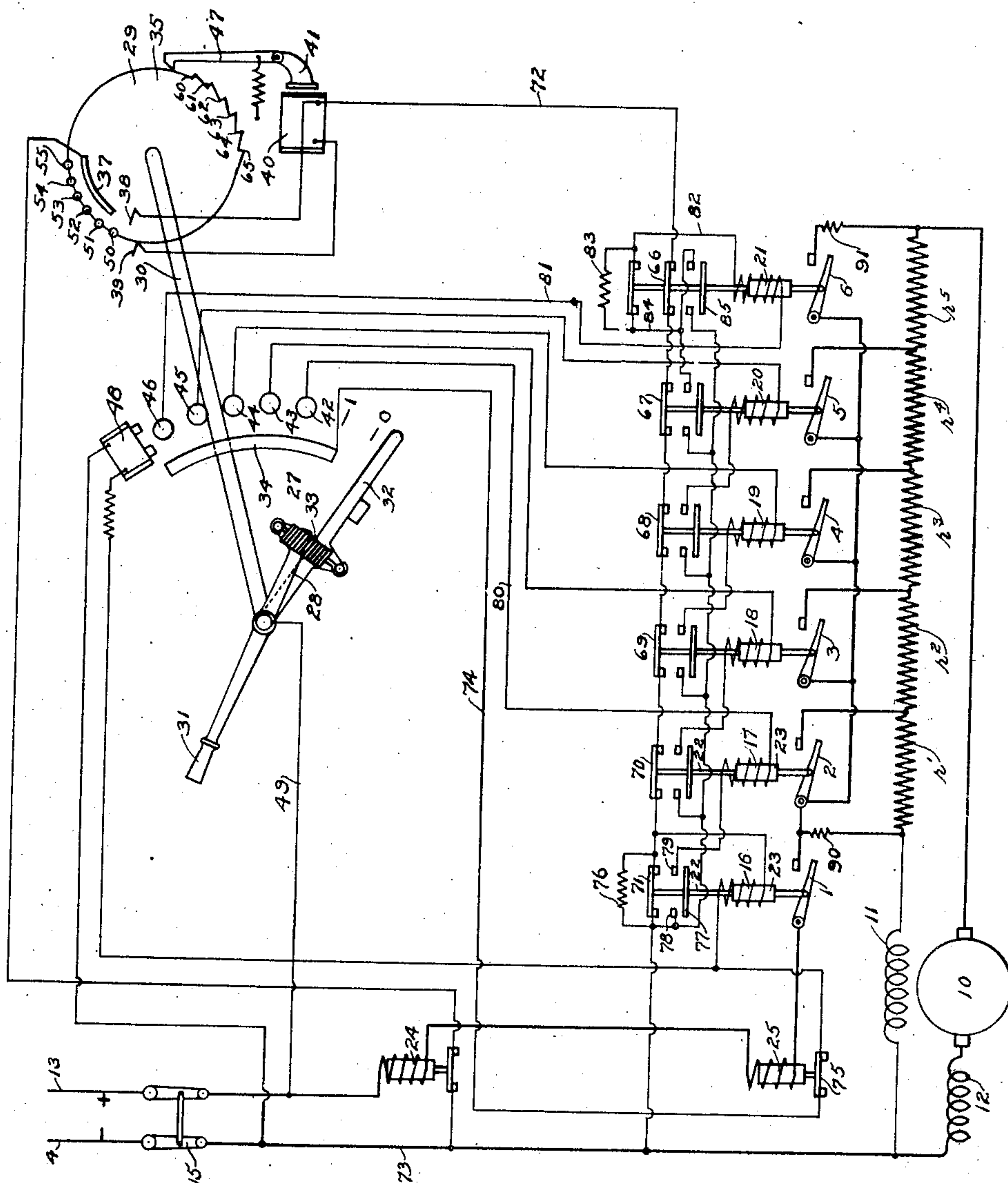


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SYSTEM OF MOTOR CONTROL.
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998,419.

Patented July 18, 1911.



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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, HALFDAN A. STEEN, a subject of the King of Norway, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Systems of Motor Control, of which the following is a full, clear, and exact specification.

This invention relates to systems of control employing a controller of the separately actuated contact type in which the several controller contacts are arranged to be operated at a rate dependent upon the value of the current in the motor circuit by means of connections so arranged that the system will be automatic, or at least partially automatic, in its operation.

The object of the invention is to provide novel means in connection with my controller to prevent a too rapid successive operation of the controlling contacts thereof.

The various novel features of my invention will be described in the specification and particularly set forth in the appended claims.

The invention is illustrated diagrammatically in the accompanying drawing.

The motor 10, here shown as having a shunt field 11 and series field 12, is connected to mains 13 and 14 by a line switch 15. In order to vary the speed of the motor, sections r^1 , r^2 , r^3 , r^4 , and r^5 of resistance are connected in series with the motor. These sections of resistance are adapted to be cut in and out of circuit by automatically operated switches 1, 2, 3, 4, 5, and 6, each being controlled respectively by adjacent contacts. All of the switches taken in conjunction with their corresponding contacts are provided with actuating circuits including solenoids 16, 17, 18, 19, 20, and 21. The bridging members of each contact are connected to the movable member of its corresponding switch by a bar 22. Each bar in turn is connected to a core 23 which is adapted to be actuated by the action of current in its actuating circuit. Connected in the motor circuit with the switches and resistance is an accelerating relay 24 and an overload relay 25 which will be considered presently.

The operation of the contacts is controlled by a master switch 27 which includes two relatively movable parts 28 and 29 respectively connected by a conducting shaft 30 through which motion from one part is

transmitted to the other. One of these relatively movable parts or members 28 includes a handle 31 flexibly connected to a contact arm 32 by a spring 33. The contact arm 32 is adapted to engage a comparatively long bar contact 34 and contact buttons 42, 43, 44, 45, and 46. The other part 29 comprises a relatively movable notched plate 35 having a contact bar 37 and contact buttons 50 to 55. This contact bar and set of contact buttons are adapted to be engaged respectively by contact fingers 38 and 39, which are connected by conductors to an accelerating magnet 40. This accelerating magnet under certain conditions is adapted to attract the armature 41, which forms one end of a spring-pressed pawl 47. The pawl is adapted to engage notches 60 to 65 inclusive in the notched plate 35 for positively preventing a speed increasing movement of the parts or members 28 and 29 of the master switch beyond any position unless with the master switch in such position the current in the motor armature is below a certain predetermined value. When the armature 41 of the pawl 47 is attracted the notched disk 35 is permitted to rotate step by step in an anti-clockwise direction, thus permitting the spring pressed contact arm 32 to move successively to different operative positions in order to make proper connections between the supply circuit and the separately actuated contacts for operating the resistance controlling switches. When the contact arm has passed through all of the starting positions and reaches the running position the contact arm is retained in the running position by a low voltage magnet 48, the electric circuit of which is controlled by the accelerating and overload relays.

The operation of the system will now be considered.

When the line switch 15 is closed, and the contact arm 32 is moved to its zero position, the notched disk 35 will be rotated in an anti-clockwise direction so that contact button 50 will be engaged by contact finger 39. If the bridging contacts 66 to 71 inclusive are in the same initial position, or in contact with their corresponding cooperating contact buttons, current will flow from the positive main 13 through conductor 49, shaft 30, disk 35, contact button 50, contact finger 39, accelerating magnet 40, conductor 72, through all of the bridging contacts 66 to

71 inclusive and conductor 73, which forms the negative side of the line. It is absolutely necessary that all of the bridging contacts 66 to 71 inclusive be in engagement with their corresponding contact buttons in order that, when the contact arm 32 is in its zero position, current will be admitted to the accelerating magnet 40 to attract the armature 41 of the pawl 47 to draw the pawl out of engagement with the notch 60, thus permitting the contact arm to move into position #1. When the contact arm 32 has come to its first position, current will pass from the positive side of the line through conductor 49, contact arm 32, contact bar 34, conductor 74, switch 75 of the overload relay, through solenoid 16, bridging contact 71, to the negative side of the line. A complete circuit is thus formed and switch #1 will be closed admitting current to the motor armature 10, through accelerating relay 24, overload relay 25, switch #1 and all of the sections r^1 , r^2 , r^3 , r^4 , and r^5 of resistance. In case there should be an overload on the line the overload relay 25 would operate to break circuit connections of the master switch so that switch #1 would be opened and the current supply of the motor shut off. Also in case the current in the motor armature exceeded a predetermined value the accelerating relay 24 would operate to break the circuit connections of the accelerating magnet thus preventing further movement of the notched member 35 and also a corresponding movement of the contact arm 32. When switch #1 is closed, the bridging contact 71 is thrown out of engagement with its corresponding contact members and the current passed through a resistance 76, in series with the actuating coil 16, to the negative side of the line. At the same instant bridging contact 77 comes into engagement with co-operating contact member 78 and 79. If the current in the armature circuit has not exceeded a certain predetermined value the pawl 47 will be drawn from notch 61 and the notched disk 35 rotated so that the pawl will engage the notch 62. This movement of the notched member 35 permits the spring-pressed contact arm 32 to engage contact button 42 thus completing a circuit from the positive side of the line through conductor 49, contact arm 32, contact button 42, conductor 80, solenoid 17, bridging contact 77 to the negative side of the line. At this instant switch #2 is closed, switch #1 remaining closed, and the first section r^1 of resistance cut out of the motor armature circuit, thus raising the electromotive force impressed on the armature terminals. When the motor armature current has dropped below a predetermined value, or if the cutting out of the first section r^1 of resistance has not raised such current above such value, the pawl 47 will operate to permit contact arm

32 to engage with contact button 43 thus closing switch #3 cutting out the second section of resistance. This step by step movement is continued until the contact arm 32 reaches contact button 46, which is its running position. It is held there by the low voltage magnet 48, and the current passes from the positive side of the line through conductors 49, contact arm 32, contact button 46, conductor 81, solenoid 21, conductor 82, resistance 83, conductor 84, bridging contact 85 to the negative side of the line. Current also passes from contact arm 32 through contact 34, conductor 74, switch 75, solenoid 16, resistance 76 to the negative side of the line. With the contact arm in this running position all of the sections of the resistance are cut out of the motor armature circuit and the motor is connected to the mains through the accelerating relay 24, overload relay 25, switches #1 and #6. Switches #1 and 6 are the only ones which remain closed when the master switch is in running position, the other switches opening when the contact arm 32 disengages the contact buttons 42 to 45 inclusive which are connected to the contacts corresponding to the other switches #2, 3, 4, and 5. If an overload occurred on the line when the contact arm 32 of the master switch was in running position, the contact arm would be released from the low voltage magnet 48 and would move out of engagement with the contact button 46 and contact bar 34, in the order named, thus opening respectively switch #6 and #1. The heavy arcing would occur naturally at the switches 1 and 6, and to avoid serious burning of the switch contacts, blow-out magnets 90 and 91 are provided.

By this system of motor control, which comprises a controller of the separately actuated contact type, actuating circuits for its contacts controlled by adjacent contacts, a master switch for controlling the operation of said contacts, and means for controlling the operation of said master switch, safe operation of motors is insured. Similar systems of control may be arranged wherein there may be modifications in the precise form and arrangement here shown and described, and I aim in my claims to cover all such modifications which do not involve a departure from the spirit and scope of my invention.

What I claim as new is:

1. In a system of control, the combination of a motor, a controller therefor of the separately actuated contact type having an actuating circuit for each contact controlled by an adjacent contact, and an electrically controlled master switch for controlling the operation of said contacts.

2. In a system of control, the combination of a motor, a controller therefor of the sepa-

5 rately actuated contact type having an actuating circuit for each contact controlled by an adjacent contact, a master switch for controlling the operation of said contacts, and electrical means for controlling the operation of said master switch.

10 3. In a system of control, the combination of a motor, a controller therefor of the separately actuated contact type having a plurality of actuating circuits for said contacts, each of said contacts controlled by an adjacent contact, a master switch for controlling the operation of said contacts, and electrical means for controlling the operation of said master switch.

20 4. In a system of motor control, the combination with a controller of the separately actuated contact type, of a master switch for controlling the operation of said contacts, and a current responsive device for controlling the operation of said master switch, said master switch being inoperative unless all of the contacts are first in the same position.

25 5. In a system of motor control, the combination with a controller of the separately actuated contact type having an actuating circuit for each of the contacts, of sections of resistance, switches for cutting in and out of circuit said sections of resistance, a master switch controlling the operation of said contacts and switches, and a current responsive device for controlling the operation of said master switch.

35 6. In a system of motor control, the combination with a controller of the separately actuated contact type having an actuating circuit for each of the contacts, of sections of resistance, switches for cutting in and out of circuit said sections of resistance, a master switch controlling the operation of said contacts and switches, and a current responsive device for controlling the operation of said master switch, said master switch being inoperative unless all of said contacts are first in the same position.

40 7. In combination, an electric motor, a controller of the separately actuated contact type therefor, a master controller comprising two relatively movable members, and means including a normally closed relay in the motor circuit for positively preventing relative speed-increasing movement of said members beyond any position unless with said controller in such position the current in the motor circuit is below a predetermined value.

50 8. In combination, an electric motor, a controller of the separately actuated contact type therefor, a master switch biased to running position and for controlling the operation of said separately actuated contacts and including means for positively stopping a relative speed increasing movement of said

master switch at every operative position unless with the switch in such position the current in the motor armature is below a predetermined value, and normally closed means in the motor circuit for controlling said first means.

9. In combination, an electric motor, a controller of the separately actuated contact type therefor, a master switch controlling the operation of said contacts and comprising means for normally positively preventing relative speed increasing movement of said switch beyond any operative position, and means including a normally closed relay in the motor circuit for automatically releasing said preventive means only when with the switch in such position the current in the motor armature is below a predetermined value.

10. In combination, an electric motor, a controller of the separately actuated contact type therefor, a master switch including means controlled by an electro-magnet, and a single electro-magnetic winding in the motor armature circuit solely controlling said means independently of the separately actuated contacts for positively preventing relative speed increasing movement of the switch beyond any position unless with the switch in such position the current in the motor armature is below a predetermined value.

11. In combination, an electric motor, a controller of the separately actuated contact type therefor, and a master switch including means controlled only by an electro-magnet winding in the motor armature circuit being independent of the separately actuated contacts and for positively stopping the speed increasing movement of said switch at every operative position unless with the controller in such a position the current in the motor armature is below a predetermined value.

12. In combination, an electric motor, a controller therefor, a master switch controlling the operation of said controller and comprising means for normally positively preventing speed increasing movement of said switch beyond any operative position, and electro-magnetic means including a normally closed relay in the motor circuit for releasing said preventive means only when with the controller in such a position the current in the motor armature is below a predetermined value.

Milwaukee, Wisconsin, September 14, 1910.

In testimony whereof I affix my signature, in the presence of two witnesses.

HALFDAN A. STEEN.

Witnesses:

CHAS. L. BYRON,

CLARA E. BENDEL.