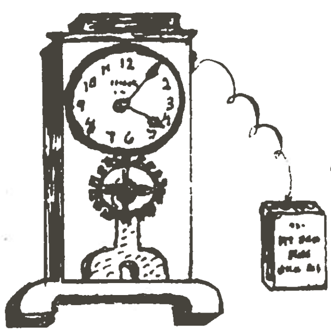

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Chapter No 78

NATIONAL ASSOCIATION of WATCH and CLOCK COLLECTORS, Inc.

VOLUME XIII, #1. JAN-FEB-MARCH 1987

This is the first issue of the Journal under the joint editorship of Harvey Schmidt and George Feinstien. We owe a debt to our past editor, Martin Feldman that can never be repaid... He WAS the Jour- for these many years, having started the publication more than 14 years ago with his newsletters, and following with the Journal, and we're sorry to see him go. Now we'll find out that it's easier to complain than do the work!

In this issue, the first of a quarterly schedule, we begin the first installment of a workbook of an IBM technician from the 1930's, and the beginning of a comprehensive listing of ALL horological patents relating to electricity from the earliest to the present, as compiled and arranged by Dr. George Feinstein. Future issues will continue these articles, but new material for the future is earnestly solicited in addition to comments, criticisms, and advice in general. Perhaps we can have a "Letters to the Editor" department, as well. Mart ads are FREE, and we encourage participation by our members... it's YOUR Journal, so use it to advantage.

Our newly elected president informs us that he expects to conduct a series of informal EHS meetings at the regionals that he attends, most of them in the eastern half of our country, and at the annual National Convention. If you attend any of the regionals, ask at the registration desk for Martin Swetsky's location, and drop by his table to say hello and check on the meeting schedule.

Dues notices have been mailed, and this reminder is the final notice to our delinquent members. As has been the recent practice, we have mailed the first issue of the new year to the entire roster, but the upcoming Journals for the remainder of 1987 will only go to the paid up members, so take notice! If you're not sure that you've paid for 1987, drop us a note... a postcard will do and we'll get right back to you so you won't miss an issue.

We look forward to hearing from you... if you're tired of the format of the Journal, or have any special preferences, please let us know.

Harvey Schmidt
George Feinstein

Service Instructions I.T.R. #222 April 1, 1938

Master Clocks

The Master Clock is, as the name implies, master of the electric clock system. It is the controlling timepiece for the system and its time is transmitted to all secondary apparatus by means of wires and electromagnets. Each master clock is fitted with a curcuit closer called an impulse contact. The impulse contact usually closes once each minute.

The master clocks are made with two types of drives, i.e. spring& weight driven.

WEIGHT DRIVEN

The International, weight-driven, motor wound Master Clock is the highest type commercial time piece manufactured. The driving power is furnished by two weights which insure constant and even power to the escape wheel at all times. Differential gears are used to furnish power to the escape wheel while the clock is winding. Ball bearings are placed at all points of heavy pressure and jewel cut pivots at the remainder, reducing friction to a minimum. The movement of the weights is controlled by an automatic switch which cuts in the motor when the weights have run down a certain distance and cuts out when the clock is fully rewound. If power is not available when the switch is turned on, the curcuit remains closed until power is restored and the weights are raised to a point where the switch turns off.

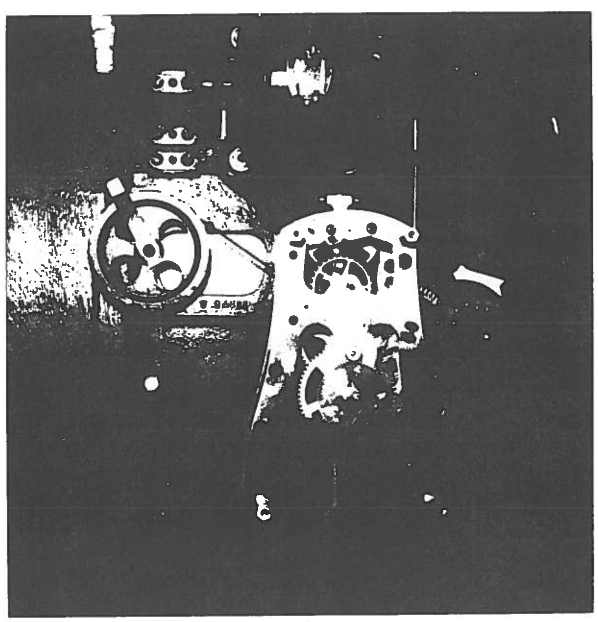


FIG. 1

SPRING DRIVEN

The International, spring-driven, minute wound Master Clock is a very high grade clock and will meet the most exacting commercial requirements. The driving power is furnished by a flat spring which has reserve power of 8 to 12 hours depending on the contact load.

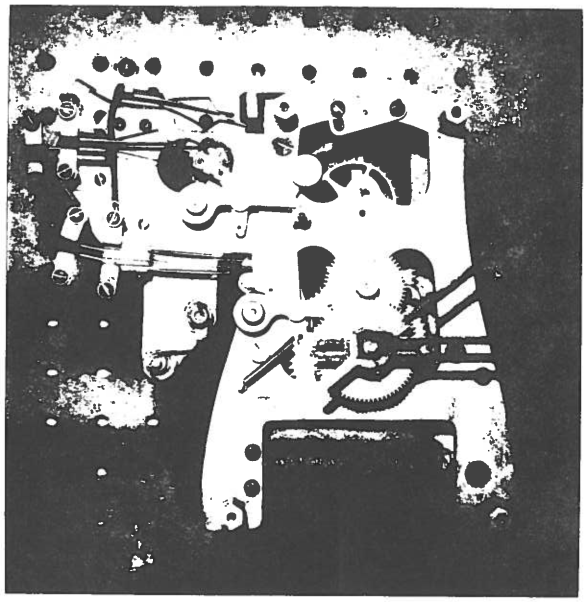


Fig. 2

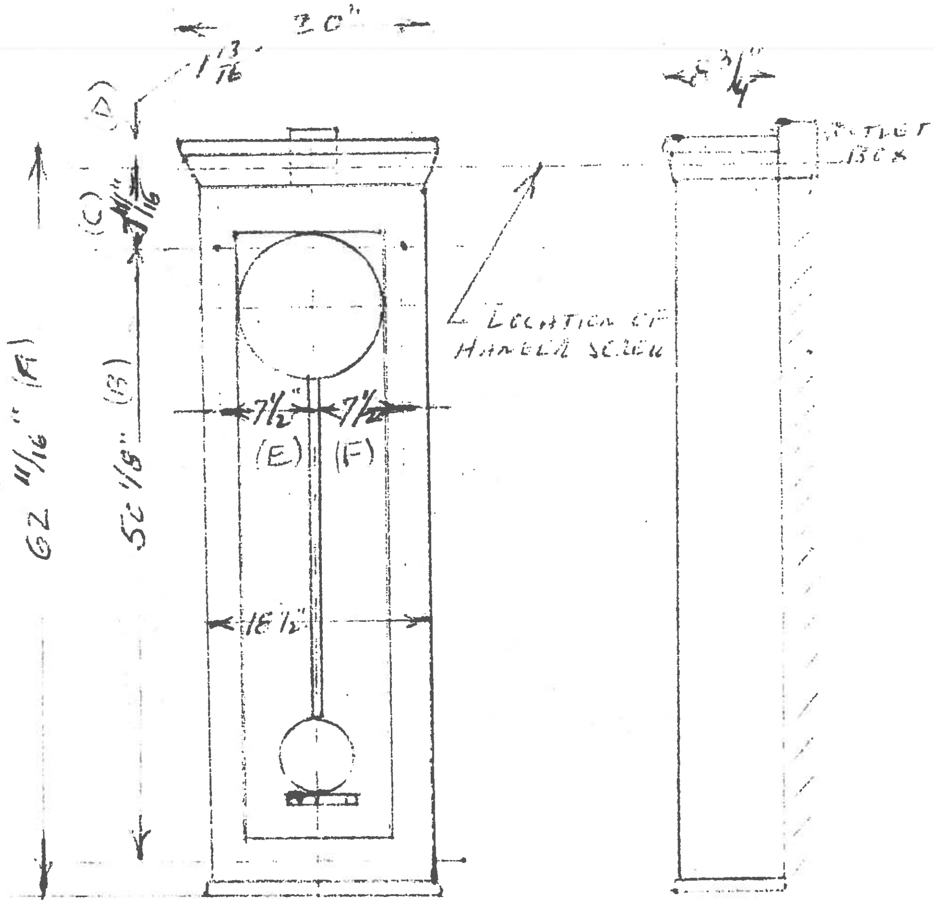
INSTALLATION

In order to secure the maximum results from this Master Clock it must be carefully installed and properly maintained.

The Master Clock should always be installed on a substantial post or wall that is free from dust, moisture, and vibration. Its location as a timepiece is of secondary importance. Special treatment is used in manufacturing to prevent oxidation of the gears and other working parts, but a clean, dry place for the clock is almost essential to prevent oxidation, regardless of the treatment during manufature.

The usual practice is to place the top of the Master Clock approximately eight feet from the floor. This locates the hands within easy reach for setting and the pendulum in a convenient position for regulation. However, local conditions may necessitate placing the Master Clock at a different height. (see Fig.3)

The Master Clock should be securely attached to the wall so that it will not move out of plumb even with a severe jolt. If the Master Clock is moved only slightly, it will throw it out of beat and thus effect its timekeeping, and may even stop it. The Master Clock is designed to be attached at four points, viz: (1) The hanger, which may be a large screw in the wall, or the special International wall box for Master Clocks. This screw or bolt in the wall box is the main support for the weight of the Master Clock. (2) One screw is provided for the bottom center of the case. This prevents side sway of the bottom of the case and keeps the clock in beat. (3 and 4) Two screws are provided for the top of the case at the sides of the dial. These screws prevent rolling on an uneven wall and hold the case rigidly against the wall.



(A) 62 11/16"
(B) 50 1/8"
(C) 7 11/16"
(D) 1 3/16"
(E) 7 ½"
(F) 7 ½"

Fig. 3

When control and program equipment is mounted in the Master Clock case, some unit may be mounted directly over the screw hole and will have to be removed before the Master Clock can be properly attached to the wall. The wall upon which the Master Clock is to be mounted should be perpendicular and true, If not, care should be taken not to tighten the screws until the case is twisted, but block out the case where necessary.

It is advisable to use the pendulum as a plumb before installing any except the top hanger screw. The end of the pendulum screw should hang directly over the "0" position of the scale, and neither in front of, nor behind the scale. (See preceding instructions for installing the pendulum.)

INSTALLING WEIGHTS.

The weights may be installed after the case is securely attached to the wall. The clock is shipped wound up and the weight cords are properly wound around the drum and tied. Extreme care should be used to see that they do not loosen and become crossed on the drum, as this will rob the movement of its power. (See fig. 4) The weight cords are attached to the weight with nuts that have standard, right hand threads. They should be screwed all the way in and then tightened. Do not touch the weights with the bare hands as it may discolor them. Use tissue paper or a clean cloth for handling the weights.

Fig. 4

INSTALLING PENDULUM

If the pendulum is of the lenticular brass bob type it is shipped with the bob removed from the oendulum stick. Insert the rod in the bob with the hook on the top of the rod pointing to the lead side of the bob, and screw up the nut that supports the bob until the top of the bob coincides with the pencil mark on the stick. A slot is cut in the back of the pendulum bob into which the top portion of the regulating nut fits. This construction prevents the possibility of friction holding the pendulum bob so that it will not follow the nut when regulating the clock to run slower.

The mercurial compensating pendulum is shipped completely assembled. If the pendulum does not hang so that the cross-bars are square with the case, loosen set screw in friction guide assembly (just under top cross-bar) and turn jar frame, intil jar frame is square with case. Re-tighten set screw.

The Invar pendulum is shipped with its heavy bob removed. To install, remove the free running nut and screw the rod in the bob until there is a clearance of 1/16" between the knurled knob on the rod and the top of bob. The free running nut should then be screwed on the rod, small end down, until it is approximately 1/8" below the bottom of the bob.

Extreme care should be taken not to kink or crack the suspension spring while installing the pendulum. The suspension spring is located almost directly back of the seconds hand shaft. The hook on

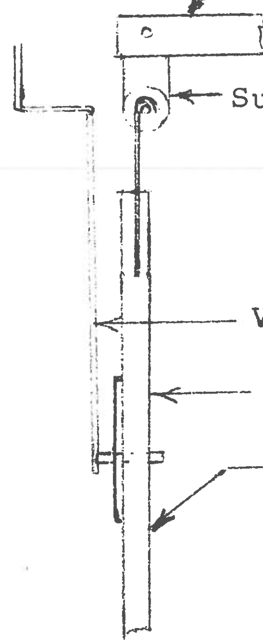


Fig. 5

the top of the pendulum rod may be easily placed over the suspension spring pin by inserting the top of the rod up between the back plate of the clock movement and the back casting. After the pendulum is properly supported, adjust the verge wire to the pendulum. On the lenticular brass bob pendulum, the verge wire fits on a slot in the pendulum stick. On the mercurial pendulum, the verge wire straddles the pendulum rod.

CONNECTING THE MASTER CLOCK

The master clock must be connected to the system according to the wiring diagram which accompanies the system; that is, all terminals should be connected to the correspondingly marked terminals of the master relay cabinet, etc., and the motor terminals to the commercial current, 110 volts; unless an external resistance is mounted on the top of the master clock cabinet, in which case it should be connected to a 220 volt lighting service. The winding power may be either A.C. or D.C. as the motor is of the universal type. (See Fig. 11 & 12)

WINDING OF WEIGHT DRIVEN MASTER CLOCK

The Master Clock should be closely watched when winding the first time to see that the tops of the weights do not rise above the lower screw holes in the back frame or casting. This indicates that the weight cords are wound properly on the drum. If they go higher, cut off power immediately and investigate. The winding motor should always be connected to the power at some point that is never turned off, as there is always the possibility of a switch being turned off and the master clock stopping because it is run down.

The weights should only drop eight (8) inches or ten (10) inches before the switch cuts in the motor and again restores them to their original position. If the weights travel much further, investigate and see that power is available before the clock stops. The motor is protected by two fuses located on the top of the case. Obviously the motor will not operate of either of these is blown.

WINDING OF SPRING DRIVEN MASTER CLOCK

The Master Clock is spring driven and winds with an electromagnet at each impulse. A unique reverse winding mechanism insures constant tension and prevents overwinding. The principle of winding will be very easily understood by studying Fig. 6, and following description of the individual parts.

A---Electromagnet.
B---Electromagnet armature attracted each impulse.
C---Lever attached to armature, advances feed pawl (D)
D---Feed pawl, moves ratchet (E) 1 tooth each impulse.
E---Winding ratchet.
F---Detent pawl, holds ratchet from turning backwards.
G---Main driving gear.
H---Winding spring, the tension of which balances through the winding ratchet (E) with the tension of the main driving spring attached to the winding ratchet (E) and main driving gear (G).
I---Adjustment for tension of winding spring.

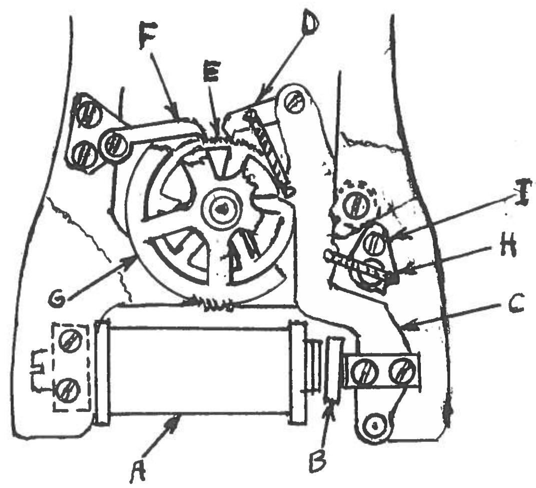


Fig. 6

CHECKING THE BEAT OF THE CLOCK

If the clock does not tick even, or if the seconds hand hesitates longer on one second than another, the clock is out of beat. The best method of accurately checking a pendulum clock to see if it is in beat is to watch the movement of the seconds hand when the pendulum is moved slowly by hand. The seconds hand should advance on any second when the pendulum is an equal distance each side of zero on the pendulum scale. In otherwords, the seconds hand should not be released when the pendulum is at II an one side of zero and I½ on the other side. It is understood that the pendulum is exactly at zero when at rest. If the clock is out of beat, it may be adjusted by turning the small, knurled, thumb screws located on the verge which is above and just in front of the upper end of the pendulum. (See Fig. 7) If putting clock in beat is not thoroughly understood, it is advisable to call in an International service man.

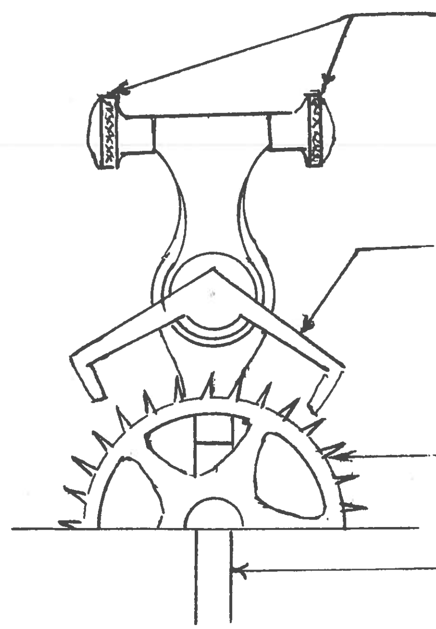


Fig. 7

REGULATING

The regulation of any pendulum clock is obtained by lengthening or shortening the pendulum. The longer the pendulum the slower the clock will run and vica versa. On the lenticular brass bob pendulum clocks, one complete turn of the nut which supports the pendulum bob will cause a variation of approximately one minute per day. The screw on the pendulum rod is a standard right hand thread. Turning the nut to the right shortens the pendulum and vice versa.

Clocks equipped with mercurial compensating pendulums have two regulating mediums, each of which is graduated for two standard time regulations. The nut upon which the pendulum jars rest is for coarse regulation and one complete turn varies the rate of the clock approximately one second per hour and one division varies the rate of the clock approximately one second per day. The free running nut (located at lower end of rod) is used for fine regulation only. One complete turn causes a variation in the rate of approximately one second per week and one quarter turn a variation of approximately one second per month.

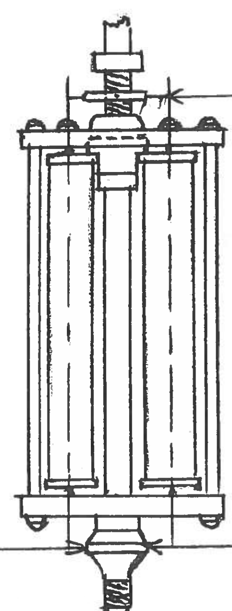


Fig. 8

SETTING MASTER CLOCK

Never turn the clock backwards nor move the hour or seconds hand. If the Master Clock is fast, stop the pendulum and then start up again when it is at the exact time.

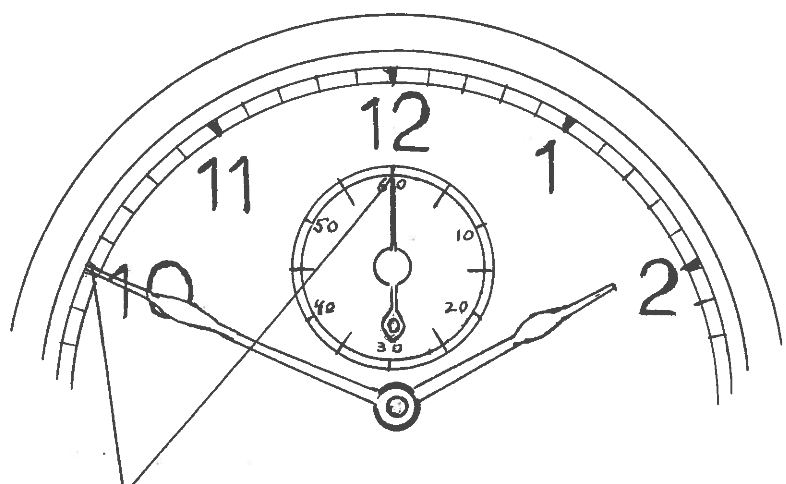
If the Master Clock is slow, stop the pendulum just after any minute as indicated by the seconds hand. Move the minute hand until it is over the minute marker and so the Master Clock is just ahead of correct time,then start pendulum swinging again at the correct instant. Note that when the seconds hand points to 60 the minute hand points directly at a minute marker. (See Fig. 9) This is importamt as some cams are timed with the seconds hand and others with the minute hand. The hourly supervising feature takes care of setting the secondary units to the correct time.

Never move the hour hand on a master clock equipped with an impulse accumulator.

REMOVING DIAL

If it is ever necessary to remove the dial, it can easily be done by removing the hands and four screws. All the hands are friction fit and may be easily removed by pulling and turning slightly in a clockwise direction after taking off the hand nut. It is advisable to replace the hands in the same position as that from which they were removed.

The seconds hand should be placed on its shaft so that the minute imoulse contact will make at the 58th second and break at the 60th second. Use extreme care to see that the hands do not interfere with each other.



Minute hand must point directly at a minute mark when seconds hand is pointing to 60.

Fig. 9

CONTACTS AND SWITCHES

As stated in the instructions covering the hourly supervised system, the Master Clock is equipped with the necessary contacts and switches for sending out minute impulses and for supervising the secondary units. (see Fig. 10). It may also be equipped with a duration contact for controlling the duration of signals such as bells, horns, etc.

The minute impulse contact is operated from a cam placed on an auxiliary shaft used solely for contact purposes and located to the left of the escape wheel. This contact makes for a period of two seconds each minute. It is timed to make on the 58th second and break on the 60th second of each minute. The contact has a positive make and break, and when properly adjusted the upper contact strap should be lifted 1/64" above its normal position when the contact is made. This contact is properly adjusted at the factory and will not need changing.

The rapid impulse contact makes every two seconds and is controlled by the swinging of the pendulum, that is, the contact operating lever is attached to the verge shaft and rocks when the pendulum swings. This contact has a positive make and is open when the pendulum is at rest. This contact alone does not have any effect upon the system, but working in conjunction with the advance switch, sends out the rapid impulses.

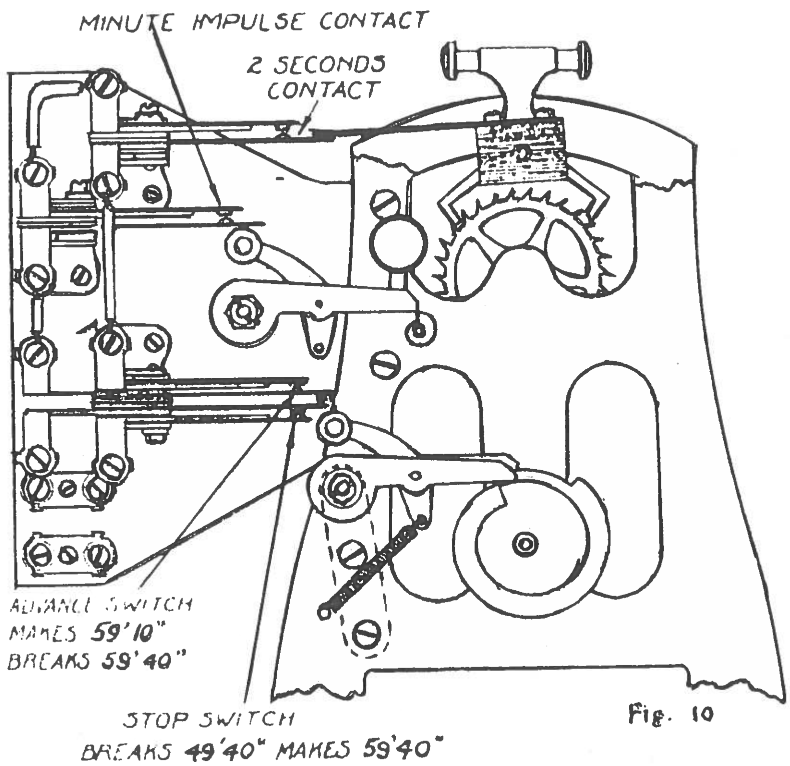


Fig. 10

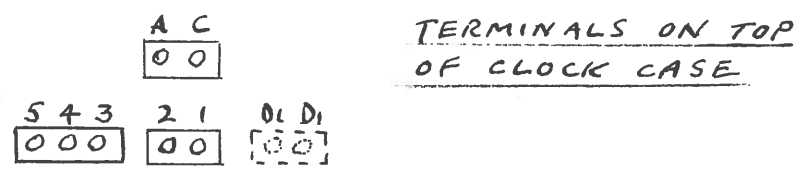
The advance switch is connected in series with the two seconds contact and thus controls the operation of the latter, The advance switch is operated from a cam placed on the center or minute hand shaft. This cam makes one revolution each hour and is cut so as to operate the advance switch once each hour, viz: closes same at 59'10" past the hour, and opens it at 59'50" past the hour. The switch remains made for 40 seconds each hour, therefore, allows only 20 of the two seconds or rapid impulses to be sent out to the system. The upper strap should be raised 1/64" above its normal position when made, and it also should have a quick break. This switch is properly timed and adjusted at the factory and should not be changed.

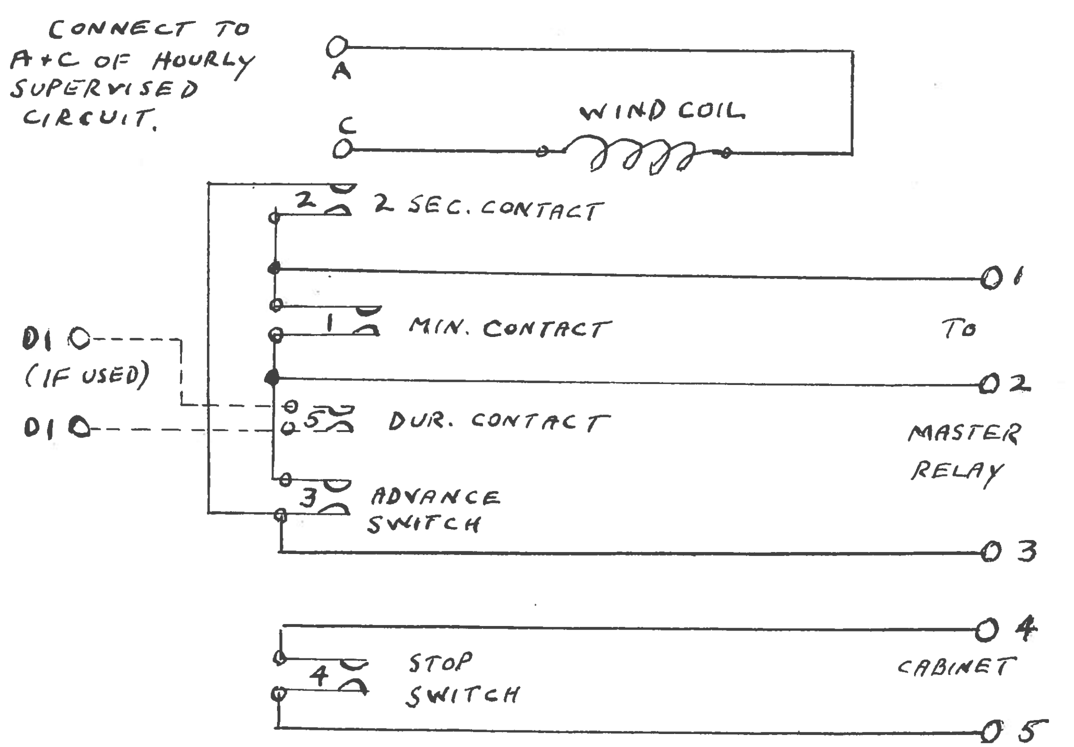
The stop switch is used to open the circuit to prevent the impulses from going out over the "B" wire to the secondary units between 49'10" and 59'50" past each hour. It is much heavier than the other switches, as it carries the current but does not break the circuit to the master circuit which controls the distribution relays or a single circuit of secondary units.This switch also operates from a cam placed on the center or minute hand shaft, and is timed to break at 49'10" past each hour and make at 59'50" past each hour. It is very important that the adjustments are such that a good contact is made; that is, there should be tension on the upper strap when made and also a good air gap when open.

The timing of the switches is not critical as 18 or 22 of the rapid impulses will serve equally as well as 20. However, the advance switch must be open before the stop switch closes.

If the Master Clock is equipped with a duration contact, it is operated from cams placed on the auxiliary cam shaft and normally makes a second or two after the minute impulse contact breaks. The cams for a duration contact are placed between the clock plates, whereas the cam for the minute impulse contact is placed on the outside of the front plate. Two cams are used for each duration contact to permit changing the length of duration of the signals. Turning the cams on the shaft so that the faces or points are farther apart increases the duration, and vice versa. The adjustments of the duration contact are exactly the same as for the minute impulse contact.

Sometimes a seconds beat contact is used for special purposes. When this is the case, the contact is a double rapid impulse contact, that is, one contact spring operates between two contact points. When the pendulum is at rest, both contacts should be open.





WIRING DIAGRAM

Fig. 11

CONTACT #1 closes every minute (Impulse)

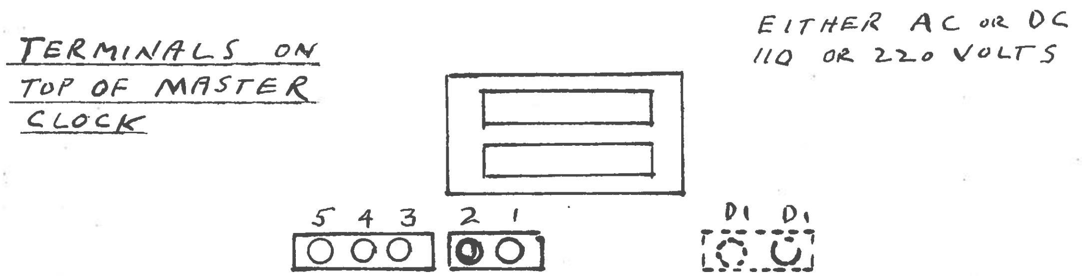
CONTACT #2 closes every 2 seconds

CONTACT#3 closes 59'10", opens 59'45" (35 Seconds)

CONTACT #4 closes 59'10", opens 49'45" (50 Minutes)

CONTACT #5 closes every minute (Duration)

#13 Spring Driven Master Clock



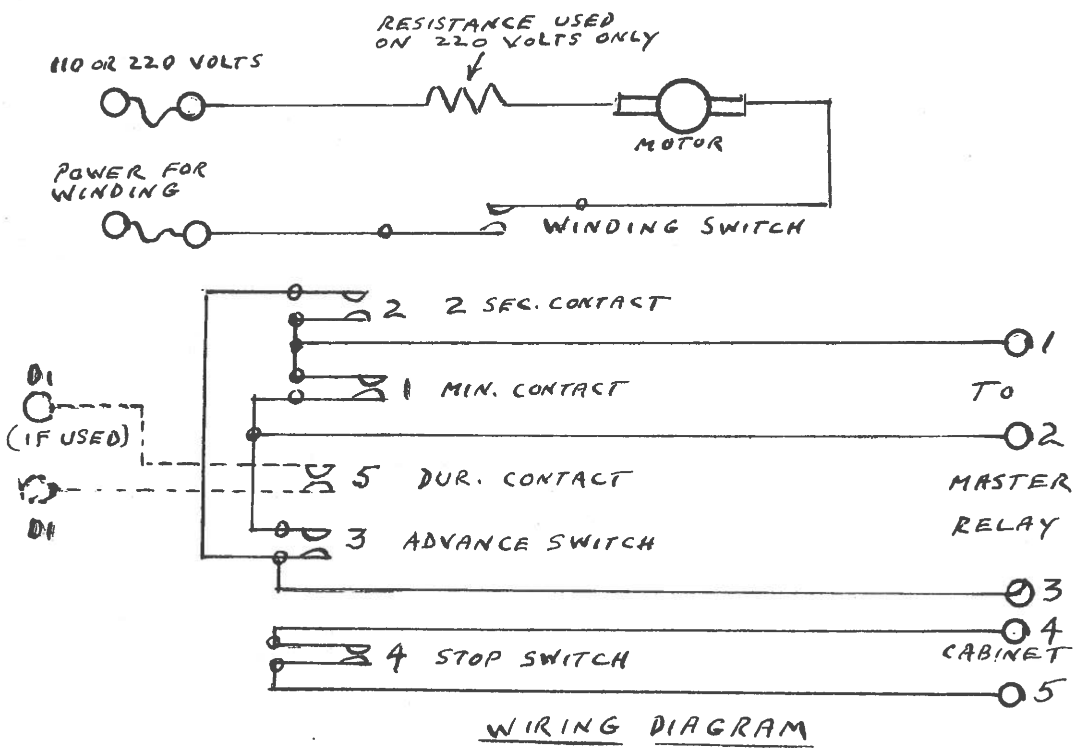
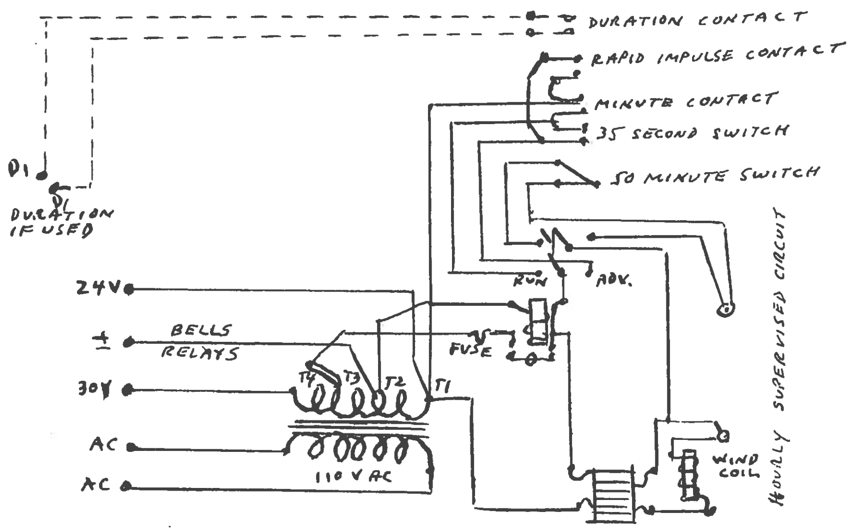
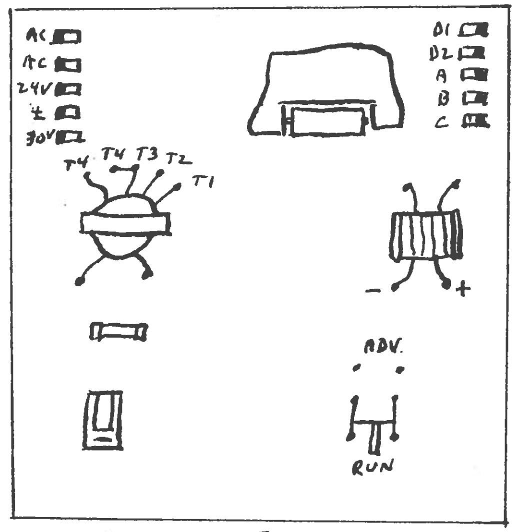


FIG. 12

CONTACT #1 closes every minute (Impulse)
CONTACT #2 closes every 2 seconds
CONTACT #3 closes 59'10", opens 59'45" (35 Seconds)
CONTACT #4 closes 59'45", opens 49'45" (50 minutes)
CONTACT #5 closes every minute (Duration)

#16 Weight driven Master Clock





ARRANGEMENT OF UNITS

Oiling

The oiling of the Master Clock is very important. It does not need frequent oiling, but when it does need oiling it should be done properly. The pallets and all bearings should be oiled, the gear teeth never. Too much oil is more harmful than not enough. Only a good grade of clock oil should be used, such as can be obtained from any clock and watchmakers' jobbers. Enough oil for each bearing can be applied by means of a wire, the size of a common pin, dipped into a reservoir to the depth of about a quarter of an inch.

Old Style Spring Driven Master Clock

The driving power for these Master Clocks is derived from a small helical spring which, at all times, is kept wound to even tension by an electro-magnet and ratchet mechanism. When the minute impulse contacts close, they cause an electric circuit to be completed. This electric circuit energizes the coils of the electromagnet and its armature is attracted. When the armature is attracted, a pawl attached to the armature engages the ratchet and winds the clock.

The winding ratchet is located on the center or minute hand shaft. The main spring is also on this shaft. Power is transmitted from this shaft through the train of gears to the escape wheel.

The Graham Dead Beat type of escapement, consisting of brass escape wheel and hardened steel verge, is used as it is considered best suited for this type of clock movement.

The magnet wound spring driven Master Clocks are made for three different sizes, i.e., 60, 72, amd 120 beat pendulum.

The principal of operation of all these clocks is the same. The contacts on all except the 120 beat clock are operated from a cam placed on an auxiliary shaft designed for this purpose. On the 120 beat clock, the cam to operate the contacts is placed directly on the escape wheel shaft.

The main spring, when fully wound, will run the movement from 51 to 53 minutes. The movement cannot be damaged from overwinding as stop pins are provided.

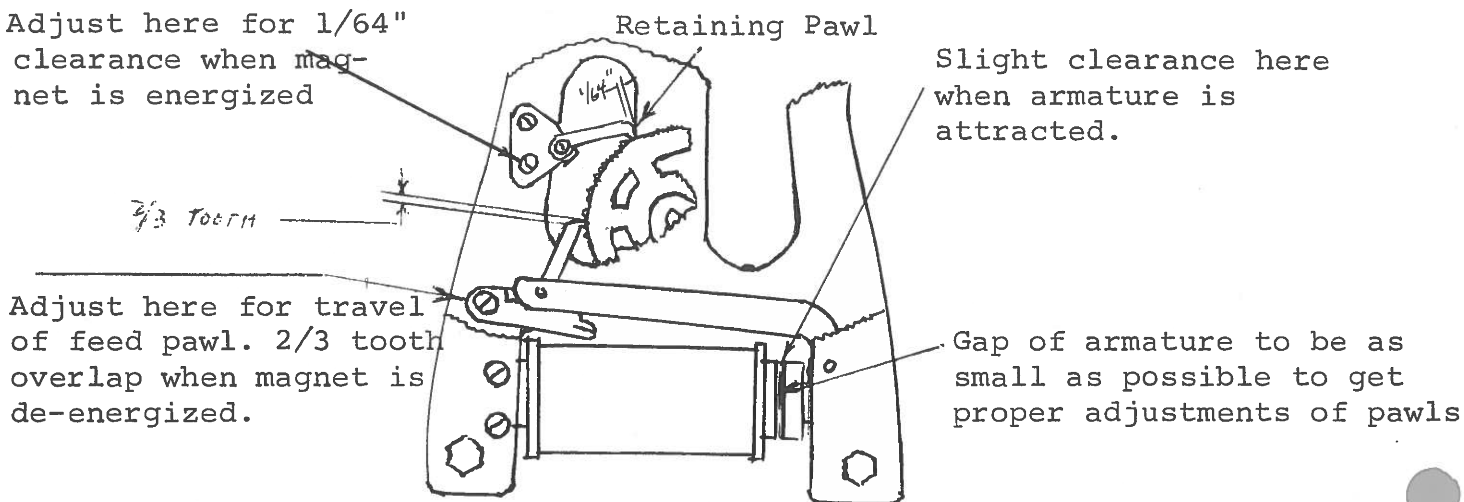
Adjustments

1. The verge adjustments are standard for any Graham Dead

Beat type of escapement. They are as follows: Escape wheel should run on the center of the pallets. To set verge, lower same by moving both bridges until escape wheel will not escape. Then raise in the same manner until the escape wheel teeth just clear throughout the circumference. This insures that the verge is set as low as possible without hitting on the escape wheel teeth and also that the verge shaft is in a horizontal plane. Under no condition must the verge bottom on the escape wheel. Adjusting screws are provided on all master clocks except the 120 beat for putting them in beat.

2. Liner must fit snugly against armature.

3. Armature must strike both poles evenly.



4. Adjust the armature and magnets for .003" clearance at the top of the armature when attracted.

5. With the armature attracted, adjust the retaining pawl for a slight clearance between the pawl and the ratchet tooth. This insures the retaining pawl dropping into the ratchet and holding same each time it is moved forward.

6. Adjust armature lever return stops so that the feeding pawl will overlap the ratchet tooth 2/3 of a tooth when in a de-energized position.

7. Adjust armature return spring for satisfactory operation on a 25% drop in voltage.

MASTER CLOCK WINDING MECHANISM

The winding mechanism of all Electro-magnet wound master clocks operates so that the clock is wound when the electromagnet releases its armature. When the armature is attracted tension is placed on a coil spring. At the end of the impulse to the electromagnet the coil spring returns the armature to its de-energized position.

A pawl as attached to the armature by means of a lever. When the armature is attracted the pawl drops over the next succeeding tooth in the ratchet. When the armature is released the armature return spring restores the pawl to its original position and advances the winding ratchet one tooth.

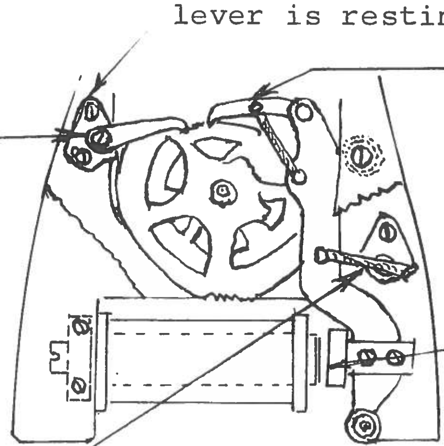
The winding ratchet has 59 teeth. The winding electromagnet is connected to the A and C wires of the self regulating systems, therefore, receives all of the impulses. The anchor posts for the main spring are shorter than before. This allows them to pass and the main-spring to have maximum tension at all times. No harm is done the ratchet and pawl if the winding electromagnet receives more impulses than necessary as the armature return spring pulls against the main-spring. As the clock becomes fully wound the difference in power of each is equal and the clock does not wind. The winding operation is much smoother than before as the spring cushions the impact which tends to occur when the armature is attracted and released.

Adjustments

1. Adjust armature on its lever until the feeding pawl will drop freely over the next succeeding winding ratchet tooth when the armature is held against the cores by hand. It is important that the armature strike pole faces squarely.

2. Adjust the retaining pawl until it drops freely in the ratchet when the armature is released and the armature lever rests against its stop. Both of the above adjustments are independent of each other and should be made when the clock is approximately 2/3 fully wound.

When winding the master clock by hand, attract the armature and let it release under its own spring power. Do not pull or force the lever against its stop.



Contact Adjustments.

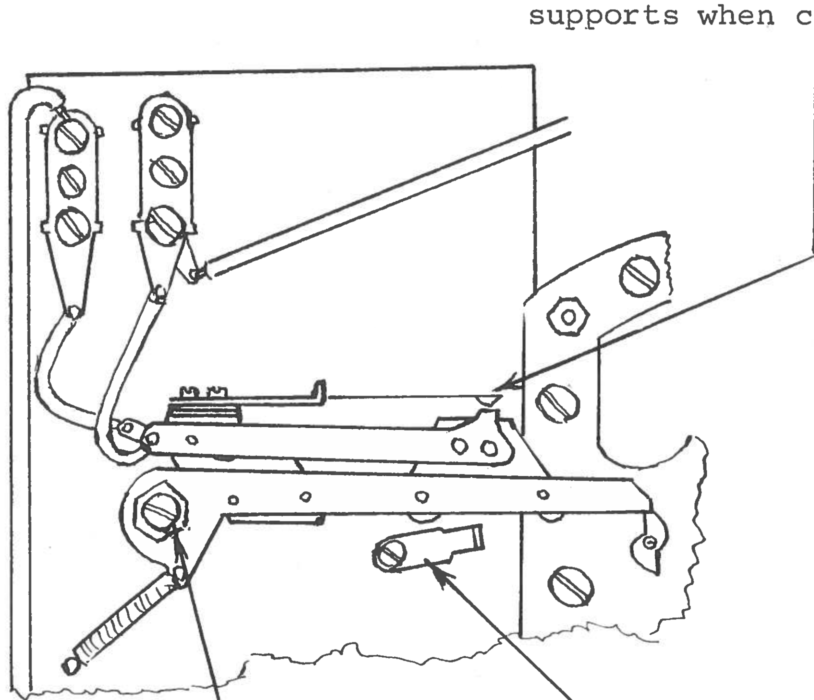
1. Adjust the minute impulse contact for two seconds duration on all clocks except the 120 beat. In the 120 beat, adjust for ½ second duration. This adjustment is made by moving the eccentric bushing at the pivot point.

2. Adjust the stop for the contact fingers so that they will not bottom on the cam.

3. Contacts should have 1/32" air gap when broken.

4. Upper contact should have 1/64" tension when made.

Any Master Clock may be equipped with a duration contact which is operated from cams placed on the auxiliary shaft between the clock plates. The adjustments are standard except for the length of duration which may be varied to suit any special requirement. If the desired length of contact cannot be obtained by adjusting the eccentric bushing, the cams may be shifted changing the relation of the dropping off points.



Minute Impulse Contact

1852-1951 A CENTURY OF U.S. ELECTRIC CLOCK PATENTS.

By Dr. George Feinstein

INTRODUCTION

Patent records have a lot of information in addition to the patent documents, which contain a written and pictorial description of the item being patented. There is generally the name of the inventor, his city of residence, date of application, list of assignees - which are people or companies that have obtained a right to the invention by the time of the patent issue date. In addition some have lists of foreign patents.

From the patent records I have prepared three sets of tables:

A. The first is a Chronological List of Patents.

B. The second will be an Alphabetical List of Inventors and Assignees.

C. The third will be a Tabulation of Patent Numbers According to Classes and Sub-classes as defined by the U.S. Patent and Trademark Office.

These tables will help you identify electric clocks, and obtain some additional background information. If you have a patent number you will be able to find the inventor and maybe even the manufacturer. Or, if you have a manufacturer's name you may be able to find patents describing your clock. If you have no information on your clock, by use of the class and sub-class listing, you may be able to find a patent describing it.

These tables are the result of several years of research at the New York Public Library's Patent Collection.

The Chronology of U.S. Electric Clock Patents, which is being published first, consists of information on approximately 1100 patents. These are not only electric clock patents, included are pneumatic clock patents. However, most patents describing electric switches operated by mechanical clocks were left out.

The first column has three pieces of information: the patent number; the date the patent was issued; and when avaible the date the patent was applied for, which can be from a few months to several years before the date of issue.

The second column has the sub-class of class 368 (Horology: Time Measuring Systems or Devices) to which the patent was assigned. In some cases the patent was assigned to another class, the information is then given in parenthesis with the number before the slash being the class and all numbers following the slash being sub-classes of that class.

The third column gives the official title of the patent, all other columns are self-explanatory.

1852-1951 A CENTURY OF U.S. ELECTRIC CLOCK PATENTS.

By Dr. George Feinstein

TABLE I: Chronology

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
9,279 09/21/1852 (05/10/52)	166	Galvanic Clock	M.G.Farmer	First U.S. electric clock patent.
11,723 09/26/1854	52	Electric Clock	A.Hall	
22,071 11/16/1858	76	Improved Electro Magnetic Fire-Alarm Apparatus	M.G.Farmer	Striking clock
41,217 01/12/1864	165	Improvement in Electro-Magnetic Pendulums	J.Hamblet,Jr. B.F.Edmands	
51,905 01/02/1866	(346/ 146) 108	Improvement in Electro-Ballistic Chronographs	P.LeBoulenge	Assignor to F.Meert
71,470 11/26/1867	124	Escapement for Electrical Clocks and Dial Indicators	B.F.Edmands J.Hamblet,Jr.	
71,624 12/03/1867 (03/29/67)	135	Electric Clock	S.A.Kennedy S.W.Holt J.Gerlach	
90,841 06/01/1869 (08/24/68)	124	Electric Clock	M.Hipp	Includes inverted version of Hipp toggle.
95,310 09/28/1869	52	Electric Clock	B.Leverett	Mechanical drive conical pendulum clock used to provide periodic impulses through mercury contact for secondary movements.
98,593 01/04/1870	161	Electric Clock	V.Himmer	Ballance wheel movement
98,594 01/04/1870	134, 165	Electric Clock	V.Himmer	Pendulum movement
99,321 02/01/1870	166	Electric Clock	S.A.Kennedy	Assignor to Kennedy Electric Clock Co. A Bain electric clock.

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
99,386 02/01/1870	166	Electric Clock	E.Wilson	Magnetic pendulum bob with fixed coil. Similar to Bain's sliding contact.
103,035 05/17/1870	(74/ 159)	Electromotor Escapement	T.A.Edison	A secondary clock.
120,185 10/24/1871	166	Electric Clock	W.M.Davis	Two pendulums
124,104 02/27/1872	166	Electric Clock	E.Wilson	Similar to Ritchie's clock.
127,483 06/04/1872	166	Electric Clock	V.Himmer	
130,971 09/03/1872	(346/ 34, 139	Electromagnetic Watch-clock	J.M. Batchelder	
140,661 07/08/1873 (03/21/73)	54, 65, 139	Transmitting Time-movements to Distant Dials	H.J.Wenzel	
143,847 10/21/1873 (10/08/72)	166	Electric Clock	F.J.Ritchie	
148,469 03/10/1874 (01/09/74)	46	Electric Clock	J.B.Kerz	
148,637 03/17/1874 (09/25/73)	54, 65, 139	Apparatus for Transmitting Chronometric Motion	H.J.Wenzel	A lever pivoted in the middle, and vibrated by clockwork, operates alternately and pneumatically distant dial mechanisms. To equalize the strain, an adjustably-weighted lever is made so to describe a semicircle as always to counteract by its gravity the expansive reaction of the air.
155,261 09/22/1874 (08/05/74)	76	Electric Clock	R.Sayer	
165,396 07/06/1875 (12/07/74)	207	Electric Winding Mechanism for Clock-work	J.W.Wignall	Weights are the plates of a battery.

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
169,057 10/19/1875 (09/14/75)	164	Electric Clock	D.F.Sweet	Assignor 1/2 to H.Moul & J.L.Reed Balance wheel movement.
171,098 12/14/1875 (04/23/75)	164	Electric Clock	E.Clark	Balance wheel movement.
173,072 02/01/1876 (11/16/75)	76	Electric Clock	R.J.Sheehy	
176,740 05/02/1876 (04/19/75)	52	Electro-magnetic Clock	W.M.Davis	Peculiar form of gravity-impellent. Cup holding the liquid immergent for the contact points so constructed as to allow the immergent to be drawn off from below without disturbing the mercury contact-surface.
179,873 07/18/1876 (03/20/76)	59	Electric Clock	R.J.Sheehy	
189,998 04/24/1877 (08/28/76)	59	Electric Clock	C.F.Brush	Assignor 1/2 to The Telegraph Supply Co.
196,404 10/23/1877 (08/28/77)	54, 65, 139	Transmitting Time Movements to Distant Dials	H.J.Wenzel	Pneumatic secondary clock movement.
201,185 03/12/1878 (04/04/77)	60	Electro-magnetic Apparatus for Synchronizing Clocks	J.A.Lund	
205,808 07/09/1878 (04/13/78)	166	Electric Gravity Escapement for Pendulums	J.F.Pratt	Pendulum, when near vertical position, closes a circuit to magnet, whereby a weight falls and impels the pendulum. At the same time an independent circuit and second electro-magnet are brought to action, whereby the weight is replaced in a position to be released again.
210,133 11/19/1878 (07/22/78)	60	Electric Clock-regulator	G.Lund	Assignor to J.A.Lund Pat. England 07/15/77
211,322 01/14/1879 (09/20/78)	(429/ 47)	Earth-battery for Electric Clocks	D.Drawbaugh	Assignor 3/4 to T. & J.H. Grissenger & J.E. Shettel

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
215,381 05/13/1879 (06/01/77)	54, 65, 139	Pneumatic Clock	C.A.Mayrhofer	Assignor to V.Popp & E.Resch Pat. England 02/07/77 France 02/10/77 Belgium 02/28/77
222,424 12/09/1879 (06/04/79)	166	Electro-magnetic Clock	C.Shepherd	Pat. England 06/20/78
223,517 01/13/1880 (11/22/78)	(346/ 34, 93)	Electric Time Registering Clock	J.B.Johnson	
224,243 02/03/1880 (09/17/79)	160	Electro-magnetic Clock	D.F.Sweet	Assignor 1/2 to W.E.Upjohn
226,401 04/13/1880 (02/05/80)	165	Electric Clock	J. Happersberger	
228,577 06/08/1880 (11/08/79)	65, 207	Apparatus for Transmitting Chronometric Motion	H.J.Wenzel	Pneumatic system
234,358 11/09/1880 (04/07/80)	65	Indicating Time by Gas-pressure	G.G.Wagner	The time at the gas-office is made a standard regulator for the city. A valve in a branch pipe of the gas-main is automatically opened at regular intervals, and the increased presure operates indicators connected with the different branch pipes.
238,428 03/01/1881 (12/29/80)	166	Electric Clock	A.Personne	Assignor to A.Lemoine Pat. France 08/07/80 Hipp type clock.
244,089 07/12/1881 (10/29/80)	59	Electric Clock	D.F.Sweet	Secondary clock.
248,995 11/01/1881 (07/12/81)	55	Combined Electric Switch & Clock System	C.E.Buell	Secondary clock pulsed through telephone lines.
249,699 11/15/1881 (05/11/81)	166	Electric Clock	C.E.Trask	

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
253,783 02/14/1882 (07/23/81)	59	Secondary Electric Clock	D.F.Sweet	
256,386 04/11/1882 (09/02/81)	129	Electric Clock	J.Schweizer	Assignor to C.Roosevelt Balance wheel movement
256,709 04/18/1882 (12/09/81)	75	Striking device for Electrical & other Clocks	A.Lemoine	Pat. France 10/24/81
258,818 05/30/1882 (12/17/81)	(310/ 46, 49)	Electric Motor for Clocks	L.H.Spellier	
259,066 06/06/1882 (12/01/81)	124	Electric Spring Clock	W.D.Whalen	
260,751 07/11/1882 (08/22/81)	166	Electric Clock	C.Gullberg	
267,300 11/07/1882 (07/12/82)	60	Device for Synchronizing Clocks	R.W.Willson	
268,322 11/28/1882 (07/05/82)	54, 65, 139	Synchronizing Clocks	L.Waldo	Pneumatic synchronizing using gas mains.
269,900 01/02/1883 (04/13/82)	54, 65, 139	Pneumatic Clock-regulator	G.G.Wagner	Assignor 1/10 to F.L.Crawford
270,058 01/02/1883 (10/07/82)	60	Electric Synchronizing Apparatus for Time-pieces	J.Hamblet	
270,533 01/09/1883 (12/02/81)	166	Electric Control for Pendulum Clocks	R.W.Willson	Assignor to Standard Time Co. Device for keeping a pendulum clock synchronized with a master clock.
271,347 01/30/1883 (10/16/80)	50	Pneumatic and Electric Clock System	L.Mautner	Pat. Belgium 08/17/80, France 09/20/80, Italy 09/20/80, Austria-Hungary 09/28/80, Spain 01/01/81, Sweden 10/16/80, Denmark 12/13/80, Germany 08/16/81

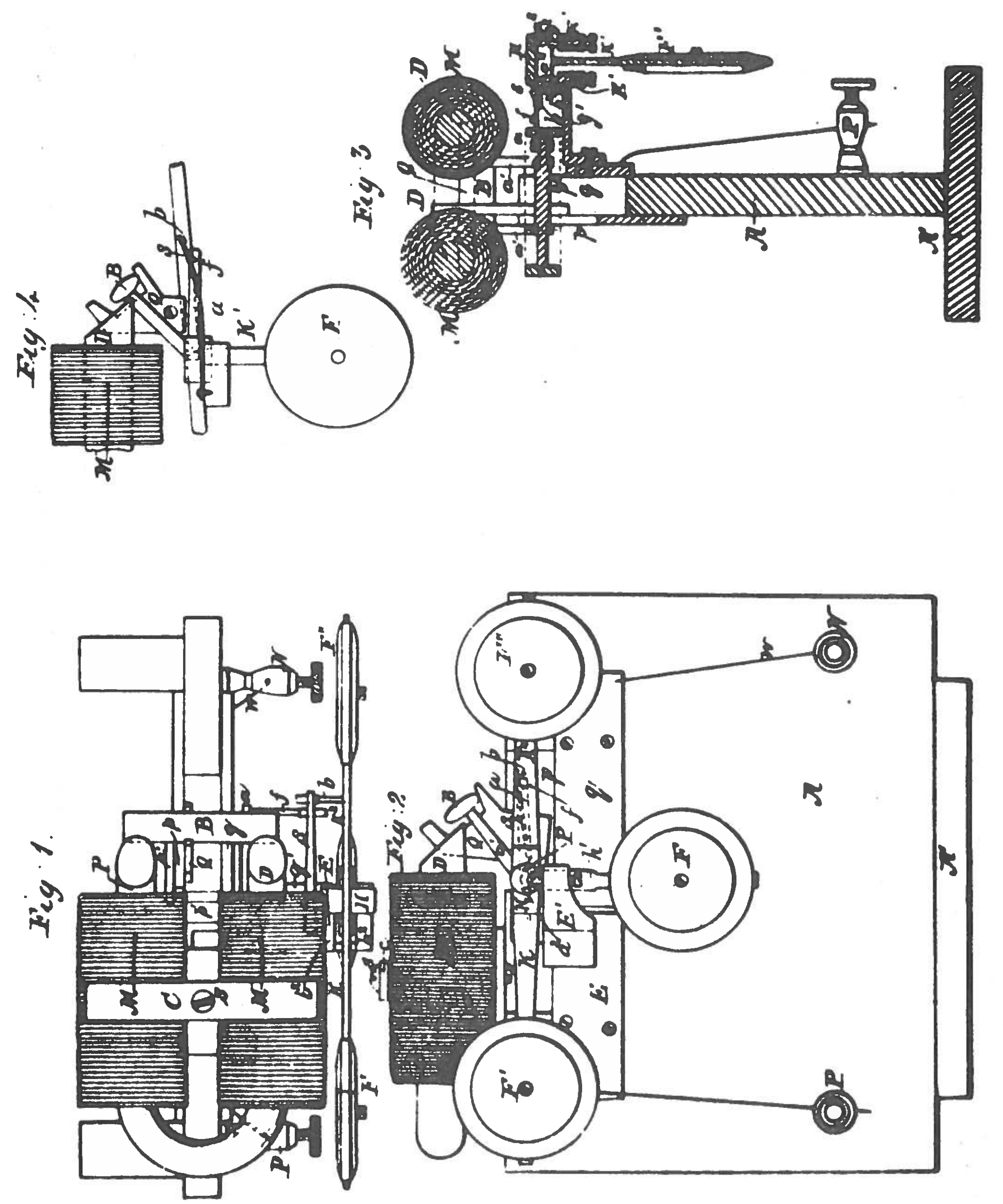
To Be Continued.

M. G. FARMER.

Electric Clock.

No. 9,279.

Patented Sept 21, 1852.



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UNITED STATES PATENT OFFICE.

MOSES G. FARMER, OF SALEM, MASSACHUSETTS.

IMPROVEMENT IN GALVANIC CLOCKS.

Specification forming part of Letters Patent No. 9,279, dated September 21, 1852.

To all whom it may concern:

Be it known that I, MOSES G. FARMER, of Salem, in the county of Essex and State of Massachusetts, have invented a certain new and useful Improvement in the Construction of Galvanic Clocks; and I do hereby declare that the same is fully described and represented in the following specification and the accompanying drawings, letters, figures, and references thereof.

Of the said drawings, Figure 1 is a top view of my galvanic or electric clock improvement. Fig. 2 is a rear elevation of it. Fig. 3 is a central, vertical, and transverse section of it. Fig. 4 is a side view, giving the relative position of the pendulum-impulse spring, pallet, armature, and magnet.

In Figs. 1, 2, and 3, A′ represents a horizontal board to which is affixed the upright board or partition A. To one side of this partition or board is attached the metallic plate *p*, which supports the bearings of the armature, and also supports the fork Q, which limits the motion of the armature B.

q is a metallic plate attached to the partition A. To this plate is affixed the arm q', which projects therefrom and supports the impulse pallet or spring *s*.

E is another metallic plate secured to the partition A. To this plate E is affixed an arm, E′, from which project upward knife edges or points a^2 a^2, upon which is suspended the pendulum.

The cross-bar H of the pendulum has a groove on its under side, which rests on the points a^2 a^2, projecting upward from the arm E′. The arm E′ is forked, as seen at b^2 b^2. The perpendicular rod K′ of the pendulum hangs between the prongs b^2 b^2 of the fork E′. The plates E and *q* are on the same side of the partition A, and are insulated from each other, (they not being allowed to touch each other,) as also from the plate *p*, which is the other side of the partition A.

M is the electro-magnet, confined above the partition A by the cross-piece C and screw S, which enters the plate *p* or a projection from it. One end of the wire of the electro-magnet M is in contact with the plate *p*, and thus is in connection with the armature lever or arm *a* and lifting-pallet *f*. The other end of the coil of wire is connected with the screw-cup P. The cup N is connected by a wire, *w*, with the plate *q*, which, by means of the arm q', supports the impulse spring or pallet *s*.

The armature B is attached to its axis or turning-axle p' by the arm a'. The pendulum is composed of a horizontal bar, k'' *k*, with a cross-piece, H, which rests upon the knife edges or points projecting upward from the arm E′, that is attached to the plate E by screws.

A perpendicular arm, k', Fig. 1, projects downward from the middle of the bar k'' *k*. Upon the ends of the bar k'' *k* are bobs F'' F'. There is a bob, F, on the lower end of the arm k'. *a* is an arm attached to the axis p', Fig. 3, of the armature B.

f is a pin (called the "lifting-pallet") projecting from the arm *a*. Its use is to lift or bend the impulse pallet or spring *s*. The pin *b* that projects from the arm k'' of the pendulum is used to lift the impulse spring or pallet *s* from the lifting-pallet *f*. It also receives the impulse from the impulse-pallet.

D D represent the poles of the magnet, with inclined faces.

Suppose a suitable electric battery or generator of electricity to be connected with the screw-cups P and N. If, under such circumstances, the impulse-pallet *s* is in contact with the lifting-pallet *f*, the magnet M will become charged and attract the armature B and draw it toward it, at the same time lifting the arm *a*, the motion of which and its lifting-pallet *f* will lift the impulse-pallet *s*. If now the bob F'' be depressed a sufficient distance and released on the return of it, the pin *b* will lift the impulse-pallet *s* from the lifting-pallet *f*, and thus break the circuit and discharge the magnet M. The armature B will then instantly recede or fall away from the magnet, so as to leave the impulse pallet or spring *s* free to act on the pin *b* and impel the bob F'' of the pendulum downward, which it will do until it (the said impulse-pallet *s*) comes into contact with the lifting-pallet *f*, when the circuit will be again restored, the magnet M again charged, and the impulse spring or pallet again lifted by the motion of the lifting-pallet and armature. The pendulum still goes on until it has completed its vibration, when it will return and the same action will again take place. Thus the pendulum will receive equal and constant impulses, while the battery retains sufficient power to raise the armature up to the extent of its motion, and no increase of battery power beyond that point ought to affect the times of vibration of the pendulum.

It is evident that the motion of the pendulum may be controlled by the force of a spring instead of the force of gravity. It will also be evident that if the impulse pallet or spring *s* were properly adjusted below the lifting-pallet *f* and the pin *b*, and if the end of the wire of the electro-magnet which is now connected with the plate *p* were charged and connected with the plate E (and, of course, with the pendulum) when the magnet is not charged, the weight of the armature B, acting by means of the lifting-pallet *f*, would depress the impulse pallet or spring *s*, and if the bob F'' were depressed till the pin *b* came into contact with the impulse-pallet *s*, the circuit would be complete, the magnet M charged, the lifting-pallet *f* raised by the motion of the armature B, and the impulse-pallet *s* left free to act upon the pin *b* and impel the bob F'' of the pendulum upward until the impulse-pallet *s* came into contact with the lifting (or, in this case, depressing) pallet *f*, when the motion of *s* would stop; but the pendulum would continue onward, thus breaking the circuit between the pin *b* and pallet *f*. The magnet M being discharged, the armature would recede depressing the impulse-pallet *s*, and it be prepared for another impulse when the pendulum returns. Thus the motion of the pendulum would be kept up while the strength of the battery was sufficient to entirely raise the armature.

It is well known that in electric clocks the armature of the magnet is connected to the wheel-work in some manner or by some machinery by which its periodical movements may be made to impel the clock-work. This connecting machinery is usually an impelling or draw pawl acting on a rachet-wheel fixed on the axle of the second-hand of the clock, or on the axle of some wheel that aids in giving motion to such axle of the second-hand.

As my improvement has no reference to such means of connecting the armature of the magnet and the wheel-work of the clock, I have not deemed it necessary to represent such in the drawings. Nor do I wish it understood that my improvement is to be confined to a pendulum, constructed in manner or having the form as described, as it may be applied to a pendulum otherwise made.

What I claim as my improvement or invention is—

The combination of the impulse-spring *s* and the pallets *f* and *b*, respectively connected with the armature of the magnet and the pendulum, and made to operate together and to make the pendulum operate or impart impulse to it, substantially as described.

In testimony whereof I have hereto set my signature this 10th day of May, A. D. 1852.

MOSES G. FARMER.

Witnesses:

R. H. EDDY,

G. W. CUTLER.

ELECTRICAL HOROLOGY SOCIETY
Chapter #78

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The
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Chapter No 78

NATIONAL ASSOCIATION of WATCH and CLOCK COLLECTORS, Inc.

Fellow Horologists: April, May, June 1987

In this, our second issue of the EHS Journal, we continue the reprint of the IBM Master Clock Manual, and the compilation of Electrical Patents by Dr. George Feinstein.

We are still in desperate need of material for future Journal issues; New or old information, magazine articles, original material, questions to the editor, mart entries, just about anything of interest to our membership. If you would like to see more interesting journals, please help by sending us material to be published.

We are informed by our president, Martin Swetsky, that the joint meetings conducted with our companion chapters, the Western Electrics of Los Angeles and the Midwestern Electrical Society of Chicago, are meeting with enthusiastic response. These meetings are held in cooperation with Regional Meetings around the country whenever their programs coincide with attendance of officers of the three electrical chapters. So far, these meetings have been held in the Strongsville, Ohio and Dearborn, Michigan areas, and at various National Conventions. We are advised that any Regional Committee can request one of these joint meetings and if the scheduling permits, can count on the fullest cooperation of the three electrical groups. Thanks due to Elmer Crum, Chicago President, and Art Bjornestadt, Los Angeles President for their participation, and to our own President, Martin Swetsky as well. These meetings help us by maintaining the interest in electrics and by inviting greater participation on the part of NAWCC members who were not aware of the electrical chapters, or could not attend meetings that were too far removed from their area.

It is the intention of the editorial committee to make every effort to complete one more Journal issue for mailing during 1987, and to start 1988 with a fresh schedule and a host of material to print.... Help, please.

Harvey Schmidt
George Feinstein

1852-1951 A CENTURY OF U.S. ELECTRIC CLOCK PATENTS.

By Dr. George Feinstein

TABLE I: Chronology (Continued)

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description and Comments
271,888 02/06/1883 (04/10/80)	54, 65, 139	Hydropneumatic Clock System	C.A.Mayrhofer	Assignor to L.Mautner Ritter von Markhof Pat. Belgium 02/16/80 France 04/01/80 Sweden 07/19/80 Germany 03/16/81
		Italy 02/20/80 Austria-Hungary 05/18/80 Denmark 08/05/80	England 03/02/80 Spain 10/19/80	
272,100 02/13/1883 (08/01/82)	165	Electric Clock	D.F.Sweet	
273,231 02/27/1883 (07/31/82)	160	Electric Mechanism for Controlling the Hands of Clocks	J. Happersberger	Assignor to Cincinnati Electric Clock Co. Secondary movement.
273,634 03/06/1883 (07/27/81)	165	Electric Clock	D.F.Sweet	
274,323 03/20/1883 (09/16/82)	184	Circuit-Controller for Electric Clocks	V.Himmer	Assignor to Time Telegraph Co.
274,324 03/20/1883 (09/16/82)	184	Circuit-Controller for Electric Clocks	V.Himmer	Assignor to Time Telegraph Co.
274,325 03/20/1883 (09/18/82)	160	Electric Clock	V.Himmer	Assignor to Time Telegraph Co.
274,445 03/20/1883 (01/02/83)	124	Electric Clock Escapement	A.W.Gray	Assignor to Time Telegraph Co. Secondary movement.
275,701 04/10/1883 (08/24/80)	54, 65, 139	Pneumatic Clock System	V.Popp	Pat. France 02/10/77 Italy 11/29/79 Belgium 04/29/80 Spain 09/10/80
		England 05/04/80	Russia 02/16/82 Germany 05/05/80	
277,104 05/08/1883 (07/06/82)	150, 207, 212	Electric Clock Winding Device	G.F.Ballou	

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
278,159 05/22/1883 (09/01/82)	47, 49, 54	Electric-Pneumatic Clock System	C.A.Mayrhofer	Assignor to himself and W.Otto Pat. Belgium 10/13/81 England 10/31/81 France 10/14/81 Austria-Hungary 10/15/81 & 12/11/81 Germany 10/24/81 A normal clock is connected by an electric distributer with an electro-pneumatic relay and with any number of district-clocks. From the latter, pneumatic impulses are sent at determined intervals to a three way cock and to the secondary clocks of a district and actuate suitable winding and synchronizing devices.
278,846 06/05/1883 (02/02/83)	52, 166	Electric Circuit and Apparatus for Synchronizing Clock-Pendulums	H.L.Bailey	Assignor to Time Telegraph Co.
278,946 06/05/1883 (09/15/82)	160	Electric Clock Movement	J. Happersberger	Assignor to Cincinnati Electric Clock Co. Secondary movement.
279,239 06/12/1883 (08/25/82)	(310/ 83)	Electro-Magnetic Motor for Clocks	H.Grau	Pat. Germany 05/05/82
279,327 06/12/1883 (03/15/82)	(178/ 49)	Combined Telegraph and Clock System	C.E.Buell	Time signal transmission over telegraph lines.
280,715 07/03/1883 (05/08/82)	49	Electric Clock System	C.E.Buell	Time signal transmission over telegraph lines.
281,585 07/17/1883 (04/10/83)	51	Synchronizing Clocks	G.G.Wagner	
284,355 09/04/1883 (07/17/83)	59	Circuit for Secondary Electric Clocks	H.L.Bailey	
284,578 09/04/1883 (04/14/83)	52	Primary Electric Clocks	D.F.Sweet	Obtaining an electric time signal from a clock.
286,181 10/09/1883 (05/08/83)	59, 126	Secondary Electric Clock	A.S.Crane	
287,015 10/23/1883 (08/22/83)	51	Time-Controlling System	W.F.Gardner	Secondary clock driven from a mechanical master clock.

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
287,710 10/30/1883 (01/06/83)	13	Telephone Time Signal Repeating System	J.M.Oram	Method for supplying standard time signals to subscribers in a telephone system.
288,175 11/06/1883 (11/29/82)	58	Circuit and Apparatus for Electric Clock Systems	J.Hamblet	Obtaining and transmitting electric time signals from a clock.
288,496 11/13/1883 (01/20/83)	124	Electric Clock	J.P.A.Schaefli	Pat. England 07/07/82 France 01/04/83 Belgium 01/05/83 Germany 01/17/83
288,623 11/20/1883 (05/09/83)	59, 126	Actuating Device for Secondary Electric Clocks	A.S.Crane	
288,906 11/20/1883 (05/31/83)	60	Device for Synchronizing Clocks	R.W.Willson	
289,944 12/11/1883 (05/29/83)	(200/ 38)	Circuit Breaker for Electric Clocks	G.B.Webb	Assignor 1/2 interest to Plumb and Marcus.
290,894 12/25/1883 (02/23/83)	55, (74/ 10.29)	Electric Clock Setting Mechanism	J.F.Kettell	
292,108 01/15/1884 (10/19/81)	(60/ 713)	Self-winding Clock France 08/05/81 Canada 11/11/82	A.Dardenne England 08/08/81 Sweden 12/23/82 Norway 05/01/83	Wind driven weight rewind. Pat. Belgium 08/3&31/81 Austria 11/23/81 Italy 12/31/82 Russia 06/09/83
292,962 02/05/1884 (11/26/83)	60	Device for Synchronizing Clocks	C.N.Talbot	
293,613 02/12/1884 (08/15/83)	165	Electric Clock	G.M.Herotizky	
294,131 02/26/1884 (04/06/83)	59	Secondary Electric Clocks	V.Himmer	Assignor to J.Koenigsberg

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
294,132 02/26/1884 (04/17/83)	58, 166	Electric Device for Synchronizing Clock-pendulums	V.Himmer	Assignor to J.Koenigsberg
294,552 03/04/1884 (09/07/83)	134, 166	Electric Clock	G.B.Webb	Assignor 1/2 interest to Plumb and Marcus. Swing of the pendulum makes and brakes circuit. Train driven by impulse from an arm attached to armature-lever.
295,287 03/18/1884 (12/26/83)	59, 75	Strike System for Secondary Electric Clocks	W.H.Sawyer	
296,256 04/01/1884 (02/27/83)	60	Clock-synchronizing Apparatus	G.G.Wagner	
298,205 05/06/1884 (01/31/84)	160	Secondary Electric Clock	I.C.Himmer & W.F. Weisgerber	Assignor I.C.Himmer
298,301 05/06/1884 (04/06/83)	52	Circuit-closer for Electric Clocks	V.Himmer	Assignor I.C.Himmer
300,139 06/10/1884 (11/08/83)	166	Electric Clock	S.Schisgall	Pat. Belgium 10/19/83, France 10/22/83, Germany 10/24/83, England 10/30/83, Portugal 11/21/83, Italy 12/31/83, India 01/07/84, Spain 01/19/84
301,569 07/08/1884 (01/26/83)	166	Electro-magnetic Clock	A.S.Crane	
301,601 07/08/1884 (09/24/83)	52	Operating Secondary Clocks	C.A.Jackson	
301,805 07/08/1884 (01/14/84)	52	Transmitting Device for Primary Electric Clocks and Means for Actuating Secondary Clocks Thereby	C.L.Clarke	Assignor to the Telemeter Co.
303,052 08/05/1884 (02/28/84)	55	Transmitter for Telephone Time System	C.W.Ruehle	Employs clock-work to make and break circuit in primary wire of an induction-coil, thus producing in the secondary wire impulses which yield audible signals in the telephone.

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
304,595 09/02/1884 (03/20/84)	59	Secondary Electric Clocks	C.E.Barschig	
305,632 09/23/1884 (09/24/83)	59	Secondary Electric Tower Clock	C.H.Pond and A.S.Munger	Assignors to Time Telegraph Co.
308,521 11/25/1884 (09/30/84)	49	Electro-mechanical Clock	C.H.Pond	
308,731 12/02/1884 (02/02/84)	59	Electric Device for Synchronizing Clock-pendulums	H.L.Bailey	Assignor to Time Telegraph Co.
308,793 12/02/1884 (09/05/83)	166	Electric Clock	C.H.Pond and H.L.Bailey	Assignors to Time Telegraph Co.
309,000 12/09/1884 (03/29/83)	58	Electric Apparatus for Setting Clocks Synchronously	J.E.Smith	Assignor to Gold and Stock Telegraph Co.
309,001 12/09/1884 (03/29/83)	4	Circuit-controller for Electric Clocks on Telephone and Other Lines	J.E.Smith	Assignor to Gold and Stock Telegraph Co.
309,269 12/16/1884 (02/13/84)	181	Synchronizing Device for Clock-pendulums	W.F. Weisgerber	
309,809 12/23/1884 (08/11/84)	59, 166	Secondary Electric Clock	G. and F.Jr. Trippen	
310,530 01/06/1885 (03/19/84)	49	Electric-pneumatic Clock System	C.A. Mayrhofer	Assignor 1/2 interest to C.Diener Pat. France 12/31/83 Belgium 12/31/83 England 01/01/84 Italy 12/31/83 Germany 01/01/84 Spain 06/09/84 Austria-Hungary 10/10/84
311,234 01/27/1885 (01/26/84)	149, 207, (74/156)	Electric Clock	A.S.Crane	

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
312,482 02/17/1885 (05/21/84)	60	Apparatus for Synchronizing Clocks	J.A.Lund	Assignor to the Standard Time Co. Pat. England 01/01/84 France 02/25/84
314,014 03/17/1885 (03/22/83)	65	Pneumatic Clock	A.Hahl and O.Mergenthaler	
314,634 03/31/1885 (06/19/84)	59	Secondary Electric Clock	W.F. Weisgerber	
316,112 04/21/1885 (03/08/84)	160	Electric Clock Movement	J.E.Carey	
316,360 04/21/1885 (02/15/84)	165	Electric Pendulum Clock	F. and O. Haenichen	Assignors to themselves and O. Seebass
319,259 06/02/1885 (12/12/84)	59	Secondary Electric Clock	C.A.Hussey	
319,534 06/09/1885 (06/14/84)	52	Circuit-closer for Primary Electric Clocks	W.F. Weisgerber	
320,997 06/30/1885 (12/12/83)	76	Electric Clock	F.Bauman	
321,062 06/30/1885 (05/16/85)	128, 129, (74/ 152, 154, 156, 577)	Mechanical Movement	S.Tideman	Assignor to E.D. Barry. Secondary clock.
324,824 08/25/1885 (06/01/85)	166	Electric Clock	F.R.Fried	Oscillation of pendulum and movement driven by electro-magnets, the circuits to which are in turn controlled by the pendulum.
325,113 08/25/1885 (09/24/84)	180	Electric Impulsion Device for a Torsion-Pendulum	H.Rabe	
327,897 10/06/1885 (01/14/85)	60, 187	Secondary Electric Clock Movement	C.H.Pond	

To Be Continued.

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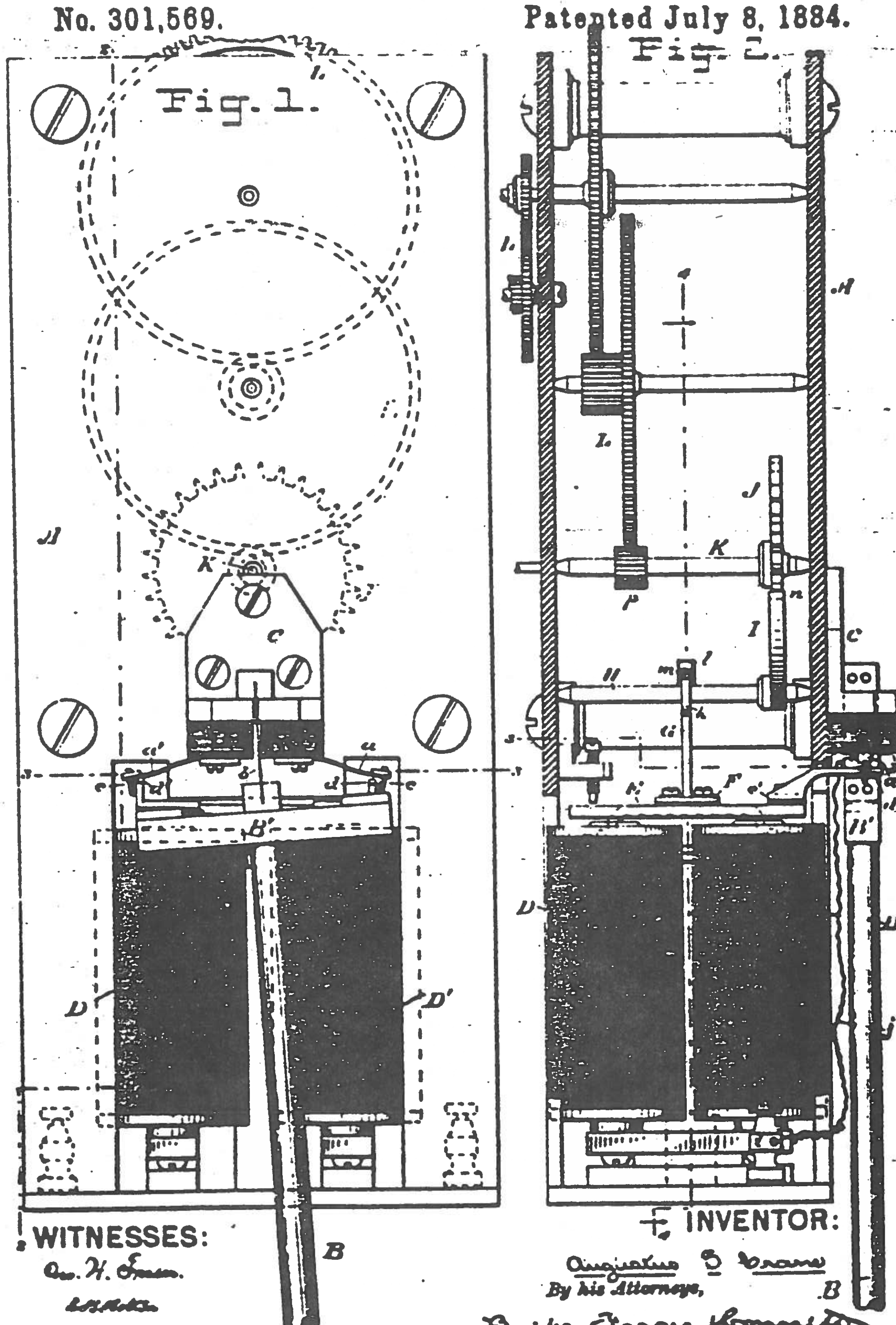
(No Model.) 3 Sheets—Sheet 1.

A. S. CRANE.

ELECTRO MAGNETIC CLOCK.

No. 301,569. Patented July 8, 1884.



WITNESSES:

Geo. H. Fraser.

INVENTOR:

Augustus S. Crane

By his Attorneys,

Burke, Fraser & Connett

-1013-9

(No Model.) 3 Sheets—Sheet 2

A. S. CRANE.

ELECTRO MAGNETIC CLOCK.

No. 301,569. Patented July 8, 1884.

Fig. 3.

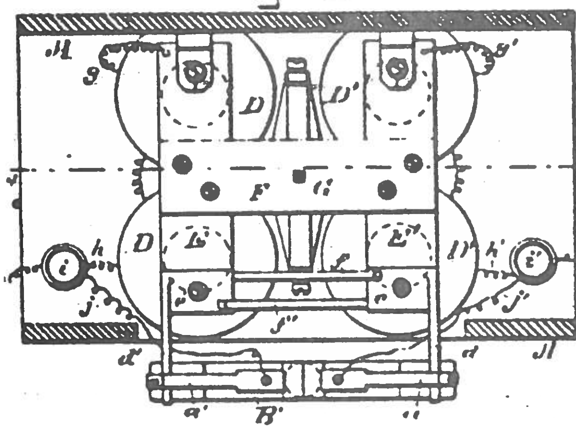


Fig. 5.

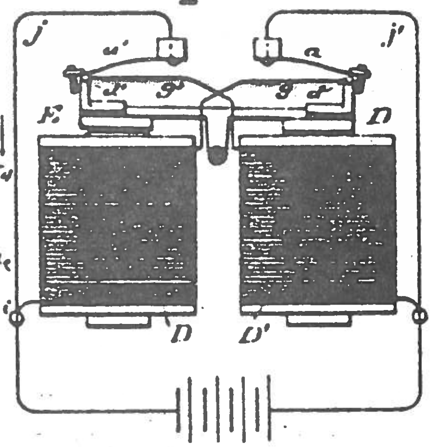


Fig. 4.

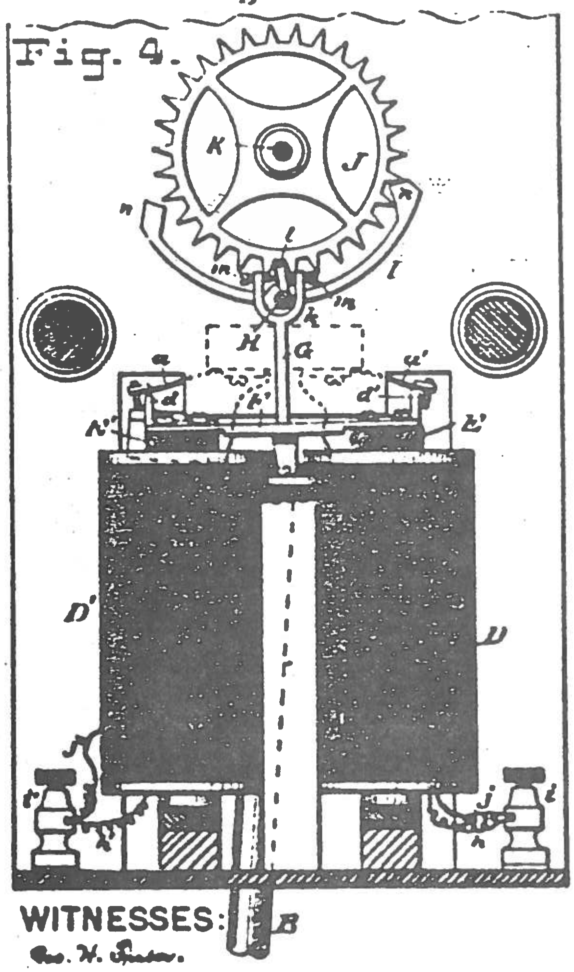


Fig. 6.

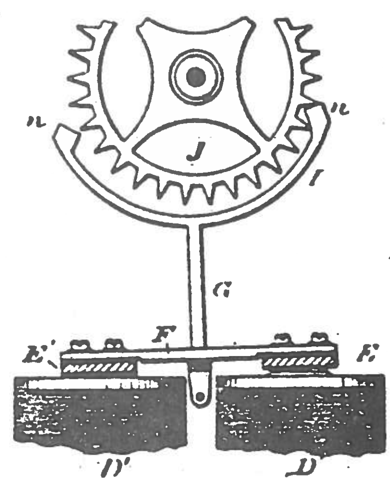
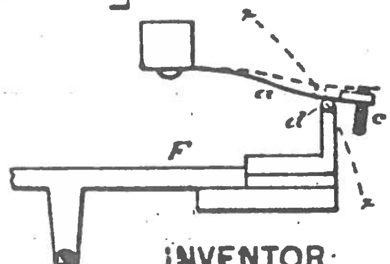


Fig. 7.



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[signature]

INVENTOR:

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By his Attorneys,

Burke, Fraser & Connett

-1014-

(No Model.) 3 Sheets—Sheet 3.

A. S. CRANE.

ELECTRO MAGNETIC CLOCK.

No. 301,569. Patented July 8, 1884.

Fig. 8.

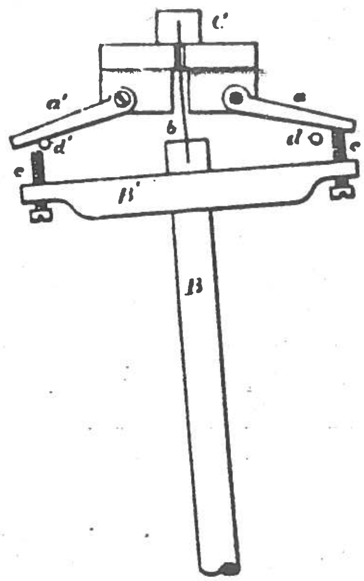


Fig. 10.

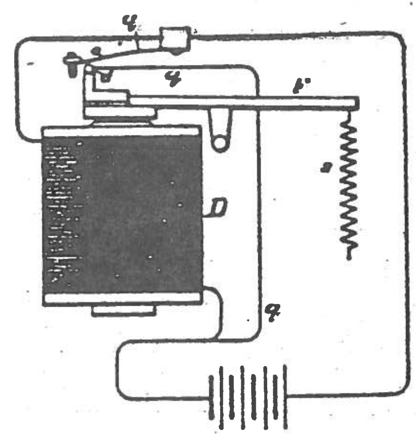


Fig. 8

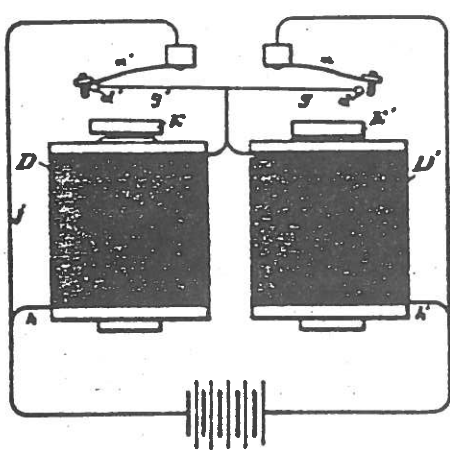
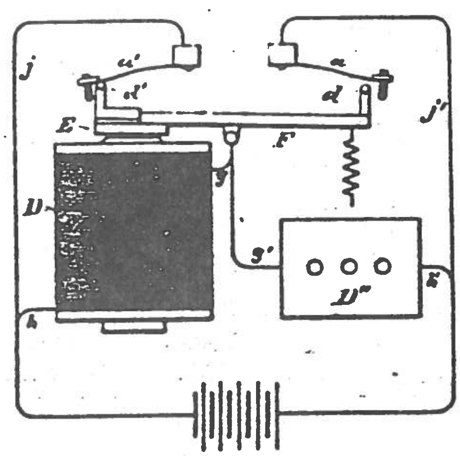


Fig. 11.



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INVENTOR:

Augustus S. Crane

By his Attorneys,

Burke, Fraser & Connett

UNITED STATES PATENT OFFICE.

AUGUSTUS S. CRANE, OF NEWARK, NEW JERSEY.

ELECTRO-MAGNETIC CLOCK.

SPECIFICATION forming part of Letters Patent No. 301,569, dated July 8, 1884.

Application filed January 26, 1883. (No model.)

To all whom it may concern:

Be it known that I, AUGUSTUS S. CRANE, a citizen of the United States, residing at Newark, in the county of Essex and State of New Jersey, have invented certain Improvements in Electro-Magnetic Clocks, of which the following is a specification.

This clock belongs to that class which is propelled by electrical power, instead of by the power of a weight or spring.

The object of the invention is to produce a clock which shall give a uniform impulse to the pendulum, whether it be actuated by a weak or strong current, in which there shall be no spark upon the separation of the circuit-breaking contacts, in which these contacts shall be constantly rubbed and kept bright, and which shall have other desirable attributes, as will hereinafter more fully appear.

Figure 1 of the accompanying drawings is a rear elevation of my clock. Fig. 2 is a side elevation, the frame being partly in vertical section cut in the plane of the line 2 2 in Fig. 1. Fig. 3 is a horizontal section cut along the lines 3 3 in Figs. 1, 2, and 4. Fig. 4 is a fragmentary vertical section cut along the lines 4 4 in Figs. 2 and 3, and looking from the front. Fig. 5 is a diagram illustrating the preferred circuit arrangement. Fig. 6 is a fragmentary view similar to Fig. 4, showing a modified construction. Fig. 7 is an enlarged fragmentary view. Fig. 8 is a fragmentary rear elevation showing a modification; and Figs. 9, 10, and 11 are diagrams showing modified electrical arrangements.

Referring to Figs. 1 to 4, A is the frame of the clock, of any suitable construction, and B is the pendulum, only a portion of which is shown, and which is hung by a spring, *b*, as usual, from a bracket, C, on the rear side of the case, and has a cross-bar, B′, at its top. The impulse-springs *a a′* are attached to the insulated bracket C, and their free ends bear alternately upon the cross-bar B′ as the pendulum swings. Their ends are fitted with minute screws *c c*, through which they bear upon the cross-bar, and by which the duration of their contact with the cross-bar may be adjusted. The cross-bar might, instead, be fitted with upwardly-projecting screws in its ends.

Beneath the springs *a a′* are fingers *d d′*, on which the springs rest, except when lifted off by the cross-bar B′. When the pendulum is at mid-stroke, both springs are resting on these fingers. The fingers have a slight up-and-down movement, and are connected together, so that as one moves up the other moves down, by means which will be presently described.

In Fig. 1 the pendulum is shown at the extreme of its right-hand swing, (when viewed from the rear,) and the spring *a* is pressing on the right-hand end of the cross-bar B′, thus impelling the pendulum to swing to the left. The finger *d* is depressed, and the finger *d′* is elevated and upholds the spring *a′*. When the pendulum swings far enough to the left for its cross bar B′ to strike the screw *c* of the spring *a′*, it lifts that spring out of contact with the finger *d′*, whereupon the latter instantly descends and the finger *d* ascends. Thus the spring *a′* is then left upheld wholly by the cross-bar B′, and is free to exert its downward tension to impel the pendulum to the right, which it continues to do until it strikes the finger *d′* or the bar B′ lifts the spring *a*. This operation is continued during the entire life of the clock, the pendulum being given an equal impulse at each vibration by the springs *a a′*. These springs are very light and elastic, and exert but a slight pressure on the cross-bar B′; but they suffice to overcome the almost infinitesimal friction of the pendulum, and after it is once started will keep it in vibration for years, or until the parts are worn out.

I will now describe the means whereby the fingers *d* and *d′* are raised and lowered with special reference to Figs. 2, 3, and 4.

D and D′ are two electro-magnets, and E and E′ are their armatures, which are both fixed to and insulated from an armature-lever, F. The fingers *d d′* are horizontal projections from plates *e e′*. The plate *e* is fixed on the armature E′, and the plate *e′* on the armature E. Both plates are insulated from the armature to which they are fixed, and each is connected electrically with the opposite armature by a copper strip, the strip *f* connecting the plate *e* to the armature E and the strip *f′* connecting the plate *e′* to the armature E′. These plates *e e′* are fixed on the rear ends of the armatures.

To the front ends of the latter wires *g g′* are connected, the wire *g* leading from the armature E and joining one terminal of the electro-magnet D, and the other wire, *g′*, leading from the armature E' and joining one terminal of the magnet D'. Thus through plate c, strip f, armature E, and wire g the finger d is connected electrically with the magnet D. The finger d' is in like manner connected with the magnet D'.

In the diagram Fig. 5, the wires g g' are shown for the sake of clearness as leading directly from the fingers. The opposite terminal of the magnet D is connected by a wire, h, with a binding-post, i, to which one pole of the battery is connected; and the corresponding terminal of the magnet D' is connected by a wire, h', with the other binding-post, i', to which the opposite pole of the battery is connected. A wire, j, leads from the binding-post i to the spring a', and a wire, j', leads from the post i' to the spring a.

The operation may now be understood by reference to Figs. 4 and 5, where the pendulum is assumed to be in the same position as in Fig. 1. The spring a is lifted off the finger d, so that the circuit between them is broken; but the spring a' and finger d' are in contact. The current then passes, Fig. 5, from positive pole of battery through wire j, spring a', finger d', wire g', magnet D', wire h', and thence to the negative pole of battery. The magnet D' is thus excited so that its armature E' is attracted and the finger d is held down, while the finger d' is elevated; but when the pendulum swings to the opposite side and lifts the spring a' off from the finger d' (by which time the spring a will have descended to and rested on the finger d) the course of the current is changed. It then flows through wire h, magnet D, wire g, finger d, spring a, and wire j', thereby exciting magnet D, whereupon the armature E will be attracted thereto, will drop finger d' and rock lever F, thereby lifting armature E' and finger d, which lifts (and compresses) spring a. Spring a' is thus left free to descend and impel the pendulum, while spring a is lifted ready for a fresh impulse. By the means thus described the two magnets are charged alternately, and the lever F is vibrated with perfect regularity, assuming, of course, that the length of the pendulum remains unaltered. To this end a compensating-pendulum should be used. The movement of the lever F is utilized to actuate the wheel-work of the clock by means which I will now describe. An arm, G, Fig. 4, is fixed to the lever F, and projects upwardly, its upper end terminating in a fork, k. A spindle or arbor, H, passes through this fork, and on it is fixed the anchor I, engaging the escape-wheel J. To the spindle H is fixed an arm, l, within the fork k, and two adjusting-screws, m m, passing through the arms of the fork, embrace this arm l loosely between them. As the lever F and arm G vibrate, the screws m m impel the arm l from side to side, and so vibrate the anchor. Instead of this indirect connection between the lever F and the anchor, the latter may be fixed directly on the arm G, as shown in Fig. 6; but the construction shown in Fig. 4 is preferred for very accurate clocks, as it permits of the adjustment of the play of the armatures and of the anchor independently of each other.

The anchor I and wheel J do not constitute an escapement; but the anchor is constructed to propel the wheel, its pallets n n being wedges, or having inclined surfaces which engage the teeth of the wheel and propel it a half-tooth forward on each motion of each pallet toward the wheel. The wheel J is fixed on the seconds-arbor K, on which is a pinion, p, which communicates motion to the train of gears L L, which actuate the hands of the clock. All these parts are of the usual construction and require no description.

The battery used to run this clock should furnish a current of considerable quantity, but low tension. A single sawdust-cell answers admirably and will run the clock six months or more without recharging. The current must have strength enough to give the magnets sufficient attractive power to cause the armatures to vibrate with force sufficient to raise the springs a a', and to overcome the friction of the lever F, anchor, train, and other parts; but beyond this a current of any ordinary strength may be used without impairing the operation of the clock, as the impulse given to the pendulum is wholly independent of the strength of the current. The springs a a' serve as conductors of the electric current only when they are not employed in impelling the pendulum, so that whatever change in their tension may be caused by the passage of a current through them ceases the instant they are lifted by the cross-bar B', and the current is not resumed until they have ceased to impel the pendulum. The pendulum forms no part of the circuit—a feature wherein my clock is superior to many others heretofore made. When the pendulum is at mid-stroke, neither spring a a' is upheld by the cross-bar, both then resting on the fingers d d'. The current has consequently two paths, which should be of equal resistance, so that it will divide, and one-half will flow through each magnet. This continues for a moment, or while the pendulum is swinging from the center to either side, and until, when at nearly its extreme swing, it lifts one of the springs, and thereby breaks one branch of the circuit. The current then has to wholly follow the other branch; but as it still has a continuous path, no spark follows the separation of the spring from its finger. I thus avoid one of the most troublesome defects of electric clocks as heretofore made—namely, the oxidation of the circuit-breaking contacts by the electric spark, which in a few months will impair the operation of the clock.

The contacting surfaces of the impulse-springs and fingers are kept bright by causing the fingers to rub across the springs at each movement. This is done by pivoting the lever F considerably below the plane of the fingers, so that the latter move in the direction of the arc x x in Fig. 7, instead of vertically. An equivalent result might be produced by fulcruming the lever F on an axis above the fingers d d', or by any other arrangement which will cause the fingers to slide along the springs while lifting them.

It will be understood that the current which excites either magnet is caused to pass longitudinally through the armature of that magnet, thereby increasing the attractive power of the magnet in the manner well known to electricians. This is desirable, but not essential, as the wires g g' may be joined directly to the fingers d d'.

Instead of using springs for giving the impulse, small weights may be used. In Fig. 8 two loosely-pivoted dogs, a a', are shown, instead of springs, and operating in the same manner.

In Fig. 9 a different circuit arrangement is shown, the difference being that the wires g g' are in fact connected with each other, so that when both springs a a' are in contact with both fingers d d' the current does not divide, but is shunted around both magnets, following the path i, j, a', d', g', g, d, a, j', and i'. This method is less desirable than that shown in Fig. 5, as upon the separation of either pair of contacts the entire resistance of one magnet is thrown into the circuit, whereby with the preferred arrangement only half that resistance is thrown in.

Instead of using two magnets and two impulse-springs, one magnet and one spring may be used, as shown in Fig. 10. Here there is one continuous circuit, which includes the magnet and is never broken, and a shunt-circuit, q q, in which are the circuit-breaking contacts a d. When a is touching d, the current traverses the path q q of least resistance, and almost entirely ceases to traverse the magnet D, leaving a retracting-spring, s, free to lift the armature. A single impulse gives a slightly unequal motion to the pendulum, and hence a double impulse is preferable. Fig. 11 shows how a double impulse may be given by a single magnet. The arrangement is the same as in Fig. 9, except that a rheostat, D'', is substituted for the magnet D', and a retracting-spring, s, is used. The resistance of the rheostat D'' should be about equal to that of the coils of the magnet D.

My clock is well adapted for use as the primary or regulating clock controlling a number of secondary clocks arranged all on one circuit. For this purpose it should be provided with some good circuit-breaking device to manipulate the line-circuit, it being preferable to employ a line-circuit distinct from the circuit which actuates the clock.

The secondary clocks may each consist of one or both magnets, D D', their armatures, lever F, anchor I, wheel J, and the train.

I claim as my invention—

1. The combination, in an electric clock, of a pendulum, an impulse spring or weight arranged to be lifted intermittently by the pendulum, a finger arranged to uphold said spring or weight, except when it is so lifted by the pendulum, an electro-magnet, its armature connected with and arranged to move said finger, and an electric circuit divided into two branches, one branch traversing said spring and finger and the other branch traversing said electro-magnet, whereby, upon the lifting of the impulse-spring off said finger by the pendulum, the branch of the circuit traversing the spring and finger is broken, and the entire current is caused to traverse said magnet, thereby exciting the latter and drawing down said finger, substantially as set forth.

2. The combination, in an electric clock, of a pair of electro-magnets, their armatures mounted both on one armature-lever, two fingers connected to and operated by said armatures, two impulse springs or weights arranged over and adapted to be held by said fingers, a pendulum adapted when at either extremity of its swing to lift one or other of said springs or weights off its finger, and an electric circuit divided into two branches, each traversing one of said magnets and one of said springs or weights and fingers, in substantially the manner and to the effect set forth.

3. The combination, to form an electric clock, of pendulum B, cross-head B', impulse springs or weights a a', fingers d d', armature-lever F, bearing said fingers, armatures E E' thereon, alternately-acting electro-magnets D D', propelling-anchor I, receiving motion from lever F, and toothed wheel J, substantially as set forth.

4. In an electric clock, the combination of a circuit divided into two branches, a circuit-breaking impulse-spring arranged in one of said branches, and the pendulum arranged to lift said spring, and thereby break the circuit in said branch, whereby during the impulse the current flows wholly through the other branch and no current traverses said spring, substantially as set forth.

5. The combination of pendulum B, cross-head B', impulse-springs a a', armature-lever F, armatures E E', fingers d d', mounted on and insulating from the rear ends of said armatures, crossing conductors f f', joining each finger to the opposite armature, wires g g', leading from the front ends of said armatures, and electro-magnets D D', substantially as set forth.

6. In an electric clock, the combination of magnets D D', armatures E E', lever F, arm G, fork k, screws m m, arbor H, arm l, and anchor I thereon, and toothed wheel J, substantially as set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

AUGUSTUS S. CRANE.

Witnesses:
ARTHUR C. FRASER,
HENRY CORNETT.

WEIGHT DRIVEN MASTER CLOCKS (CONTINUED)

All of our Weight Driven Master Clocks are motor wound. The mechanism consists of two main parts; the clock movement itself and the back frame or casting upon which is mounted the motor for winding, the gearing immediately connected to it, the drum for carrying the cables to which the weights are attached and the switch for cutting the motor in and out of the circuit. The movement can easily be removed from the back frame by locking the weights with the pawl provided and removing the four screws.

The mechanism is so arranged that the clock will run between eight and nine days from the time it is fully wound to the time when the weights reach the bottom of the case. The above statement covers the condition when a mercurial pendulum is used. Owing to the greater diameter of the metal ball pendulum and its greater swing, it is necessary to shorten the drop of the weights and the full capacity of the run is then a little over five days.

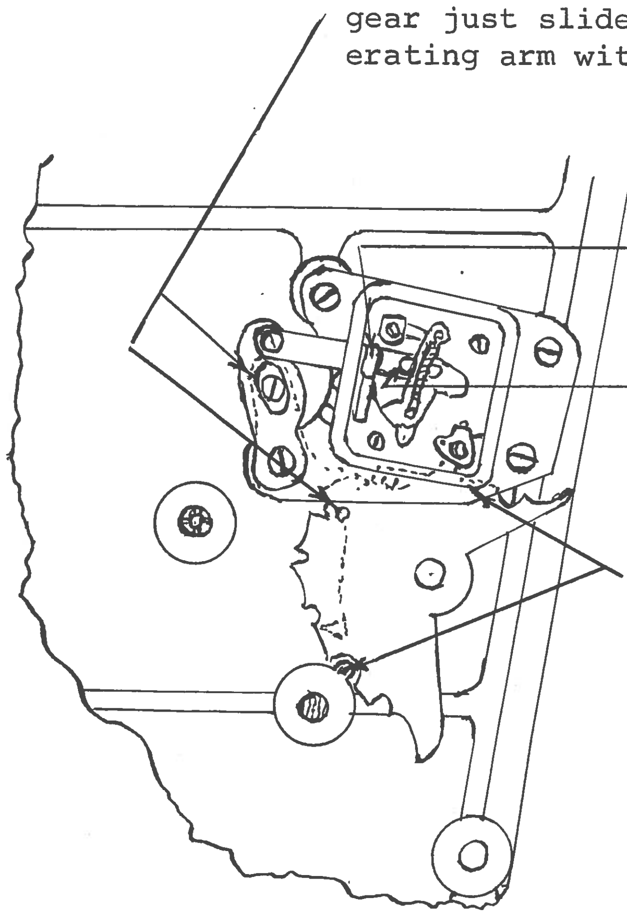
In the ordinary operation of the clocks, approximately 30 hours elapse from the fully wound condition of the clock to the point where the winding switch is closed. If there happens to be no current on at the time the switch is closed, the clock continues to run, the winding switch remaining closed. It will be apparent that if no current is available for approximately a week, the Master Clock will continue to run.

The winding mechanism is driven by a universal motor which will run equally well on alternating or direct current. To reduce the hum of the motor to a minimum, it is mounted on flexible or yielding supports which keep it from direct or rigid contact with the back frame.

In the end casting of the motor is mounted a worm and worm gear, the purpose of which is to prevent winding at an excessive speed and to form a positive lock to prevent the weights from turning the motor armature backward when not winding.

The motor is connected to the winding drum by means of a fibre coupling. Differential gears are placed in the winding drum to insure power th the escape wheel while the clock is winding. The power from the downward pull of the weights is transmitted whrough these differential gears to the main driving gear and thence through the usual train of gears th the escapement.

To make the clock as near frictionless as possible, the winding drum and main gear are equipped with ball bearings.



The winding switch is so designed that the weights cannot rise beyond a certain point without opening the switch even though the switch may be out of adjustment so that it will not snap open. There is an eccentricscrew in the switch arm which permits the switching mechanism to be adjusted so that it will snap open and closed with good tension and not bind. As stated before, the circuit will remain closed until the clock is wound.

If occasion arises to remove the winding drum from the back frame, care should be taken not to lose the ball bearings and also when reassembling, to get the one tooth pinion meshed properly with the fan gear. When the cords are out full length and the point where they are fastened to the drum is down, the one tooth pinion should be meshed in in the second tooth from the end of the fan gear. This holds true when the long cords are used. If the short cords are used, the one tooth pinion should be meshed with the fourth tooth of the fan gear. Changing the number of turns of the cords around the drum has the same effect as changing the mesh of the teeth of the gears. Under no condition should the top of the weights rise above the lower screw holes in the back casting.

If the weights do not hang even, small adjustments may be made by shifting or bending the support brackets slightly for the pulleys. Further adjustments may be made by tying new knots where the cords go into the weights.

This type of Master Clock uses the same minute impulses contact and duration contact as previously explained. This style of Master Clock is the only one used for synchronized and self regulating systems, the operation and contacts of which are fully explained in other bulletins.

Mercurial Pendulum

Any sixty beat Master Clock may be equipped with a mercurial pendulum which, through the rising and lowering of the mercury in the glass jars, compensates for the expansion and contraction of the steel pendulum rod due to changes in temperature. Any Master Clock, when equipped with a mercurial pendulum, placed on a wall free from vibration and regulated to position, is guaranteed to rate within ten seconds per month of correct time.

When any clock is equipped with a mercurial pendulum, the suspension spring is much heavier to support the extra weight. On a spring driven clock, the main spring is heavier and on a weight driven clock, the weights are heavier as more power is required to swing a mercurial pendulum.

Synchronized Master Clocks

Where it is desired to have two or more master clocks on the same system and each controlling part of the system, as in different buildings or locations, the master clocks may be synchronized with each other. When such is the case, all master clocks except one are termed auxiliary master clocks and are regulated by the one or controlling master clock.

The controlling master clock may be of the hourly supervision type, if impulse equipment is to be operated from it, however, if it is to be usedonly for synchronizing other master clocks, it need be only of the plain impulse type.

As each master clock must have its own control equipment, take its power locally, and operate as an independent system, with the exception of the synchronizing feature, any or all master clocks, if they are the weight driven type, may be equipped with an impulse accumulator.

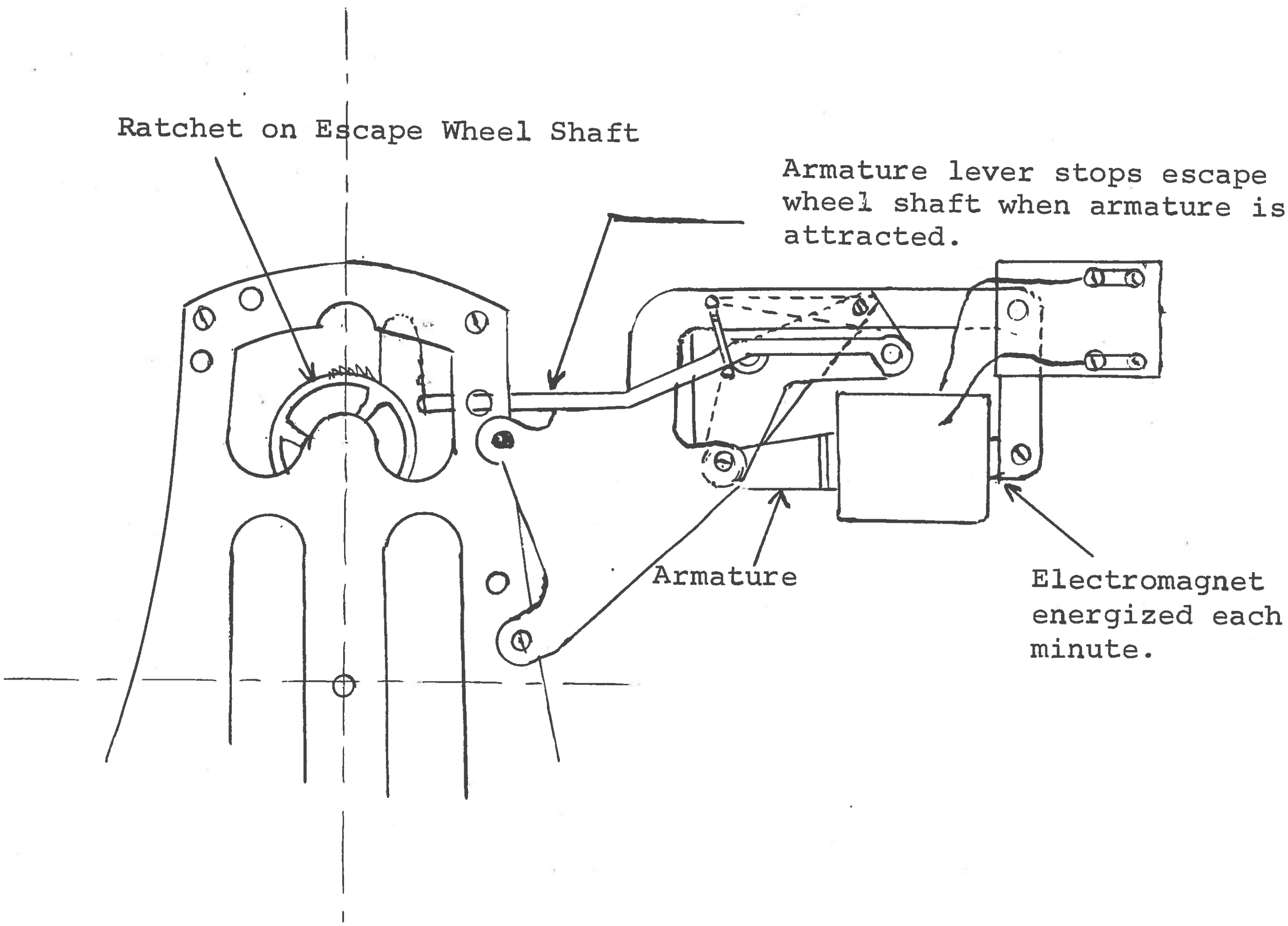
The sychronizing takes place every minute, therefore, the auxiliary master clocks may be of the 120 beat type as even under unusual conditions they would never get over a few seconds from correct time.

The sychronizing consists of an impulse sent out from the controlling master clock each minute. These impulses are received by an electro-magnet attached to the auxiliary master clock. Attached to the escape wheel shaft of the auxiliary master clock is a disc with several ratchet teeth cut therein. This disc makes one revolution per minute. When the sychronizing electro-magnet receives an impulse its armature is attracted. Attached to the armature is a lever with a flat spring which engages with the ratchet teeth on the disc attached to the escape wheel shaft, stopping same. The auxiliary master clock being regulated to run slightly fast will be stopped for an instant each minute and this keeps it in perfect step with the controlling master clock.

Several teeth are cut in the sychronizing disc to compensate for several seconds error should the sychronizing feature be out of service for long periods of time.

It is obvious from the above that the impulses must not occur oftener than once a minute. For this reason the sychronizing electro-magnet can only be connscted between the "B" and "C" wires of a supervised circuit, or to a minute impulse system. In the former case the master clock would only be sychronized for 50 minutes each hour. In either case the duration of the sychronizing impulse is approximately two seconds, therefore,the auxiliary master clock will only be corrected at the rate of two seconds per minute and should they be 10 seconds fast, five minutes would be required to sychronize them.

The usual application for this plan is to employ a high accuracy 16-1 Master Clock as a Grand Master to sychronize any number of sub-masters which we equipped to supervise hourly their representative sub systems of secondary equipment. This plan is used in the Cleveland Terminal Station and the Philadelphia Terminal Station.



120 Beat Master Clock

The train gears in the 120 beat master clock have been changed in order to use a standard 30 tooth escape wheel and verge such as are used in our 60 beat master clocks. The gear reduction is now twice what it was when a 60 tooth escape wheel was used.

The escape wheel is now mounted to the right of its former location. The larger reduction gear is mounted in the place formerly occupied by the

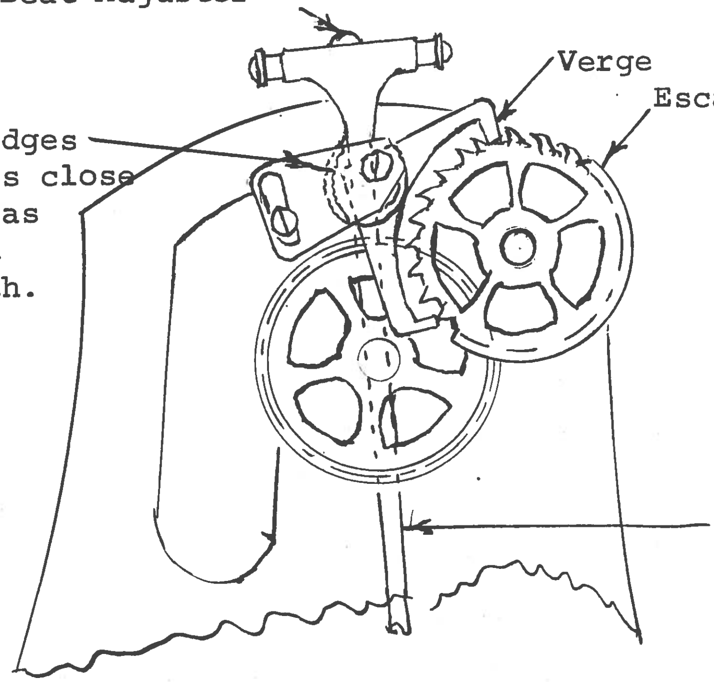
60 tooth escape wheel. The smaller reduction gear is mounted on the escape wheel shaft. This construction necessitates mounting the verge on its shaft at a different angle in relation to the verge wire and facing in the opposite direction to that generally used on our clocks, but the principle of operation and adjustments remains the same.

The above changes enable a heavier pendulum ball to be used which insures more accurate time as it is less influenced by outside or foreign forces.

The verge is now supported by new verge bridges which enable the verge to be adjusted in relation to the escape wheel.

The verge is now equipped with an adjustment which facilitates putting the clock in beat. This consists of a screw adjustment which changes the relation of the verge wire to the verge.

Extreme care must be used when making the contact anjustments on the 120 beat master clock. This is especially so on the seconds and two seconds contact as too much tension may cause the clock to run abnormally fast.



Old Style Rapid Impulse Contacts

The adjustment of the rapid impulse contact has a direct and definite relationship th the timekeeping of the master clock. Once adjustments are made they will not change but if they are not correctly adjusted the master clock will not give satisfactory results.

Fig. 1 shows the relative position of all parts when the pendulum os at rest.

Note that "D" and "E" are approximately parallel. This may be adjusted by changing the relation of "E" to the verge shaft. The contact block assembly may also be adjusted.

Spring "C" should rest on support "D" with just sufficient pressure so that it will follow "D" down about 1/64" if "D" is pressed down. More tension than this in spring "C" will do no good and tend to stop the clock.

The contacts should be open at "B" about 1/32" when the lower spring is free and not touching anything.

There should be a very small air gap at "A" when the contact is normally open and the pendulun at rest.

Fig. 2 shows the relative position of all parts at the instant of escape when the pendulum swings to the left.

Contact should be made at "G" and a very small gap at "F" when the clock escapes. The normal carry of the pendulum will make a positive contact.

Fig. 3 shows the relative position of all parts when the clock escapes as the pendulum swings to the right.

The upper operating finger should be free of the lower contact finger as shown at "H" but it should be below the upper contact finger so that in case the contacts are stuck together they will be broken apart.

If the pendulum is allowed to swing just enough to escape the clock there will be no contact at "H" Fig. 3 unless the contact fingers stick together and the upper contact finger will just break from its support at "F" Fig. 2, at each swing of the pendulum to the left.

When the pendulum swings normally there will be quite a perceptible break at "F" Fig. 2 and the upper operating finger will touch the lower contact spring at "H" Fig. 3, at each swing of the pendulum.

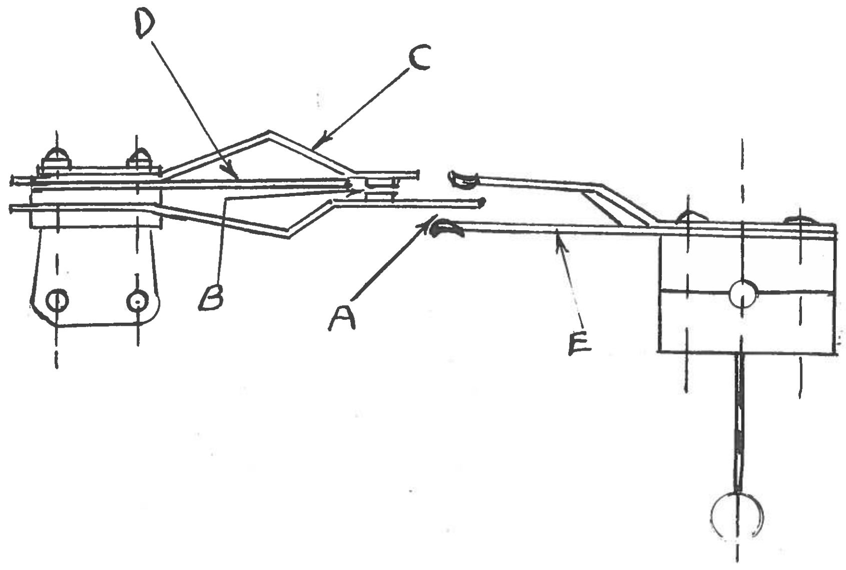


Fig. 1

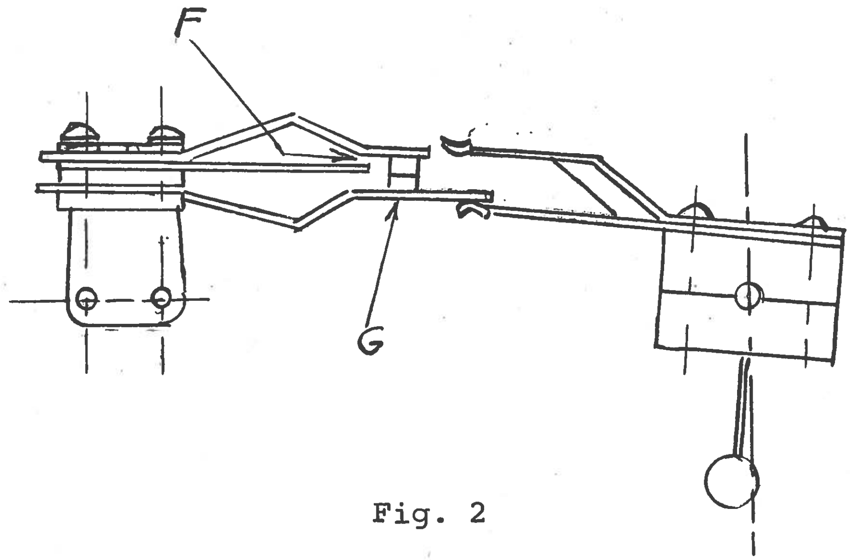


Fig. 2

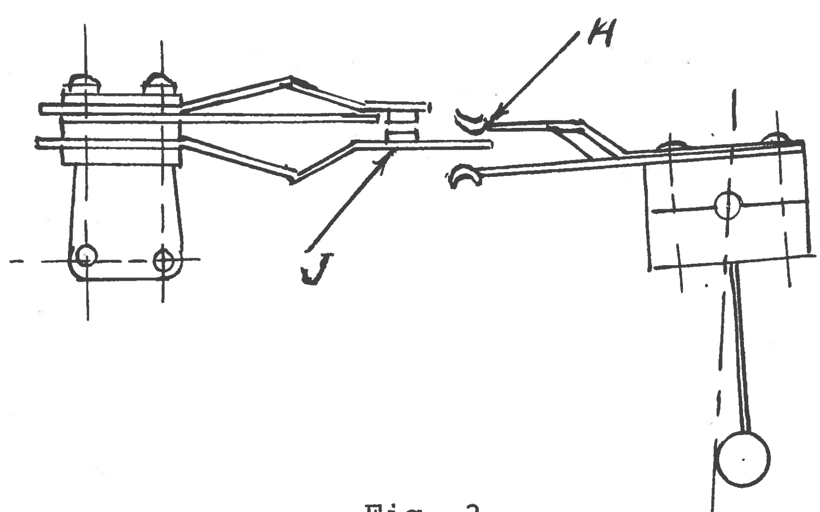


Fig. 3

to be continued

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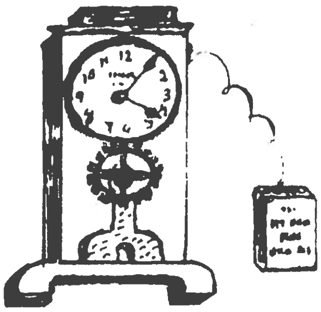

The
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Chapter No 78

NATIONAL ASSOCIATION of WATCH and CLOCK COLLECTORS, Inc.

VOLUME XIII, #3

July-Dec 1987

Fellow Horologists:

This is the final issue of 1987, and we have interrupted the IBM Workbook serial in order to print a series covering the construc- of a Eureka Clock. We are aware of course, that very few of our readers are truly interested in constructing a Eureka, but the information is invaluable when used as reference for repair work. All of the components are drawn to scale, and the technical con- tent is clear and concise providing a wealth of accurate data. The material was originally published in THE MODEL ENGINEER as a series during February and March of 1949, and we have put together the individual articles to form a continuous presentation.

Dr. Feinstein's series on Electrical Patents continues in this issue, and will continue in future journals as space and material permits.

On the more informative side of the business of the chapter, we have 86 paid-up members for 1987, and if we are fortunate enough to continue with the same number in 1988, we will be able to stay in the blue and publish approximately 70 pages of journal material as has been the past practice. It appeared earlier in the year that economies in printing and mailing would be necessary, but this proved unnecessary, thankfully. <u>1988 Dues are now due</u>, so.....

The next regular meeting is scheduled for January 3rd, 1988, in con- junction with the Westchester Chapter #90 at the Hommock's School in New Rochelle, and the agenda will consist of a presentation to our Past President, Founder, and Editor of some 14 years duration, Martin C. Feldman, FNAWCC. A well deserved and long overdue honor for a tireless and dedicated worker.

Our plea for material for future journals has been disappointing in its response, so we again appeal for anything relating to Elect- rical Horology worth printing. We will retype, edit, draw pictures, and make any needed adjustments... just send it in.

The officers and editorial staff join in wishing all our members the Very Best for the coming year and the Healthiest & Happiest Holiday Season.

Harvey Schmidt
Dr. George Feinstein

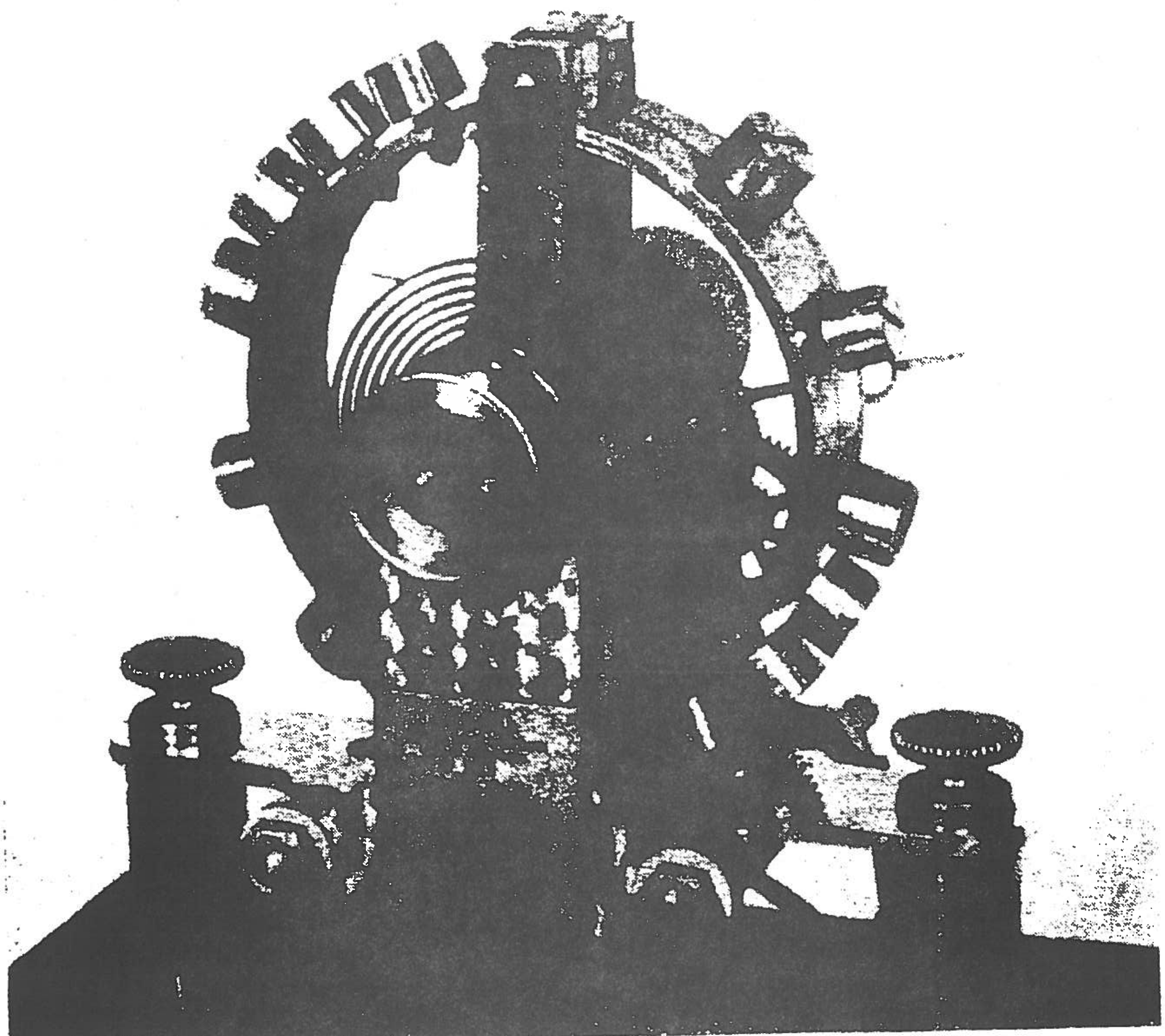
-1030-

The "Eureka" Electric Clock

by "Artificer"

THE construction of electrically-driven clocks has always been popular among model engineers, and at nearly every MODEL ENGINEER Exhibition, at least one or two specimens of these clocks are represented. But while the workmanship (and presumably, the performance) of these clocks is often extremely good, and some of them exhibit originality and ingenuity in the details of design, there is comparatively little enterprise among constructors in exploring the broad principles of design, and in utilising the many possible forms of escapements and operating mechanisms which have been devised in the past. It is safe to say that about 95 per cent. of the electric clocks which have been built by amateurs have been either of the Hipp or the Synchronome types, with minor modifications in each case; and while both these embody unquestionably sound working principles, and if properly made, work most reliably and keep accurate time, there is a strong case for going farther afield and introducing a little more variety in this branch of construction.

The obvious answer which many amateur constructors will make to this criticism is that the two types of clocks mentioned above are the only ones on which any detailed information on construction is available. This is quite true; of



The "Eureka" clock movement viewed from the rear, showing regulator star wheel two books on building electric clocks which the writer obtained some years ago, one described a number of different sizes and styles of clocks all using the Hipp escapement, while the other dealt with several Hipp clocks plus one Synchronome master and secondary clock. A third book described in detail the construction of a single

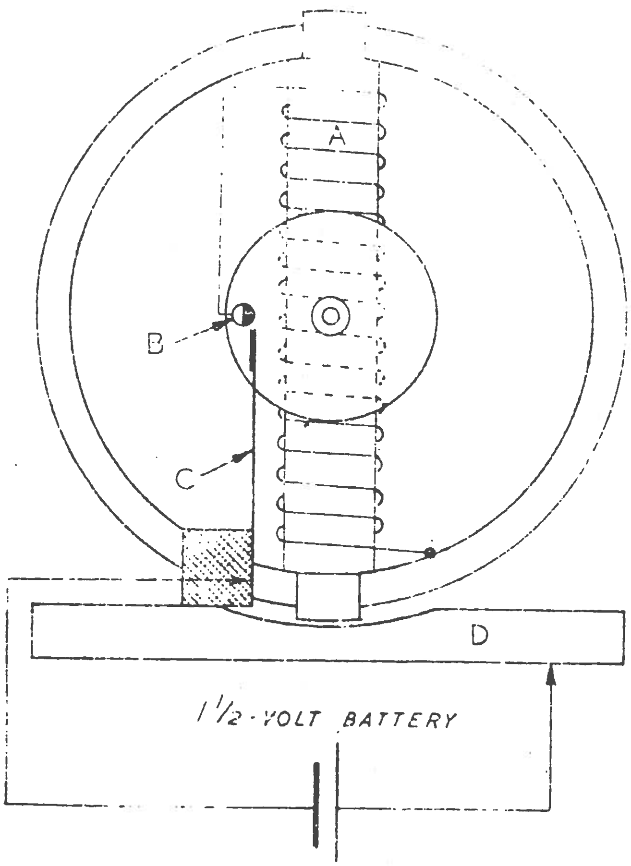


Fig. 1. Position of balance wheel when at rest

Hipp clock, while several articles published in THE MODEL ENGINEER and other journals played minor variations on the same old theme. It is in the hope of broadening general knowledge of the working principles of electric clocks, therefore, that the following particulars are given of a type of clock which is notably "different," and despite the fact that it is not claimed to be superior in any way to the popular types of electric clocks, is none the less interesting to the enterprising constructor.

It may further be noted that practically all the electric clocks built by amateurs—with the exception of a.c. mains synchronous clocks, which, one might argue, are not really clocks at all—have so far been pendulum clocks ; and while there is nothing one can object to about such clocks from the timekeeping point of view, there is no doubt that they have their own particular limitations. The normal form of pendulum is impracticable in any type of portable clock, and if one had to rely exclusively on it, timekeeping at sea would be impossible unless the clock could be held steady by an elaborate gyroscopic stabilising device. While no form of balance wheel is quite equal in isochronous property to the best form of pendulum, it can be designed so as to show no perceptible inferiority in practice, and it can be compensated for climatic and other variations just as readily as a pendulum.

The balance wheel has been successfully applied to a number of electrically-driven clocks, including some small portable clocks such as those for use in cars or other vehicles. It may, however, be noted that most of the latter may be regarded as more or less normal mechanical spring-driven clocks, equipped with an electric impulse device to wind the spring at regular (and usually frequent) intervals ; in other words, they come into a class termed "Remontoire" (self-winding) electric clocks, which present little real interest from the constructor's point of view.

There is, however, at least one notable example of a balance-wheel electric clock in which the driving impulse is applied directly to the balance wheel so that, like the pendulum of the Hipp and Synchronome clocks, it constitutes the actual driving "motor," and transmits power to the wheel train, which serves the function of an impulse counter and indicating mechanism, rather than a heavily-stressed transmission gear. Herein lies the great advantage of the true electrically-driven clock from the aspect of the amateur constructor ; the pendulum or balance wheel, together with its escapement, instead of being a delicate and finely-poised piece of

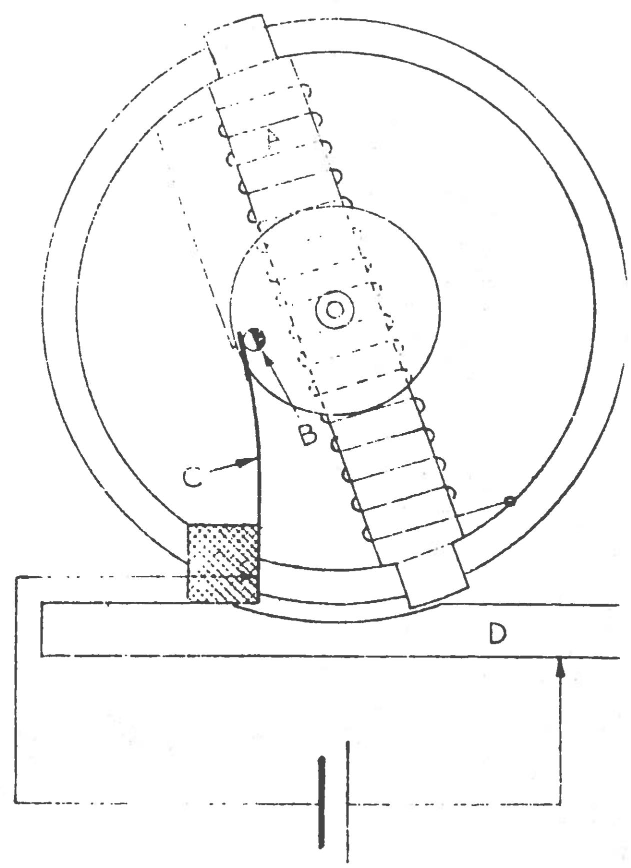
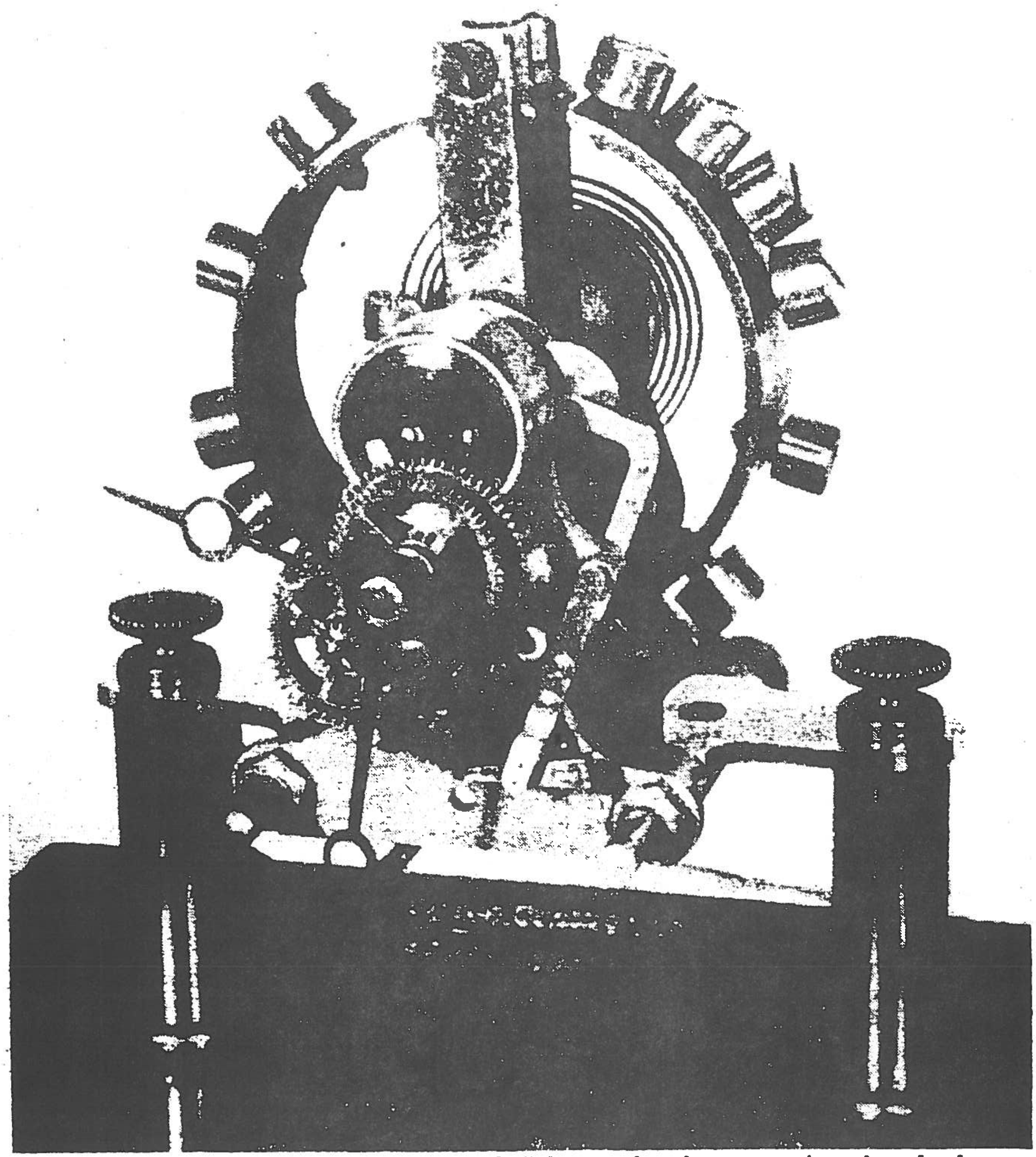


Fig. 2. Position of balance wheel at the point of making contact

mechanism, the adjustment of which demands specialised skill, is heavy and robust, requiring comparatively little finesse in either construction or adjustment. This does not mean to say that there is not just as much scope for skill and care in the construction of such clocks as in those of fact that some excellent results have been obtained with electric clocks of quite unsophisticated or even crude design and construction.

The "Eureka" electric clock, which forms the



Front view of "Eureka" clock movement, with dial removed to show gear train and ratchet lever

subject of these articles, was invented in 1906, and was put into production by the enterprise of the brothers Kutnow, of "Kutnow's Powder" fame. Its novel and somewhat spectacular design attracted a good deal of attention at the time, but it proved to be a nine day's wonder, and There were possibly several reasons for this, not the least being that inevitable teething troubles were encountered in the early stages of production, and it is more than likely that when such faults as developed were referred to clock repairers, the unfamiliar nature of the mechanism prejudiced their chances of receiving conscientious attention. The examples of these clocks which have been encountered, or on which information is available, bear evidence of unfinished design or tentative experiment, and there are certainly one or two points where the design or workmanship could be much improved. But the clock can at any rate be made to work well and reliably with a very low current consumption, and its inherent timekeeping qualities, though by no means perfect, are probably as good as those of most domestic and portable clocks of the normal type.

Some time ago, the writer was consulted about the repair and restoration of a "Eureka" clock which had been out of use for many years, and—thanks to the ministrations of someone who had tinkered with it at some time in the past — had several essential parts of the mechanism missing. There was, in fact, no visible link-up between the balance-wheel "motor" and the gear train, and though it was not difficult to reconstruct the general design of the missing parts, it was decided that it would be worth while to consult any available information on the original construction of the clock. In the course of this research, which entailed the consulting of all the books on electric clocks which could be unearthed (and incidentally some of them contained totally misleading information, worse than none at all !) and enquiries at South Kensington Museum (much more fruitful) a certain amount of data on this and other unusual types of electric clocks has been acquired. Some further advice has been given on this matter by Mr. F. Hope-Jones, who, as most readers are aware, is a world authority on electric clocks ; and as a result, the restoration of the clock in question has been very successfully carried out. In the hope that the matter will be of interest to many readers, an exact record of the design and working details of the clock in its restored form has been prepared, with some suggestions for possible improvement of the design and methods of construction.

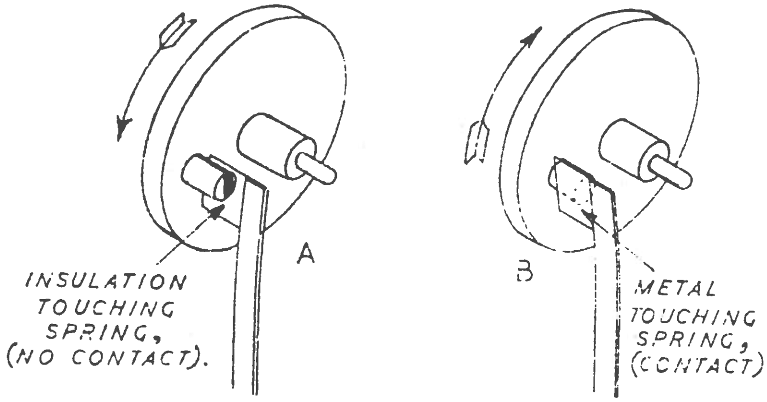


Fig. 3. Action of contact spring on both directions of balance wheel movement

Working Principle of the "Eureka" Clock

The motive power of the clock is obtained from a large diameter oscillating balance wheel, the general form of which is similar to that of a watch balance on an enlarged scale, including the hair spring. This wheel is kept in motion by an electro-magnetic device which operates on the same principle as that in any simple attraction motor. It may here be mentioned that in a clock having the motive power supplied by the pendulum or balance, a fairly substantial mass in the latter is most essential. In this case, the balance wheel is 12 oz. in weight, and the diameter over the rim is $2\frac{3}{8}$ in., the outermost diameter over the complete balance system being $3\frac{3}{4}$ in. The rim is of the bimetal compensated type, and fitted with poise screws ; the suspension of the balance is by extended pivots which roll on steel balls enclosed in an oil bath.

An iron bar, *A*, passes diametrically across the balance wheel, forming the "spokes" on which the rim is supported ; this is wound with a coil of wire so that it forms an electro-magnet when energised with current from a battery. The supply of current is controlled by a contact device which closes the circuit at the appropriate time. Below the balance wheel is a stationary iron plate, *D*, machined away in the centre so as to provide a fine clearance for the tips of the bar as the wheel oscillates.

When the clock is at rest, the bar assumes a perpendicular position relative to the iron plate, as shown in Fig. 1. The contact pin, *B*, in the cheek of the balance wheel is just clear of the contact spring, *C*, so that no current is passing, and the electro-magnet is inert. It will be noted that the contact pin, *D*, is composed of two half-round sections, the one on the left being of metal and the other of insulating material. The spring, *C*, has an attached tip of contact metal (usually gold-silver alloy), extending sideways, so that the end is shaped like an inverted L. It is adjusted in such a way that the contact pin passes on the right-hand side of it on the upwards swing (see Fig. 3A) and on the left-hand side of it on the downward swing as shown in Fig. 3B ; the spring being in each case displaced slightly in the opposite direction. The metal part of the contact pin forms the terminal point at one end of the magnet winding, the other being earthed to the frame of the wheel, and making connection with the main motion frame through the hair spring. Current is supplied from the battery by connecting one terminal to the base of the contact spring and earthing the other to the frame.

If the balance wheel is now set oscillating by hand, the first swing in the anti-clockwise direction will carry the contact pin past the spring with its insulated portion in contact, so that no current passes. But on the return (clockwise) swing, when the position shown in Fig. 2 is reached, the contact pin will again touch the spring, this time on the metallic side, so that a connection is established through the windings of the electro-magnet, which becomes strongly energised, just as its tip is approaching the concave portion of the iron plate. The result is to cause a powerful attraction of the electro-magnet to the centre of the plate, but by the time it reaches this point, contact will be broken between the pin and the spring, so that the balance wheel will continue to move under its own inertia until this is counteracted by the hair spring. This starts it on the return swing, and the cycle of events is then repeated indefinitely, so long as current is available to energise the magnet.

It will be quite clear that an essential feature in the function of the clock is that current must only be supplied during the time the magnet is approaching the centre of the iron plate, therefore contact must only be made on one direction of swing. If contact took place on the reverse swing, it would produce an impulse equal and opposite to the first, tending to stop the motion of the wheel. This point is emphasised because it has been stated by one writer in a published description of the "Eureka" clock that impulse takes place in *both* directions of swing; a statement which caused considerable perplexity when the working of this clock was first investigated by the writer, until it was proved that such action was quite impossible with the form of contact mechanism shown.

The strength of the impulse will be dependent on the e.m.f. supplied by the battery, so that any variation in the voltage, as caused by a gradual running down or deterioration will affect the applied power, and to some extent, the rate of the balance. But the isochronous characteristics of the latter will be similar to those of an ordinary watch balance, which tends to compensate variations of power by altering the arc of its swing, and timekeeping errors from this source are not serious, unless one insists on high precision standards. It would not be impossible, however, to improve on this detail, and introduce a constant-impulse form of contact device if so desired.

So far, only the operation of the balance wheel "motor" has been considered, but obviously some method of "counting" the impulses of the wheel and using them to drive the hands of the clock is essential. The gear train employed for this purpose differs in no practical respect from that of an ordinary clock, but what would normally be the escape wheel is in this case a ratchet wheel, which is fed one tooth at a time by a lever and pawl deriving its motion from the balance wheel system. This is done by providing an eccentric on the staff of the balance wheel, and a large diameter roller resting on the latter, and mounted on a pivot at one end of the lever. The ratchet mechanism is clearly visible in the photograph taken from the front side of the clock, with the dial removed; this part of the clock is of course essentially similar to that of the Hipp, Synchronome and many other electric clocks.

The balance wheel is regulated by the usual method of controlling the free length of the hair spring, a rather elaborated geared quadrant being fitted for this purpose, and operated from a pinion with a star wheel on the outside of the motion plate, as seen in the photograph taken from the rear side.

Continued

FOR the benefit of readers who may wish to construct a clock of this type, or one working on similar principles, some details are given here of the essential working components, with main dimensions, and other useful data, though no attempt has been made to give working drawings which are complete in every respect. It is more than likely that any constructor who undertakes to build such a clock will wish to introduce minor modifications of his own design, or possibly to utilise existing material, such as gear wheels or other clock parts; and so far as possible, advice will be given regarding the deviations from the set design which are permissible—or even, in certain cases, desirable.

Balance Wheel

The balance mechanism of this clock is the heart of the entire functional system, and also the most difficult, or at least the most complex, part of the clock to construct. As the balance wheel contains the windings of the electro-magnet which provides its motive power, and it is not practicable to wind it *in situ*, it is necessarily a built-up structure, the several parts of which must be assembled in such a way that the whole runs truly on its pivots. This demands great care and accuracy in machining and fitting the parts.

As will be seen from Fig. 4, the main structural items comprise the round core and two flat side plates of soft iron, which pass across the centre of the wheel, and are joined at their outer extremities by clamp blocks, to which are attached the two parts of the split bimetal rim. The pivots are mounted in flanged brass cheeks, attached by screws to the two side plates. It is recommended that the mechanical part of the structure should be completely built up and machined before dealing with electrical parts, the winding being done separately and fitted afterwards. This, of course, entails dismantling and reassembly of the wheel structure, but having once correctly machined and assured the true running of this component, it will not be too difficult to set it true on final assembly.

The side plates are $\frac{7}{16}$ in. wide by 3/32-in. flat strip, and the core piece $\frac{5}{16}$ in. diameter round bar, specified as soft iron, but as it may be somewhat difficult to obtain the Swedish "charcoal iron," which is generally represented as the ideal in the electrical text books, it may be mentioned that mild-steel has been found to work quite well for small electro-magnets in which high permeability and minimum retention of magnetism are essential properties. To ensure that it is as soft as possible, it is advisable to take the precaution of annealing it, which in the absence of a muffle or other heat-treatment equipment, is best done by packing the material inside a piece of iron pipe, in lime or ashes, with iron or clay plugs in the ends, and heating the lot up to a bright red, sustaining the temperature for several minutes and then allowing it to cool off naturally. The traditional use of the kitchen stove, and the all-night period of cooling, cannot be improved upon for this operation.

By heating the metal in an enclosed chamber so that it is protected from the atmosphere, little or no scaling or pitting of the surface should take place, but the metal should in any case be cleaned up, and trued if necessary, before proceeding further. It may here be mentioned that it would be an advantage, from the structural point of view to modify the shape of the side plates, making them at least as wide as the diameter of the brass cheeks ([illegible] in.) in the centre, and tapering off to $\frac{7}{16}$ in. wide at each end. This would allow of using three screws for securing each of the cheeks. Better still, the plates may be made wider in the centre than the diameter of the cheeks, and thick enough to allow of turning a recess to register tightly over the latter, thereby improving the rigidity of the assembly considerably. Leave a small allowance on the length of the plates for finishing.

Mark out the positions of the centre pivot and the two clamping screws on one of the plates, taking great care to ensure symmetry in both planes, and drill undersize pilot holes; the second plate is jig drilled from the first, and marked to show relative positions for subsequent location. Next make the two clamp blocks, one in iron and the other in brass; their final dimensions are $\frac{3}{8}$ in. by $\frac{7}{16}$ in. by $\frac{13}{16}$ in., but they are best left oversize on all dimensions at first. Set up each in turn in the four-jaw chuck, crosswise, and drill and ream to a tight wringing fit on the round core piece; if the only reamer available produces too easy a fit, it is worth while to make a slightly undersize D-bit from silver-steel for this purpose. Press both the blocks on to a mandrel, or on the core itself, and finish the end faces by filing or machining so that they are exactly parallel to the mandrel and equal in distance from it on each side.

The blocks should now be set in their correct positions between the side plates, with the core piece in position and the holes for the clamping screw drilled through clamp blocks and core, but not to finished size at this stage. Remove the blocks, and tin one end face of each, also the mating surfaces on one of the plates, and sweat them in position; note that this must be done on one plate only as the other must always be capable of removal. The assembly should be clamped together, with the core in place, and temporary screws or dowels in the holes, while this is being done.

Next dismantle the parts again, and set up the one side plate, with the blocks clamped thereto, on the faceplate for machining the inner concave surface of the blocks to fit the rim of the balance wheel. The centre hole in the plate, for the insertion of the pivot, must be set dead true, and to facilitate this, a temporary plug may be inserted in the mandrel socket and turned down in place to form a close-fitting pilot or spigot. If the sweated joint is relied upon to hold the clamp blocks, very light cuts should be taken on the latter to avoid the risk of their becoming detached; but this risk can be very much reduced if temporary screws are used in the clamp screw holes, and further security may be provided, if desired, by dowelling the blocks in position as well.

The Bimetal Rim

As most readers with horological knowledge are aware, the object of using a split rim made of two dissimilar metals for the balance wheel of a clock or watch is to compensate for temperature errors in timekeeping. The principle is exactly the same as the bimetal strip used in thermostats and "blinkers" as extensively used in electrical apparatus, and it is probable that the idea of these devices was evolved from the methods which had long been used by horologists.

If the rim of a balance wheel is made of solid metal, it is, of course, subject to expansion and contraction with any change of temperature, and thus minute alteration of its diameter takes place, involving similar changes in its radial centre of gravity, or in other words, the moment of its mass. The ultimate result will be that an increase of temperature will tend to slow the clock down, and a decrease of temperature will speed it up. This effect might be very much reduced by making the rim of a metal having a very low coefficient of expansion, such as Invar steel; but long before metallurgists had hit upon this solution, the problem had been dealt with in another way by the ingenious makers of clocks and watches.

In the normal "compensated balance," the rim is made of two metals which have definitely (not necessarily widely) different coefficients of expansion, the one having the greater expansion being on the outside. Brass and steel are common metals conforming to this condition, and are commonly used. The rim is supported by radial spokes, not more than two or three in most cases, and is split near each spoke, so that the composite rim is virtually in separate sections, each forming a curved strip of the two metals in close intimate metallic contact. When changes of temperature take place, expansion or contraction of the spokes of the wheel alter the moment of mass of the rim at the point of support, but this is counteracted by the behaviour of the bimetal rim sections, which alter their curvature by reason of the differential expansion of the two metals. As the spokes of the wheel expand radially outwards, the free end of the rim curves inwards, and if the wheel is suitably designed, the result is to produce a reasonably exact temperature compensation within the range normally encountered.

Having explained the principle on which the rim is designed, we may now proceed to deal with its construction. The first thing to consider is how the two parts of the rim should be fastened together. Intimate and permanent contact are most essential, and it may be remarked that in the manufacture of precision watches, the normal procedure is to make the spokes and the steel inner portion of the rim in one integral piece, machined from the solid, and fuse the brass rim on the outside of it. This virtually amounts to casting and brazing on the brass rim at one operation.

It is hardly practicable to adopt this procedure in so large a wheel as we are dealing with here, especially as the spokes cannot be made integral with the steel part of the rim. The next best thing to do is to turn up separate brass and steel rims and silver-solder them together, with allowance for finish machining on outer and inner surfaces respectively. It is essential that the solder should flow perfectly all over the joint surface and no gaps or faulty adhesion patches be left ; this should not be difficult if sound methods are employed, but constructors who are not confident of their ability to carry out this work may be prepared to take a chance with soft soldering or "sweating" together of the rims. The surfaces should be very carefully tinned all over and the fit should be close so that little solder need be used.

Should the constructor be satisfied with the standard of accuracy obtainable without temperature compensation, a solid rim may be used, preferably of steel having the minimum expansion coefficient, and in this case the subsequent splitting of the rim will not be necessary.

When finishing the machining of the rim, it is essential that the joint line should be maintained in concentric truth, so that the bimetal strips are of even thickness. The brass and steel rims, it may be noted, are of different thickness, and these dimensions, in conjunction with the length of the arcs of the rim, are presumably designed to give correct compensation. The completed rim is finally sweated in position between the clamp blocks, and the truth of the assembly checked. If possible, additional security of fixing should be provided by fitting screws or dowels. It will of course be necessary to follow through the radial holes in the clamp blocks, into the rim at each side, and ream right through to take the core. Do nôt cut the gaps in the rim at this stage.

The brass cheeks for mounting the pivots may now be turned up and drilled through the centre at one setting, then parted off and set up on a pin mandrel to face the inner side of the flange. Note that one of the cheeks has an eccentric machined on its hub, but if desired, this may be made as a separate piece, grub-screwed to the

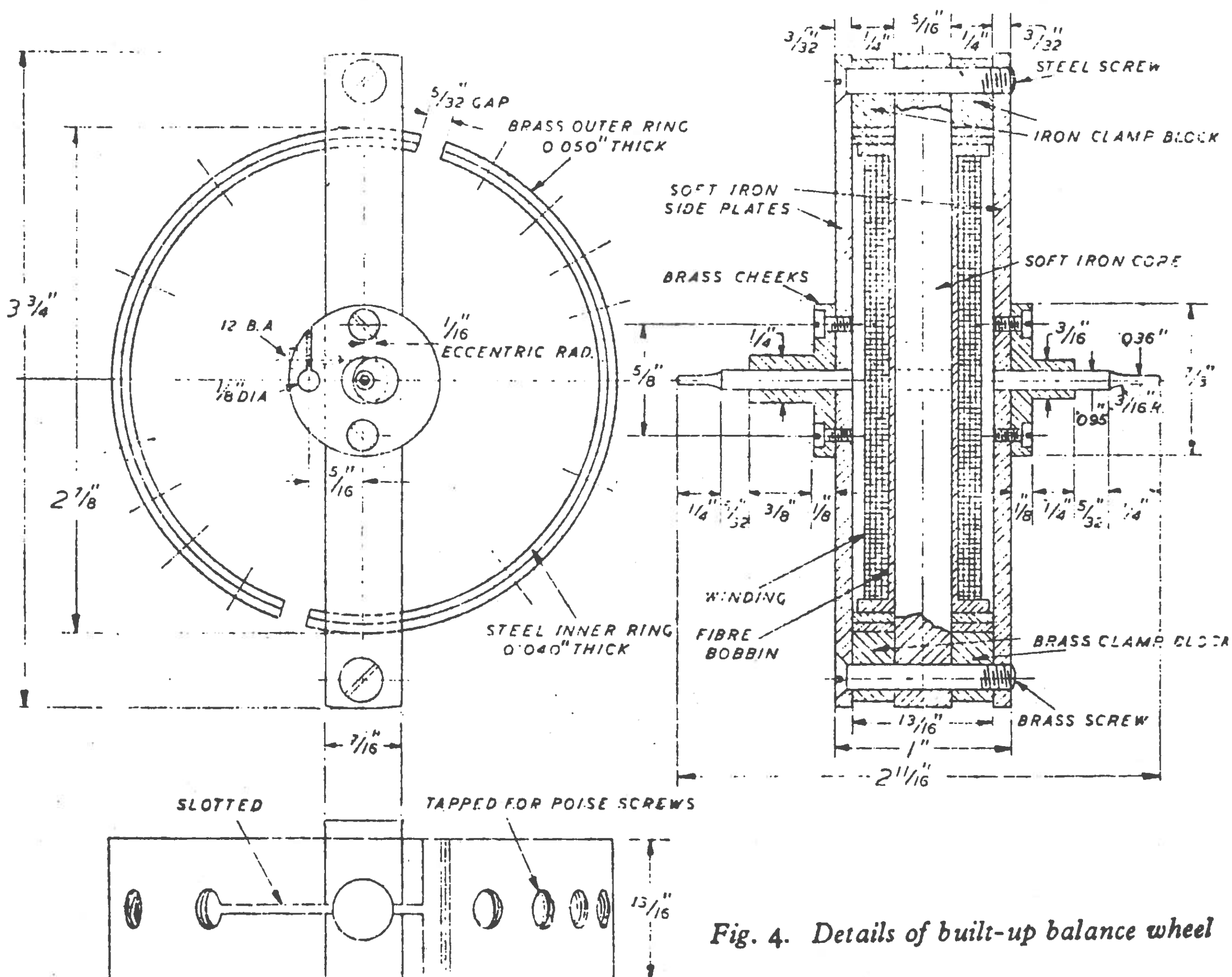
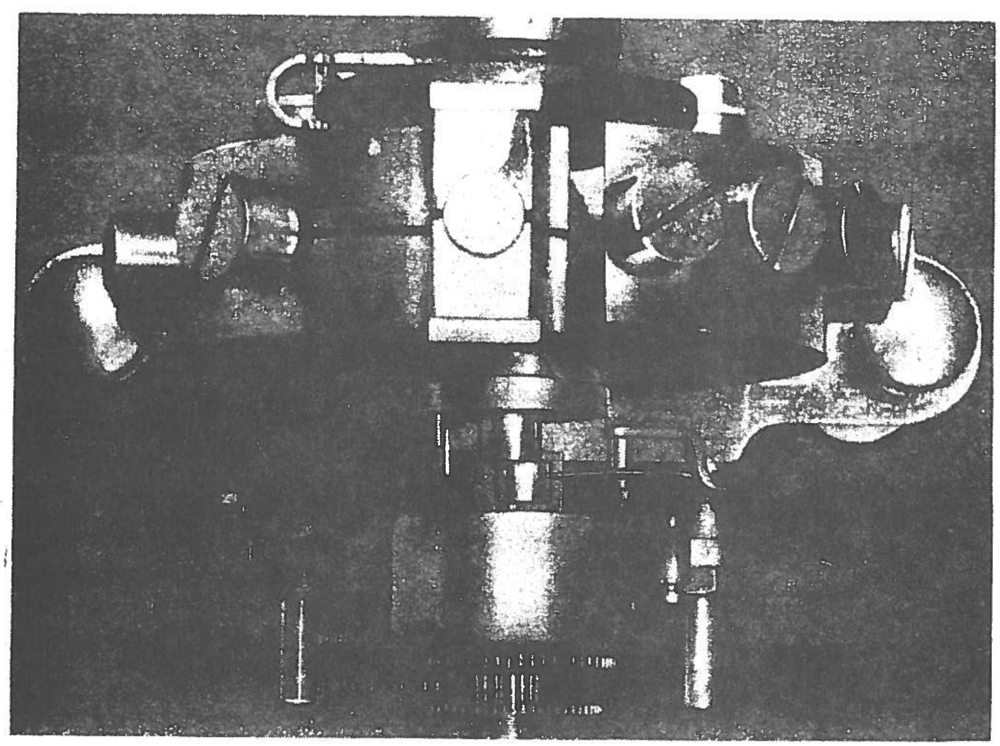


Fig. 4. Details of built-up balance wheel

shank of the pivot after assembly, and this may even be an advantage, as it provides some adjustment of timing, which may be useful, in getting the clock to work efficiently. This cheek also has a hole drilled to take the insulating bush of the contact pin, and a sawcut is taken from this hole, tangentially out to the edge of the flange, and fitted with a clamping screw. If it is found difficult to obtain or fit a screw as small as 12 B.A., the flange may be made thicker to permit the fitting of a larger screw, say 10 B.A., or $\frac{1}{16}$ in. It may also be noted that the pivot shank, specified as 0.095 in. dia., or 3 32 in., may be increased in diameter with advantage from the structural aspect.

The pivots are made of silver-steel, and it is recommended that they should be made in a single piece for the purposes of initially building up the wheel, the centre part being cut out afterwards ; or better still, a temporary mandrel with the true point centres may be used. Chuck the steel truly, in a collet chuck if available, or failing this, by any method which will ensure true running to the closest possible limit, and turn down the ends. In this case also, some increase in the diameter is permissible, indeed advisable, and $\frac{1}{16}$ in. or 0.0625 in. is a suitable dimension. The pivot shank registers in the centre holes of the side plates, and locates the cheeks in position on them ; the screw holes for securing them can then be drilled and counterbored, and the screws permanently fitted. In order to allow the pivot shank to pass through the complete wheel assembly, a clearance hole is drilled diametrically through the centre of the core piece, and it is important that this should not bind on the pivot shank or it may spring the wheel out of truth. The shank should be a press fit through the cheeks and side plates, and before fitting it, the ends may be hardened and tempered, and polished, taking great care to ensure a high finish on the radius. When the assembly is put together and spun between centres, it should spin practically dead truly, and if this condition is obtained, the clamp screw holes should be opened out to a dowel fit for the screws—which it will be noted, are screwed only for a sufficient length to engage the tapped holes in the one side plate—and the latter fitted. In the event of any bad errors in the truth of the wheel, the cause must be sought in inaccuracies of workmanship, in locating or aligning the holes, or the position of the clamp blocks.

At this stage, the end faces of the side plates and the core may be finished by taking a skim over them, but it is not advisable to do this by mounting the wheel on its fragile pivots. It is better to hold one of the cheek flanges by its rim in the three-jaw chuck, assuming the latter to be at least reasonably true, and steady the projecting pivot by a hollow centre in the tailstock. The holes for the poise screws in the rim may be marked out, drilled and tapped ; it will be seen that these are not equally spaced, the four at the free end of each arc being closer than the other two at the fixed end ; but their positions are not critical. Rather large screws, with shanks tapped 0 B.A., are used, but this feature also is optional, and smaller shanks may be used if desired. The slots for clamping the rim and the blocks securely to the core can most readily be cut by using a small circular saw in the lathe, the core piece, of course, being removed during this operation.



Plan view of " Eureka " clock, showing eccentric and roller-operating ratchet lever

HAVING completed the building-up of the balance wheel, the electrical components incorporated in this unit may be considered. The contact pin assembly, shown in detail in Fig. 5, comprises a fibre or bakelite bush turned to fit the split clamp in the wheel cheek, and drilled 1/16 in. through the centre to take the half-round pieces of metal and insulating material, which

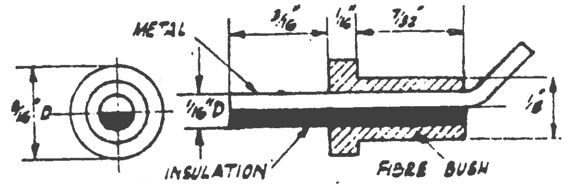


Fig. 5. Details of contact-pin assembly

should fit fairly tightly, but not so as to risk bursting the bush. A piece of 16-gauge silver wire is recommended for the contact pin, but if not available, nickel-silver (german silver) will give fairly good results. It should be carefully filed to a half-round section, using a micrometer to gauge when exactly half the diameter has been filed away.

A piece of glass or quartz rod 1/16 in. diameter is the most suitable material for the insulating side of the pin; this may be obtained from a shop dealing in laboratory glassware, and after the required length is cut off by nicking with a file, it should be embedded in a pitch block and ground down flat on one side on a metal or glass lap charged with carborundum paste. As it may be difficult to gauge exactly how much material has been removed in this case, it may be advisable to do this before making the metal part, and adjust the thickness of the latter to suit. If vitreous material is considered too difficult to work, the next best substitute is a piece of hard plastic material, such as a knitting needle, which is first turned down to the required diameter and then filed half-round. Adhesion between the projecting ends of the metal and insulation can be obtained by the use of a cement such as Durofix, or by melting in a flake of shellac. When fitted to the bush, and the latter clamped in place in the cheek of the wheel, the pin should be quite secure. The inner end of the metal portion should be bent outwards as shown to form a convenient solder tag for connecting the outer end of the magnet coil.

Winding the Coil

A bobbin for the coil should be prepared, preferably by turning from the solid in ebonite, fibre or bakelite, though it may be fabricated from tube, with end washers cemented on, if this is more convenient. The thickness of the tube and end cheeks should not be more than 1/16 in., and the bobbin should be a free sliding fit on the core, its overall length being adjusted to fit neatly inside the rim of the balance wheel.

The magnet coil of the clock examined had a resistance of just over 20 ohms, which represents

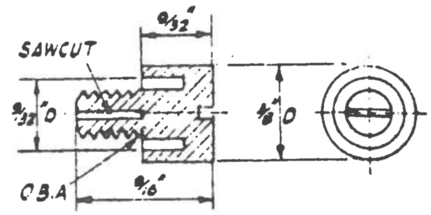


Fig. 6. Poise screws (12 off)

about four layers of No 24 gauge wire. In the writer's opinion, a coil of higher resistance would be an advantage, as the power obtained from the magnet on an input of 1½ volts appears to be greater than is necessary to maintain the swing of the wheel, and is liable to affect the accuracy of timekeeping. The higher resistance would also improve economy of current consumption, with longer battery life and less variation of voltage. It will be noted that most battery-driven clocks in which the impulses are frequent, work best with magnets of high resistance. There is plenty of space in the balance wheel for considerably more turns of the same gauge wire, or, alternatively, a smaller gauge of wire may be used to increase the resistance.

The wire may be either enamel, cotton or silk covered, and the process of winding it is quite simple; it may be carried out either in the lathe, drilling machine, or on a hand-driven spindle. There are not enough turns on the coil to make winding tedious. Care should be taken in laying the turns so as to ensure neat and even winding, which, although not important from the electrical aspect, affects the balance of the wheel, as well as its appearance.

The first layer of a coil is always easy enough to lay evenly, but difficulty is often encountered with subsequent layers owing to the slipping of end turns. If this trouble arises, a layer of stiff paper or Empire cloth may be interposed between the layers of wire; it should be cut to fit the length of the bobbin closely and with a moderate overlap, so that it can be cemented down with Durofix or shellac varnish. When the coil is completed, it should be well varnished externally, the object being not so much to improve insulation, which is not at all highly stressed, in view of the low operating voltage, as to fix the turns mechanically and prevent them moving afterwards. The end turn may be tied in place with silk or cotton thread.

To assemble the wound bobbin in place, it is, of course, necessary to remove one side of the balance wheel and slide out the core piece; if the pivot has been made in one piece to serve as a mandrel when building up the wheel, its centre must, of course, be cut out to allow the bobbin to be fitted. If there is any end play of the latter inside the rim of the wheel, paper washers should be cemented to the side cheeks to take this up; no movement of the bobbin is permissible when the wheel is assembled. The inner end of the coil winding is connected, by soldering or other convenient method, to the wheel structure, and the outer end soldered to the bent inner end of the contact pin. The arrangement of the core piece and side plates, with a single iron clamp block at one end, and the wound bobbin on the core, constitutes a three-limbed or "trident" form of electro-magnet. Assuming the tip of the core, at the end remote from the iron clamp piece, to be a N pole, the adjacent ends of the side plates will both be S poles. This constitutes a highly efficient form of magnet, and when working in close proximity to the armature plate, as it normally should, the system is completely "ironclad," so that there is practically no stray field to reduce efficiency or cause trouble by magnetisation of the hair-spring. A test of the magnet, by connecting a single dry cell between the contact pin and the balance-wheel frame, should show a powerful attractive force when a piece of iron is held near the open poles, with a current flow of about 75 milliamps at this voltage input.

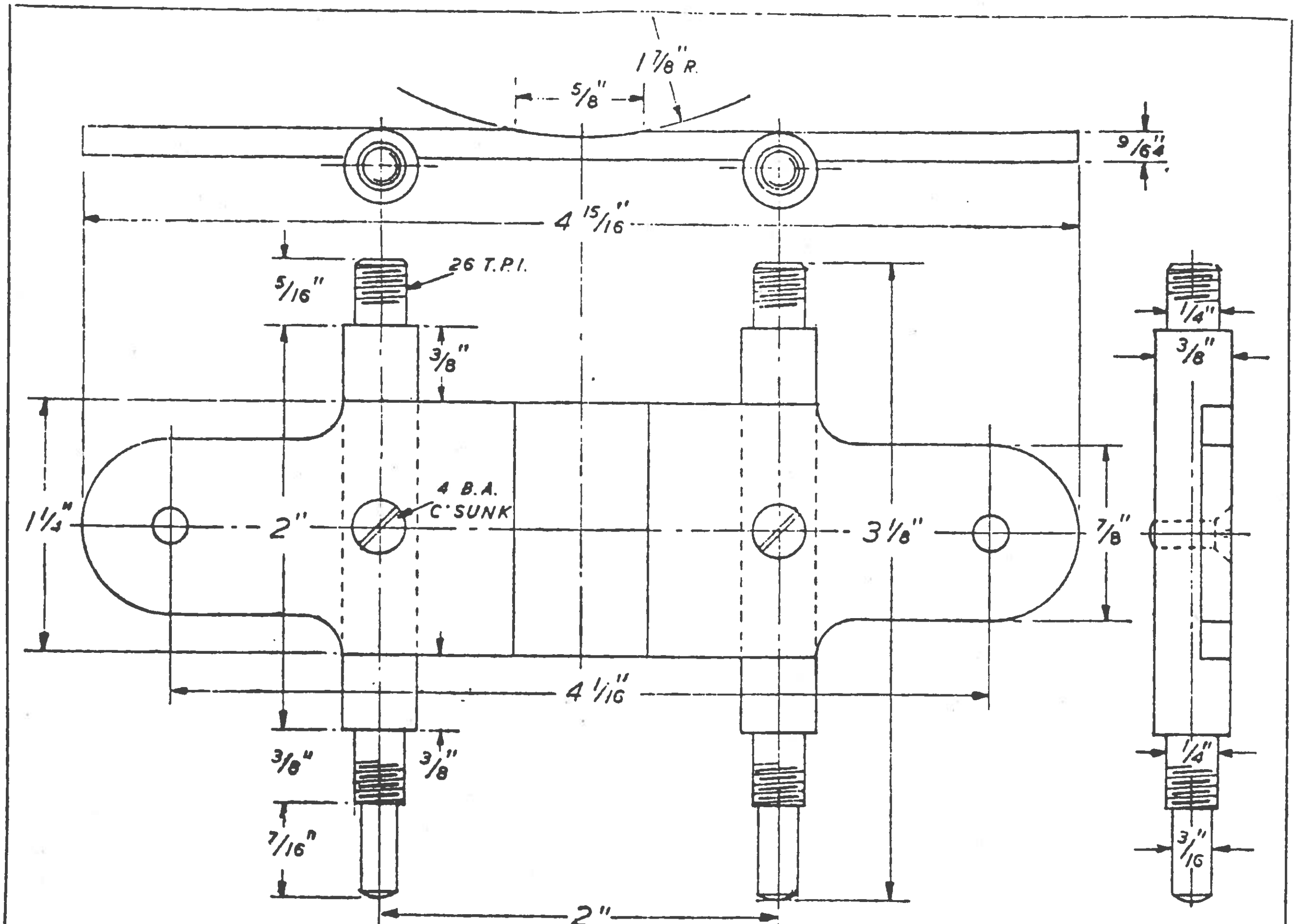


Fig. 7. Armature plate

Poise Screws

When the complete balance wheel is assembled and spun on its pivots, it should run truly and be fairly well balanced. Any error in this respect should be corrected before going further; assuming this is in order, however, the rim may now be split in two places, as shown in Fig. 4. The width of the gap is not critical, but the same amount of metal should be removed in each case, to maintain proper balance.

The fitting of poise screws is not absolutely essential, though it is usual in a compensated balance wheel. Both the balancing and the natural period of the wheel are influenced by the poise screws; they may be used to affect the rating or regulation of the clock, but their most useful function in the case of watches is the correction of position errors—that is to say, variation of timekeeping accuracy according to the position and angle of the watch frame. In the case of the "Eureka" clock, in which the position of the balance wheel axis is not likely to vary, this condition does not arise; but the weight and location of the poise screws also affects the period in relation to the arc of balance wheel swing. Adjustment in this respect may be very useful, though not easy to apply in practice unless one is an experienced horologist.

It will be seen from the photographs that the poise screws are not screwed fully home against the rim of the wheel, and in view of the fact that the shanks of the screws are split to provide a friction grip in the tapped holes, it can be assumed that they were definitely intended to be adjusted in this way. This is, however, contrary to the best watch practice, where the screws are fully tightened, and adjustment of balance or moment made by filing the screw heads, or, conversely, fitting ballast washers under them.

The detail drawing of the poise screws, Fig. 6, shows that an annular groove is machined in the underside of the head, which may possibly have been intended for ballasting with lead or similar material. As this groove will require a special tool to machine, it may be omitted and the screw head shortened to compensate for the increased weight. All the poise screws, twelve in number, should be of equal weight, and should be adjusted in the rim so that the balance wheel will rest in any position when poised on knife-edges.

The hair-spring may be made from a mainspring of a small watch. It consists of approximately 12½ turns, the material being spring steel 0.096 in. wide by 0.015 in. thick. The centre of the spring is attached to a brass collet by swaging into a tangential sawcut, and the collet is mounted on the arbor with a 14-B.A. grub screw, which is convenient for setting the balance correctly in beat. If desired, however, the usual friction-tight split collet may be fitted.

Armature Plate

This is made from annealed iron or mild steel, and forms not only the armature but also the foundation plate of the clock movement. As shown in Fig. 7, it is 1¼ in. wide in the central portion, and 9/64 in. thick, with pillar studs made either of brass or steel attached underneath. The latter have flats filed or milled to a depth practically equal to the thickness of the plate, and fitting tightly over the edges of it, so that one screw in each stud will hold it securely. At the ends of the plate, holes are drilled for the screws or studs which secure the vertical pillars by which the entire movement is mounted on its plinth or bedplate.

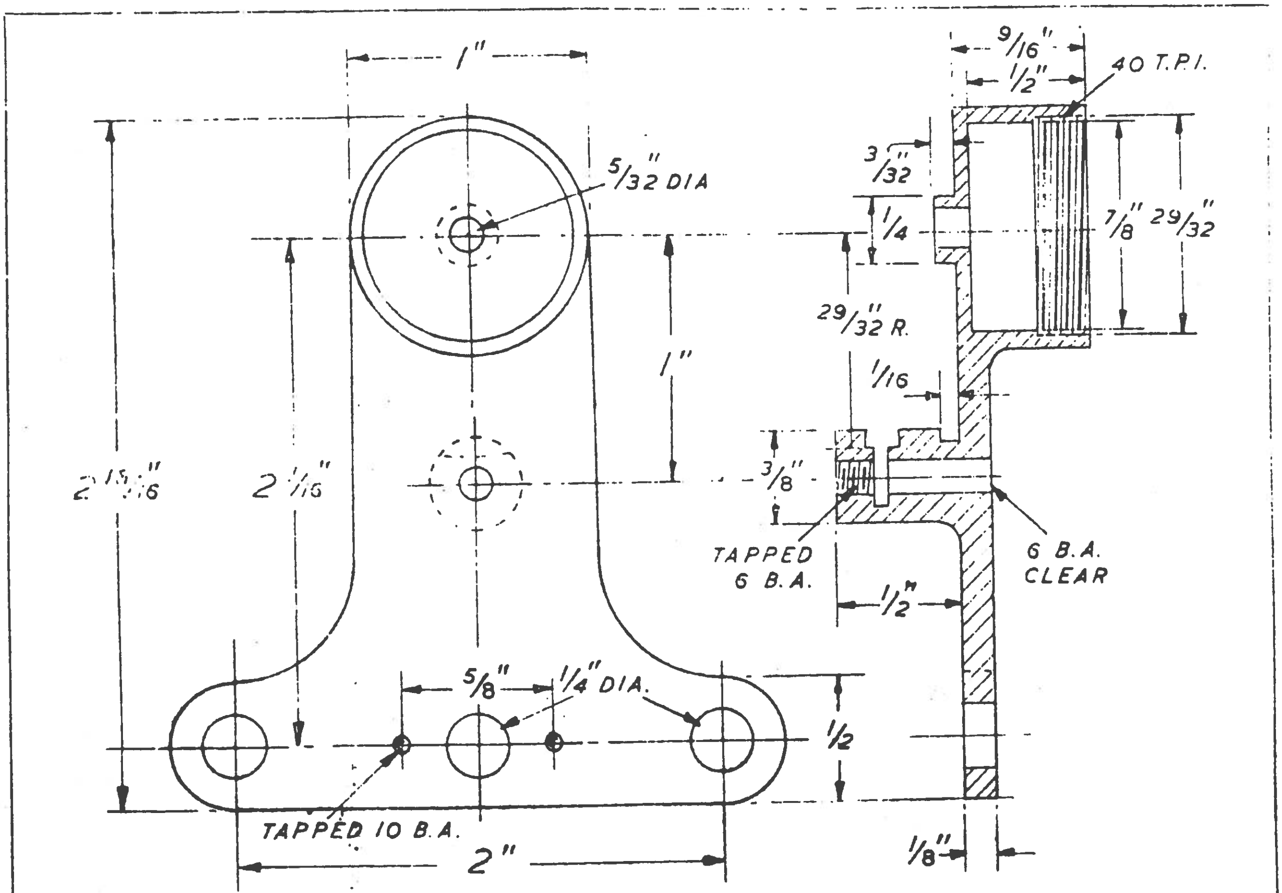


Fig. 8. Rear motion plate

It will be seen that the centre portion of the plate is machined to an arc corresponding to the radius of the balance wheel pole tips, plus clearance. This can be machined with a cutter held in a boring bar between lathe centres, the plate being clamped vertically to an angle-plate mounted on the lathe cross-slide, with its centre level with the lathe axis. In a small lathe, it will be found necessary to overhang the work to one side of the cross-slide to obtain necessary clearance.

The amount of metal to be removed here is quite small, and it is doubtful whether machining such a short arc has much effect on the magnetic efficiency as compared with a plain flat plate. In the event of difficulty in machining this surface, it is fairly certain that the clock will work satisfactorily with the plate left flat, so long as the working clearance of the pole tips of the balance wheel is suitably adjusted.

Rear Motion Plate

Both the motion plates of the "Eureka" clock are made from brass castings, but they may be fabricated by silver-soldering the bosses on to flat brass plates. The housings for the balance-wheel pivot bearings are integral with the plates, and the rear motion plate, shown in Fig. 8, also incorporates a pillar which serves to anchor the outer end of the hair spring, and also locates the regulator quadrant. A spigot is provided on the inner centre of the bearing housing for the quadrant to pivot on.

plate, already referred to, is drilled centrally to take a 6-B.A. screw, and cut about three-quarters of the way across, preferably with a circular slitting saw. The upper part of this slot is then stepped out wide enough to grip the edges of the hairspring ; a slight undercut here will be desirable. By tapping the rear portion of the hole, and opening the rest out to

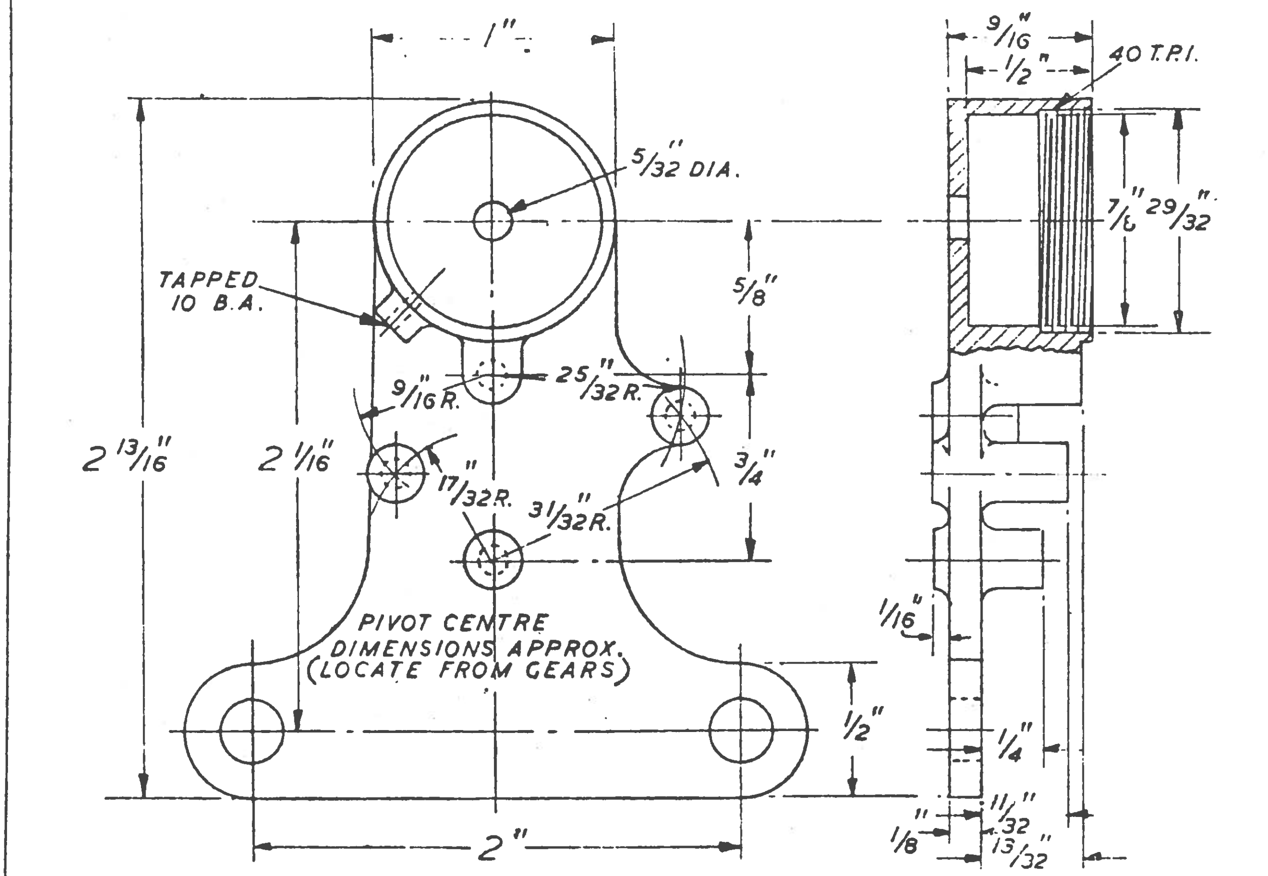


Fig. 9. Front motion plate

In machining the motion plates, the most important operation is the boring and screwing of the bearing housings, which may be carried out by clamping the plates to the lathe faceplate. It is advisable to take a skim over the face of the lower extremity of the plate, where the holes are drilled to fit the pillar studs of the armature plate, and afterwards reverse the plate, mounting the housing on a plug mandrel, to face the other and more important side of this surface. The object of this is to make certain that the two housings will be axially in line when the plates are assembled in position ; but location in this respect is by no means as positive as it might be, and this feature constitutes one of the structural weaknesses of the clock. It is desirable to provide some means of clamping the plates together, with the housings correctly aligned, for drilling the holes for the pivot studs. The spigot on the rear housing is an obstacle to doing this, and, if desired, it may be made separately and screwed or sweated in afterwards, instead of being integral with the motion plate.

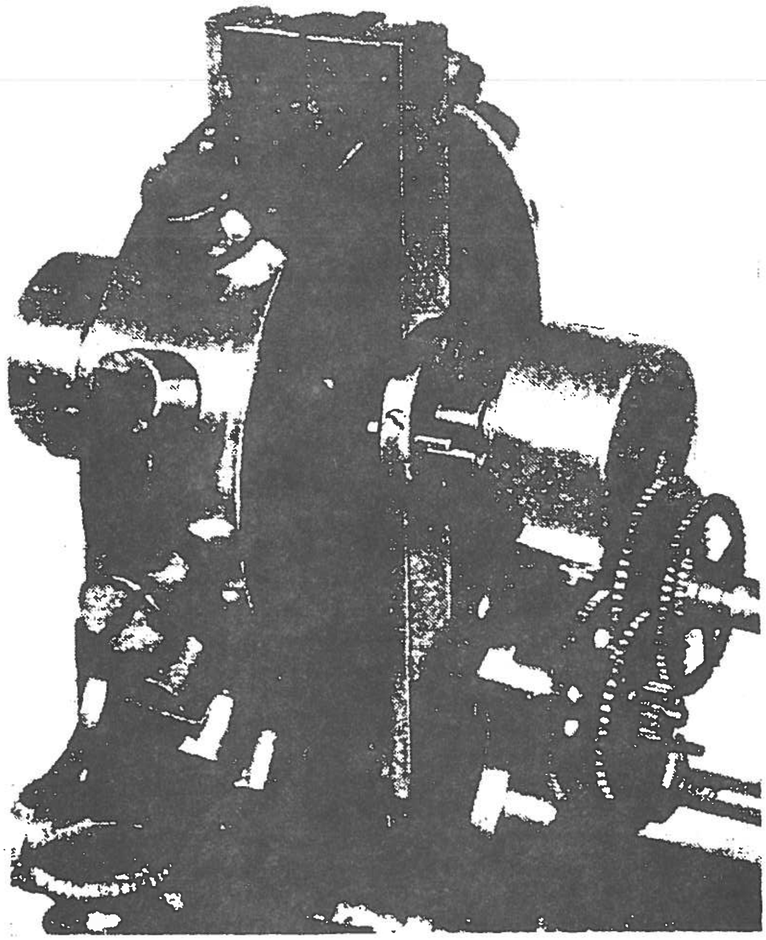
The pillar near the centre of the rear motion clearance size, the pillar will act as a clamp to secure the spring when the screw is tightened.

Front Motion Plate

The bosses for the gear-wheel pivots are shown in their approximately correct positions (Fig. 9), and whether the plates are cast or built up, this will be sufficiently exact for practical purposes, so long as the actual pivot holes are located by the usual horological methods when setting up the train. But it is extremely likely that some variation of the size or arrangement of the gearing may have to be made for the purpose of utilising existing or readily available gears ; in which case the pivot bosses may be set out accordingly.

It will be seen that a boss is cast or otherwise permanently attached at an angle under the bearing housing for the anchorage of the spring which acts as the backstop of the ratchet wheel, and the position of this also may have to be modified to suit the gearing. In all other respects, the machining of this motion plate is the same as the rear one.

THE housings in the two motion plates contain the bearings for the balance wheel pivots, which are essentially identical for each side and are of rather unusual design. As will be seen from the bearing assembly design, the pivot rests on two large steel balls, which in turn roll inside a hardened ring or "race," in a very restricted orbit, the limits of which are determined by the holes in the plate which abuts against the outside edge of the race, and is held in place by a glass disc and a screwed retaining ring. The chamber enclosing the ball-race is capable of being used as an oil bath to keep the bearing well lubricated, so long as it is not filled above the level of the pivot clearance-hole, and the clock is not moved out of its normal vertical position.



A close-up of the clock movement, showing contact mechanism and gear train

It will be clear that this type of bearing is suitable only for a shaft having an oscillatory motion, as distinct from one which rotates completely and continuously in one direction; and even then, the extent to which it can provide true rolling motion is very limited, as the balls tend to roll bodily within the race, which they cannot be allowed to do except to a very small extent. Should there be a tendency to exceed this, the balls will rub against the edges of the holes in the plate, causing some friction, and this may possibly be a deliberately designed effect to deter the balance wheel from swinging through too great an arc. To prevent the possibility of the balls becoming wedged in the holes, such as by inertia effects when the clock is moved violently, banking pins are fitted to the inner wall of the housing as an emergency limiting measure, and these also would cause friction if the balls made contact with them.

The endwise movement of the balls is prevented by the inner wall of the housing on one side and the glass disc on the other, and very little clearance should be allowed. It is possible to observe the rolling action of the balls through the glass disc, and also to see that the oil bath contains sufficient lubricant of the proper consistency and cleanliness.

Pivot Bearing Components

Details of the component parts of the bearing are given in Figs. 10, 11 & 12. The ball-race may be made either of silver-steel, hardened right out in oil, or mild-steel case-hardened.

If the pivot journals are made larger in diameter than the specified size, as suggested, it will be necessary to make the inside diameter of the race also larger, and in any case it will be desirable to "offer up" the assembly before hardening, or to make a dummy race to obtain the correct location of the pivots, as near as possible concentric with the housing, but at least close enough to avoid fouling the clearance holes in the latter. The inner surface of the race is parallel, without the concave track usually provided in standard forms of ball-races, and the width of the race is less than the diameter of the ball, by an amount approximately equal to the thickness of the abutting steel plate. After hardening, the race should be highly polished on its working surface.

It will be seen that the steel plate is provided with a locating tab, which fits in a keyway or recess formed in the wall of the housing; this does not extend to the outside of the threaded end, however, and is best formed by drilling, or chipping out with a small chisel. In order to ensure that the holes in the plate are symmetrical, relative to the vertical centre of the housing, it is advisable to locate the plate in this way before marking out and drilling them. Burrs must be carefully removed from the edges of the holes, and they should be polished with the rest of the surface on both sides of the plate, after hardening. As the plate is thin, case-hardening is not very satisfactory, and it is better to use thin carbon-steel gauge plate or "pen steel" for making it.

There may be some difficulty in cutting or obtaining small glass discs, and the possibility of using a plastic substitute such as Perspex or cellulose acetate may be considered; but it should be noted that these discs act as end-locators for the steel balls, and it is therefore desirable to use as hard a material as possible. A useful tip for cutting glass circles is to use a chip of tungsten carbide set in a radially adjustable holder like a washer cutter or trepanning tool; it may be run either in the lathe or the drilling machine.

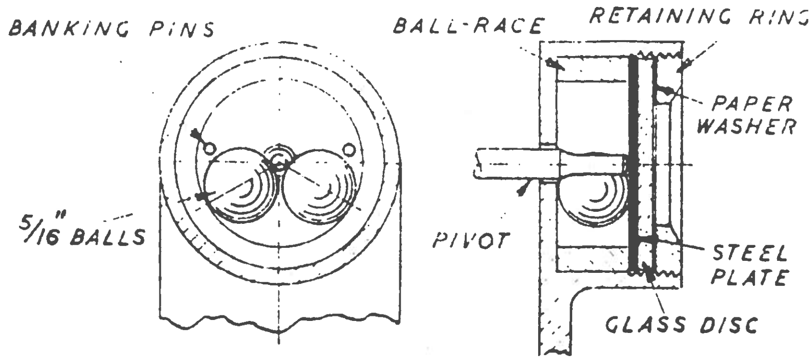
Should the end clearance of the balls be insufficient to allow free movement, a paper washer similar to the one outside the disc, but having a hole $\frac{11}{16}$ in. diameter, may be used between it and the steel plate. It seems obviously desirable to fit a washer in this position, but it was not done in the clock examined. The screwed retaining rings for the housing may be machined in one piece from brass rod, and their fit in the housings tested before parting off. They each have two blind holes drilled diametrically opposite to each other for the application of a pin spanner. A trace of varnish on the paper washers, and on the threads of the rings, will assist in ensuring oil-tightness of the housing.

When the motion plates are fitted to the studs of the armature plate, and the balance wheel assembled in place, the pivots should have just perceptible end shake between the steel plates in the two housings. Adjustment of end play can be obtained either by fitting shims on the armature studs or machining back the shoulders of the studs as required.

Should the construction of this rather elaborate form of pivot bearing be objected to by constructors, an alternative would be to use the smallest obtainable standard ball-race, or better still, one of the tiny Swiss ball-races specially made for instrument work. A cup-and-cone form of bearing like that of a cycle hub, the cone being formed on the pivot and a carefully machined and hardened cup fitted to the housing in place of the parallel ring, is also a possibility, but it should be noted that ball-bearings of this type require close end adjustment to work satisfactorily. Workers who have experience with fine horological work may be able to fit jewel bearings and endstones to the pivots in such a way as to produce little, if any, greater friction than a ball-race.

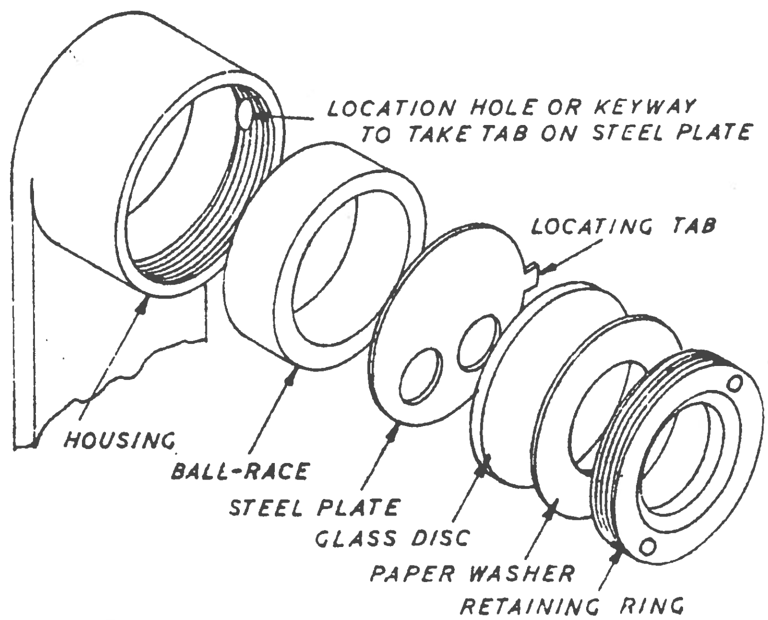
Contact Spring Assembly

This is shown, together with details of the components, in Fig. 13, and it will be seen that the spring is held by means of two 6-B.A. screws, to the vertical edge of a block of ebonite or other insulating material, which in turn is attached to the back of the front motion plate by a single 6-B.A. screw. The contact spring itself is backed up by a check spring of the same material and thickness, to prevent excessive flexure near the root of the free end, and a further backing is provided by a rigid plate of $\frac{1}{8}$-in. brass strip. All these components are of a simple and straightforward nature, the only point which calls for detailed comment being the tipping of the contact spring with a small L-shaped piece of silver or gold-silver alloy. Both in obtaining the material, and in attaching it to the spring, some constructors may experience difficulties, but in such cases it is probable that nearly any working jeweller would be able to assist in both respects. Silver is quite a satisfactory metal for a contact of this type except for its tendency to tarnish, especially in an atmosphere containing sulphur compounds, as in industrial towns; but as there is wiping contact of the conductors, they are



Left—Fig. 10. Pivot bearing and housing assembly

Below—Fig. 11. Exploded view of bearing assembly



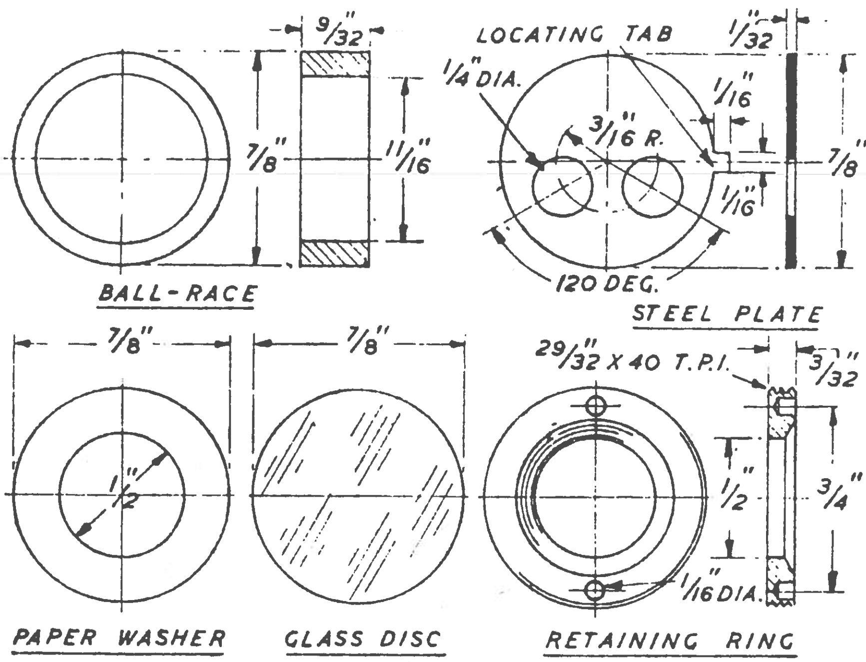


Fig. 12. Components of pivot bearings (less steel balls)

to it, but this is not absolutely essential, and it may be preferred to drill and tap the backing place and fit a small terminal screw, which would avoid the necessity for a soldered connection, and would be quite satisfactory from the electrical aspect if due care is taken in the metallic contact of the parts.

When the springs are mounted on the block and the latter attached to the motion plate, it is possible to adjust the block by pivotal motion on its single screw, so that the correct action of the contact gear is obtained; in other words, that the contact pin touches the spring on its metallic side on the clockwise swing, and on the insulated side of the return swing. This action should be possible

(*Continued on page* 331)

largely self-cleaning when kept in continuous use. The silver-gold alloy, however, does not tarnish, and being slightly softer than the silver or german-silver contact pin, acts as a lap to improve its polish.

The best material for the contact and check springs is a clock suspension spring strip of approximately the specified thickness. This material, although finely tempered, can be cut quite easily with sharp shears, and also filed; drilling, however, may present more difficulty, but it may be accomplished successfully with a glass-hard spear-point drill, made from silver-steel and hardened right out in water at the extreme tip; it should be run fairly slowly and lubricated freely with turpentine. It will be noted that the screw holes in the contact spring are elongated to allow of slight vertical adjustment; in this detail, some liberty is taken with the original design, as the actual clock examined had no provision of this kind, but it appears to be highly desirable in order to enable exact adjustment of the contact timing to be obtained.

A small hole is drilled at the extreme lower end of the contact spring to assist in soldering the lead

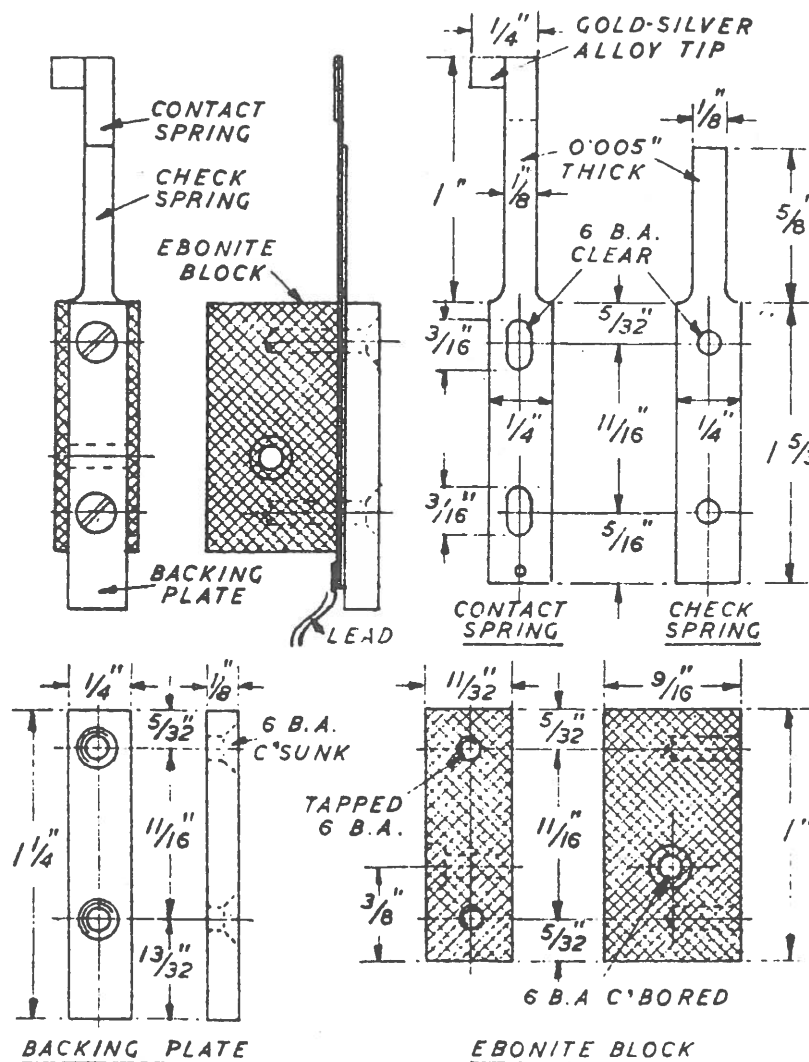
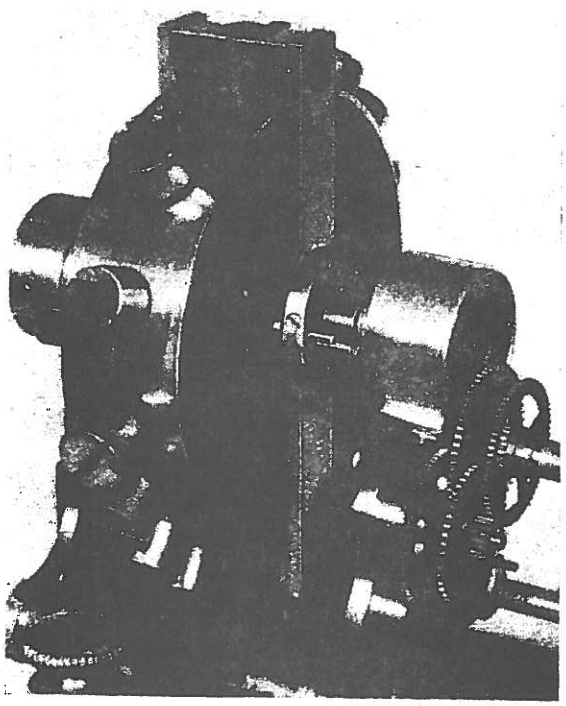


Fig. 13. Details of contact spring assembly

without the need for setting or bending the springs themselves, which is not advisable, though a slight twisting of the contact tip may be permissible. Note that very little effort should be needed to flex the spring to the extent of just over $\frac{1}{16}$ in. at the tip, as required to operate the contact; the lightest possible action consistent with just enough contact pressure to conduct the necessary current, will give the best results.

It is now possible to get the balance wheel impulse motor working, though not to get it properly rated at this stage. A hairspring of appropriate length and strength to produce a losing rate should be fitted, and the spring collet adjusted to put the balance "in beat" (i.e., with the core vertical) when at rest. Not more than $1\frac{1}{2}$ volts should be used to energise the motor. Adjust the position of the spring so that contact is established at about 15 to 20 deg. to the right of the dead centre, and broken exactly at dead centre. This will call for careful and possibly patient, manipulation of the spring and mounting block.

When properly adjusted, the action of the balance wheel should be healthy and vigorous, and the current consumption low, so that only a very minute spark, if any, is perceptible at the contacts. The motor may be left running while the rest of the clock—virtually no more than a counting and indicating gear—is completed. Its movement, however, is so fascinating to watch that it may prove to be a distraction if set up in the workshop; it is best to put it in some other part of the house, where it serves the purpose of a decoy for those admiring but often embarrassing friends who are always "dropping in" when some particularly delicate job is in progress!



LETTERS

The "Eureka" Electric Clock

DEAR SIR,—It is refreshing to see constructional data for that interesting but very maddening freak, the "Eureka" clock, now appearing in "Ours."

It would appear from the description of the compensated balance in the February 17th issue, that "Artificer" is under the impression that compensation arrangements have to be introduced in balances to counteract the thermal expansion of arms and rim.

I would like to point out, however, that this is a very minor cause of loss of "rate," the big offender being the reduction of the modulus of elasticity of the balance spring with increase of temperature. An uncompensated chronometer balance of brass is quoted as losing 11 seconds a day per degree Centigrade rise.

With its relatively enormous balance, I fear the "Eureka" would become very wild with no compensation. They are wild enough, anyway. An alternative would be to fit compensation curb pins and leave the balance a plain uncut one. This would be easier to make and can be quite an effective system, although now obsolete. I have a watch by the celebrated Breguet of Paris with plain brass balance and compensated curb pins, and the method is certainly effective when correctly proportioned. Compensation itself is now becoming obsolete, having been replaced by alloys for both balance and hairspring—the former with low coefficient of expansion and the latter with negligible change of modulus of elasticity. One of the best known proprietary metals for the spring is "Nivarox," but where one would obtain material for a spring of the size required is quite another matter.

Another point is that the "Eureka" balances appear to be made very heavy on one side—out of poise—on purpose. At least, those I have had to do with have been like that. It was not a matter of the wrong screws in the wrong holes, but I do not know the reason for it.

Yours faithfully,

Bognor Regis. C. S. COWPER-ESSEX.

A READER has pointed out a rather serious oversight in the details of the balance wheel which were described in the February 17th issue. It will be noted that the soft iron portions of this wheel are arranged to form a three-limbed electro-magnet, the limbs being connected by an iron clamp-piece at the top end, and by a brass clamp-piece at the lower end, so that the magnetic circuit is left open, except for the proximity of the armature plate below the wheel.

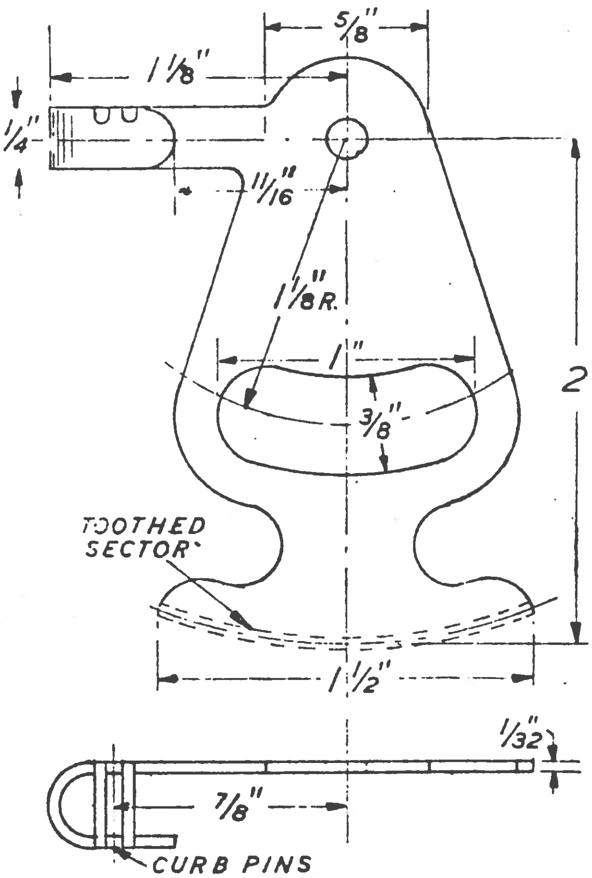


Fig. 14. Regulator quadrant

The object here, of course, is to produce the maximum attractive efficiency between the magnet poles and the armature, and to avoid the stray field which would be caused by an "open" magnet. This is all right as far as it goes, but the correspondent referred to has pointed out that when the bimetal rim is fitted to the balance wheel, the inner (steel) component of the rim will short-circuit the open poles of the magnet and cause a serious loss of efficiency.

As the clock which was restored is not now available for further examination it is impossible to say how this factor was dealt with in practice; there is a possibility that the steel part of the rim was made of a non-magnetic alloy, or that a section of non-magnetic material was brazed in at the point adjacent to the lower clamp. It may be found rather difficult to obtain a suitable piece of non-magnetic steel to make the rim, but fortunately there is a much simpler method of eliminating the short-circuit, which will considerably reduce the loss of efficiency from this source, and can be applied even if the wheel has already been fabricated.

The remedy consists in counterboring or trepanning away the portion of the rim surrounding the core at the lower end, to a diameter of $\frac{5}{8}$ in., which will leave a clear gap of 5/32 in. all round the core. This operation can be carried out by means of a cutter mounted on a $\frac{3}{16}$-in. bar by a grubscrew, and does not necessitate dismantling the wheel, except for the removal of the core and the exciting coil. As the removal of this metal will affect the balance of the wheel, it may be replaced by a washer of brass or other non-magnetic material, which need not be positively fixed in place so long as it is prevented from rattling about when fitted.

Regulator Gear

In principle, the regulator of the "Eureka" clock is identical with that of any ordinary watch or balance clock, consisting of a quadrant mounted concentric with the balance wheel pivot, and capable of partial rotation around it, having an arm fitted with curb pins which control the motion of the hairspring near its fixed end,

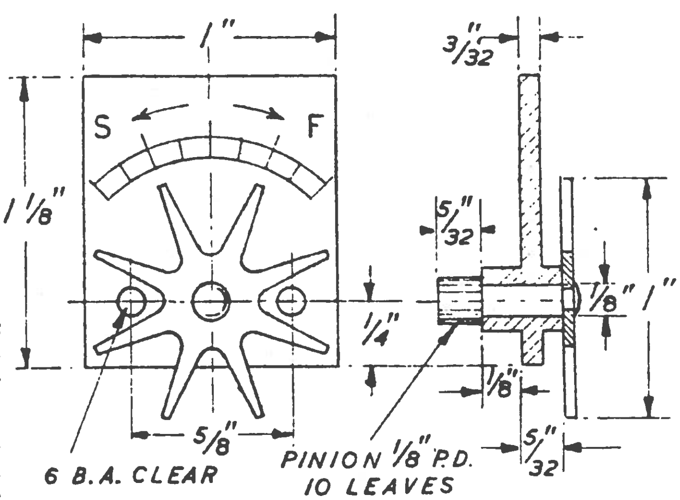


Fig. 15. Regulator pinion, star wheel and rating plate

and thereby influence the rate of vibration. The effect is virtually the same as altering the length of the hairspring, which could not be done in practice without putting the balance "out of beat."

The details of the "Eureka" clock regulator are given in Figs. 14 and 15, but it is considered that they are needlessly elaborate, and confer no practical advantage over the simpler form of regulator as fitted to a cheap alarm clock. Only if it is desired to construct a faithful replica of the original clock is it considered worth while to follow these details exactly. It will be seen that the regulator quadrant is equipped with a

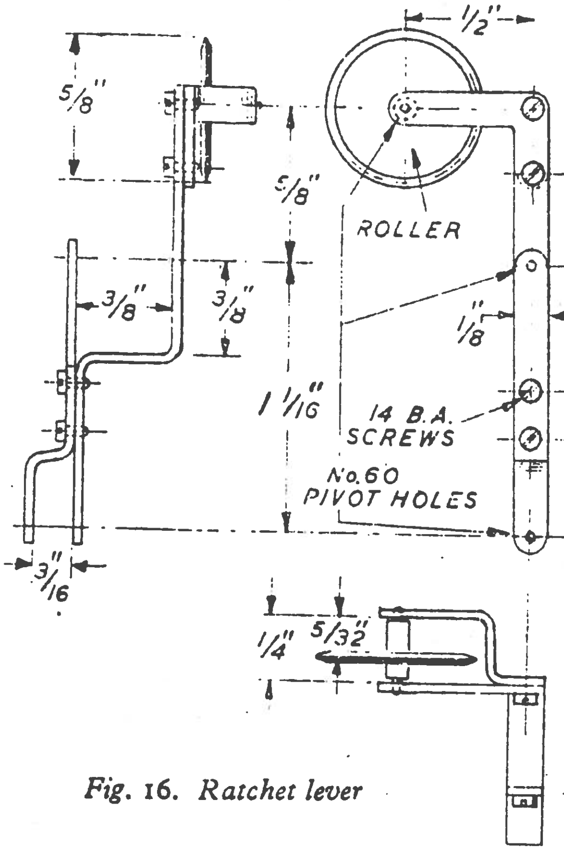


Fig. 16. *Ratchet lever*

toothed segment, engaging a pinion carried in a plate attached to the rear motion-plate of the clock, and fitted with a star wheel on the outside, by means of which it is operated. The quadrant plate has a ⅛ in. pivot hole which fits over the spigot of the rear balance pivot housing, and is retained in place by fitting a washer over it and lightly burring over or expanding the end of the spigot, so that it moves with some friction. A curved slot is cut in the lower end of the quadrant, which is located by springing it into a slot at the root of the boss which clamps the end of the hairspring, and this boss also limits the motion of the quadrant, preventing the sector from moving far enough to get out of mesh with the pinion.

The arm extending horizontally from the quadrant is bent U-shaped at the end, and notches are cut across the span, into which brass curb pins approximately 1/32 in. diameter are sweated. Under working conditions, these allow a little play for the hairspring, which passes between them, and should touch each of them in turn as it expands and contracts with oscillation of the balance wheel. By moving the quadrant towards the anchorage of the spring, its effective free length is increased and the clock is slowed down; movement in the other direction has the reverse effect and increases the working rate.

If it is decided to simplify the regulator, it is suggested that the pinion, pivot plate and star wheel may be entirely omitted, also the toothed sector of the quadrant, but the latter should then have a second arm extending upwards for operating purposes. A rating plate may be fixed to the pivot housing to indicate the position of the arm, and show the direction in which it must be moved to produce a faster or slower rate.

Ratchet Lever

As already mentioned, this component was entirely absent when the clock was submitted for restoration, and has been produced from first principles, so there is no guarantee that it is identical with the one originally fitted. The form in which it is made is somewhat elaborate, involving the use of three separate parts held together by 14-B.A. screws, and a simpler construction, with the parts fabricated by sweating or riveting would serve just as well, but it should be noted that the construction was experimental and tentative, and several alterations were called for before it produced the desired result, so that a method of construction which conferred some measure of mutability was clearly indicated. (Fig. 16.)

The top end of the lever is extended at right angles to its main length and carries a large diameter disc roller, which is reduced to a narrow rounded edge and polished to reduce friction when in contact with the eccentric on the balance staff. This may be turned from the solid, as the more orthodox horological method of making it separate, fixing it to a brass collet, and mounting the latter on an arbor, confers no practical advantage, and entails much more work. Mild-steel, case-hardened on the working surfaces is a suitable material and easier to machine than a carbon steel which could be hardened and tempered. The pivots should be highly polished and made a little larger than the holes in the lever, which are broached to a working fit;

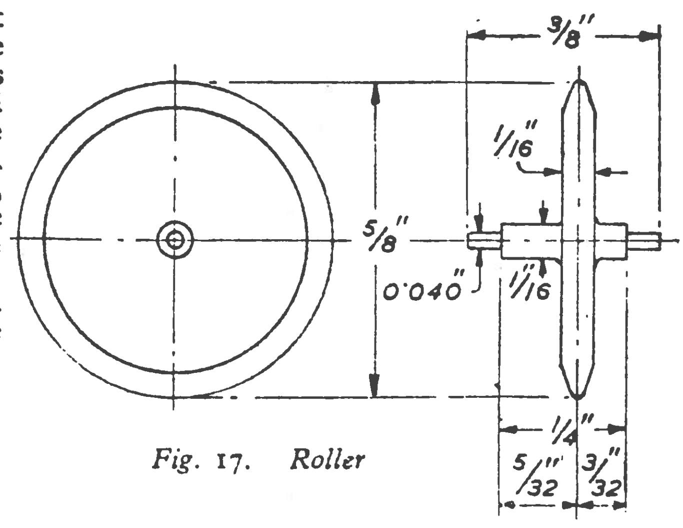


Fig. 17. *Roller*

this applies also to the other pivot holes for the feed pawl and the lever itself. (Fig. 17.)

Case-hardened mild-steel may be used also for the pawl, similarly turned from the solid, complete with its pivots, and filed to the shape shown. Before hardening, it should be tried out in position to check up on the shape of the point, which should fit the ratchet wheel teeth when at the end of its working stroke. The lever pivot is a double-ended arbor which is a press fit in the boss of the front motion-plate, so that the lever straddles the plate when in position. Note that the feed pawl must be made tail-heavy, so that it is kept in engagement with the ratchet wheel by gravity. (Fig. 18.)

The backward movement of the ratchet lever, and the depth of " bite " of the pawl, are limited by banking pins fitted to the front motion plate ; in the former case, the pin prevents the roller following the eccentric right to the bottom of its stroke, so that under conditions of variable balance action, the length of stroke of the pawl is fairly constant, or at any rate, never sufficient to enable it to gather more than one tooth of the ratchet wheel. But if, for any reason, excessive swing of the lever takes place, the second banking pin over the pawl prevents it rising too high so as to gather a second tooth or jam through engagement at too steep an angle. As it is very difficult to determine the exact positions of the banking pins beforehand, they are located as close as possible to their presumed positions and adjusted by bending.

The ratchet wheel is prevented from moving backwards, on the return swing of the ratchet lever, by a simple backstop spring, which, as already mentioned, is anchored by a screw to a lug cast on the motion plate, below the pivot bearing housing. This spring should be very light, or it will be noisy in action and also cause unnecessary friction in operating the ratchet wheel. A piece of pendulum suspension spring, bent at the end to the shape shown in Fig. 19, may be used for this purpose, and the hole for the anchoring screw may, with advantage, be elongated so that the spring can be adjusted to a nicety, to drop lightly into engagement with the teeth of the wheel as the ratchet lever comes to the end of its stroke.

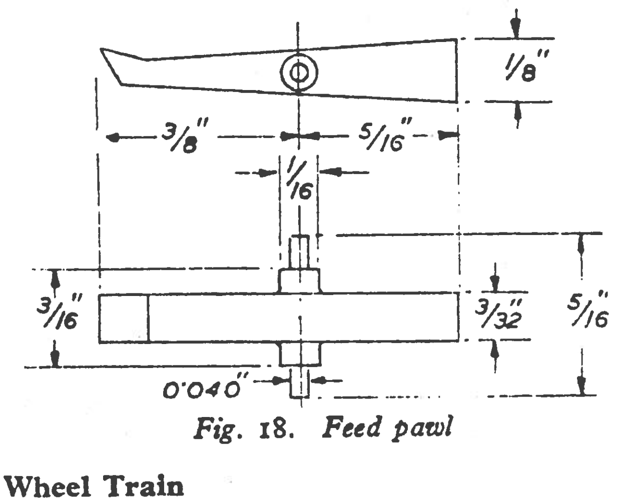


Fig. 18. Feed pawl

Wheel Train

The method of fitting the train of wheels in this clock is unusual, and it avoids the necessity of providing a pair of motion plates to accommodate both ends of the arbor pivots ; but in other respects it is of dubious advantage, and probably causes more friction than the normal arrangement of wheels on arbors pivoted at both ends. As it is more than probable that any readers interested in the construction of such a clock will either utilise an existing wheel train, or have their own ideas on its arrangement, it is not proposed to devote much space to its description, but the spacing and numbers of teeth in the wheels and pinions are illustrated in Figs. 19 and 20, the latter being in the form of a diagram in which it is assumed that the pivots are in line vertically for the sake of clarity.

A rather peculiar, and in some respects inconvenient, feature of this wheel train is that the pitches of the wheels and pinions are not all the same ; this has no doubt been done in order to

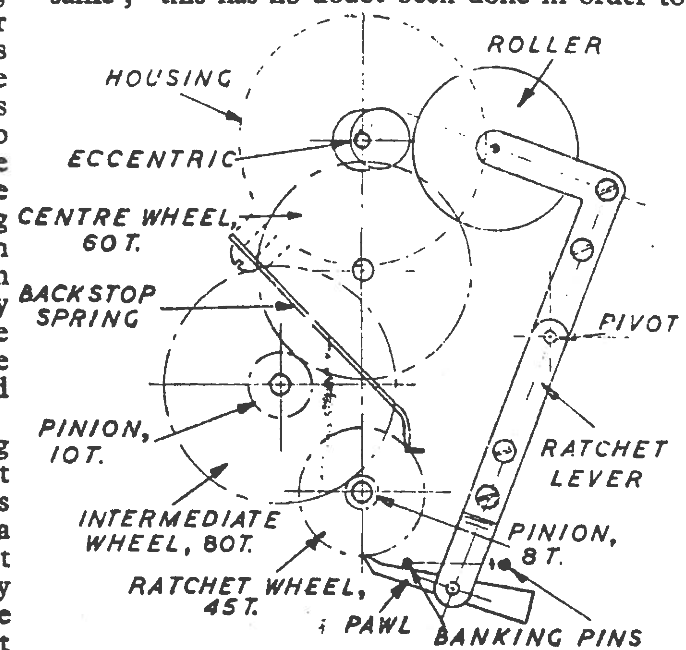


Fig. 19. Arrangement of ratchet gear and main wheel train

enable the " motion " wheel and pinion (that is, the intermediate element of the compound train required to reduce the speed of the hour wheel to 1/12 that of the minute wheel) to run on the same arbor as the intermediate wheel of the main train. But here again the advantage is questionable, and it probably would be much simpler, particularly for readers who have to collect suitable gears or cut their own, to avoid the use of " mixed " pitches. The intermediate motion wheel and its pinion would then have to be fitted on a separate fixed stud, as it is in most normal types of clocks. Apart from the motion work, which must obviously provide a 12 to 1 reduction, it is not imperative that the reduction ratio of the main train should be the same as that specified, providing that the number of teeth in the ratchet wheel is modified to produce the correct " count," and drive the train at the correct rate for accurate timekeeping.

It may be remarked that some " Eureka " clocks have been made with the gearing and motion work disposed differently to that of the example shown, and in this respect, constructors may exercise their own fancy or preference. The example dealt with has an open dial, fitted with two sockets which push over the spigot extensions of the armature plate studs, and are secured with grubscrews. The entire movement is mounted, by the lugs of the armature plate, on two vertical pillars, which are in turn bolted to the top of a hollow plinth which houses the battery—a large capacity single dry cell. A domed glass case is presumably intended to be fitted to protect the mechanism from dust,

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21

though this was missing in the particular specimen.

Supporting Pillars

These are shown in detail in Fig. 21, and it will be seen that they are of composite form, and one of them is devised to form a conduit for the battery supply lead, so that the latter can be kept invisible, or at least unobtrusive. This is another optional feature, but many constructors would consider it simpler to machine the pillars from solid brass—with or without a drilled passage for the lead. Alternatively, one of the pillars, or its centre bolt, could be insulated and used as a lead-in conductor. The other terminal of the battery is of course "earthed" to the frame of the clock, and polarity of the connections is of little importance.

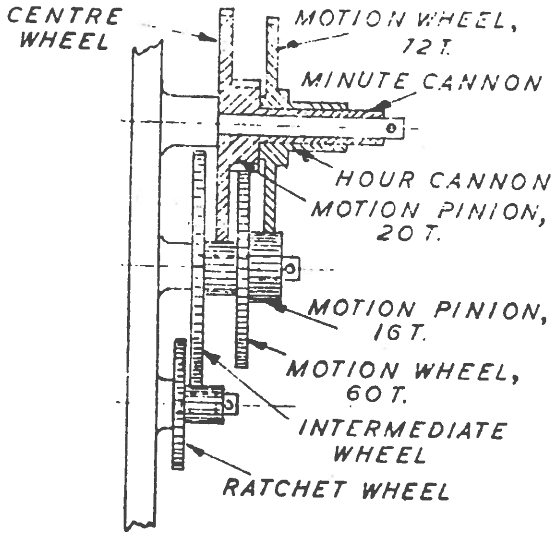

Fig. 20. Diagrammatic side view of wheel train

In the description of this unique and interesting type of clock, the writer has attempted to furnish sufficient data to enable the intelligent reader to build a clock working on similar principles, if not identical in detail. Many thanks are due to several helpers in this research, including Wing Commander J. Fitzpatrick Lewis, who first introduced the particular example to the writer's notice; to Mr. F. Hope-Jones, of the Synchronome Co., and the staff of the South Kensington Science Museum, for technical and historical data; and last but not least, to Mr. J. Message of the "M.E." Workshop, for assistance in the practical work of restoration, and preparation of notes and sketches.

Readers' Comments

Due acknowledgments are made to the many readers who have written to the writer or the Editor on the subject of the "Eureka" or other unusual types of electric clocks. Some of the letters express an adverse opinion of the clock or criticism of its design, but in nearly all cases they show real interest in the subject, and ask for further articles on similar topics.

It is not possible to publish all these letters in detail, or even to quote from them, but one or two have been selected by the Editor as containing matters of general interest, and will appear in the Practical Letters columns of The Model Engineer in due course. One rather incoherent correspondent, however, has accused the writer of "cheap sneers" at the constructors of Hipp or other simple pendulum clock, though such a thing was certainly never implied or intended. It is true, as he points out, that such clocks are easy to build with simple equipment, and perform accurately and reliably; but this fact, so far from being denied by the writer, was clearly stated and indeed emphasised in the introductory article on the "Eureka" clock, together with the motives for bringing the latter to the notice of readers.

Another reader asks "what is the significance of the title 'Eureka' applied to this clock?" That is a matter beyond the cognisance of the writer, and might be answered by another question—what's in a name? But from hazy recollection of ancient history, the name recalls the legend of old man Archimedes tearing through the streets of Athens in nudist uniform, leaving a trail of soapsuds, and yelling "I have found it!"—on the memorable occasion when he hit upon the method of finding the specific gravity of metals. By inference, one may suppose that the emotions, though probably not the actions, of the inventor of this clock were similar—in other words, he must have believed that he had really "got something." But carrying deduction still further, it is possible that after the disillusionment caused by the abortive efforts to exploit the commercial production of the clock, he may have had another search through the Greek dictionary to find the appropriate term for that much sadder phrase "I have had it!"

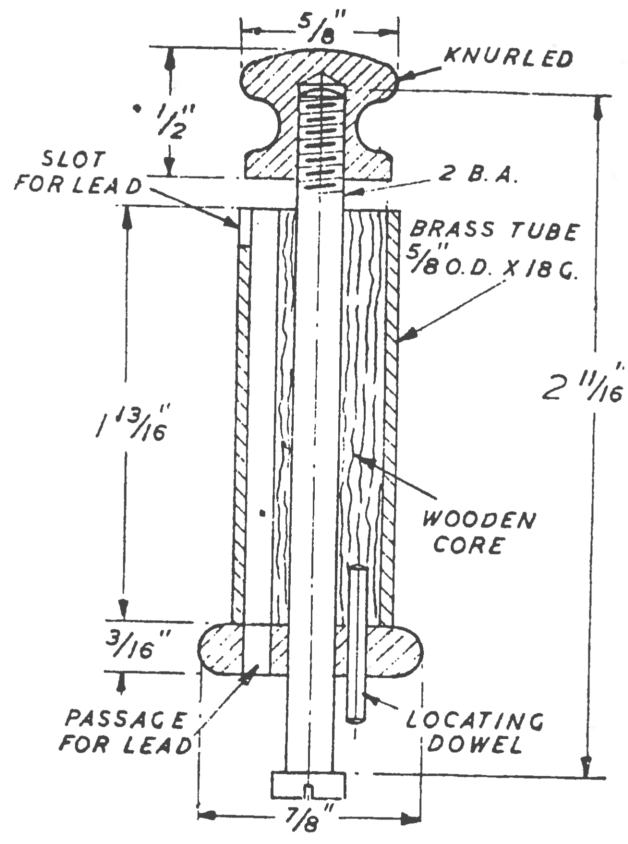

Fig. 21. Supporting pillars, 2 off (one only drilled and located to form lead conduit)

1852-1951 A CENTURY OF U.S. ELECTRIC CLOCK PATENTS.

By Dr. George Feinstein

TABLE I: Chronology (Continued)

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
327,898 10/06/1885 (01/14/85)	50	Electrical Attachments for Winding Clocks in Series	C.H.Pond	
328,769 10/20/1885 (06/01/85)	135	Electric Clock	F.R.Field	The pendulum controls the circuit of an electro-magnet, which in turn actuates a device by which impulses are given to the pendulum.
330,632 11/17/1885 (09/19/85)	52	Contact Maker for Electric Clocks	L.S.Spellier	
330,923 11/24/1885 (03/02/85)	185	Clock Synchronizer	A.Ramel & W.W.Dean	Assignors of 1/2 to P.Bakewell
330,938 11/24/1885 (06/27/85)	52	Primary Electric Clock	W.L.Stevens & E.J.Wescott	
332,987 12/22/1885 (08/10/85)	52, 166	Electric Syncronizing Device for Clock Pendulums	H.L.Bailey	Assignor to Telegraphic Time Co.
333,132 12/29/1885 (01/17/84)	185	Electric Clock-Setting Device	J.F.Kettell	S.J.Kettell administratrix assignor 1/4 interest to C.W.Sherbourne. Electric synchronizer for mechanical clocks.
333,133 12/29/1885 (06/16/84)	55	Electric Clock-Setting Device	J.F.Kettell	S.J.Kettell administratrix assignor 1/4 interest to C.W.Sherbourne. Electric synchronizer for mechanical clocks.
334,517 01/19/1886 (09/28/85)	149	Electric Clock Movement	S.C.Dickinson	Electro-magnetic rewind of a lever spring.

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
334,745 01/26/1886 (08/28/84)	(74/ 477) 134, 166	Electric Clock	J.E.Carey	Assignor to Electric Time Co. A clock driven by ordinary means has its escapement mechanism so constructed that when the normal source of power fails the train may be actuated by the pendulum and escapement-wheel. To this end the pendulum carries an armature, and may receive impulses from an electro-magnet.
334,822 01/26/1886 (06/30/85)	207	Electro-Magnetic Device for Winding Clocks	W.F.Sweet	Assignor to himself, M.Sullivan, J.Savage, and S.Sweet Jr. Circuit closed at one point by the descent of the weight and at another intermittently by a cam on the scape-wheel arbor vitalizes a magnet, the armature of which carries a pawl engaging with the winding-ratchet.
335,186 02/02/1886 (03/31/85)	51	Time Controlling and Correcting System	W.F.Gardner	
335,860 02/09/1886 (09/23/85)	52	Electric Clock System	C.D.Warner	The system involves a master clock controlling impulses to a series of secondary clocks, means for switching in an auxiliary or relief master clock, a gage for the current employed, an indicator at central station to show the condition of the secondary clocks, means for grounding the line at secondary clocks when required and means for inserting a test-battery to conveniently locate breaks in the line.
336,004 02/09/1886 (10/06/85)	52, 59, 165	Electric Clock System	F.E.Fisher	A magneto-electric generator is controlled by a central clock, so as to send alternating current through a continuous closed circuit to a polarized electro-magnet which vibrates an armature to actuate the secondary clock.
337,385 03/09/1886 (06/01/85)	181	Electric Regulator for Pendulum Clock	S.Eastman	Assignor to Synchronous Time Co. A system for electrically moving a weight up and down a pendulum rod.
337,416 03/09/1886 (11/10/84)	51	Means for Regulating Pendulum Clocks from a Distance	G.W.Millard & J.H.Clarke	Assignors to Synchronous Time Co. Vibrations of the pendulum of the secondary clock kept synchronous with those of the master-clock by devices actuated by electric connections controlled by the latter, which, at predetermined times, act to raise or lower the center of oscillation as may be required to accelerate or retard the beat.

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
337,417 03/09/1886 (12/05/84)	52	Means for Regulating Pendulum Clocks from a Distance	G.W.Millard & J.H.Clarke	Assignors to Synchronous Time Co. Electric device controlled by a master-clock and so connected with the pendulum of the secondary clock that its vibrating length may be automatically varied to cause acceleration or retardation, as may be required.
337,418 03/09/1886 (02/02/85)	47, 170	Means for Regulating Marine Clocks from a Distance	G.W.Millard & J.H.Clarke	Assignors to Synchronous Time Co. Electrical devices controlled by a master-clock and applied at predetermined times to increase or diminish the vibrating length of the ballance spring.
337,419 03/09/1886 (09/18/85)	52	Apparatus for Regulating Pendulum Clocks from a Distance	G.W.Millard & J.H.Clarke	Assignors to Synchronous Time Co.
337,583 03/09/1886 (04/23/85)	59, 160	Secondary Electric Clock	V.Himmer	Assignor to the Standard Electric Clock Co.
337,797 03/09/1886 (02/23/84)	149, 209	Self-winding Electric Clock	D.F.Sweet	Assignor to the Electric Time Co. Circuit closed by action of the train at regular intervals cause the main spring to be wound a little faster than it unwinds on the running of the clock.
338,773 03/30/1886 (06/06/85)	184	Circuit Closer for Electric Clocks	C.H.Pond	Contact between anchor and scape-wheel
339,264 04/06/1886 (12/18/84)	126	Step-by-step Mechanism for Electric Clocks	J.E.Carey	
339,688 04/13/1886 (06/06/85)	49	Clock Synchronizing Device	C.H.Pond	Designed to synchronize the hands of a clock equiped with such a winding device as is shown in Pat.No.308,521. The controlling device completes a circuit through the winding-motor and at the same time places a lever operating the setting device in position to be actuated by a mechanism moved by the motor. As soon as the hands are set a shunt-circuit is formed round the electro-magnet, and the parts are thereby restored to their original condition.

Patent No. Date (Of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
340,483 04/20/1886 (06/26/84)	49, 50	Electric Clock System	J.E.Carey	A clock actuated by a spring or weight is kept wound by electric impulses controlled by a primary clock. Similar impulses fromthe primary serve to synchronize the movement of the secondary through the pendulum.
341,110 05/04/1886 (08/01/85)	(379/ 315) 13	Electric Time System for Telephone Lines	J.S.Ross	A regulator at the central station which at the predetermined time disconnects the subscribers' lines from the switch-board and connects them to a ground-line and then closes for a moment the ground line circuit to transmit an impulse to the secondary clocks.
341,111 05/04/1886 (09/21/85)	61, 185	Electric Synchronizing Mechanism for Clocks	J.S.Ross	A secondary clock which at predetermined periods automatically switches itself into line to receive an electric impulse from the controlling clock. The effect of the impulse is to momentarily disengage the scape-wheel from its anchor and allow the train to run suddenly forward and bring the hands to the synchronizing-point.
341,449 05/11/1886 (06/16/84)	166	Electric clock & Clock System	J.E.Carey	Assignor to Electric Time Co.
341,450 05/11/1886 (03/02/86)	49	Winding & Controlling System for Electric Clock	J.E.Carey	
342,086 05/18/1886 (09/18/85)	135, 166	Electric Pendulum Clock	F. & O. Haenichen	Assignors to themselves and O.Seebass. Improvement on Pat.No.316,360
343,976 06/15/1886 (10/16/85)	166	Electric Clock Movement	P.Lange	Assignor to E.W.Moore On the center arbor is a toothed armature which is made to rotate by the alternate action of two electro-magnets, between which it is placed. The circuits through the magnets are alternately closed by the pendulum.
345,292 07/13/1886 (09/21/85)	164	Electric Clock	R.E.Fenner	Assignor 1/2 interest C.K.Giles Involves the application of electro-magnetic actuation to a balance-wheel clock.

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
346,094 07/27/1886 (02/27/86)	(185/ 40)	Electric Clock Movement	S.C.Dickinson	Improvement to Pat.No.334,517
346,862 08/03/1886 (02/19/86)	185	Clock Synchronizing Device	A.Ramel & W.W.Dean	Assignors 1/2 interest to P.Bakewell. Improvement to Pat.No.330,923
346,863 08/03/1886 (03/19/86)	52, 75	Circuit-closer for Primary Electric Clocks	A.Ramel & W.W.Dean	Assignors 1/2 interest P.Bakewell
346,970 08/10/1886 (02/23/86)	52, 166	Electrical Device for Synchronizing Clock-pendulum	H.Whiting	
347,399 08/17/1886 (05/05/86)	(340/ 310)	Electric Clock & Indicator System	T.C.H.Vance	Device for rotating cylinders with an inscribed text thereon.
347,572 08/17/1886 (05/21/86)	60, 187	Electric Clock System	C.L.Clarke	
349,493 09/21/1886 (09/05/85)	187	Electro-mechanical Synchronizer for Clocks	J.H.Gerry	Assignor to M.E.Hunter
349,494 09/02/1886 (01/13/86)	54, 65, 139	Pneumatic-mechanical Synchronizer for Clocks	J.H.Gerry & M.E.Hunter	J.H.Gerry assignor to M.E.Hunter
349,650 09/21/1886 (01/11/86)	187	Electric Synchronizer for Clocks	M.E.Hunter & J.H.Gerry	J.H.Gerry assignor to M.E.Hunter
349,879 09/28/1886 (02/13/86)	165, 166	Electric Clock	D.T.Garcia	
350,177 10/05/1886 (04/22/84)	149, 209	Electric Winding Device for Clocks	W.F.Weisgerber & I.C.Himmer	Assignors to Standard Electric Clock Co. A circuit-closer connected with the pendulum is made to act at definite intervals to vitalize an electro-magnet. The armature, when attracted, raises a weighted lever so connected wi[th] the mainspring as to wind it by its descent. The arrangement is such as to wind the spring faster than it runs off. The action of the armature is used to transmit impulses to a secondary clock.

Patent No. Date (of Appl.)	Class 368 Sub-Class	Invention	Inventor	Assignees, Foreign Patents, Description, and Comments
350,430 10/05/1886 (05/06/86)	46	Electric Time-indicating System	C.A.Hussey	
350,431 10/05/1886 (06/18/86)	52	Primary Electric Clock	C.A.Hussey	
350,432 10/05/1886 (06/18/86)	52	Electric Time-indicating System	C.A.Hussey	
350,433 10/05/1886 (06/18/86)	59	Secondary Electric Clock	C.A.Hussey	
350,434 10/05/1886 (06/28/86)	52	Electric Time-indicating System	C.A.Hussey	
350,435 10/05/1886 (07/01/86)	309	Case for Secondary Electric Clocks	C.A.Hussey	
351,222 10/19/1886 (05/14/86)	217, 220	Electric Time-piece	S.Thackara	Secondary clock.
351,239 10/19/1886 (08/04/86)	165	Pendulum for Electric Clocks	J.J.Abell & C.B.Gifford	
352,320 11/09/1886 (08/17/86)	59	Secondary Electric Clock	J.F.Hedge,Jr.	Assignor to Synchronous Time Co.
353,840 12/07/1886 (08/19/84)	(200/ 37R, 39	Electric Clock for Transmitting Signals	J.S.Bailey	
354,525 12/14/1886 (01/14/86)	52	Circuit-breaker for Electric Clocks	V.Himmer	
355,434 01/14/1887 (09/03/86)	149, 207	Clock Winding Attachment	J.Broich & A.E.G.Luebke	
355,820 01/11/1887 (01/14/86)	52	Circuit Breaker for Primary Electric Clocks	V.Himmer	Contacts opened and closed directly by pendulum.

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Information on early Self-Winding Clocks, Long-Case, Wall clocks with one or two weights. Interested in research or purchase. Jack L. Clemes, 704 G Street, Crescent City, CA 95531.

Information, pictures, ad materials, for WALTHAM ELECTRIC CLOCK CO. wall clock having 90 beat pendulum and 10" dial without seconds bit.
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