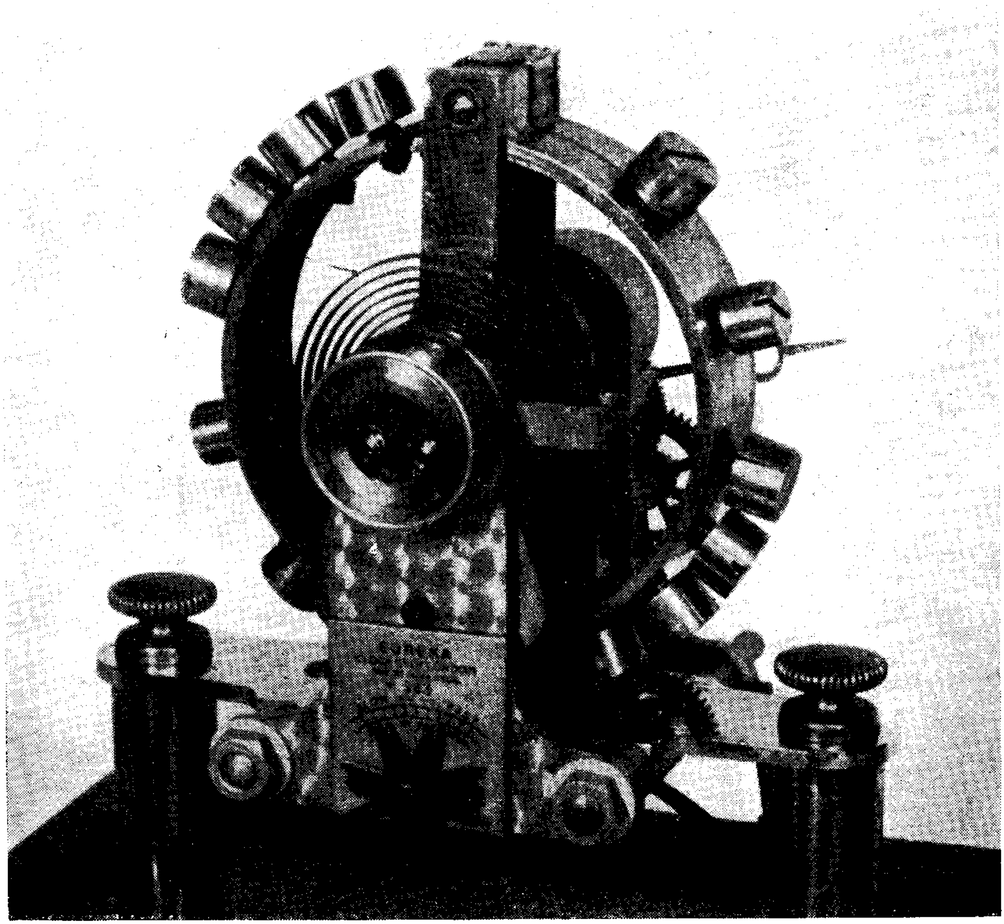
The " Eureka " Electric Clock

by " Artificer "

THE construction of electrically-driven clocks has always;been popular among model engineers, and at nearly every Model Engineer Exhibition, at least one or two specimens of these clocks are represented. But while the workmanship (and presumably, the performance) of these clocks is often extremelv good, and some of them exhibit originality and ingenuity in the details of design, there is comparatively little enterprise among constructors in exploring the broad principles of design, and in utilising the many possible forms of escapements and operating mechanisms which have been devised in the past. It is safe to say that about 95 per cent. of the electric clocks which have been built by amateurs have been either of the Hipp or the Synchronome types, with minor modifications in each case ; and while both these embody unquestionably sound working principles, and if properly made, work most reliably and keep accurate time, there is a strong case for going farther afield and introducing a little more variety in this branch of construction.

The obvious answer which many amateur constructors will make to this criticism is that the two types of clocks mentioned above are the only ones on which any detailed information on construction is available. This is-quite true ; of



The " Eureka " clock movement viewed from the rear, showing regulator star wheel two books on building electric clocks which the writer obtained some years ago, one described a number of different sizes and styles of clocks all using the Hipp escapement, while the other dealt with several Hipp clocks plus one Synchronome master and secondary clock. A third book described in detail the construction of a single

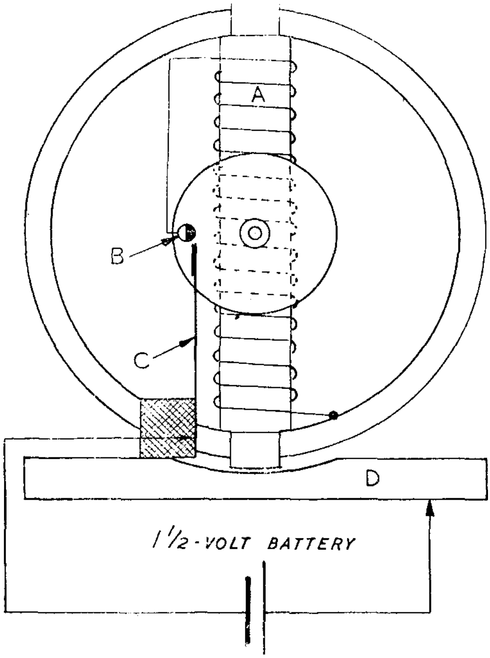


Fig.* I. *Position of balance wheel when at rest

Hipp clock, while several articles published in THE MODEL ENGINEER and other journals played minor variations on the same old theme. It is in the hope of broadening general knowledge of the working principles of electric clocks, therefore, that the following particulars are given of a type of clock which is notably "different," and despite the fact that it is not claimed to be superior in any way to the popular types of electric clocks, is none the less interesting to the enterprising constructor.

It may further be noted that practically all the electric clocks built by amateurs-with the exception of a.c. mains synchronous clocks, which, one might argue, are ndt really clocks at all -have so far been pendulum clocks; and while there is nothing one can object to about such clocks from the timekeeping point of view, there is no doubt that they have their own particular limitations. The normal form of pendulum is impracticable in any type of portable clock, and if one had to rely exclusively on it, timekeeping at sea would be impossible unless the clock could be held steady by an elaborate gyroscopic stabilising device. While no form of balance wheel is quite equal in ***isochronous*** property to the best form of pendulum, it can be designed so as to show no perceptible inferiority in practice, and it can be compensated for climatic and other variations just as readily as a pendulum.

The balance wheel has been successfully applied to a number of electrically-driven clocks, including some small portable clocks such as those for use in cars or other vehicles. It may, however, be noted that most of the latter may be regarded as more or less normal mechanical spring-driven clocks, equipped with an electric impulse device to wind the spring at regular (and usually frequent) intervals; in other words, they come into a class termed "Remontoire" (self-winding) electric clocks, which present little real interest from the constructor's point of view.

There is, however, at least ***one*** notable example of a balance-wheel electric clock in which the driving impulse is applied directly to the balance wheel so that, like the pendulum of the Hipp and Synchronome clocks, it constitutes the actual driving " motor," and transmits power to the wheel train, which serves the function of an impulse counter and indicating mechanism, rather than a heavily-stressed transmission gear. Herein lies the great advantage of the true electrically-driven clock from the aspect of the amateur constructor ; the pendulum or balance wheel, together with its escapement, instead of being a delicate and finely-poised piece of

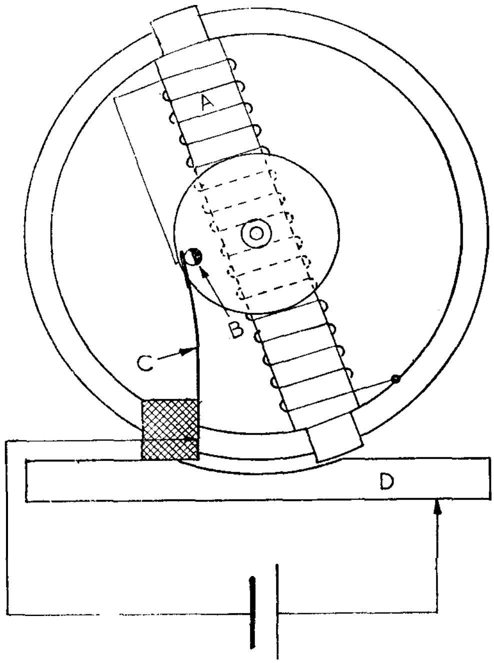
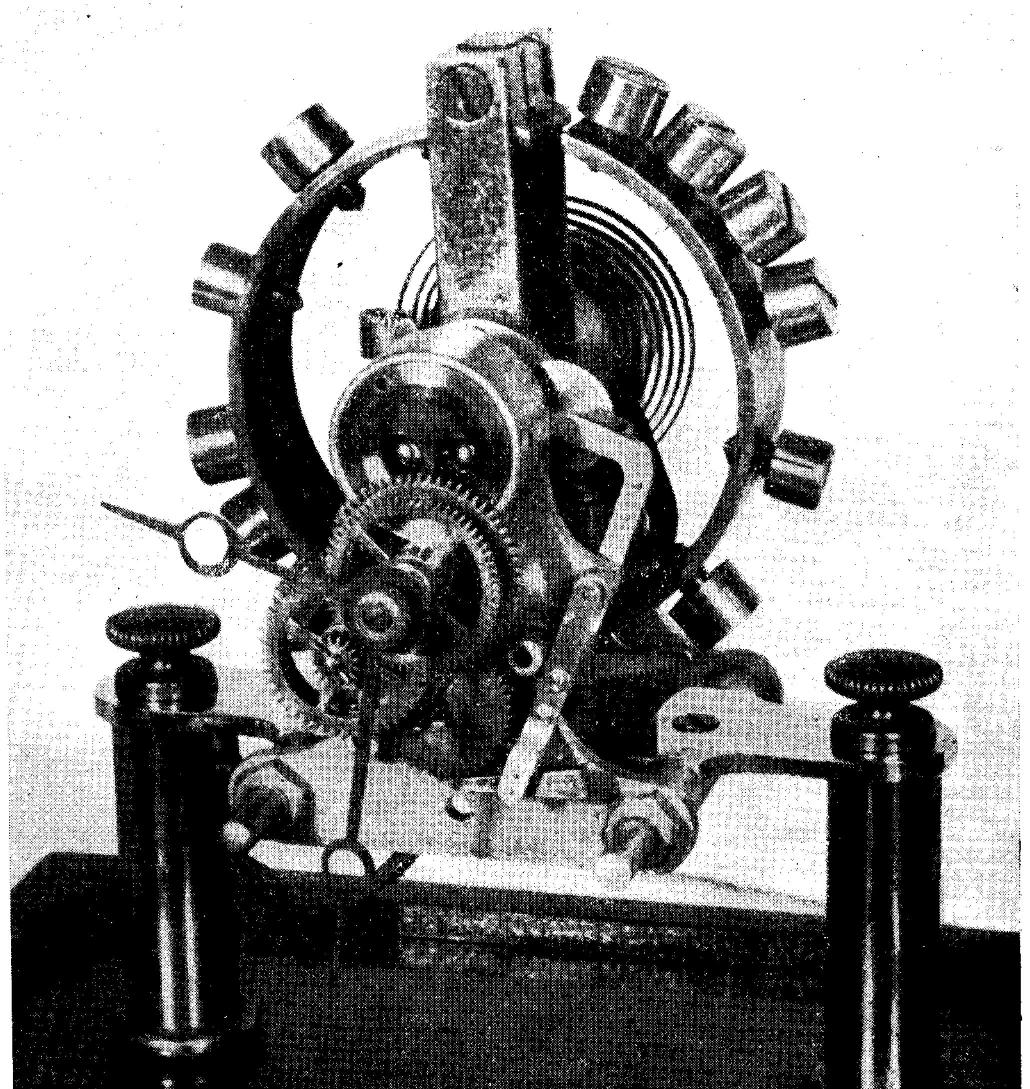


Fig. 2. ***Position of balance wheel at the point of making contact***

mechanism, the adjustment of which demands specialised skill, is heavy and robust, requiring comparatively little finesse in either construction or adjustment. This does not ***mean to say*** that there is not just as much scope for skill and care in the construction of such clocks as in those of the weight- or spring-driven type ; but it is a fact that some excellent results have been obtained with electric clocks of quite unsophisticated or even crude design and construction.

The "Eureka " electric clock, which forms the subject of these articles, was invented in 1906, and was put into production by the enterprise of the brothers Kutnow, of " Kutnow's Powder " fame. Its novel and somewhat spectacular design attracted a good deal of attention at the time, but it proved to be a nine day's wonder, and production was abandoned after about five years. There were possibly several reasons for this, not the least being that inevitable teething troubles were encountered in the early stages of production, and it is more than likely that when such faults as developed were referred to clock repairers, the unfamiliar nature of the mechanism prejudiced their chances of receiving conscientious attention. The examples of these clocks which have been encountered, or on which information is available, bear evidence of un-



Front view of " Eureka" clock movement, with dial removed to show gear train and ratchet lever

finished design or tentative experiment, and there are certainly one or two points where the design or workmanship could be much improved. But the clock can at any rate be made to work well and reliably with a very low current consumption, and its inherent timekeeping qualities, though by no means perfect, are probably as good as those of most domestic and portable clocks of the normal type.

Some time ago, the writer was consulted about the repair and *restoration* of a " Eureka " clock 'which had been out of use for many years, and -thanks to the ministrations of someone who had tinkered with it at some time in the past -had several essential parts of the mechanism missing.

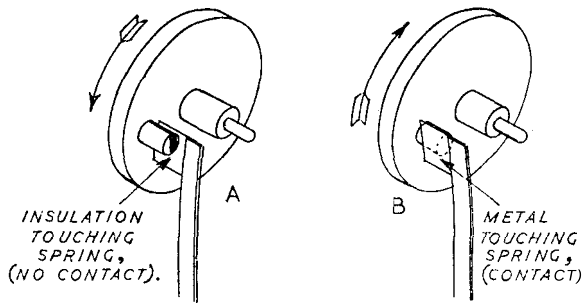


Fig. 3. Action of contact spring on both directions of balance wheel movement

There was, in fact, *no* visible link-up between the balance-wheel " motor " and the gear train, and though it was not difficult to reconstruct the general design of the missing parts, it was decided that it would be worth while to consult any available information on the original construction of the clock. In the course of this research, which entailed the consulting of all the books on electric clocks which could be unearthed (and incidentally some of them contained totally misleading information, worse than none at all !) and enquiries at South Kensington Museum (much more fruitful) a certain amount of data on this and other unusual types of electric clocks has been acquired. Some further advice has been given on this matter by Mr. F. Hope- Jones, who, as most readers are aware, is a world authority on electric clocks ; and as a result, the restoration of the clock in question has been very successfully carried out. In the hope that the matter will be of interest to many readers? an exact record of the design and working details of the clock in its restored form has been prepared, with some suggestions for possible improvement of the design and methods of construction.

Working Principle of the ," Eureka " Clock

The motive power of the clock is obtained from a large diameter oscillating balance wheel, the general form of which is similar to that of a watch balance on an enlarged scale, including the hair spring. This' wheel is kept in motion by an electro-magnetic device which operates on the same principle as that in any simple attraction motor. It may here be mentioned that in a clock having the motive power supplied by the pendulum or balance, a fairly substantial mass in the latter is most essential. In this case, the balance wheel is 12 oz. in weight, and the diameter over the rim is 2-7/8 in., the outermost diameter over the complete balance system being 3-3/4 in. The rim is of the bimetal compensated type, and fitted with poise screws ; the suspension of the balance is by extended pivots which roll on steel balls enclosed in an oil bath.

An iron bar, A, passes diametrically across the balance wheel, forming the " spokes " on which the rim is supported ; this is wound with a coil of wire so that it forms an electro-magnet when energised with current from a battery. The supply of current is controlled by a contact device which closes the circuit at the appropriate time. Below the balance wheel is a stationary iron plate, *D,* machined away in the centre so as to provide a fine clearance for the tips of the bar as the wheel oscillates.

When the clock is at rest, the bar assumes a perpendicular position relative to the iron plate, as shown *in Fig. 1.* The contact pin, *B,* in the cheek of the balance wheel is just clear of the contact spring, C, so that no current is passing, and the electro-magnet is inert. It will be noted that the contact pin, *D,* is composed of two half-round sections, the one on the left being of metal and the other of insulating material. The spring, C, has an attached tip of contact metal (usually gold-silver alloy), extending sideways, so that the end is shaped like an inverted L. It is adjusted in such a way that the contact pin passes on the right-hand side of it on the upwards swing (see Fig. 3A) and on the left-hand side of it on the downward swing as shown in Fig. 3B ; the spring being in each case displaced slightly in the opposite direction. The metal part of the contact pin forms the terminal point at one end of the magnet winding, the other being earthed to the frame of the wheel, and making connection with the main motion frame through the hair spring. Current is supplied from the battery by connecting one terminal to the base of the contact spring and earthing the other to the frame.

If the balance wheel is now set oscillating by hand, the first swing in the anti-clockwise direction will carry the contact pin past the spring with its insulated portion in contact, so that no current passes. But on the return (clockwise) swing, when the position shown in Fig. 2 is reached, the contact pin will again touch the spring, this time on the metallic side, so that a connection is established through the windings of the electro-magnet, which becomes strongly energised, just as its tip is approaching the concave portion of the iron plate. The result is to cause a powerful attraction of the electro-magnet to the centre of the plate, but by the time it reaches this point, contact will be broken between the pin and the spring, so that the balance wheel will continue to move under its own inertia until this is counteracted by the hair spring. This starts it on the return swing, and the cycle of

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Outside Help

There is no doubt that the key to good model making is knowing the right tools and knowing how to use them. Of course, methods will vary according to the facilities at hand, but the model engineer should not close his eyes to outside help. He may spend hours shaping parts which could be done much better and quicker if the right equipment was available, and this can often be had by joining or forming. an association and making use of a common workshop. The workshop would contain such items as a welding plant, and equipment for brazing and machining. Falling this kind of self-help? in most towns there are several small engineering concerns who would carry out welding and machining operations which are *outside* the scope of the individual.

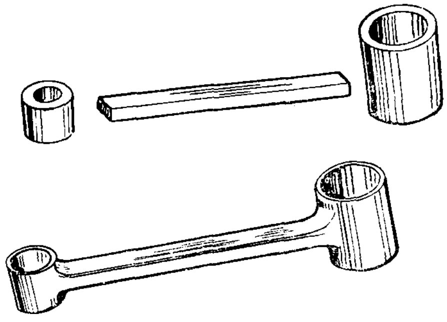

Fig. 10. A fabricated connecting-rod, made by welding steel tube to rod

The use of welding for the modelmaker should not be overlooked. Welding has made great strides in general engineering where parts which took many weeks to make, can now be made in a matter of hours. This is due to " fabrication." Take for instance a model connecting-rod ; instead of making this out of one piece, two short pieces of steel tube are welded to each end of a piece of steel rod, the ends then trued up and reamed. (see Fig. 10). This is a much quicker way and can be lust as good in every aspect. There are many parts which at one time had to be cast or forged and are now made by welding several pieces together. This method is invaluable in model making, for it often happens that it is a one off job, in which *case* pattern making and casting is a slow and expensive job.

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events is then repeated indefinitely, so long as current is available to energise the magnet.

It will be quite clear that an essential feature in the function of the clock is that current must only be supplied during the time the magnet is approaching the centre of the iron plate? therefore contact must only be made on one direction of swing. If contact took place on the reverse swing, it would produce an impulse equal and opposite to the first, tending to stop the motion of the wheel. This point is emphasised because it has been stated by one writer in a published description of the '(Eureka" clock that impulse takes place in ***both*** directions of swing ; a statement which caused considerable perplexity when the working of this clock was first investigated by the writer, until it was proved that such action was quite impossible with the form of contact mechanism shown.

The strength of the impulse will be dependent on the e.m.f. supplied by the battery, so that any variation in the voltage, as caused by a gradual running down or deterioration will affect the applied power, and to some extent, the rate of the balance. But the isochronous characteristics of the latter will be similar to those of an ordinary watch balance, which tends to compensate variations of power by altering the arc of its swing, and timekeeping errors from this source are not serious, unless one insists on high precision standards. It would not be impossible, however, to improve on this detail, and introduce a constant-impulse form of contact device if so desired.

So far, only the operation of the balance wheel "motor" has been considered, but obviously some method of " counting " the impulses of the wheel and using them to drive the hands of the clock is essential. The gear train employed for this purpose differs in no practical respect from that of an ordinary clock, but what would normally be the escape wheel is in this case a ratchet wheel, which is fed one tooth at a time by a lever and pawl deriving its motion from the balance wheel system. This is done by providing ***an*** eccentric on the staff of the balance wheel, and a large diameter roller resting on the latter, and mounted on a pivot at one end of the lever. The ratchet mechanism is clearly visible in the photograph taken from the front side of the clock, with the dial removed ; this part of the clock is of course essentially similar to that of the Hipp, Synchronome and many other electric clocks.

The balance wheel is regulated by the usual method of controlling the free length of the hair spring, a rather elaborated geared quadrant being fitted for this purpose, and operated from a pinion with a star wheel on the outside of the motion plate, as seen in the photograph taken from the rear side.

(To be continued)