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(54) BATTERY CHARGER FOR A TWO-VOLTAGE SYSTEM IN A MOTOR VEHICLE AND SUCH TWO-VOLTAGE SYSTEM EMPLOYING THE BATTERY CHARGER

(71) We, ROBERT BOSCH GMBH. a German Company, of Postfach 50, 7 Stuttgart 1, Federal Republic of 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 present invention relates to a battery charger for motor vehicles having a two-voltage electrical system, and to such a two-voltage system employing the battery charger.

In such systems the vehicle battery is provided for supplying all normal loads in the motor vehicle, while the series combination comprising the vehicle battery and an additional battery is provided for the short-time operation of high-power consuming loads in the motor vehicle.

Various types of motor vehicles are known which are equipped with a two-voltage system. The two voltages can be for example, 12 volts and 24 volts. In these vehicles, the 12 volts serves, in a known manner, to supply the conventional loads in the motor vehicle, such as headlamps and signal generators. Advantageously, the 24 volt system of the motor vehicle can be used to operate loads of especially high-power consumption e.g. the starter motor of the vehicle. The lower the battery voltage, the higher are the operating currents required in the case of such loads. However, the high operating currents involve a great many problems such as the heating of the electrical supply leads and trouble caused by faulty points of contact. On the other hand, the use of a high voltage in a motor vehicle is not advantageous for all the loads, since the service life of many loads in a motor vehicle decreases with the design for a higher rated voltage, and insulation problems also occur particularly with respect to moisture.

For this readon, it is known to equip motor vehicles with a two-voltage system in which a normal vehicle battery serves to supply the conventional loads, while a second battery is connected in series with the first battery, and the load of high-power comsumption is supplied by the series combination comprising the two batteries. However, this procedure poses a number of problems, since the batteries have to be switched over for the various modes of operation of the motor vehicle. Furthermore, special auxiliary circuitry is required in order to charge the batteries by the motor vehicle generator which is normally designed for the voltage of one battery. It then has to be taken into account that one of the batteries is only used for normal operation of the motor vehicle, and that during such operation the second of the batteries is not loaded. This means that the charging circuit only has to provide a correspondingly lower charge for the second battery.

Kierdorf's book, Praxis der Autoelektrik, 1970, describes and illustrates on page 195, Volume IV, a circuit in which two batteries are switched over in the manner described above by means of a battery change-over switch. The disadvantage of this arrangement is that a high-current change-over switch is required in order to switch over the batteries according to the mode of operation of the motor vehicle, this change-over switch being susceptible to trouble and also being expensive. Furthermore, it has been proposed to use a voltage-doubling circuit in order to produce a second, higher voltage from the rectified voltage of the three-phase generator in a motor vehicle. This circuit, known per se, can be used in this case, since the additional battery only requires a relatively low charging current. However, the disadvantage of an electronic voltage-doubling circuit is that additional devices are required in the three-phase rectifier and the circuit is correspondingly expensive.

In contrast to this, the battery charger, in

accordance with the invention has the advantage that it utilises substantially only the existing sub-assemblies and components of the vehicle system. Thus, it is possible to realise a battery charger for a two-voltage system which is particularly inexpensive and unsusceptible to trouble.

According to the present invention there is provided a battery charger for a two-voltage system in a motor vehicle, comprising a three-phase generator and a three-phase bridge rectifier the output of which is connectible to a first battery and a second battery connected in series therewith, wherein two pairs of diodes of the three-phase bridge rectifier which are connected to two phase windings of the three-phase generator are connected in parallel with one another and are connectible across the first battery, and a third pair of diodes of the three-phase bridge rectifier is connected to a third phase winding of the generator and is connectible in parallel with the series combination comprising the first battery and the second battery.

In a preferred embodiment, the pair of diodes which are connected to the third phase winding and which are separated from the other two pairs of diodes, can be connected to the bridge rectifier by way of a mechanical switch. This renders it possible to supply the vehicle battery by way of the normal three-phase bridge rectifier when the additional battery has been charged. In this case, a protective diode ensures that neither of the two batteries can discharge into the other.

In a further preferred embodiment of the invention, the mechanical switch is replaced by the emitter-collector path of a transistor whose base is triggered by a control circuit. This control circuit can be connected to respond to various vehicle parameters although, advantageously, it is connected to the 24 volt lead. Thus, the above-described change-over operation to normal charging can be made dependent upon the state of charge of the additional battery.

Three different embodiments of the battery charger in accordance with the invention are illustrated in the accompanying drawings, in which:

Figure 1 is the circuit diagram of a first of the embodiments with the batteries and loads connected thereto;

Figure 2 is a circuit diagram of a second of the embodiments showing only the rectifier portion thereof;

Figure 3 shows the third embodiment again showing only the rectifier portion.

Referring to Figure 1, a three-phase generator 1 of a motor vehicle is shown by means of its three stator windings 2, 3 and 4 and is connected to a three-phase bridge rectifier 5. The three-phase bridge rectifier 5 supplies two output voltages which are to be tapped from a 12 volt lead 15 and a 24 volt lead 16 relative to a zero volt lead 14. A first battery 12, in general the vehicle battery, is connected between the 12 volt lead 15 and the lead 14. An additional battery 13 is connected between the 24 volt lead 16 and the 12 volt lead 15. An electrical load 18 is switchable between the 12 volt lead 15 and the lead 14 by means of a switch 17. A further electrical load 20 is switchable between the 24 volt lead 16 and the lead 14 by means of a switch 19.

The circuit of the three-phase bridge rectifier 5 comprises, in a known manner, three pairs of diodes 6/7, 8/9, 10/11 which are connected to the three phase windings, 2,3 and 4 of the three-phase generator 1. The diodes 7, 9 and 11, whose respective anodes are connected to the lead 14, are designated "negative diodes" in technical terminology, while the diodes 6, 8 and 10, whose cathodes are connected to the 12 volt lead 15 or the 24 volt lead 16, are designated "positive diodes". In contrast to the known circuit of a three-phase bridge rectifier, all three cathodes of the diodes 6, 8 and 10 are not connected to a common lead connected to the positive pole of the direct voltage, the cathode of the diode 6 being isolated from the 12 volt lead 15 and being connected to the separate 24 volt lead 16.

The first battery 12 and the second battery 13 are charged by means of the three-phase bridge rectifier 5 described above. The first battery 12 is charged by way of the phase windings 3 and 4 of the three-phase generator 1, while the second battery 13 is only charged by way of the phase winding 2 of the three-phase generator 1. The phase winding 2 is loaded to a considerably lesser extent than the phase windings 3 and 4 and thus produces a higher voltage, that is the voltage required to charge the series combination comprising the first battery 12 and the second battery 13. The electrical load 18, in the present instance symbolizing the normal loads during operation of a motor vehicle, is connected to the 12 volt lead 15. When a higher voltage is required, namely the voltage of the 24 volt lead 16 for the further electrical load 20, the latter can be connected to the 24 volt lead 16 by way of the switch 19. This is generally necessary only during the starting of the motor vehicle. It is then sufficient to maintain the switch 17 in its closed state for further operation of the motor vehicle, and to switch on the electrical loads 18 as required.

In a modification of the embodiment, the phase winding 2 is extended by an additional winding 25 in order to ensure that a sufficiently high voltage is obtained for charging the series combination comprising the two batteries.

A further embodiment of the three-phase

bridge rectifier of the battery charger in accordance with the invention is shown in Figure 2. In this embodiment, the cathode of the diode 6 can be connected to the positive lead 15 by way of a switch 21. Thus, the bridge rectifier can be operated in a known manner with the diodes 6 to 11 during normal operation of the motor vehicle, i.e. without the switching-on of loads having a high-power consumption. A protective diode 22 is provided in order to prevent discharge of the second battery 13 when the switch 21 is closed.

A further bridge rectifier of the battery charger in accordance with the invention is illustrated in Figure 3. In this embodiment the mechanical switch of the bridge rectifier shown in Figure 2 is replaced by an electronic switch which, in the present instance, is a transistor 23. The transistor 23 is triggered by way of its base by means of a control unit 24. By way of example, the control unit 24 may be in the form of a threshold value switch such as a transistor having a Zener diode in its base lead. Advantageously, the control unit 24 is connected to the 24 volt lead 16. Thus, the recharging of the second battery 13 can be controlled such that the recharging operation commences when the voltage of the second battery 13 has dropped below a predetermined value. The transistor 23 is switched into its conductive state when the second battery 13 has been charged sufficiently; the transistor thus not only fulfilling the function of the mechanical switch 21, but also fulfilling the function of the diode 6, since its collector-emitter path is conductive in only one direction. In this case also, a protective diode 22 has to be provided for protecting the second battery 13. It will be appreciated that the battery charger in accordance with the invention is not limited to producing the voltages 12 V and 24 V, it also being possible to choose other optional voltage values according to the components to be supplied.

WHAT WE CLAIM IS:-

1. A battery charger for a two-voltage system in a motor vehicle, comprising a three-phase generator and a three-phase bridge rectifier the output of which is connectible to a first battery and a second battery connected in series therewith, wherein two pairs of diodes of the thre-phase bridge rectifier which are connected to two phase windings of the three-phase generator are connected in parallel with one another and are connectible across the first battery, and a third pair of diodes of a three-phase bridge rectifier is connected to a third phase winding of the generator and is connectible in parallel with the series combination comprising the first battery and the second battery.

2. A battery charger as claimed in claim 1, wherein a switch is arranged between the cathode of one of the diodes of said third pair and the cathodes of the diodes of like polarity of the other two pairs, and a protective diode is connected between a pole of the second battery and said one of the diodes of said third pair.

3. A battery charger as claimed in claim 1, wherein the collector of a transistor is connected to the junction of the third phase winding of the three-phase generator and a protective diode, the emitter of the transistor being connected to the cathodes of the diodes of like polarity of said two pairs and its base being connected to a control unit.

4. A battery charger as claimed in claim 3, wherein the control unit is connected to a pole of the second battery.

5. A battery charger as claimed in any of the preceding claims, wherein the third phase winding of the three-phase generator is provided with an additional winding.

6. A battery charger as claimed in claim 2 or 3 or in claim 4 or 5 as dependent on claim 2 or 3, wherein said diodes of like polarity are "positive" diodes of the rectifier.

7. A two-voltage electrical system for a motor vehicle comprising a battery charger as claimed in any of the preceding claims, and the first and second batteries.

8. A system as claimed in claim 7 further comprising a first switch by means of which the first battery can be connected to a first electrical load.

9. A system as claimed in claims 7 or 8 further comprising a switch (being other than said first switch) by means of which the series combination of the first and second batteries can be connected to a second electrical load.

10. A system as claimed in claim 9, wherein the second electrical load is the vehicle starter motor.

11. A battery charger substantially as hereinbefore described with reference to Figure 1, Figure 2 or Figure 3 of the accompanying drawings.

12. A two-voltage electrical system for a motor vehicle, substantially as hereinbefore described with reference to the accompanying drawings.

W.P. THOMPSON & CO.
Chartered Patent Agents,
Coopers Buildings,
Church Street, Liverpool, L1 3AB
Agents for the Applicants

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig.1

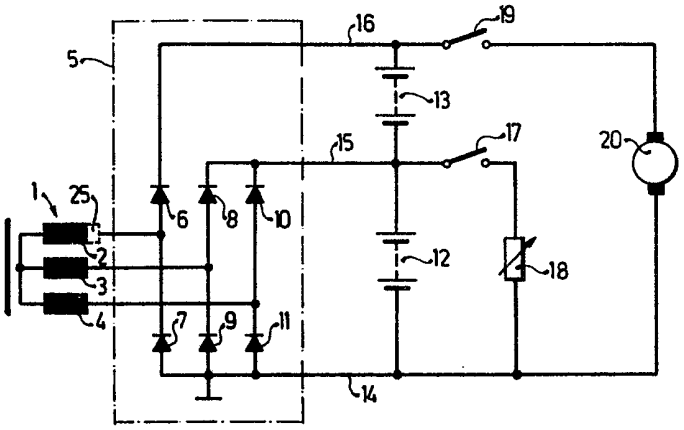

Fig.2

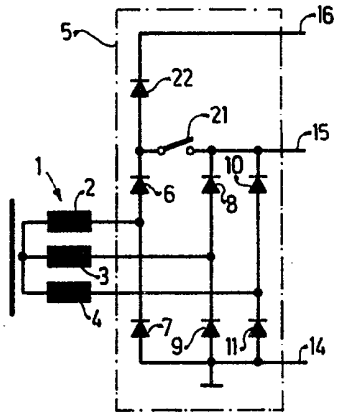

Fig.3