Retirement home for alkaline batteries

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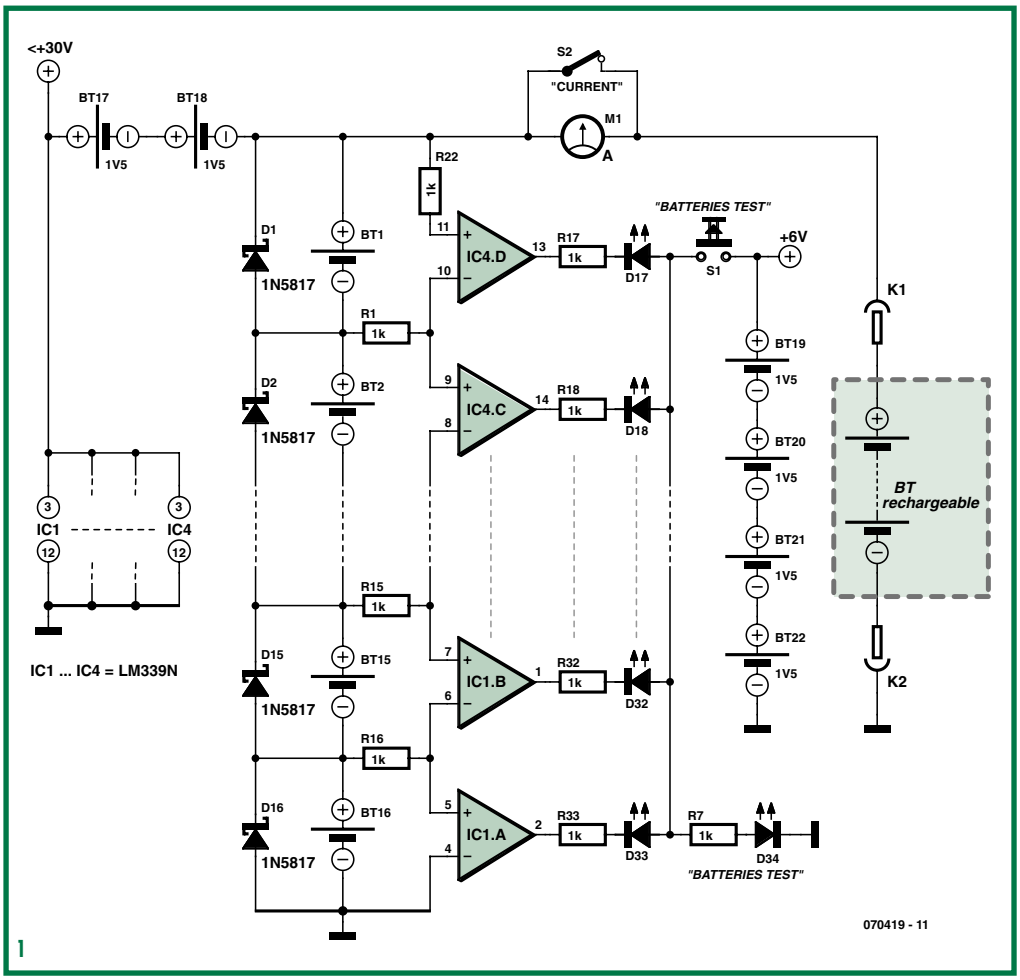
A large collection of half-empty batteries does not automatically mean that you have a nice source of energy similar to the fact that a swimming pool of lukewarm water (huge energy reservoir) can't be easily converted into a small cup of steaming hot coffee. In order to induce energy transfer from the old batteries into the rechargeable ones, a voltage difference must be established. Obviously, we can simply connect the old batteries in series and thus increase the voltage, making the system able to transfer its energy into the rechargeable battery. As always, there are number of pitfalls associated with such a simplistic solution.

First, when one of the batteries in the series 'dies', a significant voltage drop quickly occurs at the terminals of this battery and overall current drops very rapidly. Usually, it's just one battery that stalls the entire process. The dead battery starts to work against the others; developing a lot of heat and sometimes its shell bursts open releasing gas and/or electrolyte.

The second problem is to establish an automatic system that is capable of monitoring voltage for each battery in the series and when one of the batteries is dead, the system must inform the operator which battery needs to be replaced. Such a system must be tolerant of the operator not immediately replacing the dead battery.

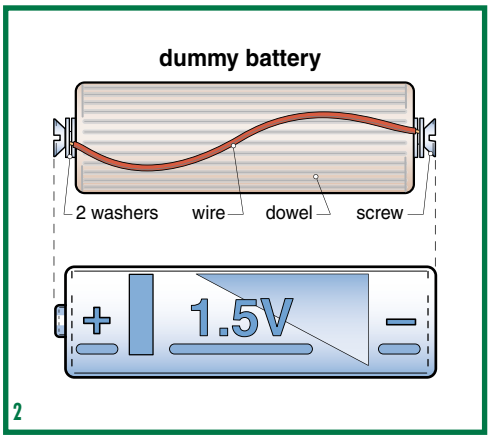
The circuit in **Figure 1** overcomes the above problems. All the batteries shown are old ones! The ones designated BT1, BT2, … BT16 supply the desired current. Their internal resistance being substantial, the current flowing through the rechargeable battery is modest. Experiments involving 16 batteries with two AAA-size 700 mAh rechargeable batteries connected in series to K1-K2 showed a maximum charging current of about 200 mA.



1

The other batteries play a low-current auxiliary role and they may be even older than the 'powerhouse' ones. BT17-BT18 provide a voltage offset to the comparator's supply pins that must be at least 2 V higher than the expected highest voltage on either input. The current flowing through BT17-BT18 is rather small, which is determined by the comparator ICs. Batteries BT19-BT22 power the indicator LEDs; these batteries are idle most of the time. Their status is indicated by LED D34; if this LED does not light when the 'Batteries Test' button (S1) is pressed, these batteries need replacement.

Comparators (4 in each of IC1-IC4) monitor the voltage at the terminals of each battery. When the voltage approaches zero (i.e. the battery doesn't contribute to the process anymore), the output of the comparator toggles to Low (open collector) thus enabling a corresponding indicator LED to light when S1 is pressed. Diodes D1-D16 are Schottky devices, serving to bridge a dead battery before it is replaced. These diodes have a very small forward voltage drop of about 0.2 V, thus being extremely helpful for neutralizing the adverse effects of the dead battery. Overall current is assessed via moving-coil meter M1 when S2 opened.



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In case you do not have enough batteries to fill up all positions (i.e. 16 batteries), it is wise to insert a dummy into the empty battery slot to short the associated diode (Dn), thus cancelling the voltage drop across it and so increasing the overall current. A dummy can be made from a wooden dowel cut to the size of the AA or AAA batteries (see **Figure 2**). Wooden dowels are available at home improvement retail stores.

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