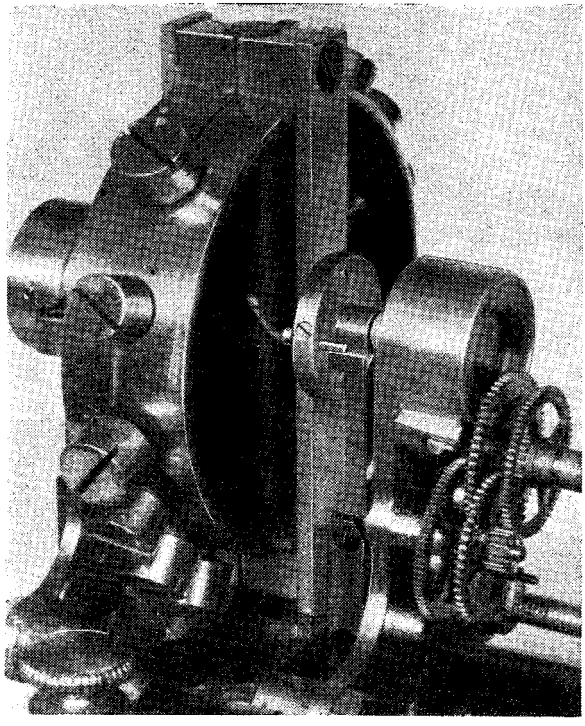
*The "Eureka" Electric Clock

by "Artifieer"

THE housings in the two motion plates contain the bearings for the balance wheel pivots, which are essentially identical for each side and are of rather unusual design. As will be seen from the bearing assembly design, the pivot rests on two large steel balls, which in turn roll inside a hardened ring or "race," in a very restricted orbit, the limits of which are determined by the holes in the plate which abuts against the outside edge of the race, and is held in place by a glass disc and a screwed retaining ring. The chamber enclosing the ball-race is capable of being used as an oil bath to keep the bearing well lubricated, so long as it is not filled above the level of the pivot clearance-hole, and the clock is not moved out of its normal vertical position.



A close-up of the clock movement, showing contact mechanism and gear ***train***

It will be clear that this type of bearing is suitable only for a shaft having an oscillatory motion, as distinct from one which rotates completely and continuously in one direction ; and even then, the extent to which it can provide true rolling motion is very limited, as the balls tend to roll bodily within the race, which they cannot be allowed to do except to a very small extent. Should there be a tendency to exceed this, the balls will rub against the edges of the holes in the plate, causing some friction, and this may possibly be a deliberately designed effect to deter the balance wheel from swinging through too great an arc. To prevent the possibility of the balls becoming wedged in the holes, such as by inertia effects when the clock is moved violently, banking pins are fitted to the inner wall of the housing as an emergency limiting measure, and these also would cause friction if the balls made contact with them.

***Continued from page** 253, "**M.E.,**" **March** 3, 1949.

The endwise movement of the balls is prevented by the inner wall of the housing on one side and the glass disc on the other, and very little clearance should be allowed. It is possible to observe the rolling action of the balls through the glass disc, and also to see that the oil bath contains sufficient lubricant of the proper consistency and cleanliness.

Pivot Bearing Components

Details of the component parts of the bearing are given in Figs. 10, 1I & 12. The ball-race may be made either of silver-steel, hardened right out in oil, or mild-steel case-hardened.

If the pivot journals are made larger in diameter than the specified size, as suggested, it till be necessary to make the inside diameter of the race also larger, and in any case it will be desirable to "offer up" the assembly before hardening, or to make a dummy race to obtain the correct location of the pivots, as near as possible concentric with the housing, but at least close enough to avoid fouling the clearance holes in the latter. The inner surface of the race is parallel, without the concave track usually provided in standard forms of ball-races, and the width of the race is less than the diameter of the ball, by an amount approximately equal to the thickness of the abutting steel plate. After hardening, the race should be highly polished on its working surface.

It will be seen that the steel plate is provided with a locating tab, which fits in a keyway or recess formed in the wall of the housing ; this does not extend to the outside of the threaded end, however, and is best formed by drilling, or chipping out with a small chisel. In order to ensure that the holes in the plate are symmetrical, relative to the vertical centre of the housing, it is advisable to locate the plate in this way before marking out and drilling them. Burrs must be carefully removed from the edges

of the holes, and they should be polished with the rest of the surface on both sides of the plate, after hardening. As the plate is thin, case-hardening is not very satisfactory, and it is better to use thin carbon-steel gauge plate or " pen steel " for making it.

There may be some difficulty in cutting or obtaining small glass discs, and the possibility of using a plastic substitute such as Perspex or cellulose acetate may be considered ; but it should be noted that these discs act as end-locators for the steel balls, and it is therefore desirable to use as hard a material as possible. A useful tip for cutting glass circles is to use a chip of tungsten carbide set in a radially adjustable holder like a washer cutter or trepanning tool ; it may be run either in the lathe or the drilling machine.

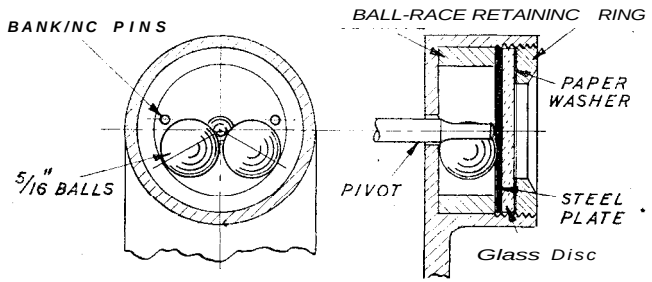
Should the end clearance of the balls be insufficient to allow free movement, a paper washer similar to the one outside the disc, but having a hole 11/16 in. diameter, may be used between it and the steel plate. It seems obviously desirable to fit a washer in this position, but it was not done in the clock examined. The screwed retaining rings for the housing may be machined in one piece from brass rod, and their, fit in the housings tested before parting off. They each have two blind holes drilled diametrically opposite to each other for the application of a pin spanner. A trace of varnish on the paper washers, and on the threads of the rings, will assist in ensuring oil-tightness of the housing.

When the motion plates are fitted to the studs of the armature plate, and the balance wheel assembled in place, the pivots should have just perceptible end shake between the steel plates in the two housings. Adjustment of end play can be obtained either by fitting shims on the armature studs or machining back. the shoulders of the studs as required.

Should the construction of this rather elaborate form of pivot bearing be objected to by constructors, an alternative would be to use the smallest obtainable standard ball-race, or better still, one of the tiny Swiss ball-races specially made for instrument work. A cup-and-cone form of bearing like that of a cycle hub, the cone being formed on the pivot and a carefully machined and hardened cup fitted to the housing in place of the parallel ring, is also a possibility, but it should be noted that ball-bearings of this type require close end adjustment to work satisfactorily. Workers who have experience with fine horological work may be able to fit jewel bearings and endstones to the pivots in such a way as to produce little, if any, greater friction than a ball-race.

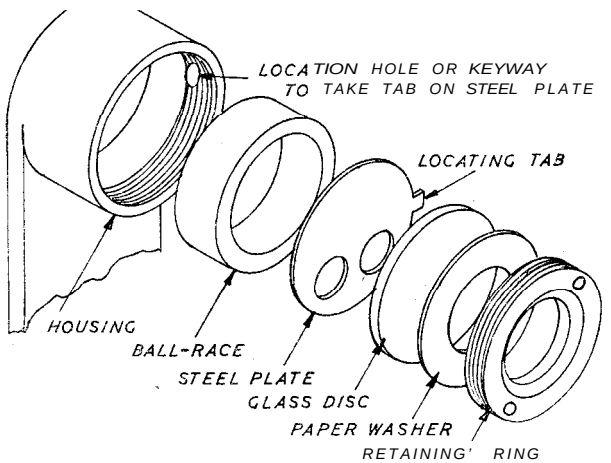
Contact Spring Assembly

This is shown, together with details of the components, in Fig. 13, and it will be seen that the spring is held by means of two 6-B.A. screws, to the vertical edge of a block of ebonite or other insulating material, which in turn is attached to the back of the front motion plate by a single 6-B.A. screw. The contact spring itself is backed up by a check spring of the same material and thickness, to prevent excessive flexure near the root of the free end, and a further backing is provided by a rigid plate of 1/8in. brass strip. All these components are of a simple and straightforward nature, the only point which calls for detailed comment being the tipping of the contact spring with a small L-shaped piece of silver or gold-silver alloy. Both in obtaining the material, and in attaching it to the spring, some constructors may experience difficulties, but in such cases it is probable that nearly any working jeweller would be able to assist in both respects. Silver is quite a satisfactory metal for a contact of this type except for its tendency to tarnish, especially in an atmosphere containing sulphur compounds, as in industrial towns ; but as there is wiping contact of the conductors, they are



Left-Fig. I0. Pivot bearing and housing assembly

Below-Fig. 11. Exploded view of bearing assembly



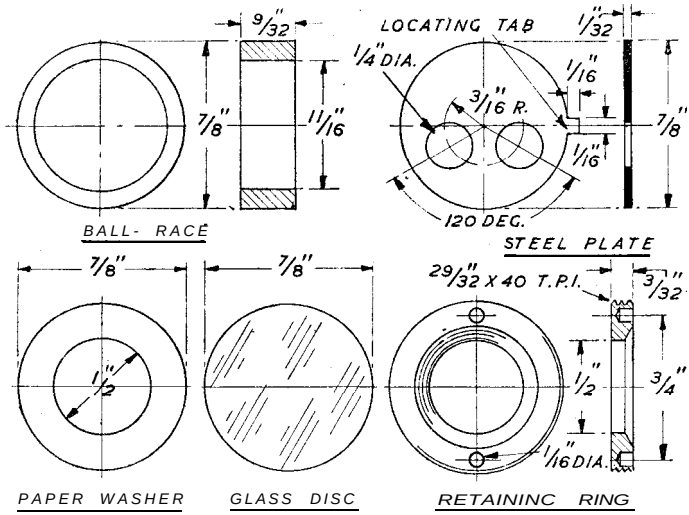


Fig. 12. Components of pivot bearings (less steel balls)

largely self-cleaning when kept in continuous use. The silver-gold alloy, however, does not tarnish, and being slightly softer than the silver or german-silver contact pin, acts as a lap to improve its polish.

The best material for the contact and check springs is a clock suspension spring strip of approximately the specified thickness. This material although finely tempered, can be cut quite easily with sharp shears, and also filed; drilling, however, may present more difficulty, but it may be accomplished successfully with a glass-hard spear-point drill, made from silver-steel and hardened right out in water at the extreme tip ; it should be run fairly slowly and lubricated freely with turpentine. It will be noted that the screw holes in the contact spring are elongated to allow of slight vertical adjustment ; in this detail, some liberty is taken with the original design, as the actual clock examined had no provision of this kind, but it appears to be highly desirable in order to enable exact adjustment of the contact timing to be obtained.

A small hole is drilled at the extreme -lower end of the contact spring to assist in soldering the lead to it, but this is not absolutely essential, and it may be preferred to drill and tap the backing place and fit a small terminal screw, which would avoid the necessity for a soldered connection, and would be quite satisfactory from the electrical aspect if due care is taken in the metallic contact of the parts.

When the springs are mounted on the block and the latter attached to the motion plate, it is possible to adjust the block by pivotal motion on its single screw, so that the correct action of the contact gear is obtained; in other words, that the contact pin touches the spring on its metallic side on the clockwise swing, and on the insulated side of the return swing. This action should be possible

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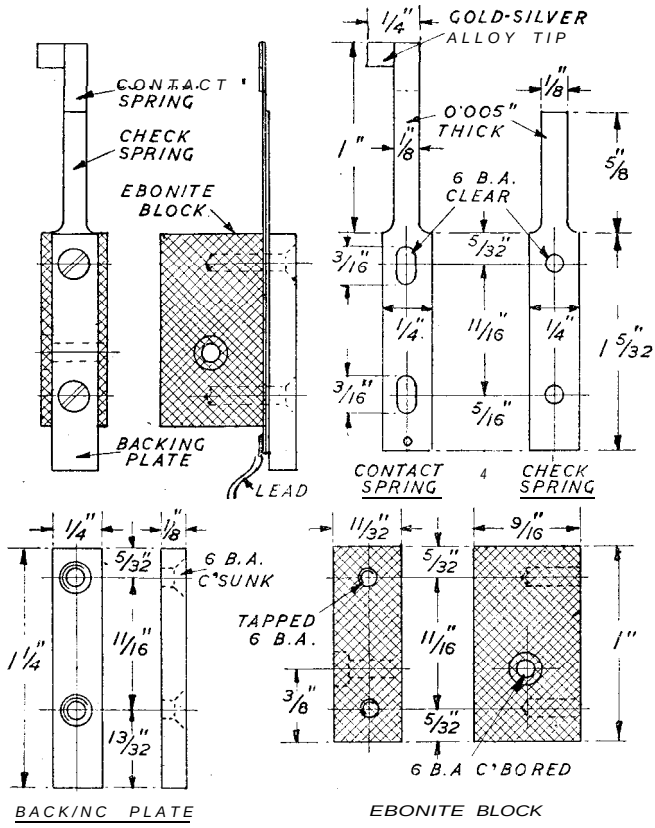
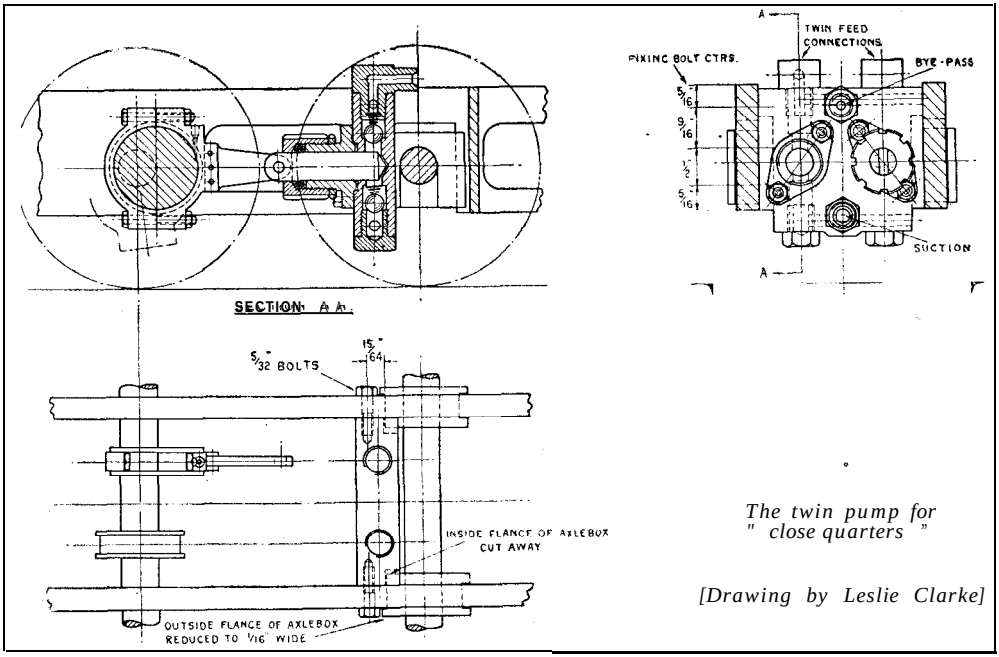


Fig. 13. Details of contact spring assembly



The twin pump for " close quarters "

[Drawing by Leslie Clarke]

practically explains itself. The valve chambers and waterways are all drilled in a very substantial cross-stay, which is set back close to the coupled axle by removing the inside flanges of the axlebox on each side. The pump barrels, which have external glands, are made separately, and attached to the cross-stay by oval flanges, with nuts and studs, as shown in the end view. The two eccentrics are set at 180 deg. or exactly opposite, so that the flow is practically continuous; and the method of drilling the waterways, calls for only one feed-pipe and one by-pass. Two deliveries are shown for clacks on each side of the boiler, but these could be combined into a single delivery if the design of the engine called for it.

The " Eureka " Electric Clock

(Continued from page 313)

without the need for setting or bending the springs themselves, which is not advisable, though a slight twisting of the contact tip may be permissible. Note that very little effort should be needed to flex the spring to the extent of just over 1/16 in. at the tip, as required to operate the contact ; the lightest possible action consistent with just enough contact pressure to conduct the necessary current, will give the best results.

It is now possible to get the balance wheel impulse motor working, though not to get it properly rated at this stage. A hairspring of appropriate length and strength to produce a losing rate should be fitted, and the spring collet adjusted to put the balance " in beat " (i.e., with the core vertical) when at rest. Not more than 1½ volts should be used to energise the motor. Adjust the position of the spring so that contact is established at about 15 to 20 deg. to the right of the dead centre, and broken exactly at dead centre. This will call for careful and possibly patient, manipulation of the spring and mounting block.

When properly adjusted, the action of the balance wheel should be healthy and vigorous, and the current consumption low, so that only a very minute spark, if any, is perceptible at the contacts. The motor may be left running while the rest of the clock-virtually no more than a counting and indicating gear-is completed. Its movement, however, is so fascinating to watch that it may prove to be a distraction if set up in the workshop ; it is best to put it in some other part of the house, where it serves the purpose of a decoy for those admiring but often embarrassing friends who are always " dropping in " when some particularly delicate job is in progress !

(To be continued)