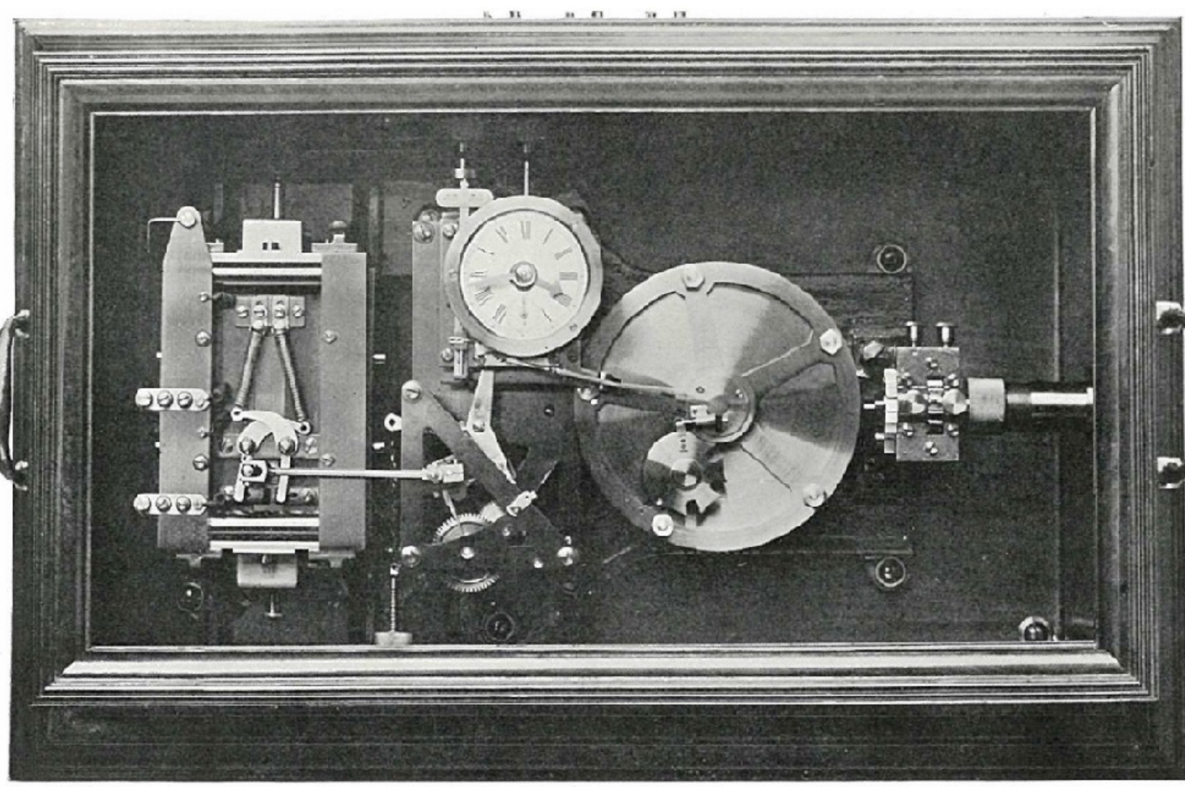
Titanic's Master of Time

(Second print date: 11/10/2019)

by Samuel Halpern

Marine clocks on board large passenger vessels in the early part of the twentieth century were almost always of the impulse type driven by a master clock having a balance-wheel escapement. It has long been known that *Titanic*, like her sister ship *Olympic*, was equipped with a large number of clocks supplied by the Magneta Company of Zurich, Switzerland, that were distributed throughout the vessel in many passenger and crew spaces. These clocks, 48 in number that we know about (See Appendix A), were controlled by two master clocks that were located in the chart room just behind the wheelhouse. Each master clock was capable of controlling 25 slave units in such a way that whenever the master clock advanced by one minute of time, the slave units that were connected to it would also advance by one minute of time, all in one synchronous operation.



MARINE MASTER CLOCK
Capable of driving 25 units
Size: 26″ x 17″ x 11″

The conditions which have to be fulfilled in marine clock installations in the early part of the twentieth century were quite different from those used on land. Any form of pendulum control was obviously not viable owing to the motion of a vessel, and the use of synchronous electric clocks for ship board use was not generally possible because the electricity supply was usually direct current (DC), which was useless for that class of clockwork.[1] In addition, since a ship's longitude changed from day to day, it became necessary to advance or retard the clocks on board daily so that at local

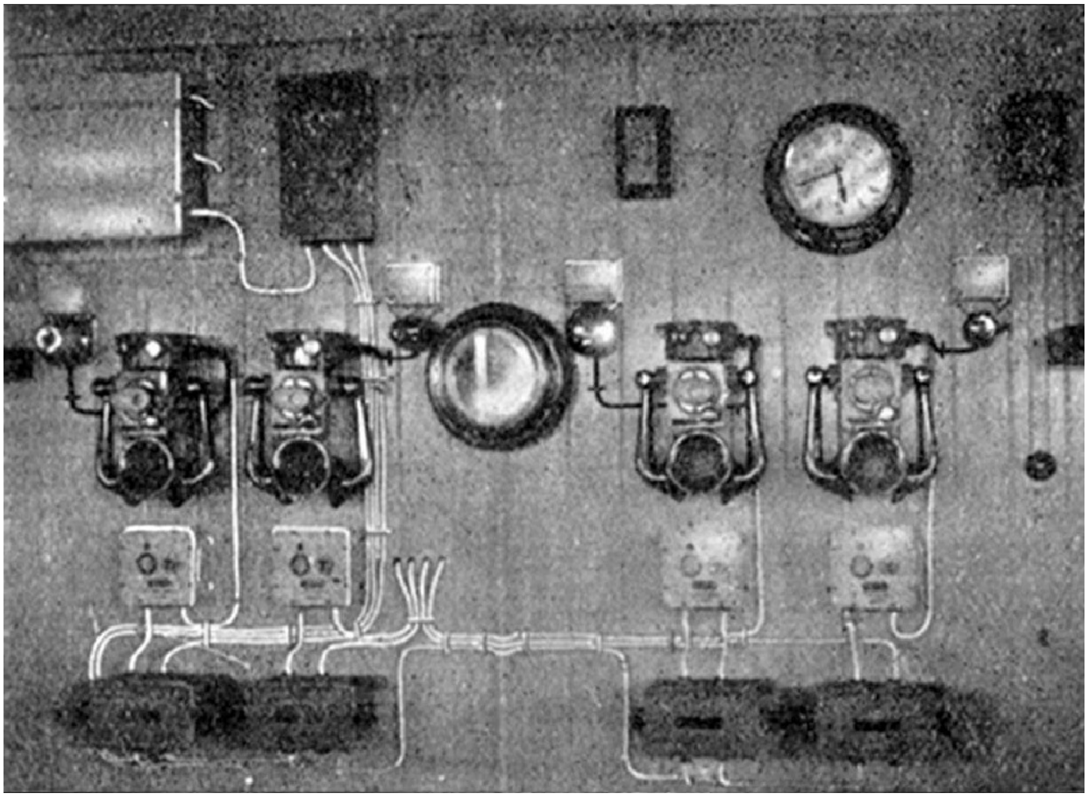
[1] Electrical power on *Olympic* and *Titanic* was supplied by a set of four 400-kilowatt steam-driven engines and dynamos having a collective output of 16,000 amperes of direct current at 100-volts.

apparent noon, when the sun reached its highest point in the sky, all clocks would show 12:00 noon Apparent Time Ship (ATS). What this meant was that when sailing eastward, the clocks on board needed to be put ahead; when sailing westward, they needed to be put back. These adjustments were usually done around midnight, each night, with a small correction done in the forenoon of the next day if it was deemed necessary.

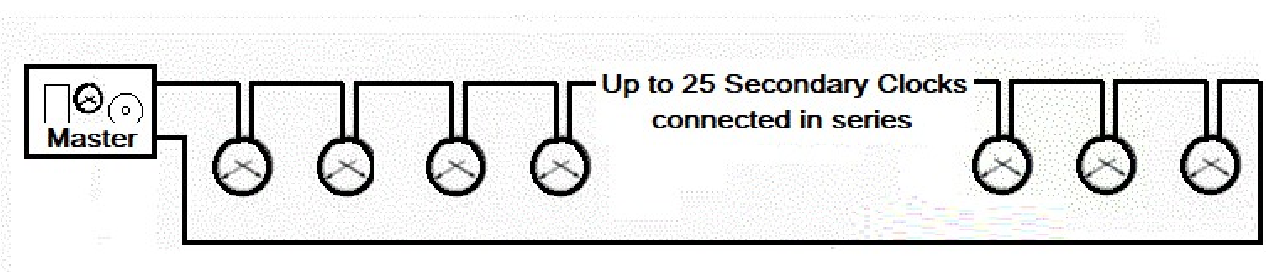
During the *Hawke-Olympic* collision trial in 1911, *Olympic*'s captain E. J. Smith was questioned extensively about the working of the Magneta clock system that was installed on board *Olympic*. The Magneta system was not new to Captain Smith, having come over from commanding the *Adriatic* before taking command of *Olympic* in 1911. The *Adriatic*, as well as *Lusitania*, *Muaritania* and a number of other vessels, were already equipped with Magneta clocks in the years prior to *Olympic* and *Titanic*. The following testimony by Captain Smith, who would later take command of *Titanic* on her maiden voyage, is extracted from the trial records:

> 462. Q. Where is the master clock?
> A. The master clock is kept in the chart room on the bridge. We have two. They have a large system in the ship, and they put in two to work the whole lot.
> 463. Q. Does the master clock show seconds of time as well as minutes? Perhaps that is not quite an intelligible question. Does the master clock, first of all, show seconds on the clock?
> A. May I explain?
> 464. Q. Yes?
> A. The system is the magneto-electric sort of thing. There is one master clock, which is an ordinary clock worked in the ordinary way. Then, when the minute hand comes to past the line of the minute, the effect is that the finger moves and that releases the contact, and the whole goes with a jump.
> 465. Q. Then the master clock does show the seconds as they proceed?
> A. Yes.
> 466. Q. Has it got a second-hand?
> A. Yes; but, of course, that is at least 40 feet inside the chart-room–inside the wheel-house–and 40 feet from the wheel [on the navigating bridge].
> 467. Q. Of course, the engineer's clock [in the engine room] would only show the minutes, as you say?
> A. That is all.
> 468. Q. What, in fact, was the clock by which the times on the bridge were recorded which, I think you said, the sixth officer kept? By which clock did he record the time?
> A. The wheel-house clock.
> 469. Q. Is that the master clock?
> A. No, the master clock is inside, in a case, in an enclosed waterproof case.
> 470. Q. It was not by that that he marked the time?
> A. No.
> 471. Q. He marked the time by another clock, which only showed the movements from minute to minute in one jerk?
> A. In one jerk.
> 472. Q. Are there, in fact any seconds marked on that clock?
> A. Not at all.
> 473. Q. All this means, I have got to ask a lot of questions to get a small fact in the case, which is, that when you put down 12.40 that may be 55 seconds out?
> A. Yes.
> 474. Q. Or 5 seconds out only?
> A. Yes.

Olympic's wheelhouse clock, which was a slave to one of the master clocks in the chart room, can be seen in the upper right-hand side in the photograph below. (The large dial about eye level that was located between the loud-speaking telephones was an aneroid barometer.)



Over the years there has been a lot of speculation and assumptions that have been made concerning how this system of Magneta clocks actually worked, and how time was adjusted during a voyage so that the time shown throughout the ship would be accurate. One of these misconceptions is that a slave clock would automatically locked up to show the same time that was shown on the master clock. That is not the way these slave clocks worked. The slave clock was an impulse driven device so that every time the master clock generated an electrical impulse, which was once per minute, the slave clock would also jump ahead by one minute. In order for a slave clock to show the same time as the master, it had to be showing the same time as the master and all other slaves clocks that were part of the same circuit when it was connected up. The slave clocks were part of what is called a closed-loop electrical circuit, all of them being connected in series with the master clock that was driving them. Once set to the same time as all the other slave units in a circuit, a slave clock would continue to show the same time as all other slave units as long as the electrical circuit remained intact, and continued to receive electrical impulses from the master.



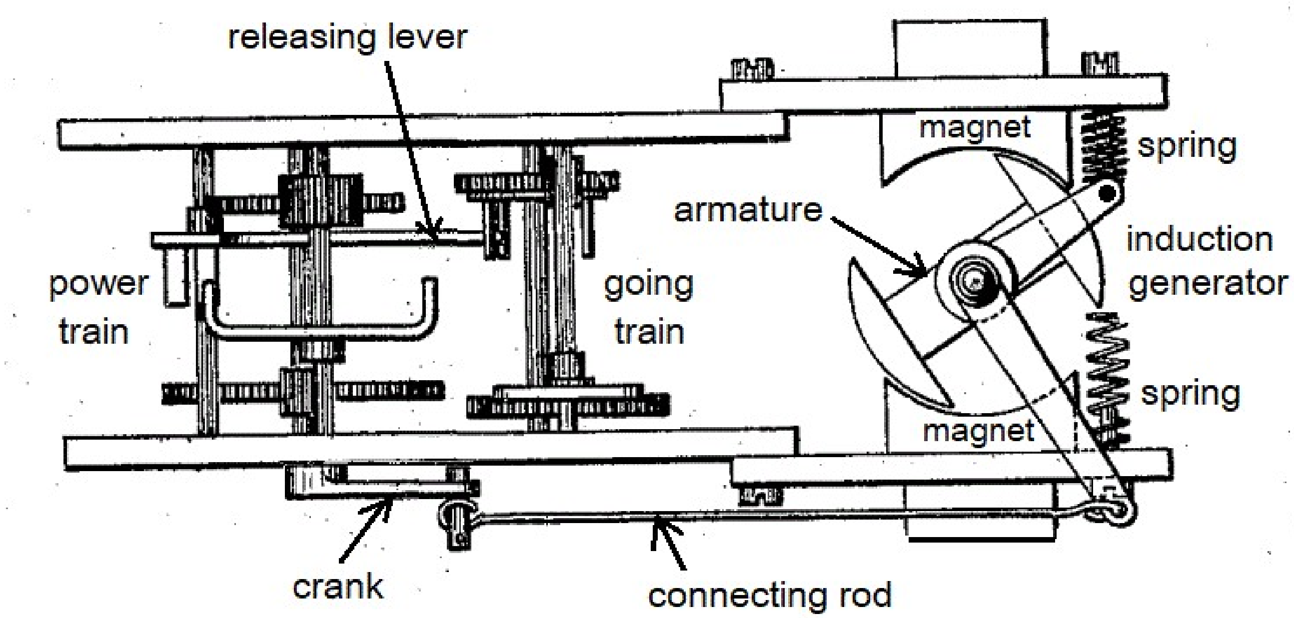
A single closed-loop system.

The other misconception regarding the operation of impulse-driven slave clocks has to do with reversal of movement. As we shall see, a slave clock cannot go backward. What that means is that whenever the master clock was put back in time, the slave clocks could not follow. The way the system was adjusted when setting the master clock back, as was done each night on a westbound crossing, was for the master unit to suspend the sending of electrical impulses to the slave units for the amount of time that the master clock was put back. On the other hand, to set the slave units ahead, as was done each night on a eastbound crossing, the master would be put ahead by the required number of minutes and the slave clocks would follow because the master unit would generate an impulse for each minute that it was manually advanced. The consequences of this operation will be examined later on.

The Magneta Master Clocks

The Magneta system was very popular in the UK, the Post Office using Magneta systems, as did several other large installations. The advantage of the Magneta system is that it was a magneto-operated system that generates its own electrical current impulse at one minute intervals, and was not dependent on any connected battery or other electrical power source. The electrical impulses that were generated by the master unit were sufficient to work a large number of slave units that were connected up in series. In addition, there were no electrical contacts that opened and closed, thereby making the system extremely reliable and almost maintenance free.

The basic principal of operation of a Magneta master clock is shown in the following diagram taken from the patent issued to Martin Fischer of Zurich, Switzerland in 1902:[2]



The diagram shows a section through a master clock. The releasing lever forms the connection between two trains of wheelwork, the ‘power’ train, and the so-called ‘going’ train. The ‘going train’ was worked off of the regular clockwork of the master, so that when the minute hand of the pilot dial of the master clock reached the next minute mark, the ‘releasing lever’ was released which allowed the crank on the ‘power train,’ which was driven by a spring or a weight, to make one-half of a revolution. This in turn, by way of the ‘connecting rod’ that was connected to an arm of the armature of the

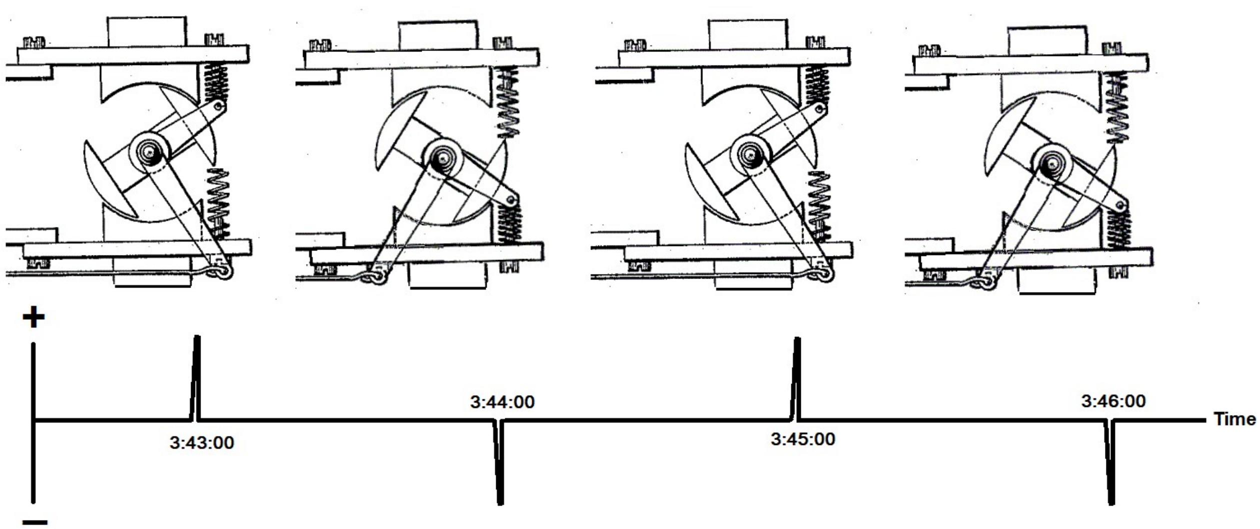
[2] US Patent Office, No. 692,509, issued February 4, 1902. Further details concerning the operation of the gears and levers and inter-working between the power train and going train can be found in US Patent Office, No. 806,332, filed July 5, 1900, and issued December 5, 1905.

device, caused the armature to rotate about 90 degrees, thereby compressing one of the springs as shown, which conserved some of the energy of rotation and reduced mechanical shock.

At the next minute of time, the ‘releasing lever’ was released again by the ‘going train’ allowing the crank on the ‘power train’ to make another half revolution, this time back to the position where it had started from. This half revolution caused the ‘connecting rod’ to again act on the arm of the armature, but this time causing it to rotate about 90° degrees in the opposite direction, and causing the other spring to be compressed. In this way we see that the armature went through an oscillating motion, first a rapid partial rotation one way the first minute, and then a rapid partial rotation the other way the next minute, and so on.

The armature of this induction generator was nothing more than a wire coil rapped around an iron core in which a voltage is induced across the coil by its movement through a magnetic field that was set up by a large permanent magnet. It was based on the Faraday principal which states that the induced electrical voltage in a coil of wire moving through a magnetic field is directly proportional to the rate of change of the magnetic lines of force that cuts across the coil. Thus, every minute, a pulse of electricity was induced in the coil by way of its rapid motion across the field lines of a permanent magnet which was completely enclosed in iron. One minute a voltage was induced in one direction, while at the next minute, a voltage was induced in the opposite direction. This set up a series of alternating current impulses separated by one-minute intervals that were then used to drive a set of slave units that were connected up in series with the wire coil in the master.

This electromagnetic inductor was highly efficient, producing alternating impulses that lasted from 0.1 to 0.2 seconds in duration every minute. The diagram below shows the alternating movement of the induction generator over a period of 4 minutes along with the corresponding induced train of electrical impulses that were generated across the coil.

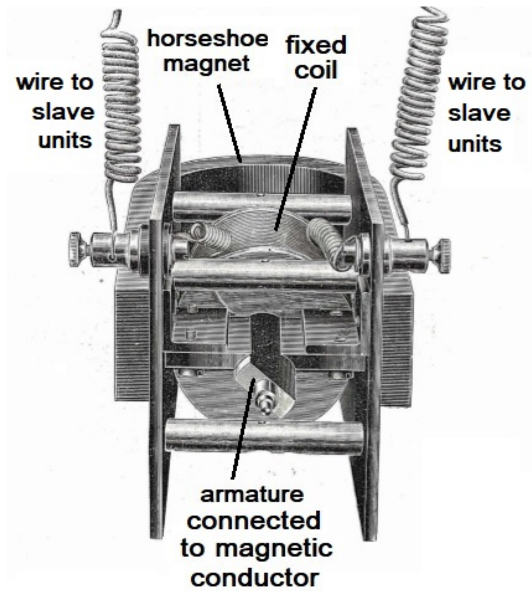


Several improvements to the basic design of the master unit have taken place over years since it was first invented.[3] Included was an induction generator in which the induction coil as well as the permanent magnetic were both stationary, while a moveable magnetic conductor, or pole changer as it was also called, was inserted in the core of the coil. This magnetic conductor was capable of oscillating in the magnetic field that was set up by the permanent magnet. It was made of soft iron, and shaped and placed in such a way within the core of the coil, that a rotation of its position produced a reversal of magnetic polarity through the stationary coil, and thereby caused a change in the direction of the

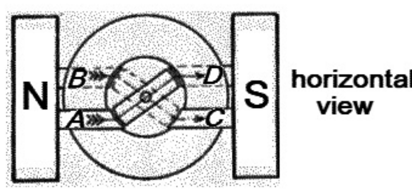
[3] US Patent Office, No. 880,485, issued February 25, 1908; and US Patent Office, No. 894,944, issued August 04, 1908.

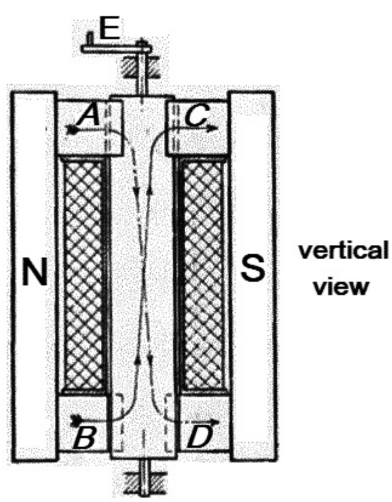
magnetic lines of force that passed through the fixed coil. The result of a rapid rotation of the position of this magnetic conductor was to induce an electrical voltage impulse across the fixed wire coil.

One such Magneta induction generator, similar in operation to those used in the Magneta marine master clock, is shown below.



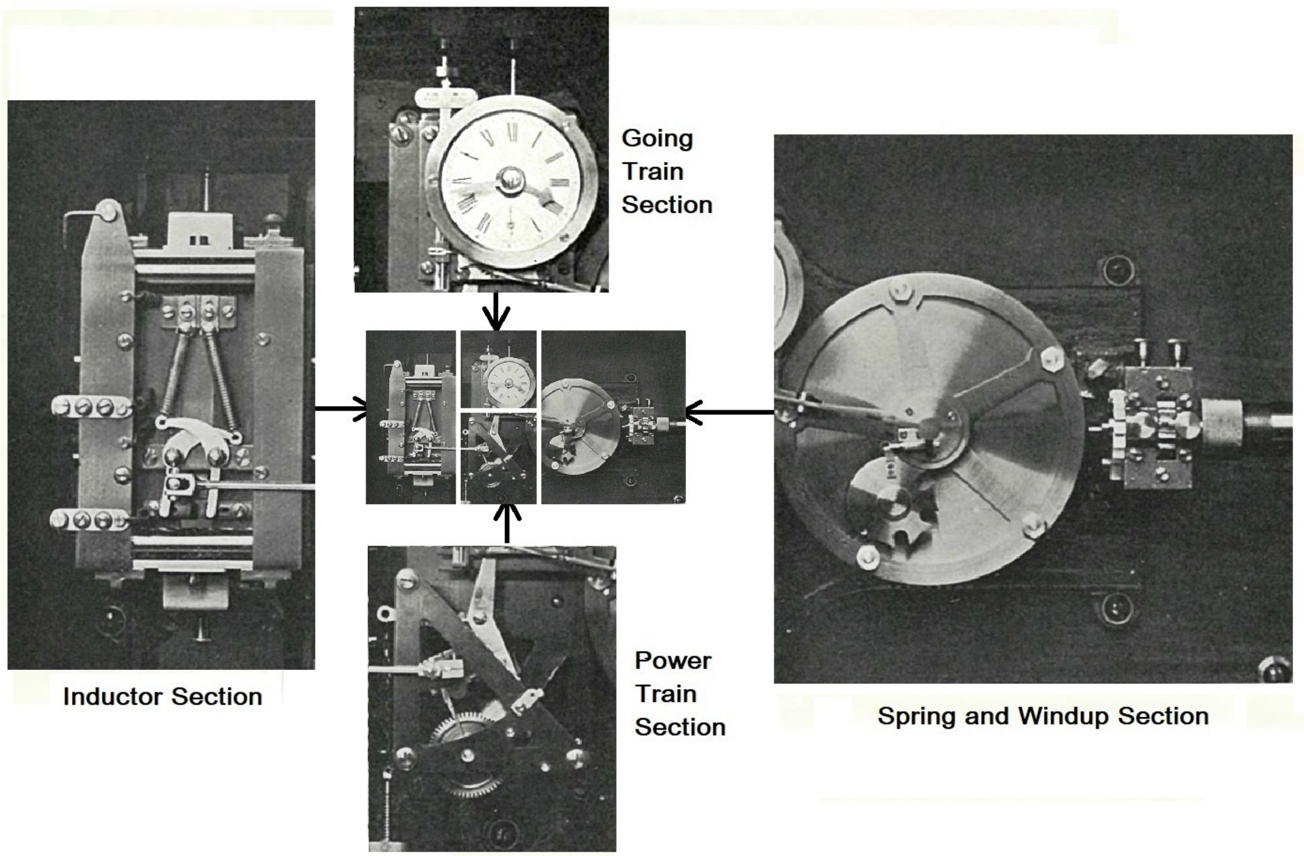
The operation of this inductor is best understood by reference to the diagram below which shows the inductor in two sectional views.





Once every minute the armature is given a rapid throw by the crank E, and taking up the position shown in the horizontal view by the solid lines one minute, and the position indicated by the dotted lines the next minute. A, B, C and D are pole shoes that are connected to pole extensions of the permanent horseshoe magnet. One minute the magnetic field lines run from pole shoe A to pole shoe D; the next minute they run from pole shoe B to pole shoe C as shown in the two views above. With each change of the armature position, an electrical impulse is induced in the fixed coil sending an electrical current impulse into the closed electrical circuit containing the slave clocks that were hooked up in series.

The Magneta Marine Master Clock contained all the necessary modifications required for shipboard conditions. The following diagram shows a close-up of the four principal sections that make up this particular master clock.



A strong tension spring, which was wound up by hand every day, served both to operate the master clock's going train, as well as the power train movement that worked the armature, which, by a revolving shaft with crank around its longitudinal axis, was moved back and forth several degrees in the inductor section. To avoid hard impacts and to store some of the energy of movement, the shaft of the armature carried two levers with coil springs, which were alternately tensioned during the oscillations. These are quite noticeable in the inductor section view above.

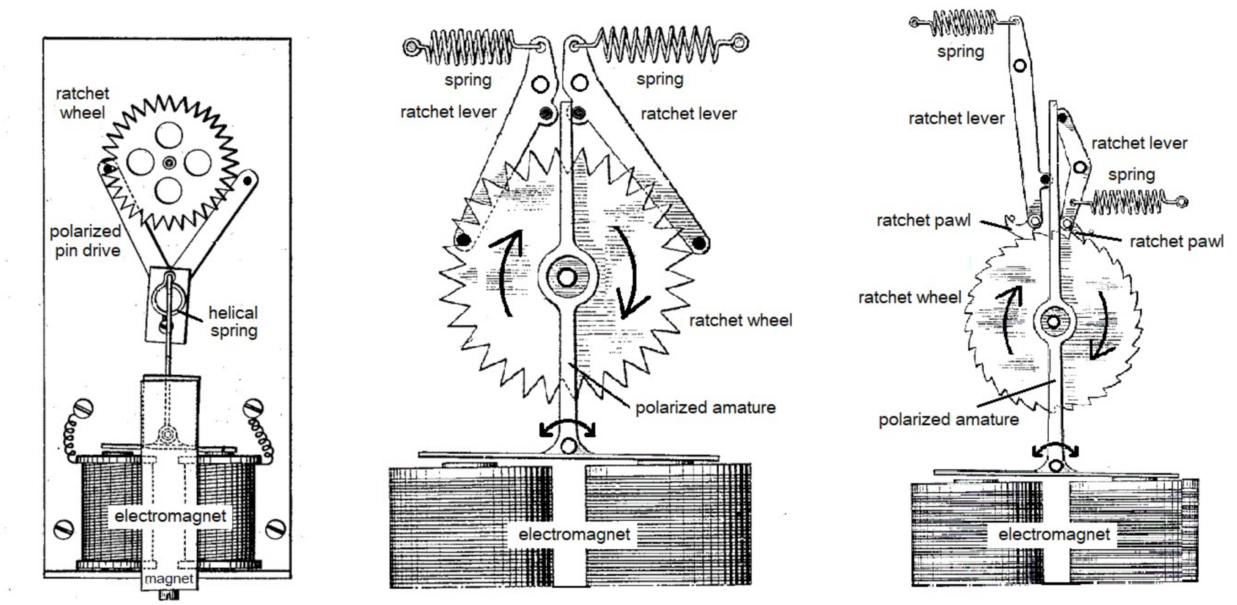
The going section had a balanced escapement within its clockwork that was similar to that used in marine chronometers. Unlike the slave units, the pilot dial of the master unit (about 2½ inches in diameter) had hour, minute and second hands as shown in the going train section above. The power train section had all the various levers and gears need to work the induction generator in the inductor section once per minute, or more often when the time on the clock was being put ahead. The power train mechanism could also be halted for a set amount of time when the time on the pilot dial was put back. The power train was connected to the inductor section via the horizontal connecting rod that can be plainly seen above, as can the releasing lever which formed part of the connection between the power train and the going train located above it.

The Magneta Type M Marine Master clock, as fitted on *Olympic* and *Titanic*, had a working period of 36 hours when fully wound. However, on White Star Line vessels, the two master clocks were actually wound every day at around 8 a.m. as were the ship's two chronometers.[4] These Magneta master clocks also had a mechanism to stop the balance-wheel escapement from running should the main windup spring happen to inadvertently wind down, thus ensuring that the time shown on the master and slave dials would remain the same.[5] The Magneta Type M master clock was capable of driving up to about 25 slave units,[6] and the system was adjusted around midnight each night by a junior officer under the command of the Officer of the Watch (OOW), in this case the ship's First Officer, who was on duty at that time in accordance with White Star Line rules and procedures.[7]

The Magneta Slave Clocks

The Magneta slave clocks were impulse driven units that had a dial mechanism that was polarized to take care of the alternating positive and negative current impulses that came from the master unit. What that meant is that these slave units would advance by one minute of time every time a current impulse was sent out from the induction generator in the master.

Over the years there have been several advancements to the workings of these slave clocks, but the basic principal of their operation had not changed. The following diagram shows the various working mechanisms of several Magneta slave clock designs.[8]



1902 1907 - 1 1907 - 2

---

[4] IMM Rule 303. - Winding Chronometers: Unless the Commander otherwise decides, he [the First Officer] will wind and compare chronometers at 8 a.m. each day, and keep a Chronometer Comparison Book. He will also see that the [ship's] clock's are wound.

[5] Zacharias J., *Elektrotechniek für Uhrmacher*, 1908, p. 137.

[6] The capacity of the master was specified by the number of slave *units* that it could control. Only slave clocks of 12 inches in diameter or less were rated as 1 unit devices. Larger sized slave clocks were rated at 3 or more units, depending on the actual size of the dial.

[7] IMM Rule 259. The responsibility to see to it that the clocks were adjusted each night so that they would show 12:00 at noon the next day was assigned to the Officer of the Watch (OOW). Since the OOW could not leave the bridge at night, the job of performing the clock adjustments was given to one of the junior officers who was on duty at the time. At midnight, the OOW on board *Titanic* was First Officer William Murdoch, who was on duty from 10 p.m. to 2 a.m.

[8] US Patent Office, No. 716,996, issued December 30, 1902; and US Patent Office, No. 844,010, issued February 12, 1907.

The following description of a Magneta slave clock that followed the principle behind the 1902 patent design was taken from a Magneta Company brochure of the period.

THE MAGNETA COMPANY 11

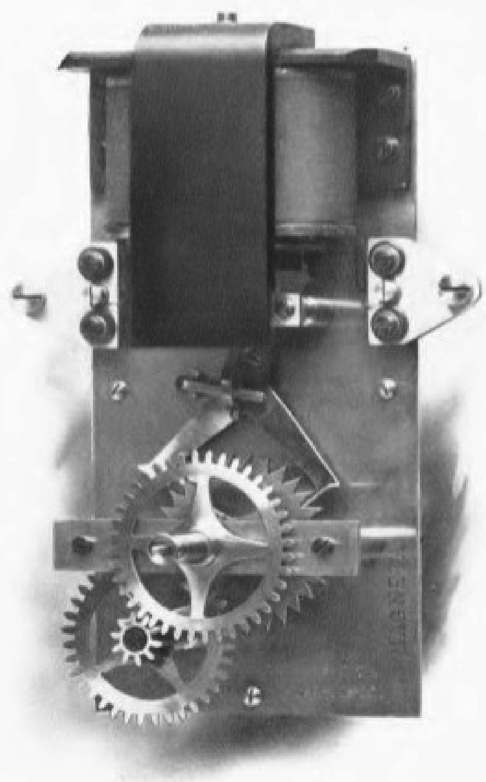
SECONDARY CLOCKS

DESCRIPTION

The Secondary-clocks all have standard "Magneta" electrical movements, white enameled dials, balanced hands, stout glass fronts, and either wooden, metal or bronze cases, of any *dial diameter desired* (dials see General Catalogue.) Glass covers over the dials of the Secondary-clocks are very essential, as these prevent the dust from getting into the movements; they also prevent interference with the hands while the clocks are being cleaned, etc. All of the clocks made by this Company, even to the largest for use in railroad depots, etc., have glass covers.

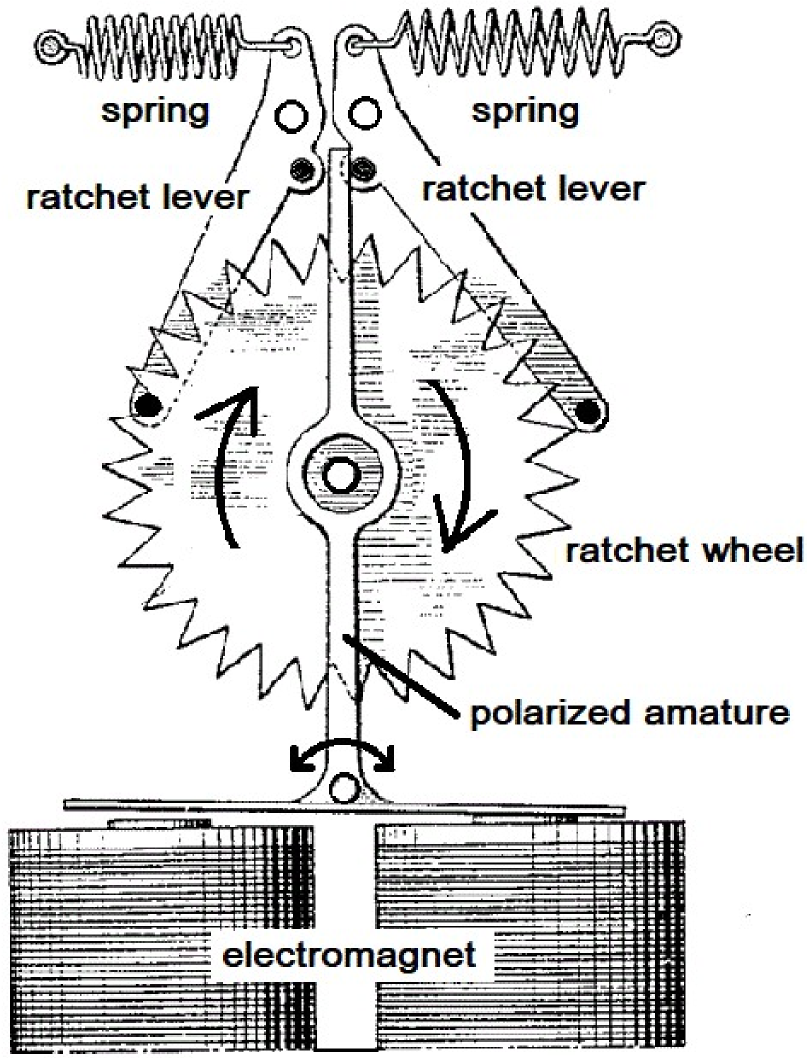
OPERATION OF SECONDARY-CLOCKS

The operation of the Secondary-clock mechanism is very simple; the current generated by the Master-clock is alternating; alternating every minute on account of the armature in the Master-clock making a semi-rotation the first minute in one direction and the following minute in the opposite direction. The importance of this method of operation cannot be over-estimated; it prevents the cores in the coils from becoming magnetic, as the reversing current, naturally, reverses the polarity. This cannot be said of battery-clocks, which, in time, are bound to become permanently magnetic;—one of their fundamental faults.



"Magneta" Secondary-clock Movement

To fully understand how these Magneta slave clocks worked, let us take a closer look at one of the enhanced designs shown below from a patent issued to Martin Fischer of the Magneta Company on February 12, 1907 (US Patent Office, No. 844,010).

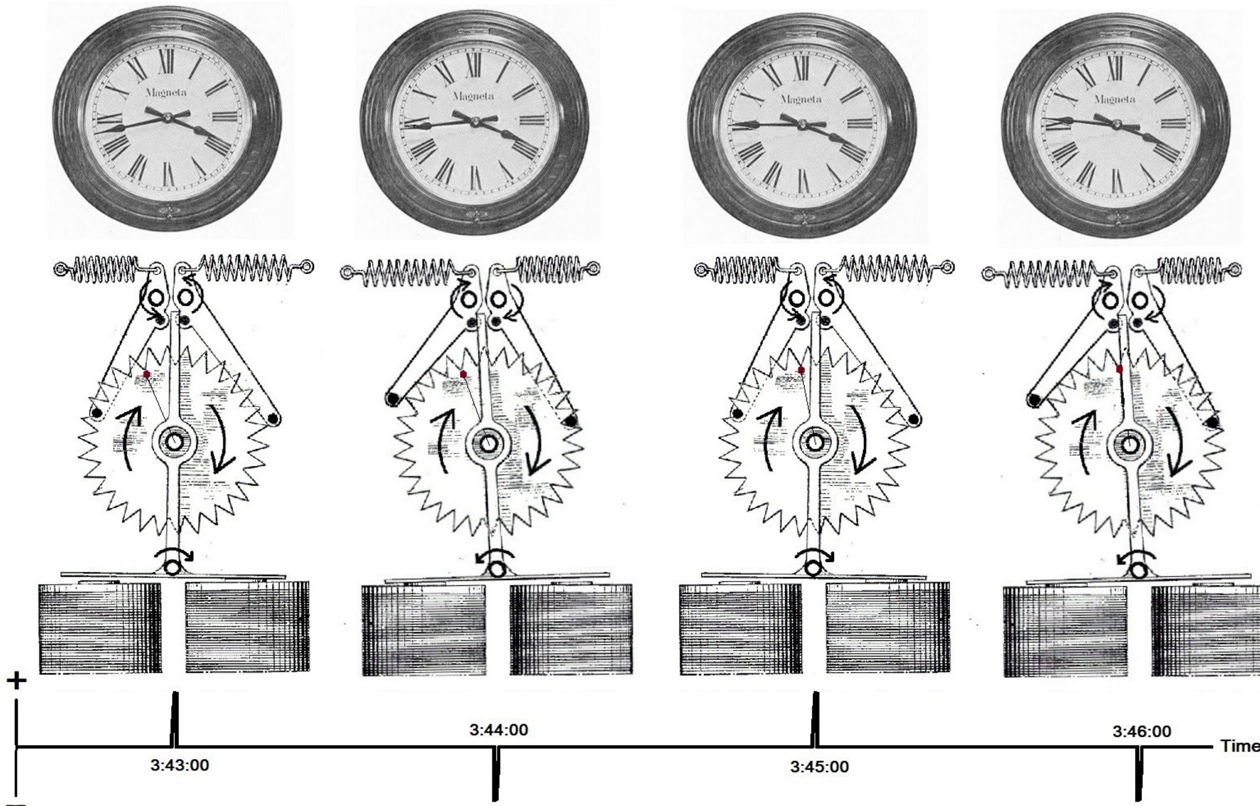


1907 - 1

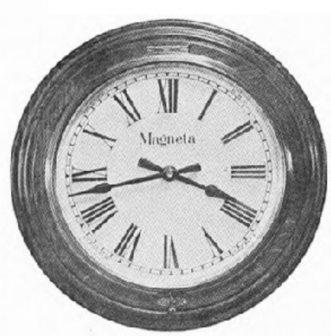
This design uses two separate ratchet levers to engage with the teeth of a 30-tooth ratchet-wheel by pressure from two separate springs. By means of a polarized armature, one of these ratchet levers (shown on the right side in the above diagram) is caused to move out of engagement with the teeth of the ratchet-wheel in opposition to its spring, while at the same time the other ratchet lever (shown on the left side in the above diagram) is caused by its spring to engage with the teeth of the ratchet-wheel thereby causing the wheel to rotate 1/60th a revolution (half-a-tooth movement) in the direction shown. This ratchet-wheel is directly connected to the minute hand of the clock, thus causing the minute hand to advance by one minute on the face of the dial.

The alternating movement of the polarized armature is controlled by the electromagnet which receives alternating current impulses from the induction generator in the master clock once per minute. Thus, the polarized armature alternates its position once each minute as the electromagnet alternates its polarity each minute when it receives another electrical current impulse from the master.

The following diagram shows the operation of this slave clock over a period of 4 minutes. Also shown in this diagram is the corresponding train of electrical impulses coming from the master unit, as well as the time shown on the dial of the slave clock after receiving each electrical impulse.



Magneta slave clocks came in various shapes, sizes and designs. A sample of just a few of these taken from Magneta Company brochures of the period are shown below.

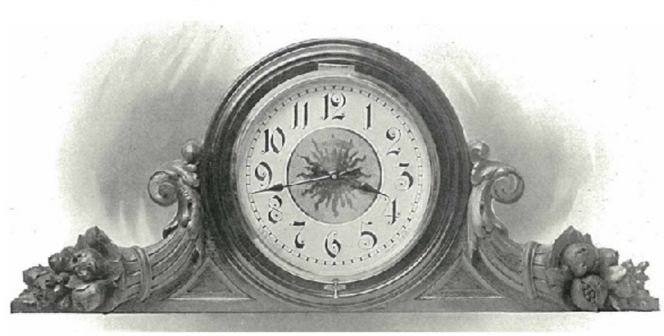


Standard Magneta Circular Slave Clock in Wooden Case

Waterproof Magneta Circular Slave Clock in Metal Case


Magneta Circular Slave Clock in Bronze Case

Magneta Secondary Slave Clock in Hand-Carved Frame


Magneta Secondary Slave Clock in Carved Frame

All Magneta slave clocks on board *Titanic* were driven in the manner described above by receiving alternating electrical current impulses once each minute from a master clock in the ship's chart room. With 48 slave clocks and two master clocks on board, it appears that each master clock ran a closed series loop containing about half of the ship's slave clocks located in different parts of the vessel. All of these 48 slave clocks were unidirectional in their movement, being put ahead by one minute of time every time an alternating current impulse was transmitted by the master through the closed circuit that it was part of.

This now brings us to the important question of just how were these clocks on board adjusted as the ocean going vessel sailed eastward or westward.

Setting the Hands of Time

Each night the clocks on board an ocean going vessel would be adjusted so when the vessel reached local apparent noon (LAN) the next day, the time when the sun reached its highest point in the sky, all the clocks on board would show 12:00. For a vessel going westward, the clocks had to be put back each night; for a vessel going eastward, they had to be put ahead each night. The amount of adjustment depended on the longitude that the ship was expected to make when it reached LAN the next day.

When the master clock was put back, the pilot dial of the going train in the master would be put back to any extent provided it was less than about one hour. During that time period no impulses were generated by the master clock. The effect of this was to hold the time on the slave clocks to that which was showing on the master dial just before it was put back. The slave clocks then had to await for the return of the minute hand of the master clock to the position from which it was moved back before the slave units were switched back in.[9]

When the master clock was set ahead, a link was operated so that the minute hand could be manually advanced in relatively quick steps, thus advancing all the clocks in the system at the same time by the number of minutes that the master was put ahead.

For example, let us see how adjustments to the master would have been applied to *Titanic* on the night of April 14th 1912. That night clocks were supposed to be put back by a total of 47 minutes. This was determined some time in the afternoon by calculating where the ship was expected to be when it reached local apparent noon the next day, Monday, the 15th of April. The adjustment of the clocks was to be implemented by splitting the total adjustment time of 47 minutes into two nearly equal periods of 23 and 24 minutes.[10] The first adjustment of 23 minutes was to take place just before midnight thereby extending the time of those who worked the 8 p.m. to Midnight watch, the so called First Watch, from their usual 4 hours, to 4 hours and 23 minutes. At the end of that time period, eight bells would be struck, and the watch on deck would be relieved by the watch below.

The striking of eight bells would not only have signaled the end of the First Watch, but also the end of Sunday, April 14th 1912.[11] The logbook page for April 14th would have then been closed, and a new logbook page for Monday, April 15th would have been started. The second clock adjustment of 24 minutes would then take place during the first half-hour following the change of watch thereby extending the time of those who worked the Midnight to 4 a.m. watch, the so called Middle Watch,

---

[9] According to horologist Frank Hope-Jones, a differential gear mechanism was customarily used within master clocks of the period for the purpose of setting it backward so as to delay the generation of impulses to the slave units until the pilot dial of the master returned to the position from which it was first moved. (F. Hope-Jones, *Electrical Timekeeping*, p. 251.)

[10] American Inquiry, p. 451. Since the slave clocks only showed whole minutes of time, and worked in one-minute jumps, a total adjustment time such as 47 minutes, had to be split into two periods, each containing a whole number of minutes. Thus 47 minutes was split into periods of 23 and 24 minutes, respectively. If the total setback would have been 48 minutes, then the split would have been in two precisely equal periods, each containing 24 minutes.

[11] On December 31st sixteen bells would be struck, to signal not only the end of the First Watch, but also the official end of the calendar year on board a vessel.

from their usual 4 hours, to 4 hours and 24 minutes.

So what would have been seen on *Titanic* had an encounter with an iceberg not taken place that Sunday night around 11:40 p.m.?

Somewhere close to midnight during the last half-hour of April 14th 1912, say at 11:58 p.m., ten minutes before the watch below was to be given notice that they were due on deck in 15 minute's time, a junior officer (either Fourth Officer Joseph Boxhall or Sixth Officer James Moody) would have gone into the chartroom to set the master clocks back by 23 minutes, the first of two adjustments scheduled to take place that night. Time on the master clock would be put back in this example from 11:58 to 11:35, while the slave clocks throughout the ship would show 11:58. For the next 23 minutes, the slave clocks would remain at 11:58 while the master clock, which was put back to 11:35, would move ahead until it reached 11:58 once again. At the next minute of time, the slave units would start to jump ahead again in sync with the master.

When the entire lot reached 12:00, the standby quartermaster, Alfred Olliver, would strike eight bells on the small bell at the fore end of the navigating bridge. This would be answered immediately by one of the lookouts up in the crow's nest who would strike eight bells in response on the large bell that was located up there, thereby marking not only the end of the First Watch and the close of April 14th on *Titanic*, but also the start of the Middle Watch and the beginning of April 15th on *Titanic*. With the striking of bells in the nest would come the call of, "All's well and lights burning brightly," which would indicate to the Officer of the Watch on the bridge, in this case William Murdoch, that the navigation lights were in working order and that the lookouts in the nest were awake and alert.[12]

Sometime later, after the new watch came on deck, but before the first half-hour of the new day was up, one of the junior officers of the Middle Watch (either Third Officer Herbert Pitman or Fifth Officer Harold Lowe) would go into the chartroom to complete the second clock adjustment, putting the master clocks back by the remaining 24 minutes. Now, for the next 24 minutes, all the slave units would show the time that was on the master clock when it was put back for the second time, waiting for the master clock to return to that time. Thereafter, the slave units would start to move ahead again in sync with the master. When all clocks showed 12:30, the new standby quartermaster, in this case Walter Wynn, would strike one bell on the navigating bridge which would be answered immediately by one of the two new lookouts in the crow's nest, Alfred Evans or George Hogg, striking one bell on the large bell up there and calling out the usual, "All's well and lights burning brightly," thereby indicating the end of the first 'half-hour' of the Middle Watch.[13]

The first of these two clock adjustments was performed around the time when all remaining public spaces that were still open to passengers, such as the smoking rooms, were about to close. Passengers who were still in these rooms would be asked to leave, and the lights in those rooms would be shut off at about the time that the clocks were put back. In the case of first class passenger A. H. Barkworth, a Justice of the Piece from East Yorkshire, he was up late in the first-class smoking room on the night of April 14th conversing with two acquaintances that he met on board *Titanic*:

> "I was discussing in the smoking room with them late on Sunday night the science of good road building in which I am keenly interested. I was going down, but somebody

---

[12] IMM Rule 254 required the lookouts in the crow's nest to answer bells every half hour and to call out the status of the ship's running lights at night.

[13] Generally, excluding the so called dog watches, bells were struck every half-hour beginning with one bell being struck at the end of the first half-hour of a four-hour watch, and ending with 8 bells being struck at the end of the 8th half-hour of a four-hour watch. Because of the midnight clock change, the time period from 7 bells to 8 bells during the First Watch on a westbound ship would be greater than 30 minutes by about half the full adjustment amount, while the time from 8 bells to 1 bell during the Middle Watch would also be greater than 30 minutes by about half the full adjustment amount. In the case of *Titanic* on the night of April 14th 1912, the interval from 7 bells (11:30 p.m.) to 8 bells (Midnight) during the First Watch was to be 53 minutes long, while the interval from 8 bells (Midnight) to 1 bell (12:30 a.m.) during the Middle Watch was to be 54 minutes long. That clock adjustments were done in this manner is further supported by logbook entries from several White Star Line vessels during WW1, including *Celtic*, *Teutonic* and *Laurentic*.

said they were going to set back the clock at midnight, and I stayed on as I wanted to set my watch. When the crash came somebody said we had hit an iceberg, but I didn't see it."

What Barkworth did not know, and apparently was not told, was that the clock in the smoking room did not actually go backward when the master clock in the chart room was put back. It would have remained fixed showing the time that the master clock was first put back, and he would have been asked to leave the room well before all the slave clocks on the same circuit would be back in sync with the time on the master. Of course he easily could have set his personal timepiece to the correct ship's time before retiring by taking the time off the clock in the smoking room, or any other public place where a slave clock was in sight, well before any clock adjustment was to take place that night. This is because the total amount of the night's planned time alteration, in this case 47 minutes, was posted in a number of conspicuous places throughout the vessel. However, on the night of April 14th 1912, 11:40 p.m. came almost twenty minutes before the clocks were to be altered, and after that, Mr. Barkworth and everyone else had other things to worry about.

There are some *Titanic* enthusiasts who try to present an argument that the first of these two planned clock adjustments had already taken place sometime before the accident happened that night, and that 11:40 p.m., as seen on clocks at that time, was in partially adjusted hours. They base their supposition on statements made by a few crew members who gave the impression that they were due to go on watch soon after the accident occurred. Upon close examination of all the evidence, it becomes very clear that a great deal of confusion took place right after the ship struck the iceberg. For most of the members of the deck crew, most of whom did not carry a personal timepiece, the only means of telling time was through the system of ship's bells or by looking at some windup clock that someone may have had in their quarters. The only known slave clock in the entire forecastle, where most of the deck crew, firemen, trimmers and greasers lived when not on duty, was in the crew's galley down on C deck where meals for the crew were prepared (see Appendix A). Thus, for many of the crew who were awakened by the impact, and even for those who were on watch when the accident occurred, the time of the accident was found out mostly by word of mouth sometime afterward.

However, for some crew members who were awake and on duty at the time of the accident, the exact time of the accident was readily available. Take for example Quartermaster Robert Hichens. Hichens was doing his trick at the wheel in the wheelhouse when the accident took place, in easy view of the wheelhouse clock that was located on the wall right behind him. As he stated in evidence:

"All went along very well until 20 minutes to 12, when three gongs came from the lookout, and immediately afterwards a report on the telephone, 'Iceberg right ahead.'"

Hichens was also asked how long he had been at the wheel before the ship struck the iceberg. His reply was, "One hour and forty minutes, sir."[14]

Robert Hichens came on duty at 8 p.m. in the First Watch that night as standby quartermaster, running various errands and performing other duties including the striking of ship's bells every half hour that was used by the crew to indicate how much time was left in their watch. At 10 p.m., four-bells into the watch, Robert Hichens took over the wheel from Quartermaster Alfred Olliver who replaced Hichens as the standby quartermaster at that time. At the same time, lookouts Frederick Fleet and Reginald Lee replaced lookouts Archie Jewell and George Symons in the crow's nest, and First Officer William Murdoch replaced second Officer Charles Lightoller as Officer of the Watch. About an hour and 40 minutes later, at 11:40 p.m, the ship struck an iceberg.

If the ship's master clocks had already been put back by half the full adjustment amount, then the clock in the wheelhouse, as well as other Magneta slave clocks in other parts of the vessel, would have shown a time close to 12 o'clock, the time when the master clock would have been put back, not

---

[14] American Inquiry, pp. 449-450.

a time close to twenty minutes to 12. Public places that were opened late, like the smoking rooms, would already have been closed, and the lights put out in accordance with White Star Line rules and procedures that were in effect at the time.[15] Yet there are numerous accounts that show that this was not the case. For example, take the account of first-class passenger William Carter:[16]

> "I was in the smoking room for several hours prior to the collision with Major Archie Butt, Colonel Gracie, Harry Widener, Mr. Thayer, Clarence Moore, of Washington; William Dulles and several other men. At exactly seventeen minutes to 12 o'clock [11:43] we felt a jar and left the room to see what the trouble was outside. We were told that the ship had struck an iceberg. Many of the men were in the card room, and after learning what had happened returned to their games."

Another account is that of Second Class Smoking Room Steward James Witter:[17]

> "It was a beautiful, clear but very cold evening, the sea was like a sheet of glass, while I, duty smoke room steward was clearing up the 2nd. Class smoke room, (11-40) ready for closing at midnight. … On that particular Sunday I had been instructed by the Chief Steward to allow them to play cards and to close the smoke room at Midnight. Then suddenly there was a jar, the ship shuddered slightly and then everything seemed normal, my first impressions were that we shipped a heavy sea, ... I went below [to find the cause of the trouble] and returned some fifteen to twenty minutes later and informed the passengers that we had hit an iceberg. All that time there were still two groups of passengers playing cards, but upon hearing my explanation they immediately got up and left the smoke room without any sign of panic whatsoever."

Once again we see that the collision happened about twenty minutes before the smoking rooms were to close for the night.

There were also some very definitive statements about the clocks not being put back that night from crew members who would actually know. For example, take the case of Boatman's Mate Albert Haines who was awake and on duty at the time the ship struck the iceberg. Haines, who was in charge of the watch on deck at the time, was standing just outside the crew's mess room talking to some of his shipmates when the ship struck the fatal iceberg. When asked about the time of the accident, Haines said: "The right time, without putting the clock back, was 20 minutes to 12."[18] And then there is Third Officer Herbert Pitman, who when asked specifically if the clocks had been put back that Sunday night, replied: "No; we had something else to think of."[19]

Based on the workings of the Magneta clock system that was installed on board *Titanic* in 1912, along with other evidence uncovered about the setting and adjustment of clocks on board the vessel, it can be stated with a high degree of certainty that the time on *Titanic*, when she encountered that fatal iceberg that cold Sunday night in April 1912, was around 11:40 p.m. ATS, in unadjusted April 14th hours; a time that corresponded to 2:38 a.m. April 15th GMT, or 9:38 p.m. April 14th in New York, Washington, Toronto and other cities in the eastern time zone of the United States and Canada.[20]

---

[15] From 'Information For Passengers' aboard White Star Line vessels: "Lights are extinguished in the Saloon at 11 p.m., Lounge at 11-30 p.m., and Smoke Room at 12 Midnight."

[16] *Auburn Citizen*, 23 April 1912.

[17] Letter from J. Witter, Second Class Smoking Room steward on *Titanic*, to Walter Lord, 09 Jul 1955.

[18] American Inquiry, p. 656.

[19] Pitman also said that he last adjusted his personal timepiece at midnight, Saturday night, so that it would be accurate for noontime Sunday, the 14th of April. When *Titanic* sank, Pitman looked at his watch in the lifeboat and told those around him that the time was 2:20 a.m. (American Inquiry, p. 294.)

[20] For more details, please see: Mark Chirnside, Tad Fitch, Ioannis Georgiou, Steve Hall, Sam Halpern, J. Kent Layton & Bill Wormstedt, "Time & Again – *Titanic*'s Final Hours," August 2018, http://wormstedt.com/Titanic/Time_And_Again.html.

Bibliography

1. J. Zacharias, *Elektrotechniek für Uhrmacher*, 1908.
2. H. R. Langman and A. Ball, *Electrical Horology*, 3rd Ed., 1935.
3. Stuart F. Philpott, *Modern Electric Clocks*, 1933.
4. F. Hope-Jones, *Electrical Timekeeping*, 1940.
5. Robert A. Simon, "The Marine Master Clock," NAWCC Bulletin Article 161, April 2008.

Acknowledgements

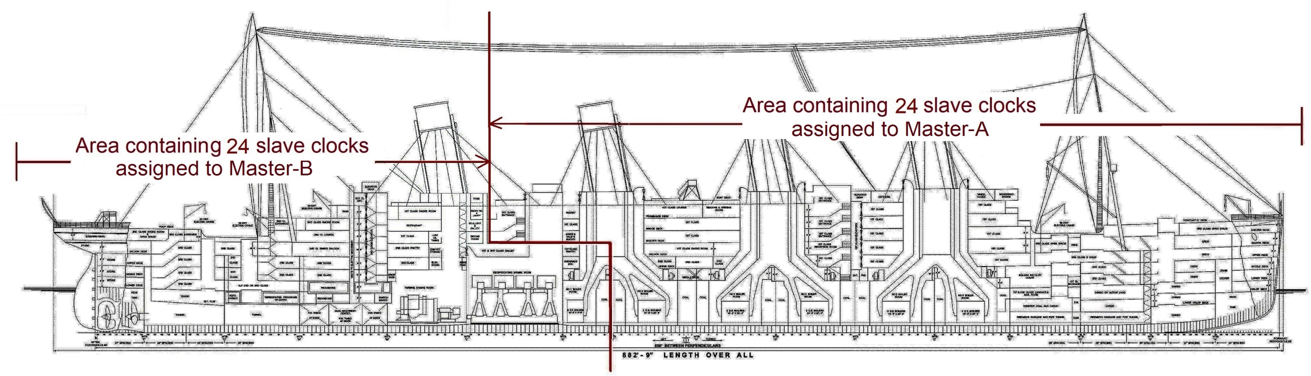
I would like to thank my colleagues on the "Time & Again" team, Mark Chirnside, Tad Fitch, Ioannis Georgiou, Steve Hall, J. Kent Layton and Bill Wormstedt, for taking the time to review and comment on this particular work.

Appendix A

Locations and Number of *Titanic*'s Slave Clocks

Note: Clocks in watch-keeping crew spaces are indicated by *italic* font.		
Clock Location	**Master-A**	**Master-B**
Chart Room	1	-
Wheel House	1	-
Officers' Smoking Room	1	-
Captain's Sitting Room	1	-
Chief Officer's Room	1	-
Officers' Mess Room	1	-
Crew's Galley	1	-
Marconi Room	1	-
First Class Gymnasium	1	-
Enquiry Office	1	-
Purser's Office	1	-
Third Class Open Space Forward	1	-
First Class Fore Entrance - Boat Deck (Grand Staircase)	1	-
First Class Staircase - Promenade Deck (A)	1	-
First Class Staircase - Bridge Deck (B)	1	-
First Class Staircase - Shelter Deck (C)	1	-
First Class Aft Staircase - Promenade Deck (A)	1	-
First Class Aft Staircase - Bridge Deck (B)	1	-
First Class Aft Staircase - Shelter Deck (C)	1	-
Reading & Writing Room	1	-
First Class Lounge	1	-
Squash Racquet Court	1	-
Swimming Bath	1	-
Turkish Bath Cooling Room	1	-
Forward Second Class Entrance (Staircase) Boat Deck	-	1
Forward Second Class Entrance Bridge Deck (B)	-	1
Forward Second Class Entrance Upper Deck (E)	-	1
Aft Second Class Entrance Bridge Deck (B)	-	1
Aft Second Class Entrance Upper Deck (E)	-	1
First Class Smoke Room	-	1
First Class Restaurant	-	1
Restaurant Pantry	-	1
Restaurant Galley	-	1
Second Class Smoke Room	-	1
Second Class Library	-	1
Third Class Smoke Room	-	1
Third Class General Room	-	1
Third Class Galley	-	1
Chief Steward's Office	-	1
Doctor's Office	-	1
First Class Pantry	-	1
First & Second Class Galley	-	1
Second Class Pantry	-	1
Engineers' Mess Room	-	1
Chief Engineer's Room	-	1
Senior Second Engineer's Room	-	1
Reciprocating Engine Room	-	1
Electric Engine Room	-	1
TOTAL CLOCKS	**24**	**24**

The slave clock locations listed in the above table were based on a list of clock locations from a builder's specification book for RMS *Britannic*, the third *Olympic*-class vessel built for the White Star Line by Harland & Wolff,[21] and from photographs of clock locations on *Olympic* and *Titanic*. The likely assignment of slave clocks to a given master clock in the above table was based somewhat on their fore/aft location within the vessel such that all clocks on a single closed loop would tend to be relatively near each other rather than be strung on a loop that stretched all over the place, thus essentially creating two zones, each controlled by its own master clock, to minimize the wiring length of any one closed series loop. The propagation time of an electrical impulse on any length of wire would be insignificant. All clocks would appear to jump at the same time as the master no matter how far it was physically located from the master unit. As shown in the profile view below, we show Master-A controlling 24 clocks in the fore part of the vessel, and Master-B controlling 24 clocks in the aft part of the vessel.



Supporting evidence for a split similar to the one presented here comes from indirect evidence that came to light during the *Hawke-Olympic* collision trial in November of 1911. In the deck log, recorded at the time by Sixth Officer Harold Holehouse, the time of collision was put down as 12:46, and the stopping of the engines and closing of the watertight doors was put down as 12:47. From several eyewitnesses, including Pilot George Bowyer, we were told that the order to stop the engines was given within seconds of *Hawke* striking *Olympic*, as can be well expected.[22] This implies that the recorded strike time of 12:46 had to be within a few seconds of the wheelhouse clock, which was a Magneta slave clock, changing from 12:46 to 12:47, the time recorded in the deck log for when the 'Stop' order was given. However, in the engine room log, recorded by Sixth Engineer Duncan Grey, the time of collision, which was marked in the log, and the ordering of the stopping of the engines, were both put down as 12:48, a difference of a full minute from what was recorded in the deck log. What this suggests is that the wheelhouse and engine room clocks were working off of different master clocks in the chart room.

For more details concerning this one-minute time difference, please refer to Appendix B.

---

[21] According to builder's specification list for *Britannic*, generously provided to us by Daniel Klistorner, *Britannic* was to have 52 slave clocks installed, including 4 within First-Class private sitting rooms located on B and C decks. They did not list a clock for the First-Class Restaurant, nor the Squash Racquets Court, however, they listed 2 for the First-Class Pantry, and 2 for the First & Second Class Galley. Although the Magneta Type-M Master was advertised as controlling from 1 to 25 secondary units, it appears that the 25 unit number was not a hard limit, especially if some of the slave units that were installed, such as those in some of the private sitting rooms, had relatively small dials of only a few inches in diameter.

[22] According to Fourth Officer David Alexander, who was standing at the bridge telegraph, the order from Bowyer to him to put the engine order telegraph to 'Stop' came just before Pilot George Bowyer shouted "hard-aport" to the helmsman Albert Haines, and that came just as *Hawke* struck. According to Bowyer, he gave the order "hard-aport" just before *Hawke* struck, and *Olympic*'s head was just starting to come round when he felt *Hawke* strike. It was "almost immediately" after *Hawke* struck *Olympic* that Bowyer gave the 'Stop' order, which agrees with what eyewitnesses down in the engine room said, and agrees with the order of events recorded in the deck log by Sixth Officer Harold Holehouse.

Appendix B

"I Do Not Think the Difference … Amounts to More Than a Minute"

The one-minute discrepancy between the wheelhouse clock and the engine room clock was first noted during the first day of the *Hawke-Olympic* trial by the Attorney General, Sir Rufus Isaacs, after questions were put to Captain Smith concerning the time of 12:43 that was recorded in the deck log when *Olympic* steadied onto her predetermined course after coming out of a sharp port turn around the West Bramble buoy.[23] At the time that *Olympic* was steadied onto S59°E magnetic, as seen on the standard compass amidships, an order was given by the pilot George Bowyer to go to full speed ahead on all engines.[24] It was noted that the deck log showed 12:43 for the time that the ship was steadied, and also when the port engine was ordered to 'Stop' and then 'Full-ahead,' having been previously reversed for the sharp turn around the buoy. However, the engineer's log recorded a time of 12:44 for when the 'Full-ahead' order was received down in the engine room, and the time that the turbine engine was put back on line.[25]

Later on in the questioning, this same one-minute discrepancy between the wheelhouse clock and the engine room clock came up once again:

> 414. Q. [Mr. Laing] The times that have been put to you, 12.43, as putting on your full speed, and 12.46, I think, as the moment of the collision, are those from your observation, or from the officer who was talking down the scrap log? A. [Capt. Smith] That is the observation of the sixth officer, the man who was taking notes.
> 415. Q. And your attention has been called to the fact that there are some differences–a minute, I think–between the deck log and the engineer's log; how do you account for that? A. I think that is a difference in the method of taking the time.
> 416. Q. I wanted to know: Do your clocks record half minutes or do they jump from minute to minute? A. Each minute.
> 417. Q. You do not know when you look at a clock how near may be to the jump? A. No, of course not.
> 418. Q. *The President*. It may be 5 seconds after 1 minute, or 5 seconds before the next, as far as appearance is concerned? A. Yes.
> *Mr. Laing*. I am not sure, but I do not think the difference between the engineer's log and the deck log amounts to more than a minute.
> 419. Q. Then your speed was put to you by the Attorney-General, and he said: If you run 25 cables [2.5 nautical miles] in 9 minutes that equals 16½ knots; the Attorney-General put to you that calculation? A. Yes.[26]
> 420. Q. Of course, a difference of 60 seconds makes a great deal of difference in the calculations? A. Yes.
> 421. Q. And even 30 seconds? A. Yes.
> 422. Q. You will understand what I mean; supposing the figure were 10 minutes instead of 9, that would bring your speed down to 15? A. Yes.

---

[23] This was right after Question 322 was put to Captain Smith on the first day of the *Hawke-Olympic* trial.

[24] It should be noted that according to Captain Smith, full ahead in confined waters coming in and out of port under "reduced steam" for *Olympic* was about 20 knots, while on the open sea it would be about 22.5 knots. (Questions 30 to 36 on day 1 of the *Hawke-Olympic* trial.)

[25] The turbine engine was taken off line whenever the ship was maneuvered around sharp turns in the channel, when one of the engines would be reversed while the other engine remained at full speed ahead. The turbine was put on-line again (by throwing a lever that controlled the changeover valves) when the engine order telegraphs called for 'Half ahead' or 'Full ahead' on both reciprocating engines. There was no separate telegraph for the turbine engine.

[26] It turns out that 2.5 cables in 9 minutes actually works out to 16.67 knots.

Mr. F. Laing, who was one of the attorneys representing the White Star Line, was trying to argue that *Olympic* may not have been going as fast as the times and passing points that were recorded in her deck log had suggested. He also admitted that there appeared to be a one-minute difference between the times as recorded in the deck log when compared to what was recorded in the engineer's log. Those who recorded the times of events for the deck and engineer's scrap logs described the same method of taking time off the clock when they were questioned. They said they took the time directly off the clock to the minute that it was showing, and if they happened to see a jump as they were looking at the clock, they would put down the time showing right after the jump. There is little doubt that the wheelhouse clock and engine room clocks were showing slightly different times, with the engine room clock being about one minute ahead of the wheelhouse clock.

This discrepancy, which as we pointed out was conspicuously noted first by Attorney General Isaacs and then conceded to by Mr. Laing on the very first day of the trial during the questioning of Captain Smith, was subsequently confirmed when Sixth Officer Harold Holehouse and Sixth Engineer Duncan Grey were independently questioned the following day about the times that they recorded of certain events in their respective scrap logs. So how could these two clocks show a difference in time if they were controlled by the same master clock in the chart room? Or, were these two Magneta slave clocks controlled by two different master clocks, with one master clock controlling a closed loop circuit of slave clocks in one part of the ship, and the other master clock controlling a different closed loop circuit of slave clocks in another part of the ship?

From the internal construction of the Magneta slave clocks, it appears that when a positive impulse of current is received from the master, the slave unit would jump say from an even-numbered minute on the dial (e.g., 12:00) to the next odd-numbered minute on the dial (e.g., 12:01). Then a minute later, when a negative impulse of current is received from the master, the slave unit would jump from that odd-numbered minute on the dial (e.g., 12:01) to the next even-numbered minute on the dial (e.g., 12:02). This would take place on all slave clocks that were connected up in series on the same closed loop circuit in step with the master.

For example, let us take the situation on *Olympic* as seen on the wheelhouse clock when it was showing 12:46. That was the time showing on the wheelhouse clock when *Hawke* struck,[27] and the time that was recorded in the deck log by Sixth Officer Harold Holehouse. Shortly after, apparently within a matter of seconds, the master unit sent out a positive pulse of current causing the wheelhouse clock, and all other clocks on the same closed circuit, to jump from 12:46 to 12:47 (from an even-numbered minute to the next odd-numbered minute). About that time, or a moment after, a 'Stop' order was given by Pilot Bowyer, all before then next jump in clock time. The time that was seen on the wheelhouse clock was then 12:47, and that was time that Holehouse put down in the deck log.

However, down in the engine room, the slave clock there was showing 12:48 when the *Hawke* struck *Olympic* causing her starboard engine to freeze up. Within a few seconds after that, a 'Stop' order came down from the bridge. The time of both of these events, 12:48, was taken off the clock in the reciprocating engine room and recorded in the engineer's log by Sixth Engineer Duncan Grey.

At first, one may suspect that the minute hand of the engine room clock was somehow showing one minute ahead of the wheelhouse clock all along, from the time they were initially connected up to the same closed circuit worked by a single master clock in the chart room. Then, when impulses were sent out from the master, all clocks on this same circuit would jump together in synch with the impulses coming from the master, and therefore the engine room clock would always show that one-minute difference from the wheelhouse clock. But this seemingly simple explanation is flawed. Why?

If one slave clock was showing say 12:01 while all others showed 12:00 when connected up to the same master showing 12:00, then when the master was set in motion, the next impulse to be sent out would be a positive impulse at 12:01 causing all the slave units that were showing 12:00 to jump to

---

[27] As an aside, the collision time that was recorded in the deck log of HMS *Hawke* was 12:45. The clocks on both vessels were keeping GMT.

12:01. The one slave unit that was originally showing 12:01 would not respond to the positive impulse since it was already showing 12:01, an odd-numbered minute to begin with. However, a minute later, at 12:02, the master would send out a negative impulse which would cause all slave clocks now showing 12:01, to jump to 12:02, and this would continue on with all slave clocks now showing the exact same time and keeping in synch with time on the master. Thus we see that a one minute difference, or for that matter any odd-numbered difference, between slave clocks that are on the same closed circuit cannot be maintained.

The only conclusion that comes out in all of this is that the wheelhouse and engine room clocks were controlled by *different* master clocks in the chart room; master clocks that were within one minute of each other when they were last adjusted.

For more information concerning the collision between HMS *Hawke* and RMS *Olympic* on 20 September 1911, please see: Mark Chirnside and Samuel Halpern, *The Sting of the Hawke – Collision in the Solent*, 2014.[28]

[28] Printed by CreateSpace, an Amazon.com company.