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CONSTRUCTION OF CLOCKS DRIVEN WITH WEIGHT AND WITH AUTOMATICALLY WOUND SPRINGS FOR USE WITH SEISMOLOGICAL AND OTHER INSTRUMENTS.

The Instruments Section at the Meteorological Office at Poona started designing and constructing Wood-Anderson type of seismographs in 1945. As an accurate clock was necessary for use with every seismograph, for making marks electromagnetically on the record at every minute and hour, the design and construction of these clocks was also attempted in the workshops of the Section. However, the design and construction of these accurate clocks had to be attempted only with the machinery available in the workshop and this consisted initially of only a few lathes and a Centec bench miller. Later a Universal milling machine was added to the workshop. We had a few sets of involute gear cutters also suitable for cutting the clock wheels.

With the facilities available it was decided to construct an eightday, weight driven clock. Fig. 1 shows the front and side elevation of the clock mechanism.

The whole mechanism is carried on a brass bracket secured to the back of the clock case. The block from which the pendulum hangs is incorporated in the bracket before casting.

The escapement is of the dead-beat type. The pendulum is of invar and carries a steel bob at the bottom which can be raised or lowered with a brass nut. It is sometimes the practice in designing and constructing good regulators, to dispense with the usual motion work as a means of reducing friction in the mechanism, and the hour hand is made to operate on a separate dial circle on the clock face similar to the second circle. In the construction of the clocks now attempted, this was not done ; the seconds hand is carried on the long pivot of the escape wheel arbor. The centre arbor also projects through the front plate and propels the motion work.

To avoid the tendency to reverse the motion of the train during winding and drive the seconds hand backwards, the well-known device known as "maintaining power" was incorporated in the clock.

The clock face was made by engraving on a sheet of "Dilecto" of 1/8″ thickness.

A few of the simple methods adopted to overcome some of the difficulties experienced in the construction of the clock may be mentioned here. The escapement pallets, etc. were made from old and unserviceable files after suitably heat treating them. As we had no specially formed milling cutters for making the escapement wheels, slitting saws of proper thickness was mounted on the milling machine arbor, and the blanks mounted on the universal head were shifted out of centre by just the amount to coincide with the vertical side of the front of the teeth. Similarly the backs of these teeth were finished off by a straight cut.

To obtain the electric contacts every minute and hour to operate the relays on the seismograph for the time marks, the usual simple arrangements were adopted.

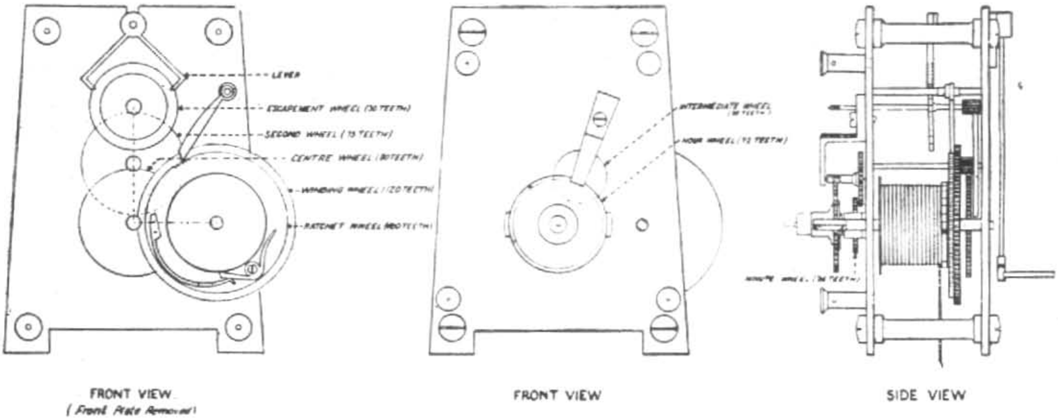

Fig. 1

Two light strips, one slightly longer than the other and carrying platinum contacts at their ends rest on an ebonite cam fixed on the arbor carrying the seconds hand. As the cam rotates, the shorter spring falls first and makes contact with the platinum wire soldered on the longer strip, till this strip also falls when the contact is broken. The duration of contact can be adjusted by altering the length of one of the strips.

For the hour mark, the minute hand carries an insulated pin and it also operates a second set of similar contacts made out of strips.

Fig. 2 shows the clock (p. 160). It has been in regular use for some time and found to work with the accuracy required with the seismographs. These clocks, can be used without the electrical contacts, when accurate time only is required.

These clocks are weight driven and have to be wound every week. Attempts were made to design a clock which is wound electrically from the main supply of the town. Usually in India, the supply voltage is 220, and it can be either AC or DC.

The employment of an electric winding gear to an ordinary mechanical clock consists of an electric motor which is started at regular intervals by means of contact switches in the clock mechanism itself. In the case of the weight clock, the length of fall available for the weight would determine the suitable period between the successive re-windings.

When an electric motor is available for re-winding the clock, it can be employed for the purpose at intervals of say two to three hours. It will then be simpler and more economical to apply the re-winding to a spring much nearer to the escapement and at frequent intervals, rather than to wind the main arbour once a week for which a motor of greater power may be necessary. By using a flat spring which can be wound at frequent intervals, one can give up the barrel, the great wheel, the ratchet etc. and thereby simplify the construction of the clock.

In the present case, a long flat spring (about 0.23 inch wide and 0.011 inch thick of about 11 feet in length) was employed and it was wound once in about 4 hours with an electric motor. The details of the method are described below.

The spring was fixed on the axle of the centre wheel (80 teeth) which rotated once in an hour. An extra gear wheel of exactly the same size as the one fixed on it was made and fitted loose on the axle. The spring was located between the two gear wheels, one end of the spring being fixed on to the centre axle and the other end to a pin fixed on the loose gear wheel on the centre axle. This loose wheel also of 80 teeth, is engaged with a pinion of 20 teeth on another axle. This latter axle carried a gear wheel which engaged with the worm on the shaft of the electric winding motor. A Garard, 220 volts, AC-DC gramophone motor was employed for winding the spring. The armature of this motor carries a worm

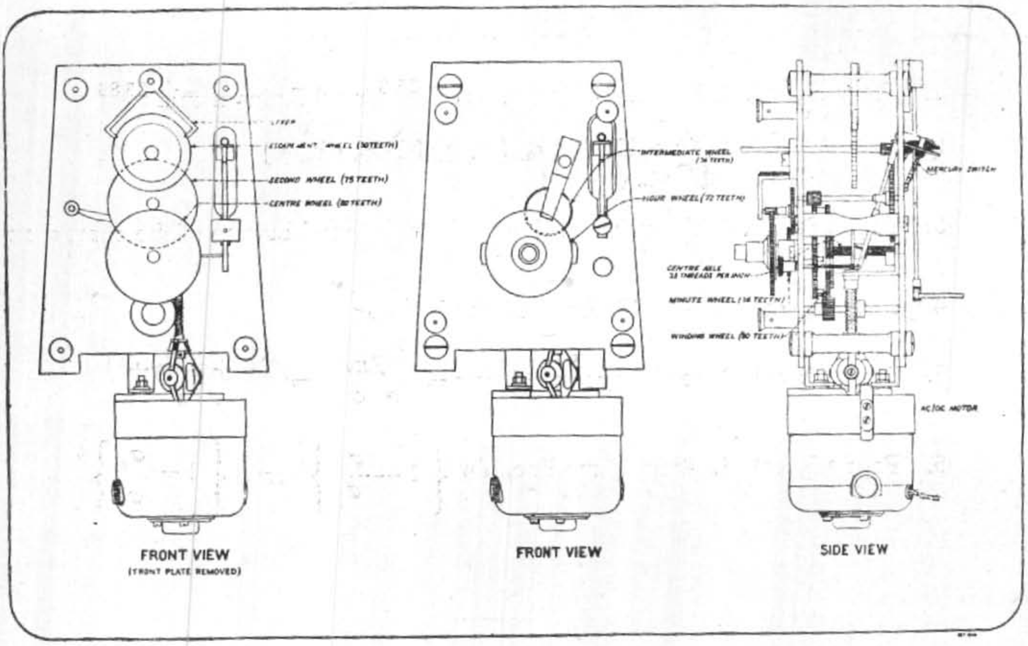

Fig. 3

engaging with a gear wheel. The armature shaft has also a governor which may be retained. This motor is noiseless in its operation. The method of mounting the motor and its gear wheel is shown in Fig.3.

The mechanism to wind the spring automatically with the motor at regular intervals is as follows—

The portion of the axle of the hour wheel beyond the two wheels between which the spring is held is threaded (26 threads to the inch) and a brass disc moves on these threads. A steel pin, about 1 inch long is fixed on the loose gear wheel and it passes through a hole in the brass disc. Thus when the hour wheel axle rotates and the spring unwinds itself, the brass disc cannot rotate due to the pin and it moves only laterally in one direction. When the motor is switched on, the loose gear wheel which winds the spring is rotated with the brass disc through the pin. This makes the disc move in the opposite direction. Thus the brass disc moves in one direction on the hour axle during the winding of the spring and in the opposite direction when the spring unwinds itself. This motion of the disc tilts a mercury switch "on" or "off". The mercury switch is fixed at one end of a rod pivoted in the middle. The other end carries an arm at right-angles to the rod and is kept pressed on the disc with a light spring. The mercury switch is thus operated due to the movement of the disc to and fro. The governor controlled motor rotates the pinion of 20 teeth engaging with the loose wheel with 80 teeth on hour axle at approximately 80 r.p.m. Thus the winding of the spring by 4 turns is completed by the motor in approximately 12 seconds in every 4 hours. A ratchet wheel with a pawl resting loosely on it is fixed on the loose wheel to prevent the wound spring tending to rotate in the opposite direction the winding train from the motor.

It is easily understood that when a spring is fully wound, it will tend to exert greater force than when nearly unwound, so that there is a variation in the pull throughout the whole operation of unwinding. With a view to equalise this natural variation with its consequent erratic effect upon the escapement and time keeping, the mercury switch is so adjusted that only the middle turns, which exert a more uniform pull, are brought into operation. In order to increase the uniformity of the middle turns, as far as possible, weaker and longer springs are employed.

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May 2, 1950.