Radio Control Models & ELECTRONICS

SEPTEMBER 1960

Free Inside

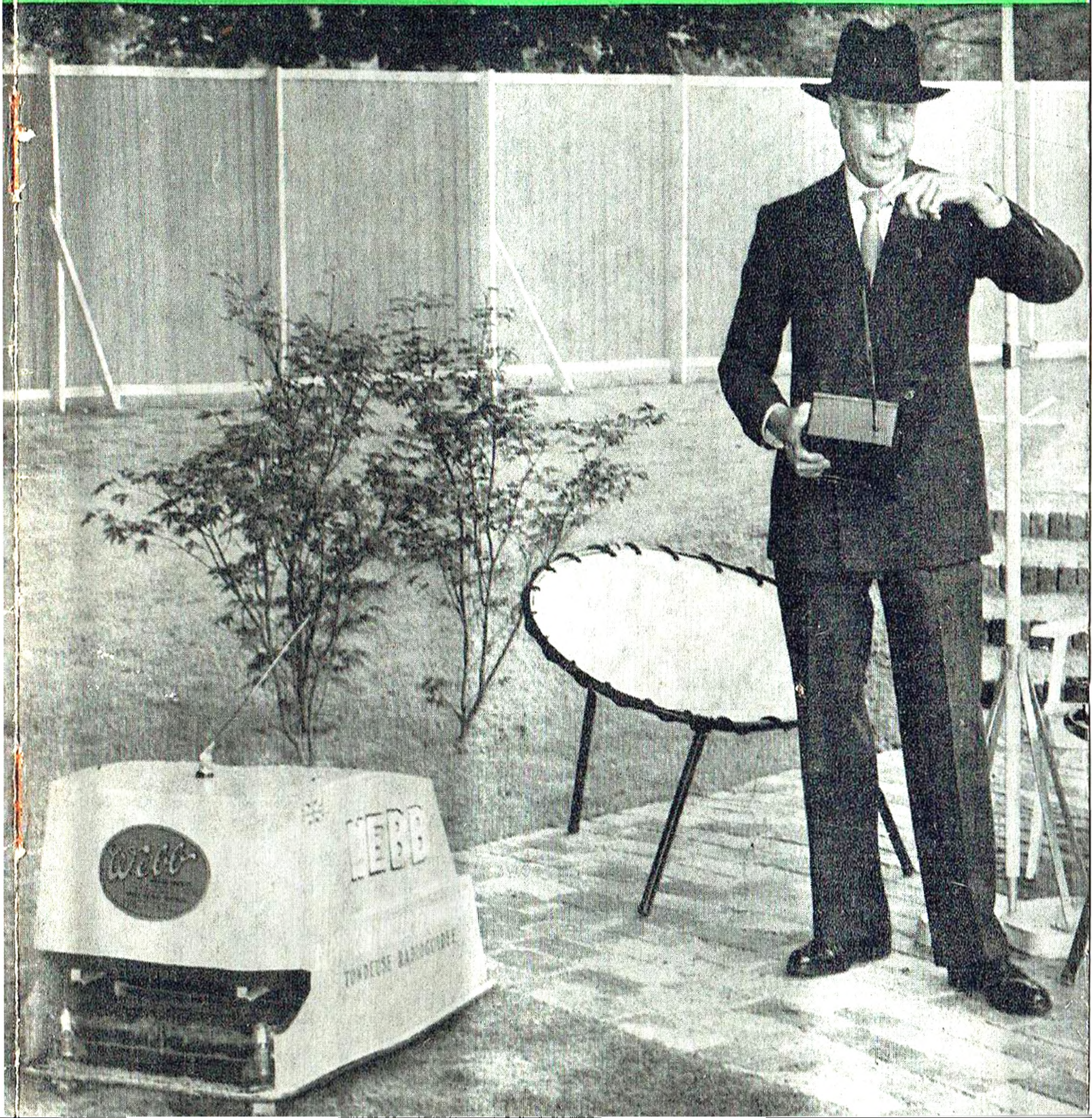
PULL-OUT FAULT FINDING CHART

★ ★ ★

THE NEW "IVY" BEGINNER'S RECEIVER

★ ★ ★

PRICE - - TWO SHILLINGS



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And look at the price £10 TAX PAID

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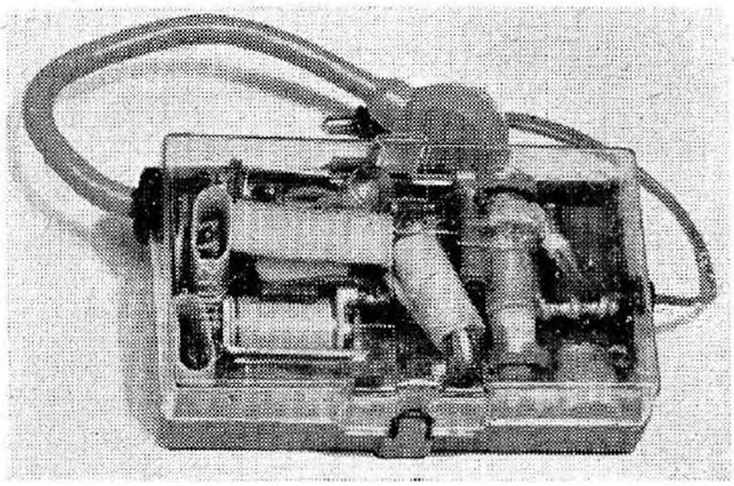

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METZ 3 KANNAL Tuned Filter Tx. and Rx. All Transistor. This gear can be operated at the same time as conventional equipment without interference. 6 volt working. 3 Gruner relays.

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Motorised Equipment
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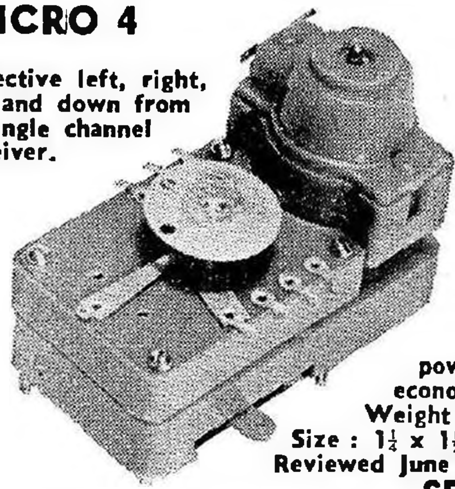

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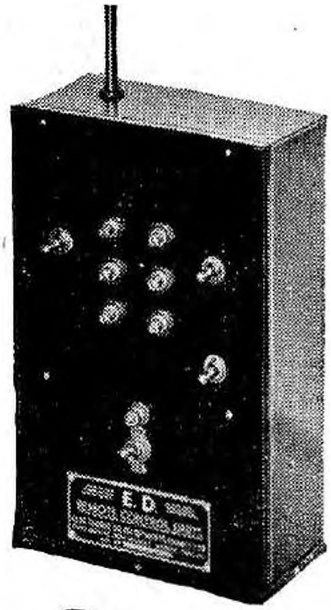

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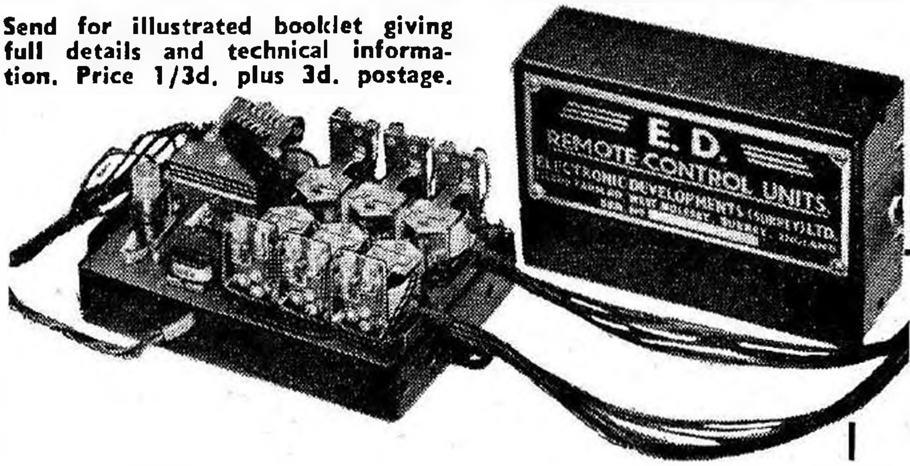

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As manufacturers of high grade electronic bakelite insulating components, we have decided to make available all our facilities and up-to-the-minute information on components and current production to enable the expert and beginner alike to obtain that little touch of finesse which marks the works produced article. It is not our intention to produce completely finished sets—this is excellently catered for by other manufacturers—but to offer those parts, tagboards, bobbins, ready wound coils, engraved front panels, etc., that cannot quite be produced on the kitchen table, resulting in discouragement to the beginner and infuriating the expert.

This service, therefore, in collaboration with leading exponents on radio control and in conjunction with articles will be offered in successive issues of this magazine. In addition those hard-to-buy components will be made available.

To allow this venture to succeed, however, the co-operation of you the reader is needed for what we feel are obvious reasons.

We are unable to enter into correspondence regarding circuits or design—this must be made through the usual channels. Advice or assistance, however, will gladly be offered for any constructional difficulties.

We cannot supply individual parts other than those advertised. Whilst every part we offer will be brand new stock, we will supply free replacement of any faulty article, and will quote for replacement of any article accidentally damaged on receipt of the parts in question.

Orders will normally be despatched in rotation within 48 hours of receipt; acknowledgment of remittances will be made should any unforeseen delay occur.

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Designed by electronic engineers to a specification unmatched by any other receiver.

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★ **ECONOMICAL** works off miniature 9v. battery at approx. 3 m.A. drain.
★ ½ amp. max. current rise on signal operates any actuator direct.
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★ Fully guaranteed for 12 months. ★ Built-in auto gain stabilisation enables maximum performance under all conditions with only one tuning control.
★ Owing to increased production, inclusive price is now reduced to **£9.16.5**

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Resistors, all values, small size (RMA 16). 3d. each.

For those who prefer to develop their own 'Pet' R/C systems, our components department has been specially planned to be of service. All components are brand new and fully tested before despatch.
TRANSISTORS : As a special service to modeller-constructors all transistors are sold with a test data report attached which gives details of characteristics of each individual transistor.
S.B. 305 (Semiconductors Ltd.): 27 mc/s transistor, specially graded by EssVee for high sensitivity, all transistor receiver applications. Price **15/-**.
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Radio Control Models & Electronics

VOLUME 1 NUMBER 5 SEPTEMBER 1960

Editorial Director : D. J. Laidlaw - Dickson.
CONSULTING EDITOR : T. H. IVES.
Advertisement Director : C. S. Rushbrooke.
Editorial and Advertisement Offices :
38 CLARENDON ROAD : WATFORD : HERTS
Telephone : WATFORD 32351/2 (Monday to Friday).

Here, There & Everywhere

Unlucky for Some !

OUR first need this month is to apologise to those of our readers who failed to collect their copies of last month's RADIO CONTROL MODELS AND ELECTRONICS on the proper publishing date. There is nothing quite so frustrating and annoying as to rely upon a copy of one's regular magazine on a due date and then find that for some reason it is not there. First impulse is of course to take it out of the unfortunate retailer by the implication that he has failed to order it; to suggest that every other shop in the district has had it for days and that he alone is at fault . . . and so on. Well this time, it was us, we are sorry and hope that this number is right up to time.

A Jolly Good Job

This leads quite naturally, into our next need. The magazine is expanding nicely and we should like to engage a suitable young man to expand with it. What we want is a reasonably skilled radio control enthusiast, preferably interested in both boat and aircraft aspects, free of service ties, aged in the lower twenties, who would like to make a career of technical publishing. We do not expect knowledge of the technical side of editorial work; the right sort of man will naturally have a fairly agile pen and a good eye for pleasant arrangement, but we are happy to teach him the editorial side if he has the necessary technical background.

The job will first of all be as an editorial assistant (which means being the office dogsbody for the time being). As soon as he is competent enough to work with a minimum of supervision, then he can expect promotion to Assistant Editor, which is quite an important role. Finally, in the not-too-distant future he will rank for elevation to the ultimate status of Editor. It is a nice chance to grow up with us, we are a friendly team, and the right sort of man will enjoy a real welcome, and have a chance of getting paid for what thousands do for fun. If you think you fill the bill drop us a line in confidence and we will interview the likely pros-

CONTENTS

Subscription Rates : 12 months (home), 28/6; (overseas) 27/6, including enlarged Christmas Number.

pects. Letters addressed to the Editorial Director and marked "Editorial Assistant" should contain details of modelling and educational background and employment to date. We hope to make an appointment to start in the early autumn.

Two Princes

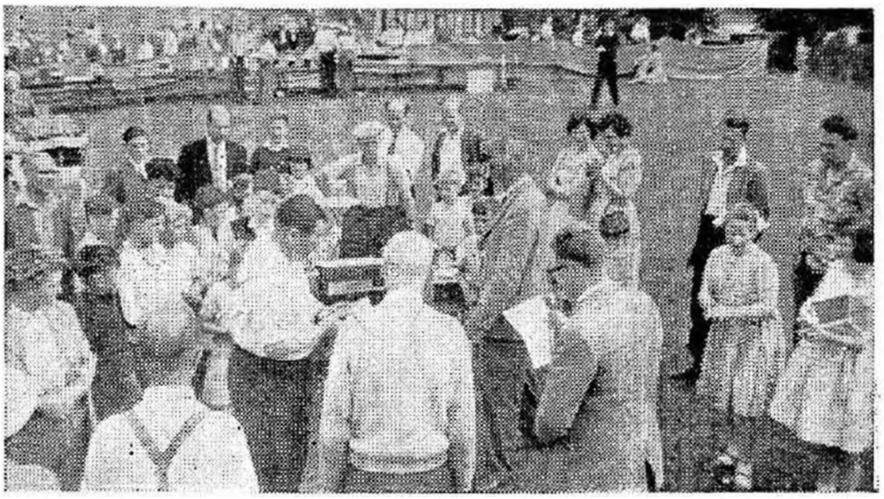
Cover picture this month shows the lazy gardener's dream of heaven—a radio controlled lawn mower. This is a British Webb machine on show at the Miracle Garden Exhibition in Paris, hence the French titling. Wielding the Tx.—yes, it is indeed our old friend the Black Prince, and E.D.'s have done a vast amount of development work on the project—is H.R.H. The Duke of Windsor, interested as ever in all that is new in the world of labour saving inventions. We have asked Vic Rigby, E.D.'s development electronician to tell us something about R/C lawnmowers, and their own work in particular (*Photo Associated Press*).

Kingston-upon-Hull Boat Meeting

With full-hearted support from the local corporation the Kingston-upon-Hull Group of the I.R.C.M.S. staged a most successful meeting on the model boat pond in East Park on June 5th/6th. Home club took the timed speed event with an Aerokits Fireboat piloted by J. D. McLean. Tyneside Group brought along some good R/C yachts, with N. Armstrong and D. White of Newcastle the winners of both timed and handicap events. Steering events went to W. Darragh & Son of Wetherby (good old father and son combinations!) and B. Burrows (Manchester) and local man J. D. McLean again. What pleases us is that Parks Superintendent H. Roscoe came along to show his council's support by presenting the prizes. As Vice-Chairman of the group Jim Spandler writes: ". . . We are really fortunate in having a Parks Dept. who are interested and give us *every* assistance". For those thinking of going next time—and there should be a lot of next times—the pond is 420 ft. by 60 ft. and 4 ft. deep, concreted all round. I.R.C.M.S. Boat Internationals were held here in both 1958 and 1959. You lucky people!

The "Ivy" Circuit

In its day the "Ivy" circuit evolved by Tommy Ives enjoyed almost world-wide fame. Production difficulties prevented the designer ever marketing it as a ready made job, except in very limited numbers, but this did not prevent a number of sets coming out that either acknowledged their debt to the "Ivy" or copied it more or less successfully. In spite of this, it has never been published officially in any model magazine that we have read until now, when we offer it in new ultra-simple form as a first ever for the complete novice. Novices' so-called receivers are legion, but most demand at least some knowledge somewhere. Our version requires only that the builder can read! Thanks to the co-operation of MacGregor Industries readers can obtain a suitable tagged panel, with tags numbered, ready-wound quench coils, and all the parts required for its construction down to a length of cored solder. All that the would-be builder requires to get is the relay and valve. As a beginner, he will probably not have a suitable soldering iron for electrical work. But it does not matter! Even a fairly hefty bit can get at these carefully arranged components. Later, he can invest in a good



Community spirit! Parks Superintendent H. Roscoe at the Kingston-upon-Hull Boat Meeting presents local start J. D. McLean with his prize. Other councils please copy!

Dangerous challenger! Karl Heinz, past winner and agog to recover title of world R/C master, this formidable member of the Stegmaier family is seen here with his characteristic model and equipment.

iron, but meanwhile not to worry, if it gets hot it will do! Good luck all you builders, you are now on the way!

For Impatient People

By the time this issue is on sale the first R/C World Championships at Dubendorf, Zurich's military aerodrome, will be over and we shall know if the European masters are as good as they have always seemed to us against the best that the New World can send in the shape of a top notch United States team. It might even happen that one of our British team may leap in to snatch the spoils as could so easily have happened in the unofficial championships last year if only Chris Olsen had had a second flight half as good as his first! Next month's issue will contain the full story in words and pictures of our men on the spot. Meanwhile, the impatient can obtain a "taster" from our big sister magazine *Aeromodeller* September issue (on sale August 15th) which will include a special insert supplement dealing primarily with the World Power Championships at Cranfield over the Bank Holiday, but will also contain results and highlights plus a picture of two of the radio event.

World Speed Record Claim

LARK newsletter gives details of a new F.A.I. Speed Record set up by Jack Bentley (designer of his *Regulus X*-29) and Bob Dunham who flew the model. Record speed was 114.5 m.p.h. attained on May 15th, 1960, at Los Angeles Model Airport at a FAST Club contest. Engine used was a Super Tigre .29, and beat the record set up earlier this year by Don Mathis at 110.8 m.p.h. using a .60. Top speed downwind was clocked at 126 m.p.h. Details of the *Regulus X*-29 are: Span, 33 in,; chord, 11 in.; wing area, 363 sq. in.; weight, 56 oz.; engine, .29 Super Tigre; Rx., Orbit 4 channel; Tx., ditto; Servos, Bonner Duramite.

Over, Under or Round

We started RADIO CONTROL MODELS AND ELECTRONICS with the laudable intention of following British Standards for circuit drawings, with dots where there were junctions and undotted crossing lines where there were not. However, we have come to the conclusion, shared by other publishers in this field, that the "old-fashioned" half-circle loop to indicate a cross-over cannot be beaten for clarity and ease of checking, so we are changing back to it. We hope it solves the ever-present worry of getting the drawings right before we go to press — not the day after publication!

Now a Beginner's Transmitter

To make a pair with the Rx. featured in this issue our next will contain similar instructions for an ultra simple transmitter to operate it. This will be a simple hand held centre-loaded aerial model, developed again by Tommy Ives, to avoid all the sort of snags that bewilder the novice, and, once again, full advertiser support will be provided in supplying components, chassis, materials, and even an engraved panel to give it a real professional look.

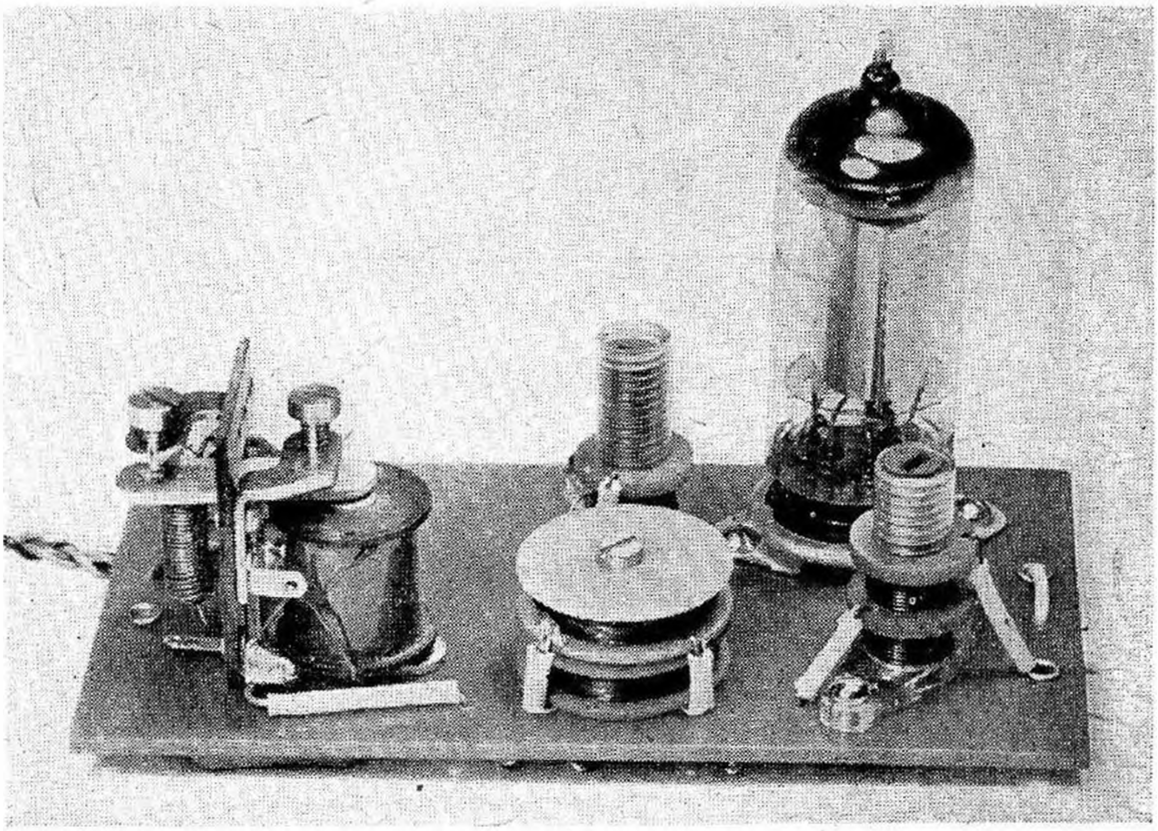
THE HILL TRANSMITTER

The following vital information should be added to circuit diagram in August issue:

L.1 $\frac{1}{4}$ in. former 22 turns 32 swg enam. wire close-wound anti-clockwise from bottom of former.

L.2 $\frac{3}{8}$ in. former $9\frac{1}{2}$ turns of 22 swg enam. wire close-wound clockwise from bottom of former.

L.3 12 turns of 16 swg enam. wire close-wound clockwise on $\frac{5}{8}$ in. dia. former. Former removed and coil slightly spaced to occupy 15/16 in.



Uncluttered nature of this beginner's set is evident in this picture, approximately full-size, using parts supplied by MacGregor Industries, who have co-operated in the production of the unit.

The New Ivy Receiver

TOMMY IVES PROVIDES AN ULTRA - SIMPLE C / W RX. ESPECIALLY FOR NOVICES

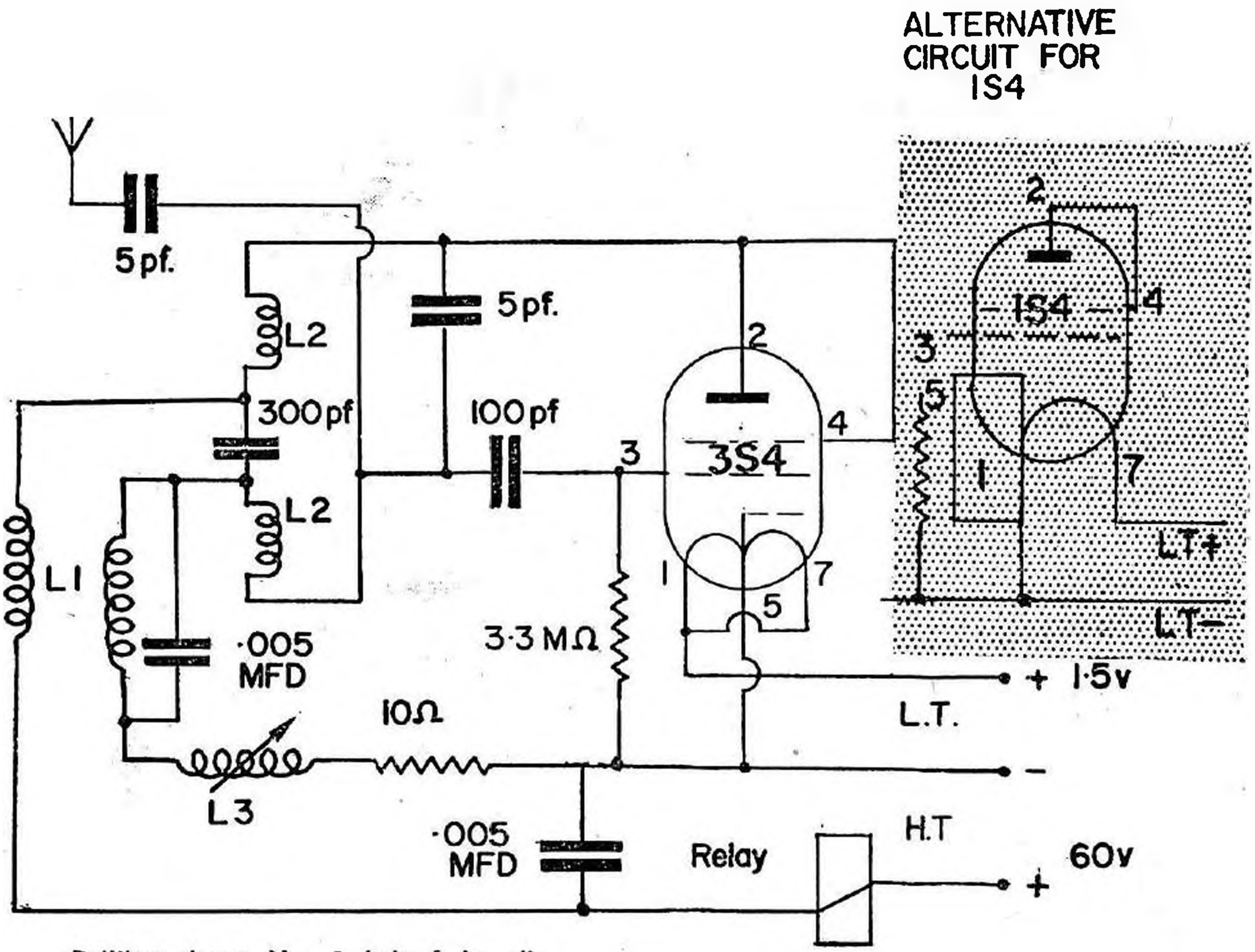
No apology is offered for re-introducing an old friend for several reasons:—(1) It is ideal for the beginner. (2) There is a demand for a single valve receiver particularly in the marine field. (3) It is a well proved design and provided instructions are followed exactly success is assured. (4) It will operate on carrier wave only and dispenses with the complication of tone modulation and its attendant problems. (5) With the addition of a single transistor it can be modified into a very satisfactory two stage receiver (still on carrier only).

It cannot be too strongly stressed, however, that the receiver relies for its success on adjustment of the sensitivity control and this can be affected by stray capacity. A long insulated tool for tuning is recommended and neither receiver nor actuators, etc. should be touched by the operator during adjustment. In other words the unit should be tuned under conditions which will arise whilst controlling. In aircraft this is very important as the conditions in flight can be quite different from those on the ground. For this reason aircraft should be held above ground during tuning and no part (including the aerial) should be touched.

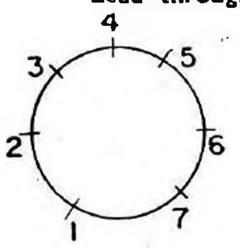
It is not uncommon to see an aircraft held whilst tuning with the operator clutching the aerial and wondering later why it failed to respond to signals.

Provided the simple precautions mentioned above are taken success is assured and apart from a small adjustment of the sensitivity occasionally to compensate for battery variation no further attention is necessary.

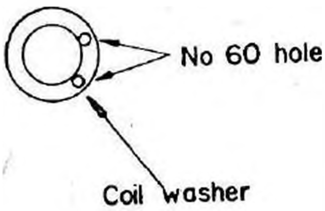
One further point which applies to all receivers is the correct adjustment of the relay contacts. This receiver has a standing (or idling) current of approx. 3 m.A. which falls to approx. 1 m.A. on receipt of a signal. This change is a minimum and some examples have a change of as much as 3 m.A. Also with

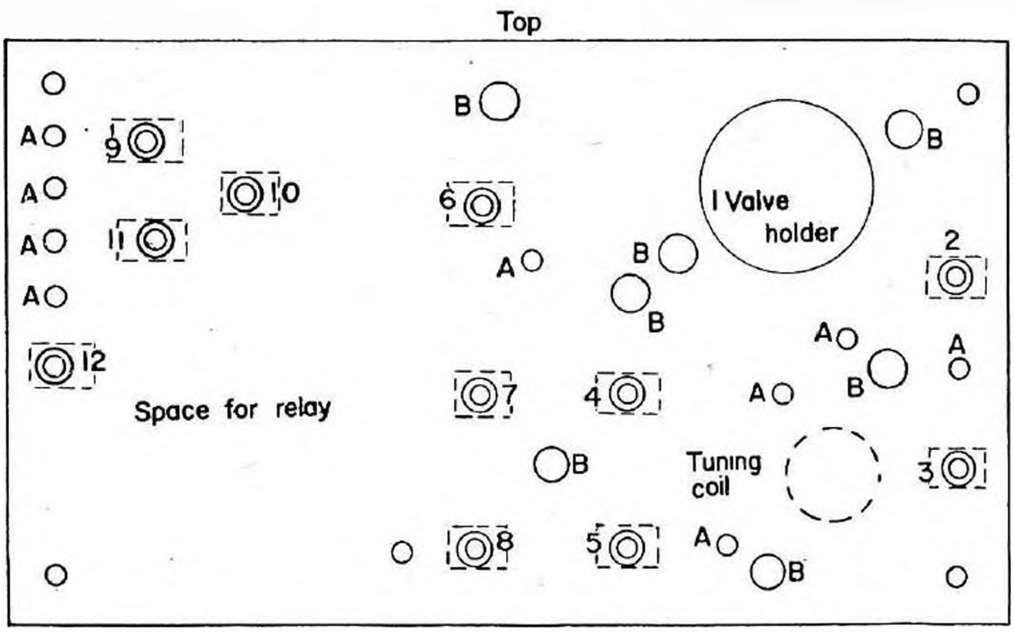


Drilling sizes: No. 1 hole ⅝ in. dia.
Holes numbered 2 to 12 : No. 42 drill.
Component fixing holes B : No. 42 drill.
Lead through holes A and corner holes: No. 51 drill.



Valve base

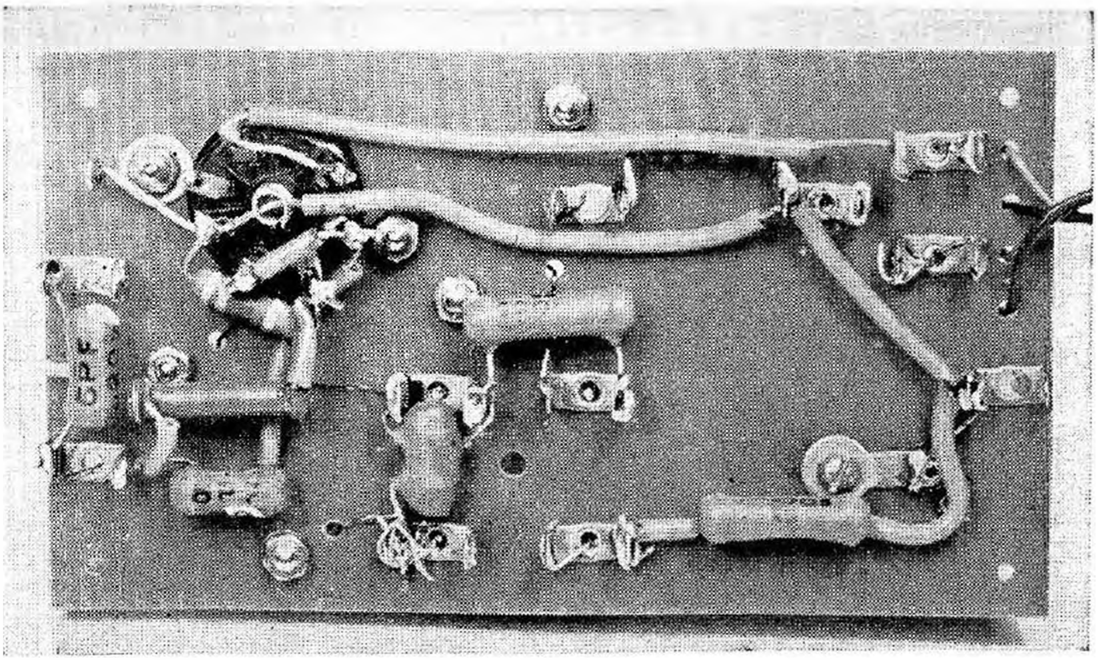




COMPONENTS REQUIRED

1 Paxolin Panel. MacGregor Industries.
1 Valve holder. B7G moulded amphenol or ceramic.
2 Coil formers. Polystyrene ¼ in. dia.
1 100 pf. ceramic capacitor. (Radiospares).
2 0.005 mfd. ceramic capacitor. (Radiospares). Hi-K.
1 300 pf. ceramic capacitor. (Radiospares). Hi-K.
1 3.3 megohm resistor ⅛ or ¼ watt. (Radiospares).
2 5 pf. ceramic capacitors. (Radiospares).
1 10 ohm resistor. (Radiospares).
1 1S4 or 3S4 Valve (or equivalent).
1 Relay (good quality) resistance 4,000 - 5,000 ohms.
1 Quench coil. MacGregor Industries.
1 L.T. battery D 18 Ever Ready.
2 H.T. batteries B105 Ever Ready (30 volt).

(Above parts, less valve and relay available from MacGregor Industries.)



Underside of panel. Ease of soldering with even a "plumber's iron" is a feature. Below is MacGregor panel with numbered tags for ease of construction.

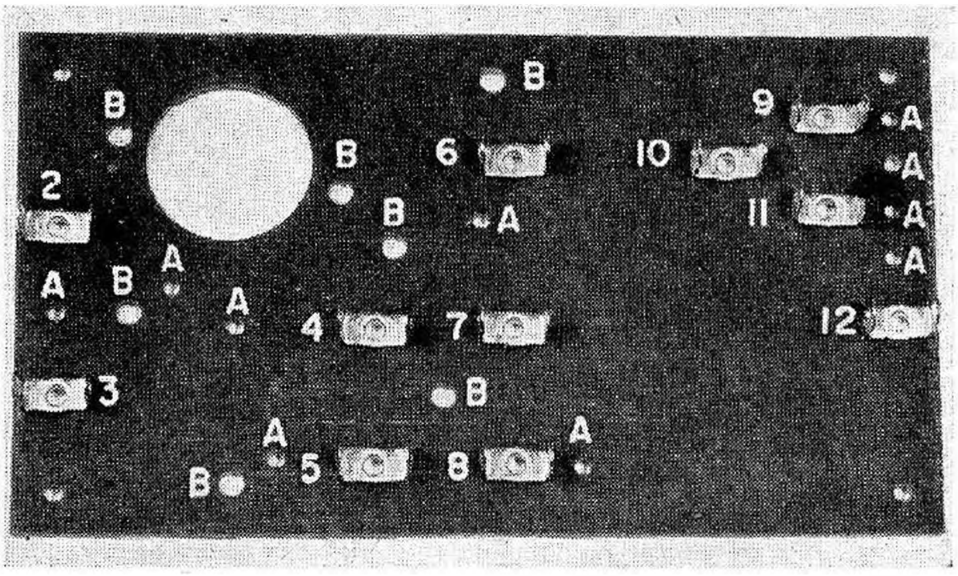
a higher H.T. voltage (normal is 60 volts) a higher standing current may be obtained with a greater change. The maximum voltage should not exceed 90.

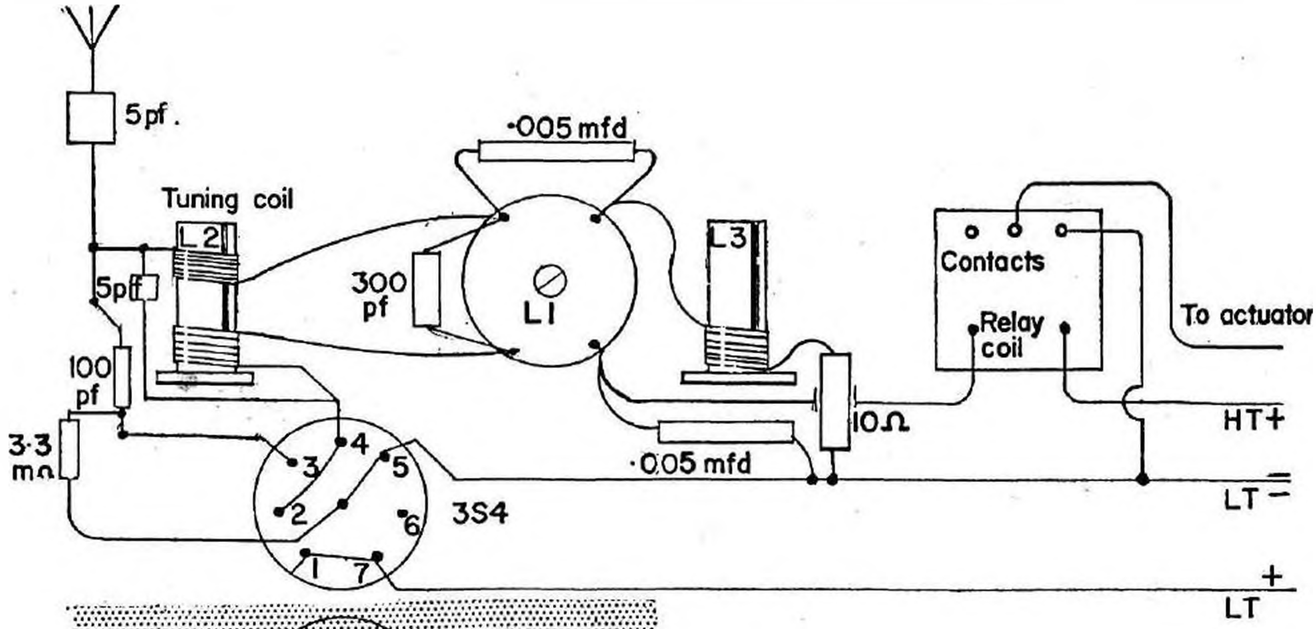
It will be clear that the relay armature must be held on at the standing current point and fall out as the current drops below a certain value. For 60 volts H.T. and a standing current of 3 m.A. the armature must be set (by adjusting the spring tension) to pull in at less than 3 m.A. (say 2.5 to 2.8) and fall out at say 2 m.A. The higher the fall out point the better as if the receiver is not properly tuned or goes out of range for any other reason the current fall may be much less than the above mentioned figure (when the model is at range). This could mean the loss of the model if an aircraft. Instruction on this point will be given later.

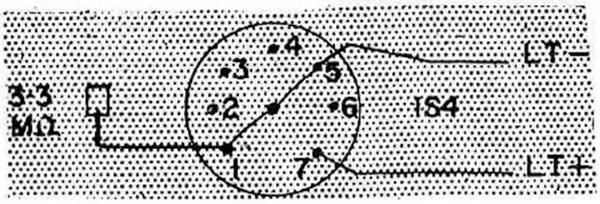
Finally be very careful about soldering. Wrap wire connections around their terminal point to insure no movement whilst the solder is setting. Have a really hot iron (the flux should sizzle) a clean joint and make sure that the solder runs freely. Do not on any account use a corrosive flux.

Construction

PANEL: This may be of paxolin or formica, the latter being quite satisfactory. The larger holes (see panel opposite) may be cut with a fretsaw. An alternative method is to drill a series of small holes round the circle drawn on







ALTERNATIVE CIRCUIT FOR IS4 VALVE

the panel. The centre may be broken away and the hole finished with a file. The remainder of the holes may be drilled to the sizes shown. The relay fixing holes are not shown as they will vary with different relays. Prefabricated panels are available.

In holes 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, fix tags or hollow rivets.

QUENCH COIL: The formers can be made from Wakefield run true bobbins if available (plastic not moulded) or fabricated from plywood. Again ready-made coils are available.

Those who wish to make their own proceed as follows:—Draw the outlines of the discs (drawing 2) on a piece of thin ply and cut slightly oversize. Sandpaper the edge to finished size. For those with a lathe this stage will be 'a piece of cake'. The bobbin cores can be made from $\frac{5}{16}$ in. dowelling cut to the correct thickness. Drill the discs and cores with a $\frac{3}{32}$ in. drill. Place discs and cores on a 6BA screw, gluing each face before the part is placed on the screw and tighten with a 6BA nut. Leave to set.

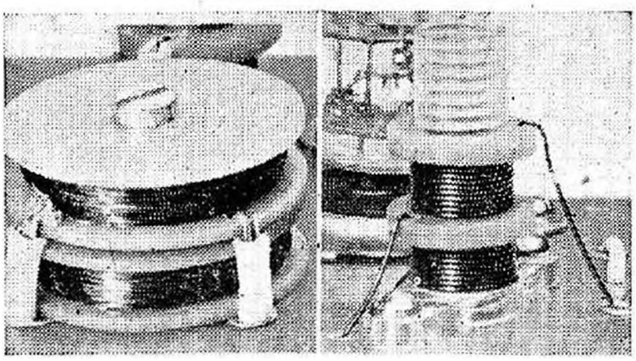
Place the screw holding the bobbin firmly in a hand drill chuck. Grip the drill shank in a vice if possible.

Fix the end of 40G enamelled wire to the drill chuck (with a rubber band). Lead the wire to the bobbin and wind on two or three turns. Cement a small piece of tissue over the wire where it goes down the bobbin cheek. Complete the winding of 650 turns. Secure the outer end whilst a strip of thin paper is wrapped round the winding. The two ends may then be wrapped round this covering and cemented in place leaving about two inches for connecting.

Repeat with the second bobbin, and again wind on 650 turns. Each coil should be wound in the same direction and the start and finish indicated. (A dab of coloured dope or paint will do.)

Those who wish to have more substantial leads may puncture the outer edge of one of the discs in two places. Two holes at each point. Thread a short length of 26G tinned copper wire through each pair as shown. The ends of the 40G wire may then be scraped and soldered to these leads.

ASSEMBLY: Fix the valve holder to the panel. Ditto the two coil formers. Hollow rivets are ideal for this job.



Close-up of quench coil, with thicker leads fitted as described. Coil with its smart spacing washers is also shown.

TUNING COIL: Take a length of 28G enamelled copper wire (approx. 14 in.), Bare one end and solder to tag 2 or 4 (valve holder) underneath the panel. Thread the wire through the hole nearby and close wind nine turns on the former. Slide on one of the washers and thread the wire through one hole in the washer. Continue the wire end through the hole near to tag 5, bare it to allow for soldering to that tag. Solder and cut off spare.

Take another length and bare the end. Solder to tag 4 and thread through the nearby hole in the panel. Thread it through the other hole in the washer on the coil former and close wind in the same direction another nine turns. Slide another washer on the former, thread the end through a hole in it and take the end through the hole in tag 3. Bare the wire and solder to tag 3. Cut off the spare.

If the washers are a tight fit and the wire has been wound tightly no fixing cement is necessary. If the coil or washers are loose, however, cement with polystyrene cement. A thin layer only.

SENSITIVITY COIL: Take a 14 in. length of the 28G enamelled wire and bare the end. Solder to tag 7 and thread through hole near tag 6. Wind 10 turns on the former, slide on washer and thread the end through hole in the washer. Thread through hole in tag 6, bare wire and solder to tag 6. Cut off spare.

QUENCH COIL: Screw bobbins to the panel. A ⅜ in. No. 2 *brass* wood screw will do. The leads for one coil should face tags 4 and 7 and the other 5 and 8. See that both coils are the same way up. Connect the leads from one coil to tags 4 and 7 (threading the lead through the appropriate tag hole). Do the same for the other coil soldering to tags 5 and 8.

PANEL (UNDERSIDE):

(1) Solder a length of 26G tinned copper wire from tag 12 to tag 10 and thence to pin 5 (valve holder) and the spigot on the centre of the holder. Place sleeving on the wire between the joints.

(2) Solder a 5 pf. capacitor from pin 2 (valve holder) to tag 3 on panel.

(3) Solder a 5 pf. from tag 2 to tag 3.

(4) Solder 100 pf. from pin 3 (valve holder) to tag 3 panel.

(5) Solder 3.3 meg. ohm resistor pin 3 (valve holder) to 5 pin (valve holder).

(6) Solder a short length of 26G T.C. wire from pin 2 to pin 4 on valve holder.

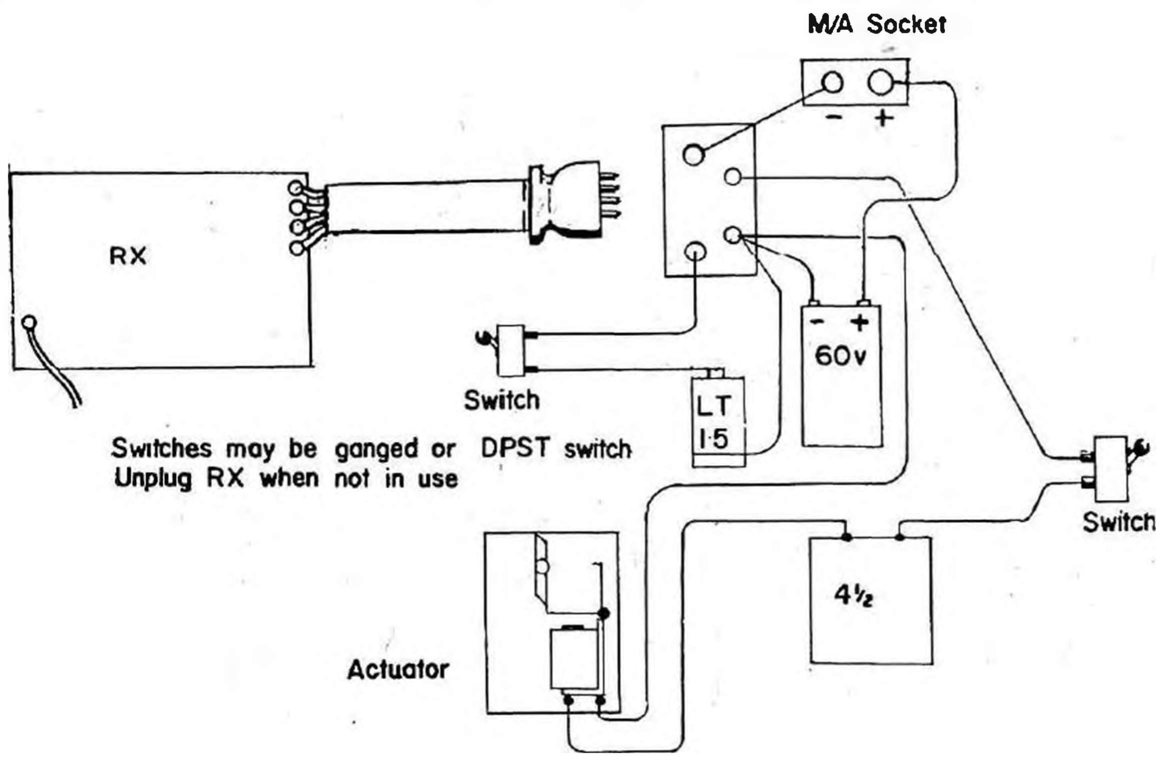
(7) Ditto between pins 1 and 7 valve holder. This for valve 3S4. Study a valve base chart if 1S4 is used.

(8) Solder a 300 pf. cap. between tags 4 and 5.

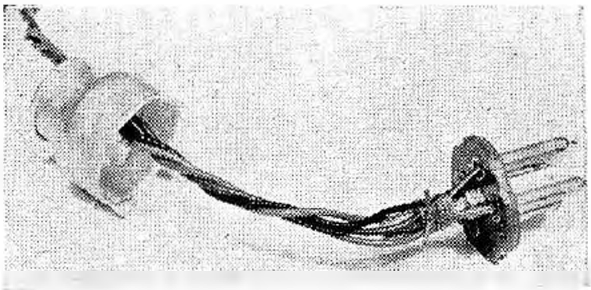
(9) Solder 26G T.C. wire sleeved from pins 1 or 7 valve holder to tag 9.

(10) Solder 10 ohm resistor (⅛ or ¼ watt) between tags 6 and 10.

(11) Fix relay to panel. Connect one end of relay coil winding to tag 8 and the other end to tag 11.



Switches may be ganged or DPST switch
Unplug RX when not in use



Anchoring leads on 4-pin plug. An 8BA screw passes through centre of paxolin pin base and leads are firmly tied to it with thread.

(12) Solder .005 ceramic from tag 4 to tag 7.

(13) Solder .005 ceramic from tag 8 to tag 10.

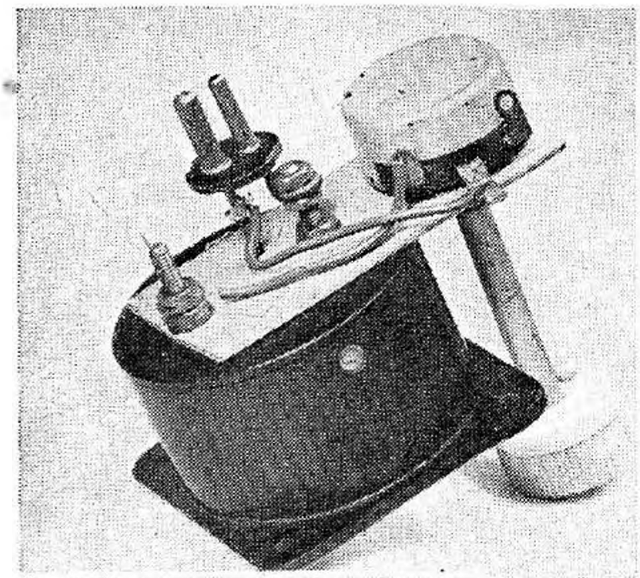
(14) Solder short lengths of coloured P.V.C. flex to tags 9, 10 and 11. Blue to 9 black to 10 and red to 11. Pass the flex through the holes nearest to each tag. This will prevent fracture through constant handling.

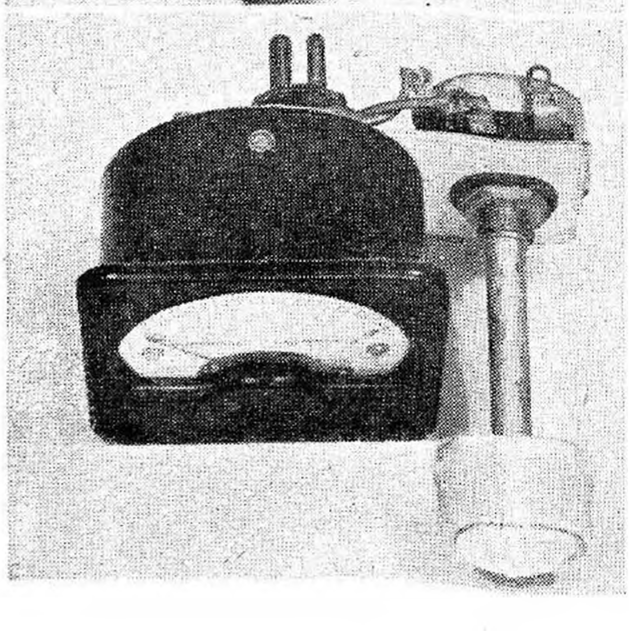
(15) Take a 24 in. length of P.V.C. flex and solder to tag 2. Pass the flex through the hole close to the tag.

(16) Connect armature of relay to tag 12.

(17) Connect short length of P.V.C. flex to the relay back contact and through hole near to tag 12.

(18) Connect all four leads to a four pin plug. Do not forget to anchor the leads at the P.V.C. covering.





Meter and potentiometer complete with 2-pin plug. This indispensable testing aid takes no time to make and is of everlasting value! It is ideal for relay setting.

This is a must and will ensure freedom from fracture. Note: If not provided for on the relay, connect a .01 capacitor from the centre armature to the back contact. The connection could be to tag 12 from the back contact. This is to suppress sparking.

SETTING UP AND TESTING:

Check all wiring before setting up.

Obtain a 5 m.A. meter and fix it to a small panel with a 50K potentiometer. Include a two pin plug on the panel so that the unit can be plugged into circuit for testing (see photo). The pot. is essential for safety reasons and to enable the relay to be set up correctly. (See drawing).

Connect up all parts as shown. A similar hook up can be made permanently in the model when tests are complete. The pot. should be in the minimum position before connecting up as this may save the price of a new valve.

Make a tuning tool from a large plastic knitting needle. File the end to a screwdriver form.

Plug meter in socket and switch on. Rotate the pot. slowly towards the maximum position watching that the current does not go above the max. (say 3.5 m.A.). If it does switch and recheck the wiring.

If all is well take the tuning tool and rotate the tuning coil slug (L2) until it is approx. $\frac{3}{8}$ in. above the top of the upper winding. Rotate the sensitivity slug (S slug) until the current rises to a maximum. If already at a max. rotate it in a clockwise direction until the current falls. This slug should be approx. $\frac{3}{8}$ in. above the top of the winding.

Now rotate S slug until the current is approx. 2 m.A. and switch on the transmitter. Return to the tuning slug

(T. slug) and with the Tx. key depressed rotate the slug until the meter shows a dip in current. It will be found that as the tuning coil is rotated the current changes anyway. This is due to interaction between the two controls and must be taken into account. Rotating T slug clockwise will cause a current rise and anti-clockwise a current fall. Tuning in the signal, however, will cause a current fall whichever way the slug is rotated followed by a rise as the slug continues to rotate in the same direction. It is thus possible to detect the effect of a signal as the slug is rotated.

Due to the interaction, however, it is necessary to adjust the S slug at the same time in order to keep the current at approximately the same figure until the signal is detected. Once it is found rotate S slug in the anti-clockwise direction until the current just rises to a maximum.

With the Tx. still keyed a full drop in current should now be obtained. A further small adjustment of the T slug and the S slug in order to obtain the full drop and at the same time maintain the standing current at its correct value. The best position of the S slug is a fraction of a turn anti-clockwise past the point where the current reaches a maximum.

This may sound complicated but is quite easy when the procedure has been mastered.

Having completed the test the gear may be installed and a further test made at a range of 100 yards.

The relay should be set up in the following manner:—With the current at a maximum rotate the pot. attached to the meter and as the current falls watch for operation of the actuator. Adjust the spring tension of the relay so that it makes at approximately 2.5 m.A. and falls out at 2 m.A.

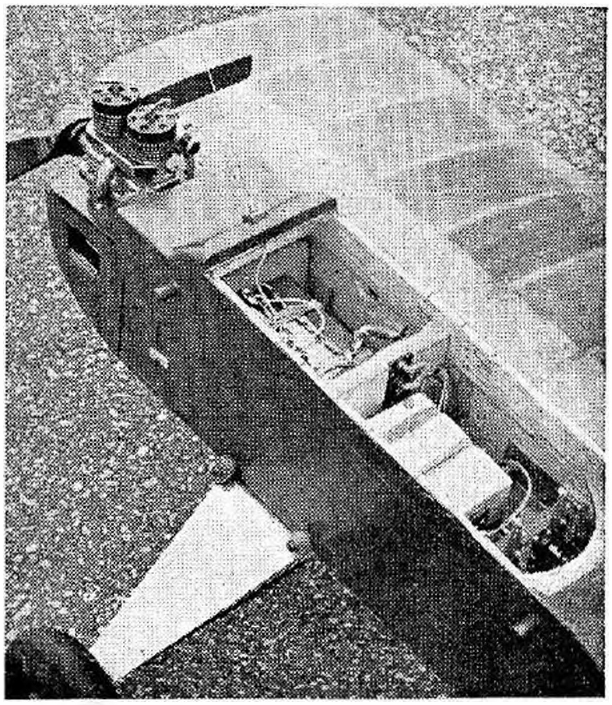
Note: Where possible any metal linkages in the control system should be electrically shorted with a short length of plastic flex.

Radio Installation

A FURTHER ARTICLE IN WHICH LATEST "COMPACT" DESIGN FEATURES ARE DISCUSSED

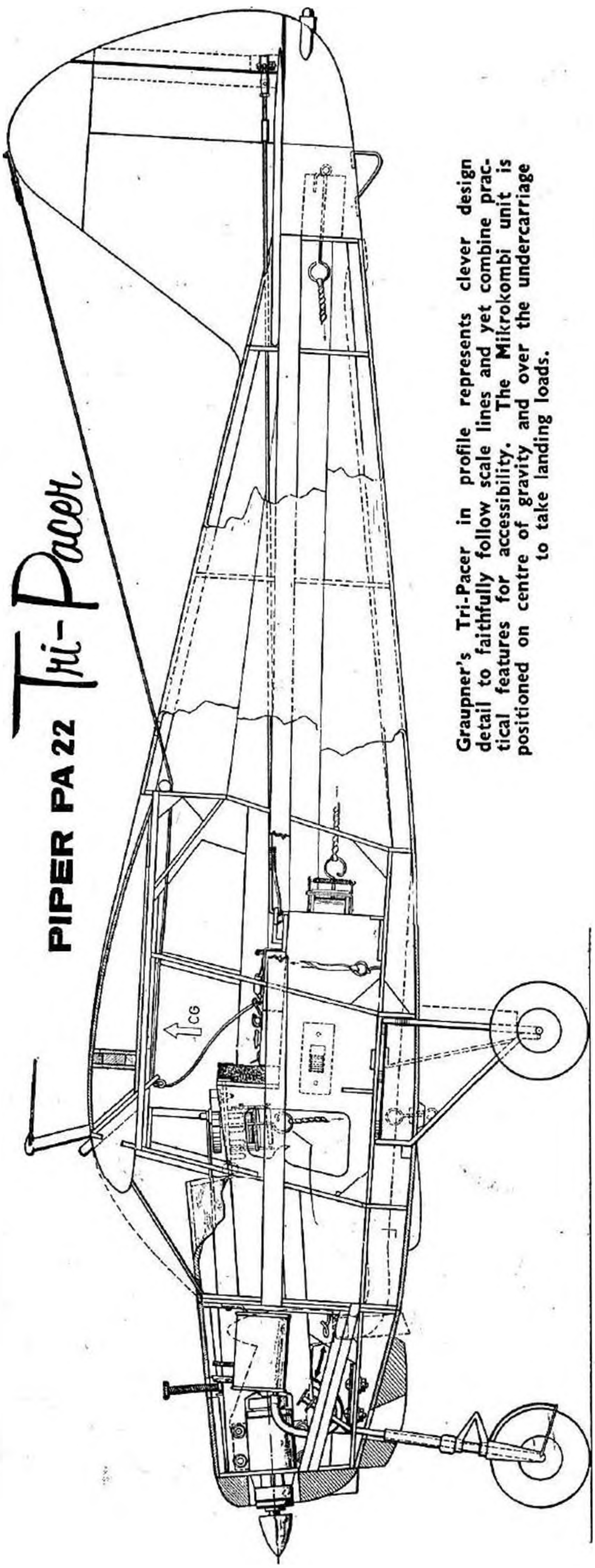
In July we introduced a feature under this title to give a general guide on the factors governing disposal and protection of radio control equipment in model aircraft. In the main, our discussion was centred on the simple single channel machine as is generally used: but one must also consider the more refined design approaches now fast becoming a feature of German and United States modelling, and certain to come eventually to Great Britain.

For the single channel enthusiast, the "packaged" units such as the Graupner Mikrokombi, or British Reptone, offer a far more simple and neat approach,



Sqdn. Ldr. 'Bill' Verney, R.A.F. (Retired) is well known for his high standard of model finish and neatness of installations. This is one of two models he demonstrated at the recent R.A.F. M.A.A. Championships.

PIPER PA 22 Tri-Pacer



Graupner's Tri-Pacer in profile represents clever design detail to faithfully follow scale lines and yet combine practical features for accessibility. The Mikrokombi unit is positioned on centre of gravity and over the undercarriage to take landing loads.

so permitting a new field in model design. By this we mean the use of smaller models, or models with far less "cargo capacity". We have chosen the Graupner kit plan for the Piper PA 22 TriPacer as a classic example of what is now possible through the medium of these combination packs of battery/receiver/actuator(s) in a small model. Study of the drawing shows how the Mikrokombi is equally disposed about the centre of gravity. It is held down to a base board by rubber band tension and connected to the rudder by a push-rod with adjustable turnbuckle at the rudder end. Forward motion of the pack is resisted by a small false bulkhead, above which is mounted the secondary servo-relay (as Graupner calls it), to actuate motor speed through quick-blip action on the transmitter. Sorbo rubber is used as a packing for vibration absorption and as the fuselage is small, the aerial travels forward to a knotted arrestor point before moving aft to the fin. The wing detaches, so all is readily accessible. The 1.5 c.c. Graupner marketed Taifun Hurricane diesel is mounted sideways in the cowl for realism, and the exhaust is ducted down below the model through a single port silencer. All components and accessories are manufactured and distributed by Graupner, this enabling a state of completeness and neatness in the design to place it high in our estimation of kitting standards. Note too, how the rubber winding points under the fuselage for the motor speed control, and under the tailplane for the rudder are unobtrusively arranged to maintain full scale effect.

The individual designer can learn a lot from study of such a model, preferably through gaining the experience of making the kit. Without the combination R/C unit, the design problems are acute in a model of this size, not only from the point of component disposal but also on the weight question.

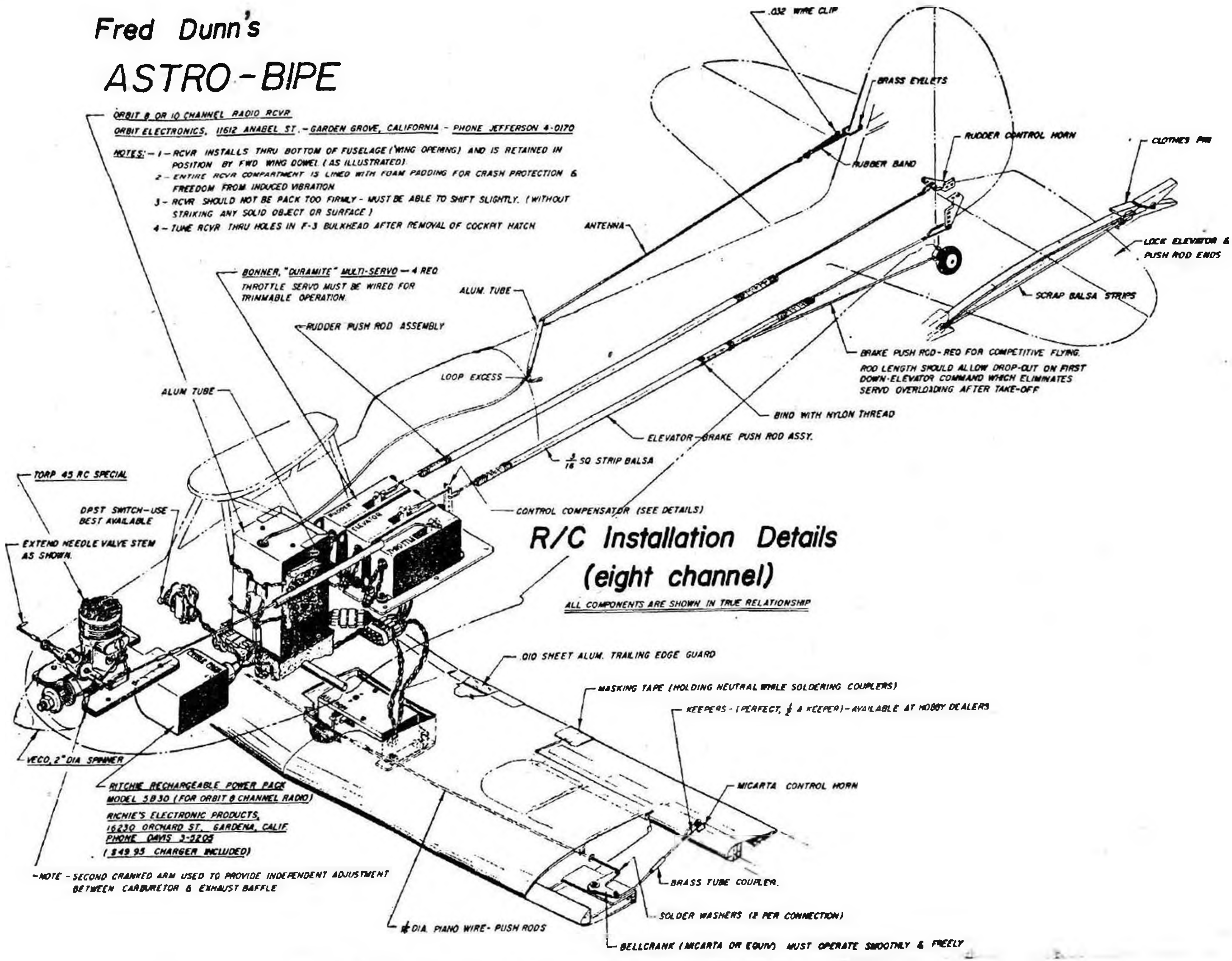
The integral battery container saves the need for a specially strong battery compartment and most important of all for the novice radio controller, the wiring side of installation is reduced to positioning the switch for "on-off" which is usually supplied ready soldered to reasonable length leads.

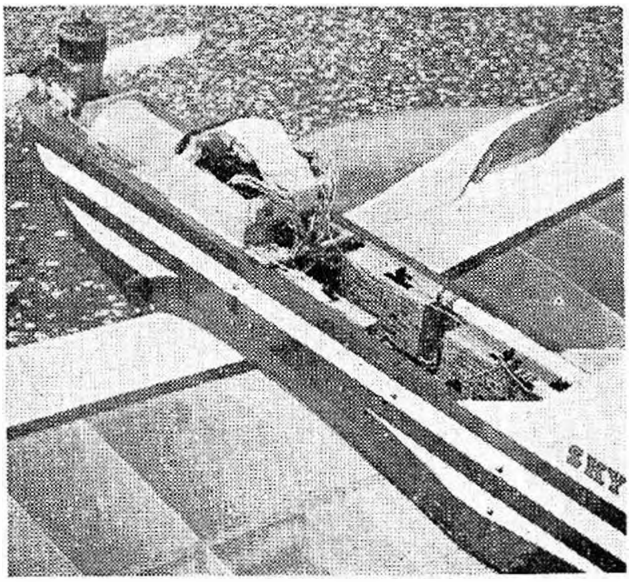
We trust that die-hard readers who have come through the mill with traditional separated components will appreciate our apparent adulation of

Fred Dunn's ASTRO-BIPE

R/C Installation Details (eight channel)

ALL COMPONENTS ARE SHOWN IN TRUE RELATIONSHIP





Frank Van den Bergh's "Sky Duster" has Bonner Duramite servos bolted direct to the fuselage sides in latest U.S.A. style. K&B 45 engine.

the combination unit, for we believe that it is a mark of progress for the future likely to render our batteries-to-switch-to-receiver-to-actuator and more batteries rather old fashioned in outlook.

In a similar way the current American approach to heavy dry battery rate of consumption and conversation of electrical supply weight has lead to the introduction of many re-chargeable power packs and converters, whereby 3 volts supply or thereabouts can be used in a variety of ways. We have chosen to illustrate another section of Fred Dunn's remarkable *Astro-Bipe* plan as the finest possible example of the current American design approach. Note how the relatively small Ritchie power pack is installed immediately aft and below the engine. This feeds supply to the Orbit 8-channel receiver and all 4 Bonner Duramite servos which are interconnected with lightweight multi-pin plugs and sockets through a plaited harness taped neatly, where possible, to the relative components.

As far as installation is concerned, the Astro-Bipe is also an object lesson for designers.

The lower wing detaches, together with its installed aileron servo and this permits the receiver to be removed from its position through the bottom fuselage opening. Fred Dunn particularly advises that the receiver should not be firmly mounted and should be able to shift, thus reducing the possibility of transmitted vibration. Note too, how the receiver is mounted vertically and can be tuned by removal of the cockpit hatch.

Three Duramites are mounted on a board, side by side, for rudder, elevator and motor control. The brake push-rod is used only during the initial ground taxi-ing manoeuvres and is disengaged during the flight when down elevator is applied.

We are sorry to disappoint those readers who might think we shall be running a series of instalments on the *Astro-Bipe*. Those who want to get a copy of the 25 feet long beautifully produced plan for this 54 in. multi-channel can do so for the sum of 10 dollars by sending to Fred W. Dunn, 5322 Clark St., Compton, California, U.S.A.

The power pack, or converter, offers great possibilities. One of the handicaps which has been tending to hold back British model advance in the aerobatic field has been our natural tendency to build heavily and use weighty components. When they do reach British shores, these lightweight sources of power supply will make both flying and installation all the more easy.

There is one other aspect on multi-channel installation which deserves mention and that is the comparatively recent swing to fuselage side mounted servos. The system is used by Frank Van den Bergh on his "Sky Duster" which topped the British team trials.

As we mentioned in July edition, these pages are open to your suggestions in a regular information forum. What's *your* installation angle?

Next Month . . . HIGHLIGHTS OF THE ISSUE INCLUDE:

EXTRA ART PAGES FOR Man-on-the-spot Report of World R/C Championships ★ Beginner's C.W. Hand-held Transmitter with centre-loaded aerial ★ Elevator and Proportional Rudder from One Actuator Interesting Circuits ★ New Equipment ★ Kitchin Rudder and R/C for Boats ★ Making a Simple C. R. T. Oscilloscope ★ Transistors, Part 4 ★ McQuery Column ★ Here, There and Everywhere

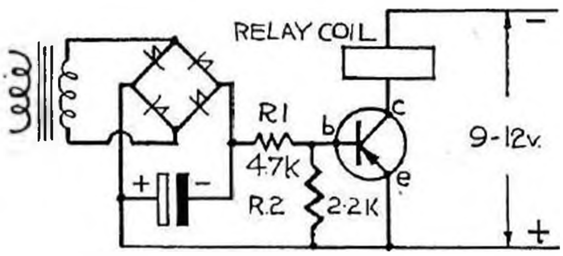
McQUERY COLUMN

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.

I ALSO notice that I have the same trouble as M. P. W., Blandford (Rx. relay will not take a high enough pulse rate to produce a steady D.C. current from the rectifier circuit) and wonder what type of relay would be best suited to operate on the small rectified current obtained, as I find high resistance relays are not successful.—C. L. K. L., CHIPPENHAM.

Probably the most economical way of getting over your difficulty would be to use a single transistor as a current amplifier.

You can use relays of 2K upwards and get nearly the full supply voltage across them when pulsing. If say, your relay is 3K and the supply (from the actuator batteries is 9 v. you will get a maximum of 3 m.A. which should be more than adequate. A cheap yellow/green spot TR will do (5/- today).



I have indicated starting values for R1 and R2. Increasing R2 increases the sensitivity of the circuit. It is put in to cut down the leakage current when not pulsing.

WHAT is the secret of designing and trimming an R/C 'plane for wind penetration? I am currently flying a model which is composed of the Rattler fuselage, one inch larger at nose and tail, Rohma wing, and a symmetrical tail. It is powered with a 3.40 Frog, is fitted with the Cobb Hobby system and weighs 4¾ lbs.

On a calm day it flies like a dream, but in the slightest breeze it goes haywire. On launching it will fly dead into wind at a fairly high angle, and on reaching a fair height 300-400 ft., will then just rear up into the wind, followed by a series of stalls until it usually strikes the ground.

C.G. is at 30 per cent, and I have tried more downthrust on the engine, which seems to make matters worse, packing under the T.E. of the wing, and greater negative incidence on the tail. All to no avail. Would a lifting tail help or is there something fundamentally wrong on which you can advise me? Any help would be much appreciated.—C. D., TIVERTON.

When one is dealing with a model trimmed to make a steady climb on a constant output and which will perform admirably in calm, it is only natural that wind and gust effects will create a change of trim which is usually most obvious when the model turns from downwind, into the wind. This 'ballooning' is typical of many radio designs for single function controls. Use of a symmetrical section tailplane with a considerable vertical distance between tail and wing chord lines is a cure. This is a characteristic of the A.P.S. Waveguide, the Satellit and Livewire series.

But the real answer, as fully exploited in the U.S.A. is to use a trimmed engine speed control in conjunction with the rudder and to utilise this engine speed control in a sensible *three* speed setting arrangement. Thus high speed is only used for a take-off and climb to altitude, medium speed for the manoeuvres and slow speed for the descent and landing. Such a model should be trimmed to maintain height on the medium speed setting.

I HAVE a query regarding the circuit on page 90 of your June issue. In sketch A you give a circuit for obtaining a blip signal. I have employed a Ripmax heavy duty relay and .5 mF. condenser 500 V. working, as per your sketch, but was unable to obtain any current in the relay coil. I was wondering whether the condenser should be of the electrolytic variety.

I am interested in this device since I have been using the Kinematic Servo Unit for many years, and it occurred to me that such a device would ensure an accurate short signal for operating the engine controls.—W. H. S., WEMBLEY.

I rather fancy that the relay you are using is of low resistance and to obtain results you would need a capacitor of high value.

The correct resistance for a relay in this type of circuit is around 4,000 or 5,000 ohms.

Incidentally if you are not using an electrolytic you will need a resistor across the capacitor (say 47K).

AS a raw beginner I am debating whether to buy Reptone, or make the Aeromodeller receiver and transmitter for single channel operation. Initially I want to construct a slope soaring glider, and therefore want a good range, secondly I want to convert the same equipment to "Galloping Ghost", for use in a powered model. Which equipment would you recommend me to use, and what relay should I use with the Aeromodeller receiver for Galloping Ghost operation?

—M. S. P., LONDON.

Any of the commercial R/C units now available can be recommended to the newcomer as great improvments have been made in recent years. You will, of course, appreciate that to recommend one particular system would be invidious and is a practice which we try to avoid.

The Aeromodeller Tx. and Rx. are still quite sound propositions provided batteries of sufficient capacity are included in the receiver. In a slope soaring glider this should present no problem.

Although still in the relatively simple class Galloping Ghost is a little ambitious for the raw beginner and I would suggest that you limit your choice in the first place to a simple system with a self-neutralizing actuator. The step towards proportional control could be attempted when sufficient knowledge is gained on R/C equipment and its use.

There is a point about slope soaring gliders which will probably interest you, that is quite important if successful flying is to be achieved. It is that without some form of control of height (i.e. elevator control) the model has to be trimmed either in the under elevated position in which case the trim has to suit wind conditions, or fully elevated trim in whch case the model may be blown back over the slope if the wind is at all high. A precise adjustment is almost impossible.

I HAVE a problem and I wonder if you can help me.

The problem is relay contacts blacking over and so failing to pass current, the relays concerned are R.E.P. and the servos used are Bonner Duramites battery supply are 4 DEAC 225 each way.

It has been suggested that a resistor across the motor is a cure, also a resistor and condenser across the relay contacts—what do you think?

I have been reading Warring's article on contact design and in Fig. 2 he gives some examples but states it is for suppression in order to avoid interference with the radio circuit.—D. E., HIGH WYCOMBE.

Sorry to hear that you are having contact trouble. With 4.8 volts and Bonner Duramites I am not surprised that you are getting blacking of the contacts as I expect there is an appreciable current flowing and on breaking the E.M.F. could be quite high.

In such a case it is not all that easy to cure the trouble but a .01 capacitor and a resistor from 20 to 100 ohms might alleviate it. The network is across the points, of course, and you should vary the resistor in a darkened room and watch that the spark is lessened or eliminated.

Another way is to use a high voltage diode across the servo coil connected in such a way that when the relay makes and current flows the diode is non-conducting. On break it acts as a virtual short circuit of the coil and reduces the back E.M.F. considerably.

I am told that Mullard 0A81 is rated at 150 volts and if so it might do. Otherwise it means a silicon diode and they are expensive.

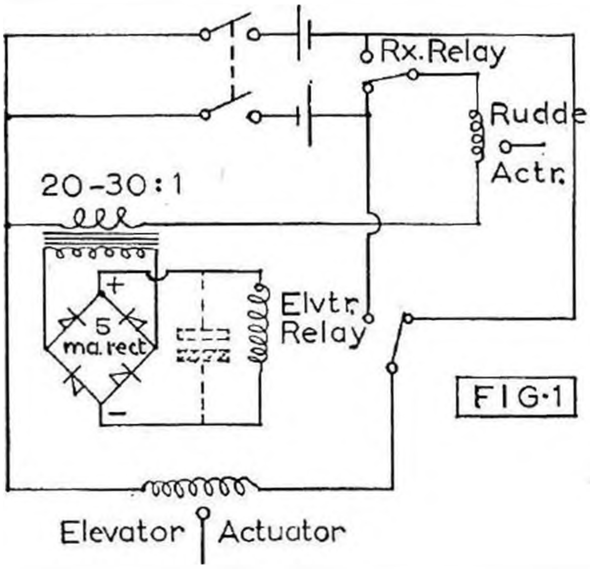
A further way is to use a power transistor driven from the reeds through a driver transistor. This saves the cost of the relay and there is no contact to become sooted. For reversing, however, another transistor is needed.

Not easy is it? Anyway the other lads seem to carry on without trouble so I suppose it can be done.

Two-Channel Simultaneous Proportional Control

By PETER LOVEGROVE, B.Sc.

IN the *Aeromodeller* of April, 1958, Howard Boys described a system by which rudder and elevator could be controlled simultaneously and proportionally (Fig. 1). Mark-space variation controls the elevator in his system. Any mechanical pulse-box or electronic oscillator such as the Galloping Ghost circuits will serve as the controller at the transmitting end.



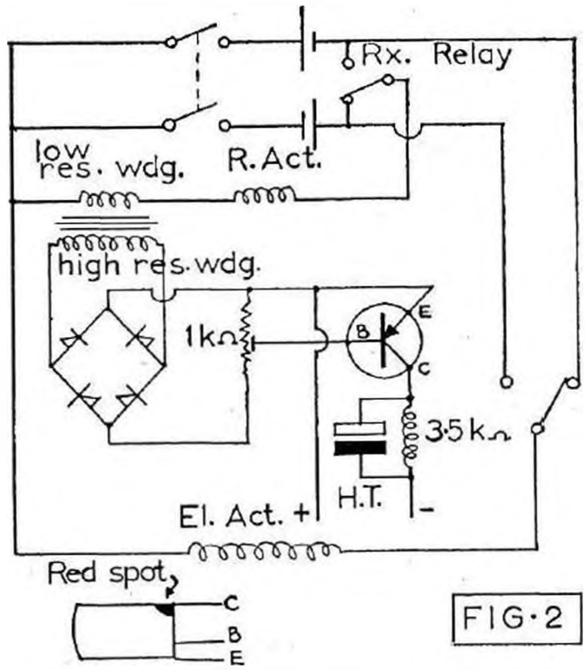
Obviously, the first question which arises in the mind of the reader is, "Why go to all that trouble when the Galloping Ghost scheme gives the same result with one Mighty Midget, or Ever-Ready motor, and two batteries in the 'plane?" This argument is valid up to a point, but that scheme does have some short-comings. There is no independent control over the torque available for rudder and elevator and the control surfaces must therefore be small and light enough to be handled by a single servo, without additional gearing. This sets a limit on the size of 'plane which can be flown by G.G.

Secondly, with lots of mark-space range on the control box, there may be a tendency for interaction of rudder and elevator on the model. This is disastrous to the tyro!

Thirdly, the scheme cannot be elaborated to use full- and no-signal conditions to give additional controls, since whenever the servo is switched off, it must leave at least one of the control surfaces away from the neutral position. There can be no 'fail-safe' on such a set-up.

For these and other reasons I felt that Mr. Boys' scheme warranted inspection. However, in these times, when we normally use receivers which give 3-5 milliamps current change through normal relays, it seems ridiculous to control the elevator of all things, via a relay fed by a niggardly current.

By virtue of a little high-speed pulsing of the brain-cogs the circuit of Fig. 2 was arrived at and tested!



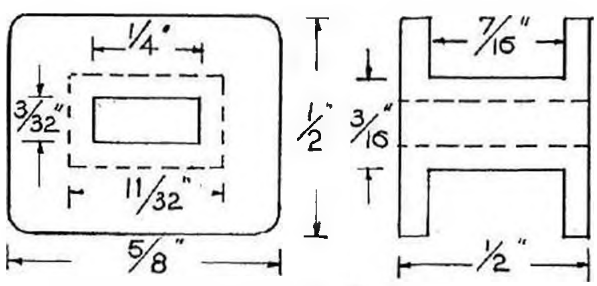
Transformer: 20/40 : 1 (see text). Meter rectifier: 0.5, 1, or 5 m.A. Potentiometer: 1/2.5 K Ω. Transistor: OC71, OC72, OC76, Red Spot, etc. Capacitor C: 3/50 μF. (see text). H.T. Potential: 10/30 volts depending on transistor and relay.

The principle is simple enough; it differs from the Boys circuit in that the output from the rectifier is not fed to the relay directly, but is used to trigger a transistor and cause it to pass a high current (3-6 m.A.) through the elevator relay. The transistor can be an OC 72, OC 71 red-spot or anything similar, but watch the maximum operating voltage.

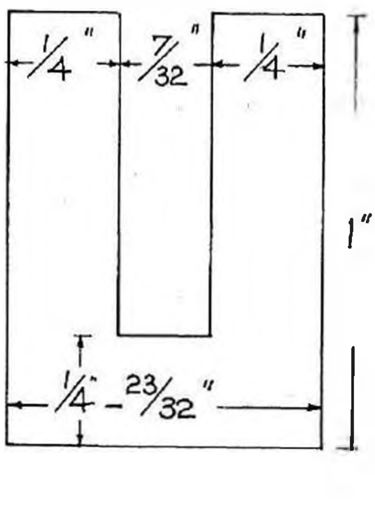
Provided a fairly large electrolytic condenser is fixed across the H.T. positive to negative lines in the receiver circuitry or wiring harness, this receiver battery can be used to feed the elevator relay as well. Sets like the "Unitone" have such a condenser built into them, but if necessary an external one can be added in the model's wiring.

One advantage of this present scheme is that the transformer ratio is no longer critical, nor is the rectifier. Transformer ratios of 20:1 up to 40:1 have been tried with equal success and meter rectifiers of 0.5 m.A., 1.0 m.A. and 5 m.A. have all proved satisfactory. Ardente make an 18:1 miniature which would probably do well.

The transformer which I ended up with was wound on an old bobbin from a Siemens relay, the primary being 60 turns of 32 s.w.g. enamelled copper wire and the secondary was 2,000 turns of 47 s.w.g. wire (which *can* be wound with a hand drill and patience!) But here again 45 or 46 s.w.g. would suffice. One simply winds the primary turns first and then fills the remainder of the bobbin with the thinner secondary wire. For the benefit of anyone unable to obtain a Siemens bobbin, the approximate dimensions are given in Fig. 3 together with details of the laminations. These were cut from old transformer laminations 0.014 inches thick but if thinner ones are available, cut out enough to give a stack 0.085-0.090 inches thick. But do not be tempted to omit them altogether; their weight is negligible and such a transformer is disgustingly inefficient already without adding insult to injury!



TRANSFORMER BOBBIN.



FIG·3

Laminations 6 off 0.014 in. thick.

In case anyone thinks that this scheme must be heavy at the receiving end let me point out that I have made up the panel of bits described here to weigh 3¾ ounces. 2¾ ounces of this were accounted for by two Siemens 96 relays, the receiver relay being on the same panel. So the transformer, rectifier, slugging capacitor (5 mfd. in this instance), transistor, spark quenches, panel and case only weighed about an ounce.

A magnetic actuator drives the system well but motors need choosing carefully. An Ever-Ready TG 18, for instance, gives a good drive. The elevator motor is not fussy and any will do, even a Bellamatic if you are filthy rich!

Incidentally, it is not generally realised that spring centring will pull back a Mighty Midget, or similar motor, through gearing as high as 250 : 1.

Setting-up the system is reasonably straightforward. Wire a 2-5 mfd. capacitor across the elevator relay temporarily and set this relay to open and close between 1.2 and 2.2 m.A. (This is for a 3.5 KΩ relay).

With the transistor battery supply connected through a 0-5 m.A. and with the actuators switched off, set the 1 KΩ potentiometer so that about 0.1-0.2 m.A. are shown on the meter. Switch on the transmitter, receiver and actuator batteries and adjust potentiometer to give maximum reading on transistor current meter when kicking, whilst still maintaining a lower (standing) current of 0.3 m.A. or less.

If the elevator actuator is wired into circuit it will show whether the relay is following when frequency of pulsing is altered.

The exact capacity needed across the elevator relay depends on the relay resistance, pulse frequency range and the type of transistor. Try increasing it from 1 mfd. until the elevator is neutral with the joystick neutral. But be sure your actuator batteries are giving equal voltage on load. Preferably, use Deacs, but if you do use dry batteries, then reversing their positions will show whether they are equal in voltage.

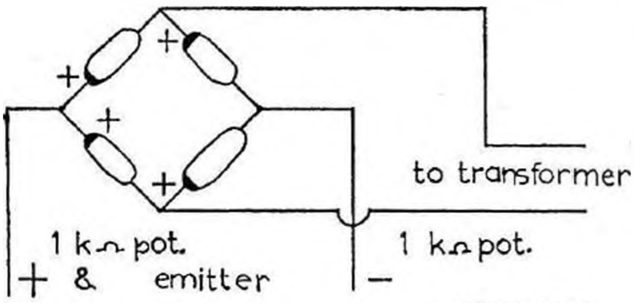
When this scheme was originally devised, a Galloping Ghost pulse-box was to hand, so that variation of pulse rate which that provided was used for tests. The variation was about 3-10 cycles per second. But all systems like this work better at faster rates, so if you can use about 6-25 c.p.s. then so much the better.

For users of the McQue transistorised pulse-cum-modulation generator, this is easily arranged.

Reducing the size of the 40 mfd. capacitor between the emitters of transistors 1 and 2 will raise the rate range.

Now this is an experimenters' magazine so here are a few suggestions as to how the circuitry may be made to give of its best with given components, or requirements:

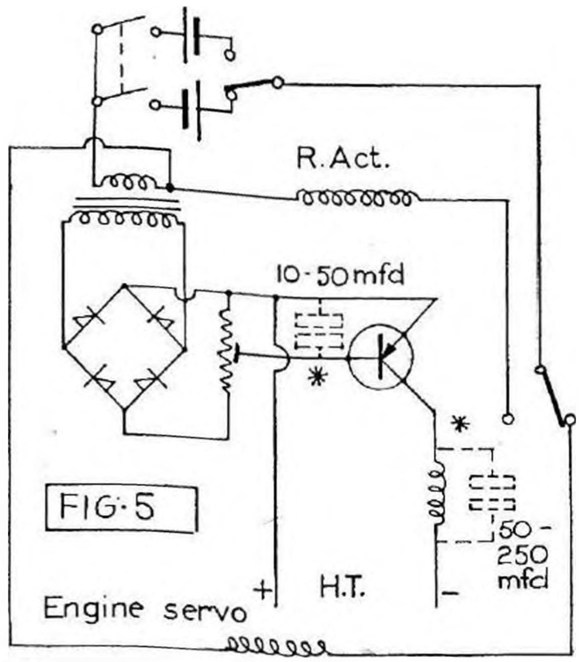
1. The elevator relay may be anything from 1 KΩ up to 10 KΩ with appropriate battery supply.
2. Four diodes may be joined to give a bridge rectifier. (See Fig. 4).



FIG·4

3. The transformer ratio may be varied. If the transformer primary is wound to a higher resistance, or connected in series with a resistor then it may be possible to place it in parallel with the rudder actuator and reduce the battery voltage to 3V.
4. The elevator relay may be converted to a pulse—no pulse set-up for use in a boat. The revised circuit of Fig. 5 shows how this is arranged.

   Obviously the relay must not pulse with the rudder relay but must hold in while pulsing is present and drop out with full or no signal. So a large slugging capacitor is required across the secondary relay, or across the transistor base to emitter, or the circuit of Fig. 6 can be used (a David McQue idea) to give a useful slugging action without massive electrolytics. The capacitor values shown are intended as a starting point for experiments. They might have to be changed considerably.



FIG·5

★ Alternative positions for slugging capacitor.

The scheme of Fig. 5 will give proportional rudder with trimmable engine speed on full and no signal, or the rudder may be made positional with proportional engine inductive kick as *the rudder motor* so use identical types.

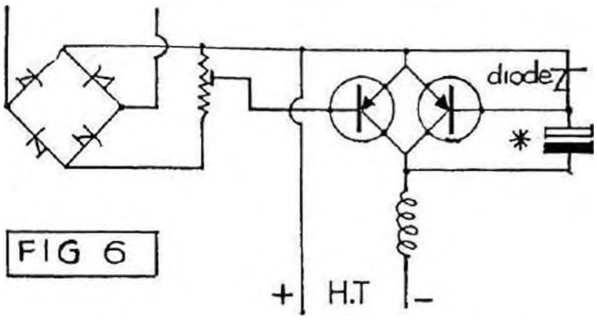
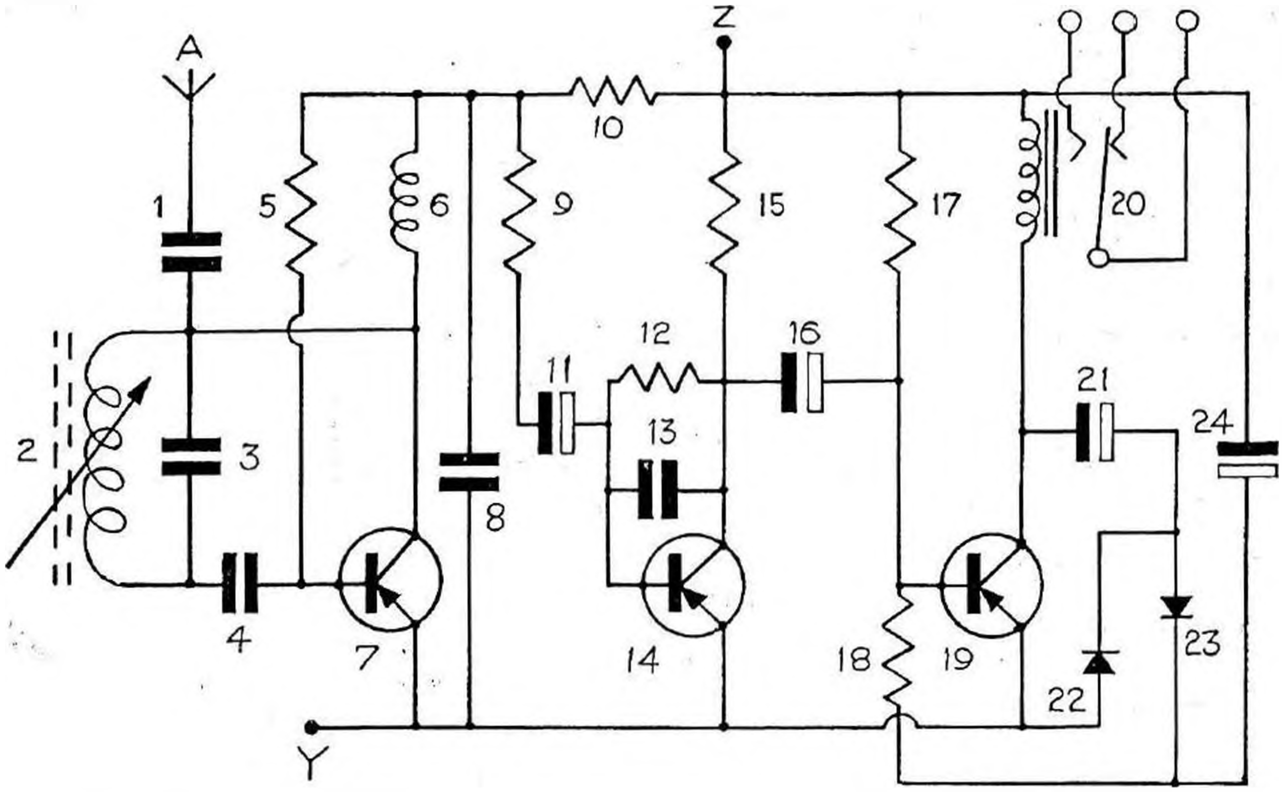


FIG 6

★ Slugging capacitor (smaller than in other arrangement 1/25 mfd.).



Grogan's Micro - X Transistor Rx.

FROM PAUL RUNGE'S GRID LEAKS

Specification

Frequency	**27.255 mc. to 26.995 mc.**
Tone Frequency	**100 cycles to 900 cycles.**
Weight	**1 ounce.**
Power Requirements	**6 volts DC at 1.5 m.A. with tone rising to 18 m.A. with constant carrier.**

DRILL all component holes with a No. 62 drill and No. 38 for the relay mounting screw and aligning pin, and a No. 18 for mounting of the LSM coil form. Do not centre punch but use the indentation that has already been formed by etching.

The etched board is now cleaned and polished by using a household cleanser. Now lay out all components in the order of their component numbers and proceed to wire them in by using a small pencil type soldering iron. Use good solder with an internal resin flux and apply only enough heat to insure a good connection. If you think a component will not make a good connection, clean and pre-tin the leads before inserting in the board. Start with the coil part No. 2 and connect part No. 3, the 47 mmf. Discap to the coil terminals with one turn and then solder, leaving the leads long. Now place in position on the board as indicated in the layout and put the bottom terminal lead of part No. 3 through the hole between the location of part No. 5 and No. 9. Place the nut on the coil form and tighten firmly. Cut off the lead near the board and solder. Now insert one lead of part No. 1, the 3 mmf. capacitor and bend the other lead to go through the hole between the location of part No. 7 and part No. 5 and at the same time make sure that it touches the lower terminal of the coil form. Solder to the coil form terminal and then turn over the board and cut off the leads and solder. Now part No. 4, the 470 Discap, is placed in the position indicated by the layout with one lead through the board and the other lead against the top terminal of the coil form. Solder the lead to the top terminal of the coil and cut off the remaining lead of part No. 3 and No. 4. Turn over and cut off the lead and solder.

Now insert and solder the rest of the components in the order indicated in the following list and in the position set forth by the layout drawing.

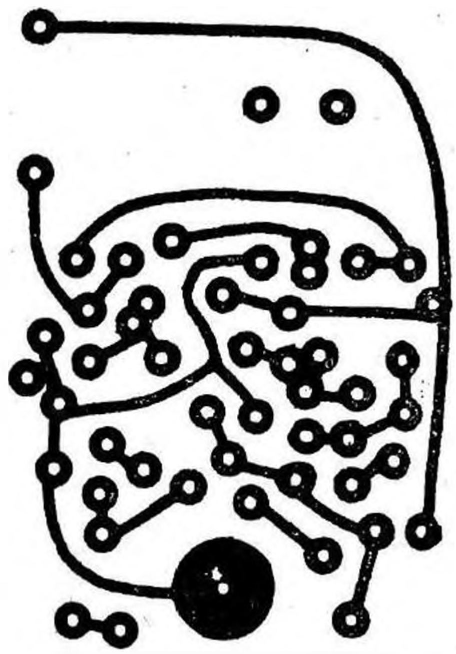
Component No. 5	Component No. 16*
Component No. 6	Component No. 13
Component No. 10	Component No. 15
Component No. 9	Component No. 17
Component No. 8	Component No. 18
Component No. 12	Component No. 21*
Component No. 11*	Component No. 24*

The parts No. 11, 16, 21 and 24 as indicated by the asterisks are correctly polarised when the positive end is next to the board and the negative end away from the board.

When installing the diodes and transistors, be sure to use a heat sink of cotton wrapped around the component and saturate with alcohol. Next install part No. 22. It is correctly polarised when the cathode end (marked end) is away from the board. Part No. 23 is correctly polarised when the cathode end is placed next to the board. Now install part No. 7, the detector transistor. It is correctly polarised when the collector lead (the one by which there is a red mark) is inserted in hole indicated by the large round mark on the layout drawing. Leave lead lengths of about ¼ inch between board and transistor body. Then cut off excess lead and solder.

Part No. 14 is now installed and then part No. 19 in the same way as part No. 7.

The relay, part No. 20, is now installed and the coil terminals are connected to the board with excess pieces of lead that have been cut from components that have been installed.



Printed circuit layout full size.

The aerial consisting of a 24-inch length of flexible wire is now connected. Then the power connection leads are connected, red for "Y" and black for "Z". If tuning is to be done with headphones or voltmeter then also attach another wire to the other side of the relay coil.

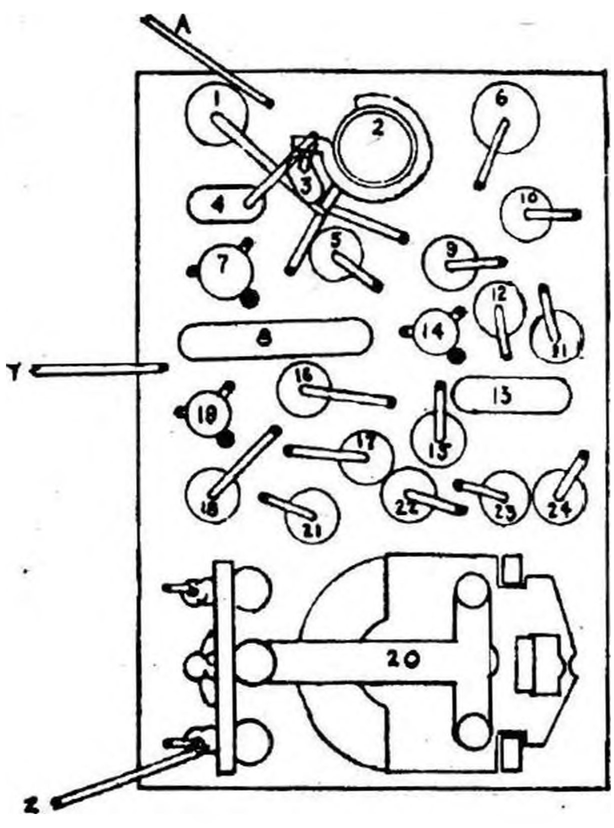
The receiver can now be given an operational test by connecting to a six-volt battery. The plus side to the red

LIST OF COMPONENTS REQUIRED

(Numbers correspond with those on circuit and layout drawings)

1. **3 pF. Capacitor Ceramic.**
2. **8 turns No. 26 on LSM form.**
3. **47 pF. Discap.**
4. **470 pF. Discap.**
5. **100 K ½ W Resistor.**
6. **22 μ H R.F.C.**
7. **SB103 Transistor.**
8. **.01 MFD Discap.**
9. **30 K ½ W Resistor.**
10. **5.8 K ½ W Resistor.**
11. **.25 MFD Capacitor.**
12. **1 Meg. ½ W. Resistor.**
13. **.001 MFD Discap.**
14. **Transistor T 0037 (OC 71 or OC 72).**
15. **10 K ½ W Resistor.**
16. **.25 MFD Capacitor.**
17. **47 K ½ W Resistor.**
18. **10 K ½ W Resistor.**
19. **Transistor T 0037 (OC 71 or OC 72).**
20. **Gem Relay 350 Ohm Coil.**
21. **.25 MFD Capacitor.**
22. **Germ. Diode.**
23. **Germ. Diode.**
24. **.25 MFD Capacitor.**

A. Aerial 18 in. to 24 in.
Y. + Side of six volt battery.
Z. — Side of six volt battery.



or "Y" lead and the minus side to the black or "Z" lead. A headphone or a voltmeter having a 6 volt or higher scale can be connected to the black lead and to the other lead coil. A 0-1 m.A. meter can be used in place of the voltmeter if a 10,000 ohm resistor is connected in series with it. If headphones are used a strong hiss should be heard and then with a transmitter turned on to continuous carrier, the hiss should disappear as the receiver coil slug is tuned to the proper frequency.

Now when an audio signal is turned on, the audio tone should be heard very loudly.

If a voltmeter is used, the following conditions should be observed. With no carrier, the voltage across the relay coil should be about 4 to 5 volts, then with continuous carrier and the receiver coil slug is tuned to the proper frequency, the voltage should rise to about 6 volts across the relay coil. When the audio is turned on the voltage across the relay coil should approach 9 volts.

If these results are obtained, then connect flexible wires to the relay contact terminals and install the receiver in an aluminium case.

The receiver is now ready for a distance check and installation. When making a distance check tune for optimum slug position.

If the receiver does not operate properly, then have a friend check your soldering and layout and connections.

When this receiver is to be used in small 'planes, the aerial should be allowed to trail from the fin. The sensitivity can be somewhat increased by connecting a length of wire to the case and extending it in another direction from the aerial.

This receiver is very efficient and will work for a very long time on the smallest batteries. I suggest the use of the half size pen cells. Connect four in series and they should give power for many hours of flying. Change them when they measure 4.5 volts under load. This receiver is designed to operate on voltages as low as 4.5 volts with some loss of sensitivity. Another fine power source is made by four of the small nickel cadmium batteries which can be recharged and used many times.

The installation of this receiver is not critical. However, the following things should be done. Adequately shock mount the receiver and mount it so that the relay armature pivot is not in the same direction as the shaft of the engine. (This is to prevent engine vibration from affecting the relay operation.) A spark suppressor should be used across the terminals of the actuator and can be one of the following:—

1. 100 ohm ½ watt resistor.
2. .01 Discap.
3. .01 Discap in series with a 10 ohm resistor.

The receiver is not particularly sensitive to electrical noise, but a suppressor should be used.

The relay should be adjusted to come in at about 8 m.A. and fall out at about 6 m.A.

Russian Relayless S/C Receiver

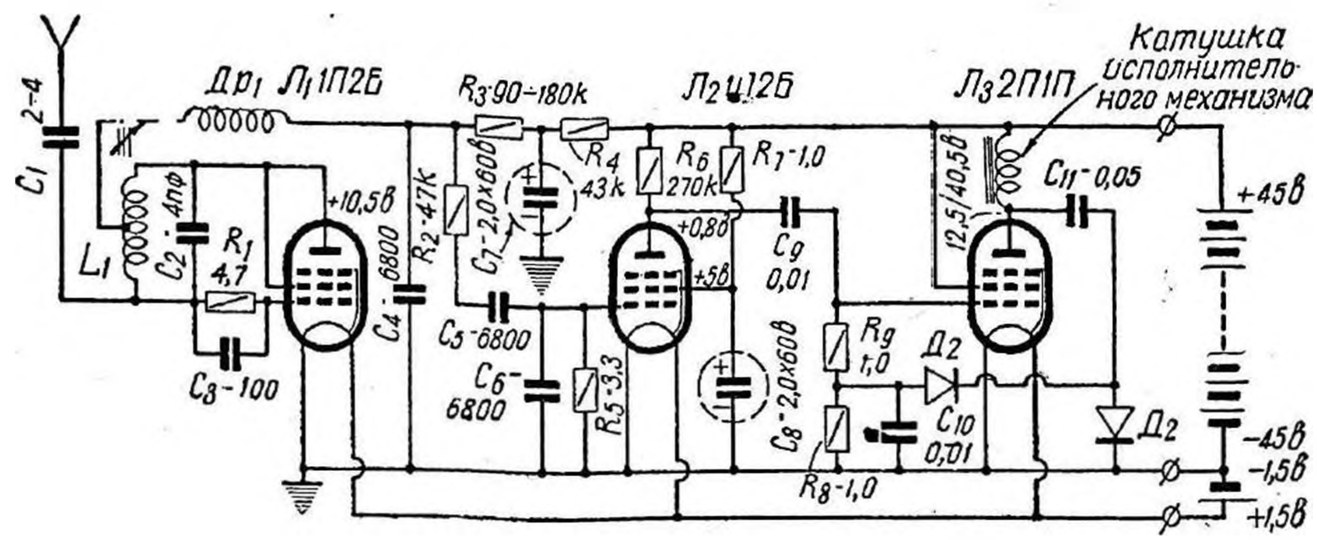
DIGESTED FROM AN ARTICLE IN "RODINY KRILA"

NOWADAYS the single channel radio receiver is often linked up in a series of separate units. It works dependably and has an excellent response (2-15 μv) but it also has several disadvantages, such as the weight and difficulty in adjusting the miniature relay, the whole apparatus depending upon the reliability of this relay. The operating mechanism (servo or solenoid) is supplied from a separate source.

The relayless receiver, connected by semi-conductor triodes (transistors), despite its advantages over valves, is not always easy for the modeller who is beginning as it demands much theoretical and practical preparation.

Described below is a relayless single channel receiver in the output stage of which is a 2P IP valve (see diagram).

The receiver is a super-regenerative front end with a two-stage amplifier The coil L1 is a polystyrene former with glass ribs, the former being 12 mm. in diameter. The dust core is 8 mm. dia., and 18 mm. in length. The winding is 12 turns of plastic covered wire 0.7 mm. in dia.



centre tapped. (For frequency of 28-29 megacycles).

The choke D.R.1 is wound with wire .15 mm. dia. close wound the whole length of the former. (A resistor of the same size can be used as a former).

With the tone feedback arrangement current in A reaches 5 to 8 m.A. Such a change is sufficient for directly operating the mechanism.

The resistance of the coil of the operating mechanism (it is better and more advantageous to use a solenoid) should be 5 to 8 K. If a servo relay it will operate satisfactorily with a resistance of 3 to 4 K. The coil is wound with enamelled wire .05-.06 diameter to the required resistance. The weight of the servo relay is 45 grammes.

When adjusting the receiver special attention must be paid to suppression of the quench noises (voltage) at the input circuit of the last stage.

The receiver operates from any transmitter having amplitude modulation of the carrier at 200 to 400 cycles.

Following this diagram the author made three receivers and they are being tested in the aeromodelling circle at the Pioneer House in the town of Sochi and have given excellent results.

CONTEST CALENDAR

August 21st : I.R.C.M.S. Annual R/C Rally. R.A.F. Wellesbourne Mountford, Nr. Stratford-upon-Avon. Single, Intermediate, Multi. Pre-entry by August 13th to : A. E. Newby, 56 Lime Ave., Leamington Spa.

August 21st : R/C Power Boat Regatta by I.R.C.M.S. and Fleetwood M.Y. & P.B.A. at Fleetwood. Details and entries : G. M. Tipton, 2 Beamsley Drive, Wythenshawe, Manchester 22.

August 21st : Wolverhampton Regatta, W. Park Pool. R/C.★

August 28th : S. Midland Area Rally, Cranfield. R/C Single and Multi.★

September 4th : Southern Counties R/C Rally. Army Air Corps, Middle Wallop, Nr. Andover. 10 a.m. Single, Intermediate, Multi. Pre-entry to : D. Grocott, 12 Wyndham Road, Salisbury. *Note this change of date !*

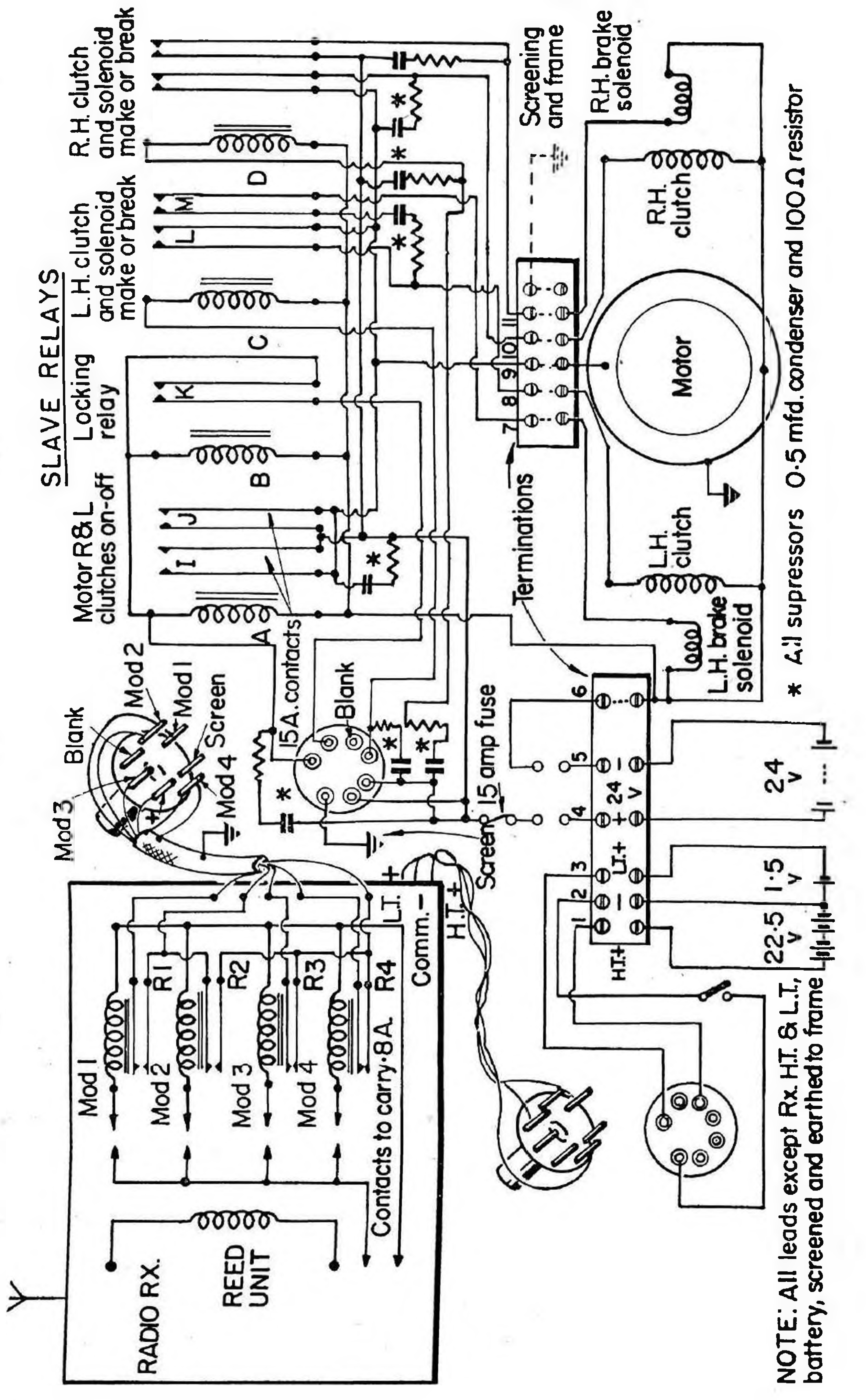
September 4th : Walthamstow Regatta, Victoria Park. R/C.★

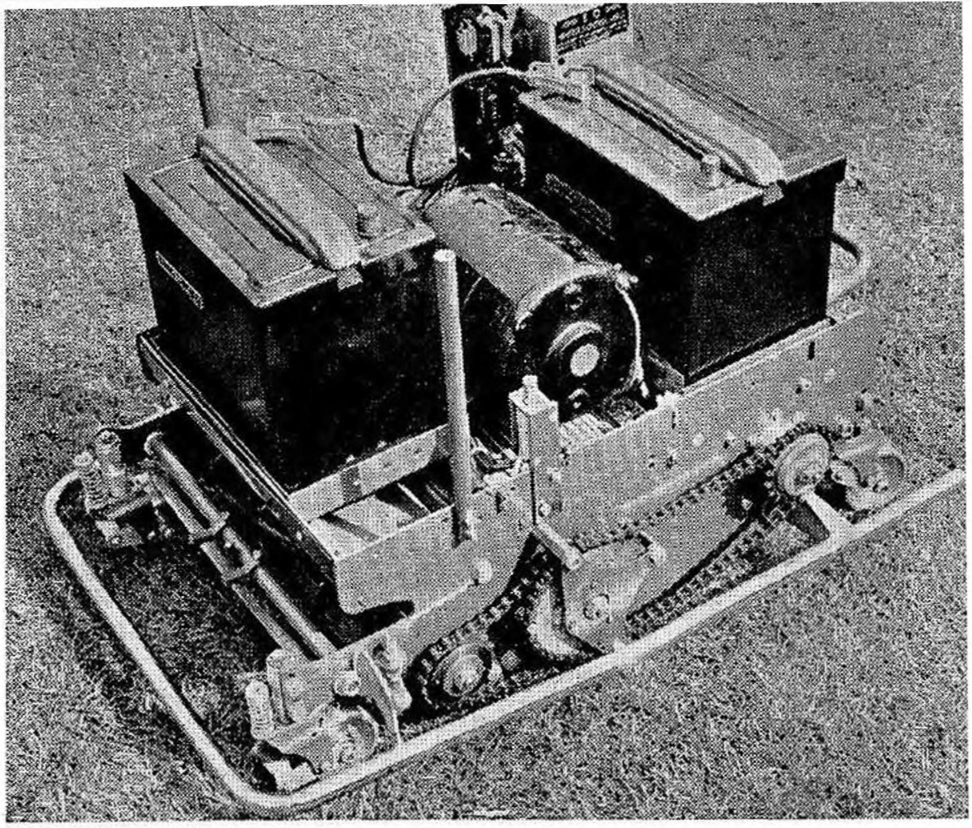
September 11th : Kingsmere Regatta, Rushmere Pond. R/C.★

★ Mixed programme with R/C events.

FAULT FINDING CHART

We hope this chart will prove helpful to less expert readers. It offers some basis for a "fault-finding drill" but is necessarily very general in application. We hope, later, in co-operation with the various manufacturers, to develop specific fault-finding charts for the popular commercial sets on the market.


SLAVE RELAYS
Motor R&L clutches on-off
Locking relay
L.H. clutch and solenoid make or break
R.H. clutch and solenoid make or break
A
B
C
D
I
J
K
L
M
Screening and frame
R.H. brake solenoid
R.H. clutch
Motor
L.H. clutch
L.H. brake solenoid
Terminations
7 8 9 10 11
1 2 3 4 5 6
H.T.+
L.T.+
+ 24 V −
15A. contacts
Blank
Mod 1
Mod 2
Mod 3
Mod 4
Screen
15 amp fuse
H.T.+
L.T.+
Comm.−
R1
R2
R3
R4
RADIO RX.
REED UNIT
Contacts to carry·8A.
24 V
1·5 V
22·5 V
* All supressors 0·5 mfd. condenser and 100 Ω resistor
NOTE: All leads except Rx. H.T. & L.T. battery, screened and earthed to frame



Robust Webb lawnmower with top removed. 24 volt car accumulators provide the power, whilst the faithful E.D. R/C equipment can be seen top right. Apart from small steering castors mower layout is fairly conventional.

Vic Rigby

Electronician to E.D. Ltd. describes his work on

Commercial R/C Lawn Mower

THIS project was a most interesting one. The lawn mower was developed by Messrs. H. C. Webbs Ltd., of Birmingham. Early experiments with the machine operated by trailing cables and fitted with switches, proved that the machine would really work. Our job was to install the radio link. At this time we were almost ready to place on the market our new "Black Prince" and "Black Arrow" series. We felt that this presented a golden opportunity to give this equipment a thorough testing, by installing standard equipment into the mower.

The main power for the machine was derived from a ¼ h.p. electric motor supplied with 24 volts from two 12 volt car accumulators wired in series, this produced approx. 2½ hours continual running. This type of propulsion was used for two reasons, firstly for the quiet running, secondly the low running costs (many people who run cars have battery chargers).

Having fitted the radio link together with the auxiliary relays we were ready tc test. After starting and stopping the motor a few times, the motor continued to run on its own, inspection showed that the contacts of the motor relay, which were rated at 10 amps, required 15 amps to cope with the surge. These were replaced, and further tests were made, more trouble arose, this time with turning radius, declutching from the split rollers was not sufficient, and brakes, operated from the solenoids were installed. This worked well and the mower could be turned in a radius of three feet; this was thought to be adequate. All was now ready for testing on a lawn, after a few preliminary runs I soon became quite profficient and was soon doing the most intricate manoeuvres around the flower beds, and in and out of the trees, through narrow gaps, stopping inches from obstacles, eventually, however, the mower came to an abrupt stop, wrapped around a small tree. In my excitement I had forgotten just for a second that the direction was reversed when coming towards me.

More tests were carried out, and the machine was then given back to Messrs. Webb Ltd., to take over. The first major exhibition was the "Chelsea Flower Show"—no trouble was experienced during the whole period of the show. The mower continued to operate for approximately five hours per day. This mower has now been shown at every main gardening event throughout Britain, and has since been to the Parish garden show, where great interest was shown.

The radio operated perfectly during the whole year, in fact, I was told by Messrs. Webbs Ltd., who for a matter of interest moved a field of grass ¼ of a mile away, and perfect control was still possible.

Operational

Sequence of mechanical operations of the mower when Mod. M1, M2, M3 and M4 are received in consecutive order from the R.C. Transmitter.

Action due to Mod. 1.

D.C. current is passed via contacts R.1 and R.2 of the small Radio Control relays, through winding of slave relay A to 24 V.; due to this relay A will become energised. The winding of locking relay B same being connected in parallel with that of relay A will also become energised.

Contacts I, J, K will close (I and J are connected in parallel to allow a greater current carrying capacity), and same being in closed position will cause main drive motor to start. Contact K also being closed will bridge contacts R.1 and Mod. 1 will no longer be required to keep motor running. Its circuit now being maintained by relay B.

Contact R.2 being in series with R.1 is normally closed and it will be observed that it is in the 24 V. + side of the supply to relay A and B.

Action due to Mod. 2.

H.T. + supply to relays A and B is broken by the opening of contact R.2 and motor will stop.

When contact I and J are closed at the time when motor is switched on, 24 volts + will also be passed to contact L of relay C and to contact N of relay D which are normally closed. The remaining sides of these two contacts are connected to one side of the two land rollers clutches, namely Nos. 8 and 10, on tagboard respectively. No. 8 being the left hand clutch and No. 10 the right hand. The other side of the two clutch windings return to 24 volt —. It will be seen therefore that when motor is in operation both clutches are energised and are held in the 'OFF' position. Referring to relays C and D again, there are two remaining contacts namely M and O which are wired in positions 7 and 11 on tag board respectively. These are normally open, but when closed complete the circuit for the land roller brake solenoids. No. 7 being left and No. 11 right.

Action due to Mod. 3.

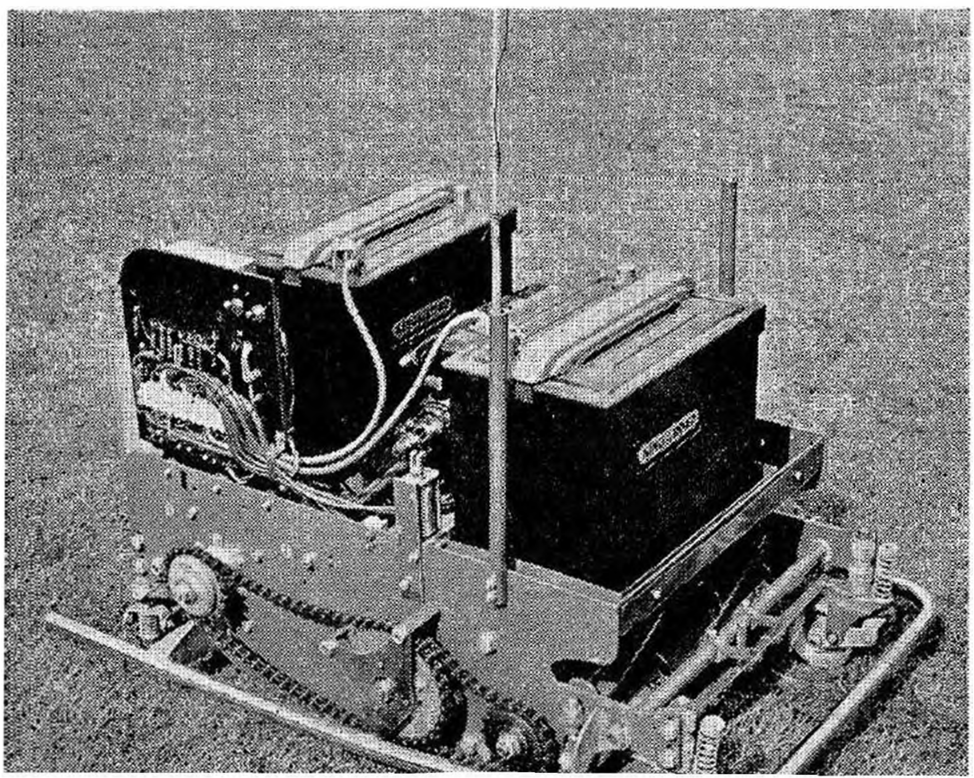
Relay C is energised by the closing of Contact R.3. Contact L on relay C will therefore open and the L hand clutch will become de-energised. At the same time contact M will close causing L hand brake to operate. Mower will now steer left due to the pivot action on the L hand side.

Action due to Mod. 4.

Relay D is energised by the closing of Contact R.4. Contact N on relay D will therefore open and the R hand clutch will become de-energised. At the same time Contact O will close causing R hand brake to operate.

Mower will now steer right due to the pivot action on the right hand side.

The .5 M.F.D. and 100 ohms networks represent suppressors across contacts.



Offside of the Webb lawnmower, which gives more detail of the E.D. installation. With metal hood in position as shown on cover the R/C and electrical equipment would be adequately protected from grass clippings. Grass box would clip on to front by castors.

The Cathode Ray Oscilloscope

PART 3

By F. C. JUDD, A.Inst.E.

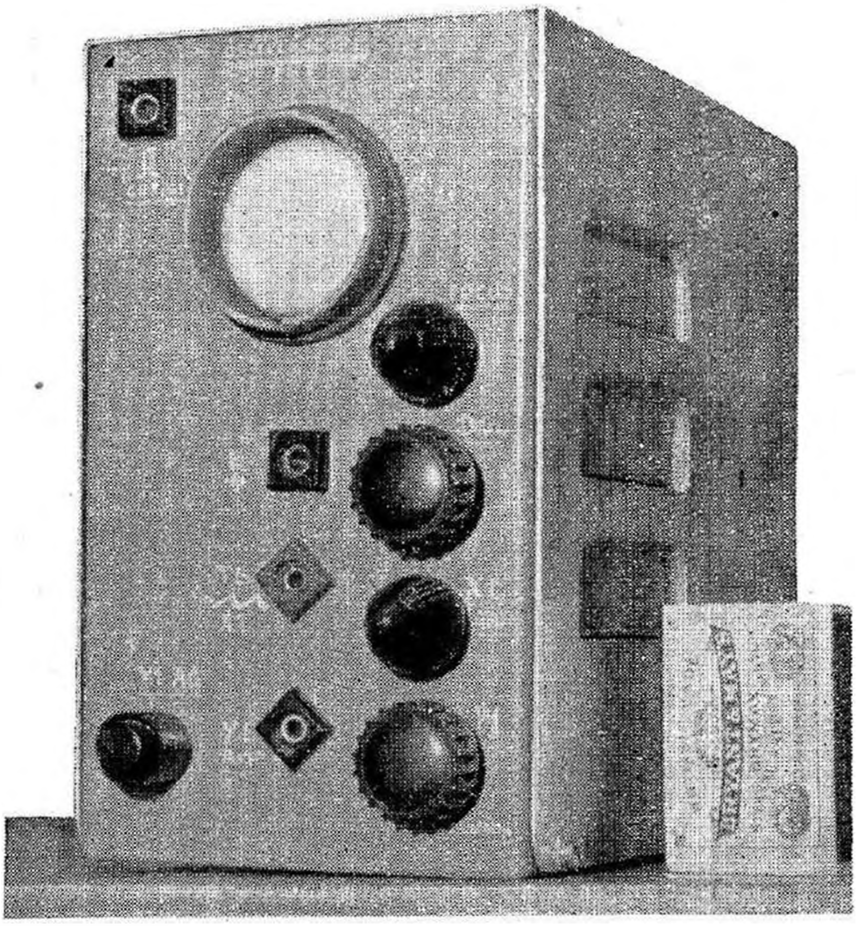


FIG. 8. Simple home built oscilloscope, using a G.E.C. 1¼ in. diameter tube, by the author.

THE second part of this series of articles discussed the time base, systems of deflection and finally, but very briefly, the use of the oscilloscope for frequency comparison by Lissajous figures. This is one of the most common uses of an oscilloscope and may be accomplished without the use of a time base, by simply applying a signal of known frequency to one set of plates and an unknown frequency to the others. For example, if we apply a signal at a frequency of 50 c.p.s. to the X plates and a signal also of 50 c.p.s. to the Y plates the ratio of one frequency to the other is 1:1. The oscilloscope will therefore present a display as shown in Fig. 1 which will be a complete circle if the waveform of each signal is perfectly symmetrical and the two signals are *exactly* at the same frequency. If the frequency of one deviates by even as little as a quarter of a cycle, the pattern will commence to move, apparently round and round, the rate of this apparent rotation being determined by the difference in frequency between the two signals. If, for instance, one signal were different by say, two cycles per second, the apparent rotation would be twice in one second. This applies whether the frequency difference is plus or minus the known and fixed frequency, in this case 50 c.p.s. Therefore to see the circle rotating twice per second would indicate that one of the signals was either 48 or 52 c.p.s.

As the ratio of one frequency to another becomes greater, further stationery patterns will be obtainable and these are particularly prominent when the unknown frequency bears some harmonic relationship of the unknown frequency. For example, if we accept 50 c.p.s. as our known frequency, a signal of 150 c.p.s. (ratio 3:1) will produce a pattern like Fig. 2 which has three loops. A signal of 100 c.p.s. (ratio 2:1) would have produced only two loops. Likewise a signal of 200 c.p.s. (ratio 4:1) would have produced four loops and so on.

The actual frequency range that can be covered by the Lissajous figure method is very wide and normally limited only by losses due to the capacity of signal leads and the c.r.t. plates themselves.

The Use of a Time Base

If one or a number of waveforms are to be examined the presentation must be an accurate one. It must show the

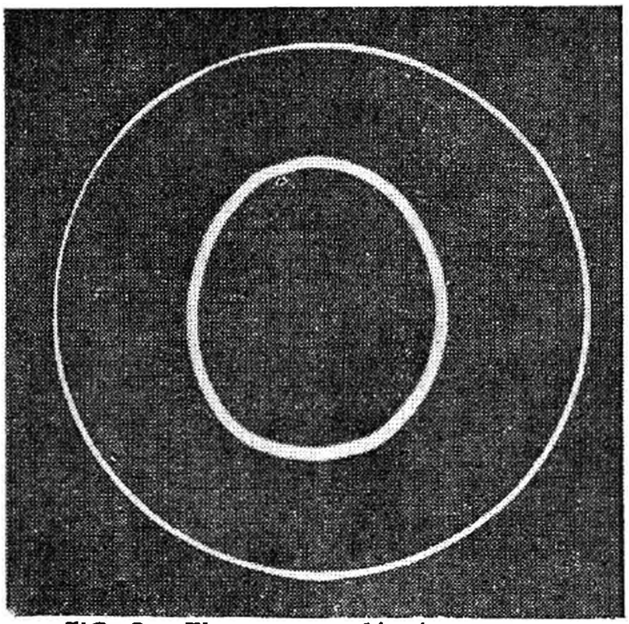


FIG. 1. 50 c.p.s. signal on "X" plates and 150 c.p.s. on "Y" plates; ratio 1 to 1.

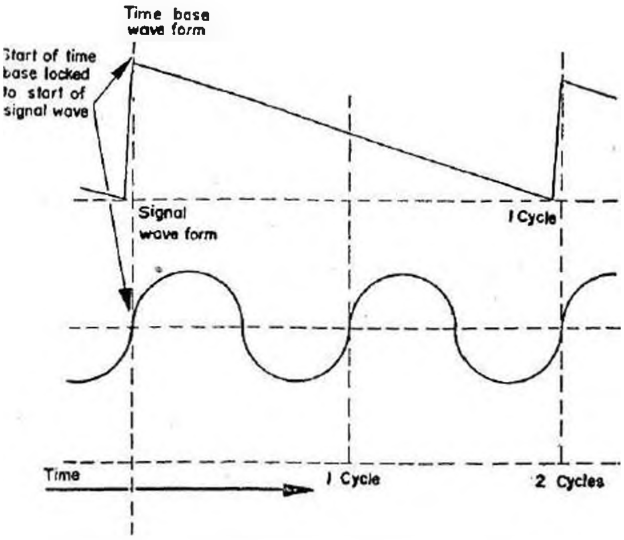


FIG. 3. Relationship between time base and signal being displayed on screen (see text).

FIG. 2. Three to one Lissajous pattern 50 c.p.s. signal applied to "X" plates with 150 c.p.s. signal (sine waves) applied to "Y" plates.

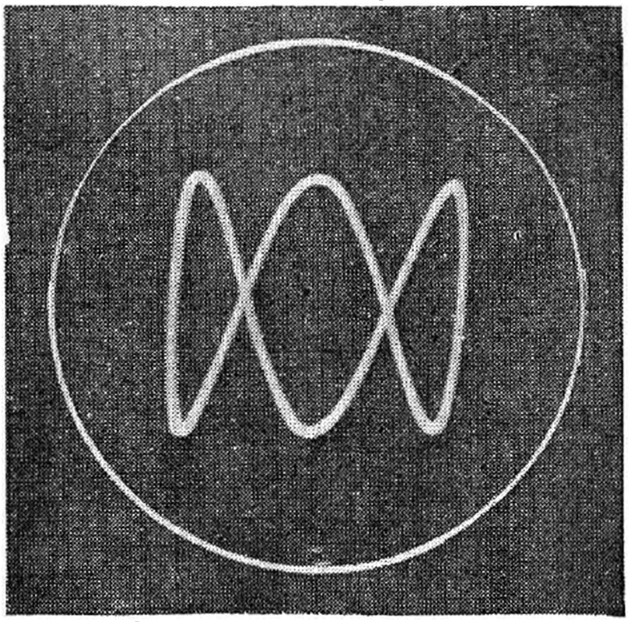
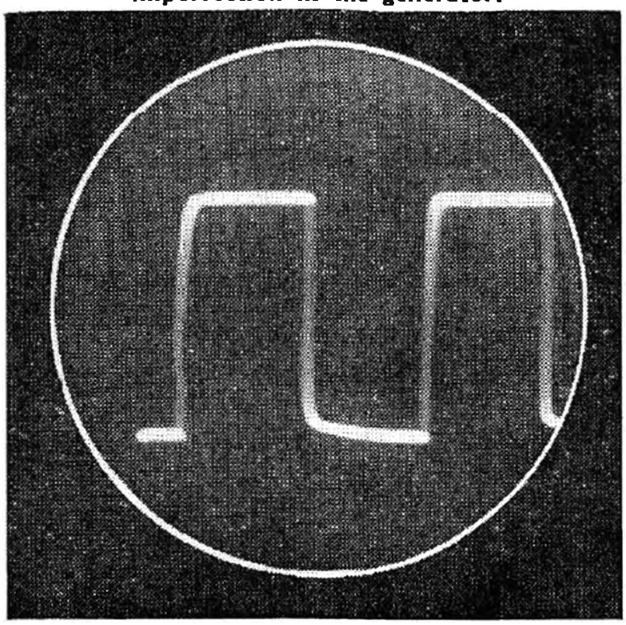


FIG. 4. 1,000 c.p.s. square wave. Note the curvature at the top edge due to imperfection in the generator.



correct time relationship of each waveform to its neighbour and to itself. In other words the scan must be linear with time. There will also be a frequency relationship between the time base and the waveform(s) being examined and like the Lissajous pattern method a definite ratio will exist between the two. A time base with a repetition frequency of say 100 c.p.s. would show two complete cycles of a c.p.s. sinewave. This relationship is shown diagrammatically in Fig. 3. On the other hand a time base repetition frequency of 400 c.p.s. would show eight complete displays of a 50 c.p.s. sinewave signal.

With the aid of a linear time base all kinds of waveforms may be displayed for close examination. This facility is a vital one to the electronics engineer especially when the 'goodness' of a sine, square or other wave is essential to the correct functioning of some piece of electronic equipment. In Radar work for example a square-wave may be required to have an extremely fast leading edge (Fig. 4). A low frequency generator for audio work may have to produce a very pure sinewave (Fig. 5). An amplifier may be required to operate without inter-modulation of signals fed into it (Fig. 6). The output from a transmitter may need to be examined for 100 per cent modulation of its carrier (Fig. 7) and so on. The oscilloscope will show all of these functions and many more besides. (The photo-

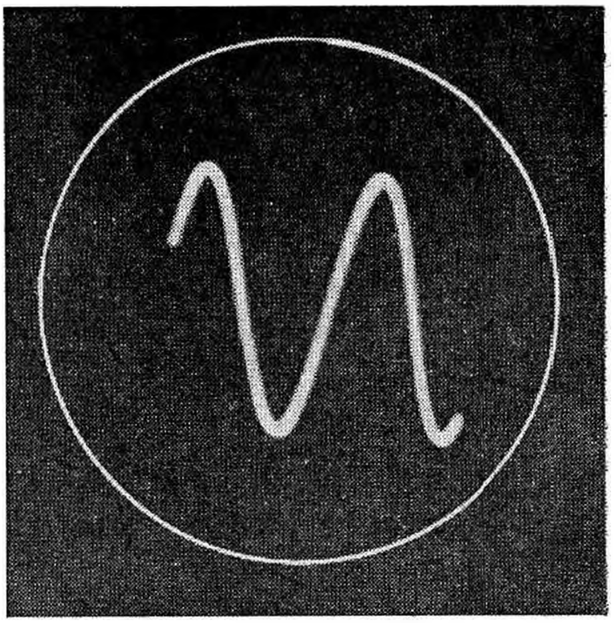


FIG. 5. Pure sine wave from an audio frequency generator.

graphs of Figs. 1, 2 and 3, 5, 6 and 7 are of actual oscilloscope displays).

The displays shown in the photographs are stationery and in order to view them directly on the oscilloscope screen in the same way, a means of 'locking' the display must be provided. This is carried out by injecting a small portion of the signal being examined, into the time base, so as to synchronise the beginning of each time-base wave with one of the signal waves. Usually a variable control is provided, often called the 'sync' control, so that signals of varying amplitude may be accommodated and for the avoidance of 'over synchronisation' which would give rise to non-linearity and possible distortion of the waveforms being displayed. When internal or external 'Y' plate amplifiers are used to amplify a signal to be displayed, the frequency range of the oscilloscope becomes limited, but limited only by the frequency range of the amplifier. With careful design an amplifier with a linear response from D.C. to 5 Mc/s. is usual and amplifiers with a bandwidth of 10 or even 20 Mc/s. are possible with modern high mu valves and special circuits.

A Complete Oscilloscope

The construction of a complete oscilloscope is not a difficult one providing some knowledge of radio or electronic circuits has already been gained by building such equipment from theoretical circuits. Those readers who contemplate the use of an oscilloscope but who have not a reasonable experience of constructing and testing such equipment would be well advised to purchase an oscilloscope 'kit'. There are at least three available today that use printed circuits and require only the use of a few simple tools to complete assembly and wiring. Be guarded against ex-Government surplus units, for many advertised as so-called oscilloscopes are quite unsuitable for general purposes without very extensive modification.

Those who feel capable of working from theoretical circuits are recommended, the Mullard 'Service Scope' design which may be obtained free of charge from Mullard Publications Department, Mullard Limited, Torrington

(continued on page 245)

FIG. 6. Two sinewaves of a different frequency passed by a linear amplifier.

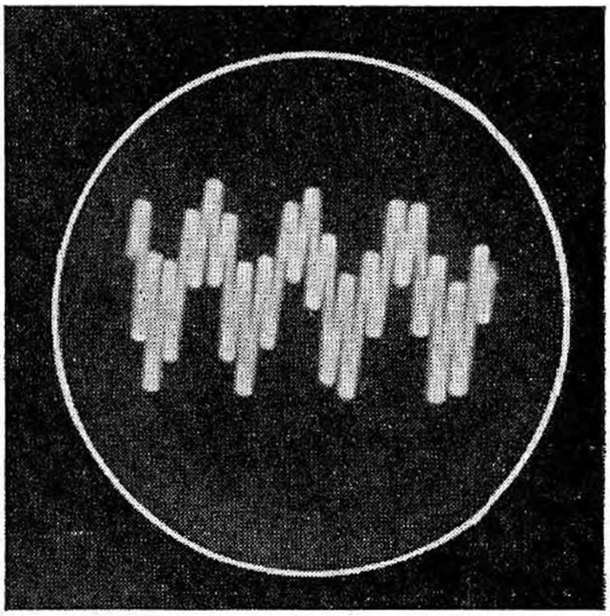
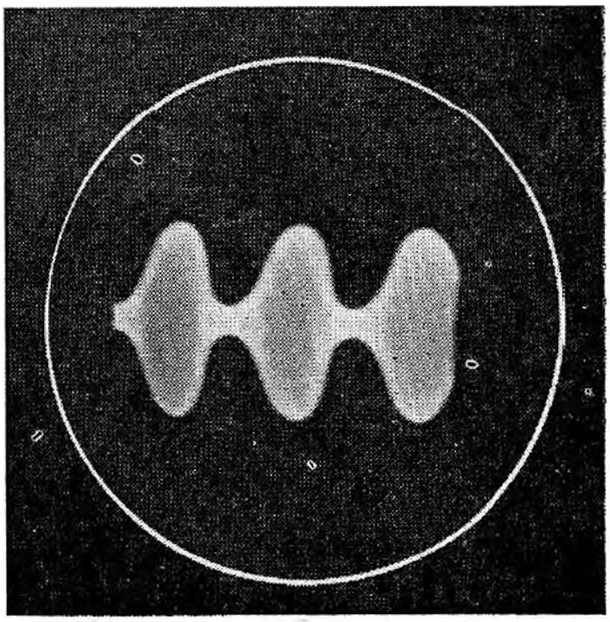


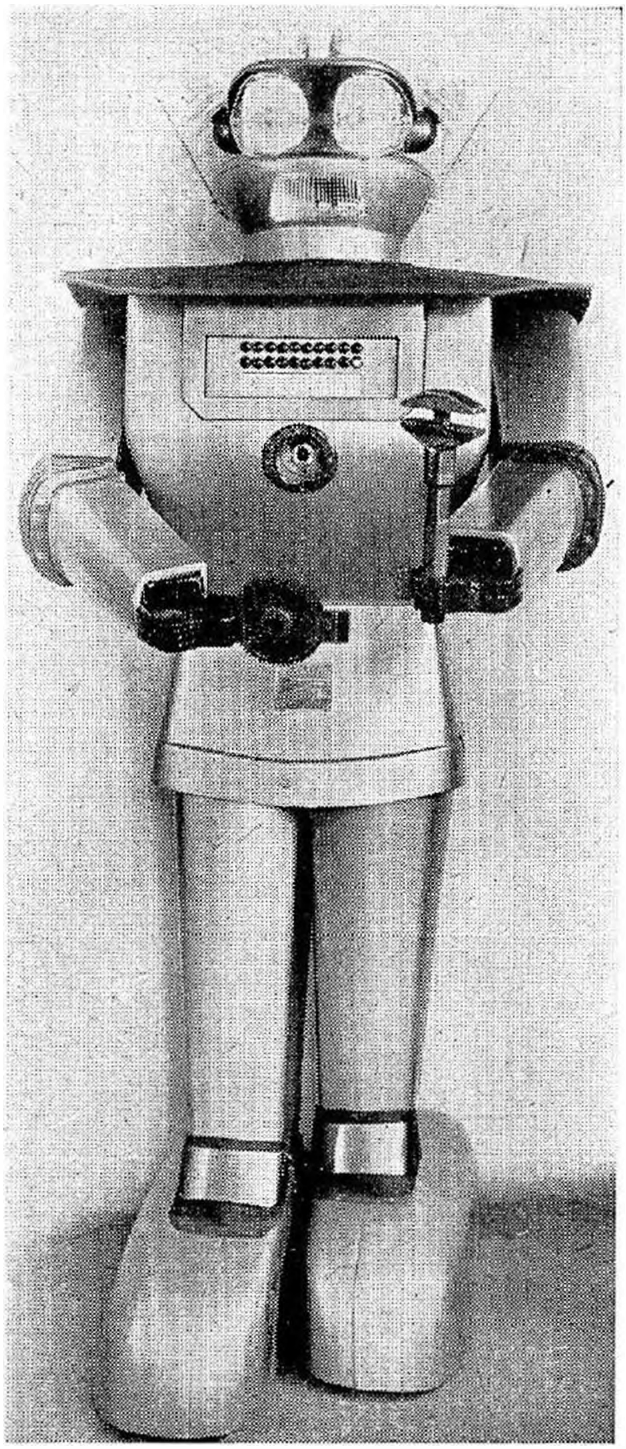
FIG. 7. 100% modulated v.f. carrier.



CYGAN

Dr. Fiorito's Giant Electronic Robot

From Italian Rassegna di Modellismo

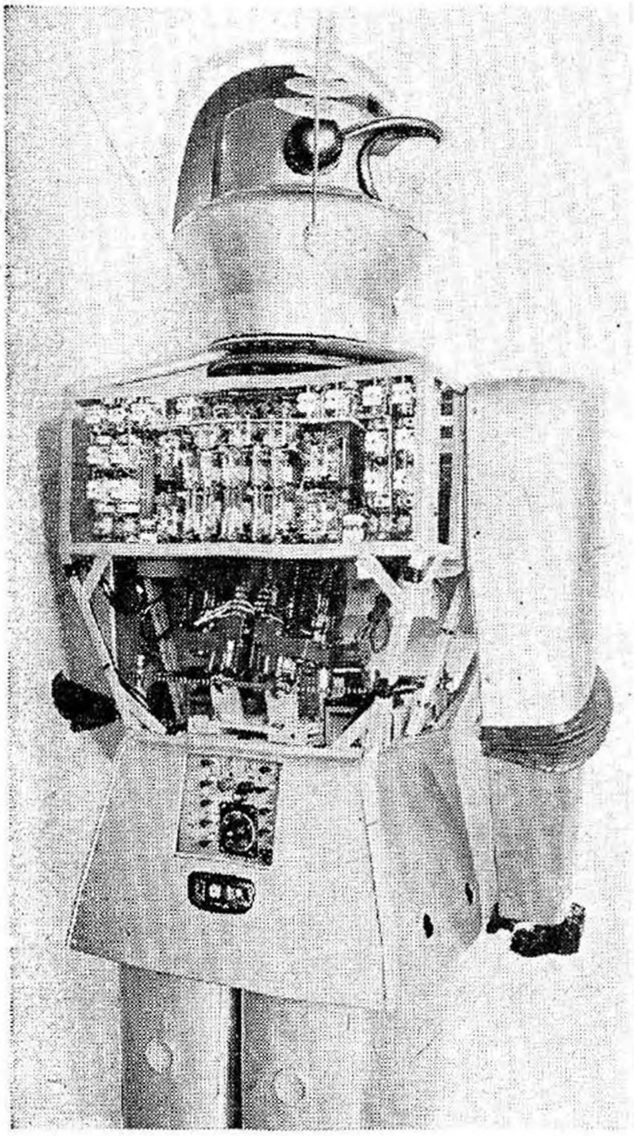


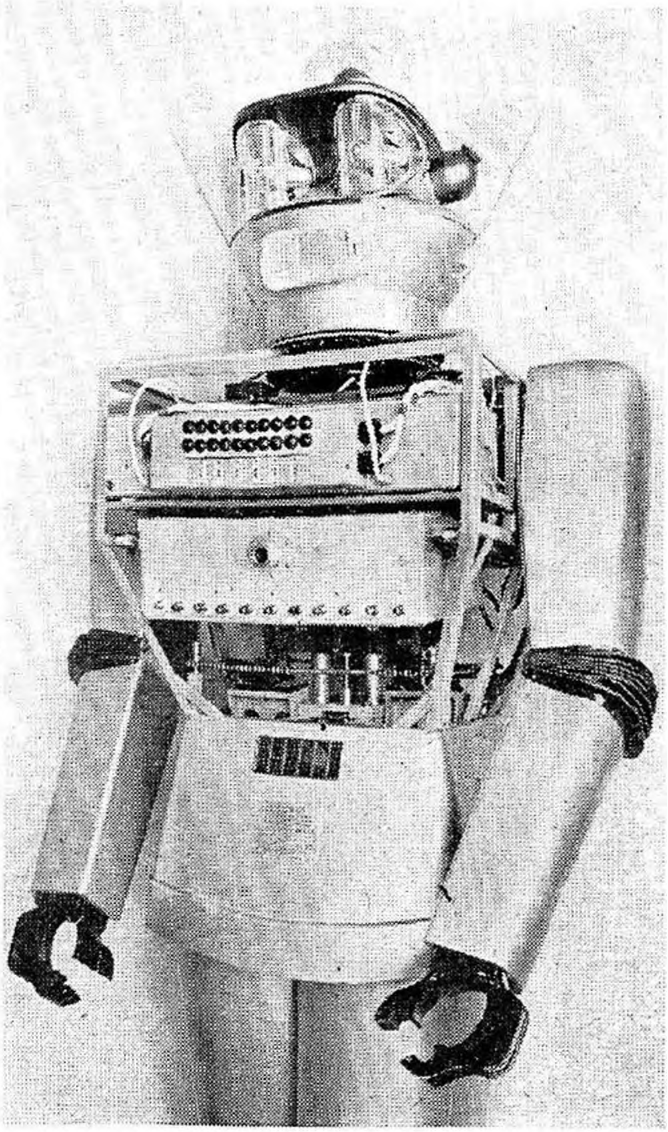
THIS fantastic robot is the work of Dr. Ing. Fiorito, a keen aeromodeller from Turin, who has been working on a whole series of such models and fitted them with radio control circuits. Construction—in spite of appearances to the contrary—has been kept comparatively simple, Meccano parts being largely used in building. First prototype to be built was about five feet high, and models two and three were built to a similar size, with the addition of cybernetic and autocontrols.

The final design, after months of work looked, so the designer declares, like "a proud Englishman" so he called it "Cygan". (We confess to being baffled by the connection!).

"Cygan" is positively enormous! According to our figures it is over eight feet tall and weighs over a 1,000 lbs.! This weight includes batteries and accumulators, which give an operational time of 4½ hours. It will walk forwards or backwards, turn right or left, raise its arms singly or together, and perform simple operations with them with the greatest delicacy, such as lifting iron bars, picking up pieces of apparatus and putting it down again where told. It is adapted to accept spoken commands as well as signals, and will also respond to light rays. Current consumption is 28v. at 70 ah. Accumulators weigh about 2 cwts. and are placed as low down as possible to give stability to the robot. Other interesting data includes: R/C range approx. one mile; top speed 10 ft. per min.; left or right turns up to 180° made in three seconds on level ground. Arm movements complete from rest to raised or vice versa in three seconds. Coloured lights can be flashed from sockets, and robot will acknowledge signals, and make some responses.

Unfortunately no data is offered on radio control circuits or servos in use. From the illustrations we can count at least twenty relays. Propulsion method seems based on that used in Peter Holland's "Mr. Robot-ham" some years ago, whereby wheeled trolleys are located under each foot, with electric motors which make and break automatically as each foot comes forward for a step. Turn is presumably made by slowing down or stopping the motor on one foot.





C. R. T. OSCILLOSCOPE (continued from page 243)

Place, W.C.1. The Service Scope leaflet No. TP.374) gives full circuit and component details for a versatile instrument, complete with time base and Y plate amplifiers and audio probe. Those interested in the oscilloscope as a demonstration unit for educational purposes are advised of the Mullard Booklet 'Students Constructional Oscilloscope' free of charge from Mullard Limited (Educational Service) address as above.

Ex-service instruments such as the Cossor 339 double beam instrument can be obtained from re-conditioned instruments suppliers such as R.T.I. Services, Ashville Old Hall, Ashville Road, Leytonstone, London, E.11. Such instruments are thoroughly tested before despatch and bona fide dealers will advise as to the suitability of them for general purposes as outlined in these articles.

Simple Oscilloscope for Lissajous Patterns, etc.

A very simple oscilloscope using a 50 c.p.s. A.C. time base and with provision for direct connection to X and Y plates may be designed around one of the small one inch diameter tubes such as the Mullard DB-91 or E.M.I. 1CP1 These small tubes will provide a clear well focused display and are eminently suitable for Lissajous patterns or for showing low frequency waveforms on a simple time base derived from a linearised portion of a 50 cycle sinewave. The tubes will operate from comparatively low H.T. voltages and a complete instrument can be built quite compactly as shown in Fig. 8. Details for construction and the circuit diagrams will appear in Part 4 of this series.

Notes on Using Standard Wire Tables

By R. H. WARRING

THE electrical side of electromagnet coil design may be concerned with establishing a certain coil resistance (i.e. consistent with a required current), specified magnetic requirements (i.e. a particular value of ampere turns), or more usually a combination of both. The geometry involved is closely bound up with the electrical requirements whilst secondary effects, particularly heating, have to be borne in mind. Low inductance is also important on such designs as high-speed relay coils to ensure a rapid build-up of current. Basic coil design requirements are, however, relatively straightforward.

The most general problem is to determine the correct size of wire to wind a cylindrical coil of given dimensions to produce a given number of ampere turns in a circuit of specified applied voltage. The 'cut-and-try' method is to guess the wire size and then calculate the number of turns and total wire length which can be accommodated on the given bobbin or former. From this the resistance of that length of wire can be calculated, when:—

$$\text{ampere-turns} = \frac{\text{applied voltage} \times \text{number of turns}}{\text{resistance of wire.}}$$

If this results in the number of ampere-turns being too small, the process is repeated using a wire of larger diameter (or smaller diameter if the ampere-turns figure is too large), or the current-voltage/resistance—too high).

Using standard tables this is not a lengthy or tedious process and can give quite satisfactory results. Standard wire tables give the following data:—

(i) Overall diameter of different covered conductor (for insulated wires).

(ii) Turns per inch for different conductors.

(iii) Turns per square inch for different covered conductors.

Data (ii) and (iii) are, of necessity, somewhat arbitrary since they may vary slightly in practice—or vary quite appreciably with different winding techniques. On the whole, however, they are reliable figures for design work. More accurate working can be achieved by the use of specific formulas.

For a bobbin or former of given dimensions—Fig. 1—the space occupied

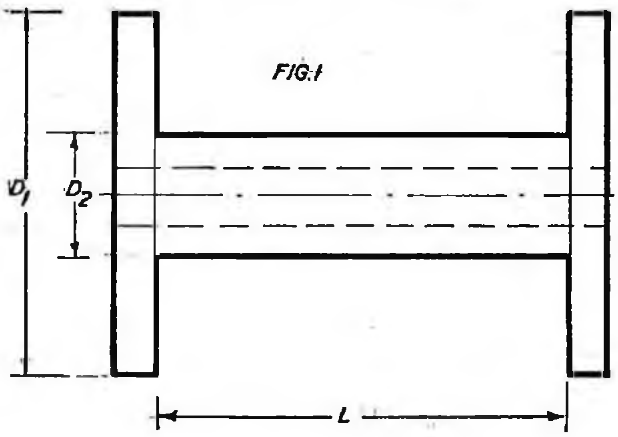


TABLE I. OVERALL WIRE DIAMETERS (Abridged).

Type of Wire S.W.G.	Bare Upper	Ena-melled	Single Silk	Ena-melled & Single Silk	Double Silk	Ena-melled & Double Silk	Double Cotton	Lumex QF
36	.0076	.0086—.0092	.0091	.0100	.0102	.0111	.0167	.0109
38	.0060	.0069—.0075	.0075	.0083	.0086	.0094	.0151	.0088
40	.0048	.0056—.0061	.0063	.0070	.0074	.0081	.0139	.0072
44	.0032	.0039—.0043	.0048	.0059	.0059	.0065	—	.0048
47	.0020	.0025—.0027	.0036	.0040	.0047	.0051	—	.0033

TABLE II. TURNS PER LINEAR INCH (Abridged).

Type of Wire S.W.G.	Enamelled	Single Silk	Enamelled & Single Silk	Double Silk	Enamelled & Double Silk	Double Cotton	Lumex QF
36	116.3—108.7	109.9	79.37	98.04	56.82	59.88	91.74
38	145 —133.3	133.3	91.74	116.3	62.89	66.23	113.6
40	179 —164	158.7	104.2	135.1	68.49	71.99	138.9
44	256 —233	208.3	—	169.5	—	—	208.3
47	400 —370	277.8	—	212.8	—	—	303.0

TABLE III. TURNS PER SQUARE INCH (Abridged).

Type of Wire S.W.G.	Single Silk	Enamelled & Single Silk	Double Silk	Enamelled & Double Silk	Double Cotton
36	12,963	10,500	10,092	8,369	3,767
38	19,167	15,241	14,197	11,634	10,291
40	27,315	21,429	19,176	19,872	—
44	51,851	37,380	34,711	27,315	—
47	96,419	69,033	56,788	43,731	—

by the actual conductors may vary considerably, depending on the type of insulation and also the manner in which the individual windings are laid. Data table (ii) covers the former (or alternatively the number of close turns can be calculated directly by dividing L by the actual overall diameter from data table (i)). The amount of 'waste' space in a complete winding, however, can be much higher if adjacent layers are piled exactly above one another as in Fig. 2a, rather than staggered as in Fig. 2b. The latter is the more usual arrangement in giving maximum *space factor*.

The *space factor* of a coil is simply the ratio of the total cross section of all the conductors in the complete coil to the total winding space available. Besides being highest with 'staggered' windings, it is also higher with enamelled wire compared with thicker insulations, and higher for larger wire diameters. Basically, a high space factor gives a coil with maximum ampere turns in a given size for a given current density.

With the type of winding shown in Fig. 2a, theoretically it should be possible to achieve I/d turns per inch length, where d is the overall diameter of the wire. This would be difficult to maintain in practice and a more realistic figure is

turns per inch = .95 divided by d.

Similarly for wires piled in a vertical direction. Wire tables for turns per inch length, however, are usually calculated on the theoretical value and so if followed specifically may yield a higher figures of turns than can actually be achieved.

A complete winding of Fig. 2a type would, however, be unusual. The close wound coil (Fig. 2b) would be more likely, when theoretically the increase in number of turns possible should be of the order of ten per cent. This would yield

(continued overleaf)

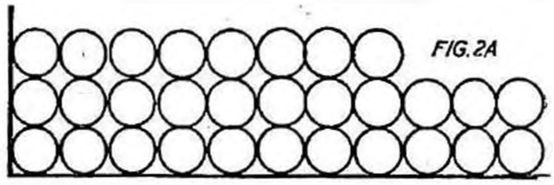


FIG. 2A

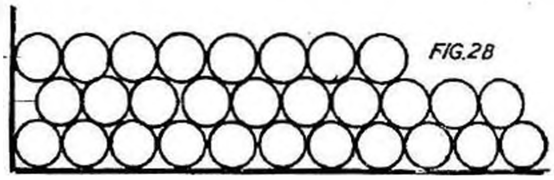


FIG. 2B

$$\text{turns per } \textit{square} \text{ inch} = \frac{.95 \times .95}{d \times d} \times 1.1 = \frac{.99}{d^2}$$

Almost all coil winding data giving turns per square inch, however, are calculated on the more conservative figure of

$$\text{turns per square inch} = \frac{1.05}{d^2}$$

Although essentially an 'average' or approximate figure, such data can be adopted as essentially practical. Hence it is usually better to work from a table of *turns per square inch* rather than one giving turns per inch and factoring for the number of layers which can be accommodated within the depth of the winding.

Another very useful table is one giving current rating for various wire sizes in terms of amperes consistent with a rating of 1,000 amps per square inch of conductor. The latter figure is usually considered the maximum safe rating for coils subject to continuous operation. Since this does not appear generally available it is given in full in Table (iv). This also gives a guide as to the suitability of a very fine wire size for a particular duty, chosen initially on the basis of accommodating a high resistance in a minimum size of coil.

Wire resistance is, of course, independent of the type of insulation, although special insulations may be suitable for wires carrying higher rated currents and thus operating at higher temperatures. The *rating* of a coil is most properly expressed in terms of watts per square inch, i.e.

$$\frac{(\text{current})^2 \times \text{resistance}}{S}$$

where S is the area of curved surface of the coil dissipating heat. A nominal maximum rating for continuous operation is 0.5 watts per square inch.

A point to remember is that when the coil is carrying current it is invariably heating up to some degree and if the temperature rise is appreciable the *resistance* of the wire (and thus the coil) can be considerably changed. As an approximation

$$\text{increase in resistance} = \frac{\text{original resistance} \times \text{temp. rise } ^\circ\text{C.}}{250}$$

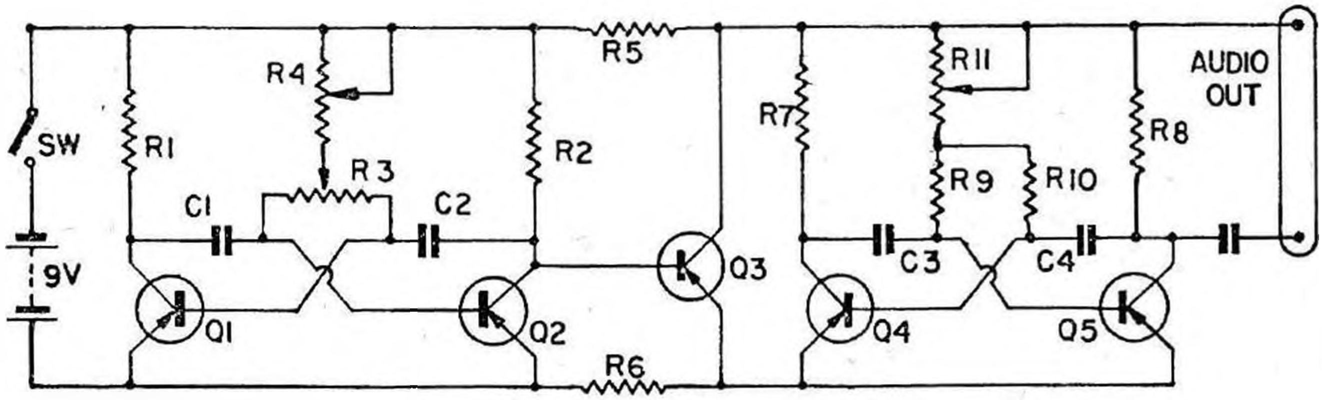
Resistance values quoted in standard tables (usually resistance in ohms per 1,000 yards), refer to 'cold' (normal room temperature) values and thus under operating conditions the actual amperage and thus ampere-turns may be reduced from the original estimated figure. It is general practice, in fact, to allow anything up to 25 per cent increase in (original) ampere-turns to allow for this, depending on whether the duty is intermittent, semi-continuous or continuous.

TABLE IV. MAX. AMP. RATING AT 1,000 AMPS/SQ. IN.

S.W.G.	16	17	18	19	20	21	22	23
AMPS	3.27	2.46	1.81	1.26	1.02	.80	.62	.45
S.W.G.	24	25	26	27	28	29	30	31
AMPS	.38	.31	.255	.211	.172	.145	.121	.106
S.W.G.	32	33	34	35	36	37	38	39
AMPS	.092	.078	.067	.055	.045	.036	.028	.021
S.W.G.	40	41	42	43	44	45	46	47
AMPS	.018	.015	.013	.010	.008	.006	.0045	.003

TABLE V. WIRE RESISTANCES (OHMS PER 1,000 YARDS).

S.W.G.	36	38	40	44	47
OHMS	529	849	1,327	2,935	7,642



COMPONENTS REQUIRED

Q1 to Q5: Motorola 2N652 PNP Transistors.
R1, R2, R7 and R8: 2.2 K Ω ½ watt.
R3 and R4: 250 K Ω linear taper potentiometers modified as above and in text.
R5: 1 K Ω.
R6: 15 K Ω.
R9 and R10: 22 K Ω.
R11: 25 K Ω linear taper pot.
C1 and C2: 2 mfd., 9 volt or higher rating.
C3 and C4: 0.02 mfd., larger for lower audio tones, see text.
C5: 0.1 mfd.

Jay's Pulser

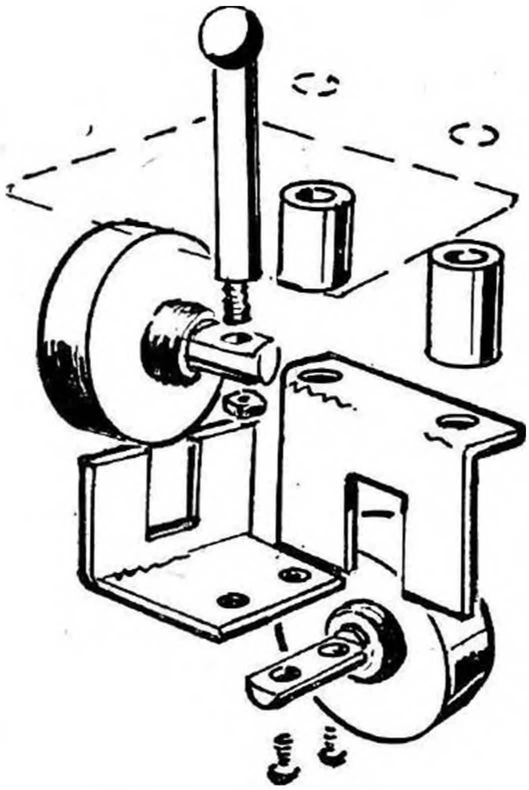
This little unit of particular interest to the rather more advanced types will serve to recall designer Munro J. Kreinik, that tireless young American "Jay" who so enjoyed our British R/C activities during 1959.

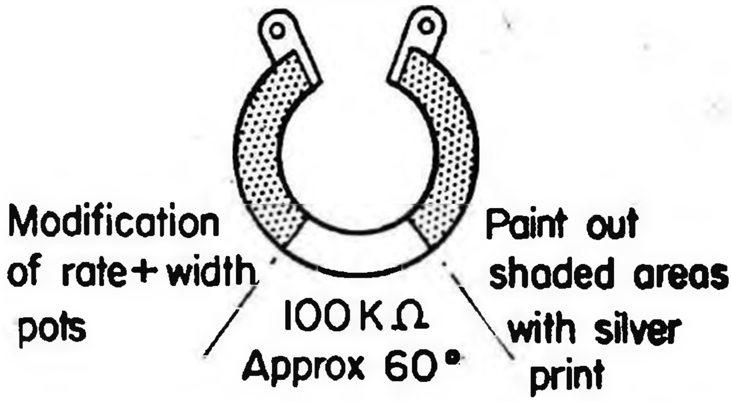
THE primary considerations for this proportional pulser were that it fit easily in the hand, and that it be convenient to operate. That the first has been achieved may easily be seen from the illustrations, while the second is achieved by use of special 'gimmicked' potentiometers, eliminating the need for gearing in the stick control. The smoothness of the control must be felt to be appreciated, and its very lack of stiffness allows precision manoeuvres without any jerkiness.

The pulser was designed to operate a special receiver, which is tone selective, the range being determined by Ferroxcube filters. The single channel Rx. used in the GG ships has a tone of 3,500 c.p.s., but by changing the filter will work anywhere from 1,000 to 6,000 c.p.s. Therefore, it is necessary for the audio tone put out by the pulser to be adjustable anywhere in this region without disturbing the mark/space ratio or the pulse frequency, also the tones must be stable enough not to drift out of range of the audio bandpass of the Rx., which is, with GG, fatal. However, the Rx. will operate quite well within a range of plus or minus 100 c.p.s., and is also quite happy with square wave modulation, this makes it very easy to operate and also quite trouble-free.

The schematic diagram shows that the pulser is actually three circuits, a low frequency multivibrator which is controlled by the stick pots. to give variable pulse width and pulse frequency, a switch, controlled by the preceding MV, and a high frequency MV which serves as the output stage, supplying the audio tone necessary to operate the Rx. The output from this pulser is quite adequate for use with the McQue transmitter, providing that the Rx. is capable of operating from high frequency audio, or the high frequency MV is slightly modified to accommodate Rx. using lower audio tones. If found necessary, this is simply and easily done, only two capacitors must be changed.

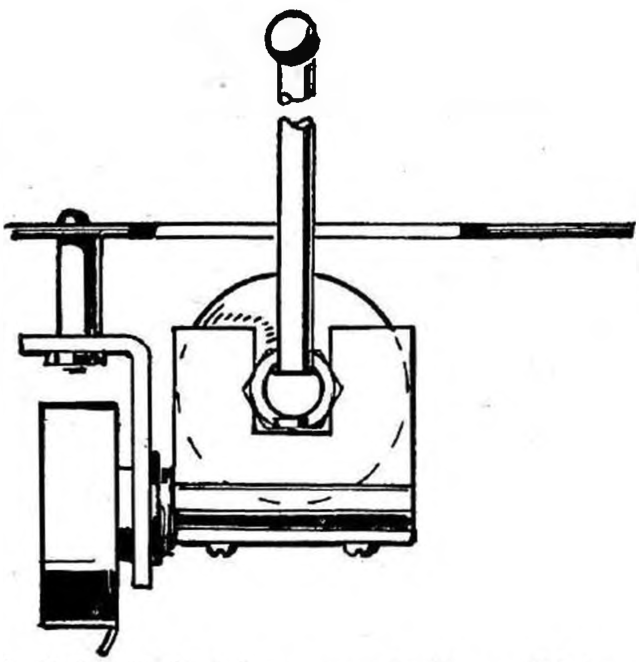
As the construction of the unit is straightforward no overall instructions will be given, other than those for the unusual parts of the design. The most complex of those happens to be the modification of the potentiometers, so let's start with those in former pulsers, the most conspicuous feature was the huge and cumbrous gearing protruding from the top of the box. The reason for that is that, for a certain operating frequency and rate change, a certain resistance must be covered, and that in about 60 degrees of angular differential, as this is a 'natural' amount to move the stick to accomplish a violent manoeuvre. If the same amount of resistance change may be achieved in the same rotation of the pot. shaft, then the gears are no longer necessary. To do this, the pots. are modified by shorting out most of their resistance with silver depositing paint. This paint is used for the repair of broken etched

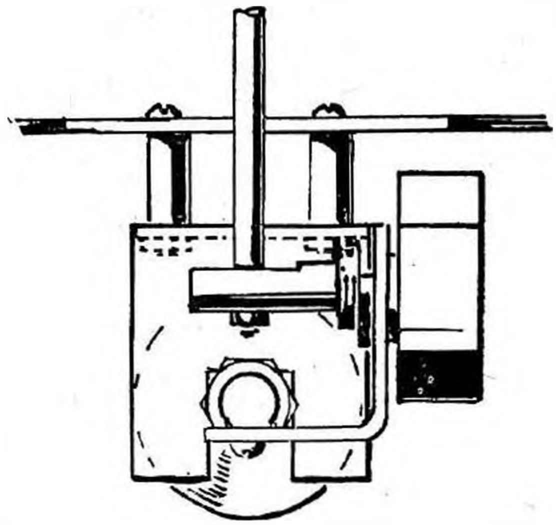




circuitry boards, and should be available from any electronic supply house specialising in industrial electronics. In the U.S.A. this is known as Silver Print, and is manufactured by General Cement. Also in the U.S.A., these pots., already modified, are available from Ace Radio, in Missouri. If you cannot get these, or prefer to make your own, here is the proper procedure. First carefully remove the rear cover from the pot., bending back the ears with a small pair of pliers; remember that they will have to go back later so don't break off any ears. Then ascertain if the shaft is removeable. Most are, either by removing a metal or rubber O-Ring in front of the pot., on the shaft where it goes into the ferrule. If the shaft is removeable, then remove it, if not you will have to be a little careful with your painting, and the job will take a little longer, but it is still not impossible. Following the drawing, paint out the outer section of the pot., leaving only 60° of resistance for operation. This is very simply done by connecting an ohmmeter of the proper range across the pot., as the paint dries, the resistance will decrease. Paint small sections until, when the paint is dry, the total resistance reading will be 100 kilohms. Use a very small brush for this operation and try not to get paint all over, as shorting of the pot. to ground can give some very odd and hard to trace symptoms. Check with the ohmmeter to eliminate this disorder. There is only one other caution on the pots., be sure to get 250 kilohms, LINEAR TAPER pots. If a non-linear taper is used, the operation of the pulser will be non-linear. After the pots. have been modified, and the paint is thoroughly dry, the stick control mechanism may be assembled. Depending on the size of the pots., different size brackets will be needed, and as these are simply right angle brackets with the proper size holes for the pot. shafts, etc., no dimensions will be given for these, nor will dimensions for any other parts, as the scrap box under your bench may provide many of the parts for this rig. I might mention that none of the values are over critical, and 10 per cent values may be used for all resistors, as most inaccuracies may be adjusted out of the pulser at time of completion.

The original circuit board was wired in the 'peg and string' method, but is especially applicable to printed circuit construction, and future models will have this feature. This model is extremely bare, having only the stick control, the on-off switch, and the output tone adjust protruding from the front, and the output and monitor terminals from the back. As there are many things that may be gainfully added to the pulser, it might be well to describe some of them now. Perhaps one of the most useful additions that could be made is that of an elevator trim adjust, allowing the forward and back position of the stick to coincide with the neutral position of the elevator. This is done by shunting the SYMMETRY pot. with another pot., a value of about 200 kilohms should be satisfactory. Another useful modification would be the addition of full signal—no signal buttons on the back of the box, so placed that they are easily reached by the hand while holding the pulser in the natural position. This position will vary with the

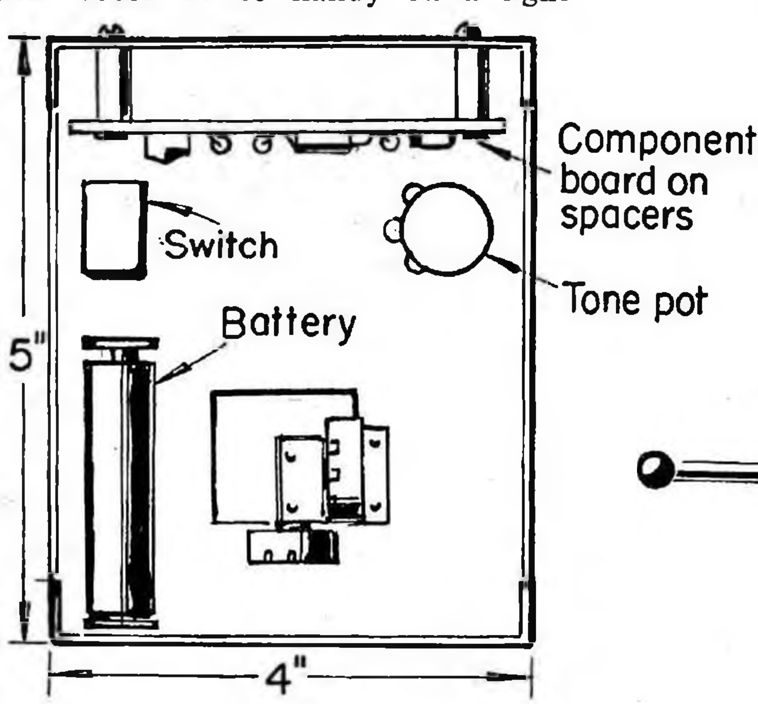


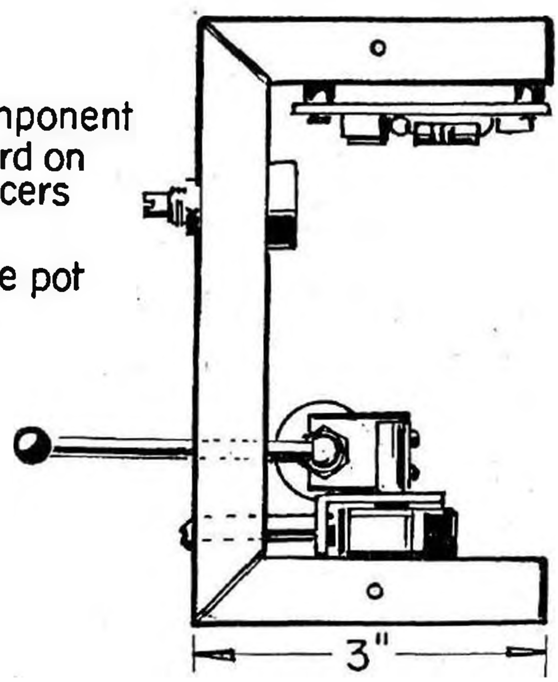


individual, but in my unit they will be placed one above the other on the upper left back of the box, and will be operated by the fore- and second finger of the left hand. Electrically, the easiest place for these switches is across each of the low frequency MV transistors, Q1 and Q2. Use these in such a manner that they short out, in operation, the respective transistor, causing the MV to lock in one position, i.e. if Q1 is shorted out (emitter to collector), the result will be full signal; if Q2 is shorted, the result will be no signal. This is very useful for violent manoeuvres, such as 'flick rolls' and as Mr. Riall says . . . The result is very exciting . . . It should be quite interesting to be able to mix in other audio tones to operate other devices, such as motor control, or (for example) the spoilers which would be so handy on a light slope soarer. All these things are being experimented with on the breadboard, and as they are proven, will be put into use.

Some of the transistor pulsers used in the past have not been too successful, but do not have any fears about this one. As I happen to work for a firm that manufacturer electronic gear for military contracts, I was able to give it a most arduous set of tests before this article was written. Be it enough to say that it passed every test, shock, vibration, temperature, etc., that are required for operation of a piece of missile-borne electronic gear. A word of caution though, this type of multivibrator, as may be known, is not stable enough to use with Rx. using reed banks. Alternate circuitry must be used with these, and as the art of pulsing

(continued on page 257)





Introduction to TRANSISTORS

In Part 3 Dave McQue leaves basic theory and gets down to practical uses. From now on the series provides the answers to problems that baffle many — "experts" and otherwise.

So much for how the transistor works, now let's see how we can put it to use.

The transistor has three terminals, emitter, base and collector, so to use it as an amplifier we have to connect the input between two terminals and take the output from another pair. Thus one terminal will be common and gives its name to the configuration (see Fig. 1). Sometimes 'grounded' or 'earthed' is used in place of common, but this can be confusing as the physical 'earth' or 'ground' need not necessarily be connected directly to the common terminal. It may not always be immediately apparent from a practical circuit diagram, which arrangement is used but, remembering that no change in voltage should occur across the power supply batteries and by-pass capacitors, if these are shorted, any single transistor circuit will reduce to one of those shown in Fig. 1.

Let's have a look at the common base arrangement first.

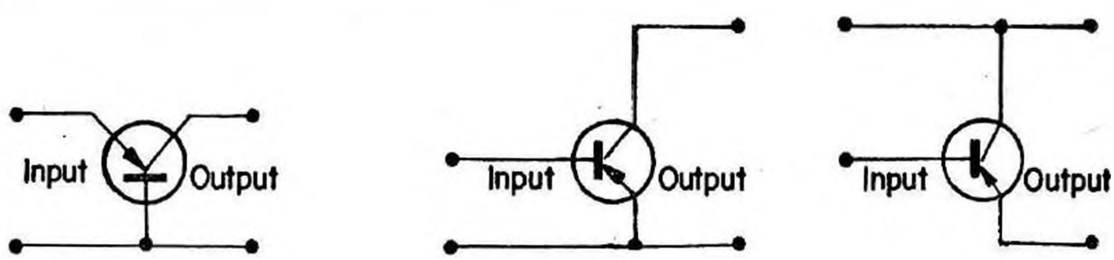
Here the collector current (Ic) is equal to the small collector/base leakage current Icbo plus the emitter current Ie minus the base current Ib, i.e. Ic = Icbo + (Ic — Ib). The ratio of the *change* in Ic to the *change* in Ie is called α (alpha), i.e. $\alpha = \frac{\delta \text{ Ic}}{\delta \text{ Ie}}$

Now as the change in Ic will always be less than the change in Ie it doesn't look as if this arrangement will be much good as an amplifier. However, hook up the circuit shown in Fig. 2 leave the emitter battery disconnected for a moment and connect the collector battery. The only current you will get will be the Icbo and, if the transistor is a good one this will barely move the meter. Try increasing the collector volts to 3V. and then 4.5V. Now connect the emitter battery and vary the emitter current by means of the 5K pot. You will see that, for all practical purposes, the collector current varies in step, so the transistor provides no *current* amplification but if you vary the collector voltage it has very little effect on the collector current (unless you reduce it to zero) and this is the clue for, if we put a resistor in the collector circuit—say 1K, and set the collector battery to 4.5V., the collector voltage (VCB) will vary as the emitter current is charged and, as only a small voltage (VEB) is required across the forward biased emitter base junction to produce this current, voltage and power amplification is obtained. Typical characteristics are shown in Fig. 3 and you will see that to get 1 m.A. change in Ie from say, 2 to 3 m.A., the input voltage charge is about 0.01V. whilst the voltage change across the load (from A to B) is 1 m.A. times 1,000 ohms = 1 volt.

At high frequencies the α of a transistor will fall and the frequency at which α has fallen to $\frac{1}{\sqrt{2}}$ or 0.707 is usually quoted as the cut-off frequency (f α co). Broadly speaking the common base arrangement is the one where the useful power amplification is maintained up to the highest frequency, so it is used in the superegen stage of all the current 'all transistor' receivers.

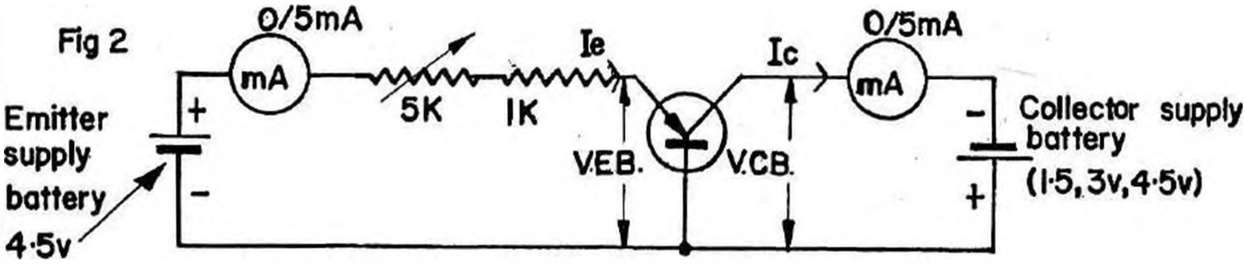
Fig. 4 shows the circuit of a practical oscillator which will work up to and beyond the alpha cut-off frequency of the transistor. The collector load is a tuned circuit L1 and C1. C2 is also effectively across the coil as the base

Fig I



Common base — Common emitter — Common collector

Fig 2



emitter circuit has a low resistance and C3 effectively 'shorts' the battery for radio frequencies. Now the tuned circuit acts as an energy store in much the same way as a pendulum. When a pendulum is at either peak of its swing it has no motion and the elevated position of the bob represents potential energy which corresponds to the capacitor being charged. When the pendulum is at the bottom of its swing there is no potential energy, but the bob has momentum, this corresponds to the condition where the capacitor is discharged and the energy is stored in the magnetic field around the coil due to the current through it. There is a constant interchange of energy between the two at the resonant frequency. In just the same way as a pendulum may be kept going by gentle pushes in step with its swing, so can the tuned circuit. In fact, the current 'circulating' in the tuned circuit can be many times the feed current. Part of the 'circulating' current flows in and out of C2 and due to the 'pendulum' action it can be greater than the current from the collector of the transistor.

The ratio of the circulating current to the make-up current is known as the 'Q' of the tuned circuit. Thus so long as the fraction of the circulating current fed back to the emitter is greater than α times $\frac{1}{Q}$ the circuit will oscillate. To use this type of oscillator as a superegen Rx. it is necessary to add additional components which will cause it to squegg at a quench frequency of about 20 Kc/s. Fig. 5 shows the circuit of a superegen, 'front end' like that used in the TR 4.5. C3 and R3 are the timing components for the quench frequency and the R.F.C. choke is required

On the right are typical characteristics of a Mullard OC70 junction transistor, based on a drawing supplied by the company. (Courtesy of Mullard Ltd.)

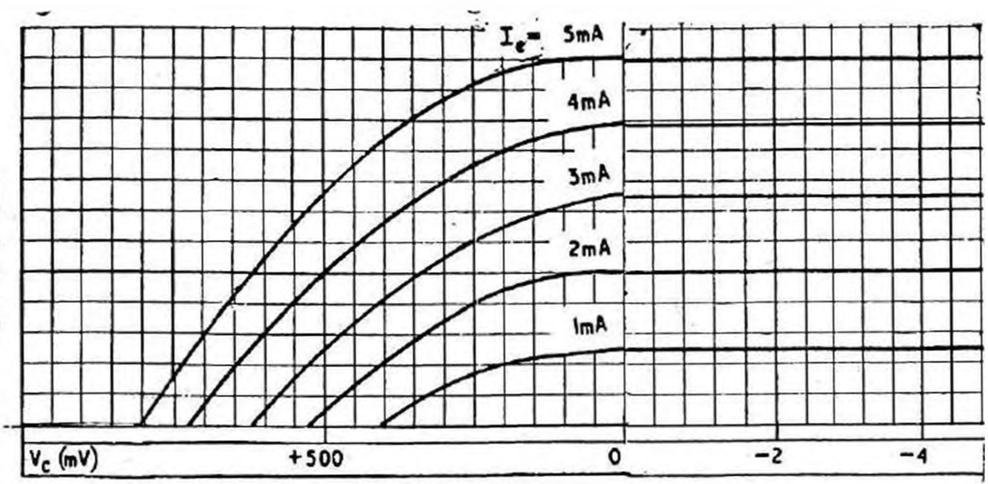
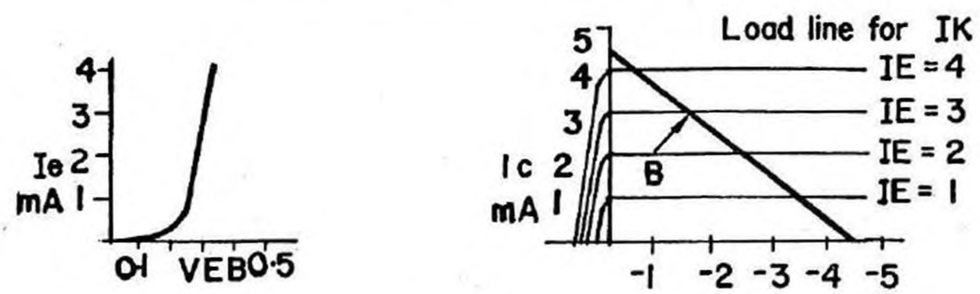


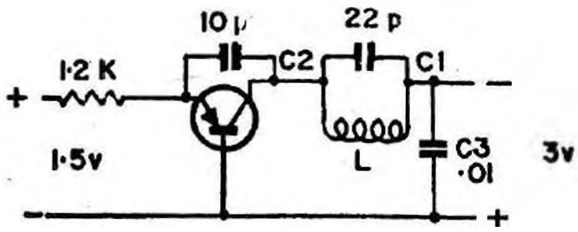
Fig 3



Common base input characteristic

Common base output characteristics

Fig 4



to prevent C3 shorting the radio frequency it fed to the emitter via C5. To avoid the use of two batteries R1 and R2 are used necessitating the two decoupling capacitors C1 and C2. C1 has to be large as it also decouples at audio and quench frequencies.

Here's how it works. Just like any other superegen. the oscillator has to be stopped and started. Let's start from where the oscillations in L1, C4 have died away and the transistor cut-off by the charge on C3 holding its emitter negative with respect to its base. The oscillations in the tuned circuit will, in fact, fall to the level of the inherent noise of the circuit or the received signal picked up by the aerial, whichever is the greater. C3 is discharging via R3 and eventually the transistor starts to conduct and the R.F. oscillations will start to build up from their present level. Now the build up of oscillations follows an exponential or compound interest law, and after a few hundred cycles a limiting level will be reached when the oscillations at the emitter are sufficient to swing the emitter in and out of conduction, rectifying the R.F. and charging C3. The charging of C3 tends to lag on the build up of oscillation, so when it catches up the bias is too great to sustain the oscillations and they tend to fall in amplitude, leaving the transistor cut off once more. This process repeats at the quench frequency which depends on the received signal level. Weaker signals require more cycles of build up to reach the limiting level.

If the signal is modulated by a tone the quench frequency will vary in sympathy as will the average current drawn by the transistor, as this depends on the quench frequency. When no signal is being received the quench frequency will vary in random fashion and the output of the Rx. will be simply noise. However, any signal picked up which is greater than the noise level will take over. The effect is that we have a Rx. of great sensitivity due to its very large effective gain.

Next month we shall look into the other transistor configurations, particularly the common emitter and examine the workings of an audio amplifier suitable for use with the superegen. detector.

If you are going to build this detector circuit here are a few tips:

Use high resistance (2K or 4K) phones in place of the transformer.

Disconnect battery whilst making any component charges.

L1 10 turns ¼ in. former (with core) 28g. enamelled.

L2 2 turns lightweight flexible.

R.F.C. CH1 Denco neosid choke core (1 amp. T.V.I. choke) wound full 40g. enamelled.

Correct operation is denoted by noise or rushing sound in phones—it won't be very loud.

C3 and R3 are the critical components and only starting values are given. Put a 5K. pot. in series with R3 and try various values of C3 from 0.001 to 0.02.

CORRECTION: Page 186 in previous issue first column last but one line read "positively" for "negatively".

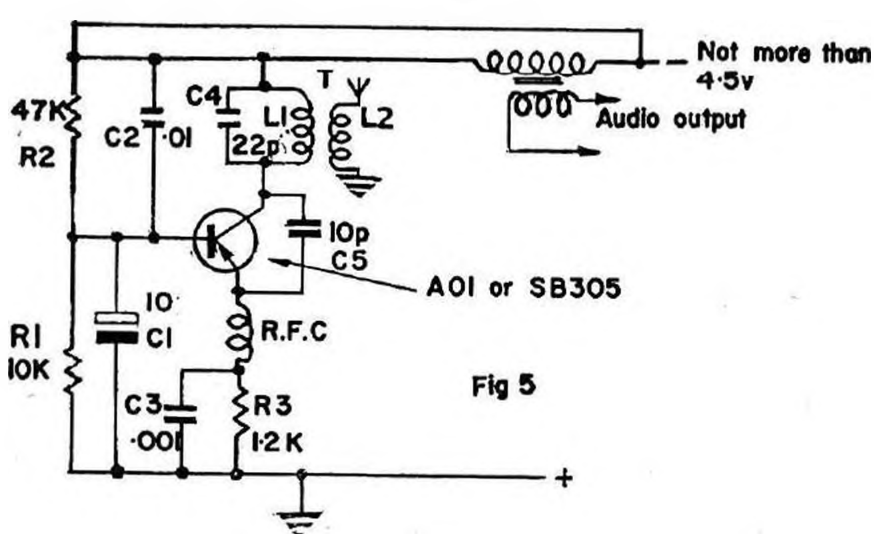
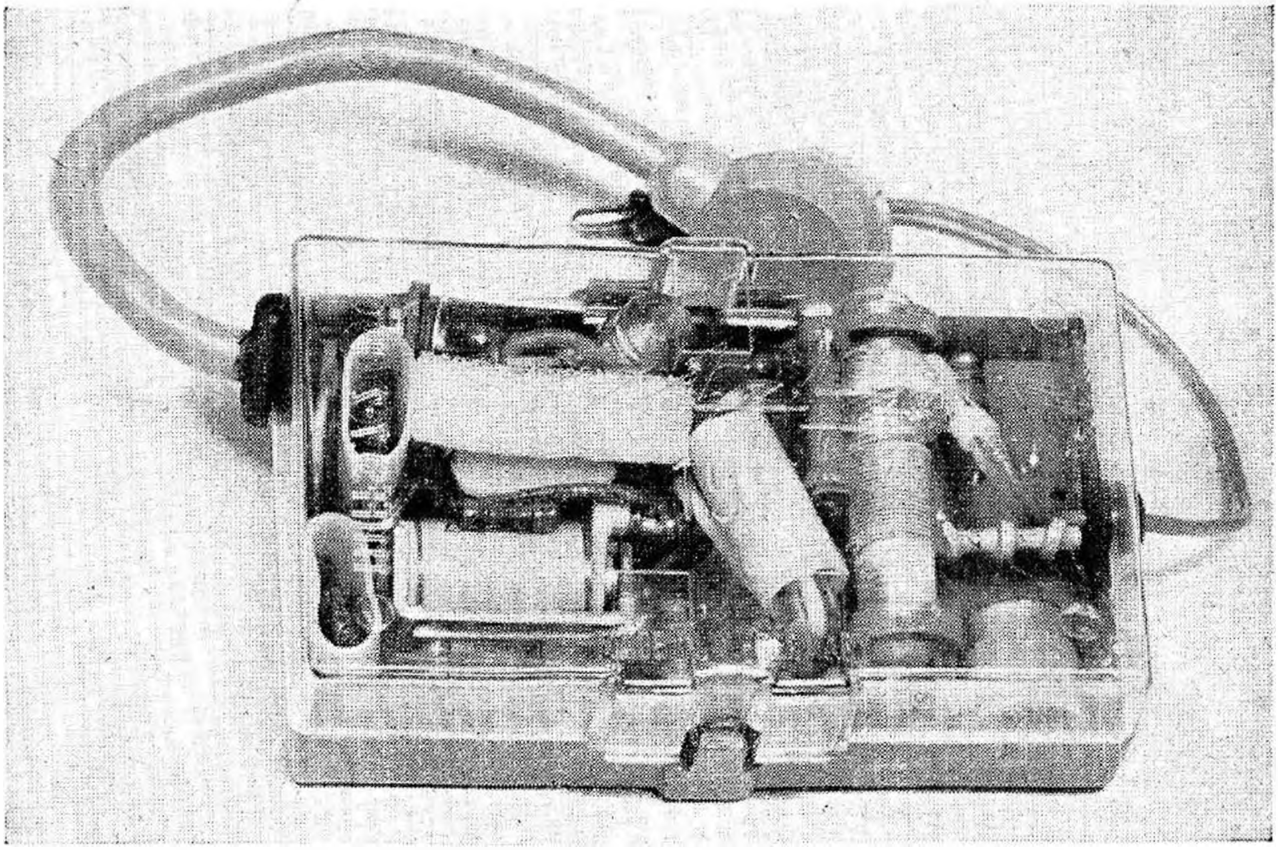


Fig 5

Earlier articles in this series appeared in our issues of July and August, copies of which may still be obtained, price 2/4d. including postage, from our Editorial Offices, 38 Clarendon Road, Watford, Herts.



Truly a "baby" this shot shows the receiver larger than life! It is actually 2½ x 1½ x ¾ in., and merits the old saying "little but good".

R.C.M. & E. TEST REPORT No. 4

Metz Mecatron "Baby" Receiver (Type 191)

Equipment reviewed is considered under aspects of electrical testing carried out by F. C. Judd, A.Inst.E., and from the model operator's point of view by T. H. Ives. This splitting of reports will, we believe, enable us to provide readers with the best possible appraisal of new products.

Of German manufacture the Metz Mecatron 191 (Baby Empfanger) employs two transistors (OC170 Detector and OC74 L.F. Amplifier) in a completely printed circuit arrangement mounted in a tiny plastic container.

There is no doubt about the German thoroughness that has gone into the design and manufacture of this receiver for it is well constructed and robust and weighs only 55 grams (approximately 2 oz.). It is supplied complete with trimming tool and spare wire, and a 'piano-wire' aerial which has a mounting platform and lead. All connections to the receiver are made via a 7 pin plug. (Standard B7G).

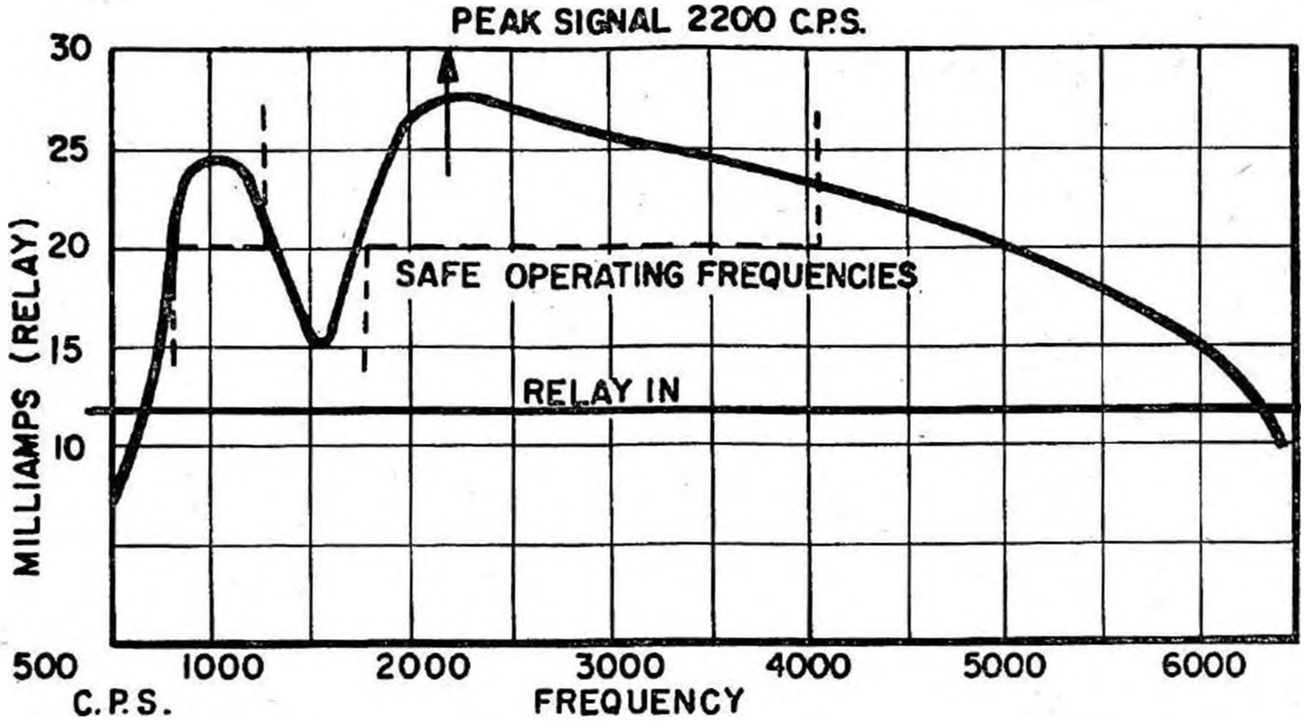
Power requirements are 6 volts only but in view of the large current consumption during a signal transmission, a fairly large capacity battery seems advisable. The makers' specification provided the following information:—

Frequency (R.F.):—27.12 Mc/s. (tunable).
Modulated signal:—for normal operation: 600 to 3,500 c.p.s.
Idling current:—5 m.A.
Relay (IN):—25 m.A. (Min. 12 m.A.).
Temperature range:—5°C. to 60°C. (this is quoted because of the transistors).

Other than the above information and a connecting diagram for the seven pin plug no other operating instructions were supplied with the receiver. I would strongly recommend that the distributors include some notes on tuning and the (low frequency) modulated signal required to operate the receiver satisfactorily.

Construction

The receiver components and relay are all mounted on a single printed circuit paxolin chassis. The tuning coil is provided with a slug for critical carrier



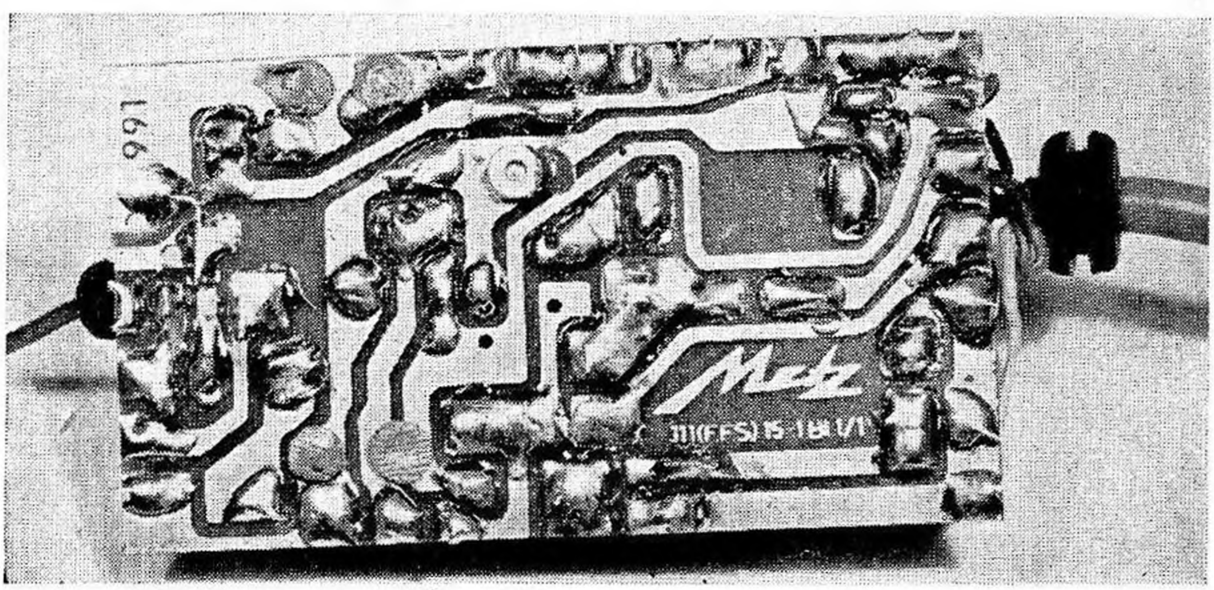
tuning and each transistor is flexibly mounted, at least enough to withstand shock. The relay, which has a D.C. resistance of approximately 100 ohms, has no provision for adjustment, but uses silver wire contacts enclosed in a plastic shield. These contacts provide a single pole changeover circuit which is brought out to the seven pin plug. Removal of the receiver from its case can be effected in a matter of seconds, as the plastic container is in two parts which are self locking when closed together. The receiver is therefore, well protected from dust and fuel, and against shock.

Functional Tests

As per the usual arrangement, practical tests are being applied separately and the reviewer concerned with this will comment accordingly. Electrical testing showed that the tuning and the stability of the 27 Mc/s tuned circuit during reception is acceptable and has sufficient tolerance to operate with almost any self-excited *tone modulated* transmitter (see below).

The idling current is approximately 5 m.A. with a 6 v. battery but increases to 8 to 10 m.A. (depending on range and power of the transmitter) with transmitter carrier on only. This is not sufficient to operate the relay under normal working conditions, but in very close proximity with the transmitter the current may rise to over 20 m.A., so allowing the relay to close.

With tone modulation (100%) to the transmitter, the current rises to between 15 and 28 m.A. *depending on the frequency of the modulation*. As the curve



Upper left: Modulation frequency response of the Metz Mecatron 191 which should assist potential users in gauging usefulness of their present Tx. It is, of course, ideal when used with the matching Metz transmitter.

Lower left: Baby out of box! Well etched printed circuit makes small size possible. Note also grommets to protect leads against box edges.

which has been included shows, the maximum obtainable current rise is nearly 28 m.A. at 2,200 c.p.s. falling steadily to 15 m.A. at 6,000 c.p.s Note the dip at 1,500 c.p.s. where the current rises to 15 m.A. only. The relay closes at about 12 m.A. For best results it would be advisable to use a modulating frequency of 2,000 to 2,500 c.p.s.

Note: These tests were carried out using pure sine wave modulation. With square wave modulation a slight increase in current rise was obtainable at all frequencies but amounted to little more than a milli-amp or so.

The receiver remains stable for long periods with or without incoming signals. In all respects operation according to the makers' specification is satisfactory. If maximum range and the function of the receiver under working conditions in the model are also satisfactory, then the receiver can be recommended; potential purchasers should, however, keep in mind the unusually high modulation frequency required to operate the receiver at maximum efficiency.

The Mecatron 191 retails at £10.0.0 and was submitted for test by Leigh Model Centre, 97 Railway Road, Leigh, Lancs.

Modeller's Viewpoint

The receiver comes in a most attractive box and on opening the owner will not be disappointed with the contents. It is an extremely well made unit using subminiature components arranged neatly and connected to a printed circuit board. The flexible leads are well protected and are nicely anchored to a beautiful little 7BG miniature plug.

The case is a plastic box measuring 2½ in. x 1½ in. x ¾ in. and has a weight of 2 oz. It is obviously ideal for the lightweight model boat or aircraft. It operates on 6 v. the minimum on which an OC 170 will function satisfactorily.

Relay resistance is approximately 100 ohms and the contacts make at approximately 12 m.A. The maximum change obtainable is 25 m.A. so that it is important to tune the receiver accurately to the transmitter in order to avoid losing contact at range.

Whilst tuning is relatively sharp there is only one control and no difficulty should be experienced.

Range was checked with a standard hand-held transmitter (input approx. 1 watt) with a standard 4 ft. aerial.

Whilst the Metz Tx. was not used, range was found to be adequate with our tone Tx.

JAY'S PULSER

(continued from page 251)

with reeds is not too well-known, nothing will be said about it here . . . if experimentation with this is commenced by one of the readers of this article, I wish he would communicate his findings to me. The pulser is adequately stable to operate any Rx. of the non-selective audio tone type, or any Rx. of the type that I use with the inductance-capacity audio filter. Under such conditions, it will probably never have to be retuned after having been properly set.

Experimentation is not ended on this type of unit; even though the current drain of the pulser is only 5 milliamps at the battery voltage of 9 volts, attempts are being made to reduce this, and a tiny transistor transmitter, operaing from the same battery is in the breadboard stage. This is truly a watchmaker's delight, much smaller than the pulser, and capable of being put in the pocket. It is not recommended that gear this small be attempted, if for no other reason than that some bystander may suddenly have the urge to put YOUR transmitter and pulser in HIS pocket.

I will welcome and answer any correspondence or problems sent to me through the magazine, so go to it, and here's wishing you lots of good flights and success with GG.

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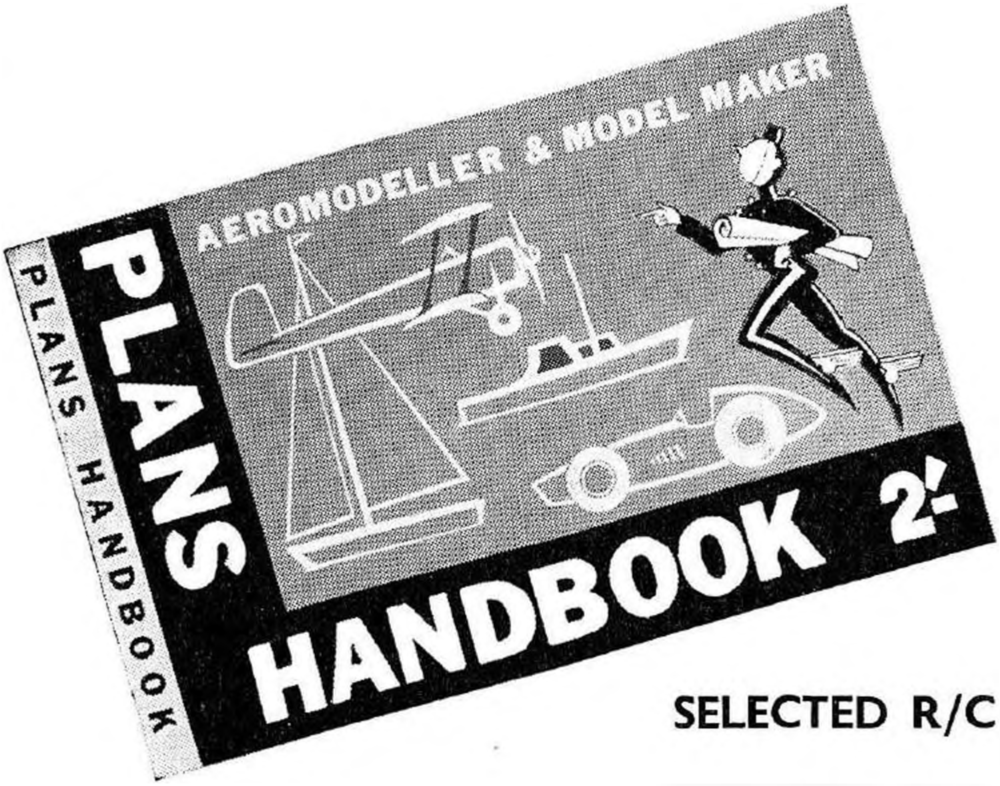

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