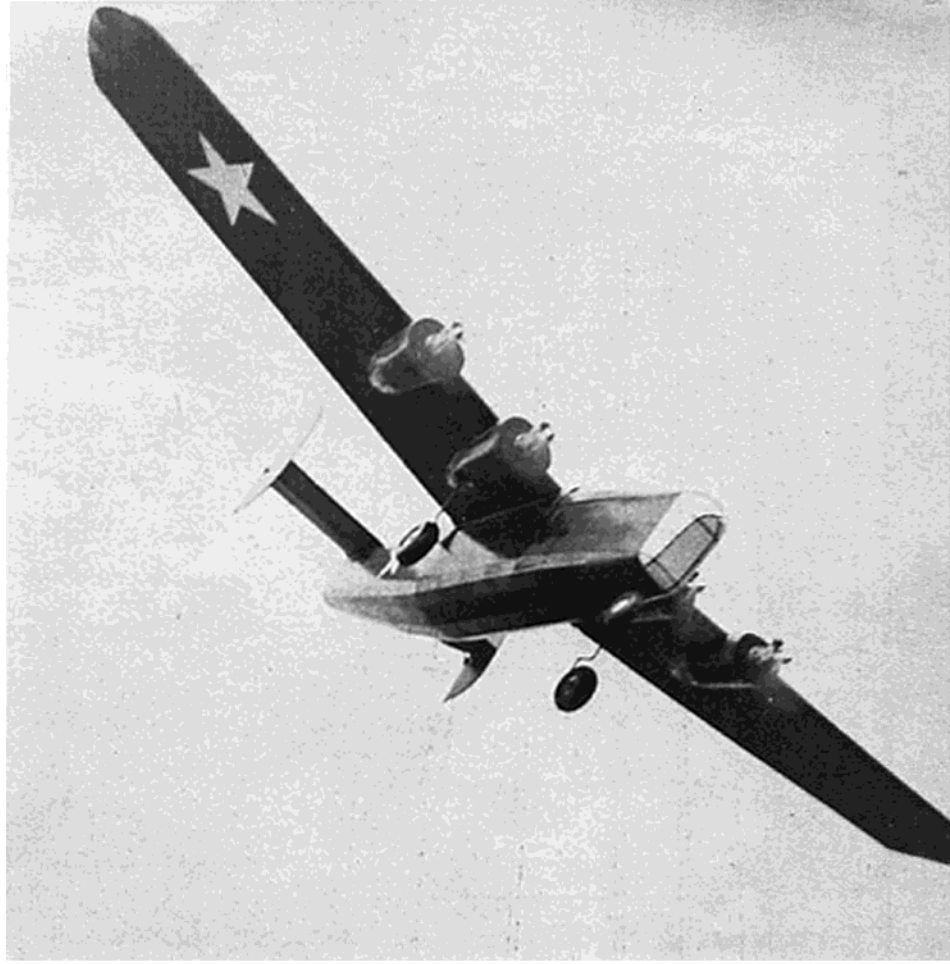


# FOUR ENGINE SINGLE CHANNEL

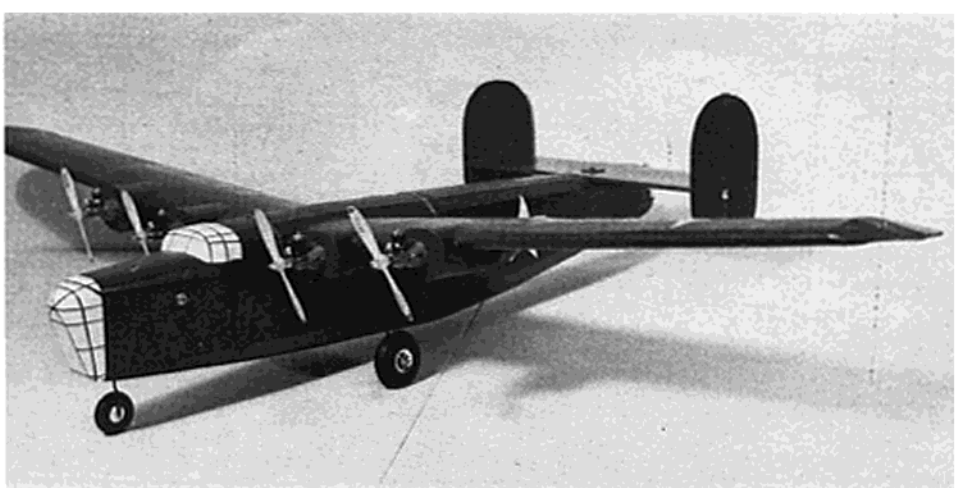
# B-24

## BY FRANK BAKER

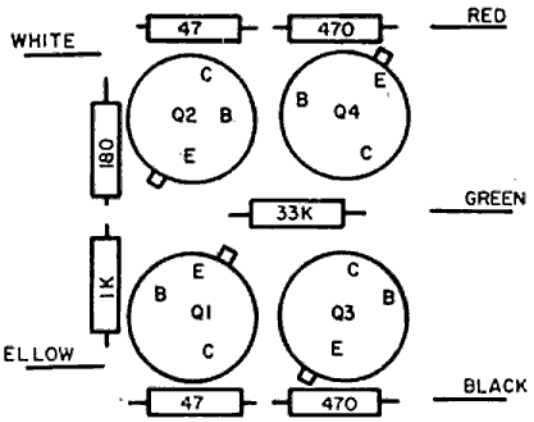
### Easy To Build, Stable Semi-Scale Model For Single Channel Proportional

WHEN I indicated my intention to build a radio controlled scale B-24 at a meeting of the Madison Area Radio Control Society, I received the usual smiles reserved for such projects. Mentioning that it would be for rudder only brought a chorus of "you are out of your mind!" Thus encouraged, I proceeded to build and successfully fly what appears to be the world's first four engined rudder only scale R/C model.

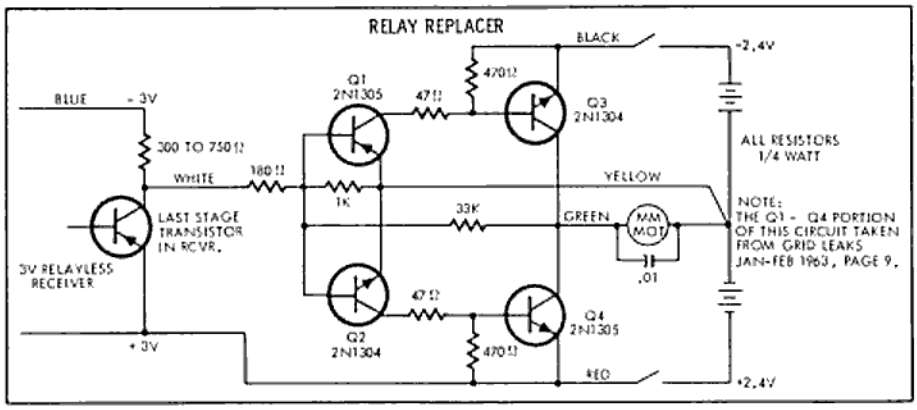
The B-24 was a natural choice due to the large twin rudders which are directly behind each pair of engines and the general bulky airframe configuration. Before building the B-24 I constructed a semi-scale PBY which was used to test several radical ideas about multi-engined R/C models. The PBY turned out to be a very docile ship on either or both engines. In fact, the PBY was used as my practice plane for our local limbo contest. Experience with the PBY indicated that the secret to successful multi-engined rudder-only design was fourfold: First, some form of proportional control is mandatory. Second, build the plane large. Third, make it as light as possible. Fourth, do not over-power the plane. A glance at the B-24 plans reveals all four of these maxims have been closely followed. The radio equipment is simple pulse proportional, the span is a generous 60", the weight ready-to-fly is only 44 ounces, and the power is provided by four Cox TD .020's. These characteristics are diametrically opposed to the usual multi-engined scale plane which is normally heavy, overpowered, and aerodynamically unstable. Hopefully, the B-24 will start a new trend as I am convinced nearly any four engined plane can be flown following the four axioms given above.



The most common question heard at the flying field is, "How are you going to start all those engines?" Rather than keep you in suspense, here is how it is done. Start the outboard right (facing the model) engine and adjust it to run smoothly. I do not attempt to peak out the engines but settle for a smooth running engine on sport type fuel (Cox Blue Can). Then, start the next engine and repeat the process until all four engines are running smoothly. On larger multi-engined planes tachometers are used to synchronize the engines but this is too much bother for sport flying. Hence, the engines are synchronized by sound and sight and not too well at that. When all four engines are running, I quickly stop them by stuffing a cloth into the props. The tanks are topped off, and I restart each engine. Using this procedure, the Cox's will actually start with ONE flip, hence, engine starting is no problem. Normal practice has been to start the two outboard, then the two inboard engines in hopes that they will quit in the same order. It has also proved more convenient to let one person start the




COMPONET LAYOUT




Schematic and component placement for driving a motorized proportional actuator from a relayless receiver.

engines while a second person holds the plane.

The B-24 is a very docile aircraft to fly and behaves similar to a Midwest Esquire or a Debolt Champion on a .15 engine. The first few flights were hand launched but it was discovered quite by accident (someone let go!) that it will R.O.G. from a grass field in about 50 feet. An R.O.G. with the four Cox's chiming away and the rudders banging back and forth is a breathtaking sight which never fails to elicit oh's and ah's from those assembled. Upon breaking ground it climbs out at a good pace and gains altitude quickly. The engines tend to terminate in a random pattern which does not cause any problems. The first several "stoppages" can usually be detected by a shift in the center position of the stick even before they can be heard. With all four engines running the B-24 will climb; on three it will maintain altitude; on two it will start a slow descent; and on one it will enter a fast powered glide. Landings are easy, with or without power, as the big wing produces a natural flare out at about 18" from the ground which results in nearly three point landings. Now that the joys of flying have been clarified, a few construction pointers are in order.

The two enemies of success are weight and vibration, hence the plane must be light, yet rigid. The wing is built first. The center section of the wing is a D-tube structure to a point just outside the engines in order to provide a rigid mount for the engine nacelles. Prior to installing the outboard engine nacelles it is advisable to silk cover between the ribs where the nacelle fits in order to simplify covering the balance of the wing. The engine nacelles are constructed on the wing from the sets of three profile formers. After the profile formers are in place, the firewalls are installed, being careful to keep the engine mounting holes parallel to the ground. Do **not** change the engine offset from that shown on the plans as the rudder behind each pair of engines eliminates the need for any other offset. The nacelles are covered with 1/16" sheet and the firewall joint reinforced with gauze or fiberglass cloth. The combination of well constructed nacelles tied into a D-tube wing provides a strong rigid assembly upon which to mount the four engines.

The remainder of the construction is conventional and should offer no problems. It should be noted that all wing spars and body stringers are 1/8" square spruce, and balsa should **not** be substituted for any reason. A major source of the favorable strength to weight ratio is the spruce. Build the body except for formers 5A-7A and then glue the completed wing onto the 3/32" incidence blocks. Formers 5A-7A are then trimmed to fit the wing and the 1/8" stringers are added the full length of the upper body. The stringers are then cut with a razor saw between formers 8A and 9A and the whole forward body section lifted off as a unit. Such a hatch provides access to the whole front half of the body for ease of radio installation, etc. In keeping with the "keep it light dictum," two coats of clear were brushed on to fill the silk and two coats of olive drab were sprayed on. The early (1941) B-24 was used primarily as a trainer, hence few, if any, markings are appropriate.

As mentioned earlier, the B-24 requires some form of proportional control due to a requirement to be able to hold the rudders in an off-center position. A Mighty Midget motor was used on the prototype, as a motorized actuator is necessary in order to hold the rudders against the slipstream. It is not recommended that actuators of the magnetic type be used due to the low power involved. In addition, with four engines running in only slight semblance of synchronization it is impossible to use a relay type receiver, yet most relayless receivers will not switch a motor. This dilemma was resolved by the use of an all transistorized "relay replacer." Figure 1 contains the schematic and a PC board for this device. Any 3 volt receiver such as a Kraft or Controlaire 5 can be used. The only additional requirement is that the receiver be operated at a voltage higher than one side of the servo batteries, i.e., 3 vs. 2.4 volts. In place of the usual escapement add a 300-750 ohm resistor (this will vary with receiver) on the receiver board from the collector to —3 volts. Connect the receiver +3 to the servo pack +2.4. The wire which normally goes to the escapement serves as the input to the relay replacer. Using this device, one has a completely solid state radio installation which is immune to vibration. A number of these relay replacers have been used for over three years in planes ranging in power from .020 to .35 without a single failure.

The original design of this B-24 model was near optimum as it has been flown as designed without adjustments of any kind for a period of over two years. The only further refinement suggested is to install a feedback servo using the filter technique given in the February 1965 issue of RCM. The relay can be replaced in the diagram by the relay replacer given above to produce a proportional system which should result in even more realistic flights of your B-24. In addition, any of the smaller full house proportional systems can also be used, utilizing only one servo for the rudder.

Regardless of your choice of equipment, you'll enjoy building and flying the B-24.

Printed circuit board shown twice normal size. Reduce 50% for actual sized board.