G. H. HILL.

SELECTIVE A. C.- D. C. SYSTEM.

APPLICATION FILED JAN. 18, 1908.

935,023.

Patented Sept. 28, 1909.

2 SHEETS—SHEET 1.

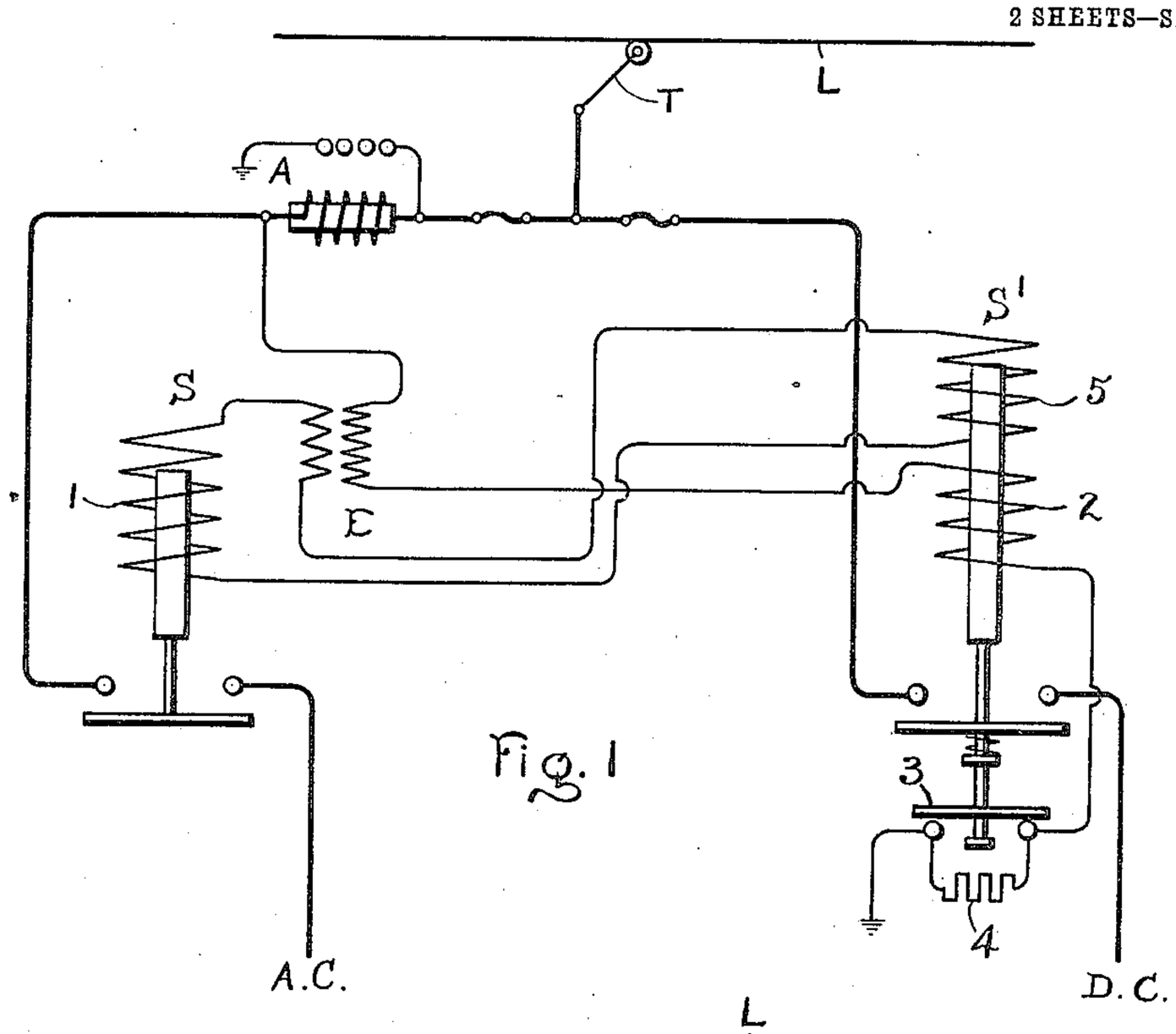

Fig. 1

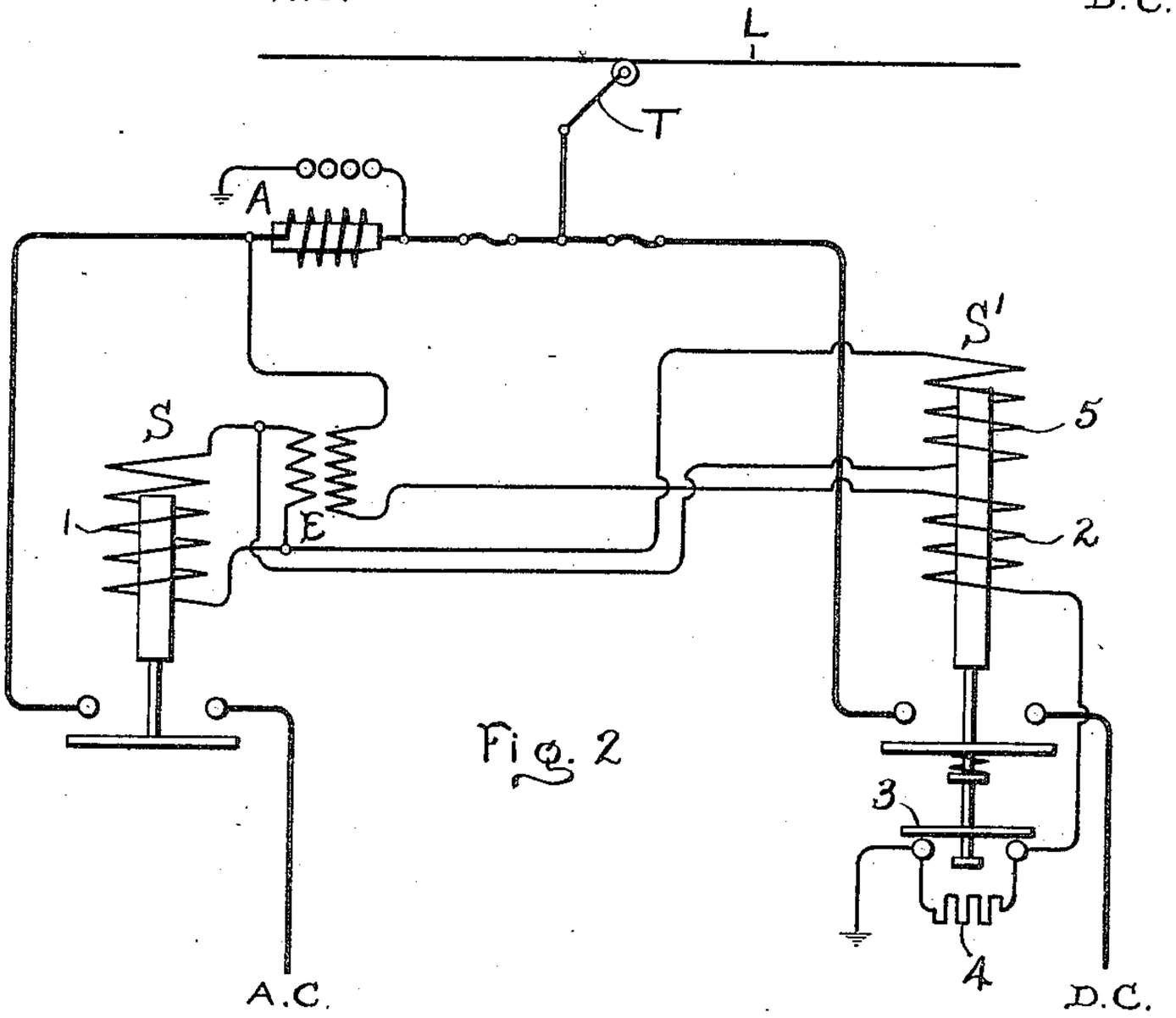

Fig. 2

WITNESSES.

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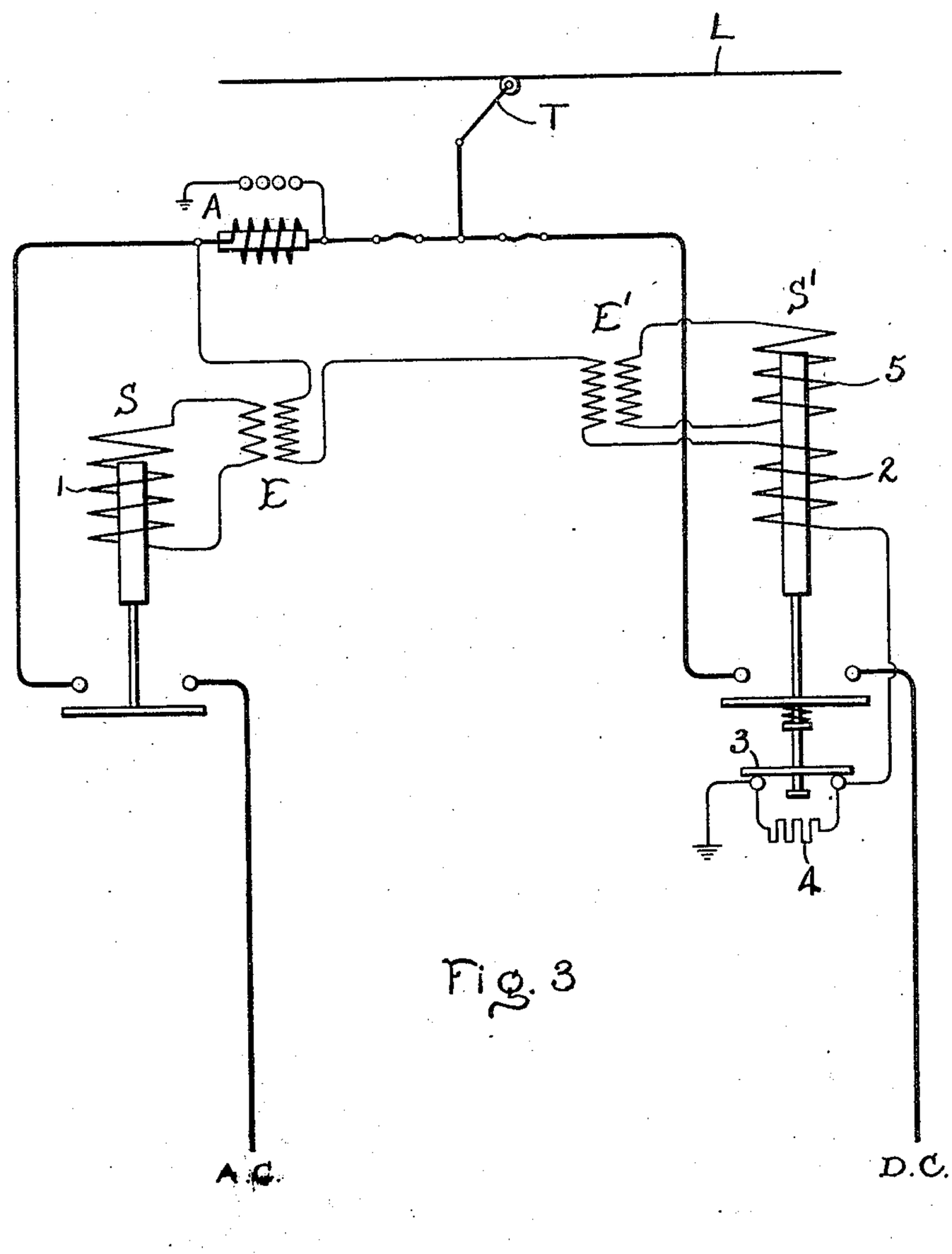

Fig. 3

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UNITED STATES PATENT OFFICE.

GEORGE H. HILL, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

SELECTIVE A.C.-D.C. SYSTEM.

935,023. Specification of Letters Patent. Patented Sept. 28, 1909.

Application filed January 18, 1908. Serial No. 411,506.

To all whom it may concern:

Be it known that I, GEORGE H. HILL, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Selective A.C.-D.C. Systems, of which the following is a specification.

In electrically driven cars intended for operation either on alternating or direct current, usually high potential alternating current and low potential direct current, the change from one to the other being ordinarily made while the car is moving, it is customary to provide a system of selective switches arranged to automatically connect the current collecting device to the proper circuits of the car for either alternating or direct current operation. Such a system of selective switches is shown in the patent to Frank and Pevear, No. 854,730, dated May 28, 1907, Control of electric cars. The arrangement there shown consists of a small step-down transformer having its primary connected to the power circuit, the actuating coil of the A.C. switch being connected across the secondary of said transformer, and the actuating coil of the D.C. switch being in series with the primary of said transformer. With this arrangement the A.C. switch is operated only when the current collecting device is receiving alternating current, and the D.C. switch is supposed to operate only when the current collecting device connects with a source of direct current.

It is found in actual practice that a system such as that mentioned above is open to the objection that when the car enters an alternating current section the first rush of current, before the counter E. M. F. of the transformer has had time to build up, may operate the D.C. switch. Such an occurrence is, of course, highly objectionable, and it is an object of my invention to provide means for absolutely and certainly preventing the D.C. switch from operating when the car enters, or while it is on an alternating current section.

To the above end, my invention consists in providing in a system of the kind above mentioned, an auxiliary coil on the D.C. switch which is arranged to receive current from the secondary of a small transformer, the primary of which is connected to the power circuit. With this arrangement, when the car is on an alternating current section, current in the auxiliary coil on the D.C. switch produces a magnetic field in phase with the field produced by the actuating coil on that switch, but displaced 180° from it, so that the two fields oppose and neutralize one another. As a result there is substantially no flux in the magnet and the D.C. switch is prevented from operating.

In its broad aspect my invention contemplates the use of an auxiliary coil on the D.C. switch, and the excitation of this coil from the secondary of energy transforming means, the primary of which is connected to the power circuit.

More specifically stated, my invention consists in the use of an auxiliary coil on the D.C. switch for the purpose above mentioned, said coil being excited either from the secondary of the transformer from which the operating coil on the A.C. switch is energized, or from the secondary of a second transformer having its primary either connected directly to the source or arranged in series with the primary of the transformer which furnishes current for operating the A.C. switch. When the auxiliary coil on the D.C. switch is energized from the secondary of the same transformer as that which furnishes current to the operating coil of the A.C. switch, the said auxiliary coil may be connected either in series or in shunt to the actuating coil of the A.C. switch.

My invention will be best understood from the following description taken in connection with the accompanying drawing, in which—

Figure 1 shows diagrammatically a system of selective A.C.-D.C. switches in which an auxiliary coil on the D.C. switch is connected in series with the actuating coil on the A.C. switch; Fig. 2 shows a similar system in which the auxiliary coil is connected in shunt to the actuating coil on the A.C. switch; and Fig. 3 illustrates a similar arrangement in which the auxiliary coil on the D.C. switch is excited from the secondary of a transformer, the primary of which is connected in series with the primary of the transformer which furnishes current to the operating coil of the A.C. switch.

I deem it unnecessary to illustrate any system of motor control, as it is obvious that

my invention is not limited in its application to any particular type of control. It may, however, be stated that, as illustrated, my selective A.C.-D.C. system is applicable to the system of control described in a patent in my name, No. 904,780, dated November 24, 1908.

Referring to all the figures of the drawing, L represents the trolley wire, or other supply conductor, with which the trolley T or other current collecting device, carried by the car, engages. It is to be assumed that the supply conductor is at some places supplied with alternating, and, at other places, with direct current, the potential of the alternating current section being usually high, for example, 6600 volts, and the potential of the direct current section being relatively low, for example, 600 volts. The usual kicking coil and lightning arrester are indicated in a well-known conventional manner at A. The main switch, which is intended to close only on alternating current operation, is indicated at S, and the main switch which closes only on direct current operation is shown at S^1. These switches S and S^1 may be of any suitable design. A small step-down transformer represented at E is shown with its primary connected between trolley and ground in shunt to the power circuit. The actuating coil 1 of the A.C. switch S receives current from the secondary of the transformer E, and the actuating coil 2 of the D.C. switch S^1 is connected in series with the primary of the transformer E. A contact 3, carried by the D.C. switch S^1, is arranged to cut a resistance 4 into circuit with the coil 2 so as to reduce the current flow in this coil after the switch S^1 has closed. An auxiliary coil 5 is shown provided on the D.C. switch, which coil will under certain conditions, as hereinafter described, produce a magnetic field which will buck the field produced by the coil 2.

In Figs. 1 and 2, respectively the auxiliary coil 5 is shown connected in series to and in shunt with the actuating coil 1 on the A.C. switch. When so arranged the coil 5 receives current from the secondary of the transformer E.

In Fig. 3 the auxiliary coil 5 is shown connected across the secondary of a small current transformer E^1, the primary of which is connected in series with the primary of the transformer E and in series with the actuating coil 2 of the D.C. switch.

The operation of my selective system is as follows: Suppose the switches S and S^1 in the positions illustrated; that is, open. If the current collecting device engages with a section of supply conductor furnishing alternating current at high potential, current will, in the arrangements shown in each of the figures, flow from the line, through the primary of the transformer E and the coil 2 of the D.C. switch S^1, through the contact 3 to ground. In the arrangement shown in Fig. 3, this current will also pass through the primary of the transformer E^1. Before the counter E. M. F. of the transformer E has had time to build up the current passing in this circuit will be large, and the magnetization of the coil 2 might be sufficient to close the D.C. switch S^1 were it not for the fact that the auxiliary coil 5 is simultaneously energized and produces a magnetic field which bucks that produced by the coil 2 and produces a resultant field of practically zero. In the arrangements illustrated in Figs. 1 and 2, the auxiliary coil 5 will be energized from the secondary of the transformer E. In the arrangement shown in Fig. 3, the coil 5 will be energized from the secondary of the transformer E^1. In each of the three arrangements shown, therefore, the switch S^1 will be prevented from operating on the first sudden rush of alternating current. The A.C. switch S will, however, be closed by the energization of its actuating coil 1 from the secondary of the transformer E. If, on the other hand, the current collecting device T engages a section of supply conductor furnishing direct current, in each of the three arrangements illustrated, current will flow through the primary of the transformer E and the actuating coil 2 of the switch S^1 and cause this switch to close. In the form shown in Fig. 3 this current will also pass through the primary of the transformer E^1. In none of the arrangements does the coil 5 interfere with the operation of the switch S^1 when the car is on a direct current section. The A.C. switch S, of course, will be unaffected by direct current and will not close. As explained above, closing of the switch S^1 cuts the resistance 4 into circuit with the actuating coil 2 and reduces the current flow through that coil and prevents heating thereof.

It is not my intention to limit myself to the particular constructions and arrangements of parts shown. I aim to cover in the following claims any modifications which are within the scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. A selective A.C.-D.C. system for electric cars comprising an A.C. switch having an actuating coil, a D.C. switch having an actuating coil, an auxiliary coil on said D.C. switch, energy transforming means connected to the power circuit and arranged to supply current by transformer action directly to the actuating coil of the A.C. switch and the auxiliary coil on the D.C. switch, and circuit connections permitting current to flow to the actuating coil of the D.C. switch directly from the source through said transforming means.

2. A selective A.C.-D.C. system for elec-

tric cars comprising energy transforming means connected to the power circuit, an A.C. switch, an actuating coil therefor receiving current by transformer action from said energy transforming means, a D.C. switch, an actuating coil therefor receiving current directly from the source through said energy transforming means, and an auxiliary coil on said D.C. switch receiving current by transformer action directly from said energy transforming means.

3. A selective A.C.-D.C. system for electric cars comprising a transformer having its primary connected to the power circuit, an A.C. switch, an actuating coil therefor connected across the secondary of said transformer, a D.C. switch, an actuating coil therefor in series with the primary of said transformer, a second transformer having its primary connected to the power circuit, and an auxiliary coil on said D.C. switch arranged to receive current from the secondary of said second transformer.

4. A selective A.C.-D.C. system for electric cars comprising a transformer having its primary connected to the power circuit, an A.C. switch, an actuating coil therefor connected across the secondary of said transformer, a D.C. switch, an actuating coil therefor in series with the primary of said transformer, a second transformer having its primary in series with the primary of said first named transformer and in series with the actuating coil of said D.C. switch, and an auxiliary coil on said D.C. switch arranged to receive current from the secondary of said second transformer.

5. A selective A.C.-D.C. system for electric cars comprising a transformer having its primary connected to the power circuit, an A.C. switch, an actuating coil therefor connected across the secondary of said transformer, a D.C. switch, an actuating coil therefor in series with the primary of said transformer, a second transformer having its primary connected to the power circuit, and an auxiliary coil on said D.C. switch connected across the secondary of said second transformer.

6. A selective A.C.-D.C. system for electric cars comprising a transformer having its primary connected to the power circuit, an A.C. switch, an actuating coil therefor connected across the secondary of said transformer, a D.C. switch, an actuating coil therefor in series with the primary of said transformer, a second transformer having its primary connected to the power circuit, and an auxiliary coil on said D.C. switch connected across the secondary of said second transformer.

7. A selective A.C.-D.C. system for electric cars comprising a transformer having its primary connected to the power circuit, an A.C. switch, an actuating coil therefor connected across the secondary of said transformer, a D.C. switch, an actuating coil therefor in series with the primary of said transformer, a second transformer having its primary in series with the primary of said first named transformer and in series with the actuating coil of said D.C. switch, and an auxiliary coil on said D.C. switch connected across the secondary of said second transformer.

In witness whereof, I have hereunto set my hand this 16th day of January, 1908.

GEORGE H. HILL.

Witnesses:
HELEN ORFORD,
BENJAMIN B. HULL.