Frank Holden – the Man and his Clocks

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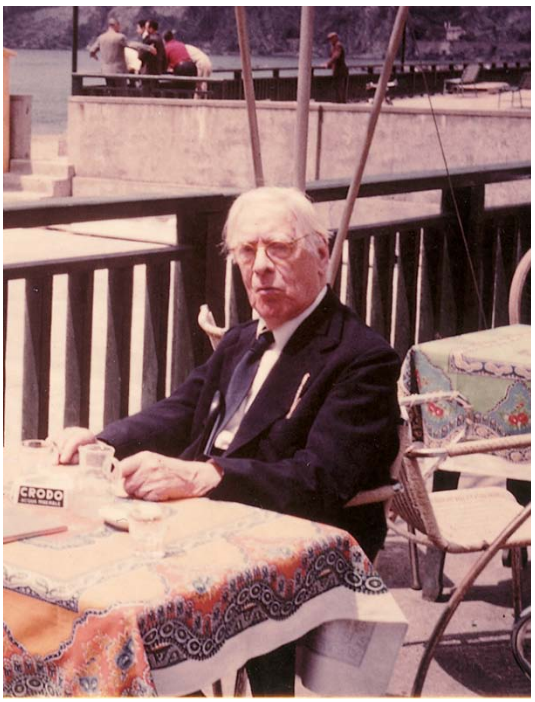

Fig. 1. Frank Holden in Levanto, 1959.
Image courtesy of the IET Archives.

Introduction

To date, little has been written about the life and career of Frank Holden, yet his clocks remain universally popular. In this paper I summarise the material I have been fortunate to recover in the recent past, providing an overview of Holden's life, with a short illustrated commentary on his clocks. I hope that this effort will result in more information being pooled and that this paper can be joined by other research in due course.

I unearthed useful biographical material in the library at Warwick University, in the archive of papers belonging to Andrew Primrose Young (1885–1977), employed by Holden at the British Thomson-Houston Company (a subsidiary of General Electric) between 1901 and 1928. On the occasion of Holden's ninetieth birthday in 1959, Young (known to Holden as "A.P.Y.") made an effort to contribute material about Holden to various newspapers, encouraged contacts in the electrical world to send telegrams and letters of congratulation to Holden, and even tried to propose Honorary Membership of the Institution of Electrical Engineers (now the IET). Alas, this effort was in vain.

The IET archive retains Holden's application forms for membership, bearing the countersignatures of Silvanus Thompson (IEE Chairman) as his proposer and Ayrton as seconder. Other luminaries of the day signing the form included Perry – clearly Holden was operating in distinguished electro-technical company. These forms are valuable sources of biographical information, yielding Holden's locations at different times, providing greater detail than Young's later account, written in 1959.

More than anything Holden appears to have been occupied in the design and testing of equipment to measure electric current and the hysteresis of magnetism. It seems to me that the design and production of clocks was a sideline – his clock-related activities are not mentioned at all in Young's biographical notes. In Tony Mercer's two books on chronometers, Holden features as a friend of his father's, influential in the creation of the Mercer marine time distribution system, but Holden's own clocks merit very little mention.[1]

Biographical detail

Frank Holden was born on 12 June 1869 in Bridgeport Connecticut U.S.A., and first went to school there. He later graduated from Yale University, taking mechanical and electrical courses at its Sheffield Technical School. Following an early commission servicing the pump motors in a Pennsylvanian coal-mine, he began work in the autumn of 1889 at Lynn, Massachusetts, the birthplace of the Thomson-Houston Electrical Co., which in the 1880s had merged with the Edison Company to form the General Electric Company. He was placed in charge of the laboratory for electromagnetic measurement. In 1878, Professor Elihu Thomson had played the leading role in starting the Thomson-Houston company, in a disused shoe factory in Lynn. Soon after commencing work, Holden forged a relationship with this distinguished pioneer of the electrical industry, and for several years acted as his personal assistant. The friendship established with the Thomson family remained lifelong.

Around 1894 Holden devised a hysteresis meter, described in *The Electrical World* (New York) in June 1896, and took charge of the standardizing laboratory at the General Electric works in Schenectady, N.Y., in the autumn of 1894, staying there for nearly a year. For a short time, till June 1896, he served as a draughtsman for a firm of New York dock builders, during which time he visited Europe, making his first trip to England. After a period as a draughtsman at Cooke's locomotive works and then at a manufacturer of foundry machinery he travelled to England again, where he settled from July 1897. In London, he rejoined the GE Group, at the British Thomson-Houston Co. Ltd. His duties included looking after the engineering side of the meter business and supervising all electrical testing. By late 1899 this role expanded to include all matters involving electrical rolling-stock. At that time British Thomson-Houston acted mainly as agents for General Electric products and initially possessed no manufacturing plant. The meters, imported from France, were tested in London and then dispatched to customers. Here we can perhaps trace the first element of the link between Holden and France, where he was later to have his clocks manufactured. Through a close association with the Compagnie Francaise Thomson-Houston in Paris (in which General Electric had an interest) a growing and prosperous meter business was established under Holden's able direction, between 1897 and 1902.[2]

[1] Tony Mercer, *Mercer Chronometers : Radical Tom Mercer and the House He Founded* (Ashford: Brant Wright, 1978), pp. 78–81; Mercer, *Mercer Chronometers*, (Mayfield: Ashbourne, 2003), pp. 66–67, 219.

[2] In his notes, Young actually refers to 'The French Meter Co', but this is presumably Compagnie Francaise Thomson-Houston.

In May 1902, British Thomson-Houston established a new works at Rugby, and moved all of its London-based meter-testing activity there. Later the entire manufacture of meters and instruments was undertaken at Rugby, to designs evolved under the direction of Holden, his mercury Ampere-hour meters (using a novel rotating copper cup) replacing the Thomson-design switchboard Watt-hour meters. On arrival in Rugby, Holden established the Experimental Laboratory. In this he was assisted by Young (engaged in 1901 by Holden as a meter tester) while James Muirhead carried out the work. Within two years the space was expanded into a two-room affair, known as the Standards Room and Experimental Laboratory, which remained in the same location for more than fifty years. Writing in 1959, Young described Holden's pioneering work in providing what was effectively sandwich course training, in that industry and technical college worked hand in hand. This apparently led on from the close relationship Holden had developed with Silvanus Thompson in London, Principal of the Finsbury City & Guilds Technical Institute. In his encomium, Young sums up – "*Without question, he was the foremost foundation builder of the company* [BTH]*"*.

A curious omission in Young's account is however any mention of Holden's activities from 1907 onwards (when he probably left London), before he moved to settle in Italy (probably in 1923).[3] Judging from his prolific patent record, Holden moved first to Paris, to work for (or with) the BTH affiliate Compagnie pour la Fabrication de Compteurs et Matériels d'Usine à Gaz, though links with London remained. One early 1920s patent and then a string of patents in the 1930s were taken out jointly with Measurement Limited in London, a subsidiary of Parkinson Cowan. This firm manufactured a number of the standard electricity meters deposited at the NPL and used as approved patterns for other meter manufacturers, as the electricity sector started standardising.[4] Of this later period, Tony Mercer writes:

"One day [1923] *an American, Frank Holden, who worked as a Research Engineer for British Thomson-Houston, approached Frank* [Mercer] *to see the chronometer contact device. He liked it and Frank liked him, which was a rare occurrence, and this started a long friendship. In Frank Holden's later years the two used to meet in Levanto near Genoa, Italy, a little fishing village where he had married an Italian Countess and settled down. They, the two Franks, used to take long walks in the hills visiting friends. One was an ex Chicago gangster who had been evicted from the U.S.A. and another was the Abbot of the local monastery. All these meetings were stimulated by the local acid-dry white wine or by the aperitif, Cocchi. Frank Holden was a delight to know, tall, long white hair, rimless glasses and a curious habit of travelling with his cello, always staying in hotels that had an orchestra, inviting himself to join in. He had also designed a technically advanced electric clock. Though ahead of its time, it was not a real success. Much of his time was spent at the St. Albans factory, he had such a way that no one could ever refuse to do a small job for him and he was really an "electrician" rather than a mechanical*

[3] 'Peterborough' column, *The Daily Telegraph*, (11 June, 1959), quoted in *Mercer Chronometers*, (1978), p. 81.

[4] See, for example, *London Gazette*, (31 July 1923), p. 5255 and (22 August 1924), p. 6356.

engineer; he became known to everyone as Solder Sam. He was a humorous fellow with a Mark Twain turn of speech; an intelligent well read man with wide interests always questioning statements, never failing to bring out the best in people . . ."[5]

Fig. 2. Frank Holden (left) and Tony Mercer, from *Mercer Chronometers (1978*).

It was Holden that encouraged Mercer '*to start a chronometer controlled electric clock system for ships . . . From the ideas of Frank Holden, Mercer's equipped over a hundred ships, including the Cunard super-liners.'*[6]

Despite leaving New York in his twenties, Holden retained his American citizenship throughout his life, remaining a prolific designer and inventor. He was associated with more than sixty patents granted in the UK alone, between 1898 and 1936, together with a handful granted in Switzerland. These were very largely associated with electricity meters, other measuring devices, motors and prepayment mechanisms. Regrettably, I did not succeed in establishing the date of Holden's death, but in 1961 he appeared for the last time in the IEE membership list, with an address that had not changed since 1930: Villa Parnaso, Levanto, Spezia, Italy.

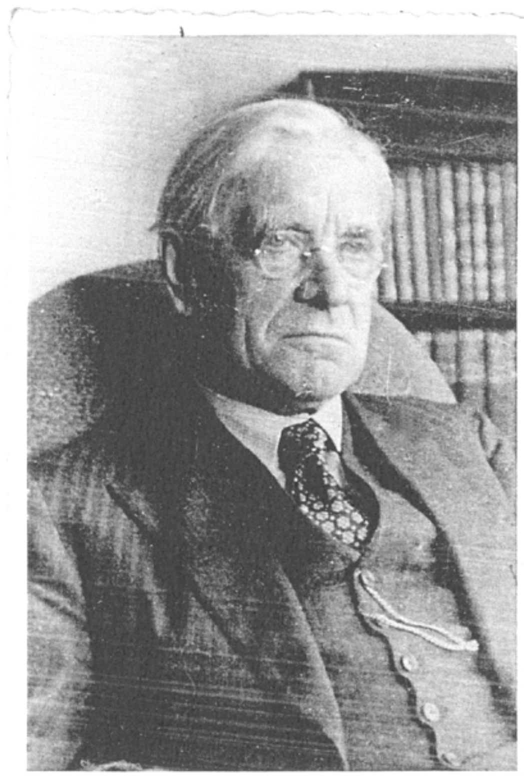

Fig. 3. Frank Holden, in his eighties. Papers of Andrew Primrose Young, courtesy of Warwick University.

The Clocks

A limited range of clocks to Holden's designs were produced in the first quarter of the twentieth century, and these are highly sought after by collectors, not as a result of outstanding timekeeping properties but because of the high quality of their manufacture and their fascinating mechanisms. They are predominantly table clocks with few wall clocks known.

At least some of Holden's clocks were made in Paris, as we shall discuss,

[5] *Mercer Chronometers*, (1978), pp. 78–80.
[6] *Mercer Chronometers*, (2003), p. 66. **NB** there is a typo which gives 1933 instead of 1923 for the meeting of Holden and Mercer.

but since a significant number have been found in St. Croix in Switzerland the possibility of some being manufactured there has been raised.

Why Holden had his clocks made elsewhere than England is not clear, but he did visit the Continent in 1896 and the firm he worked for imported their meters from Paris, tested them in London and retailed them further to their customers. These links in his main career may be of significance in explaining Holden's choice of manufacturer.

Many dials are signed 'A.S.E.M.' alongside 'Paris'. This was the acronym of Ateliers de Spécialités Électriques et Mécaniques, of 45 rue Lévis, Paris. In a 1925 directory the firm listed its products as 'Pendules LR à balancier horizontal, Montres électriques pour automobiles'.[7] Both pendulum and horizontal balance clocks have been seen bearing the initials A.S.E.M, so it seems safe to conclude that this firm manufactured many of Holden's clocks, if not all. The firm appears not to have been long-lived, appearing first in the 'Bottin' directory in 1921, and for the last time in 1929. It had no connection with the Thomson-Houston group.

The dials are also variously signed "Regina", "Rebesi", "Apollo", "EXACT" and "L.R." No explanation of the acronym "L.R." has been advanced. Rebesi may possibly refer to a limited company of the same name, formed in the UK in 1913, operating from City Road in London.[8] Its patents involved telegraphy and telephony apparatus and its directors had roles in various companies in the same fields. Regina was a UK trademark for a patented railway ticket printing and registering machine, made by the Regina Machine Co, formed in 1910.[9] In the case of both firms there is nothing explicit to connect them to Holden, or A.S.E.M., other than the fact they operated in the world of electro-mechanical machinery.

The earliest clock patent taken out by Holden, together with Alexander Garfield, dates from 1900 and was granted in Switzerland under patent no. 21,563. It describes a mechanism for rewinding the driving spring in otherwise conventional clockwork. The winding mechanism resembles the Aron system. It is unclear if any manufactured clocks exploited this patent.

However, Holden's UK patent of 1909, no. 14,873, forms the basis of extant clocks (see the patent drawings in Figs. 4 and 5).

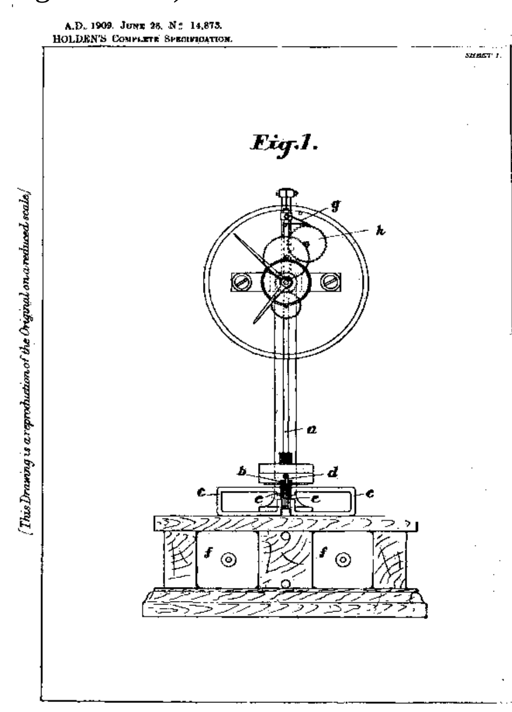

Fig. 4. Drawing from the 1909 patent.

[7] *Annuaire de commerce Didot-Bottin (1925),* Vol. 1, p. 2128.
[8] TNA PRO: BT31/21262/127391
[9] TNA: PRO BT 31/19270/107878.

Improvements followed in 1910 under patent no. 14,126. Owing to occasional contact bounce, and consequent variations in current during contact closure, the trailing finger was magnetized and the fixed contact surfaces made from magnetic material. Frank Hope-Jones describes (and predictably criticizes) this clock as follows:

"In 1909 and 1910 Frank Holden produced a pendulum-driven clock which was like Professor Fery's in that it was applied to a half-second pendulum. His aim was to concentrate the electro-magnetic impulse upon the pendulum at zero and to leave it altogether free throughout the rest of its path.

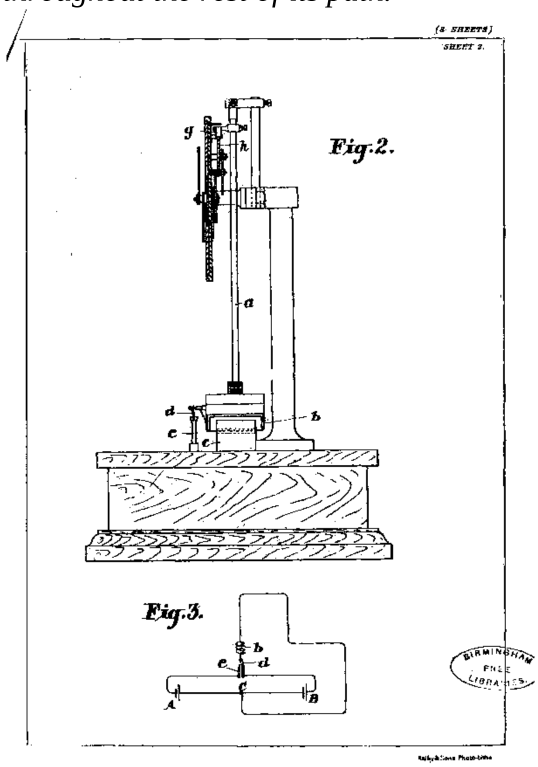

Fig. 5. Drawing from the 1909 patent.

[**Fig. 6**] *shows the cylindrical high-resistance coil A that constitutes his pendulum bob, and B the two horseshoe permanent magnets, the upper poles of which pass into it. Observe the pole pieces designed to concentrate the field at zero. The contact consists of a trailer C, which gives an impulse of short duration in each direction commencing just before and ending just after zero.*

Thus all interferences due to contact-making and impulse are concentrated at zero, but unfortunately they take place every half-second; nevertheless the clock may be looked upon as a well-designed electro-motor of which the flywheel is the pendulum. It is useful to consider it as such in order to appreciate the effect of the counter electro-motive force set up by the movement of a coil in a magnetic field.

Let us assume for a moment that there are no mechanical losses; then the pendulum would swing permanently with amplitude of such size that the E.M.F. generated by the coil passing through the magnetic field would be equal to that of the E.M.F. of the battery. It could not exceed that amplitude, for that would involve the pendulum giving up energy to the battery, and it could not be less than that amplitude, for that would involve the battery supplying energy to the pendulum, which by hypothesis has no losses, and therefore would not require it. In the result the losses due to air and contact friction and the flexure of the spring are replaced by a very small consumption of current, and the arc is fairly constant, though of course it is primarily dependent upon the E.M.F. of the battery employed."[10]

[10] Frank Hope-Jones, *Electrical Timekeeping*, (NAG: London, 1940, repr. 1943), pp 67–69.

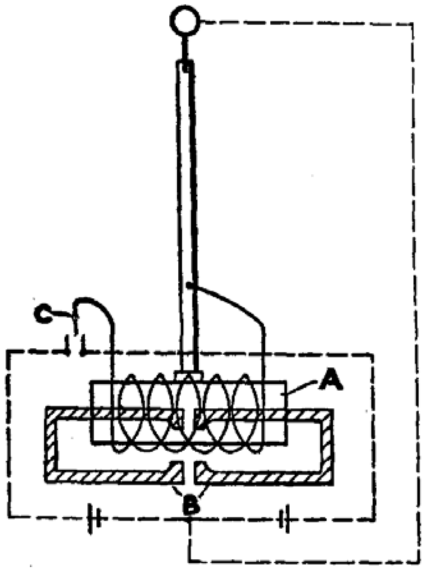

Fig. 6. Hope-Jones's drawing of Holden's design.

Hope-Jones's description of the pendulum bob is not quite correct. In addition to the coil there are two brass discs, one of which acts as a rating nut, since it can be rotated and therefore moved up and down on a threaded mount. Further, the diagram is incorrect, since as drawn the current would always flow in the same direction through the coil. The battery connections should instead be as in Fig. 7.

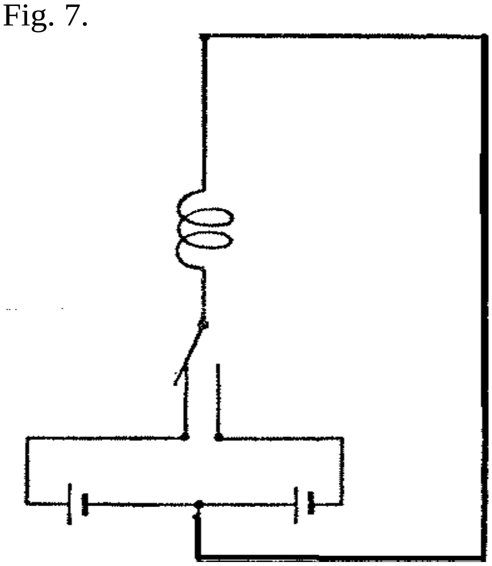

Fig. 7. Correct wiring diagram, 1909 clock.

This clock has a rather light half-seconds pendulum, which mitigates against a stable rate. Contact pressure is relatively light, and the resistance of the circuit is not constant, although this is, to a degree, compensated for by the high coil resistance of 700 Ohms.

Since the pendulum has to work hard (*i.e.* driving the motion-work) and this has a negative influence on the rate, a further patent (GB 722) appeared in 1912 in which the pendulum is arranged to close a contact whilst a separate motor is switched, driving the motion-work through a string. Examples of clocks of this type appear to be unknown.

Existing clocks appear in different models and the cases are of various woods. The clock case in Fig. 8 is veneered in mahogany, but other examples exist in oak, or with four-glass cases, or the clocks are mounted on a base with a glass shade (Fig. 10). Some examples exist with the magnets nickel-plated (Fig. 11).

Fig 8. The 1909 model.

Fig. 9. Close-up of the coil, magnets and contact arrangement.

Fig. 10. Glass-shaded model

Fig. 11. A nickel-plated movement.

Fig. 12. Frame machined from solid.

Fig. 13. Construction using pressed brass.

The construction of the frame of the clock has been seen either machined from solid brass, as in Fig. 12, or (probably in later models) pressed from flat brass, as in Fig. 13. A set-screw is provided under the clock to allow for precise levelling, preventing the coil from touching the magnets. The coil windings are very thin and vulnerable, and a pendulum locking-screw is provided in the movement column to aid safe transportation.

Details of the coil

The coil is wound from approximately 1200 turns of 46swg (0.06mm) enamel covered wire, and has a DC resistance of around 700 Ohms. The frame on which it is wound is brass, and is part of the electrical circuit, as is the pendulum rod. The inner end of the coil is soldered to the brass former, and the outer end is connected to the silver pin on which the contact toggle is pivoted, the pin being insulated from the pendulum bob (Fig. 14.)

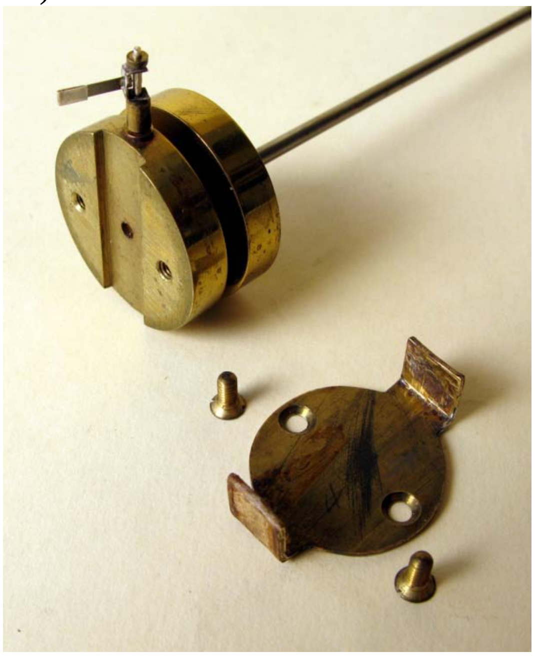

Fig. 14. Pendulum bob and empty coil former.

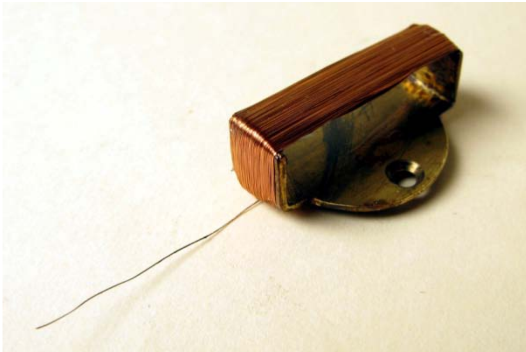

Fig 15. Coil wound on former.

The coil former is U-shaped so that the minimum thickness passes between the magnet poles (Fig. 15). The former has no cheeks, and is less than 10mm wide. Coil re-winding is a slow process and must be as even as possible to allow the unsupported part of the finished coil to pass between the magnet poles. Lacquer or varnish can be sparingly applied during the winding process to help retain the edges of the coil on the former.

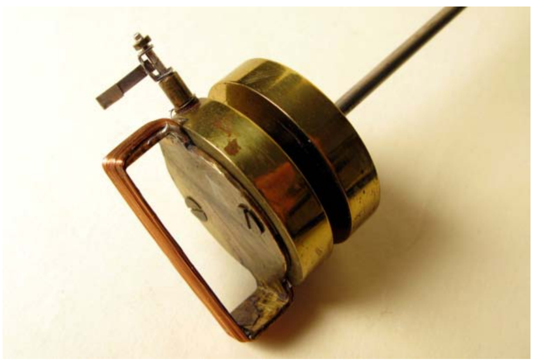

Fig. 16. Completed coil and pendulum.

The 1919 clock

Ideas from the 1909 patent (Fig. 17) that had not been utilised resurfaced later, with Holden's design for a clock with a coil moving over a circular magnet (1917 GB patent 118329). But he soon saw that a flat coil, moving between the poles of two magnets would be an improvement, leading to patent 156408 of 1919 – see Fig. 18.

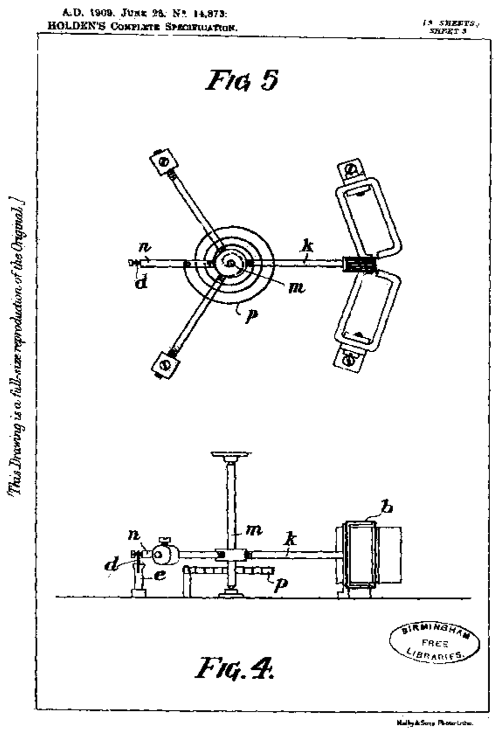

Fig. 17. Drawing from the 1909 patent.

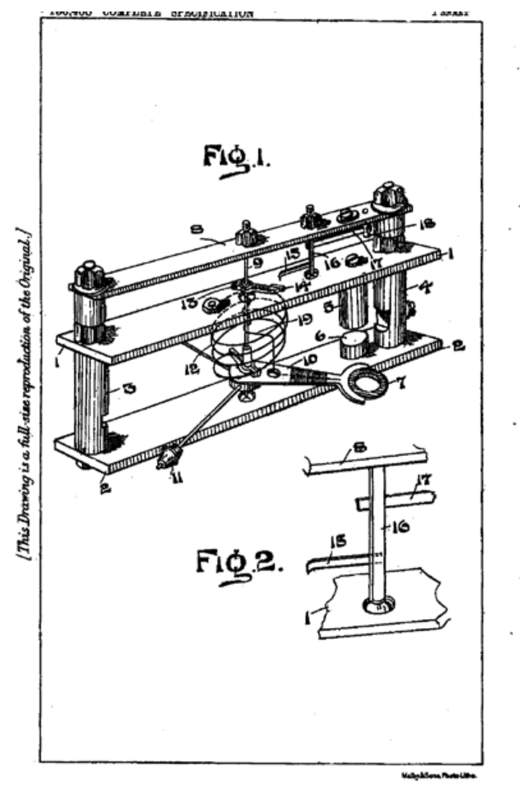

Fig. 18. Drawing from the 1919 patent.

Looking at Fig. 18., in the portion (originally marked) Fig 1. the parts marked 1 and 2 are plates consisting of magnetic material, of which 5 and 6 are the poles. Parts 10, 11 and 12 form the armature, carrying 7, which is the flat coil. Parts 14, 15 and 16 form the contact, in this drawing executed with a flat spring, but contacts with a horizontally-coiled spring exist. The "balance" spring is drawn in helical form, but also occurs in a horizontally-coiled form. In the clock in Figs. 18 and 19 a helical spring is mounted above the plates, instead of between. Possibly Holden was inspired here by the chronometers of his friend Frank Mercer.

How the contact works

The rotating part 13 bears a silver contact 14. A second contact 15 is attached to an arbor 16 in such a way that it falls in the path of contact 13. Arbor 16 is pivoted between plates 1 and 8 and has an area finished flat on which the flat spring 17 rests. This spring is inclined to keep contact 15 in its zero position and is mounted in such a way that contact 13 and 15 touch each other at the moment coil 7 starts to enter between the poles 5 and 6 and that this touching is maintained until the coil is practically concentric with the poles when the contact breaks and 15 returns quickly in its zero position. Because of the shape of contact 15 the moment of closure during the return movement is so short that hardly any current flows through the coil whereas during the first movement a much longer "sweeping" action takes place.

Later clocks

In 1924 Holden was granted a patent (GB 225401) for slave clocks, to be used on ships. These clocks could be advanced and retarded, making for easy adjustment as a ship changed time zones. I have never encountered such a slave. Holden's last patent dates from 1927 (GB 274373). It concerns a clock with a balance wheel, flat coil and a rather complicated contact.

Fig. 19. A fine example, following the 1919 patent.

Acknowledgements

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Hans Vrolijk
Rotterdam, October 2009

Fig. 21. Marble bust of Holden, Levanto, 1959. Image courtesy of the IET Archives.

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