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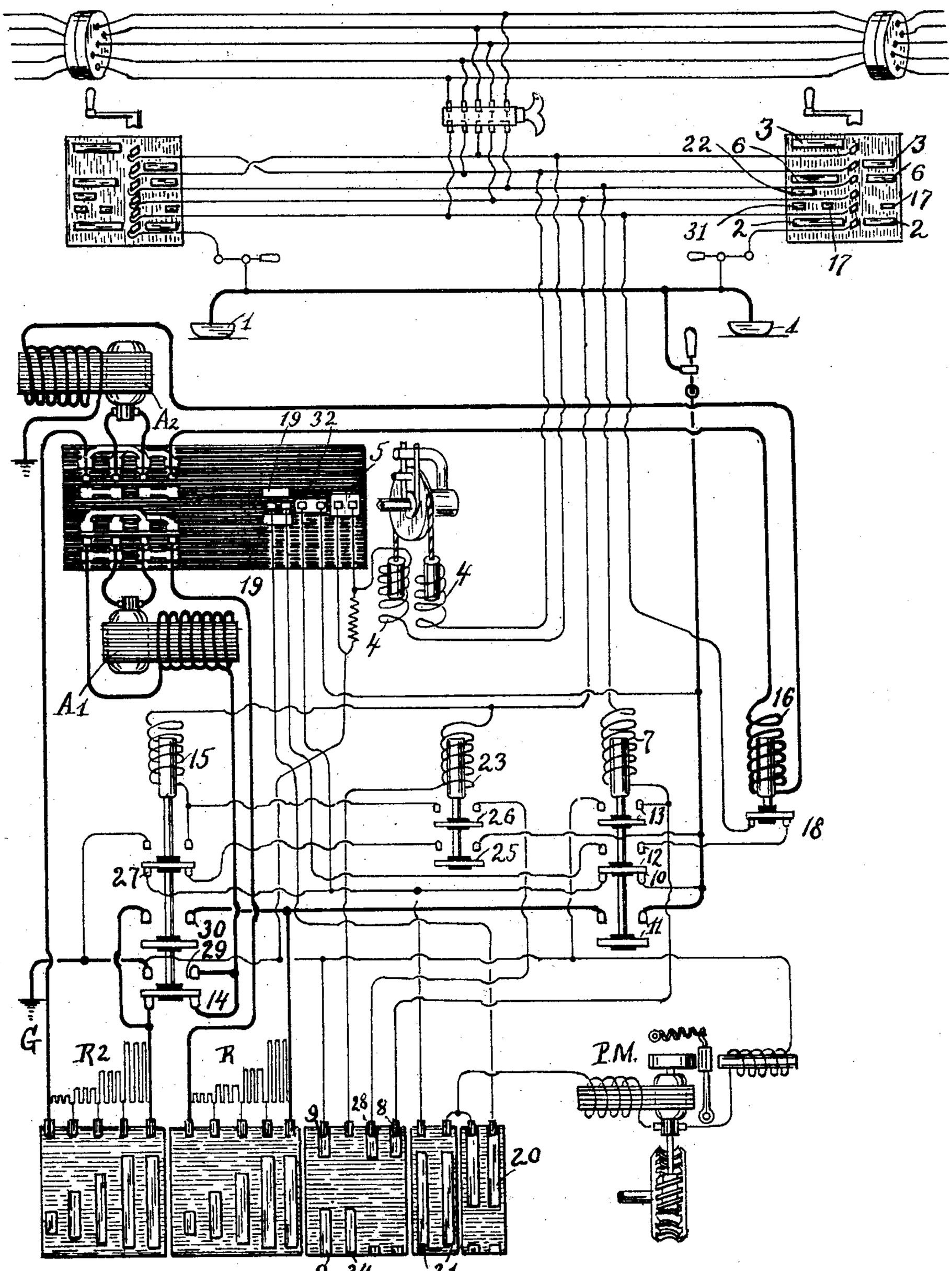
E. R. CARICHOFF.

CONTROL OF DYNAMO ELECTRIC MACHINERY.

(Application filed Jan. 18, 1901.)

(No Model.)



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CONTROL OF DYNAMO-ELECTRIC MACHINERY.

SPECIFICATION forming part of Letters Patent No. 706,723, dated August 12, 1902.

Application filed January 18, 1901. Serial No. 43,729. (No model.)

To all whom it may concern:

Be it known that I, EUGENE R. CARICHOFF, a citizen of the United States of America, and a resident of East Orange, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Control of Dynamo-Electric Machinery, of which the following is a specification.

My invention embraces the combination of three switches—*a* a rheostatic switch, *b* a pilot-switch, and *c* a motor-grouping switch—so connected that the pilot-switch is operative in one position of the rheostatic switch and the motor-grouping switch is operative in another position of the rheostatic switch, provided, however, that the pilot-switch has first been operated, but not otherwise. The position of the rheostatic switch in which the pilot-switch is operative is where it admits current through the motors, and the position of the rheostatic switch in which the motor-grouping is operative is where the rheostatic switch is in an open or high-resistance position. The pilot-switch and the series-multiple switch also partly control the operation of the rheostatic switch, as will be hereinafter explained.

The invention consists in certain other features hereinafter specifically described and claimed.

Referring to the accompanying drawing, which forms a part of this specification, the figure is a diagrammatic representation of a pair of motors with switches and circuits for connecting the motors in series and in multiple and in varying the resistance, one form of my invention being embodied in the system in this diagram.

The invention is primarily intended for operation in connection with what is known as the "multiple-unit system of electric-railway operation," described and patented in United States Letters Patent to Frank J. Sprague, No. 660,065, to which reference may be had for features not here disclosed. So much as is necessary to the understanding of my invention is here set forth.

It is to be understood that the invention is applicable to systems other than that described in the patent to Frank J. Sprague referred to.

The motor-grouping switch is, as shown, a set of contacts for connecting the motors in series and multiple. As shown, certain contacts in the circuit provided for operating the motor-grouping switch are mounted upon the same cylinder as the contacts of the rheostatic switch. The cylinder with this double set of contacts, constituting what will be called the "main switch," is driven by a small motor called a "pilot-motor" in the general manner represented in the patent to Frank J. Sprague, above referred to. The pilot-motor, however, is provided with only one field instead of two, as in said patent, because the main cylinder is, as shown, revolved in one direction only. The pilot-motor referred to is not to be confused with the pilot-switch. The pilot-switch is, as shown, a solenoid which effects closure of a double set of contacts, one set being in the circuit of the series-multiple switch and the other set being in the circuit of the pilot-motor.

The main motors are controlled from an operator's or master switch partly through a set of relay-circuits. The master-switch is provided with reverser-contacts and speed-contacts for operating the main switch and the motor-grouping switch. On closure of the master-switch the reverser is thrown in the direction corresponding to the direction of movement of the master-switch. The reverser-contacts of the master-switch are closed in all closed positions of the master-switch. Upon closure of the master-switch on the reverser and series contacts the circuit is closed through the operative coils of the reverser and the line-switch as follows: from the line through contact-plates 2 and 3 of the master-switch, through one coil or the other 4 of the reverser, through contacts 5 on the reverser-cylinder, (shunted by a resistance,) and thence to ground G. Immediately afterward the circuit is closed at contact 6 of the master-switch, thence through the coil 7 of the line-switch, through contact-plates 8 and 9 on the main-switch cylinder to ground at G. This actuates the line-switch, lifting its plunger, breaking one pair of contacts 10, and establishing three other pairs of contacts 11, 12, and 13, as indicated. As shown, the main circuit is established from the line 1

through the lowermost contacts 11 of the line-switch, through resistance R′, through the armature and field of one of the main motors A′ and reverser-contacts, through the lowermost contacts 14, controlled by the coil 15 of the series-multiple switch, through resistance R^2, and through the armature and field of motor A^2, reverser-contacts, and throttle-coil 16 to ground G. This connects the motors in series with all the resistance in circuit. The motors will start up. They will not reach more than a suitable speed for switching purposes, however, in this position of the apparatus. It will be obvious that the main switch can be arranged to open circuit at this position by dropping out the right-hand resistance-sections of R′ and R^2, the other resistances and contacts being suitably arranged. Upon further movement of the master-switch, so as to close on the full-series contact-point 17, the circuit is completed through the pilot-motor as follows: from line through contacts 1 and 17 of the master-switch, through throttle-contacts 18, through contacts 12 of the line-switch, through contacts 19 on the reverser-cylinder, through contact 20 on the main-switch cylinder, and thence through the pilot-moter P M to ground G. This will cause the main-switch cylinder to revolve until the pilot-motor circuit is broken at contacts 20 thereon. These contacts are therefore called "limit-contacts." In this position of the main switch and the other parts of the apparatus the motors are in what is called "full series"—that is, in series with all of the resistances R′ and R^2 cut out of circuit. If the master-switch be returned to the open position, the line-switch will drop and the pilot-motor circuit will be closed from the line through contacts 10, controlled by the line-switch, through limit-contacts 21 on the main-switch cylinder, and thence through the pilot-motor P M to ground G. This will cause the main switch to move forward to the off position. Simultaneously with the dropping of the line-switch plunger the main circuit will be opened at contacts 11, controlled by the line-switch. If, however, instead the master-switch be moved on so as to close at the multiple contact 22, the circuit is established through the pilot-switch as follows: from the line 1 through contacts 2 and 22 of the master-switch, through the pilot-switch coil 23, through limit-contacts 24 and 9 on the main switch-cylinder, and thence to ground G. This will cause the pilot-switch to close at its two pairs of contacts 25 and 26, and a circuit will be established through the pilot-motor as follows: from the line 1 through the lowermost contacts 25 of the pilot-switch, through the contacts 27 of the series-multiple switch, through contact 21 of the main-switch cylinder, and thence through the pilot-motor P M to ground G. This will cause the main-switch cylinder to be driven forward, and contact will be closed through the series-multiple switch-coil 15 as follows: from the line 1 through contacts 2 and 22 of the master-switch, through coil 15 of the series-multiple switch, through contacts 26 of the pilot-switch, through contacts 28 and 9 on the main cylinder to ground G. The series-multiple switch will thus be brought into position to connect the main motors A′ and A^2 and their resistances R′ R^2 in circuit in multiple. The main motor-circuit is as follows: from the line through the lowermost contacts 11 of the line-switch. Then branching to the two main motors the circuit is (*a*) through resistance R′, motor A′, including the reverser-contact, through a set of contacts 29, controlled by the series-multiple switch, to ground G, and (*b*) through a set of contacts 30, controlled by the series-multiple switch, through resistance R^2, through motor A^2, including the reverser-contacts and the coil 16 of the throttle, to ground G. If the master-switch is moved further, so as to close at the full-multiple contact 31 of the master-switch, the circuit is completed through the pilot-motor as follows: from the line 1 through contacts 2 and 31 of the master-switch, through throttle-contacts 18, through contacts 12 of the line-switch, through contacts 19 on the reverser-cylinder, and thence through limit-contacts 20 and the pilot-motor P M to ground G. This will cause the main-switch cylinder to revolve until the pilot-motor circuit is broken at the limit-contacts 20. In this position of the main switch and the other parts of the apparatus the motors are in full multiple—that is, in multiple with all resistance cut out. As shown, if the master-switch is opened at the multiple contact 22 the series-multiple switch is dropped, bringing the motors into series grouping without movement of the main-switch cylinder. It is obvious, however, that a circuit could be provided which shall be closed when the line-switch and the series-multiple switch are both closed, which will cause the series-multiple switch whenever lifted to remain up so long as the line-switch remains closed. Opening the master-switch releases the line-switch, the series-multiple switch, and the reverser. This cuts off the motors from the line and closes a local circuit through the pilot-motor as follows: from the line 1 through contacts 10 of the line-switch, through limit-contacts 21, and the pilot-motor to ground. There is also established in multiple with contacts 10 a branch through contacts 32 on the reverser-cylinder.

Instead of having contacts 24 and 28 on the main cylinder which determine the positions of the rheostatic switch in which the pilot-switch and the series-multiple switch can be operated, the same general result may be attained as follows: There may be two coils in the main motor-circuit, one wound on the plunger of the pilot-switch in addition to coil 23 (which latter would then be a retaining-coil and be connected directly to ground) and the other opening contacts in series with con-

tacts 26. In this arrangement the pilot-switch can be operated only while the main circuit is closed, and the series-multiple switch can be operated only while the pilot-switch is held closed by its retaining-coil and the main circuit is open. This would be used with the open-circuit arrangement of the rheostatic switch described above.

The system of control herein disclosed is applicable to dynamo-electrical machinery generally. There are herein combined three switches, which, as shown, are respectively a rheostatic switch, a pilot-switch, a series-multiple switch, means controlled by one of the switches, which, as shown, is the rheostatic switch, for operating another of the switches, which, as shown, is the pilot-switch, for the pilot-switch cannot be operated excepting when the circuit is closed at contact 24 on the main-switch cylinder. There is also means controlled by these two switches for operating the third—namely, the series-multiple switch—for this latter cannot be operated except when the pilot-switch is closed and to change the motor from series to multiple the circuit is closed at contact 28 on the main-switch cylinder, and in certain conditions both the series-multiple switch and the pilot-switch control contacts which control the resistance-switch. There is also provided a master-switch for operating the system. It will also be evident that the pilot-switch can be operated only when the rheostatic switch is in a position to admit current through the motors and the series-multiple switch can be operated only when the rheostatic switch is in the open-circuit or a high-resistance position. Since the resistance-contacts could be operated separately from the contacts of the main-switch cylinder which effect the coöperation of the switches, I do not limit myself to one of the switches included in the combination described in my broader claims, being a resistance-switch, and the specific functions of the other switches can be changed.

Numerous changes can be made without departing from the spirit of my invention.

Without limiting myself to the details shown, what I claim, and desire to secure by Letters Patent of the United States, is—

1. In a system of control of dynamo-electric machinery the combination of three switches, means controlled by one of the switches for operating another of the switches, and means controlled by these two switches for operating the third switch, and means controlled by either of the other switches for operating the first, substantially as shown.

2. In a system of control of dynamo-electric machinery the combination of a rheostatic switch, a pilot-switch, a motor-grouping switch, means controlled by the rheostatic switch for operating the pilot-switch, and means controlled by the rheostatic switch and the pilot-switch for operating the motor-grouping switch, substantially as described.

3. In a system of control of electric motors, the combination of a rheostatic switch, a pilot-switch, a motor-grouping switch, means controlled by the rheostatic switch for operating the pilot-switch, means controlled by the rheostatic switch and the pilot-switch for operating the motor-grouping switch, and means controlled by the pilot-switch for operating the rheostatic switch substantially as described.

4. In a system of control of a pair of electric motors the combination of a rheostatic switch, a pilot-switch, a series-multiple switch, means controlled by the rheostatic switch for operating the pilot-switch, and means controlled by the rheostatic switch and the pilot-switch for operating the series-multiple switch, to change the motors from series to multiple, substantially as described.

5. In a system of control of a pair of electric motors the combination of a rheostatic switch, a pilot-switch, a series-multiple switch, means controlled by the rheostatic switch for operating the pilot-switch, so that it can be operated only when the rheostatic switch is in position to admit current to the motors, and means controlled by the rheostatic switch and the pilot-switch, for operating the series-multiple switch to change the motors from series to multiple, which means can be operated only when the rheostatic switch is in the open-circuit or a high-resistance position, substantially as described.

6. The combination of three switches, means controlled by one of the switches for operating another of the switches, means controlled by the two for operating a third of the switches, means controlled by the second switch for operating the first of the switches, and a master-switch for operating the system, substantially as described.

7. In a system of control of dynamo-electric machinery, the combination of a rheostatic switch, a pilot-switch, a motor-grouping switch, means controlled by the rheostatic switch for operating the pilot-switch, means controlled by the rheostatic switch and the pilot-switch for operating the motor-grouping switch, and a master-switch for operating the system, substantially as described.

8. In a system of control of electric motors, the combination of a rheostatic switch, a pilot-switch, a motor-grouping switch, means controlled by the rheostatic switch for operating the pilot-switch, means controlled by the rheostatic switch and the pilot-switch for operating the motor-grouping switch, and a master-switch for operating the system, substantially as described.

9. In a system of control of a pair of electric motors, the combination of a rheostatic switch, a pilot-switch, a series-multiple switch, means controlled by the rheostatic switch for operating the pilot-switch, means controlled by the rheostatic switch and the pilot-switch for operating the series-multiple switch to

change the motors from series to multiple, and a master-switch for operating the system, substantially as described.

10. In a system of control of a pair of electric motors the combination of a rheostatic switch, a pilot-switch, a series-multiple switch, means controlled by the rheostatic switch for operating the pilot-switch, so that it can be operated only when the rheostatic switch is in a position to admit current to the motors, means controlled by the rheostatic switch and the pilot-switch for operating the series-multiple switch to change the motors from series to multiple, which means is operated only when the rheostatic switch is in the open-circuit or a high-resistance position, and a master-switch for operating the system, substantially as described.

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