

11

Specification

The invention relates to a method for the optical and/or acoustic indication of the state of charge or of the reserve charge of a battery or of an accumulator for supplying voltage to an electrical load through a function selector switch which can be switched on and off and selectively switched over, and to a circuit arrangement for carrying out the method.

A circuit arrangement for monitoring the supply voltage of battery-operated devices is known from DE-A-25 17 138, wherein the state of charge of the battery is monitored by means of a reference element, and a drop in the battery voltage below the switching threshold preset by the reference element actuates an indicating device which indicates to the user of the battery-operated device that the state of charge of the battery makes an early replacement or charging necessary. In the known circuit arrangement, the reference element consists of a Schmitt trigger, the switching threshold of which is independent of changes in the battery voltage. The Schmitt trigger is actuated by a variable RC network connected in parallel with the battery to be monitored, and on a drop below the switching threshold of the Schmitt trigger, the indicating device in the form of a light-emitting diode is actuated. The switching threshold can be adjusted by varying the resistance value of the RC network by means of a potentiometer serving as a resistance element, so that a drop in the state of charge of the battery below a critical value can be indicated in good time to the user of the battery-operated device. With the known circuit arrangement, if the battery is sufficiently charged, there is only a brief drop below the threshold voltage when the device is switched on, so that the light-emitting diode lights up briefly and then goes out. If the state of charge of the battery is no longer sufficient,

however, that is to say if, after switching on, the battery voltage no longer exceeds the threshold voltage set at the RC network, the light-emitting diode is caused to light up continuously by means of the Schmitt trigger so that, on a drop below the set threshold voltage, energy is continuously drawn from the battery to feed the light-emitting diode.

It is the object of the present invention to indicate a method and a circuit arrangement for the automatic indication of the state of charge or of the reserve charge of a battery or of an accumulator, which reliably indicates the drop below a value of the state of charge which can be preset and, in operation, causes only a low current loading and no drain on the battery or the accumulator after the actuation of the device or after a drop below the preset value of the state of charge.

According to the invention, this problem is solved in that the function selector switch comprises a plurality of "on" positions for different modes of operation of the electrical load, in which a threshold switch having various threshold values is actuated during the particular mode of operation of the electrical load, and that a trigger switch is actuated by the threshold switch if the charge of the battery drops below the predetermined limiting state of charge, depending on the particular loading.

The method according to the invention renders possible the recognition in good time of a predetermined state of discharge of the battery of an electrical device and an optical and/or acoustic indication of this state after the device has been switched off. The indication is effected automatically without operation of a separate test button or switching on a separate switch position of the function selector switch. During the operation of the electrical device, the battery is loaded only with a low current through the voltage divider and not with an additional flow of current through the optical and/or

acoustic indicating device on a drop below the set threshold value. In the switched-off state, the monitoring circuit does not consume any current.

A circuit arrangement for carrying out the method according to the invention is characterised in that, connected in series with the make contacts of the function selector switch is an adjustable voltage divider to which there is connected the base of a first transistor, the collector of which is connected on the one hand to the make contacts of the function selector switch, either directly through a resistor, or through a resistor and a voltage-divider resistor, and on the other hand to the base of a second transistor, the collector-to-emitter path of which is connected in series with the optical and/or acoustic indicating device at the break contact of the function selector switch, and connected in parallel with the base-to-emitter path of which is the series connection of a capacitor and a charging resistor.

This circuit arrangement ensures that an optical and/or acoustic indication of the state of discharge of the battery is effected after the switching-off of the device, depending on the state of the battery during operation and that, after the switching-off of the device, no current is consumed even in the event of a drop below the state of charge and hence actuation of the optical and/or acoustic indication. During the operation itself, there is only a slight current consumption by the voltage divider but, because of the high resistance value of the voltage divider, this can be regarded as negligible in comparison with the current consumption of the actual electrical load.

An advantageous development of the solution according to the invention is characterised in that the function selector switch has three switch position, in the first of which the electrical load is switched off and there is a connection between the battery or the accumulator and

and the indicating device, in the second of which the electrical load is switched on in a first mode of operation and establishes a connection to the one terminal of the voltage divider, the other terminal of which is connected to the other pole of the battery or accumulator, and in the third position of which the electrical load is switched on in a second mode of operation and establishes a connection to the other terminal of the voltage divider.

This development of the solution according to the invention renders it possible to use the function selector switch, necessary for switching on and off and selectively switching over the electrical device, without an additional test position or providing a further test button to indicate the state of discharge of the battery.

A further advantageous circuit arrangement for carrying out the method according to the invention is characterised in that, in the "on" position of the function selector switch, a first control input of a threshold switch is acted upon by the voltage of the battery and, on a drop below a set threshold value, charges a storage element which actuates the control input of a trigger switch through the switching path of which a continuous or intermittent current flows in the acoustic and/or optical indicating device when the switch is in the "off" position, and that, in an intermediate position of the switch, the battery voltage is again applied to a second control input of the threshold switch and the storage element discharges if the set threshold value of the threshold switch is again exceeded.

This solution renders possible an optical and/or acoustic indication on a drop below a specific value, which can be preset, of the state of charge of the battery or of the accumulator after termination of the operation of the electrical load fed by the battery or the accumulator, without an additional test button or switch position of the appliance switch, so that the user's attention is in any

case drawn to a low state of charge. The solution according to the invention is therefore particularly suitable for use in small electrical appliances which are actuated for a specific period at a time so that the preset value of the state of charge can be such that a specific period of time or frequency of operation of the electrical device is possible with the charge still present in the accumulator or the battery. A particular advantage of the circuit arrangement according to the invention consists in that the optical and/or acoustic setting off of the alarm is effected with special allowance for brief heavy loading of the battery or of the accumulator, for example as a result of different kinds of loading, so that a drop in the battery or accumulator voltage due to heavy loading does not lead to an indication if the state of charge of the battery or of the accumulator still renders possible appropriately frequent operation. During the operation of the electrical device, the battery is loaded only with a slight additional current and after the device is switched off, only the small current for the indicating device is consumed for a limited period of time.

A further advantageous development is characterised in that the switch comprises a plurality of contact paths which are so arranged that, in the "on" position, the second contact path, which is connected to the battery, is connected both to the first contact path, connected to the electrical load, and to the sixth contact path, connected to the first control input of the threshold switch, in the intermediate position of the switch, the second contact path is connected both to the first contact path and to the seventh contact path, connected to the second control input of the threshold switch, and in the "off" position of the switch, the second contact path is connected to the fifth contact path which is connected to the switch-path input of the trigger switch.

This development enables a brief drop in the battery voltage, due to loading on setting off the alarm, to be taken into consideration by simple means and the alarm to be set off only after termination of the operation of the electrical load.

A further advantageous development is characterised in that the threshold switch comprises a voltage divider which is connected, on the one hand to the sixth contact path, and on the other hand to earth or reference potential, and to the first voltage-divider tap of which there is connected the base of a third transistor, a fifth diode which is connected at the anode side to the seventh contact path and at the cathode side, through a fourth resistor, to the collector of the third transistor, as well as a fifth resistor which bridges the sixth contact path and the fourth contact path, the emitter of the third transistor being connected to earth or reference potential.

This development renders it possible to construct a threshold switch in a simple manner wherein not only can the particular threshold value be set in a simple manner but also a brief drop in the battery voltage due to loading during the actuation of the optical and/or acoustic indicating device can be taken into consideration.

A further advantageous development is characterised in that the trigger switch contains a fourth and fifth transistor in a complementary Darlington circuit, and the base of the fourth transistor is connected, through a sixth resistor, both to the collector of the third transistor and, through a third capacitor, to the collector of the fifth transistor, the collector of the fourth transistor is connected to the base of the fifth transistor, the emitter of the fifth transistor is connected to the fifth switch contact of the switch, and the collector of the fifth transistor is connected to the one terminal of the optical and/or acoustic indicating device, the other terminal of which is connected to earth or reference potential.

The construction of the trigger switch renders it possible to actuate an intermittent optical and/or acoustic device with a specific adjustable frequency and duration of the indication.

A further advantageous development is characterised in that the collector of the fourth transistor is connected, through a fourth capacitor, to the fifth switch contact of the switch.

This development of the solution according to the invention provides a suppression of the breaking pulse if the switching threshold has not yet been reached and the switch has been brought into the "off" position.

A further advantageous development of the solution according to the invention is characterised in that the emitter of the fifth transistor is connected to the cathode of a sixth diode, the anode of which is connected, through a thirteenth resistor, to a second tap of the voltage divider.

This development of the solution according to the invention prevents the circuit arrangement from consuming current in the "off" position of the switch through the voltage divider of the threshold switch as well as a brief turning-on again of the first transistor as a result of a reduction in the voltage threshold for the first transistor, so that a hysteresis behaviour of the circuit is ensured.

A further advantageous development of the solution according to the invention is characterised in that an eleventh resistor is connected in parallel with the base-to-emitter path of the fifth transistor.

This development of the solution according to the invention ensures that, after the discharge of the storage element, the third transistor is sure to remain non-conductive so that the circuit arrangement does not consume any current in the "off" position of the switch.

A further advantageous development of the solution according to the invention is characterised in that the voltage divider comprises a first voltage-divider resistor which is connected to the sixth contact path of the switch and the connection of which to a fifth voltage-divider resistor forms the second voltage-divider tap, that the fifth voltage-divider resistor is connected both to a sixth voltage-divider resistor and to an NTC resistor connected in parallel with the sixth voltage-divider resistor, the connection of the fifth voltage-divider resistor to the sixth voltage-divider resistor or to the NTC resistor forming the first voltage-divider tap, and that a seventh voltage-divider resistor is connected on the one hand to the parallel connection of the sixth voltage-divider resistor and the NTC resistor and on the other hand to earth or reference potential.

The connection of an NTC resistor into the voltage divider enables temperature influences on the circuit arrangement to be compensated, apart from a reliable setting of the switching threshold, so that a faulty indication or non-indication is largely ruled out.

A fifth capacitor connected in parallel with the base-to-collector path of the third transistor serves to stabilize the a.c. voltage of the threshold voltage at the base of the first transistor.

Finally, in a further development of the solution according to the invention, an eighth resistor, which is connected to the emitter of the fourth transistor and which is connected to earth or reference potential, ensures a constant luminous intensity of the light-emitting diode serving as an optical indicating device.

The idea on which the invention is based will be explained in more detail with reference to an example of embodiment illustrated in the drawing.

Figure 1 shows a circuit diagram of a first variant of the battery reserve indication,

Figure 2 shows a block circuit diagram of a second variant of the battery reserve indication and

Figure 3 shows a detailed circuit diagram of the battery reserve indication shown in Figure 1.

The circuit diagram illustrated in Figure 1 shows a direct-current motor 1 as an electrical load which is fed from a primary battery 2 through a function selector switch 3 constructed in the form of a sliding switch. The function selector switch 3 comprises three switch paths 31, 32, 33, the first switch path 31 being connected to the one terminal of the direct-current motor 1, the second switch path 32 being connected to the positive terminal of the primary battery 2 and the third switch path 33 being connected to the circuit arrangement according to the invention for the optical and/or acoustic indication of the state of discharge of the primary battery 2. At the same time, the third switch path 33 is divided into three portions, namely into a disconnecting contact 331, into a closing contact 332 and into a change-over contact 333. A contact maker 34, which sweeps over the three switch paths 31, 32, 33, in the "off" position connects the middle switch path 32 to the disconnecting contact 331 and in the two "on" positions, connects the first switch path 31, the second switch path 32 and either the closing contact 332 or the change-over contact 333.

The closing contact 332 is connected to a voltage divider 4 which consists of four voltage-divider resistors 41, 42, 43, 44 connected in series and of a setting potentiometer 45. The tap of the setting potentiometer 45 is connected to the base of a first transistor 5, the collector of which is connected, through a collector resistor 10, to the closing contact 332. Starting from the junction between the first voltage-divider resistor 41 and the second voltage-divider resistor 42, a direct connection to the change-over contact 333 is provided. The emitter of the first

transistor 5 is directly connected to earth or reference potential. Connected in parallel with the base-to-collector path of the first transistor 5 is a smoothing capacitor 19 which reduces the sensitivity of the switching threshold with regard to the ripple of the battery voltage under motor load.

The collector of the first transistor 5 is connected to the anode of a first diode 11, the cathode of which is connected to the base of a second transistor 6. Starting from the junction between the second voltage-divider resistor 42 and the third voltage-divider resistor 43 there is provided the series connection of a first resistor 12 and a second diode 13, the cathode of which is connected to the collector of the second transistor 6. A second resistor 14 is provided between the base of the second transistor 6 and earth or reference potential. The emitter of the second transistor 6, like the emitter of the first transistor 5, is connected directly to earth or reference potential.

Connected to the disconnecting contact 331 of the function selector switch 3 is the anode of a light-emitting diode 7, the cathode of which is connected, through a third resistor 15, to the collector of the second transistor 6. Connected in parallel with the base-to-collector path of the second transistor 6 is the series connection of a capacitor 8 and of a charging resistor 9.

Connected in parallel with the fourth voltage-divider resistor 44 is the series connection of a third and a fourth diode 16, 17 with the fourth diode 17 being connected to earth or reference potential at the cathode side. An NTC resistor may be provided instead of the series connection of these two diodes. The series connection of these two diodes or the provision of the NTC resistor instead of the two diodes serves for the temperature correction of the switching threshold at the base of the first transistor 5.

The mode of operation of the circuit arrangement illustrated according to the invention will be explained in more detail below.

In the "on" position of the function selector switch 3, that is to say the position in which the switch contact 34 connects the first switch path 31, the middle switch path 32 and the closing contact 332, the voltage divider 4 is connected in parallel with the primary battery 2. By means of the setting potentiometer 45 of the voltage divider 4, a switching threshold which is proportional to the voltage of the primary battery is set for the first transistor 5. If the voltage of the primary battery drops below the set switching threshold, the first transistor 5 is turned off. Through the collector resistor 10, the first diode 11 and the second resistor 14, a positive voltage jump at the collector of the first transistor 5 activates the base of the second transistor 6 and so turns on the second transistor 6. As a result, the collector of the second transistor 6 jumps to earth or reference potential, reduced by the inevitable emitter-to-collector voltage drop.

With the turning-on of the second transistor 6, the capacitor 8 which, in the non-conducting state of the second transistor 6, is charged to a positive voltage corresponding to its polarity, has its charge reversed to the base voltage of the second transistor 6, oppositely to the original polarity in the non-conducting state of the second transistor 6. In the conducting state of the second transistor 6, the series connection of the first resistor 12 and the second diode 13 is connected in parallel with the series connection of the third voltage-divider resistor 43, the setting potentiometer 45 and the fourth voltage-divider resistor 44. As a result of this parallel connection, the base voltage of the first transistor 5 is further reduced and as a result of the current coupling, the blocking operation of the first transistor 5 is reinforced. As a result of the reduced base voltage of the first transistor,

this only reaches the switching threshold again, at which the first transistor is biased into conduction, when there is an increased voltage of the primary battery. This mode of operation ensures a hysteresis behaviour of the switching threshold.

If the function selector switch 3 is then switched off, that is to say the switch contact 34 is brought into the "off" position in which it merely contacts the middle switch path 32 and the disconnecting contact 31, the light-emitting diode 7 receives positive primary-battery voltage. The charge of the capacitor 8 is again reversed through the light-emitting diode 7, the third resistor 15, the charging resistor 9 and the second resistor 14. A positive voltage drops at the third resistor 14 and biases the base and hence the second transistor 6 into conduction. During the operation of reversing the charge, the time constant of which is determined by the product of the capacitance of the capacitor 8 and the resistance value of the charging resistor 9, the light-emitting diode 7 receives current through the third resistor 15 and the collector-to-emitter path of the second transistor 6, and lights up. This is only the case, however, if the base of the second transistor 6 has previously received a positive potential and the second transistor 6 is turned on. If, on the other hand, in the preceding switch position of the function selector switch 3, the switching threshold set at the setting potentiometer 45 is not reached and so does not cause any positive voltage jump at the base of the second transistor 6, the second transistor 6 remains non-conducting during the subsequent switching over of the function selector switch 3 into the "off" position, and so no reversal of the charge of the capacitor 8 and no lighting up of the light-emitting diode 7 takes place.

As can clearly be seen from the above description of the mode of operation of the circuit arrangement according to

the invention, the light-emitting diode 7 lights up during a specific, adjustable period of time after the switching off of the device, the period of time being determined by the time constant of the charging operation of the capacitor 8 and hence by the values of the charging resistor 9 and of the capacitor 8.

If the switch contact 34 of the function selector switch 3 is in the change-over position, that is to say if it connects the first switch path 31, the second switch path 32 and the change-over contact 333, the first voltage-divider resistor 41 is connected in series with the resistor 10 and the switching threshold set at the setting potentiometer 45 is only reached at the base of the first transistor 5 with a lower primary-battery voltage.

If a primary battery is inserted in the circuit arrangement according to the invention or a charged accumulator is connected up, the light-emitting diode 7 likewise lights up. After it has gone out, the circuit arrangement according to the invention is ready for operation so that the correct polarity and adequate contact making of the inserted battery can be checked in this manner.

The threshold value which can be set at the setting potentiometer 45 for the response of the acoustic and/or optical indicating device can be set so that, after the preset state of discharge of the battery 2 is reached, the consumer device 1 can still be operated for a certain time with its rated data. As a result, assurance is provided that, after acoustic and/or optical indication of the state of discharge reached, operation of the electrical device is still possible and the user is reminded in good time about the charging of the accumulator or the replacement of the primary battery.

Variations in the circuit arrangement according to the invention are possible in such a manner that an indication of the state of discharge of the battery is possible both

during the operation of the electrical consumer device and after the electrical consumer device has been switched off. A further modification may consist in that the adequate state of charge of the battery is indicated optically via a light-emitting diode after the device has been switched off, that is to say, an indication is always effected when the preset state of discharge has not yet been reached.

Although the example of embodiment has been described with reference to a light-emitting diode to indicate the state of discharge of the primary battery, it is easily practicable for an expert to use an acoustic signal generator, for example a quartz resonator, instead of the light-emitting diode 7, or to combine it with an optical light-emitting diode indication.

The block circuit diagram illustrated in Figure 2 shows a direct-current motor 1 as an electrical load which can be connected to a battery 2 as a source of feed voltage, through a switch 3. The switch 3 comprises a switch contact 34 and five contact paths 31-37, of which the first contact path 31 is connected to the direct-current motor 1. The second contact path 32 is connected to the battery 2, while a sixth contact path 36 is connected to a first control input of a threshold switch 20. A seventh contact path 37 is connected to a second control input of the threshold switch 20, while a fifth contact path 35 is connected to the load terminal of a trigger switch 50, the control input of which is connected both to a storage element 30 and to the output of the threshold switch 20. The output of the trigger switch 50 is connected to a light-emitting diode 7 as an optical indicating device.

In the "on" position, the switch contact 34 of the switch 3 bridges the first, second and sixth switch paths 31, 32, 36 while in an intermediate position, it bridges the first, second and seventh switch paths 31, 32, 37 and

in the "off" position, it bridges the first and fifth contact paths 31, 35, so that in the last-mentioned switch position, the electrical load 1 is disconnected from the battery 2 and there is only a connection to the trigger switch 50 and hence, on actuation of the trigger switch 50, to the optical indicating device 7. The intermediate position of the function selector switch, in which the first, second and seventh switch paths 31, 32, 37 are bridged may, for example, be a load position for a second mode of operation of the electrical consumer device 1. Thus, if the solution according to the invention is used in an electric shaver which can be operated independently of the mains, a long-hair cutter may be actuated in the first position of the function selector switch 3 while the long-hair cutter is switched off but the shaver is switched on in the intermediate position. In this case, the two switch positions represent different loadings for the battery 2. In order that the switching threshold for the indicating device may be adapted to both kinds of loading, the threshold switch 20 delivers different threshold values so that, for example, with the higher loading in the first switch position, the switching threshold is set lower.

The basic mode of operation of the block circuit shown in Figure 1 will be explained briefly below.

In the "on" position "1" of the electric switch 3, the battery voltage U_B is applied both to the electrical consumer device 1 and to the first control input of the threshold switch 20. So long as the battery voltage U_B is above an amount which can be preset in the threshold switch 20, under loading by the electrical consumer device 1, the electrical threshold switch remains inactive. If, under load, the battery voltage U_B drops below the preset voltage value, the threshold switch 20 is set through its first control input and, through the connection of the switch contact 34 and the sixth contact path 36, causes

charging of the storage element 30 and hence activation of the control circuit for the actuation of the trigger switch 50. If there is only a brief drop below the set voltage value as a result of higher loading, for example when a long-hair cutter is switched on, and so the storage element 30 is charged through its first control input as a result of the actuation of the threshold switch 20, the storage element 30 is immediately extinguished again through the third transistor 21 if the threshold voltage plus the set hysteresis voltage is again exceeded.

If the threshold switch 20 has been set because the battery voltage U_B has dropped below the set minimum value and so the storage element 30 has been charged, the trigger switch 50 is actuated and causes the battery voltage U_B to be applied to the optical indicating device, that is to say the light-emitting diode 7, via the closed switch paths 31, 35. An acoustic indicating device may, of course, be provided instead of or in addition to the optical indicating device. The trigger switch can selectively effect an intermittent or continuous actuation of the optical indicating device 7 and is actuated until the storage element 30 is discharged. In the "on" position "2" of the function selector switch 3, the threshold value for the second case of loading is set lower, while the electrical operations otherwise take place as in the switch position "1".

As can be seen from the above explanation of the principle, the circuit arrangement according to the invention ensures that the optical indication is effected after the termination of the operation of the electrical consumer device 1, for a period of time determined by the charge of the storage element 30, while in operation and during the indicating operation of the device, the control circuit only takes a little power out of the battery 2 and no power after termination of the indicating operation.

The detailed circuit diagram illustrated in Figure 3 shows a preferred form of embodiment of the battery-reserve indicating circuit of Figure 2.

The circuit arrangement for indicating the battery reserve, illustrated in Figure 3 shows, similarly to the illustration in Figure 2, a direct-current motor 1 as an electrical load which can be connected, via the switch contact 34 of a switch 3, to the first switch path 31 and, via the second switch path 32, to a battery 2. The threshold switch 20 contains a voltage divider with four voltage-divider resistors 23, 24, 25, 26 connected in series, of which the first voltage-divider resistor 23 is connected to the sixth contact path 36 of the switch 3 and the fourth voltage-divider resistor 26 is connected to earth or reference potential. An NTC resistor 27 is connected in parallel with the third voltage-divider resistor 25. The connection of the second voltage-divider resistor 24 to the third voltage-divider resistor 25 forms a first voltage-divider tap to which the base of a first transistor 21 is connected.

The emitter of the first transistor 21 is connected to earth or reference potential while the collector is connected, through a fourth resistor 22 and a fifth diode 28, to the seventh switch contact 37 of the switch 3, the fifth diode 28 being connected, at the anode side, to the seventh switch contact 37. The sixth and seventh switch contacts 36, 37 of the switch 3 are bridged by means of a fifth resistor 29. In addition, a fifth capacitor 40, which can be omitted with a purely ohmic load instead of a direct-current motor 1, is connected in parallel with the base-to-collector path of the first transistor 21.

The storage element consists of a second capacitor 30 which is connected in parallel with the collector-to-emitter path of the first transistor 21.

The trigger switch is connected, via a twelfth resistor 60, to the collector of the third transistor 21 and to the one terminal of the second capacitor 30 respectively and comprises a fourth transistor 51, the base of which is connected both to the twelfth resistor 60 through a sixth resistor 54 and to the collector of a fifth transistor 52 through a third capacitor 53. The base of the fourth transistor 51 is connected to earth or reference potential through a seventh resistor 55, and the emitter of the fourth transistor 51 is connected to earth or reference potential through an eighth resistor 56.

The collector of the fourth transistor 51 is connected, on the one hand to the base of the fifth transistor 52 and on the other hand, through a fourth capacitor 61, to the fifth switch path 35 of the switch 3. The collector of the fifth transistor 52 is connected, through a ninth resistor 57, to the anode of a light-emitting diode 7 as an optical indicating device, and through a tenth resistor 58, to earth or reference potential. An eleventh resistor 59 is connected in parallel with the base-to-emitter path of the fifth transistor 52.

The fourth and fifth transistors 51, 52 form a complementary Darlington circuit, the fourth transistor 51 being constructed in the form of an n-p-n transistor and the fifth transistor 52 in the form of a p-n-p transistor.

The emitter of the fifth transistor 52 is connected both directly to the fifth switch path 35 of the switch 3 and to the cathode of a sixth diode 63, the anode of which is connected, through a thirteenth resistor 62, to a second voltage-divider tap of the voltage divider 23, 24, 25, 26, which tap is formed by the connection of the fourth voltage-divider resistor 23 to the fifth voltage-divider resistor 24.

The switch positions drawn in the illustration of Figure 2 show with "2" a first load position of the switch, with the switch position "1" a second load position and with the switch position "0", the "off" position of the switch 3.

The mode of operation of the detailed circuit arrangement shown in Figure 2 will be explained in more detail below.

According to the position or "2" of the switch 3 constructed in the form of a sliding switch, a voltage threshold is applied to the base of the third transistor 21 by the voltage-divider resistors 23, 24, 25, 26 and the NTC resistor 27. If, as a result of the falling battery voltage U_B , there is a drop below the set threshold voltage of the third transistor 21, the third transistor 21 becomes non-conducting and the second capacitor 30 is charged through the series connection of the fifth diode 28 and the fourth resistor 22. When the second capacitor 30 is fully charged, the fourth transistor 51 of the trigger switch becomes conductive through the twelfth resistor 60, the sixth resistor 54 and the seventh resistor 55.

With the fourth transistor 51 conducting, the complementary Darlington transistor or the fifth transistor 52 likewise becomes conductive. The voltage threshold of the third transistor 21 is lowered through the series connection of the thirteenth resistor 62, the sixth diode 63 and the tenth resistor 58, in order to prevent a brief turning-on again of the third transistor 21, as a result of which a hysteresis behaviour of the third transistor 21 is achieved.

If the sliding switch 3 is then brought into the position "0", a current flows from the positive pole of the battery 2 through the switching path of the fifth transistor 52, which is in the conductive state, the ninth resistor 57 and the light-emitting diode 7 which thus lights up. A current branched off from the collector of the fifth transistor flows through the third capacitor 53, the sixth resistor 54, the base-to-emitter path of the fourth transistor 51 and the eighth resistor 56 to earth or reference potential and reverses the charge of the third capacitor 53. As a result, the voltage at the eighth resistor 56 is increased and the base-to-emitter voltage of the fourth transistor 51

is increased to such an extent that the fourth transistor 51 becomes non-conducting. Consequently, the fifth transistor 52 also becomes non-conducting and causes the light-emitting diode 7 to go out.

Then the third capacitor 53 again has its charge reversed to the polarity entered at it, through the second capacitor 30, the twelfth resistor 60 and the tenth resistor 58. When the reversal of the charge of the third capacitor 53 is ended, the fourth transistor 51 is again activated and becomes conductive as a result of the voltage appearing at the second capacitor 30, the twelfth resistor 60 and the sixth resistor 54 and seventh resistor 55.

When the fourth transistor 51 becomes conductive, the fifth transistor 52 also becomes conductive and the light-emitting diode 7 lights up afresh. This procedure is repeated until the capacitor 30 is discharged to such an extent that no fresh activation of the fourth transistor 51 is effected. During this time, the light-emitting diode blinks at a frequency which essentially depends on the capacitance of the third capacitor 53, for example a frequency of 3 Hz.

The duration of the blinking of the light-emitting diode 7 can be fixed as desired by means of the capacitance of the second capacitor 30, for example at a duration of 15 seconds.

The fourth capacitor 61, which is connected into the connection between the collector of the fourth transistor 51 and the fifth contact path 35 of the switch 3, provides for the suppression of the breaking pulse when the switch contact 34 of the switch 3 moves into the position "0" when the switching threshold of the threshold switch has not yet been reached.

The eleventh resistor 59, connected in parallel with the base-to-emitter path of the fifth transistor 52, keeps the fifth transistor 52 reliably non-conducting after the discharging of the second capacitor 30 so that the

control circuit does not draw any current from the battery 2 in the position "0" of the sliding switch 3. The emitter resistor or the eighth resistor 56 works with the fourth transistor 51 in voltage feedback and ensures a constant luminous intensity of the light-emitting diode 7.

The fifth capacitor 40, connected in parallel with the base-to-collector path of the third transistor 21, serves for the a.c. voltage stabilization of the threshold voltage of the third transistor 21.

As already explained above, the circuit arrangement according to the invention is secured against a wrong indication being given as a result of brief high loading, for example as a result of the starting current of the direct-current motor. The arrangement of the fifth diode 28 prevents the second capacitor 30 from discharging across the voltage divider 23-27.

Finally, the sixth diode 63 prevents the control circuit from consuming current in the switch position "0" through the voltage-divider branch formed by the fifth, sixth and seventh voltage-divider resistors 24, 25, 26.

As can be seen from the mode of operation of the circuit arrangement for indicating the battery reserve, described above, the falling of the battery voltage U_B below a threshold value which can be preset, during operation with an operating load, is detected and stored in a simple and effective manner and is indicated optically and/or acoustically after the operation of the electrical load 1 has ended. At the same time, assurance is provided that a brief drop in the battery voltage as a result of high loading is allowed for, if the battery voltage then rises again above the set threshold value. The control circuit itself works after the electrical load 1 has been switched off, without drawing additional power from the battery 2, so that a current is only needed for the operation of the optical and/or acoustic indicating device. The duration and possibly the frequency

of the indication can be controlled as desired and be adapted to the particular requirements. As a result of the frequency being adjustable by means of the third capacitor 53, not only can a constant or intermittent luminous indication be effected but also, with an increased frequency, an acoustic indication, for example by means of a piezo-electric element.