

## PRINCEPS ELECTRICAL CLOCK (SECONDS PENDULUM)

### INSTRUCTIONS.

#### MASTER CLOCK.

The Princeps System of electrical clocks consists of a unique form of switching, which is controlled by the pendulum and a specially designed reverser. The pendulum, being part of the electrical circuit, is used to close the circuit, and the reverser to break it, the period between the two operations being just sufficient to pass a current through a seconds impulse dial which registers the time.

#### REVERSER.

The reverser is mounted on a permanent magnet, the positions of the N and S Poles are shewn Fig.1. The two iron cores inside coils A & B being in contact with Pole S forms a return of the magnetic path towards pole N, both cores being of the same polarity a magnetic gap is created between A.B & N. In this gap the armature C is placed, and is naturally attracted by both Cores A & B, but being pivoted in the centre it can only rest on one at a time. Fixed to the Armature Staff and working with it are two contacts D & D<sup>1</sup>, which are arranged to displace at each throw of the armature, springs carrying contacts E, E<sup>1</sup>. Fig.1. shows the armature being attracted by the permanent magnet to Core B, and in so doing causes the contacts E.D. to be pressed together, and thus remain in a waiting position for the circuit to be closed by the pendulum K at the tube contact H. When this occurs the current passing through coil B causes the permanent magnetism in this core to be neutralized, which also has the effect of repelling the armature, and in doing so brings the opposite end of the armature within the influence of the permanent magnetism of the core in coil A, and also breaks the circuit between contacts E.D. at the same time pressing contacts D<sup>1</sup>, E<sup>1</sup>. together in the waiting position for the return swing of the pendulum K to the tube contact J. Hence it follows that as soon as the circuit is closed by the pendulum it is almost immediately opened by the reverser, and remains so until the pendulum completes its outward swing and returns to the other tube contact, when the reverser again rocks over to the other side; thus following the command of the pendulum at each swing. The adjustment of the reverser contacts E.D. and E<sup>1</sup>. D<sup>1</sup>. can be made with the arms M.M. to which contact springs E, E<sup>1</sup>. are attached. It must be arranged that each pair of contacts are just open when the armature is seating itself on coils A or B.

#### PENDULUM SUSTAINING.

The method employed to sustain the swing of the pendulum is novel, and found only in the Princeps System - Attached to the pendulum rod are contacts K, which as the pendulum swings, press against fine spring contacts in tubes H & J. These being very flexible are carried out by the pendulum and thus remain in contact until the pendulum returns, and are given up when the spring reaches its place of rest inside the tube. Each tube acting as a stop, and protection for its own contact spring. A very slight displacement by mechanical means of one of these springs from its place of rest before the pendulum picks it up, would necessarily mean, that

the pendulum would not have to push this spring out as far as the spring would push it back on its return, if it was then allowed to return to its original stop inside the tube.

To make this small displacement a tail L, is fixed to the armature of the reverser which moves freely just behind the pendulum rod, and is so arranged that as the pendulum K, touches the contact in tube J the reverser rocking over causes this tail to displace the spring in the tube H. The pendulum in returning picks up the contact in its new position, and the armature rocking back again carries its tail L, quite out of the path, and enables this spring to complete the journey to its place of rest inside the tube on the return swing of the pendulum. This allows energy to be imparted to the pendulum in frequent and minute quantities, and maintains its swing even and constant. The invar rod and scientifically compensated bob doing no mechanical work whatever results in the Princeps Clock creating its acknowledged reputation for perfect timekeeping.

#### GENERAL ADJUSTMENT.

The Clock should be firmly fixed to a substantial wall, with the point of the pendulum over the centre line of the scale when hanging at rest, with three dry cells connected in series to their respective leads. The Suspension Spring passes between two slots, of which the lower one is vice-like, tightened by two thumb screws, while the other one is a loose fit. In erecting the clock the vice should be opened and the pendulum allowed to hang freely from its upper support and take up its own vertical position. Care being taken to see that the pendulum contact K picks up the spring in tubes H and J, safely on their platinum portions, and that the pendulum rod, when swinging, does not interfere with the free path of the reverser tail, L, immediately behind it or touch the back of the impulse dial, situated in front. The vice is then tightened on the spring, and if the clock is properly plumbed, will then give a perfectly horizontal grip of the vertical spring and buckling will not be possible.

Care should be taken to adjust the two vice thumb screws equally, since if one edge of the spring is held tighter than the other a slight wobble may be caused; in fact a slight adjustment in the different tightness of these screws is a useful way of correcting the least remnants of wobble.

If it is necessary to adjust the Sustaining Spring, the right hand contact H, should be brought up to just touch the pendulum contact K, but in no way to move the spring from its place of rest on the inside of the tube. Please note that the tail of the reverser L, is to the left, and not displacing the spring, when this adjustment is made and that the pendulum is hanging at rest. On moving the reverser tail L, to the right, it should then move the tube's spring about  $1/16$ th of an inch from its position of rest. Then start the pendulum swinging and adjust the left hand contact J, to a position that gives an even tick to the ear.

This should allow the pendulum to swing from  $1^{\circ}$  to  $1\frac{1}{2}^{\circ}$  each side of the centre of the scale. As the pendulum swing depends on the displacement of the right hand tube contact, H, it follows

that the more the spring is displaced by the reverser tail L, the greater will be the swing of the pendulum, hence, to reduce the swing move the right hand contact away, and to increase the swing move it nearer the Reverser Tail L. One hour should be allowed for the pendulum to settle down to its steady amplitude. These movements should be made by the horizontal arms on which the tubes are fixed, and it must be noted that a very little movement is necessary in making these adjustments. The pendulum should not swing beyond the limit of the scale.

The Centre Seconds Master Movement should be set to time by turning the small nib at the back. The movement being hinged on the left hand bracket for this purpose. The Minute hand should be set to point to the fraction of a minute that corresponds with the position of the seconds hand on the dial. The Clock may be set a little in advance of the correct time; this allows the pendulum to be started, or the current switched on when the exact second arrives - The seconds hand must not be touched -

#### REGULATION.

After installing, the clock must be regulated. Coarse regulation is done by means of the rating nut below the bob. Below this again is a lock nut which must be slackened off before attempting to turn the rating nut. When doing this the rod (and not the bob) must be held carefully from turning, to avoid damaging the suspension spring. One complete turn of the rating nut makes a difference of about half a minute a day of 24 hours; each dividing line makes about 2 seconds. Screwing it up, that is, raising the bob, makes the clock gain, unscrewing it makes it lose. Fine regulation is best done by altering weights on the tray in the middle of the pendulum rod; each 250 milligrams making a difference of a second a day. Each clock is provided with weights consisting of 1 gram and fractions. The 1 gram weight should be put on the tray, before beginning coarse regulation, by which the clock should be regulated to within four seconds a day. Then the addition of each 250 milligrams will speed it up a second in 24 hours and vice versa.

#### HALF MINUTE IMPULSES.

The Princeps half minute impulse system is operated on exactly the same principle of switching as that employed in the Master Clock, a second reverser being introduced for this purpose, the only difference being, that the Master impulse movement takes the place of the pendulum. The driving wheel which carries the seconds hand and makes one revolution per minute, carries on its arbor a cam. Two pairs of contacts O fig.1. being arranged so that at each half revolution of the wheel, one pair of these contacts are automatically closed by this cam. In this instance, doing each half minute exactly the same as the Master pendulum does each second. The half minute reverser P being connected to these contacts and to the cells fig.1. provides for the circuit to be almost immediately opened again. The period of contact being just sufficient to operate a relay R having contacts U robust enough to carry a heavy load of current. Across these contacts the half minute Slave dials are connected in parallel, a suitable current supply being introduced into the circuit to operate them. A perfect system of half minute synchronism is thus obtainable, to which additional dials may at any time be added, without interfering with the existing system or current supply.

Line relays can also be added to operate separate circuits for very long distances, or to work large turret dials where variation in the consumption of power may be necessary.

All contacts in the Princeps System are wherever necessary, provided with suitable condensers and resistances to reduce sparking to a minimum.

#### CONNECTING MASTER DIALS.

There are four leads from the Master Centre Seconds movement which may be identified by coloured sleeving near the lugs, and must be connected to the pendulum unit as follows:- The lead marked red being earthed to the movement, its free end should be connected to terminal T. fig.1. The plain lead with no sleeving whatever comes from the dial magnet and should be connected to terminal V. The two white leads coming from the half minute contacts must be connected to terminals W & Y. Should it be necessary to operate a seconds line relay this must be inserted between the plain lead with no sleeving and the terminal V.

#### CONNECTING HALF MINUTE ATTACHMENT.

The terminals on the half minute attachment are in groups of two and three respectively; those in the group of three should be connected direct to the three terminals, W.X.Y on the pendulum unit. The remaining pair of terminals 1 and 2 being connected to the relay contacts - one should proceed to one terminal of each slave dial, the other should be connected to one pole of the cells, the opposite pole of which should go to the other terminal of each dial. It is recommended that the wiring of all slaves should be made with 18 or 20 gauge wire, joints to be well soldered and insulated, and all terminals screwed down tightly.

#### CHARGING THE ATTACHMENTS.

The Princeps system can be worked entirely from the main electrical supply, but it must be direct current and not alternating. The method recommended is to pass the main supply to a suitable high resistance according to the type of the system, to an accumulator, through which a trickle charge is kept constantly passing. This method has been found very satisfactory for large systems and will work for very long periods without attention. The Princeps charging attachment should be of special interest to all users of electrical clocks.

Enquiries should be addressed to -

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