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ELECTRICAL CONTROL CIRCUIT

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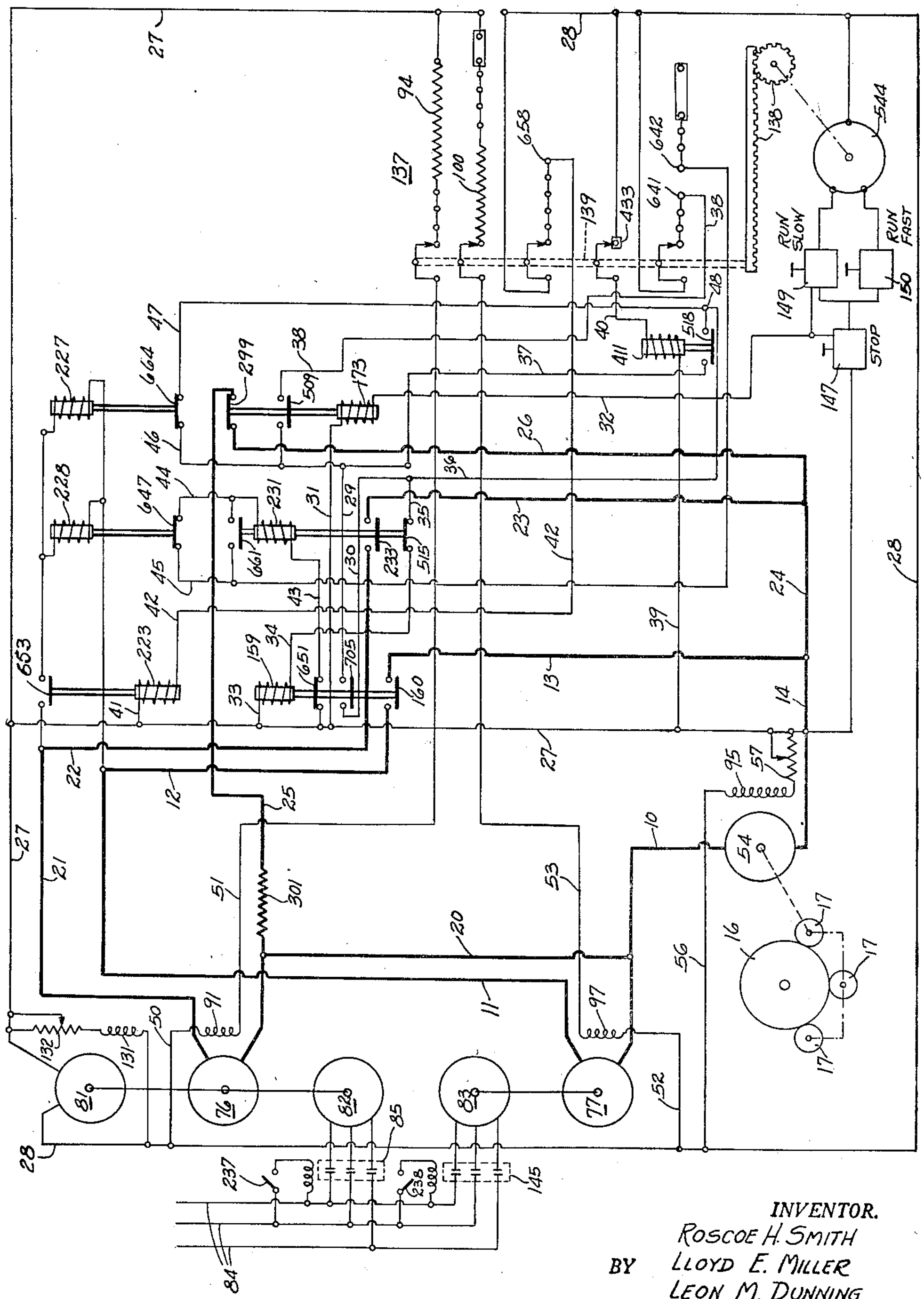

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ELECTRICAL CONTROL CIRCUIT

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7 Claims. (Cl. 172—239)

This application is a division of our application Serial No. 353,102, filed August 17, 1940, for Electrical control systems.

Our invention relates in general to electrical control circuits and more particularly to electrical control circuits including motors and generators connected to drive a load which has a wide speed variation such, for example, as a cloth printing machine.

The main drive for the cloth printing cylinder is applied to the several engraving rolls by a suitable gearing arrangement. The pressure of the engraving rolls on the large printing cylinder drives the latter by friction. In actual practice the circumferences of the engraving rolls vary between 16 inches to 24 inches for different lengths of patterns being printed. Accordingly, the linear speed of the printing machine cylinder varies from a given speed of the main drive, depending upon the circumferences of the engraving rolls. At the maximum linear speeds the drive is designed to provide at least 300 yards per minute, which is made available even with the minimum size engraving rolls; namely, the 16 inch circumference rolls, and at the minimum linear speeds the drive is designed to give as low as 10 yards per minute for threading or matching-up purposes, which is made available with the maximum size engraving rolls; namely, the 24 inch circumference rolls. Although this appears to be a 30 to 1 speed range, it is actually 45 to 1 by reason of the variations in the diameters of the engraving rolls. In threading the machine, the operator may run it at a low speed by setting the electrical control at "run slow" condition. For production printing speeds the operator operates the machine under "run fast" condition.

An object of our invention is to provide for selectively energizing the main motor which drives the engraving rolls and the printing cylinder from a low voltage and a normal voltage generator to obtain the wide speed variations.

Another object of our invention is to provide for electrically energizing the main motor from the low voltage generator under the run slow condition and to provide for energizing the main motor from the normal voltage generator under the higher speeds of the run fast condition.

Another object of our invention is to provide for preventing the main driving motor from being subjected to an electrical jar upon the transition from the low voltage generator to the normal voltage generator.

Another object of our invention is to provide for making the transition from the low voltage generator to the normal voltage generator, and vice versa, at a point or condition where the voltages of the two generators are relatively close together.

Another object of our invention is to provide for making the transition from the low voltage generator to the normal voltage generator, and vice versa, at a point or condition where the voltages of the two generators are relatively close together while the voltages of both generators are changing.

Other objects and a fuller understanding of our invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawing, in which:

The figure shows a diagrammatic illustration of our electrical control circuit, the figure comprising the only view of the drawing.

The figure has been made by taking the divisional subject matter from Figures 3, 4 and 5 of our application Serial No. 353,102 hereinbefore mentioned, and in doing this the corresponding parts are designated by the same reference characters, except that the reference characters which designate the conductors in the figure of the present application do not correspond to the conductors designated in the Figures 3, 4 and 5 of our application Serial No. 353,102.

With reference to the figure, the printing cylinder is indicated generally by the reference character **16** and is driven by a main driving motor **54** through the plurality of engraving rolls **17**. As explained hereinbefore, the speed variation from low speed to high speed may be as much as 45 to 1 and to take care of this wide variation in speed, we arrange for selectively connecting the main motor **54** to a threading or crawl generator **77** or to a main generator **76**. In other words, for slow speed operation the threading generator **77** supplies energy for operating the main motor **54** and for production purposes the main motor **54** is energized from the main generator **76**. An alternating current motor **82** is arranged to drive the main generator **76** as well as an exciter **81**, all of which may be suitably driven by the same shaft construction. The threading or crawl generator **77** is arranged to be driven by an alternating current motor **83**. The two alternating current motors **82** and **83** may be suitably energized from an alternating current source **84**, in which the motor **82** may be connected to the alternating current source through the set of contactors **85** upon the closing of the switch **237** and in which the motor **83** may be suitably connected to the alternating current supply source through a contactor 145 upon the closing of the switch 238. The exciter 81 supplies current for governing the control circuits as well as for the fields of the generators 76 and 77, the field for the main motor 54 and the field for the exciter itself. As illustrated, the field 131 for the exciter is connected across the conductors 27 and 28 energized by the exciter and governed by a resistor 132 of the adjustable type. The field 91 for the main generator 76 is energized by a circuit which extends from the exciter conductor 28 to a conductor 50, the field winding 91, and a conductor 51 to a variable resistor 94 of the motor operated rheostat 137 and to the conductor 27. The circuit for energizing the field 97 for the threading generator 77 may be traced as follows: beginning with the exciter conductor 28, current flows through a conductor 52, the field winding 97, and a conductor 53 to the variable resistance 100 of the motor operated rheostat 137 and to the conductor 27. The circuit for energizing the field winding 95 for the main motor 54 extends from the exciter conductor 28 through the conductor 56, the winding 95 and the illustrated adjustable resistor 57. The generated voltage range for the threading generator 77 is lower than the generated voltage range for the main generator 76. However, the upper portion of the range for the threading generator 77 overlaps the lower portion of the voltage range for the main generator 76.

The selection as to whether the crawl or threading generator 77 or the main generator 76 supplies current to the main motor is governed by the transition relays 159 and 231. When the transition relay 159 is energized the main motor 54 is connected in circuit relation with the threading generator 77 through a circuit which may be traced as follows: beginning with the conductor 10 the circuit extends through the armature of the threading generator 77, the conductors 11 and 12, the contacts 160 of the relay 159, and the conductors 13 and 14 through the opposite terminal of the main motor 54. When the transition relay 231 is energized the main motor 54 is connected in circuit relation with the main generator 76 and the circuit may be traced as follows: beginning with the conductor 10 the circuit extends through a conductor 20, the armature of the main generator 76, the conductors 21 and 22, the contacts 233 of the relay 231, and the conductors 23 and 24 to the opposite side of the motor 54. Under a dynamic breaking circuit, the generators 76 and 77 are both disconnected from the armature of the main motor 54 and the armature of the main motor is connected in a closed circuit including a resistor 301. The closed dynamic breaking circuit extends from conductor 10 through the conductor 20, the resistance 301, the conductor 25, the contacts 299 of the relay 173 and the conductors 26, 24 and 14 to the opposite side of the motor 54.

The motor operated rheostat 137 which controls the operation of the circuits is driven by a motor 544 through a rack and pinion drive 138. (The motor operated rheostat 137 and the motor 544 which drives it may be the same as that substantially shown and described in our parent application, Serial No. 353,102, filed August 17, 1940.) As illustrated diagrammatically, the motor 544 may be controlled by a run slow contacting device 149 or a run fast contacting device 150. A "stop" contacting device 147 is positioned in advance of the run slow contacting device 149 and the run fast contacting device 150 and is arranged to arrest the operation of the control system. The stop contact device and the run slow and the run fast contact device as well as the motor 544 for the motor operated rheostat 137 are diagrammatically illustrated as being connected across the exciter conductors 27 and 28.

In starting the equipment in operation, the run slow contact device 149 is actuated which establishes a circuit for energizing the dynamic breaking relay 173 through a circuit which extends from the exciter conductor 27, the conductor 31, the winding of the relay 173, and conductor 32 to the run slow contact device 149. In the run slow position the motor operated rheostat 137 is in the position shown in the drawing with the movable contact member 139 positioned in the standstill location. In other words, the motor 544 which drives the motor operated rheostat 137 is inactive under the run slow condition. The energization of the dynamic breaking relay 173 opens the contacts 299 to remove the dynamic breaking circuit and closes the contacts 509 for establishing a circuit for energizing the transition relay 159. The circuit for the transition relay 159 may be described as follows: beginning with the exciter conductor 27 the circuit extends through the conductor 33, the winding of the relay 159, the conductor 34, the contacts 515 of the relay 231, the conductors 35 and 36, the contacts 518 of the relay 411, the conductor 37, the contacts 509 of the dynamic breaking relay 173, and the conductor 38 to the contact member 641 of the motor operated rheostat and then through the exciter conductor 28. The energization of the transition relay 159 connects the main motor 54 in circuit relation with the threading generator 77 through the closure of the contacts 160. The speed at which the main motor 54 operates under the run slow condition of the circuits may be as low as 10 yards of cloth per minute for threading or matching-up purposes and this may be governed by the amount of the resistance in the resistance element 100 of the motor operated rheostat 137. Under the run slow condition, the motor operated rheostat 137 remains at the standstill location as shown in the drawing, under which condition the relays 223 and 411 are both energized. The relay 223 is energized through a circuit which extends from the exciter conductor 27, through the conductor 41, the winding of the relay 223, and the conductor 42 to the contact member 658 of the motor operated rheostat whereupon the current flows to the exciter conductor 28. The operation of the relay 223 closes the contacts 653 and connects the two differential relays 227 and 228 across the conductor 21 of the main generator 76 and the conductor 11 of the threading generator 77. The circuit for energizing the relay 411 extends from the exciter conductor 27 through the conductor 39, the winding of the relay 411, and the conductor 40 to the standstill contact member 433 of the motor operated rheostat 137 whereupon the current flows through the exciter conductor 28.

Upon the actuation of the run fast contact device 150 a condition is established for causing the motor 544 to operate the motor operated rheostat 137 and causing the movable member 139 to move to the right as shown in the drawing. As the movable member 139 moves to the right the resistance 100 is reduced and causes the voltage of the generator 77 to gradually increase. By the time that the movable member 139 substantially reaches the contact member

641, the voltage of the threading generator 77 has substantially reached the voltage of the generator 76 so that the electrical jar upon the main motor 54 is reduced to a minimum and the transition takes place in shifting from the threading generator 77 to the main generator 76. As the movable member 139 moves past the contact member 641 the circuit is interrupted which formerly energized the relay 159 and a new circuit is established for energizing the transition relay 231 for connecting the main generator in circuit relation with the main motor 54. The circuit for energizing the transition relay 231 may be traced as follows: beginning with the exciter conductor 27, current flows through the contacts 651 of the relay 159 which is now de-energized, the conductor 43, the winding of the relay 231, the conductor 44, the contacts 647 of the relay 228, the conductor 45 to the contact member 642 of the motor operated rheostat whereon the current flows to the exciter conductor 28. Inasmuch as the circuit for energizing the transition relay 231 extends through the contacts 647 of the relay 228, the circuit is not actually established until the relay 228 becomes sufficiently de-energized to close the contacts 647. In the actual operation of our circuit, we preferably hold the contacts 647 open until the difference in voltage generated by the threading generator 77 and the main generator 76 have been reduced to approximately 5 volts. We also preferably make the transition take place when the voltages of the two generators are in the neighborhood of 35 or 40 volts. The threading generator 77 has a more rapid voltage rise than the main generator 76 during the early stages of the movement of the motor operated rheostat 137. The purpose of the relay 228 is to insure that the differential voltage between the threading generator 77 and the main generator 76 is less than 5 volts, for example, during the transition period in order to prevent too large a current disturbance upon the main motor 54 which would tend to damage the cloth being printed. After the transition takes place, the relay 223 is de-energized which opens the contact 653 for removing the differential relays 227 and 228 from the circuit. The disruption of the circuit which energized the relay 223 occurs when the movable member 139 of the motor operated rheostat passes beyond or to the right of the contact member 658 of the motor operated rheostat. In this application, when the movable member 139 is described as moving with reference to the contact members of the motor operated rheostat, it is to be understood that this is to be interpreted to mean that the contacts which are carried by the movable member move with reference to the contact members upon the motor operated rheostat. The speed at which the motor 54 operates under the run fast condition depends upon the setting of the motor operated rheostat which determines the voltage generated by the main generator 76. When the movable member 139 is moved to the extreme right hand position, the voltage of the main generator may be in the neighborhood of 230 to 240 volts.

In stopping the equipment, the run slow contact device 149 is preferably first actuated after which the stop contact device 147 may be operated to finally arrest the operation of the equipment. Upon actuation of the run slow contact device 149 the motor operated rheostat moves to the left until it reaches the standstill position as shown in the drawing. As the movable member 139 of the motor operated rheostat moves to the left the voltage of the main generator 76 gradually decreases. Upon the movable member 139 reaching the contacts 658 the circuit is again established for energizing the relay 223 which closes the contact 653 for including the relays 227 and 228 in circuit relation with the two generators 76 and 77. After the movable member 139 passes the contact member 642 the circuit is disrupted which formerly energized the relay 231 and thus the motor 54 is disconnected from circuit relation with the main generator 76. When the movable contact member 139 engages the contact member 641, a circuit is established for energizing the transition relay 159 which connects the motor 54 in circuit relation with the threading generator 77. The circuit for energizing the relay 159 extends from the exciter conductor 27, the conductor 33, the winding of the relay 159, the conductor 34, the contacts 515 of the relay 231 which is now de-energized, the conductor 36, to the point 48, the conductor 47, the contacts 664 of the relay 227, the conductor 46, the contacts 509 of the relay 173, the conductor 38 to the contact members 641 of the motor operated rheostat whereupon the current flows to the exciter conductor 28. Upon the deacceleration of the equipment, the current for energizing the relay 159 upon reaching the point 48 does not flow through the contacts 518 of the relay 411 for the reason that the relay 411 is energized only at the standstill position through the contact member 433. The object of making the current flow through the contacts 664 of the relay 227 upon the energization of the relay 159 for the decelerating condition is that relay 159 is prevented from becoming energized until the voltage between the two generators has been decreased to a value substantially equal to 5 volts in order to prevent the electrical jar upon the motor during the transition from the main generator 76 to the threading generator 77. Therefore, in our circuit the transition relays 159 and 231 are not operated for transferring the load of the motor 54 to either one of the two generators 76 and 77 until the voltage between the two generators has been decreased to the value of substantially 5 volts as determined by the operation of the protective relays 227 and 228. When the equipment has been reduced in speed by actuating the run slow contact device 149, the movement thereof may be entirely arrested by actuating the stop contact device 147 which operates the dynamic breaking relay 173 to de-energize the relay 159 as well as establish the dynamic breaking circuit through the contacts 299.

Since the relay 411 can be energized only in the standstill position of the motor operated rheostat 137 by current flowing through the contact member 433, the equipment cannot be started unless the motor operated rheostat is in the standstill position as illustrated in the drawing. As the motor operated rheostat partially moves to the right from the standstill position, the relay 411 becomes de-energized but the circuit for energizing the relay 159 still is maintained through a holding circuit established by the contacts 705 of the relay 159 when once energized. The contacts 705 and the two conductors 23 and 39 shunt the contacts 518 for the relay 411 so that the relay 159 remains energized even though the contact is broken at the standstill contact 433 of the motor operated rheostat as the movable member moves to the right. A holding circuit is also established for the relay 231 for holding the relay energized even though the contacts 647 of the relay 228 may be open as will be the case before the movable contact member 139 passes to the right of the contact member 658 which disrupts the circuit that energized the relay 223 for removing the relays 227 and 228 from circuit relation with the two generators 76 and 77. In other words, the relay 223 is disconnected from being energized just as soon as the movable contact member 139 of the motor operated rheostat passes to the right beyond the point 658 which means that the relays 228 and 227 are removed from the differential voltage of the threading generator 77 and the main generator 76 under high speed operation where the differential voltage would be large and subject to windings of the relays 227 and 228 to the large current value. However, before the relay 228 is de-energized by the movable contact member 139 passing beyond the point 658, the holding circuit through the contact 661 is established for holding the relay 231 energized. The equipment continues to run with the main motor 54 energized from the main generator 76 and the speed to which the equipment attains is determined by the setting of the motor operated rheostat 137.

Although we have described our invention with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

We claim as our invention:

1. In a control system, the combination of a motor having an armature and a field, a normal voltage generator having an armature and a field, a low voltage generator having an armature and a field, electrical means for energizing the said fields, variable resistance means for varying the field excitation of the normal and low voltage generators, first circuit means for connecting the armature of the motor in circuit relation with the armature of the low voltage generator, second circuit means for connecting the armature of the motor in circuit relation with the armature of the normal voltage generator, selective control means for selectively operating the first and second circuit means, common means for operating the variable resistance means and the selective control means, and protective means responsive to the voltage difference of the generators for also operating the selective control means.

2. In a control system for a cloth printing machine having a printing cylinder and rolls, the combination of a motor for driving the printing cylinder and rolls, a normal voltage generator, a low voltage generator, said motor and said generators having an armature and a field, electrical means for energizing the said fields, first circuit means for connecting the armature of the motor in circuit relation with the armature of the low voltage generator, second circuit means for connecting the armature of the motor in circuit relation with the armature of the normal voltage generator, selective control means for selectively operating the first and second circuit means, a motor operated rheostat for varying the field excitation of the normal and low voltage generators, said motor operated rheostat also having electrical contact means for operating the selective control means, and protective means responsive to the voltage difference of the generators for also operating the selective control means.

3. In a control system, the combination of a motor having an armature and a field, a first generator having an armature and a field, a second generator having an armature and a field, electrical means for energizing the fields and varying the generated voltage of each of the generators, the generated voltage range of one of said generators being lower than the generated voltage range of the other said generator, selective transition means for connecting the armature of the motor to either one of the armatures of the generators under changeable generated voltage conditions of both generators, and means for causing the transition means to operate when the difference between the generated voltages of the two generators is at a low value.

4. In a control system, the combination of a motor having an armature and a field, a first generator having an armature and a field, a second generator having an armature and a field, electrical means for energizing the fields, first circuit means including a first relay for connecting the armature of the motor in circuit relation with the armature of the first generator, second circuit means including a second relay for connecting the armature of the motor in circuit relation with the armature of the second generator, a motor operated rheostat for varying the field excitation of the generators, the generated voltage range of the first generator being lower than the generated voltage range of the second generator with the upper portion of the voltage range of the first generator extending at least up to the lower portion of the voltage range of the second generator, a first selective circuit for operating the first relay to connect th armature of the motor in circuit relation with the first generator, a second selective circuit for operating the second relay to connect the armature of the motor in circuit relation with the second generator, said motor operated rheostat having electrical contact means for sequentially governing the operation of the first and second selective circuits, and differential relay means responsive to the difference between the voltages of the generator for also governing the operation of the first and second selective circuits when the voltage differential between the two generators is at a low value.

5. In a control system, the combination of a motor having an armature and a field, a first generator having an armature and a field, a second generator having an armature and a field, electrical means for energizing the fields, first circuit means including a first relay for connecting the armature of the motor in circuit relation with the armature of the first generator, second circuit means including a second relay for connecting the armature of the motor in circuit relation with the armature of the second generator, a motor operated rheostat for varying the field excitation of the generators, the generated voltage range of the first generator being lower than the generated voltage range of the second generator with the upper portion of the voltage range of the first generator extending at least up to the lower portion of the voltage range of the second generator, a first selective circuit for operating the first relay to connect the armature of the motor in circuit relation with the first generator, a second selective circuit for operating the second relay to connect the armature of the

motor in circuit relation with the second generator, said first selective circuit being connected through contact means on the second relay and said second selective circuit being connected through contact means on the first relay, said motor operated rheostat having electrical contact means for sequentially governing the operation of the first and second selective circuits, and differential relay means responsive to the difference between the voltages of the generator for also governing the operation of the first and second selective circuits when the voltage differential between the two generators is at a low value.

6. In a control system, the combination of a motor having an armature and a field, a first generator having an armature and a field, a second generator having an armature and a field, electrical means for energizing the fields, variable resistance means for varying the generator fields and thus the generated voltage of each of the generators, the generated voltage range of one of said generators being lower than the generated voltage range of the other said generator, selective transition means for connecting the armature of the motor to either one of the armatures of the generators, means for causing the transition means to operate when the differential between the generated voltages of the two generators is at a low value, and common means for governing the operation of the variable resistance means and the selective transition means.

7. In a control system, the combination of a motor and a plurality of generators for selectively supplying energy to the motor, said generators having different voltage ranges with a portion of each of their ranges substantially coinciding, selective transition means for selectively connecting the motor in circuit relation with the generators, and means for causing the transition means to operate when the voltage differential between the generators is at a low value.

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