July 26, 1927. 1,636,900

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ELECTROMAGNETIC SWITCH FOR CONTROLLING THE CIRCUITS OF TRAIN LIGHTING AND SIMILAR INSTALLATIONS

Filed Feb. 4, 1922 3 Sheets-Sheet 1

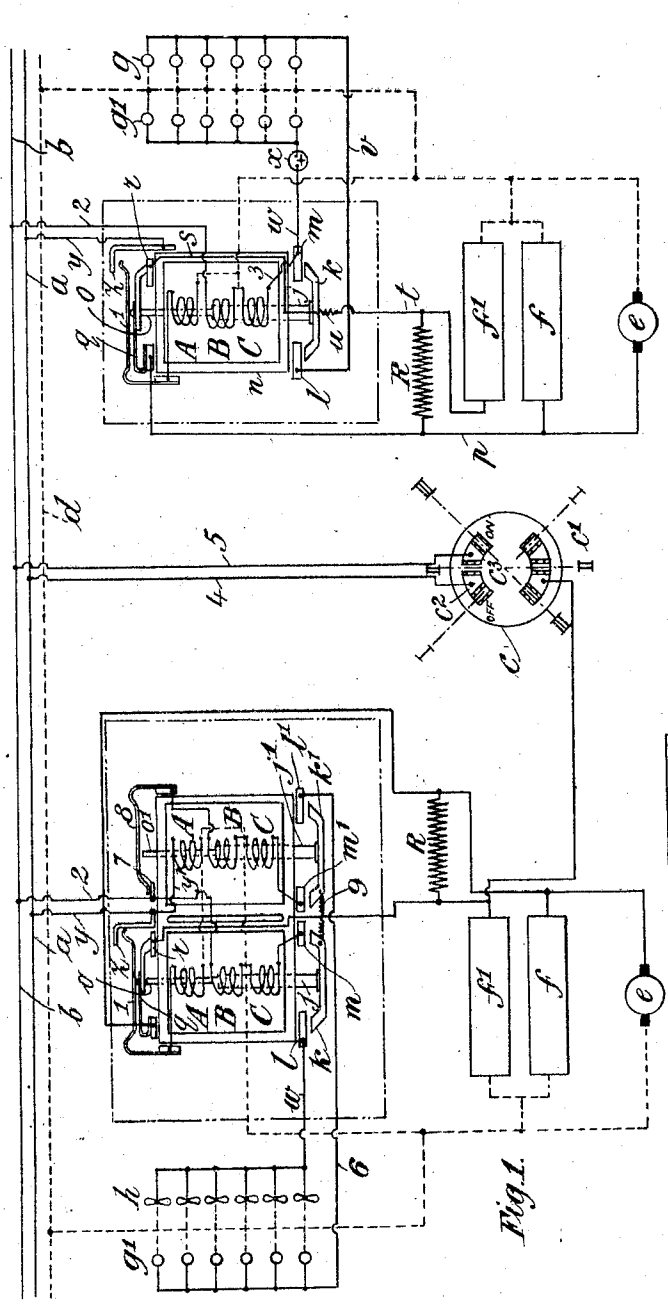


Fig. 1.

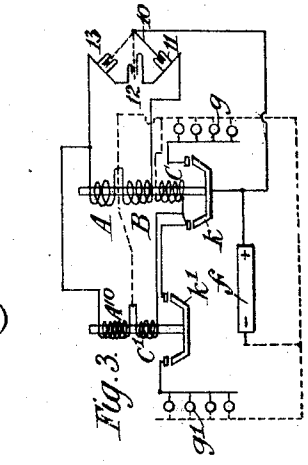


Fig. 3.

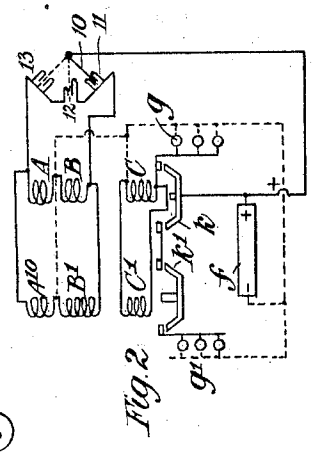


Fig. 2.

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Filed Feb. 4, 1922 3 Sheets-Sheet 2

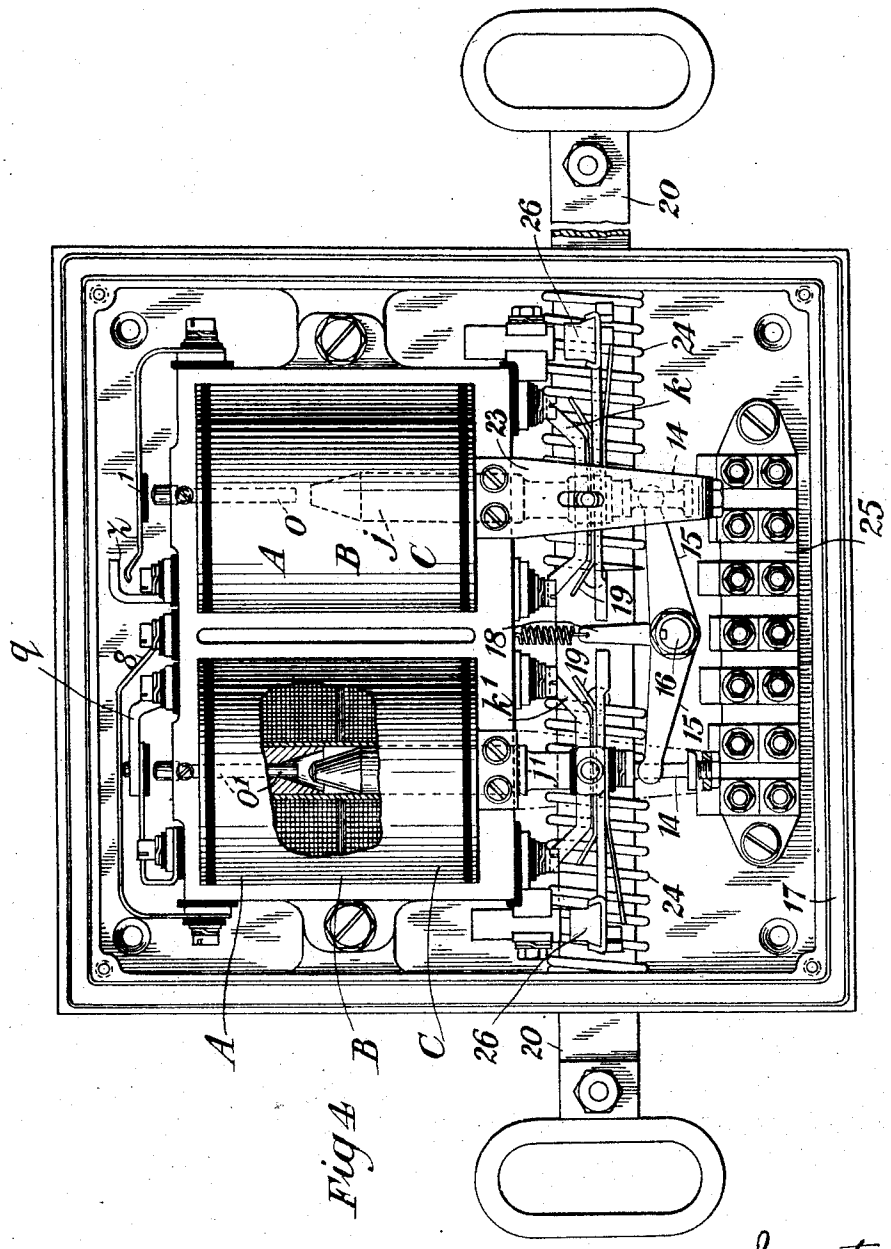


Fig 4

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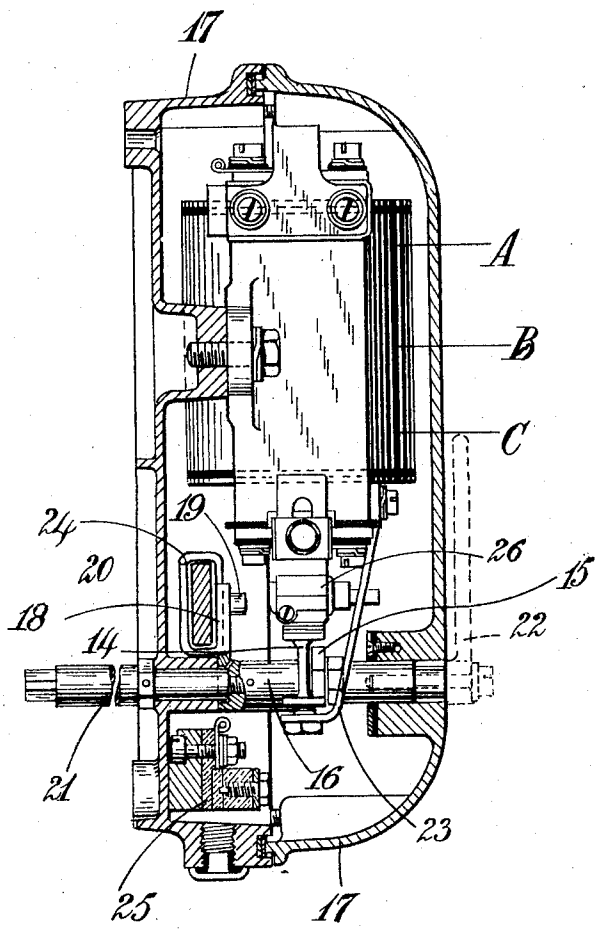
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Fig. 5.



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UNITED STATES PATENT OFFICE.

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ELECTROMAGNETIC SWITCH FOR CONTROLLING THE CIRCUITS OF TRAIN LIGHTING AND SIMILAR INSTALLATIONS.

Application filed February 4, 1922, Serial No. 534,118, and in Great Britain February 17, 1921.

This invention comprises improvements in and connected with electromagnetic switches for controlling the circuits of train lighting, and similar installations. The object of the invention is to provide a simple and efficient switch which is particularly suitable for use in installations in which switches, all along the train, are under the master control of a guard at either end or at some intermediate position for the purpose of enabling full-lights, half lights, and no-lights conditions of the circuits to be obtained. It is generally necessary, moreover, to arrange for these switches to be operated individually, as for example by means of a sliding bar at one end of each coach, or by means of a key or push button, and it is a further object of the invention to provide a switch of this type in which no mechanical locking devices are required and which, consequently, is simpler and more efficient and reliable than the usual type of electromagnetic switch employed for the purpose.

The improvements are advantageously applicable to switches of the duplex solenoid type and in such switches the coils of the two solenoids need not be of the same character or number, but the arrangement of the coils is capable of variation for suiting different practical requirements while still retaining the essential features of these improvements. In a known type of duplex solenoid lighting switch now in use for train installations, one of the solenoids is energized for making the connections for "full lights," the other solenoid is energized for "lights out," and the two solenoids are simultaneously energized for making the connections for "half lights." An advantage attaching to the present improvements is that the switches made in accordance therewith can readily be adapted for working under the same control as the existing switches above referred to.

In order to enable the invention to be readily understood, reference is made to the accompanying drawings, in which:—

Figure 1 is a simplified diagram of the circuits of the installations on two railway vehicles in a train, one vehicle being fitted with a single solenoid switch and the other with a duplex solenoid switch.

Figures 2 and 3 are diagrams of modifications, these diagrams being very much simplified so that they may be referred to as key diagrams.

Figure 4 is a view of an encased duplex solenoid switch as seen when the cover is removed from the casing.

Figure 5 is a central vertical section of Figure 4.

In any of the solenoids hereinafter described, the reference letter A indicates a demagnetizing or release coil, the reference letter B indicates a closing or pull-on coil, and the reference letter C indicates a holding-on coil. The diagrams in Figure 1 are simplified diagrams and may be assumed to show installations of two vehicles in the same train. The diagram to the right hand of this figure illustrates the use of a single solenoid switch, while the diagram to the left hand side illustrates the use of a duplex solenoid switch. *a* and *b* are two positive conductors running along the whole length of the train, and these conductors are connected up with a suitable battery by means of a switch *c* hereinafter described. *d* is a negative conductor which may or may not be in the same cable as the positive conductors *a b*, these conductors being connected between the carriages of the train by any suitable coupling devices. *e* are the dynamos for charging the battery *f* in a single battery installation, or the batteries *f f'* in a double battery installation and for supplying the consuming circuits *g g'* and *h g'*. The circuits *g g'* are shown as being entirely composed of lamps and the circuit *h* is shown as being entirely composed of ventilating fan motors, but it will be understood that any one of these circuits may be composed of lamps, or of fans, or of heaters, or of some of each of these. For example, it would be usual for the circuit *h* to comprise lamps in addition to the fan motors indicated therein. Referring to the diagram to the right hand side of Figure 1, it will be seen that the solenoid switch comprises the three coils A, B, C, above referred to. The core *j* of this solenoid carries a switch brush

k which is adapted to be lifted against contacts l m in the lighting or consuming circuits g g'. The solenoid is advantageously ironclad as indicated at n, and its core j is provided with an extension rod o for operating switch devices at the top of the solenoid as hereinafter described. The positive p from the dynamo e is connected with the positive of the battery f and also passes to the terminal connection of the switch blade q on the top of the solenoid, the blade q normally resting upon a contact block r which is connected by a conductor s with the main switch brush k. The latter is connected by the conductor t, which latter includes a flexible portion u, with the positive of the battery f'. The main switch contact l is connected by conductor v with the positive side of the consuming circuit g and the contact m is connected by conductor w with the positive side of the consuming circuit g', a hand switch x being inserted in the conductor w so that the lamps g' may be turned off when desired.

The cable conductor a is connected by a wire y with a terminal bracket z, the latter being adapted to be engaged by a switch blade 1 when this blade is raised by the rod o upon the sucking up of the core j taking place. The blade 1 is connected with the positive terminal of the coil A. The cable conductor b is connected directly with the positive terminal of the coil B by means of the wire 2. The positive terminal of the coil C is connected by the wire 3 with the switch contact m. The negative terminals of all the coils A, B, C, are connected with a negative main conductor which is indicated by dotted lines.

The switch c is a master switch which may be placed at any suitable place or places along the train. The switch c may be of any suitable type, and in Figure 1 is shown as a revoluble blade switch, the blade of which can be turned into any one of the three positions I—I, II—II, or III—III. The switch c comprises three terminal contact plates c', c^2 and c^3, the plate c' being connected with the positive pole of a suitable battery, the plate c^2 being connected by conductor 4 with the cable conductor a, and the plate c^3 being connected with the cable conductor b by the conductor 5. The plate c' has pairs of contacts for engaging the blade of the switch in any one of the positions I, II or III, while the plate c^2 has one pair of contacts for engaging the blade when turned to the position I and a single contact for the position II, the plate c^3 having one pair of contacts for the position III and the other contact of the pair for the position II. The switch is preferably of the type in which the blade is turned to the selected position and is then depressed against the action of a spring into engagement with the pairs of contacts in the selected position, the blade being released from those contacts immediately the pressure of the hand is removed. In the arrangement shown, the depression of the blade in the position I—I causes the conductor 4 to be electrified by the battery, the depression of the blade in the position II—II causes both the conductors 4 and 5 to be electrified by the battery and the depression of the blade in the position III—III causes the conductor 5 only to be electrified.

Assume that the magnetic switch is in the open condition seen in Figure 1; in that condition of the switch brush k, the switch q is closed on to its contact r so that the two batteries f and f' are both connected with the positive p of the dynamo, the battery f' being so connected through the wire t, wire s, contact r and switch q. In this condition the batteries are charged when the dynamo runs at the requisite speed. The means for interchanging the connections of the batteries from time to time, in a double battery installation, are not shown in the drawing, for as already stated the diagram is a simplified diagram. If it be desired to have all the lights g g' turned on (and assuming the small switch x to be closed) the blade of the switch c is turned to the position III—III and is depressed for a second or two so that the blade electrically connects the contact plates c' and c^3. The current then flows from the battery through the switch c to the conductor 5 and so to the cable conductor b. From the conductor b the current flows through all the branch conductors 2 along the train and energizes the various coils B. When any coil B is energized, and speaking now with particular reference to the coil B at the right hand side of Figure 1, the core j is sucked up, thereby closing the brush k on to its contacts l and m. When the core rises, the extension thereof lifts the switch q from off the contact r. Therefore only the battery f is now connected directly with the positive p of the dynamo, the lamp resistance R being inserted in the circuit of the battery f' and the lamps g being supplied through the wire t, switch brush k, contact l and positive lead v. Also the lamps g' are supplied through the conductor t, switch brush k, contact m and positive wire w. Immediately the brush k touches the contact m, the coil C is energized and maintains the brush k in the closed condition when the coil B is de-energized by the release of the master switch blade from the contacts of the plates c' and c^3. The rising of the core j and its extension o also effects the closing of the blade 1 against the bracket z but for the present this is without effect seeing that the wire y and cable conductor a have not been electrified. If it should be desired to extinguish the lamps,

the blade of the master switch c is turned to the position I—I and depressed so that the plates c' and c^2 are electrically connected and the wire 4 and the cable conductor a receive current from the battery. This current passes from the conductor a through the branch wires y, brackets z, switch blades 1 and coils A of the various solenoid switches. The effect in every case is the same, as will be understood from the right hand side of Figure 1, namely, the coil A will demagnetize sufficiently to counterbalance the holding-on effect of the coil C, so that the core j will drop and restore the condition seen in the diagram, which is a "lights out" condition. As already stated, if there are duplex solenoid switches on some of the vehicles of the train, it is possible to operate them so as to produce the condition of "half-lights" by simultaneously electrifying the conductors a and b. In the installation seen to the right hand of Figure 1, the condition of half-lights is obtained by opening the small switch x when the lights are turned on by the solenoid switch. However, the single solenoid must respond to the electrical control exercised by the simultaneous electrification of the cable wires a and b, otherwise the master switch c could not be said to exercise control all along the train. Assume, then, that switch k is open and that the master switch blade is turned to the position II—II and is depressed into engagement with the contacts of the plates c', c^2, c^3, this will cause current to be supplied from the battery through the switch to the two wires 4 and 5 so that the two cable conductors a and b will both be electrified. The coil B is thereupon immediately energized in the manner described, but the coil A is not energized, because its circuit is broken until the blade 1 touches the bracket z. The coil B sucks up the core j and closes the brush k on to the contacts l and m as described above and the holding-on coil C is energized. Simultaneously, the core extension o raises the blade 1 into engagement with the bracket z so as to complete the circuit of the demagnetizing coil A. The latter, however, now only has the effect of wholly or partly neutralizing the effect of either the coil B or the coil C, so that there is still one of these coils effective for holding up the core j. Immediately afterwards, the coils A and B are de-energized by the release of the blade of the master switch c and the coil C then holds up the core j until such time as the cable conductor a is electrified for "lights out" as hereinbefore described. In actual practice, and in a double battery installation, the function of the switch q in opening contact with the block r at the same time that the lighting circuit closes is to open the short circuit of the lamp resistance R and make the latter effective between the dynamo and the lamps and that battery which is in what is known as a floating condition, in the well-known manner. In a single battery installation the switch q would similarly cut out or switch in the lamp resistance.

Referring now to the duplex solenoid seen at the left hand side of Figure 1, the left hand solenoid of the pair operates in exactly the same manner as the single solenoid described above with reference to the right hand side of Figure 1. In this construction, however, the branch wire y from the cable conductor a is not only connected with the bracket z but also by an extension y' with the coil A of the second core j'. Also the branch wire 2 from the cable conductor b is not only connected with the coil B of the core j but also with a contact block 7 normally engaged by a switch blade 8 connected with the coil B of the core j'. The coil C of the core j' is connected with a contact m' adapted to be engaged by the brush k' of the core j', the brushes k and k' being connected in series by the connection 9. The contact l of the brush k is connected by a wire w with the positive side of the fan motor circuit h, but, as stated above, these fan motors may be wholly or partly substituted by lamps. The contact l' of the brush k' is connected by a wire 6 with the positive side of the lamp circuit g'. The connections of the batteries in the left hand installation in Figure 1 are the same as those of the right hand installation and therefore involve the same simplification and omissions as have been referred to. In the operation of this duplex solenoid if the blade of the master switch c be depressed in the position III—III, the cable conductor b is electrified in the manner above described and current flows through the branch 2 directly to the coil B of the core j and to the coil B of the core j' through the contact 7 and blade 8. The cores j and j' are thereupon lifted and close the brushes k and k' on to the contacts l m and l' m' so that both of the circuits g' and h are supplied with current. Also the coils C of the cores j and j' are energized by the brushes k k' touching the contacts m m' and thereafter serve for holding up the cores j j'. It will be noticed that the rising of the core j' and its extension o' causes the switch blade 8 to open the circuit of its coil B, but this only takes place after the energizing of the coil C, (the brush k' having sufficient flexure for permitting the raising of the blade 8 after the brush k' has touched the contact m') so that the switch brush k' remains closed on to its contacts. To extinguish all lights, or to cut off the current from both of the circuits g' and h, the blade of the master switch c is depressed in the position I—I with the result that the wire 4, cable conductor a, branch conductor y and the demagnetizing coils A of

both solenoids j j' are supplied with current so that the effect of the coils C is neutralized and the cores j j' drop to the open position. For putting only the fans h into circuit, or for producing "half lights" if the circuit h is a lighting circuit, the blade of the master switch c is depressed in the position II—II thereby electrifying the cable conductors a and b and energizing the coils A and B of the two cores j and j'. As regards the core j, its coil A will not be immediately energized owing to the presence of the switch 1 as already explained with reference to the single solenoid, so that when this coil A is energized, the coil C is already holding up the core j, thereby retaining the fan motors h in circuit. The core j' in rising, however, opens the switch 8 and breaks the circuit of its coil B, whereupon the coil A, which is energized as stated, neutralizes the effect of the coil C so that the core j' drops leaving only the fans h in circuit. It will be understood, therefore, that duplex and single solenoids may be placed under the same master control without the presence of the latter interfering with the proper functioning of the former.

If desired, and in known manner, the core j and the cores j and j' may be arranged in operative relation with mechanical means for operating them individually instead of by the master control. For example, if a lever, sliding cam, or push button be arranged beneath any one or all of these cores, the latter may be raised by such mechanical means and as soon as the brush k or k' touches upon the contact m or m', the coil C is energized and holds up the core in question for closing the desired lamp or fan circuit. Similar mechanical devices may be arranged for operating upon the upper ends of the extensions o or o' of the cores so that these latter may be depressed to open the said circuits. Or, of course, the core or a number of cores having been raised by hand may be released by the exercise of the master control.

In some cases, the coil B of any solenoid may be connected in series with its companion coil C when the lighting switch k or k' closes, but in that case the corresponding coil A would have to be sufficiently strong for neutralizing to such a degree as to release the core, as will be readily understood. In any duplex solenoid, either or both of the cores may operate short circuiting switches for lamp resistance in the manner above described.

In the simplified key diagram seen in Figure 2, the coils A, A^{10} of a duplex solenoid are connected in parallel, as also are the coils B, B', and the coils C, C'. In this modification the coil B is stronger than the coil B', and the coil A^{10}, instead of being a demagnetizing coil like the coil A, or like the coils A A of the construction first described, is a magnetizing coil which assists the coils B' and C'. In fact, in this modification, it requires the joint effort of the coils A^{10}, B' and C' to close the switch k' although when this switch is once closed the effort of the coil C' is sufficient for retaining it in the closed condition. 10 is a switch blade which can be turned to any one of three positions, as indicated by the full and dotted lines, and in those positions can be depressed into engagement with pairs of contacts 11, 12 and 13. The switch blade 10 is connected with any suitable source of current. When the blade is depressed, in the full line position, into engagement with the contacts 11, the coils B, B' are energized and the coil B raises the brush k to the closed position, thereby turning on the lamps g and energizing the coils C and C'. However, the coils B' and C' together are not sufficiently powerful for closing the switch k' so that the lamps g' are not turned on. When the blade 10 is released from the contacts 11, the coil C retains the switch k in the closed position. This operation of the switch 10 gives what is known as the "half lights" condition. If when the switches k k' are open the switch blade 10 should be turned to and depressed in the mid-position, it engages with the contacts 12, thereby effecting the energization of the coils A, A^{10}, B, B'. However, the contacts 12 are not of the same length, and that appertaining to the B circuit is of greater length than the other. Consequently, the coil B will be energized before the others and will effect the closure of the switch brush k and the energization of the hold-on coil C before the demagnetizing coil A comes into action. When the coil A is energized, therefore, it only partly neutralizes the effect of the coils B and C, so that the switch k remains closed. The closing of the switch k also energizes the coil C' and the coils B' and A^{10} being also energized, these three coils co-act to close the switch k'. When the switch blade 10 is released from the contacts 12, the coils C, C' will retain the brushes k k' in the closed position. If the switch blade 10 be now turned to the third position and depressed into engagement with the contacts 13, the demagnetizing coil A is energized and neutralizes the coil C so that the brush k falls to the open position and turns off the lamps g, at the same time breaking the circuits of the coils C and C'. The brush k' now drops and opens the circuit of the lamps g' as the coil A^{10} by itself is incapable of retaining the switch brush k' in the closed position. However, even if the brush k' should remain in the closed position, no harm will be done as the circuit of the lamps g' has already been opened by the dropping of the switch brush k which is in series with the brush k'. The blade 10 is then released

and disengaged from the contacts 13, so that the coils A and A^{10} are quickly de-energized, and the apparatus is then ready for the next turning on of the lamps.

From what has been described with reference to Figure 2, it will be readily understood that the closing coil B′ of the second solenoid may be dispensed with, as seen in Figure 3, provided that the hold-on coil C′ and the assisting coil A^{10} together are powerful enough for closing the switch brush *k′* on to its contacts. In this modification, the coil C′ receives assistance only when the circuit of coils A A^{10} is closed by the blade 10 engaging with the contacts 12 or 13 and not when the B circuit is closed by engaging the blade 10 with the contacts 11. The engaging of the blade 10 with the contacts 13 may result in the brush *k′* being held up against its contacts, but as the circuit of the lamps *g′* has already been opened by the dropping of the brush *k* immediately the coil A neutralizes the coil C, the retention of the brush *k′* in the closed position makes no difference and the coil A^{10} will soon be de-energized by the release of the blade 10 as aforesaid.

Figures 4 and 5 show a duplex solenoid mounted in a casing and adapted for operation by mechanical means, in addition to operating under the electrical control above described. This duplex solenoid is practically the same as that described with reference to the left hand side of Figure 1, excepting that the positions of the cores *j* and *j′* are changed side for side in Figure 4 and the resistance short-circuiting switch *q* is placed above the core *j′* instead of above the core *j* as in Figure 1. From Figure 4, it will be seen that the tops of the cores *j j′* are suitably shaped in accordance with known practice and that they rise against the separately supported rods *o o′* which actuate the switches *q*, 1 and 8 as hereinbefore described. At the lower ends of the cores *j j′* there are recessed or dumb-bell shaped pieces 14 adapted to be engaged by the arms 15 of a double-armed lever pivotally mounted at 16 in the enclosing casing 17. An arm 18 fixedly mounted on the pivot spindle 16 of the lever 15 normally stands in the path of projections or pins 19 of the pull or push bar 20 commonly found at the end of a railway vehicle. By pulling or pushing the bar 20 in one direction or the other, the lever 15 will be rocked in one direction or the other so that one of its arms will strike upwardly against one of the pieces 14 and raise the core *j* or *j′* as the case may be. The raising of a core closes the switch *k* or *k′* and brings into action the holding-on coil C. The re-opening of a switch *k* or *k′* which has been closed is accomplished by a reverse movement of the bar, as will be readily understood. As will be seen from Figure 5, the spindle 16 may be turned by the application of a key to the projecting portion 21 of an extension thereof, or by the manipulation of a lever arm 22 secured to the end of the spindle 16 on the outer side of the cover of the casing. 23 are stops for the cores *j* or *j′* to drop on to and 24, 24 are springs operating on the bar 20 for always returning and maintaining it in the mid or neutral position. 25 is a terminal board for the making of the necessary external and internal connections. 26 are carbon sparking contacts for the switch brushes *k* and *k′*. From Figures 4 and 5 it will be apparent that push button devices may be arranged in the top and bottom of the casing 17 in vertical alignment with the cores *j j′*, so that by pushing up either or both of the lower buttons the core or cores *j j′* is or are pressed up into the circuit-closing position, and by pushing down either or both of the upper buttons the core or cores is or are depressed into the open circuit position, the efforts of the hold-on coils being overcome in the act of such depression.

Instead of employing a spindle 16 extending from front to back of the casing 17, a spindle may be employed extending from side to side of the casing and revoluble in bearings in such sides. Such a spindle may be fitted with crank arms disposed at suitable angles and adapted to operate appropriate cores in predetermined manner according to the amount of turning of such spindle.

With switches of the nature hereinbefore described, if the lights are left burning inadvertently while, for example, the train is in a siding, the partial exhaustion of the batteries results in a weakening of the holding-on coil or coils C, which may be calibrated so as to hold on only when impressed with a certain battery voltage. In this case, the switches would open automatically and put out the lights long before the complete exhaustion of the battery had taken place, this being an advantageous result not obtainable with switches which are mechanically locked in the closed position. Moreover, the fact that the switches have been opened is important, because as soon as the train, after re-starting, has attained a proper speed, the dynamo will immediately begin to effectually charge the batteries which would not be the case if the exhausted batteries had been left connected up with the lamps.

I claim:—

1. Electro-magnetic switching means for controlling consuming circuits of train lighting and similar installations, comprising duplex electro-magnets operatively connected with respective consuming-circuit switches and reversible under line control, said electro-magnets including respective

hold-on coils adapted to be energized upon exercise of either one of two phases of line control but to be effective on one only of the switches under one of said phases of control, substantially as set forth.

2. Electro-magnetic switching means for controlling consuming circuits of train lighting and similar installations, comprising duplex electro-magnets operatively connected with respective consuming-circuit switches and subject to line control, the said electro-magnets being each provided with a combination of closing, hold-on and demagnetizing coils as hereinbefore specified, and the arrangement being such that the simultaneous control of the closing and demagnetizing coils for bringing about their energization results in the closing of only one of said switches, substantially as set forth.

3. Electro-magnetic switching means for controlling consuming circuits of train lighting and similar installations, comprising duplex electro-magnets operatively connected with respective consuming-circuit switches and subject to line control, the said electro-magnets being each provided with a combination of closing, hold-on and demagnetizing coils as hereinbefore specified, a break in the circuit of the damagnetizing coil of one electro-magnet which break is normally open but is closed by the rising of the solenoid core to close the respective switch and means for effecting the opening of the circuit of the closing coil of the other electro-magnet upon the rising of its core to close the other switch, substantially as set forth.

4. A duplex solenoid switch for controlling circuits of train lighting and similar installations, said switch comprising leading and following solenoid elements of which the leading element comprises closing, hold-on and demagnetizing coils as hereinbefore specified, and the following solenoid element comprises a combination of coils arranged to operate in conjunction to raise the solenoid core but one only of which is capable of acting as a hold-on coil to maintain the core raised, substantially as set forth.

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