*The " Eureka " Electric Clock

by " Artificer "

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 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.

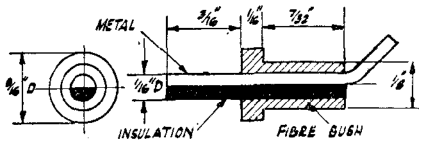

Fig. 5, Details of contact-pin assembly

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 sun. 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 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 1-1/2 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.

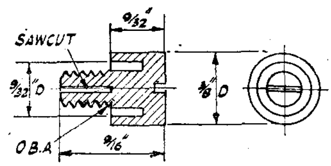

Fig. 6. Poise screws (12 off)

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.

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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 curent flow of about 75 milliamps at this voltage input.

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.

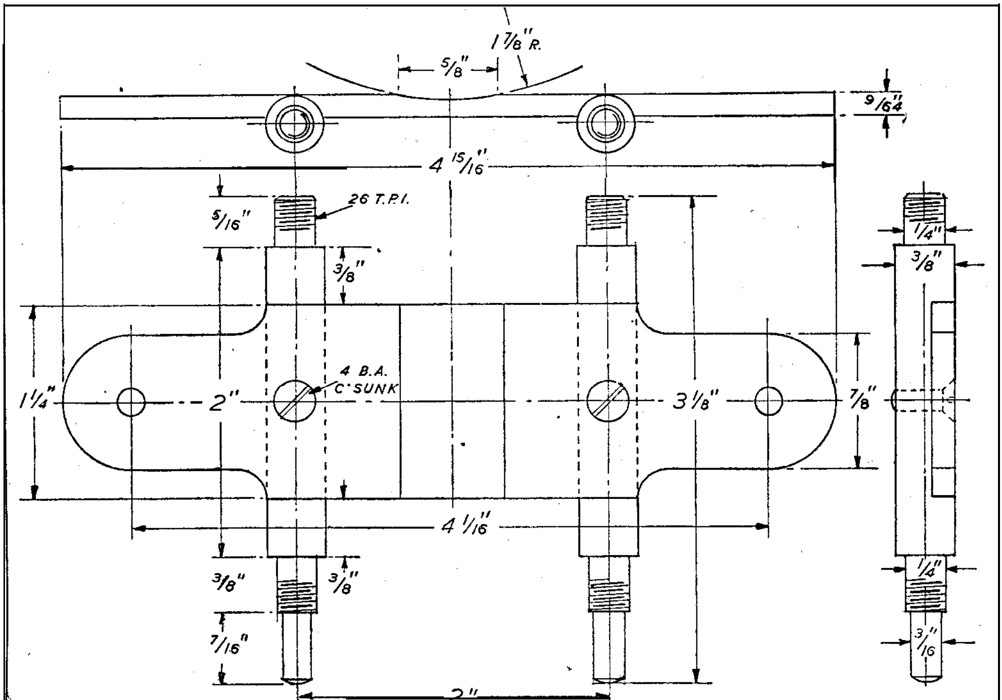

Fig. 7. Armature plate'

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 12-1/4 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.

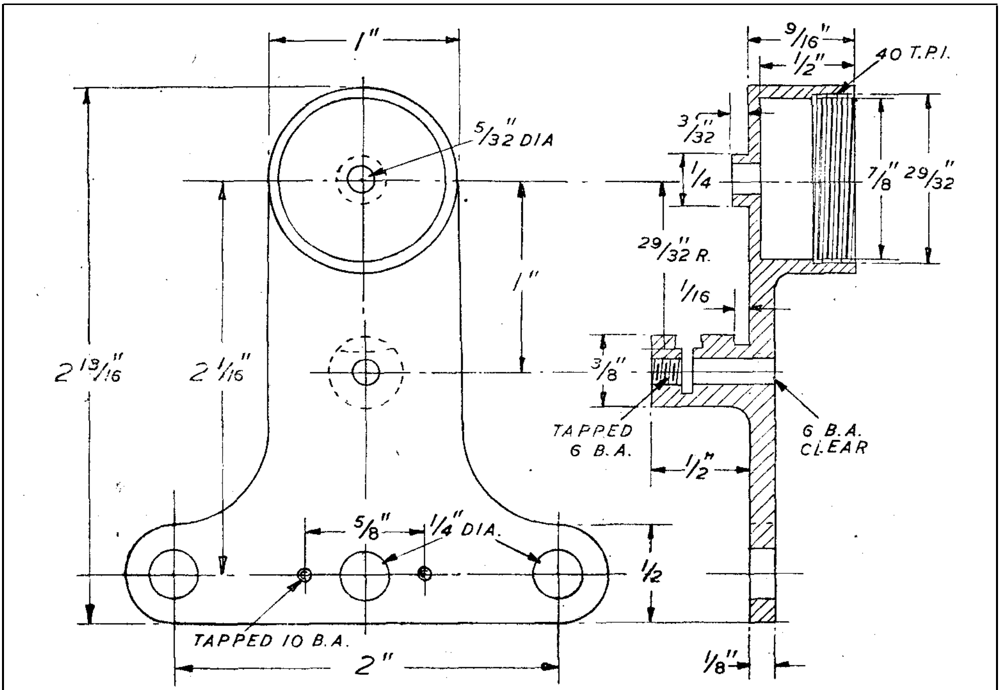

Fig. 8. Rear motion plate

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 1-1/4 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.

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.

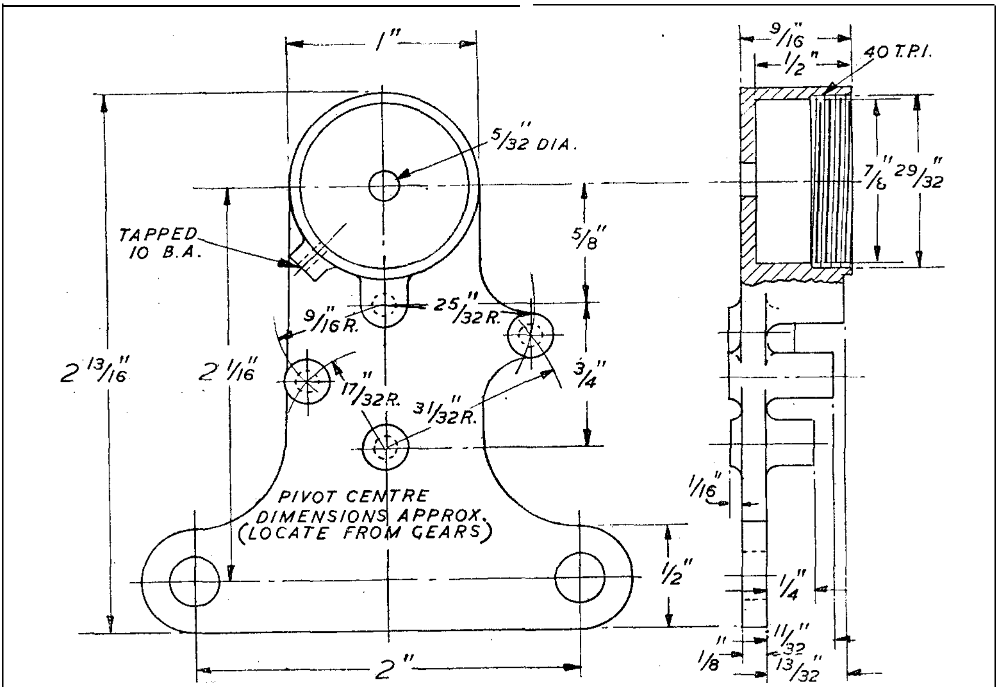

Fig. 9. Front motion plate

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 clearance size, the pillar will act as a clamp to secure the spring when the screw is tightened.

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 plate, 'already referred to, ...

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.

(To be continued)