*The " Eureka" Electric Clock

by " Artificer "

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

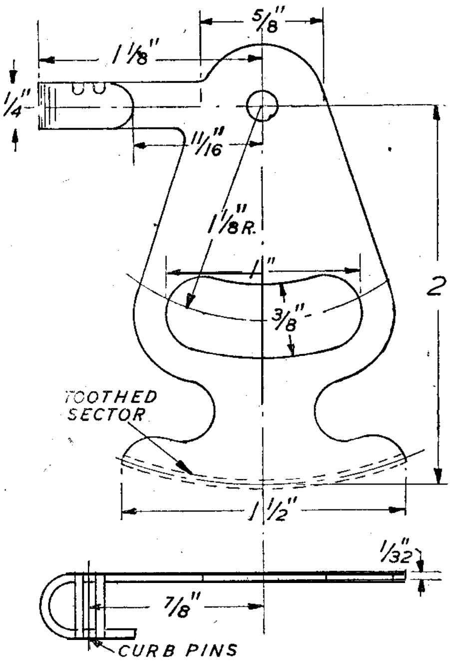

Fig. 14. Regulator quadrant

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

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

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

Regulator Gear

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

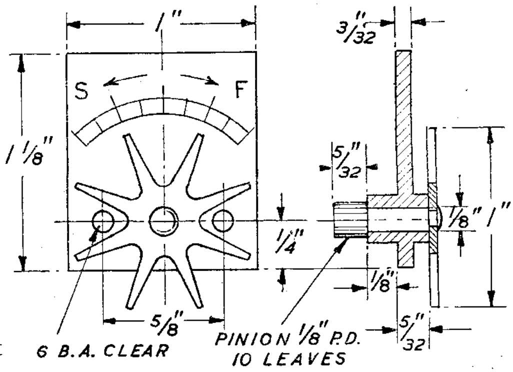

Fig. 15. Regulator pinion, star wheel and rating plate

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

The details of the " Eureka " clock regulator are given in Figs. 14 and 15, but it is considered

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

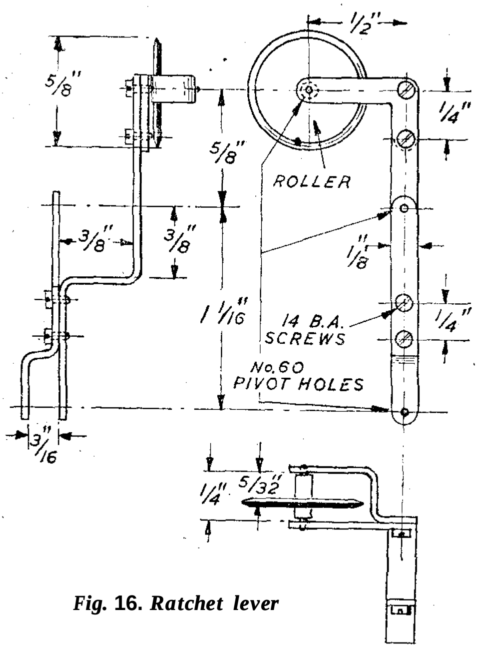

Fig. **16.** ***Ratchet lever***

toothed segment, engaging a pinion carried in a plate attached to the rear motion-plate of the clock, and fitted with a star wheel on the outside, by means of which it is operated. The quadrant plate has a 1/4 in. pivot hole which fits over the spigot of the rear balance pivot housing, and is retained in place by fitting a washer over it and lightly burring over or expanding the end of the spigot, so that it moves with some friction. A curved slot is cut in the lower end of the quadrant, which is located by springing it into a slot at the root of the boss which clamps the end of the hairspring, and this boss also limits the motion of the quadrant, preventing the sector from moving far enough to get out of mesh with the pinion.

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

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

Ratchet Lever

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

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

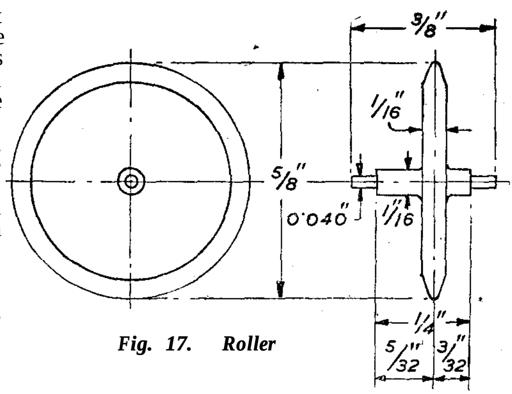

Fig. 17. Roller

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

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

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

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

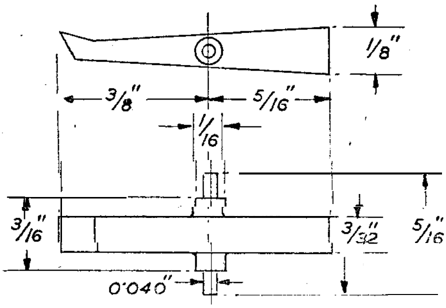

Fig.* 18. *Feed pawl

Wheel Train

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

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

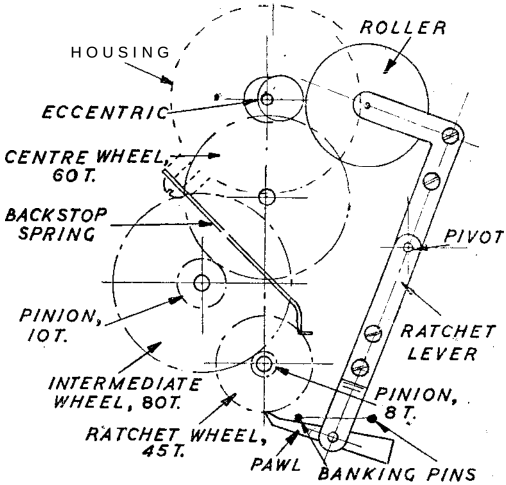

Fig. 19. Arrangement of ratchet* gear and *main wheel train

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

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

Supporting Pillars

These are shown in detail in Fig. 21, and it will be seen that they are of composite form, and one of them is devised to form a conduit for the battery supply lead, so that the latter can be kept invisible, or at least unobtrusive. This is

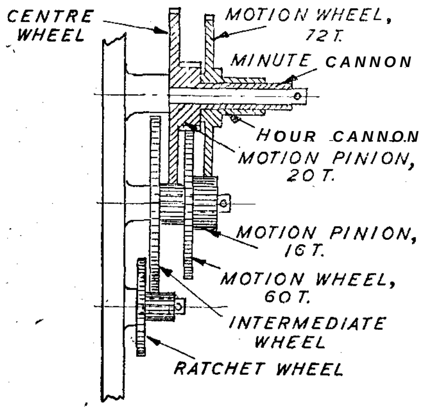

Fig. 20. Diagrammatic side view of wheel train

another optional feature, but many constructors would consider it simpler to machine the pillars from solid brass-with or without a drilled passage for the lead. Alternatively, one of the pillars, or its centre bolt, could be insulated and used as a lead-in conductor. The other terminal of the battery is of course " earthed " to the frame of the clock, and polarity of the connections is of little importance.

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

Readers' Comments

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

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

Another reader asks " what 'is the significance of the title ' Eureka' applied to this clock?" That is a matter beyond the cognisance of the writer, and might be answered by another question-what's in a name ? But from hazy recollection of ancient history, the name recalls the legend of old man Archimedes tearing through the streets of Athens in nudist uniform, leaving a trail of soapsuds, and yelling " I have found it ! " -on the memorable occasion when he hit upon the method of finding the specific gravity of metals. By inference, one may suppose that the emotions, though probably not the actions, of the

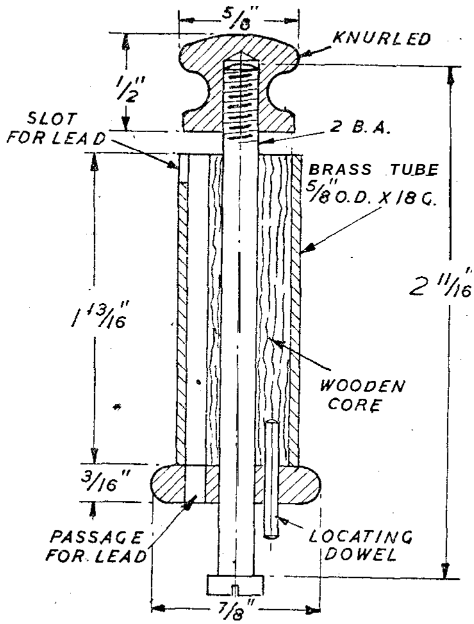

Fig. 21 Supporting pillars, 2 *off (one only drilled and located to form lead conduit)*

inventor of this clock were similar-in other words, he must have believed that he had really " got something." But carrying deduction still further, it is possible that after the disillusionment caused by the abortive efforts to exploit the commercial production of the clock, he may have had another search through the Greek dictionary to find the appropriate term for that much sadder phrase " I have had it ! "