No. 676,305. Patented June 11, 1901.

A. G. DAVIS.

SYSTEM OF MOTOR CONTROL.

(Application filed Mar. 5, 1900.)

(No Model.) 2 Sheets—Sheet 1.

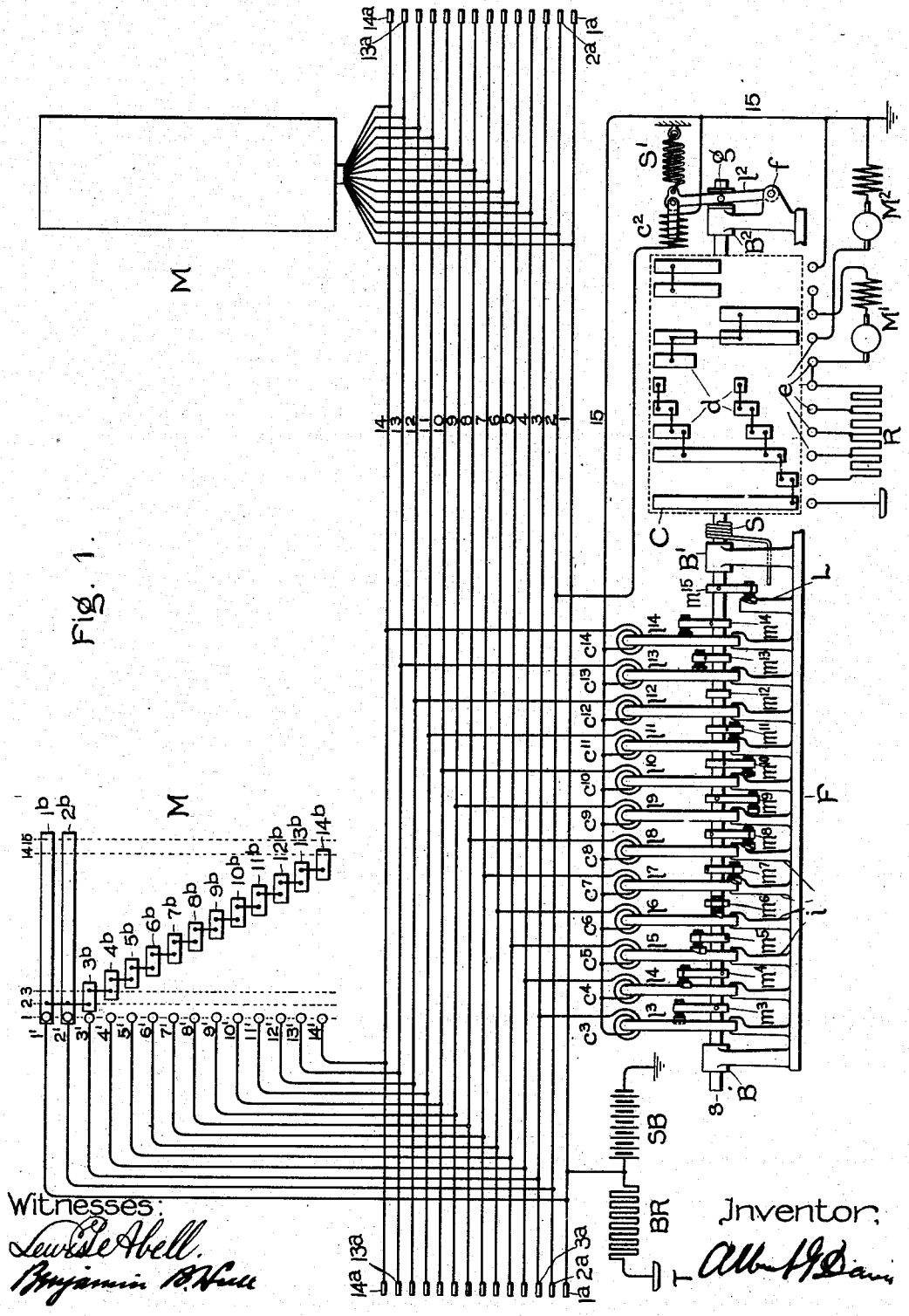

Fig. 1.

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Fig. 3.

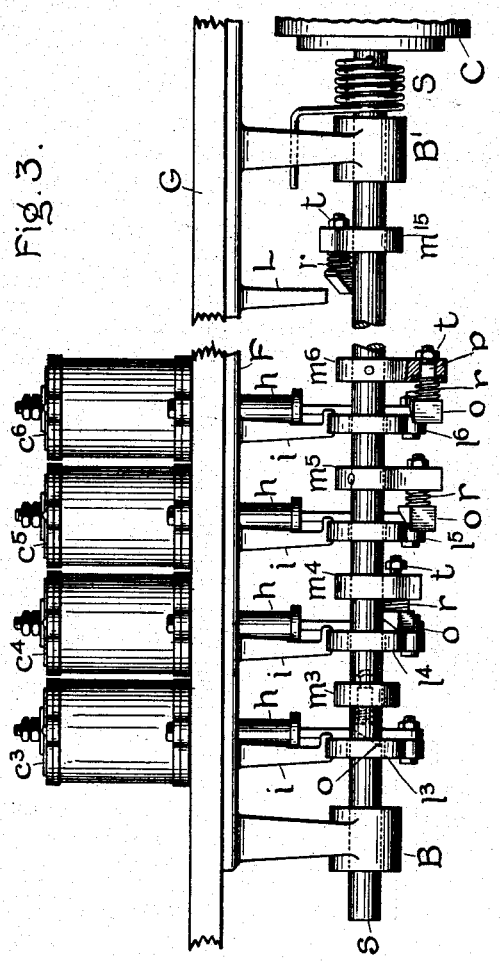
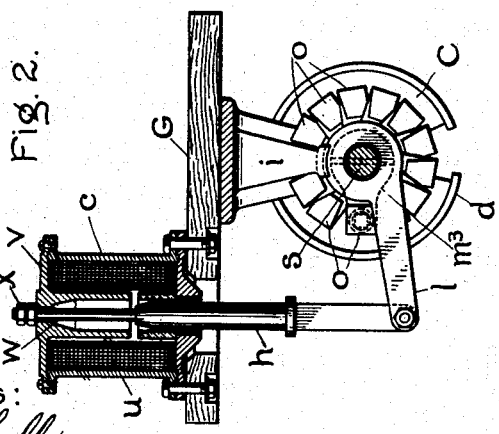


Fig. 2.



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UNITED STATES PATENT OFFICE.

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SYSTEM OF MOTOR CONTROL.

SPECIFICATION forming part of Letters Patent No. 676,305, dated June 11, 1901.

Application filed March 5, 1900. Serial No. 7,262. (No model.)

To all whom it may concern:

Be it known that I, ALBERT G. DAVIS, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Systems of Motor Control, (Case No. 1,009,) of which the following is a specification.

My invention relates to a system of motor control, and is particularly adapted to the simultaneous control of motors situated at a plurality of different points, as in train-control systems.

The systems heretofore proposed for controlling the operation of motors on a plurality of cars constituting an electric train may be divided into two distinct classes, in one of which the controller-contacts are separately operated by a plurality of independent actuating devices and in the other of which the controlling-contacts for each motor equipment are mounted on a common support operated by a suitable actuating means. Whichever system is employed it is essential for successful operation of a train that the controllers on the separate cars shall be so actuated that a given set of motor connections in the motor-circuit will be made simultaneously on all of the cars, and while this result has been successfully attained in those systems in which separately-actuated contacts are employed it has been thus far impossible in those systems in which the controller-contacts for each motor equipment are mounted on a common support to secure a synchronous operation of the several controllers without resorting to complications which render the system objectionable from a practical standpoint.

My invention relates to a system of the class in which the contacts for each motor equipment are mounted on a common support, and has for its object to provide a simple and effective system for controlling the operation of the various controllers in a train-control or similar system and at the same time one which will insure the simultaneous operation of all the controllers in a step-by-step manner.

In the accompanying drawings, illustrating an embodiment of my invention, Figure 1 shows, diagrammatically, my system as applied to a single car of a train. Figs. 2 and 3 show details of construction.

In Fig. 1 the conductors 1 to 14, inclusive, represent the conductors of a train-control system, the said conductors being shown of a length sufficient for a single car and provided at their ends with connecting devices 1^a to 14^a, inclusive, by means of which they are connected to similar conductors on the other cars of the train in a manner now well known in the art. M′ and M^2 represent the motors constituting a car equipment, R the resistance, which is commonly used in connection with a motor-controller, and C the controller by means of which the resistance R and the motors M′ M^2 are connected in various circuit combinations. The letters M M indicate the master-controllers, placed one at each end of the car and similarly connected to the train-conductors 1 to 14. The controller on the right is shown in outline merely, while the one on the left is shown in development, its fixed contacts being indicated by the small circles 1′ to 14′, inclusive, and its movable contacts by the rectangles 1^b to 14^b, inclusive. The movable contacts are shown developed on a plane surface, as is customary in illustrating such a structure, although in actual construction the movable contacts are commonly mounted upon a cylinder, so that by rotation of the cylinder they may be successively brought into engagement with the fixed contacts or brushes 1′ to 14′, inclusive. SB indicates a storage battery connected at one end to ground and at the other end to the train-conductor 1, it being of course understood that all the storage batteries on the train are similarly connected. Each of the storage batteries is kept continually charged by current supplied from the main source of supply through a trolley-shoe T and resistance BR. Whenever any one of the master-controllers is moved so as to bring its fixed and movable contacts into engagement, the several storage batteries supply current in multiple through the contacts of the master-controller to the actuating devices of the several motor-controllers in a manner to be hereinafter described. The motor-controller C comprises a plurality of movable contacts *d* and a plurality of fixed contacts *e*, the contacts shown being adapted for the

series-parallel method of control, although the particular type of motor-controller used has evidently nothing to do with my invention. The movable contacts *d* are shown developed on a plane surface, although in actual construction they would be mounted upon a cylinder supported on the shaft *s*, by means of which the said cylinder is rotated. The shaft *s* is supported from a frame F by means of the bearings B B′ B² and is moved step by step as the master-controller is operated in a manner hereinafter to be described. This shaft is longitudinally movable in its bearings and is provided at one end with a lever l^3, pivoted at one end on the controller-supporting frame at *f* and at its other end connected on one side to the spring S′ and on the other to the core of an electromagnet c^2. At the other end of the controller-shaft, between the bearings B and B′, there are provided a number of devices or arms m^3 to m^{15}, inclusive, through which motion is transmitted to the shaft from the electromagnetic actuating devices c^3 to c^{14}, inclusive.

Referring to Figs. 2 and 3, it will be seen that each of these transmitting devices consists of an arm enlarged at one end to surround the shaft *s* and at its other end provided with a latch comprising a beveled head *o*, supported by a shank which is squared, as shown at *p*, at its lower end and which engages a square hole in the end of the arm *m*, a nut *t* being provided at the lower end of said shank and a spring *r* being inserted between the head *o* and the face of the arm *m*. The arms m^3 to m^{14}, inclusive, are uniformly spaced around the shaft *s*, so that the latches carried thereby occupy the positions shown in Fig. 2. When the several motor-controllers are being operated from any one of the master-controllers, the shaft *s* will be maintained by the electromagnet c^2 in such a position that the latches on each of the transmitting devices m^3 to m^{14}, inclusive, will be in alinement with the levers l^3 to l^{14}, inclusive, which are directly connected to and operated by the cores of the several electromagnetic actuating devices, and the said transmitting devices will therefore be in operative relation to their corresponding actuating devices. The shaft *s* is also provided with an arm m^{15}, carrying a latch similar in construction to those carried by the several transmitting devices and adapted to engage in the full-on position of the controller a stop L, projecting from the frame F. A spring S is provided for returning the motor-controller to its off position whenever the electromagnet c^2 is deënergized by the breaking of the circuit supplying current thereto at the master-controller. The frame F, supporting the motor-controller contacts and the transmitting devices, is fastened in any convenient position on the car—as, for example, on the under side of the car-body—and the electromagnets of the actuating devices are supported in such a position as to be in operative relation to the said controller, the parts being mounted, as shown in Figs. 2 and 3, on a common support G, which may represent the bottom of the car. The actuating devices comprise each a lever *l*, loosely mounted on the shaft *s* and held against longitudinal movement thereon by engaging a groove in the lug *i*, and a core *h* of magnetic material pivoted at one end to the lever *l* and at the other end in operative relation to an electromagnet *c*. This electromagnet, as shown, is of the iron-clad type and has a head *v* projecting toward the movable core *h*, and at its lower portion is provided with a non-magnetic bushing between the movable core *h* and the lower frame of the electromagnet. A rod *w*, of non-magnetic material—brass, for example—is fastened to the core *h* at its upper end, and this rod carries at its upper end a check-nut *x*, also of brass, which when the electromagnet is not energized rests against the upper head of the magnet and maintains the lever *l* in a definite initial position. In this position the latch of the transmitting device m^3 will lie in the position shown in Figs. 2 and 3, with its long side resting against the upper surface of the lever l^3. The latches of the other transmitting devices will lie each behind its corresponding actuating-lever, the said latches being regularly spaced one behind the other, as shown in Fig. 2.

Normally the spring S′ maintains the shaft *s* of the controller in its extreme right-hand position, with the latches of the several transmitting devices out of alinement with their corresponding levers; but when any one of the master-controllers is moved into its first operative position, with the movable contacts 1^b and 2^b engaging the corresponding fixed contacts 1′ and 2′, (this being the position illustrated in Fig. 1,) a circuit is closed from the train-conductor 1, to which the positive terminals of the storage batteries on each of the motor-cars are connected, through the fixed contact 1′ and cross-connected contacts 1^b and 2^b of the master-controller to the fixed contact 2′, train-conductor 2, and thence in multiple through the electromagnets c^2 on the several motor-cars to the conductors 15, to ground, and back to the negative terminals of the several storage batteries. Each of the electromagnets c^2 will therefore be energized and the shaft *s* of each of the motor-controllers will be moved to the left into the position shown in Fig. 1. If now the master-controller is moved into its second operative position current will be still supplied through contacts 1′ 2′ and 1^b 2^b to the electromagnet c^2; but in this position another circuit is closed through the movable contact 3^b to fixed contact 3′ and train-conductor 3, whence current will flow through the energizing-coil of the electromagnet c^3 to the common conductor 15 and thence to ground. The electromagnet c^3 will therefore be energized and its core be drawn up. The lever l^3 will be actuated and through its en-

gagement with the latch on the transmitting device m^3 will move the same, together with the shaft s, and will bring the controller C into its first operative position. As the lever l^3 is moved the beveled surface of the latch of the transmitting device m^4 will engage the side of the lever l^4 and will slide over the same, compressing the spring r until in the final position of the lever l^3 it will have snapped back into its normal position on the upper side of the lever l^4. When the master-controller is moved into its third position, the electromagnet c^4 will be energized, and by means of the lever l^4 and the transmitting device m^4 the shaft s will be moved through another step, the latch of the transmitting device m^5 snapping over the lever l^5, so as to be in a position to be operated by the said lever when the master-controller is moved into its next position. As the master-controller is thus moved the actuating devices will be successively energized, each device moving the motor-controller into a certain definite position until in the position of the controller marked 14 the lever of the last actuating device will be operated and the latch on the holding-arm m^{15} will be caused to engage the fixed stop L. With the controller in its final position 15 the electromagnetic actuating devices c^3 to c^{14}, inclusive, will all be deënergized and the controller will be maintained in its full-on position by the latch on the holding-arm m^{15}. If now the controller is brought to its off position, the circuit supplying current to the electromagnet c^2 will be broken as the contacts 1^b and 2^b leave the brushes $1'$ $2'$, and the spring S′ will draw the shaft s back until the latch on the holding-lever m^{15} no longer engages the stop L, when the spring S, which has been put under tension by the revolution of the controller-shaft, will throw the controller back to its zero position, in which position it will be held by a lug (not shown) with the latch of the transmitting device m^3 lying in such a position that when the electromagnet c^2 is again energized it will engage the upper surface of the lever l^3.

It is of course to be understood that the master-controller M, from which the several motor-controllers are operated, may be situated in any desired position on the train and that in its operation it serves merely to connect the several train-conductors to the source of current-supply, the corresponding actuating devices of the controllers on the several cars being connected to the same train-wire, so that they will be simultaneously operated. It is also to be noted that in the operation of the master-controller only two of the electromagnetic actuating devices c^3 to c^{14}, inclusive, are in operation at the same time, the first being thrown out of circuit as the third beyond it is being cut in. It is of course possible to so arrange the contacts of the master-controller that the circuit to any one actuating device is broken as the circuit to the succeeding device is completed; but in order to insure successful operation and to permit the controller-handle to be moved with considerable speed it is advisable to elongate the contacts of the master-controller in the manner shown.

In the embodiment of my invention which I have shown I have provided actuating devices equal in number to the number of steps through which the motor-controller is to be moved, and I have provided a device independent of the actuating devices for holding the controller only in its full-on position; but it is evident that I may, if desired, operate a number of transmitting devices from a single actuating device and provide holding devices at any desired positions of the motor-controller. For example, the transmitting devices m^3, m^6, m^9, and m^{12} might be combined in the same structure and operated from the lever l^3. Similarly m^4, m^7, m^{10}, and m^{13} might be operated from the lever l^4 and m^5, m^8, m^{11}, and m^{14} operated from the lever l^5. Similarly the holding device m^{15} might be constructed with a plurality of arms carrying latches adapted to engage the stop L both in the full series and in the full parallel position of the controller. In this case the contacts of the master-controllers M would be so arranged that in the full series, as well as in the full parallel position, all of the actuating devices would be open-circuited.

While my invention is especially intended for controlling the several motor equipments of a train-control system, it is also applicable whenever it is desired to control a number of motors simultaneously or even when it is desired to control a single motor or motor equipment from a distant point. Also it is obvious that the system of connections and details of construction may be widely varied or modified without departing from the spirit of my invention.

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

1. In combination, a controller comprising fixed and movable contacts, a common support for said movable contacts, a series of separately-actuated devices for moving said controller, step by step, through a series of operative positions, and means for successively operating said actuating devices.

2. In combination, a set of fixed contacts, a cylinder carrying a set of movable contacts adapted to engage therewith, a plurality of independent actuating devices for moving said cylinder, step by step, through a series of operative positions, and means for successively operating said actuating devices.

3. In combination, a cylinder carrying electric contacts, a plurality of electromagnetic devices for operating said cylinder, each of said devices being adapted to move said controller-cylinder through a portion only of its full movement, and means for successively energizing said electromagnetic devices.

4. In combination, a motor-controller com-

prising fixed and movable contacts, a common support for said movable contacts, a plurality of electromagnetic devices for operating said controller, each of said devices being adapted to move said controller-cylinder through a portion only of its full movement, a source of current-supply, and means for successively energizing said electromagnetic devices from said source.

5. In combination, a controller, a plurality of independent actuating devices for said controller, separate electromagnets for operating each of said actuating devices, means whereby the operation of one actuating device brings another of said devices into operative relation with said controller, and a master-controller for separately and successively energizing said electromagnets.

6. In combination, a controller comprising movable contacts mounted on a common support, a plurality of separate actuating devices for operating said controller, each of said devices corresponding to a particular operative position of the controller, and means for separately and successively energizing said actuating devices.

7. In combination, a controller comprising movable contacts mounted on a common support, a plurality of electromagnetic devices for operating said controller, means for separately and successively energizing said electromagnetic devices, and means whereby each electromagnetic device when energized operates to move the controller into a definite operative position.

8. In combination, a motor-controller comprising fixed and movable contacts, a common support for said movable contacts, a plurality of actuating devices for shifting said movable contacts through a series of operative positions, each of said actuating devices being adapted to move said common support through a portion only of its full movement, and a master-controller operatively connected to said actuating devices, said master-controller being constructed and arranged to successively operate said actuating devices.

9. In a train system, a plurality of motor-controllers each having its movable contacts mounted on a common support, a plurality of separate electromagnetic actuating devices operatively related to the common support of each controller, each of said devices being adapted to move the controller through a portion only of its full movement, a train-line to which the windings of the electromagnetic actuating devices are connected, and a master-controller connected and arranged to supply current simultaneously to the windings of the corresponding electromagnetic actuating devices of the several controllers.

10. In a train system, one or more motor-controllers each having its movable contacts mounted on a common support, a plurality of separate actuating devices operatively related to the common support of each controller, each of said devices being adapted to move said controller through a portion only of its full movement, a train system to which the separate actuating devices are operatively connected, and a master-controller connected and arranged to simultaneously operate the corresponding actuating devices of the several controllers.

11. In a train system, one or more motor-controllers each comprising a set of fixed contacts and a set of movable contacts mounted on a common support, a plurality of separate electromagnetically-actuated devices operatively related to the movable contacts of each controller, each of said devices being adapted to move said controller through a portion only of its full movement, a plurality of train-conductors to which the windings of the electromagnetic actuating devices are connected, and a master-controller for controlling the connection between a source of supply and said conductors.

12. In combination a controller, means tending to maintain said controller in its off position, a plurality of independent actuating devices for said controller, a fixed stop, devices for transmitting motion from any one of said actuating devices to said controller, a holding device, means whereby the operation of any one transmitting device will bring another of said devices into engagement with its corresponding actuating device, and means whereby certain of said actuating devices will bring said holding device into engagement with said fixed stop.

13. In combination, a cylinder carrying electric contacts, a shaft for revolving said cylinder, a plurality of independent actuating devices, arms on the shaft each adapted to engage with a corresponding actuating device, means normally maintaining said arms in an inoperative position with respect to said actuating devices, and means for bringing said arms into an operative position.

14. In combination, a shaft, a plurality of independent actuating devices, arms corresponding in number to said actuating devices carried by said shaft, and latches on the said arms, the said arms being so related to the several actuating devices that a movement of one arm by its actuating device will bring the latch of another arm into engagement with its corresponding actuating device.

15. In combination, a controller, a plurality of independent actuating devices, means for transmitting motion from any one of said actuating devices to said controller, means for controlling the relative positions of said actuating devices and said transmitting means, so that in one position the said transmitting means will be in operative relation to the corresponding actuating devices, and means for returning said controller to its zero position whenever said transmitting means are in an inoperative position.

16. In combination, a controller, a plurality of independent actuating devices, a fixed stop,

means for transmitting motion from any one of said actuating devices to said controller, means carried by the controller for actuating said fixed stop, means for controlling the positions of said actuating devices and said fixed stop with respect to said transmitting means and said engaging means, so that in one position they will be in operative relation and in another position inoperative, and means for returning said controller to its zero position whenever said transmitting means and said engaging means are in an inoperative position.

In witness whereof I have hereunto set my hand this 2d day of March, 1900.

ALBERT G. DAVIS.

Witnesses:
BENJAMIN B. HULL,
MABEL H. EMERSON.