The Marine Master Clock

By Robert A. Simon (CA)

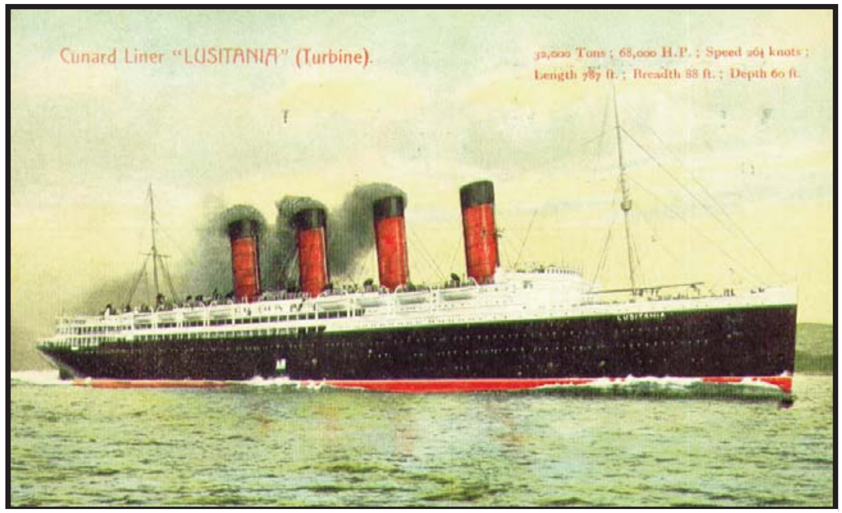


Figure 1, above. Cunard Line, the *Lusitania*, equipped with a Magneta system.

In the early 1900s when the steam-powered, steel hull passenger ships (the *Titanic*, *Lusitania,* and many other famous ships) were being built to meet the demands of transoceanic travel, offering modern amenities was part of the competition for luring new travelers, and so the marine master clock was born. The challenge of daily time changes to slave clocks in key locations on the ship, such as common areas, dining and grand staircase locations, as well as first-class staterooms, was met by famous makers such as Mercer, Magneta (English, based on a Swiss patent), Synchronome, Gents Pulsynetic, and later into the 1900s, E. Howard, Harlandic, Favage, and others.

We are all familiar with the master clock concept, which is typically an accurate one-second beating, pendulum clock that controls electric pulses once or twice a minute to slave clocks. Some methods for achieving this include the reversing of polarity through the wires, at each minute pulse to the slave clocks. These "land-based" clocks, some with 1/2-second pendulum, or 80-beat pendulum all shared the fate of permanent stable mounting and unsuitability for marine application. Unlike the navigational chronometer with a rating card and daily log entry adjustment, necessary for proper longitude calculation, a marine master clock did not require precision accuracy. F. Hope-Jones explains that a ship is like an isolated community, not concerned with its neighbors' time. There is a casual nature to time on a ship and from the eight bells of Drake's day, each ship kept its own time. The wireless officer would reset clocks each night by an arbitrary amount, with some input to the approximate longitude, as this is many hours after a noon sun reading and chronometer longitude calculation. Consider that a moving ship may experience head winds or changing ocean currents, affecting exact longitude; therefore, a minute or two tolerance on the slave clocks was insignificant. The longitude time change is required when you travel east or west over the oceans. Manual and/or automatic advance/retard control from the master to the slave clocks is in minute or half minute increments (and takes perhaps ±30 seconds to rapid advance) and would have been a daily task based on the ship's speed and compass heading. The time change was an approximation based on longitude.

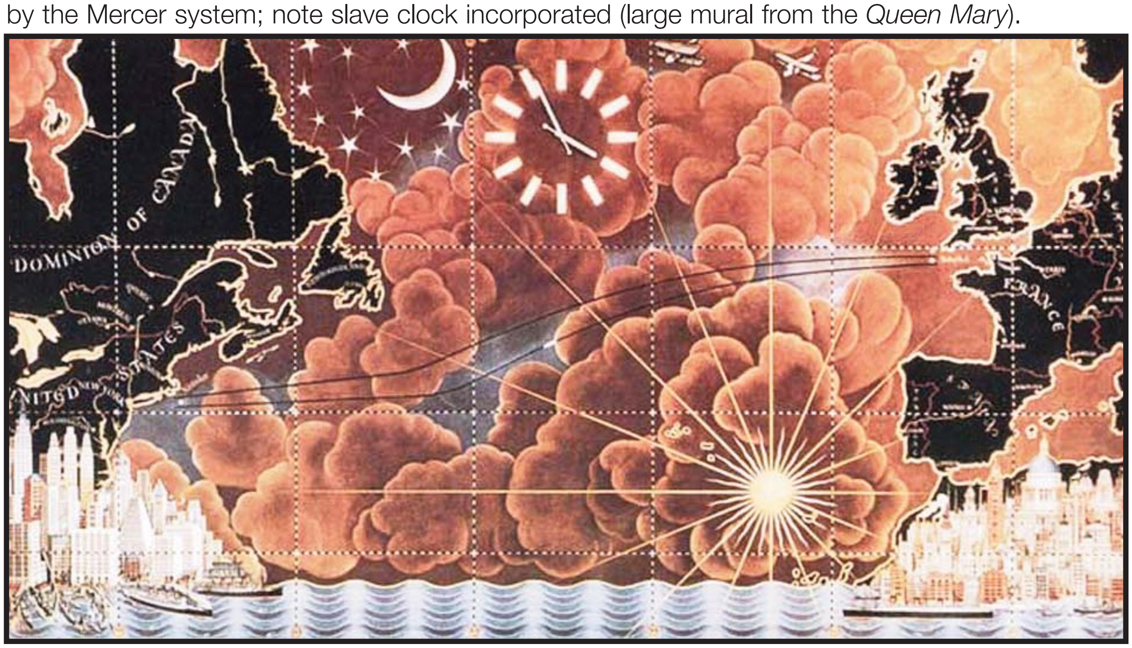


Figure 2, below. Moving model for ship crossing the ocean (either direction) with ship advanced by the Mercer system; note slave clock incorporated (large mural from the *Queen Mary*).

As a ship would head west from Liverpool to New York even at a fast clip (20 knots: 23 mph), in a 24-hour period the ship would travel less than 15º longitude, requiring less than a full hour time adjustment. The distance between each degree of longitude varies from 0 to 69 miles from the poles to the equator, respectively. At 40º latitude (New York), one degree longitude is roughly 85 km (53 miles) and the distance through 15º of longitude or one hour time zone is roughly 795 miles; and at 23 mph this will take ±34 hours. The great circle route to and from Liverpool, which is a farther north latitude, would reduce the longitude degree distances. In 24 hours of travel time, the time per day change would be less than one hour on the ship's clocks. Heading east, a middle of the night adjustment to advance the ship's clocks would be in order. A westerly sail would require clocks to be set back or retard. Travelers would adjust their watches and their "body clocks" slowly over the course of the trip. Accurate time would be set when reaching final port.

There were experiments with early make/break electric attachments to a chronometer. A delicate momentary switch was actuated by a special tooth on a separate wheel attached to the fourth, or seconds, wheel arbor on a marine chronometer. The chronometer contact Mercer "Octo" system, is an example (Figure 3). In 1866 a make/break system for marine chronometers was successfully demonstrated by Dr. Adi Hirsh, director of the Neuchatel Observatory. In 1868 Charles Fordsham had a concept to use a separate drive-spring gear train that was released every minute to provide contact independent of the time train to avoid any effect on the timekeeping accuracy of the navigational chronometer, which was also providing the make/break circuit. At first these make/break contacts were for field survey or chronograph chart recording to time events. In 1900 Kullberg demonstrated a chronometer at the Paris exhibition with a contact for controlling "dial clocks or chronographs" but not referenced as being installed on a ship. By 1905 a chronometer could be

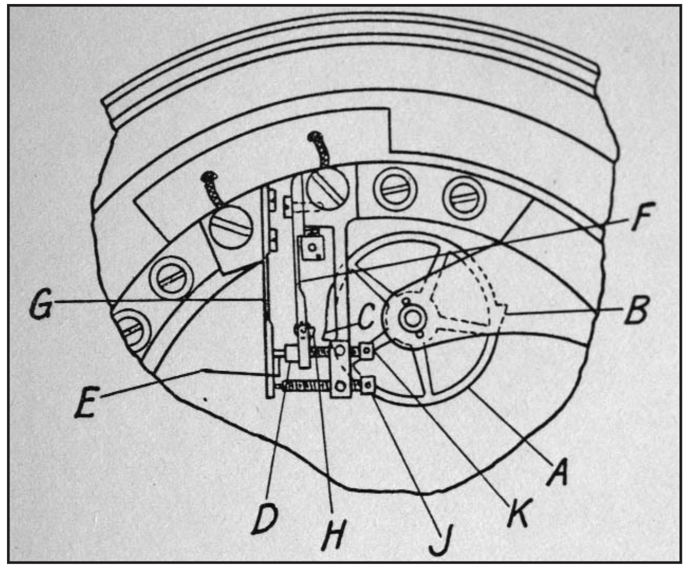


Figure 3. A chronometer contact Octo system as installed on a Mercer marine chronometer.

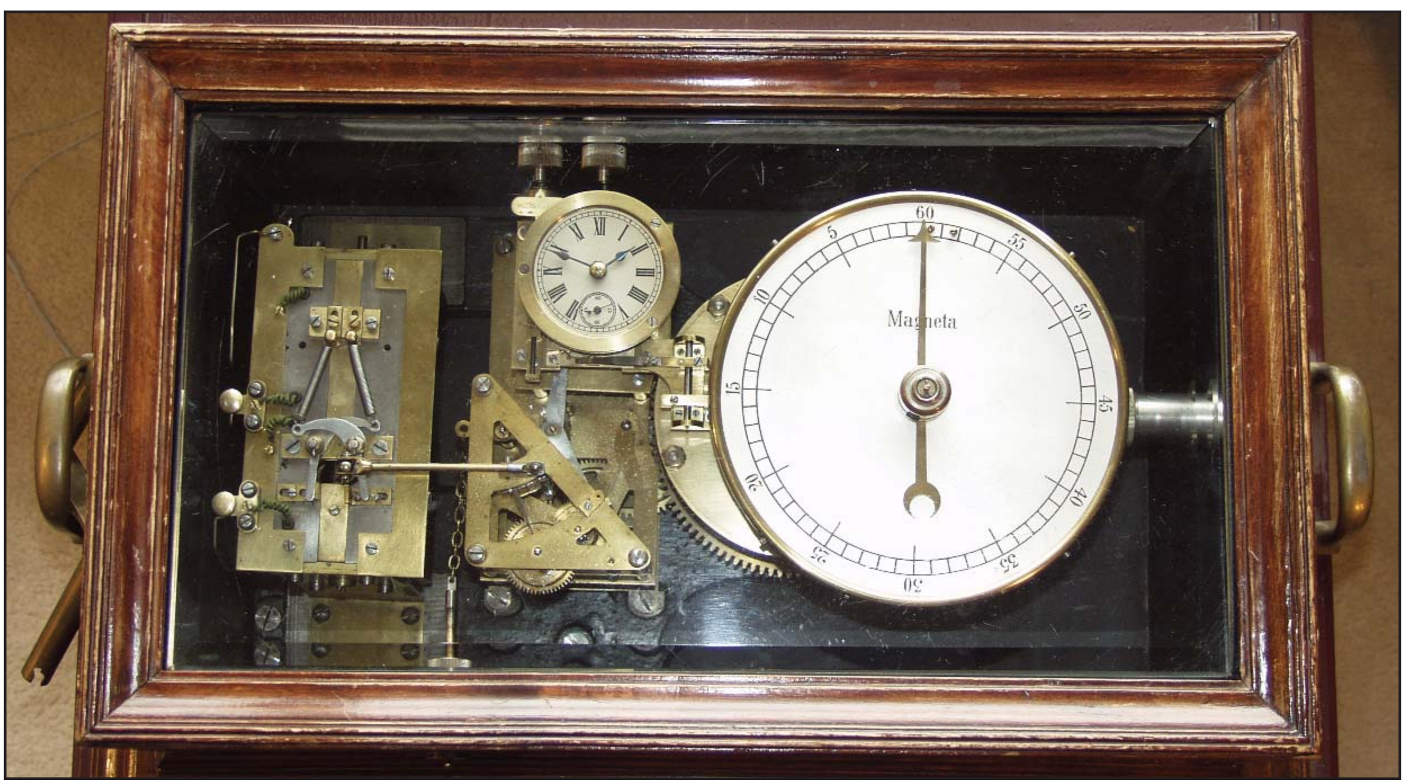


Figure 4. A Magneta marine master clock (a later model) with an automatic retard mechanism that requires setting the hand on the dial on the right to the number of set-back minutes.

modified with many combinations of duration contacts even as needed for an anchored light ship. Mercer produced chronometers with different duration contacts to various needs. Some of these chronometers were used in conjunction with a separate control panel in the Mercer Octo system for ships, but not until the 1920s. Radio transmission for telegraph communication and time signals for ship navigation started as the "wireless" in the early 1900s.

Early information, albeit any information in detail on these marine master clocks, has been very elusive. With much assistance from the BHS and the NAWCC, as well as the kindness of individuals worldwide, I will progress at this point to describe the systems available in the early 1900s.

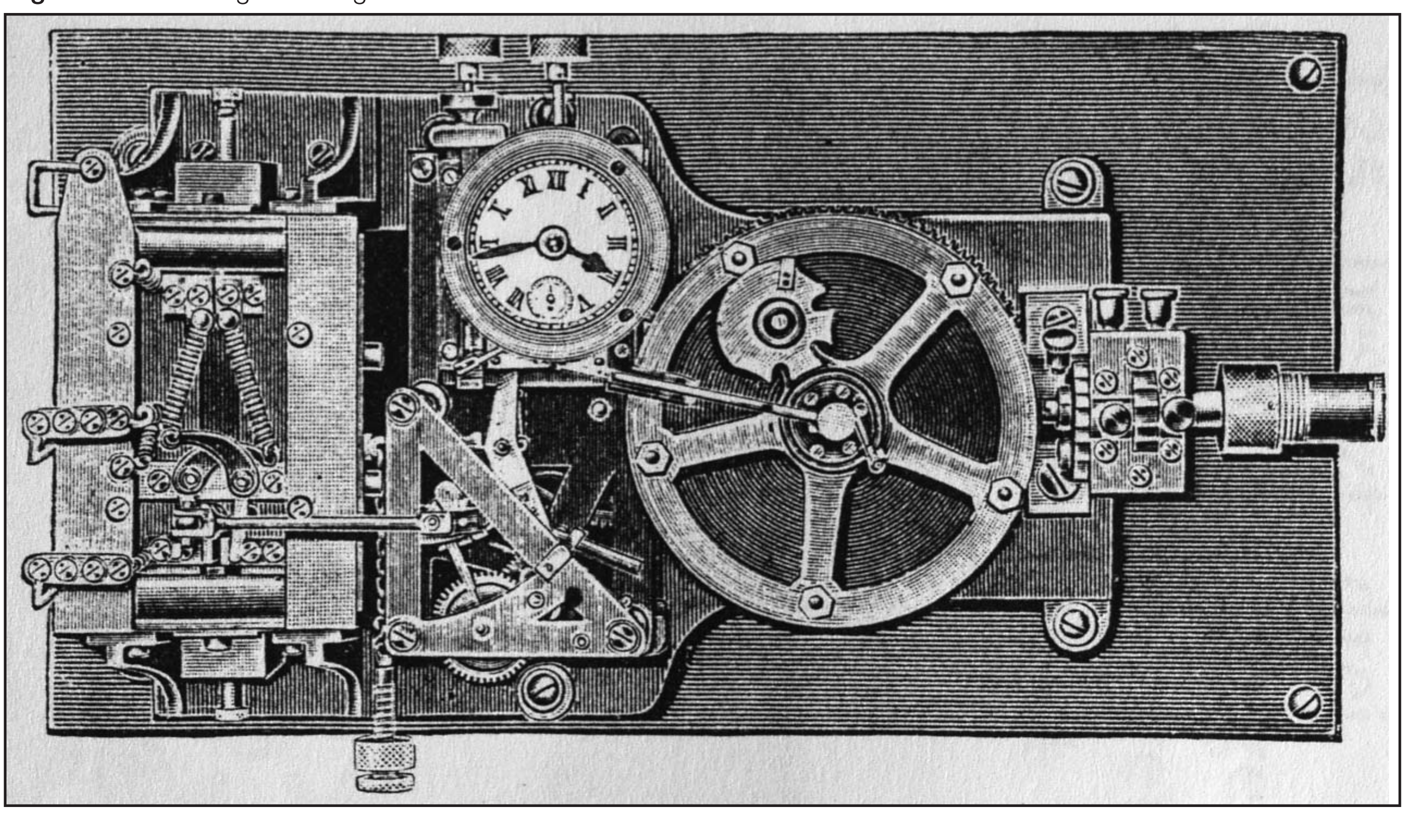
THE MAGNETA MARINE MASTER CLOCK

In 1900 Martin Fischer, of Switzerland, patented (Swiss) a master clock system that offered important improvements over the electric contact make/break system. There were no contacts to open/close, which eliminated the corrosion and fatigue problems that led to poor contact, or no contact, for the minute impulse, or to a loose contact that could hit and bounce and send two impulses at the same time!

This system included an internal electric generator that used a wired armature coil. The coil spun less than a quarter turn, inside several parallel horseshoe magnets. Each partial rotation generated an electric impulse. The polarity reversed at each turn (when the coil changed direction). Because the slave movement used reverse polarity, double impulse jumps were prevented as there were no concurrent pulses of the same polarity. Documented in 1908, this was the first successful ship's clock system. (Synchronome claimed marine clock systems as early as 1895, but I have not found any references or examples that early.)

The Magneta Clock Company of England, using the Fischer patent, produced both pendulum and lever escapement clocks. The marine clock uses a large 2" wide mainspring. Either version will release the heavy weight or the powerful mainspring each minute, to generate the reversing polarity pulse. As early as 1908, the Magneta master was installed on seagoing vessels. The top-view sketch shown in Figure 5 from the 1908 book *Elektrotechnik fur Uhrmacher* by Johannes Zacharis, shows a first production Magneta. The July and August 1911 issues of the British trade journal *The Electrician* refer to the *Titanic* and *Olympic* as having the same master clock (Figure 6). The *Lusitania*, *Mauretania*, and other ships also used Magneta systems. The clock shown in Figure 7 has an 11-jewel horizontal platform escapement that has a remontoir drive train and a mechanical release unit for the powerful spring to move the eccentric arm to rotate 1/4 or less turn of the coil in the horseshoe magnet. Each day a large crank would be installed on the right side of the case to wind the spring. This early version allowed a rapid increase pulse to advance clocks (including the

Figure 5. A drawing of a Magneta marine clock from a 1908 German textbook.



pilot slave clock next to the master). A small chain connected to the release mechanism was pulled and released, once for each minute. Disconnecting the circuit from the master served to retard the clocks. See Figures 8 and 9. The improved Magneta master used a second escapement that worked with the automatic retard memory to count down the selected time for clock "set back." The retard unit was set with a key through the glass, and the setting hand was rotated counterclockwise to the desired minutes. The rotation wound a small watch movement spring, started the retard unit escapement, and dropped a lever spring directly onto the main clock balance wheel edge. This prevented time pulses from being sent until the retard minutes had elapsed.

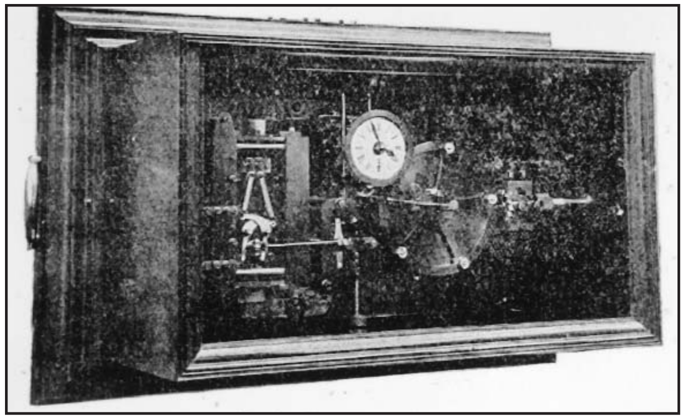


Figure 6. An early Magneta master clock from the *Titanic*, *Lusitania, Olympic*, and other ships.

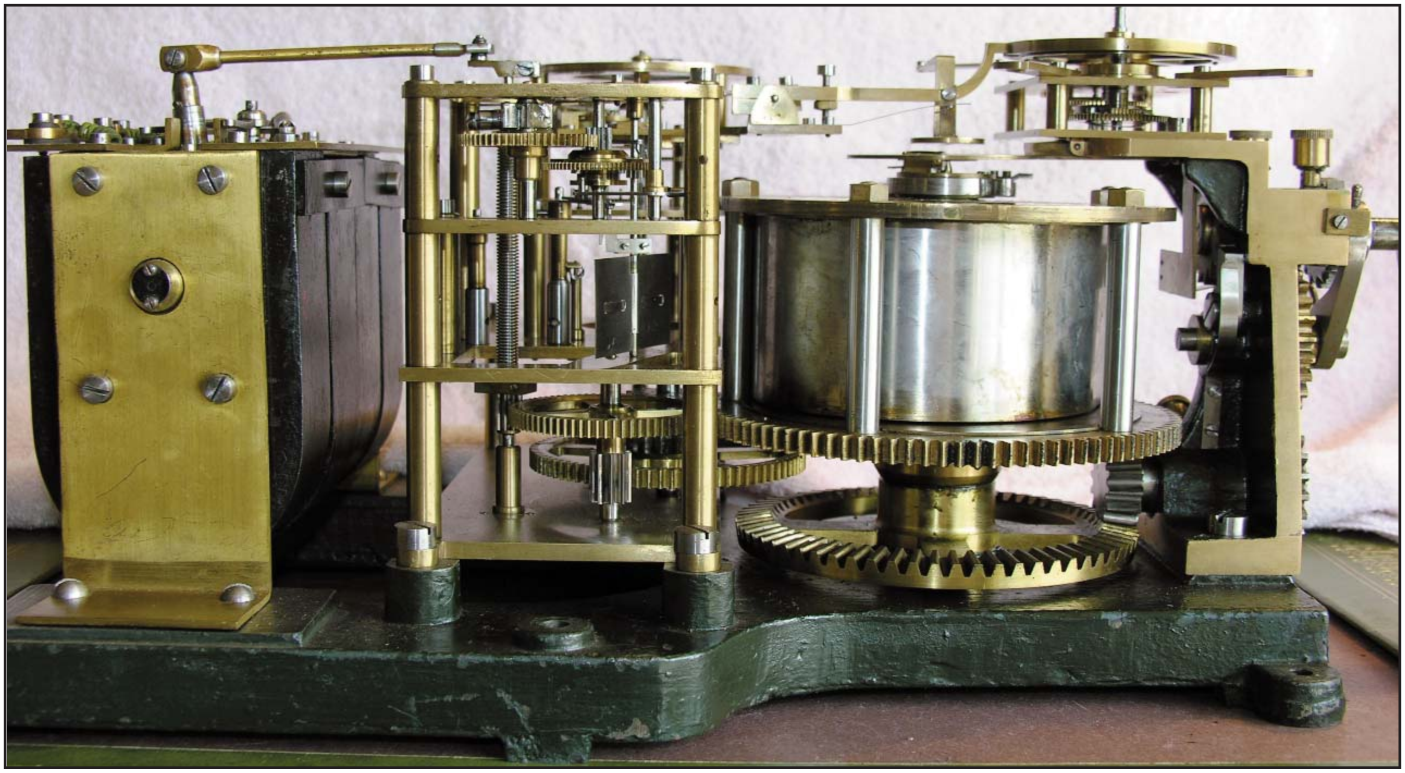


Figure 7. Side view of a Magneta movement showing horseshoe magnets (with coil inside) on left, mainspring on right, and clockwork with remontoir in middle.

Figure 8. Detail of Magneta time escapement (left) and retard escapement (right).

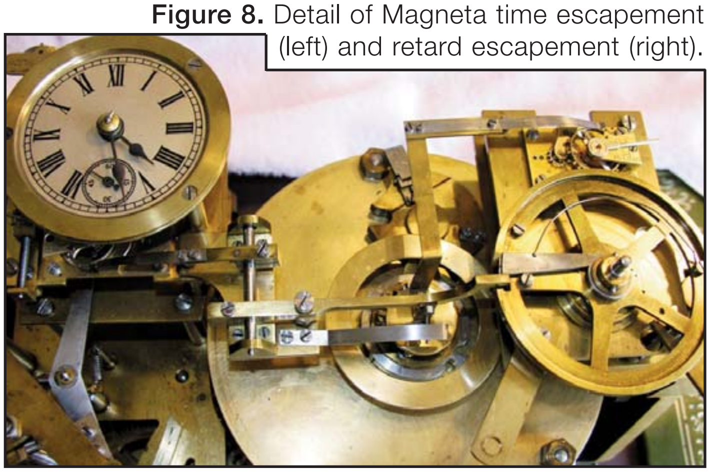
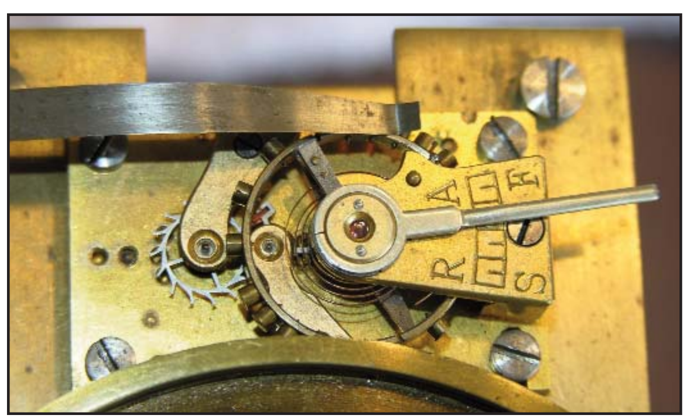


Figure 9. Close-up of platform escapement in the automatic retard mechanism.



The slave movement (Figures 10 and 11) is a delicate device with a quiet design that transferred the coil impulse to a see-saw arm, which in turn used a long lever to develop the necessary energy to advance the slave clock hands. The need for a quiet or silent slave movement in sleeping staterooms was important. Fancy slave clocks of large proportions to smaller stateroom clocks all used the same movement.

Figure 10. A large and fancy Magneta wall slave clock.

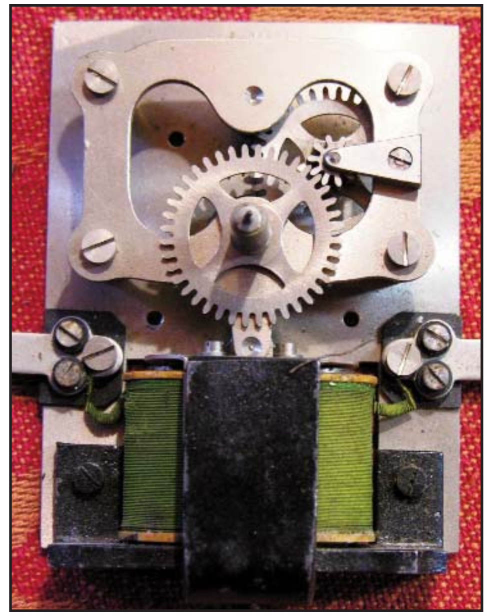


Figure 11. Reverse polarity impulse Magneta slave clock movement.

THE SYNCHRONOME MARINE MASTER CLOCK

F. Hope-Jones was an amazing man and a prolific inventor with many ideas: the free pendulum, the gravity arm, the Shortt Astronomical Observatory Clock, and through a subsidiary company (Dykes Brothers, Glasgow) a marine clock division. One invention for marine application used AC motor clocks that adjusted the AC frequency to the clocks for a uniform advance or retard over the entire voyage! Timekeeping at sea is an entire chapter in Hope Jones's book *Electrical Timekeeping*. The Synchronome marine master clock was a modification of the Synchronome "switch" as used on his famous pendulum master clock. The marine clock was fitted with a vertically oriented platform escapement and an unbalanced weighted crossbar that was set by an electric "kick up" mechanism

Figure 12. Synchronome master clock with manual operation.

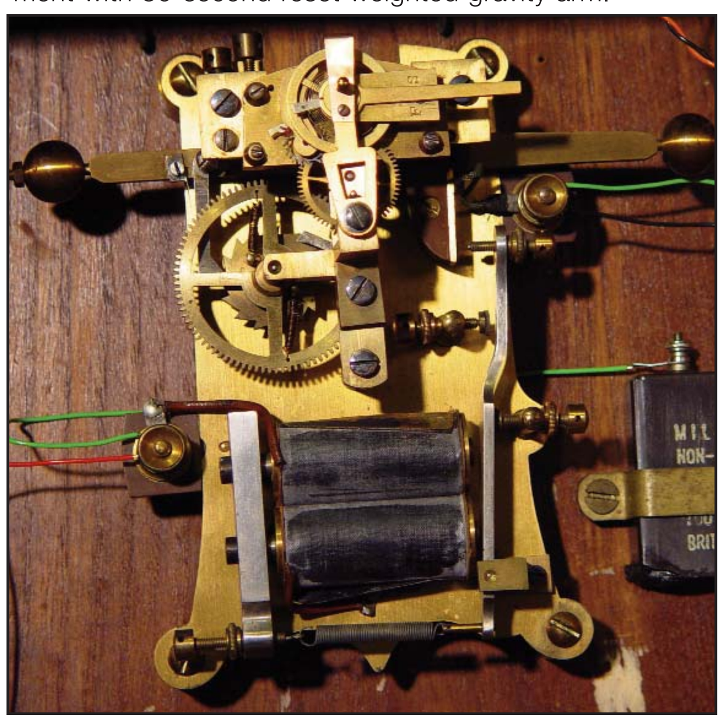


Figure 13. Synchronome vertical balance wheel movement with 30-second reset weighted gravity arm.

Figure 14. Close-up of dial showing push button "SET ON" and "SET BACK."

exactly every 30 seconds. At the same time the contact is made to reset the drive weight for the time train, a coil is closed that sends the impulse out to the slave clocks. See Figures 14 and 15. The clocks were advanced as needed by manual push button and time change was confirmed by monitoring the slave dial in the unit. Retard operation was done by opening the slave clock glass door and moving the minute hand back to the new time; then pressing the start button for the clock to continue; no impulse went out to the ship's clock until the retard mechanism has counted down to the new time. The countdown was on a real-time basis, so it may have taken up to an hour in the middle of the night to complete the reset. They also made an automatic set and retard unit (Figure 16). Another concept that Synchronome and also Harlandic Clock Company used was an AC 50-cycle generator for the master and AC motor for the slave. For example, say the slave clock motors run at real time rate of 50 cycles per second (hertz). If your generator was adjusted to put out 48 cycles per second, it would reduce "real time" by 1 hour in 24 hours. At 52 cycles per second, it would increase real time by 1 hour in 24 hours. It was a great idea because you set your travel speed and clock adjustment once and it continued until your destination! This would allow a uniform rate change through the entire transatlantic voyage. Passengers would be told not to wear their watches, and set them to time "…when passing the Statue of Liberty…" It is interesting that no mention of Synchronome marine systems was found in all of the textbooks that have chapters on marine master clocks (other than Hope-Jones).

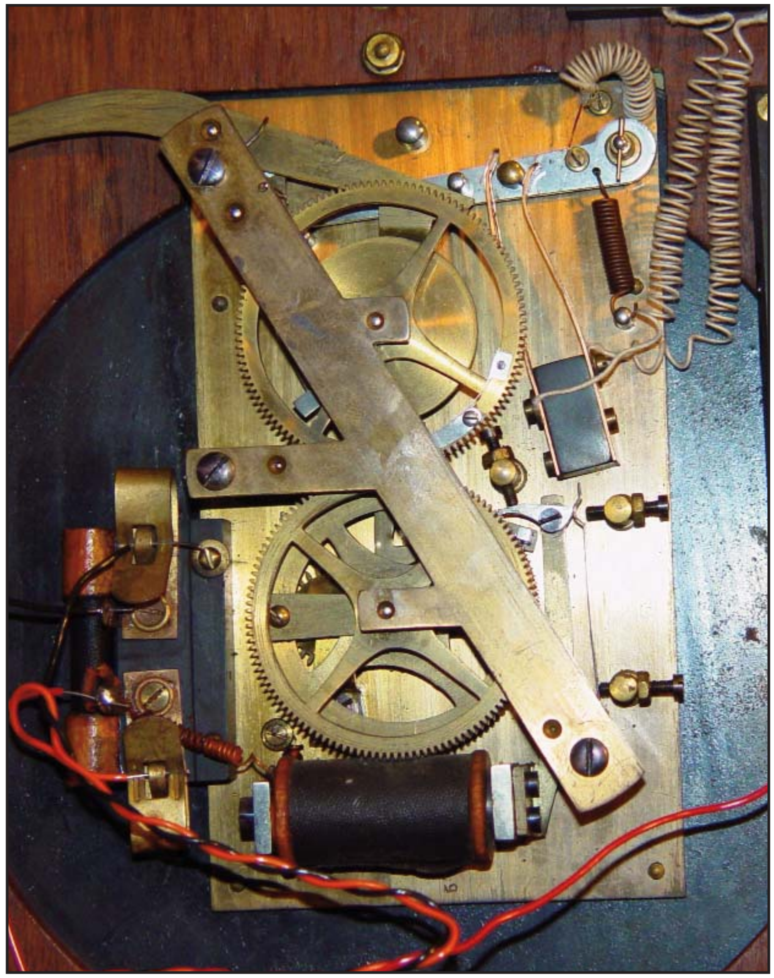
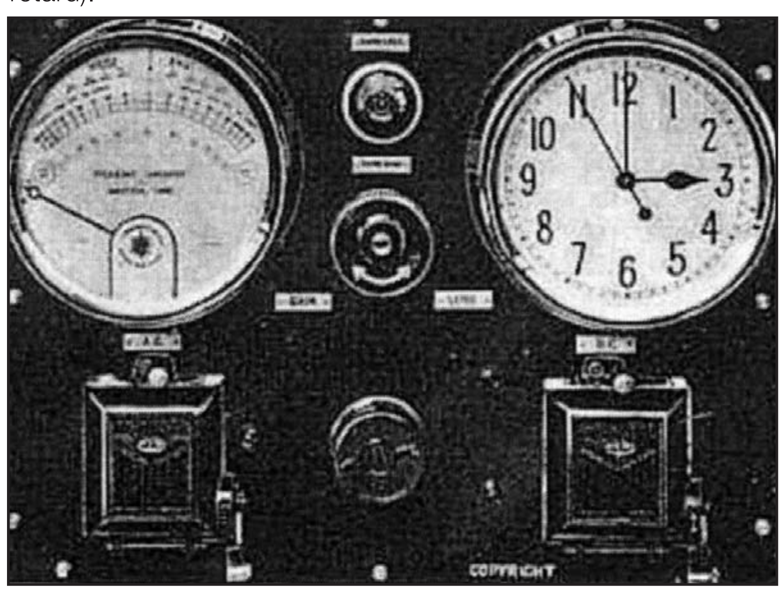


Figure 15. The slave clock movement on the bottom is geared to the slave clock countdown wheel above it; this is for setback of clocks on the Synchronome system.

Figure 16. Photo of the control panel of the Synchronome AC synchronous motor master clock (with automatic set and retard).



After the war years, Tom Mercer pioneered his Octo system with the very elaborate clock system installed in 1927 on the *Ragatini*, a trade ship to and from Australia. Mercer of St. Albans, England, produced both marine chronometers with a 30-second contact and a separate electric wound, horizontal chrono-meter platform escapement, marine master, 30-second impulse movement. Modifications to these movements would provide contacts for light ships or survey chronographs, etc. See Figures 3, 17, and 18. Mercer offered 30-second contacts on the ship's chronometer to impulse slave clocks through the Octo panel control. The *Queen Mary* had two electric-wound movements in a redundant system to allow seamless live maintenance on one escapement while the other escapement provided time signal (Figure 21). The M33B control system consisted of a 30-second impulse movement, with a mainspring that is electrically wound through a ratchet and pawl impulsed every 30 seconds. The design of a perfectly matched mainspring winding and unwinding system (keeping perfect time) is almost impossible. The choice is to try to overwind the mainspring and have a make/break contact on the winding coils that keeps the spring in an uniform tension range just under fully wound. The winding arbor has a screw thread attached to a spring contact switch that prevents overwinding by removing current to the winding ratchet pawl coils periodically. A separate contact is used for the advance of/or retard countdown of the ship's slave clocks. A mahogany case with slave dial on the door provided the common circuit monitoring of the clocks. Advance/retard control through two independent mechanisms in the lower portion of the case provided for real time, minute by minute, retarding of

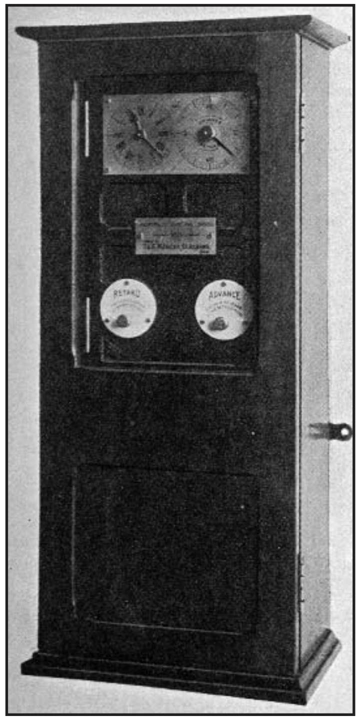
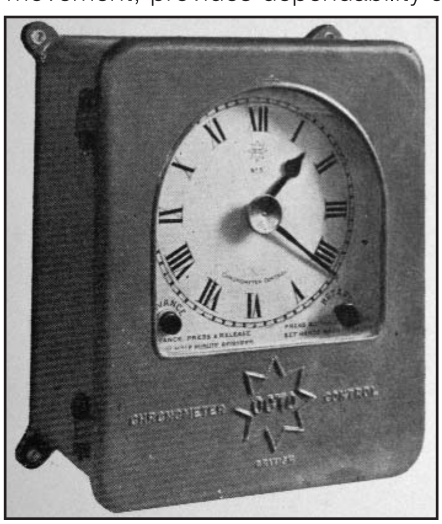
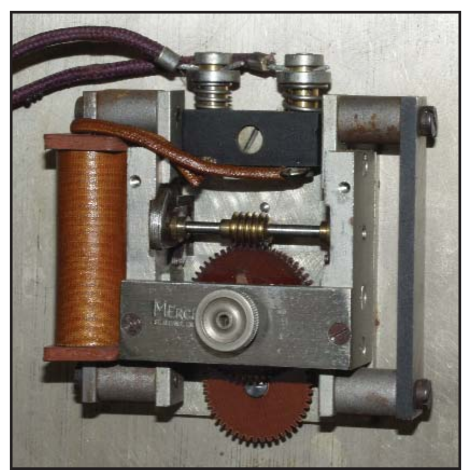


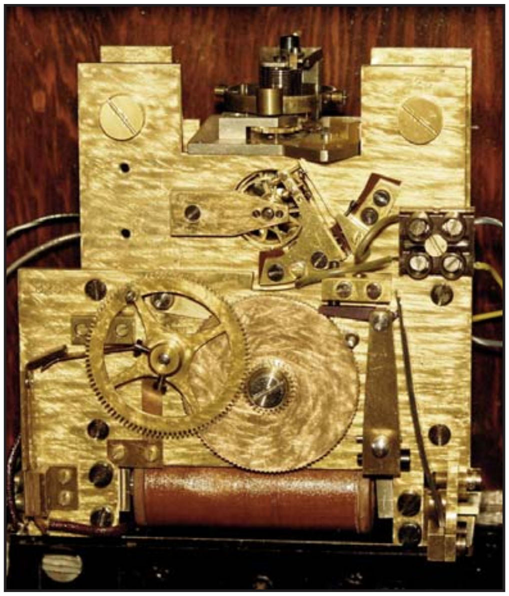
Figure 17. Early Mercer Octo automatic control panel that works from 30-second impulses off the navigational chronometer.

Figure 21. Mercer 1936 control cabinet from the *Queen Mary*. This unit has two electrcally wound master movements, allowing servicing of one while the other functions as the master clock.

Figure 18, left. Early Mercer Octo manual control panel that works from 30- second impulses off the navigational chronometer. **Figure 19, center.** A very fancy late 1920s silver case Mercer Octo slave clock, note bottom of dial reads "Chronometer Control." **Figure 20, right.** The 1909 Bowell patent "self induced electro magnet" slave clock movement, provides dependability and almost perfect quiet, so as not to disturb your cabin sleep.







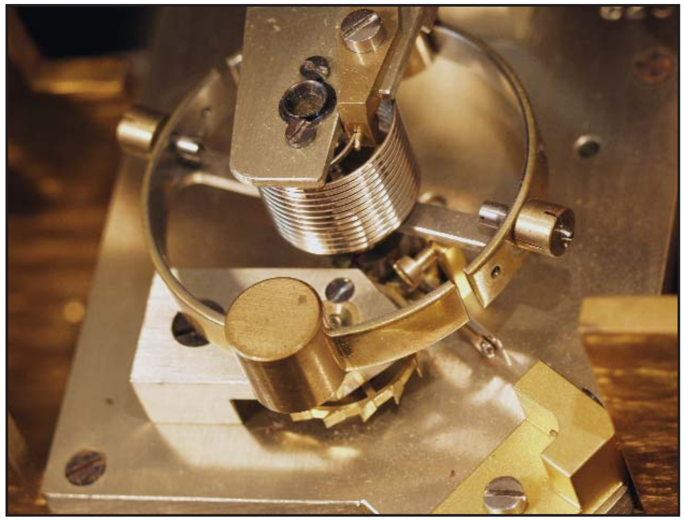


Figure 23, left. Close-up of Mercer spring detent escapement.

Figure 22, left. Typical Mercer electrically wound 30-second impulse movement with a horizontal platform chronometer escapement.

clocks to the exact number of minutes set on the dial. Advancing clocks used a "rapid fly wheel" device that was powered by a mainspring and advanced the slave clocks in half minute jumps every 2 seconds. Capacitors, high amperage relays, and resistors were included to eliminate large currents from delicate clock contacts on the movement. See Figures 24-28.

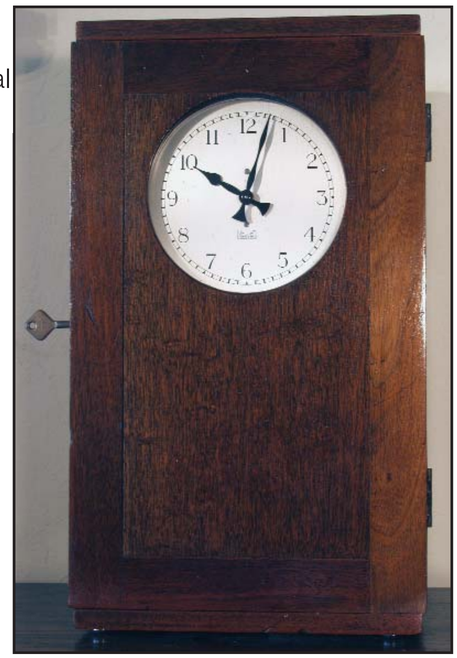


Figure 24, right. Mercer master for a small passenger ship with electric wind movement and automatic advance retard.

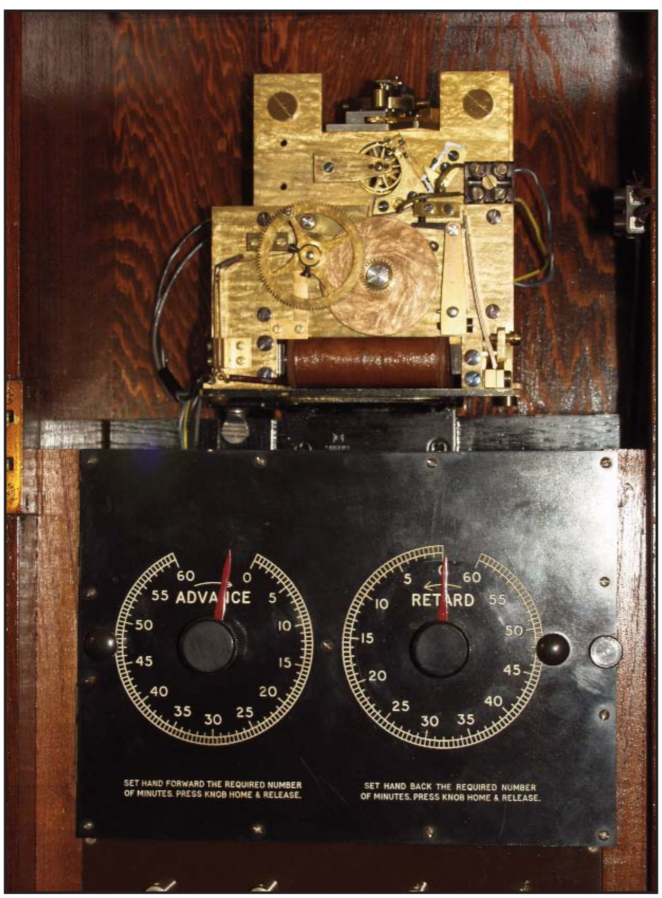
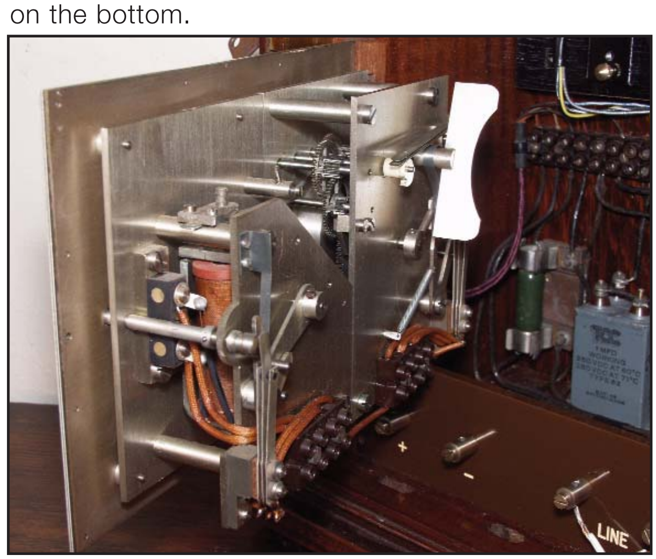


Figure 25, left. Mercer movement on top and the advance and retard control on the bottom.

Figure 26, below. Open panel showing Mercer movement on top and the advance and retard control on the bottom.



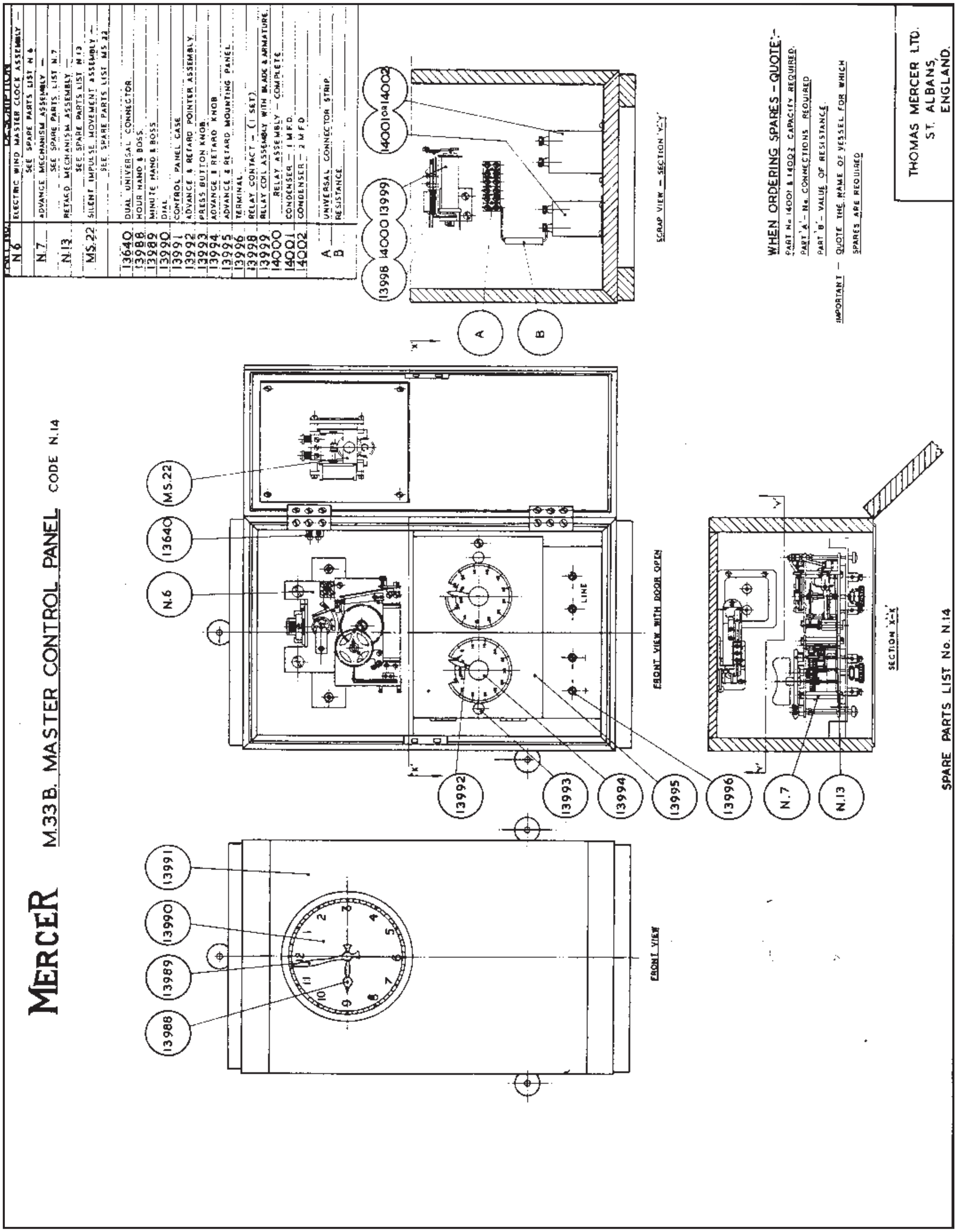


Figure 27. M33B control panel diagram.

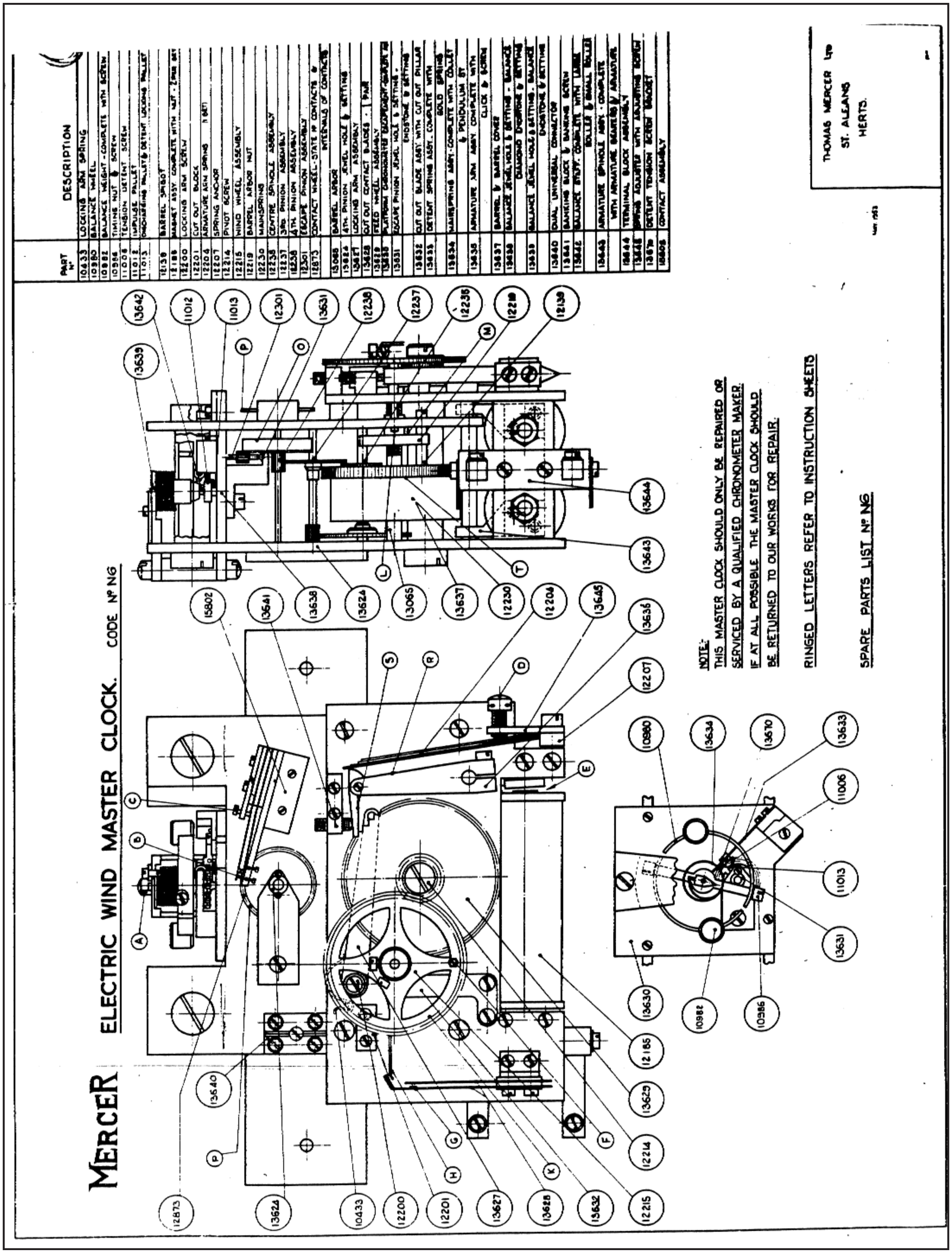


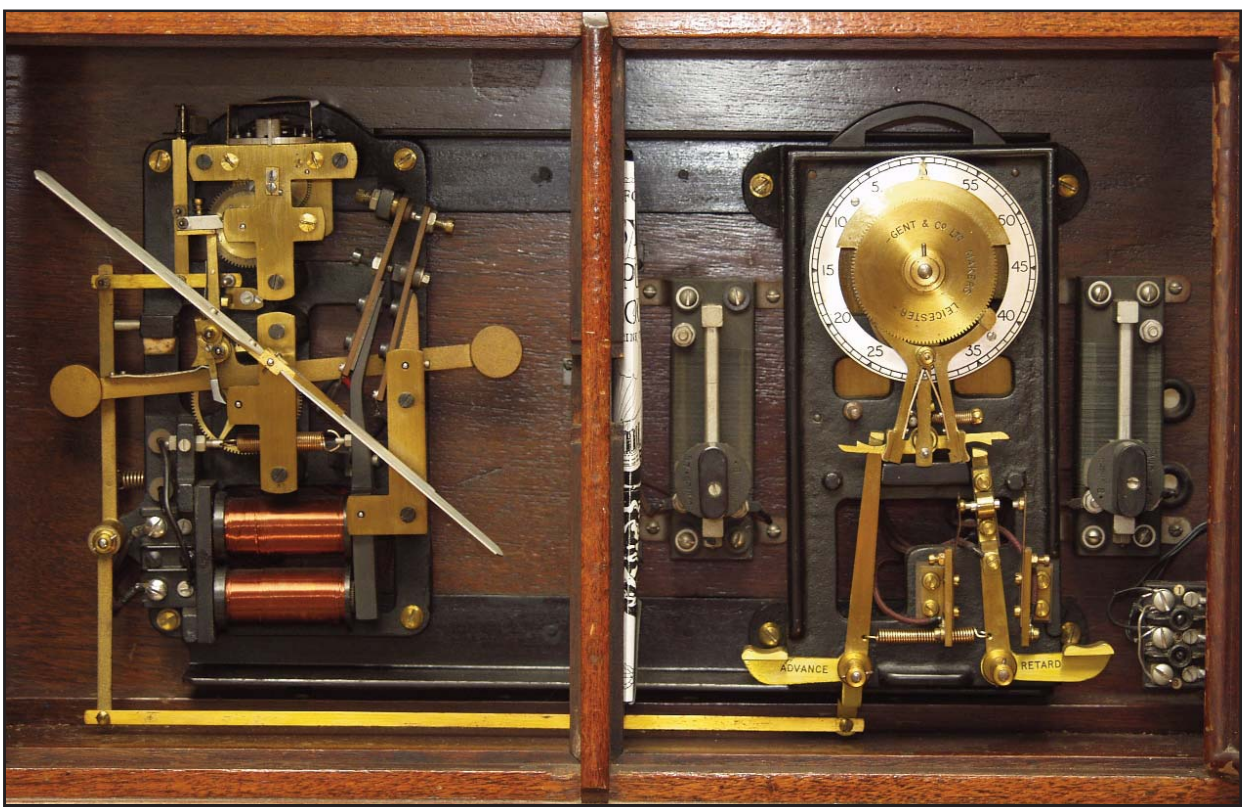
Figure 28. Electric wind master clock movement diagram.

THE GENTS PULSYNETIC MARINE MASTER CLOCK (Text continues on next page.)

Figure 29. Gents Pulsynetic marine master clock from the 1930s.

Figure 30. Gents moving model of ship crossing the ocean with ship position advanced by Pulsynetic system.

Figure 31. The 30-second gravity arm reset movement with platform escapement on left and advance retard mechanism on right (shown also in the case above in Figure 29).



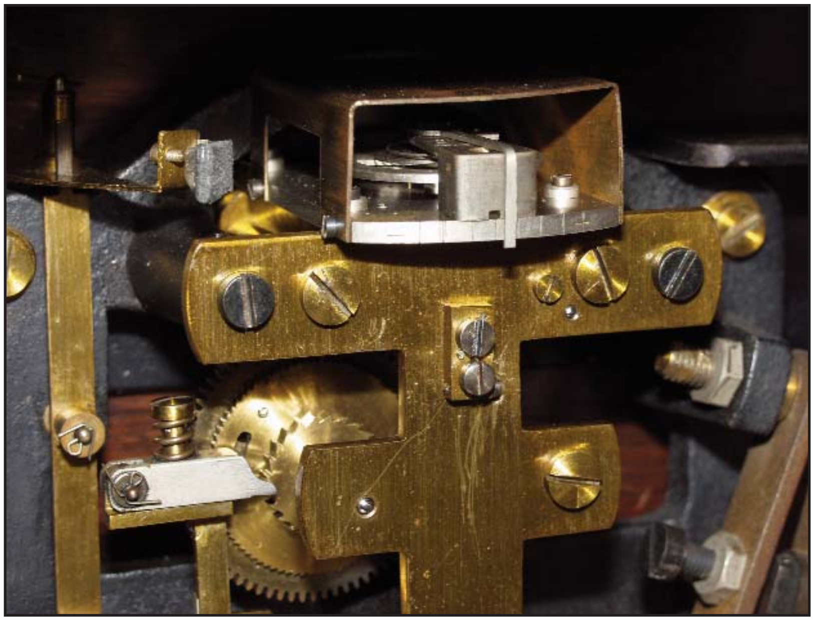


Figure 32. A close-up of the balance wheel escapement of the Pulsynetic movement shown in Figure 31.

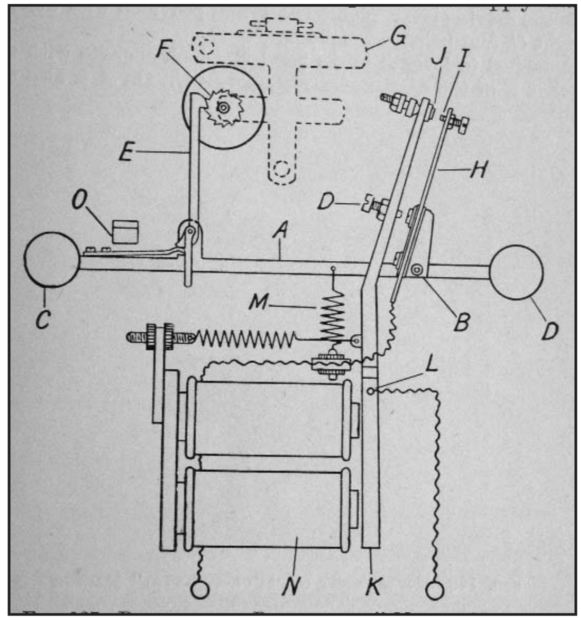


Figure 33. Diagram of gravity, ratchet and pawl weight driving unit for the escapement at left.

The Pulsynetic system has a beautifully designed mahogany case with beveled glass doors and a curved top. Most major ship installations included the Pulsynetic at sea ship location display, a world map with a ship moving across the board mechanically. See Figure 30. Some present-day transatlantic airlines offer this "you are here" display electronically. The concept is similar to both Synchronome and Mercer in that there is an automatic advance/retard operation; however, the clockwork driving force is very different. There is a 30-second timing and reset of the fall of a gravity arm, via ratchet wheel and pawl. There is a horizontal platform escapement with no jewels (a spare escapement is supplied with each new installation). The unit has a gravity arm not unlike the Gents Pulsynetic pendulum master clock with reset every half minute concurrent with the half minute impulse to the slave clocks. See Figure 29. The automatic retard countdown unit works minute by minute, and the upper slave dial monitors all ship's clocks. The rapid advance is interesting; when time is set and the advance lever pressed, the escapement is forcibly stopped by a felt finger against the balance wheel. At the same time a large fly wheel is connected to the gravity arm and the two to three second per minute advance is engaged. See Figures 32-33.

E. HOWARD CLOCK COMPANY

This well-known manufacturer had a well-respected share of the American market for pendulum master clocks and offered minute contacts on the seconds bit of their marine lever clocks. See Figure 34. Various E. Howard movements have been so fitted. Although E. Howard did not compete in the complicated transatlantic market, they did provide unique clocks for the "ferry boat" and perhaps coastal steamer operations. In San Francisco, prior to the 1939 opening of the San Francisco Oakland Bay Bridge, ferry service from all points around the Bay provided commuters their twice-daily sea voyage into downtown San Francisco. The Key System (electric interurban trains) contracted with Moore Shipbuilding and Drydock in 1926 to build two sister ships. The *Peralta* and the *Yerba Buena* each had an E. Howard electric wound 11-jewel high-quality platform escapement master clock in an oak case with see-through silver dial (Figure 35). These clocks put out a 24-volt, one-minute impulse to the slave clocks and were adjusted by disconnecting the circuit or pressing a rapid advance impulse. The *Peralta* burned in a ferry terminal fire in the 1930s, and correspondence from E. Howard confirms that the clock shown here was from the sister ship, *Yerba Buena*.

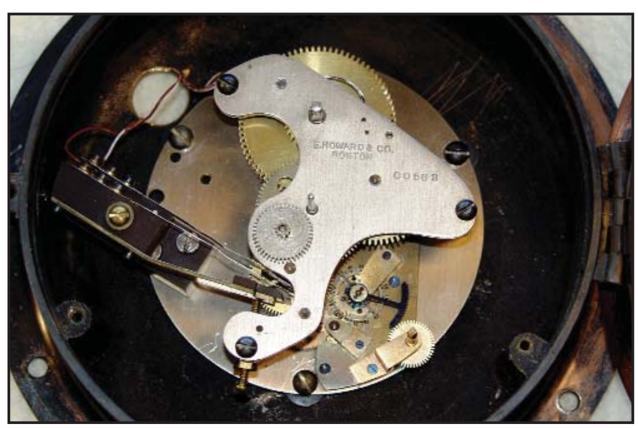


Figure 34, right. E. Howard 8-day Marine lever movement fitted with minute contact on seconds wheel.

FAVAGE, HARLANDIC, AND OTHER SYSTEMS

Many simple systems were available by the seconds bit contact method. There were other control clocks on ships such as the H. Hughes & Co. impulsing clock, which put out impulses at 1/2, 1, 2, 30, and 60 seconds, for the ship's chart recorder, depending on which chart/navigation system you were using. See Figures 38 and 39. Favage, a Swiss maker, had a metal case multi-movement and triple slave clock dial master clock. A British firm, Harlandic Clock Company, used a low AC hertz system with a balance wheel master clock as reference and in an ingenious interconnect so you could set your advance or retard for all clocks with both the speed faster/slower to complete the time change and then automatically cut back to normal time. See Figures 35, 36, and 37. The Inducta system, a modern version of the Magneta clock, also contributed to marine clock installations. The Self Winding Clock Co. of New York produced electric wound balance wheel escapement clocks that were used on ships, and the U.S. military had telechron clocks that could be time modified from master clock control.

In closing, from correspondence that I have had, it is not likely that there are many of these wonderful timepieces in existence today. Many ships were lost at sea,

Figure 35, right. An E. Howard master clock from the San Francisco Bay Key System ferry boat *Yerba Buena,* ca. 1920s.

Figure 36, far right. A close-up view of a 24-volt electric wind master movement with platform escapement; one contact is for ship slave clocks, and the other is to power wind coils.

Figure 38, left. H. Hughes and Son Navigational Chart impulsing master clock.

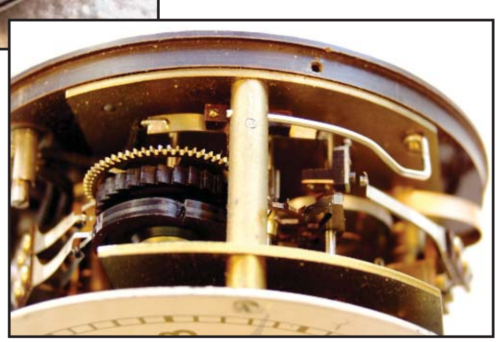
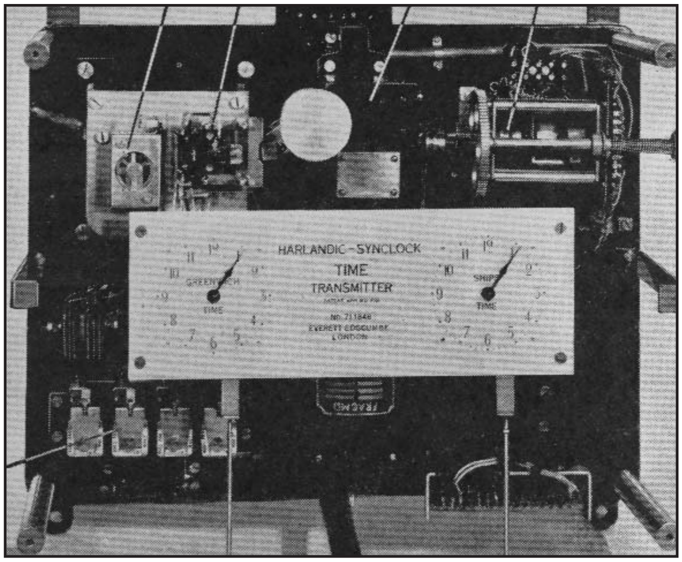
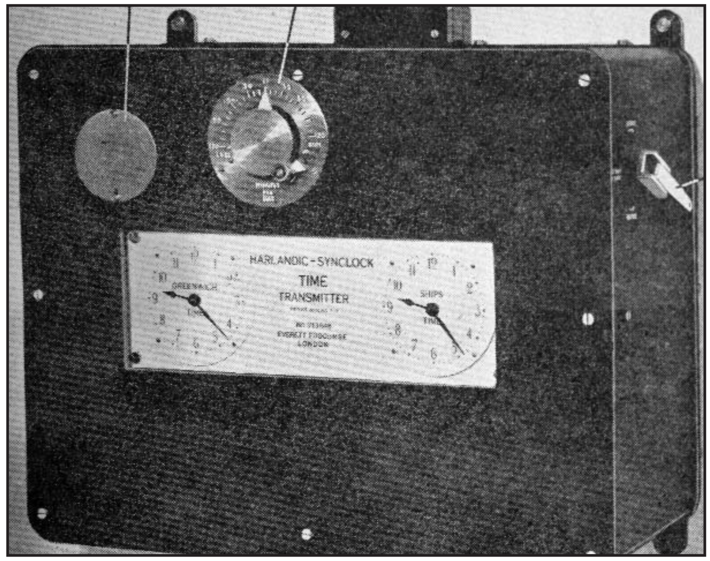


Figure 39, below. Close up of various duration contacts in the movement.

Figure 37. A Howard 10" brass case slave clock for marine application.





The Harlandic System for AC synchronous operation controlled clocks by changing frequency to a uniform rate of time increase or decrease through the voyage. **Figure 40, left.** Inside view. **Figure 41, right.** Front panel view.

and the cutting up of a ship for scrap did not preserve these clocks. Clock manufacturers list in their catalogs various ships and their owners, such as White Star, Cunard, etc. In total there may be ±250 ships with sophisticated clock control systems, dating prior to the 1950s. I often think about that far away coast in India where ships "like beached whales" come to die, perhaps there are a few early passenger ships that may yet offer their master clock to the same fate. I would very much enjoy corresponding with anyone interested in these clocks. My e-mail is ticktock2me@sbcglobal.net.

References

Bartkey, Ian R. *Selling the True Time: Nineteenth Century Timekeeping in America*. Stanford, CA: Stanford University Press, 2000.

"The Electrician." *British Trade Journal* (August 1911 and July 1911).

Elektrotechnik Zacharias, 1908.

Gent Pulsynetic Book 5, Section 3, 1930.

Gould, Rupert J. *The Marine Chronometer: Its History and Development.* London: Holland Press, 1960.

Guye & Bossart. *Horlogerie Electrique*, 2nd ed. 1957.

Hope-Jones, F. *Electrical Timekeeping*, 2nd ed. London: NAG Press, 1949.

Langman, H. R. *Electrical Horology.* London: Technical Press, 1946.

Magenta Clock Co. Catalogue, 1915.

Mercer, Tony. *Mercer Chronometers*: *History Maintenance and Repair.* Mayfield, Ashbourne, Derbyshire, England: Mayfield Books, 2003.

Philpott, Stuart F. *Modern Electric Clocks*, 3rd ed. London: Pittman, 1938.

Philpott, Stuart F. *Modern Electric Clocks*, 4th ed. London: Pittman, 1949.

Synchronome (Misc. sources and copies).

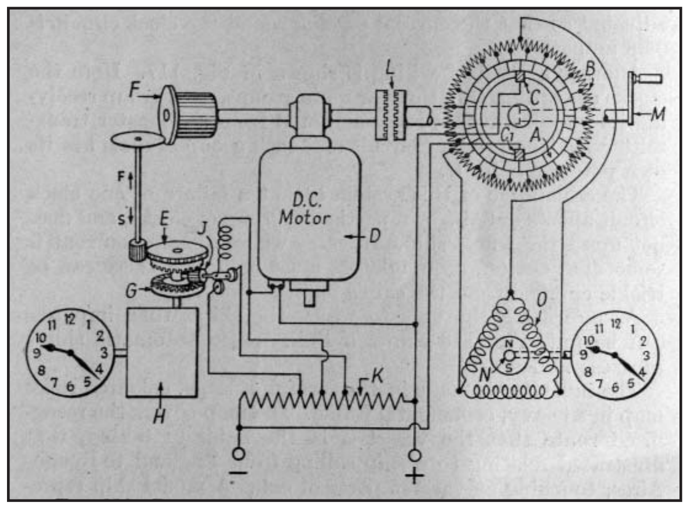


Figure 42. The Harlandic system operation diagram.

About the Author

Robert Simon is a graduate civil engineer who has worked in the railroad and rail transit industry for over 30 years. He has held project director and construction and maintenance positions at Boston & Maine Corporation, Amtrak, and BART (Bay Area Rapid Transit). He and his wife Lynn have been collecting clocks since 1976, when their mutual engagement present to each other was an early "Rochester" Bundy Manufacturing time recording clock! Robert has specific interest in industrial and commercial clocks, such as time recording, master and slave clock systems, bank time locks, watchmans' clocks, etc. Robert has lectured, with detailed slides, on the above at many NAWCC chapter meetings.