatively connected to an intermediate part of said conductor and arranged to cause a transverse movement of said conductor at the point of connection owing to the increase in length of said conductor due to the passage of current therethrough, a spring contact blade arranged to form an electrical connection with said conductor at said point of connection and to move with said resilient member through a predetermined range of movement, the connection of said spring contact blade with said conductor being broken after said intermediate part has moved beyond the limiting position which said spring contact blade can assume by virtue of its resiliency.

10. In a lighting system, a circuit including a plurality of lamps and an expansible conductor in series, said conductor being supported at its extremities, a resilient member operatively connected to an intermediate part of said conductor and arranged to cause a transverse movement of said conductor at the point of connection owing to the increase in length of said conductor due to the passage of current therethrough, a spring contact blade arranged to form an electrical connection with said conductor at said point of connection and to move with said resilient member through a predetermined range of movement, the connection of said spring contact blade with said conductor being broken after said intermediate part has moved beyond the limiting position which said spring contact blade can assume by virtue of its resiliency, and adjustable means coacting with said spring contact blade for varying the limiting position which it assumes by virtue of its resiliency.

11. In a lighting system, a circuit including a plurality of lamps and an expansible conductor in series, said expansible conductor being supported at its extremities, a leaf spring bearing on an intermediate part of said conductor and tending to cause a transverse flexure of said conductor as the same expands due to a current passing therethrough, a spring contact having a part adapted to coact with said leaf spring and to move therewith through a predetermined range of movement of said leaf spring, and a shunt connected to said spring contact and around a part of said lamps to render said parts of said lamps inoperative when said spring contact is in electrical connection with the expansible conductor through said leaf spring.

12. An electro-thermal switch comprising an insulating base, supports on said base, a thermally expansible member stretched between said supports, a spring bearing on an intermediate part of said expansible member and tending to cause a transverse flexure thereof, and a movable contact spring mounted on said base with its free end normally in electrical connection with said expansible member, said contact spring being adapted to break its electrical connection with said expansible member after it has moved as far as its resiliency will permit upon expansion of said member.

13. An electro-thermal switch comprising an insulating base, an expansible conductor having its extremities secured to said base, means for forming an electrical connection with the extremities of said expansible conductor, whereby the latter may be included in an electric circuit, resilient means engaging an intermediate part of said conduc-

tor and tending to cause a transverse flexure thereof as the length of said conductor increases due to the current passing therethrough, a movable contact adapted to form an electrical connection with said intermediate part of said conductor and to maintain said connection throughout a predetermined range of movement of said conductor, and means for forming an electrical connection with said movable contact whereby said contact member may be included in a branch circuit.

14. An electro-thermal switch comprising an insulating base, an expansible conductor having its extremities secured to said base, means for including an expansible conductor in an electric circuit, resilient means engaging an intermediate part of said conductor and tending to cause a transverse flexure thereof as the length of said conductor increases due to the current passing therethrough, a movable contact adapted to form an electrical connection with said intermediate part of said conductor and to maintain said connection throughout a predetermined range of movement of said conductor, means for forming an electrical connection with said movable contact whereby said contact may be included in a branch circuit, and means to vary the transverse movement of said conductor required to break the electrical connection with said movable contact.

15. An electro-thermal switch comprising an insulating base, supporting means mounted on said base, a thermally expansible conductor stretched between said supporting means, a spring blade mounted on said base and operatively connected at its free end with said conductor at an intermediate point thereof, a spring contact blade mounted on said base and adapted to contact at its free end with said first-named spring blade to effect an electric connection with said conductor at said intermediate point, said spring contact blade being adapted to move with said first-named spring blade as said conductor expands due to a current passing through a part thereof and to break contact therewith when said first-named spring blade moves beyond the normal position which said spring contact blade tends to assume by virtue of its resiliency, and means connecting said expansible conductor and said spring contact blade in an electric circuit.

16. An electro-thermal switch comprising an insulating base having transversely extending lugs adapted to engage a support, a casing arranged to fit over said base to form a chamber between said lugs, supports mounted on said base in said chamber, a thermally expansible conductor stretched between said supports, a resilient member mounted in said chamber and bearing against an intermediate part of said expansible member, a movable contact carried by said base and adapted to form an electrical connection with said expansible member until the latter has moved by expansion beyond the limit of movement of said movable contact, and means to include said movable contact and said expansible member in an electric circuit.

17. An electro-thermal switch, comprising an insulating base having transversely extending lugs adapted to engage a support, a casing arranged to fit over said base to form a chamber between said lugs, supports mounted on said base in said chamber, a thermally expansible conductor stretched between said supports, a resilient member mounted in said chamber and bearing against an intermediate part of said expansible member, a movable contact carried by said base and adapted to form an electrical connection with said expansible member until the latter has moved by expansion beyond the limit of movement of said movable contact, means to include said movable contact and said expansible member in an electric circuit, and means operable from the outside of said chamber for regulating the operation of said switch.

In testimony whereof, I have subscribed my name.

WILLIAM K. McIVER.