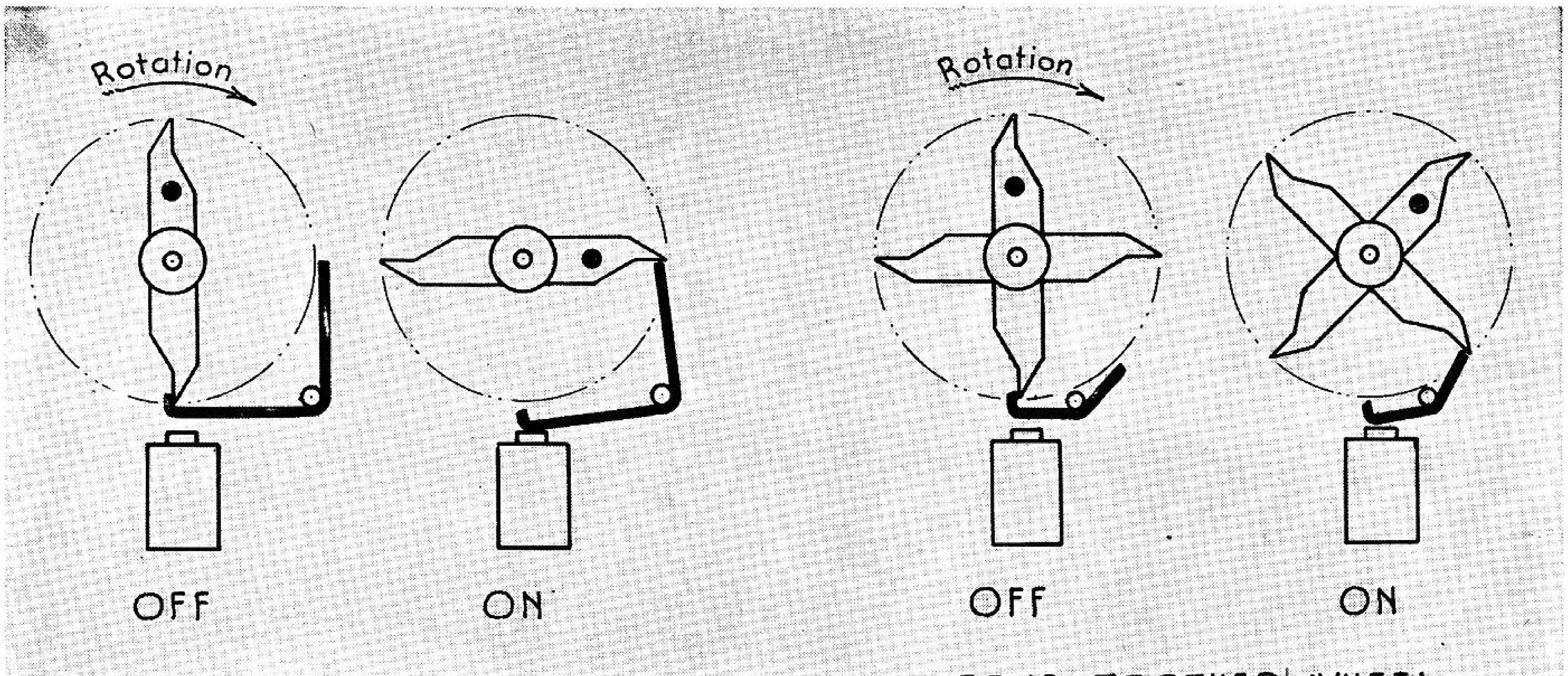


TWO-TOOTH WHEEL

Sequence	1	2	3	4
Off	N		N	
On		R		L

FOUR-TOOTHED WHEEL

Sequence	1	2	3	4	5	6	7	8
Off	N		R		N		L	
On		½ R		½ R		½ L		½ L

Fig. 1 Comparison of common escapement sequences. (a) two-tooth wheel, 45° rotation. (b) four-tooth wheel, 22½° rotation

reliable escapements

by J. S. LUCK

THE escapement in a radio controlled plane is very seldom respected as it should be. Compared to the receiver or the transmitter it has very little electronic glamor. Yet, if the receiver is the brain of the controlled ship, then the escapement is the brawn which guides it.

Escapements in general use employ escape wheels with either two or four teeth. *Fig. 1* gives the sequence of rudder positions for both. The accepted method of stopping or locking the wheel at a required position is by means of a pallet similar to that of a standard clock escapement. The pallet is, in R.C. practice, the armature bent at either end, *Fig. 2.*

Assembly of wheel and pallets is a matter for critical study. Poor alignment, wrongly designed or faced pallets, and improper relationship between the wheel and armature pivots, *Fig. 3a,* are among the most frequent causes of escapement failure. However, the adjustment most frequently demanded on a badly behaving mechanism is concerned with the amount of lock given by the pallets; the pivoting layout is seldom incorrect in commercially built escapements. The lock must be deep enough to provide a positive stop, yet desirably fine in order to keep friction between escape tooth and pallet, and the gap between armature and pole-piece at a minimum.

PART ONE

The possibility of establishing an ideal relationship between pallet and escape tooth is materially dependent upon the quality of the mechanism to be adjusted. So perhaps the first step is to inspect the bearings of the armature pivot and escape wheel shaft. If they are sloppy, they should be corrected. Use a nail-set and give the pivot holes a smart tap. This tends to close up a worn hole which may then, if necessary, be drilled out to the correct size. A short length of piano wire, of the same size as the pivots, may be used as a drill.

Reassemble the unit and examine its operation. Referring to *Fig. 2,* compare its operation to the lock and clearances indicated. As the principle is the same,

(*Turn to page* 36)

Fig. 2 Ideal layout and action for R.C. escapement

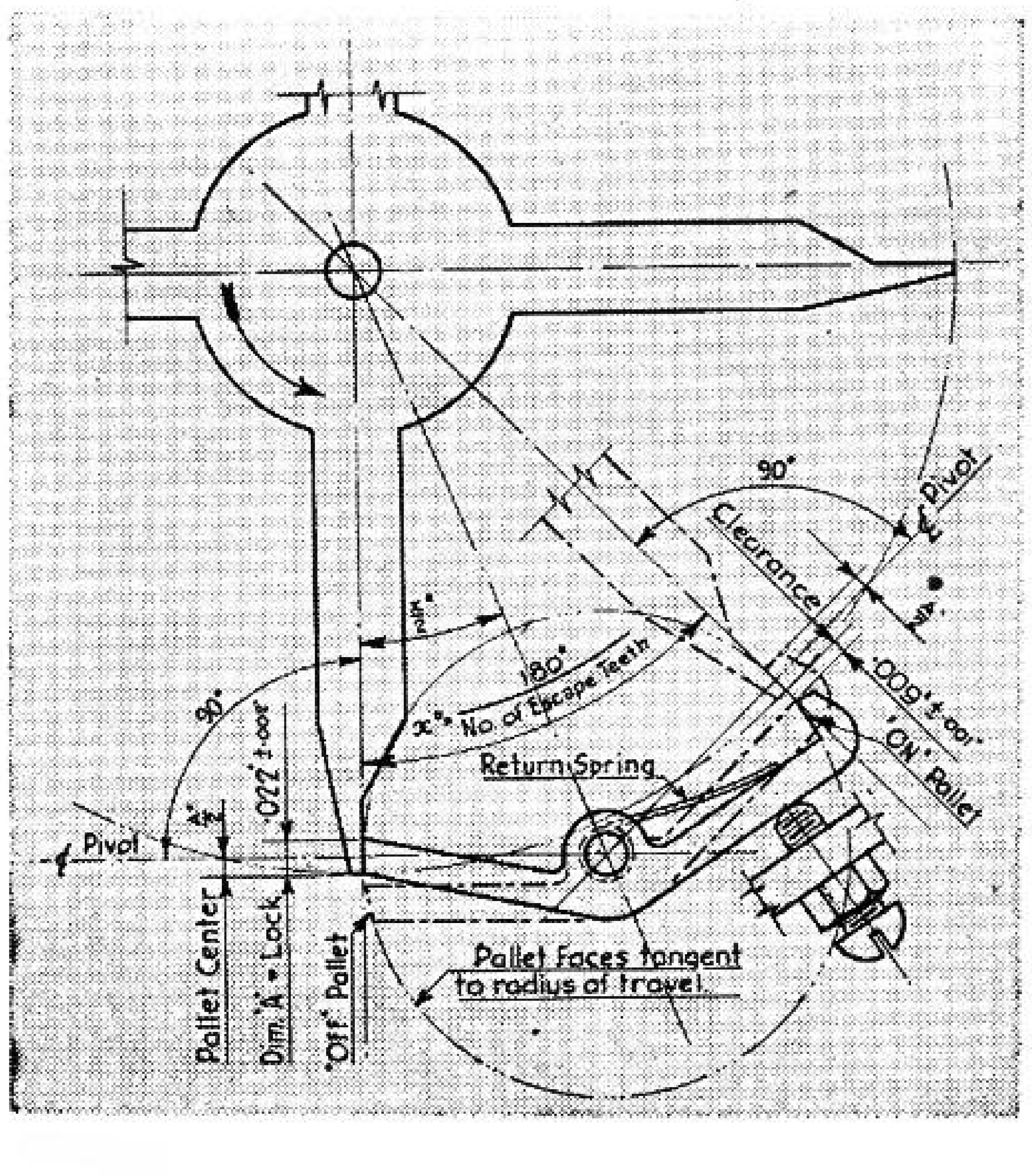
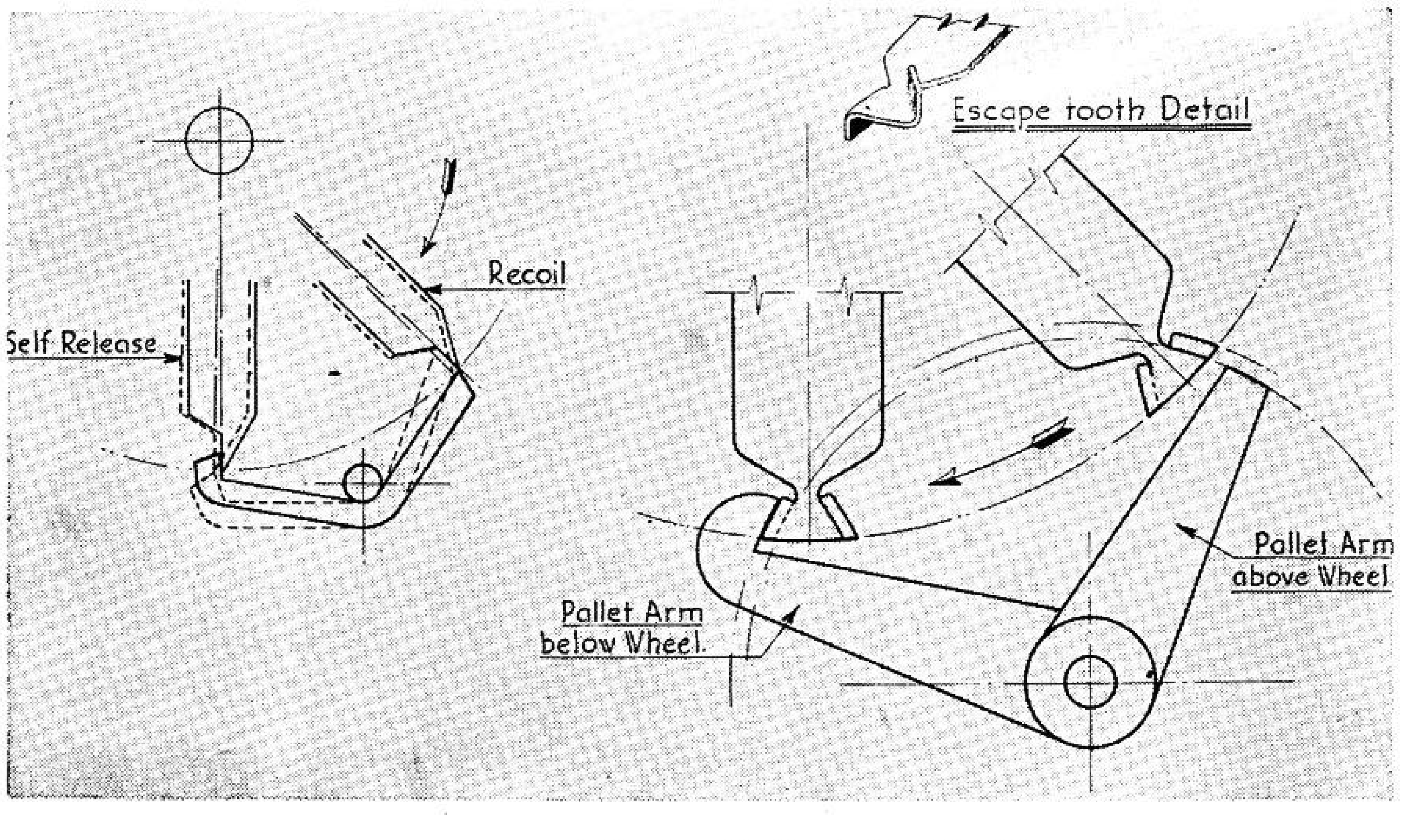


Fig. 3 (a) recoil from incorrectly faced pallets. (b) deadbeat pallet and wheel



Reliable Escapements

(*Continued from page* 24)

regardless of the number of teeth in the escape wheel, only a four-toothed unit is illustrated. All is lost at this point if the escape wheel does not run dead true. The teeth must describe the exact same diameter, or, if that is too loosely put, a tolerance of plus or minus .001" is all that could be allowed. To begin the process of alignment: hold the armature in contact with the pole-piece, then adjust until the tooth clears the "on" pallet by about 8 to 10 thousandths (use a set of feeler gauges if available). The pole-piece itself, acts to limit the travel. Rotate the tooth until it touches the "OFF" pallet and adjust until the lock is about 20 to 24 thousandths. This entails firm, but delicately precise, bending of the armature with a pair of strong long-nosed pliers. Move the pallet until it clears the locked tooth by 8 to 10 thousandths and see that its travel is limited to this point. A set screw is sometimes provided for this purpose, or else there is a piece of metal placed so that it may be bent until the desired clearance results. Smooth and polish the faces of pallets and teeth. The clearance between the pole-piece and armature should now be about 32 thousandths (something close to 1/32"). Even finer measurements are practical *if* the bearings, wheel, and pallets are close to perfection.

The next point to study is the action of the wheel as each tooth is released and then stopped. Preference to *Fig. 3a* makes it quite obvious that if the pallet faces are not tangent to the arc of their travel, the wheel will either move forward or backward, according to the pallet angle, as the release is in process. In itself this is no serious fault, and could be ignored except for the fact that the coil must exert sufficient pull not only to overcome surface friction but also push that wheel back against the torque of the rubber bands driving it. The correct name for this type of escape action is "recoil" and it is commonly used in mass produced clock movements. Better clocks employ what is called a "deadbeat" escapement; and that is what we should strive for. The escape wheel should remain perfectly stationary as the tooth is being released. Proper facing of pallets will ensure this, but it requires almost microscopic inspection and refinement to attain the ideal. At the same time, proper relationship between armature and escape wheel pivots, and armature pivot and escape tooth contact face, should be as closely correct as possible. The exact relationships may be established according to *Fig. 2*. But if the escape tooth—armature pivot relationship is much greater, special treatment of the escape teeth may be required for ideal "deadbeat" operation. A solution for such a condition is shown in *Fig. 3b*. It is not simple and may require new wheel and armature.

Lacking patience, the best alternative is to err on the right side. The locking pallet when the coil is energized, i.e., the "ON" pallet, could be slightly "self-releasing." That is, the angle of the pallet is such that the torque of the rubber motor which is holding the locked tooth against the pallet is utilized, to a very small degree, in forcing the pallet to release as soon as the coil is de-energized. However, it must be emphasized that this self-release condition must be barely perceptible: for, if it exists to any marked extent, the tooth, which approaches with considerable force and speed, can easily knock the pallet aside before the coil has fully attracted the armature, and so continue right past. This condition is one of the most commonly seen failures at any R.C. contest, and is aptly dubbed "skipping" (another cause of skipping, nothing to do with the escapement, is a weak or chattering contact at the receiver relay).

If it is important to keep the self-release action of the energized stop at the very barest minimum; it is doubly true for the locking pallet when the coil is inert. The armature return spring alone must then prevent the approaching tooth from knocking the locking pallet from its path; but, if the spring is too strong, the coil has an excessive and needless additional force to overcome. The best compromise for the ideal "deadbeat" condition would be to reduce the surface of the pallet to within aces of becoming a knife edge. However, that is not too good from the viewpoint of resistance to wear and distortion from the continued hard impact of the escape teeth. If, on the other hand a "Recoil" action is allowed to take place, the coil again is taxed by the torque of the rubber drive, and may be quite incapable of pulling the pallet away from the tooth without greatly increased voltage.

The armature return spring is functioning correctly when the tension is just sufficient to return the armature with a sharp positive click. It is essential to avoid a sluggish return action under load, but it is equally poor practice to expect the spring to overcome excessive friction at the pallets, torque of the escape wheel (as in "Recoil" action) and a "sticky" pole-piece. This last is due to a small degree of magnetism remaining after the coil has become inert. The remedy is to coat the pole-piece or armature with a film which will not easily flake or chip. Shellac is excellent under normal conditions, but if the coil is allowed to heat up (more common to 2-toothed escapements), the shellac may melt and *really* stick armature and pole-piece together. Friction between teeth and pallets is kept to a minimum by careful surfacing. Coarse finishing is done with a needle file of "fine" cut. The faces are then further surfaced with a well-worn file and finally burnished with a highly polished piece of steel. Great care being taken in this last process not to distort either pallet or teeth. In place of burnishing—admittedly a highly delicate operation demanding practice and skill—a few touches with a smooth Arkansas ("Washita") stone should be satisfactory.

Some means must be provided to complete the magnetic circuit. The usual way of doing this is by returning the pole-piece to the armature.

Weight conscious enthusiasts have been known to cut away this return magnetic conductor as it just looks like so much useless metal. The efficiency of the coil is thereby drastically cut. Furthermore, it is useless to substitute a nonmagnetic metal, such as aluminum or magnesium, for this all-important part of the circuit.

To insure greatest possible pull from any given coil the reluctance must be reduced to a minimum. "Reluctance" in a magnetic circuit is the same as resistance in an electric circuit. Reluctance increases with the gap between pole-piece and armature, and the attracting force is reduced as the square of the gap.

Far from being just a "poor relation" the escapement is, and should be, an important part of radio controlled flight: it is a precision instrument worthy of careful attention. Keep this text available as references will be made to it in Part Two.