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(54) CIRCUIT ARRANGEMENT FOR THE RAPID CHARGING OF AN ACCUMULATOR

(71) We, FRANKIE & HEIDECKE GmbH, a German Body Corporate, trading as ROLLEI-WERKE FRANKE & HEIDECKE, of 196 Salzdahlumerstrasse, Braunschweig, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a circuit arrangement for the rapid charging of an accumulator with a pulsating current in which at least one switch is arranged between a transformer or a rectifier connected thereto and the accumulator, which switch is controllable by means of a threshold value switch which detects the voltage of the accumulator in the current flow intervals. With such circuits it is possible to charge up accumulators within a short time with only slight temperature rise. The threshold value switch here has the task of recognising the desired state of charge of the accumulator and of disconnecting the accumulator from the transformer when charged to the predetermined voltage.

In a known circuit arrangement for the rapid charging of an accumulator of the initially stated kind, the threshold value switch connected in parallel with the accumulator consists of two transistors, the base and the emitter of the first transistor being connected respectively with the collector and the base of the second transistor and the emitter of the second transistor being connected through the series connection of a part resistance of a potentiometer and of a resistor with the negative pole and through the other part resistance of the potentiometer with the positive pole of the accumulator, at least one switch circuit containing a diode and a resistor being arranged between the connection point of this resistor and the potentiometer and the mains voltage side of the switch.

Starting from this known rapid charging circuit, the invention preferably provides a similarly operating circuit arrangement for the rapid charging of an accumulator, in which the number of requisite electronic components is substantially reduced.

According to the present invention the threshold value switch comprises a thyristor, the anode of the thyristor is connected on the one hand with the control electrode of the switch and on the other through a first resistor with the positive pole of the accumulator, the cathode of the thyristor is connected on the one hand through a second resistor with the mains voltage side of the switch and on the other through a third resistor with the negative pole of the accumulator and the control electrode of the thyresistor is connected with the centre tapping of an adjustable voltage divider connected in parallel with the accumulator. In comparison with the known circuit arrangement a saving of three electronic components is obtained, which not only takes effect as regards cost but also is above all essential for the desired miniaturisation of the rapid charging appliance, on account of the reduced space requirement.

So that the discriminator cannot be influenced by external influences, for example transient voltage peaks, to improve the object of the invention a capacitor is connected in between the control electrode of the thyristor and the negative pole of the accumulator.

In further development of the invention a simple charge indication for the accumulator can be brought about due to the fact that the series connection of a luminous diode and a resistor is connected in parallel with the switch. On disconnection of the accumulator from the charging transformer as a result of blocking of the switch taking place by means of the threshold value switch, a current flows through the luminous diode and this indicates that charging of the accumulator is complete.

The circuit diagram for an example of embodiment of the circuit arrangement according to the invention for the rapid charging of an accumulator is represented in the

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drawing. A transformer 1 is connected by its primary winding to a mains voltage source 2, for example 220 volts alternating current. Its secondary winding is connected with the input of a full wave rectifier bridge circuit 3. The output of the bridge circuit is connected through disengageable plug connections 4 and 5 with the supply leads 7 and 8 leading to the accumulator 6. A switch in the form of a thyristor 9 is connected into the supply lead 7. A voltage divider preferably of adjustable formation consisting of the resistors 10; 11; 12 is connected in parallel with the accumulator.

The threshold value switch consists of a thyristor 13 the anode of which is connected on the one hand with the control electrode (gate) of the thyristor 9 and on the other hand through a resistor 14 with the positive pole of the accumulator 6. The cathode of the thyristor 13 is connected on the one hand through a resistor 15 with the supply lead 7 and thus with the anode of the thyristor 9 and on the other hand through a resistor 16 with the supply lead 8 and thus with the negative pole of the accumulator. The control electrode (gate) of the thyristor 13 is connected with the adjustable centre tapping of the resistor 11 of the voltage divider 10; 11; 12 and is additionally connected through a capacitor 17 to the negative pole of the accumulator to keep away interference voltages. The control electrode of the thyristor 9 is also additionally connected through a resistor 18 with its anode. The series connection of a luminous diode 19 and a resistor 20 is connected in parallel with the thyristor 9.

The manner of operation of the circuit arrangement according to the invention is as follows:—

In every period of the mains alternating current voltage, two positive half-waves of the transformed mains alternating current voltage are present at the output of the rectifier bridge circuit 3. As a consequence of the unavoidable voltage drops in the forward direction of the rectifier bridge circuit, brief voltage-free phases lie between the individual half-waves. At the beginning of each half-wave, as soon as the momentary value of the transformed mains voltage exceeds the voltage of the accumulator, the thyristor 9 is turned on, since a potential which is positive in relation to the cathode is present through the resistor 18 on its control electrode. At the same time the half-wave voltage, reduced by the divider ratio of the resistors 15 and 16, is present on the cathode of the thyristor 13. Thus the cathode potential of the thyristor 13 increases in accordance with the half-wave voltage and by adjustment of the voltage divider it is guaranteed that the thyristor 13 can turn on only in the phases when the thyristor 9 is blocked—that is when no current flows—and also only when the part voltage of the accumulator voltage present on its control electrode is higher than its cathode potential by the ignition voltage. In every half-wave the thyristor 9 blocks whenever the voltage difference between the momentary value of the half-wave voltage and the charge voltage of the accumulator no longer suffices to permit the requisite holding current to flow through the thyristor 9. After the blocking of the thyristor 9 the voltage between the control electrode of the thyristor 13 and its cathode increases and reaches the maximum when the half-wave voltage at the output of the rectifier 3 has reached the value "zero". It is now exclusively dependent upon the magnitude of the accumulator voltage or of a fraction of the accumulator voltage which is adjustable on the voltage divider 10; 11; 12. Finally at a value of the accumulator voltage which is adjustable by means of the variable resistor 11 the voltage difference between control electrode and cathode of the thyristor 13 is greater than the ignition voltage of the thyristor and the thyristor 13 turns on. Thus the gate of the thyristor 9 is connected through the resistor 16 to the supply lead 8 and thus to the negative pole of the accumulator. The resistor 14 is designed so that only a current of the magnitude of the thyristor holding current flows through the thyristor 13 and thus the latter holds itself self-conducting. Thus the charging operation of the accumulator is terminated, for at the next positive half-wave which arrives on the thyristor 9 the thyristor 9 remains blocked because its control electrode always has substantially lower potential than its cathode and therefore no control signal can pass by way of the resistor 18 to the control electrode. If the thyristor 9 remains blocked, the difference of the positive half-wave voltage and the charge voltage of the accumulator is applied to the series connection of the luminous diode 19 and the resistor 20 and the luminous diode lights up and indicates the termination of the charging operation.

The circut arrangement according to the invention also works when the rectifier bridge circuit 3 is omitted and the secondary winding of the transformer 1 is connected directly to the disengageable plug connections 4 and 5. In this case a positive half-wave voltage is only present on the disengageable plug connections 4 and 5 or on the supply leads 7 and 8 in each half period of the mains alternating-current voltage. So that the accumulator cannot discharge through the secondary winding of the transformer 1, a blocking diode 21 is connected into the connection between resistor 14 or anode of the thyristor 13 and

control electrode of the thyristor 9. Otherwise the circuit arrangement according to the invention works as described above.

WHAT WE CLAIM IS:—

1. Circuit arrangement for the rapid charging of an accumulator with a pulsating current, in which at least one switch is arranged between a transformer, or a rectifier connected thereto, and the accumulator, which switch is controllable by means of a threshold value switch which detects the voltage of the accumulator in the current flow intervals, wherein the threshold value switch comprises a thyristor, the anode of the thyristor is connected on the one hand with the control electrode of the switch and on the other through a first resistor with the positive pole of the accumulator, the cathode of the thyristor is connected on the one hand through a second resistor with the input of the switch and on the other hand through a third resistor with the negative pole of the accumulator and the control electrode of the thyristor is connected with the centre tapping of an adjustable voltage divider connected in parallel with the accumulator.

2. Circuit arrangement according to claim 1, wherein a capacitor is connected between the control electrode of the thyristor and the negative pole of the accumulator.

3. Circuit arrangement according to claim 1 or 2, wherein the series connection of a luminous diode and of a resistor is connected in parallel with the switch.

4. A circuit arrangement, substantially as described herein with reference to and as illustrated by the accompanying drawing.

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