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(54) A control system for railroad track switches

(57) A system wherein a central control station (4) supplies, through a three-pole cable (66), a peripheral station (6), wherein an electric motor (10) causes a railroad track switch (8) to move between a first and a second limit of travel position. System (1) comprises an electromechanical position sensor (20), coupled with a first and a second capacitor (41, 40), connected in series, for either first or second position, and through three-pole cable (66), with a first and a second inductor (54, 60), respectively, of the control station. A signal generator (46) supplies, at its output, a periodic alternating signal (S), capable of causing the electric circuit, comprising first capacitor (41), connected in series with first inductor (54), or second capacitor (40), in series with second inductor (60), to resound. Central station (4) comprises first and second measuring means (58, 61), respectively coupled with first and second inductors (54, 60) and capable of measuring thereon a resonance voltage peak to measure the position of both position sensor (20) and switch.

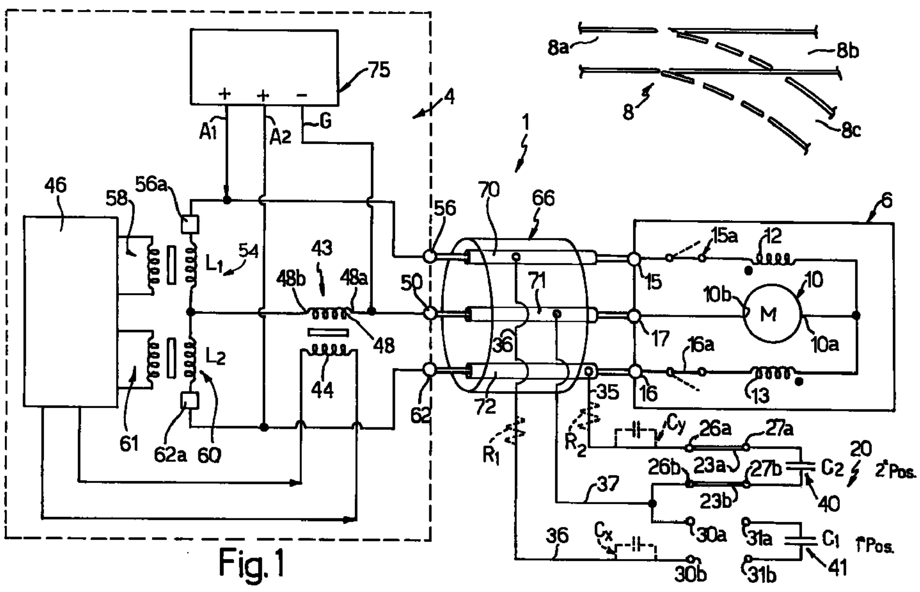

Fig.1

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Description

The present invention relates to a control system for railroad track switches.

Railroad track switches are known to be movable, by an electric motor, between a first limit of travel position, wherein an input track segment of the switch communicates with a first output track segment, and a second limit of travel position, so that the input track segment communicates with a second output track segment.

The electric motors used for such railroad switches are of the direct current type and are generally provided with a first excitation winding and a second excitation winding. Such electric motors, therefore, are powered by means of a three-pole cable comprising a common wire and two conductors, capable of supplying either first or second winding, respectively, to select the direction of rotation of the motor itself.

Such railroad switches are further provided with an electromechanical position sensor, capable of detecting the disposition of the switch, namely, in either first or second position.

A position sensor of the known type can comprise a pair of wiping contacts, operated by a mobile member of the switch and capable of moving between a first contact position and a second contact position. In the first contact position (corresponding to the first limit of the switch of travel position), the wiping contacts connect a first pair of input terminals to a first pair of output terminals, while in the second position (corresponding to the second limit of the switch of travel position) the wiping contacts connect a second pair of input terminals to a second pair of output terminals.

The position sensor receives, at its input, a pair of direct voltage (for example, equal to 48 volts) wires and is provided with a first and a second output wire. Voltage polarity on the first and second output wires is inverted, according to whether the wiping contact finds itself in either first or second contact position. Therefore, it is possible to trace back the position of the switch on the basis of the polarity on the first and second output wires.

On the grounds of the foregoing, each railroad track switch is connected to a control station through a bundle of cables, comprising at least the three-pole cable, supplying the motor, and four wires for the position sensor.

The main drawback of the control systems of the known type is represented by the use of such bundles of cables, in that they are very expensive, rather bulky and difficult to install.

Current leakages are further possible between adjacent wires of the position sensor, consequently leading to erroneous measurements of the position of the switch.

Aim of the present invention is the embodiment of a control system for railroad track switches, which may overcome the drawbacks of the known systems.

This aim is achieved by this invention in that there is provided for a control system as described in Claim 1.

The invention will be better described with reference to the accompanying drawings, in which:

Fig. 1 shows a simplified wire diagram of a control system for railroad switches according to the present invention; and

Figs. 2a, 2b show the working principle of the system in Fig 1.

In particular, with reference to Fig. 1, there is indicated with number 1, in its whole, a control system for railroad track switches, wherein a central control station 4 controls a peripheral station 6, coupled with a switch 8 of the known type (schematically shown).

Switch 8 is activated by an electric motor 10 of peripheral station 6 and is capable of moving between a first limit of travel position (shown in full lines), wherein an input track section 8a of switch 8 communicates with a first output track section 8b, and a second limit of travel position (shown in dashed lines), so that input track section 8a communicates with a second output track section 8c.

Electric motor 10 is of the direct current type and is provided with a first excitation winding 12 and a second excitation winding 13. The direction of rotation of motor 10 is selected on the basis of powered winding 12,13. According to the schematic view in Fig. 1, said first winding 12 is fitted with a first terminal, connected to an input terminal 15 of station 6 through a limit switch 15a, and a second terminal, communicating with a first supply input 10a of motor 10.

Second winding 13 is fitted with a first terminal, connected to an input terminal 16 of station 6 through a limit switch 16a, and a second terminal, communicating with said first input 10a of motor 10. Motor 10 is further provided with a second supply input 10b, communicating with an input terminal 17 of station 6.

Railroad switch 8 is further provided with an electromechanical position sensor 20, capable of measuring whether switch 8 is located in either first or second position.

Device 20 comprises a pair of wiping contacts 23a, 23b (schematically shown), operated by a mobile member (not shown) of switch 8, and capable of moving from a first contact position to a second contact position. In the first contact position (corresponding to the limit of travel position of switch 8), wiping contacts 23a, 23b connect a first pair of input terminals 30a, 30b to a first pair of output terminals 31a, 31b, while in the second position (corresponding to the second limit of travel position of switch 8) wiping contacts 23a, 23b connect a second pair of input terminals 26a, 26b to a second pair of output terminals 27a, 27b.

Input terminal 16 of station 6 is connected to terminal 26a by a power line 35, input terminal 15 is connected to terminal 30b by a power line 36 and input terminal 17 is connected to terminals 26b, 30a by a power line 37.

According to the present invention, input terminals

27a, 27b are connected to the terminals of a capacitor 40, having a capacitance value C_2, while input terminals 31a, 31b are connected to the terminals of a capacitor 41, having a capacitance value C_1.

Central station 4 comprises a decoupling transformer 43, provided with a primary winding 44, powered by an electronic processing circuit 46, and a secondary winding 48, first output terminal 48a whereof being connected to an output terminal 50 of station 4.

Secondary winding 48 is fitted with a second output terminal 48b, connected to a first terminal of a winding 54, comprising a second terminal, connected to an input terminal 56 of station 4 through a separating switch 56a.

Winding 54 is magnetically coupled with a winding 58, cooperating (in the manner described hereinafter) with circuit 46.

Winding 54 has an inductance value equal to L_1.

Second output terminal 48b of winding 48 is further connected to a first terminal of a winding 60, a second terminal whereof is connected to an output terminal 62 of station 4 through a separating switch 62a.

Winding 60 is magnetically coupled with a winding 61, cooperating (in the manner described hereinafter) with circuit 46.

Winding 60 has an inductance value equal to L_2.

Peripheral station 6 is connected to the central station by means of a three-pole cable 66 (schematically shown), comprising three wires 70, 71 and 72, extending between terminals 56 and 15, 50 and 17 and 62 and 16, respectively.

Central station 4 is further provided with a power supply 75, comprising a common (negative) main G, communicating with terminal 50, and capable of alternatively supplying either terminal 56 or terminal 62, through respective (positive) power mains A_1, A_2, with a voltage (for example, +144 volts) for powering motor 10.

During electric powering of mains A_1, A_2, separating switches 56a, 62a are kept open by uncoupling windings 54,60 of power supply 75. As shall be described later on, during measuring of position of the switch (detailed hereinafter), separating switches 56a, 62a are kept closed.

When terminal 56 is powered, the electric current flows in winding 12 and motor 10 rotates in a first angular direction of rotation (for example, clockwise), while when terminal 62 is powered, the electric current flows in winding 13 and motor 10 rotates in a second angular direction of rotation (for example, anticlockwise).

In use, in order to control the first position of the switch, circuit 46 (or power supply 75), further to controlling opening of switches 56a, 62a, supplies an output terminal of station 4 (for example, output terminal 56) with a direct supply voltage, which is supplied to a winding of motor 10 (for example, winding 12). Motor 10, therefore, rotates in a first direction of rotation (for example, clockwise) and switch 8 shifts towards a limit of travel position (for example, towards the first limit of travel position). Upon its reaching the first limit of travel position, limit switch 15a (schematically shown) is actuated and motor 10 stops. In such a position, the pair of wiping contacts 23a, 23b causes terminals 30a, 30b to be electrically connected to terminals 31a, 31b and capacitor 41 is inserted between power lines 71 and 70.

According to the present invention, circuit 46, further to controlling closing of separating switches 56a, 62a, supplies to transformer 43 an excitation signal S, comprising alternating first pluralities of impulses with frequency f_1 and second pluralities of impulses with frequency f_2 (FSK). Frequency f_1 is substantially equal to the resonance frequency of an L_C circuit (inductive capacitive), comprising the series of a capacitor with capacitance C_1 and of a coil with inductance L_1, while frequency f_2 is substantially equal to the resonance frequency of an L_C circuit, comprises the series capacitor with capacitance C_2 and coil with inductance L_2.

When position sensor 20 is arranged in the first contact position, signal S is supplied, through transformer 43, to Mesh M_4 (in dashed lines in Fig. 2a), consisting of inductor 60 of winding 13, winding 48 and motor 10. Signal S is further supplied to Mesh M_3 (in dashed lines), consisting of inductor 54, winding 48 and capacitor 41. Mesh M_3 has an impedance Z_1, substantially determined by the series capacitor 41 (having capacitance value equal to C_1) inductor 54 (having inductance value equal to L_1); such impedance Z_1 takes on a minimum value in connection with frequency f_1 and Mesh M_3 resounds at frequency f_1.

The output of the signal with frequency f_1, therefore, corresponds to the presence, on coil 54, of a voltage peak V_{ris1}, which is transmitted by inductor 54 to winding 58 and, consequently, measured by circuit 46.

Mesh M_4 has an impedance Z_b, with a different value from Z_1; such impedance Z_b does not take on a minimum value for frequency f_1 and frequency f_2.

Therefore, measuring a voltage peak on winding 58, in connection with the output of the signal having frequency f_1, circuit 46 positions contacts 23a, 23b in the first contact position.

Circuit 46 further measures whether voltage on winding 60 (inductance value equal to L_2) is substantially equivalent to that on secondary winding 48; indeed, should said voltage be different, in particular, null circuit 46 would measure the break from Mesh M_4, caused, for example, by cable 72 becoming uncoupled.

Measuring of wiping contacts 23a, 23b (and, consequently, of switch 8) contact position is therefore carried out by voltage measuring on windings 54, 60 (and, consequently, on windings 58, 61, coupled thereto) and, if a voltage peak is measured on winding 58, in connection with the output of the signal having frequency f_1, switch 8 is positioned in the first limit of travel position. Besides, if voltage on winding 60 is substantially similar to that on winding 48, no break is measured along cable 66.

In order to control the second position of the switch, circuit 46 controls opening of separating switches 56a, 62a and supplies the output of station 4 (for example, output 62) with a direct supply voltage, which is supplied to a winding of motor 10 (for example, winding 13). Motor 10, therefore, rotates in a second direction of rotation (for example, anticlockwise) and switch 8 shifts towards a limit of travel position, for example, towards the second limit of travel position. Upon its reaching the second limit of travel position, limit switch 16a is actuated and motor 10 stops. In such a position, the pair of wiping contacts 23a, 23b causes terminals 26a, 26b to be electrically connected to terminals 27a, 27b and capacitor 40 is inserted between power lines 71 and 72.

Switches 56a, 62a are then closed and signal S is supplied to Mesh M_2 (shown in dashed lines in Fig. 2b), consisting of inductor 60 and capacitor 40, and to Mesh M_1 (in dashed lines), consisting of inductor 54, winding 48, winding 12 and motor 10.

Mesh M_2 has an impedance Z_2, substantially determined by the series capacitor 40 (having capacitance value equal to C_2) inductor 60 (having inductance value equal to L_2); such impedance Z_2 takes on a minimum value in connection with frequency f_2 and Mesh M_2 resounds at frequency f_2. The output of the signal with frequency f_2, therefore, corresponds to the presence, on coil 60, of a voltage peak V_{ris2}, which is transmitted to winding 61 and measured by circuit 46.

Mesh M_1 has an impedance Z_a, which does not take on a minimum value for frequency f_1 and frequency f_2.

Therefore, measuring a voltage peak on winding 58, in connection with the output of the signal having frequency f_2, circuit 46 positions contacts 23a, 23b in the second contact position.

Circuit 46 further measures whether voltage on winding 54 (inductance value equal to L_1) is substantially equivalent to that on secondary winding 48; indeed, should said voltage be different, in particular, null, circuit 46 would measure the break from Mesh M_1, caused, for example, by cable 70 becoming uncoupled.

No voltage peak is measured on either winding 58 and winding 61, in connection with the emission of the signal with frequency f_1.

System 1 is further capable of measuring any coupling/assembling error of three-pole line 66.

In the event of the inversion of power lines 70 and 72, the positions of capacitors 40, 41 are virtually inverted. Therefore, when device 20 is positioned in the first contact position, Mesh M_3 (Fig. 2a) includes capacitor 40 (with capacitance value equal to C_2), in place of capacitor 41. Being this the case, no resonance would be measured in connection with frequency f_1 and frequency f_2. System 1, therefore, would not be able to operate and the assembly error would be detected forthwith. Similar remarks apply when device 20 is positioned in the second contact position.

On the grounds of the foregoing, the system according to the present invention clearly overcomes the drawbacks connected with the known systems, in that the position of the switch is measured without the aid of any further line, other than three-pole line 66, and extending between position sensor 20 and station 4.

The signals required for positioning the switch are transmitted directly through three-pole line 66.

Finally, the control system for railroad track switches described hereinabove may undergo modifications and alterations, provided they fall within the scope of protection of the invention.

System 1 could be provided with two resistors R_1 and R_2 (shown in dashed lines in Fig. 1), located on power lines 36 and 35, respectively.

Such resistors R_1, R_2 are capable of limiting load current of capacitors 41, 40 during powering of motor 10 by power supply 75.

Moreover, resistors R_1, R_2 have a further, important function, in that they regulate the resonance voltage peak value on windings 54, 60. In a resonance condition, indeed, the voltage value on windings 54,60 substantially depends (since capacitance and inductance contributions become null) on the resistive characteristics of the resonant circuit which, in turn, depend on the resistance of cable 66.

Since resistance of cable 66 depends on its length, cables with different lengths would measure resonance voltage peaks with different amplitudes. Introducing resistors R_1, R_2 and choosing therefor a higher resistance value than that of cable 66, the resistive characteristics of the resonant circuit substantially depend on resistance value R_1, R_2. In this manner, the resonance peak value is therefore substantially independent of the cable length.

Along each line 36, 35 there can be further connected in series a respective capacitor Cx and Cy (said capacitor Cx, Cy is therefore connected in series, with respect to respective resistor R_1, R_2, if present).

According to such an embodiment, the position sensor is further capable of short-circuiting, with respect to each other, free input terminals 26a, 26b and 30a, 30b, i.e., such input terminals, as are not connected to output terminals 27a, 27b and 31a, 31b through wiping contacts 23a, 23b.

In such a way, when the position sensor is located in the first position (Fig. 2a), capacitor Cy is located between lines 71 and 72.

Furthermore, the capacitance value of capacitor Cy is such, that it can behave as a short circuit for frequencies f_1 and f_2; in so doing, motor 10 is "disconnected" from Mesh M_4, so that impedance Z_b thereof only depends on the inductance of windings 60 and 48.

When the position sensor is in the second position (Fig. 2b), capacitor Cx is located between lines 71 and 70.

Furthermore, the capacitance value of capacitor Cx is such, that it can behave as a short circuit for frequencies f_1 and f_2; in so doing, motor 10 is "disconnected" from Mesh M_1, so that impedance Z_a thereof only depends on the inductance of windings 54 and 48.

Uncoupling of motor 10 from Mesh M_3, M_1 allows for measuring, without interferences and noises, caused by the transfer function of the motor, the voltage on winding 48, in order to verify continuity of cable 46.

Claims

1. A control system for railroad track switches wherein a control station (4) controls at least one peripheral station (6), wherein at least one electric motor (10) is capable of operating a switch (8), provided with at least one member, movable between at least a first limit of travel position and a second limit of travel position;

 said peripheral station (6) comprising at least one common supply input terminal (17) and at least first and second input terminals (15, 16), capable of being alternatively supplied for the advance of said electric motor (1O) in different directions;

 said control station (4) comprising at least one common output terminal (50), capable of communicating with said common supply input terminal (17) through a respective common power line (71) and first and second output terminals, communicating with said first and second input terminals (15, 16) of said peripheral station (6), through respective first and second power lines (70, 72);

 said control station (4) comprising power supply means (75), capable of supplying a supply voltage to said either first or second output terminal (56, 62) for the advance of said motor (10) in different directions;

 said system (1) further comprising position sensors (20), movable with said switch between a first contact position, corresponding to said first limit of travel position of said switch (8), and a second contact position, corresponding to said second limit of travel position of said switch (8),

 characterized in that said system (1) comprises at least first and second reactive means (41, 40), coupled with said position sensors (20);

 said central control station (4) further comprising at least first and second complementary reactive means (54, 60) and excitation signal (S) generating means (46);

 said signal generating means (46) sending said excitation signal at least to said first complementary reactive means (54) of said control station (4) and to said first reactive means (41), when said position sensors (20) are located in said first contact position;

 said signal generating means (46) sending said excitation signal at least to said second complementary reactive means (60) of said control station (4) and to said second reactive means (40), when said position sensors (20) are located in said second contact position;

 said excitation signal (S) having a frequency, which is substantially equal to the frequency whereat impedance (Z_1, Z_2), comprising one of said first and second reactive means and one of said first and second complementary reactive means, takes on a minimum value;

 said central station (4) comprising first and second means (58, 61), coupled with said first and second complementary reactive means (54, 60), respectively, and capable of measuring thereon a resonance voltage (V_{ris1}, V_{ris2}), to position said position sensors (20) and said switch.

2. A system according to Claim 1, characterized in that said position sensors (20), when in said first contact position, are capable of connecting said first reactive means (41) in series with said first complementary reactive means (54) and, when in said second contact position, of connecting said second reactive means (40) in series with said second complementary reactive means (60).

3. A system according to Claim 2, characterized in that said position sensors (20), when in said first contact position, are capable of positioning said first reactive means (41) between said first power line (70) and said common power line (71) and, when in said second contact position, of positioning said second reactive means (40) between said power line (72) and said common power line (71).

4. A system according to any one of the previous Claims, characterized in that said excitation signal (S) comprises alternating first pluralities of impulses with a first frequency (f_1) and second pluralities of impulses with a second frequency (f_2);

 said first frequency (f_1) being substantially equal to the frequency whereat the impedance comprising said first reactive means (41) and said first complementary reactive means (54), takes on a minimum value;

 said second frequency (f_2) being substantially equal to the resonance frequency whereat the impedance comprising said second reactive means (40) and said second complementary reactive means (54), takes on a minimum value.

5. A system according to Claim 4, characterized in that said first frequency (f_1) is substantially equal to the frequency whereat impedance (Z_1) comprising the series said first reactive means (41) and said first complementary reactive means (54), takes on a minimum value;

 said second frequency (f_2) being substantially equal to the resonance frequency whereat impedance (Z_2) comprising the series said second reactive means (40) and said second complementary reactive means (60), takes on a minimum value.

6. A system according to any one of the previous Claims, characterized in that said first reactive means (41) and said second reactive means (40) comprise first and second capacitors (41, 40), respectively.

7. A system according to any one of the previous Claims, characterized in that said first complementary reactive means (54) and said second complementary reactive means (60) comprise first and second inductors (54, 60), respectively.

8. A system according to Claim 7, characterized in that said first measuring means and said second measuring means comprise first and second electric windings (58, 61), magnetically coupled with said first and said second inductors (54, 60), respectively.

9. A system according to any one of the previous Claims, characterized in that it comprises circuit means (46), capable of measuring the first contact position of said position sensors (20), upon measuring a resonance voltage peak (V_{ris1}) on said first measuring means (58), and capable of measuring the second contact position of said position sensors (20) upon measuring a resonance voltage peak (V_{ris2}) on said second measuring means (61).

10. A system according to any one of the previous Claims, characterized in that it comprises first resistors (R_1), capable of being connected in series with a respective first reactive means (41) of said peripheral station (6), upon reaching said first contact position;

said system (1) further comprising second resistors (R_2), capable of being connected in series with a respective second reactive means (41, 40) of said peripheral station (6), upon reaching said second contact position.

11. A system according to Claim 10, characterized in that said first (R_1) and second resistors (R_2) have a resistance value, which is higher than that of said first or second power line (70, 72).

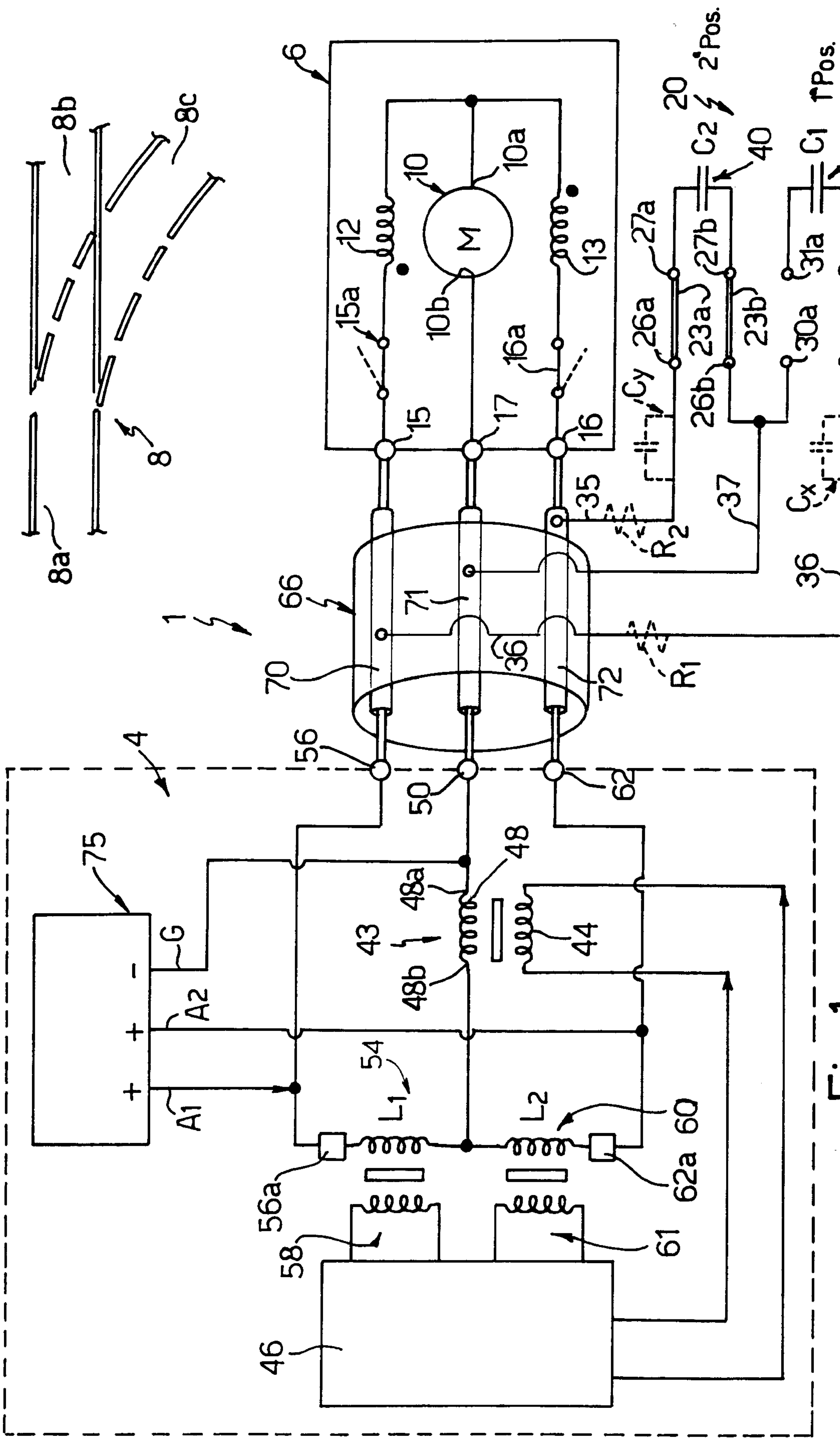
12. A system according to any one of the previous Claims, characterized in that it comprises first capacitors (Cx), capable of being inserted between said common line (71) and said first power line, upon reaching said first contact position;

said system (1) further comprising second capacitors (Cy), capable of being inserted between said common line (71) and said second power line, upon reaching said second contact position.

13. A system according to Claim 12, characterized in that said first (Cx) and second capacitors (Cy) have such a capacitance value, that said capacitors behave as a short circuit for said excitation signal.

14. A system according to any one of the previous Claims, characterized in that it comprises continuity measuring means (46), capable of measuring the voltage on said non-resonant complementary reactive means (54, 60);

said continuity measuring means (46) being capable of measuring the break of said first or said second power line upon measuring a substantially null voltage.


6
M
10
10a
10b
12
13
15
15a
16
16a
17
20
2°Pos.
1°Pos.
C2
C1
40
41
27a
27b
26a
26b
23a
23b
30a
30b
31a
31b
Cy
Cx
35
36
37
R2
R1
8
8a
8b
8c
1
66
70
71
72
4
56
50
62
75
G
A1
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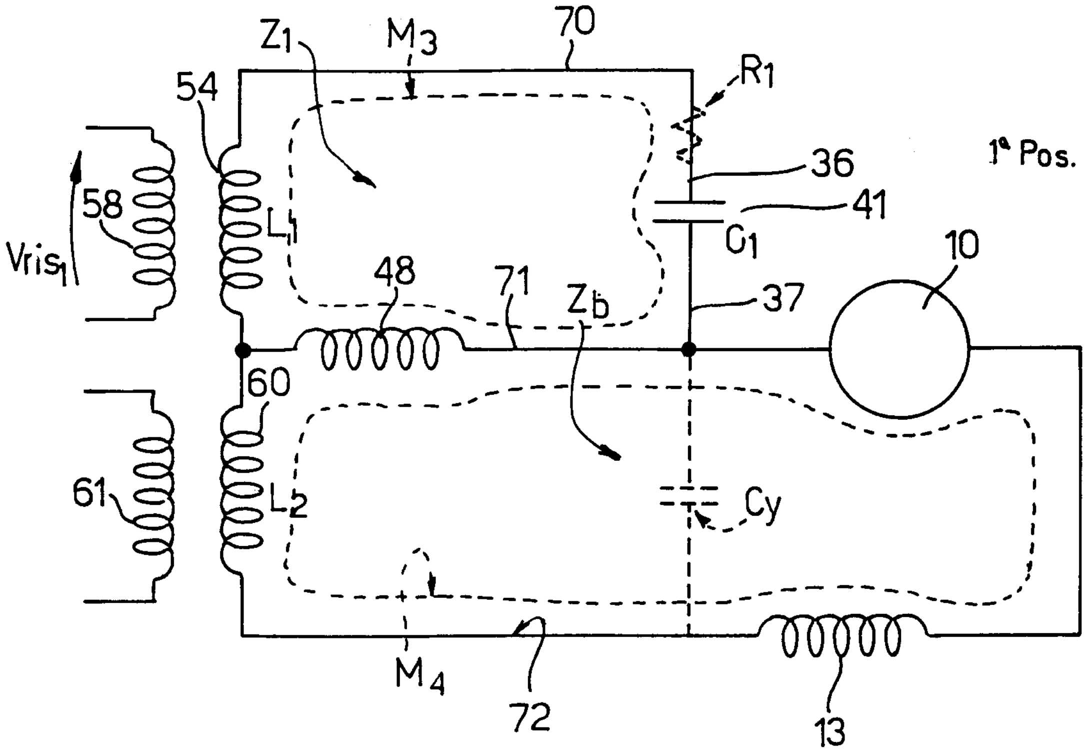
48b
54
L1
L2
60
62a
56a
58
61
46

Fig. 1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R1
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1ª Pos.
58
41
C1
Vris1
L1
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71
Zb
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Cy
61
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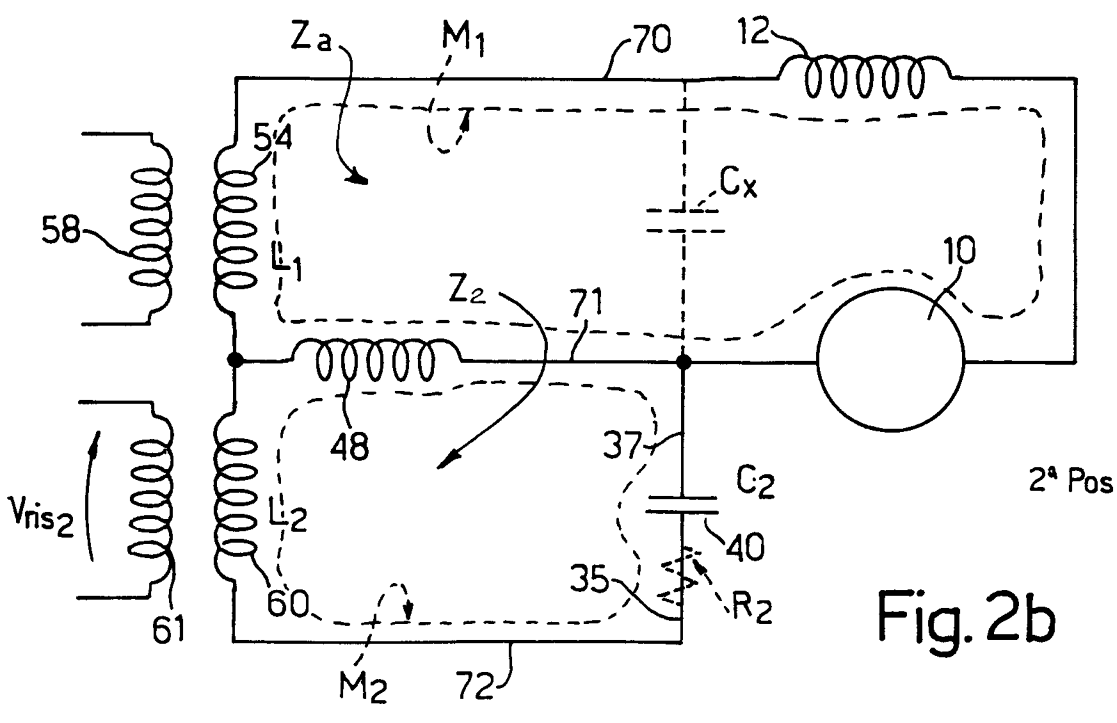
M4
72
13

Fig. 2a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70
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58
L1
10
Z2
71
48
37
C2
2ª Pos.
Vris2
L2
40
35
R2
60
61
M2
72

Fig. 2b