

Description

Circuit arrangement for limiting the switch-on current of a capacitive load

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The invention relates to a circuit arrangement for limiting the switch-on current of a capacitive load which is operated with an operating voltage.

10 When a capacitive load, for example from servo output stages for operating X-Y motors, is switched on, the capacitive load charges up suddenly. In the case of energy storage capacitors (up to 18 000 μF) of the output stages, current peaks of up to 200 A which fuse the contacts or contactors which are connected into the
15 circuit for safety reasons may occur. These contactors are then no longer operational.

The object of the invention is to specify a circuit arrangement for limiting the switch-on current of a capacitive load which reduces the currents flowing
20 during the switching-on process.

The object is achieved according to the invention by means of the circuit arrangement having the features of patent claim 1.

25 Two switches which switch at different times are advantageously used. The first switch switches the current via a NTC thermistor which is connected between the operating voltage and capacitive load. The switch-on current is thus limited and increases over time a result of self-heating of the NTC thermistor. The
30 second switch switches after a delay time relative to the first switch and thus causes the NTC thermistor to be bypassed and makes the operating voltage of the capacitive load available.

A particularly simple circuit arrangement is obtained according to patent claim 2 by means of the further NTC thermistor which brings about the delay time.

5 In order to avoid a current surge during the switching-on process after the NTC thermistors are warmed up, claim 3 advantageously provides that the first and second switches are embodied as a jointly switching relay whose supply voltage is not switched
10 until the further NTC thermistor, and therefore also the other NTC thermistors have cooled down.

The invention is explained in more detail in an exemplary embodiment with reference to the single figure of the drawing.

15 The figure here shows a circuit arrangement for limiting the switch-on current of a capacitor load.

 According to the figure, a capacitive load 1 is connected to an operating voltage 2 via a rectifier 3 and a circuit composed of contactors 4, 10, 20. Here,
20 the inputs of the first contactor 4 are connected to the operating voltage 2. The three-phase power supply comprises three inputs which each have the same circuit. One circuit is described below, the other two circuits being connected in a corresponding way. The
25 first contactor 4 is equipped with switches 5 which are switched by an exciter device 6 when an exciter voltage is applied to the exciter input 7 and to the exciter output 8. The inputs of the first contactor 4 are connected to the outputs of the first contactor 4 via
30 the switches 5. The output of the first contactor 4 is connected to some of the inputs of a second contactor 10 which is equipped with switches 11 and a further switch 15. The switches 11 and the further switch 15 are switched by an exciter device 12 of the second
35 contactor 10 when an exciter voltage is applied to the exciter input 13 and to the exciter output 14 of the second contactor

10. The outputs of the second contactor are connected to the inputs of the rectifier 3, which rectifies the applied three-phase voltage and applies it to the capacitive load 1, for example the servo output stage of X-Y motors.

A series circuit composed of a third contactor 20 and NTC thermistors 40 is connected parallel to the second contactor 10, between the output of the first contactor 4 and the rectifier 3. The NTC thermistors 40 have a temperature-dependent resistance characteristic, the resistance decreasing as the temperature increases (NTC: negative temperature coefficient). To this end, the outputs of the first contactor 4 are connected to the inputs of the third contactor 20, and the inputs of the third contactor 20 are connected via switches 21 to the outputs of the third contactor 20. The switches 21 are switched by an exciter device 22 in the third contactor 20 when an exciter voltage is applied to the exciter input 23 and to the exciter output 24.

The NTC thermistors 40 are arranged in a switch-on current limiter 33 and are connected via terminals 39 to the output of the third contactor 20 and to the outputs of the second contactor 10.

In order to control the contactors 4, 10, 20, two control voltages 30, 31, which are each, for example, 24 V DC voltage with respect to ground 32, are used. The terminal of the first control voltage 30 is connected to the exciter inputs 7, 13, 23 of the first contactor 4, second contactor 10 and third contactor 20 and to a first terminal 34 of the switch-on current limiter 33. The exciter outputs 8, 24 of the first contactor 4 and third contactor 20 are connected to a second terminal 34 of the switch-on current limiter 33. The second terminal 35 of the switch-on current limiter 33 is connected via a first switch 42 of a relay 41 to a third terminal 36 of the switch-on current limiter 33 which is connected to the ground line 32.

The exciter output 14 of the second contactor 10 is connected to a fourth terminal 37 of the switch-on current limiter 33. This fourth terminal 37 is connected to the third terminal 36 of the switch-on
5 current limiter 33 via a second switch 43 of the relay 41 and via a further NTC thermistor 34 which is connected in series therewith.

The exciter output 14 of the second contactor 10 is also connected to a further output 17 of the
10 second contactor 10, the further output 17 being connected via the further switch 15 to a further input 16 of the second contactor 10 and the latter being connected to ground 32.

The terminal of the second control voltage 31
15 is connected to a fifth terminal 38 of the switch-on current limiter which is connected via a resistor 47 and an additional NTC thermistor 48 based on an npn-type transistor 46. The emitter of the npn-type transistor 46 is connected to ground 32 via the third
20 terminal 36, while the collector of the transistor 46 is connected to the first terminal 34 of the switch-on current limiter 33 via a fuse 45.

The second terminal 35, the fourth terminal 37 and the collector of the transistor 46 are each
25 connected to the first terminal 34 in each case via quenching diodes 49.

The function of the circuit arrangement is as follows: the first control voltage 30 is used as a supply voltage of the relay 31, the second control
30 voltage 31 is used as a control voltage of the relay 41. If one of the voltages 30, 31 is absent, the relay 41 is not excited and the capacitive load 1 is not connected to the operating voltage 2. If the relay 41 switches, the first contactor 4 and the third contactor
35 20 also simultaneously switch. Current can flow into the load circuit 1 via the rectifier 3, limited by the NTC thermistor 40. This limited switch-on current

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increases over time as a result of self-heating of the NTC thermistors 40. As a result,

the capacitive load 1 charges up very suddenly. The charge current decreases as the charging increases. Since operating current already flows when switching on occurs, a certain voltage drops across the NTC thermistors 40. The lower the impedance of the NTC thermistors 40, the lower the voltage drop. If the second contactor 10 then bypasses the NTC thermistors 40, the current peak stays within non-damaging limits due to the residual charging of the capacitive load 1.

At the same time as the exciter current circuits of the first contactor 4 and of the third contactor 20, the relay 41 also closes the exciter circuit of the second contactor 20. The current through this circuit heats up the further NTC thermistor 44. The impedance of the further NTC thermistor 44 drops, the voltage drop across the further NTC thermistor 44 is reduced and the exciter voltage rises. If the switching threshold of the second contactor 10 is exceeded, the second contactor 10 bypasses the NTC thermistors 40. The electrical energy is thus available without restriction of the capacitive load 1.

A self-locking circuit via the further switch 15 keeps the second contactor 10 in the switched-on state. All the NTC thermistors 40, 44 now cool down to the same degree so after the switching off of the first contactor 4, second contactor 10 and third contactor 20 it is possible to switch on again after a delay. However, if the cooling time is too short, so that the switching-on current surge could become too large when switching on occurs, the ambient-temperature-compensated basic voltage divider at the npn-type transistor 46 prevents the switching of the relay 41 by means of the additional NTC thermistor 48 until, as a result of the cooling down of the further NTC thermistor 44, the threshold value of the basic voltage is exceeded. It is only at this point that the relay 41 switches, the first contactor 4 and the third contactor 20 switch and the second contactor 10 is delayed.



Patent claims

1. A circuit arrangement for limiting the switch-on current of a capacitive load (for example 1) which
5 is operated with an operating current (2),
having a first contactor (4) to whose operating input the operating voltage (2) is applied,
having a second contactor (10) at least some of whose
operating inputs are connected to the operating outputs
10 of the first contactor (4) and whose operating outputs are connected to the capacitive load (1),
having a third contactor (20) whose operating inputs are connected to the operating outputs of the first contactor (5),
15 having NTC thermistors (40) which are each connected between the operating outputs of the third contactor (20) and the capacitive load (for example 1),
having a first switch (42) which closes the first contactor (4) and the third contactor (20),
20 and having a second switch (43) which closes the second contactor (10) after a delay time after the closing of the first switch (4) and of the third switch (20).
2. The circuit arrangement as claimed in claim 1, characterized in that the delay time is generated by
25 the heating of a further NTC thermistor (44) which is arranged in the supply circuit of the second contactor (10).
3. The circuit arrangement as claimed in claim 2, characterized in that the first switch (42) and the
30 second switch (43) are embodied as a jointly switching relay (41), the relay (41) drawing its supply voltage from an ambient-temperature-compensated voltage divider of a transistor (46) with the result that the relay (43) does not switch until the further NTC thermistor
35 (44) has cooled down.

