The Seth Thomas sidereal clock, now located in the UH Institute for Astronomy library. The large hand reads minutes, upper small hand, hours, and the lower small hand, seconds, of sidereal time, or time by the stars, as opposed to solar time. On the right is seen one of the two weights that drive the clock. They must be wound to the top once a week.

A close up of the clock’s nameplate shows that it is clock no. 13.
SIDEREAL CLOCK

This Seth Thomas Clock is an example of the most accurate mechanical clocks ever built. Such clocks were the best timekeepers until modern crystal and atomic timing was perfected.

The clock has many ingenious features. An example is the way the length of the pendulum is compensated for temperature changes. The speed of the clock depends upon the length of the pendulum. As the temperature increases, the pendulum shaft gets longer, and the clock runs more slowly. The weight at the end of the pendulum of this clock is a container of mercury which expands as it warms, so its center of weight moves up to compensate for the lengthened shaft. The clock speed remains unchanged.

This is a "sidereal clock," adjusted to keep time with the stars. It gains 3 minutes 56 seconds per day over the "standard time" clock.

Standard time is based upon the sun. It tells us where the sun is at any time of day. We all live by the sun and standard time. It may be the only thing all nations agree upon.

Sidereal time is based upon the stars. It tells the astronomers and navigators where the stars are. Most people do not need this information, so few people know about sidereal time.
Soon after the turn of the century an astronomical event of major scientific as well as popular interest stirred the citizens of Honolulu: the predicted appearance of Halley’s Comet in 1910. By public subscription an observatory was built on Ocean View Drive in Kaimuki, which was then a suburb of Honolulu in the vicinity of Diamond Head.

A civic group known as the Kaimuki Improvement Association donated the site, which offered an excellent view of the sky. A six-inch refractor manufactured by Queen and Company of Philadelphia was placed in the observatory along with a very fine Seth Thomas sidereal clock and a three-inch meridian passage telescope. The observatory was operated by the fledgling College of Hawai‘i, later to become the University of Hawai‘i. The public purpose of the Kaimuki Observatory was served and Halley’s Comet was observed. But, unfortunately, the optics of the telescope were not good enough for serious scientific work.

From “Origins of Astronomy in Hawai‘i,” by Walter Steiger, Professor Emeritus, University of Hawai‘i
The Seth Thomas sidereal clock is now located in the UH Institute for Astronomy Library. It was used in the University of Hawaii's first observatory, constructed in 1910 to view Halley's comet.

The large hand reads minutes, the upper small hand reads hours, and the lower small hand reads seconds, of sidereal time, or time by the stars, as opposed to solar time. On the right is seen one of the two weights that drive the clock. They must be wound to the top twice a week.

**Winding the Clock**
The clock needs to be wound every three to four days. To wind, insert the handle through one of the holes in the glass front and into the face of the clock and turn the handle clockwise. This will raise the weight until it is visible. The bottom of the weight should be about even with the top of the tube, BUT the pulley that rises with the weight must not touch the pulley positioned at the top of the clock.

**Restarting the Clock**
*Note:* This procedure is much easier with two people.

Preparation: Lift the glass top off; unscrew the two knobs on the front of the pendulum case to open.

To restart the clock, set the hands to a time a few moments in the future, then start the program "clocktime" on the hubble server. When the clocktime program gets near the time the clock has been set to, the person at the computer should start a 10- or 15-second audible countdown, so that at zero, the person at the clock can start the pendulum swinging. The pendulum just needs to be held off to one side and then let go; it is not necessary to push it at all. The "clocktime" program can be exited by CTRL-C.

The following text is from the black sign on top of the clock.

**Sidereal Clock**

This Seth Thomas Clock is an example of the most accurate mechanical clocks ever built. Such clocks were the best timekeepers until modern crystal and atomic timing was perfected.

The clock has many ingenious features. An example is the way the length of the pendulum is compensated for temperature changes. The speed of the clock depends upon the length of the pendulum. As the temperature increases, the pendulum shaft gets longer, and the clock runs more slowly. The weight at the end of the pendulum of this clock is a container of mercury which expands as it warms, so its center of weight moves up to compensate for the lengthened shaft. The clock speed remains unchanged.

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The IfA Seth Thomas Sidereal Clock

Jason Surace

May 22, 1998

1 Materials & Design

The clock is made from the materials commonly available at the turn of the 19th century. All of the parts are brass. The clock face is brass plated with nickel. The body is cast iron. The pendulum shaft, flex hinge, and mercury canister are steel. The vernier scale is nickel-plated brass. The weights are brass and filled with lead.

This clock is heavy! Altogether I would guess the clock weighs at least 500 pounds.

2 Cleaning and Maintenance

The clock needs to be wound every 3-4 days. The weights descend approximately 6 inches per day. The winders both turn clockwise. Wind them slowly so that the wires wind on to the take-up spools properly.

The brass will need polishing periodically. **Do not be tempted to lacquer the brass.** While this will prevent it from tarnishing for a while (may be 20 years, tops), it will ultimately tarnish and will then be uncleanable, because the lacquer will prevent cleaning. It is much better to do some light polishing periodically on the bare metal. The brass can be polished with any metal cleaner like Brasso. A coat of paste (car) wax will help slow the tarnishing afterwards.

**Do not oil the clock mechanism.** If it ever starts working erratically, call a clockmaker to clean and oil it. Household oils will eventually collect dirt and gum up the clock, preventing it from working.

3 The Flex Hinge

The flex hinge is a very clever little contraption. It enables the pendulum to swing on an essentially frictionless pivot. The only real energy loss is due to internal deformation of the hinge and air resistance to the swinging pendulum. Rather than having a mechanical hinge, the entire pendulum swings back and
forth by deforming a thin piece of sheet steel from which the pendulum shaft is hung. Eventually, metal fatigue will cause this hinge to break, and the 50 pound pendulum assembly will crash down (as the scars inside the clock body attest to). We have one spare flex hinge; possibly the shop could make more.

Figure 1: Details of the flex hinge.

4 Calibration

Ideally the clock should only need to recalibrated if the pendulum is taken apart. Hopefully this will not happen until the next time the flex hinge breaks!

I have never ascertained how the clock was originally meant to be calibrated. Since electronic clocks didn’t exist when this thing was made, I had originally assumed it was calibrated from basic first principles. However, the only calibrator on the clock is the vernier scale mounted to the pendulum, and I don’t know of anything relating the period of a pendulum to its amplitude. After some discussions with various horologists, I have discovered that this vernier scale exists primarily to make sure the “tick” is the same length as the “tock,”
and that in all likelihood the clock was calibrated by observing a star through a meridian circle, and then tweaking the various adjusters to compensate for the offset on the clock. However, today you can just calibrate the clock against an absolute reference. This is best done by using the WWV time signal, since digital clocks drift by as much as 1 second per day.

There are two adjusters for setting the clock’s period. The first is the thumbwheel that holds the mercury canister on the pendulum. One full rotation changes the clock’s rate by 30-35 seconds per day. I don’t know the exact amount, but notice the little holes to make it easy to adjust in 1/8 increments, which make me think the wheel adjusts by 32 seconds/rotation. The correct setting is when the upper thumbwheel is near the top of the threads cut in the pendulum shaft. The second adjuster is the small sliding brass weight on the pendulum shaft. Adjusting this by 1 inch changes the period by 1 second per day. Obviously, raising the pendulum bob or the sliding weight shortens the period of the pendulum, making the clock speed up.

Simply time the clock over a roughly one day period, and adjust the thumbwheel accordingly. When you have the rate correct to within a couple seconds, adjust the sliding weight accordingly. You might then time the clock over a week to make some final small adjustments.

Of course, this is meant to be sidereal clock (it is also possible to adjust it to be a solar clock, but this is defeating its original purpose). The correct period is 23h56m04.1s of solar time (the kind of time the rest of us are measuring on conventional clocks). In other words, when set correctly the clock will gain about 4 minutes per day. There are a variety of programs to calculate the local sidereal time on a computer (e.g. Xephem), or you can look up the formula in the astronomical almanac. The IfA’s latitude and longitude are 2ld18m38s, 157d48m50s, or you can use the MKO summit coordinates.
History of the Seth Thomas Sidereal Clock

Walter Steiger
July 2000

Soon after the turn of the century (i.e., 1900) an astronomical event of major scientific as well as popular interest stirred the citizens of Honolulu: the predicted apparition of Halley's Comet in 1910. By public subscription an observatory was built for the express purpose of permitting the viewing of the comet by the public. It was located in the suburb of Honolulu known as Kaimuki, in the vicinity of Diamond Head, The site, at the summit of Sea View Avenue, offered an excellent view of the sky. It was donated by a civic group known as the Kaimuki Improvement Association. A six-inch refractor manufactured by Queen and Company of Philadelphia was placed in the new observatory along with a three-inch meridian transit telescope and a very fine Seth Thomas sidereal clock. The observatory was operated by the fledgling College of Hawai'i, later to become the University of Hawai'i. Following the successful observation of Halley's Comet by the public, the observatory was used for occasional astronomy classes at the University or public "star parties," but a serious interest in developing astronomy as an academic pursuit at the University did not materialize. This may have in part resulted from the fact that the observatory became surrounded by the rapidly growing city of Honolulu with its inherent light pollution, and also the fact that the telescope was really not a very good one in terms of the quality of the objective lens.

This was the situation that prevailed until 1958, by which time the neglected building had so deteriorated from rot and termites that the University was compelled to raze the building. The two telescopes and clock were moved into storage at the University's Physics Department.

In 1962, the beautiful new planetarium and science center at the Bishop Museum became the active center of public interest in astronomy and home to the Hawai'i Astronomical Society. At this point it was deemed desirable to loan the clock to the Museum for use as a display in the exhibit hall outside the planetarium. Fortunately, a highly skilled and enthusiastic retired machinist, by the name of Louis Miller, volunteered to refurbish the clock. He took the clock all apart, cleaned and lubricated it and put it all back together so that it was again in mint condition and running smoothly.

By 1987 the center of mass of astronomy in Hawaii had moved to the Institute for Astronomy at the University of Hawai'i, and it was felt that it was time for the clock to "come back home." The move to the Institute for Astronomy resulted in damage to the flex hinge that supports the heavy pendulum and so the clock was no longer operable without repair. Unfortunately, the clock sat idle and non-functional in the IfA library for some years before graduate student Jason Surace came along and made the necessary repairs and put it back in glorious operation again! As of today, then, the Seth Thomas Sidereal Clock is once again running smoothly and its brass parts shining brightly for all to admire.
The sidereal clock now in the IfA Library appeared in the original Hawaii 5-0 with Jack Lord when the clock was located at the Bishop Museum planetarium. The episode, "Horoscope for Murder" (the second episode of season 11), was broadcast on October 5, 1978.