Radio Control Models & ELECTRONICS

JULY 1960

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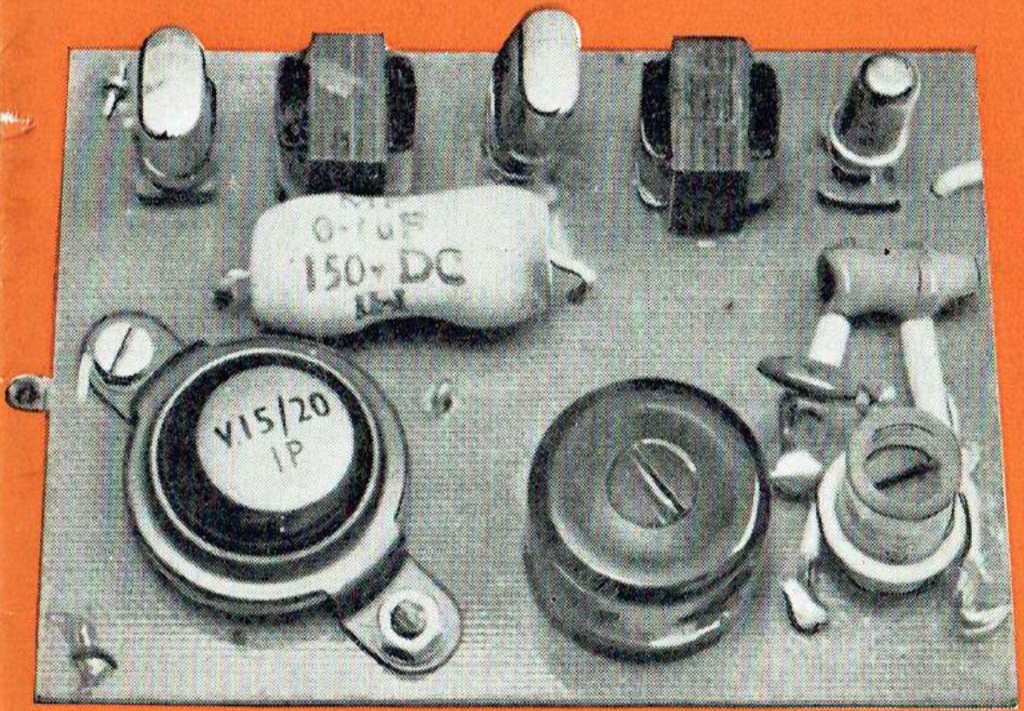

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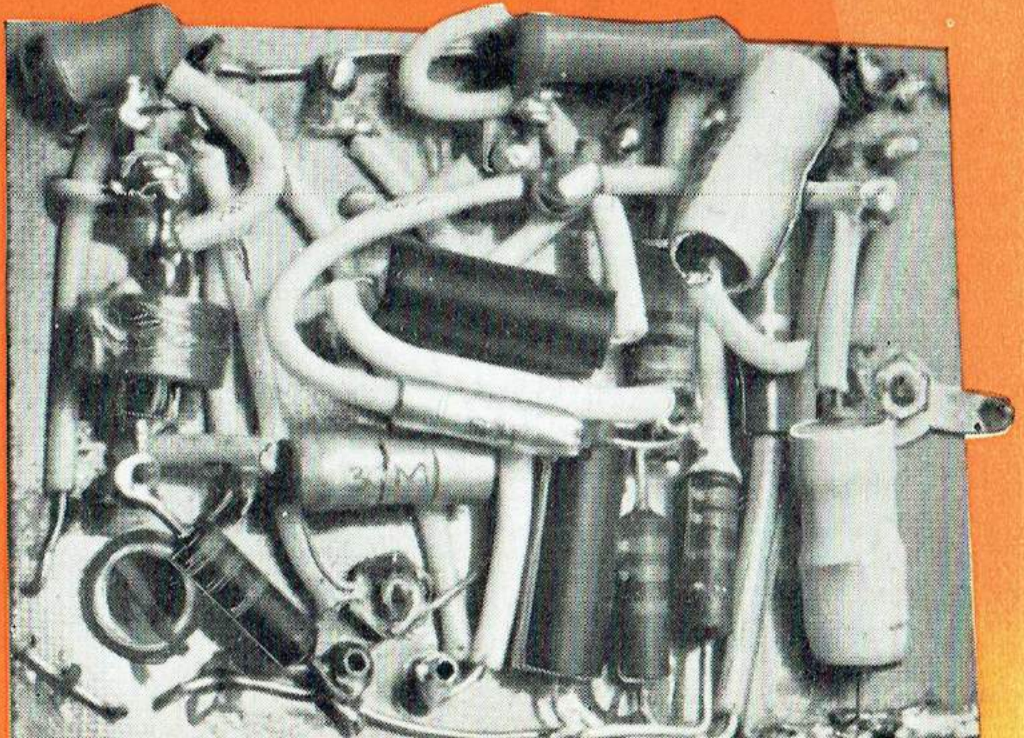

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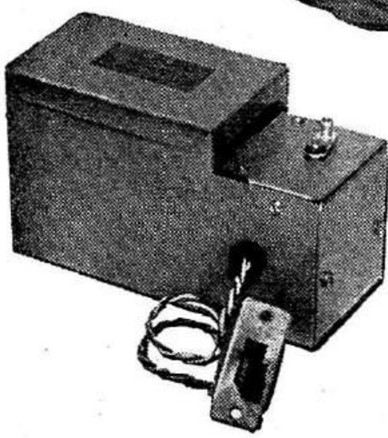

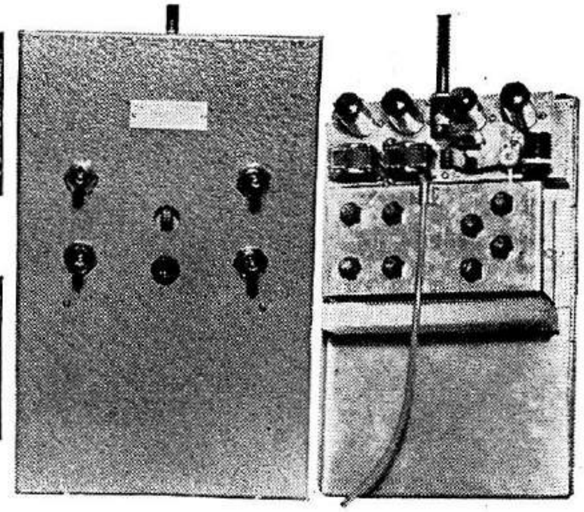

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Radio Control Models & Electronics

VOLUME 1 NUMBER 3 JULY 1960

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Here, There & Everywhere

Establishing a Pattern

ONE of the great joys of producing a magazine that caters for hobby activities is that readers emerge as "real people". When they write to us, or telephone, they do so because they have something to write or say about things they enjoy doing and so bring a genuine enthusiasm to the subject. There is no question of putting on their political hat, no tongue in cheek for fear of saying the wrong thing, no putting on an act to keep up with the Joneses, but just good honest comment of one fan to another. Thanks to the very many who have taken the trouble to tell us what they like and what they don't like about our new magazine we feel that a pattern is beginning to be established. Only beginning, mark you, for there are still many who have not expressed an opinion.

Need No. 1 seems to be more and more articles on what is actually on the market waiting to be used for radio control — something of a super Trade Notes report every month. Need No. 2 is information on exactly what to do with equipment, how to test it, how to install it in the model, and how to make the best use of it when it is there. Need No. 3 is the heart cry of the keen beginner "please tell us the basic facts so that we too can enjoy all those lovely circuits" allied with the middle-aged novice whose plea is for "the maths leading up to the formulae—since it is a long time since we were at school . . ." We will try to meet all these requirements and others that may come along.

R/C Records for British Flyers

Dave Adcock of Foresters M.F.C. has had his closed circuit R/C record claim of 13.469 km. ratified by the F.A.I. Technically he met the conditions of the Taplin Prize but very sportingly did not press his claim—however Lt.-Col. Taplin did persuade him to accept an ex-gratia cheque for £25.

The Dance/Skeels team have now put

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in a claim for a point to point distance record of 45½ miles—Lympne to Sidcup, ratification of which is still awaited. Meanwhile we are able to give some account of the technical background to the effort in this issue. *Aeromodeller* is covering the story of the actual flight in its current issue.

Several other likely champions are limbering up for attempts on speed and altitude records in R/C and their efforts will be watched with interest. Certainly the modelling movement cannot complain of the fine national press coverage afforded to the Dance/Skeels flight. This sort of thing does an incalculable amount of good to the movement in establishing it as a truly scientific and adult hobby. Thanks and congratulations to all concerned!

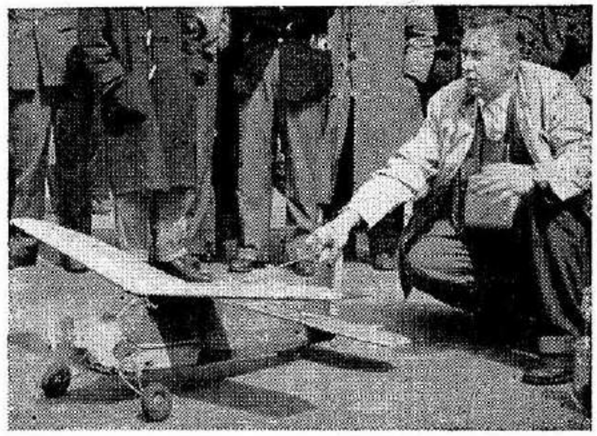
Something Special

With the Poole Regatta still to come as we write, we are looking forward to seeing one of the American boats coming over from Seattle. This is a 1/20th scale Seattle fireboat, the *Alki*, 6 ft. long, 80 lbs. weight, 6,000 hours work over nine years. A six-valve Tx. operates an 11-valve, 4-transistor Rx., 14 electric motors, and a mere 43 relays, giving three speeds ahead and three astern (electric drive), eight rudder positions, independent control of three pumps (15 gallons per minute) raising and lowering pump tower, proportional pump nozzle positioning, three lighting circuits, searchlight (including sweeping and elevation) and siren. Binary digital throttles are used by the way. Frank Reynolds is the builder, and this is one model we must see!

F.A.S.T. Club

Pasadena's F.A.S.T. Club (First All Speed Team) announce their new rules for R/C Team Racing! They seem so very happy that they may well attract attention over here for the growing sport of pylon racing—and since these boys have been doing it longer than most, deserve consideration. Here they are:—

1. Maximum Engine .199 displacement (3¼ c.c.).
2. Wing area 576 sq. in. minimum.
3. Fuselage cross section at cockpit: 3½ in. wide, 6½ in. high.
4. Cockpit or cabin with pilot's head of approx. 1⅝ in. size.



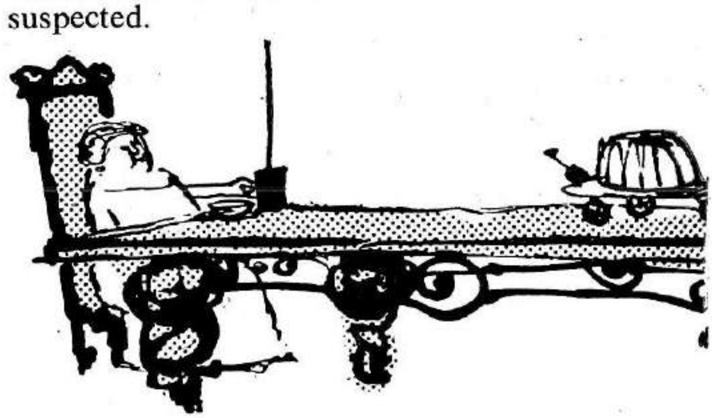
Roy Lever, proprietor of Leigh Models was putting up some fine single channel demonstrations with his Bellaphon/Ultraton equipped model at the Woodford Rally. It's nice to see the trade showing off its wares in so practical a manner.

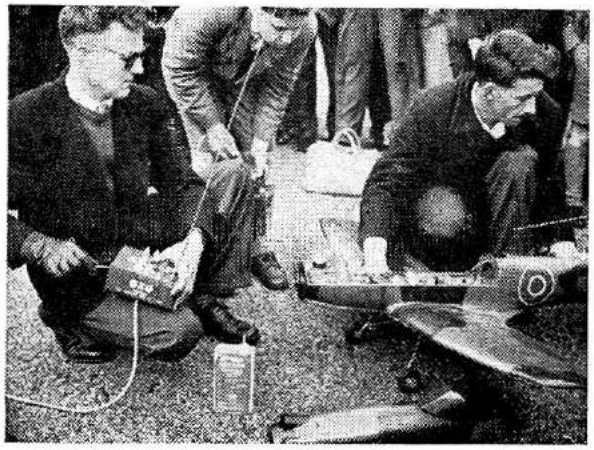
5. Wheel size 2¼ in. minimum dia. If wheels retract they must extend for landing.
6. A.M.A. licence on upper right, lower left wing and each side of rudder.
7. Racing number—upper left lower right wing so they can be read when plane is vertical in a left bank. Numbers also on each side of fuselage.

Team race entries will be judged for realism of design, workmanship finish and scale detail.

"Two Lumps, M'lord?"

Our cartoon this month comes from the *Esso Magazine* illustrating an article, "Big World, Little Engines", where they comment on the constant scaling down on engine sizes and their growing use in mo-peds, mowers, and the like with the concluding comment, "who knows what impact the modeller of today may have on the little engines of tomorrow?" Artist by the way is Andre Francois and not Roland who "does" for *Aeromodeller* as we at first suspected.





R. Rigby of Tottington, near Bury, Lancs, is first in our knowledge to tackle an R/C scale Spitfire. His Mark XIV has OS MAX 35, 6 reed, Aerotone, home constructed Victory Industries gear train servos. Note McQuee influenced OXO TX box !

R/C Down Under

R/C Models Club of N.S.W. has sent us a copy of their *Relaytor,* an ambitious 10-pager hectograph newsletter which contains a wealth of information on their activities. Weather is something to dream about—with flying 7 a.m. to 9 a.m., and then *too hot to fly!* Motors just don't give out any power and models wallow about at 20 feet altitude too tired to climb. Interesting Technical Notes deal with a "Shawtone" Rx. which turned out to be the famous American Kraft circuit under another name, but was valuable in that it gives advice on making some hard to get components, notably the R.F.C. Should anyone be stuck for this making a Kraft (circuit, etc. was in *Aeromodeller Annual* 1959/60, thanks to *Grid Leaks*), instructions are: "20 uh R.F.C. can be made with 8 ft. of double silk covered wire (finest you can get) and wound very carefully on a large value resistor (1 meg. or more)". We never seem able to get the dainty little R.F.C. on the other chap's Rx.—maybe readers are in the same boat and will set to and make theirs.

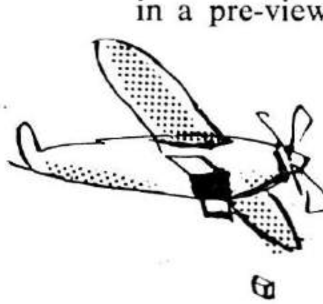
Czechoslovak Activity

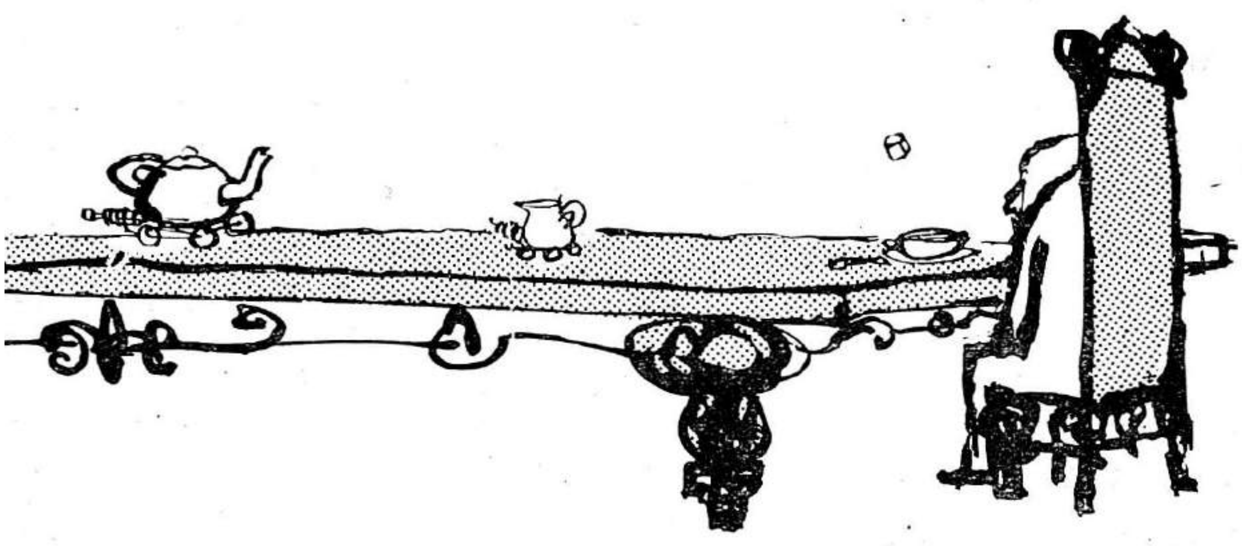
Price of principal Czech available equipment is around £45 for the MVVS Tx. and Rx., writes our Prague correspondent, so small wonder some 80% of modellers make their own. More surprising in a comparatively small country is that more than one thousand hold radio control licences! Most of the active R/C modellers are grouped in the aeroclubs of the larger towns; Prague for example has about 30 members. Ship modelling R/C is still in its infancy in common with other soviet countries, China apparently being a notable exception, that is making radio control apparatus like mad.

Eliminators have been held for the Championship at Dubendorf, so that there is every hope we shall be meeting Czech modellers there, competing in international R/C for the first time.

Southern Counties R/C Rally Taster!

"Greatest R/C competition in the country", writes "Barnum" Ed. Johnson in a pre-view of second Southern Counties Radio Control Rally to be held at Middle Wallop (kind permission of the Army Training Corps) on August 21st. Contestants can arrive by light plane or any other means of transport, classes include





Singel (Rudder only engine), Intermediate (anything from *one* RF or *one* audio frequency) and Multi. Intended as a county championship best flyers from each county will be allowed to fly in each class; manufacturers will be invited to demonstrate their products and swell the prize list. No profits! Any surplus will go back as extra prizes. Full particulars in next issue, meanwhile Ed. says, write in for them to him by all means, but do not expect an answer until details all ironed out neatly.

New Consultant

Peter Cummins, well-known radio control pioneer and I.R.C.M.S. stalwart, is going into the business of R/C consultant, specialising in industrial applications. A devotee of the 465 m/c band, Peter has forsaken power boats for yachts, and is largely responsible for the yacht control system used by several of the London Group I.R.C.M.S., where six yachts are simultaneously controlled by one transmitter. He has been awarded a contract to supply equipment for the R/C models to be used by the Red Duster Syndicate to develop an America's Cup Challenger; working in conjunction with the Saunders Roe test team, the models will be sailed on the open sea and cine-filmed, the films being used for analysis. The equipment to be fitted in the models will be similar to that successfully employed by the I.R.C.M.S. yachts with an excellent reliability record over many months.

Endurance Record for Cars ?

We heard the other day from that very enthusiastic model car fancier, Mr. William Boddy, Editor of *Motor Sport* who has long wanted to encourage an endurance record for i.c. model cars. His first thoughts were for something based on the old time cable racing model car but having a smack of scale class such as one of the vintage Renaults. Thinking around the notion it occurred to us that it might be possible to do the thing in real style with a R/C car, suitably powered (did someone whisper Taplin Twin?) and conducted round one of the aerodrome circuits by a following pilot car. We feel the pilot car would blow up first if forced to follow at some very low speed so that model m.p.h. must be at least twenty. Experts say it could not be controlled at that speed, but we think its speed will surely be relative to that of the controlling vehicle. We should welcome any suggestions, and, even more, any practical information from those who have tried.

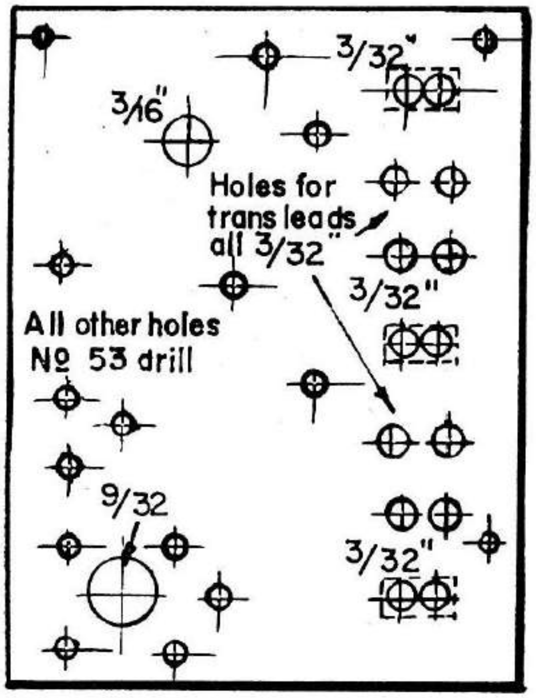
Now — The Hill Transmitter

Eric Hill, whose Hill receiver in its various marks has probably been built by more home constructors than any other European set, has now produced a terrific transmitter which readers will be able to enjoy in full step-by-step constructional form in our August issue. Crystal controlled, it can be considered and constructed in three distinct stages: (a) RF section, all that is required for carrier operated Rx. (such as the Hill); (b) tone section, with this addition modulated Rx.s can be operated; and (c) control box added to (a) and (b) gives you the needful for tuned reed working. Finally, like the Hill Rx., it has been so thoroughly checked, rechecked, and tested that success is virtually certain even in unskilled hands. Get August *R.C.M. & E.* and make it!

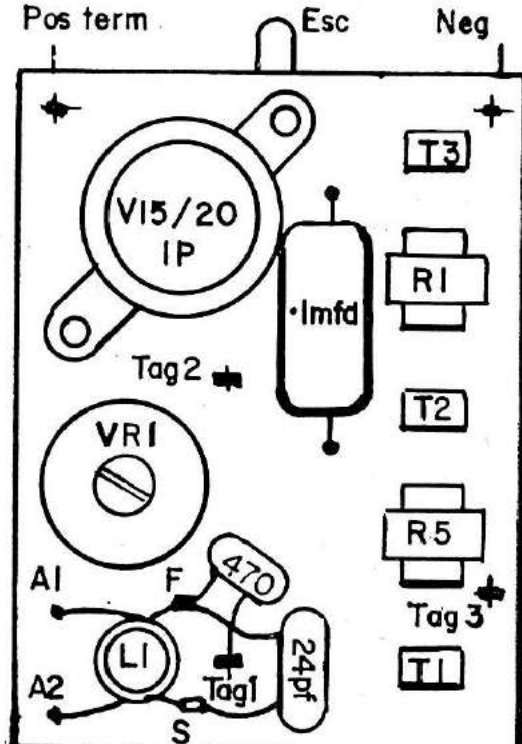
Radio Control in Punch

To be mentioned in *Punch* is to have really arrived! Recent cartoon by A. E. Beard depicts suburban "Jonesmanship" with owners of hand operated, motor-driven, de luxe motor-driven lawnmowers, looking progressively frustrated at their more fortunate neighbours, until last man looks at R/C mower unaccompanied by owner. We may not agree with A.E.B.'s "space ship" type of mower, but thank you Mr. Punch for the kind thought!

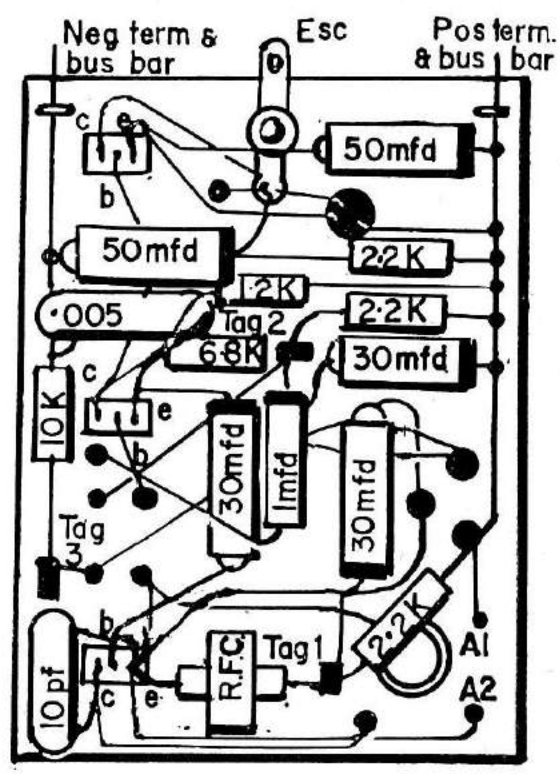
Hans Schumacher—complete with Bellaphon, rather naturally—and his 59 in. span glider fitted with ailerons and controlled by 6-channel Rx. With it he won German R/C class championship.



"305"



Drilling jig for chassis and top and underside component layout. Heading shows the authors' receiver with its battery of DEAC cells. Compare quality of their soldering with that of our novice !



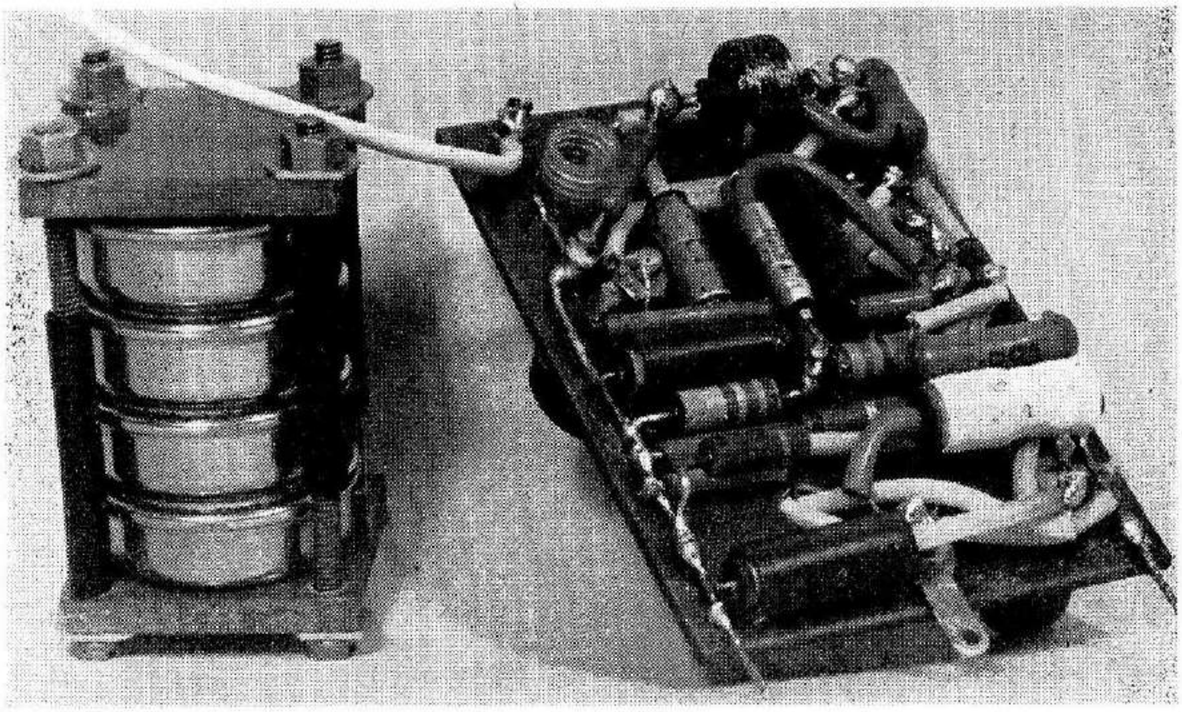
LIST OF COMPONENTS REQUIRED

1 Tufnol chassis 1/16 in.
3 Transistor holders. Henry's Radio.
*1 ¼ in. dia. coil former and dust iron core (core shortened to ¼ in. long). Radio spares.
1 47 K. sub-miniature pre-set potentiometer. (Plessey).
1 Transformer R1. (Fortiphone).
1 Transformer R5. (Fortiphone).
1 R.F.C. miniature pile wound. (Henry's Radio).
1 .1 mfd. tubular condenser. (Hunts).
2 50 mfd. electrolytic condenser 6 volt. (Plessey CE/24/1).
3 30 mfd. electrolytic condenser 6 volt. (Plessey CE/3/1).
1 1 mfd. electrolytic condenser 15 volt. (Radio-spares).
1 470 pf. condenser disc ceramic. (Radio-spares).
1 10 pf. condenser ceramic. (Radiospares).
1 24 pf. condenser ceramic. (Hunts).
1 .005 mfd. condenser ceramic. (Radiospares).
1 1.2K. ohm resistor miniature 10%. (Dubilier or LAB.).
3 2.2K. ohm resistor miniature 10%. (Dubilier or LAB.).
1 6.8K. ohm resistor miniature 10%. (Dubilier or LAB.).
1 10K. ohm resistor miniature 10%. (Dubilier or LAB.).
1 V.15/201 P. power transistor. (Newmarket).
1 V.10/50 A. transistor. (Newmarket).
1 V.10/1S transistor (switching). (Newmarket).
1 SB 305 H.F. transistor. (Semi-conductors).
1 yd. 30 s.w.g. enamelled copper wire.
1 yd. 22 s.w.g. tinned copper wire.
1 yd. 28 s.w.g. tinned copper wire.
1 yd. 1 m.m. sleeving.
1 ft. 4 m.m. sleeving (insulation for electro-lytic condensers. Slide over case).
2 8 b.a. × ½ in. C/SK brass bolts with nuts and washers.
1 8 b.a. double solder tag.
4 ft. plastic covered wire, red, black, yellow, white.

* *Core is locked in former with a short piece of 1/32 in. sq. rubber.*

ALL - TRANSISTOR SUPER - REGEN RECEIVER

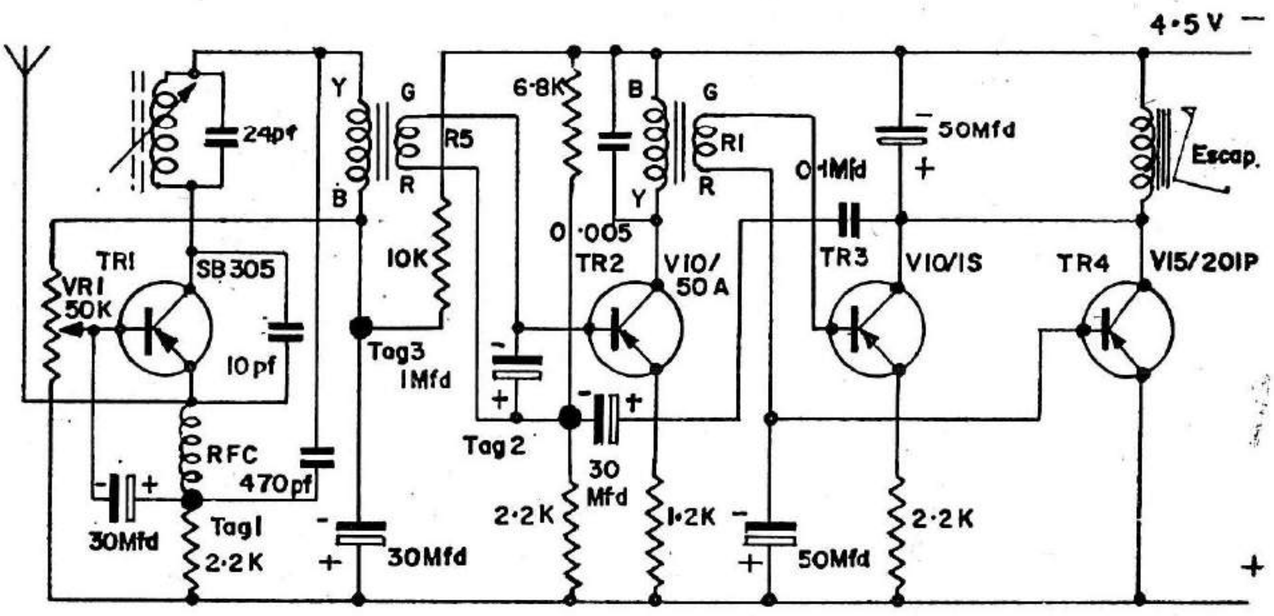
By DAVE CUTTRISS and TOM TAYLOR

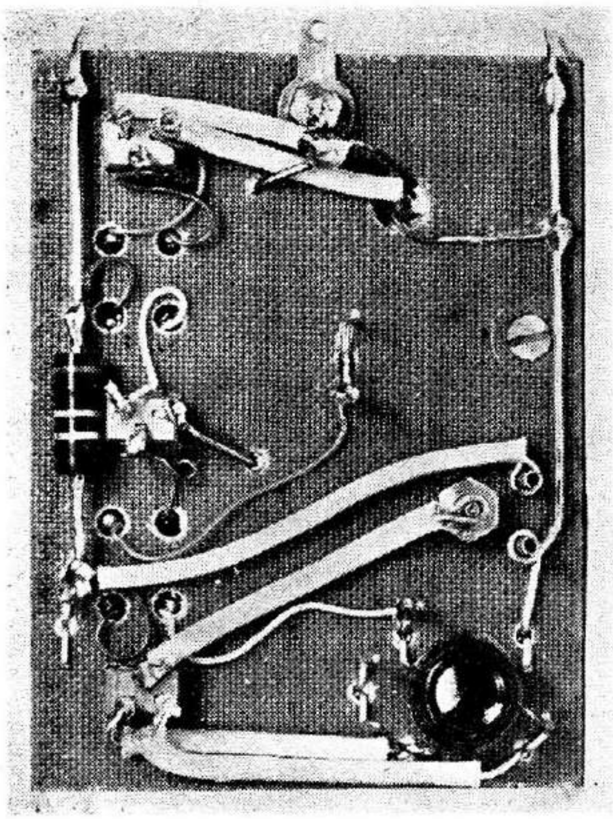


When this receiver was offered to us it presented a challenge. Could a complete radio control novice build one without assistance? Tommy Ives checked the result with the following comments: "... apart from three dry joints and a desirable improvement in soldering technique was very well done. In fact, after the dry joints had been corrected the receiver worked perfectly".

THIS receiver has been designed round a new inexpensive High Frequency Transistor the SB 305, available at the low price of 15/- retail. Previously a transistor of this type would have cost in the region of £2.

The variable bias control R.V.1 makes it possible for this type of 'front end' to be built by home constructors. Positive feedback is employed in the circuit to keep down cost and simplifies the circuit by giving an increase in overall





Underside of chassis after step (22). Note looping of wire at connections, where further components are to go, and also turning up of clever tag features. This chassis is by the authors.

gain, equivalent to that of an extra stage.

The receiver has NO relay, the power transistor being coupled directly to the escapement. *One* battery only is required, this can either be a 4½ volt dry battery or miniature 'button' type rechargeable cells made up to the required voltage. Receiver weighs under 2 ozs., and with the battery weighing a little over 2 ozs., total radio flying weight can easily be kept under 6 ozs.

It is not necessary to leave the TX. carrier switched on in order to hold down the receiver standing current. *It is very important to note that both the carrier and modulation of the TX. must be keyed simultaneously* — which also saves the H.T. battery. If the 'quick blip' method of motor control is required with the relayless receiver, the necessary contacts should be fixed to the moving armature of the compound escapement.

Pre-Assembly Drill

Study circuit, layout, parts and instructions until every step is clear in your mind. A couple of evenings just browsing over the job without doing any work on it is not too long to spend.

Be sure your soldering iron is suitable for delicate work. A light iron of not over 35 watts, with bit not thicker than ¼ in. dia. (⅛ in. is even better) having end filed off at about 60° is the handiest tool. Heat shunt (that is hold wires with pliers to disperse heat) wherever you are close to delicate parts, particularly transistors, and electrolytic condensers.

Sleeve all exposed wires where there is any chance of other parts touching them. This means virtually everything except the positive and negative bus bars. When soldering to these bus bars, it is as well to remember that later work may cause earlier joins to come unsoldered. This is avoided by a single turn of wire round the bus bar before soldering. Loop wire round connections before soldering, especially where more than one connection is to be made at that point. Study a "professional" job and you will see that this is the standard practice.

Electrolytic condensers have to go "right way round" with positive end facing as set out in layout. Case is negative, and positive is insulated from it by a little black washer. Positive end is usually marked with a red splash, but it can sometimes have rubbed off.

It really needs three hands to work comfortably. Third hand can be supplied by anchoring panel in the bench vice—but not so tightly as to bend it! A machine vice can be used for the same purpose and can be moved about more conveniently.

Assembly Instructions

(1) With coil hole at bottom left-hand corner glue into position with Araldite (used very sparingly):—

- (*a*) Aerial coil former, allowing it to protrude about ⅛ in. on underside.
- (*b*) Transistor holders into rectangular filed holes (use ⅛ in. square Swiss file) with pins facing as layout drawing.
- (*c*) Transformers, gluing on laminations, and with coloured flex through holes to underside. R.5 with blue and yellow flex facing TR1; R1 with blue and yellow flex towards TR2.

Check parts are correctly positioned before allowing glue to dry overnight.

(2) Next bolt V15/201P, power transistor in position, allowing the leads to protrude on the underside of chassis. One bolt secures the double ended solder tag. The countersunk head of the other bolt must be flush with the underside of the chassis.

Make sure that you can identify the leads, i.e. white spot nearest to collector lead. A spot of white paint on underside of chassis is helpful here.

(3) Now wire terminals are formed, this is done by making a split pin of 22 g. tinned copper wire, pushing the ends through the hole, and with a short piece of wire through the loop, the loose ends are pulled with pliers flush with chassis in the desired direction. The short piece of wire can now be removed or cut short on either side or soldered.

(4) (*a*) Start L1. Coil terminal to collector of TR1.

(*b*) Yellow flex R5 transformer to L1. Finish terminal.

(*c*) A1 Aerial link coil terminal is formed leaving one long lead.

(*d*) Other link coil terminal A2 continues to emitter of TR1 (sleeved).

(*e*) Scrape off insulation of wire for about 1 in. each end and tin. Now wind L1 coil 10 turns of 30 s.w.g. en. wire wound tightly.

(5) Next bolt 47 K. ohm potentiometer in position.

Long lead from aerial link coil terminal A1 is wrapped once around + ve potentiometer pin and then on to + ve bus bar terminal. Do not let this touch the countersunk head of the power transistor bolt, a coating of Araldite on the screw head is as well here.

(6) Tag 1. Wire terminal is formed bending ends upwards and cutting off about ⅜ in. from chassis.

(7) Tag 2. Wire terminal is formed, the ends bent upwards ⅜ in. long.

(8) 10 K. ohm resistor from Tag 3 to — ve bus bar terminal.

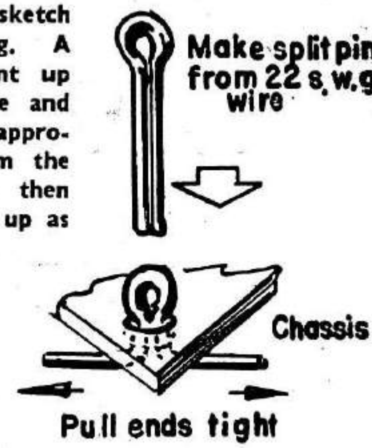
(9) Blue flex R1 transformer to negative bus bar.

(10) .1 mfd. condenser leads are pushed through holes in chassis.

(11) Wire one lead to double solder tag. The other lead to emitter to TR2.

(12) Wire from collector of power transistor (white spot) to inside tag of double solder tag, and continue to collector of TR3. Both these runs should be sleeved and a heat shunt should be used near to transistor (pointed nosed pliers) while soldering the solder tag.

Much enlarged sketch of tag making. A split pin is bent up from 22 g. wire and pushed through appropriate holes from the top. Ends are then bent and turned up as photo left.



(13) Wire from base (centre) of power transistor to emitter of TR3. Heat shunt lead and use sleeving here.

(14) Red flex R5 to Tag 2.

(15) Emitter of power transistor to + ve bus bar (shunt and sleeve).

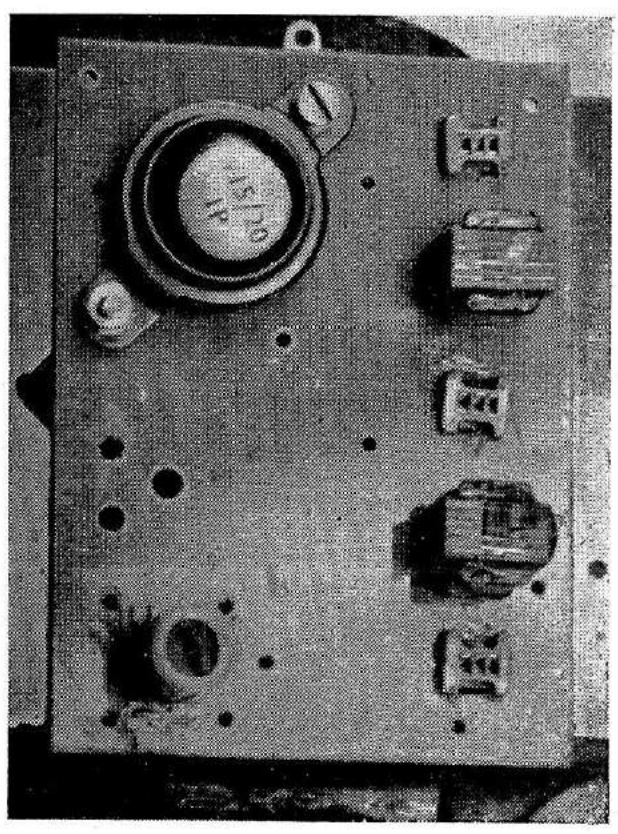
(16) Now green R5 to base of TR2.

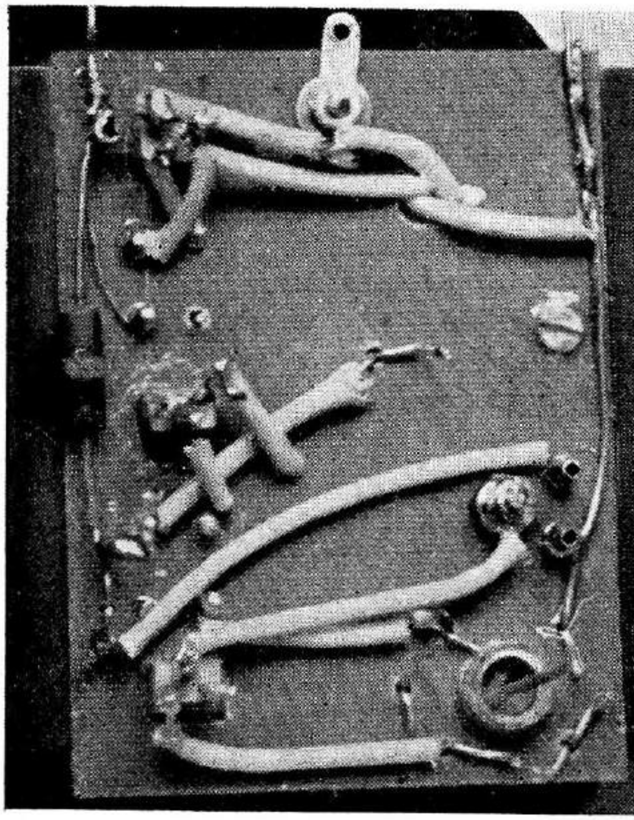
(17) Blue of R5 to Tag 3.

(18) Tag 3 to negative pin of potentiometer.

(19) Centre pin of potentiometer to base of TR1.

Top of chassis partly constructed by our novice, with transformers and transistor holders stuck in place. Try to file holes for these more accurately !





Our novice's chassis again! Above position after step (29). Note sleeving of electrolytic condensers and adequate use of "spaghetti" sleeving on wires. Below, top and underside of completed job: all parts used and fervent hope that it works! Minus marks for soldering—please do not copy !

(20) Red flex R1 to emitter of TR3.

(21) Green flex R1 to base of TR3.

(22) Yellow of R1 to collector of TR2.

(23) R.F.C. from emitter to TR1 to Tag 1.

(24) 30 mfd. from centre pin of potentiometer to Tag 1.

(25) 2.2 K. ohm resistor from + ve pin on potentiometer to Tag 1.

(26) 30 mfd. (case insulated) from — ve pin of potentiometer to + ve bus bar.

(27) 6.8 K. ohm Resistor from Tag 2 to negative bus bar.

(28) 2.2 K. ohm from Tag 2 to + ve bus bar.

(29) 30 mfd. from Tag 2 to emitter of TR2 (case insulated).

(30) 1.2 K. ohm resistor from emitter of TR2 to + ve bus bar.

(31) 1 mfd. electrolytic from Tag 2 to base of TR2.

(32) 2.2 K. ohm resistor from emitter of TR3 to + ve bus bar.

(33) 50 mfd. electrolytic from double solder tag to — ve bus bar.

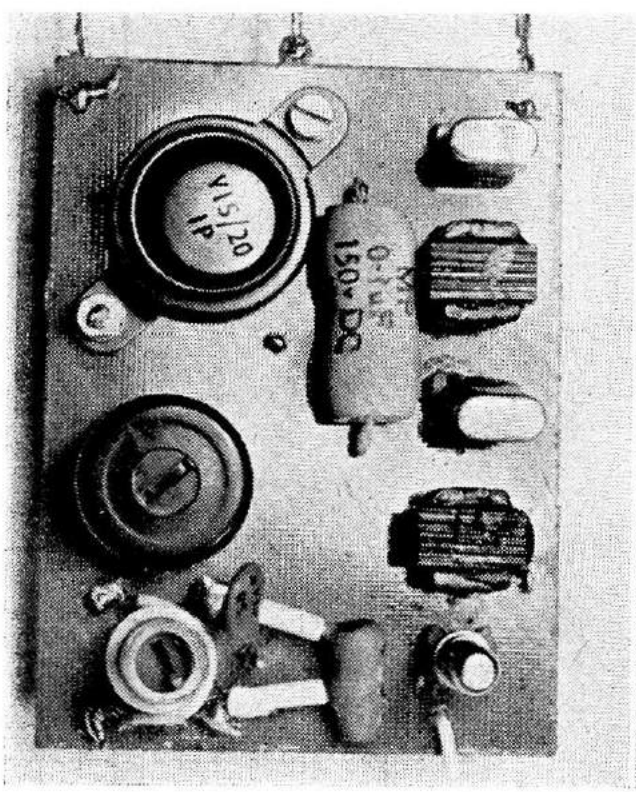
(34) 50 mfd. electrolytic from emitter TR3 to + ve bus bar (case insulated).

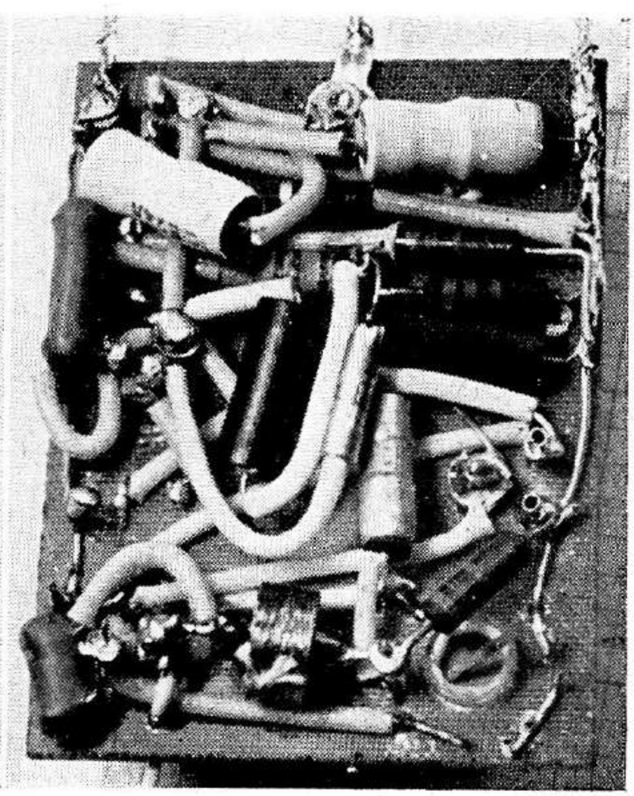
(35) .005 mfd. condenser from collector of TR2 to — ve bus bar.

(36) 10 pf. condenser from collector to TR1 to emitter to TR1.

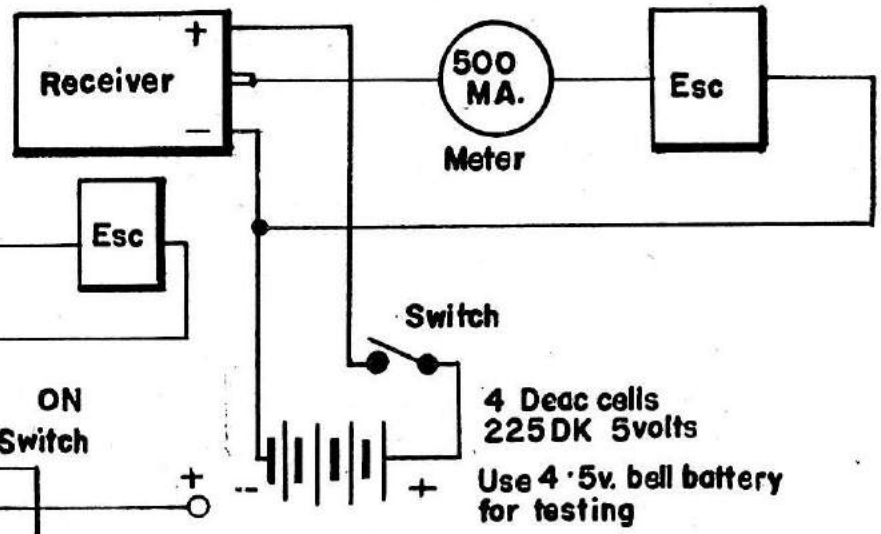
(37) Solder about a foot of plastic covered wire aerial tag.

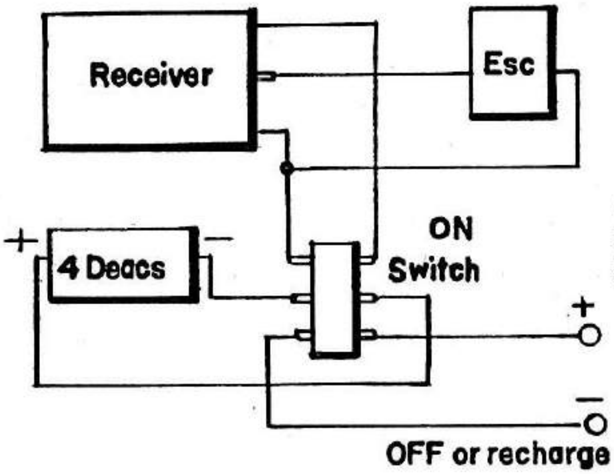
Turn chassis over.





Below: Suggested circuit for rechargeable batteries. On right: Receiver set up for testing with milliammeter in circuit.





(38) 24 pf. condenser from L1, start tag to L1, finish tag.

(39) 470 pf. condenser from L1, finish tag to Tag 1.

(40) Solder about 6 in. of red, yellow and black plastic covered wire to the + ve bus bar terminal, double solder tag and — ve bus bar terminal in that order.

To Tune

Switch on receiver, turning R.V.1 clockwise *slowly* until a point is reached when the collector current fluctuates or 'motor boats', now turn R.V.1 slightly anti-clockwise until 'motor boating' ceases. Meter should now read about 4 m.A. With transmitter switched ON (and no aerial) tune receiver L1. Dust-iron slug with non-metallic tool, until a current rise occurs.

Now re-adjust R.V.1 for maximum current rise (300-400 m.A. depending upon voltage, and type of transistors used).

Now increase aerial length of receiver to about 30 in. and repeat the process with full transmitter aerial for range check. The receiver is very sensitive and great range should be obtained.

Swamping or saturation will occur if transmitter is operated too close to the receiver. To overcome this swamping effect, both the carrier *and* modulator must be keyed together.

R.C.M. & E. Technical Notes and Comments

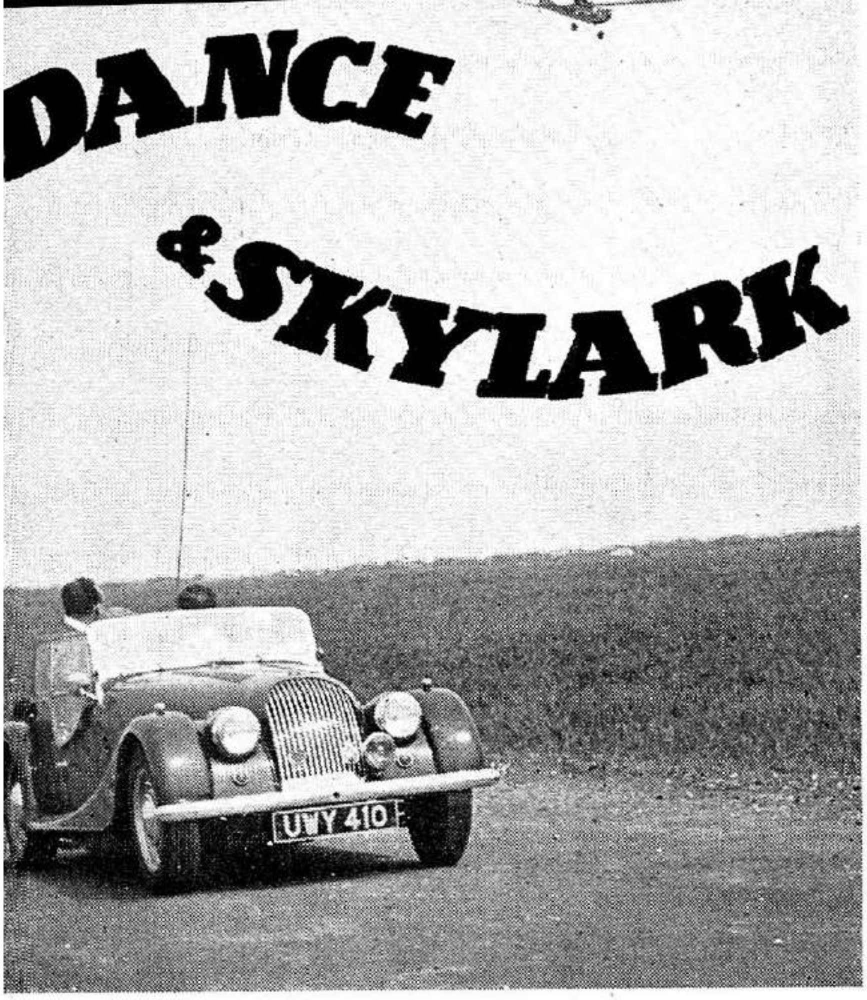
A completed receiver was submitted for test. Tuning was quite sharp for this type of Rx. and care in tuning should be exercised. On test it worked perfectly and with an extremely low standing current is an attractive proposition. Current rise to 350 m.a. with four DEAC cells (450 type) and a Fred Rising actuator was achieved without difficulty. Temperature stability was good. Pulsing up to approx. 15 c.p.s. was achieved without difficulty. The Rx. would also appear to be attractive for low resistance reed work. A modification to include a relay for pptnl. work would also seem to be feasible.

A kit of parts was also made up by a complete R/C novice, and, as noted at beginning of article proved successful. In the light of his experience some changes to instructions were made. A further set was then made exactly to these instructions by the authors, and worked first time!

Parting remarks: This is *not* a cheap set—do not try to make it so by buying inferior parts or skimping work. It will cost around £6 to make and is well worth a little trouble. Again, do not economise on batteries: run down batteries may mean loss of control (and model!); see that they are fresh or fully charged. McQuery Column is, of course, open to answer any special problems arising. Good luck!

[The authors regret that they are unable to enter into any correspondence over the construction and operation of this receiver. The "305" has been so successful, however, that it was felt this article should be published for the benefit of other constructors and experimenters.]

DANCE & SKYLARK



BACKGROUND TO THE DANCE / SKEELS WORLD RECORD R/C FLIGHT IS GIVEN BY THE P.R.O. OF THE NORTH KENT NOMADS M.F.C. OF WHICH CLUB THE ASPIRANTS ARE MEMBERS. THEIR $45\frac{1}{2}$ MILES FLIGHT FROM LYMPNE TO SIDCUP HAS YET TO BE RATIFIED BY THE F.A.I.

"Dance & Skylark" is a ship's order announcing the beginning of a leisure period and seems appropriate to Charlie who has certainly had a wonderful sky lark !

Pilots aboard the speedy Morgan Plus 4 which was often extended to keep the model in view during the $45\frac{1}{2}$ mile flight.

SOME time ago, Wally and Charles decided to team up for cross country radio controlled flying.

In the first place, it was the desire to get to the other side of the airfield fence which tempted them in this venture.

Various models gave varying performances, and after many armchair chats and much midnight-oil burning, a modified Junior 60 appeared. This model covered 10 miles of fun and experience, but their appetites were whetted and something bigger was in mind.

After much thought, based on experience, they firmly believed that something of at least 8 ft. span and a steady powerful engine up front was necessary to carry the fuel and give the model penetration.

From under the bed was produced an old Smog Hog fuselage. Modification to this took place right away.

In the meantime Wally took pencil to paper and produced a design for suitable wings and tail-plane. The wings are 8 ft. 6 ins. span by 12 ins. chord and used an R.A.F. 32 section. The tail-plane is 34 in. span by $7\frac{1}{2}$ in. mean chord using a thin Clark Y section.

Start of the flight. Wally Skeels hand launches the fuel laden model from Lympne soon after first light.

Scanning both workshop shelves for a suitable engine and conducting fuel consumption and power output tests showed that the fuel consumption was higher than desirable for long distance flying.

Searching the model press and from various reports showed the Taplin Twin to have possibilities. The purchase of one of these units showed it to have the right sort of fuel consumption, coupled with power output. Further, the two speed throttle was most effective and gave what was required. Being a Twin, vibration was kept to a minimum.

Fuel consumption tests on the Taplin Twin gave up to $6\frac{1}{2}$ minutes per fluid

Anxious moment! Model has been momentarily lost and the two pilots bear worried expressions. (Rx. had been accidentally switched off!)

oz. of fuel. Junior 60 experience showed that the pressure feed was a must, and towards this end, with check valve in the crankcase and a ping pong ball float chamber, Wally made an extremely efficient pressure feed system.

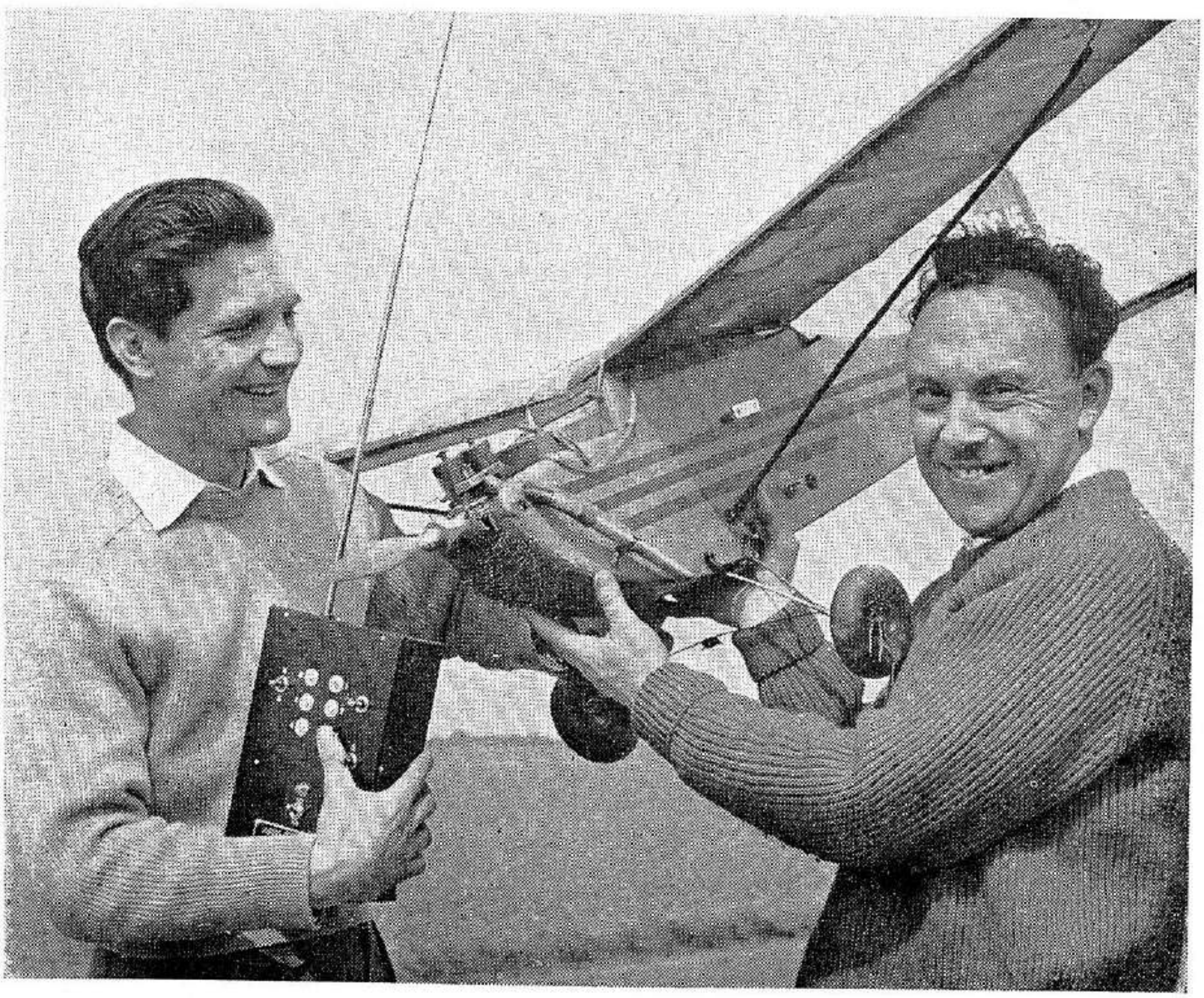
As our two tyros were considering a distance of over 40 miles, then it is quickly realised that a tank with something in hand had to have a capacity of at least 30 ozs.

The radio gear in the plane was a modified Tommy Ives Rx. Tommy actually gave a lot of assistance in this direction. The escapements were ED standards modified to give cascade operation. It was soon shown that for this sort of endurance, rubber was not the ideal driving force for the actuators, and motorised actuators were produced.

The system, briefly, was a master actuator operating the rudder which, in turn, operated the engine and elevator at will. But this system required too much head work, and as Charlie is over 21 he found it much too complicated! A think box was produced to overcome this problem. This was the form of the gear which took the air for the 23½ mile flight.

It is worth mentioning that glide testing of the model gave little indication to the trim, but, much to our friends' delight, the first power flight at 9½ lbs.

All over! Safely landed at designated point Charlie and Wally have every right to look pleased with themselves, even if model has lost a prop blade! (All photos by John Jackson).



showed the model to have first class flying characteristics and rate of climb.

This equipment was used for trips totalling some 60 miles with complete reliability, but on each occasion the engine was found to peter out after running for some time, and dropping the castor oil content down cured this.

Activities were brought to a halt when Charles and Wally were both taken sick. On the first field test after their lapse of flying, a piloting mishap resulted in a rather disastrous crash when all the gear was smashed. Fortunately the plane did not suffer too badly, but a tremendous amount of repair work was necessary.

As time when the roads are not too crowded was running out, some time was saved by installing ED 6 reed Black Prince equipment as the old equipment could not be replaced by buying over the counter. ED motorised actuators were installed as well. Once again thorough field tests had to be carried out with special reference to range, and it was found that at ground range of sight the meter showed full whack.

The Rx. was mounted at the CG under the main fuel tank on sponge rubber. The actuators were mounted either side of the wide fuselage, and the engine control was mounted immediately behind the fire wall. All the equipment was protected by thin aluminium covers.

The actuator circuits were wired to give high-low engine speed, full left and right rubber, full up and proportional down elevator. The elevator amounted to no more than a trim tab.

Particular attention was given to wiring, and all joints were sleeved after soldering so as to make them mechanically strong.

Vibration and actuator tests under working conditions, i.e. continuous operation for up to two hours, proved the equipment to be entirely reliable.

The weight due to these alterations, both gear and structural, increased the all up weight to 10 lbs. 8 ozs. It is fair to say that the engine took no notice of this increase in weight. A small change in trim gave increased flying speed. After flight testing for several hours a change of batteries was made in preparation for the great day. The remainder of the equipment remained untouched.

On the actual day, May 8th, having roused his team from the North Kent Club (amazing how good Charlie has become at persuading people to get up at 2.30 a.m. on a Sunday morning), the model was prepared and launched at Lympne at first light. Charles was first on the button and brought the plane to 500 ft. and the Morgan Plus 4 and occupants made off for the A.20.

The team gave information regarding speed and time and estimated minutes of fuel remaining, and also the engine note was observed from time to time by outriders. Fortunately traffic control was only necessary in Maidstone.

All control from Lympne to Crittals Corner at Foots Cray was without fault.

Charles and Wally wish to thank all concerned, especially the wives, for their continuous support over the past seven months.

The actual team of observers and past assistants consisted of enthusiastic members of the public and fellow members of the North Kent Nomads. They were:—Jack Ashcombe, Ivor Bittle, Tug Burne, Geoff Chapman, Nigel Dance, Mr. Grou, John Jackson, Ray Parker and Alan Smith.

Our Battery Data Sheet

WE HAVE CRAMMED quite a lot of information on our Battery Data Chart, including socket diagrams, and equivalent types. For this reason it does not contain EVERY battery that is on sale, but it does provide examples of all those of interest to radio control operators available at the present time and generally in use for the purposes stated.

Chloride Batteries Ltd. have been most helpful in providing information and assistance and we should like to thank them most cordially. We must add, however, that, as good manufacturers must be, they were very conservative on the subject of recommended current range of their products. Figures given, as noted on the chart, are for long life use, they can often be exceeded several times for special purpose use, and there is nothing wrong with this so long as user realises there is only a fixed amount that he can take from a given battery. He can have it little and slow for a fairly long time, or in a few glorious surges of energy, and finish!

Exide are shortly releasing a new high rate discharge battery the T22 which will approximate to giving the best of both worlds long life and high discharge. It is not included in the list since we have not yet had an opportunity of testing it, but is one to look out for in the near future.

In using the equivalent chart, principal alternative makes are shown, and their characteristics should be much the same as those listed in detail, but naturally, there may be minor differences between makes though socket fitting will be the same.

Radio Installation

INTRODUCTORY ARTICLE OF A SERIES IN WHICH READERS ARE INVITED TO PLAY A PART

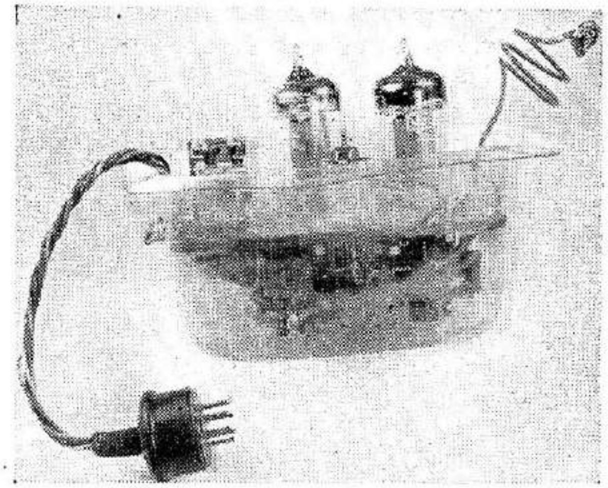
THERE appears to be a dearth of information on proper methods of radio installation. Some kit manufacturers make no effort at all to provide universal details to cover even the more popular range of equipment, and the radio gear manufacturers do little to help.

What are the basic requirements? Firstly to *safeguard the investment.* The gear must be shock mounted and so disposed as to withstand an airframe write-off.

Secondly the gear should be *accessible* without recourse to complete disassembly of the airframe just to tune a slug.

Thirdly the gear should be disposed in the airframe so that the deadweight or *cargo effect* has least effect on the model performance.

Fourthly the gear should have *planned wiring.* The mess of wires resembling rats nests as seen in our visits to the flying field only invite disaster. Fifth and final in our basic needs is provision of *ample power source* in the shape of dry cells or nickel cadmium cells with full charge and safety margin for the leads involved in operation.



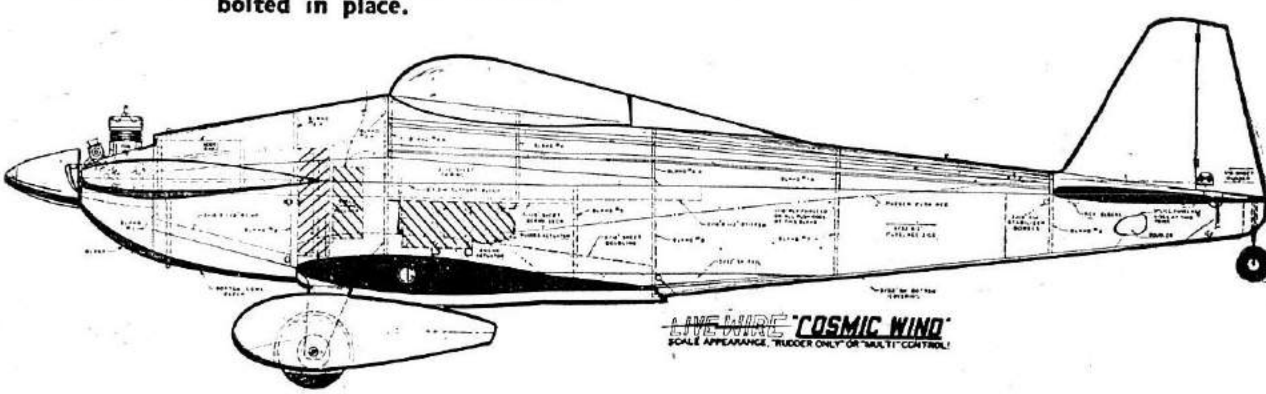
The Hill CW set in an acetate "bath" as advised. Plastic is easily heat moulded over a rough forme, leaving edges untrimmed for rigidity. Can then be imbedded in foam. Note B7G and snap fastener for connections.

We know there are more precautions: but those are of prior importance and perhaps through the medium of R.C.M. & E. we can establish a regular forum for readers to put forward their own approaches to this often overlooked but so important side of radio control modelling. What about it readers? How do **you** do it?

To set the ball rolling, here are a few pointers on the five golden rules of R/C installation as we see it.

There are two main types of Rx. The canned or plastic encased, and the older or home constructed hard valvers with tubes and components projecting from two sides of a base. Without a doubt the safest way to mount any canned, or plastic cased Rx. is *base forwards* with the set up "on end". The majority of unintended terminations are in a forward direction. A vertical dive or collision with a vehicle are typical. The sudden halt from up to 60 m.p.h. is likely to ask the tail to make company

Harold de Bolt's low wing shows the Rx. mounted vertically and stuck to a battery box lid via sponge rubber against front bulkhead, servos are behind, bolted in place.



with the wing, and what it will do to any vertically mounted transistors let alone valves, on pins is incredible. Many a Hill set still functions with slant mounted, 3V4's; but for how many more flights ?

Stick Dunlopillo on the base if it's a one-side-of-the-base assembly and pack it up against a bulkhead, allowing slight movement to each side before it contacts more Dunlopillo. Remember, the tighter you pack it—the more vibration is going to get through to the relay from the engine.

Of course if the fuselage is not deep enough then the Rx. has to be flat on the base, relay foremost as the heaviest internal component. Foam plastic does pack and absorb light load compression safely: but it compresses to nothing in a real spar bender, so be warned!

With sets that have hard valves it is all the more important to try and get the base vertical or change the valve mounts to horizontal as did Les Wright in his clever Rx. from New Zealand. If it cannot be done—then mould an acetate "bath" for the exposed lower side of the Rx., get the base firmly installed and push the lot into a hole scooped out of a Dunlopillo or foam plastic "brick". Then wedge the lot in the fuselage and pack on the top with more foam to keep things in place.

Elastic band suspension for whole Rx.'s is now very much old stuff and has little to commend it, especially since it is often a vibration promoter, leading to further troubles.

If the Rx. is safely installed, we also have to ensure that it will not be subjected to flying wreckage such as four or five ounce battery packs or motorised servos. The latter need rigid attachments so careful nut and bolt application will help there; but the batteries are always in need of a check so must be accessible.

Get the batteries as far forward as possible. Certainly they must be ahead of all other components except the fuel tank and engine. The batteries do not need to be boxed, provided the fuselage itself is sheeted, and we can get best serviceability from a battery pack with enough wire attached to permit removal from the fuselage without disconnection.

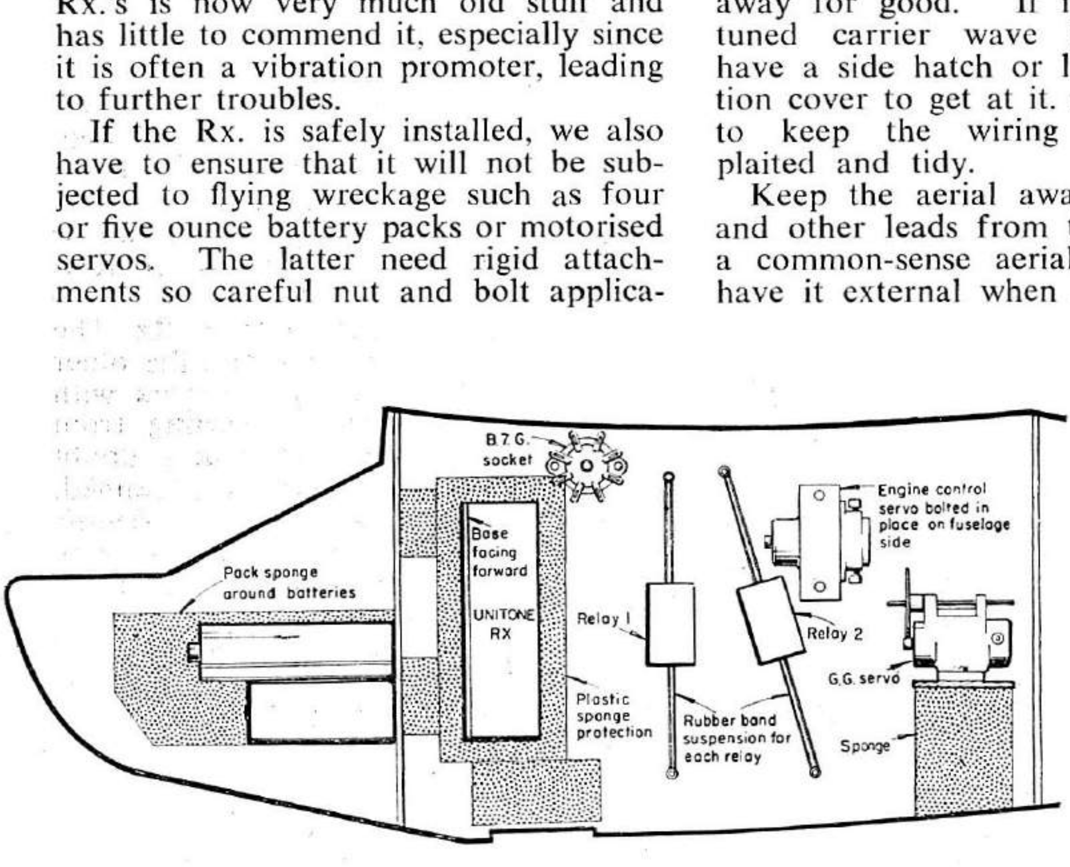
Wrap the batteries with foam and pack them in tightly against a bulkhead. Solder snap fasteners to ends of connector wires and wind the wire harness into a respectable but not too long plait to a B7G socket connection whence come the Rx. and servo wires.

The ideal is, of course, to use a nylon battery box and have the Rx. Pliobonded to its lid with a Dunlopillo sandwich as advised for example in the de Bolt Cosmic Wind Kit—but first get your nylon battery box!

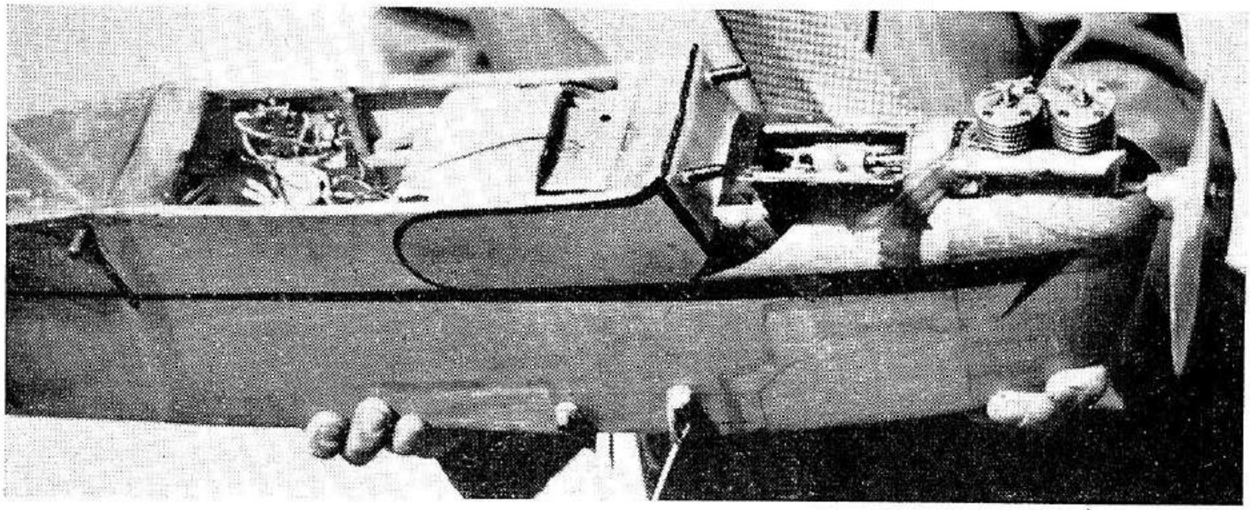
Accessibility is a function of careful design.

Be specially thoughtful of "how to get at it" when planning the lay-out. Did someone say it is no good sticking the Rx. up "on end" and then have the tuning plug access hole buried in foam rubber? If it is a tone set all you should need to do is tune once with the Rx. out of its packing then put it away for good. If it is a sensitivity tuned carrier wave home-built then have a side hatch or lifting centre section cover to get at it. And don't forget to keep the wiring harness neatly plaited and tidy.

Keep the aerial away from actuator and other leads from the Rx., and use a common-sense aerial position. Why have it external when many a fuselage



Typical installation set-up is provided by this extract from the Aeromodeller Plans Service design "Rattler" by Charles Riall for Simpl Simul. Note the extensive use of foam plastic or rubber and the vertically mounted Rx. Separate relays are rubber band suspended tightly between dowels.



Dutch Typhoon engine maker Veenhoven has a Smog Hog with neat installation of his own twin diesel, 8-channel Rx. and pneumatic servos. Note Rx. accessibility in cabin, loose mounted yet foam protected.

will absorb the length required? All one needs is a length of ⅛ in. bore fuel tube stuck down a longeron, and the aerial can be slid in place, held in its location yet easily detachable.

Fifth of our golden rules concerns the power source. There is no denying that the DEAC cell is ideal for many purposes. Remember, however, that the charged cell is 1.2 v. and *not* 1.5 v. for Rx. LT connections. If 30 volt HT is called for, don't skimp the grammes, go for the larger dry cell (layer type) battery. Our Hill, Mikroton and Marcytone still use 1959 batteries because we chose the bigger unit, but for safety's sake, make it a rule to invest in fresh cells regularly. The proportion of running costs is relatively low to the value of your equipment! Be wise too — always meter check the batteries when *on load*.

What's *your* Installation angle? These pages are open to your suggestions in a regular information forum.

McQUERY COLUMN

DAVE McQUE WILL ANSWER QUERIES THROUGH THIS COLUMN EACH MONTH, AND WE WELCOME GENERAL INTEREST PROBLEMS. AT THE MOMENT WE CANNOT UNDERTAKE TO ANSWER QUERIES THROUGH THE POST, NOR SHOULD SETS BE SENT TO US UNLESS SPECIFICALLY REQUESTED.

REGARDING the design of the 6-Transistor Superhet receiver by J. W. Ford. Can you please explain how the mixer delivers an output of 200 K/c. when in fact the oscillator is operating at 13,500 K/c.? Assuming the signal frequency to be 27,120 K/c., and the oscillator frequency 13,500 K/c, then surely the mixer output should be in the order of 13,620 K/c. or 40,620 K/c. The former being the lower, and the latter the higher intermediate frequency. To obtain an intermediate frequency of 200 K/c, using the same signal frequency, an oscillator frequency of either 26,920 K/c or 27,320 K/c would have to be used.—K. B., RADFORD.

You are quite right in assuming that a local oscillator frequency of 26,920 K/c or 27,320 K/c would be required and, if separate oscillator and mixer transistors were used this would be the most efficient arrangement. However, if an attempt is made to combine the functions of oscillator and mixed, 'pulling' of the local oscillator frequency and other unwanted effects are bound to occur due to the small percentage difference between the desired LO, and signal frequencies.

In this receiver (as in my valve superhets) the oscillator is operated at half (⅓ in my valve sets) of the required frequency, and the required frequency appears as a harmonic of the actual oscillator frequency due to the nonlinearity of the current/voltage relationship of the transistor emitter-base circuit.

In practice the efficiency of such an arrangement is quite reasonable and the use of a separate oscillator TR is hardly justified.

I HAVE built an all Transistor RX from a kit put up by Henry's Radio Ltd. I wonder if you can advise me how to modify the set to give a greater range as it is rather low on range and power.—D. J. L., AYLESBURY.

I am not surprised that the little all Transistor set is low on range. My experiments have shown that three audio stages after the detector stage are required. We do not, however, advise on mods. to commercial gear, for obvious reasons, so it is best to take the matter up direct.

I WONDER if you could supply me with the circuit for a transistorised crystal-controlled 'speech' transmitter with a frequency of 27 mc/sec.; also a receiver of the same calibre.

—P. D., CHEAM.

I suggest you look at the October, 1959, issue of *Radio - Electronics*, p. 55.

WITH regard to your Versatile Tx., would it be all right if I mounted the Tx. in a wooden box instead of a metal one?

The control box I have at present is the one from the March, 1959, "Aeromodeller", can this be used with your Tx.?

Can SK2 be replaced with an ON/OFF switch?—R. P., FELTHAM.

There is no reason why you should not use a wooden box so long as you arrange that the works on the underside of the chassis are enclosed by metal. It is handy to keep SK2 as a socket (and cheaper), but a switch could be fitted.

A suitable control box for reeds appears in the June issue of RADIO CONTROL MODELS & ELECTRONICS.

IN reply to Dave McQue's statement in his article, the fact that crystals in the band 6740 to 6820 Kcs. are the obvious choice when building a transmitter.

When using a crystal in the range 8990—9090 Kc. we either have to treble in the oscillator stage, and use a straight P.A. stage with all the difficulties of neutralising, or use an oscillator at the crystal fundamental and treble in the P.A. stage, which is not usually done, due to extremely low power output. By using a fourth harmonic crystal we can double in the oscillator stage, getting quite enough drive, and then use a power doubler output stage which does not require neutralisation, and still gives a useful power output. An example of such a transmitter is given in the December, 1959, issue of "Model Maker".

The average type of radio control constructor does not want a transmitter which has unnecessary complications in construction, and difficulty in setting up.
—H. T., DUNMURRY.

My remarks were intended to apply particularly to my transmitter and to fend off the inevitable query as to whether ¼ freq. Xtals could be used.

You will also note that I particularly recommended ½ freq. Xtals, although the Tx. is equally effective with ⅓ freq. Xtals without any modifications. Even the ¼ freq. Xtals will work at reduced output and efficiency.

I do not dispute that the use of ¼ freq. Xtals in a two valve set-up, viz. osc/doubler plus power doubler is not an attractive scheme, especially if one already possesses such an Xtal. An even simpler scheme is to use a ½ freq. Xtal in an oscillator plus power doubler, e.g. the 'Marcytone' Tx. which has both in one twin triode, the 3A5.

One particular reason for recommending the use of Xtal freq. which require multiplying by only small numbers, is that there is less chance of tuning the Tx. to the wrong harmonic.

A well laid-out 3V4 P.A. stage does not require neutralising, and a straight amplifier has a greater efficiency than a multiplier.

I have been asked why I have not used overtone Xtals. I have for myself in other Tx.'s, because I possess equipment for checking that the Tx. is working on the Xtal freq. Several commercial Tx.'s use overtone Xtals, but these are set up and checked by the manufacturers, and are highly satisfactory. My recommendations are based on practical experience in assisting amateurs to sort out their Tx.'s, and I would generally advise against the purchase of 'surplus' Xtals of unknown accuracy, by those without facilities for ensuring that they are satisfactory.

R/C Yachts at the Rick Pond

AT the invitation of the Y.M. 6m. O.A., radio yacht enthusiasts held an informal meeting at the Rick Pond, Hampton Court, on May 15th. Seven boats were sailing, six of them ex-"A" class and one Marblehead; three were on 27 m/c and the others on 465. A complete race (i.e. six races for each model) was comfortably run off during the day, despite very little wind in the morning and only a 5-7 m.p.h. breeze in the afternoon. The pairs of boats each raced one lap round a triangular course of a little over 300 yards.

The 465 m/c models were four of the six London Group I.R.C.M.S. yachts which regularly sail together, all controlled from the one transmitter, which has six audio frequencies, one for each model. Each yacht has, therefore, virtually single channel control, the use to which the signal is put being up to the ingenuity of the individual. Most skippers used a pulse-box plugging into the Tx., and the one which attracted us most gave simultaneous rudder and sheet control by a slave relay system employing mark/space and pulse rate variation. (Articles on similar Rx./intergear set-ups appeared in *Model Maker* December, 1956, April and May, 1957, and March, 1958.)

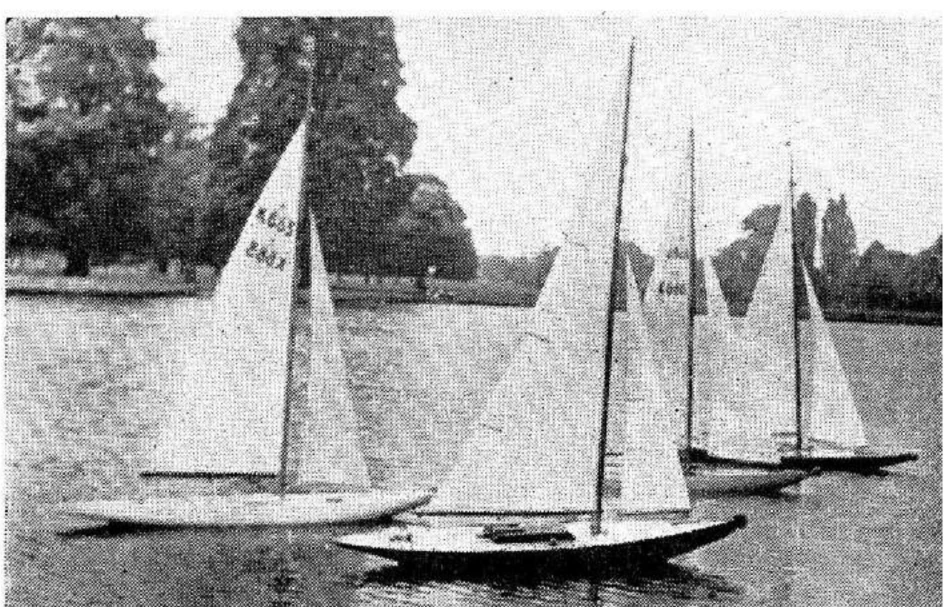
Limitations of this control system include the necessity for close co-operation between the users and, consequently, the likelihood of any other "outside" model on 465 interfering; the equipment weight carried in the yachts is as much as 16 lbs. (this could be very much reduced) and finally, fairly complex pulse systems are fine for the expert but often troublesome for the man of only moderate experience.

The Marblehead present was experiencing teething troubles, not infrequent with a new model, but when it was sailing properly it seemed to be holding the bigger As. A glass fibre *Jemima Duck* hull was used, with R.E.P. Sextone gear of which four channels were in use. This model used a two-diameter drum winch, the I.R.C.M.S. models used mostly the endless belt sheeting system, and the others various types of drum winches.

Not in use, but interesting in principle, was the automatic sheeting, vane operated, on Alan Tamplin's *Kit*, which worked in the standard way (May 1955 *Model Maker* gave basic systems) except that light beams and a photo-electric cell were used as limit switches. The vane can be momen-

[Continued on page 136]

Heading shows the five skippers sailing together for the final race. Nearest camera is the independent 27 m/c transmitter; the other four are all plugged into one transmitter and the three control boxes visible show wide variation. Right, four of the boats sailed on this occasion; the picture gives some idea of the problems which can arise approaching a buoy should more than two boats be sailed together.



The Right Battery for Your Model

A Factual Article

By STANLEY BROWN, A.M.Brit.I.R.E.

of Chloride Batteries Ltd., whose help is also gratefully acknowledged in the preparation of our Data Sheet No. 2 Battery Data and Socket Diagrams.

THE successful operation of small batteries in models is very much a matter of the correct correlation of the electrical requirements and the size of the battery. Those factors being settled satisfactorily, the subsequent performance of the battery becomes a matter of good maintenance.

For the propulsion of sizeable models we are usually considering currents in the order of amperes and in these cases the best results are likely to be obtained from rechargeable lead-acid batteries.

It is, however, very necessary to relate the load demanded by the model sensibly to the size of battery which can be accommodated.

Rechargeable batteries are usually rated in 'ampere hours', which is the product of the current the battery will deliver in amperes over a fixed period of time—usually 20 hours in the case of the types used for models. Thus a battery which may loosely be described as having a capacity of '10 ampere hours' is most likely capable of discharging at a rate of 0.5 amperes for a period of 20 hours—i.e., 10 ampere hours. Unfortunately it does not mean that the battery would be capable of discharging at a current of, say, 2 amperes for a period of five hours. Actually at this discharge rate the time period would be reduced to something less than four hours. This is where the first difficulty in choosing a battery may well arise and where the load current is appreciably greater than the figure obtained by dividing the capacity in ampere hours by 20, it is well to refer the problem to the battery maker or his agent.

Generally, however, it may be said that where the capacity of the battery

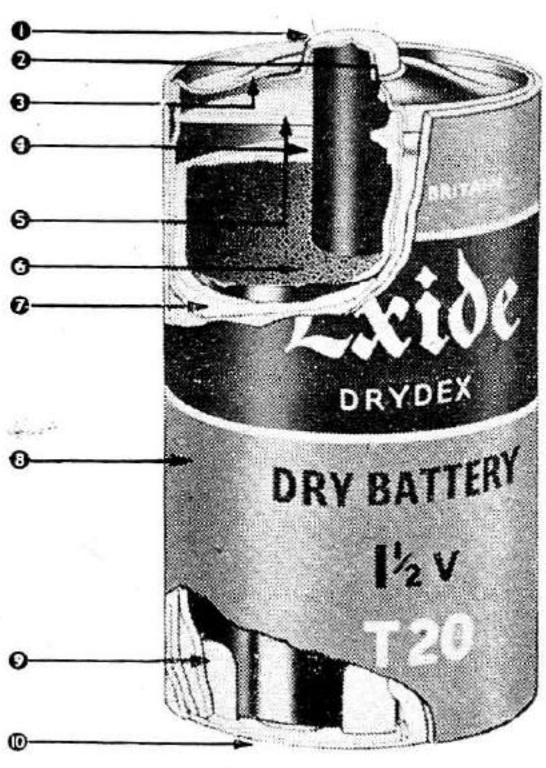


FIG. 3. EXIDE DRYDEX TYPE UNIT TORCH CELL.

1. Brass Cap specially made with a pointed pip to secure the best possible electrical contact between cells.

2. Insulating Washer to separate brass cap from metal seal.

3. Metal Seal spun on to the zinc cup to close the cell. It effectively prevents bulging, cracking, breakage or leakage.

4. Positive Electrode made of high conducting carbon. It functions as a conductor and remains unaltered by the reactions occurring within the cell.

5. Cardwasher to centralise and stabilise the bobbin in the cell.

6. Depolariser contains manganese dioxide to act as the depolarising agent and carbon for conductivity. Ammonium chloride and zinc chloride are other necessary ingredients.

7. Electrolyte consisting of ammonium chloride, zinc chloride, starch and wheat flour. These form a paste which sets on heating to a stiff jelly.

8. Paper Tube made from two layers of paper adhered together by a layer of bitumen. The printed label is glued to the outside of the tube.

9. Paper Insulating Washer separates the bobbin from the zinc cup and at the same time centralises it correctly.

10. Negative Electrode consists of zinc metal extruded to form a seamless cup. It holds all the other constituents making the article clean, compact, and easily portable. When the cell is discharged part of the cup is consumed to produce electrical energy, and it thereby becomes the negative pole.

at the 20-hour rate of discharge is called 100%, then if discharged in 10 hours the obtainable capacity would fall to about 90%—to about 80% if discharged in five hours and to about 55% if the rate is so high that the battery is discharged in one hour.

The electrical equipment may also be critical in terms of operating voltage. The motor rated for a given performance at 6 volts may put up a disappointing performance if the voltage falls to, say, 5. Now the voltage of a battery not only falls during discharge but falls more rapidly as the discharge current increases. The 6-MNA17 battery shown in Figure 1 is capable of discharging at a rate of 0.4 amperes for a period of 10 hours. Under these conditions the initial voltage will be 12 and at the end of 10 hours discharge it will be approximately 10.5 volts.

If, on the other hand, the rate of discharge were increased to 2.5 amperes, the total period of the discharge would be reduced to about $1\frac{1}{4}$ hours and the voltage at the end of that time will fall to 8 volts.

It will be seen then that to enable the proper choice of battery to be made, it is advisable to know the load current in amperes, the total number of hours service required, and the lowest voltage at which the equipment will work satisfactorily.

Generally, propulsion motors are nothing like so sensitive to voltage as the associated electronic equipment may be in a radio-controlled model. Here the loads may be but a small fraction of an ampere but usually a much closer tolerance in operating voltage is demanded.

Where the current involved amounts to a matter of milliamperes, it is probable that the most economical battery—both in terms of space and cost—

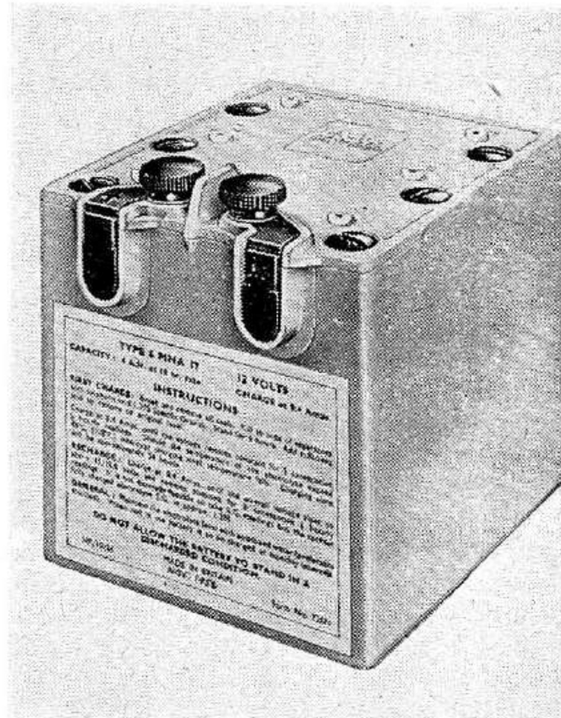


FIG. 1. 12-volt battery type 6-MNA17.

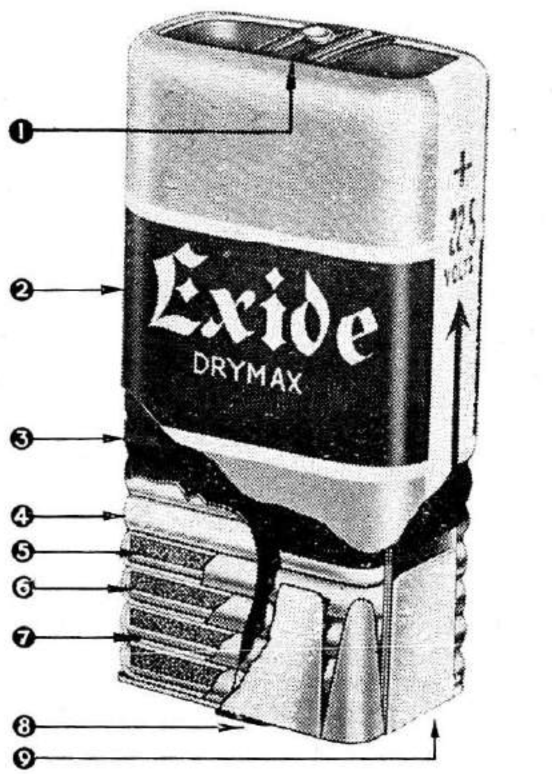


FIG. 2. EXIDE DRYMAX TYPE H.T. BATTERY.

1. Brass Positive Contact in electrical contact with the duplex electrode which is the positive pole of the battery.
2. Plastic Jacket surrounding the complete battery.
3. Wax Coating seals any capillary passages between cells and thus prevents loss of moisture and electrical inter-cell leakage.
4. Binding Tape holds the cells together under the correct pressure to ensure good electrical contact.
5. Plastic Cell Container holds all the elements of a single cell together.
6. Depolariser containing manganese dioxide as the depolarising material and carbon to render it conducting: also includes zinc chloride and ammonium chloride.
7. Electrolyte-Soaked Card contains the electrolyte (ammonium chloride and zinc chloride): also acts as a separator between the depolariser and the zinc electrode.
8. Carbon-coated Zinc Electrode consisting of a zinc plate to which adheres a thin layer of highly conducting carbon, which is impervious to the electrolyte.
9. Brass Negative Contact in electrical contact with the zinc plate which forms the negative pole of the battery.

will be some form of dry battery. Here again, however, for the best results it is advisable to try and relate the load to the battery.

The best use of the dry battery is obtained when it is possible to make use of the rather large variation in voltage which occurs during discharge.

The popular battery illustrated in Figure 2 has a nominal voltage of $22\frac{1}{2}$ and at a discharge rate of 5 milliamperes it will provide about 20 hours' service to the point where its voltage has fallen to approximately 11. If this voltage is too low for satisfactory operation of the equipment, then the period of service obtained would have to be reduced. That period will only amount to about $8\frac{1}{2}$ hours if the minimum voltage which can be tolerated is 16.5 and about 11 hours if the lowest usable voltage is 15.

It will be obvious that from the point of view of battery economy alone it is advisable to design electronic equipments to work over as large a range of applied voltage as possible. As is the case with a lead-acid battery, capacity of the dry battery is also affected by the actual rate of discharge. Thus the battery mentioned above which will provide 20 hours' service down to 11 volts at a discharge rate of 5 milliamperes will only provide seven hours' service if the discharge rate is doubled to 10 milliamperes. Incidentally, in all these cases the total period of discharge has been stated but it should be remembered that dry battery discharges of this nature are calculated upon the basis of two hours discharge in every 24 hours, the intervening rest or recuperation period being of considerable value in enabling the battery to give its maximum service.

In the Battery Data Sheet the figures shown in the column of suggested 'Current Range' give an indication of the most economical discharge rates which would enable the greatest capacity to be obtained from a battery. Many times the current indicated can be obtained but, as will be seen from the writer's earlier remarks, only at the cost of an immediate drop in voltage and a very short life.

In some instances battery users are mainly concerned with size and weight and are prepared to accept a very short life without question.

Accumulator Maintenance

Good maintenance of the rechargeable battery is simple enough to achieve if two or three essential points are kept in mind:

(1) It must be correctly recharged following any discharge;

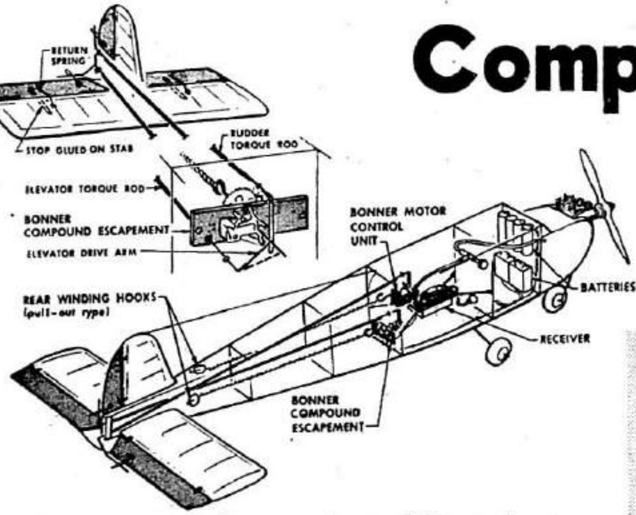
(2) It should not be allowed to stand idle in a partly-discharged condition; and

(3) Regular freshening charges should be given during long idle periods.

There should be no doubt about the correct recharging of the battery if the manufacturer's instructions on the label are followed. This is likely to be the case if the battery is handed over to an accredited charging station, but if charged at home, with some form of home charger, care should be taken to see that it is not charged at a rate of current much in excess of the recommended value.

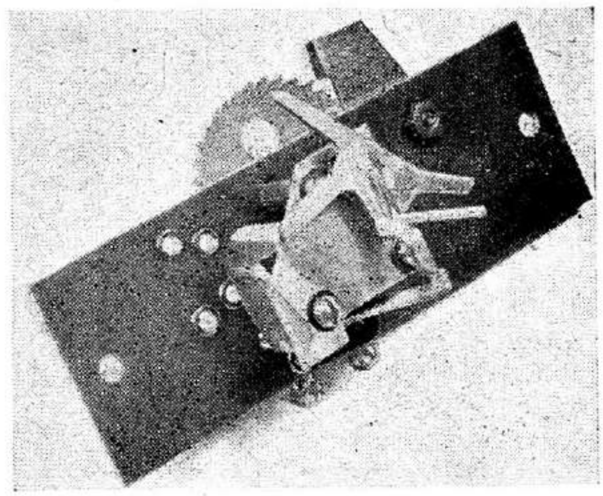
Similarly the label will also lay down the method of determining when a charge is completed and this also should be carefully followed.

Frequently, one comes across cases of serious damage done to model batteries by allowing them to remain in a discharged or partly discharged state for a long period. Similarly, where outdoor models are concerned the vagaries of our climate, no less than the vagaries of some models, often cause the battery to be laid up for long periods. When this happens the battery should first be given a full charge immediately following the preceding discharge and then given a freshening charge every month or not less frequently than two months during the idle period. In this way, and by keeping the level of the electrolyte topped up with pure water and the terminals clean and vaselined, there should be no difficulty in getting a long and useful life from your battery.



Compound Interest

RUBBER DRIVEN MULTIPLE CONTROL UNITS SUMMARISED



Bonner's first Compound at right, and mode of application sketched above (from instructions with the unit) show how the escapement has four specially disposed pawls and is regulated in its rate of action by cog wheel on other face. Note "kick" elevator modification in top sketch, and use of second escapement for positive elevator/motor use in lower sketch.

Is the single-button R/C operator in a rut? It seems surprising that with so many advantages to offer over the simple sequential self-neutralising two position non-selective actuator, the compound units do not enjoy more popularity.

Or is it that they frighten off the enthusiast with an increase in cost and apparent complication? Perhaps this explanation of the rubber driven range of compounds will help to clear the air.

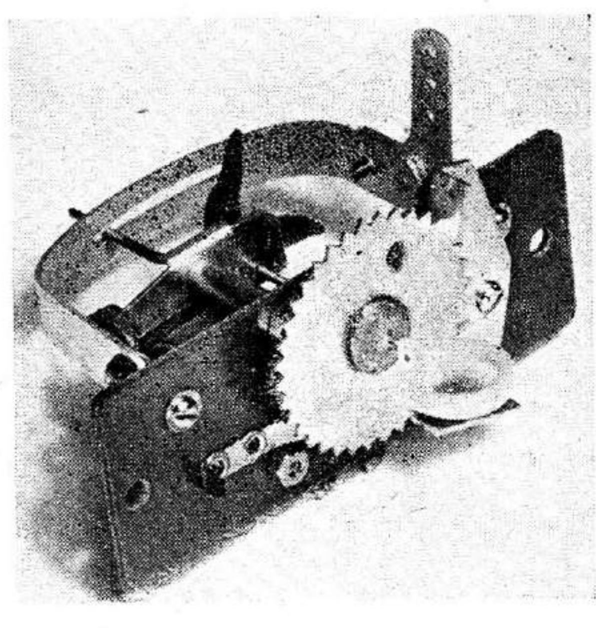
What is a compound? Firstly it is an actuator with multiple purpose. It can have three positions plus one neutral, can have a quick-blip selector added, can be the primary in a cascaded circuit, or it can mechanically provide rudder and elevator motion.

The variations are legion. In fact they create in the U.S.A. an "intermediate" class for the rudder—elevator—motor control fraternity still using just one Rx. relay.

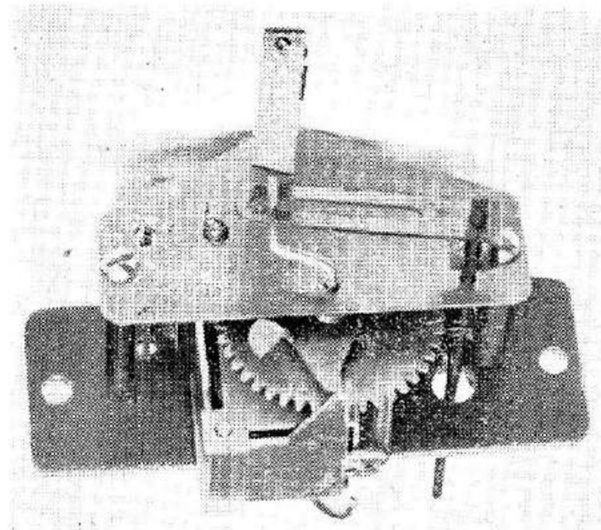
We should begin with the simplest, *Howard Bonner's* first compound which had a four pawl catch with action delayed by a simple ratchet on a shaft wheel. Right and left rudder could be selected by keying once, or by "press and release, then press and hold". The elevator could be actuated by a trip wire on the rudder shaft when the compound was stopped at its third position and this was gained by "press, release, press, release, press and hold" action. At the same position two electrical contacts completed a circuit so that a motor control actuator could be used for fast or slow engine speed.

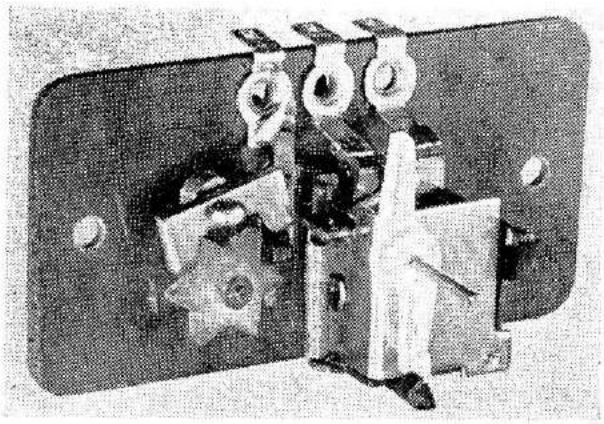
The business of "press and release" timing had to be a matter of practice for the pilot to teach himself on the bench before field application, but it is soon acquired and the devoted "compounders" can separate the desired commands in the most complex of selective systems.

The *O.S. Compound* from Japan included a yoke so that it became self

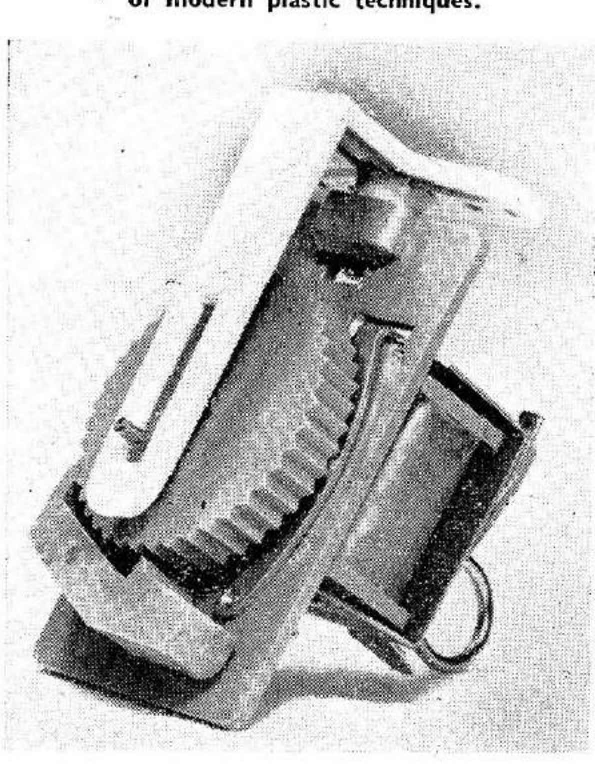


Japanese O.S. Compound taken from the regulating cog wheel side and showing the yoke linkage for translating action to a push rod. Has electrical points at third position for auxiliary escapement.

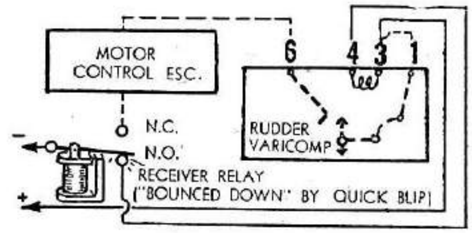


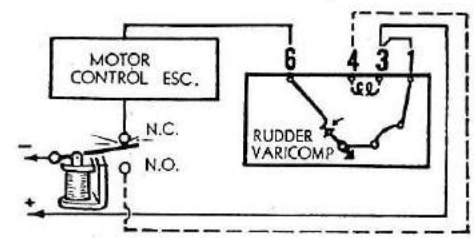


Above is British Rising Compound, with selective two positions plus quick blip for motor and star wheel regulator. Needs adaptation for torque rod use, circuit at right shows typical wiring for one set of batteries. If using two sets, be careful of polarities. Below is the Graupner Servo Relay, making full use of modern plastic techniques.



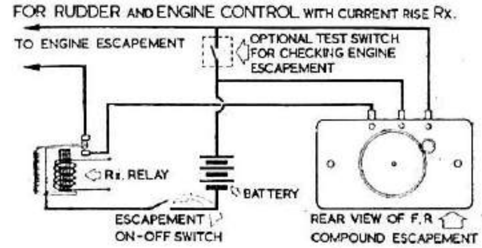
Babcock Super Compound Mk. 2 at left is very popular, has a cog and star wheel regulator and comes with two arms as seen here, for rudder and elevator action. Horizontal follower with slot is rudder, suspended vertical bar is "kick" elevator. Also has "quick blip" contacts.





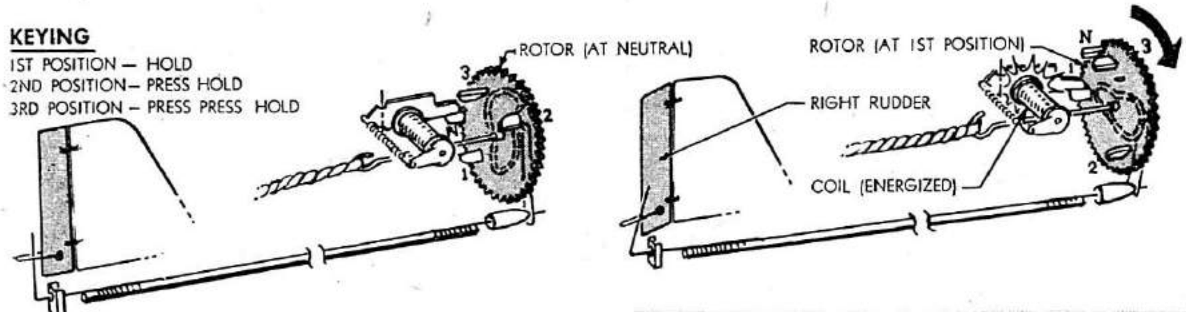
Mysteries of "Quick blip" are best explained by these sketches from the Bonner Varicomp instruction. At top, a quick blip sets Varicomp rolling from neutral. Lower sketch shows how armature at NC position makes circuit for motor control.

WIRING DIAGRAM FOR F.R. COMPOUND ESCAPEMENT—FOR RUDDER AND ENGINE CONTROL WITH CURRENT RISE Rx.



complete not needing a torque rod to convey motion from the cabin sited Compound to the rudder. Its design is otherwise similar to that of the Bonner, using the third position to bring in an electrical switch for the motor actuator. When the Compound is held in this position it will change engine speed but a quick wipe when returning to neutral should not affect the engine. The O.S. is still in production and popular by virtue of its cheapness. It can, of course, also be amended to get a "kick" elevator from third position as well as engine speed change.

The *Babcock Super Compound* operates in much the same manner, but with torque rods for the rudder and "kick" elevator. At the third position, the electrical switch will bring in a secondary escapement for the motor. Instructions with the Babcock tell how to amend the electrical contact quite simply to get "quick-blip" action. This

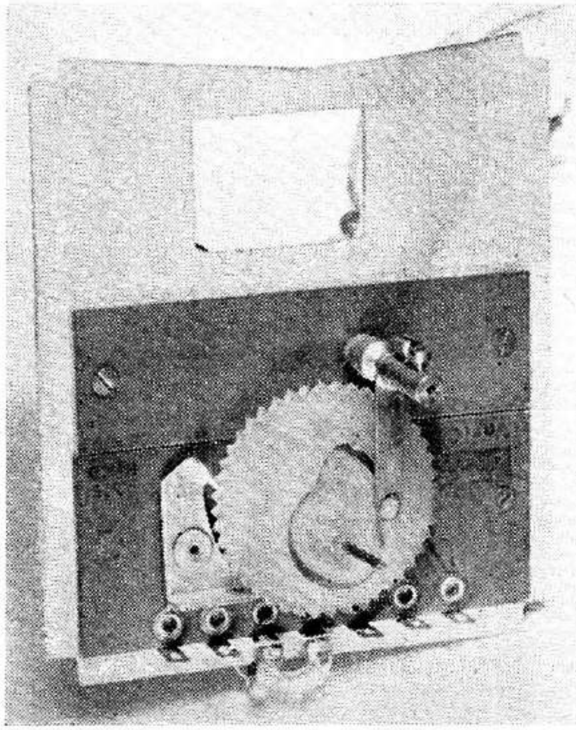


How a Varicomp works is seen above. There is only one neutral and three other working positions. The third is close to neutral so that rudder is not affected when another auxiliary is being signalled. Torque arms convey action from a sensible mid-fuselage mounting of the control unit.

utilises the back contact (N.C. for "normally closed") on the relay and when the operator gives a quick tap on the Tx. button to free the compound from neutral, the relay armature becomes a switch to bring in the motor control. The Babcock Super Compound is a very popular unit among U.S. fliers and comes with torque rod fittings. It uses a small star wheel and ratchet to obtain time delay, a feature also found on the British *F. Rising Compound* which offers quick blip and selective rudder positions but no elevator as there is no third position. This is an ideal set-up for the Rudder-Engine contest man although the vast majority of sport fliers would doubtless like to see another arm on the clever Rising unit. The Nylon moulded pawl of the Rising also limits the application of a torque rod operating arm, leaving one to install the unit in the traditional British position of the rear fuselage. Fittings for torque rod operation of the surfaces would be an asset.

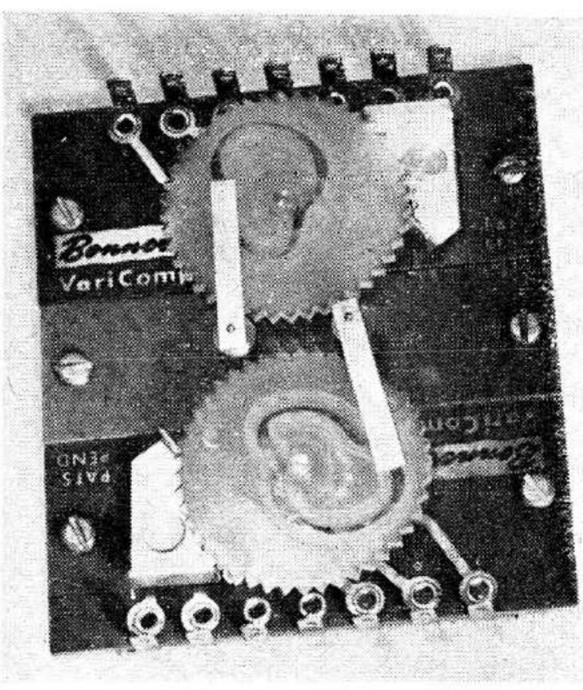
In Germany, the *Graupner* Compound equivalent is non-selective but sequential as with older actuators, but it has the advantage of a delaying ratchet, clever pallet operation and integral plastic actuating arm to transmit radial motion to push-pull. It slides into a mounting plastic box, is light and has "quick-blip" contacts but not a third position. It is not claimed to be a compound though it has many such features except the third position. Its true title is the "Servo Relay".

Howard Bonner's Varicomp—or variable compound actuator to give its full title is the Queen of the compounds, being the hardest working and most adaptable. The nylon delaying ratchet wheel serves as a face Cam for the ele-

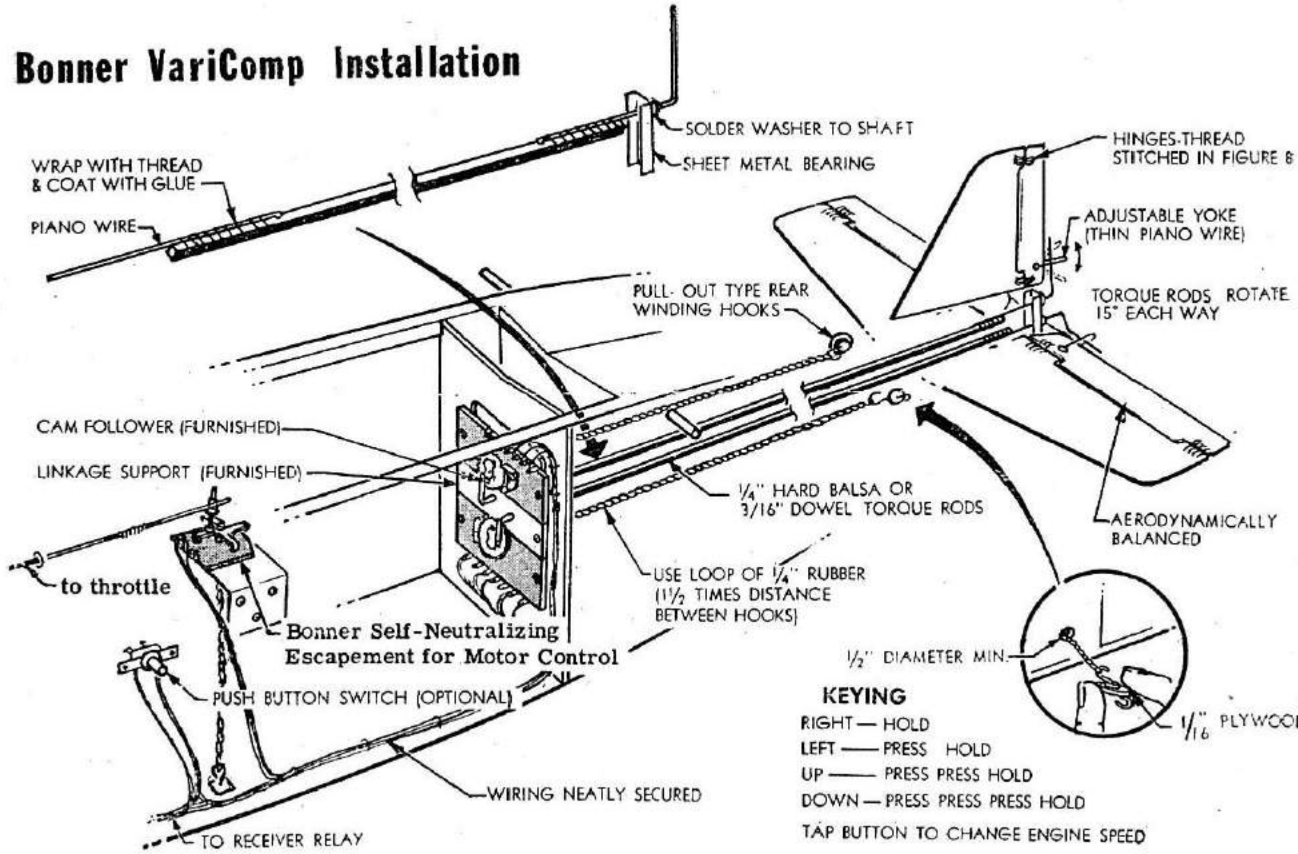


Varicomp on a sliding bulkhead is the RE type for kick elevator (not used here), shows face cam for follower on nylon cog wheel.

Cascaded Varicomps can give six different actions from single channel, shown here with rudder and elevator followers in place on face cams. See sketch overleaf.



Bonner VariComp Installation



How the Bonner Varicomp system works. Twin units drive the rudder and elevator direct. Wiper circuits on the printed circuit bases can be used to select slave units. Here a motor control is employed off the quick blip. Note suggestion for elevator balance and the neat rubber winding plugs. In use for many years, this cascaded Varicomp application can be further improved with a "bleep" box to sort out the signals for the operator.

vator follower and on its rear face is a double wiper for a printed circuit base board that offers many permutations. Seven tags connect for as many as *six* control actions which can come from one simple, single relay, Rx. with a pair of Varicomps "Cascaded". This is a subject in itself not altogether popular in view of the button pushing skill required, but the basic R-E Varicomp offers: selective rudder, "kick-elevator" on the third position and "quick-blip" for motor speed. The Varicomp is dismantled easily for cleaning and the screw-on cam wheel is a regular feature of SN escapements used for engine speed in U.S. Nats. winning models. The three positions on the cam, if fitted to the smaller SN escapement, will give high, cruise and slow speed, off "quick-blip". A Varicomp on the rudder and modified SN for engine is a contest winning combination but not necessarily the complete key to success for, after all, a compound depends largely on the operator and his experience.

de Bolt, Babcock and Cobb motor driven Compounds are also widely used but this review has been limited to the rubber driven types.

It is a great pleasure to be able to signal left or right rudder at will and "quick blip" for a change of engine speed or hold up elevator for series of single channel loops as our own experience has shown—why not advance from that "what was my last signal?" stage and become selective?

R/C YACHTS AT THE RICK POND

[Continued from page 129]

tarily over-ridden by the skipper's controls, which helps in manoeuvre.

Altogether this meeting ran smoothly with few hitches; what became obvious was that as radio equipment is becoming more reliable and selective, some hard thinking on sailing rules is going to be necessary, especially if more than two yachts are sailed together. As a finale, five boats were sailed round the course, and even at 60 yards range it was extremely difficult to sort out who was calling "Water!" or "Starboard!" to whom!

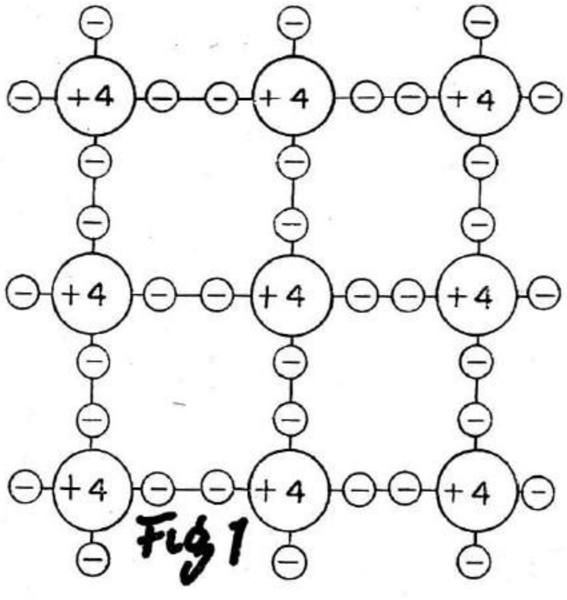
Introduction to TRANSISTORS

Dave McQue describes how transistors work in simple analogies. Further articles will relate this basic theory to practical applications and clear up the mysteries of transistors for R/C use.

To understand how to use transistors it is necessary to know something about how they work. There are many excellent publications on this subject aimed at the tyro, i.e. but simple if non-rigorous explanation will be attempted here.

An electric current is the flow or movement of electric charges. All matter is composed of positive, neutral and negatively charged particles—protons, neutrons and electrons. An atom of any element contains an equal number of protons and electrons and is electrically balanced. The protons and neutrons, having the greatest mass, are contained in a nucleus together with some electrons and the remaining electrons rotate about the nucleus in various orbits arranged in 'shells' the electrons in the inner orbits are tightly bound whilst those in the outer orbits are relatively loosely bound. It is the way in which the electrons in the outer orbits behave which determine whether a material is a conductor, semi-conductor or insulator. For example, copper, which is an excellent conductor, has only one electron in orbit in its outer shell or valence ring and in a piece of copper these valence electrons are constantly moving from one atom to another in random fashion. If a potential is applied to the copper the electrons tend to drift towards the positive pole, this drift forming an electric current. The current is analogous to beads on a string. When one bead is put on

FIG. 1.—Tetravalent material such as germanium or silicon in lattice pattern with balance of equal positive and negative charges.



one end of the string all the beads are displaced and one is pushed off the other end. It takes a considerable time for any one electron to progress any distance through the copper, but the effect of the addition of electrons at one end is transmitted at almost the speed of light through the material.

Now to turn to the semi-conductor materials used in transistors.

These fall into three groups; trivalent, tetravalent and pentavalent, these have three, four and five electrons in their valence or outer 'shell' of orbits respectively. The principal materials used are Germanium and Silicon and these are tetravalent. Today Germanium is the most common.

Pure Germanium in single crystal form at low temperatures is virtually an insulator. The four valence electrons associated with each atom arrange their orbits in sympathy with their adjacent atoms. The valence electrons form covalent bonds (see Fig. 1) and it is necessary to break these bonds before a current can flow.

Heat and light energy will both cause ruptures in the lattice and at normal room temperatures about one electron per million is 'free'. As the temperature is raised the number of free electrons is increased and at about 80° C., they are so numerous as to prohibit normal transistor action.

Thus we see that transistors must not get too hot and require lightproof containers.

The conductivity of the pure (often called intrinsic or I) Germanium can be modified by the introduction of minute quantities (about 2 in 10^8) of pentavalent or trivalent impurities. Let us look at the effect of the pentavalent first. Fig. 2 shows one such impurity atom in the Germanium lattice. Four of its valence electrons satisfy the local bonds, but

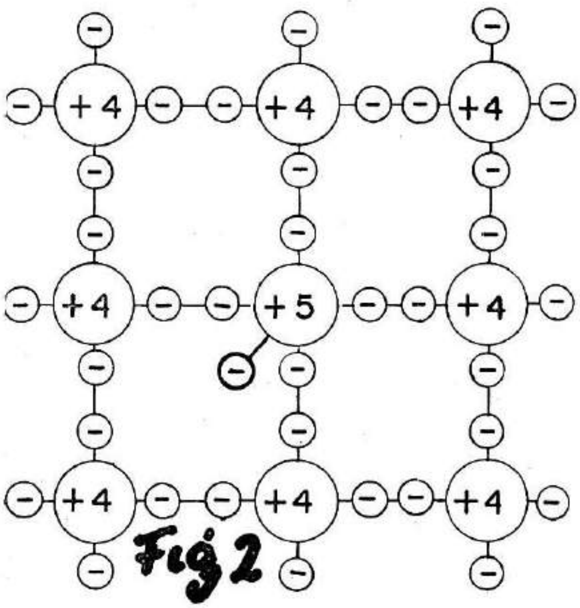


FIG. 2.—The introduction of a pentavalent impurity to the germanium leaves a surplus electron.

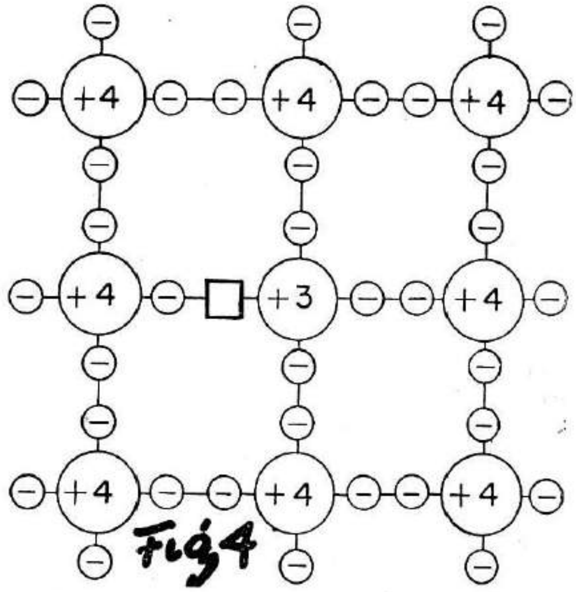


FIG. 4.—The opposite state of affairs with a trivalent impurity added. The lattice is left with an unsatisfied bonds, represented by the square.

one is surplus. Taking the material as a whole then it is electrically neutral but there are some loosely bound electrons or negative charges and these move randomly around the lattice. This is shown diagrammatically in Fig. 3.

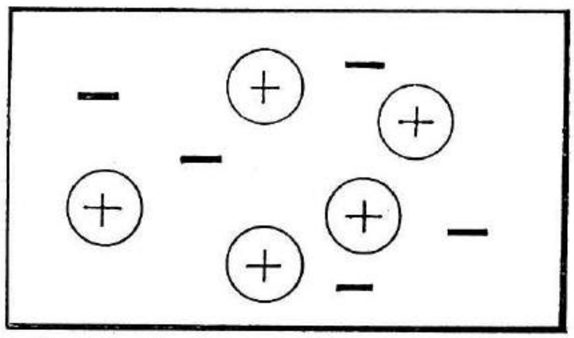


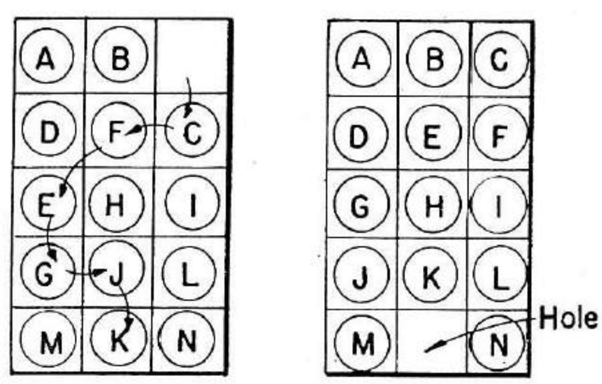
Fig 3

FIG. 3.—Diagrammatic illustration of these loosely bound negative charges free to move at random around the lattice.

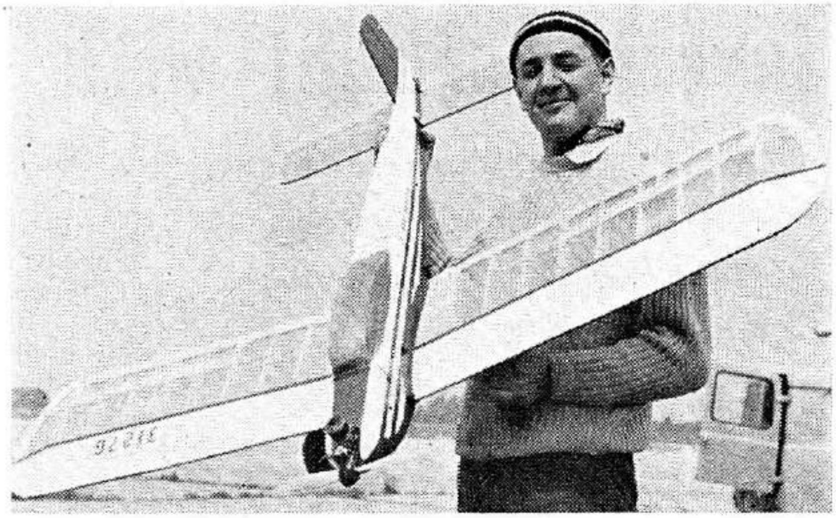
Notice that when an electron moves away from an atom it leaves behind a nett positive charge. These are fixed in the lattice (shown ringed) and if a battery is connected across the material the electrons which are free to move will drift towards the + Ve terminal, electrons entering the material from the — Ve terminal exactly as in a normal conductor. The material so treated or 'doped' with a pentavalent or donor impurity is known as 'N' type as the majority charge carriers are electrons.

What happens if a trivalent impurity is added to the pure Germanium? Well, this is where we have an entirely new state of affairs. As can be seen in Fig. 4 three bonds are satisfied but there is a gap or 'hole' in the lattice (represented by the square). Once again the material as a whole will be electrically neutral, i.e. have an equal number of + Ve and — Ve charges, but it will appear that the + Ve charges are mobile! In this manner, suppose an electron moves into a 'hole', it will make the impurity atom negatively charged as a whole, but will cause the adjacent atom to become positively charged as a whole. This atom in turn will capture an electron from another atom. Thus, in a piece of the treated material there will be a constant interchange of electrons each making short journeys the nett effect giving the impression of moving holes or positive charges. Try it with a draughts board! (See fig. 5).

FIG. 5.—Using part of draughts board to illustrate movement of "holes" or positive charges, giving a constant intercharge of electrons.

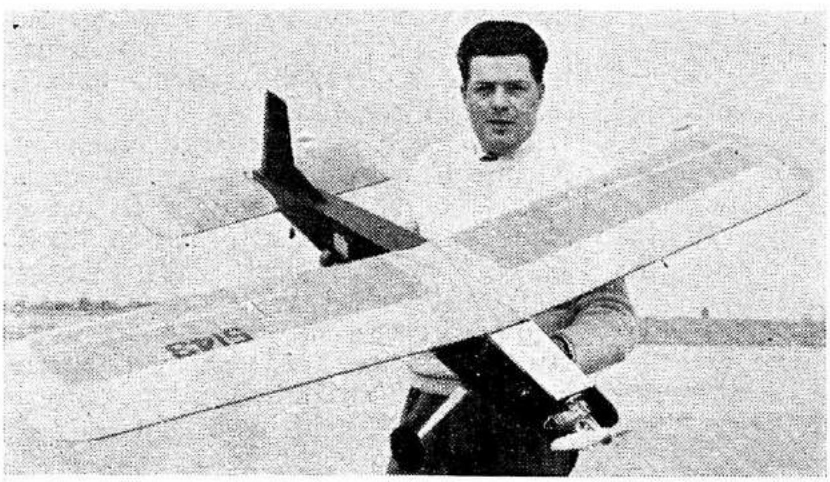


Alpine Aces



Frank Van den Bergh of Bromley, second man in the British team for the World Championships with his "Sky Duster" own design, a very smooth flier using Orbit 10-channel gear with five Bonner Duramites, one of them used to re-position elevator neutral centre trim.

EIGHTEEN COMPETITORS were entered for the radio control selection trials at Wigsley, Lincs., on May 21st/22nd but only 10 made official flights. The outstanding feature of the meeting was the consolidation of their superiority in standards by the acknowledged expert fliers and excitement came in the last (5th flight) of the meeting as Chris Olsen just edged Ed. Johnson out of a team place with a very good flight, unfortunately Ed. having to cope with non-simultaneous gear, which was too much of a handicap. We can rest assured that Britain will be represented by her best R.C. fliers at the Dubdendorf finals, but it is significant to note that our top average points total of 1,790 is way below Stegmaier's average of 2,122 in the German eliminators.



Stuart Uwins and his winning Uproar in the international team trials made an average of 1,790 points through five flights showing considerable consistency. Uses R.E.P. Octone 8-channel and Merco 35 Multi-speed. Similar combination but with an ETA 29 with throttle was used by Chris Olsen to place third in the team, just beating Ed. Johnson by a few points.

Multi Channel for Beginners

Lt.-Col. H. J. Taplin concludes his series with a short postscript on those reeds and relays which lack screw adjustment.

IN the previous instalments we have dealt with reed units, which are provided with adjustments by means of screws, examples of which have been shown in the illustrations, but in more recent times some commercial sets have appeared in which no such adjustments have been provided either on the reed unit itself or on the relays.

The new method is to arrange a light gauge silver wire above each reed, anchored firmly on the insulated top plate of the reed coil, the ends of these wires being bent to form a 'knuckle' with which the reed makes contact when vibrated.

The gap between these wires and their corresponding reeds is pre-set by the makers before leaving the factory, and in this sense are not adjustable.

Obviously, however, they can be set by bending, but this is a somewhat

[Continued on page 148]

Inverted Flight with Simpl Simul

Probably best known of the Pulse Proportional Systems, *Simpl Simul* or *Galloping Ghost* is still capable of improvement in the right hands.

CHARLES RIALL remains a firm devotee of the *Simpl Simul* system and has been trying to achieve consistent inverted flight and outside loops for some time, the tendency of high air loads to "blow-back" the elevator being the major problem with the type of model used. Possibly others with more lightly loaded models may not have had the same difficulty.

A real "break-through" into outside loops has now been made by following Peter Lovegrove's idea of adapting the Ever Ready T.G.18 to power the servo. Figs. 1 and 2 show alternative versions.

Other ideas which are being used in conjunction with this to combat "blow-back" are detailed below. Depending on model size, speed, etc., the T.G.18 servo may well be found to be sufficient on its own.

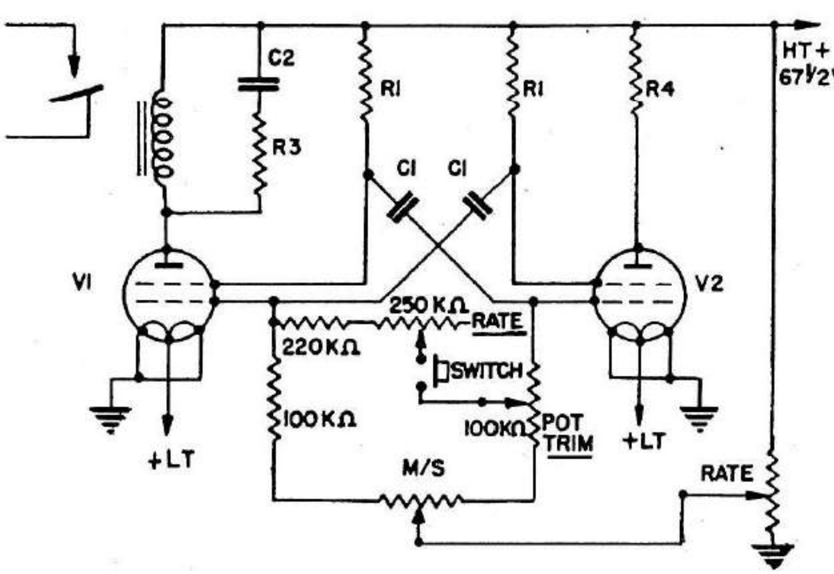
1. Elevator drive link can be made up with a slight dip at the centre:
2. Control box can be modified to give an *extra fast* pulse rate at full down, as follows:—

Various changes to the pulser circuit can be used to produce the extra fast pulse. The following alteration is being used by Charles Riall, the original circuit being that published in *Aeromodeller* of August, 1957. By adjustment of the 250K rate pot., the rudder rate can be chosen to be just fast enough to stay "in the groove" and tendencies for the rudder to go off centre can be counteracted by the 100 K. trim pot.

A push switch can be fitted or a small switch arranged to close when the shaft driving the normal elevator pot. is in the position corresponding to stick fully forward. This is considered to be the better arrangement since the hand need not then leave the stick.

The original "PRESS ON" engine control system which switches 45 volts through the reed unit may *not* hold engine at fast, if *too fast* a rate is used. With the T.G.18, the faster rate is not considered essential.

Those not familiar with pulse proportional systems such as *"Galloping Ghost"* or *"Simpl-Simul"* will find our plans service R/C information booklet RC/735 most helpful. This 16-page booklet includes contributions by the leading experts on the subject and is available, price 3/6d. plus 3d. postage, from the Editorial Offices.



Simpl Simul Multivibrator Circuit with its latest amendments. Values for amended sections in place of the former R2s are given on the diagram.

Other values are :

R1 15,000 Ω
R3 5,000 Ω
R4 Same resistance as relay.
C1 0.35 mfd.
C2 0.05 mfd.
Rudder Pot. 1 meg. linear.
Elevator Pot. 100 K. linear.
Valves. 3V4.
Relay. 4K to 10K.
H/T. 67½ v.
L/T. 1½ v.

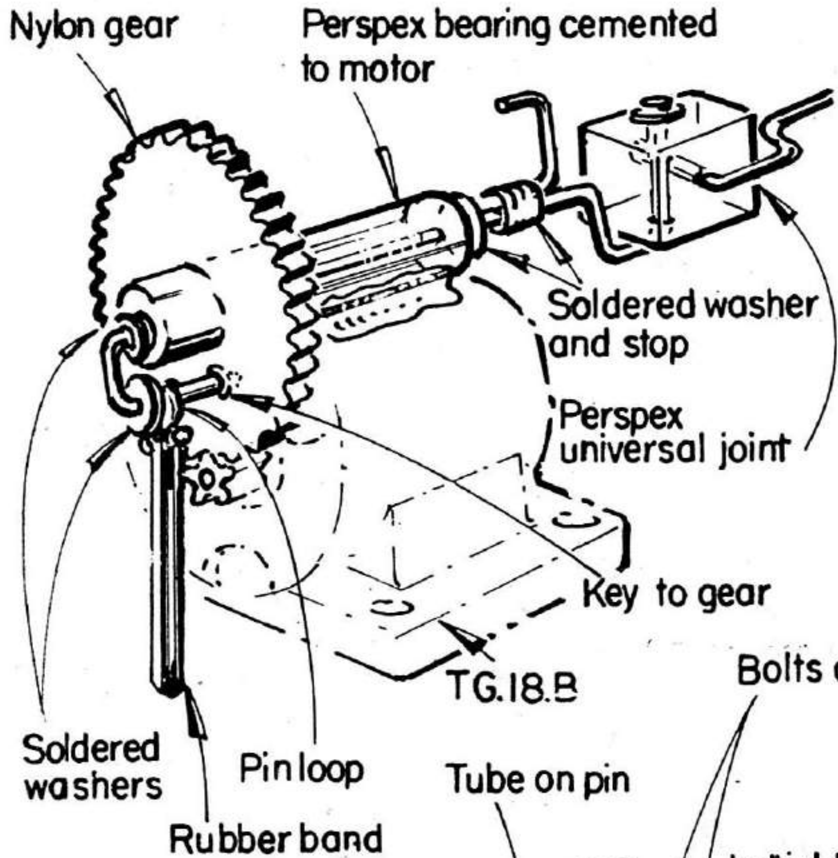


FIG. 1.—Lovegrove version using T.G.18 B and Nylon Mighty Midget gear. This arrangement is kind to motor since armature is not stopped abruptly, with resulting extension of gear life. Any rocking tendency rocks gear INTO mesh. Nylon gear boss sleeved with scraps of 16 and 14 s.w.g. brass tube to fit its 3/32 in. bore to 16 s.w.g. shaft. These tubes float and need not be fixed.

NOTE.—Motor case is cellulose acetate. Tensol No. 6 is one suitable cement. Make certain that this joint is secure.

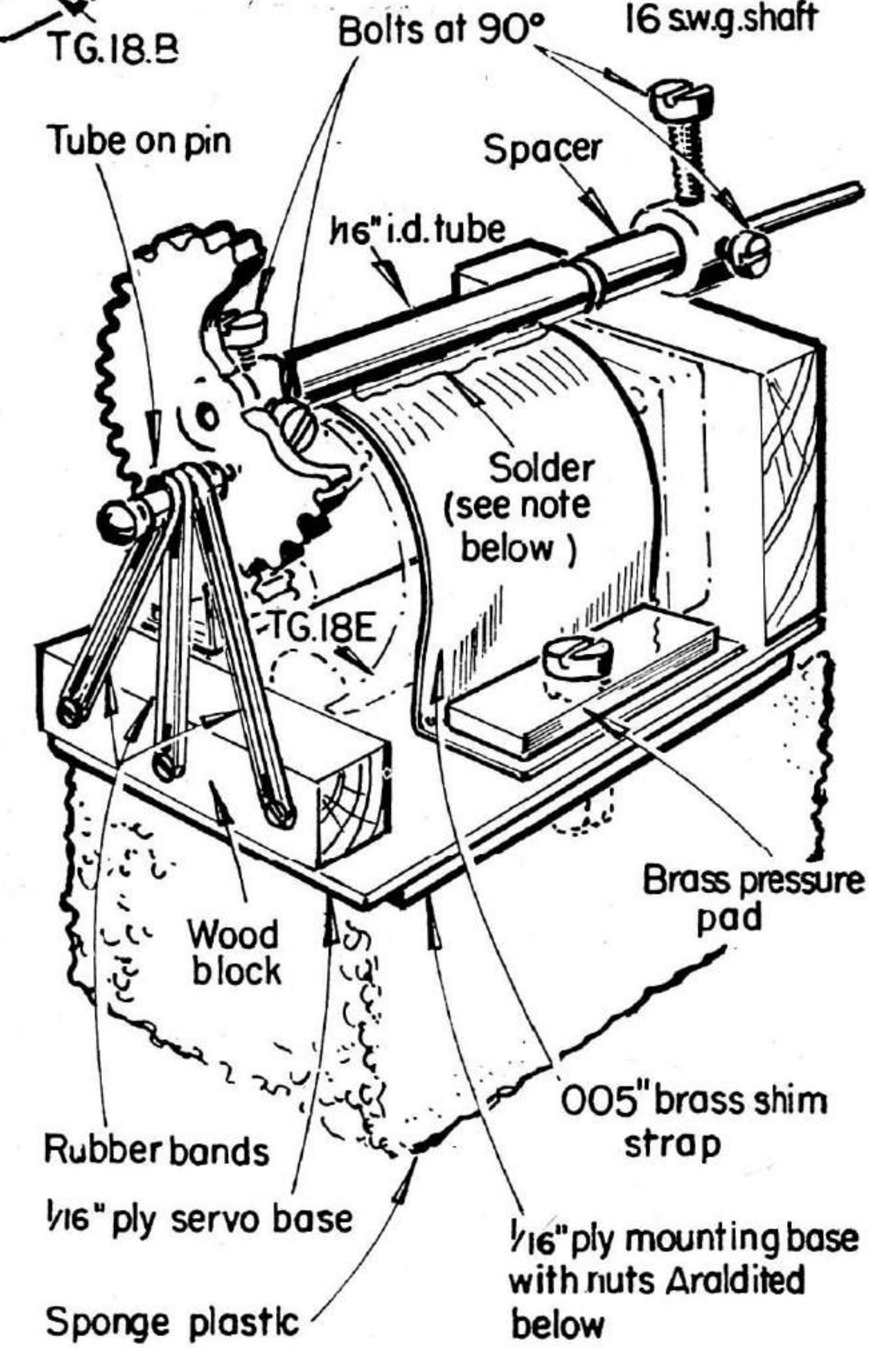
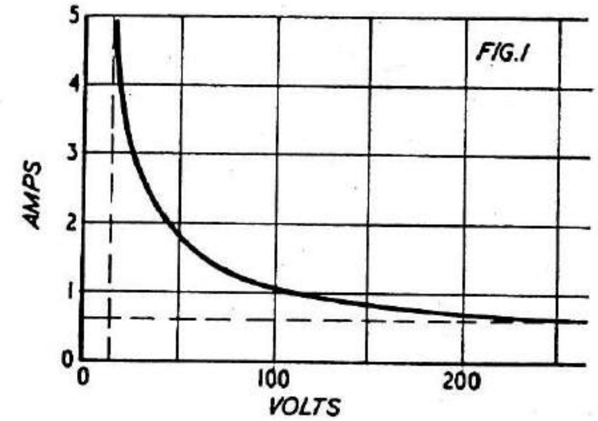


FIG. 2.—Riall version using T.G.18 E and brass Mighty Midget gear. Existing cutaway in motor case is enlarged to clear boss and screws of large brass gear. Small pinion gear is soldered to shaft if necessary. Shim brass and tube should give approximately correct gear meshing. Adjust by filing tube before soldering to close up mesh or use paper packing between brass strap and motor case to open up mesh. Spot solder tube to strap in situ, then remove to complete soldering as heat may affect motor casing. Up to three rubber band tensioners have been tried (one only in the Lovegrove version).

Contact Design

By R. H. WARRING

who will provide a further article in our next issue on "Contact Materials".



BASICALLY an elementary method of switching, consistent performance from electrical contacts is obtained only from very careful consideration of design requirements and the selection of suitable contact materials for the job. Spring brass strips, for example, may appear as a simple mechanical solution to make suitable contacts for switching low voltage D.C., but from the electrical point of view will almost invariably present varying contact resistance, troubles through corrosion (brass not being an 'acceptable' contact material), and tend to highly unreliable performance. The purpose of this article is to clarify and describe briefly the main factors influencing contact design and performance. A following article will then deal exclusively with contact *materials* and their selection.

Direct current operation represents more severe operating conditions than if the contacts are called upon to interrupt A.C. Electrical wear is higher since with A.C. the voltage will pass through zero each half cycle, tending to produce a quench effect. In fact, with contacts in all D.C. circuits there is always present a tendency for material to be transferred from the positive contact (leaving a crater) to the negative contact (building up on the surface). This is normally negligible where the contacts are correctly designed, but is aggravated by arcing caused by the current carried exceeding the critical value for the contact material concerned.

All contact materials have a characteristic current-voltage curve, similar to Fig. 1. This represents the current which, if exceeded for any given voltage, will cause arcing when the circuit is interrupted. For currents *below* the critical values represented by the curve the circuit can (theoretically, at least) be interrupted without arcing. This is not strictly true in all cases since other factors also affect the tendency to arc, such as humidity, the temperature of the contact faces and the speed of break.

The shape of this current-voltage curve is interesting for it tends to become asymptotic at both ends. This means that at some lower voltage value usually between 10 and 15 volts (but varying with different contact materials) virtually any practical magnitude of current can be interrupted without arcing. At the other end, above about 250 volts, the critical current value is appreciably constant and any *voltage* can be carried without arcing (up to the breakdown voltage of the air gap). Limiting arcing currents consistent with this latter feature are listed in Table I for various established contact materials.

The majority of servo switching circuits fall within the lower voltage limit and although current values carried normally exceed the minimum arcing current for the contact materials used, arcing should not be a particular problem. However, due to the influence of other electrical and mechanical conditions, some arcing is nearly always present in practice. This seldom presents an electrical wear problem but may need suppression in order to avoid interference with the radio circuit. Possible methods of suppression are shown in Fig. 2, method B generally being the most satisfactory. Typical values are

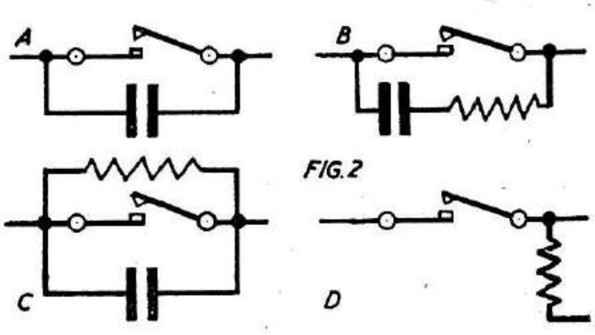


TABLE I*

Contact Material	Limiting arcing current	*Contact Material*	Limiting arcing current	*Contact Material*	Limiting arcing current
	amps		*amps*		*amps*
Silver	.45	Rhodium	.35	40% Silver-Palladium	.50
Platinum	.90	10% Gold-Silver	.25	40% Copper-Palladium	.60
Palladium	.60	10% Palladium-Silver	.30	Platinum-Gold-Silver	.35
Gold	.40	10% Iridium-Platinum	1.0	Tungsten	1.4

* *Johnson, Matthew and Co. Ltd.*

47 ohms for the resistor and .1 to .5 microfarads for the capacitor, matching commercial actuators.

The major *cause* of arcing when the contacts are apparently called upon to interrupt a circuit voltage of such a low value that it should be free of arcing is usually an inductive load (e.g. the actuator coil). Interruption of an inductive circuit produces an instantaneous 'peak' of higher voltage which immediately transfers the operating point of the contact material to that higher voltage point on the current-voltage curve. The only way to ensure against arcing at the contacts (unless the rest of the circuit is purely non-inductive) would be to keep the maximum current carried by the contacts below the limiting arcing current for the material. Few materials, it will be seen from Table I, have a limiting arcing current greater than half an amp and many actuators and servos draw more current than this.

Arcing, although it produces electrical wear, is also directly responsible for contacts 'sticking' or welding up. If the heat produced by arcing is not dissipated rapidly enough the local increase in temperature on the contact face may be sufficient to melt the material and cause welding of the two contact surfaces. Where the current carried is normally above the limiting arcing current for the material, in fact, arc suppression may be an essential feature for fully reliable operation.

Mechanical conditions concern the contact pressure, contact size and shape and contact action. Dealing with these in order, increasing contact pressure will, with any clean contact material, decrease the contact resistance which apart from increased electrical efficiency will also reduce the heating effect of the current, i.e. increase the maximum current which can be carried without overheating. Overheating alone can cause welding; and overheating combined with moderate arcing can produce sticking contacts at apparently 'safe' current values.

Limits to contact pressure are inherent in the design of the contact assembly and its method of operation. Relay contact pressure is essentially a compromise arrived at by adjustment. On other switching devices it may be limited by friction—excessive contact pressure on a cantilever brush on a subminiature electric motor, for example, can represent a considerable friction load on the commutator, slowing the motor right down. In such cases a high brush pressure can often be used and friction reduced by lubricating the commutator very lightly with a contact oil (or even ordinary thin oil will work on some commutators).

As a point of detail design, the maximum contact pressure which can be obtained from a flat cantilever spring can readily be calculated by assuming that the spring material can be stressed within its limit or proportionality and

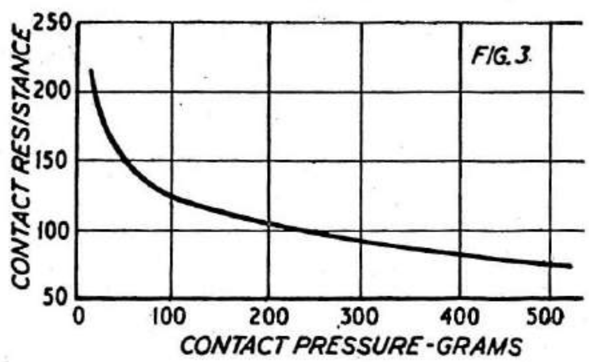


TABLE II

Spring Material	*Condition*	*Max. Permissible Stress p.s.i.*
Brass Strip	Full Hard	30,000 — 40,000
Copper Strip	Cold Worked	15,000 — 30,000
Steel Strip	Spring Tempered	120,000
Nickel-Silver	Spring Tempered	40,000
Phosphor-Bronze ...	Spring Tempered	60,000
Beryllium-Copper ...	Heat Treated	90,000

retain a consistent setting.

The formula is:

$$\text{Max. contact pressure} = \frac{2{\cdot}7\,B\,t^2\,F_s}{L}$$

ounces.

$$= \frac{76{\cdot}8\,B\,t^2\,F_s}{L}\ \text{grams.}$$

where B = spring width in inches.
t = spring thickness in inches.
L = spring (cantilever) length in inches.
F_s = maximum permissible material stress (see Table II).

The resulting maximum contact pressure is then given in ounces or grams, according to which of the above formulas is used. These formulas are very useful for checking that a cantilever spring is not over-set—i.e. adjusted to give an excessively high pressure where the material will 'fatigue' and not retain a consistent pressure setting. It is a simple matter to measure the actual spring pressure and compare with the maximum calculated for that size of spring and spring material. The effect of contact pressure on contact resistance is shown in Fig. 3, these curves being for clean silver contact rivets with flat surfaces, resistance being measured in milliohms.

Normal flat headed rivet type contacts are far from an ideal choice, particularly where low contact pressures have to be employed. Apart from the difficulty of getting them perfectly in alignment so that the full contact area is utilised, flat surfaces will always tend to collect dust (even when mounted vertically). Thus the domed head pair (Fig. 4) is better, but the compromise of one domed and one flat contact is probably more practical since such a combination is easier to align. For light duty work a head diameter of $\frac{1}{16}$ inch should then be entirely adequate. The best solution of all for very light contact pressures is undoubtedly the crossed wire combination (usually round or half-round silver or gold wire). This provides localised contact pressure and has little or no tendency to collect dust on the contacting surfaces.

A most useful alternative to fitted (rivet or screw) contacts or brazed-on contacts (wire) is contact bi-metal. This consists of a facing of contact material applied to a suitable backing metal strip (usually copper or copper alloy) which can be fabricated to almost any desired contact form. Such bi-metal strip is produced in widths from $\frac{1}{8}$ in. upwards and thicknesses from ·005 in. up.

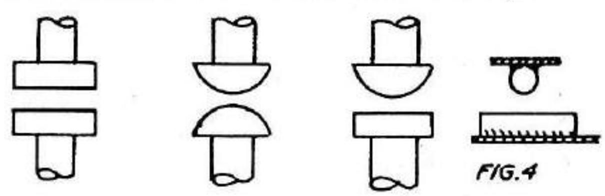
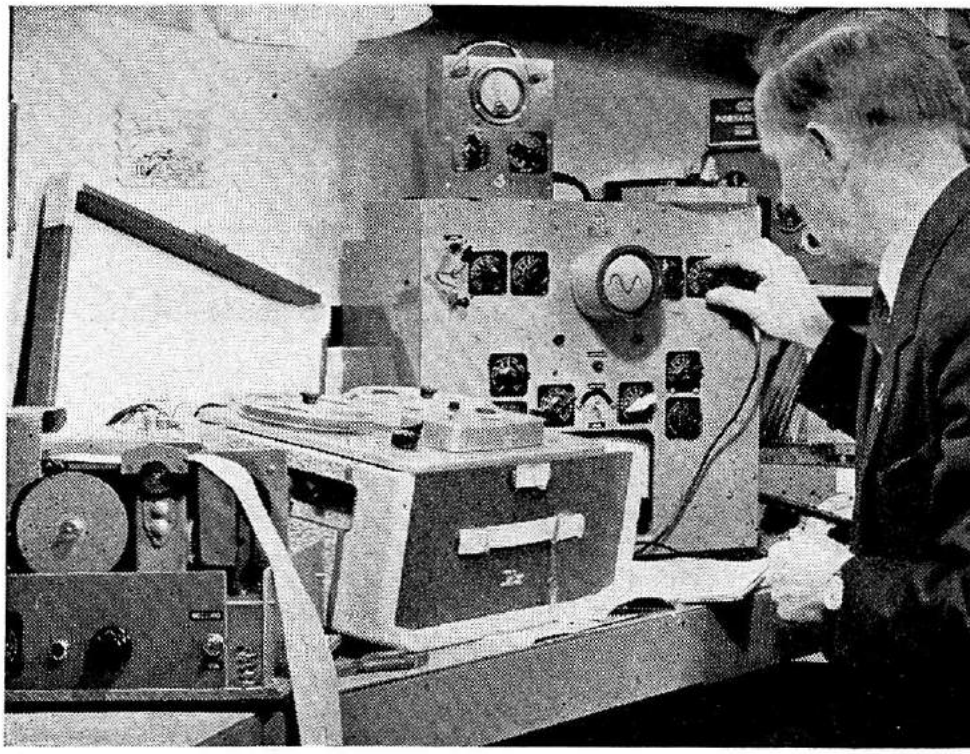


FIG. 4

Next Month . . . .

HIGHLIGHTS OF THE ISSUE INCLUDE:

COMPONENTS & SYMBOLS DATA SHEET to pull out (one for the beginners!) ★ Hill (of Hill Rx. fame) Crystal Controlled Transmitter Poole R/C Regatta Report ★ Contact Materials ★ Motorised Actuators and Servos ★ C.R.T. Oscilloscope, Part 2 ★ Marine R/C Installation ★ More on Aero Installation ★ Making a 6-Way Selectuator ★ Latest Equipment ★ McQuery Column E. D. Single Channel Equipment Reviewed ★ Here, There & Everywhere



The author using an Oscilloscope for testing the frequency response of a tape recorder.

The Cathode Ray Oscilloscope

Part I of a series of four articles by F. C. Judd, A.Inst.E., which will cover not only operation and theory but also give detailed instructions for the construction of a simple Oscilloscope suitable for Radio Control test purposes.

ONE of the most versatile and most useful instruments to the Electronics Engineer is the Cathode Ray Oscilloscope, for it is the only electronic measuring device that will readily present an actual picture of rapidly changing or alternating voltages. The speed at which an electron beam can be made to move depends on a number of conditions, although in practice alternating voltages at frequencies up to several megacycles may be displayed on a c.r.t.* screen. For example the average laboratory instrument will display an a.v.* at frequencies up to two or three megacycles and such oscilloscopes invariably contain amplifiers that will amplify linearly from very low frequencies to the comparatively high ones mentioned above. Aside from its ability to display both simple and complex waveforms (WAVEFORM is a general reference to an alternating voltage display irrespective of its shape), the oscilloscope may be used for voltage and current measurements and frequency checking. These are its essential uses and of course visual display makes the instrument almost indispensable for all electronic work whether it be Radar, Television, Radio, Audio or Computor design.

The Radio Control enthusiast will find even a simple oscilloscope invaluable, for with it one can examine and measure the amplitude and frequency of tones used for reed control, check the r.f. output of a transmitter. the correct operation of a quench (super-regenerative) or superhet receiver, the modulation of a tone transmitter may be visually examined, the proper function of proportional control systems monitored, and so on. With the aid of an oscilloscope new circuits may be developed, circuits sometimes abandoned for lack of functional information, for the oscilloscope is an instrument that will display information which conventional metered instruments fail to indicate.

As the nucleus of the oscilloscope,

**Abbreviations used in text: c.r.t. = Cathode Ray Tube ; a.v. = Alternating Voltage.*

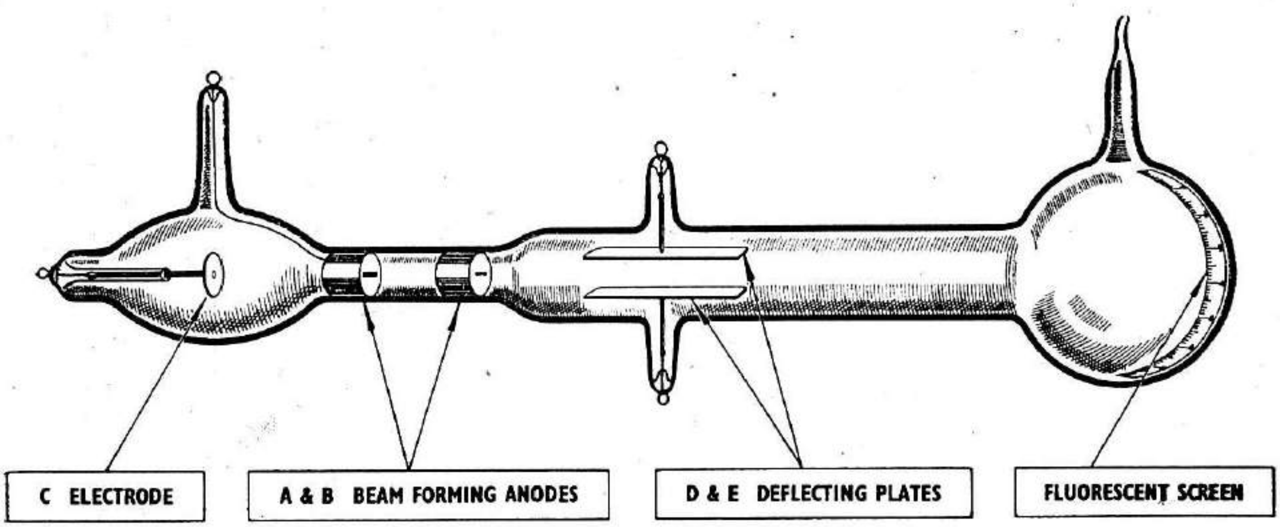


FIG. 1.—J. J. Thomson's cathode ray tube (1897).
(Courtesy Siemens Edison Swan Ltd.)

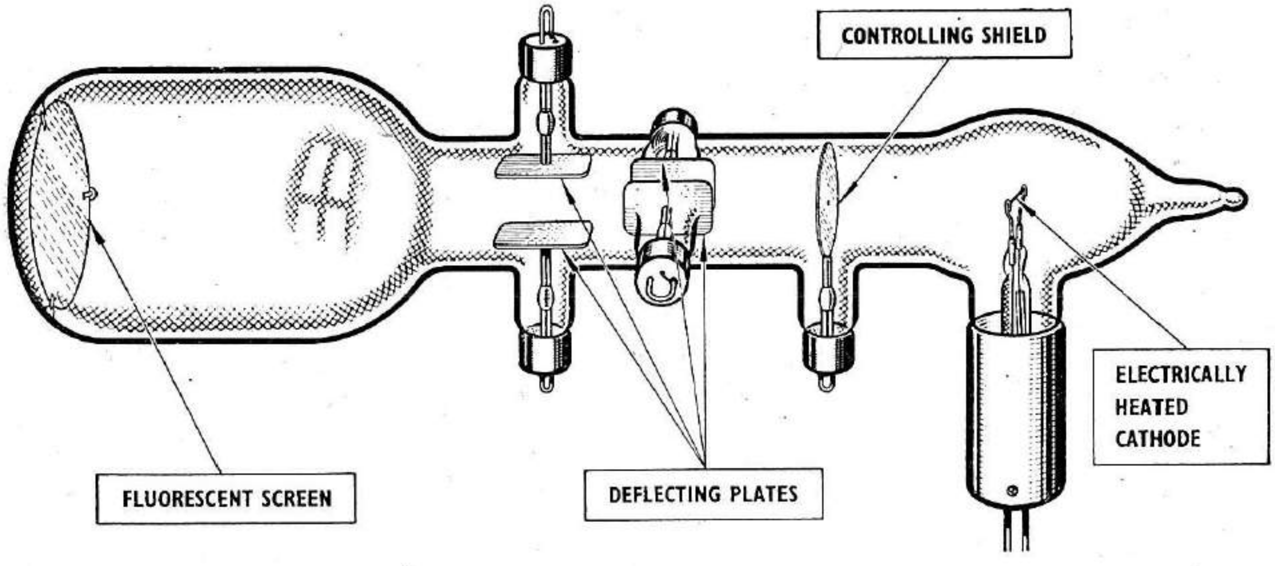
the cathode ray tube is almost as old as radio itself (see Fig. 1). Development was in progress before 1900 and very soon working tubes were being used for simple displays and measurements. The advent of the second World War brought about many new techniques in electronics and radar alone was responsible for a number of major developments in oscillography. Thousands of oscilloscopes were manufactured for use by the Services in their research and development departments and for maintenance of their electronic equipment. Many of these instruments, particularly the double beam oscilloscopes, are available today as surplus from the dealers who specialise in this field. (Readers are advised to consult someone with a good knowledge of oscilloscopes before attempting to purchase surplus equipment of this nature.)

FIG. 2.—The Wehnelt cathode ray tube (1904)
(Courtesy Siemens Edison Swan Ltd.)

How the Oscilloscope Works

The 'oscilloscope' is a complete instrument. The 'cathode ray tube' is the component which displays an actual picture of alternating voltages applied to its deflecting plates or the modulation of such voltages when they are applied to its grid. Like the conventional radio or thermionic valve, the cathode ray tube has an electron emitting 'cathode' and a control grid. These electrodes supply and control the electron stream which is ultimately 'beamed' at a screen coated with a special chemical that gives off light when bombarded by electrons.

The basic assembly and function of the c.r.t. has changed very little since its invention. The diagram of Fig. 2 shows the assembly of a tube developed in 1904 and also serves to illustrate the general assembly of the modern c.r.t. whose cathode structure is similar to that of the thermionic valve. In the modern c.r.t. electrons are emitted from a heated cathode and attracted by an anode which is held at a positive potential. Since protons (positive electricity)



attracts electrons (negative electricity) the electron stream from the cathode will move towards this anode which is usually cylindrical and closed at one end except for a small aperture. Most of the electrons pass through this aperture but those that do not are attracted to the metal structure of the anode and returned to earth via the anode potential supply.

Since the electrons are moving very fast when they pass through the aperture in the anode, they continue to move in a more or less straight line. In fact they have been partially formed into a beam. With such a simple arrangement, however, the beam would not be very narrow and we should see a round, but somewhat blurred small circle of illumination on the fluorescent screen. For correct function of the c.r.t. the electron beam must be very narrow and must produce a spot of bright illumination less than a half millimeter in diameter. To achieve this a focusing anode, which in effect is an electronic lens, and which is analogous to a lens used for ordinary light is used. This focusing anode is generally cylindrical and held at a negative potential, so that electrons that pass through it are repelled and compressed into a narrow beam (see Fig. 3).

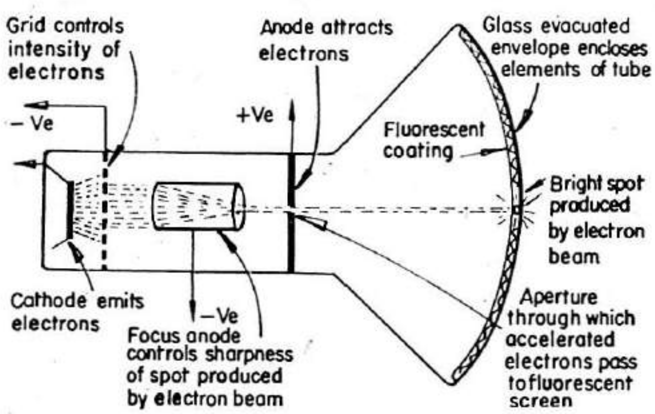


FIG. 3.—Basic function of a cathode ray tube.

Having produced this very narrow beam and the consequent small but brilliant spot of luminescence on the screen of the c.r.t., the next step is to deflect the beam in one direction or another and so cause the spot of light to move. A simple experiment will demonstrate how a fast moving spot of light can create an apparently continuous line of light. Hold a lighted cigarette in a dark room and wave it backwards and forwards quickly over a distance of five or six inches. The red glow will appear as a continuous red line if the movement is fast enough to overcome the persistence of vision. The bright spot formed on the screen of a c.r.t. is used to trace a line in the same way, i.e., by making it move rapidly enough to overcome the persistence of vision. The television tube operates in a similar manner, although in this case the light spot is made to 'scan', not just one line, but a whole series one underneath the other starting from the top of the tube.

The electron beam is sensitive to the presence of other electrons or negative electricity which will cause the beam to be deflected away from them. The presence of protons, or positive electricity will cause the beam to be deflected toward them. By applying positive or negative potentials to two metal plates either side of the electron beam, deflection of the beam may be

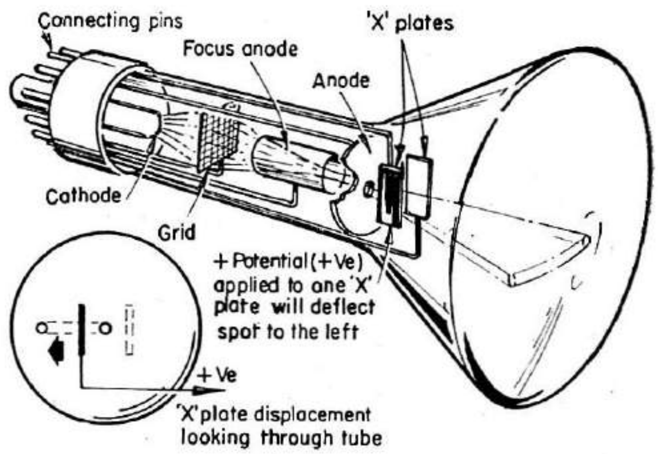


FIG. 4.—"X" plate deflection (electrostatic tube).

achieved as shown in Fig. 4. For example if the plate to the left is made positive the electron beam will move towards it. By alternating the voltage on one or both plates the beam can be moved rapidly between them. The bright spot focused on the c.r.t. screen can thus be made to create the illusion of a continuous line of light. This simple 'scan' across the face of the c.r.t. is usually called the 'time base scan' for if the spot deflection is made to alternate at a known frequency the time taken by the spot to traverse the face of the c.r.t. in one direction can be ascertained. A time base thus formed can have a duration of as little as a few micro-seconds (millionths of a second)

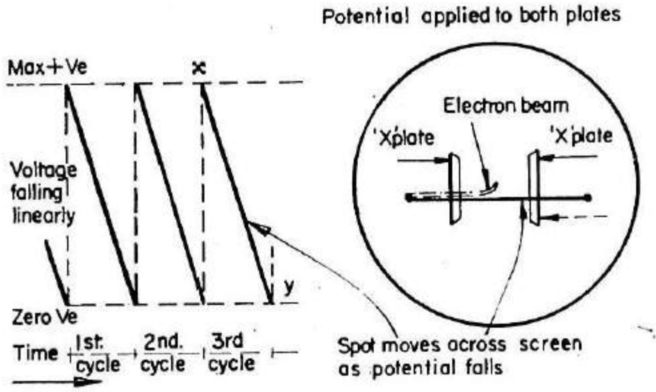


FIG. 5.—The "saw-tooth" time base potential used to move the c.r.t.

which means a scanning frequency of a few megacycles. In other words the potential on the deflecting plates would be changing every few millionths of a second. A scan speed of this order is of course very fast and generally only used on laboratory instruments. Scan speeds of a few milli-seconds (thousands of a second) are more usual, and most used for low frequency application.

In order to achieve a linear scan, e.g., one in which the spot moves linearly with time, the potential at the deflecting plates must change linearly as well. These potentials are normally derived from a special oscillator and if viewed on an oscilloscope they would appear as in Fig. 5. It will be seen that the rate of change of potential starting from point X is gradual and linear with time. When the voltage reaches zero, one cycle of the oscillator has been completed and the potential commences at maximum again. The linear portion (X to Y) is used for moving the c.r.t. spot and is usually referred to as the time base voltage. The oscillator and any associated amplifier is called the time base generator.

The plates used to deflect the spot horizontally across the face of the c.r.t. are called the 'X' plates and to these the time base potentials are generally applied symmetrically from a special amplifier circuit. A second pair of plates, called the 'Y' plates are mounted at right angles to the 'X' plates and are used for vertical deflection of the electron beam so that the spot can be made to traverse the screen in two directions simultaneously, or apparently so, as will be described in part 2.

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E. M. Price, M.Sc., Tech. A.M.I.E.E., Cleave-Hume Press.
The Oscilloscope at Work:
A. Haas and R. W. Hallows, M.A. Cantab., M.I.E.E., Iliffe and Sons Ltd.

MULTI-CHANNEL FOR BEGINNERS

(from page 139)

tricky operation, since the silver wire is springy, and somewhat difficult to set in exactly the right positions.

The object of this new method is to have the top contact slightly springy so that when the reed hits it, it gives somewhat and produces a slight wiping action, the idea being that this wiping action keeps the contacts always clean, and obviates the need for periodically cleaning off the little black spot previously mentioned, and that no adjustment is necessary. That at any rate is the idea! Whether this always works out in practice remains to be seen.

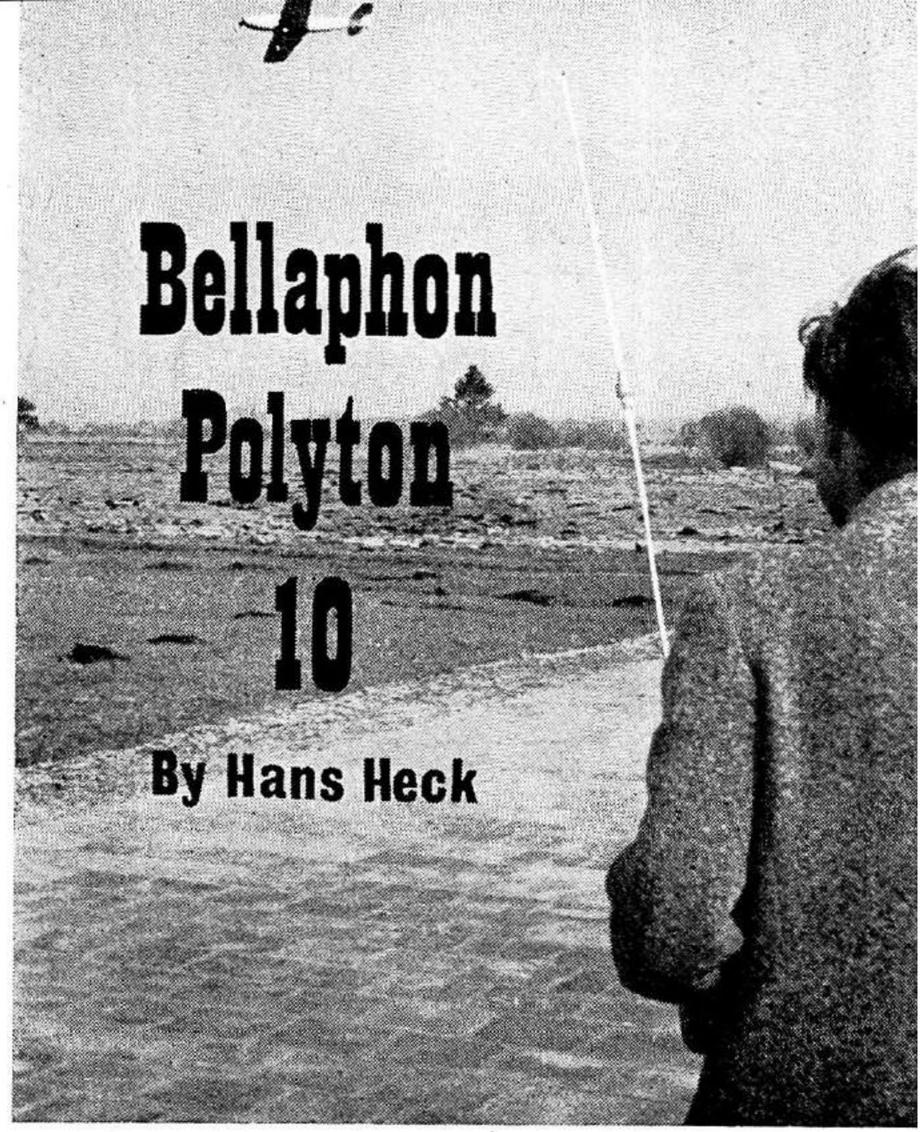
The disadvantage of this system is the fact that these light gauge wires can easily be inadvertently bent — possibly when handling the set with the lid off.

Some of the latest light weight relays are also pre-set at the factory, and no means of adjustment is provided other than bending the metal stampings which carry the contact points. In this case, however, there is no wiping effect, so that, sooner or later the little black spot will appear. The contacts points on these light weight relays, are for the most part fairly accessible, and can be cleaned with a slip of paper as previously mentioned.

It should be borne in mind that on any of the small relays as used in model radio control, the contact points are not intended to carry heavy currents—the bigger the current the quicker the little black spot will appear.

For general guidance a maximum of 4½ to 6 volts at 400/500 milliamps should be considered the limit. To drive a 24 volt motor taking 800/700 milliamps through the contacts of a model radio control relay is asking for trouble.

Digested from a report in the German "Modell" by Hans Heck on technical details and performance of the Graupner 10-channel transmitter and receiver.



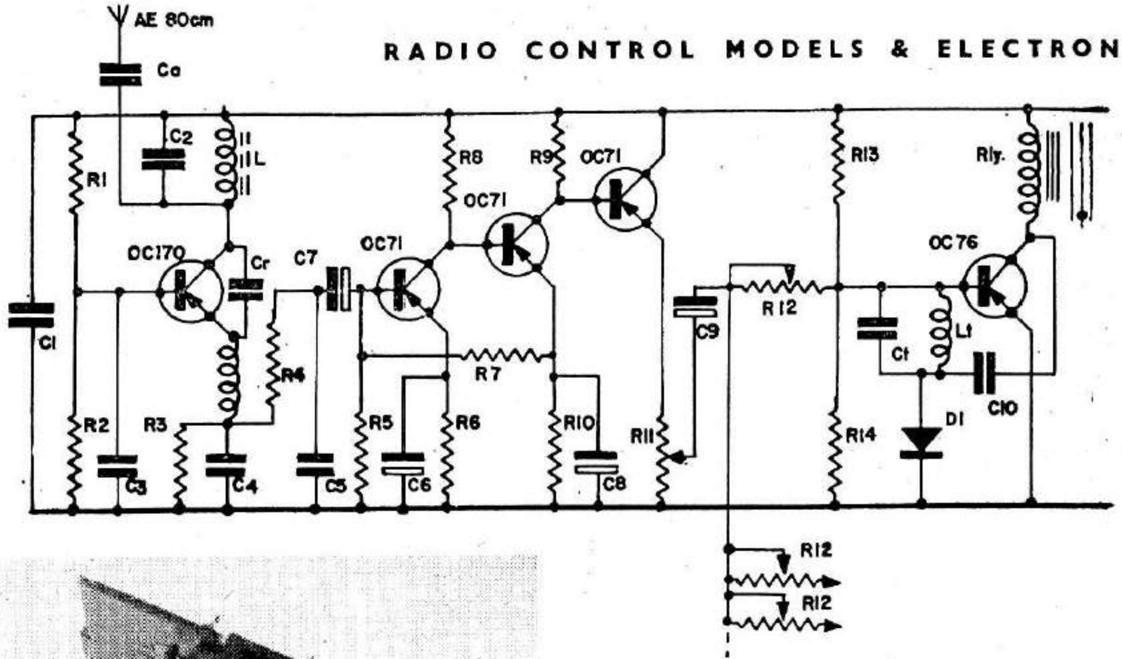
Designer Hans Schumacher flying his semi-scale ME 109 with the 10-channel equipment. Extension coil to aerial has already earned it the nickname of "TV Tower" from its resemblance to the Stuttgart TV station tower.

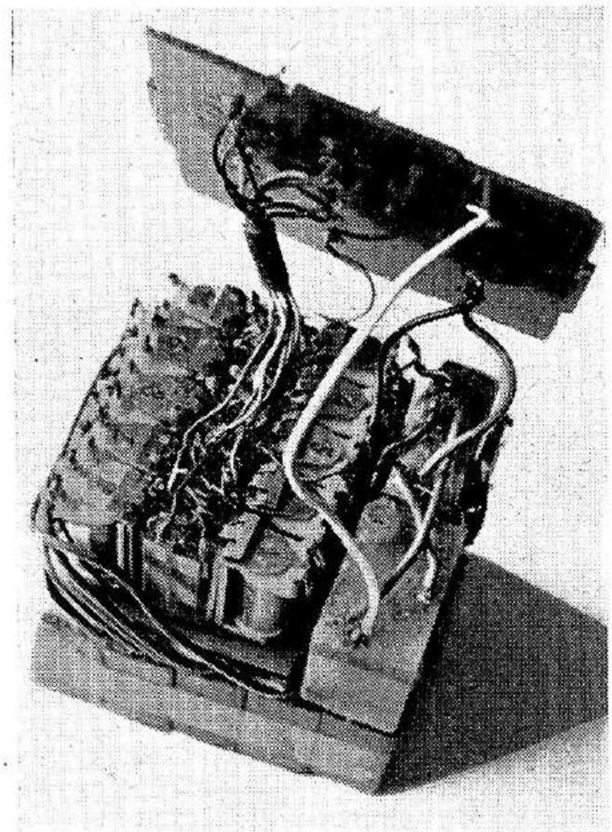
WHEN a magazine reports on a new car model it is obvious that the editorial staff will test drive the car thoroughly. However, when one wants to report about the most developed and refined R/C control system to date, and perhaps for a considerable time to come, it is sufficient to operate the equipment on the ground and to let the pilot afterwards put the model through its paces. It is obvious that a model equipped with a fully working 10-channel control set requires some practice to fly properly. For that reason we didn't fly the model equipped with the new Graupner Polyton 10-channel ourselves, when we visited Hans Schumacher.

Every possibility is provided for and the set is technically as complete as ingenuity can make it. The main control lever of the Bellaphon 10 Tx. works in exactly the same way as the control column in a full-size aircraft, and when displaced elevator and aileron deflections are obtained in exactly the same way as the controls of a full-size aircraft. The same goes for the second lever on the Tx. which works in the same manner as the rudder pedals on a full-size aircraft.

Technical Details

The Polyton 10-channel Rx. is packed in sorbo rubber in Schumacher's model. One servo unit each is used for the rudder and elevator and two more for the ailerons, without connecting rods between the ailerons. The two servos are connected in parallel with reversed polarity and built into the wing. The engine throttle is controlled with a Motomatic also over two channels. The Motomatic is installed in the same way as the Bellamatic, but without a neutral position and with the spring stop in the end position so that the throttle on receipt of a signal will go either to the idling or full power position. A 6 volt DEAC accumulator provides the power for the Rx. The servos with their low current consumption are powered by two DEAC batteries of 2.5 volts. The wiring is shown in the diagram overleaf. The controls are actuated by simple push rods. The Rx. itself including the relays weighs only 10 ozs., each Bellamatic $1\frac{1}{4}$ ozs. and all the DEAC cells together $3\frac{1}{2}$ ozs., so a total weight, including all push rods, etc. of about $1\frac{1}{4}$ lbs. will be easily achieved.





Polyton 10 Receiver. On the left are the ten relays in a double row; front right, the tuned filter, behind it the LF amplifier, and below the tone circuit switch stages.

CIRCUIT DIAGRAM :

Only one of the ten channels is shown.

R1, R2	**10 K. Ω**
R3	**5.1 K. Ω**
R4	**1 K. Ω**
C1	**3,000 pF.**
C2	**50 pF.**
C3	**2 MF.**
C4	**9,000 pF.**
C5	**40,000 pF.**
Ca, Cr.	**15 pF.**
L	**$7\frac{1}{2}$ turns 24g on $\frac{1}{4}$ in. former.**
R5, R7	**10 K. Ω**
R6	**820 K. Ω**
R8, 9, 10	**5.1 K. Ω**
R11	**Pot. 5 K. Ω**
C6, C8	**10 MF.**
C7, C9	**2 MF.**
R12	**Pot. 100 K. Ω**
R13	**330 K. Ω**
R14	**4.7 K. Ω**
C10	**40,000 pF.**
Di	**OA 85.**
RL	**Genner relay 300 Ω No. 957.**
Lt.	**Tone circuit coil.**
Ct.	**Parallel capacitor for tone circuit. Value in accordance with modulation frequency cycles :—**

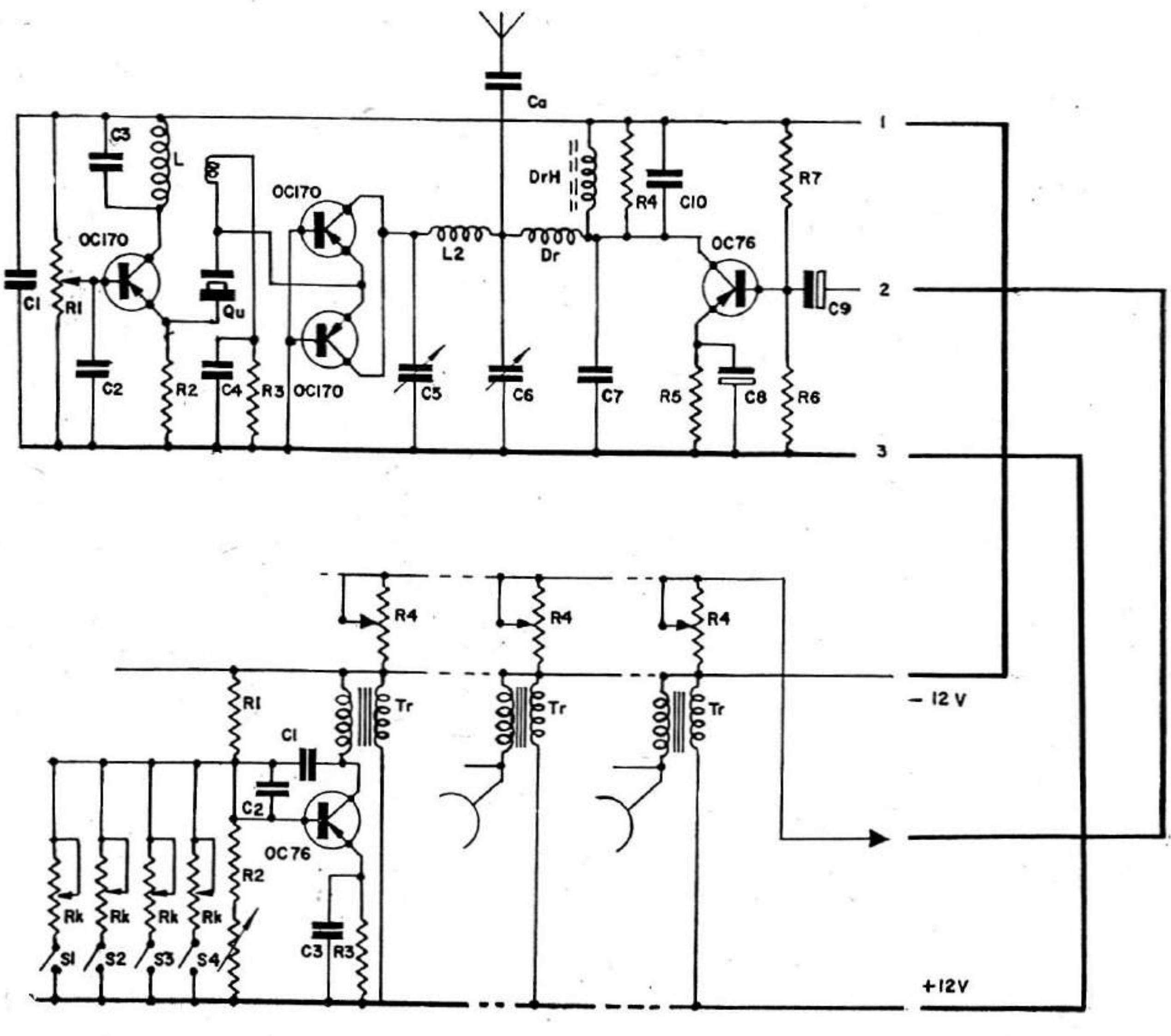
1	**1080**	**2**	**1320**	**3**	**1610**	**4**	**1970**
5	**2400**	**6**	**2940**	**7**	**3580**	**8**	**4370**
9	**5310**	**10**	**6500**				

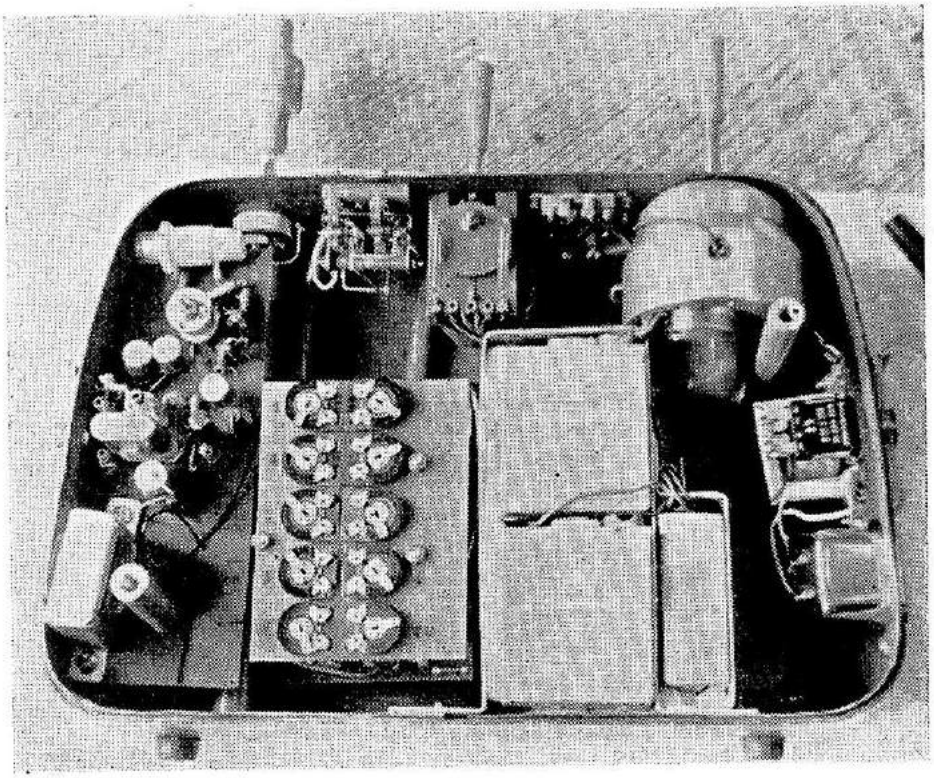
Next we will examine the Tx. of the Bellaphon 10-channel.

The new outfit has only the name and the elegant case in common with the old Bellaphon single channel. The inside is totally different. It is a two-stage crystal controlled *fully transistorised* Tx., which with the two-stage modulator draws only 28 m.A. from the accumulator of 12 volt working voltage. That is 75 times *less* current than the old Bellaphon drew from the 6 volt accumulator. The Tx. oscillator works with an O.C. 170 in the basic circuit (earthed base). The 40.68 MH2 crystal, however, is not exited between collector and emitter, but is exited on the collector side by a coupling coil, which has been wound on the oscillator coil and at the same time acts as a coupling coil for the final stage. This P.A. is fitted with 2 O.C. 170 transistors in parallel whose emitter is controlled with an earthed base. The collector circuit includes C 5, L 2 and C 6, which function as a Collins filter for the critical tuning of the rod aerial. When 2 P.A. transistors are used an 80 mW. H.F. power output is obtained with a 12 volt working voltage, with one transistor approximately 60 mW. is generated. Provision has been made to divide the current so neither of the transistors will be overloaded. It has been shown after months of research with a similar mock-up Tx., that two P.A. transistors wired in opposition do not show an improvement in performance. The relative low output is made good with a special aerial with an extention coil in its centre. As proof of the saying, 'A good aerial is the best and cheapest amplifier', this aerial gives about 10 times as much power as the usual short rod aerial, so that the effective radiating power of the weaker fully transistorised Tx., is higher than that of the Bellaphon with 75 × as much current. The collector voltage is fed to the transistors of the Tx. end stage by the LF choke DrH, across which also the collector voltage of the modulator O.C. 76 output stage appears. The modulation frequency is obtained from 3 O.C.

TRANSMITTER CIRCUIT DIAGRAM, with modulation amplifier above and three modulation oscillators below :

R1 Pot. 10 K. Ω
R2 270 Ω
R3 47 Ω
R4 1.5 K. Ω
R5 100 Ω
R6 1 K. Ω
R7 10 K. Ω
C1, C2, C4, C7 1,000 pF.
C3 12 pF.
C5 35 pF. trimmer.
C6 150 pF. trimmer.
C8 80 MF.
C9 4 MF.
C10 3,000 pF. Ca 5,000 pF.
L1 Oscillator coil and coupling coil.
L2 Filter coil.
Dr. LF choke.
Qu Crystal.
Oscillator Circuit.
R1 6.8 K. Ω
R2 4.7 K. Ω
R3 (unmarked below R2) 4.7 K. Ω
R3 1.5 K. Ω
R4 Pot. 25 K. Ω
C1, C2 30,000 pF.
Rk Channel pot. 1 K. Ω
S1, S2, S3, S4 Channel pulse switches.
Tr Transformer BV 31.
Repeated in each oscillator. In No. 2 C1, C2, 20,000 pF.





Transmitter opened for inspection. On left modulation amplifier, then the ten pots., followed by the two 6 volt Sonnenshein accumulators and batteries for the pulser. On extreme right is the charging unit. Above, retracted aerial, centre, rudder joystick, and to the right joystick for elevator and ailerons.

76 modulation transistor circuits, each working as a L.F. oscillator, whose outputs are connected in parallel and which can work singly or all three together (with simultaneous signals), and at the same time can modulate the Tx. with 3 different tones. The L.F. oscillations work on a phase shift principle with an inductance in each collector circuit (Tr) and the R/C link C1, Rk, C2, by switching of pots. Rk, which one can bring into operation through a switch S in the circuit, the frequency over which the oscillator works can be altered over a wide band. The different channel frequencies are brought in by the various switches S. The ten modulation frequencies between 1080 and 6500 cycles are divided over these oscillators. Oscillator 1 can provide 4 frequencies, while the others have three each. Upon studying the circuit it can be seen that the collector inductance has a low impedance coupling winding which acts as a special transformer. The three coupling windings are connected in parallel and feed through a common conductor to the base of the modulation transistor. The pots. R4 make it possible to control the voltage variations for each oscillator, thus maintaining a constant L.F. amplitude on the base of the modulation transistor.

Proportional Channel Selection

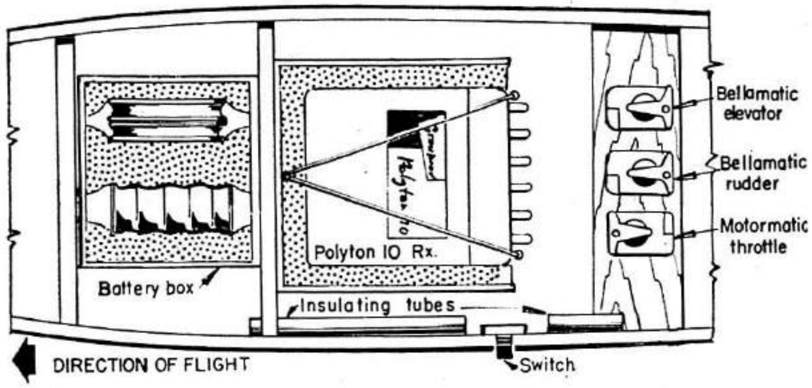
In the Bellaphon 10 Tx. are two mechanical pulsers (disc type) for the proportional selection of six channels, so six control movements can be actuated proportionally. The separate channel pots. Rk. of the modulators are switched through contacts in variable periodic amounts.

The disc is moved to left or right by a control lever on the Tx.

The Receiver

The receiver is fully transistorised. RF frequency for 27.12 or 40.68 Mcs. is convertible by a core change. There is a three-stage fully temperature stabilised L.F. amplifier, and 10-tone circuit (tuned filter) stages. The principle of the use of tone circuit stages for R/C was proposed by Schumacher and is, of course, used in the Polyton 10. Experience has shown that there is no better system for multi-channel operation than the tuned circuit. It is far superior to the reed relay, as it operates without mechanical contacts and has a band width which doesn't make great demands on the frequency stability of the modulator. It allows such large frequency spreads between separate modulation frequencies, that frequent tuning of the channels is unnecessary even at high temperature variations. The Rx. is blocked in resin in the same way as the Ultraton single channel. The aerial ends in the unit of the tuned coil of the O.C. 170.

The second unit is the L.F. amplifier with the O.C. 71, wired in cascade. The



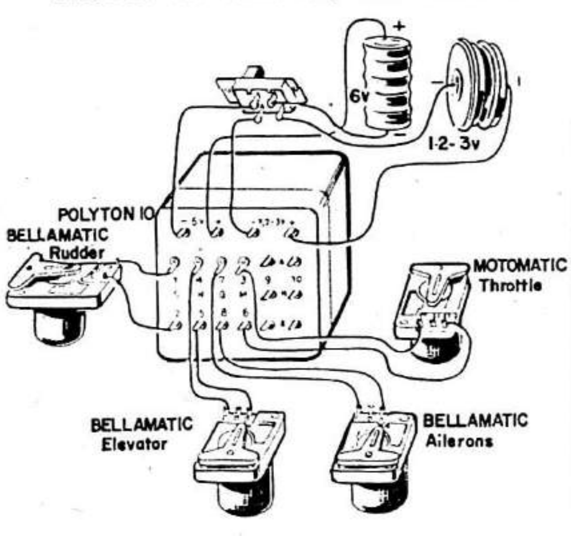
Installation of Rx. in model. It is packed in sorbo rubber in a plywood case and retained by rubber bands. Rudder elevator and motor control servos are located behind. Batteries are in front and may be moved to adjust trim. Aileron servo is in wing. Wiring goes through insulating tube shown.

base of the following transistors is connected with the collector of the previous transistors. This method provides exceptional temperature stabilisation. The third O.C. 71 is wired in such a way that it acts as a limiter and decreases the strong L.F. signal in the immediate neighbourhood of the Tx., preventing overload of the stage, when the Tx. is operated adjacent to the model. Behind the amplifier unit are the 10 filter units wired in parallel. They are all identically wired, except the values of L and C of the L.F. filter circuit, which is appropriate to the particular frequency of each unit. The 10 Genner relays of 300 ohm which are positioned over their tone circuit units are not encapsulated. The relay connections are wired in such a way that the servos can be connected directly to the numbered tags on the aft end of the Rx. With 4 to 5 microvolt sensitivity, the normal sensitivity of a modern R/C Rx., the set is as sensitive as a normal R/C receiver.

Due to the polarisation of the signal from the vertical Tx. aerial, the Rx. aerial should also be vertical. It is also advisable to have the Rx. aerial at right angles to the wiring on the model, so that it is outside the electromagnetic field and gets less interference from the wiring. As all the important and fragile parts of the Rx. except the relays are mounted in resin, it is less prone to damage on impact.

A few further points need mentioning. For instance the special Sonnenschein accumulators which power the Tx., the built-in charging unit, and sundry refinements, which are not strictly necessary and could be provided for by experienced people themselves. The most outstanding point is that the outfit is so complete that people without any electronic knowledge will be able to use it without having to worry. In that way they can concentrate on the flying side where they will have their hands more than full. It will not do any harm, however, to obtain some knowledge of what goes on inside.

Connection of controls and batteries to Rx. If two servos are used for ailerons they are connected in parallel. The double pole switch above Rx. operates batteries for both Rx. and controls.



Hans Schumacher (with cigar) about to start his attractive semi-scale ME 109 which has been the 10-channel test bed. Model is about 5½ ft. in span, tailplane about 20% of mainplane, and power supplied by favourite German twin the Ruppert Boxer of 8.5 c.c. All up weight about 9 lbs. (just over 1 lb. being radio installation).

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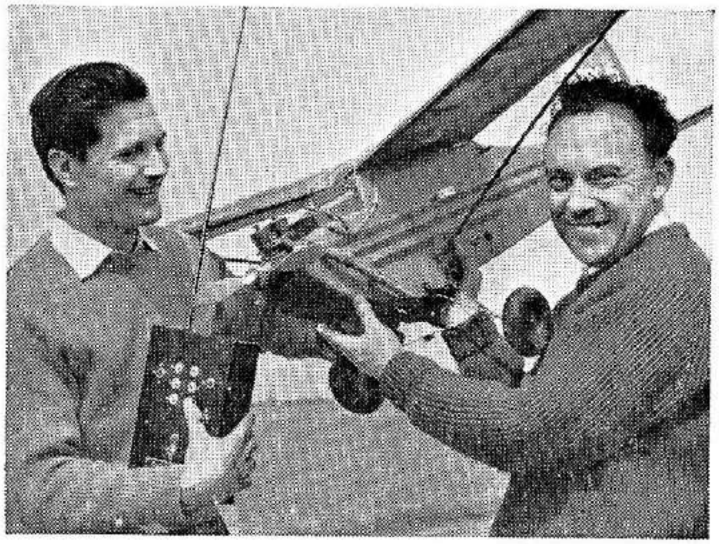

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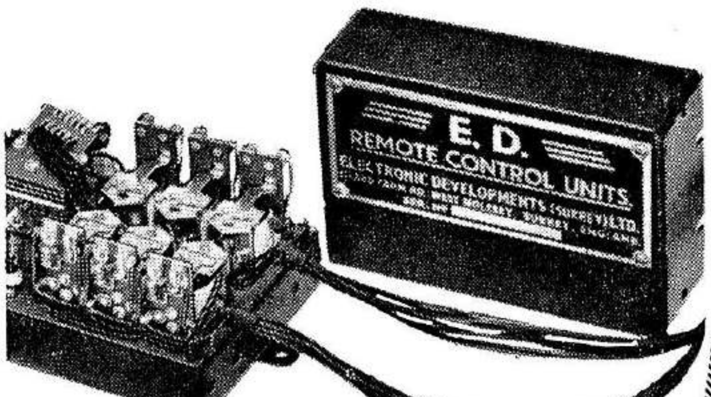

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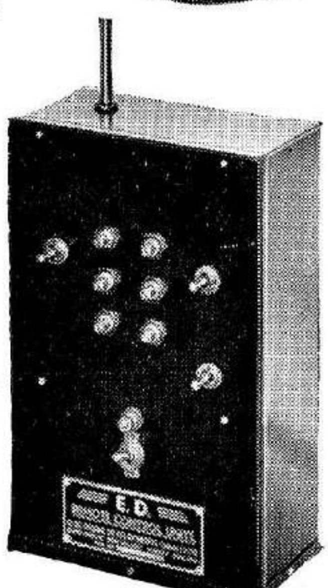

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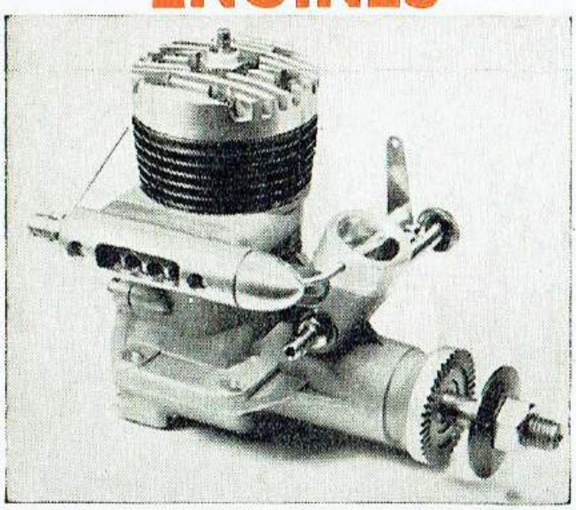

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