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FOR CHRONOMETER, WATCH & CLOCK MAKERS, JEWELLERS, GOLD AND SILVER SMITHS.

BRITISH HOROLOGICAL INSTITUTE 1858

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ELECTRIC CLOCKS

By T. D. WRIGHT.

(Illustrated)

The British Horological Institute.

A Meeting of the Council was held at the Institute on Tuesday, July 20th, Mr. W. J. L. Smith presiding.

NEW MEMBERS.

The following were elected :—

Mr. J. N. MASTERS, Clifton House, Rye (Member).

Mr. MALCOLM WEBSTER, 37, Great Portland Street, London W.1 (Member).

Mr. GEORGE L. OVERTON, 35, Ellerby Street, Fulham S.W.6 (Fellow).

FORTHCOMING EVENTS.

Members and others are asked to make a point of keeping the following dates open :—

Thursday, 14th October.—Institute Dinner at Gatti's Restaurant, Strand, London, W.C

Tuesday, 19th October.—Annual Meeting of Members.

Further particulars will be announced in next month's Journal.

The columns of the HOROLOGICAL JOURNAL *are open to expressions of views from all sections of the trade. Contributors write on their own responsibility and their opinions do not necessarily represent the views of the Council of the Institute.*

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Electric Clocks.

NO apology is needed for devoting the bulk of this issue of the HOROLOGICAL JOURNAL to the subject of electric clocks.

For many years horologists have looked askance at electric clocks and have not gone out of their way to assist and encourage the development of this branch of their important industry. The reason may be that horologists, by the very nature of their vocation, are cautious individuals and apt to move slowly in connection with innovations, for it seems to be an accepted belief that the grounds for horological discoveries have been long since covered. They have also waited to see whether the anticipations and prophecies of the pioneers of electric clocks were likely to be realised. Unfortunately, excessive claims appear to have been put forward by the enthusiasts of the various systems and their vibrant statements ended, in several instances, in the inevitable failures. Consequently, horologists became more lukewarm than they were even at the outset. However, it is now common knowledge that electric clocks are rapidly coming into their own and perforce horologists must give them the attention they deserve. They will be wise to regard them, not as rivals to the independent clocks of the recognised types, but as an important adjunct of their business, to be encouraged and not cold shouldered.

It would be quite easy now to speak with flamboyant rhetoric and yet not overstate the case with regard to the progress of electric clocks, but it is unnecessary to do anything but state the facts, and if this issue of the journal assists in placing the subject in its proper sphere, it will have served a useful purpose.

It is needless to say that the proposal to devote a special number of the HOROLOGICAL JOURNAL to the subject has caused the liveliest satisfaction amongst those intimately associated with the industry, and perhaps the best method of introducing the subject to our readers is to quote the following expressions from two of the leading and representative men in the trade, who have given lifelong attention to the subject.

Mr. Bowell (Silent Electric Clock Company, Ltd.) writes:—

"It is difficult to offer advice upon what is ostensibly a horological subject to horological experts, but we should like to draw the very particular attention of the clock and watch trade to the following very great difference between electric clocks and the ordinary mechanical clock. Mechanical clocks, we believe, do require personal adjustment after they leave the manufacturers and consequently some watch and clock makers, when they purchase electric clocks, approach the subject from the standpoint that certain adjustments are likely to be necessary. We have, of course, no right to speak on behalf of any other system than that manufactured by ourselves, but as regards the electric clock mechanisms manufactured by us, it should always be borne in mind that these mechanisms are sent out perfectly adjusted and require no attention beyond the proper connecting up to the battery supply and the ordinary regulating of the pendulum by the turning of a rating nut. Electric clock mechanisms, in fact, have only one point in common with mechanical clocks and that is that both indicate the time. As a parallel, the electric lamp and the ordinary oil lamp have one feature in common that they both provide light, but because it is necessary to trim the wick of the ordinary oil lamp, it does not follow that it would be advisable to

attempt to trim the metal filament of an electric lamp! If the retail clock trade would therefore pay the greatest attention to verifying the detail of construction of electric clocks by a personal inspection of their manufacture, and would then follow out the ordinary instructions with regard to connecting up, we think that they would find electric clocks a line in which they could do very substantial business, especially in these days where the time recorder clocks are legally admitted as providing the necessary check upon the hours of work, and it is only by means of synchronising the time recorders with the electric master clock that the various time recorders in one factory can be kept together to give identically the same time."

Mr. F. Hope-Jones, M.I.E.E. (Synchronome Co., Ltd.), writes:—

"I understand that the HOROLOGICAL JOURNAL is devoting an issue mainly to electric clocks.

"It will be the first occasion that this or any other journal has done so, and I welcome it as an evidence of its enterprise, and as a landmark, a footprint on the sands of time, in that branch of the profession which it has been my lot to champion for 25 years.

"It would be interesting to look back upon the early efforts in this direction and to trace the history of the electric clock inventions of the Victorian era, but it would take too long to sift the wheat from the chaff and there is much of the latter in the patent library. It would seem that the idea of self-wound clocks was fatally alluring to the dreamer in search of perpetual motion, who has done so much to swell the revenue of the Patent Office. In that unproductive period there were literally hundreds of patent specifications which can only be described as feeble attempts by electricians who were not clock makers and clock makers who were not electricians.

"At the date of my first paper on the subject before the British Horological Institution in 1895, three British and four foreign systems had been tried and found wanting. In the ten years that followed one or two systems were practically alone in this country and succeeded in breaking down the prejudice aroused by past failures. Looking back now, one can see that this decade was of importance because it demonstrated the commercial possibilities of electric clocks and attracted other brains and capital. For, as I said in one of my papers before the Institution of Electrical Engineers, competition is essential to the establishment of an industry and since the pioneering work was done it was high time that others came into the field.

"But truth requires it to be said that the encouragement did not come from the watch and clock making profession. With a few notable exceptions the watch makers and jewellers of this country continued to push electric clocks away from them with both hands. They did not understand them, and did not want to. They feared for their key-winding contracts and past failures gave them a ready excuse for condemnation. But that attitude was wrong; they could no more repel the Atlantic with Mrs. Partington's broom than stay the advent of electrical horology. We all like to be thought enterprising and up-to-date, and what better way of enhancing that reputation than by equipping the local school, institution, or factory with a reliable installation of electric clocks? As for the key-winding contracts, if the system selected is a good one and the advice of the makers is carefully followed, they will find a supervision contract more easily earned and more remunerative.

"Your pages this month will show several systems vying with each other in healthy rivalry to supply the most reliable installations of uniform and accurate time keeping. There is room for all and more, but let there be no petty jealousies. May there be a constant flow of new ideas patiently tried out by manufacturers not too greedy of immediate gain to starve experiment and development.

"Thus shall the Motherland retain its reputation as the birth-place of inventions, a position which it has already won among the nations of the world in the new science of electric time service."

The foregoing expressions of opinion well define the attitude of the profession towards the subject of electric clocks in the past, but there are good grounds for confidence that in the future it will be different.

Mr. T. D. Wright's valuable "Notes on Technical Horology," which are appearing in the journal, have now reached the subject under review. They follow these introductory remarks and with the aid of the illustrations will help to place the subject on its proper pedestal.

Notes on Technical Horology.

By T. D. WRIGHT.

ELECTRIC CLOCKS.

In reproducing the notes on electric clocks some additional matter has been added to the original notes to bring the subject more up to date.

These additions are mostly due to the courteous assistance of the firms concerned in their production.

There are various forms of electric clocks.

1. Self-contained independent clocks, in which electricity provides the motive power, usually by electro-magnetic impulses to the pendulum.
2. Clocks with an independent motive power, but having the vibrations of their pendulums controlled by electric currents from a standard clock.
3. Clocks having an independent motive power, wound at regular intervals by electricity.
4. Dial works, or "journeyman" clocks, actuated at regular intervals by an electric current from a "master" clock, which may be, or may not be, an electric clock.
5. Synchronised clocks, not necessarily electric clocks, but clocks of any kind, having their hands set right at regular intervals, usually once an hour, by an electric current from a standard clock.

For more than seventy years electric clocks have been experimented with. Many were more or less failures, probably because the clockmaker did not sufficiently understand the mysteries of electricity, or because the electrician was not a good horologist.

During the period 1840-1852 Alexander Bain took out many patents, pretty well covering all the ground in this direction.

The pendulums of his clocks received electro-magnetic impulses at every beat, and were based on Professor Oersted's discovery that when a current of electricity passes through a coil of wire a magnetic action is induced, and by this magnetic induction Bain maintained the vibrations of his pendulum. The action in the clock was reversed; instead of the escape wheel driving the pallets, they, guided by the pendulum, drove the escape wheel, and the escape pinion in turn conducted the rest of the train forward.

Some of Bain's clocks are still in existence, but they have not been generally adopted.

During these early years Professor Wheatstone experimented with magneto-electric currents for driving clocks, but was not very successful.

In 1858 R. L. Jones, of Chester, utilised one form of Bain's pendulum successfully for controlled clocks. The master clock is a high-class regulator, closing an electric circuit at every beat of the pendulum, controlling the vibrations of the Bain pendulums, and causing them to vibrate in sympathy with that of the master.

Messrs. J. Ritchie and Son, of Edinburgh, who had a high opinion of Jones's system, improved upon it, and, I believe, still employ it (see HOROLOGICAL JOURNAL, September, 1875). In their improvements they utilised the system to energise the pendulum as well as control it, and, dispensing with the driving weight and necessary winding, caused the pendulum to raise two gravity arms, which, in falling, turned the escape wheel and drove the mechanism of the clock.

Charles Shepherd took out a patent in 1849 for improvements in electric clocks. His method was to use electricity in winding up a remontoir spring or weight. There is still at the Royal Observatory of Greenwich a "Shepherd" clock, used as a reserve mean solar clock.

When the clock swings in one direction it closes the circuit, and the current raises a small weighted arm; in the opposite vibration the arm falls and gives impulse to the pendulum. In spite of more than half a century of constant work, and a rather rough-looking complicated mechanism, it continues to go well.

Dr. Hipp introduced a system, derived, I believe, from the celebrated Foucault, which has been very successful. A little loose bar, or trailer, is pivotted on the back of the pendulum rod. Under this, on a bracket fixed to the back of the clock case, are two springs, or weighted levers, with contact points; the upper spring has a notched block. While the vibrations of the pendulum are sufficiently large the trailer drags over the block and leaves it; when the vibration falls off for want of energy the trailer does not leave the block, and in the return vibration it is thrust into the notch, depressing the spring, thus making contact and closing the circuit. The electro-magnet is fixed in the

base of the clock vertically under the pendulum suspension, and a soft iron armature is fixed to the bottom of the pendulum rod. The arc at which contact shall take place is predetermined, and once this has been adjusted it remains constant, so that always when the vibration falls off to this arc the pendulum seeks renewed energy by closing the circuit. If it receives a big impulse the vibrations continue for a considerable time without making further contact, as the battery grows feeble, the impulses are sought at more frequent intervals. When arranged as above the impulse will always be received *during the descent* of the pendulum, and will cease before the central position is reached. Every time the pendulum receives impulse its motion for that one beat will be accelerated, and as the impulses, from their nature, will vary in intensity and frequence, there is a possible element of uncertainty in the time-keeping. I am assured that these uncertainties are insignificant in practice.

Mr. Bowell, of the Silent Electric Clock Co.; Messrs. Gent and Co., with the motor pendulum of their "Waiting Train" for turret clocks; and Mr. T. Murday, of the Reason Manufacturing Co., all utilised the "Hipp" principle.

In all of these the pendulum derives its impulses from an electro-magnetic current.

One of the oldest commercially successful electric clocks is that of the Synchronome Co.

The earlier form of Synchronome master clock had a gravity arm with a pivotted propulsion click driving a ratchet. Turning with the ratchet and linked to it by a maintaining spring was a wheel driving an ordinary escapement to maintain the vibrations of the pendulum. At the end of every half-minute the tail of the gravity arm made contact with a point on the armature of an electro-magnet, closing the circuit. The armature being drawn smartly to the magnet, throws the gravity arm to its raised position with a quick break of contact. The whole cycle of operations is repeated every thirty seconds, and each time the contact is broken all the subsidiary or "journeyman" dials in the circuit have their hands advanced half-a-minute.

In the later form of Synchronome master clock the escapement is entirely discarded, a count wheel of fifteen teeth, advanced one tooth at every alternate beat of the pendulum, unlocks the gravity arm at the end of each complete turn of the wheel, and the arm gives a direct gravity impulse every half-minute to the pendulum. (Campiche was the first, I believe, to employ a count wheel of this kind advanced by the pendulum which received an electro-magnetic thrust once every minute. See HOROLOGICAL JOURNAL, December, 1893. In 1902 W. E. Palmer patented his system, having a count wheel and a direct gravity impulse without an escapement. About the same time R. M. Lowne patented his invention with a count wheel and spring propulsion. Messrs. Gent and Co. also use a count wheel with gravity impulse.)

In the four systems mentioned the count wheel is advanced by a push. In the Synchronome clock (Fig. 1) the wheel is

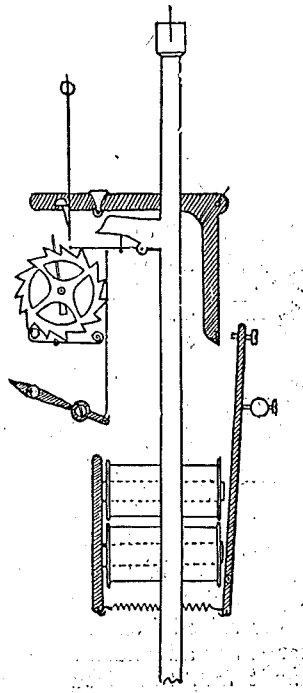


Fig. 1.

advanced by a pull as the pendulum is descending from left to right, a better way, less likely to disturb the rate of the pendulum. At each complete turn of the wheel the arm D fixed to the arbor of C unlocks the arm G from the catch K, and the roller R gives impulse to the pendulum by passing down the pallet J. A light spring arm B, with a looped end, rides over the wheel teeth as the pendulum swings to the left, and, by means of the loop, draws the wheel round one tooth in the return vibration. A spring back-stop, or Jumper O, prevents the wheel

being turned the wrong way when B passes over it. The catch locking the gravity arm is, in principle, a chronometer detent. The impulse pallet on the pendulum is shaped to give the greater part of the impulse during the time the pendulum is near the middle of its swing, as is best. The gravity arm is pivotted at F, and when the impulse is completed the tail makes contact with the armature A, closes the circuit, and the armature, drawn smartly to the magnet, throws the arm up to its locked position. The contrivance on the left is for the purpose of altering the hands of the dial works or "journeymen." When the lever is moved from its normal position at N to R, the

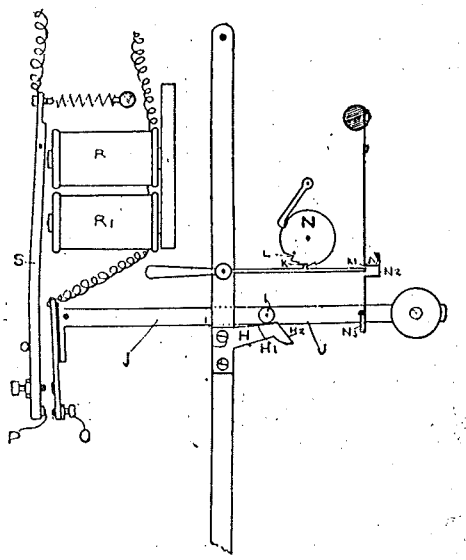


Fig. 2.

spring B is raised free of the wheel so that the latter is not advanced at all, the gravity arm cannot fall, the circuit remains open, no current can pass, and all the dials are delayed for two seconds or any multiple of that time so long as the pointer remains at R. If the lever is brought down to A, the piece B is raised high enough to unlock the gravity arm at every alternate beat of the pendulum, advancing the dials half-a-minute each time. As soon as the dials have been set the lever must be moved back to N.

This, of course, is not an electrically-driven clock; it is a weight clock re-wound every half-minute by an electric current.

Gent and Co.'s master clock (Fig. 2) is an electrically re-wound weight clock. The count wheel N has ratchet teeth all round, one space L being cut deeper than the others, it is advanced by a projecting piece K on the lever K^1 pivotted on the pendulum rod. The gravity arm J is locked at N^3 on the catch. So long as K acts only in the short spaces of N, the end of K^1 passing into the knee of the catch does not disturb it, when K falls into the deep space K^1 will be above the opening, will press against the catch itself, and so unlock the gravity arm to give impulse to the pendulum, close the circuit, and actuate the dial works. With a seconds pendulum and a count wheel of fifteen, this will also be re-wound every half-minute.

Palmer's master (Fig. 3) differs in some details, but is similar in its main principles. I believe it was the first in which the direct gravity impulse, combined with the count wheel, was employed, but Gent and Co.

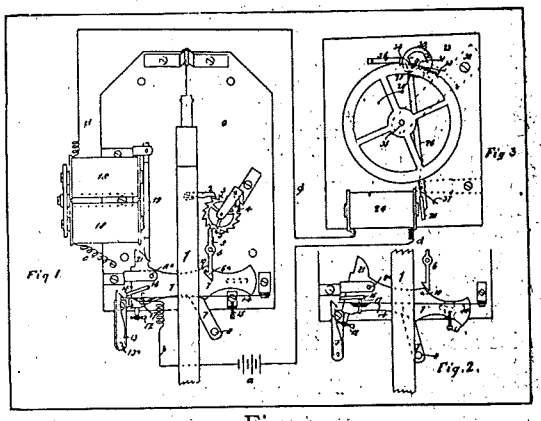


Fig. 3.

appeared to be the first to combine with these two features a roller on the gravity lever operating in conjunction with an angular face of an impulse pallet fixed to the pendulum.

The count wheel 3 is advanced at every alternate vibration by a finger 2 on the pendulum rod; at each complete turn of the wheel a pin in it 5 pushes the pivotted catch 6 on one side and releases the gravity arm 7, which in falling gives impulse to the pendulum by means of the roller 11. The arm is pivotted at 8a. As it completes its impulse and is about to reach the stop 15 an adjustable screw 12 pushes the click 13 out and releases a broad flat brass spring 14 carrying an insulated contact point 17. When the spring is released it flies up, the point makes contact with the plate 16 fixed on the gravity arm, and closes the circuit energising the magnets of all the dials. As the armature 19 is drawn to the magnet, its end, by

pressing on the projection 21, throws the arm up on to the catch at 6a, and as the arm goes up the end of the contact plate at 16a presses the brass spring under the click and breaks the circuit.

Walden's master (Fig. 4) is a direct

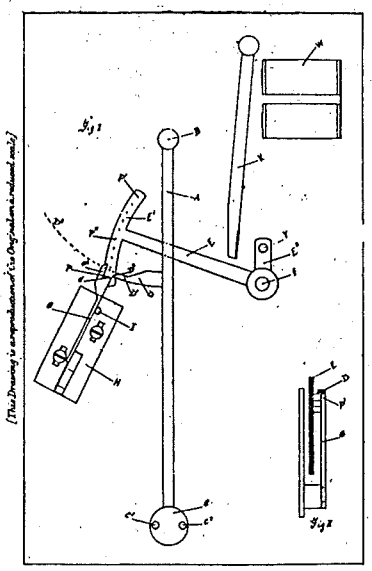


Fig. 4.

gravity impulse clock, electrically re-wound, but differs from those just described, as, although it only closes the circuit to demand energy from the battery at half-minute intervals, the pendulum receives impulse at every alternate second. The gravity arm E is a sector of a pin wheel, with the pins P, P^1, etc., standing up from its face. G is a locking detent on which the pins rest after completing impulse. D is the impulse pallet fixed to the crutch; it has a dead face D on which the pins rest before commencing the impulse. When the pendulum swings to the left the pallet presses against the nose of the detent, releasing the pin resting there; the next pin drops on to the dead face, resting there during any small supplementary arc; as the pendulum swings to the right the pin gives impulse by passing down the face D^2, and then falls on the detent, when the last pin completes its impulse, and just before it reaches the detent, the pin in the tail of the arm at Y makes contact, the armature is brought up to the magnet, and in doing so throws the gravity arm to its raised position. The lowest pin is only a banking pin, and is thicker than the others, as it has to bear the rebound of the arm when thrown up.

The illustration, taken from the specification, only shows ten pins, but there may be any convenient number. With a seconds pendulum and half-minute advances of the dials the arm has fifteen impulse pins.

The detent is mounted on an adjustable platform H, and has an eccentric banking screw I.

The pin wheel escapement with its continuous impulses appeals to the clock maker, but when the arm is thrown up all the pins have to pass and displace the spring detent, causing an unpleasant swishing noise.

Lowne's master (Fig. 5) is a spring impulse clock, electrically re-wound. The impulse spring A^{13} is fixed at the right-hand end to the frame, and normally, by means of the rod A^{14}, holds the armature away from the magnet. The count wheel A^1 is advanced, as the pendulum swings to the left, by a pawl A^2 attached to an arm on the pendulum crutch; at every half-minute one end of the lever A^7 presses A^8 and closes the circuit, the armature is drawn down, and the circuit is broken at A^{15} on the armature; in the meantime the pin A^{16} in a pivotted lever has ridden on top of the armature at A^{18}, and holds it

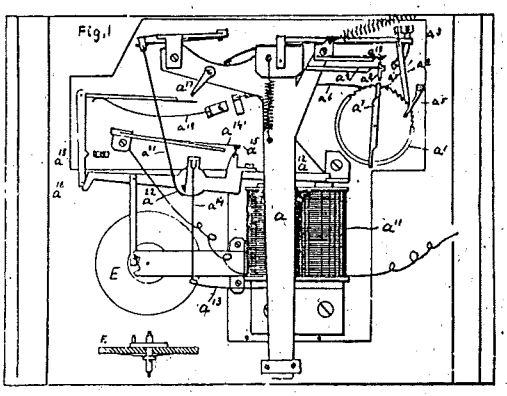


Fig. 5.

down while the escapement rod A^{21} has mounted the catch A^{22}; as the pendulum swings to the right a piece A^{17} on the crutch arm pressing on the pivotted lever turns it and releases the armature, which is thrust upwards by the impulse spring, and pressing the escapement rod up gives impulse to the pendulum. The purposes of the adjustable inertia piece E is to slow down the motion of the armature and regulate its speed.

Step-by-step dial works or "journeymen" are much alike. That of the Synchronome Co. is shown in Fig. 6. A simple "motion work" train has a wheel of 120 teeth A on the centre arbor which carries the minute hand. The armature D of the electro-magnet carries a propulsion click E, a spring F,

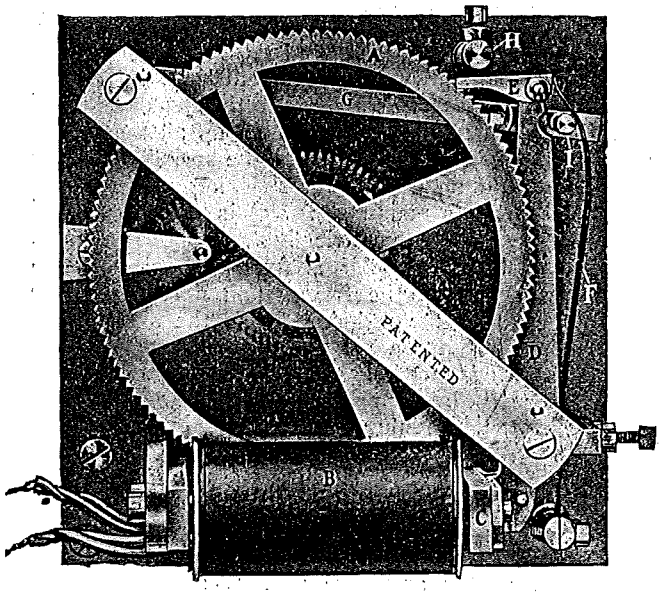


Fig. 6.

presses the armature back with a constant force and advances the wheel A one tooth each time the circuit is broken at the master clock, every half-minute. The lock stop H prevents more than one tooth advancing at each propulsion, while the stop I limits the motion of the armature and prevents more than one tooth being picked up when the circuit is closed. G is a back stop to prevent the wheel A from turning backwards. In most dial works there is nothing to prevent the hands being moved forward during the short time that the circuit is closed. In the latest form of Synchronome journeyman, the lever G carrying the back stop is prolonged beyond the armature, and has the stud I standing up from it, acting as a stop. In the earlier forms I was an adjustable stop fixed in the plate of the clock. When the armature is drawn to the magnet the semi-circular notch in back of armature embraces the stud, holding G down so that the wheel A cannot move until the circuit is broken again.

Palmer's dial work is shown in Fig. 3. The armature has a forked end embracing a pin in a disc, on which is pivotted the propulsion click 33. The boss 31 of the disc has a notch to allow one tooth to advance with it when the circuit is broken, but as soon as one tooth has passed the circular portion of the boss resting between two teeth prevents any further motion of the wheels.

All the modern systems described act satisfactorily for clocks of moderate size having their hands protected from wind pressure.

For turret clocks Messrs. Gent and Co. have invented a "waiting train" movement—Fig. 7.

A heavy motor pendulum carries a Hipp trailer, which closes the circuit and seeks energy as often as needed—whenever the vibrations fall off to a given arc. Normally this occurs about once per minute, but if resistance is applied to the hands, such as is produced by wind pressure, the circuit would be closed more frequently.

As the pendulum vibrates the pawl A advances the wheel E at each alternate vibration and drives the hands forward a half-minute at each turn of E. It is regulated to go fast and completes the half-minute in about twenty-seven seconds, by which time the pin F reaches the control lever C, and, raising it, lifts the pawl out of the wheel so that the hands can no longer be advanced

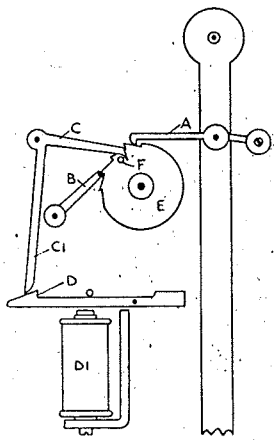


Fig. 7.

and the motor train "waits" until the master clock signifies that the half-minute is really complete by closing the circuit. When C is raised by F its tail C^1 is locked by D. While it remains in this position A cannot act in the wheel E, and F is carried just in

front of the point of C. When the circuit is closed and the armature is drawn over, D liberates C^1, and C falls back into position, allowing A to engage E, and the advance of the hands proceeds as before.

The very large dials in the Royal Liver Buildings at Liverpool are equipped with these motor pendulums and have given excellent results.

The master clock, which may be as Fig. 2, is the real timekeeper. The rate of the motor pendulum is unimportant so long as it is always certainly fast of the master.

Fig. 8 shows a motor pendulum for turret

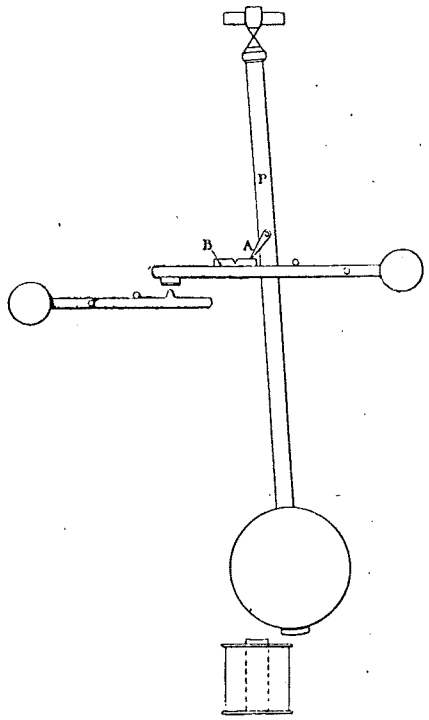


Fig. 8.

clocks by Mr. Murday. A is the Hipp trailer, B the notched block over which A trails until the arc falls off to the predetermined minimum when it does not leave the block; A is then thrust into the notch, closing the circuit and energising the magnet to give renewed impulse to the pendulum.

The silent electric clocks have some features quite different to the systems previously described. The master clocks are made either with half-seconds or full seconds pendulums.

Fig. 9 illustrates the half-seconds "master." Energy is communicated to the pendulum on the "Hipp" system. The Hipp trailer is pivotted in the crutch frame behind the pendulum rod. When the predetermined minimum arc is reached the trailer is thrust into the notched block, the pendulum circuit is closed, the pendulum receives an electro-magnetic pull increasing the arc again and enabling the trailer to leave the block at each vibration until the arc once more falls to the minimum, when the pendulum again makes its request for renewed energy.

The count wheel, shown on the right of the illustration, has 30 teeth. As the pendulum swings to the left the driving click resting on top of the count wheel, from the left side, just trails over the wheel teeth; in the return vibration the click advances the wheel one tooth, so that the wheel makes a complete turn in half-a-minute. One of the spaces in the wheel is cut deeper than the others and when the driving click enters this deep space it engages the "bird's mouth link" shown above the wheel on the right-hand side, which then closes the contact springs of the dials circuit.

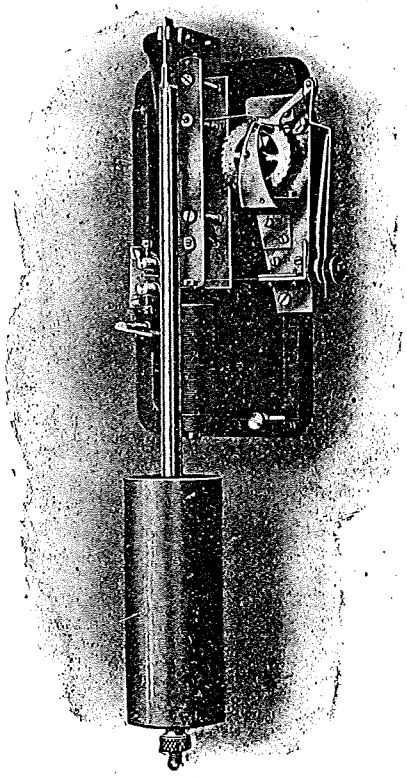


Fig. 9.

As there is no gravity arm to be thrown

up and no mechanical work to be done except the advance of the lightly pivotted count wheel there is no sensible noise and the clock justifies its right to the title of the " silent " master.

The mechanism of the " journeymen " or " receiving " clock (Fig. 10) is also silent. The hands are advanced by magnetic effect, by means of an eccentric armature rotating freely inside a circle of four pole pieces, two of which are poles of a permanent magnet, the other two, at right angles to the first pair, are poles of an electro-magnet. Normally the armature is locked by the permanent magnet and the hands cannot advance. As soon as the dial circuit is closed by the master the electro-magnet, more powerful than the permanent one, draws the armature forward a quarter of a turn, directly afterwards the circuit is broken, the permanent magnet re-asserts itself and the armature is drawn forward another quarter of a turn. The hands have now advanced half-a-minute by two short steps, following one another rapidly, the armature being locked alternately by either magnet.

As the whole energy is electro-magnetic and the only motion the turning of the armature on its pivots, and the turning of hand-work, the effect is noiseless.

The Standard Time Co., whose system of synchronisation of ordinary clocks is so well known, have designed a turret impulse movement. Turret clocks with ordinary copper hands, of any size, can be successfully driven by half-minute or minute impulses from the master clock.

This movement is unique in that it has two magnets, the armatures of which are mounted on the long end of the lever. A separate locking ratchet is used which insures the hands being locked at all portions of the stroke.

There is also a magnetic brake attached to one armature to prevent any possible bouncing.

With one of these small movements 4-feet dials with copper hands can be safely driven with 10 volts and a current of .13 amperes.

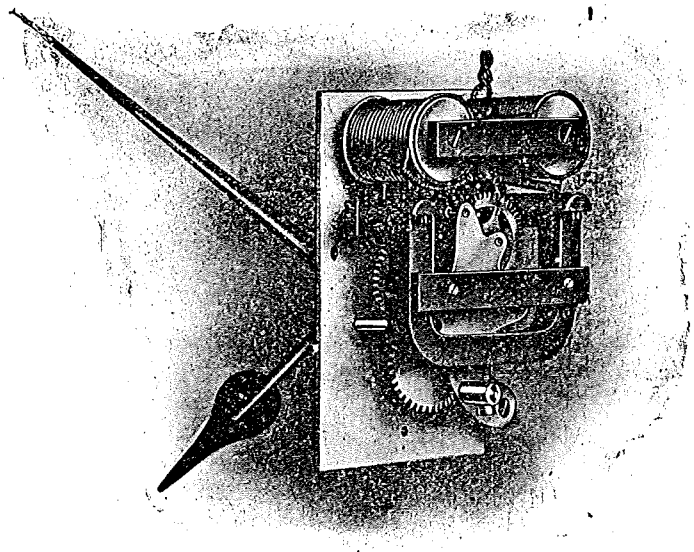


Fig. 10.

The Standard Time Co.'s transmitter (Fig. 12) has a gravity impulse acting direct on the crutch without any pallet. Two arms pivotted close to the crutch arbor, one on each side, hang about 20 degrees out of the vertical, right and left of the crutch; the right-hand arm is the gravity arm and is provided with an armature for replacement and its lower end with a catch and trigger, it also has a " break " contact which simultaneously short circuits the clock circuit, thus obviating sparking due to self-induction. The left-hand arm has a " make " contact normally closed and a horizontal lever at its lower end passing in front of the crutch and engaging with it on being raised by means of the count wheel at half-minute intervals. The engagement

of this lever with the crutch causes it and the arm to which it is attached to be drawn on the right by the pendulum and the right-hand gravity arm is unlocked and falls to the left with the pendulum until the

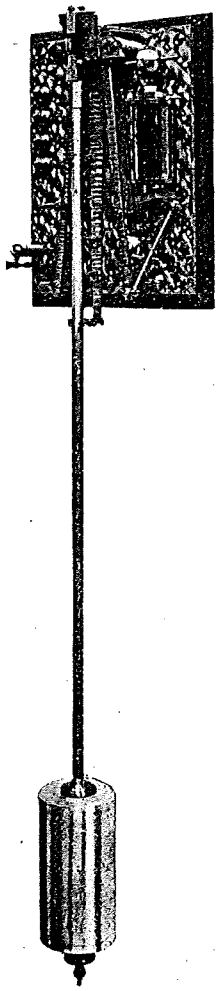


Fig. 12.

" make " contact on the left arm is closed, when the gravity arm is replaced and locked by the magnet acting on the armature. The connecting lever then falls out of engagement with the crutch until it is again raised by the count wheel.

The Magneta Time Company's clocks are on an entirely different principle to any of those already described.

The Master Clock is a substantial well-made clock driven by a heavy weight. This weight has to supply all the energy required by the subsidiary or " journeymen " dials. Once every minute the clock causes the rotation of an iron cylinder through a quarter of a turn inside a coil of wire. This movement sets up an undulating magneto-electric current through the coil, which is instantly transmitted to the secondary dials so that their hands are set forward one minute.

The great advantages claimed for the system are that no batteries are required, and as it is a closed circuit there are no contact points to get corroded or dirty.

As the pendulum has nothing to do with the electrical arrangements, its vibrations are in no way disturbed by outside interference of any kind, and this is conducive to good timekeeping.

The secondary dials, like those of the other systems described, need no winding-up, but as the weight of the Master Clock has to do all the work, that clock needs frequent re-winding.

THE SYNCHRONOME SYSTEM.

The " Synchronome " system has not only a history of its own, but may truly be said to have made the history of Electrical Time Service as now established.

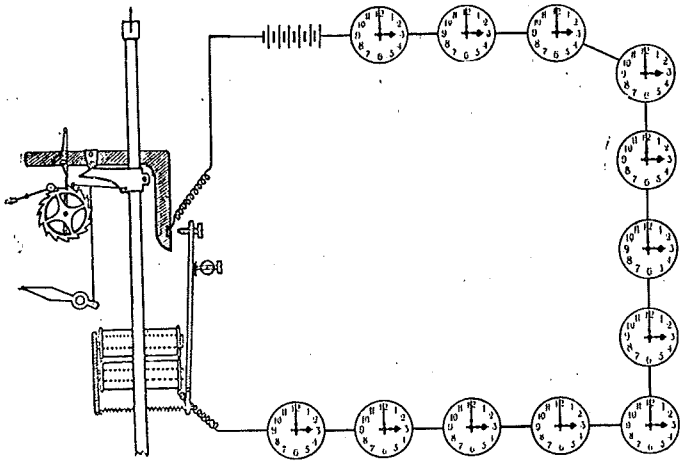
The first of a long series of patents was taken out in 1895, when Mr. F. Hope-Jones read a Paper before the British Horological Institution in that year. The literature of the subject is mainly from his pen, and he has since read many Papers before Scientific Societies, notably the Royal Astronomical Society and the Institution of Electrical Engineers, in 1899 and in 1910. In the discussion following the latter, Mr. H. R. Kempe, Electrician to the Post Office, said: " I have mentioned Mr. Ritchie as being a pioneer, but I must assert, and, I think, with authority, that by no man living or dead, have electric clocks been brought to such perfection as they have been by Mr. Hope-Jones."

The " Synchronome " system was alone in England from 1895 to 1905, and in that ten years it succeeded in breaking down the prejudice previously aroused by the many failures of other systems.

Progressive improvements have achieved an ideally simple system of half-minute electrical impulse dials, operated by a pendulum which is altogether free except at the moment of passing through its zero position, yet has a detached gravity escapement—a combination which Horologists have been striving after for centuries.

Our illustration shows the switch in diagram operating a circuit of electrical impulse dials. The Synchronome switch consists of two moving parts, both shaded in the illustration, (1) the right-angled gravity lever centred at its corner and supported on a spring catch. Once every half-minute this lever is let down, in the act of giving an impulse to the pendulum, upon (2) the armature, which is almost vertical and is centred near its lower end. Current from any available source then passes through the series circuit of dials and the magnet which attracts the armature and throws up the gravity lever on to its catch again.

If the current is insufficient, the pendulum assists the electro-magnet to replace the gravity lever, thereby giving warning of impending failure of battery by lighting a lamp or ringing a bell.

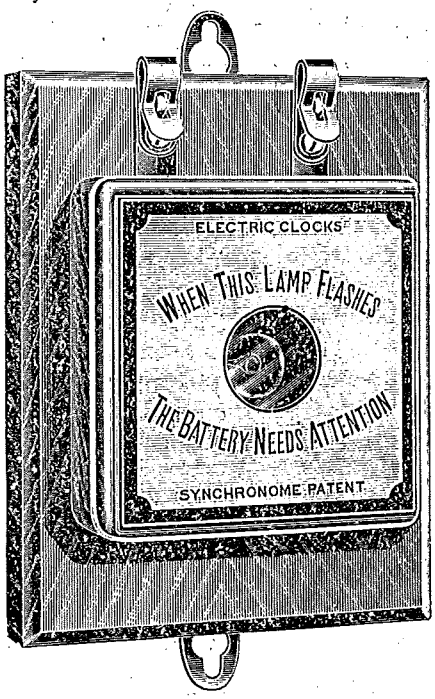


The pendulum releases the switch by means of a wheel of 15 teeth, which carries a vane to engage the catch at each revolution. The jewelled hook pivotted upon the pendulum turns this wheel every 30 seconds. At the moment of its release the little roller on the gravity arm is just above the curved end of the pallet forming a bracket on the pendulum, down which it runs, giving an impulse to the pendulum at the moment when it passes through its zero or central position.

It thus ranks as an horological instrument of the very highest class, but its merits are not less distinguished from the electrical point of view. The Synchronome Switch is well known as the first and natural embodiment of those great principles enunciated by Mr. Hope-Jones and which may be briefly defined as follows:—

1. The transmission of energy through the surfaces of the contact (instead of robbing it from the clock).
2. The use of self-induction to dictate the duration of the contact (thus ensuring that every dial gets enough current without wastage).
3. Impossibility of stopping in closed contact.
4. Battery warning as a natural function of the apparatus.

The latter function is now made use of in a new way to flash a red lamp. An illustration of one of these is shown, and it is found that it compels attention more effectively than the ringing of a single-stroke bell. It can, of course, be included in the series circuit at any point, such as in or above the Master Clock or on the desk of the Premises Superintendent or Works Engineer.



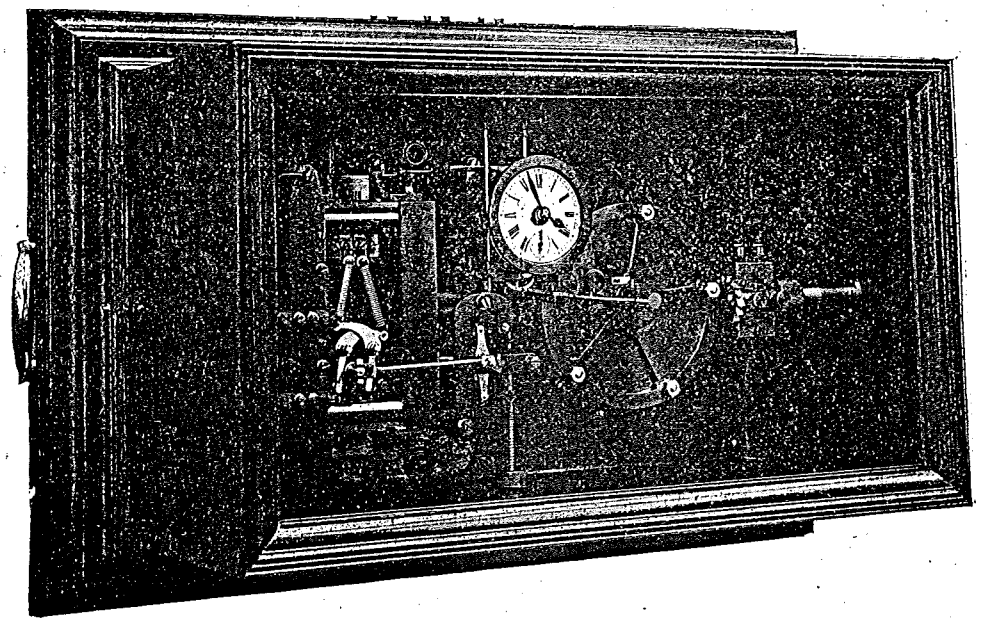
THE MAGNETA ELECTRIC TIME SYSTEM.

The Magneta Electric Time system, which is patented in all countries throughout the world, differs fundamentally from any other electric time system, and owes

its efficiency and trustworthiness to the peculiarly simple nature of the principle on which it works.

Magneta Marine Master Clock.

The "Magneta" Master Clock is the central point of each installation, and by it the whole system of Secondary Clocks is both actuated and synchronised, and the highest timekeeping qualities are secured by the extreme simplicity of construction of the various parts of the system. The Master Clock, by its own mechanical energy, generates the electric impulses, which are always of precisely equal strength and duration.



Magneta Marine Master Clock illustrated is identical in construction with Magneta Master Clocks for land purposes, except that it is spring instead of weight controlled.

These Master Clocks, which constitute the heart of the system, are of peculiarly massive and solid construction, the general design being more of the type used for high-grade machinery than that usually employed for clockwork, and their mechanism can be relied upon to be working with the same precision at the end of a quarter of a century as when first erected.

The Secondary Clocks require neither winding, setting, nor repairing, and when once fixed the cases can be closed and permanently fastened; no further access to them is, under ordinary circumstances, required. There are no incidental or working expenses of any kind, and however large the number of dials, or however widely distributed, their indications are always identical.

In his report on the Magneta system, the late Sir William H. Preece, K.C.B., F.R.S., said:—

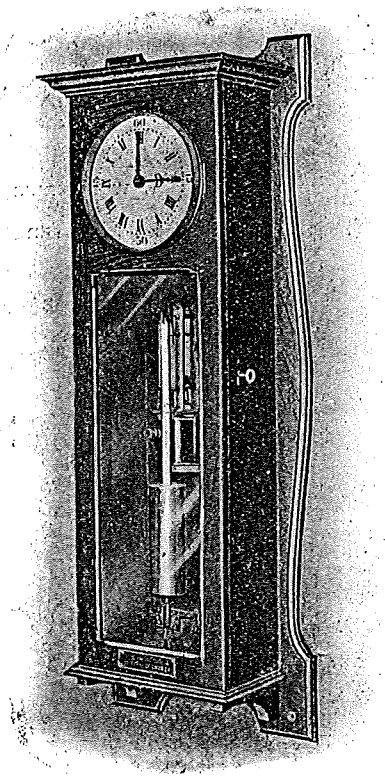
> "The 'Magneta' system removes these two weak points. The battery is replaced by an alternator, and the circuit is never broken. There are no sparks and no contact points to get dirty. . . . The system is trustworthy. There is little to maintain and nothing to renew. Occasional lubrication is, of course, desirable, as it is in common clocks, but the Secondary Clocks require no winding, setting, or repairs. . . . I have formed a very high opinion of its practical merits."

In a general survey of electric clocks throughout Europe (drawn up for the Right Hon. Sir J. G. Ward, P.C., K.C.M.G., Postmaster-General, Wellington), which was issued as a Parliamentary Paper, "Magneta" was recommended for Government use as being the most perfect apparatus.

SILENT ELECTRIC CLOCK.

The Silent Electric Clock Company, Ltd., 192, Goswell Road, have now been established in Clerkenwell for over ten years, and are the manufacturers throughout of the mechanisms of the electric clocks which bear their name.

The important art of wheel-cutting has been carefully studied, and it is not an idle boast when the Company state that the wheels that they cut are in every respect the best possible.



The care taken over the manufacture of the clocks is a very potent reason for the success which has attended the Company's activities in spite of the fact that during the war period every man of military age joined up and the business was carried on at a minimum.

Apart from the care taken in manufacture, an even stronger reason for the reliability of the well-known "Silectock" electric clocks is the patented principle upon which the receiving clocks are made.

At the commencement of the Company's commercial activity they broke away from the old tradition of making an electric clock receiving mechanism an extremely small affair with teeth so infinitesimal that the electric current frequently jumped several teeth at a time, thus causing the unfortunate receiving clock to indicate several minutes faster than its fellows.

The "Silectock" patent rotary armature principle has abolished springs, ratchets, backstops and all other artificial assistances to the working of the clock mechanism, and in their place has substituted a simple rotating armature which must, and cannot fail to, respond at every half-minute to the electric current.

The Master Clocks also constructed by the Silent Electric Clock Company are built in a substantial and solid manner, mounted on heavy cast-iron bases and fitted with pendulums of negligible coefficient of expansion.

The Company's name, "Silent," is fully borne out by the quiet action, not only of the receiving clocks, but also of the Master Clock, and the unpleasant noise caused by the falling of a lever at each half-minute which used to be considered inseparable from an electric Master Clock, is now a thing of the past, so that the Master Clocks made by the Silent Electric Clock Company are in every respect suitable to be placed either in a private office or in the library of a residence. For this reason the Company has always made a strong point of a substantial well-designed case together with an ornamental dial.

Visitors to the Company's workshops and Test Rooms are welcomed, in order that they may satisfy themselves as to the substantial and accurate methods of manufacture.

THE "PULSYNETIC" SYSTEM OF ELECTRIC CLOCKS.

THE "Pulsynetic" system made its appearance in commercial form some sixteen years ago (1904), and at once marked an advance in the science of electric clock making, inasmuch as it provided a master clock or transmitter which possessed an advantage inherent with its construction, the advantage being that it would not stop on contact (and consequently ruin the battery) and also enabled an audible and timely indication of a weakening battery to be given by means of a warning bell which it is capable of operating, and by a visible change in the action of its mechanism.

The "Pulsynetic" system also intro-

duced for the first time "a roller and incline plane" impulse to the pendulum through a gravity lever at the usual half-minute periodicity. Clocks embodying these improvements were introduced under the title of the "B.P. system," after the names of the inventors, but the system was shortly after known under the registered title of "Pulsynetic," and under this name the clocks have been sent to all parts of the world.

With the "Pulsynetic" system was introduced the nomenclature "impulse clock" and "impulse or time transmitter," which names are now almost invariably adopted by the trade.

The "Pulsynetic" system in its simplest form consists of a number of impulse clocks, a time transmitter, a weak battery warning bell, and the necessary battery.

The warning bell is not an absolute necessity, but experience has proved its worth, and its small extra cost should not be grudged.

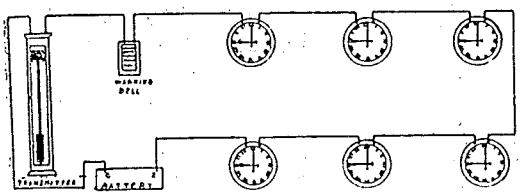
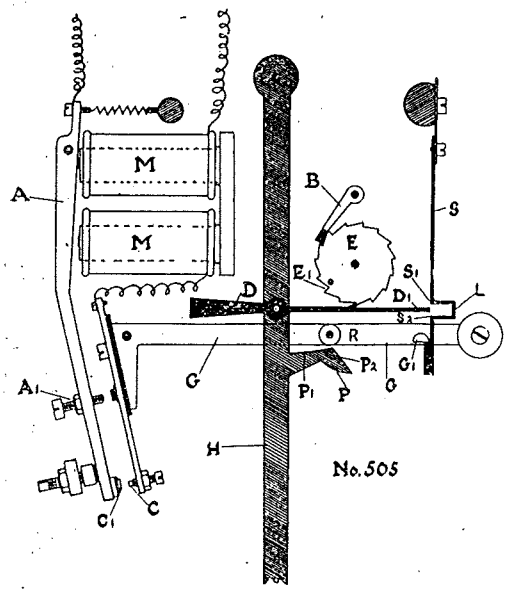


Diagram No. 506 illustrates the system, and, as shown, would give absolutely uniform time in all departments of, say, a business house. The time keeping, after regulation of the time transmitter, in position is found to be far above commercial requirements—many watch makers use a time transmitter as their shop regulator. Drawing No. 505 shows diagrammatically the "movement" of the time transmitter, and incidentally shows the simplicity of the mechanism, which operates as follows:—Normally, while swinging with the pendulum, the pallet P of the crutch H passes close under, but does not (and must not) touch the roller R, which is pivotally mounted on the gravity or impulse lever G. The driving pawl, D, pushes round the escape wheel, E, tooth by tooth, with each oscillation of the pendulum. The pawl, B, prevents the backward rotation of this wheel. At each half minute, however (one revolution of the wheel), the driving pawl, D, enters the deep cut tooth, E1, and the extension D1 of the pawl D rises, and engages the supporting or stirrup catch, S, at the point S1, instead of passing freely through the loop L as normally. The supporting catch S is then pushed out of engagement with the gravity lever G at G1, allowing this lever to descend. The roller R with the gravity lever first drops on to the dead face P1 of the pallet P, and rolls down the inclined face P2, during the pendulum's swing to the left, thus imparting to it mechanically a gravity impulse of unvarying force. The downward path of the gravity lever is definitely arrested by the contact C meeting the contact C1. The circuit being then complete through the magnet MM, and the external circuit (including a battery and a number of impulse clocks), the armature A is attracted, and the gravity lever consequently lifted to its normal position (by the armature), the contact being broken by the breaking screw A1, which arrests the motion of the armature, and causes the contacts C and C1 to separate.



Automatic Advancement of the Impulse Clocks from the Transmitter.

While holding down the repeating cord provided in each transmitter, the extension D1 of the pawl D is depressed, and, consequently, engages the supporting catch S at the point S2 at each vibration of the pendulum, thus releasing the gravity lever G and causes it to make contact every two seconds, instead of at each half minute, as above described. The impulse clocks are

then advanced at the rate of half minute every two seconds, so long as the repeating cord is held down.

The "Pulsynetic" system is economical in regard to current consumption.

This, in the first place, is due to the duration of the contact being only that required to operate the circuit of clocks at each half-minute impulse, the duration being only approximately one thirtieth of a second, the actual duration being self-adjusting, depending on the condition of the battery.

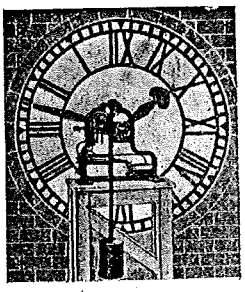
In the second place, the value of the current which flows momentarily through the circuit is low, being only one fifth of an ampere, consequently a current source such as a Leclanche battery, which is unable to give a large output, is quite suitable for operating "Pulsynetic" clocks.

Cases are on record where the same porous pots have been in use for eight years without renewal.

In addition to operating clocks which give uniform time, the "Pulsynetic" system is largely used for synchronising workmen's recorders, and operating automatic sound signals for the starting and ceasing of work, special apparatus being made for these purposes. The "Pulsynetic" system is also employed for recording the output of machinery and the maxim which the "Pulsynetic" system puts into force is "One Factory and One Time."

Another feature of the "Pulsynetic" system is the "Waiting-Train" movement, which is a powerful "Pulsynetic" clock mechanism for driving the heavy hands of large clocks with a practically continuous motion, the mechanism being controlled by the periodical half-minute impulse of the transmitter. The Royal Liver clock with its four twenty-five feet dials is an example of such a clock, as it is fitted with the "Waiting-Train" movement, and its accuracy is beyond question as this clock has become the standard time-keeper for Liverpool.

The accompanying illustration shows the "Waiting-Train" movement in position in a tower, and also one of the dials which it drives.



Apart from the advantage of working in unison with other electric clocks, the "Waiting-Train" clock has advantages not possessed by others, the foremost being the faculty of automatically producing additional driving power, when such is required to meet the resistance given to the hands by adverse weather conditions.

PRINCIPLE OF WORKING.—The "power factor" of the "Waiting-Train" movement is an electrically driven pendulum (termed a motor pendulum), the function of which is not to keep time, but to drive (by means of a pawl), a ratchet wheel, tooth by tooth, at each vibration, the ratchet wheel, in turn, by means of worm gearing, driving the hands of the clock. The motor pendulum is, by a simple device, re-energised by an electro-magnet when its oscillations fall below a predetermined arc.

Under normal working conditions re-energisation takes place about once per minute, but on heavy work being thrown on to the movement, due to resistance and wind pressure on the hands, the motor pendulum becomes energised more often; each complete vibration if necessary. On being energised at each complete vibration, the motor pendulum then develops 30 times its normal power, and it is impossible to stop the movement by hand, even when exerting one's full power on to the worm wheel.

The "Waiting-Train" movement drives one, two, three, or four pairs of hands (by means of the usual crown work), as may be called for by the number of faces of the clocks.

PRINCIPLE OF HALF MINUTE TIME CONTROL.—The gear ratio is such that the minute hand is driven through a half-minute space on the dial in approximately 27 seconds. The pawl of the motor pendulum is then automatically lifted out of engagement with the ratchet wheel, so that, although the motor pendulum maintains its action, the hands remain stationary for two or three seconds, locked by the worm gear. A current impulse from the transmitter, dead on the half-minute, releases the pawl, and the hands are driven forward for another half-minute on the dial. As a rest of two to three seconds is inappreciable, the hands appear to move with absolute regular progression, and do not move in half-minute jumps as is the case in impulse movements.

The employment of a " Waiting-Train " Movement for driving, say, a large tower clock, enables the time transmitter (containing the time keeping pendulum) to be fixed in the basement of the tower where it would be in the best position for time keeping, besides being easy of access for regulation; while the " Waiting-Train " Movement would be fixed directly behind the dials, and therefore connected direct to the hand gears —the best position for driving the hands. As this position dispenses with the perpendicular shafts and nests of bevelled wheels the back lash due to same is eliminated.

The pendulum of the " Waiting-Train " Movement is, as will be perceived, a " motor pendulum " only, therefore the time keeping of this movement is not affected by vibration as usually experienced in tall towers. It is this vibration which has compelled the mechanical clock maker to fix his clock movement lower down in the tower, where the vibration would be less, with the result that long perpendicular rods are necessary to convey the motion of the clock to the hands, and thus introduce objectionable back lash.

THE STANDARD TIME CO., LTD.

Electric Impulse Movement for Driving Turret Clocks.

(Patent 1641/1915.)

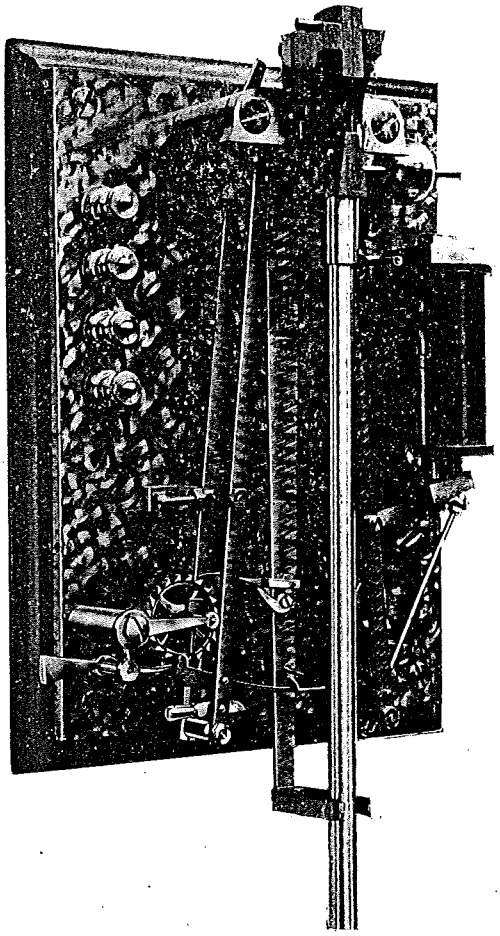
Owing to the vagaries of wind pressure and to the light type of hands hitherto required for use with electric impulse movements, the driving of Turret Clocks with exposed hands electrically has until recently been somewhat unsatisfactory.

The Standard Time Co., Ltd., have, however, now solved the problem, and by means of their Turret impulse movement here illustrated Turret Clocks with ordinary copper hands, of any size, can be successfully driven by half-minute or minute impulses from the Master Clock.

This movement is unique in that it has two magnets the armatures of which are mounted on the long end of the lever. A separate locking ratchet is used which ensures the hands being locked at all portions of the stroke. There is also a magnetic brake attached to one armature to prevent any possible bouncing. With one of these small movements 4ft. dials with copper hands can be safely driven with 10 volts and a current of .13 amps.

Electric Master Clock or Transmitter.

The Standard Time Co.'s Transmitter has a gravity impulse acting direct on the crutch without any pallet. Two arms pivoted close to the crutch arbor, one on each side, hang about 20 degrees out of the vertical, right and left of the crutch; the right hand arm is the gravity arm and is provided with an armature for replacement



and its lower end with a catch and trigger. It also has a " break " contact which simultaneously short circuits the clock circuit, thus obviating sparking due to self-induction.

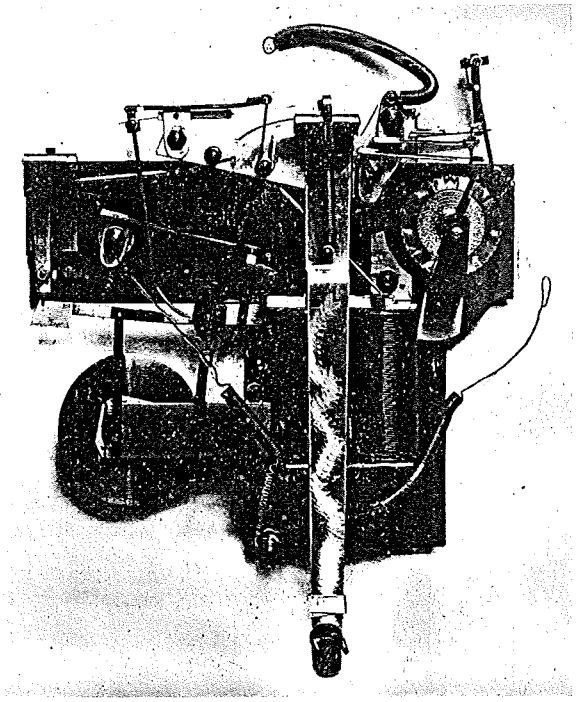
The left-hand arm has a " make " contact normally closed and a horizontal lever at its lower end passing in front of the crutch and engaging with it on being raised by means of the count wheel at half-minute intervals. The engagement of this lever with the crutch causes it and the arm to which it is attached to be drawn to the

right by the pendulum, and the right-hand gravity arm is unlocked and falls to the left with the pendulum until the " make " contact on the left arm is closed, when the gravity arm is replaced and locked by the magnet acting on the armature.

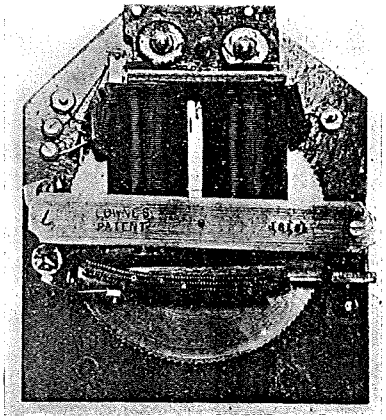
The connecting lever then falls out of engagement with the crutch until it is again raised by the count wheel.

THE LOWNE ELECTRIC CLOCK.

" Trifles make perfection, and perfection is no trifle." Many mechanical devices bear testimony to the truth of this dictum,



but none to a more marked degree than a modern electric clock. The main principles governing the application of electricity for driving clocks are simple enough, and any amateur with electrical knowledge can devise a clock that will work, at least for a time. It is, however, the little things that count, and to evolve a system that will operate successfully for years under commercial conditions at low initial and maintenance cost, without calling for constant attention and with certainty that its time-keeping qualities will not vary, demands inventive genius and constructive ability of the highest order. It is claimed for the system perfected through the experience of twenty years by the Lowne Electric Clock Co., Ltd., of Bromley Road, Catford, that it represents the last word in reliability, accuracy and freedom from breakdown. The following notes will make clear the features that have been responsible for its wide adoption in railway stations, schools, workshops, factories, and in private houses throughout the United Kingdom, and in many places overseas. The pendulum, being caused to vibrate, moves a transmitter wheel step by step, until an arm carried by the wheel coincides with the path of motion of a spring piece carried by the pendulum fork. This closes the electrical circuit, and current energises an electro-magnet which draws down an armature. In its movement towards the pole-pieces the armature breaks the electrical circuit and depresses a spring



which is held in tension by a stop. The return beat of the pendulum releases this stop, and the stored-up energy from the spring is communicated to the pendulum through an escapement-rod and a pallet, sufficient impulse thus being given fully to maintain the swing of the pendulum until another contact is made. As soon as the impulse has been given, the escapement-rod leaves the pallet and thus is ready to come into operation again at the next contact, these successive movements recurring as long as a supply of current from a battery or other source is available. A friction-tight disc in mechanical connection with the armature serves as a governor to regulate the electrical energy that passes through the complete circuit, in which are included both the pendulum and the receiver-dials. It will be seen that the func-

tion of this governor is most important, since should the battery be weak, the governor will maintain contact over a longer period to permit of a heavier current passing. Conversely, with a strong battery the duration of the contact is exceedingly short and the current passing is extremely small. In both cases the energy absorbed in giving an impulse to the pendulum and receiver-dials is practically the same, and a galvanometer placed in the circuit will show almost identical readings over a very wide range of battery power. Thus, in the Lowne system, only sufficient power is taken from the battery to perform the necessary work, with the result that the life of the battery is prolonged enormously, the conditions being such that the clocks will continue to operate and to keep accurate time so long as any current remains in the cells. All moving parts are so designed that for all practical purposes friction is eliminated, and the action of the pendulum may be compared with that of an accurate pair of scales, which will weigh its quantities continually without appreciable wear or friction.

All the receiver-dials are connected in series with one another, with the pendulum and with the battery. Their operating movements are exceedingly simple, and comprise pawl and click moving by gravity a single toothed wheel through the medium of an armature attracted by an electro-magnet, the latter being energised by the regular impulses transmitted from the pendulum. The frequency of these impulses may vary according to requirements, the usual practice being to arrange for half-minute intervals. An electrical cut-out in connection with the armature fulfils a two-fold purpose. It comes into operation as the armature nears the pole-pieces, and serves not only to minimise sparking at the contacts, but to obviate all tendency for the armature to "hang up" or stick to the poles. The armature cannot vibrate, and freedom from sparking prolongs enormously the life of the contacts.

Installations of the "Lowne" Electric Clocks continue to operate perfectly for many years without any attention beyond that needed when ultimately the battery requires renewal. The system may be used with equal success on a small scale in private houses or business premises, or may be applied to the largest installation needed in public buildings, in extensive works, throughout railways, or large areas in which uniform time is required. If a thousand clocks are called for, the method adopted would be to instal a single seconds-beating pendulum of high precision, which would synchronise 10 three-quarter seconds-beating pendulums of standard type, each of which would control a local circuit to which 100 receiver-dials were connected. All the 10 circuits would be quite independent, and an accident in any of the local circuits would affect only the one involved, while an accident to the Master Pendulum would not prevent the installation from operating, but for the time being merely would deprive the sub-pendulums of their synchronised control, the degree of error that would exist in such circumstances after several days depending upon the accuracy with which the respective pendulums were regulated in the first instance.

Trade Unionism and the Horological Trades.

By FRANK E. HUMM,
London District Secretary, National Union of Gold, Silver and Allied Trades.

IN the April issue of this journal, the writer dealt with the general principles of Trade Unionism, as applying to industry generally. We will now endeavour to show how they would apply to the horological workers and benefit employer and employee.

We shall find on looking back into the past of these trades that the direct antithesis of these principles has generally prevailed.

Instead of a collective price for labour, each man has been a law unto himself as to how *cheap* he could work. Instead of meeting together and exchanging news and views each man has looked askance upon his fellow-workman, and when by these customs it has been found impossible to earn *literally* a "living wage" the men have sought a remedy by becoming an outside "jobber" or small master man, but still in seclusion, either in their own homes or by sharing a "sit" with some other recluse. In this respect, perhaps, it is unfortunate that the sedentary nature of these trades lends itself to creating a self-centered habit in the individual, and in certainly the watch working section, as a comparatively small kit will enable a man to work for himself, outworking has flourished.

We are not forgetting that the Horo-

Correspondence.

ELECTRIC CLOCKS.

DEAR SIR,—May I thank you for your interesting August issue of the Journal?

Your leading article describing "Horologists as cautious individuals and apt to move slowly with innovations" might be put in much stronger terms. The thought occurred to me while reading it, that the HOROLOGICAL JOURNAL dated August, 1920, could have been dated *1910*, for ten years ago practically all the information therein was common knowledge to the few *interested* in Electric Horology. I emphasize *interested*, as unfortunately most of the Horological trade at that time displayed little desire to know more of Electric Horology.

I asked a firm of Turret Clockmakers relative to fitting a church clock, and was told "Electric Clocks were failures for Turret work," so the order had to go to Electrical Enginners who had enough confidence in their work to tackle driving 25ft. outside dials by electricity, and successfully, too!

I consulted a firm of clock manufacturers *re* fitting a factory, and was told "That an English Shortfall dial would beat any Electric on the market." Another order had to go to the Electrical Engineers instead of the trade.

Imagine any up-to-date man of business equipping his mill with Shortfalls!

In my enthusiasm, I talked with my retail friends, who said: "What about losing our windings?" Well I would gladly exchange all my windings for maintenance contracts for Electric recording dials.

Thus by our superior attitude we are losing today the English clock trade as rapidly as we lost the English watch trade, so superior were we to machine-made watches.

May your able and instructive articles be continued, and arouse the members of our ancient craft to more interest in the fascinating branch of Electric Horology.

Yours faithfully,

Leicester. GEO. TARRATT.

DEAR SIR,—You and Mr. T. D. Wright are to be greatly congratulated on the excellence of this special Electric Clock number of the "Journal," but I should be grateful if you would allow me to point out that a reference to myself in your editorial columns is too flattering. You kindly refer to me as one of those "who have given life-long attention to the subject." I can only claim a matter of 16 years attention to the industry of the *manufacture* of Electric Clocks, and I think that possibly you are confusing me with by brother, Mr. G. B. Bowell, the original *inventor*, not only of the Silent Electric Clock system, but of earlier electric clocks. Mr. G. B. Bowell, although no longer commercially connected with the actual manufacture of this Company's Electric Clocks, is still keenly interested in the subject and is, without any doubt, the doyen of those who have worked *on the technical side* on behalf of the industry. His first patents were taken out in 1895 and related to a system that he *had devised for personal use fully a year earlier.*

While, therefore, I thank you for your kindly reference, I would beg the favour of your inserting this small correction, that honour may be given where honour is due.

Yours faithfully,

H. T. W. BOWELL.