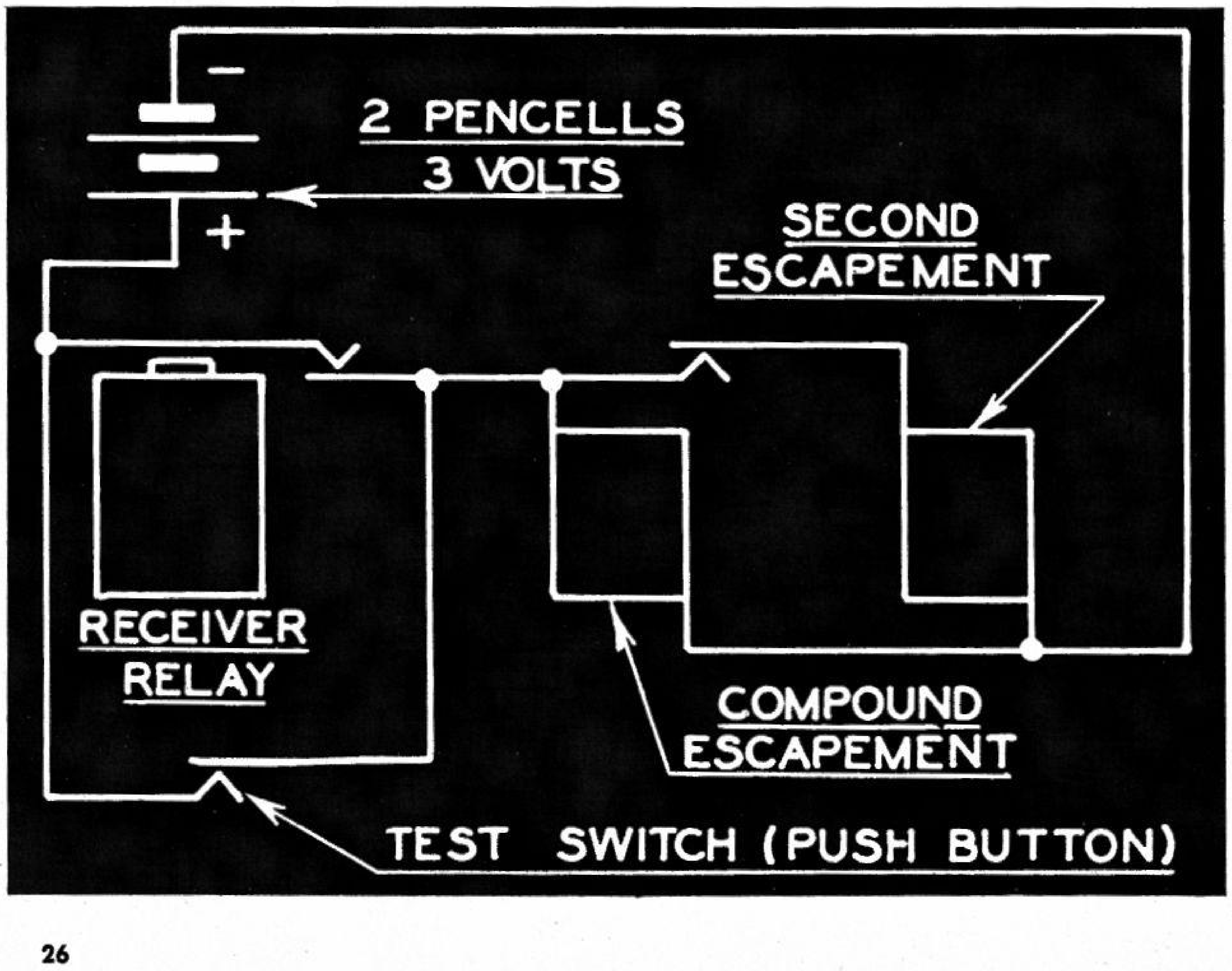
A *Rudder Bug* gets away. With the compound escapement power approaches, loops are possible.

for the R. C. fan

compound escapements

by HOWARD BONNER and HERB OWBRIDGE

Still using a single channel, the operator now can get left or right rudder and motor or elevator without having to follow a sequence. Either rudder position can be repeated as desired.



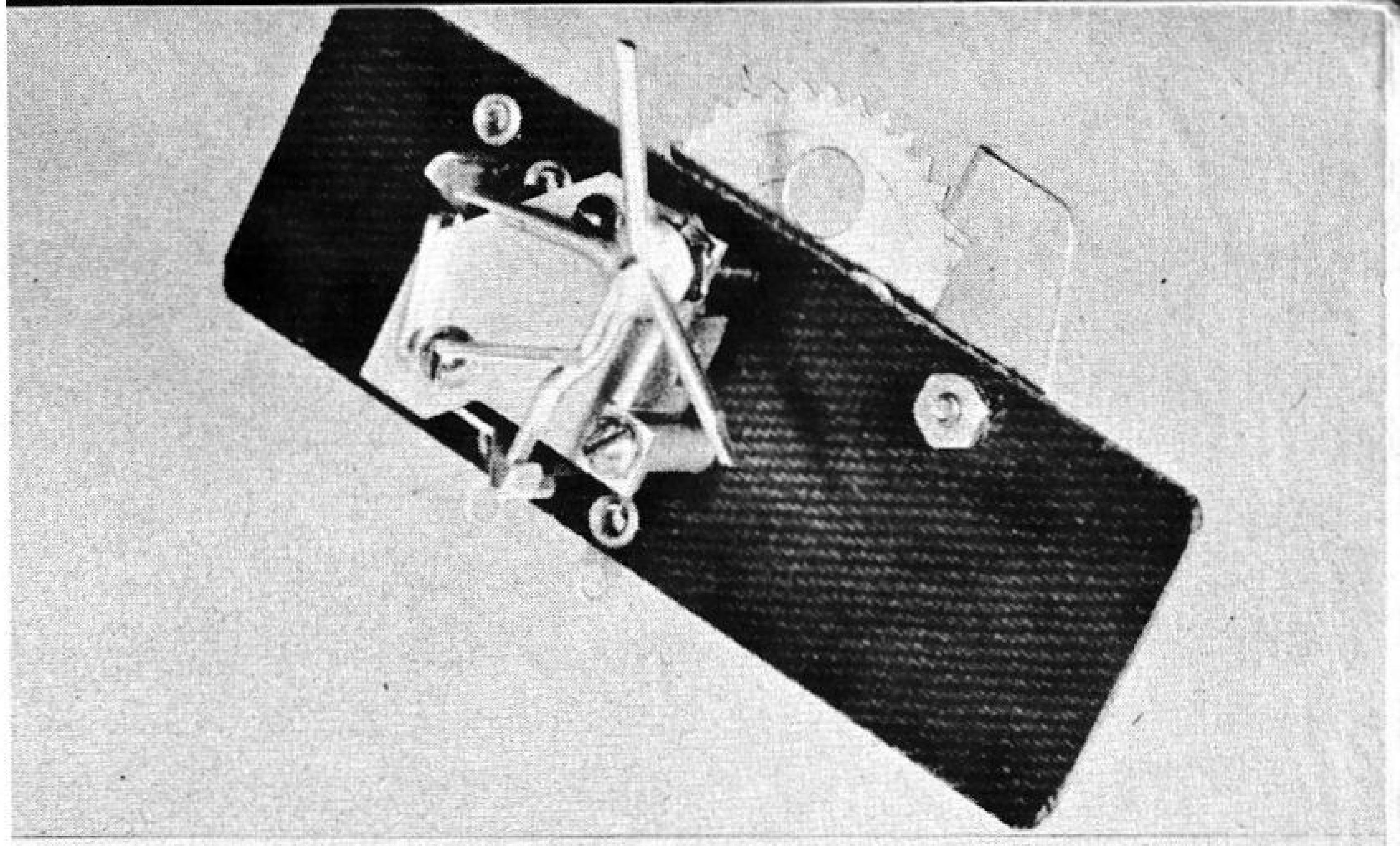
Because of its simplicity, low weight and cost, the escapement has always been the most popular device for moving the controls of a radio-controlled model. But it has always had the disadvantage of being a sequence control. Going through right rudder to get left rudder is all right because it can be done quicker than the model can respond. But when other controls are added (such as engine or elevator control) separation is a must. That is, one should not have to disturb the engine or elevator setting just to change the rudder position. Other types of controls have natural separation. Walker's control separates different signal lengths, Trammell's control separates signal rhythms and Rockwood's control separates signal tones. Now, by means of a very simple and reliable device that has been with us for years, just waiting to be used, we have an escapement that can recognize and separate the count of one, two or three signals. Since the operator no longer has to keep a mental record of which rudder comes next and, since he can operate the rudder without disturbing the setting of the motor control, the intelligence level of the common escapement has been brought up to very near that of the more complex controls. As far as proportional control is concerned, the compound escapement comes about as close as other control types since either rudder position can be repeated as often as desired without the fear of skipping a control and getting out of synchronization.

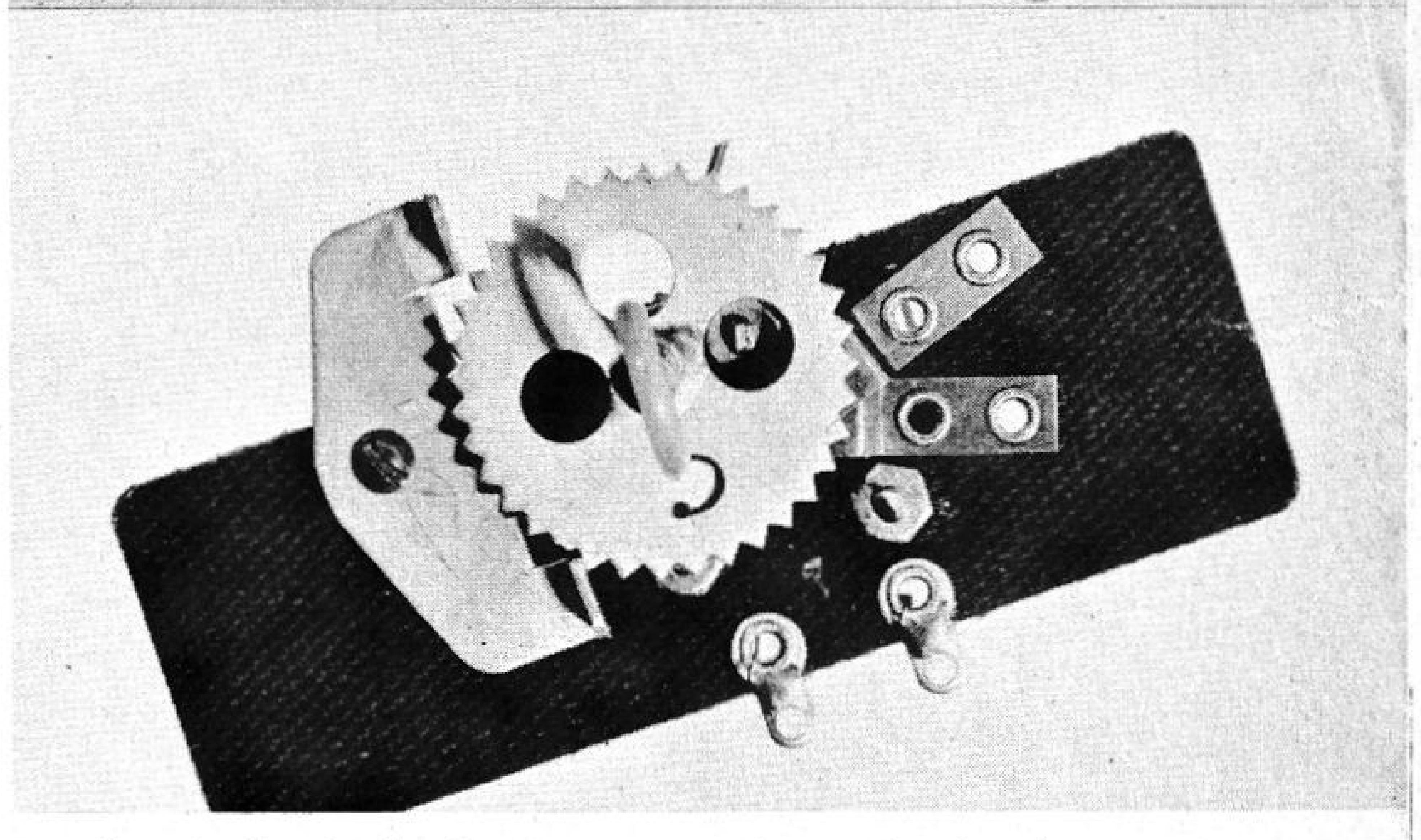
Like the escapement in the article "Exit the Beep Box" (September 1951 M.A.N.) this escapement has only one neutral position. This is no minor detail but a major step toward reducing the mental effort required by the operator. But (to resort to phonetics) instead of going "click," this escapement goes "bzzzt." That is, instead of operating with a mouse trap action that requires accurate timing at the transmitter to stop it at the right place, it has a very simple speed reducer so that timing is no problem, and the ordinary push button at the transmitter is good enough. The speed reducer is very common but if it has a name, we don't know it. So we call it a resonant-inertia escapement. If it ever had an inventor we are grateful to him for it has everything we need. It is cheap, light, easy to make and is so reliable that it will operate down to the last knot in 1/8" rubber band. Also its speed is uniform over a wide range or rubber band torque and there is no wear or adjustment problem. What more could we ask? It is only natural that new ideas should obsolete old ideas so all production of Ruddevators and related controls has been discontinued. The original compound escapement was turned over to Howard Bonner not only for flight testing but also for simplification of the design down to the production model shown here.

Figure 1 is a front view showing the escapement in the one and only neutral position. Only the joggled bar, with the crank soldered to it, can touch this neutral or de-energized armature stop. The other three bars hit the energized armature stop only when the electro-magnet is energized by a signal from the transmitter. The rubber band is wound right hand so it turns the bars counter-clockwise in this view. On the first signal, the neutral (lower) stop will release and the energized stop (upper left) will catch the uppermost bar. This could be left or right rudder. Since we rig the torque shaft bearing (which goes back to the rudder) 13/16" above the escapement shaft (an optimum position) this first signal gives right rudder. The next bar gives left rudder and the last bar (which stops the rudder very close to neutral position) is related to motor control which we will explain later. Notice that Bonner has made the angle between the energized stop and the first bar small. But the angles between the first bar and the second bar, and the second bar and the third bar are large and equal. This is to get the time from right rudder to left rudder and from left rudder to motor control as long and as equal as possible. Actually this is just a production refinement.

Figure 2 shows the star wheel and rocker bar at the rear of the escapement. This is the resonant-inertia escapement. Its speed is determined by three factors. Number of teeth in the star wheel, tooth depth (or stroke of the rocker bar) and weight (or inertia) of the rocker bar. This star wheel has 36-90 degree teeth in a one inch diameter steel disc. With the steel rocker bar shown, it makes about one revolution in 3/4 second. The teeth don't have to be even but it helps. Use a square file and if it comes out too fast, add solder to the ends of the rocker bar to slow it down. This speed was chosen to suit the following: fast enough so the ship would not respond when the rudder cycled through the unwanted position (this was easy) and also fast enough so that it is vertually impossible to send an extra signal too soon and catch the wrong control. Then, slow enough so that there is plenty of time to release the transmitter button and push it again to catch left rudder or motor control. At an escapement speed of one revolution in from ¾ to one second, the whole thing comes out to be a very natural one, two, three operation. One signal always gets you right rudder, two signals always gets you left rudder and three signals always gets motor speed change. You hold the rudder as long as you need. Release and it goes neutral. If you hold the third signal for three or four seconds, you get motor cut-off, which we will now explain.

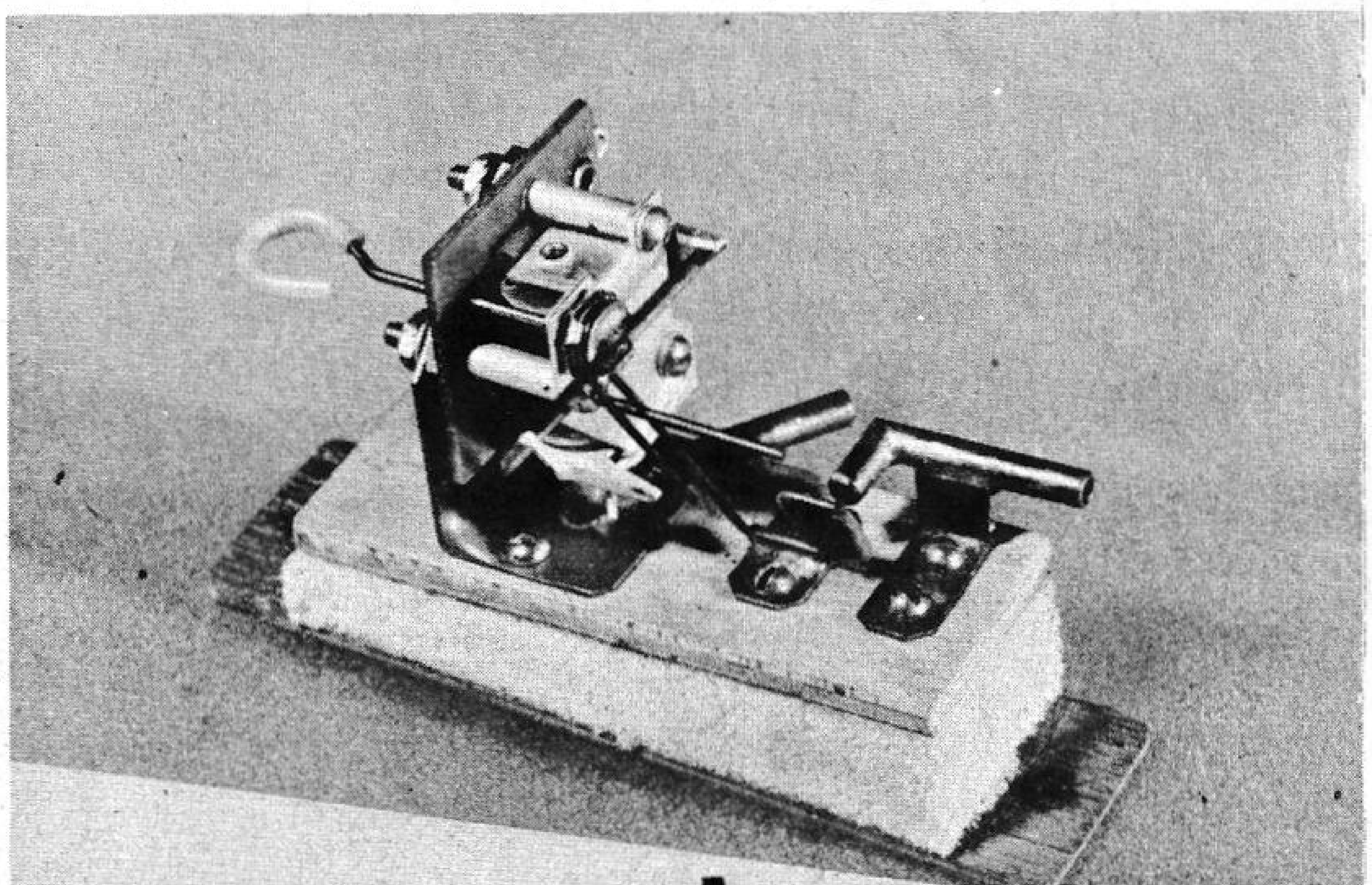
In figure 2, to the right of the star wheel, can be seen part of the two leaves of a switch which is closed by a tab in the star wheel only when the motor control bar is at the energized armature stop. This switch gets its voltage from the receiver relay just as the (*Continued on page* 44)

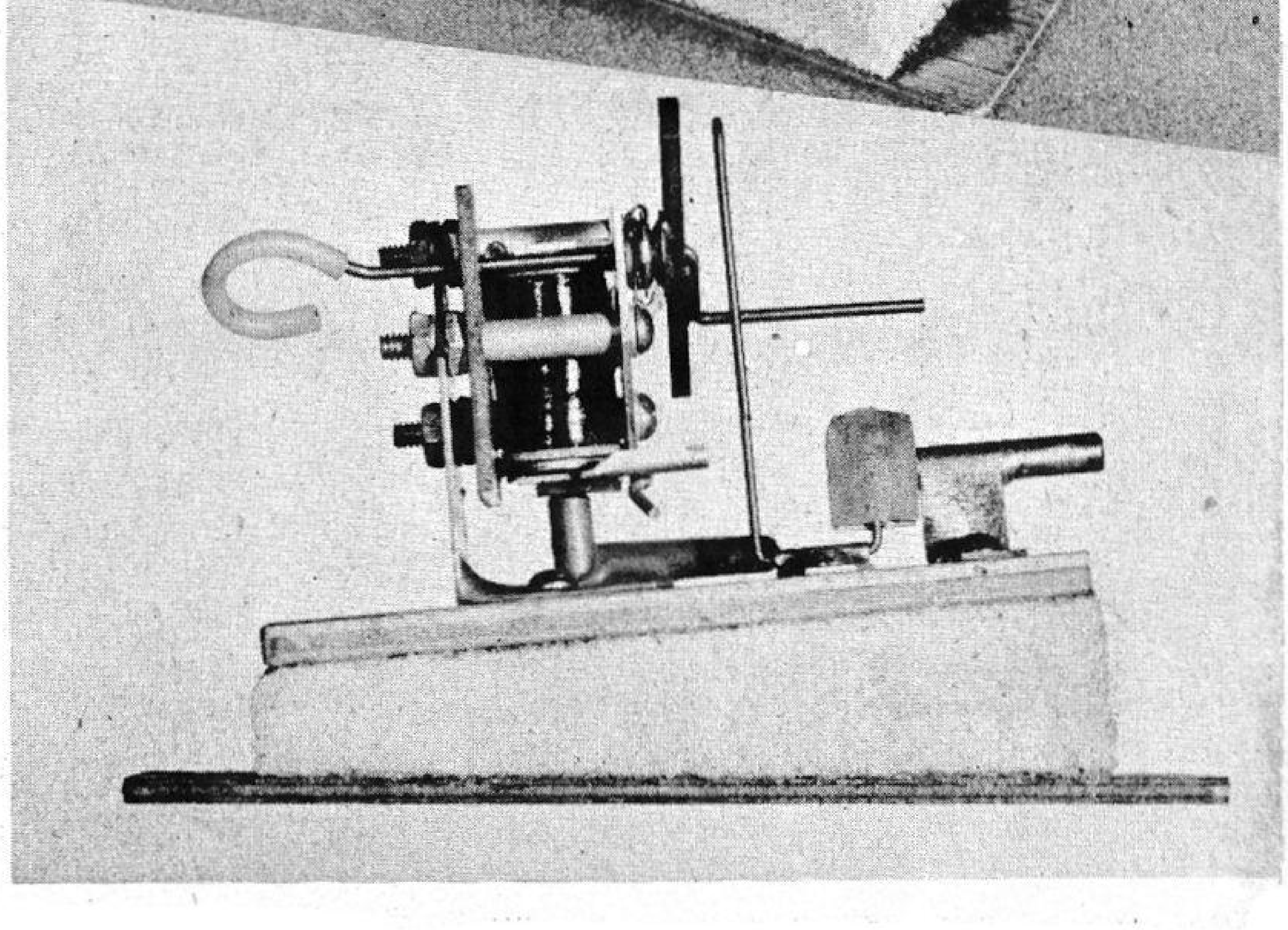




Top—Fig. 1 (front) showing escapement in one and only neutral. Above—Fig. 2 (rear) star wheel which limits speed to one rev in 3/4 sec.

Below—Fig. 3. Bonner escapement for two-speed motor and cut-off. Bottom—Fig. 4. Showing second air bleed valve operating same escapement.





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compound escapement does, so it is only hot when the compound escapement is hot (energized) or, in other words, transmitter on. This switch closes every time the star wheel tab comes around, but it will only operate a second escapement if the signal is on at the time. The wiring diagram of figure 5 will further clarify this. This second escapement can operate anything. But in figure 3 is shown a standard Bonner escapement rigged to give two speed motor control and cut-off. This method of motor control is known as the double needle valve method and seems to be the most reliable method for glow plug operation. In the West, we swear by the glow plug and defy anyone to prove that the fuel is hard on our ship's structure. Even if so, we can always use an overboard exhaust extension that will make sure that the stuff will miss everything but the tail. Mr. Brodbeck of K & B motors showed radio control modelers some sympathy by making available an intake for his 19 engines that will accommodate two needle valves. Anyone knows that a needle valve will draw air instead of fuel if there is a leak in the fuel hose. So we turn these needle valves off or on by opening or closing an air bleed in the respective fuel lines. The high speed needle valve air bleed can be seen as a rubber pad, centered to the armature and resting on a pipe under the escapement coil in figure 3. This air bleed is closed (and the high speed needle valve draws fuel) as long as the escapement is relaxed. This bleed is only open when the escapement is energized by the third signal. In figure 4 we see another bleed valve operated by the crank of the same escapement. This escapement has four positions—two energized and two relaxed. In two energized and one relaxed position, the bleed valve is open. The bleed valve is shown in the relaxed open position. Since this bleed valve is open, its needle valve cannot draw fuel. But since the escapement is relaxed, the other bleed valve is closed and its needle valve can draw fuel. This is high speed because only one needle valve drawing fuel gives a lean or high speed mixture. If the low speed bleed valve of figure 4 were closed (in the relaxed escapement position) both needle valves would draw fuel, giving a rich mixture or low speed. But in any energized escapement position, both bleed valves would be open, neither needle valve would draw fuel and the engine would stop. This is cut-off and the number of seconds to cut-off is determined by the location where the bleed line is teed into the fuel line. We tee the low speed bleed line into the low speed fuel line as close to the engine as possible to get a quick change from low to high speed. But we teed the high speed bleed line into the high speed fuel line about one inch from the needle valve to get a three or four second delay before the engine quits. The motor control escapement is mounted in the fuselage and never gets gummed up with fuel because all it ever handles is good clean air.

Now that we have certain and reliable separation of rudder control from a second control, this second control could be elevator instead of motor control. Since motor control and elevator control give two distinct types of flying, we don't need them at the same time. Motor control is for low altitude flying whereas elevator control is for dives and straight away loops which require a safe altitude. So, we set our motor control escapement in high speed, disconnect the wires and connect them to another escapement which operates elevator on the third signal. Since up elevator is not necessary if you have a generous amount of down, we cut off one bar of a standard escapement so that it will only stop in down on signal. When released, it will swing thru up but go to neutral. This gets us our drives and loops with the least possibility of a mechanically or mantally stuck elevator which can be very dangerous.