

**ANTIQUARIAN HOROLOGICAL SOCIETY**

**Electrical Horology Group**

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**Pul-syn-etic Clocks**  
**Installation, Maintenance and Repair**

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**INTRODUCTION**

These notes, which supersede the "Hints for Servicing Pul-syn-etic Clocks", are intended to assist AHS members to install a Gent Pul-syn-etic master clock, with or without impulse clocks, in their own premises (section A); to carry out routine servicing as required (section B); and if they wish, to undertake more extensive repairs (section C). Guidance is also given (section D) on maintenance of commercial clock systems, for any members fortunate to be involved in this rewarding branch of our hobby. Finally, a separate section deals with rectification of some common ailments which can afflict these clocks (section E).

If the excellent instruction book is available, please read it, carefully. If not, follow the setting-up instructions below.

**SECTION A - INSTALLATION**

**1 MASTER CLOCK**

The two basic models (Fig C6, impulse transmitter movement and pendulum; Fig C7 with pilot impulse dial) are identical as regards installation except that an impulse clock must be visible from the C6. Choose a sound, flat, dry masonry wall, preferably out of direct sunlight and away from heat sources. Though one acquaintance had a C7 master clock going in his bedroom, in most households the site should be such that the sound of the resetting does not interfere with sleep.

Most examples have five fixing points and all should be used if the clock is to serve a useful purpose. First install a substantial round-head screw for the top fixing and hang the case, checking the marks top and bottom against a plumb line. All but the earliest clocks have plumbing marks at the left-hand side also. Mark the positions for the remaining fixings through the case and use large washers under the bottom screws, to avoid damaging the slots. When the case is secured, hang the pendulum, shiny side to the front, checking that the suspension spring lines up with the crutch pivot. If necessary, a slight adjustment of the case position can be made to bring the pendulum central to the beat scale (if fitted), before finally tightening the screws.

Set the pendulum swinging sufficiently to turn the 'scape wheel and see that the driving and backstop pawls drop equally past the tooth points. The backstop is adjustable to achieve this but make sure, before altering it, that the wheel is against the backstop when the pendulum is to the left, or you may be fooled.

## 2 WIRING THE SYSTEM

Next install the wiring, power source and any impulse clocks you wish to drive from your master clock. 1mm mains cable is preferable in industrial premises but bell wire is acceptable in a domestic situation. Telephone cable is a good compromise, looks neat and indeed was always used by Telephone Rentals Ltd, which probably installed more industrial clock systems than anyone else. The conductors were paired of course and cleat spacing was nine inches. Many variants of the Pul-syn-etic system were produced during eighty-odd years of manufacture, which can affect battery requirements and how the system is wired. Some common ones are listed below.

### (i) Standard Series System

Transmitter coil resistance 20-30 ohms total; dial movement (C7) 3, 4 or 5 ohms. No additional contacts for clock circuit.

Working current (theoretical) 0.22 ampere (standard); battery voltage determined by circuit resistance, i.e.

TOTAL RESISTANCE (OHMS) x 0.22 = BATTERY VOLTAGE

From the late 1930's a rheostat was fitted in the master clock case. A convenient battery voltage in excess of that required can thus be used and the current adjusted as necessary.

### (ii) Half-Minute Series Clocks and One-Minute Parallel Time Recorders (Gent System)

Additional spring contact on gravity lever and corresponding contact screw on frame (to give long duration impulses); impulse converter (make/break) contacts, operated by 60-tooth cam on dial movement (to suppress alternate impulses from long duration contacts).

Battery voltage determined by pilot dial movement (which is energised at battery volts from duration contacts), as follows:-

COIL RESISTANCE (Ohms)	900	2500	3500
BATTERY VOLTS	24	40	48

Also found are the Blick conversions, which achieved the same result by a mercury switch, operated every minute by a cam driven from the 'sape wheel. Normal half-minute series clocks are supplied as (i) above.

### (iii) Half-Minute Parallel System

Additional long duration contacts on transmitter movement as (ii). Transmitter coil resistance 360-400 ohms (total), dial coil 3000 ohms. Battery voltage 24 (standard). Note, if the dial movement has impulse converter contacts, the system included a polarity changer unit, to drive polarised impulse clocks (Fig C404 movement).

### (iv) CEGB Models

Two versions, for power station use, one having a single dial movement with 30-minute contacts, but otherwise suitable for the normal half-minute series system, as (i). The version with extended dial plate and additional impulse movement having off-peak changeover contacts, requires 50 volts.

Earlier models for power station purposes had a mercury switch operated by the pendulum, through a wheel train and cam system.

#### (v) Seconds Indicating Impulse Clocks

Two principal types of transmitter were produced, both having contacts on the frame operated from a roller on the crutch lever. If the contacts close at zero and open at each side, ordinary step dial centre-seconds clocks, operating on uni-directional seconds impulses, can be used. If the contacts are closed with the pendulum at one side and released when it swings the other way, a pole-changing relay was used to drive clocks with the Fig C400A rotary movement, the current being reversed each second. Two-second impulse clocks can be driven direct from the master clock however. Both series and parallel seconds clocks were used, with various coil resistances, working currents etc. Latterly, 24-volt parallel working was standardised.

#### (vi) Transistorised Relay Units

Master clocks made after c1960 have an additional terminal in the case, connected directly to the gravity lever, for the above. This terminal, usually marked "2+" (1 in CEGB clocks) is not used for basic series systems.

### **3 POWER SOURCE**

If you obtain a Gent trickle-charger with your master clock, check the model number. The earlier Fig C150 type is an adjustable-voltage model, simple and reliable. It is suitable for charging ordinary lead accumulators, such as motorcycle batteries, the latter being readily-available at moderate cost, giving about five years' service. Constant potential chargers are usually 24/48 volts and are suitable for use with modern sealed lead acid batteries. If it is an early model such as the Fig C157, it is probably best to inspect it, to see if it contains any useful parts, and bin the rest. Later models in the 5000 series should have some useful life left. Sealed lead-acid batteries should be replaced every six years.

The modern alternative to the above is the access control power unit, with sealed lead acid battery back-up. These are generally available in various voltages from locksmiths and security firms at very reasonable prices. The 1 or 1 ½ amp models are best for clock system operation.

Battery capacity depends on system requirements. Assuming that the trickle charger is always energised, then for maintenance-free batteries, 2.5 to 7 Ampere-hours for series systems and 6 to 12Ah for small parallel systems should suffice. These figures should be doubled for batteries requiring topping-up, the higher values giving longer periods between top-ups, for a given system. It should be noted that battery capacity requirements increase with each sub-transmitting relay in series, and with the number of impulse clocks in parallel systems. As an example, 5Ah motorcycle batteries in good condition have satisfactorily run a Pul-syn-etic system for a fortnight without mains.

Bike batteries need a preliminary charge, using a car battery charger or equivalent. The C150 trickle-charger should be set to 12-15mA for a simple series system adding 2mA for each sub-transmitting relay. These rates should be doubled for alkaline cells, which also need a boost charge every six months or so (typically 0.5 ampere).

It might just be mentioned that the Pul-syn-etic system can be run direct from the mains, via a transformer and full-wave bridge rectifier. A regulated-voltage power supply can be used if you happen to have one, but such sophistication is quite unnecessary. Any sort of half-way house arrangement, such as the addition of "smoothing" capacitors to the basic transformer-rectifier, will not give a stable voltage when the contacts close, so you get a funny impulse. Similarly with the miniature battery-eliminator units intended for use with radio sets. Unless the unit has sufficient capacity, the current will be controlled by the internal resistance of the device rather than by the transmitter. All these power supplies have the serious fault that when the mains is switched off, or fails, the clock system stops. At best, this is a nuisance, but if any impulse clock is in a visible position, it will be condemned!

On the general subject of power supplies, members skilled in electronics may wish to introduce current control devices into the circuit. The writer's preference is however to allow the transmitter to perform this function, which it will, if correctly adjusted.

#### **4 STARTING AND REGULATING THE SYSTEM**

Having first checked that all connections are tight and that all impulse clocks are synchronized, a suitable test meter, set to measure DC amps (e.g. 1.0A scale) should be connected in series (series system) then a conducting item placed between the transmitter contacts (Gent technicians used to keep an old Florin for this purpose) and the current adjusted by means of the variable resistance, to the nominal figure of 220mA.

Draw the pendulum bob to one side (past the '3' mark) and release it. Check that the gravity lever is released when the deep tooth comes around and reset when contact is made. Check around the system and see that all clocks are going. If a number of impulse clocks give trouble, suspect the transmitter. If only one fails, look there first.

If all is well, set the system to time using the repeater cord, restraining the pendulum as necessary if the arc becomes excessive. The system should be left running and the time checked at intervals. Coarse adjustment of the rate can be achieved by raising or lowering the bob, each division on the rating nut representing one second per day gain or loss respectively; a complete revolution giving forty seconds. For fine adjustment, regulating weights can be placed on top of the bob, if losing, or on the rating nut, if gaining. Special weights were supplied by the makers for these clocks, see Section C for details. As well as checking the rate, note the arc of swing of the pendulum after the master clock has been running for a few hours. This should preferably extend to between the 3 and 3 ½ marks at each side of zero on the beat scale (if fitted). If there is no beat scale, ensure that the driving pawl moves well past the tooth points as the pendulum swings to the left, and that the teeth move well past the backstop on the other vibration. If the arc is less than 3 each side, or the pawls only just drop past the teeth, the transmitter probably needs cleaning and oiling - see Section B. A healthy pendulum arc is essential for reliable operation, good contact action and satisfactory timekeeping.

After initial regulation, check the time at regular intervals (e.g. weekly) and make further fine adjustments as necessary. Do not attempt to correct the rate each time. Either make adjustments after at least two observations or just correct for half the error. Rates of better than a second per week have been achieved by the Pul-syn-etic system under ideal conditions but rapid climate changes, particularly in barometric pressure can wreak havoc. Aim for better than a second per day in any case. Erratic gaining or losing point to transmitter faults, see Section E below.

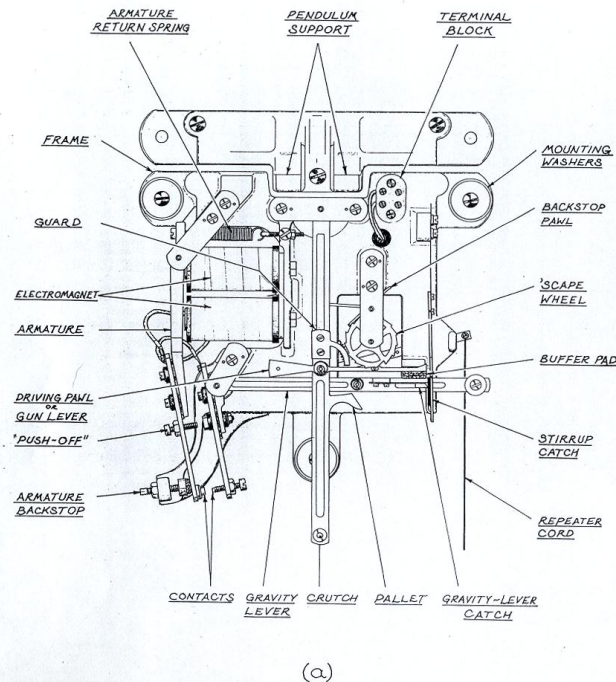
### **SECTION B ROUTINE SERVICING**

#### **1 TRANSMITTER DISMANTLING, CLEANING AND LUBRICATION**

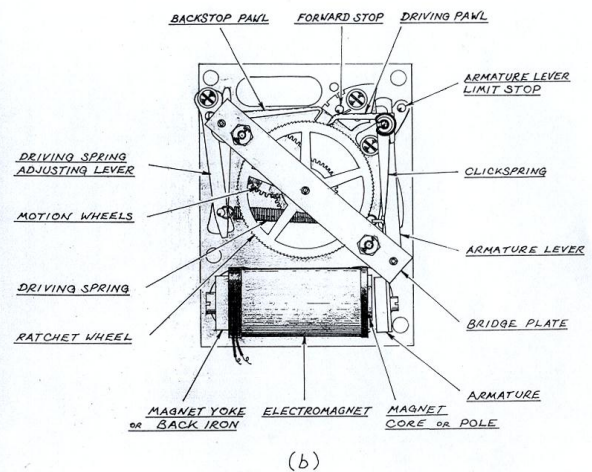
Before removing the transmitter movement from the case, detach the repeater cord from the advance lever. Note which wires need to be disconnected and mark any where there is the possibility of confusion. Take out the three movement securing screws, supporting the frame until free. On some early clocks (c1917-23) the upper screws also secure the case and can be rusted into the wall, so be prepared for this.

Prior to dismantling, check all pivots for shake and note any which need attention. Note whether or not the pivot plates have steady pins and, if not, mark to assist reassembly. Check for "shake" of the gravity lever in the latched position and, if appreciable, examine the felt buffer pad to judge whether or not it will have to be replaced.

Actual dismantling requires little comment. Unless the movement is very dirty, or a coil fault is suspected, it is usually advisable to leave the electromagnets in place. Check that the magnet yoke is sitting squarely on the casting and that the bobbins are clear of the frame. Rear pivot plates can often be left in-situ as well.



(a)



(b)

IDENTIFICATION OF PARTS :

- (a) IMPULSE TRANSMITTER MOVEMENT
- (b) IMPULSE DIAL MOVEMENT

The parts can be rinsed in white spirit and the frame wiped over with a rag moistened with the same. Use of clock cleaning solution is not usually needed and must be avoided for grained and lacquered parts. Clean out pivot holes and oilsinks with pegwood. Check the pivots for condition, particularly those of the 'scape wheel, burnishing as necessary. From the early 1930's, all pivot studs and arbors were hard-chrome plated and seldom cause trouble. The gravity lever buffer pad is held in place by a 7BA countersunk screw; remove at this stage if necessary. If in good condition it may be re-used, but renewal is preferable if there is any doubt. Replacement felt pads are now available from the Secretary. See Section C for fitting details. Check the other buffer pads for condition and renew as necessary. Cork-loaded synthetic rubber or reconstituted cork are acceptable for the armature backstop; rubber alone is not.

Burnish the vertical face of the deep tooth in the 'scape wheel. Check the driving and backstop pawls for wear and renew as necessary. Check the contacting surfaces of the stirrup catch for wear and polish as necessary. Inspect the Tufnol pad in the later type stirrup and either renew or reverse it if worn. Clean the contacts and remove any pitting with fine glasspaper, not emery cloth. Wash dust away with methylated spirits. If little contact material is left, renew the contacts as shown in Section C.

Check the connecting wires for condition, particularly the gravity lever connection and replace as necessary. In a domestic situation, early clocks can retain their fabric-covered flex for as long as possible. Otherwise replace with flexible PVC-insulated cable, avoiding garish bright colours at all costs. Use solder tags where possible but in any case scrape connection faces to ensure a good contact.

Reassembly follows cleaning and any repairs necessary. Put a drop of light oil in each pivot hole and a small amount on the pivot, before assembling. Wipe away any surplus. The best oil for these clocks is a pocket watch oil such as "Microtime F" (British Industrial Products Ltd). This oil has proved satisfactory in a wide range of locations and climatic variations.

When assembling the armature on early clocks, check that it comes squarely into contact with the magnet poles and that the contacts are in line. Note in particular that it does not bind against the upper magnet core. Adjust the pivot plates to ensure this and tighten the screws securely (Fig 1). When replacing the stirrup catch, leave the screws finger-tight at this stage, to permit adjustment.

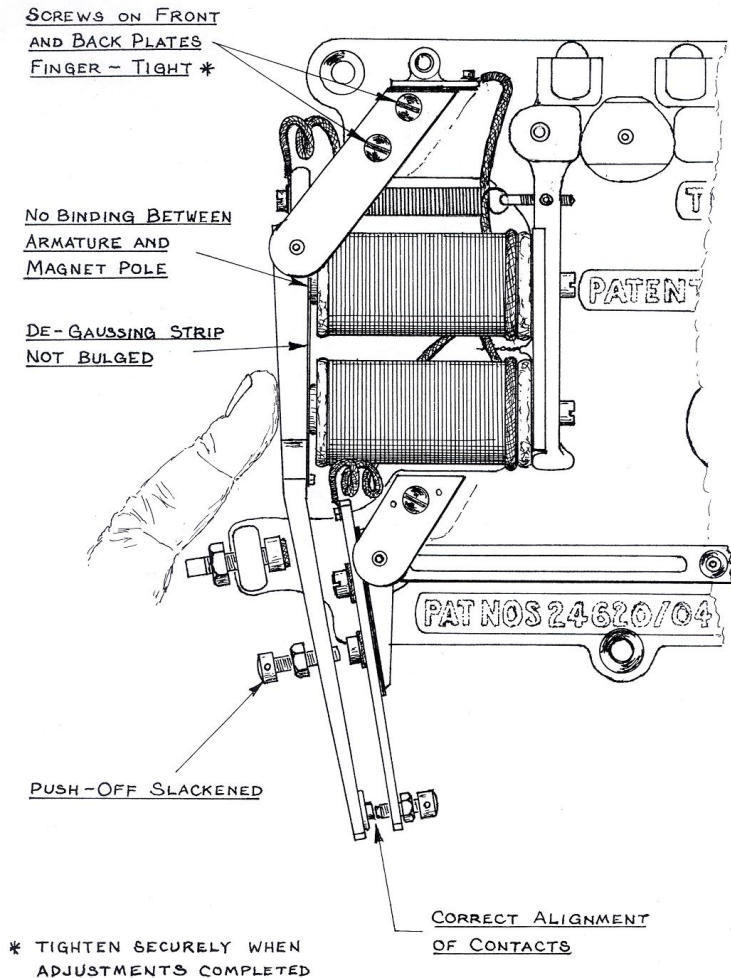


Fig. 1. ARMATURE CLEARANCE

## 2 TRANSMITTER ADJUSTMENTS

Correct transmitter settings are absolutely essential for reliable operation of the Pul-syn-etic system. There is no room for trial and error or guesswork; they are either right or wrong. This is because the settings, rather than the applied voltage, are the primary factor determining the current transmitted. Initial settings can be made with the movement on the bench but final adjustment requires the movement to be re-fitted in the case. See Fig 2.

First set the stirrup catch so that the impulse roller clears the dead face of the pallet, in the latched position, by 0.010". Then determine whether or not the felt buffer pad will produce negligible shake of the latched lever. If not, fit a new felt pad. Then see that the tip of the gun lever, with the pawl in the root of the shallow teeth, just clears the top of the slot in the stirrup by 0.025". Carefully bend the gun lever to achieve this if necessary and note that it makes good contact with the stirrup in the deep tooth. Check that when the gravity lever is released, the roller falls on to the corner of the pallet - neither on the impulse face nor too far past the corner on the dead face. The position of the lever catch can be adjusted to obtain this setting (see Fig 3).

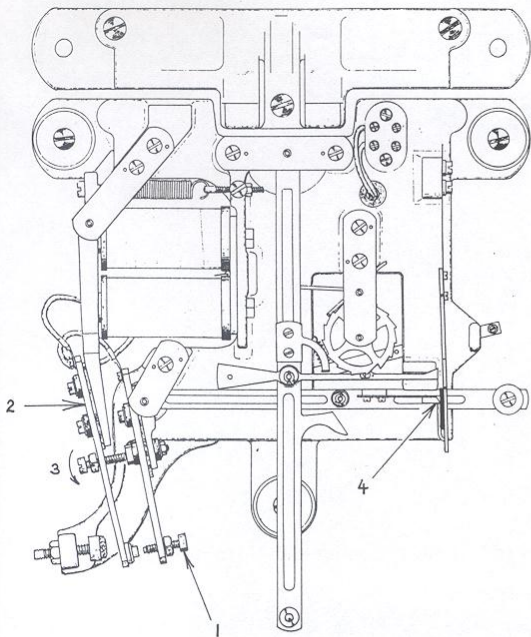
Check that the 'scape wheel spins perfectly freely. If not, re-examine the pivots and burnish as necessary. Even the chromed pivots can be polished, using a fine emery stick fed by metal polish while rotating at high speed. Check also for correct alignment of the front and rear pivot plates.

If everything is in order and stiffness is still apparent, lightly broach and burnish the pivot holes, cleaning finally with pegwood again. In all gravity-impulse and Hipp master clocks, the greatest factor affecting timekeeping is the condition of the 'scape wheel pivots/pivot holes and the lubricant. A Pul-syn-etic transmitter (1951 model) had its timekeeping improved from about +/- 6-7 seconds per day to +/- 1 second per 10 weeks, following attention in this respect!

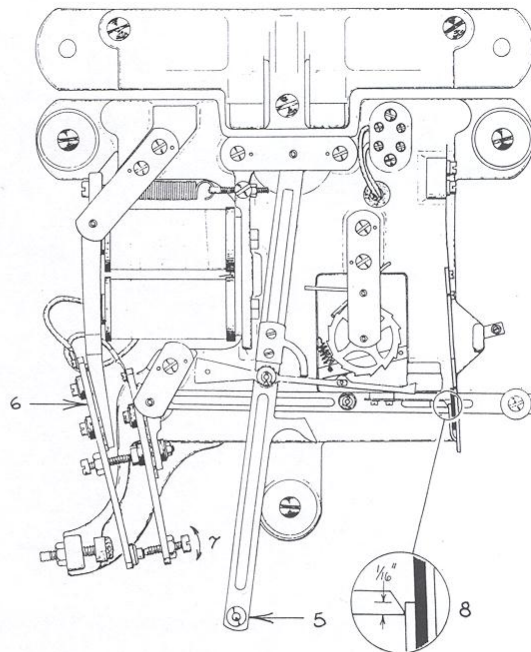
The gun lever and impulse roller are secured either with split pins or tinned copper wire. Do not re-use dicky split pins. The wire should be neatly coiled around the pivot, ensuring that some end-float is present.



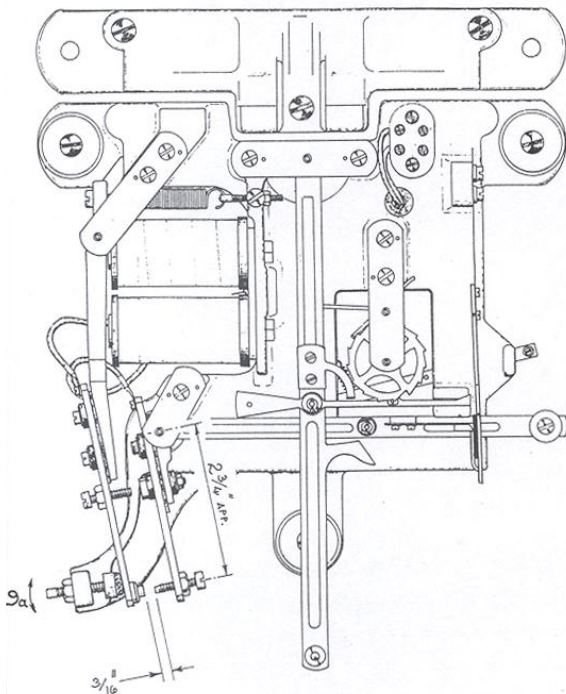
Fig. 2. PUL-SYN-ETIC TRANSMITTER CONTACT SETTINGS



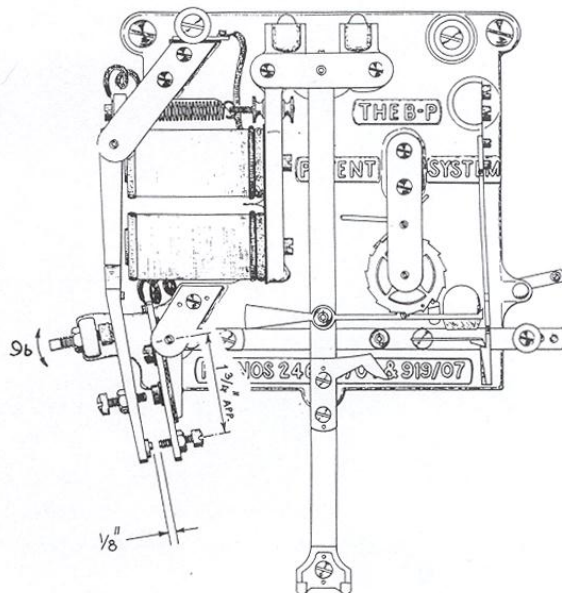
- 1 - CONTACT SCREW SLACKENED OFF
- 2 - PRESS ARMATURE IN AGAINST MAGNET POLES
- 3 - SCREW IN PUSH OFF UNTIL LEVER CATCH RESET ON STIRRUP (4)



- 5 - CRUTCH HELD TO THE LEFT
- 6 - PRESS IN ARMATURE
- 7 - ADJUST CONTACT SCREW UNTIL CONTACT JUST BROKEN WHEN LEVER CATCH 1/16" BELOW STEP ON STIRRUP (8)



- 9a - ON MOST TRANSMITTERS (CONTACTS ABOUT 2 3/16" BELOW GRAVITY LEVER PIVOT) ADJUST ARMATURE BACKSTOP TO GIVE CONTACT GAP OF 3/16" IN REST POSITION.



- 9b - ON VERY EARLY MODELS (BEFORE c 1913, CONTACTS ABOUT 1 1/2" BELOW GRAVITY LEVER PIVOT) CONTACT GAP SHOULD BE 1/8" ONLY.

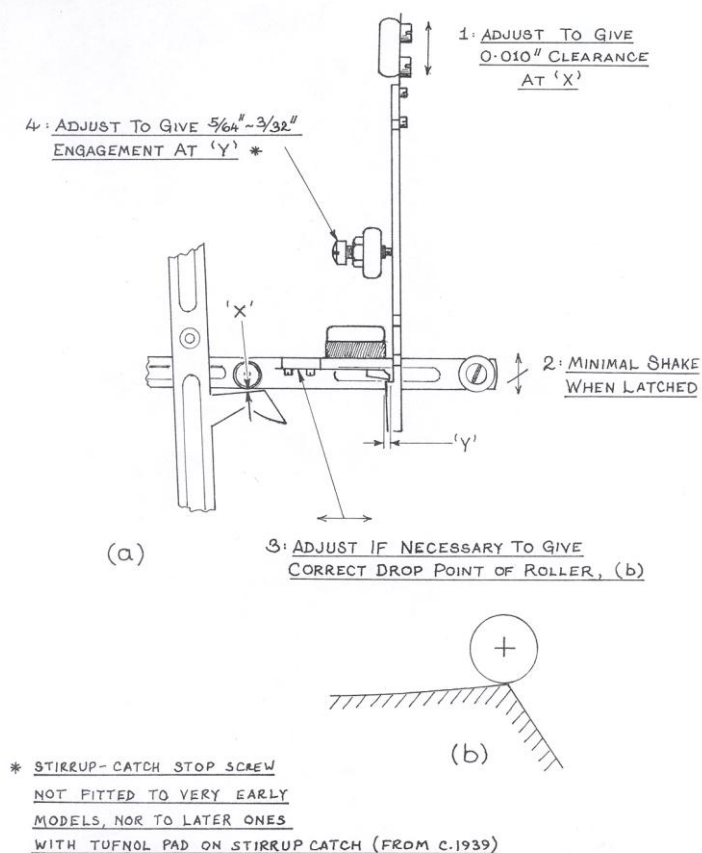


Fig. 3. CATCH SETTINGS

Release the gravity lever again and carefully adjust the contact screw so that contact is broken when the gravity lever catch is  $\frac{1}{16}$ " below the step on the stirrup. Finally, adjust the armature backstop so that the contact gap in the rest position is  $\frac{3}{16}$ ". (On early transmitters, made before c1913, with contacts  $1\frac{3}{4}$ " below the gravity lever pivot, this gap should be  $\frac{1}{8}$ " only). Tighten locknuts finger tight for now.

Examine the rubber mounting washers (on clocks from the early 1930's onwards) and renew if perished. Replacement washers are available from the Secretary. Return the transmitter movement to the case and re-connect all wires. Examine the condition of the repeater cord and renew as necessary (lacing cord is ideal). Check that the armature return spring just returns the lever to its buffer pad and adjust if necessary. Re-check the contact settings, also that when the gravity lever is released it cannot be raised by the pallet to a position where it is held by the catch.

### 3 CHECKING THE WARNING RATE

Hang the pendulum and set it swinging sufficiently to enable the gathering action to be checked. When considered correct, set the guard (if fitted) so that the driving pawl contacts the wheel teeth as shown in Fig 4.

Fig. 4.  GUARD SETTING

If a stirrup catch stop screw is fitted, set it to give a depth of engagement between the lever catch and stirrup of between  $\frac{5}{64}$ " and  $\frac{3}{32}$ ". Hold the lever against the felt pad so that the catch clears the stirrup slightly and check the stirrup catch spring tension. Using a tension gauge at the tip of the stirrup, the tension at which it just moves should be 35g. However, as this is tricky to hit exactly, anything between 25 and 40g is acceptable. With the earlier types of catch, it will be necessary to remove it to bend the spring. If no tension gauge is available, ensure the catch returns to its stop firmly. Tighten the stirrup catch screws when all is correct.

Next adjust the contact settings as follows. Unscrew the contact, backstop and push-off screws a few turns and release the gravity lever. Then press in the armature firmly against the magnet poles and screw in the push-off screw until the gravity lever is just replaced on the catch.



Connect a large-scale ammeter (e.g. Avometer) and a suitable variable resistance (if none is fitted) in circuit. Set the pendulum swinging and, with the repeater cord held down, slowly increase the resistance. The armature will reset the gravity lever with decreasing enthusiasm until a point is reached when it refuses altogether. The contacts remain closed until the pendulum returns to the right and assists the resetting. Note the maximum current at which this happens, which should be not less than 170 milliamps. This is the "warning rate" of the transmitter, which determines the actual current sent out to impulse clocks. The current rises slowly in an inductive circuit and does not have chance to attain the nominal mean value before the contacts part. The maximum current is typically of the order of 20mA above the warning rate, at a setting current of 220mA. The correct warning rate is vital therefore and, if instantaneous resetting is achieved at less than 170mA, you should proceed as follows.

If the warning rate is only just below 170mA, a slight increase in the tension of the armature return spring may be sufficient to correct. Otherwise the air gap must be increased. Release the locknuts and unscrew the armature backstop screw a few turns. Holding the crutch to the left, release the gravity lever and set the current to 170mA. Screw in the backstop slowly until the lever is reset and tighten the locknut. Then adjust the contact screw to give the 3/16" (or 1/8") gap in the rest position and the push-off screw so that the contacts part when the lever catch is 1/16" from the step on the stirrup. Re-tighten the locknuts and re-check the warning rate. (An alternative position for the push-off screw is in the bottom of the case, which it will automatically assume if you forget to tighten the locknut sufficiently!)

As well as checking the warning rate current, see that the gravity lever is reliably replaced on the long impulse and at a current value just below the warning rate. If the action is uncertain, i.e. multiple impulses are transmitted, see "double faults", Section E.

#### **4 PARALLEL SYSTEM TRANSMITTERS**

Most of the above comments apply equally to parallel transmitters, with the following qualifications. The main contacts are used only for resetting. The master clock pilot dial and external clocks are energised from the additional spring contact on the gravity lever and contact screw on the frame. This contact gap should be 1/32" in the rest position (main contacts 3/16" as above). The warning rate should not be below 22 volts, checked using a voltmeter in parallel with the transmitter coils.

#### **5 IMPULSE CLOCKS, DISMANTLING AND CLEANING**

Many different types of impulse movement have been introduced into the Pul-syn-etic system. If this paper is to be kept within reasonable proportions however, it will be necessary to concentrate on the basic ratchet-and-pawl step dial movements, which in any case constituted the vast majority of production. (The writer is always ready to advise or assist any members who have different types of movement to overhaul).

Impulse clocks, when correctly adjusted and lubricated, require virtually no routine servicing. Clocks which stop or lose time must be removed from the circuit between impulses and, in the series system, the wires re-connected immediately by a reliable method. Of course, on parallel systems the wires must not be joined and care must be taken to prevent accidental shorting.

First inspect the general state of cleanliness of the movement. If the whole movement is dirty it should be removed for servicing. If the ratchet wheel teeth are dirty or oily, the centre arbor can be extracted with the movement in-situ, without removing the coil. In either case the minute hand will have to be removed, the means of access to which varies with date and style of case. A jewellers' screwdriver will be needed to slacken grub screws or a fine punch to knock out the taper pin of earlier hand collets.

A small "Golden Syrup" tin makes an ideal movement stand for dismantling and reassembly of impulse movements. Screws and small parts can be put inside to avoid losing them. First check for any worn pivot holes and test the coil for continuity. Dismantle as necessary and rinse off excessive oily grime with white spirit. If the electromagnet assembly is to be removed, this will normally necessitate removal of the bobbin, which can cause problems as the securing screw is very tight. If the ratchet wheel teeth are still dull they can

be cleaned up using an old toothbrush dipped in metal polish. This should be rubbed across the teeth, gradually working around the wheel. When dry, the teeth can be polished using a clockmaker's polishing brush and rinsed off again. The pawls should also be honed and polished, to remove any wear which may cause unreliable action if the parts do not go back in exactly the same position. After any re-bushing necessary, clean out all pivot holes with pegwood and clean the armature lever limit stops, faces of the electromagnet, armature and yoke (back iron). On movements with the flat driving spring, check that this has not worn a notch in the armature lever. File smooth and burnish the lever as necessary.

For more extensive work, access to the motion wheels will be necessary. In most earlier movements it is simply a matter of removing a cock or short bridge plate. In the later (1933-on) standard type, the main pillars can be unscrewed from their studs, using smooth pliers.

## 6 ASSEMBLY AND ADJUSTMENT OF IMPULSE CLOCKS

Re-assemble the wheelwork, driving and backstop levers etc. and replace the bridge plate. Put a drop of clock oil in each pivot hole before inserting the pivots and also on the hour wheel pipe.

**DO NOT OIL THE RATCHET WHEEL OR PAWL FACES.** Do oil the driving pawl stud, however. If the wheel and pawls are oiled they will become dirty and worn. If they are not oiled they become brightly polished but do not wear appreciably. Put a spot of clock grease on the tip of the clickspring and also on the armature lever, where the flat driving spring bears in earlier movements. Alternatively, dry graphite can be used. Ensure that the clickspring bears flat against the tail of the pawl (Fig 5).

Check that the pawls are central with the wheel teeth and that the driving pawl stud is parallel to the lever spindle.

Set the forward stop of the driving pawl so that the latter propels the wheel forward until it is four teeth away from the backstop click, i.e. to leave three empty tooth spaces between the pawls in the rest position. See that the backstop pawl drops freely in place and that the wheel travels a short distance further, to give a little backlash when the driving pawl is withdrawn.

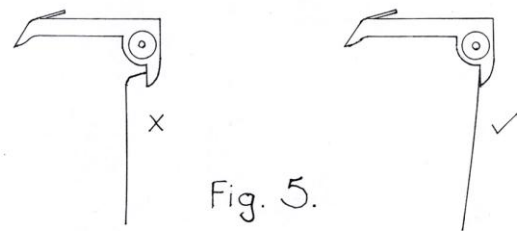


Fig. 5.

CLICKSPRING AND DRIVING PAWL

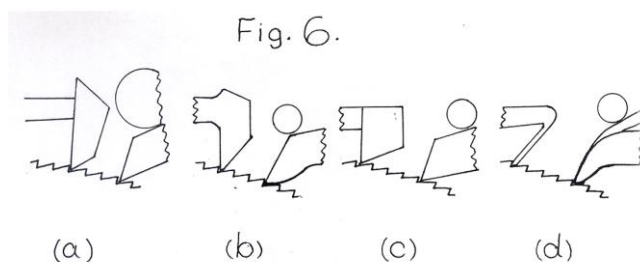


Fig. 6.

On early movements, made before c1916, the inter-pawl space should be three teeth (two empty spaces) only. (Fig 6).

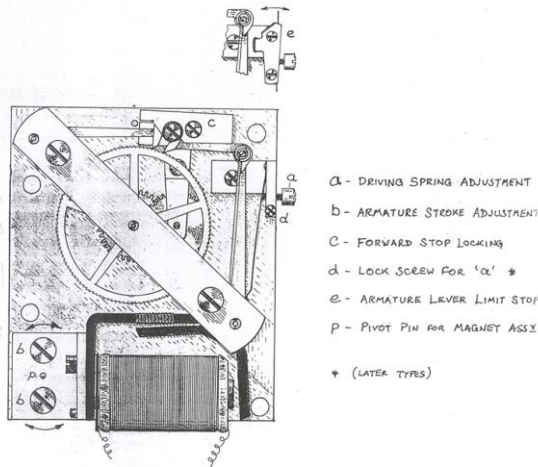
Set the armature lever limit stop or top spring so that the driving pawl gathers one tooth and travels about 1/3 tooth further.

EMPTY TOOTH SPACES BETWEEN DIAL PAWLS

Check that the armature face is at right-angles to the backplate and re-fit the back iron (without the coil). Press in the armature so that the lever is against the limit stop, slide the back iron squarely into contact with the armature and tighten the securing screws. Again check the action. Re-fit the coil, taking care not to trap or break the flying leads, and tighten the screw as tightly as possible. Again check that the armature comes squarely against the pole faces and check the action for a complete revolution of the wheel.

In the early "parapole" movements there is no armature lever limit stop, the extended magnet pole forming the stop, against which the upper limb of the armature comes when attracted. The adjustment for the

armature stroke is by slackening the two screws securing the electromagnet bracket to the baseplate, thus allowing the assembly to be swivelled. From c1910, an upper stop was introduced, in which case this is set first and the magnet then swivelled into contact with the armature (Fig 7).



Finally, check for end-float in all spindles and that nothing is binding anywhere.

When satisfied that the movement is mechanically correct, refit to the clock and check that the minute arbor is central with the dial, by sighting across between 6 and 12 and between 3 and 9. Replace the hands, checking that the minute hand is perfectly balanced, by lifting both pawls from the 120-tooth wheel and spinning it. The minute hand may have its own counterweight or it may be balanced with the wheel, or by an additional weight on the centre arbor. Check that the hands clear each other and the dial.

Fig 7. PARAPOLE MOVEMENT (TYPICAL)

Align the minute hand with 12 and the hour hand with 6 exactly. Operate the movement by hand and check that the minute hand points exactly to the dial markings at all positions. If any discrepancy is found, the movement is out of centre - readjust as necessary. Remove any fingermarks or dust from inside the glass before sealing up the case. Check that the minute hand is clear of the glass also.

Place the clock in a vertical position and connect it in series with a battery, large-scale ammeter and a suitable variable resistance, in order to set the driving spring tension. The minimum current at which the armature is attracted is termed the "failing rate", the correct value of which, for all dial movements is 130mA (originally quoted as 120mA). This is an essential check, to ensure that the movement responds positively at the actual current transmitted on the fleeting impulse, but also because a failing battery might not be attended to immediately the "battery warning" indication is given and the voltage falls more rapidly due to the long impulse in this condition.

Set the tension of the driving spring so that, when the current is slowly increased from a low value, the armature is attracted when the current reaches 130mA. Check several times, each time increasing the current slowly and checking that the armature moves positively.

For parallel operation, the failing rate should be 18 volts. In this case of course the voltmeter should be across the movement.

Finally, ensure that the movement case is dustproof. The standard Bakelite case is fitted with an elastic band as a seal. The tin case must have the cable entry point sealed.

## 7 OTHER TYPES OF SECONDARY EQUIPMENT

The same principles of adjustment and servicing apply to all types of equipment operated by normal step dial movements. Programme instruments, feature clocks with exposed hands and small turret clocks have double-locked movements, in which the centre wheel is locked when the armature is attracted. This point should be checked but note that the backstop should still have slight movement in the locked position, with the armature attracted.

## 8 RELAYS

The Fig C63 sub-transmitting relay, as used to control multiple loops of impulse clocks on series systems, is a robust unit which seldom gives trouble. The coil has a large copper slug, which provides an artificially-extended impulse duration. The armature is always fitted with a residual screw or screws, to adjust the air gap in the attracted position. After many years' service, the screw points tend to wear, reducing the residual gap and increasing the impulse duration. This will not affect the reliability of the system, but very long impulses cause an excessive drain on the batteries. A gap of about 0.012", measured next to the screw point, should be sufficient.

Inspect the contacts and clean as necessary. If sooty, wipe around the contacts with a cotton wool pad moistened with methylated spirits. Then draw a piece of clean paper between the contacts while holding in the armature. Proprietary contact cleaners e.g. Electrolube, are very acceptable here and a final spray is a good idea, particularly in damp locations.

If the contacts are seriously eroded, use a fine contact file or fine glasspaper to remove the pitting. Blow away the dust then preferably finish with crocus paper and clean as above.

The armature should pull in reliably at 130mA max. Check the contact action to ensure that there is "block lift", ie that the upper spring leaves are lifted from their stops in the attracted position. See that the contact springs sit down positively on their stops when the armature is released. If a tension gauge is available, set the tensions to 8-10g (lower) and 16-20g (upper); otherwise don't touch!

Relays used in parallel systems are usually of standard commercial pattern. Contact wear is more of a problem and the height of the contacts does not permit many servicings. Replacement of the relays should be considered if serious contact wear is found. Octal-based plug-in relays will provide for easier future maintenance. Solid-state relays have also been used successfully.

There is nothing difficult about servicing electric clocks. It is really just a matter of having the correct tools; observing standard settings and checks and, above all, taking care. Essentials are suitable screwdrivers and spanners in good condition and a reliable test meter. The dial type of meter such as an AVO 7 or 8 is perfectly adequate, providing it zeroes reliably both mechanically and electrically. The meter is needed primarily to check the "warning rate" current of the transmitter (lowest value at which resetting occurs without pendulum assistance) and the "failing rate" current of the impulse movements (minimum value at which the armature is attracted). Any repair or adjustment carried out without checking these values is a complete and utter waste of time!

## SECTION C MISCELLANEOUS REPAIRS

### 1 Fitting New Felt Buffer Pad to Transmitter

The replacement buffer pads, available from the Secretary, are made from pressed wool felt, to the correct specification, and should be at least as good as the originals. Any old felt will not do. The overall dimensions will be found suitable in the great majority of cases. However, since the position of the fixing screw hole varies, this has to be drilled (or punched) on assembly.

Dismount the gravity lever (removal of the crutch will facilitate this). Poke a small terminal screwdriver into the felt pad to locate the 7BA countersunk screw and remove.

The method of marking the position of the screw hole depends on the style of casting. Position the new felt pad centrally against the mounting and, if possible, pass a sharpened stick of pegwood or a small drill down through the tapped hole into it. Otherwise a suitable peg is made to go in the hole and the felt pressed up against it.

The pad can be held in a small machine vice and drilled through with a No 38 drill, using a moderate speed and pressure. Take the drill through several times to clear the hole. Stop and rest if there is a burning smell! Then drill a short distance into the felt with a No 18 drill, to clear the screw head.

It is possible to punch the felt but the precise diameter of punches must be used.

Fasten the felt pad in place and re-assemble. Check that latching is not prevented with a clearance of 0.010" between the roller and top of the pallet, in the latched position. If the pad is too thick, it will probably be more satisfactory to relieve the casting by careful filing, than to try to alter the felt.

## 2 Pendulum Suspension

The suspension is more robust than that of most clocks but can still be broken if the person removing the clock from a building is sufficiently determined. In that event, the top trunnion will probably be thrown away, therefore a drawing of the complete assembly is given herewith (Fig 8).

Owing to the thickness of the spring, unless a proper punching jig can be made, it should be worked in the annealed state, then hardened and tempered.

## 3 Contacts

Points frequently requiring attention after long service are the contacts. These were originally platinum, then platinum-silver, gold-silver and finally palladium-copper alloys. They must withstand mechanical wear, thus ordinary silver relay contacts are not really suitable. Car ignition contacts have been used, though their very hardness can be a problem where sparking has caused pitting, which is then very difficult to remove. Engineers' "Nickel-Silver" (brass with 10-12% nickel content) is looking promising in long-term trials on both Synchronome and Pulsynetic master clocks. It turns beautifully and takes a high polish. Use 1/8" (3mm) diameter rod for the screw contact and 3/16" (4.5mm) for the armature contact, turning a smaller diameter shank which can then be soldered into the drilled out screw/contact pad.

## 4 Gravity Lever Catch

When the gravity lever catch is found to slope upwards at its tip, causing unreliable latching, if the condition is not too severe it may be corrected by slightly relieving the mounting on the gravity lever as shown in Fig 9. Note that a small amount of brass removed will give greater effect at the extremity of the catch.

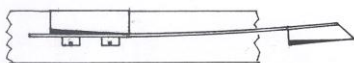


FIG. 9. GRAVITY-LEVER CATCH

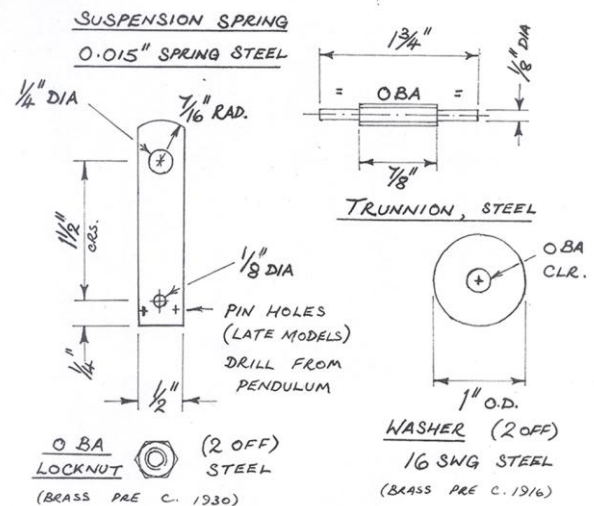


FIG 8. - PENDULUM SUSPENSION



## 5 Contact Alignment

Uneven contact wear can result from misalignment of the contacts. There is usually sufficient movement available in the mounting screw holes of the armature and gravity lever extensions to enable the contact screw to be set to engage the armature contact in the centre. Excessive misalignment of the levers may be corrected by removing metal from the armature as shown in Fig 10. Note that a longer contact screw may be required. Alternatively, gently bend the gravity lever close to its pivot.

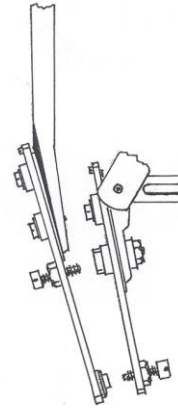


FIG.10. ARMATURE / SWITCH LEVER ALIGNMENT

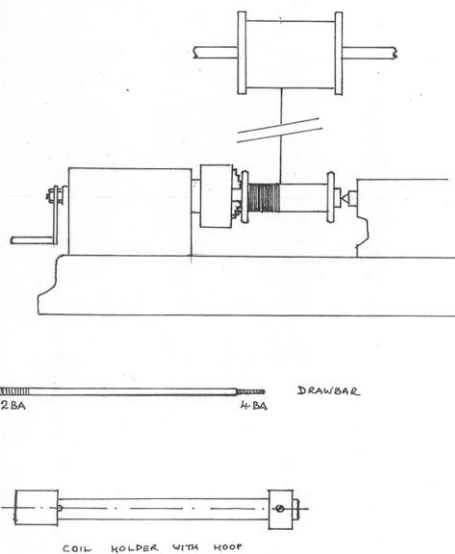


FIG. 11 - COIL WINDING SET-UPS

## 6 Coil Winding

Rewinding electromagnet coils requires some practice, considerable care and much patience. A small lathe may be used with the setup as shown in Fig 11. First check the wire diameter at both ends of the coil. This sounds silly but early transmitters had the four inside layers of the coils wound with 28swg and the eight outer layers with 26swg. Count the number of layers when unwinding the bobbin and note the position of any paper interleaving.

Position the bobbin of wire above the lathe on a spindle, thread the end through the hole in the coil flange and leave a generous length free

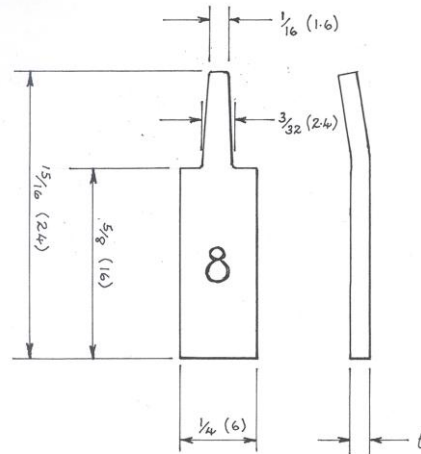
Certainly in the case of coils for series systems, never attempt to wind under power, not even at slow speed. If gaps or overlaps occur, and they will, you need to stop immediately and reverse. Apply moderate tension to the wire and do not lead it along the coil, rather restrain it so that the wraps lie as close together as possible. Wind right up to the flanges and take care when changing from one layer to the next. Watch for bad winding as faults on inner layers will show up in the finished coil. A layer of paper may be interleaved before the final two layers to improve the appearance if necessary.

Make a point of winding all coils in the same direction. When electromagnets are in pairs, as in the transmitter, the inner ends of the windings are joined together so that the current flow is opposite in each coil, giving opposite polarity and a strong field via the armature and yoke. When winding is complete, secure the end by knotting or threading through the special holes in the flange and preferably apply a spot of shellac varnish. Test for continuity and resistance. Handle with care.

Patience will be rewarded by a powerful action and reliability. That was not the case in an ex-British Rail master clock which came into the writer's hands. On removal of the untidy, sticky, bright green PVC tape from the transmitter coils, the appearance of the windings was reminiscent of waste yarn accidentally wrapped around a shaft, referred to in the Bradford trade as a "mullock", or "reight mullock" in severe cases. The incorrect wire had been used and the clock would not transmit anywhere near the correct current!

## 7 Replacing Hand Counterweights

The lead counterweight sometimes drops off the tail of the minute hand (hour hand also in large clocks). The most satisfactory solution is to replace it in brass. The material will have to be somewhat deeper than the lead weight to start with. A suitable piece of brass strip is drilled and tapped in a small BA size, blued and fastened to the hand tail with one or two round head screws. The hand profile is marked on to the brass, which is removed and filed to size. Check for balance and reduce the thickness of the weight as necessary. Check that the finished job will still clear the hour hand.



## 8 Rating Weights for Transmitter

From the 1930's onwards, packets of regulating weights were supplied with all Pul-syn-etic master clocks. The design was later changed but, as the earlier pattern is easier to make, details are shown in Fig 12. According to the packet, a No 8 weight, weighing one dwt (pennyweight), makes a difference of one and one-fifth second per day when added or removed from the transmitter pendulum. Other weights to be in proportion!

No.	MATERIAL	t in	t mm	FINISH
8	BRASS	1/16	1.6	POLISH + LACQUER
4	BRASS	1/32	0.8	BRONZE + LACQUER
2	NICKEL SILVER	30 SWG	0.315	LACQUER
1	ALUMINIUM	26 SWG	0.45	LACQUER

REGULATING WEIGHTS

Fig. 12

4/01

2/8

## SECTION D MAINTENANCE OF COMMERCIAL CLOCK SYSTEMS

There can be few more rewarding jobs in electric clocks than setting a neglected or stopped system to rights. Such installations as have escaped attack from peddlers of cheap kitchen clocks and battery insertion movements, are becoming rare but prized possessions of enlightened owners. With a few honourable exceptions, the British horological trade is not interested in clock systems, so the amateur has a vital role to play if anything at all is to survive. The following summarises the work needed to maintain reliable operation of a clock system. As well as light engineering tools and electrical test meter, you will need an accurate watch with stop action seconds hand or a digital one.

### 1 ROUTINE VISIT

- 1.1 Check installation synchronised by inspection of impulse clocks and/or time recorders near central equipment.
- 1.2 **Impulse Transmitter**, check and record:-
  - a) time error
  - b) value of rating weights on bob, if any
  - c) amplitude of swing
  - d) note any unsatisfactory actions, stiffness in 'scape wheel or pawls
  - e) If resetting action sluggish or violent, check setting current. Clean, service and rate impulse transmitter as necessary, including a wipe around the bottom of the case periodically. Set to time, record all changes and as finally left.

### 1.3 **Batteries, Trickle Charger and other Central Equipment**

- a) clean as necessary
- b) check and record battery voltage prior to and during one minute pulse (where applicable)
- c) check and record charging current immediately after impulse (as shown on ammeter on charger)
- d) adjust charge rate as necessary; for alkaline cells note if six-monthly boost charge due (from records) and switch to boost if necessary (8 hrs)
- e) examine any relays; take action as necessary
- f) check sub-circuit currents, adjust if required and record
- g) examine programme instrument, clean and lubricate as required
- h) inspect batteries and check for corrosion; take any action required and apply petroleum jelly as necessary to terminals
- i) on initial visit, check fuses for correct value (generally 1 amp).

### 1.4 **Impulse Clocks**

- a) check synchronised
- b) clean any glasses and/or cases as required
- c) remove any faulty clocks from circuit, re-making the connections before the next impulse (series systems). Note, in a modest, compact system of C7 master clock, C69 programme instrument and 20 impulse clocks, removing four clocks will increase the theoretical or "setting" current from 0.22 to 0.25 amp. i.e. still within acceptable limits.

### 1.5 **Time Recorders**

- a) check for correct time indication
- b) stamp a card and check time, print quality, colour and day. On auto machines check manual operation with mains disconnected
- c) check owner's cards for possible defects
- d) remove case and brush out dust accumulation
- e) inspect mechanism for loose screws, parts etc
- f) clean and lubricate mechanism as necessary
- g) clean type wheels as required
- h) change ribbon if necessary, check auto reversal
- i) replace cover and after next impulse stamp card three times; check all in order.

### 1.6 **Sound Signals**

Make visual check and enquire locally if OK. Check associated batteries, if any.

### 1.7 **Cable, Junction Boxes etc.**

Examine as proceeding around the installation. Deal with any minor fixing as necessary and/or note where more work needed. Note any poorly-made junctions and replace with terminal boxes as opportunity allows.

### 1.8 **Final Check**

Before leaving, re-check amplitude and time of impulse transmitter. Check case locked and return key to safe place.

If the responsibility for timekeeping rests solely with the reader, the system should be visited every four to six weeks in industrial premises. Depending on the condition and siting of the master clock, and the accuracy required, longer intervals may be permissible. Similarly, siting of batteries affects the frequency of topping up required. The small motorcycle batteries should not be left longer than three months, in good conditions. Maintenance-free batteries should be replaced after six years service.

## 2 STORAGE BATTERIES

Batteries found in neglected condition, unless they are alkaline cells, are probably best replaced. If of the latter type, or lead-acid ones which are not too bad, remove all corrosion and crystal encrustation from cell tops and terminals and check specific gravity using a hydrometer. Ammonia is useful in removing verdigris, if you can get it.

In the case of lead acid batteries, the specific gravity indicates the state of charge, more or less accurately depending how close the original acid was to specification.

Typical limits (at 20 deg C) are:-

fully charged	1.215 (1.28 for automotive types)
part charged	1.210 (1.22 for automotive types)
discharged	1.180 (all types)

If around the lower limit or less, discard the batteries. Car-type hydrometers are not suitable for checking motorcycle batteries. An excellent, reasonably priced, motorcycle battery tester is available from Hein Gericke (see Appendix II).

The specific gravity of the electrolyte in alkaline cells (nickel-iron or nickel-cadmium) gives no indication of the state of charge. It does however indicate the condition of the solution and when replacement is necessary. A special hydrometer is preferably used or at least, one which has never been used with lead-acid batteries. Readings for typical cells are:-

new electrolyte	1.190-1.200
part used	1.170
exhausted	1.145

New electrolyte (basically caustic potash solution) is available from the makers or from Alcad Industrial Batteries of Ilford, Essex. It lasts for many years on clock system use. NB follow instructions carefully on handling and use of this highly corrosive solution. A suitable resistance will be needed for running down the battery voltage before disconnecting, changing the electrolyte and re-charging. Do not be surprised if the cell voltage appears to increase after re-filling but before re-charging. This voltage will not be retained on closed circuit until re-charging is completed. The normal "float" voltage in use (on trickle charge) should be around 1.4 to 1.5 volts per cell. Old batteries might not achieve the specified voltage on charge but for normal clock system use this does not matter. A set of NiFe nickel-cadmium batteries, in a clock installation looked after by the writer, dates from 1952.

Plastic laboratory wash bottles are ideal for topping-up. One fault of most makes of motorcycle battery is the very opaque plastic used for the cases, making level checking difficult. This can more easily be achieved by means of a small-bore glass or rigid plastic tube which is inserted down to the plates, a finger placed over the top, then the tube withdrawn. About ¼" of acid in the end of the tube is plenty.

Alkaline cells are usually provided with a combined level checking and filling bottle. The end tube is inserted diagonally through the hole in the plug, the bottle squeezed and released. Any liquid in the plastic tube shows a sufficient level. If no liquid is drawn up, tip up the bottle above the cell to admit distilled water. Top up after boost charging if necessary, not before. It is the writer's experience that alkaline batteries need far less topping-up than lead acid types.

Only pure distilled or de-ionised water should be used for topping up. Use of tap water really is false economy.

After cleaning and servicing the batteries, ensure all terminals are tight and liberally-coated with industrial petroleum jelly.

### 3 GENERAL APPRAISAL OF SYSTEM

#### 3.1 Master clock position satisfactory?

The writer has found a master clock high on a wooden partition, with the batteries, under a south-facing glass roof. Another was in a tiny kitchen containing a large geyser, which filled the room with steam at each tea break, making the partition wall (on which the transmitter was mounted) soggy.

#### 3.2 Impulse clocks suitably positioned?

Over a period of time, machines, pipework etc can be re-sited, often impairing visibility of the clocks. Work patterns change, so that people can spend more time in areas without clocks. This is often when horrible battery clocks gain a foothold.

#### 3.3 Time recorders clean and suitably positioned?

There should be plenty of room around the machines, with "in" and "out" card racks either side, so that people do not get in each other's way when clocking in and out.

#### 3.4 Sound signals audible where required?

### 4 FEATURE CLOCKS

Frequently found in foyers, boardrooms, senior management offices, lecture theatres and fashionable stores; these have movements set in walls or panelling, with applied numerals and exposed hands. They can look most impressive but can also be problematical. Whereas the principal enemy of the normal impulse clock is the factory painter, the culprit for feature clocks is the cleaner. Dusters and brushes are caught in the hands, breaking or loosening them. If a system is allowed to develop a time error, even intelligent people might attempt to "set" the hands to time. Often the ratchet wheel has a large lead counterweight, so the balance is upset if the hand is moved. If a new minute hand collet has to be made, it is better to fix the hand to it by three countersunk screws, in a suitable BA size, rather than by riveting.

Finally, a word of warning. Beware distractions from well-meaning individuals. One of the very best electric clock men I ever knew related how, on arriving for a routine service visit, the caretaker started talking to him. After about half the cells had been topped up, he noticed a peculiar smell. Checking the bottle of distilled water, carefully placed beside his buffet, he found it still stoppered. As luck would have it, at the other side of the buffet was an identical bottle containing turpentine...

## SECTION E SOME COMMON FAULTS AND THEIR RECTIFICATION

### 1 TRANSMITTER STOPPED

#### 1.1 System Stoppages - General

The first thing to do when hearing that a clock system has stopped is to give instructions that nothing must be touched. Much can be learned by studying the condition of the equipment. First inspect the transmitter and note whether the gravity lever roller is resting on the pallet or the lever is held up on the catch. If the lever is on the catch, it suggests that the stoppage is due either to some mechanical fault in the mechanism or to lack of lubrication. Look closely at the 'scape wheel and note where the driving pawl is resting. If it is in the tooth **before** the deep tooth (i.e. the tooth to the right of the deep tooth) the cause is most probably friction in the 'scape wheel pivots. If in the teeth **after** the deep tooth (i.e. to the left of it) this points to failure in the release. If the lever has not been reset on to its catch, the fault is most probably electrical.

Having made this examination, set the pendulum swinging and note whether or not the gravity lever is released and reset when the deep tooth comes around. If all appears well, or the lever is not released, check



for mechanical faults as described below. If the lever is released but not reset, look for electrical faults as described later.

### 1.2 Stoppages due to Mechanical faults

Failure to release the gravity lever may be due to stiffness in the gun lever pivot – clean and lubricate as necessary. It can be caused by the driving pawl sticking to the upright face of the deep tooth in the 'scape wheel. This can be due to dirt or stickiness in the wheel, or to the gun lever being too delicately balanced. Clean and burnish the wheel teeth and add weight on the tail of the gun lever if necessary. The **minimum** load on the steel driving pawl, which will not deflect the gun lever below the horizontal position, is 0.5g. A standard steel paperclip (typically 0.5–0.55g) makes a convenient gauge to use here, which can be hung on the pawl without any dismantling. If deflection occurs, add weight to the tail of the gun lever. Later transmitters are usually satisfactory but some earlier examples are found to require attention, which can conveniently take the form of an 8 BA screw and washers, to achieve the correct balance. If not spotted, this problem can gradually worsen. A transmitter which habitually failed to release was found to have a slight notch worn in the vertical face of the deep tooth, at a position corresponding to the normal tooth depth.

Faulty latching of the gravity lever can cause the clock to stop, through the roller rebounding against the pallet face. Refer to "multiple impulses" below. If the stirrup-catch spring is over-tensioned to cure the latter fault, it may stop the clock.

Check all adjustments as described in section B; clean and lubricate the transmitter, paying particular attention to the 'scape wheel pivots. Check the warning rate and, if low, see whether a weight appears to be missing from the gravity lever. Check that the case is securely fixed. A 1923 transmitter with a poor pendulum arc was found on examination to have small dent in the crutch pallet, where the roller falls on to it before giving impulse. Careful filing of the upper pallet surface; polishing and burnishing, gave an improvement.

### 1.3 Stoppages due to Electrical Faults

If the armature makes any attempt to move when the contacts close and the lever is lifted by the pendulum, check the batteries for condition and particularly check all battery terminals for tightness and corrosion. Service as described in Section D.

If the system is completely "dead", check the load fuses in the trickle charger, if one is in use, as these are in the clock circuit. If operated direct from the mains, check for mains or fuse failure of course. If fuses blow immediately, the cause will most likely be a short-circuit in the system. If all seems in order, look for a break in the circuit.

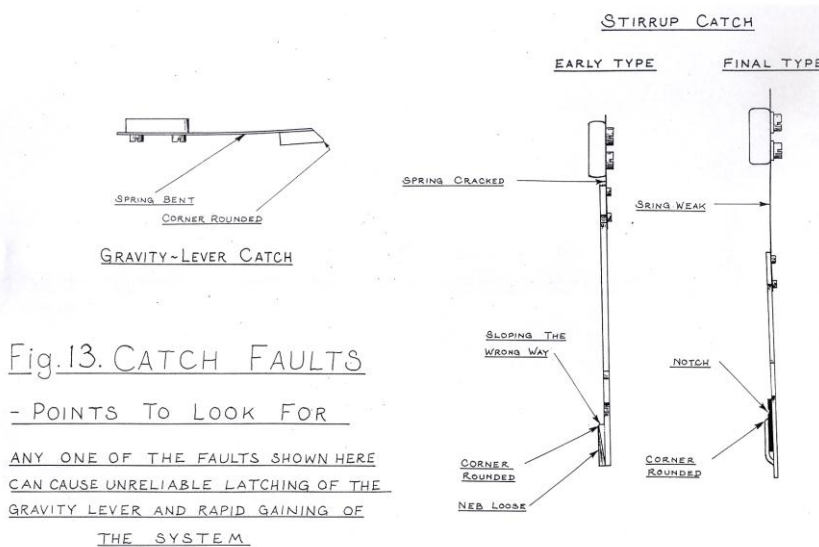
First check the connections in the transmitter, particularly the wire to the gravity lever. Look closely at the rheostat windings, if one is fitted. Tracing circuit faults can be a daunting task in a large building, but more often than not they are caused by accidental interference. This means that usually the fault will be at a point where the wiring is exposed. Enquire if any contractors have been working recently and check there first. Sometimes impulse clocks are moved e.g. when a room is divided, and the wiring extended, often with poorly-made connections. A clock may have been knocked off a wall, breaking the wires. One loose terminal anywhere can stop the system. In one instance, a stripped thread in a terminal block was the cause. This did not come to light until the connector and conductors had become tarnished after years of use. In another case a late 20th Century tradesman stopped a large system by deliberately cutting the wires in a terminal box. The tell-tale cracked paint around the lid and screw heads gave the game away.

## 2 ERRATIC TIMEKEEPING

### 2.1 Multiple Impulses or "Double Faults"

The standard Pul-syn-etic master clock should be capable of keeping time to within a few seconds a week. If a sudden gain of half a minute or more occurs in a day, this is usually caused by rebounding of the gravity lever. This fault can be difficult to rectify because it can be due either to the lever being reset but the catch not holding, or to the lever catch not reaching the step on the stirrup catch. If the fault is frequent, place a finger level with the buffer pad and watch the stirrup closely to try and determine which is happening.

latching faces of catches worn (Fig 13), excessive shake of lever in latched position (replace felt pad, Section C1) and notched Tufnol pad causing the catch to be pushed away on the rebound.



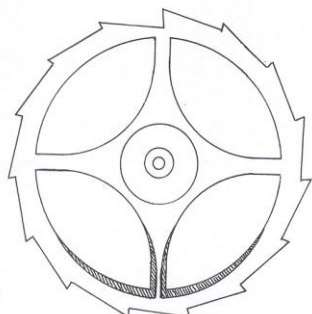
If the catch is not holding, check for correct spring tension (Section B2), lever catch sloping upwards (Section C4), If the lever is not being lifted high enough, check for worn/incorrectly adjusted contacts (Section B1-2), armature binding against top magnet pole (Section B1), bulged de-gaussing strip (Fig 2), electromagnet yoke incorrectly seated (wartime clocks), failing electrical connection to gravity lever or unsuitable power supply. A transmitter movement out of vertical has also caused this problem.

### 2.2 Other Causes of Erratic Timekeeping

Erratic losing may be due to occasional failure to release the gravity lever, check as under 1.2 above. It may also be caused by the case being out-of-vertical, pendulum trunnion nuts out-of-adjustment or by the pendulum being in back-to-front. Check also the gathering action and catch settings.

Erratic gaining may also be due to a worn driving pawl, allowing the tip of the gun lever to catch the stirrup when in a shallow tooth; renew as necessary. The same result can occur if the gun lever is bent upwards excessively at the tip, see Section B2 for correct adjustment. In early transmitters, without the guard on the crutch, erratic gaining can be caused by an excessive pendulum arc, coupled with stiffness in the 'scape wheel pivots, allowing two teeth to be gathered at times. If this is not corrected by freeing the wheel, so it is drawn back against the backstop as the pendulum swings to the left, a slight increase in the "drop" of the roller on to the pallet may be necessary.

Fig. 14. BALANCING THE 'SCAPE WHEEL



METAL REMOVED OBLIQUELY FROM THE  
SHADED AREAS ON REVERSE SIDE

This is achieved by raising the stirrup catch, then screwing in the contact and push-off screws to achieve the correct settings (Section B2). Don't touch the armature backstop, or you will alter the current transmitted. Erratic gathering on early transmitters may be due to the 'scape wheel out of balance. To correct, remove metal opposite the deep tooth obliquely, as shown in Fig 14.

Generally poor timekeeping can be due to poor fixing or inappropriate location of the master clock - see section A for guidance.

### 3 INDIVIDUAL CLOCKS STOPPED

#### 3.1 Sticking on Attraction

The most prevalent cause of impulse clocks sticking in the attracted position is over-oiling of the armature pivots. This results in oil finding its way on to the armature/magnet faces, so they eventually stick together. To clean, draw a piece of clean paper between the armature and magnet pole/back iron, while pressing in the armature.

On early movements (pre-1913), de-gaussing was dependent upon a piece of paper glued to the armature. If this is worn or missing, rust can develop on the contacting faces, eventually causing sticking. The cure is obvious. Later movements have the parts copper-plated to prevent this.

Although the materials used for the magnetic circuit should be impossible to magnetise, passage of an excessive current for a long period has been known to cause the problem. This happened when the batteries failed on a school system. A science master decided not to consult the instruction book (nor the text on the existing cells) but instead worked out the current needed from first principles, arriving at a figure of 3 amps. The Clocks Dept was called in when the transmitter contacts were no more! The impulse clocks were made to work by sticking thick paper to the armatures and re-adjusting. Had a de-magnetizer been available, no doubt this could have been used instead.

Sticking on attraction has also resulted from faulty solid-state relays. A leaky transistor, allowing a gradually-increasing current to flow in the "off" mode will not affect all clocks at once, due to inevitable slight differences in the failing rates. The most serious result of this fault, if not spotted soon, is destruction of the batteries.

#### 3.2 Incorrect Failing Rate

This can cause clocks to lose or stop altogether. It is sometimes the result of incompetent interference, either by adjusting the driving spring tension without checking the failing rate current, or by over-oiling and/or oiling the wheel teeth.

Impulse movements of the later standard type, having the tension-type driving spring, sometimes stop due to the spring apparently becoming work-hardened in use. When checked, the failing rate is usually around

190mA instead of 130. In such a case, the spring tension should be reduced to give a failing rate of 120mA (the old standard), allowing for some recurrence of the condition. (This incidentally demonstrates the difference between the theoretical current of 220mA and that actually transmitted).

### 3.3 Other Causes of Clocks Stopping

Missing movement cases, or imperfect sealing of cases in a dusty environment, is an obvious cause of clocks stopping. One reason that the Pul-syn-etic system would work where others failed was the attention paid to dustproofing of impulse clocks. It is a pity when this is sabotaged by lazy maintenance personnel.

Counterweights dropping off minute hands will stop the clock instantly (see Section C7). Insufficient end-float in the centre arbor, causing it to press on the glass, can stop the clock. In one case this had to wait for cold conditions over a Christmas holiday, when greater contraction of the brass movement pillars exerted sufficient pressure on the steel arbor.

In the earlier (pre-1933) impulse movements, the flat driving spring sometimes wears a notch in the armature lever, causing it to bind. File out the wear, polish and burnish the brass and the spring. Check that the latter is properly rounded and that it does not bear too close to the pivot. Another fault of these models is the driving pawl stiff on its pivot. This is not helped if the clickspring contacts the tail end-on (see Section B6).

In some movements the motion wheel teeth are very close to a pillar and have been known to rub on it, causing stoppage. Engineers dismiss such occurrences as "accumulation of tolerances", which sounds more helpful than it is.

In the early parapole movements, erratic working or stoppage can be due to the brass rivets, holding the armature to the lever, working loose. Re-fix using steel rivets.

### **ACKNOWLEDGEMENTS**

It is nearly fifteen years since the first issue of these notes was written. During this time the writer has had the pleasure of meeting many individuals in the course of working on electric clock systems. Together with those mentioned previously, all have contributed in some way or other to a greater understanding of the subject. Some, sadly are no longer among us. To those remaining, too numerous to mention individually, I extend a most grateful "thank you".

Instructions on settings are taken from Gent literature. The section on maintenance of commercial systems is based largely on Telephone Rentals practice.

Derek Bird  
2001  
(revised November 2012)

## APPENDIX I METRIC EQUIVALENTS

<u>inch/drill gauge</u>	<u>mm actual</u>	<u>mm rounded*</u>
0.010	0.25	0.25
0.012	0.30	0.3
0.015	0.38	0.4
0.025	0.64	0.6
1/32	0.79	0.8
1/16	1.59	1.5
5/64	1.98	2
3/32	2.38	2.5
No 38	2.60	2.5
1/8	3.18	3
No 18	4.30	4.5
3/16	4.76	5
1/4	6.35	6.5
7/16	11.11	11
1/2	12.7	12.5
7/8	22.22	22
1	25.4	25
1 1/2	38.1	38
1 3/4	44.45	44

\* The figures in this column have been rounded to practical values, taking into account the degree of precision required in the inch sizes, where quoted in the text.

## APPENDIX II AUTHOR'S SUGGESTED SUPPLIERS

Microtime F oil NB: to order.	Northern Watch & Clock Supplies 32 Culcavy Road Hillsborough Co Down BT26 6JD Phone 02892 688599 Email <a href="mailto:maymoorhead@yahoo.co.uk">maymoorhead@yahoo.co.uk</a> Web <a href="http://www.nwcsupplies.com">www.nwcsupplies.com</a>
Access Control System power supply units	"C&K" or "Elmdene" Available from Locksmiths who install access control systems
Motorcycle Batteries	"Global" or "Blue Label" from motorcycle dealers.
Gefo "Minitop" battery hydrometer	Hein Gericke UK Ltd 81-83 Westgate Bradford BD1 2RD Phone 01274 732437  Head office:- Hannover House Hornbeam Square East Harrogate HG2 8QT Phone 01423 873070



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