Running Self-Winding Clocks with Alternative Batteries

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With the advent of the rail transportation industry came the challenge of keeping accurate time between broad varieties of locations. Line-operated electric clocks would not be available until much later. Even then, the reliability of the distributed power system would be relatively unproven until well into the 1940's. There was a need for a centrally synchronized clock system to support the growth of the railroad as the predominant emerging public transportation system.

The advent of broadly distributed synchronized timekeeping was marked in the 1880's by the emergence of the Self-winding clock. The concept was simple. A multiplicity of "Slave" clocks at numerous locations were synchronized by a "Master" clock at a central location, synchronized by the Naval Observatory in Washington, DC. The various synchronization signals (usually one per hour) were transmitted over Western Union's telegraph lines to the clocks. The Self-Winding Clock Company owned and maintained the clocks. They would provide a service through Western Union to customers in need of accurate or synchronized timekeeping. They charged appropriate fees for this service.

In the most popular arrangement, two early 1.5V carbon-zinc dry cells (measuring 2.5 inches round by 7 inches long) were hooked in series to produce 3V which powered an automatic winding mechanism or motor. This kept the mainspring at constant torque, producing a very accurate running clock. The winding mechanism would trigger generally once per hour, but other intervals were also used. On the average, batteries would need to be changed about once per year or so.

Today, these Self-winding clocks have risen to the status of collectors items. The going prices at marts have exceeded $500 for many models—even more for those with precision mercury-filled pendulums and beautiful wood cases. Some long case styles are selling for over $1500.

Powering these clocks can sometimes be a challenge. It is possible to buy the pair of 1½V EN-6 batteries used to power these clocks, but they are not easily available. So they must be purchased by mail order or via the internet. Add shipping to the cost and you could be out $40-$50 every time the batteries need changing for each clock you own. On the up side, these Eveready EN-6 cells have good capacity—as long as the cells are fresh.

Replaceable Batteries

Alkaline D Cells. Alkaline D cells are the obvious option. Alkaline technology has advanced to where two pairs of these readily-available, low cost cells can adequately run a typical 3V self-winding clock. Model 1900 is a very attractive, high-quality D cell holder that offers a nostalgic, antique look (The label is a replica of the original National Carbon Co. label) and provides a reliable holder and connection method for the battery. This is important especially if the cells are visible from outside the clock; for example, through glass doors. See Figure below.

The theoretical capacity of an Eveready Energizer D cell is 18-20A-Hr to 0.9V per cell. On the surface, this would run a clock for well over 2 years. In reality however, it doesn't work out that way. Most self-winding clocks require fairly fresh cells to wind. The cell capacity to where the clocks typically malfunction is only about 8000 hours to 1.1V per cell which translates to a run time on the order of 1 year with fresh cells. You won't quite get double the capacity for double the cells due to shelf life. Nonetheless, for around 1 year of service between changing cells, this is an excellent and very economical option.

A rechargeable version, identical to the 1900, is also available. This model, the 1900R, will be discussed later in this article.

Lithium D Cells. There is a UL-approved lithium technology that has the right voltage (3.6V), ultra-low self-discharge and high energy density suitable for powering self-winding clocks. This is the Lithium-thionyl chloride cell. See picture to the left.

These cells are meant for low-drain standby applications such as powering commercial utility meters, beacon or emergency location transmitters, and military applications. A single D cell such as the Saft LS33600 Lithium cell would fit perfectly in the 1900 (http://www.atbatt.com/product/6710.asp). Installed in a 1900 holder (picture above) they can run a clock for 1.5 to 2 years. Two 1900 cells in parallel equipped with the Saft LS33600 could run a clock for 3-4 years, theoretically! We have not had sufficient run time to fully validate this, but it is very likely. Their discharge curves are ruler-flat which would assure reliable winding and timekeeping over the full run time. More expensive than alkaline D cells, the Saft LS33600 cell would cost around $18 every 2 years per replacement.

While one such cell would do very well powering clocks manufactured by the Self-Winding Clock Company, it would take two in parallel as described above to power the impulse-style clocks such as those manufactured by the American Clock Co. This is because the impulse current required would otherwise exceed the cell's capacity.

Additional Voltages. A major intrigue of the 1900 series is the possibility of generating exotic voltages in a very compact space. A 1900-3V contains a dual Alkaline D cell holder. Two such 1900-3V units in series could produce 6V.

The 1900 Series is available in other voltages as well. The 1900-12V is equipped with Alkaline D cells and an innovative, high-efficiency electronic voltage converter. It converts the 3V from the Alkaline D cell pair into 12V which can power the unusual 12V self-winders we occasionally encounter. A pair of these will power the 24V self-winders! That about covers the range of required voltages we would ever need. If however you require other voltages, let us know. We can provide them.

Users of alkaline and lithium cells should dispose of spent batteries responsibly. This applies to all batteries, and lithium is certainly no exception. Ken's Clock Clinic will continue to run tests using these cells and will post results as they become available.

Rechargeable Alternatives and the 1900R

Recently we have been investigating the feasibility of running Self-winding clocks from rechargeable batteries. Below is a comparison table between numerous rechargeable technologies available today:

Technology	**Advantages**	**Disadvantages**	**Typical Cost $/Watt-hr**
NiCd	Can be deep discharged	Low cell voltage (1.2V) Poorest self-discharge (3 months) Very sensitive to over charging Standby use can damage battery	$.80
NiMH	Higher energy density than NiCd		$1.00
Li Ion	Best cell voltage (3.6V) Good self-discharge (10 months)	Safety considerations means expensive protection Most expensive	$.90
Reusable Alkaline	Best self-discharge (5 years)	Poor availability Very few recharge cycles (as low as 8 in practice)	$.13
Sealed Lead Acid (SLA)	Better self-discharge (2 years) Good tolerance to standby use Tolerant to overcharge Good cell voltage (2V) Probably the safest cell overall	Weight Venting during overcharge Requires circuitry to prevent deep discharge	$.21-$.45*

*Price depends on type of construction. Spiral wound cells offer best performance but are more expensive.

From the above table, it is very difficult to find a reliable rechargeable battery with low self-discharge and good tolerance to standby use. These are among the most important selection criteria for powering clocks. Reusable Alkaline cells would possibly represent the potential winner overall. Unfortunately they suffer from limited availability and can only be recharged a few times because the capacity of the cell diminishes significantly with each recharge.

NiCd and NiMH technologies are excellent for high cycle applications like power tools but standby use can cause irreversible damage to the cell. Lithium ion cells are very expensive and have similar issues with self-discharge (although better than Nickel technologies). SLA technology surpasses all others in almost every category except weight, and they're relatively economical. Improvements in this 40 year old technology have established it as the preferred choice where reliable service is a concern, such as hospital equipment and standby lighting systems—and our Self-winding clocks!

A rechargeable solution has the following advantages:

- Rechargeable batteries can be conveniently re-used for their service life (about 10 years with Hawker Cyclon cells) with annual or semi-annual charging
- Saves on inconvenience and cost of battery replacement, and is friendlier to the environment in the long run
- Units available that can fit into any clock.

Safety Concerns. All sealed lead-acid battery manufacturers (and for that matter, all rechargeable battery manufacturers) warn against charging their batteries in a sealed container due to hydrogen production if over-charged. The contacts used in Self-winding clocks might produce an arc during winding, which could theoretically ignite the hydrogen if the clock were tightly sealed. Hydrogen resists attempts to contain it in anything but a sealed metal or glass case, and these clocks are not well sealed (holes, seams, etc). To be on the safe side, simply leave doors or lids of the clock ajar during charging to avoid problems.

Choosing a Battery. In our opinion, the Hawker Cyclon battery is the finest high-quality miniature SLA rechargeable unit suitable for running self-winding clocks. It has excellent long-term performance when used in low drain applications (like self-winding clocks) because self-discharge is 2x lower than any alternative technology. It is rugged enough to be used in a vacuum and is the lowest venting of all SLA technologies. For these reasons, it has been selected as the power plant for our Model 1900R.

The conventional SLAs such as the Genesis series (also available from Yuasa, PowerSonic, etc) also work if aesthetics are not an issue. However, they must be over-specified due to their self-discharge. For example, a 2.5A-Hr 12V Cyclon battery pack will run a clock 1 year with the right voltage converter. But if a conventional SLA is used, you'd want to select a 3.4A-Hr rating because service capacity diminishes with time even if it isn't connected. Of course, voltage converters (discussed later), are necessary to provide charging and conversion from the standard 12V to the 3V needed to run most clocks. These converters are discussed later in the article.

A comparison of Hawker cells and conventional SLAs are shown below. More information is available from the manufacturers by following the links at http://www.batterystore.com. Battery Store offers all of these batteries for reasonable prices.

SLA Batteries suitable for Self-Winding Clocks
(based on Manufacturer's data)

Battery	Size (inches)	V	Run Time	Fit in clock?	Service Life (years)	Price
Cyclon 0810-109	1.48 x 2.66 x 8.08	12.6	1 yr	Some	10+	$43
Genesis NP1.2-12	2.15 x 1.89 x 3.82	12.6	4-6 mo	All	5	$12.95
Genesis NP3.4-12	2.36 x 2.64 x 5.23	12.6	1 yr	Some	5	$16.00
Cyclon 0800-004	Used in 1900R	4.2	8-10 mo	All	8-10	N/A**

**Data on the Cyclon 0800-004 included for comparison. This battery is the power plant of the Model 1900R.

Model 1900R. This model is the twin brother to our nostalgic alkaline battery holder 1900. It is based on a pair of Hawker Cyclon X cells which are built into a vintage No. 6 package. It includes a line charger. Run time between recharging is approximately 8-10 months depending on the clock.

The standard 1900R is a 3V output unit. This simplifies the charging on most clocks since only one cell needs to be charged. If, for aesthetic reasons, it is desired to have a second battery in the clock, an economical cell body can be supplied which acts only as a terminal for the second set of wires installed in self-winders and to complete the circuit for the single 3V unit.

Powering 12V and 24V Clocks with 1900R. Again, the appeal of the 1900R is its availability in other voltages besides 3V. Some self-winders used as masters were originally powered from large battery arrangements available at the master site. In these cases, the batteries were not installed in the clock, but were remotely located in closets and basements (so they could stay cool) where there was sufficient room for the 8 or 16 (or more) cell banks. Wires were run within the structure between the battery banks and the clocks. These somewhat rare clocks were powered from 12V and even 24V dry cell stacks. There simply wasn't any aesthetically clean way to power these clocks until the 1900 and 1900R. With the 12V versions, a single, charming No. 6 rechargeable cell provides enough voltage and power to run the clock for many months!

The rechargeable 1900R is in many ways an ideal solution. It carries the vintage charm of the original battery, complimenting the clock's heritage. It pays itself back because it is reusable. It is convenient to recharge, with visual indication that the battery is charging or charged. It's also the ideal diagnostic battery for the bench, where clocks with unknown problems are connected and tested. No risk of damage to the clock or battery exists.

The standard 12V SLA described in the previous section is a viable option for 12V and 24V clocks, if (once again) aesthetics are not an issue. An approved charger must be used to assure maximum battery life. Also, the battery must be disconnected from the clock once its terminal voltage drops below 11V or irreversible damage to the battery will take place. Later in this article we'll discuss battery converters that address these requirements.

Test Runs. We have been testing a variety of these SLA batteries (plus converters) and the 1900R with our clocks with great success. Since the output voltage is constant regardless of battery state, timekeeping is improved. It's convenient to simply "plug in" the unit and recharge the batteries vs. scrambling around for new batteries and hoping they are fresh. If the clock malfunctions mechanically, no damage occurs and batteries aren't wasted. We simply correct the problem, recharge the batteries, and the clock is running again.

Solar Power? For you techie types, there is a way to get perpetual running out of your self-winder. The high efficiency of both the charge circuitry and the voltage converter circuitry within the Model 1900R and 1000R (see below) opens the door to float charging the battery with sunlight. Small 6V and 12V solar cells are available from hobby, boating and outdoor sporting goods stores that can help accomplish this task. See Figure below.

These solar cells can be fitted with connectors that will simply plug into the 1900R. Just let us know and we can make these connectors available to you, or make solar panels fitted with these connectors available. kensclockclinic@aol.com

GM-684 Solar panel used with some of our clocks. It is rated at 1.2W and keeps the battery charged continuously.

This solar panel can be purchased from Academy Sporting Goods or Electronix Express
http://www.elexp.com/opt_lc01.htm

Part No. 08SLC09

Price plus shipping will be about $20.

Keep in mind that since solar charging the battery is virtually a full-time charging process; the clock should not be tightly sealed if used with a solar panel. Used with a GM-684 solar panel, minimal hydrogen gas will be generated by the cell. However, it would be best to assure that there is a 1/8 inch opening around the perimeter of the door to prevent hydrogen buildup within the clock (to be safe). Or, mount the battery outside the clock.

The wires from the solar cell can be extremely thin (even AWG 28 will work adequately) since the current supplied by these solar cells is small. The wires can be run under closed windows with the solar cell mounted on the outside ledge of the window (this is where ours has been for 6 months now).

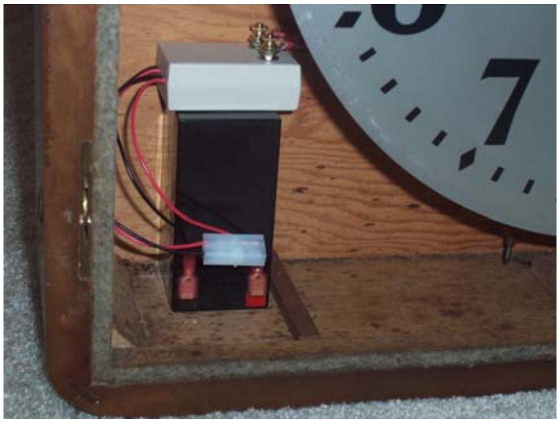
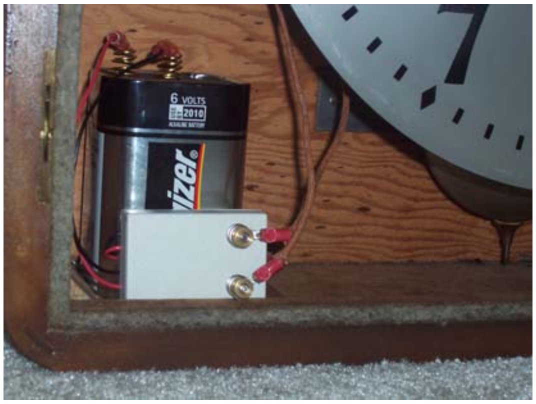
Using a GM-684 1.2W solar cell available for about $20, about all that is needed is about 30 minutes of bright sunlight per day on the average. Per 6 month period, most US locations will provide adequate sunlight to “top off” the battery and keep it charged with a grand total of about a week of sunlight. (There is plenty of reserve energy in the battery to make it through the snowy winters in most locations!) Even a cloudy day will produce a trickle charge to the battery. **Note:** Inside lighting is not sufficient to charge the SLA.

Separate Battery Converters and Other Battery Alternatives

The Model 1000 DC Voltage Converter. The economical Lantern battery has the capacity needed for self-winding clocks. Previously they could not be used with these clocks without risk of damage to the clock because they are 6V. The Model 1000 will provide efficient voltage conversion to 3V. It can be powered from any alkaline lantern cell. See photos below.

The Model 1000R. The Model 1000R is an economical solution for those who prefer to provide their own SLA battery. It is very small and compact (as is seen in the following photos) and fits easily into any clock, connecting to the battery with pre-installed 0.25” inch slip connectors. It is available with 3V, 6V, and 12V output voltage (just let us know what you need). Two would be required to power a 24V clock, along with two SLA’s.

The Model 1000R packs a lot of capability into a very small package. It provides internal dual-level charging circuitry, voltage converter, and low battery shut down to prevent damage to the SLA cells. It comes with wall adapter for charging and is ready to hook up and use.

Above left: Model 1000R converter. This configuration fits into every self-winding clock we could find. At right: The Model 1000 powering a Self-winding clock from a 6V lantern battery. This arrangement will yield close to 2 years of life from the battery.

NOTE: If you are interested in using the Model 1000, 1900 or accessories please email us at kensclockclinic@aol.com. We will also consider custom voltages and configurations to fit your exact needs.