Radio Control Models & ELECTRONICS

MAY 1960

Free inside

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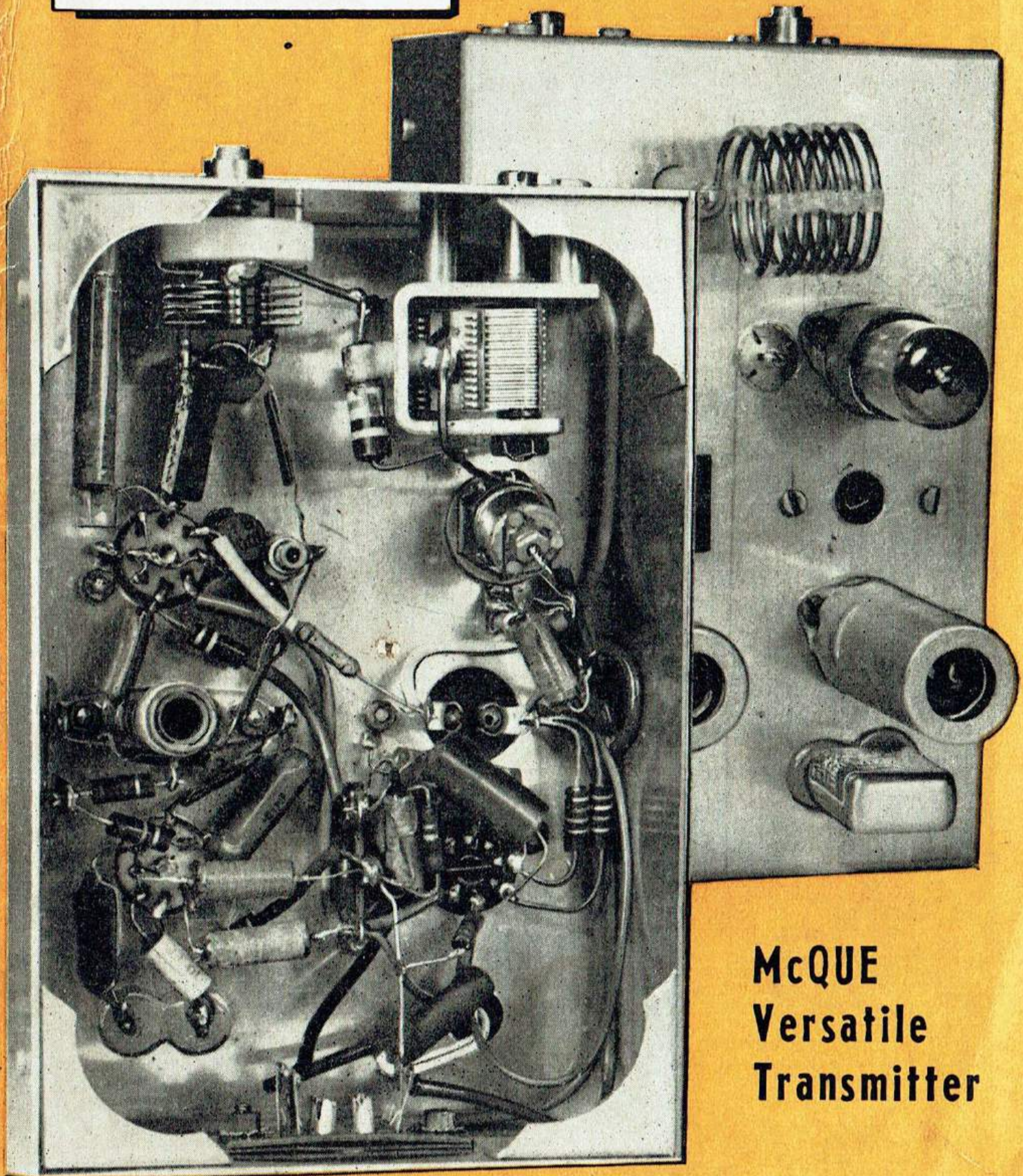
PRICE TWO SHILLINGS



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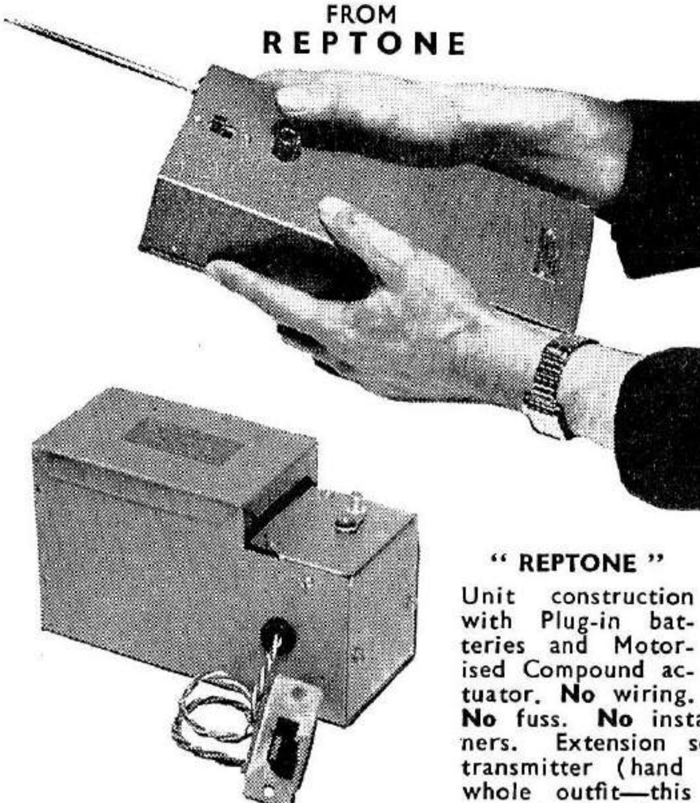
FROM **REPTONE** TO **OCTONE**



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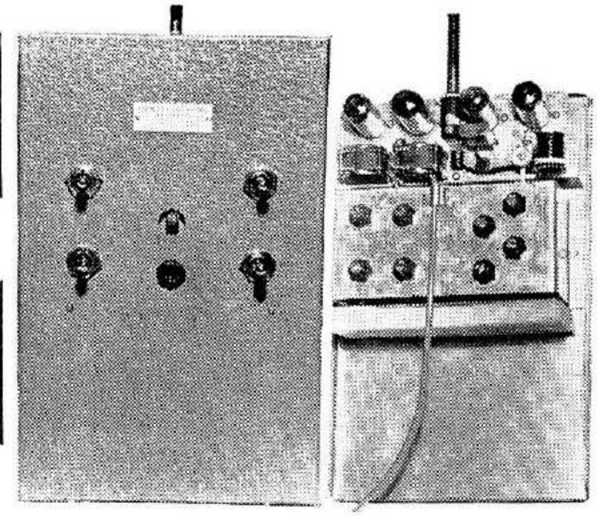
Unit construction with Plug-in batteries and Motorised Compound actuator. **No** wiring. **No** fuss. **No** installation worries. **No** trouble ! Ideal for beginners. Extension socket fitted for further control, complete with transmitter (hand held and neat in size)—at £15 8s. 0d. the whole outfit—this for a tone set ! **Unbeatable** value—nothing more to buy for **perfect** single channel R/C !



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Eight channel simultaneous crystal controlled TX. 10 oz. receiver.

★ **From components to complete kits of parts there is R.E.P. equipment to satisfy novice or champion, for aircraft or boats designed and produced by practical experts.**

COMPLETE EQUIPMENT

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Full 12 months' guarantee

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"SEXTONE" 6-channel reeds. Crystal controlled transmitter with "Joystick". 8-oz. receiver **£31/17/3.**

"OCTONE" 8-channel reeds. Simultaneous operation. Crystal controlled Transmitter and matched 10-oz. receiver **£50.**

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R.E.P. ½ oz. Relay	**24/-**
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"UNIAC" motorised **44/-.** "MINI UNIAC" motorised **52/-.** "OMNIAC" motorised for single or multi **60/-.**

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"AEROTONE" Receiver. Single or multi-channel "tone" **83/-.** "AEROMODELLER" Receiver. Single channel "carrier" **64/-.** "PRINTED CIRCUIT" Carrier transmitter pre-tuned **20/6.** "MODULATOR" tone generator **38/8.** "P.C." and "Modulator" combined are suitable for the "Aerotone". All kits are pre-assembled and contain all finished components.

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★ "Tone stability" achieved by use of tuned high Q chokes in all transmitters.

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★ "Temperature" stability ensured by choice of high stability components.

★ "Sextone and Octone" fitted with original "neon flasher" battery voltage indicator.

★ "Pretuned", no adjustments or tuning required.

★ **EXTENDED PAYMENTS** available on equipment from £15 ★ You can order R.E.P. equipment from your local model shop ★ S.A.E. for Price Lists and information. Trade enquiries invited.

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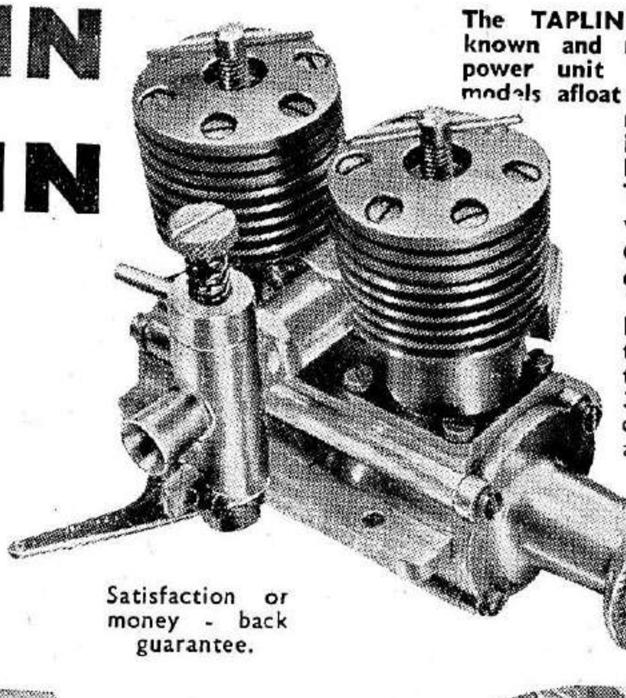
THE MOTOR FOR ALL R/C JOBS!

The **TAPLIN TWIN** is the best known and most widely esteemed power unit for all radio control models afloat and in the air. Your model experience is incomplete until you have tried Taplin Twinning!



VITAL STATISTICS

Capacity: 7 c.c. (6.92 c.c. actual). Weight: 15 oz. Engine bearers: Fixing holes 1½ in. centres laterally and longitudinally. Max. height 3½ in. Max. width (excluding throttle toggle arm) 2⅜ in.

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Easy to start, with speed range of 500/7000 r.p.m. Infinite adjustment of barrel-type carburettor. Quiet and clean running, in either direction. Simple to adjust, rigidly mounted, vibrationless in action. Runs on simple diesel fuel formula. Price **£8.12.0d.** (Inc. P.T. post. and pkg.)

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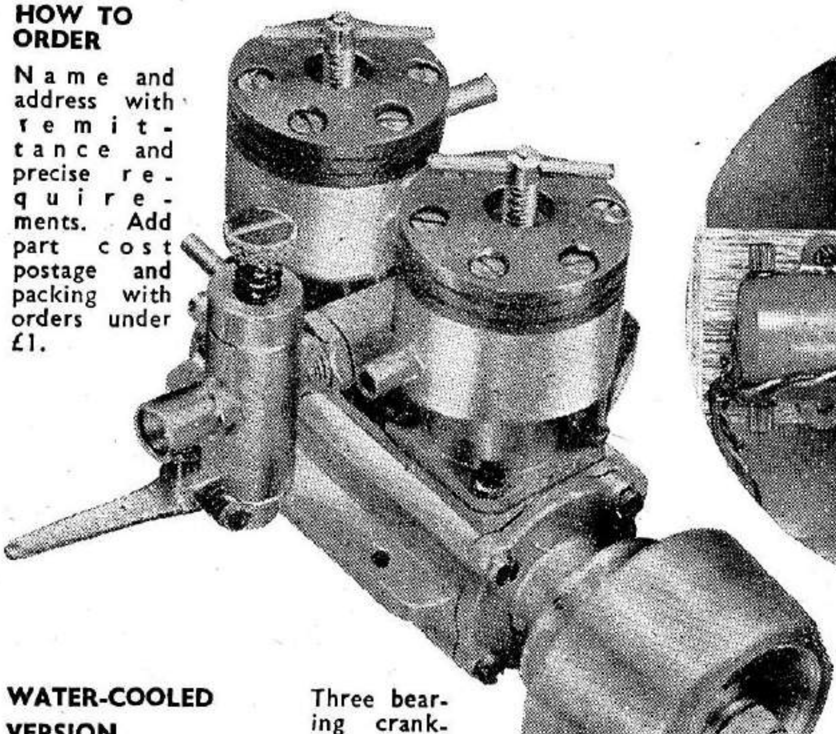

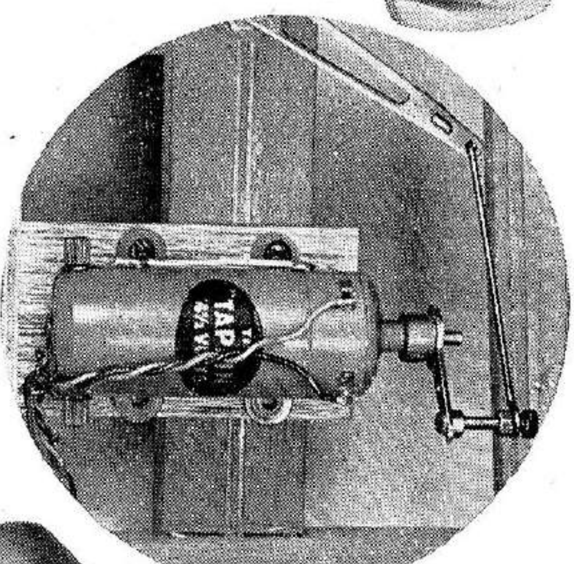

SINGLE CHANNEL ACTUATOR

Specially designed for single channel operation. Optional right or left turns and self-neutralising without mark-space complications. Connected direct to relay in circuit with 4½ v. battery one key gives one turn; two the other; no signal neutral. Movements at 90° and 270°. Powered by Taplin Micro-geared motor Suitable for boat rudder or engine control, etc. Price : **54/-** inc. P.T.

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Same characteristics as air-cooled version, and the favourite of knowledgeable model boaters. Supplied complete with flywheel and ball and socket coupling. Price £9.16.0, inclusive of postage and packing. (In response to requests the T.T. is also available to order with double - ended crankshaft and forward flywheel at an additional cost of £1.12.0.)

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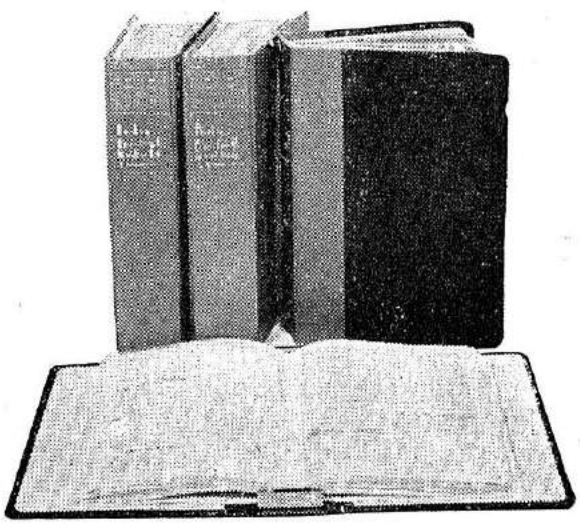

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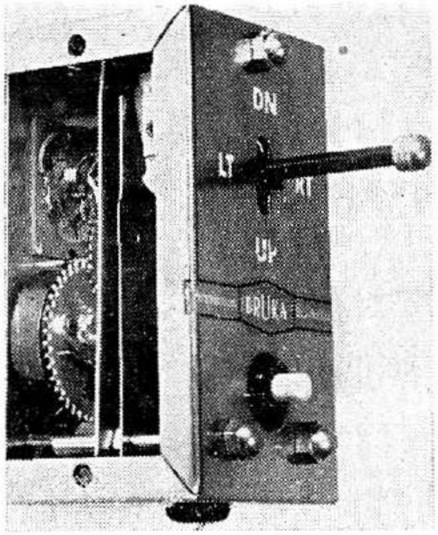

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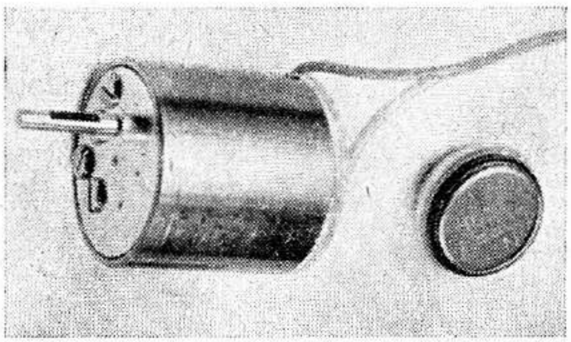

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"CONTROL YOUR COMPOUND WITH PILOT CONTROL" **£4.2.6**

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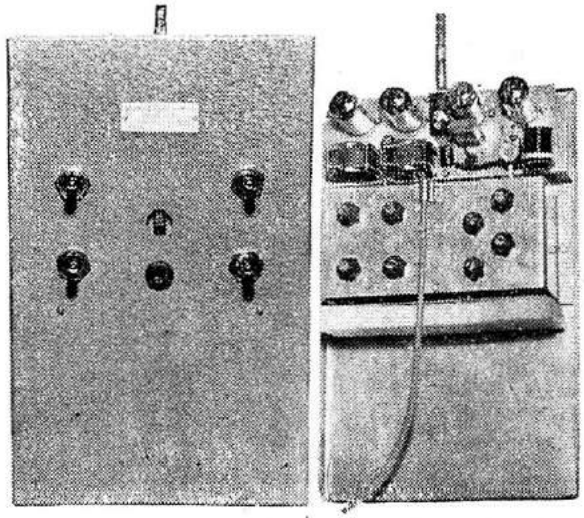
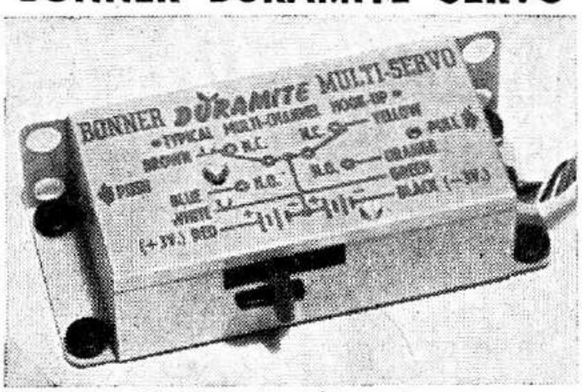


BONNER DURAMITE SERVO



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Self-neutralising.
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$1\frac{1}{2}'' \times 1\frac{1}{32}'' \times 1\frac{25}{64}''$

Two-channel or single channel pulse.
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OMNIAC motorised actuator, with 5 interchangeable commutators to give various types of single or multi-operation, 3 oz. **60/-**
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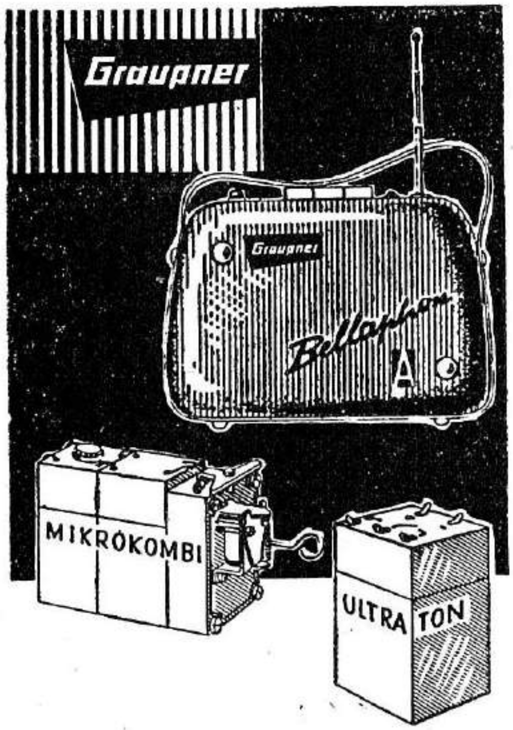

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12-24 Magnetic type rotating cams, operating 5 sets of contacts in sequence. Used in radio controlled boats will give 3 rudder and 2 motor positions. Price 10/6d., postage 1/9d.

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(Crystal controlled transmitter)

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Only 3½ oz. with battery.

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RADIO CONTROL MODELS & ELECTRONICS
(PLANS DEPARTMENT)

38 CLARENDON ROAD : WATFORD : HERTS

Radio Control Models & Electronics

VOLUME 1 NUMBER 1 MAY 1960

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Here, There & Everywhere

We Make Our Bow

THERE is something particularly exciting about starting a new venture, and we have revelled in the extensive preparatory work that brought RADIO CONTROL MODELS & ELECTRONICS through the various stages from pipe dream to reality. Those eight thousand enthusiasts who returned the questionnaires circulated by our associate magazines *Aeromodeller* and *Model Maker* played a great part in convincing us all that we had a real and urgent need to fill. We only hope that our offerings from month to month will meet it. Your tolerance and patience is still solicited together with your friendly criticisms, contributions and much spreading of the word.

You will probably be interested in the exact editorial structure that is producing the magazine. First of all, we have Tommy Ives, who will always enjoy a niche in R/C history for his Ivy receiver, to mention but one of his many contributions to our hobby, in the chair as Consulting Editor. To assist him Ron Moulton, Editor of *Aeromodeller* and Vic Smeed, Editor of *Model Maker* will sit on the Editorial Consulting Board, and look after the respective interests of models aloft and afloat. Presentation in general will be the task of Editorial Director Dickie Dickson. As special problems and needs arise experts on subjects under discussion will be brought in to deal with them 'ad hoc'. In this way we hope to be able to give all phases of this rapidly growing hobby a fair share of attention, without the risk of any hobby horse being ridden too hard.

We have chosen our new size of $8\frac{1}{2}$ in. $\times$ $5\frac{1}{2}$ in. with due thought. It is a departure from our traditional magazine size, but then so is the subject matter. It seemed to us that this format was ideal to display our material to advantage and provided a pleasant sized magazine to go on the shelf for reference. Not least in importance was the thought that most other magazines in similar fields were published in this size or thereabouts. Needless to say,

CONTENTS

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

Easibind covers are available for convenient storage.

Finally, may we extend a hearty invitation to all clubs with radio control interests to let us have information on their activities, advance notice in good time (six weeks ahead if possible) of functions where public support is invited, with particulars of meeting, venue, models eligible and the like. Good pictures will also be welcome, informed articles, and queries of a nature that can be usefully answered in our columns.

Leading them a Dance

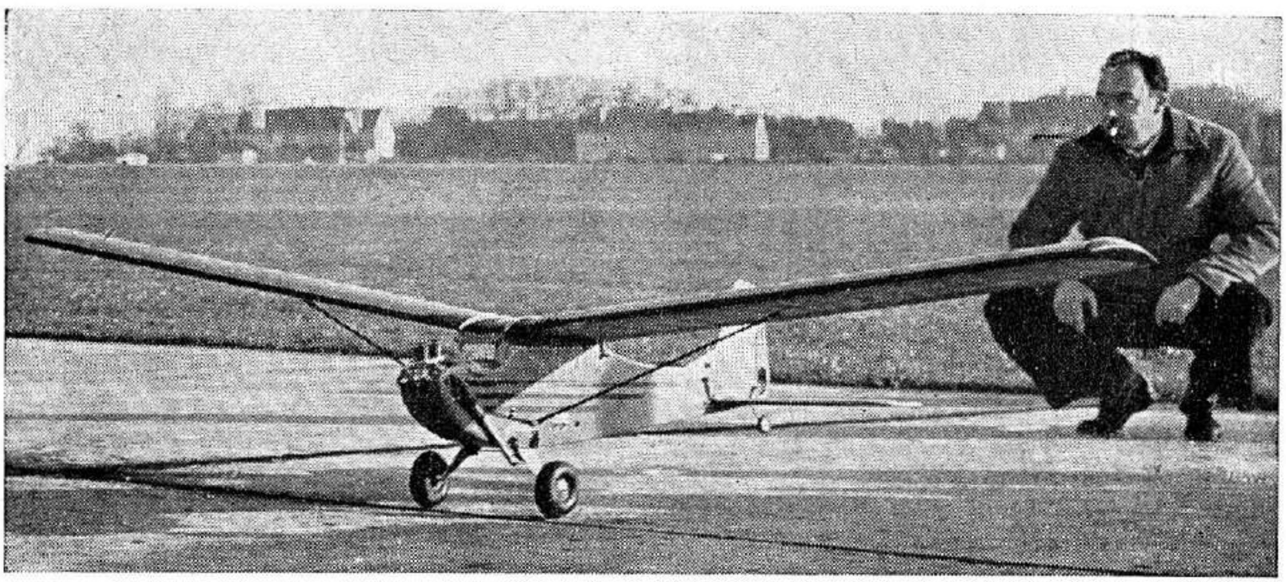
Radio control attempts on a world record to win the £75 Taplin Award are assuming the complexion of a Butlin Carnival with some score of would-be champions arming for the fray. First off the mark was C. D. Adcock of Nottingham, who has put in a closed circuit claim (Record No. 31) for his 13.469km. flight on February 13th. Since records lie on the table between meetings of the appropriate F.A.I. Committee to ratify them there is always the chance of a better effort turning up between times, so that putative records can be beaten before ever they can be promulgated—and promulgation is the essence of the Taplin Prize.

One month later on March 13th Charlie Dance and his backroom boffin Wally Skeels persuaded the B.B.C. Television unit to be present shortly after dawn at Lympne Aerodrome to film his attempt on the U.S.A. held record of Dick Everitt's standing at nearly 2½ hours and a distance of 37 miles. Take-off drill was anything but smooth and Charlie managed to break the beautifully prepared propeller to which the Taplin Twin engine had been tuned. Replacement was rather different and model was released with engine over-compressed and running lean. In spite of this obvious handicap it flew off manfully pursued by the Dance-Skeels team in a Morgan Plus Four which at times had to exceed 60 m.p.h. to keep in touch. Some 23½ miles and 55 minutes later the much abused engine faded to bring the model down two miles on the coast side of Maidstone. Subsequent inspection of tank showed that over 50 per cent of the 30 oz. load of fuel remained, so that with more meticulous tuning and the right prop at least twice the distance could be covered. It was a gallant effort and a splendid trial run for a more serious attempt. Whether others will be joining the Dance remains to be seen. Wally Skeels has developed a clever control system for multi-control on single channel equipment which we hope to be able to describe for readers shortly.

Watch Out — Multi

Pulse proportioners who are currently absorbed in the delightful possibilities of "Galloping Ghost", or should we call it *Simpl-Simul* rudder / elevator systems will be thrilled to know that the outside loop and inverted flight, so long the bogey stunts, are now firmly established in the repertoire of doyen Charles Riall, and Peter Lovegrove. It was Peter's demonstration of these manoeuvres at the February A.R.C.C.

Charlie Dance poses besides his Taplin Twin powered plane on an earlier trial jaunt from Manston Aerodrome. Span is 8 ft. 6 in., unladen weight 9 lb. 5 oz. Fuel capacity 25 oz. Endurance 2½ hours.



Hey—YOU up there ! How's about five flick rolls and an Immelman — Chris Olsen tweeks the Octone switches for simultaneous control operation during February's snowy weather.

meeting that clinched the situation. Charles Riall spied the ways and means, and now they're both at it, figure eights and all! The secret? None at all, they have simply dropped the universal Mighty Midget in favour of the higher torque from the Ever Ready T.G.18. Of course, there is a little more to it than that; but we hope to get the lads to tell all in a future issue of RADIO CONTROL MODELS & ELECTRONICS. One thing we will say, an O.S. Max 35 on 48 in. (Lovegrove) and Fox 35 in a Rattler (Riall) certainly churn up the air and will make the reed men look to their laurels.

Full Marks for Merco

As we go to press, 'glowing' reports of the Merco 35 come from that tough spot in the world's model mart, Australia. Frankly they like it, and so do we. Congratulations are due to Ron Checksfield and Bill Morley for matching the best from anywhere and in producing Britain's first infinitely variable speed glow-plug 35. Our bet is that there will be a lot of Merco Hogs airborne in the coming season.

Encapsulated Hill

Use of resin encapsulating from the latest sets from Germany reminds us that this idea is many moons old in Watford. When one of the stalwart (*every* Sunday) fliers did eventually have to remove the wing on his Keil-Kraft Junior 60 to check a battery connection two summers back, we spotted a glutinous blob wrapped in plastic foam. Our query was met with the explanation that it was a Hill Mk. 1 Rx., liberally encased in candle grease to keep every part in place and seal the trimmer. Never did see the set fail, or need a tune so there must be a moral in it somewhere.

What's Wanted ?

Brand new at the Nuremburg trade show was Graupner's 3-Channel Bellaphon outfit and an A/2 glider to take the escapement rudder/servo elevator set up, also his Piper Tri-Pacer with servo rudder and escapement engine controls. Is this the next stage for those who want to get into multi without taking the big step to 6 or 8 channel? As arranged in the Piper, the 3-channel set qualifies for Rudder only (plus engine control) in British or American events and has the great advantage of selective control without fear of losing count of the blips on an escapement set-up. Or is it worthwhile to spend a few pounds extra for 4 channels so that two servos can be used for rudder/engine ? For the man who wants to leave single channel without leaving his competition class, three reeds seem the logical economic choice for aircraft—what say the readers ?

Umbrellas will be worn !

News letters from Los Angeles Radio Kontrollers (*Lark*) and East Bay Radio Controllers (*Carrier*) both touch happily on the same theme—objects dropped from the air by models. *Carrier* reports exploits of Darryl Usher with a modified *Smog Hog* which was a circus in itself. No less than ten bombs and/or gliders would be released at will and in addition the model fired a 'machine gun' and indulged in crop-dusting. Dusting was accomplished by dropping flour out of a hopper in the cabin.

In announcing their monthly club contest as a Spot Landing and Bomb Drop event *Lark* give details of a simple bomb, which as they say, is likely to be fun since so many bombs fail to hit the intended target. Fold a large Kleenex in half, pile some cheap flour in the middle, bring up the corners, wrap round with fine copper wire and finish with a loop for the release mechanism. Suggested releases include for single channel models, a SN operated on the third position of the escapement, and for multi-channel, a line pulled when full up is applied. Other methods will no doubt suggest themselves.

In their Easter Bonners !

Our South African correspondent Al Payne of Pretoria reports peak activity in those parts in preparation for their Nationals to be held at Bloemfontein over the Easter long weekend. Nearly a dozen multi-channel entries expected mainly based on the Bonner *Smog Hog* or *Astro Hog*. Al himself has deserted the *Hog* family for an own design shoulder wing using the same N.A.C.A. 2415 section. He is also at work on a one-sixth scale semiscale Spitfire with retractable u/c for demonstrations, plus a spare wing and fixed u/c for contest work. Dimensions are span 80 ins., chord 18 ins., N.A.C.A. 2415 section, length 60 ins., engine ENYA 60. Elliptical wing is 10 per cent increased on scale in span and 2½ per cent in chord. Tailplane also 10 per cent up all round. Flight should be exciting.

Amateur Radio Control Club

A.R.C.C. at their Annual General Meeting in January, with George Honnest-Redlich in the chair, found occupation for newly joined Tommy Ives by electing him Hon. Secretary and News Letter Editor. Flying fields are available to members at Odiham and Oakington, near Cambridge, and monthly club contests are being arranged with general flying on remaining weekends. Question of flying by visitors was raised and it was agreed that those wishing to make use of the club flying facilities should be requested to join the club as Associate Members.

Radio Yachts

It is hoped that this year will see a definite decision by the Model Yachting Association on a smaller R/C yacht class—a decision impatiently awaited by a considerable number of modellers who have responded to the challenge of sailing a motorless model but are at the moment reluctant to commit themselves to a new boat in case their choice falls outside any officially adopted Rule. At present only one class is recognised, the "Q" or ex-"A", with an average length of some seven feet and a weight of about 56 lbs. Early prejudice against radio in some of the yacht clubs is giving way to growing interest, and some have gone as far as to alter their constitutions in order to be able to include R/C models. One such (incidentally the nearest to London) is the Y.M.6m.O.A., traditionally an A-class only club, who sail at the Rick Pond, Hampton Court, and who will welcome any enthusiasts; a special R/C yacht day will be held on May 15th.

Radio Boats at Ulm

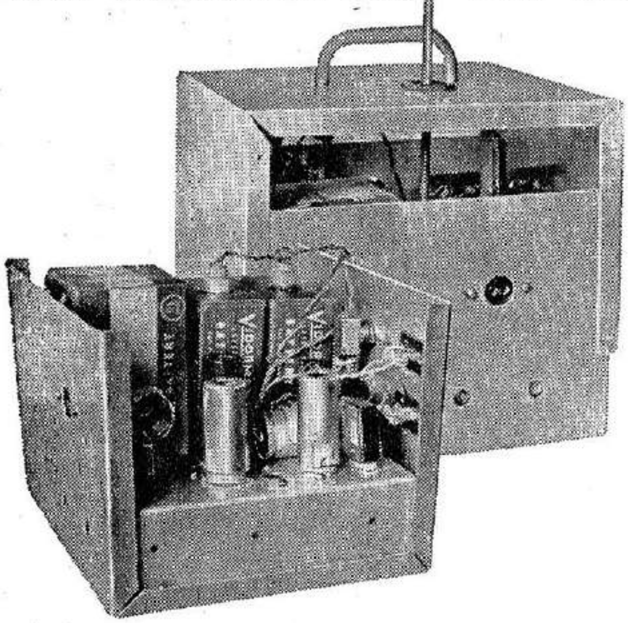
Those planning a Continental holiday may like to know that one of the bigger German regattas, the Nauticus meeting at Ulm, S. Germany, is scheduled for July 16th/17th. Radio events include steering and speed, plus balloon bursting, and electric or i/c models are eligible. Meeting is in lovely surroundings among friendly people—recommended.

Manufacturers Learning ?

It seems we may expect some makers of commercial radio gear to get away from 3-channel equipment in favour of 4-channel. This is common sense, for it is simple to omit a fourth relay, etc., but adding an extra control to a 3-channel is difficult. Since most boat modellers want two channels for rudder and two for engine, the demand for 4-channel gear will rise with the interest in boating, already acknowledged the fastest-growing side of the hobby.

Well ? Chris isn't the only one says engine maker Den Allen also using Octone at the same Winter meeting, and showing us that he has not lost his old love of aerobatics.

THE TRANSMITTER ON THE COVER . . . .

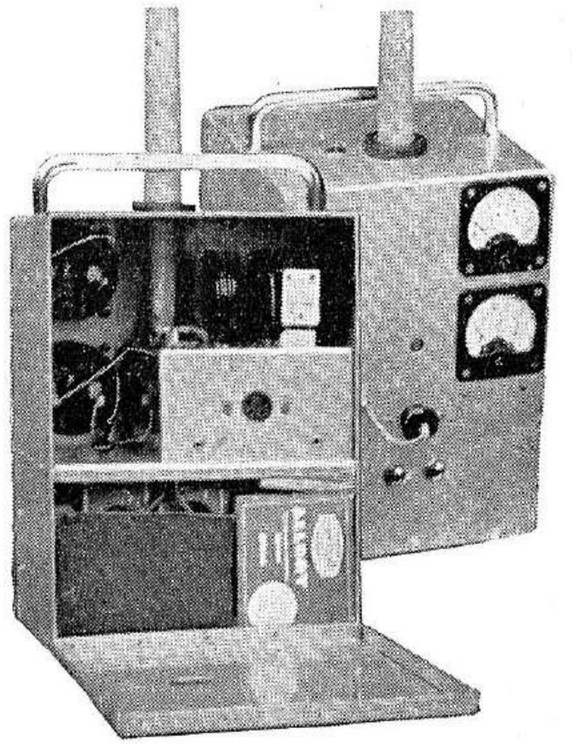


Above : The author's own TX, using the horizontal arrangement shown in lower sketch. On the right : S/Ldr. Bill Verney's version, which favours the vertical layout and is embellished with a couple of meters.

For the first time ever a TX that is tone or CW single, multi or pulsing plus emergency power boost.

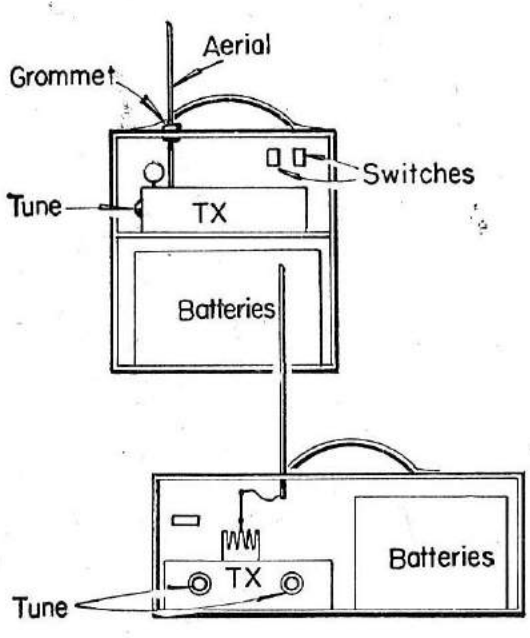
McQUE VERSATILE

By DAVE McQUE



THE advantages of a Xtal controlled TX are:—

1. The order of frequency stability is such that no difficulty is experienced in meeting licensing requirements.
2. No wavemeter is necessary for checking frequency and for setting up. It might be mentioned that the order of resolution and accuracy achieved by a simple absorption wavemeter is barely adequate to meet licensing requirements and anyway, a Xtal controlled frequency source is necessary for accurate calibration of such a wavemeter.



3. Due to the much better frequency stability greater effective range is obtained and receiver (RX) retuning is rarely necessary as the transmitter (TX) frequency is not affected by changes in loading due to site, weather, aerial length and H.T. variation. Also where a two stage (Xtal osc. and power amplifier) TX is used the output tuning and coupling have no effect on the frequency and can be readily adjusted to get maximum output on different sites.
4. Where highly selective RX's (superhets) are used, a Xtal controlled TX (and RX) are essential. The present TX was designed as a basic standard for the Bletchley Club, for use with both superhet and superegen RX's.

The requirements were firstly that it had to be reasonably easy to construct and set up with the minimum of field adjustments. Secondly to be capable of use as plain carrier TX and of modulation by plug in units for reed tones, mark/space, etc. Whilst a single valve Xtal TX could be used, something of greater output and flexible enough to cope with a wide variety of modulation systems was required.

The TX has two stages. V1, a 3V4, is the Xtal osc./multiplier; its anode circuit is tuned to the Xtal harmonic in the 27 Mc/s band. Xtals of from 8,990-9,090 or 13,480-13,640 Kc/s can be used without modifications and are interchangeable.

Although the TX will still work with 6,740 to 6,820 Xtals the output is much reduced and they are not recommended.

If you are buying a Xtal for this TX my advice is to choose one in the range 13,480 to 13,640 Kc/S preferably to suit one of the channels of the I.R.C.M.S. Band Plan.

V2 is the power amplifier which is normally grid modulated via V3 from external generators (Anode modulation via SK2 is also possible).

A 3A4 valve was originally used as power amplifier with 120V. H.T. and could still be used, if appropriate pin connections are made and, only if 120V. H.T. desired, a 3.9K resistor is inserted in the common H.T. feed to R2 and R3, and 6V. 0.15A lamp is used as dummy load. However, recent models have a 3V4 valve, as shown, which is more economical on L.T. current, but is restricted to a maximum H.T. of 90V. This is no disadvantage as even the 45V. H.T. provided in the low (¼) power position of S2 has proved adequate for controlling my 8 ft. span glider to the limit of visual control.

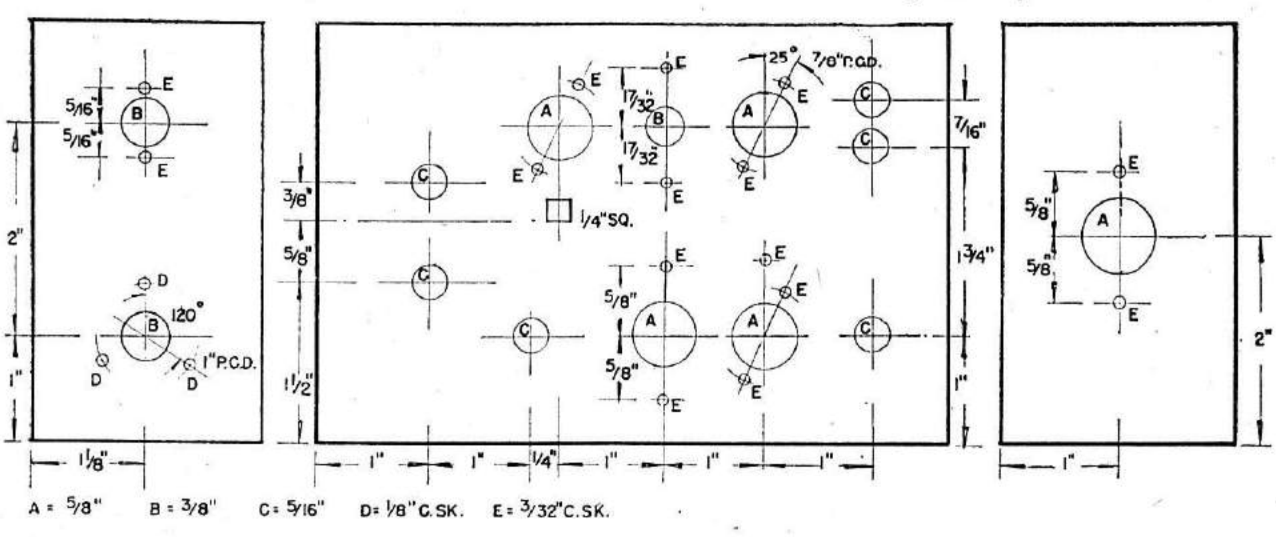
This power amplifier is neutralised by a network consisting of C7, C8 and C9, which, as C7 is connected to one end of L3 and the grid of V2 to the other, cancels the feedback caused by the anode to grid capacitance of the valve. Strictly speaking this refinement is not essential with the 3V4 but is advisable if a 3A4 is fitted.

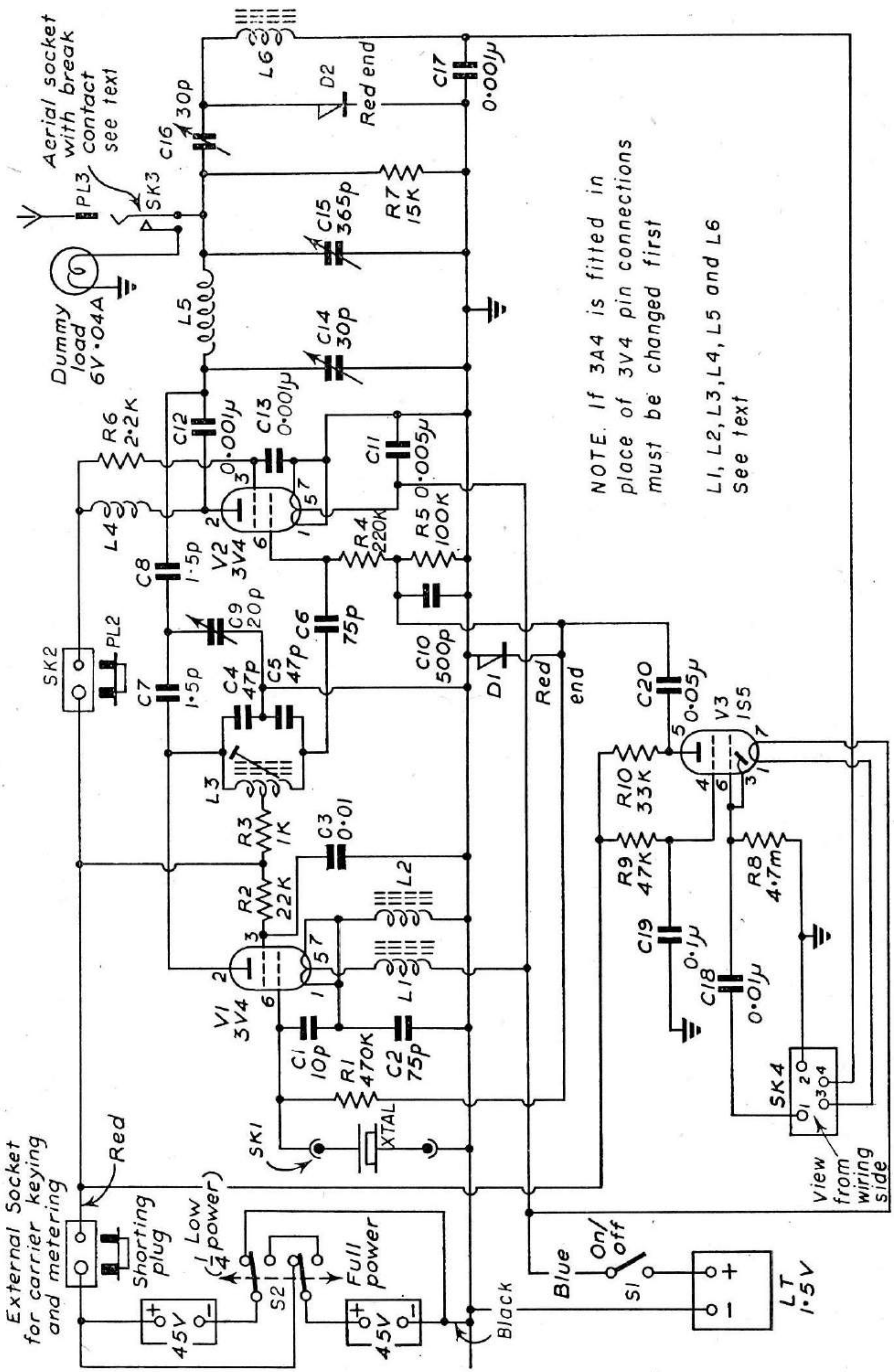
This particular arrangement of three capacitors is used in preference to a single variable capacitor because it is easier to adjust. The output from the P.A. is coupled to the aerial which should be 7 ft.—9 ft. 6 in. long by a π coupler which again is easier to adjust than the more usual coupling coil and attenuates harmonics of the TX frequency which could cause T.V.I. (television interference). Roughly speaking varying the larger capacitor (C15) varies the coupling whilst the other C14 tunes the whole circuit. In practice the two are adjusted progressively for maximum output starting with C15 at max. (*reducing* C15 increases the coupling) and always finishing with C14.

V3 is the modulator valve which is used to amplify the low level output from the external, hand held, transistor tone oscillators. It is automatically switched off, for plain carrier operation, when there is no plug in SK4. Use a screened cable from the external modulators.

A sample of the output applied to the aerial (or dummy lamp load if the aerial is removed) is rectified by the diode D2 filtered by L6 and C17 and fed to pin 4 of SK4. Phones or a meter can be connected for output monitoring purposes. Meters of 0.5mA, 1mA or 5mA can be used, C16 being adjusted for about half scale deflection on full

Chassis dimensions and drilling layout. A ready drilled chassis is obtainable (see parts list).





Aerial socket with break contact see text
PL3
SK3
Dummy load 6V ·04A
C16 30p
D2
Red end
L6
C17 0·001μ
C15 365p
R7 15K
L5
C14 30p
R6 2·2K
C12 0·001μ
C13 0·001μ
C11 0·005μ
R5 100K
R4 220K
L4
V2 3V4
C8 1·5p
C9 20p
C6 75p
C10 500p
D1
Red end
SK2
PL2
C7 1·5p
C4 47p
C5 47p
L3
R3 1K
C3 0·01
R2 22K
L2
L1
V1 3V4
C1 10p
R1 470K
C2 75p
SK1
XTAL
C20 0·05μ
V3 1S5
R10 33K
R9 47K
R8 4·7m
C19 0·1μ
C18 0·01μ
SK4
View from wiring side
NOTE. If 3A4 is fitted in place of 3V4 pin connections must be changed first
L1, L2, L3, L4, L5 and L6 See text
External Socket for carrier keying and metering
Red
Shorting plug
Low (¼ power)
Full power
S2
45V
45V
Black
Blue
On/off
S1
LT 1·5V

power output. The meter is used as a convenient means of adjusting C15 and C14 for max. output on different sites and is better than a meter in the H.T. line for this purpose.

Only two switches are required and these are mounted on the case external to the TX chassis. The single pole (S1) is L.T. on/off, and the double pole (S2) connects the two 45V. B104's in series for 90V. H.T. (Full Power) and in parallel for 45V. H.T. (Low or ¼ Full Power). Besides the economy in H.T. consumption afforded by the low power position of S2, it is very comforting to have 'something in hand'.

PARTS LIST

McQUE VERSATILE. PARTS LIST

CAPACITORS

C1 10pF ceramic or silvered mica.
C2 75pF silvered mica.
C3 0.01μF Hi K ceramic tubular.
C4 47pF (or 50pF) silvered mica.
C5 47pF (or 50pF) silvered mica.
C6 75pF silvered mica.
C7 1.5pF silvered mica.
C8 1.5pF silvered mica.
C9 20pF Tube Trimmer (silvered ceramic).
C10 470 or 500pF ceramic or mica.
C11 0.005μF Hi K ceramic disc.
C12 0.001 mica or 0.002μF mica (**Not** Hi K ceramic).
C13 0.001 Hi K ceramic disc.
C14 30pF Airspaced variable (see photo).
C15 365pF Airspaced variable Jackson Single 'O' Gang.
C16 30pF Beehive Trimmer, Phillips.
C17 0.001μF Hi K ceramic disc or tubular.
C18 0.01μF Hi K ceramic tubular.
C19 0.1μF metallised paper tubular 150v. working.
C20 0.05μF or 0.1μF metallised paper tubular 150v. working.

RESISTORS

R1	470K	All resistors 10% ½ watt.
R2	22K	
R3	1K	
R4	220K	
R5	100K	
R6	2.2K	
R7	15K	
R8	4.7M	
R9	47K	
R10	33K	

Chassis, 6 in. x 4 in. x 2¼ in. (or 2½ in.) with reinforced corners. 18G aluminium. (Radio spares).

A ready drilled and punched version can be obtained from F. Rising, Central Garage, Whissendine, Oakham, Rutland.

Three spacers for mounting C15 ¼ in. or ⅜ in. diameter drilled 4BA clearance 2, ½ in. long exactly and one ½ in. less one thickness of the chassis metal (to allow for thickness of corner stiffening).

Three, B7G valve holders with cans, those for V1 and V2 being P.T.F.E. or ceramic for preference. That for V3 is not so critical and loaded bakelite or nilo K is adequate.

PLUGS AND SOCKETS

SK1, a standard Xtal holder can be fitted, but in the original this was made by moulding Polythene from surplus coaxial, drilling and fitting sockets taken from spare battery sockets.

SK2, Standard 2 pin battery socket.

SK3, Bulgin insulated telephone jack socket with break contact. Modified by moving break contact to position adjacent to chassis and bending in contact remote from chassis to prevent aerial slipping through.

SK4, Standard 4 pin battery socket for modulation input and monitor output. Engaging plug should have input applied to pins 1 and 2. Pins 2 and 3 should be shorted in the plug to switch on V3. Output to phones and/or meter for monitoring from pins 4 and 2.

PL1 Pins on base of Xtal holder.
PL2 Standard 2 pin battery plug—shorted.
PL3 ¼ in. dia. brass rod fitted to lower end of aerial.
PL4 (not shown) one per modulation unit (see (SK4). Standard 4 pin battery socket with cap.

In addition one 2 pin socket is fitted to the case for 'carrier only' keying and H.T. current metering, this is fitted with a shorting plug for modulated use.

The batteries require two 3-pin plugs and one 2-pin plug.

SWITCHES

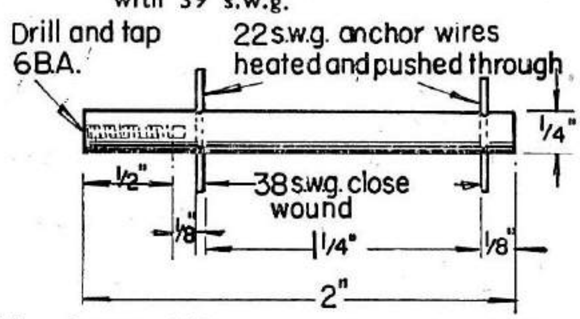
S1 Single pole single throw quick make and break toggle switch (S.P.S.T. Q.M.B.).
S2 Double pole double throw Q.M.B. (D.P.D.T. Q.M.B.).

Two three-way tag strips, centre tag earth on one and end tag earthed on other. Tags can be readily interchanged.

One two-way tag strip with one tag earthed.

INDUCTORS

L1 '2 amp' Neosid wire ended cores, closewound full with 30 s.w.g. enam.
L2 and L6 as L1.
L3 ⅜ in. Aladdin coil form with dust core (preferably polystyrene). 12¾ turns 22 s.w.g. bare, tinned or enam. centre tapped, see text.
L4 Wound on ¼ in. diam. polystyrene rod (supplier Denco) closewound for 1¼ in. with 39 s.w.g.



L5 8 turns 18G enam. or bare, closewind on a valve can as mandrel; coil will spring to an internal diameter of ⅞ in. Stretch to overall length of ⅞ in. Form loops to solder coil to feed through connections made from polythene insulated ex. Govt. coax. with 18G. conductor **or** leave ends so that one can be soldered to C15 and other end taken through a banana plug socket to C14. 'Stringy' polystyrene cement, e.g. Joyplane is used to form the stiffening spreaders.

Construction

The transmitter has been fitted in a variety of metal cases and is readily secured by Parker Kalon self-tapping screws through the corner brackets of the chassis. The case or shelf then closes the bottom of the chassis.

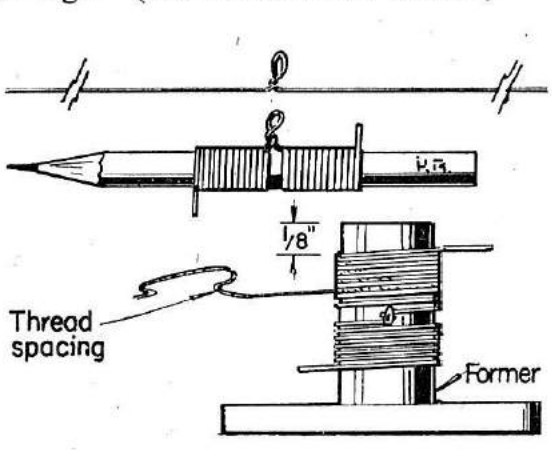
The TX is built on a standard 6 in. × 4 in. × 2½ in. (or 2¼ in.) ali. chassis. Mark out and drill the holes as shown on page 13. Note you may require an additional fixing hole for the Xtal holder (SK1). Our prototypes use sockets taken from battery sockets, first mounted in polythene stripped from government surplus coaxial cable and then moulded into the chassis holes over the gas stove.

C15 is mounted using three ½ in. spacers turned from ¼ in. or ⅜ in. dural or aluminium rod. Note that one will have to be shortened by the thickness of the chassis corner reinforcement, unless part of this is cut away.

4 BA R.H. fixing screws are required and these must be carefully cut to length so as not to foul the plates, or the capacitor may be damaged.

L3 is wound by taking a 20 in. length of 22G wire forming a ¾ in. loop in the middle flattened and held in place by a single twist. Then 7 turns are close wound each side of the twist using a pencil as a mandrel, to form a continuous winding with a centre tap. When released the coil will spring a little and can be carefully worked onto the ⅜ in. former.

Finally it is bound on with thread (embroidery silk) so as to space the turns by a little less than the wire thickness. Arrange the centre tap to be at right angles to the fixing lugs of the former with 6⅜ turns either side of the centre tap and one end of the winding about ⅛ in. from the end remote from the lugs. (See illustration below.)



Assembly and Wiring

If home moulded sockets are used for SK1 these should be fitted first. C15 requires a screwdriver slot cut by hacksaw then it is mounted followed by C14. The earth connection from C14 to C15 should then be made using a piece of 18G wire as short as possible whilst ensuring that it does not foul the moving plates of C14. The valve-holders, tag strips and sockets can be mounted next.

Where solder tags are required (see wiring figure or photo) these should be fitted loosely at first as it is best to remove them for soldering as otherwise the chassis conducts heat away and a poor joint can result, or in the case of the tag for C5, L3 former can be melted! Check the security of all nuts and screws after soldering and use shakeproof washers. Wire the more difficult components first. In general these are the capacitors as they have to be fitted with the minimum of lead length as per photo, and the layout as shown strictly followed. Note how their wire ends are used for multiple connections, e.g. C1 end connects SK1 to pin 6 of V1. Heat sinks should be used when soldering the diodes.

A piece of raw potato about ⅜ in. cube pushed onto the wires is quite effective and easily removed after soldering.

Solid 18G tinned wire is used for the longer leads insulated with P.V.C. sleeving, suitable material is sold as 'coloured cane' at handcraft shops. See how the lead from L4 to SK2 tucks into the corner of the chassis. This is achieved by making it slightly over-length so it will 'spring' into position.

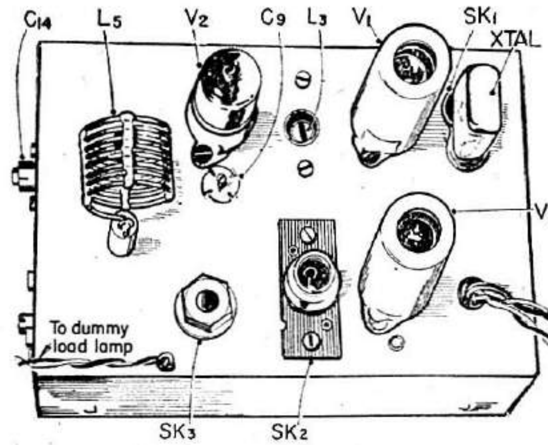
The leads from the chassis should, of course, be stranded flexible conductors.

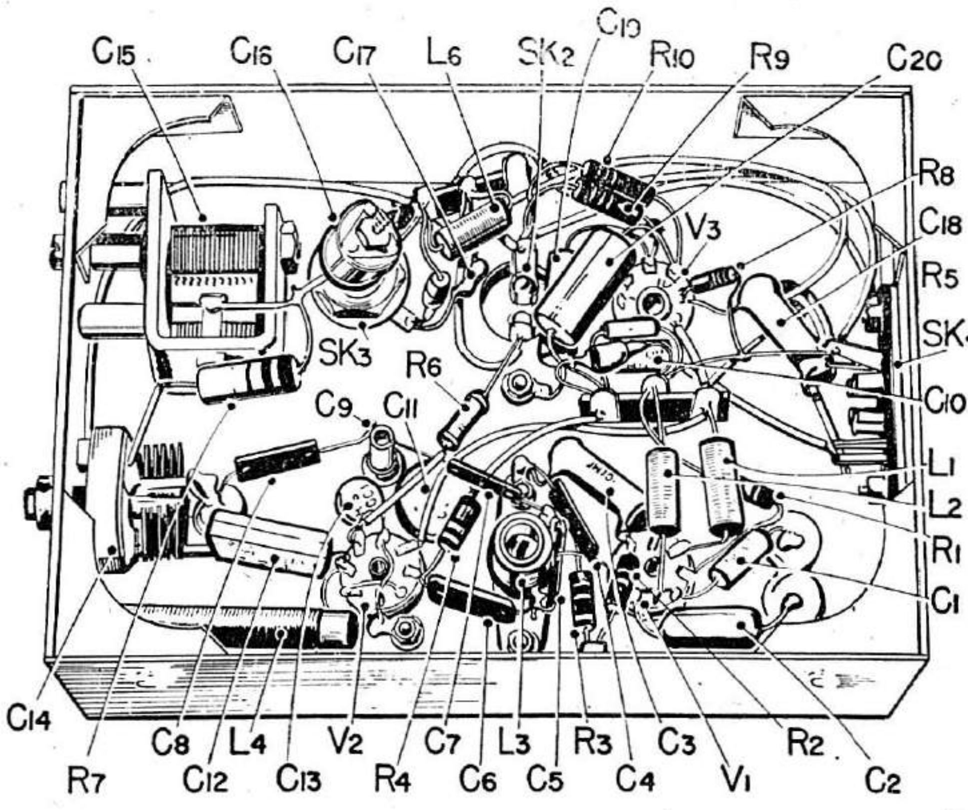
L1 and L2 should be fitted last and stand away from the chassis parallel to it at the height of the tags or a little more. As can be seen sleeving is only used where it is necessary.

Initial Setting Up

After a thorough check of the wiring insert a meter in the external socket, remove the shorting plug from SK2, insert all valves, short pins 2 and 3 of SK4, connect L.T. battery and switch on. Check that all valves glow normally then remove V3. . Next insert Xtal and with S2 in the low power position connect H.T. batteries. (If these get hot you have boobed on S2 connections and will have to get some new batteries so don't be in a hurry and make sure the wiring is right!). Don't let one 3 pin plug dangle on the chassis while the other is plugged into one H.T. battery, as it will be live.

With this 45V. H.T. the current reading will be about 2mA with the Xtal in, and about 4mA with it out. The lower reading with the Xtal in indicates that it is oscillating correctly.





Diagrammatic sketches showing disposition of components. This can be best employed in conjunction with cover illustrations, though dummy aerial load lamp is not installed in the set pictured.

Next tune L3 for a dip in the H.T. current starting with the slug full in. The dip will be small, only about 0.1 mA. Switching to 90V. H.T. is permissible and both current and dip in the current will be larger.

Now replace PL2 in SK2, set C15 to max. capacity and with 45V. H.T. tune C14 for a dip in H.T. current.

This will be about a 1mA dip from about 7mA. There should now be a weak glow in the dummy load lamp. Switch to full power and the lamp should light brightly and H.T. current be about 15mA.

Connect the meter you propose to use as an output indicator to pins 2 (+) and 4 (—) of SK4. This should have a full scale deflection of 5mA or less, the more sensitive the better. Switch on with 45V. H.T. and adjust C16 to obtain about ¼ full scale reading. L3 can now be given a final adjustment for maximum reading of the output meter. It should be secured in position by means of wax, or better still a high viscosity core grease (as sold by Rocal) and will require no further adjustments unless valves and/or Xtals are changed.

Field adjustments can be made by use of the output meter only.

Simply start with C15 at maximum (fully anti-clock) tune C14 for maximum output then C15, repeat as necessary finishing with C14. As the output meter is essentially a Voltmeter its readings are purely relative. For example reducing the aerial length enables a higher maximum output reading to be obtained, but this will only indicate that the same maximum power is being fed to the shorter aerial. If on your aerial the output meter reading goes over full scale on full power reduce C16 setting accordingly.

To check the modulator insert V3 and plug a tone generator into SK4. The plug should have a short between 2 and 3 to complete the L.T. circuit to V3, and the screen of the input lead should be connected to these pins.

When a tone is sent the output reading will fall or, if phones (or loudspeaker fitted with matching transformer) are connected between pins 3 and 4 of SK4 in place of the meter, the tone will be heard. This is a useful facility as it provides a continuous check on the operation of the TX and modulator and once saved a plane by a continuous tone indicating that a microswitch had stuck —the modulator was switched off and the switch cleared just in time!

If the neutralising circuit consisting of C7, C8 and C9 is fitted this is readily adjusted by first removing PL2 and connecting the most sensitive meter you possess (I use a 50 microamp movement) between pins 2 and 4 of SK4. Set C9 to minimum, i.e. screwed almost all out, and remove the dummy load lamp. Make sure that PL2 is out then switch on full power and tune C14 for maximum reading on the meter. Adjust C9 for minimum reading and as minimum is approached touch up L3 and C14 for maximum, finally set C9 for minimum and the job is done. Switch off and disconnect the sensitive meter. Then replace PL2 and the dummy load lamp. C9 must not be touched again unless V2 is changed.

Tuning Receivers to the TX

First tune the receiver roughly with the TX aerial plugged in then remove the TX aerial. The dummy load will take over and the radiated output will be drastically reduced to simulate conditions at range. Carefully tune the receiver moving a few feet away to reduce the signal still further. Finally replace the TX aerial and, first time only, tramp off into the blue with a friend keying the TX just to convince yourself—once and for all. From then on make your 'range checks' by removing the TX aerial, only make sure you put it back again before flying—I wish I had !

June issue will contain details of Dave McQue's Transistor Pulsed Tone Generator designed for use in conjunction with this TX and Tone Receivers for Galloping Ghost and other similar systems.

PRACTICAL SERVO TESTING (from opposite page)

approximately the elevator size of popular multi and intermediate class planes. Rudder loads are very low since they are usually much smaller in area than half of the elevator. Aspect ratio effects were not extensively explored since they have no immediate value.

No attempt was made to be scientific in the tests but the results are practical and useful as well as informative.

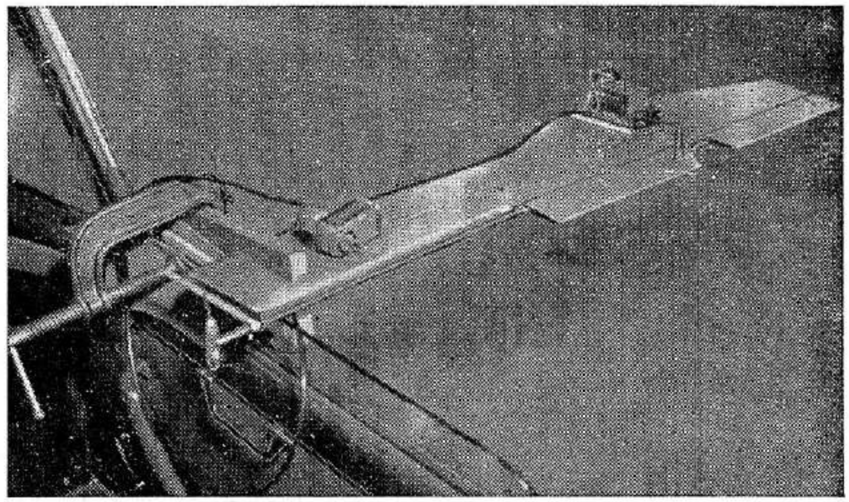
The charts show speed in MPH vs. load in inch ounces. The lines show these factors at 10, 20 and 30 deflection from neutral. The size of the surface is shown in each chart.

It is difficult to determine from most servo manufacturers specifications just how much power is actually available since the power is usually expressed in pounds which is not a complete term. The output forces should be expressed in inch-pounds or better still in inch-ounces since this size term better suits the actual needs of the type models flown today. Most servos are several times as powerful as necessary, however, and a trend toward smaller-lighter units is already beginning. These servos will be more realistic in their power output.

Escapements were not evaluated since it is generally conceded that they are rapidly becoming obsolete.

Test apparatus of the type described could be improved and made into an interesting tunnel substitute, which would yield very informative slow speed data.

COBB SERVO DESIGNER L. R. PURDY DESCRIBES HIS METHODS. RESULTS ARE EXCELLENT AND COULD ONLY BE IMPROVED BY THE ADDITION ON AN ENGINE ON THE WING TO PROVIDE SLIP STREAM EFFECT.



Practical Servo Testing

How much power is needed to move a control surface? In the face of obvious contradictions between models I fly and those of the nervous (pulse) type, I decided to find out how much power was required at various speeds to move surfaces to realistic control angles.

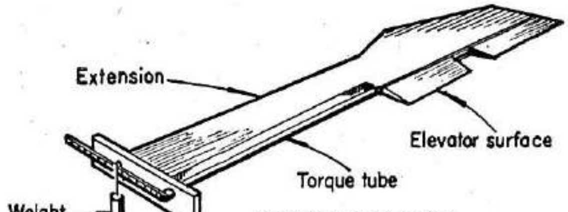
Most engineers are familiar with the "cut and try" theory, in other words, if it works, it's good enough. My purpose ruled out this approach to the control surface power requirement problem. Servos of the P-C type which I design and use (pulse counting) require a fast reaction time. When an attempt is made to find a satisfactory compromise of voltage and gearing to achieve a realistic actuator speed it becomes necessary to determine the air loads imposed on the actuator by the control surface.

Providing more power than needed wastes batteries, hence it is desirable to determine the actual loads and design around them.

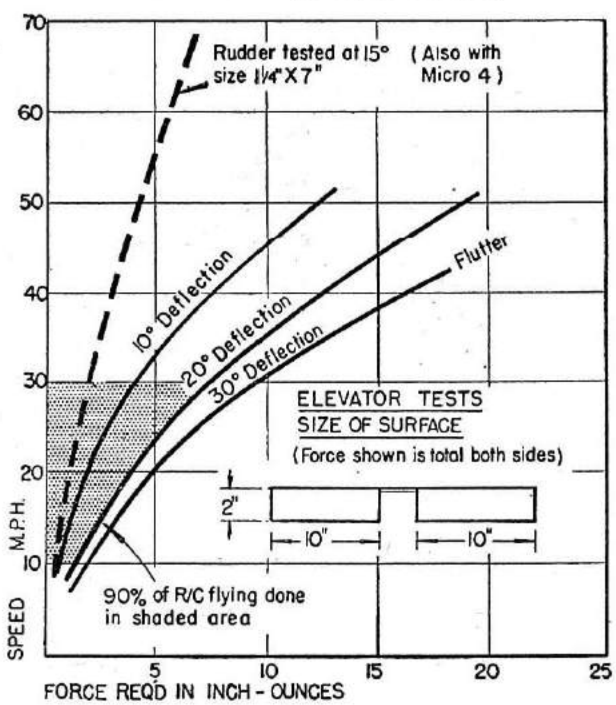
Lacking a suitable wind tunnel in which I could conduct my tests, I decided to make a simple automobile mounted balance arrangement. Most wind tunnels operate at too high speeds anyway. As you can see in the accompanying photo, the surface used is from a discarded model with an extension to allow it to protrude far enough out from the car body to avoid turbulence.

The actuator in the picture is a 4 position P-C type controlled by the stick type controller shown. Various tests of this type were run for evaluation purposes. A fairing was provided around the actuator during the actual tests.

The charts show the results which support my long standing suspicions that a lot less power is required than was generally believed necessary. Other factors such as inertia, friction, cold weather effects and safety factors must be considered as well as the air loads but these can be accurately predicted. Two surfaces were tested. They were



SKETCH OF TESTER



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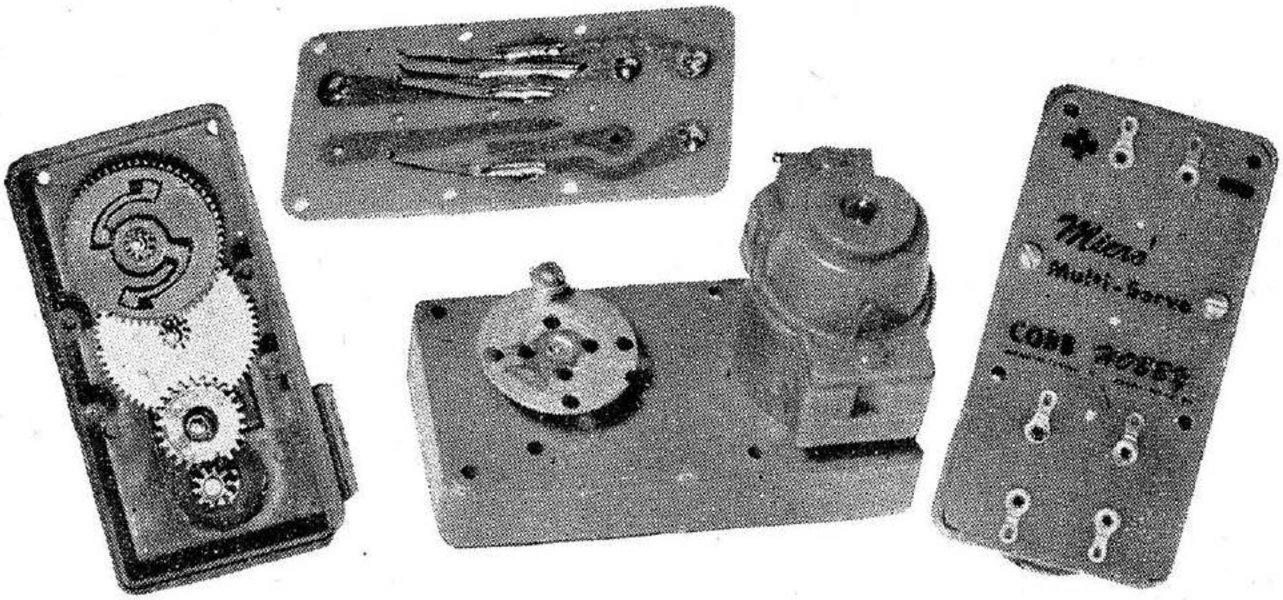


Tommy Ives Tests Servos . . .

COBB MICRO SERVOS

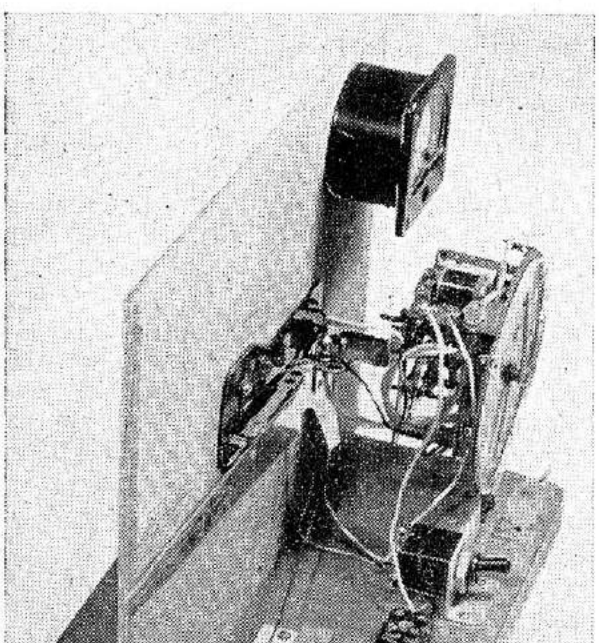
THESE servos have been modified in order to increase torque and improve current drain. This has been achieved at the expense of response time which is now less than the average servo unit.

The current drain, however, is fairly low and the use of a higher voltage to speed up the response time is now possible without the danger of over-run when reaching neutral, etc. The units can now be used with the heaviest model and will take all reasonable loads.

There is some criticism of the motor which is sealed and the brushes cannot be renewed. The low current drain, however, should result in long life and the necessity for brush renewal may not arise.

Provided allowance is made for the increased response time satisfactory control should be no problem.

Current readings were taken whilst the control was moving from neutral.



Heading shows complete and dismantled Cobb Micro Servos. Note p.c. disc with wiper contacts. Standard parts are used for a variety of contact arrangements.

Above : Bellamatic with size comparison, and on right similar latest Motomatic which is non-self-neutralising, for motor operation or trimmable control.

Test report on Cobb servos

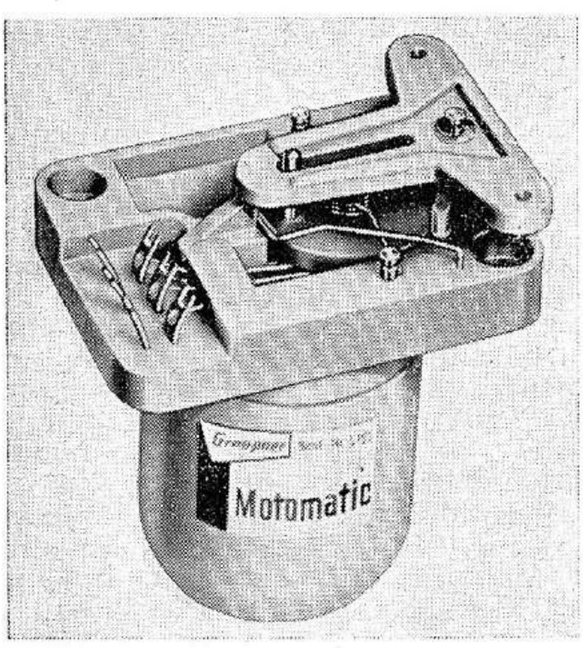
	1.2 v.	2.4 v.	3.6 v.
No load current ...	120mA.	120mA.	180mA.
16 oz. load ...	*	180mA.	210mA.
24 oz. load ...	*	210mA.	270mA.
Transit time			
No load ...	2.6 secs.	.9 secs.	.6 secs.
16 ozs. ...	*	1.1 secs.	.6 secs.
24 ozs. ...	*	1.4 secs.	.75 secs.
Torque ...	*	6 in. ozs.	9 in. ozs.

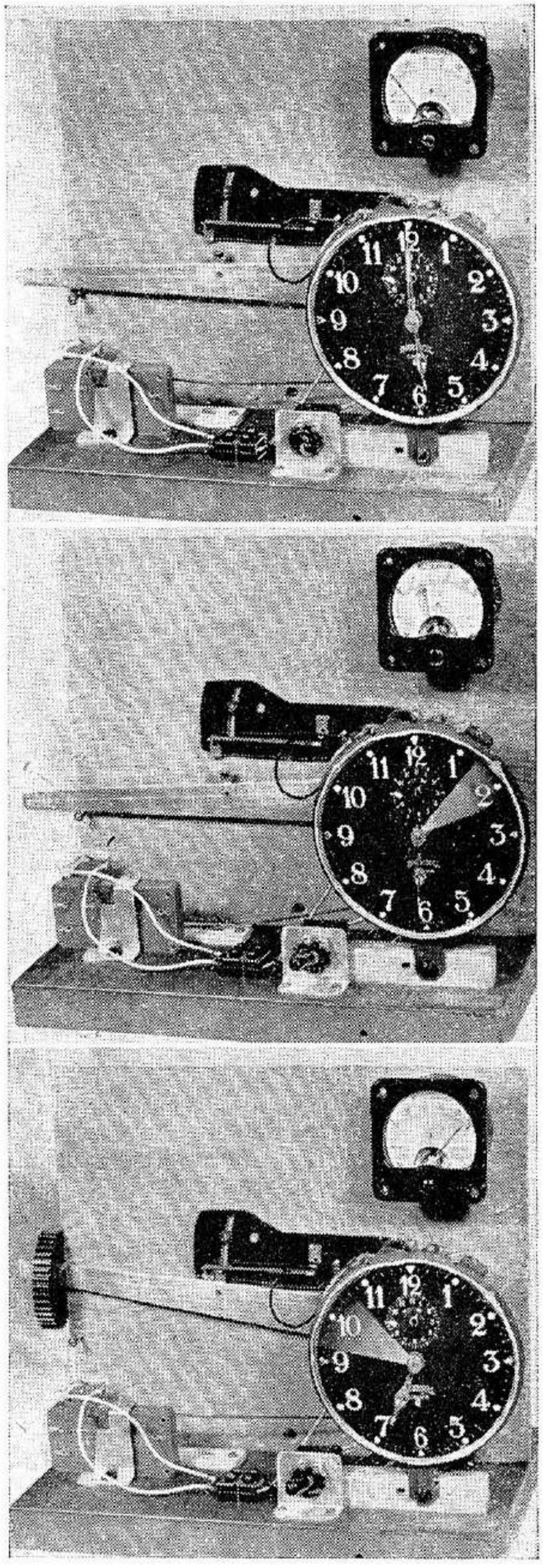
Travel of control arm ... ⅜ in. Return to neutral. 100%.
Recommended voltage not less than 2 volts.

** The motor was stalled here and no readings were possible except stalled current which was* 350 *m.a.*

GRAUPNER BELLAMATIC

THIS unit produced by the well-known Graupner concern is a departure from the normal motorised actuator. Firstly it is a completely new type of motor in that there is no magnetic force on the armature until a current flows. This means that no force is required to overcome this and efficiency is much greater. The permanent magnet is placed within the armature winding and the result is a small light unit with sufficient power to control the largest model. Secondly the method of self neutralising is ingenious and operates by reason of the fact that when the armature has travelled 90° the circuit is broken stopping the motor. The return spring tries to move the armature to neutral but the circuit is again made and the process is repeated. This results





Above and far left: Tommy Ives' ingenious test rig. Alarm clock regraduated to read in seconds! Top at rest, centre free running load, bottom stall conditions. Lathe change wheels used as weights, exactly ounce and multiple weights. Cobb Servo is undergoing test.

in a rapid fluttering at the position of maximum travel and there is a substantial saving in current drain. The contacts for this purpose are of gold but it might be advisable to suppress the spark in order to prevent burning.

Although a very efficient unit, a word of warning is not out of place. The makers do not guarantee it against damage due to overload and the danger of burning out the armature is great if the maximum safe current is exceeded.

Tests were made for torque, current consumption and time of travel and a chart is appended giving details for various voltages.

A test of the maximum torque in inch-ounces was not made in view of the danger of burn out but the figures quoted by the makers are not regarded as excessive.

The current ratings are at the point of maximum travel. The instantaneous currents whilst moving were not taken but did not exceed twice the above mentioned figures.

Test report on the Bellamatic servo

	1.2 v.	2.4 v.	3.6 v.
No load current ...	90mA.	90mA.	90mA.
Load 16 oz. ...	150mA.	160mA.	180mA.
Transit time			
No load ...	.3 secs.	.15 secs.	.15 secs.
16 oz. load ...		.3 secs.	.25 secs.
4 oz. load ...	.5 secs.		
Torque (not max.)	1.5 in. ozs.	6 in. ozs.	10 in. ozs.

Travel of control arm. 3/16 in. Return to neutral. 100%.

Recommended voltage 2 to 4 (max.).

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.

. . . When I switch the carrier on the Tx. begins to pulse sufficient to work a relay through the Q-tone Rx. without keying the modulation . . . I have built the Tx. as per instructions and used a 27.0 m/c. crystal. Pulsing is not apparent when tone is sent.—E.J.S., Grimsby.

Mr. S. has sent his Tx. to me. His crystal is an ex-government surplus marked "Channel 70 27.0 MC" and between the pins "FT 241 A". These crystals were used in service FM sets and have to be multiplied by 54 so that their fundamental frequency is 500 Kc/s.

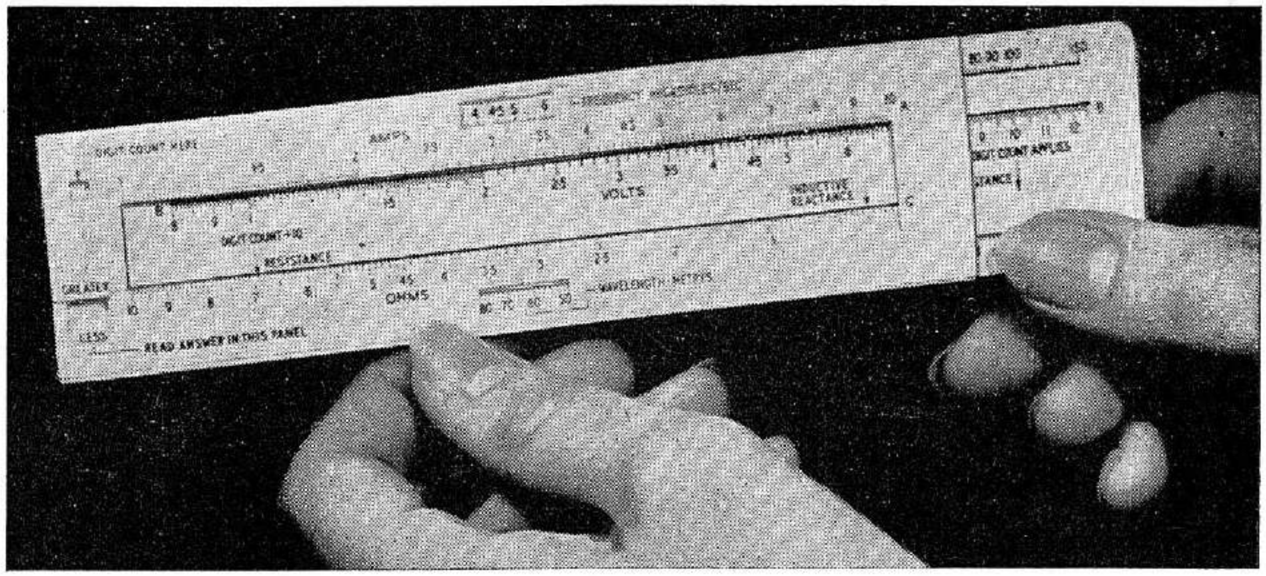
I wish to use the Simpletone Tx. in conjunction with the Transmutone Tone Rx. and would like to know how to add the various frequency controls. Presumably it is by adding push buttons and 100 k. pots in parallel with that shown in circuit diagram . . . With reference to the above you specify OC 71 transistors. I have several OC 72 so could I use them instead?—J.D.R., London.

Additional 100 K. pots and push buttons can be added as you suggest. However, this type of oscillator is not really stable enough for reed work and the pots. will require frequent checking. You can do no harm in trying OC 72 in place of OC 71 specified for the Transmutone.

I have an Aeromodeller No. 1 Tx. I was troubled with flyaways which I put down to inexperience . . . On checking for the new season I noted that meter reading of Tx. was only 20 mA. when the button was pressed, when instructions say it should be 27-30 mA. . . . Would I be better with 120 v. H.T.? —C.F.F., Blackburn.

Check the output of the Tx. with a torch bulb and loop near tuning coil and see if anode current rises to specified value. If it does, check aerial and earth connections. A 6.3 v. 0.15a. lamp from aerial to earth will also indicate output. Make sure all components are secure and cannot flop about as any movement of parts will vary frequency and these variations have a greater effect on range than power output. Always check Rx. tuning to take account of slight shift in Tx. frequency when moved from, say, grass to concrete.

Increasing H.T. to 120v. will not affect range greatly.



How to Use our SLIDE RULE CALCULATOR

THE slide in conjunction with scales A and C can be used for solutions to Ohms law, e.g.

To read *resistance*, set *volts* value on slide against *amps* on body scale A and read off corresponding resistance on scale C against the appropriate (right or left hand) arrow marked resistance.

To read *volts*, set arrow on slide against *ohms* value and read off volts directly opposite the *amps* value on scale A.

To read amps, work as for volts, reading *amps* against the *volts* value on scale B.

Scales A, B and C can also be used for straightforward multiplication and division.

For *multiplication* set 'resistance' arrow against the first number to be multiplied on scale C. Read answer on *scale B* against the second number to be multiplied on *scale A*.

For *division* set numerator on scale B against divisor on scale A and read off answer on scale C against right hand 'resistance' arrow.

Calculation of Inductive Reactance

Use scale C for frequency (or inductance) and set inductive reactance arrow against this value. Read inductance (or frequency) on scale A and read off value of reactance opposite on scale B.

The small cut out windows top and bottom give conversion of frequency to wavelength. Simply set frequency (or wavelength) value in the panel against the centre line mark and read off the corresponding equivalent in the other panel.

Use of the 'Digit Count' Windows

These windows give the correct *order* for the answer when computing current from known voltage and resistance values. Method of use is as follows.

(i) Count the number of digits in the *volts* value and compare with the number of digits in the *ohms* value. There will either be more, and equal number or less, i.e. +1, +2, etc., —0 or —1, —2, etc. Set this appropriate figure in the top window (marked 'digit' count here).

(ii) If the *first* digit of the volts value is greater than the *first* digit in the ohms value, read the answer in the *top* half of the bottom window.

(iii) If the *first* digit of the volts value is *less* than the *first* digit in the ohms value, read the answer in the *bottom* half of the cut out.

(iv) The reading obtained refers to the *correct order* for the answer.

A designates a current reading in *amps*.

mA designates a current reading in milliamps.

MA designates a current reading in microamps.

Example : Suppose the voltage value is 12 and the ohms value 470. There are two digits in the volts value and three in the ohms value, hence the digit count is —1.

The first digit of the volts value (1) is *less* than the first digit in the ohms value (4). Therefore read the answer in the bottom half of the window, i.e. in this case milliamps × 10.

The answer given by the scales to this sum is 2.56 on the amps scale.

The true answer is therefore 2.56 × 10 milliamps = 25.6 milliamps.

Note : These corrections for the order of the answer apply *only when using the right hand 'resistance' arrow.* If the left hand resistance arrow is used *the answer given by the digit count should be divided by* 10.

Once familiar with its use, it will be appreciated that the digit count check can be applied to decimal values just as readily; also for inserting current readings in milliamps, etc.

Tables on back of slide rule will be found most useful for coil winding, in conjunction with the formulae below:—

COIL WINDING FORMULAE

Turns per layer = turns per inch (from table) $XL = A$.

Number of layers = turns per inch (from table) $\times \frac{D_1 - D_2}{2} = B$.

Total number of turns $= A \times B$.

Winding depth $= \frac{D_1 - D_2}{2}$

Winding space $= \frac{L(D_1 - D_2)}{2}$

Length of average turn $= \frac{11 \times (D_1 + D_2)}{7} = C$.

Length of wire required $= A \times B \times C$.

Meters are MUSTS in R/C

Digested from Paul Runge's GRID LEAKS

In a casual conversation at one of our hobby jobbers the other day, we ran into a dealer from an isolated community where there is little R/C. He was complaining about a well-known make radio controlled receiver (manufactured by one of the oldest and largest manufacturers) and the difficulty the boys were having in his community.

He admitted frankly there were no radio men in the crowd and further conversation with him revealed that they were attempting to tune by ear!

We asked further details. "Oh," he said, "we listen for the relay click and then try to tune to see that we get the relay click." We inquired further as to whether they used meters. Came the question: "Meters? Are you supposed to use meters?" It came as a surprise to us that instructions which were furnished by this particular and other manufacturers could be so obviously bypassed. Any carrier wave receiver (and these were all carrier wave receivers) can be tuned by ear but it is extremely a haphazard proposition and very unlikely.

The use of the meter is to be highly recommended to the beginner in R/C. The meter is just as essential as the battery for his engine glo-plug starting. Old timers couldn't and don't do without either.

What type of meter to use is another question that we were asked. We expressed our opinion of a moving coil type of probably a 0-5 milliamps would provide the best bet. The moving coil being chosen for the reason that it had the least internal resistance and it would not detune the tuning. Some of the iron vane meters that are fairly inexpensive have an internal resistance of from 300 to 500 ohms and while they will tune the receiver can easily cause a detuning when the meter is removed from the circuit as it would have to be.

We asked further, if he had a volt meter to check his battery voltages to make sure that the battery voltages were up to the required minimum as specified by the manufacturer. No, they didn't have but they were using fresh batteries and they should be perfectly all right.

Meters are essential for enjoyment in R/C. Buy the best meter you can afford in the milliamp range required or, if possible, buy a multitester which will provide milliamp ranges as well as volts and also give you a continuity check through the ohm meter. These are comparatively inexpensive and some are on the market for as little as £5.

Now, how do you use meters in radio control? Why are they so essential? Why can't you tune up a carrier wave receiver using the relay click as the indication? In practice, the 0-5 milliamp meter or multimeter with roughly that same scale is inserted in the H.T. plus lead of most carrier wave receivers. It may also be inserted in the relay stage of audio receivers although these are easily tuned by using headsets.

The receiver is then switched on and the meter reading observed. On most single hard tubes the idling current varies between 2 and 3 mils depending on which receiver it is. Upon receipt of signal, when properly tuned in, this will drop from .5 to 1 milliamp depending again upon the make of the given receiver.

It has been found to avoid fly-aways that range checks must be made with the meter in the installation. This is quite readily done by using a phono type jack and using two plugs one of which is connected to the meter, the other of which is shorted and is used while the plane is in flight.

Simply fasten the 2-pin plug in such a way that it is permanently afixed to the small 0-5 meter if this is what you are planning to use. Many builders connect a strap of synthane or other insulated material across the two terminal points of the meter and mount the RCA phone plug permanently on this insulator strip so that it may be readily inserted in the jack.

Another recourse is to use the standard closed circuit type of jack which, of course, requires no shorting plugs since when the phone plug is removed, the jack automatically closes its circuit.

To tune, follow the manufacturer's instructions to the letter, but generally, the procedure is to take a range check in excess of 300 yards to make sure that you have range in the air. The range check is done by having a helper key the transmitter while the plane is being taken away observing the meter periodically.

Battery voltages also must be checked and kept at the operating levels for satisfactory results since fly-aways can result when the battery voltages become marginal since receiver malfunction happens quite easily.

All in all, we told our friend that they shouldn't blame the receiver until all these possible points were checked. Current radio receivers today from the simplest to the most complex are getting more and more dependable but we still must take in account the human element.

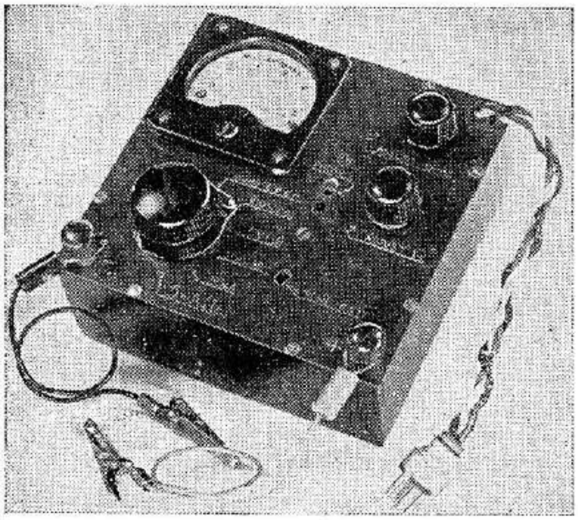
It is quite possible by using a simple 0-5 milliamp meter to construct a multitester at home. A moving coil 0-5 type is highly recommended. These may be purchased with an already wound shunt although a shunt may be quite readily wound for it.

To use this as a volt meter, it is necessary to use the meter less shunt and add resistors in series to increase the range. By adding resistors of different sizes, different voltage ranges may be had—5, 50, and 250 volts being probably the best ranges available for R/C work.

To find the required value of resistance when the milliammeter is to be used as a volt meter, the value of series resistance can be found by Ohms Law. This is $R = \frac{1000\,E}{I}$ where E is the desired full scale voltage and I the full scale reading of the instrument in milliamperes.

The accuracy of a volt meter depends on the calibration accuracy of the instrument itself and the accuracy of the multiplier resistors. Precision wire-wound resistors are to be recommended in high quality instruments but for most purposes, the standard ½ watt composition resistors will make an acceptable and economical substitute. Such resistors are supplied in tolerances of either plus or minus 5% and these are to be recommended. To obtain a voltage reading of 5 volts on the 5 milliamp scale, let's do some substituting in the formula we had shown above, If $R = \frac{1000 \times 5}{5}$ this comes out to 1000 showing that a 1000 ohm resistor is required. Further substitution for 50 volts will show that this will come out to R equals 50,000 over 5 to 10,000 ohms resistance required in series. For 250, the formula comes out R equals 250,000 over 5 or a showing that a resistor of 50,000 ohms is required.

Now read on . . .



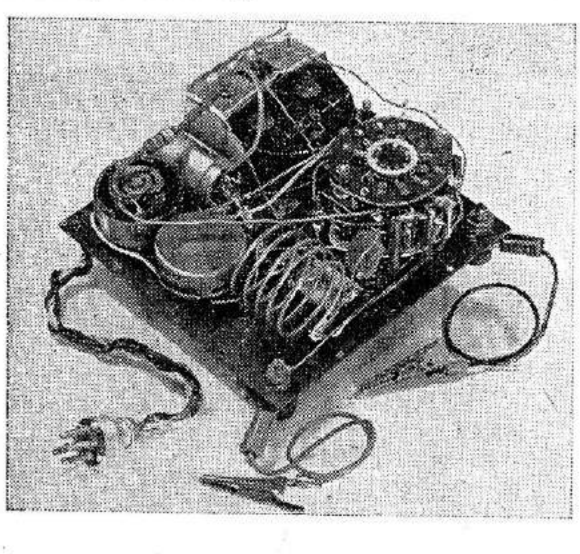
Multimeter

By J. S. BLACKBURN

Do be tempted to build this most useful aid to better results . . . You will thank us and be for ever wondering, "how you ever managed before . . ."

MOST R/C modellers possess a 5mA meter movement which they use for tuning and relay setting, but probably very few of them use their meter to fullest advantage. The author decided quite early on that he was going to make things as easy as possible for himself, and so a multi-meter was designed which would do as many jobs as possible and yet be self-contained. Below is a typical pre-flight check using the meter:

1. Plug the meter into the transmitter, and by rotating the switch check the voltage of the H.T. and L.T. batteries, and then check that the L.T. current is the correct value. If it is less than it should be, one or more of the valve filaments has blown or L.T. battery down. Remove the offending valve, and check it on the ohms range. If, however, all is in order, switch to anode current and check that it is the correct value. Tune for minimum current where appropriate. Finally switch to Field Strength, and by placing the meter near the aerial, check that the TX is actually radiating.



2. Now plug the meter into the side of the aircraft, and check H.T. voltage and L.T. voltage and current as for the TX. If in order, switch to anode current, and tune in the usual way. To check the relay settings, reduce the valve current by adjusting the variable resistance marked "Adjust Ia".
3. Unplug the meter from its box, and plug the meter movement alone into the side of the aircraft, when it will register anode current only, and give a final tuning check. This is necessary with temperamental super-regenerative receivers because of the impedance of the meter leads and capacity to earth.
4. Remove meter, and replace with shorting plug. This will switch on both H.T. and L.T., and you are ready for flight.

Thus everything that can be checked is checked, nothing is left to chance, and you are far less likely to find, a few minutes after launching, that there is no response to the button. In addition most of the faults that occur can be found without removing the receiver from the plane.

Circuit

The receiver is fitted with a five-pin socket in the battery lead as in Fig. 2a. A five-pin plug on a lead from the meter-box plugs into this, and a three-bank switch selects in one of six positions the part of the circuit to be metered. The meter movement has a four-pin plug on the back (Fig. 2b), which plugs straight into the aircraft and also mates up with a four-pin socket inside the box. The shorting plug is a four-pin type. Fig. 3 is the front panel upon which the meter is built and shows the layout and marking of the switch and potentiometers. The

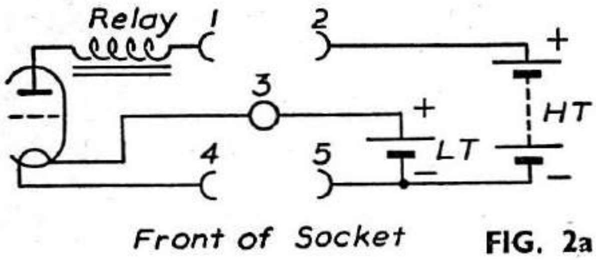


FIG. 2a

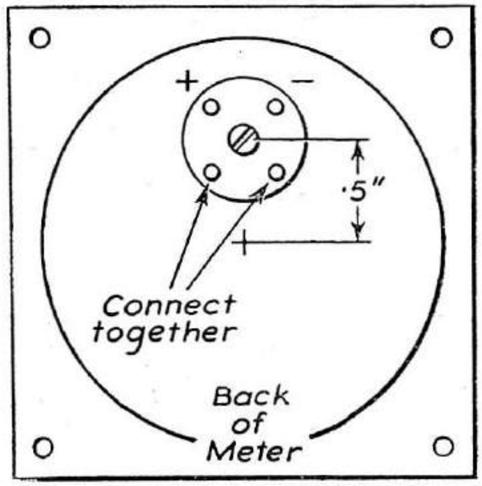


FIG. 2b

two terminals at the bottom are for external measurements.

As soon as the meter is plugged into the receiver, the filaments are switched on by the shunt R1 connecting pin 4 to pin 5 on the five-pin socket (Fig. 1). The meter is then switched across 4 and

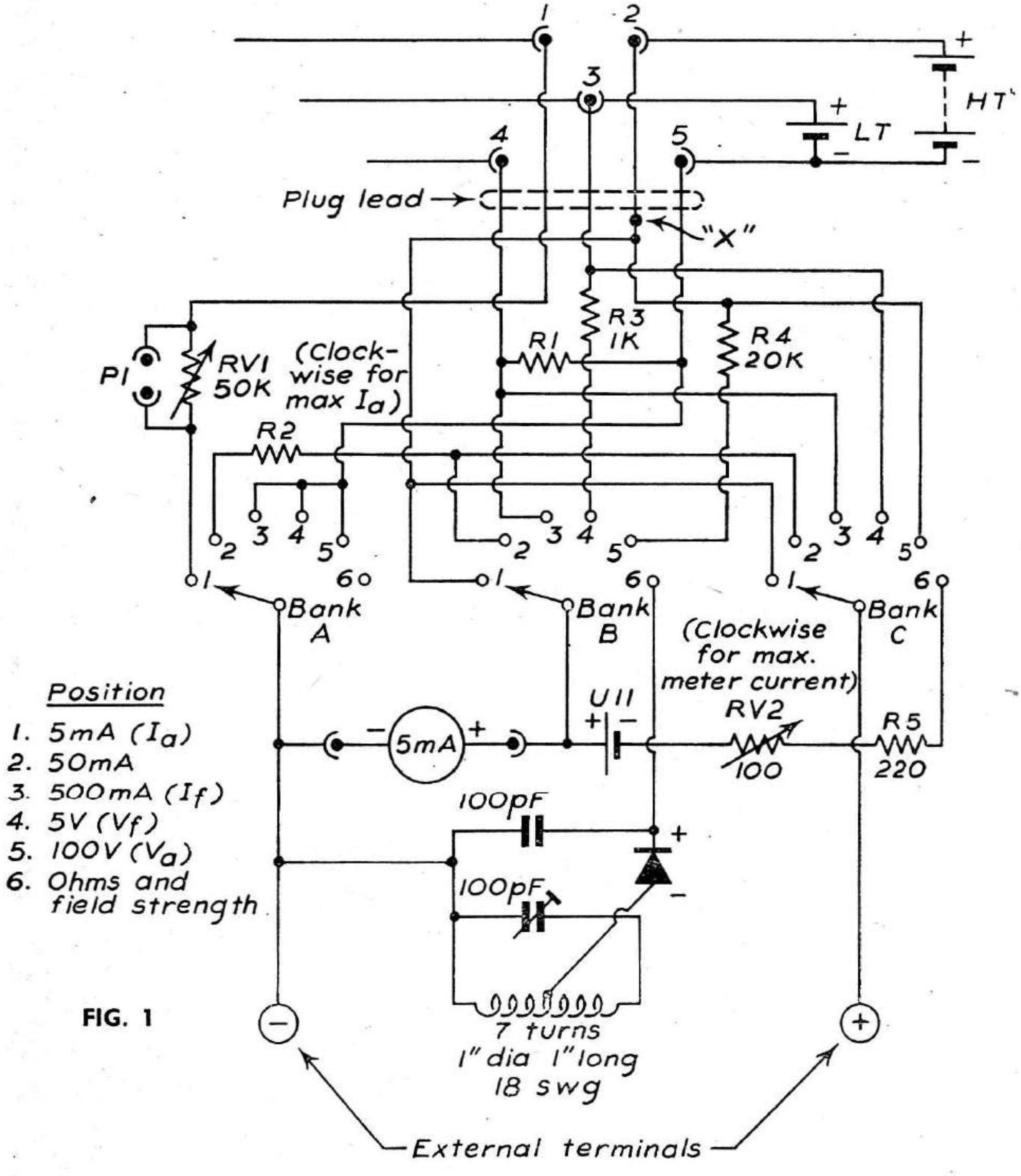


FIG. 1

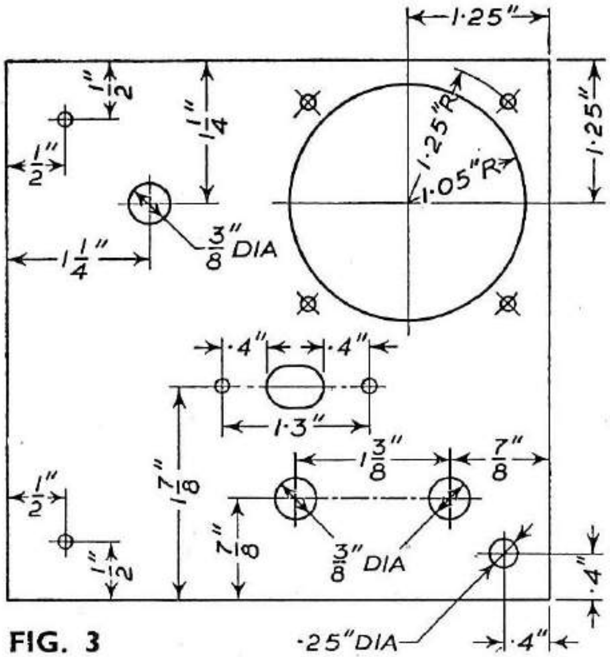


FIG. 3

5 for filament current, 1 and 2 for anode current. (RV1 in series for relay setting), 3 and 5 for filament voltage (R3 in series), and 2 and 5 for anode voltage (R4 in series). This is accomplished by banks A and B of the switch. Bank C selects the appropriate range for the "external" terminals. The 50mA range can be used for external measurements only, similarly the field strength and ohms position. RV2 is for zeroing the ohms range. Phones are connected in the two-pin polarised socket P1.

Construction

The movement is a standard ex-government 2 in. 7-ohm moving-coil type. Figs. 3 and 4 give the dimensions of the $\frac{3}{32}$ in. paxolin front panel upon which the meter is built, and also the aluminium bracket for the meter movement and dry cell (Ever Ready U11). This is shown bent to shape in Fig. 5. The rotary switch, two potentiometers (small 1 in. dia type), and two-pin polarised socket are bolted to the panel. As all the small components are self-supporting, no difficulty should be found in wiring so long as thick copper wire and plenty of Systoflex are used. The connection to the positive terminal of the cell is a standard valve grid cap (small size). A four-pin plug is mounted on the back of the meter with a counter-sunk 6BA bolt; the bottom two pins are connected together, the top two to the meter, and any bolts on the back are sawn off flush.

Difficulty may be found when mounting the tuned circuit of the field strength meter. This is most rigidly done by bolting both ends of the coil to the front panel. A hole should be drilled for adjustment of the trimmer. The plug lead should be about 4 in. long and comes out via a $\frac{1}{4}$ in. grommet. Shunts R1 and R2 are wire-wound on formers similarly to chokes—R1 is 1/99 and R2 1/9 of the meter resistance. For the 7-ohm meter R1 is about 0.07 ohms and can be a short length of resistance wire from an old wire-wound potentiometer. R2 is about 0.8 ohms and is wound from about one yard of 38 s.w.g. copper wire (0.85 ohms/yd.). In both cases, wind on too much wire, connect

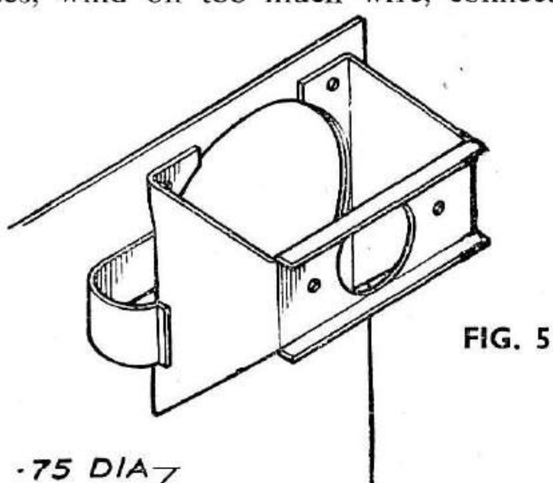


FIG. 5

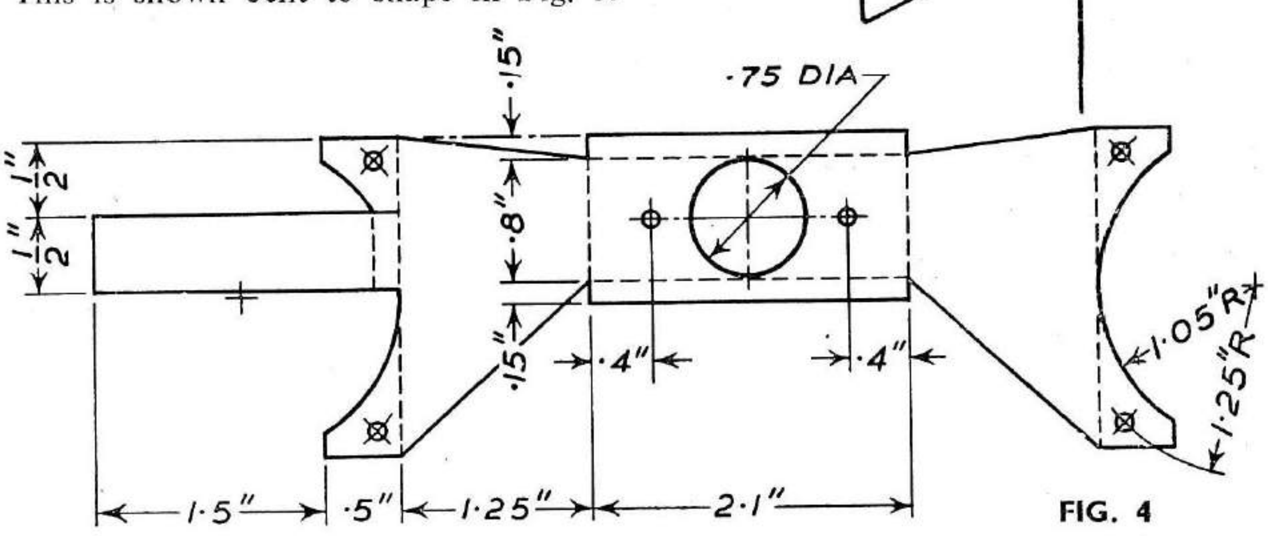


FIG. 4

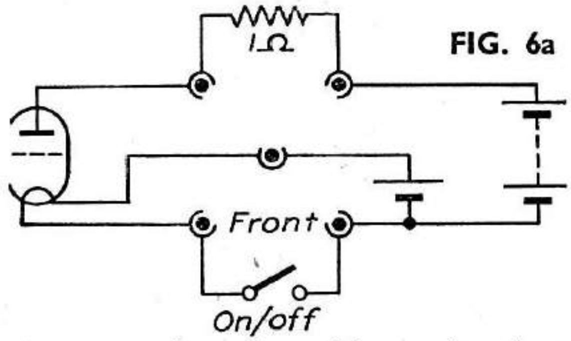


FIG. 6a

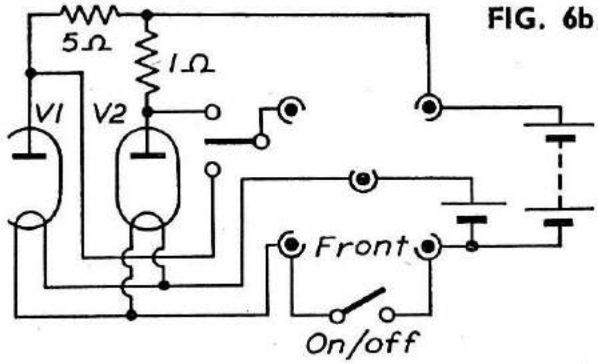


FIG. 6b

the meter in series with an already calibrated meter, and reduce the shunts until both meter readings correspond.

When complete, mount the meter in a ply box, and clearly mark the switch positions on the front. In the original the markings were scratched on with a needle and the grooves filled with paint. The surplus was scraped off when dry. This can make a very neat job.

Warning

Examine your rotary switch carefully. If the moving contact, while moving from one position to the next, joins two fixed contacts together, do not use the switch—it will cause your filaments to blow. Either file the moving contact until it is too narrow to join the fixed ones, or buy a new switch; both types are available. If in doubt, fit a push-button at point X, to isolate the meter from H.T. until it is pressed.

Transmitter Modifications

Fig. 6a is the best circuit for simple TX's. The 1-ohm shunt is necessary as TX's take more than 5mA; the meter is now a 40mA movement. The McQue TX can have both valve currents metered separately by adding a two-way switch as in Fig. 6b. If a multivibrator is used for pulsing, a second five-pin socket and two-way switch can be added to meter the M.V.B. valves. In the case of an M.V.B. coupled directly on to the TX grid (see February, 1958, *Aeromodeller*), the meter, when being used to measure the current in the M.V.B. valve used for biasing, will also measure the TX grid current with the M.V.B. switched off (Fig. 7).

Note that the Full Scale Deflection of the H.T. voltmeter is 100v. For TX's with higher H.T. voltages, this can be increased to 125v. by increasing R4 to 25K.

Receiver Modifications

Single valve receivers are modified as in Fig. 2a.

Multi-valve receivers present a problem. In Fig. 8a, the current through the relay valve only is metered. In 8b, the current through all valves is metered. 8b is best so long as the current through all valves except the last

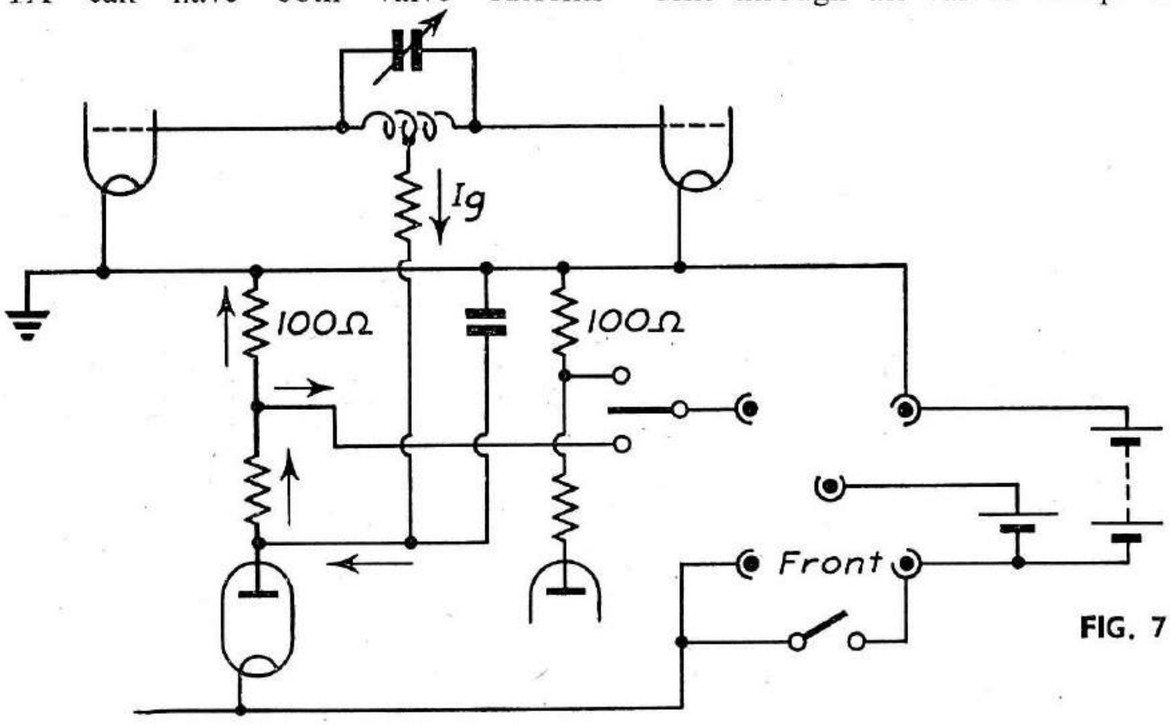


FIG. 7

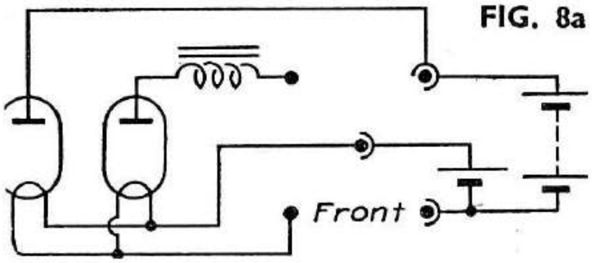


FIG. 8a

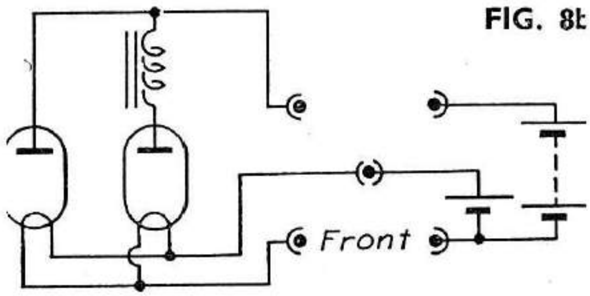


FIG. 8b

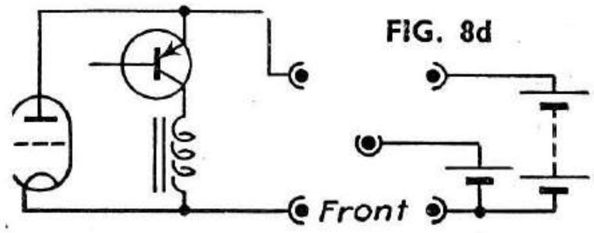


FIG. 8d

does not vary appreciably with signal, and the total current does not exceed 5mA. In the case of the Hill Rx, 8b is essential as the H.T. must be switched off to prevent the batteries draining through the bleeder. 8a may be used, however, if the first valve is replaced by a DAF91, which has a built-in diode that does not conduct when the filament is switched off. The grid leak and anode dropper for the first valve may both have to be reduced. This also simplifies the diode problem so there is now only one high-quality, high back-resistance diode to be bought.

Reed receivers are best connected as in Fig. 8c.

A/M transistor Rx's are not very suitable. Preferably only the relay transistor should be metered, but owing to the leakage through transistors the H.T. must be switched off. Therefore, Fig. 8d is the only possible circuit. On receipt of signal there is a net rise in current, and therefore tuning is possible. However, as the author has not made a transistor receiver, he would not like to be dogmatic about it.

Notes

Do not short the external leads together when taking readings.

A more complex and satisfactory Field Strength Meter can be installed if desired. (See September, 1957, *Aeromodeller*.)

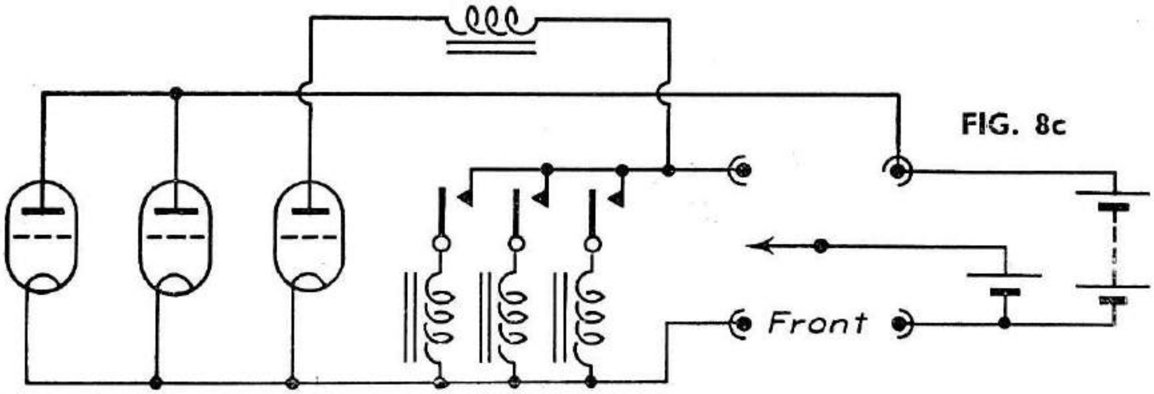


FIG. 8c

HAVE YOU GOT A LICENCE?

THIS may be a very rude question to ask the more enlightened expert, but judging from the queues at the Post Office when the B.B.C. monitoring van is reported in the district to detect pirates on sound and vision wavebands is not entirely unnecessary. There are certainly a lot more people interested in radio control than have taken out licenses.

Newcomers may not be aware that a transmitting licence *is* required for operating remote control equipment for model aircraft, boats, cars, etc. Happily, no form of technical test is needed, but there are restrictions covering power output and frequency limitations which are given in detail on the G.P.O. licence form.

This essential document costs £1 and is valid for five years (4/- a year is not very much is it?). Application form and full particulars are available from : Radio Branch, Radio and Accommodation Department, G.P.O. Headquarters, London, E.C.1.

PHASE SHIFT OSCILLATORS

Not long ago Ted Sills sent us a few notes on Phase Shift Oscillators which covered the subject so happily in its original letter form that we prevailed upon him to edit it a little for publication to the somewhat wider circle of our readers.

IF you look up the meaning of the word oscillator in a dictionary you will find that it means, among other things, to swing like a pendulum. You might be forgiven for thinking that there is little resemblance between the familiar pendulum and the electronic gadgetry described by the article, but we shall see that, in fact, the resemblance is very close.

Once started, the pendulum continues to swing because, at the proper intervals, it is given a push 'in the right direction' by the escapement wheel, which in effect controls the release of energy from a falling weight or tightly wound spring.

In the electronic oscillator, a voltage or current is made to rise and fall in magnitude at some fixed rate (c.f. pendulum), and energy from a power unit (c.f. falling weight) is fed to the timing circuit via a valve or valves (c.f. escapement) at the proper time, or, as we say, in phase. Notice that if the pendulum is pushed in the wrong direction it will soon stop swinging, so that it is most important that the maintaining energy be fed in at the correct time. Now read on!

DEAR READER,

It occurred to me recently that in view of the interest in the so-called phase shift oscillator you might find graphical design data and a brief dissertation on the properties of the oscillator of some value.

Let us begin by considering the fundamentals of oscillators (other than relaxation types) in a perfectly general way.

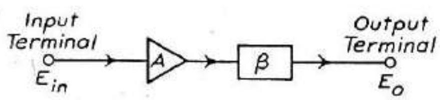


FIG. 1

In accordance with convention Fig. 1 denotes an amplifier of gain A followed by some kind of network, with attenuation (i.e. loss) β, neither amplifier or network having any phase shift. If an input signal E_{in} is applied to the input terminal, it is magnified by the amplifier and attenuated by the network, as shown in Fig. 2. The top waveform

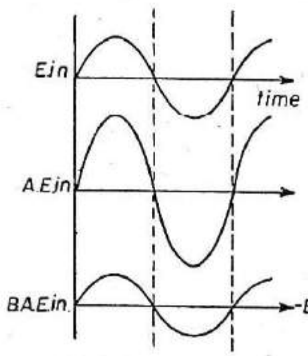


FIG 2

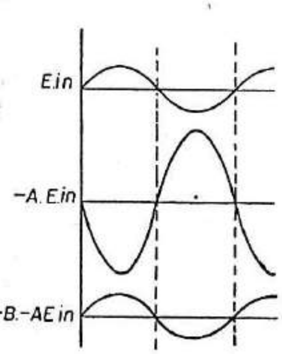


FIG. 3

represents the input signal, the centre waveform represents E_{in} multiplied by the gain of the amplifier, i.e. $A.E_{in}$. Due to the fact that there is no phase shift in the amplifier, these signals are in phase. The fraction of $A.E._{in}$ which passes through the network is $\beta.A.E._{in}$, and this signal is represented by the lower waveform. It ought to be obvious that under certain conditions the system can provide its own input signal by connecting the output terminal back to the input terminal. We have now produced an oscillator! The aforegoing argument may be presented more concisely as follows:—

$$E_o = A.\beta.\ E._{in}$$

$$\therefore \frac{E_o}{E_{in}} = A.\beta.$$

For maintenance of oscillation $\frac{E_o}{E_{in}}$ must be greater than 1.

$$\text{i.e. } A.\beta > 1$$
$$\text{or } A > \frac{1}{\beta}$$

Thus, if the network has $\beta = \frac{1}{50}$

Then A must not be less than 50.

If the network introduces a shift in phase of 180°, i.e., the waveform is inverted in its passage through the network, then a compensating phase shift must also be introduced by the amplifier as shown by Fig. 3, the negative signs indicating 180° phase shift, or inversion.

The Phase Shift Oscillator

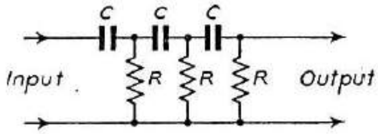


FIG. 4

The network in this oscillator generally consists of three or four capacitor resistor couplings or elements (see Figs. 4, 5). If the phase shift in these networks is investigated, it is found that it is exactly 180° at only one frequency. This means that an amplifier with 180° phase shift can only maintain oscillation at a particular frequency, namely that at which the network phase shift is precisely 180°. This mechanism is the basis of the good frequency control characteristic of the phase shift oscillator, which accounts for its popularity.

It now remains to discover what β is for the two networks we are considering. As one might expect, it varies with frequency, but of course we are only concerned with the one particular frequency which results in 180° phase shift. The attenuation factors are readily calculable and turn out to be:—

For 3-leg network $\beta = \frac{1}{29}$

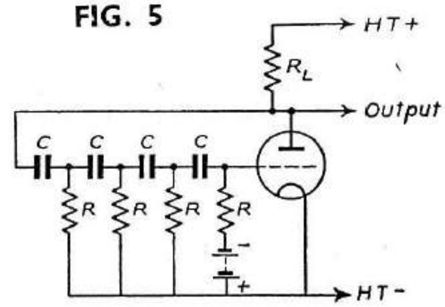
For 4-leg network $\beta = \frac{1}{18.4}$

Thus the gains required are at least 29 and 18.4 respectively, although in practice, rather greater gains than these are desirable in the interest of amplitude stability. Gains of these orders are readily obtained from one stage of amplification only, which automatically provides the 180° phase shift required.

Practical Circuits

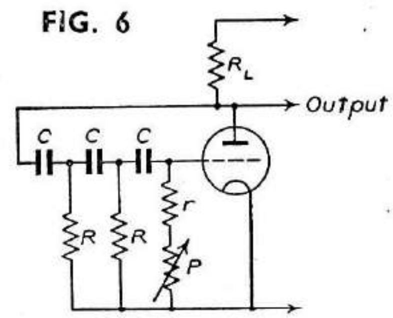
It is best to use a four-leg network with a triode amplifier (see Fig. 5), since triode amplifiers tend to have low gain. The choice of type is quite large with indirectly heated valves, and either ECC81 or ECC83 will do quite well.

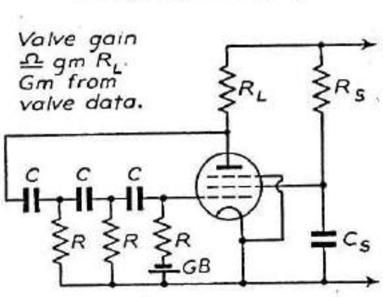
FIG. 5



These are both twin triodes, so that two oscillators can be made with only one valve. If one wishes to use 1.4v. valves it is best to use a four-leg network and a pentode such as the N18, 3S4, etc. Keep the anode load as low as possible, commensurate with obtaining sufficient gain. When it is desired to design the oscillator to yield an accurate frequency it is essential to bias the valve so that grid current does not flow, otherwise zero grid bias can be used. The result of operating at zero grid bias will be to raise the frequency about 10-15% above the design value. No harm is done to the valve under these conditions, since grid current will flow and provide automatic bias.

FIG. 6





Pentode three leg P.S.O.

For N18 R_L = 33K. R_S = 100K
C_S = 0·1 (See text)
HT. 60 to 120v
GB 3 to 4v

FIG. 7

Choose the decoupling capacitor so that

$$C_s \;\overline{>}\; \frac{10^3}{fR_s}$$

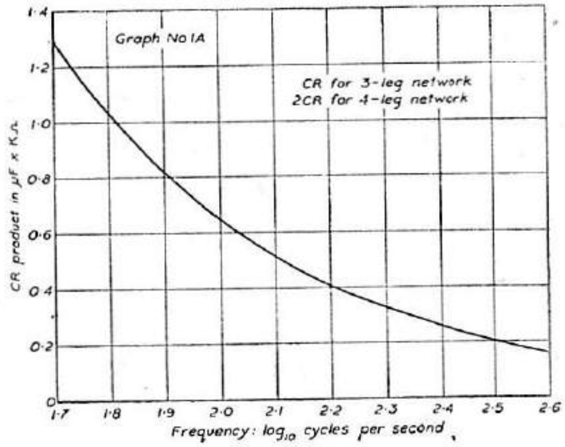
where C_s = screen decoupling capacitor in μ Fd.
 f = oscillator frequency.
 R_s = screen feed resistor in K.
For example, for frequency of 100 c.p.s.
 R_s = 100 K.
 C_s = 0.1 μ Fd.

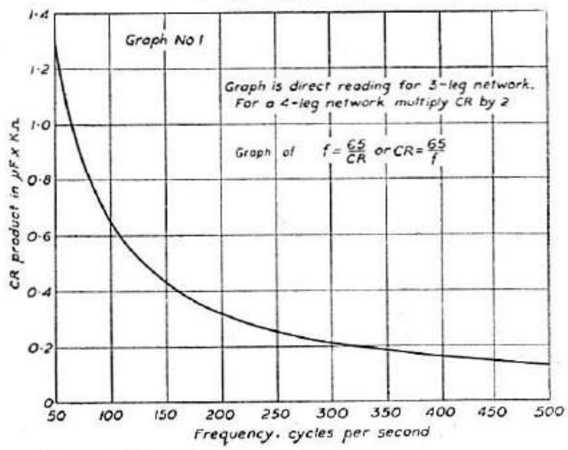
Frequency Variation

Sufficient frequency variation to enable resonance to a tuned reed to be effected may be obtained by making one of the resistors in the network variable. The best resistor to choose is that which connects to the grid of the valve. The variable portion, P, should not be much greater than 2r, where r is the fixed amount in series with P Both P and r should be chosen so that

$$R \simeq r + \frac{P}{2}$$

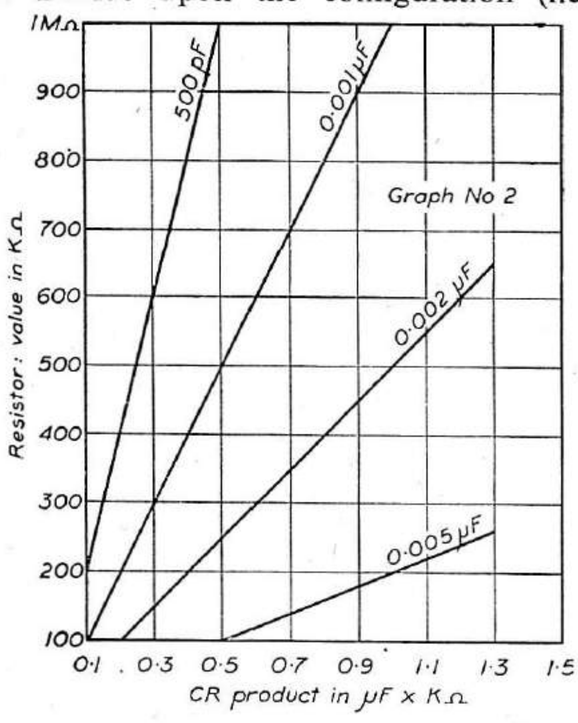
This choice of P, r will ensure positive and negative changes of frequency about the resonant value. Sufficient has now been said about the fundamentals of the oscillator to enable the graphical data to be used in an effective way.

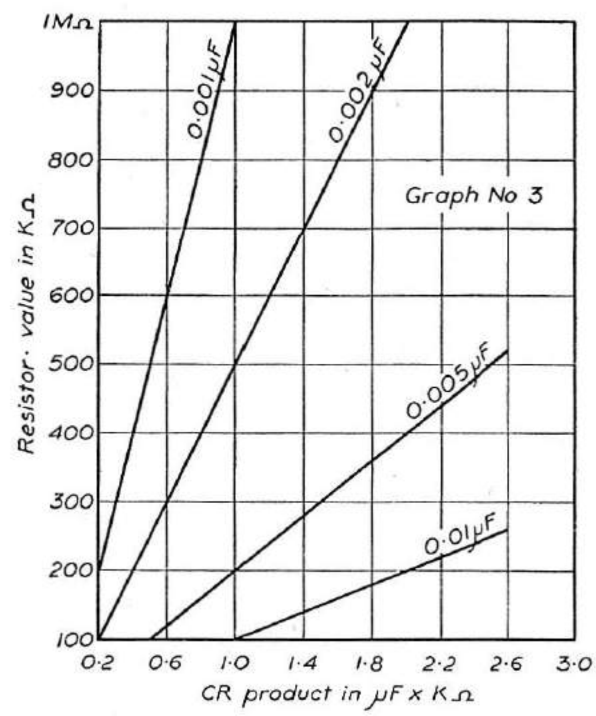




Using the Graphs

1. Determine the desired frequency of oscillation.
2. Decide upon the configuration (i.e. 3 or 4 leg).
3. Enter the frequency into Graph 1 and read the required CR product. Greater accuracy when warranted may be obtained by taking the common logarithm of frequency and entering this into Graph 1A. As an example, for 200 c.p.s., Graph 1 yields CR = 0.32. Alternatively, $\log_{10}$ 200 = 2.3, and from graph 1A, CR = 0.325.





4. For the three-leg network, refer to Graph 2. Enter the CR value found above, choose a capacitor or resistor value, and read off the corresponding component value.
5. For the four-leg network, repeat (4) but first double the CR value before using Graph 2. Graph 3 will take care of values outside the range of Graph 2.

Two examples should make the modus operandi quite clear.

Example 1.

A p.s.o. with three legs is required to tune to 170 c.p.s.

From Graph 1 the required CR is 0.38. Reference to Graph 2 shows that possibilities are:—

Capacitor	*Resistor*
0.002	190 K
0.001	380 K
0.0005 (500 PF)	760 K

In practice one would choose 0.001 and 390 K. If R is small, the action of the anode load shifts the frequency, and if R is made too large, grid current flow likewise shifts frequency.

Example 2.

A p.s.o. with four-leg network is required for a frequency of 230 c.p.s.

Graph 1 shows that CR = 0.28, but 2 CR is required for 4 leg p.s.o. ∴ the CR value to be entered into.

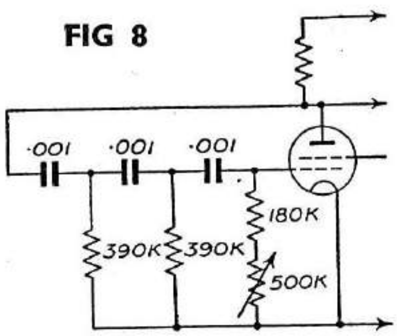
Graph 2 is 0.56.

This yields the following possibilities:

Capacitor	*Resistor*
0.005	110 K
0.002	280 K
0.001	560 K

The latter values would be chosen, since 560 K is a preferred value.

FIG 8



Accuracy

The potential accuracy of these curves is as good as reading errors permit, but in practice the finite value of anode load and onset of grid current both combine to introduce errors. Components of 10% tolerance will normally suffice, and 5% will be better when the amplifier is carefully designed.

For your guidance 1 decade of 5% resistors are shown, with 10% values in heavy print.

100	**270**	620
111	300	**680**
120	**330**	750
130	360	**820**
150	**390**	910
160	430	
180	**470**	
200	510	
220	**560**	
240		

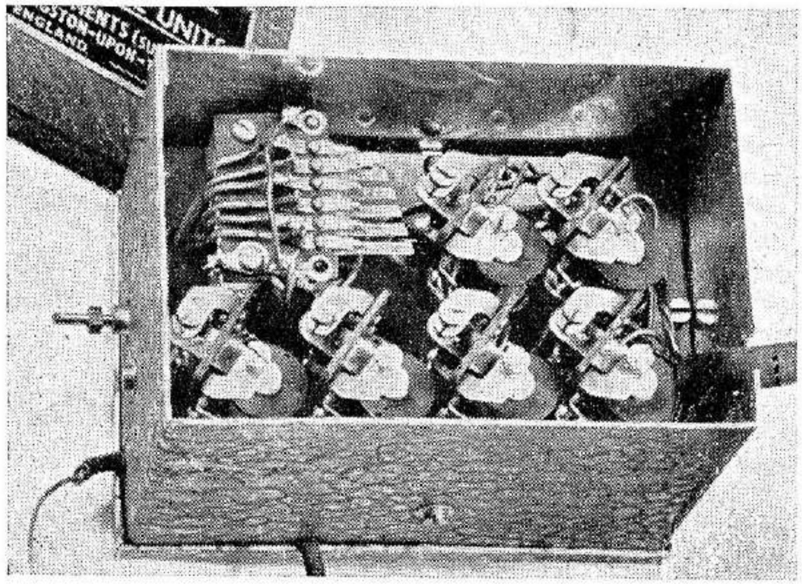
Close tolerance capacitors of the silvered mica variety can be obtained from any radio dealer who has an account with Messrs. Radiospares Ltd.

Well, now, that's all there is to it. With the aid of these graphs you can design an oscillator while the other bloke is getting his slide rule out of its case, and wondering where on earth to start!

Next Month . . . .

HIGHLIGHTS OF THE ISSUE INCLUDE:

COLOUR CODE CHART to pull out for wall fixing ★ DEAC Cells, Use, Care, and Charging ★ Transistor Pulsed Tone Generator for use with McQue Versatile Tx. ★ Swiss and American All-Transistor Receiver Circuits ★ McQuery Column in full swing ★ Potpourri of Gadgets and Gimmicks to make ★ Multi-channel for Beginners, Part 2 ★ Test Report: R. E. P. Octone Tx. and Rx. ★ Latest Equipment ★ Here, There and Everywhere.



Typical tuned reed unit marketed for a long time by E. D. Ltd., and only recently replaced by their improved miniaturised outfits. Author has used this type of unit since its inception for both boats and aircraft.

A FEATURE FOR BEGINNERS

MULTI CHANNEL OPERATION

PART I

By Lt. Col. H. J. TAPLIN

"Taps" as he is affectionately known to thousands of enthusiasts the world over is very nearly "Mr. Aircraft" himself, since as a young man he helped A. V. Roe make his first ever flight, served in the R.F.C., and developed a form of "George" the automatic pilot while General Manager of Spokane Airways in U.S.A. in the twenties. More recently he has produced the Taplin micro-geared motor, and his greatest triumph the famous Taplin Twin model boat and aero engine.

WITH single channel transmitters and receivers it is possible to get a number of different operations in sequence by means of suitable actuators, either by interrupting the simple carrier wave or vice versa, or alternatively by transmitting a permanent carrier wave and modulating it to operate the receiver. We should also know that extra operations may be carried out by the mark space or in other words by pulsing the simple carrier wave.

We can now go on to the more advanced type of transmitters and receivers which are capable of transmitting and receiving a number of different and entirely independent signals, each of which can be arranged to operate a separate piece of apparatus or actuator. Such equipment, of course, is known as a multi-channel.

There are two well-known types of multi-channel equipment, the reed and tuned choke type, the former being by far the more popular.

Now when a carrier wave is modulated, it produces an audible note in the receiver and when used in the single channel equipment the pitch of this note is immaterial. With a multi-channel type of equipment, however, the transmitter is arranged so that the pitch of the note can be varied at will; this is normally done by a control box which is plugged in to the transmitter; in this control box are a number of switches or buttons according to the number of channels that are required, and each button is provided with a potentiometer and the pitch of the note produced by any particular switch may be raised or lowered by means of its own particular potentiometer. Thus if we have a control box with six switches on it and six potentiometers, we are able to make the transmitter transmit six different notes according to the adjustment of the potentiometer for each switch.

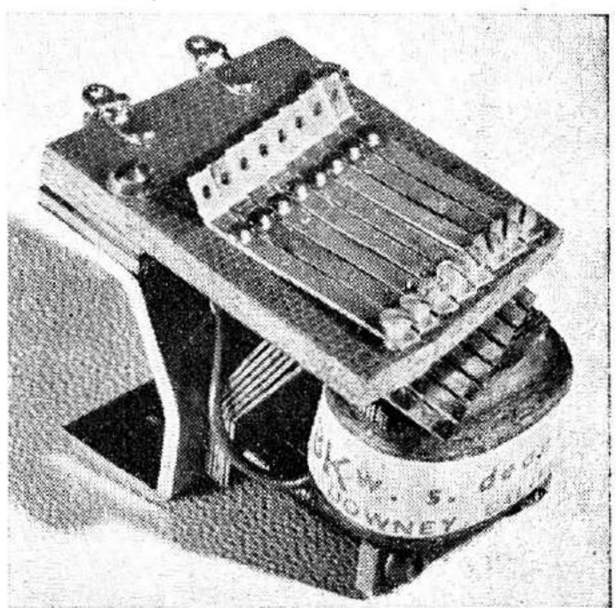
Now let us look at the receiver. The

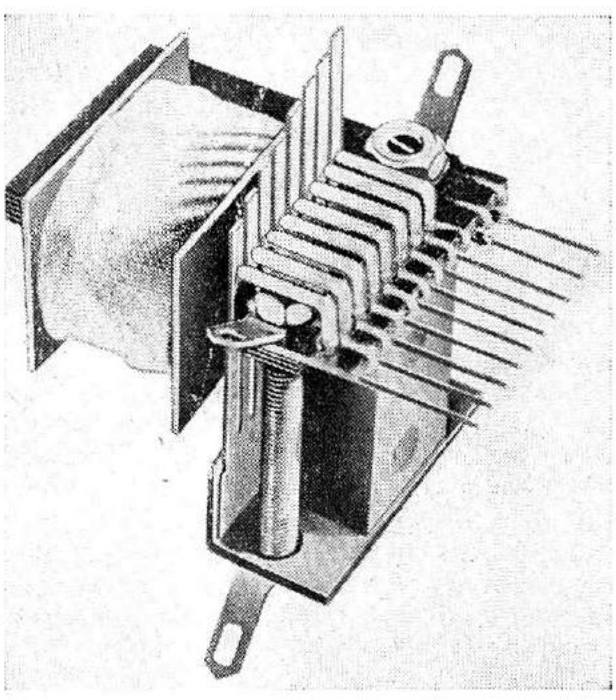
first part of the receiver is similar to that on other single channel systems, i.e. detector valve collecting and rectifying the signal and subsequent amplification valves, but whilst the high tension current from the last valve in the case of the single channel receivers is passed through the coil of the relay, in the case of the multi-channel receiver, the current from the last valve is not passed through the relay direct but is passed into a separate coil which surrounds an iron core. Mounted over this iron core are a number of small reeds somewhat similar to those in an ordinary harmonica, but made of spring steel instead of brass, each reed being of different length to its neighbour. Above each of these reeds is mounted a separate small insulated contact screw or wire which is adjusted so that it does not touch its individual reed. Each of these reeds will respond or vibrate only to an audio note of its own frequency—the longer the reeds, the lower the note to which it will respond and vice versa. When a note is sent out from the transmitter and picked up by the receiver, the high tension current passing through the last valve into the reed coil pulsates at the same frequency as the note sent out by the transmitter. This current in turn magnetises the iron core in a series of pulsations at the same frequency. If we assume that this particular note corresponds to say that of the longest reed, this reed will vibrate. Now we have already said that we have a small contact screw or wire mounted above each reed. This contact screw or wire is connected directly to a relay, so that if we adjust the contact screw or wire so that when the reed vibrates it makes contact, we shall pass a current through the relay in a series of pulses. Since, however, these pulses are intermittent, they are not capable of operating the relay in this form. We therefore have to connect a condenser in the circuit so that the pulsations are evened out and the relay receives a steady current which will operate it.

We have now shown how the multi-channel reed receiver operates in principle. It is only a matter of adjusting

Below : American reed unit designed by W. S. Deans of Los Angeles for Orbit and other sets. Adjustment by screws. Coil resistance of 3,000 ohms.

Below, left : Eight reed relay commercially built by Martin Pfeil of Hildesheim, W. Germany. Note adjustment by bending back contacts.





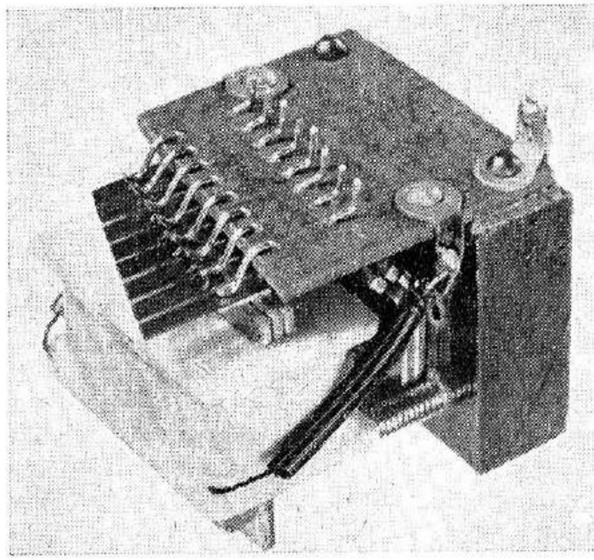
each particular switch or button on the control box to the same note as each individual reed by means of the potentiometer, so that we can make any reed operate independently by pressing the right button on the control box. It will, of course, be understood that each reed has its own separate relay and each relay operates its own piece of apparatus or actuator.

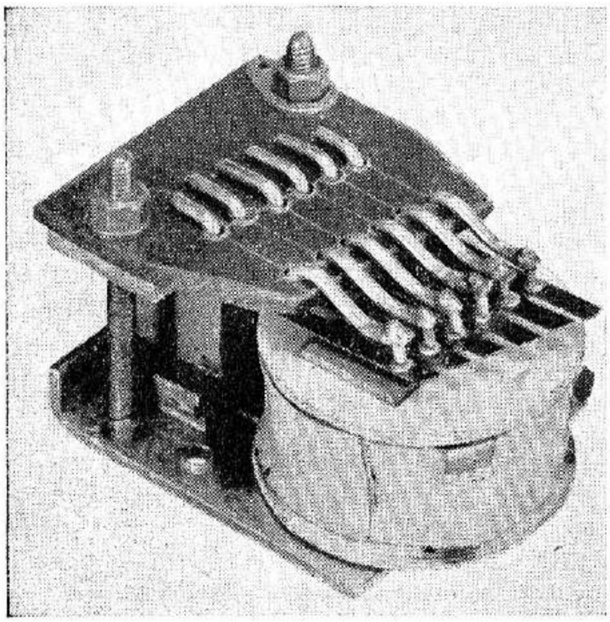
Having adjusted all the switches on our tone box to each individual reed and adjusted the contact screws or wires on each reed to operate its own relay, broadly speaking, they will stay put.

All this may sound very simple to

you and you may ask quite justifiably why use a single channel at all, surely there must be some 'nigger in the wood pile', well, we are not prepared to admit the presence of the said nigger. We will admit, however, that these multi-channel receivers do require care and the adjustments must be understood.

It cannot be denied that a multi-channel receiver and transmitter do require more experience to obtain the best results than with simpler type of apparatus, but nevertheless we will endeavour to explain how to adjust them





Above : Albert Wastable's own design home-built relay, again adjustable by bending. Coil is circular. This French unit set the pattern for European products.

Above, right : R.E.P. octone, a similar unit made commercially, though with oval coil, which clearly shows the Wastable influence.

and how to find any faults which may occur. If you buy a reputable commercial reed set, it should be properly tuned and adjusted when you receive it so don't endeavour to practice adjusting it when you first get it.

It is not our intention to show you how to *make* a multi-channel receiver or transmitter, but to assume that you already have either a commercial or a home-made one correctly wired up in accordance with the instructions.

It should be mentioned here that in installing and wiring up your receiver, you should provide means to register the current flow through the set by means of an 0-10 milliammeter. This meter may be connected in series with the high tension lead (usually the positive). A convenient method of doing this is to use a two pin socket, across the terminals of which is connected a 100 ohm resistance. The terminals of the meter can be connected to a two pin plug to match the socket, to enable it to be plugged in easily. When the receiver is switched on, the milliammeter should show a reading from possibly 1-6 milliamps according to the type of set. Should the needle of the milliamp meter tend to go backwards when the current is switched on, it means that the terminals of the milliamp meter must be reversed.

Having got a steady standing current on the milliammeter, one of the buttons on the control box is depressed and if the set is on the correct wave band a drop in the milliamp meter will be observed. Whilst holding the key on adjust the wave tuning on the receiver until the maximum drop on the milliamp meter is observed, this means that you are then on band so far as the wave length is concerned. It is just possible that by chance you may already be on band. It is also possible that the pitch of the note sent out by the transmitter may exactly coincide with one of the reeds, in which case the current instead of dropping on the milliammeter, will rise. The reason for this is that the reed which responds to this note vibrates, causing the current to flow through its contact screw and bring in its particular relay. Since the coil of this relay receives the high tension current as well, it is obvious that more current will flow and the needle will rise. In other words, whenever the current rises on the milliammeter when a note is sent out by the transmitter, it is an indication that one or other of the relays are coming in. So far we have only tuned the receiver to the correct wave band of the transmitter and we must next tune the reeds individually.

Let us start by depressing the first switch on the control box whilst at the same time slightly turning the potentiometer knob and observing the effect on the receiver. Every time the note on the transmitter, which is being varied by the movement of the potentiometer, corresponds with that of one of the reeds, the milliammeter will be seen to kick over to possibly 5 milliamps. It is perhaps more convenient to tune the reeds in rotation, so whilst still depressing number 1 key on the tone box, we move the potentiometer round until number 1 reed (either the long one or the short one) answers and number 1 relay comes in. Since the twin tuning of the reeds is very critical it is as well to move the tuning knob past its best position as indicated on the meter, and back again. To be sure that the tuning is correct release the key, and operate a number of times, making sure that the relay kicks in every time. Moving on to the next key on the control box we repeat the same performance with number 2 reed and so on until all the reeds are tuned with their individual switch on the control box. If this is correctly done, each switch will operate its own reed and relay.

We have already told you that the reeds will only respond to their own particular note sent out by the transmitter, but this is not entirely true since the two reeds either side of the one which is being operated may also vibrate slightly in mechanical sympathy but insufficiently normally to operate their relays, and this sometimes produces a peculiar effect.

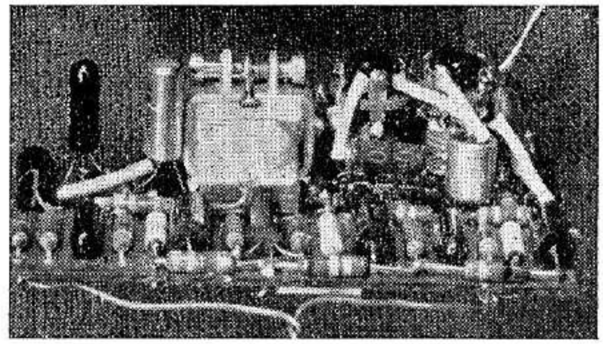
Let us assume that number 1 and number 2 reeds through their relays are wired to operate respectively the right and left turn of the rudder through its actuator; we tune in number 1 reed and subsequently we find the rudder moves as it should do to the right. We then proceed to tune number 2 reed with the next button on the control box to give us a left turn on the rudder but find that no matter where we turn the potentiometer number 2 reed will not operate the rudder to the left, but we note that at a certain point in the tuning, the milliamp meter instead of jumping to 5 milliamps jumps right over and hits the stop, this means that more high tension current is passed than is normally used by the reed coil and one relay, and it becomes obvious that a second relay is coming in at the same time; in other words, although we don't know it, both our number 1 and number 2 reeds are coming in at the same time trying to make the rudder go both ways at once with the result, of course, that it stands still! We do *not* look for the trouble in number 2 reed, but go back to number 1 which, as has previously been pointed out, vibrates faintly in sympathy with number 2; but the adjusting contact screw on number 1 is a shade too close with the result that the faint vibration is sufficient to make contact. We therefore back off the contact screw on number 1 reed slightly and we find that number 2 works quite satisfactorily; inversely, of course, we may find that we get no current rise at all on number 2, whilst attempting to tune it, then it means that the reed itself is probably not making contact with the contact screw. In this case number 2 relay contact screw must be screwed down but must never be allowed actually to touch the reed when the reed is stationary. The gap between the reeds and their contact screws may vary from a few thousands of an inch up to as much as a thirty-second, according to the length of the reed and also the strength of the signal. The failure of a relay to operate may also be caused by the relay itself being set too coarsely. This fault can be identified by tuning the reed so that it is in fact vibrating and making contact with its contact screw, this is certified by the rise of current shown on the meter and indicates that the extra current is passing through the relay coil, but is not operating the relay itself; obviously the remedy here is to re-adjust the relay so that the moving iron is closer to the magnet. To get the maximum efficiency and range from a reed set it is always best to adjust the reed contact screw as close to the reed as possible without actually touching but not so close as to get the interference which we have mentioned above.

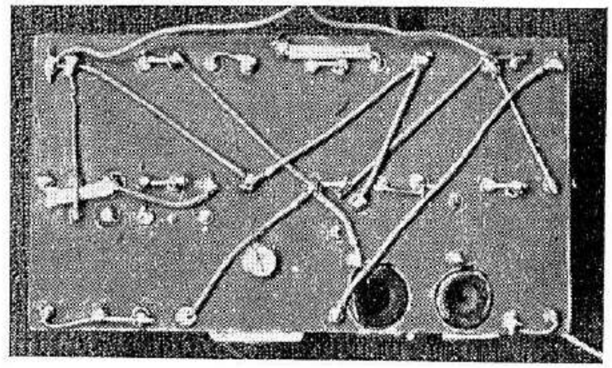
[To be continued]

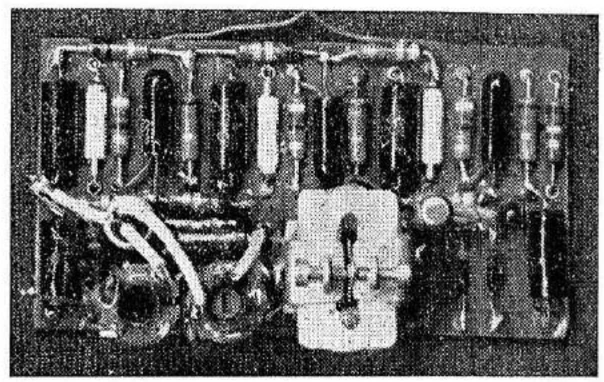
6-Transistor Superhet Receiver

DESIGNED AND BUILT BY
J. W. FORD of S. RHODESIA

Six of these receivers have been built by designer and his friends and operated successfully during the unceasing Southern Rhodesian flying season.







Circuit Description

THE first stage T1 is a self-oscillating mixer, oscillating at approximately 13.5 Mc/s to prevent coupling between oscillate and signal. The mixer delivers an output at approximately 200 Kc/s on receipt of signal.

The following three stages have a total gain of ten thousand times and a bandwidth of over 200 Kc/s. This technique makes the receiver not only easier to construct than the conventional tuned transformer method, but ensures that the receiver still operates even if the transmitter or receiver drift off tune slightly.

The amplified signal from T4 is detected by D1 and D2 which form a voltage doubling detector, applying a D.C. voltage between base and transmitter of T5 causing it to conduct. This in turn causes a heavy current to flow in T6 operating the relay.

The circuit is fully temperature compensated.

Performance

Using a D.C.C.90 type transmitter maximum current change is produced at over two miles with a 2 ft. 6 in. receiver aerial. Using a 100 Ω relay, the maximum current is about 40 m/A. Average standing current is about 2 m/A, the relay is set to operate at 10 m/A. The relay being of much lower resistance than conventional types, operating currents are quite different to those normally encountered.

Supply is from a 4.5 volt dry battery and the current consumption of the receiver on no signal is typically 8.5 m/A. Thus one battery will last for many hours. The writer's receiver was accidentally left switched on from 1.30 p.m. till 10.30 p.m., the same evening, and was still functioning perfectly when tried. A recommended battery is the 4½ volt flat No. 703 (Ever Ready).

CONSTRUCTIONAL DETAILS

The Relay

The following types of relay have ben used on these receivers: Ripmax, E. D. Boomerang, E.D. polarised. In each case those were dismantled and rewound with 38 s.w.g. enamelled copper wire. When the bobbin is full the resistance is approximately 100 Ω. An error of ± 20% on this value can be tolerated although maximum current will be different to the figure quoted.

SUPERHET LIST OF COMPONENTS REQUIRED

Mullard Transistors used :

T_1	OC 170.
T_2, T_3, T_4	OC 44.
T_5	OC 45.
T_6	OC 72 or OC 77 or OC 78.
D_1	OA 70 or OA 71 or OA 81 or equivalents.

Other Components used :

		No. off
Hunts	0.04μ fd. capacitors 150 volt WKG.	7
Hunts	0.002μ f. capacitor 400 volt WKG.	1
L.E.M. or Suflex	47 pf. capacitor	1
	10 pf. capacitor	1
T.C.C.	C_1 C_2 C_3 4μ fd. Miniature Electrolytic capacitors. NB Values of up to 12μ fd. are suitable but a minimum of 4μ fd. is essential.	3
ERIE or Dubilier	¼ or ½ watt resistors.	
	15 k	3
	3.9 k	1
	3.3 k	3
	1.2 k	4
	1 k	1
	470 Ω	4
Aladdin	¼ in. dia. Coil formers (with tuning slug)	2
Relay	100 Ω (see text)	1
Paxolin	⅛ in. sheet	
Rivets or eyelets		43

Aerial Coil

*L*1(*a*). Wind nine turns of P.V.C. covered wire type 1/.018 on ¼ in. outside diameter Aladdin or similar former, close wound. Cement with Polystyrene cement (not balsa cement).

*L*1(*b*). When cement is dry, wind one turn of same wire on outer of *L*1(*a*) and twist ends. Directions do not matter. Connect ends direct to other components or to tags on tag ring which fits on top of former.

Oscillator Coil

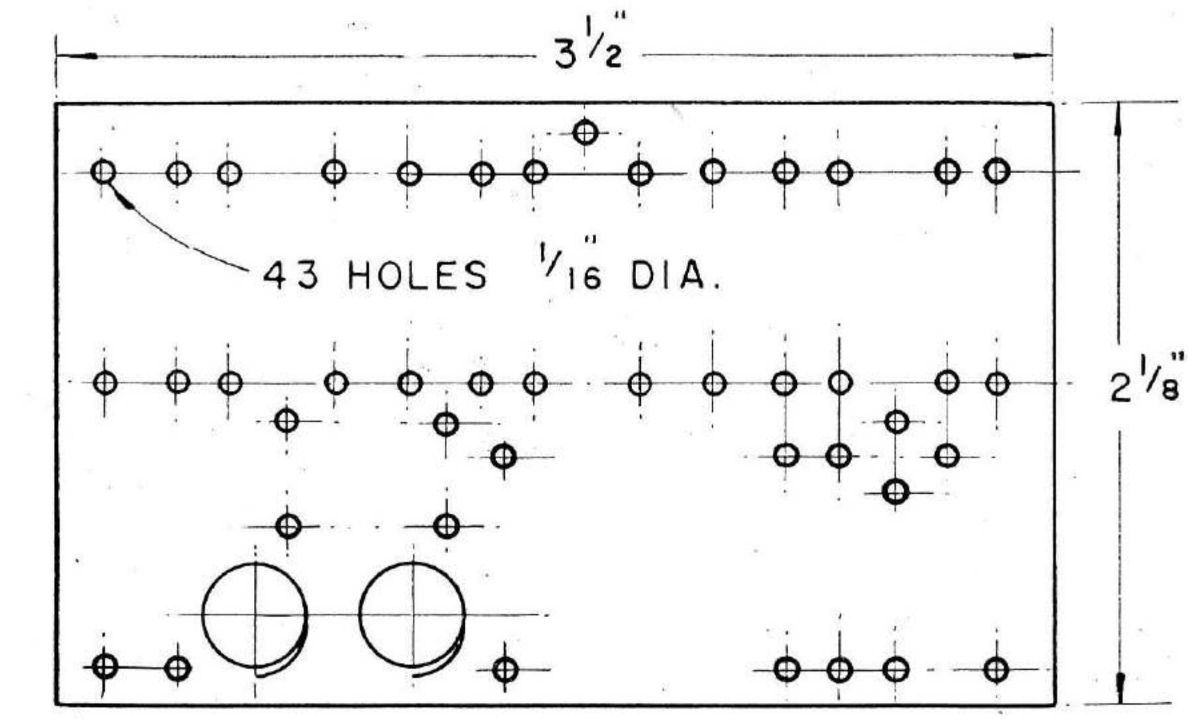
This is wound on a similar type former to the aerial coil but uses Litz wire.

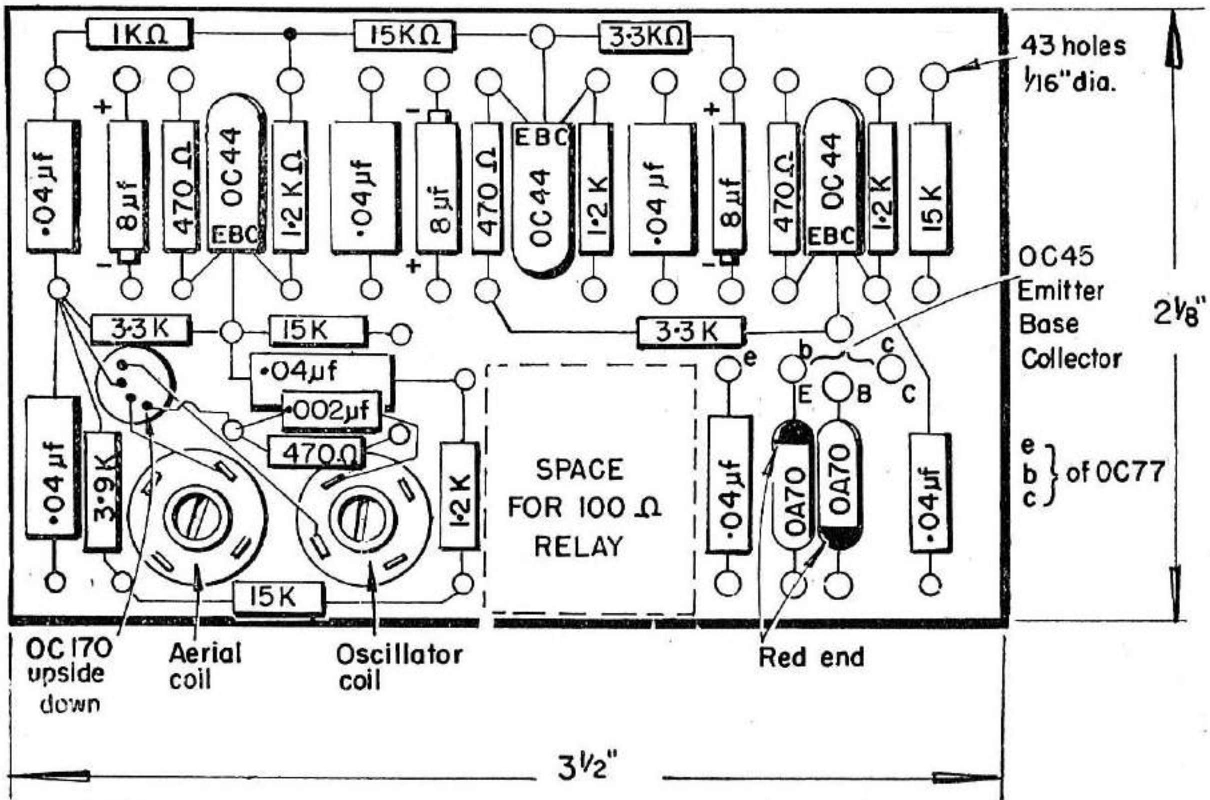
Using 10/47 Litz wire start at the bottom of the former and wind on three turns. Cement and take out a tap at this point.

Continue winding in same direction a further 11 turns. When these are completed, cement, and leave to dry but do not break off wire.

When dry wind a further 11 turns in same direction on top of first layer and cement. This winding is L2(b), the tap being as shown on the circuit, the start being the earthy end. When completely dry wind three turns of ¼ in. wide sellotape over this winding.

Now wind on eight turns of the same wire on top of the sellotape and cement. This winding is L2(a) N1B. It is important when using Litz wire to make sure all 10 strands are soldered to any connections to which it is made.





Other Wiring

The paxolin is cut to size and drilled as shown. Small hollow rivets are then inserted into the holes. Many types of rivet are available for this purpose, the author uses a type used in construction of wafer switches. A suitable alternative is to use soldering pins in place of the rivets.

The wire ends of the components are inserted into the rivet holes soldered in place and the surplus wire clipped off.

Wiring from component to component can be carried out as shown in photograph of the underside of the paxolin.

Layout

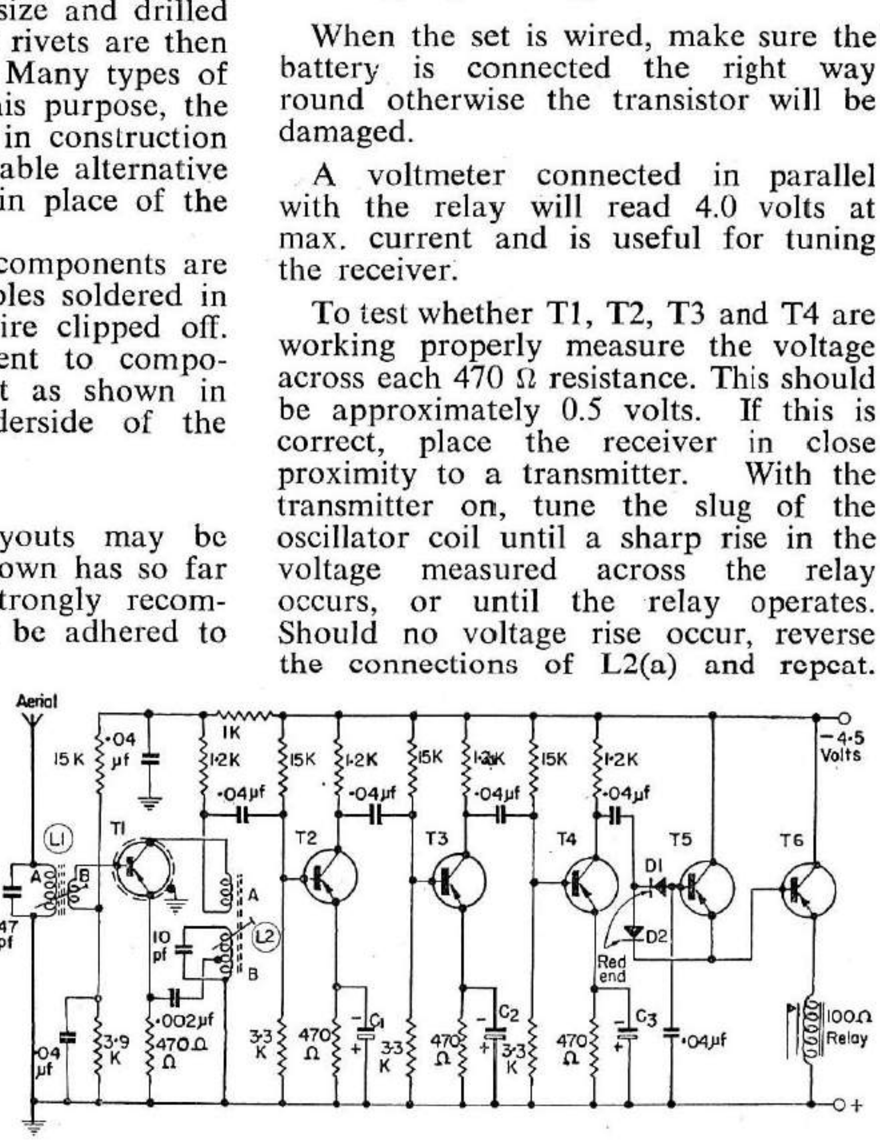
Although different layouts may be satisfactory, only that shown has so far been used, and it is strongly recommended that this should be adhered to as closely as possible.

Testing, Operating, etc.

When the set is wired, make sure the battery is connected the right way round otherwise the transistor will be damaged.

A voltmeter connected in parallel with the relay will read 4.0 volts at max. current and is useful for tuning the receiver.

To test whether T1, T2, T3 and T4 are working properly measure the voltage across each 470 Ω resistance. This should be approximately 0.5 volts. If this is correct, place the receiver in close proximity to a transmitter. With the transmitter on, tune the slug of the oscillator coil until a sharp rise in the voltage measured across the relay occurs, or until the relay operates. Should no voltage rise occur, reverse the connections of L2(a) and repeat.



For the sake of clarity the OC45 and OC77 are not shown on the diagram above; the EBC connectors of the OC45 and EBC connectors of the OC77 are shown. The 10pf and 47pf capacitors are not shown. These are very small and connected vertically from earth to the appropriate coil tags.

Panel on left is shown full-size as drilling jig.

Tune for maximum voltage. Now place the receiver several feet from the transmitter and tune the slug of the aerial coil until maximum voltage across the relay is produced. Final tuning should be carried out at about $\frac{1}{2}$ a mile.

It is always possible to tell whether the oscillator is operating by placing the receiver on top of a short wave broadcast receiver tuned to 13.5 Mc/s or 22 metres. When this is done switch on both receivers, tune the oscillator coil slug until a distinct whistle or hiss is heard on the short wave receiver. If no whistle or hiss is heard reverse the connection of L2(a) and repeat the tuning.

Specification:

6-Transistor Superhet Receiver—
CARRIER OPERATED

Weight: 2 oz. with relay but no battery.
Size: $2\frac{1}{8}$ in. × $3\frac{1}{2}$ in.
Supply: 4.5 volts at 8.5 m/A.
Range: Over two miles.

Radio Control Models & ELECTRONICS

A set was made up and thrown to the tender mercies of our more expert wolves. Comments and designer's answers are given below . . .

TECHNICAL COMMENT ON THE SUPERHET

1. This is not a selective Rx. Bandwidth, is no different from a super-regenerative set.

Designer Ford replies:

Rx. has been deliberately designed for a wide bandwidth to allow for frequency drift in the transmitter and receiver oscillation. Had it been designed for narrow band operation it is probable that both receiver and transmitter would require crystal control, which in addition to increasing cost, would make construction harder especially for a non-technical person.

2. It works and is nearly as sensitive as a super'regen.

Reply:

Would appear to indicate some short-sightedness on the part of your experts, as the reliability and freedom from "touchiness" is far in advance of any super'regen. I have seen. With regard to self capacity of the oscillator coil I am unable to agree with your experts that this is excessive, and in any case cannot see what bearing it has on the performance of this design of receiver.

3. Rather expensive to build.

4. Has good interest value and may stimulate other work in this direction.

Designer has naturally no comment on these expressions of opinion. Cost is always comparative, and the average experimenter would already have many components and so would not have to pay out for them at the time of building. In any event, money spent on a good receiver usually pays dividends in that equipment and a valuable model return safely to home base when less expensive and reliable gear might well have lost both!

The interest angle is surely the important aspect. It will frequently be our practice in the future to publish unusual and perhaps controversial circuits, equipment and modifications in this magazine, when we shall candidly express our opinions and qualify the author's claims if it should seem necessary.

In this instance J. W. Ford's receiver has given us a great deal of pleasure and no little technical profit, and we cannot do better than quote Tommy Ives' final remarks:

"I am very interested in the system and have a valve transistor version which I am playing with, but I am reducing the bandwidth to obtain selectivity as I think it will be worthwhile and will attract the more experienced modeller. The additional cost of the crystal is justified and in any case all our transmitters should really be crystal controlled . . . we may indeed be compelled to do so in the not-too-distant future. In its present form I suggest we include it in the new magazine and the response of our readers will soon put us in the picture".

R.C.M. & E. TEST REPORT No. 1

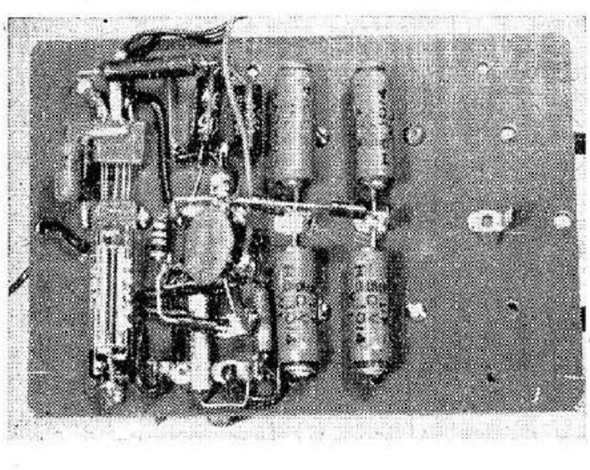
E.D. Black Prince & Black Arrow

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.

BOTH the transmitter and receiver are entirely new developments in reed control using modern electronics techniques, new Mullard type transistors and miniature components. The complete equipment comprises a very compact hand held transmitter and a lightweight reed receiver, both of which are available for 4, 6 or 8 channel operation. This part of a combined review is concerned with electrical testing and performance only; I will deal with the transmitter and receiver separately.

The 'Black Prince' Transmitter

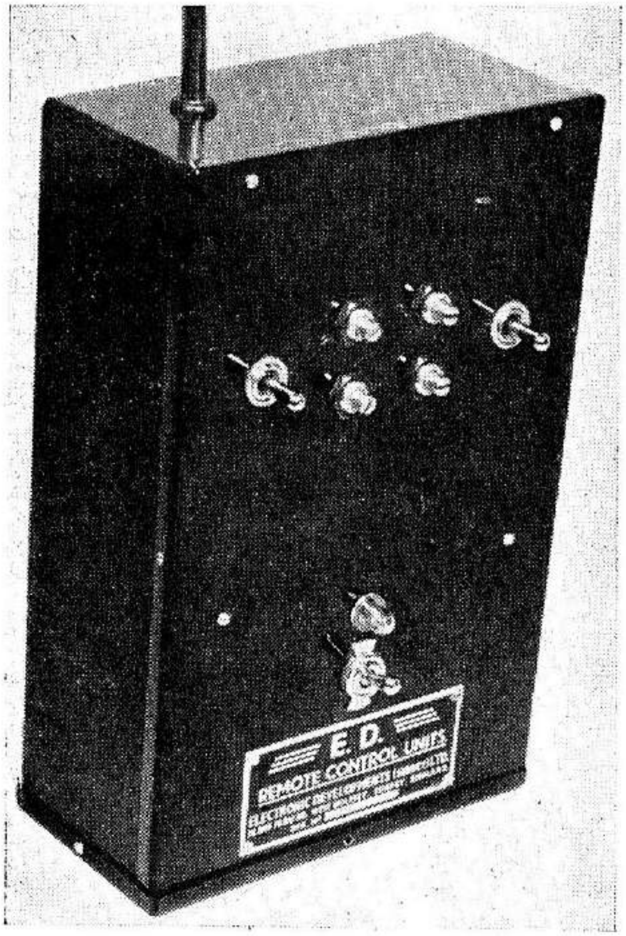
The model submitted for review has a black anodised finished case which being of aluminium helps considerably in keeping weight to a minimum. Construction generally is robust and I was particularly impressed with the chassis which is shaped to comfortably accom-



Above: Receiver with top removed. Note that eight reeds are installed on this four channel unit though four only in use. Below: Underside of the unit.

modate all the transmitter components and valves, and at the same time is rigid enough to prevent trouble from frequency shift due to movement of the transmitter and oscillator tuning coils. The size of the transmitter makes it convenient to carry in one hand whilst operation of the controls is carried out with the other. The aerial is also of quite unique construction being telescopic from 10 in. to its fully extended length of 5 ft. Loaded to resonance by an internal series inductance, this type of aerial is fully efficient, such losses as there are being very small indeed when compared with a full quarter wavelength aerial of 8 ft. 6 ins.

The *Black Prince* is designed to operate from two Ever Ready B101 batteries (67.5v. each) for H.T. and 1 AD4 (1.5v.) for L.T. and employs a circuit which is not widely used for radio control but is actually one of the most economical arrangements for obtaining good frequency stability and maximum efficiency. Two working valves are used, the DL 94 as a self-excited oscillator, this has both anode and grid tuning, resulting in a very efficient circuit. The DK 96 valve is used, as a tone generator and used in conjunction with a high Q Ferroxcube coil thus ensuring complete stabilisation of the generated



tones, each of which is selected by biased switches on the front panel.

Performance Tests

The model sent for review was a four channel version and was tested first with recommended H.T. supply (total 135v. from two Ever Ready B101 batteries) and then with the H.T. voltage reduced to 90v. The frequency stability at 27 Mc/s is good and remained so even with reduced H.T. and as the transmitter is pre-tuned at the factory the only operating frequency adjustment to be carried out is that of tuning the receiver. The waveform of the tone generator was examined and on each range a nearly squarewave signal is applied as modulation voltage to the grid of the power amplifier. Although the voltage output from the transmitter is too low to examine properly on the Y plates of an oscilloscope there was in fact just sufficient to show that the modulation is about the 100% mark; so the maximum possible low frequency signal is available at the reed unit.

Other tests included those of checking the frequency separation between tones. Each tone control covers about 100 c.p.s. so that the range of each channel overlaps the next, and by choosing an approximate mid-setting for the highest tone, each of the others may be set accordingly. None of the settings are critical and once adjusted there is ample separation between operating frequencies to obviate both drift and inter-action between channels. Having set all four reeds to work entirely independently the operating frequencies were measured as follows:—

No. 1 ... ... 480 c.p.s.
No. 2 ... ... 430 c.p.s.
No. 3 ... ... 412 c.p.s.
No. 4 ... ... 390 c.p.s.

The relays pulled in solidly at within ± 5 c.p.s. of the frequencies above and over a long running period a check on the highest frequency proved it to be within ± 1 c.p.s. of the original setting. This is extremely good for a self-generating L.F. oscillator and since the frequency separation required by the reeds is approximately 22, 28 and 50 c.p.s., between channels 4 and 3, 3 and 2 and 2 and 1 respectively, there should be absolutely no inter-action between them whatsoever.

General

Current consumption is 10ma. for carrier only and 12ma. when modulation is applied (at full H.T. voltage). This is comparatively low so that a fair life should be obtained from the recommended B101 batteries. The transmitter was tested at 90v. H.T. and still continued to function satisfactorily from an electrical point of view. L.T. consumption at 1.5v. is only 75ma. The weight of the transmitter is 5 lbs. complete with batteries and its dimensions are $9\frac{3}{4}$ in. $\times$ $6\frac{1}{4}$ in. wide and $3\frac{1}{8}$ in. deep. The layout of the transmitter is such that battery changing is simple and can be done without disturbing the transmitter.

My only criticism and at the same time a suggestion, is that special lock nuts, known as 'pot-locks' should be fitted to the tone controls to prevent accidental shift for although these controls are slotted for screwdriver adjustment, they can be turned easily with the fingers. Each of the channel selectors are spring biased so that they return to the off position when released and are arranged to move up and down for channels 3 and 4 and right or left for channels 1 and 2. Suggested applications are as follows: Channel 1—right rudder, channel 2—left rudder, channel 3—up elevator, channel 4—down elevator. Alternatively channels 3 and 4 could be used for engine control, etc.

Instructions for operating are supplied although I would suggest these include a little more information in simplified style for the non-technical user. E.D. equipment is well known to all radio control enthusiasts and knowing something of their products and of the care that goes into design and production I have no doubt that the *Black Prince* multi-channel R/C transmitter will prove itself a thoroughly reliable unit and enjoy the same prestige as does all E.D. equipment in the field of Radio Control.

The 'Black Arrow' Receiver

Although designed for use with the *Black Prince* transmitter I see no reason why this receiver should not work efficiently with any well constructed multi-channel transmitter. It was, however, tested in conjunction with the E.D.4 channel tone modulated *Black Prince* transmitter and gave a remarkably good account of itself.

Firstly, considering its compactness and lightweight (8 ozs.) the construction of the receiver is robust and it is completely protected against shock and the intrusion of water or oil spray, etc. The reed unit relays the receiver components and transistor are all assembled on a strong bakelite chassis that is locked within the lower half of the receiver case which, like the transmitter, is black anodised finished. Layout is tidy and components are all securely fixed. The leads from each set of relay contacts are brought out ready for connection to servo units, each being clearly labelled and colour coded. Instructions include diagrams for the battery and relay connections as well as full information on installation, tuning and the various other adjustments required.

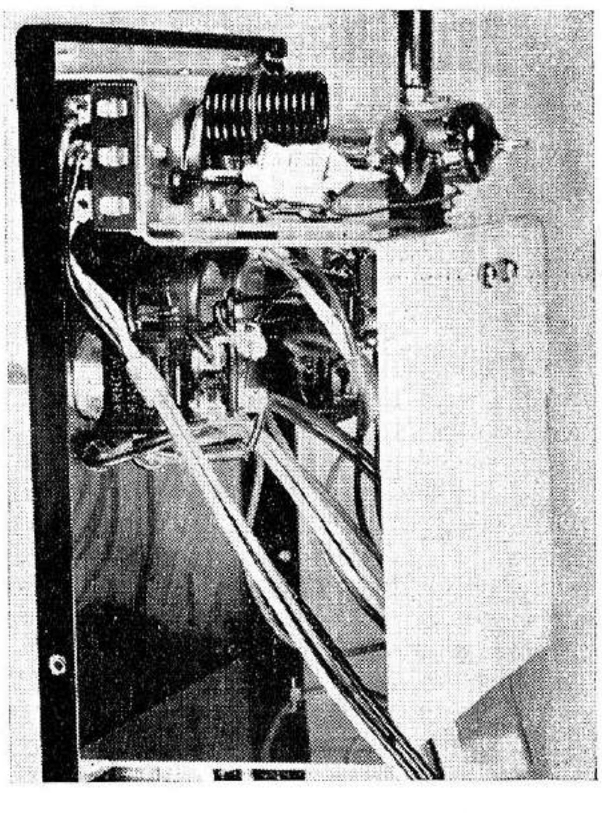
General

The *Black Arrow* sent for review was a four channel version but there was space on the chassis for two additional relays whilst the reed unit fitted was an eight channel unit. The receiver operates from a 30v. H.T. supply and since current consumption is only 1ma. when receiving carrier only, small hearing aid batteries should give good service where requirements demand extra lightweight. Idling current is 1.5ma. (no carrier) and consumption when tone is being received goes up to 5ma.

The circuitry is based on latest type Mullard transistors (OC75) and uses a Hivac XFY34 sub-miniature valve as quench oscillator/detector. The two transistors are operated as low frequency amplifiers and develop some 22 volts r.m.s. of signal into the reed unit. Transformer coupling is used between transistors and temperature stabilisation ensures steady non-drift operation. Tuning requires the aid of a milli-ammeter but is otherwise a simple function.

Performance Tests

The receiver is fitted with a flexible aerial, which from the tests appears quite long enough for all practical purposes. Tuning is not critical owing to the broad band characteristics of the super-regenerative detector and no trouble was experienced in getting the reeds to respond to the four tones from the transmitter. Various tests were made to determine the frequency tolerance required by the reeds (see paragraph on transmitter) and the entire receiver was tested at reduced H.T. (22v.) from which



Above, left: Handsome and handy case in black anodised alloy whence comes series name of "Black". On right: A view inside the compact unit which allows ample battery stowage.

it continued to function perfectly.

The reliable operation of this receiver is undoubtedly due to the nature of the tone signals fed into the reed unit. These signals are nearly squarewaves when transmitted but once received are re-shaped with a fast leading and trailing edge, thus ensuring maximum and rapid movement of the reeds. Various tests were applied to check continuous function of both reeds and relays and a time test revealed that tone frequency drift is no more than ± 1 c.p.s. over a period of 10 minutes continuous operation. Intermittent operation over a period of one hour showed that the tone circuits remained completely stable and almost drift free. Frequency need only be maintained within ± 5 c.p.s. which is more than sufficient for reliable function.

Like its associated transmitter the *Black Arrow* receiver should gain prestige for reliability which surely is of prime importance in any R/C equipment. The working range tests for this equipment must be left to the reviewer who is to test both transmitter and receiver from a more practical point of view, e.g. in a working model. I have no reason to believe that other than a really good performance will be the result of the next stage of testing, for if both units perform successfully during these trials, the manufacturers should be proud of having designed them and potential purchasers will be assured of many hours of trouble-free multichannel radio control.

MODELLERS' REPORT

The units were tested under conditions which could be expected to obtain in normal use for model work. A servo was connected and all batteries included. (TX.: 2 Ever Ready B101, 1 ditto, AD4; RX.: HT.B123 LT. U 10.)

Transmitter

This was found to be well up to standard as technical report indicates.

At 67½ volts H.T. (i.e. half the recommended value) satisfactory operation of the reeds was possible at reasonable range. It is not recommended, however, that R/C operation should be attempted at such low voltage but is an indication of the reliability of the instrument. At this point the neon voltage indicator did not glow and a more precise adjustment of the reed frequency was found to be desirable.

The H.T. current consumption is quite low and a reasonably long life can be expected from the batteries without any falling off in efficiency.

Receiver

This was found to be very sensitive in operation. Was quite easy to install and very little adjustment was necessary to obtain satisfactory operation. Again the remarks in the technical review are fully endorsed but some minor criticisms arise on points which the manufacturers are modifying in production models. This being so there is no doubt that the units represent one of the finest at present obtainable.

It is recommended that care is taken in installation and use. All R/C equipment needs such care and these units are no exception.

Range with the aerial fully extended was found to be:—At 135 volts ground range exceeded ¼ mile with full aerial, and retracted 125 yards.

Points noted are listed below.

(1) A certain amount of feedback was present in the RX. and if the H.T. battery falls, the internal resistance can cause excessive feedback to such an extent that operation of the reeds is not possible. In a severe case "motor boating" could arise. This applies also if phones are connected in the H.T. lead.

The inclusion of a capacitor of from 2 to 4 mfcs. across the H.T. line completely cured the trouble and response was improved.

(2) It was found that the relays as set by the makers operated at a current which appeared to be low. Adjustment of the spring tension is very limited and should not normally be attempted by the user. The makers are arranging for correct contact pressure during assembly.

(3) Relay contacts are not suppressed.

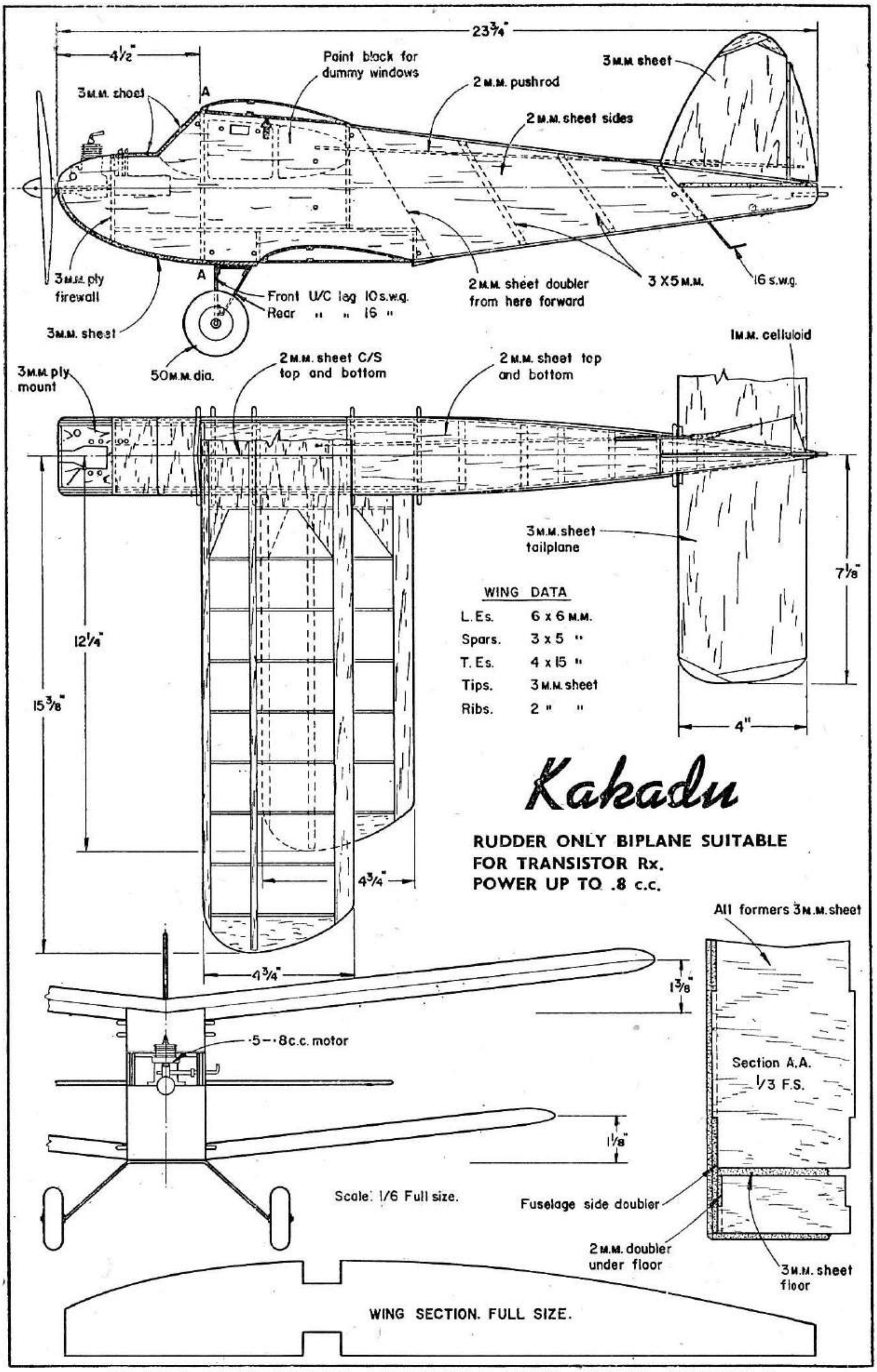
(4) The reed pots. on the transmitter need some protection (e.g. a cover plate or locking arrangement).

(5) The channel switches are a little stiff.

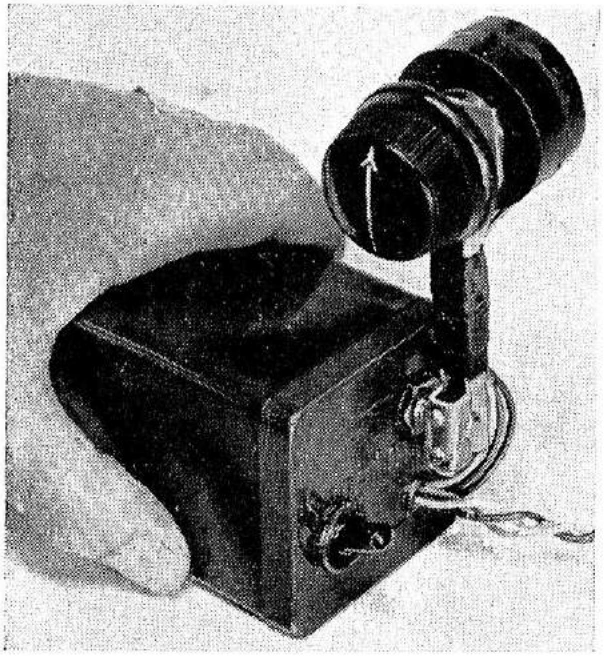
(6) Flexible leads to the TX. and RX. are not anchored and frequent movement in use might cause fracture at the point of connection.

Subject to attention to the points mentioned the two units can be recommended with every confidence.

[N.B. Circuits not available for publication.]



BY KARL HEINZ DENZIN, REPRODUCED FROM GERMAN "MODELL".



"Boystick Control"

THE "Galloping Ghost" system, properly adjusted, has proved itself remarkably good. It is the simplest system except for the control switch, for obtaining two controls, and what is more they are proportional. Suitable switches so far described have used two valves and two geared variable resistors, with L.T. and H.T. batteries.

Since transistors have become available for about the same price as valves, and take far less battery power, the writer has been experimenting with the circuit that David McQue introduced for rudder control, and modified it to suit the requirements of the "Galloping Ghost" system. Using variable resistance of suitable values with restricted movement, it has not been necessary to gear them. Fig. 1 shows the circuit, and the photo the general layout. The 9 volt battery can be made from three penlight batteries, broken apart and coupling wires soldered to connect them all in series. The maximum current flow is only 8 milliamps with a 2,500 ohm relay, so the batteries will have a long life. With a motor driven pulser the battery power required will be about one watt. With the valve pulser it will be a little less, though from more expensive batteries. With the transistor pulser the battery power needed is only about one twentieth of a watt using cheap batteries too.

The fixed resistors, condensers, and transistors can be mounted on a tagboard, or tag strip. There is no real need to use transistor holders but the leads should be kept fairly long and the soldering carried out quickly with a hot iron so that no heat reaches the transistor. The 4 mfd. condensers can be low voltage types, though the really low ones are generally expensive. Those used by the writer were rated at 100 volts and cost 1/3d. each. The relay must have a small and light armature since it has to follow very brief impulses. The one used by the writer was available some years ago and is sometimes a bit tricky to adjust, but is one of the best for the purpose. It has been rewound, the resistance now being 2,500 ohms which is very convenient. However a Seimens high speed relay of 1,000 ohms has also been used. If a Siemens relay with two coils of 1,700 ohms each is available, this can be used by connecting the coils in parallel.

In this case a resistance of 150 ohms should be connected in series with it between the on/off switch and the transistor. This brings the total resistance across this part of the circuit to 1,000 ohms, and the resistance R1 should equal this. If a 2,500 ohm relay is used, then R1 should be 2,500 ohms. The diode D1 is to by-pass the inductive kick from the relay, to prevent possible damage to the transistor.

To avoid gearing the pulse speed resistor, the low resistance end of a 30,000 ohm variable has been used. It is wired so that as the control column is pushed forward, the resistance is reduced. The control column being mounted on this resistor moves fore and aft about a quarter of a revolution. It could move further back, but the pulse would then be too slow for use.

The control column is made from 16 s.w.g. aluminium sheet, about $\frac{3}{4}$ in. wide and 3 in. or 4 in. long. For most of its length it is bent into a channel section as shown in Fig. 2. At the top, which is flat, a $\frac{3}{8}$ in. hole is drilled to take the mark/space variable resistance, and at the bottom a groove is filed to take the other variable resistance. Another piece of channel is made similar but short with which to clamp the resistor shaft, see Fig. 5. A stop plate Fig. 3 is required for clamping

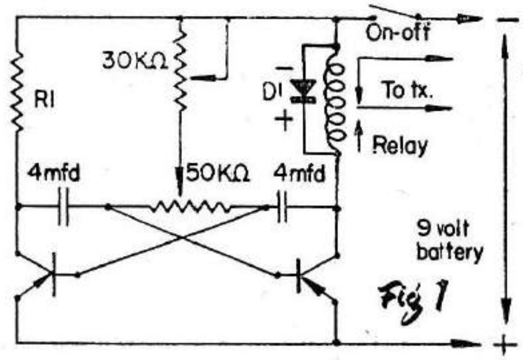
That ingenious experimenter Howard Boys gives his version of a Galloping Ghost modification that we cannot resist calling Boystick Control . . .

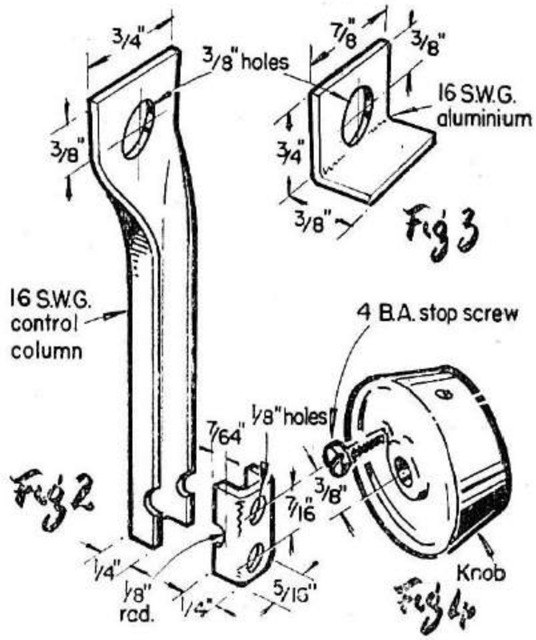
under the nut of the resistor. The top of the control column could be bent over for this, but would make final adjustment more difficult. A large solid knob is the best type to use, so it can have a screw fitted in the back to form a stop Fig. 4. An arrow head on the front of the knob is useful. In this case it will be most convenient if the stop screw is put in line with the arrow head.

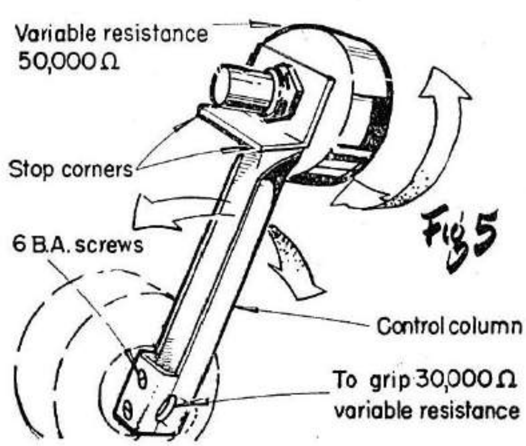
Fig. 5 shows the assembly of the column, resistor and stop plate. The resistor is then set about central and the knob put on with the arrow head, or screw upright. Final adjustment to these parts is carried out with all the equipment in working order so that rudder movement and control knob match up. To achieve this, the stop corners are bent up to catch the stop screw and so limit rotation of the variable resistor. This adjustment should be made with the column forward in the high pulse rate position.

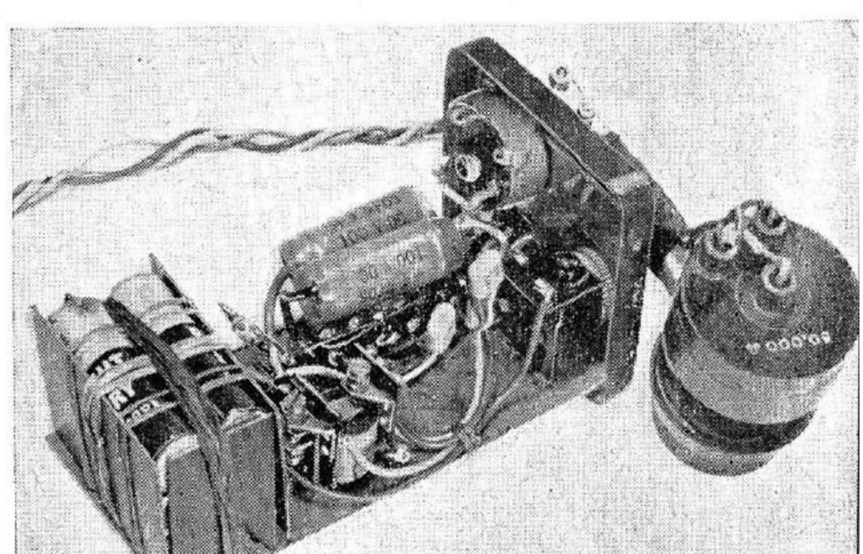
Some sort of case is needed for the pulser, and quite a variety can be made to serve. It is natural to look for an existing tin and a rectangular one will be most suitable. All the parts are best fixed to the lid, using an angle bracket for some of them if the box is deep with a small area. The on/off switch needs to protrude, and also the 30,000 ohm resistor. This should be in a position which allows its shaft to be rotated about ⅓ to ½ a turn with the control column. A rubber grommet is also required in the lid for the wires to the 50,000 ohm resistor, and the transmitter.

The circuit shows only two wires to the transmitter, and only two are needed, but the writer has fitted three wires from a change over relay to a plug which fits the actuator system on the model. This enables tests to be carried out on the model, without the radio link. The connecting socket on the transmitter can be the same type as that in the model.









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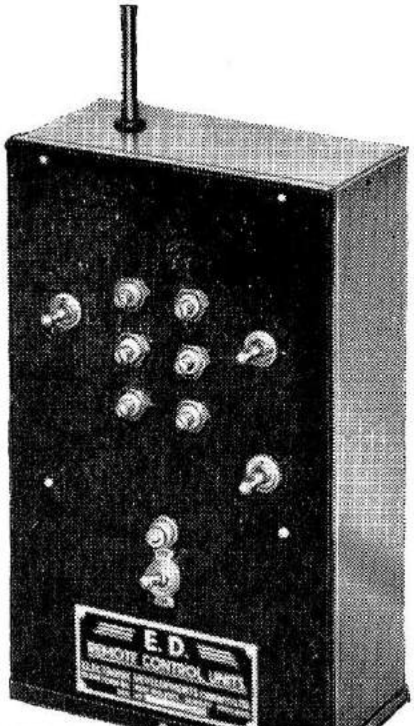

BLACK PRINCE /6

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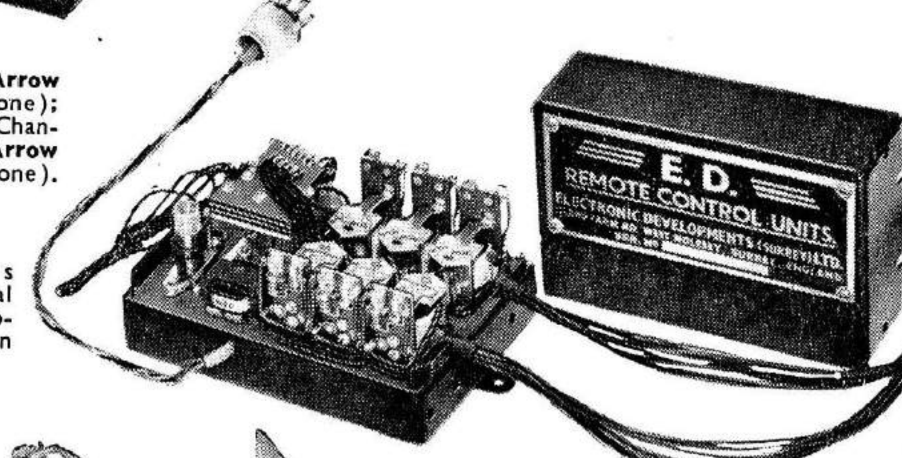

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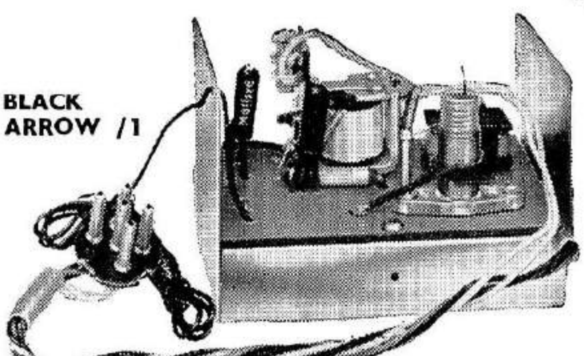
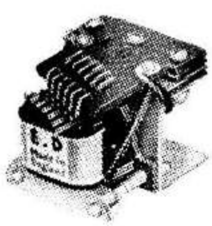


BLACK ARROW /1



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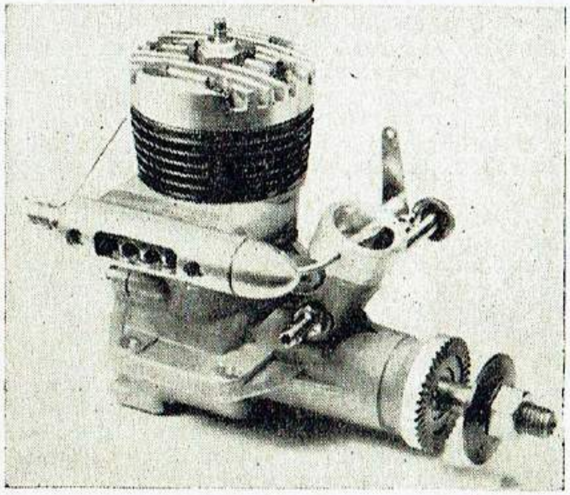

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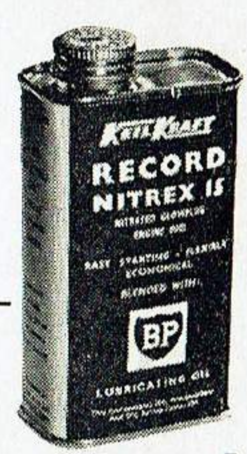

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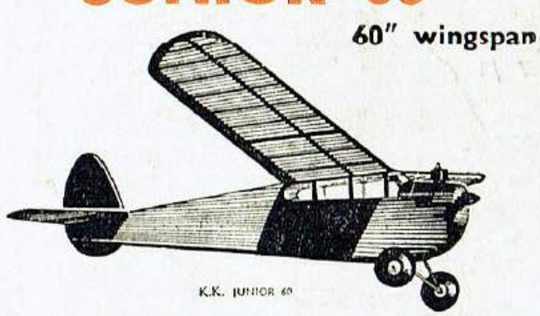

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