Radio Control Models & Electronics

AUGUST 1960

Free Inside

PULL-OUT COMPONENTS & SYMBOLS DATA CHART

★ ★ ★

HILL XTAL CONTROLLED TRANSMITTER

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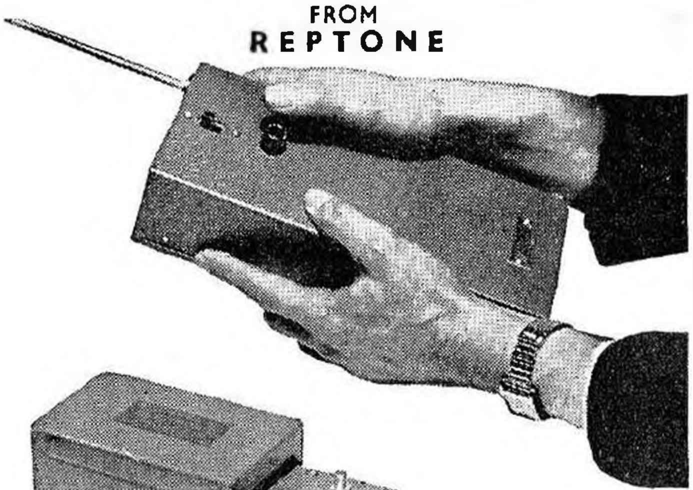

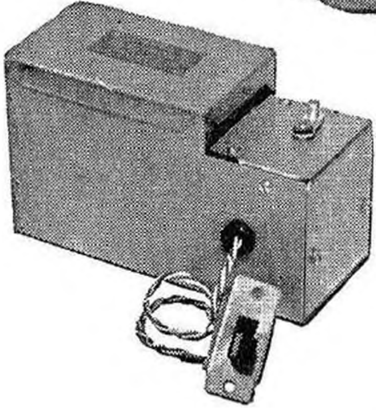

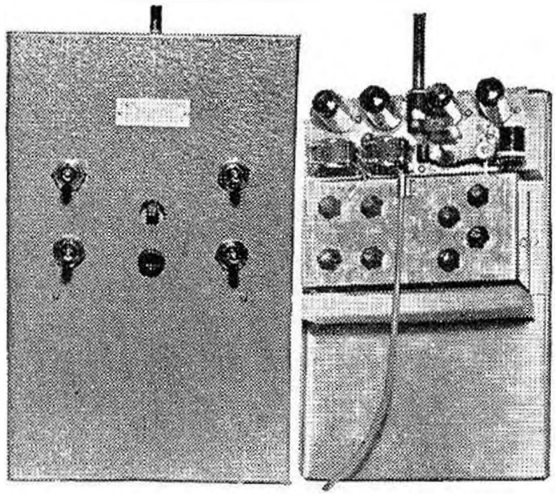

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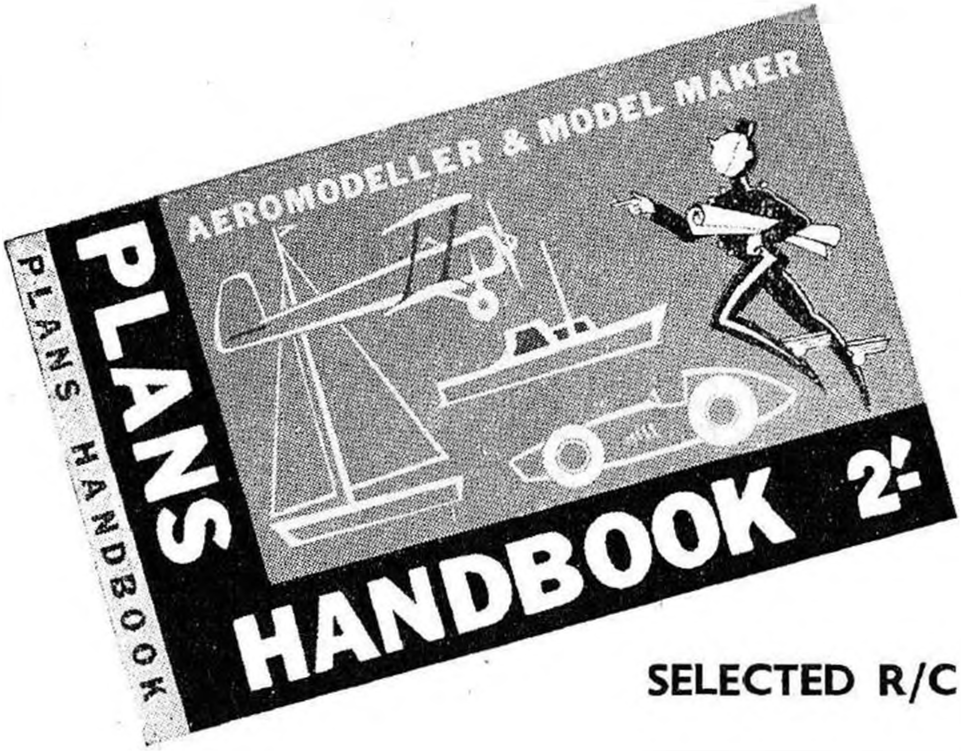

160 PAGES

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AEROMODELLER & MODEL MAKER PLANS HANDBOOK is more than just a catalogue, it is full of useful articles to help the newcomer to the hobby, in addition to the many hundreds of proven designs of aircraft, boats, cars, etc., that have been sold and built in their thousands all over the world. Whatever your interest there is sure to be something in it to rouse your building instincts and set you to work. Every model is illustrated and even if you decide on a design of your own in the end, there is more than enough material to provide you with hosts of suggestions.

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Here, There & Everywhere

Are You All Right, Jack ?

THIS is the time of year when everyone who is anyone in the radio control world is out and about trying out in practice their winter built models on pond or lake or in one of those ever rarer free air spaces so eagerly sought by the aircraft contingent. We have been around studying form and must admit to a degree of amazement at the strides taken by our *leading* exponents in the past year or two. Aloft, it takes a truly polished performance of loops, bunts, rolls and the like to provoke applause from an enlightened crowd. At the pondside, again, mechanical and electronic efficiency in a beautifully prepared craft is the least expected of a contest entrant, who will weave nonchalently through a complicated pattern of buoys in vain unless his boat is faster than ever and impeccably steered.

Alas, this must seem very disheartening to the ordinary man who likes to potter with his boat or aircraft far from the madding crowd and would never dream of even trying most of the experts' manoeuvres, let alone have any hope of executing them successfully. But, take heart, just as there are thousands of average cricketers throughout the land, and only eleven who will play for the M.C.C., so we have our thousands of enthusiasts, who get as much fun as—very often much more than—the limited group of experts, enjoying their hobby at their own pace without thought of fame or prizes. We cater for both groups, but there are so many more of the latter that they can expect, and will receive, far more of our space.

We do hope, however, that any occasional "boffin" sorties that we may make will not prevent them regarding us as the best source of helpful advice . . . as one reader writes: "I am a novice of nearly 40 and don't like to air my ignorance at the local model shop, so do please keep it simple . . ." We will try and if you are still unsure of the answer, a 3d. stamp will invoke our aid without any thought that it is something you ought to know already.

CONTENTS

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

Try This One On Your Friends

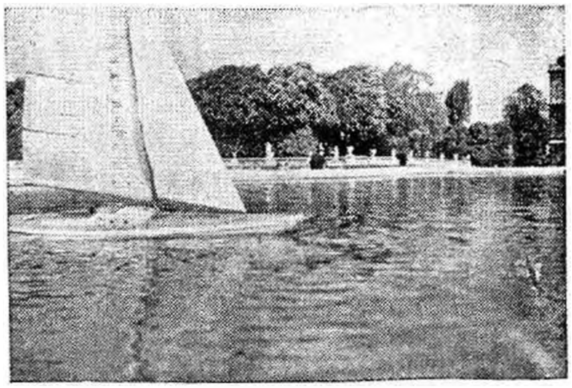
Reader T. M. Wright of Bentley points out the danger of positive statements, by reminding us that gold and silver bands *can* be used as multipliers in addition to their normal use as tolerance indicators, and sends along a resistor to prove it. Gold is x 0.1 and silver x 0.01. If you can get one of these it may bring down your local expert (self styled) a peg or two, concludes our merry reader.

Rather more "clangerlike" was, of course, the omission of the red 2% tolerance pointed out by Reader D. J. Edmonds of Stevenage. This was a consequence of our efforts to keep the Data Chart within normal radio control channels, so ink it in on your chart in case you need to be reminded of it later.

I.R.C.M.S. Annual General Meeting

Arranged unwittingly on Poole's Radio Regatta Sunday, Derby-held A.G.M. of the I.R.C.M.S. was not bursting at the doors to get in all the members. However, the centres were nearly all represented, and the smaller than hoped for attendance did enable business to be completed without those usual digressions that tend to hold up model A.G.M.s. Some administrative streamlining was agreed whereby hon. treasurer K. J. Hayward also embraced the functions of records secretary, and duties of technical secretary devolved on pamphlets secretary N. F. Armstrong, jointly with new general secretary and the group secretaries, all of whom have normally been doing this work anyway. Dr. Dawes continues as Chairman, with E. C. Kennedy as Vice-Chairman and Roy Martin as P.R.O. Newcomer to the most important office of Hon. General Secretary is P. T. Bellamy, who has been making such a fine job of running the large London Group in that local capacity. His address is 28 Thornton Way, London, N.W.11, for the benefit of would-be members.

The I.R.C.M.S. has now been in existence nearly twelve years and does a great deal more than organise the contests associated with its name. Regular technical bulletins are issued to members, there is an instructional pamphlet service, and active centres established in London, Coventry, Birmingham, Tyneside, Hull and Manchester, each enjoying a degree of autonomy something like Crown Colonies! P.R.O. Martin has been a keen propagandist, and only recently arranged a most successful month long display in Damascus on behalf of the British Council. Drop the secretary a line and learn all about it!



Shot taken by R/C camera installed in Dr. Nordin & Son's yacht. With practice true "Beken & Son" quality model shots are possible.

Wagtails Fly High!

Formed only in February of this year, Wagtails R.C.C. is as yet only twelve members strong, and must be content to be a "wandering" team without home flying space, but has certainly leapt to the front with first and second place in single channel event in the British National event at Scampton. D. Knight, with the "Phil Craft Byfly" and G. White with the high wing "Reflex" thus earn a joint first place as subject of the first R.C.M. & E. aeromodelling cover! Congratulations to them both. Club member T. Coppard upheld Wagtail honour in the multi section with a second place, so this was truly a grand week-end outing for the boys. If you are a real enthusiast and live in the Kingston-Richmond area drop a line to the hon. secretary for details: Vic Rigby, 14 Ivydene, West Molesey, Surrey.

Birmingham I.R.C.M.S. Group

Some five thousand spectators enjoyed the Birmingham Group's R/C meeting at the little Valley Pool at Bournville over Whitsun. Local man Chris Guy gave a masterly performance to take the steering event with his *Kingfisher*. E. Millward of Wulfruna R.C.C. took the speed contest with his

Gannet powered glass fibre P.L.4, whose speed and sleek lines delighted the crowd.

Witton Lakes, Birmingham, will be venue of a R/C yachts meeting on September 17th, arranged by Valley Parkway Association. There will also be a high speed course for power boats to try during lunch breaks, etc., as this is mainly a yacht do. With 300 yards width and more than a quarter of a mile length this is the lake really to extend that fast boat! I.R.C.M.S. Birmingham Group Secretary is P. Turner, 40 Ringmere Avenue, Castle Bromwich, Nr. Birmingham. (Tel.: CAS 2845).

A.R.C.C. Grounded !

We are advised that Chalgrove aerodrome is no longer available for flying by A.R.C.C. members. Local residents have protested loudly enough to the landlords to be heard above the noise of engines, model, motorcycle, kart, etc., which was the subject of their complaint and alas this is one less airfield for the boys. In all fairness, the model side is really suffering for the faults of others in this instance, since its modest complement of sound would have offended no one but they are off all the same! A new club venue has not yet been found, but members will be kept informed.

R/C Triggered Cameras

Some readers may have seen recent pictures of the tennis championships at Wimbledon taken by balloon camera, which today is very different from the hit-or-miss crudity of bygone years and features remote control triggering, directional aids and so on. We have not yet seen any modeller doing much in this line, though Geoff Pike had a cine camera in one of his models and produced a film of himself taken by himself from the model! French father and son team of Dr. Pierre Nordin and Nordin Jr. of Paris have a camera equipped R/C yacht which will take pictures of its opponent during a race or any other desirable feature, as our picture shows. Boat is only three feet long but carries a Brownie. Photos are taken by trigger worked via a second escapement. Apparatus is very reliable and very simple, only snag being that it will take only one shot per trip (presumably winding on the film and resetting is impracticable in so small a model).

Colour Guide

We had intended to stick to an orange second colour on our cover, and perhaps come to be known as the "orange 'un" but readers have complained that they cannot at a glance check whether the new issue is in at their favourite model shop without lingering and perhaps even buying some expensive novelty. To help them we are therefore providing a monthly change of cover colour as well as contents in our mutual interests.

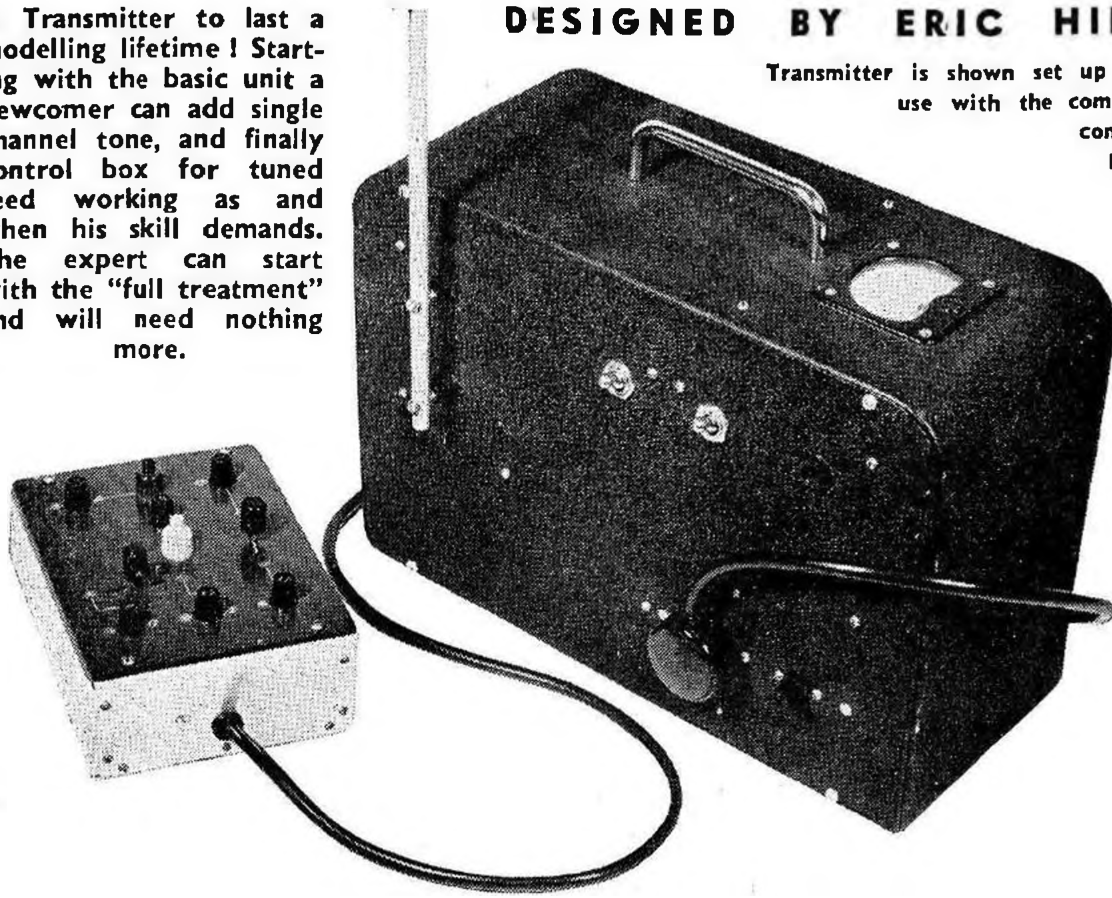
Starting at the Very Beginning

Next month we shall be implementing our promise to look after the absolute beginner by offering a receiver that can not only be made but also easily operated by the complete novice, with even the soldering practically foolproof. This will not be a new set, but rather a new slant on a very old one, since Tommy Ives has re-designed his famous "Ivy" circuit to make an ideal introduction to the subject for newcomers. Panel will be large enough for one solder joint not to menace any other, parts will be easily procurable, and instructions comprehensive. The resulting Rx. will be suitable for either aircraft or boat use.

To round off the picture we are arranging for a ready drilled and eyeletted panel to be available, and for the quench coil bobbin to be made up ready for wind-to be made up complete. A set of components will also be offered.

A Transmitter to last a modelling lifetime! Starting with the basic unit a newcomer can add single channel tone, and finally control box for tuned reed working as and when his skill demands. The expert can start with the "full treatment" and will need nothing more.

DESIGNED BY ERIC HILL



Transmitter is shown set up for use with the compact control box.

The Hill Transmitter

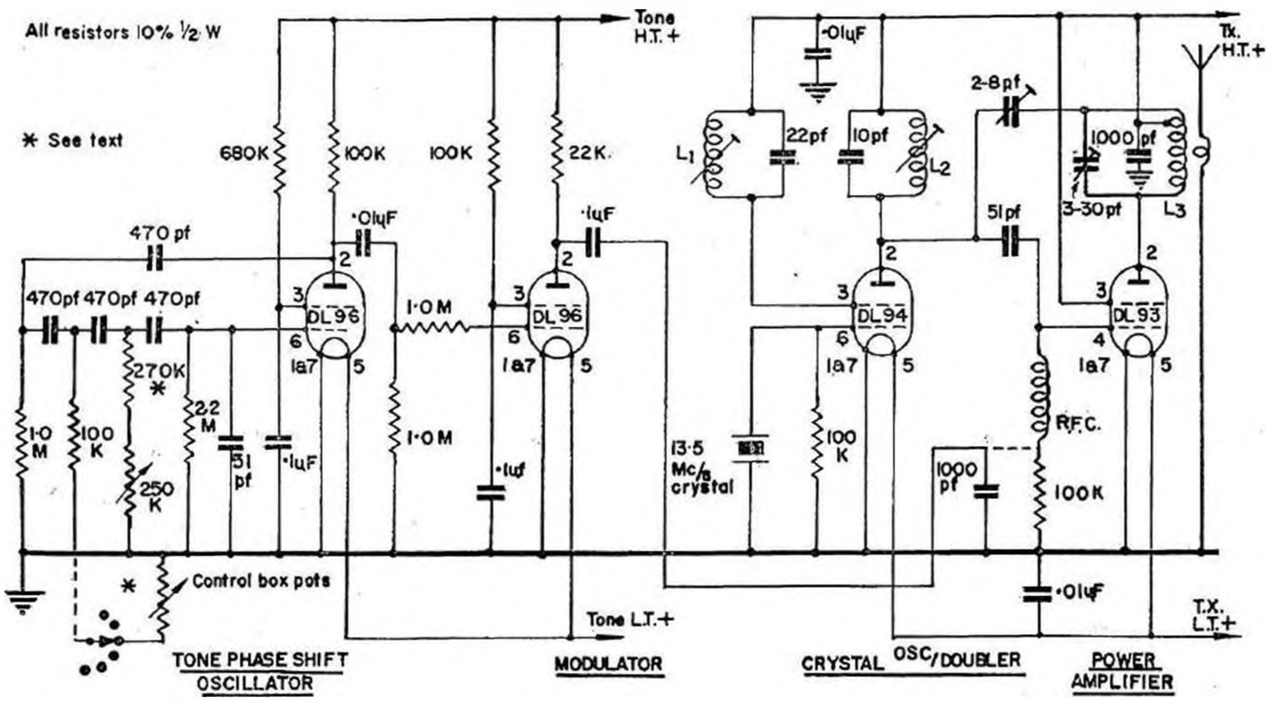
THIS transmitter cannot claim to be the simplest, cheapest or even the lightest, which has ever been offered.

Perhaps the cardinal sin is that it is not even hand held. The writer was never able to keep up with his models anyway!

It does, however, have a number of good points in its favour and these are enumerated below:—

1. It is crystal controlled. A 'must' in the writer's humble opinion.
2. The power output, whilst insufficient to light a car bulb, is not in the 'mouse power' bracket of some transmitters which shall be nameless.
3. Batteries of a sensible size are employed.
4. The tone generator is remarkably stable compared with transformer coupled types and provides a high output.
5. The tone modulator stage isolates the tone generator from the transmitter, this further improves the tone stability and provides 100% modulation of the carrier.
6. Tag panel mounting of the components used in the tone stages makes for ease of construction.
7. Due to the overall stability of the complete transmitter, both carrier and tone can be keyed. This represents a considerable saving in H.T. current and can be used to advantage with superhet receivers and with super-regen. receivers where the quench noise has been adequately suppressed.
8. From the above remarks it will be seen that the system of tone working depends on the receiver employed and not on the transmitter. However, whether keyed tone and carrier or just keyed tone working is required (with single channel or tuned reed) it is merely a matter of appropriately strapping two pins of the octal plug.
9. The complete transmitter can be considered and constructed in three distinct stages:

(*a*) *The R.F. section.*



This, of course, is all that is required for working a carrier operated receiver (such as the 'Hill' Rx.).

(*b*) *The tone section.*
With the addition of this section, receivers requiring a modulated carrier can be operated.

(*c*) *The control box.*
Added to (a) and (b), you are in business with a transmitter for tuned reed working.

10. Owing to the high level of modulation applied to the P.A. stage its current falls with tone working. This offsets the current drawn by the tone oscillator and modulator and results in a current drain, which is substantially constant at approx. 30 m.A.

Circuit Details

The Transmitter

Valve V3 combines the functions of crystal oscillator, amplifier and frequency doubler. The screen grid is effectively the anode of a triode crystal oscillator and is tuned by L1 and the 22 pF. to the crystal frequency of 13.5 Mc/s. The anode is tuned to 27 Mc/s. (the second harmonic of the crystal) by L2 and the 10 pF.

The drive so obtained is applied to the grid of V4 via the 51 pF. coupling capacitor. This capacitor in conjunction with the 100 K. grid resistor provides dynamic bias for V4, the P.A. (Power Amplifier) stage. The R.F. choke has a high impedance at 27 Mc/s., and provides the grid load when the 1,000 pF. capacitor is connected across the 100 K. for tone working. This capacitor can be omitted if the transmitter is used solely for carrier working.

V4 is operated as a straight pentode P.A. stage with its anode tuned to 27 Mc/s. by L3 and the 3/30 pF. trimmer.

The P.A. stage of any transmitter is the stage used to provide the power to the aerial. It is also the stage which invariably uses most of the H.T. current. To operate this stage as a frequency multiplier as well considerably reduces its efficiency and can hardly be justified merely because a straight P.A. stage (that is one in which the grid and anode are tuned to the same frequency) may require neutralising. This has always puzzled the writer, particularly as with radio control transmitters we are working with one fixed frequency.

There is nothing mystical about this business of neutralising and a few words here about it may not go amiss. When the anode and grid of a valve are tuned to the same frequency the signal appearing at the anode (the output) is an amplified version of the signal applied at the grid (the input). If the sum of the external stray capacities and the capacity which exists within the valve between the anode and grid (i.e. between the output and input circuits) is sufficient, self oscillation may occur.

Whilst good layout can minimise external coupling, there is little that can be done about the internal capacity of the valve.

All is not lost however, as by feeding back externally the same amount of energy as is being fed back internally, but in the opposite sense or phase, this internal capacity can be cancelled out or 'neutralised'.

In designing the P.A. anode coil assembly, the writer incorporated a neutralising circuit and was then agreeably surprised to find that it was not strictly necessary. However, other constructors may not be as fortunate and it is far easier to fit it during construction than afterwards.

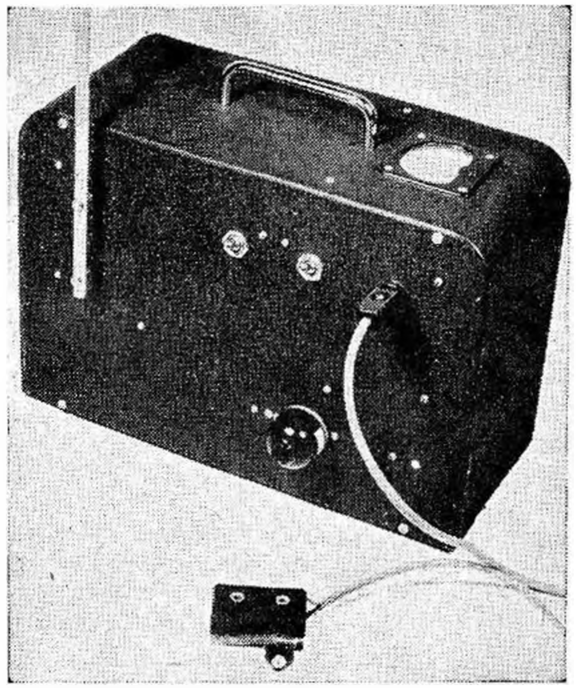
In this transmitter, neutralising is achieved by tapping the coil one turn down and applying the H.T. at this point. The R.F. developed in this turn is applied to the grid of the P.A. valve via the 2/8 pF. trimmer. The reason why this trimmer is connected to the other side of the 51 pF. is to remove the H.T. from it.

The aerial (which should be approx. 8 ft. 6 in. long) is coupled to the P.A. coil by means of a two-turn link.

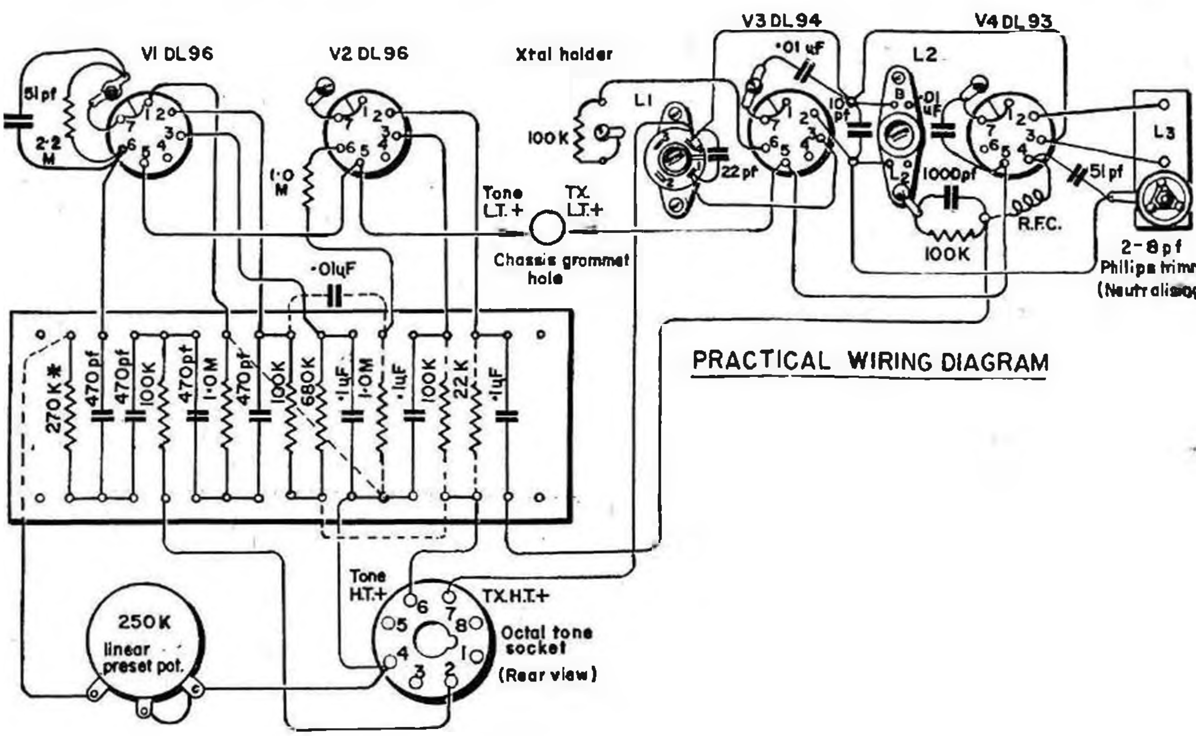
The Tone Circuit

The problem of providing a stable tone source is not as easy as might be expected, and has been tackled in various ways in different transmitters. The output must be sufficient to provide a high percentage of carrier modulation and yet must not be subject to drift due to variations in the H.T. supply or R.F. drive.

In this transmitter a phase shift oscillator is employed, followed by a



Octal tone socket connection is plugged off, and button lead jacked in place on the Tx. in this picture.



modulator stage. This arrangement satisfies all these requirements to a high degree and provides 100% modulation of the carrier, with minimum H.T. current drain.

The only disadvantages are that two valves are used and that the frequency range is limited to an octave. As the reeds of a reed unit should be within an octave anyway, this latter point presents no real problem.

The Phase Shift Oscillator

In any valve the amplified signal appearing at the anode is opposite in phase to that applied at the grid. In order to obtain oscillation this signal must be reversed in phase and then applied to the grid, so reinforcing, the signal which produced it. With transformer coupling this is done by connecting the secondary winding the right way round, whilst in phase shift oscillator it is achieved by utilising the change of phase which occurs with resistor-capacity coupling.

In this transmitter four R.C. sections are employed, each section playing its part in reversing the phase of the signal. Only at one frequency will phase be shifted through 180° and this is determined by the values of the resistors and capacitors used in the network. Increasing the value of any of the capacitors or resistors in the network will result in a decrease in the tone frequency, and, of course, decreasing their values will increase the frequency.

LIST OF COMPONENTS REQUIRED.

(1) FOR BASIC TRANSMITTER

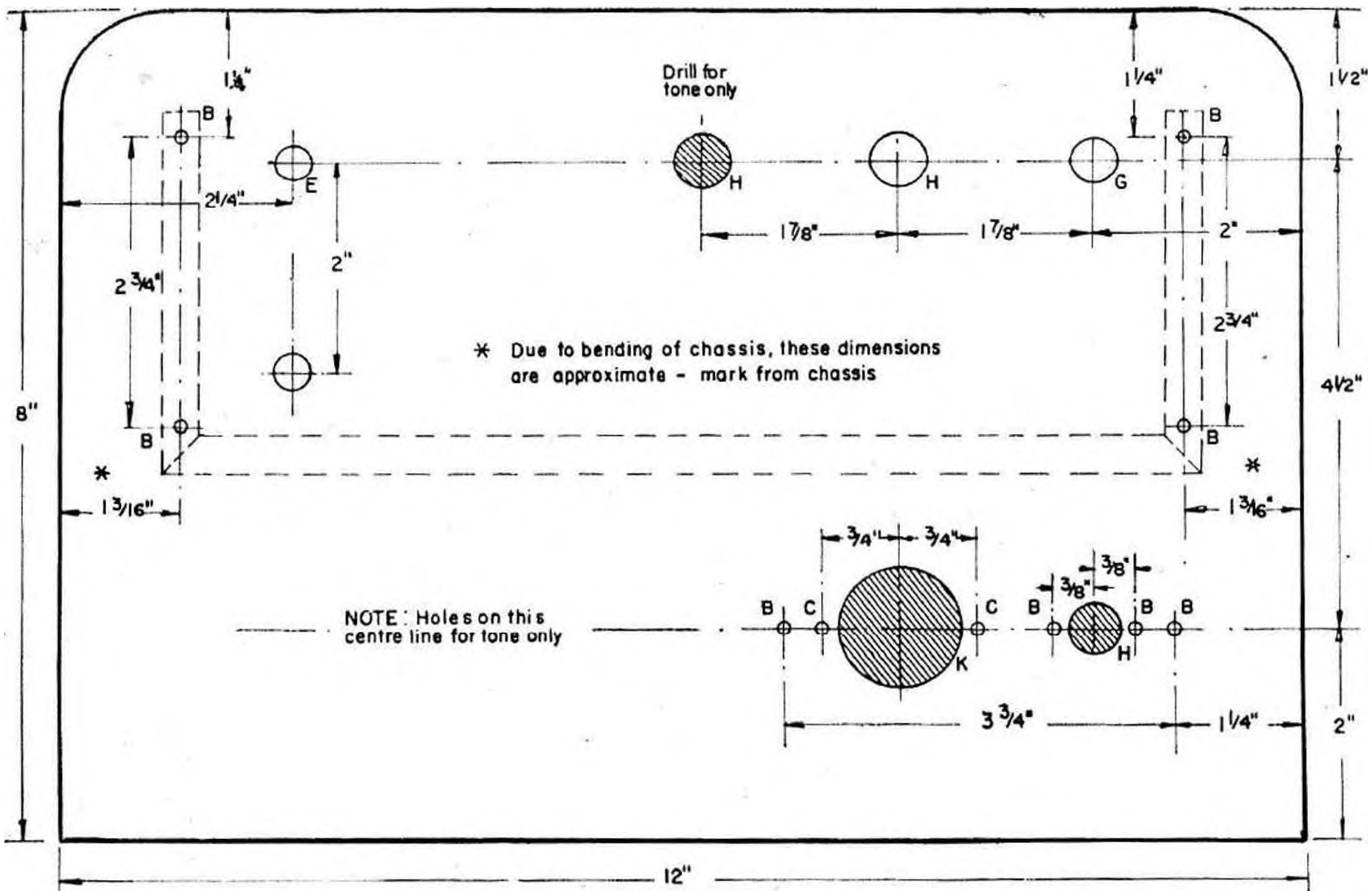
1 12 in. x 8 in. x 5 in. deep, steel cabinet. (Reosound De-Luxe).
1 17 in. x $2\frac{3}{4}$ in. piece of 18 s.w.g. aluminium.
1 0-50 m.A. $2\frac{1}{2}$ in. flush square moving coil meter.
1 Double pole, Double throw toggle switch.
1 Midget jack (Igranic type P71).
2 Aerial stand off insulators (Denco type F.T.1).
1 Aerial and Base.
1 13.5 Mc/s. Crystal ($\frac{1}{2}$ in. pin spacing). (Brookes type S.M.).
1 Crystal holder.
1 DL93. (3A4) valve.
1 DL94. (3V4) valve.
2 B7G Moulded valve holders.
1 2/8 pF. Philips trimmer. Type T940.
1 3/30 pF. Philips trimmer. Type T941.
1 10 pF. Ceramic tubular (Erie type G.P.1).
1 22 pF. Ceramic tubular (Erie type G.P.1).
1 51 pF. Ceramic tubular (Erie type G.P.1).
1 1000 pF. Ceramic tubular (Erie type G.P.2).
2 0.01 microfarad paper tubulars (Hunts 'Mouldseal' type B810).
2 100 K. $\frac{1}{8}$ watt 10% (Dubilier type BTS).
1 R.F. Choke (Denco CH2 choke core fully wound with 40 s.w.g.).
1 $\frac{3}{4}$ in. coil former ("Neoform").
1 $\frac{3}{8}$ in. coil former (fully threaded fine pitch) ("Neoform").
1 Jack plug (Bulgin type P38).
1 $1\frac{7}{8}$ in. x 1 in. x 3/32 in. Paxolin (for P.A. Coil Base).
1 yd. each of 32, 22 and 16 s.w.g. enam. copper wire.
1 bot. Denco polystyrene cement. (Note: tube type for models unsuitable).
1 Battery plug, two pin type E.R.2.
2 H.T. Banana plugs, Red (Clix type MPT1).
1 H.T. Banana plug, Black (Clix type MPT1).
1 yd. 1 mm. Systoflex sleeving.
1 yd. 22 s.w.g. tinned copper wire.
1 yd. each of red, black and blue plastic flex (Radiospares).
1 doz. 6 B.A. $\frac{1}{4}$ in. R/H brass screws and lock nuts.
6 6 B.A. $\frac{1}{2}$ in. R/H brass screws and lock nuts.
2 8 B.A. $\frac{1}{2}$ in. R/H brass screws and lock nuts.
4 6 B.A. full nuts.
3 6 B.A. solder tags.
2 Miniature rivetting soldering tags.

(2) ADD. FOR SINGLE CHANNEL TONE

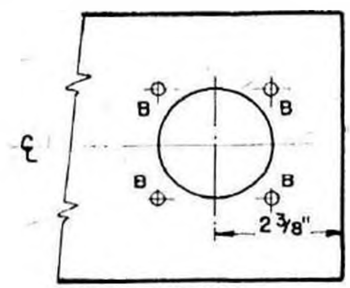
2 DL 96. Valves.
2 B7G moulded valve holders.
1 Octal moulded valve holder.
1 Octal plug (Bulgin type P448).
1 Double pole, double throw toggle switch.
1 0.01 mF. paper tubular (Hunts "Mouldseal" type B810).
3 0.1 mF. paper tubular 250 volt (Hunts "Mouldseal" type A306).
1 1000 pF. ceramic tubular (Erie type G.P.2).
4 470 pF. 10% ceramic tubulars (or Silver Mica) (Erie type G.P.2).
1 51 pF. Ceramic tubular (Erie type G.P.1).
1 2.2 Megohm. $\frac{1}{2}$ watt 10% (Dubilier type B.T.S.).
3 1.0 Megohm. (Dubilier type B.T.S.).
1 680 K. ditto
1 270 K. ditto
3 100 K. ditto
1 22 K. ditto
1 250 K. linear pre-set potentiometer ("Morganite").
1 "Radiospares" Miniature Tag Panel.
6 6 B.A. $\frac{1}{4}$ in. R/H brass screws and lock nuts.
2 6 B.A. $1\frac{1}{4}$ in. R/H brass screws and lock nuts.
6 6 B.A. full nuts.
1 yd. each of single flex, assorted colours (Radiospares).

(3) CONTROL BOX

1 Control box size 6 in. x $4\frac{1}{2}$ in. x 2 in. deep. (Fabricated from 18 s.w.g. aluminium).
1 Paxolin panel size 6 in. x $4\frac{1}{2}$ in. x 3/32 in.
2 Push button switches, double pole, Push to make types (Castelco).
2 Double pole, double throw, key switches.
Linear pre-set potentiometers (Morganite) :—
(For E.D. six red unit).
3 500 K.
3 2.0 Megohm.
(For E.D. eight reed unit).
2 100 K.
2 250 K.
2 500 K.
2 2.0 Megohm.
1 Octal plug (Bulgin type P448).
2 yds. Plastic four cored circular cable.
1 yd. each of red, blue, green and yellow plastic flex (Radiospares).
4 6 B.A. countersunk $\frac{1}{4}$ in. brass screws and nuts.
4 $\frac{3}{8}$ in. binding head P.K. screws.



FRONT PANEL

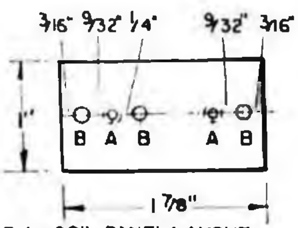


TOP OF CABINET
METER POSITION
Cut holes to suit meter

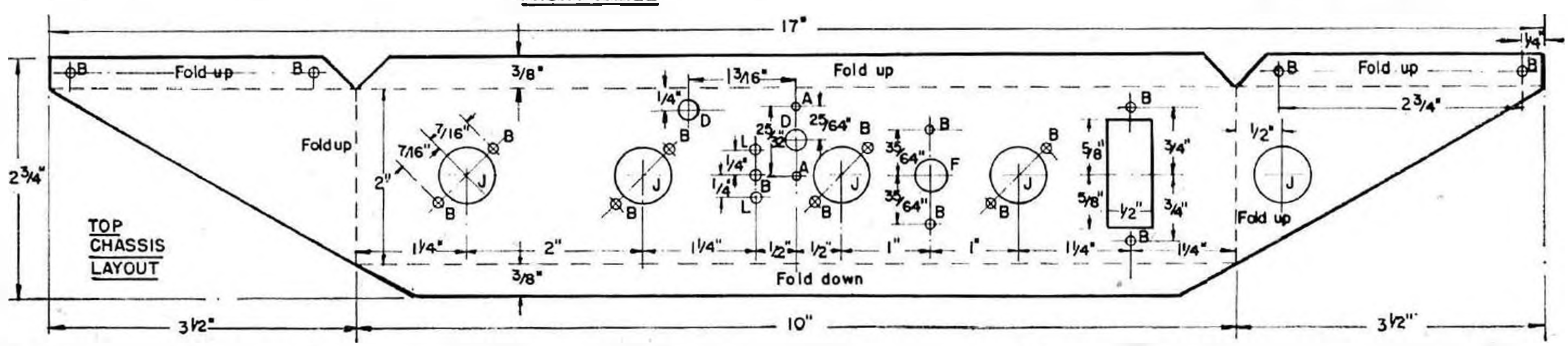
HOLE DRILLING CODE

A : No. 40 ; B : No. 31 ; C : No. 25 DRILLS ; D : 1/4 IN. DIA.; E : 5/16 IN. DIA.; F : 3/8 IN. DIA.; G : 7/16 IN. DIA.; H : 15/32 IN. DIA.; J : 5/8 IN. DIA.; K : 1 1/8 IN. DIA. ; L : TO SUIT XTAL HOLDER.

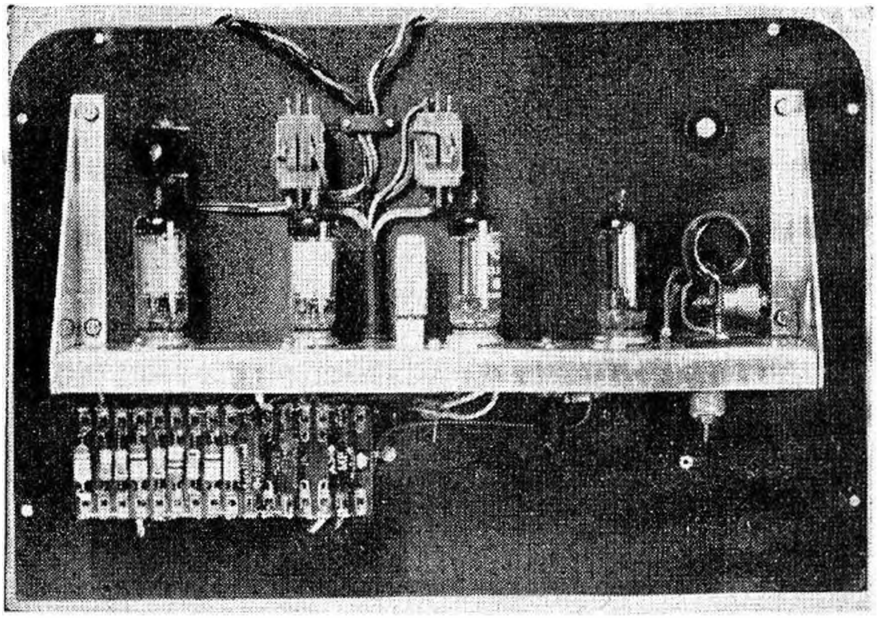
Countersink 'A' holes on top side of panel



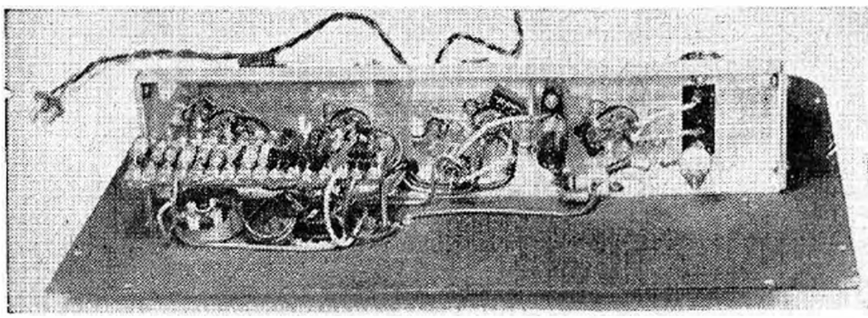
P.A. COIL PANEL LAYOUT



TOP CHASSIS LAYOUT



Two views of the Tx. showing its extremely neat and tidy layout. Adequate spacing and tagboard ladder layout makes construction and checking a real trouble-free treat.



On opposite page this near full-size picture of P.A. coil should assist in following the clear text and ensure accurate construction.

The second leg is fed via a 100 K. resistor and the cable to the control box when using tuned reed control, the amount of additional resistance introduced being determined by the control operated.

The third leg contains the 250 K. variable resistor which is located in the transmitter and forms the 'Fine Adjust' control.

The Modulator

The 1.0 Meg. resistor in series with the grid is used to further reduce the possibility of oscillator loading, whilst the 100 K. screen dropper restricts the current through the valve, as no standing bias is applied to the grid. Apart from these two points the stage is quite conventional.

The Control Box

A flexible circular plastic four core cable connects the control box to the transmitter case via an octal plug. All the control switches are of the double pole type, one pole being used to introduce the appropriate potentiometer whilst the other is used to key the H.T. supply to either the tone and carrier circuits, or just the tone circuit, according to the position of the strap in the octal plug.

Although the full frequency coverage is provided with 2.0 Meg. pots. the degree of rotation to bring in each individual reed, is far from linear. The highest three reeds are encompassed within the first 500 K., whilst the remaining 1.5 Megohm is required to cover the lowest three. This makes the adjustment of the highest reeds rather fine, and it is for this reason that 500 K. pots. are recommended for the controls using them.

Values are also given should six reeds of an eight reed E.D. unit be employed, or all eight reeds be used with a modified control box.

Transmitter Construction

1. Cut out and bend chassis.
2. Drill and punch all holes in chassis and front panel.
3. Mount all components on front panel. Solder a 4 B.A. tag under head of lower aerial stand-off insulator screw, before assembling it.

4. Mount valve holders and crystal holder on chassis. Ensure that valve holders are correct way round and secure 6 B.A. solder tags under nuts where shown. One 6 B.A. tag is also required above chassis under head of V4 screw nearest slot.
5. Construct P.A. coil assembly.

(*a*) Cut, drill and countersink panel as shown on page 171.

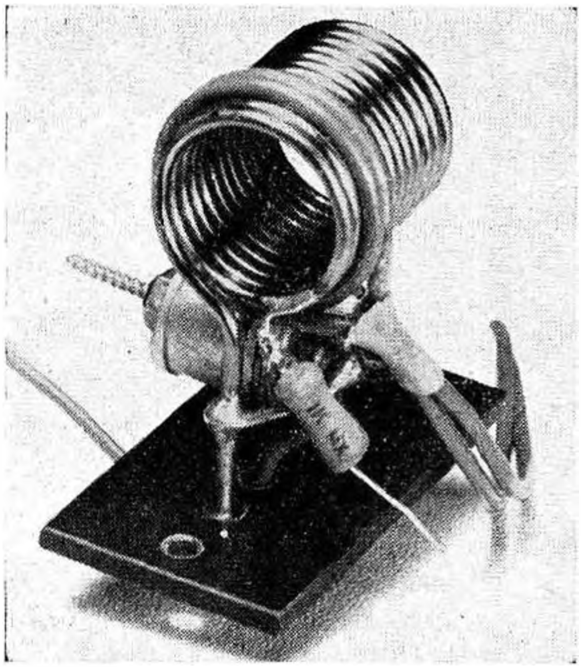
(*b*) Rivet tags in two 'A' holes and then bend up at right angles to panel.

(*c*) Wind P.A. coil. (Note that whenever heavy gauge wire is used for coil winding, it should be quite straight first. This is best done by securing one end in a vice and gently but firmly, pulling the other end with the aid of a pair of pliers until the wire is felt to stretch slightly. A soft duster run along it will also help). With the wire held at one end in the vice, wind 14 turns close together round a piece of $\frac{5}{8}$ in. dowel or tubing. Make quite sure that the resulting coil will have a clockwise pitch. Cut off surplus wire. Unwind one turn each end to form the down leads,, scrape off enamel to within $\frac{1}{4}$ in. of coil and tin leads.

(*d*) Pass leads through eyelets of rivetting tags and solder in, allowing $\frac{3}{4}$ in. between coil base and coil. Cut off surplus wire.

(*e*) Connect 3/30 pF. trimmer across coil leads. The longer tab is bent down to form one connection, whilst a short piece of T/C wire soldered to the trimmer's centre connection and brought out at the opposite side, forms the other. The shorter tab is snipped off. With the coil assembly viewed from the end nearest the hole between the tags, the trimmer is on the left hand side with its centre connected to the near end of the coil. The trimmer is positioned centrally between the coil down leads and midway between the coil and the base.

(*f*) Connect the H.T. lead to the coil. First bare the end of a piece of red plastic flex, wrap the wire round the lead of the 1,000 pF. ceramicon as close to it as possible and solder. Scrape the enamel off the side of the coil for $\frac{1}{4}$ in. one turn in and tin. Bend back ceramicon lead and solder to coil.

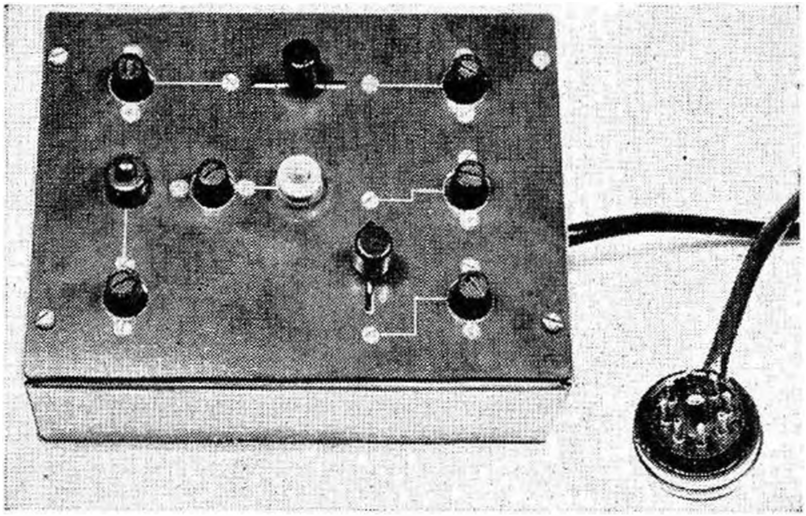


(*g*) Wrap two turns of plastic flex round the coil as close to the H.T. connection as possible, and lock with polystyrene cement.

(*h*) Bolt panel to chassis and solder floating end of ceramicon and end of two turn link nearest H.T. connection, to solder tag above chassis. Solder other end of link to tag on lower aerial base stand-off insulator screw.

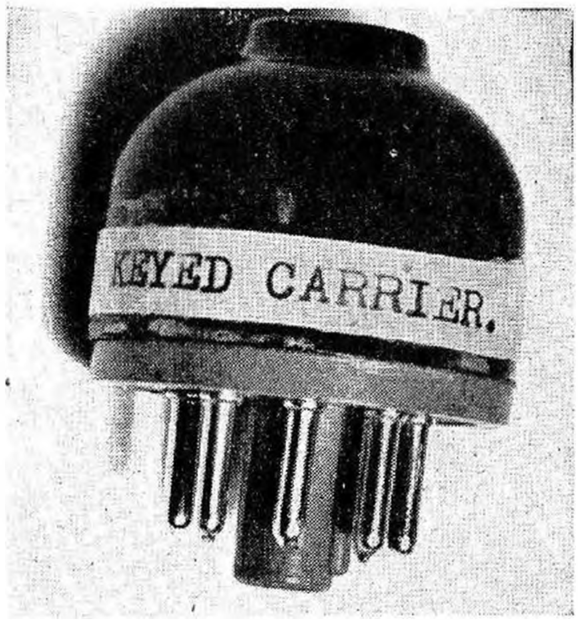
(*i*) Snip off the shorter tab on 2/8 pF. trimmer and solder centre connection to eyeletted solder tag as shown in practical wiring diagram.

6. Wind coil L1. Secure tag ring as shown with polystyrene cement. Wind coil in an anti-clockwise direction starting at the bottom of the former. Lock winding with polystyrene cement, bare ends, and terminate the bottom to tag 4 and top to tag 1. Space former away from chassis with two 6 B.A. full nuts.
7. Wind coil L2. Secure start of winding by passing wire through the two small holes in base of former ('B' on wiring diagram) and wind in a clockwise direction. Bring the end of the winding down and secure in the same way at the other side. Take great care not to damage the enamel on the wire during this operation. Lock wind-



Control box 6 x 4½ x 2 in. is a convenient size to hold. Access within should this ever be necessary is quick, whilst practical appearance makes it a component that anyone can flaunt with pride.

Below: Keyed carrier plug with its appropriate strapping is plugged in as required. Another marked plug is also prepared for Keyed Tone, with different strapping.



ing with polystyrene cement, leave ½ in. of wire at ends, scrape off enamel and tin. Space former away from chassis with two 6 B.A. full nuts and secure earthing tag on one side as shown.

8. Wire up appropriate switching circuit.
9. Wire up transmitter starting with earthing points, H.T. and L.T. wiring.
10. Cut holes and mount meter in cabinet as shown on page 171. Connect red plastic flex to positive of meter leaving sufficient length to reach battery positive. Fit red banana plug on end. Take the smaller socket from an old L.T. battery and secure to other meter terminal.

Tone Circuit Construction

1. Wire up earth points, L.T. circuit and two chassis mounted components.
2. Connect 3 in. of plastic flex to each of the five connections which go to the tag panel and leaving ½ in. of wire, connect 1.0 Meg. resistor to pin 6 of V2.
3. Wire up tag board as shown. Components and leads shown dotted are on the underside of the board. Connect all wires to tag board and space away from panel with two 6 B.A. 1¼ in. screws.

Tone Box Construction

1. Construct 6 in. × 4½ in. × 2 in. deep aluminium box with ⅜ in. top lips to secure paxolin panel.
2. Cut and drill panel as shown.
3. Mount all components and wire up using the four colours throughout to simplify circuit tracing.
4. Connect up four core cable. Use a clip within the box to anchor the cable and prevent strain on the leads. The cable must not exceed six foot in length otherwise trouble may be experienced due to excess loading on the oscillator.

Transmitter Tuning Procedure

General Notes

1. All tuning adjustment should be made with non-metallic trimming tools. A plastic knitting needle filed to a screwdriver point is ideal for adjusting the dust cores of L1 and L2, whilst a piece of dowel can be cut to adjust the two Philips trimmers.
2. The dust cores should be tight in their formers, yet free enough to be rotated. This is best achieved by using core locking compound.

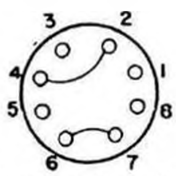
Initial Bench Tuning

The dust cores of L1 and L2 are adjusted from BELOW the chassis during initial tuning.

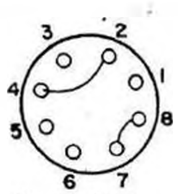
1. Connect the L.T. plug and the H.T. plug. The H.T. + plug is inserted in the 60 volt tap of the H.T. battery.
2. Screw in the dust cores of L1 and L2 until they are flush with the tops of the formers.
3. Unscrew the 3/30 pF. P.A. tuning capacitor (above the chassis) to minimum capacity and the 2/8 pF. neutralising capacitor to approx. half mesh.
4. Connect a 2.5 volt 0.3 amp. torch bulb between the aerial base and the chassis.
5. Switch on the transmitter and key the carrier. This can be done either by using the keying lead or by inserting the 'carrier on, tone keyed' octal plug if wired for tone, with the tone switch 'off'. The current should be approx. 26 m.A.
6. Screw in the dust core of L1 for minimum reading and then UNSCREW until the current rises by 3 m.A. The current reading should be approx. 23 m.A.

Note.—Whilst working with only 60 volts H.T. it is as well to get the feel of tuning a crystal oscillator if you have not used one before. The current will fall slowly as resonance is approached, but will rise rapidly the other side. This is characteristic of crystal oscillator circuits and it is to ensure that the crystal will always oscillate that the dust core of L1 is backed off on the gentle rise side and not adjusted for maximum output.

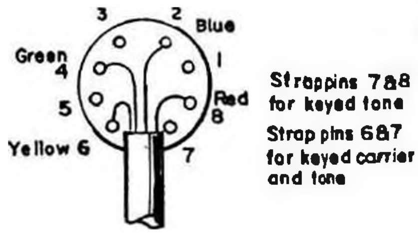
7. Screw in the dust core of L2 for minimum reading. The current reading should be approx. 15 m.A.
8. Tune the P.A. tuning capacitor for minimum reading.

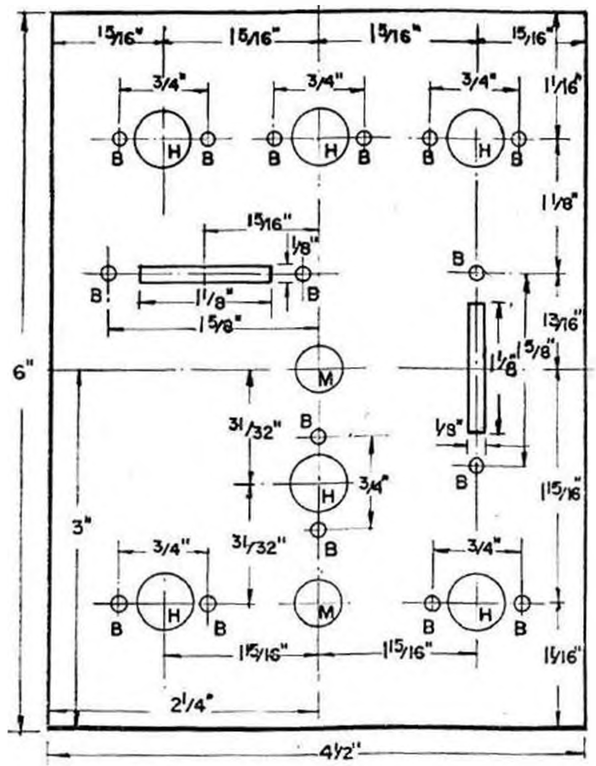


Keyed carrier and tone



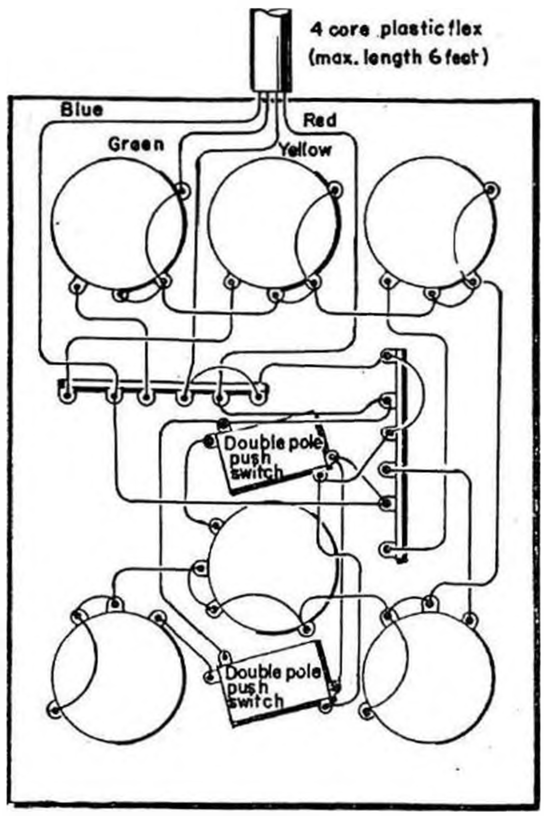
Keyed tone



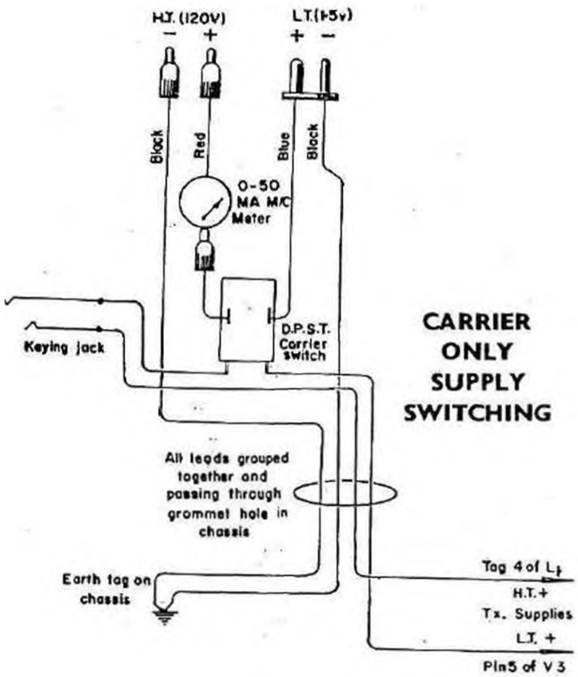


Drill sizes H= 15/32" M= 13/32" B = No. 31

PANEL LAYOUT. UNDERSIDE VIEW

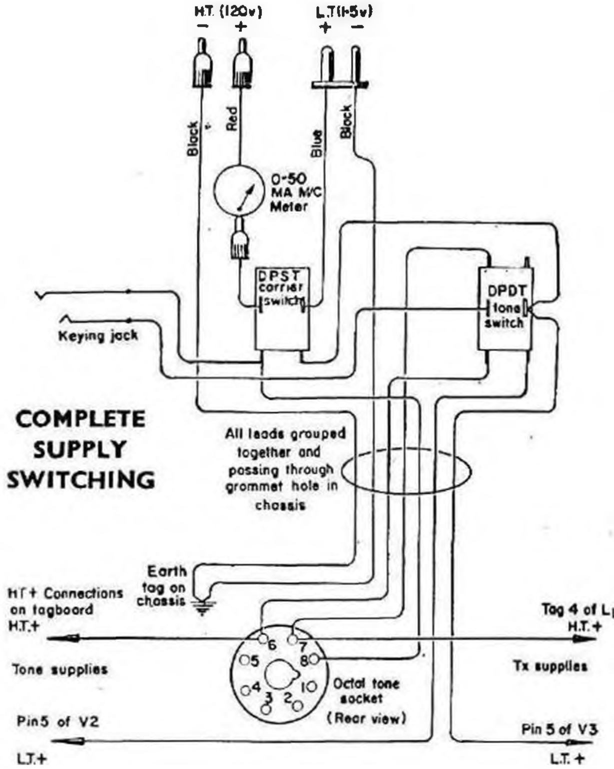


Lower solder tags of push switches shown at ends for clarity



CARRIER ONLY SUPPLY SWITCHING

COMPLETE SUPPLY SWITCHING



9. If a tuning dip has been obtained with all three tuned circuits apply the full H.T. and the bulb should light to full brilliance.

Final Tuning

1. Remove the bulb and place the transmitter on the ground.
   After connecting the full aerial (¼ wave) retune the P.A. and neutralising capacitors for minimum current reading on the meter. Finally adjust the P.A. tuning for maximum radiation from the aerial with the aid of a simple wavemeter or a carrier operated receiver which can be off-tuned or reduced in sensitivity for the purpose.
2. Retune L2 for minimum reading on the transmitter meter.
3. Retune L1 CAREFULLY to the minimum reading on the transmitter meter and then back off by screwing in (if now adjusted from the top) until the current rises 3 m.A.

The total H.T. current should be approx. 30 m.A. when transmitting carrier only.

Tone Circuit Adjustment

No difficulty should be experienced here providing the specified components have been used. Should the range of tone frequencies require slight adjustment this can be made by varying the value of the 270K. resistor in series with the 'fine adjust' pot. (starred in circuit).

Batteries

H.T. 120 volts standard 8 in. × 6½ in. × 2⅞ in. 120 volt battery.

L.T. 1.5 volts Ever Ready type AD1.

Battery Replacement

Battery voltages should always be checked *on load* and preferably after being on load for a few minutes.

The H.T. battery should be replaced if its voltage falls below 100 V. on load and the L.T. battery if below 1.3 V. on load.

Designer Eric Hill tells us this Tx. took a mere fortnight to design and construct in its original form but a further nine months was devoted to ironing out all possible points of difficulty likely to thwart the home constructor. A number of sets have been made up by builders of only moderate skill and all produced satisfactory fully operational outfits. Good luck with YOUR set; if you are in trouble for any reason, drop us a line and we will try to get you out!

The Cathode Ray Oscilloscope

By F. C. Judd, A.Inst.E. **In Part 2, the screen and images thereon are considered and R/C uses outlined in brief.**

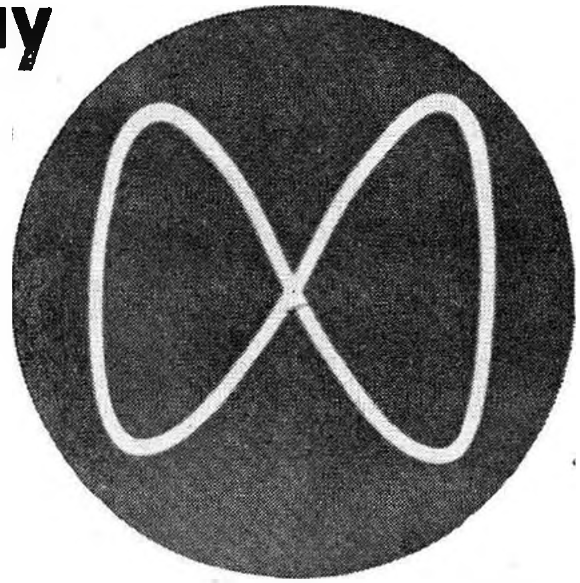


FIG. 7.—Lissajous figure, 2 to 1, 50 by 100 cycles, photographed directly from a c.r.t. screen. (Photo by E. A. Rule).

The Fluorescent Screen

BEFORE continuing with details of deflection methods, etc., a brief description of the function of a c.r.t. fluorescent screen may be of interest. There are a number of materials that can absorb power from radiation and re-emit power as a radiation of lower frequency. In some cases the emission continues after the excitation has been removed, decaying gradually. The emission of radiation can also be produced by electron bombardment and this is the source of the light emitted by the screen of a c.r.t.

The fluorescent powder is applied to the screen in a finely divided state, the activity of the powder being controlled by the introduction of certain 'activators'. Among the materials used to obtain fluorescence are zinc ortho-silicate, which gives a green trace, calcium tungstate, giving blue and ultra-violet, radiation (very suitable for photography) and zinc sulphide, which with other materials gives the white light suitable for television tubes. Zinc phosphate produces a pronounced 'after-glow' and provides a display which continues after the scan or when the electron beam is cut off. In other words the picture continues to show for some time after an applied signal has finished. This 'after-glow' property is useful for examining signals of short duration or transient phenomena.

The amount of light obtained from a c.r.t. screen depends on the characteristics of the fluorescent material, on the number of bombarding electrons and on the energy of the electrons, which in turn, depends on the accelerating voltage used on the final anode. Tubes intended for normal visual display operate at anode voltages from as little as 300 volts to as much as a 1,000 volts, whilst special tubes intended for fast photographic work need 1,500 volts or more. Some electrostatic (a term to be explained later) and some television (magnetic) tubes require accelerating voltages of up to 5,000 or 6,000 volts.

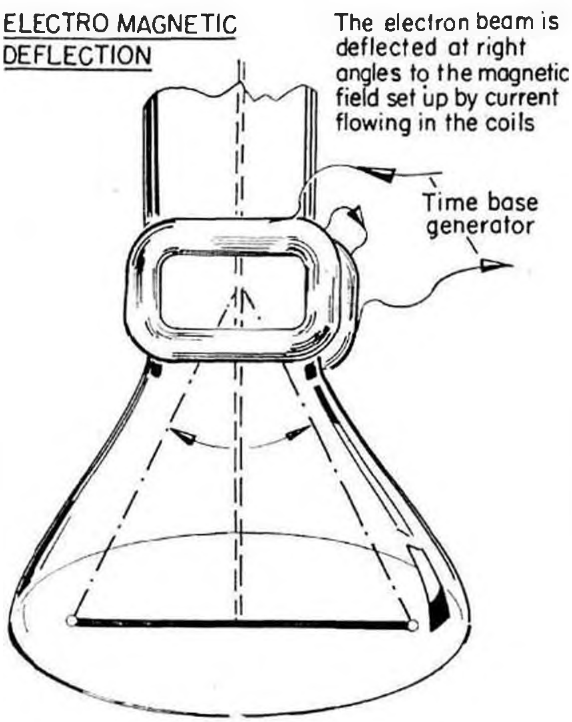
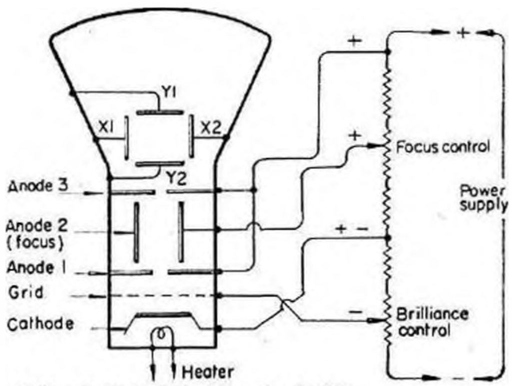


FIG. 1.

Deflecting the Electron Beam

With no deflection plates the c.r.t. would be incomplete since the spot would simply remain stationery on the fluorescent screen. The method of obtaining a horizontal scan or time base



C.R.T. potentials derived from a potential divider across the power supply

FIG. 2.

has been explained in some detail in Part 1, and we now come to 'vertical' or 'Y' deflection. Two metal plates are used, being mounted at right angles to the 'X' plates. A potential applied to one of the plates as in Fig. 1 will cause the spot to move downwards or upwards, depending on the polarity of the potential. This system of beam deflection is called 'electrostatic' and c.r.t.'s using it are called electrostatic tubes.

Deflection may also be accomplished by magnetic methods and if an ordinary magnet is held at the side of a c.r.t. the spot will be deflected, its direction being determined by the polarity and position of the magnet. A magnetic field may be created by passing current through a coil (or coils) around the neck of the c.r.t. and is a method commonly used for scanning television and radar displays, but rarely for oscilloscopes (Fig. 1).

Symmetric and Asymmetric Deflection

Deflecting voltages may be applied symmetrically or asymmetrically to the deflector plates. The asymmetric method requires a fairly simple amplifier but certain problems arise in connection with the sensitivity. In assymetric deflection only one plate is fed with the deflecting potentials so there must be some limitation on the amount of deflection, whereas for symmetrical deflection both plates are charged, thus permitting greatest possible deflection sensitivity. Asymmetric deflection also produces astigmatism which is a form of distortion at the edges of a display.

Control of Spot Brilliance and Focus

It is highly essential to have control over the brightness of a display and its sharpness of focus. Brightness control is carried out by varying the grid potential of the c.r.t. Since electrons are being emitted from the cathode, any negative potential at the grid will have the effect of repelling the electron stream therefore reducing its strength and consequently the brightness of the display. If the negative potential at the grid is high enough the beam can be cut off completely.

The action of the focus anode is somewhat similar except that the beam intensity is not reduced, but the electrons are 'compressed'. The focus anode is usually very much negative with respect to the third anode, but appears positive to the grid and cathode. For this reason the electron stream is not diminished but compressed into a narrow beam, as outlined in Part 1.

The D.C. potentials used for the grid, focus anode, and anode(s) are usually derived from potential dividers across a common power supply. By this method the required potentials are directly related to each other and the design and construction of the power supply becomes somewhat simplified. The schematic diagram of Fig. 2 shows how the c.r.t. electrodes are connected across the potential dividing chain which includes the 'brilliance' control and 'focus' control. The current drawn by all the electrodes is extremely small, but the actual potentials depend largely on the size of the screen. (Typical anode voltages are shown in the table below.) The total high tension current of a c.r.t. is seldom more than 200 micro-amps.

TYPICAL C.R.T. POTENTIALS.

SCREEN DIAMETER (Inches)	FINAL-ANODE POTENTIAL (Volts)
1½	600 – 1,000
2¾	800 – 1,500
3½	1,500 – 4,000
6	2,000 – 5,000

Other things being equal it is advisable to choose a tube whose anode H.T. requirements are on the low side. This applies particularly to the third or final anode. If a given deflecting voltage produces an image 25 milli-meters in height (Y plate deflection) with the third anode at 1,500 volts, a 50 milli-meter image will be produced by the

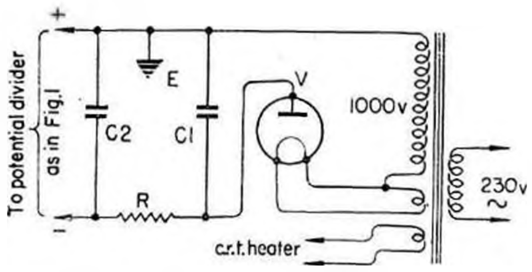


FIG. 3.

A typical power supply circuit, using a single H.T. winding and diode rectifier valve. NOTE : The positive terminal is earthed. This is done in order to bring the final anode and deflector plates at earth potential which overcomes the problem of isolating them from high positive potentials by means of large capacitors.

same deflecting voltage with the third anode voltage reduced to 750 volts.

The intensity of the brilliance is usually determined by the third anode voltage and since excessive brightness is unnecessary, particularly if the screen is shielded from strong light, the use of a lower anode H.T. results in increased screen life.

Power Supplies

In view of the negligible current taken by the c.r.t. the output from the H.T. rectifier of the power supply is practically equal to 1.414 times the r.m.s. (root mean square) voltage supplied by the transformer secondary. With the arrangement shown in Fig. 3 an H.T. voltage of about 1,400 volts is obtainable. Special diode valves are available for voltages of this order, but if higher H.T. is used it is simpler and safer to use voltage doubling systems.

A Typical Cathode Ray Tube

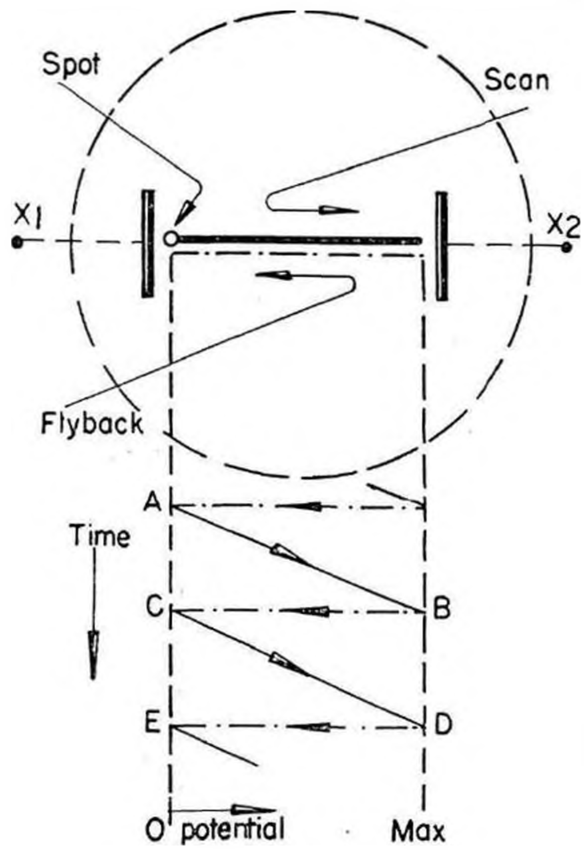
The electrode assembly of the modern cathode ray tube differs a little from the arrangements described in Part 1 inasmuch that two and sometimes three actual anodes are used hence the references in previous paragraphs to the third anode. As the focus electrode is also counted as an anode a typical tube will have three anodes which are assembled as shown in Fig. 2. The first anode is for primary acceleration of the electron stream and is usually designated anode 1 or A1. Then follows the focus anode A2 and then the final anode A3 which is the one normally held at high positive potential. The X and Y deflector plates are placed after this. There are some special tubes which have a fourth anode called a 'post deflector anode' since its position is between the X and Y deflector plates and the c.r.t. screen. The purpose of this additional anode is to provide a somewhat higher brilliance when using a high speed scan. Tubes fitted with a PDA are used mainly for laboratory type high speed oscilloscopes.

The Time Base 'X' Deflection

When appropriate voltages are applied to the X and Y deflecting plates the spot can occupy any position on the screen. Hence it can be made to trace curves of either the polar or Cartesian types although the two pair of deflector plates, at right angles to each other, make the c.r.t. specially suitable for tracing those of the latter kind.

Note that the designation of the deflector plates is in accordance with the Cartesian system, i.e., horizontal displacement: X plates = X_1 and X_2. Vertical displacement: Y plates = Y_1 and Y_2.

If a steadily falling potential is applied to the X plates (rate of fall linear with time) the spot will move at a steady rate across the screen and fly back quickly when the potential reaches zero. The spot is now ready



Linear sweep or scan and flyback

FIG. 4.

to repeat its excursion as soon as the potential reaches maximum again. The nature of this potential was described in a diagram in Part 1 but in order to explain the spot 'flyback' process we must refer to a similar diagram (Fig. 4) which again shows how a linear sweep or X scan is produced by a sawtooth wave. The forward movement A-B and C-D is proportionate to time. The 'flyback' or period during which the potential returns from zero to maximum is represented by B-C and D-E which must be as rapid as possible, almost instantaneous in fact.

'Y' Deflection

If we apply a sinewave voltage to the Y plates and move the spot horizontally at the same time across the screen by means of the time-base sawtooth potential applied to the X plates; what will be the result?

One or more sinusoidal waveforms will appear on the screen and it will, of course, be possible to examine them closely. The diagram of Fig. 5 may serve to illustrate how this occurs. If the time period of the time-base potential from maximum to zero were two seconds, the spot would take two seconds to move from say left to right of the screen.

If a sinewave of one cycle per second were applied to the Y plates with the beginning of a cycle synchronised with the start of the t.b. potential we should see, on the c.r.t. screen, two complete cycles of the sine wave. Syncronism of both t.b. and signal waveform is accomplished by a special circuit in the time base generator. To this circuit is applied a portion of the signal voltage to which the t.b. generator is locked. Thus both signal and t.b. cycles start at exactly the same moment. The return of the t.b. potential to maximum again may be regarded as almost instantaneous although it is never quite that fast and the spot brilliance is usually suppressed during the 'flyback' period.

The diagram of Fig. 6 shows more clearly the application of the time base and signal voltages to their respective deflector plates and how the amplifiers are connected so that such voltages are symmetrical.

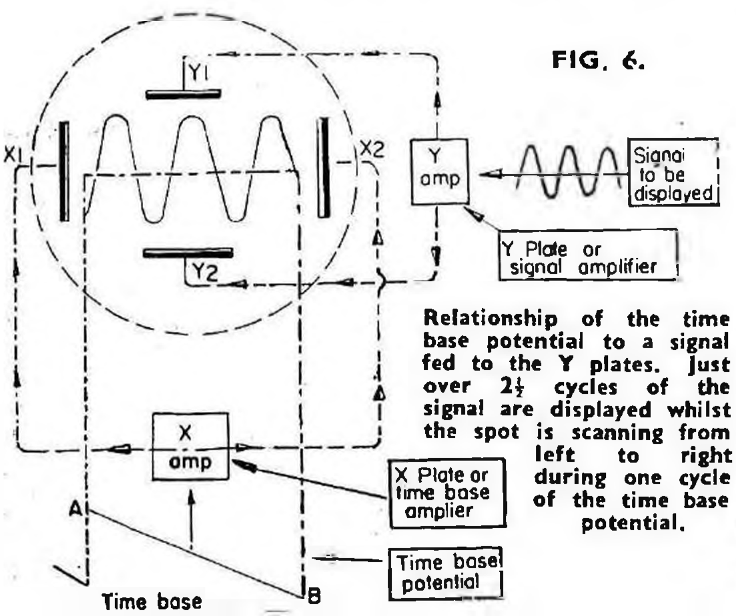
The linear time base is only one form of X scan and for the examination of repetitive waveforms is generally the most ideal. It is possible, with careful syncronising, to display one cycle of an alternating signal voltage whether it be sinusoidal or squarewave shape or complex form, e.g. sine waves with modulation.

Lissajous Figures

For frequency comparison it is more usual to apply sine waves to both the X and Y plates, a procedure which actually produces a display from which one can see the ratio of one frequency to another. This is not frequency measurement but a method of determining an unknown frequency by comparing it with a known one. A typical display is shown in the photograph of Fig. 7 which shows two loops and is actually a two to one pattern produced by applying a 100 c.p.s. signal to one set of plates and a 50 c.p.s. signal to the others. These oscillograms are called Lissajous figures (after the French Physicist M. Lissajous).

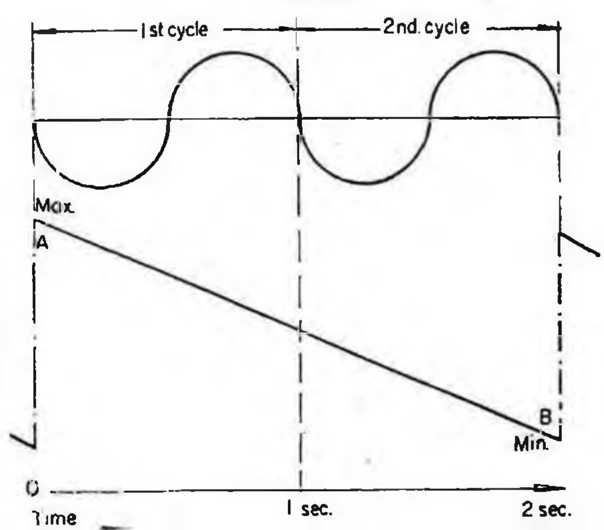
Very precise frequency comparisons may be carried out by the foregoing method which would be invaluable to R/C enthusiasts experimenting with tone control systems, especially where it is required to tune low frequency oscillator circuits precisely to a known and desirable frequency.

FIG. 6.



Relationship of the time base potential to a signal fed to the Y plates. Just over 2½ cycles of the signal are displayed whilst the spot is scanning from left to right during one cycle of the time base potential.

FIG. 5.



McQUERY COLUMN

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

I HAVE built the Pike Miniature Receiver from "Simple Radio Control" using a 0-10 milliammeter I switched on. The meter went to 0.5 m.A. and when I turned up the potentiometer, the meter did not move and the valve did not go any brighter. I found out later that when I put my fingers on the filament minus (or D on your plan) and the grid (or C) that both the meter and the valve worked as they should. I later short-circuited the fil—(or D) and the grid (or C) with the same effect as above (both worked as they should). Will it be all right to keep these valve wires short-circuited ?

—D. B. F., BOLTON.

All you did was to stop the valve oscillating and the RX would certainly not function under these conditions. Did you have an aerial connected? This type of RX relies on loading for correct operation. Adjust the aerial length until the current rises to the correct value (the pot. gives a fine control). The current will then drop on receipt of an unmodulated (plain carrier) signal, if it doesn't the aerial is too long.

I WONDER if there are disadvantages of using a harmonic Xtal, e.g. do you have to check it is not on another harmonic—say 39 Mc/s? I understand that Henry's Radio and Radio & Electronic Products can supply fundamental Xtals.—M. A. R., BIRMINGHAM.

To tune L3 to 40.5 Mc/s (third harmonic of 13.5 Mc/s Xtal) would need a copper slug instead of dust iron. So long as the spacing between the turns of L3 is, as specified, slightly less than the wire diam., the tuning point will be with the slug well inside the coil. The only one I had trouble with has the turns overspaced, and to save rewinding 10 pF. was added across the ends of L3.

The Xtals you mention are not fundamental Xtals, but overtone types. These have a fundamental frequency of 9 Mc/s and are made to oscillate on a mechanical harmonic or overtone by means of a special osc. circuit. If you put one of these Xtals in my circuit it will oscillate at *about* one third of its marked frequency as the mechanical overtone frequency is not exactly three times the fundamental.

I HAVE built an "Aeromodeller" No. 1 hand valve receiver, but I find that I cannot get the standing current of 2 m.A. to drop on movement of the tuning condenser. I have stripped it down and rewired it again but still get the same results.—D. McL., NEWCASTLE-ON-TYNE.

I take it that you are referring to the "Aeromodeller" receiver No. 1, which was published in 1952. If so I also presume your reference to the tuning condenser means the feedback condenser from the valve plate to the top of the tuning coil. The actual tuning is carried out by the slug in the tuning coil and the condenser acts as a sensitivity control.

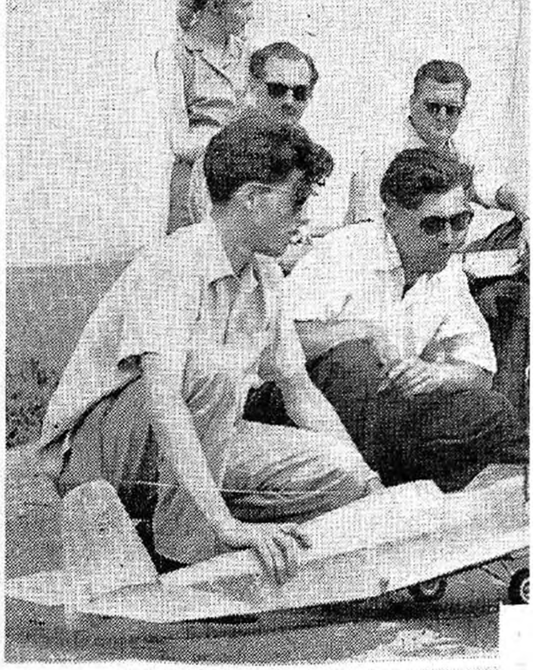
Actually it controls the feedback from the plate to the grid of the valve and if the components are beyond suspicion should cause the valve to oscillate when it is screwed home. In the condition the valve current drops and as you cannot get it to drop I suspect a faulty H.F. choke, feedback condenser or condenser at C2 or C3. Try replacing each in turn and if this fails try replacing the valve. I should also check the wiring carefully.

I WISH to build a Simpletone transmitter and McQue Versatile transmitter.

I am having trouble obtaining the parts, so can you give me the address where to get the parts, I enclose S.A.E.?
—D. A. BOWDON.

You should be able to get all the parts for the two Tx's from F. Rising, Whissendine, near Oakham, Rutland.

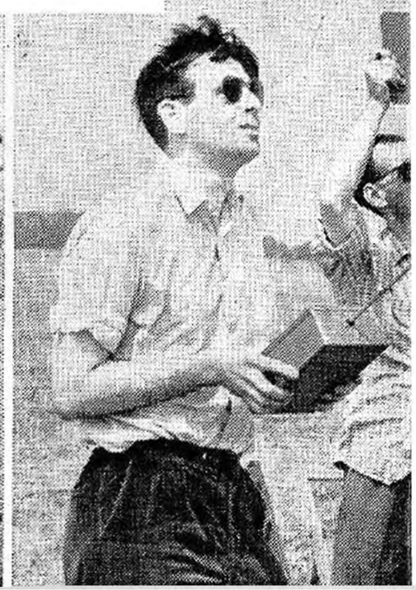
[Continued on page 205]



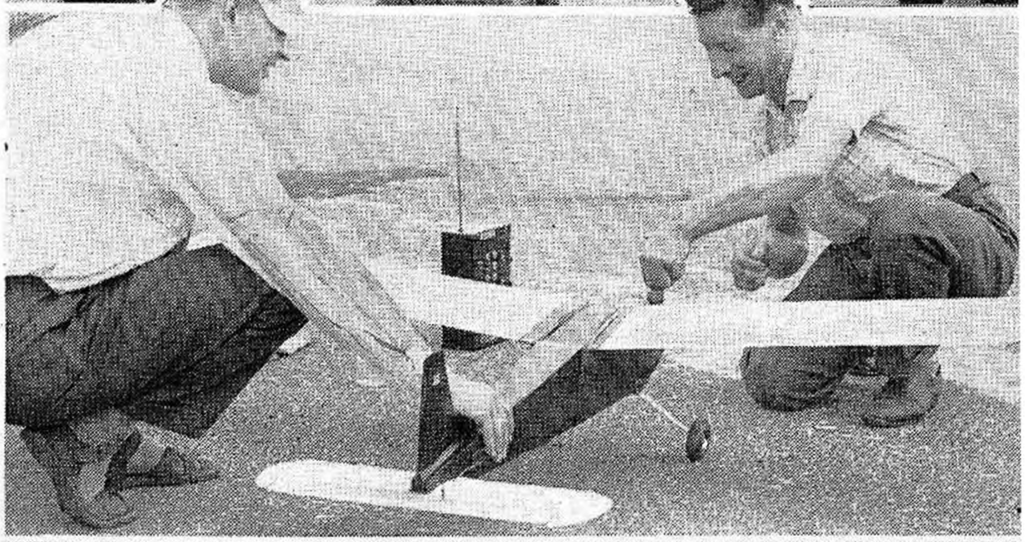
Ed. Johnson warms up his Ruppert twin powered low-wing held back by helper. Centre left : Sutton Coldfield's Dennis Thumpston with his 52 in. Fokker E.1 using Wright Rx. and relaytor.

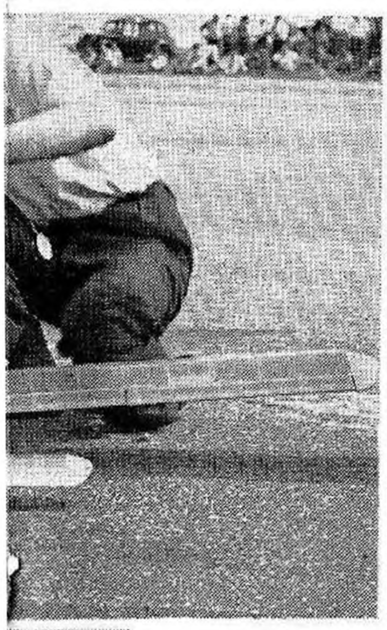
R/C at BRITISH NATIONALS

Above centre : John Singleton of Larkhill—low wing again, K & B 45, OMU Rx. 5 lbs. weight. Below left : R. Donahue of Kersal with modified "Waveguide". Below centre : Chris Olsen in typical attitude with judges Henry J. and Rushy in trouble with the sun.

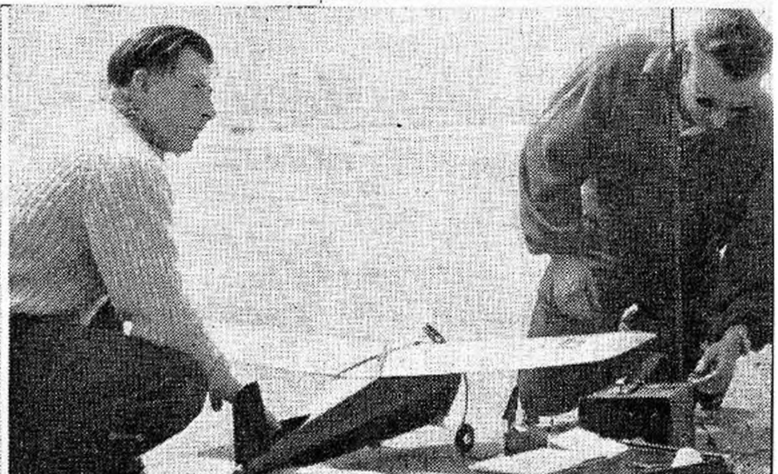


Above : Frank Knowles of Reigate, another low wing adherent. On the right (top) : Frank Van den Bergh with the immaculate "Sky Duster" which he will be flying in Switzerland.





Upper centre right : Ted Coppard of Wagtails with his "Uproar", making a Wagtails treble place. Lower centre : Farmer Dick Higham from Diss, sometime team member, with his De Bolt Biplane. Bottom right : Arthur Collinson of Bradford with De Bolt "Live Wire" featuring Cobb Hobby system.



Boat R/C Installation

D. Connolly describes the ingenious R/C set up in his electric powered model of KING GEORGE V.

THE radio installation in this boat (described in *Model Maker*, July, 1960 issue) was designed to give fully proportional rudder control and a fail-safe radio operated main motor switch. This system switches the motor off automatically in the event of radio failure and also allows the motor to be switched off in emergencies such as weeding up of the propellor, etc. Although the prototype was designed for boat use, the same system could be used to cut out an aircraft engine in the event of a flyaway.

The Receiver (Rx.) used is the Aeromodeller Transistor Rx. since relay adjustment is then unnecessary. The relay used is the Sealed Siemens High Speed type H96E with 1700 + 1700 ohm coils as advertised elsewhere in this issue. Receiver batteries are Ever Ready types D19 for L.T. and B115 for 22.5v. H.T. Both these types have socket connections and are therefore ideal for R/C work. The B115 is, however, difficult to obtain and is usually only stocked by the large chemists as a flash battery, but for this Rx. it is well worth the search. The Rx. switch is a three-pole three position rotary type positioned in the stern of the boat and operated by the aft gun turret. The positions are:

1. Rx. and Actuator off;
2. Rx. and Actuator on;
3. Rx. on, Actuator off.

This allows for Rx. trimming without draining the actuator batteries. The actuator uses a Mighty Midget motor with two gear trains giving a total reduction of 49 : 1. This enables low voltage actuator batteries to be used, these being two Venner H.105 accumulators in the model.

The Rx. is fitted in a watertight box glued to the bottom of the boat, since all Rx. failure so far has been traced to a damp Rx. The Rx. batteries lie either side of this box, and are supported ½ in. off the bottom of the boat, again to prevent them getting wet. The two decoder units, one containing Rx. relay, Rx. supply socket and the on/off switch for the motor switch unit, the other containing the motor switch unit, are fixed to two pieces of wood glued to the sides of the boat so that these units are also clear of the bottom of the boat.

Motor Switch

The motor switch is designed to operate the motor only when the Rx. is receiving a pulsed signal from the transmitter. If the transmitter is switched to full on or full off, the motor will stop. The motor will also stop if either the Tx. or Rx. fails. The unit is designed to run off the main motor battery which is 4.5v. in the model. Maximum current drain is 5 m.A. which is negligible compared with 1-2 amps for the main motor. The unit will work off other voltages provided the relay used will pull in firmly when the supply voltage is connected directly across the relay coils. The transformer used is a midget audio output type which can be used as bought by connecting the secondary winding (thick wire) in series with the actuator motor. The actuator will then need two 3 volt batteries to obtain the same performance as before the insertion of the transformer, and if accumulators are used this means extra expenditure. The transformer can be wired in parallel with the actuator motor and the original 1.5 volt batteries used without very much extra current drain if the transformer is modified as follows:—

1. Remove outer cover and transformer laminations.
2. Remove outer (secondary) winding and refill the bobbin with 38 or 40 s.w.g. enamelled copper wire, using 18 or 20 s.w.g. tinned copper wire leadouts.
3. Replace outer cover and transformer laminations.

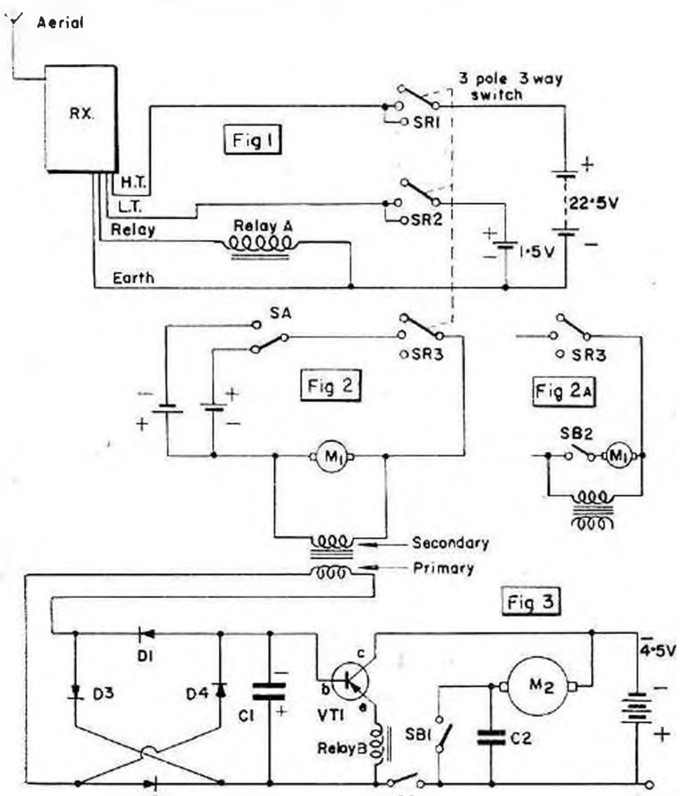
The new secondary winding is then connected across the actuator motor terminals.

Circuit Theory

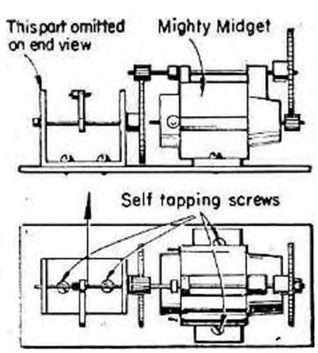
The current in the secondary of the transformer is continually changing direction, and is therefore alternating current. This will appear across the primary of the transformer, and is converted to D.C. by a bridge rectifier network. The D.C. output is smoothed by a 50 uF. capacitor which prevents the motor switch relay operating on the pulses superimposed on the D.C. output. The D.C. is then fed into a transistor which operates the motor switch relay. If there is no pulsing in the actuator, there will be no A.C. input to the circuit, hence no D.C. and the relay will drop out.

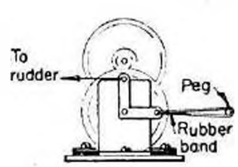
The relay used in the prototype is a Siemens High Speed open type with 850 + 850 ohm coils. Operating current does not exceed 5 m.A. so a Red spot or OC 71 transistor can be used although an OC 72 was used in the model. If the relay current is 5-10

(Continued on page 194)



D1 – 4	Germanium diode	Relay A	1700+1700 Ω (series)
C1	50μF electrolytic 12 V.W.	Relay B	850 + 850 Ω (parallel)
C2	0·5μF paper 150 V.W.	Transformers	See text
VT1	Red spot, OC 71, OC 72		
M1	Mighty Midjet	M2	Kako 4 (main motor)

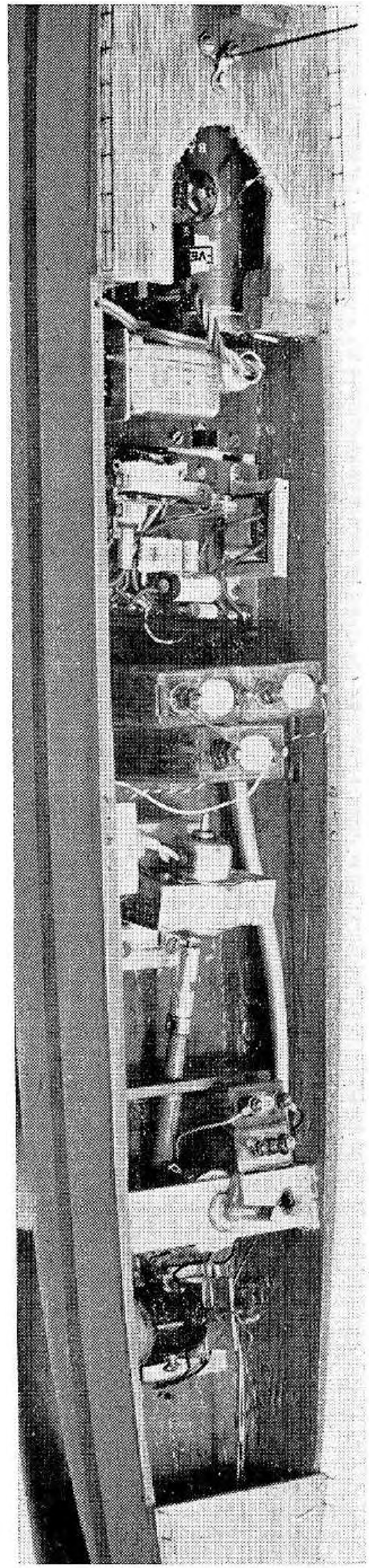




End View

ACTUATOR

Circuitry should be studied in conjunction with the full length photo of the set-up when all parts can be readily identified and their skilful arrangement appreciated.



Introduction to TRANSISTORS

In Part Two Dave McQue continues his lucid explanation, including PNP & NPN types and general transistor structure. More to follow.

WE have seen how the characteristics of a pure germanium crystal can be altered by the addition of quite minute quantities of particular impurities and how conduction of electricity in the N 'doped' material is mainly by electrons and in P type by holes. Let's have a look at what happens when we have a bar of crystal with both an N and P region, and that the change from N to P at the junction is abrupt (Fig. 1).

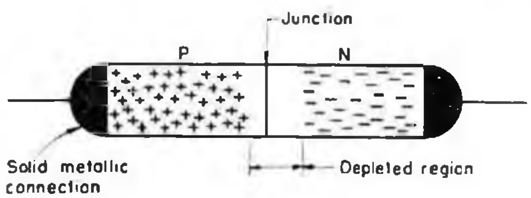


FIG. 1.

The mobile majority charge carriers, holes, are shown as + in the P material and —, electrons, in the N region. There will also be a relatively small number of minority carrier (electrons in the P and holes in the N). These are omitted for clarity. In Fig. 1 the P material is more heavily doped, so there are more holes in the P region than electrons at the junction and they are all bobbing around at random. Notice what has happened either side of the junction, some holes have diffused into the N region and been mopped up by combining with electron and some electrons have diffused into the P region and been mopped up by the holes, hence there are no mobile charge carriers in the depleted region either side of the junction. You might say, "Well, why haven't they all joined up?" The reason is that holes in moving from the P region have left it with a net negative charge and likewise the movement of electrons from the N region has left it negatively charged. So the P region is now trying to pull the holes back out and the N the electrons, so we have a state of equilibrium. Don't think you can get something for nothing by jointing the two end connections together for you would still have the N region trying to pull electrons out of the P where there are only holes.

Now let's connect it to a battery. (Fig. 2).

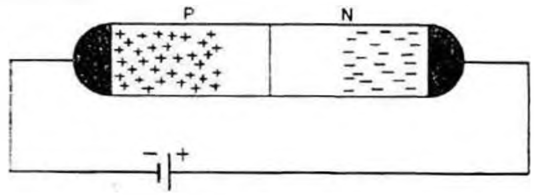


FIG. 2

Here we are trying to push electrons into the P region, making it more negatively charged, and to pull electrons out of the N region which is the same as trying to push holes in. This is like water on the lock gates, it only shuts them tighter, so we get no current flow due to majority carriers. There will, however, be a small temperature dependent leakage current due to minority carriers and, unless the crystal is absolutely clean, surface leakage which is why transistors and diodes have to be hermetically sealed to keep them clean.

We'll turn the battery round now and see what happens in Fig. 3.

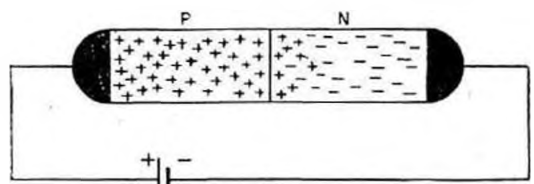


FIG. 3

Here the battery is pushing electrons into the N and pulling them out of the P which is the same as pushing holes in which is the way they want to go to cross the junction. In fact, due to the greater hole density in the P some holes diffuse some distance into the N region before they combine with an electron and so get mopped up. It only takes a pressure of about a $\frac{1}{4}$ of a volt with germanium and about $\frac{1}{2}$ a volt with silicon for the barrier set up by the depleted region to disappear. The current flow is then limited only by the resistance of the P and N regions and the external circuit. So we have a device which will effectively pass current in one direction only. We can use it for rectifying alternating current (AC) to get direct current (DC) for power supplies, battery charging and as a detector in a simple receiver. In fact, anywhere we want a device which will conduct in one direction only.

These diodes come in all shapes and sizes. The most common, and cheapest, are the little wire ended, glass, point contact, germanium types. Here the junction is formed by fusing a wire to the surface of either a P or N type crystal and forming a PN junction. Due to the small size of the junction, they can be used up to quite high frequencies, certainly 27 Mc/s (some silicon point contact diodes developed during the war and since are used at 10,000 Mc/s. and even higher).

They have some limitations, however, consequent on the small junction, a higher forward resistance than a junction diode, with a maximum mean forward current of around 25 to 50 m.A., their maximum reverse voltage is usually less than 100 (often much less), and the reverse leakage makes most unsuitable for jobs where a very low reverse current (high back resistance is required(, e.g. the diodes in the Hill Rx.

Junction diodes are usually restricted, because of their greater capacitance and 'hole storage' effect to mains and audio (tone) frequency jobs. To get the idea of hole storage have another look at Fig. 3, imagine that we reverse the battery quickly. To get back to the conditions of Fig. 2 holes have to be pushed back and that means a momentary current flow. Quite moderate sized junction diodes are rated to carry 500 m.A. or so and these can be used across limit switches in motor driven actuator circuits to simplify wiring and in compound motor driven escapement circuits. Put across an escapement coil in reverse to the battery, they effectively suppress the back E.M.F. when the relay contacts open and are more effective than the usual resistor and capacitor at the job. (Fig. 4a).

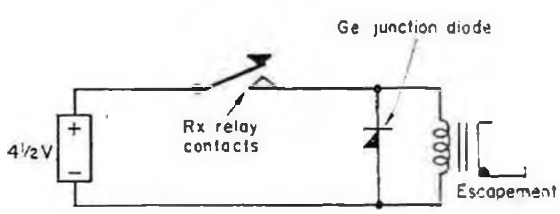


FIG. 4a

To make sure you don't put the diode in back to front (with disastrous results) connect it up in series with a m.A.mmeter and 1K resistor. (Fig. 4b).

Make the relay contact and try the diode both ways. Then fit it so it draws little or no current when the relay is made.

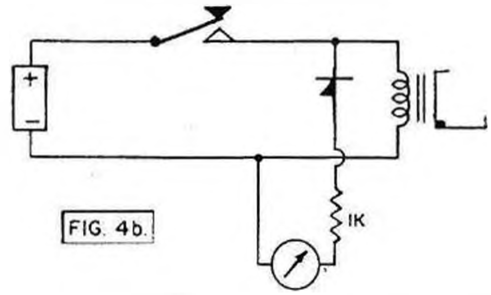


FIG. 4b.

Let's leave the diodes for now and move on to the junction transistor. The first transistors were point contact type but, fortunately for me as they are more difficult to explain, these are now virtually extinct. All the transistors available today are junction types and that includes the cheap surplus substandard ones.

The junction transistor is made, by various processes, with two PN junctions close together. Fig. 5a is a diagram of a PNP transistor, 5b that of an NPN.

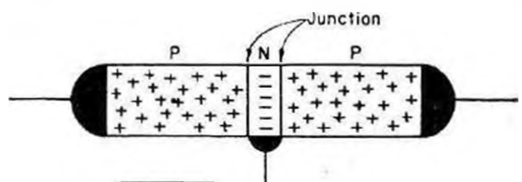


FIG. 5a.

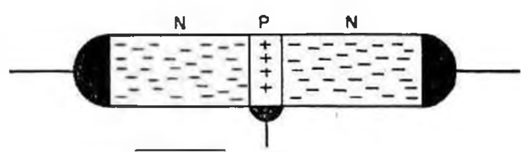


FIG. 5b.

The PNP is the most common for germanium transistors as it is the easiest to make, so we'll stick to the PNP. There are two junctions and a depleted region at each junction. The spacing between the junctions has to be very small, 2 thou or less (a few millionths of an inch in some high frequency transistors.)

If we connect two batteries to reverse bias both junctions (Fig. 6) only the small leakage currents will flow.

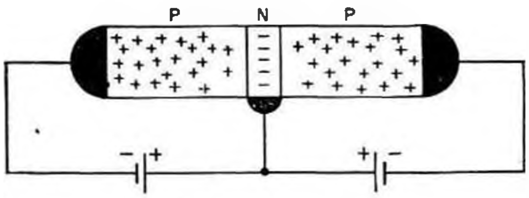


FIG. 6.

If, however, we forward bias one junction, we have, for that junction, the same state of affairs we saw in Fig. 3 where, if you look again, you will notice that holes have been pushed into the N region where they diffuse before being mopped up. To get an idea of diffusion up-end a sack of potatoes or apples on the kitchen floor and gently remove the sack when the spuds (or apples) will spread out in an attempt to level themselves. As this experiment is likely to prove a little unpopular with the lady of the house, the weaker types had better try a bag of marbles on a flat (cloth covered) table. Notice that as the surface is level the spuds or marbles will only spread so far in an attempt to level themselves out. In the same way there is no appreciable accelerating electric field in the region close to the junction, so the density of injected holes falls off exponentially from the junction. However, in Fig. 7 we have the second junction close enough for the injected hole density in the N region to be high, and the bias at this junction is such as to pull them across, as they arrive, into the P region.

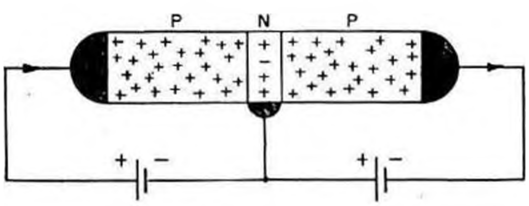


FIG. 7.

Some holes, of course, don't make it, they meet up with an electron in the N region and are mopped up so some electrons have to flow into the N to make up and this represents some holes going out. In a good transistor 95% to 99.5% do make it. The P region from which the holes are injected into the N is known as the emitter, the N region the base and the P region which collects the holes the collector.

Usually in the typical alloy junction transistor the collector is larger than the emitter to assist collection of the holes, see Fig. 8. Thus as the collector can only collect holes injected by the emitter, the collector current is very nearly equal to the emitter current and the base make-up current, the difference is very much less.

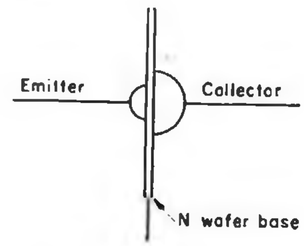


FIG. 8.

The action of the NPN transistor is similar to the PNP except that the N emitter injects electrons into the base and when they have diffused across the base to the base collector junction they are swept into the collector by the, for them, accelerating field. The polarity of the supplies for the NPN transistor are the reverse of those for the PNP as is the direction of the currents. The use of both PNP and NPN transistors together in servo circuits can lead to considerable simplification as unlike valves where we can only control current flowing in one direction the use of PNP and NPN transistors in complementary circuits makes it possible to control currents in both directions through a common load without the complications of phase splitters and the like, to reverse servo motors in actuators for example. Reasonably priced germanium NPN transistors are becoming available and I hope to deal with their use in servo circuits later in the series.

A simple analogy for the normal diffusion transistor using 'gravity' in-

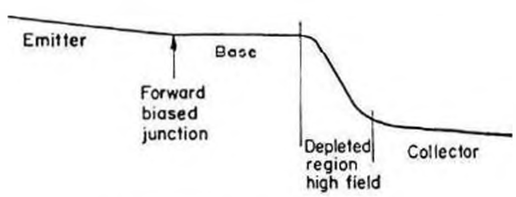


FIG. 9.

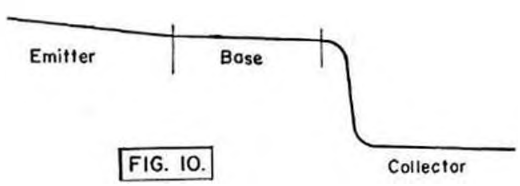
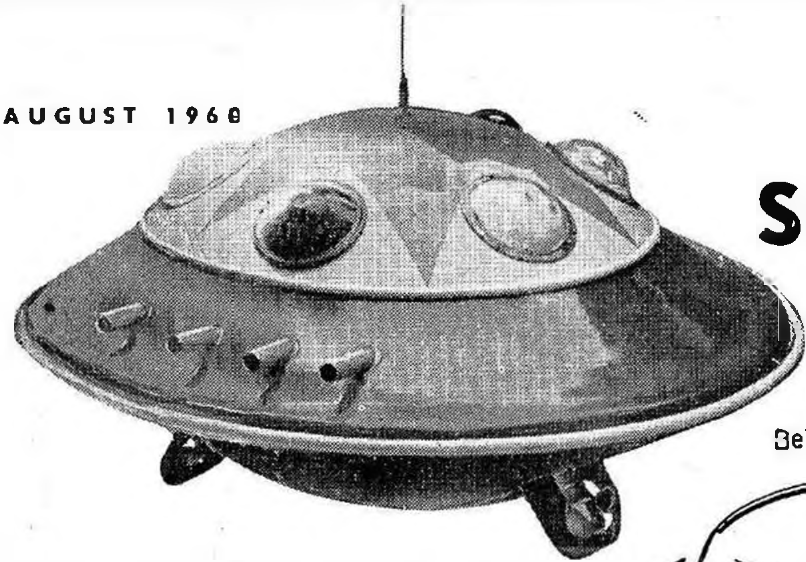
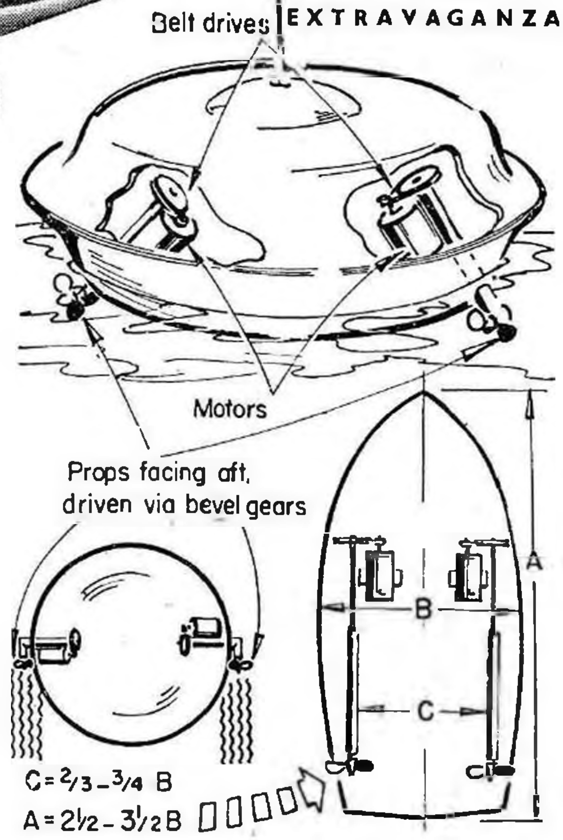


FIG. 10.

Star of the Seas

A FRENCH EXTRAVAGANZA





Example: 30" hull, 12" beam, 9" prop spacing

THIS highly unorthodox model boat was photographed at a regatta in Paris two vears ago.

We have never seen a more manoeuvrable model, which is hardly surprising, since the *Star* can spin round at a very high speed on the water without moving an inch. It could probably work up to something like 200 r.p.m.! At the same time it was capable of perfectly straight running.

The secret is the electric drive mechanism which consists of two motors driving twin screws through bevel gears in little stalks mounted practically on the periphery. With both props driving ahead a straight course resulted; one prop stopped, gave a sharp turn in the direction of that propeller, while one prop ahead and one astern gave the remarkable spinning.

Construction of such a boat is fairly simple, especially as it should be possible to use plastic washing up bowls or similar objects (suggest you remove the handles first).

It should be quite feasible to use a similar motor set-up with widely spaced propeller shafts in a tubby little boat of somewhat more orthodox appearance. Although this could not quite spin in its own length, it should still have considerable manoeuvrability.

A suggested layout for such a boat is sketched, and if reverse is dispensed with, this could be operated with a wide measure of control by a simple single-channel pulse system. On 50/50 pulse both motors would drive, on mark only one, and on space the other.

INTRODUCTION TO TRANSISTORS, PT. 2 (continued from page 188)

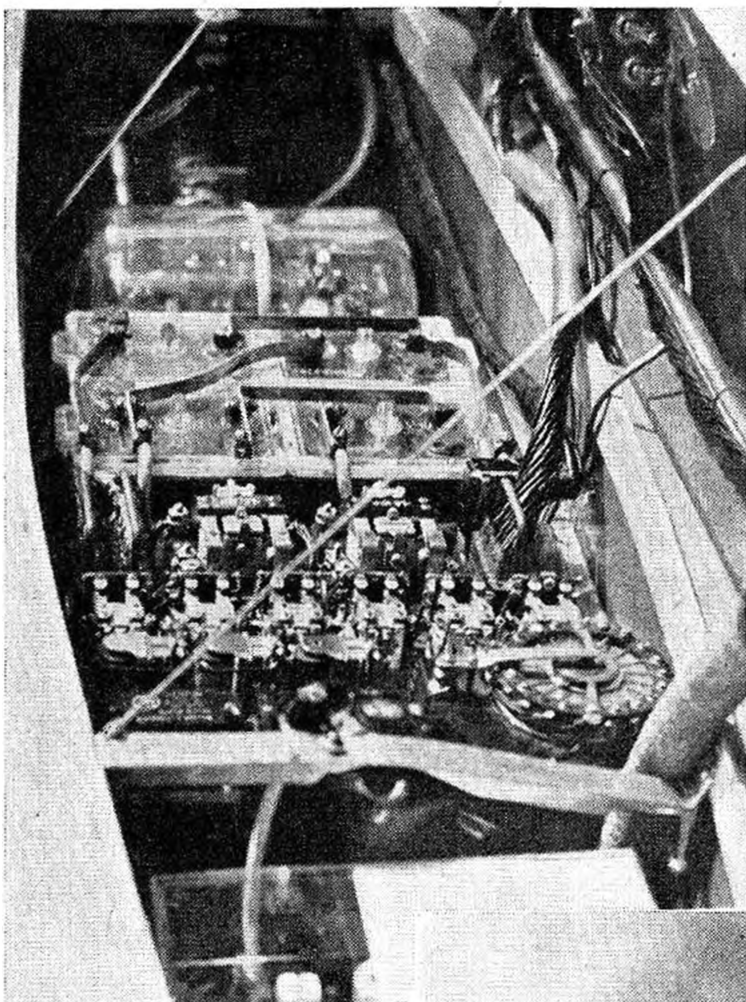
stead of electric fields looks like Fig. 9, so far as the holes in PNP transistor are concerned.

For high frequency operation the time taken for the diffusion across the base is a serious limitation and high frequency transistors have to have rather thin base regions and in general they have lower maximum current and voltage ratings. However, manufacturing techniques are always on the move and in a few years time we may all be able to afford transistor Tx's capable of the legal max. output.

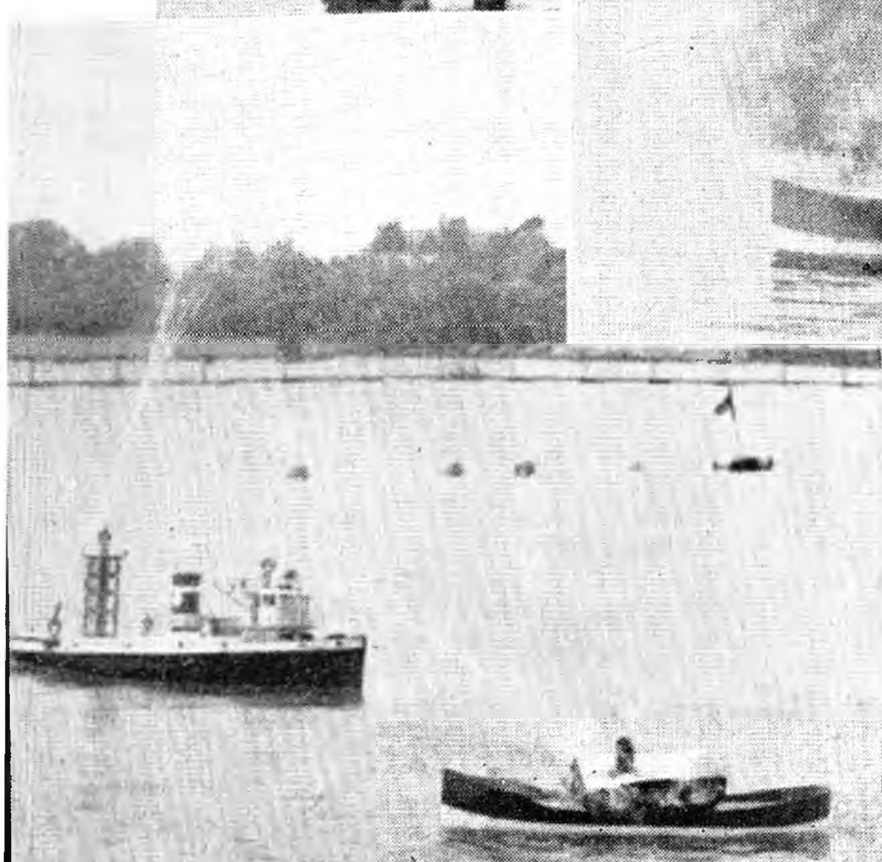
There is one important type of H.F. transistor where the doping of the base region is graded so as to produce a built-in field. The holes now drift across the base under the influence of the field and so get to the collector more quickly than they would by diffusion, an example of this type is the OC.170 used in Bellaphon Rx. and Tx. (see pages 150 and 151 July issue).

For these the analogy would be as in Fig. 10.

U.S. Fireboat at Poole



The show-stealer at Poole was undoubtedly Francis Reynolds' Seattle fireboat, which had been shipped from Seattle via the Panama and which arrived in working order—quite a tribute to its rugged installation. Pictured at top is a glimpse of the inside—twenty simultaneous channels including such refinements as speech or music from the shore coming back from the boat's loudspeaker—and we are promised a few notes by the builder for a future issue. Centre shows the metal boat which is rubber powered; when the rubber runs out a trigger mechanism fires a floating line and ignites the petrol aboard. Bottom, the fireboat approaches, siren screaming, with its three main monitors, each throwing a 30 ft. jet, getting the fire out even before the boats close; it then picks up the floating line and tows the wreck back to shore. Fourteen electric motors in the boat cover such functions as raising and lowering fire tower, sweeping and elevating monitors and searchlight, etc., automatic bilge pump, water pumps (45 amps—15 gallons a minute), siren, and main propulsion. Lead acid accumulators provide power for all functions, contributing to the 80 lbs. needed to bring the 6 ft. hull to her marks.

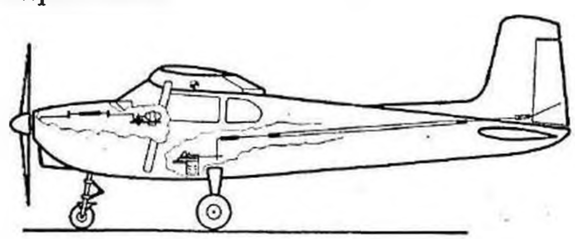


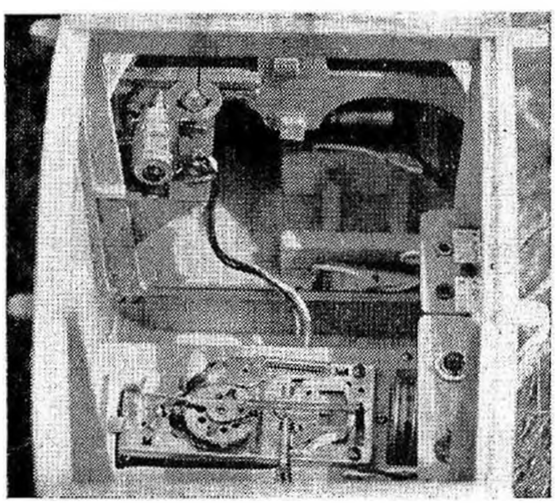
Kinematic Aloft

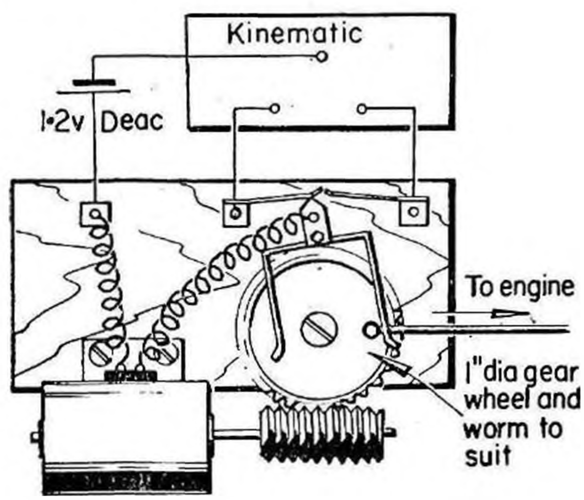
DIGESTED FROM MECHANIKUS

OUR recent article on the Kinematic actuator aroused interest amongst boat enthusiasts, but the aircraft brigade hardly considered it at all, so that we were delighted to come across a successful user in *Mechanikus*, particularly as he appears to have built the unit into a model based on our own A.P.S. Cessna 172 plan!

Dr. Weber who made this experiment is a frustrated single channel R/C flyer, whose efforts to step into the multi ranks proved costly and unrewarding. Determined somehow to enjoy the added pleasures of additional controls he decided to try the Kinematic, in spite of "expert" warnings that it *must* be fitted dead horizontal and that it would be extremely touchy in flight. His approach was to instal it in a test rig and try it at all angles, when he found forebodings much exaggerated. Installed at C.G. as shown it functions happily. Change over to multi controls was to be gradual, first need being engine control in addition to normal rudder, to which he was already accustomed. For this a 1.5v. motor (ex electric kitchen clock) was fitted, working a 1 in. dia. plastic gear wheel via a worm. Contacts were adjusted to permit one half revolution of the gear wheel for every signal. Meanwhile the rest of the Kinematic provides his usual rudder control. This may seem a lot of effort to get one more control, but there are still half a dozen other controls left in that actuator which the worthy doctor can add as his skill permits, with minimum effort and little expenditure.







Contact Materials

Ron Warring supplements his Contact Design article with facts on materials.

DESPITE its good electrical conductivity, *copper* is a very poor contact material because of the readiness with which the surface tarnishes. Even under ordinary room conditions a sufficiently thick film forms on a clean copper surface in a matter of hours to increase the contact resistance considerably and in a day or so, particularly under adverse conditions, this resistance has become so high that the copper surface may then be an effective insulator. Copper contact surfaces are, however, still tolerated for rubbing contacts, relying on the wiping action to provide surface cleaning. This is still not good practice and cannot be recommended. The same applies to all other base metals and alloys of these metals. Even stainless steel and chromium plate (irrespective of their relatively poor qualities as conductors) develop high resistance oxide films on the surface on exposure to air, although this may not be visible.

For complete resistance to oxidation or tarnishing, in fact, only platinum, rhodium and gold are satisfactory amongst the pure metals, and to a lesser extent iridium (where reasonably high contact pressures are involved). Price is against their widespread adoption, except where they can be employed in the form of electro-deposited films on a base metal.

An interesting exception to the above rule is cadmium, which is a quite inexpensive form of plating. Although cadmium does oxidise in air the oxide is a good conductor and cadmium plated reeds, for example, have given good performances.

Silver is commonly quoted as a good contact material. Certainly it does not oxidise readily (not at all in air even under arcing conditions), but it is readily attached by sulphurous compounds and tarnish with a brown to black surface film of silver sulphide. In 'clean' atmospheres, free from sulphurous films, silver may prove an excellent contact material. In industrial atmospheres where there is an appreciable proportion of sulphur dioxide in the air, silver contacts may be subject to rapid tarnishing.

Improved performance can be obtained from silver alloyed with another metal—see Table I. Of these alloys, silver-gold (10% gold) is commonly used for relays, telephone keys, etc., although complete freedom from tarnishing is only realised with a much higher gold content (over 50%). Silver-cadmium alloy is an attractive alternative, considerably cheaper and in specific proportions excellent for low voltage low pressure contacts. Silver-copper alloys are not suitable for light contact pressures and are really only to be recommended where a wiping action is present.

TABLE I. SILVER ALLOY CONTACT MATERIALS.

ALLOY	PROPORTIONS	TARNISH RESISTANCE	RESISTANCE TO WELDING	HARDNESS	WEAR RESISTANCE	CONTACT RESISTANCE
Silver — Gold	10% Gold ↓ Over 50% Gold	Slight Improvement ↓ Complete	Improved	Not Improved	Not Improved	V. Low
Silver — Copper	7% Copper 10% „ 20% „ 50% „	Fair ↓ Poor	Improved	Improved ↓	Improved ↓	Increasingly Variable ↓
Silver — Cadmium	17% Cadmium	Improved	Much Improved	Improved	Improved	V. Low
Silver — Palladium	5% Palladium 10% „ 20% „	Improved ↓ Complete	Improved	Improved	Not Improved	V. Low

TABLE II. PLATINUM ALLOY CONTACT MATERIALS.

ALLOY	PROPORTIONS	TARNISH RESISTANCE	NOTES
Platinum — Iridium	10% Iridium 20% „ 25% „ 30% „	Complete	Relay Contacts. Limit for Rivet Contacts.
Platinum — Ruthenium	Up to 5% Ruthenium 10% 14%	Complete Some oxidation at high temperatures	Commercial Alloys.
Platinum — Iridium — Ruthenium	"Irru"	Complete except at very high temperatures	High Resistance to Erosion, Arcing and Mechanical Wear.
Platinum — Molybdenum		Very good	Hard, Wear Resistant Alloy for Heavy Duty.
Platinum — Osmium	Also contains a high proportion of Iridium	Complete	Exceptional Hard Wearing for Severe Duties, Calling for Low Contact Resistance.

There are also a number of specially developed contact materials produced under the trade name of Elkonites—comprising silver-tungsten, silver-tungsten carbide, silver-molybdenum, silver-cadmium oxide, silver-graphite (and copper-tungsten). These contact materials are produced by powder metallurgy since the combination represents metals, or a metal and a refractory base, which do not alloy normally. They are intended principally for severe duty applications where the good conductivity of silver (or copper) is required with high resistance to wear and erosion, etc., especially under heavy contact pressures. They do not normally come within the scope of model radio control requirements.

Platinum is excellent as a contact material where contact pressures are low and high reliability is essential—but it is expensive. It is completely immune to tarnishing or oxidation, but pure platinum is rather too soft for general use as a contact material. The hardened 'C' type is normally specified. A wide range of platinum alloys have been developed, partly with the idea of reducing cost but also to improve hardness and resistance to wear. The more important of these are summarised briefly in Table II.

Palladium, much cheaper than platinum, is the least corrosion-resistant of this group of metals (the platinum group, which also includes iridium and rhodium). It does not oxidise or tarnish at normal temperatures, however, so is attractive as an electro-deposited coating (usually in the form of a thin coating over silver plating).

Rhodium is also corrosion-free at normal temperatures, hard and with excellent resistance to wear. As a contact material its application is almost exclusively confined to electro-deposited coatings (particularly over a silver coating). It is an excellent contact material with the limitation that since only thin films are normally formed these may be perforated and broken down by arcing. It is not a suitable material for plating on to rivet type contacts, nor can it be plated directly on to steel, tin, cadmium or aluminium (in such cases a preliminary deposit of silver is called for). Rhodium will, however, electro-deposit directly on to silver, gold, copper and copper alloys.

Iridium is another of the same group of metals highly resistant to oxidation or tarnishing, and also a very hard material strongly resistant to wear. It is difficult to work in the metal form and in such applications is limited to simple contact shapes brazed on to a suitable base metal backing.

It is more commonly used in the form of iridium-platinum alloys (10% to 30% iridium) which combine hardness with complete freedom from tarnishing. Their main application is for sensitive equipment operating at high speeds under fairly high contact pressures.

Of the other standard contact materials, *tungsten* is not suitable for low voltage circuits since its contact resistance is too high. *Platinum-silver-gold* PGS alloy (7% platinum, 26% silver, balance gold) was developed specifically for low voltage relay contacts (for telephone initially, and it is known as Post

Office alloy no. 1). It is excellent for light duty work with low contact pressures but high reliability. *Copper-silver-gold* alloys, on the other hand, are only really suitable for sliding or rubbing contacts. In such cases, the mating rubbing contact should preferably be of copper, silver or rhodium. A further useful feature of this alloy is that it has good spring properties.

Electro-deposited coatings have already been mentioned, but it is worthwhile adding that there is a considerable application for electro-deposited silver and gold. This is a comparatively inexpensive method of utilising these materials as contact surfaces applied over a base metal.

Fine silver electro-deposits can be built up to almost any required thickness (although .202" is about a practical maximum and the usual run of silver coatings are usually only of the order of .0005"). A particular application is in the coating of printed circuit contact surfaces to overcome the tarnish limitations of the parent copper (e.g. when part of the printed circuit is used for switching). Gold can also be electro-deposited readily on base metals, or on silver, to provide freedom from tarnish under atmospheric conditions. It is again particularly suited for light duty work but it must be remembered that gold is a soft metal and thus subject to relatively high wear.

BOAT R/C INSTALLATION (Continued from page 185)

m.A. then an OC 72 must be used. Note that at low voltages the relay coils are connected in parallel, i.e. green to red and red to green, on the Siemens relay.

The Siemens relay is not designed to switch currents of the order of 1 amp, and sparking will soon make the contacts dirty unless a spark quenching capacitor is connected across the contact points. 0.5 uF. was found to eliminate sparking in the prototype.

One disadvantage with the circuit as it stands is that when pulsing stops the rudder will go to full left or full right depending on whether the Tx. is switched to full off or full on. Since the motor does not stop immediately pulsing ceases (due to discharge of C1) this results in a jerk to one side on stopping the motor. This can be overcome by the use of a double pole motor switch relay, the second pole being in the actuator circuit as shown in Fig. 2a. Note that if a series transformer is used this circuit cannot be used since the engine switch relay will then disconnect its own signal source!

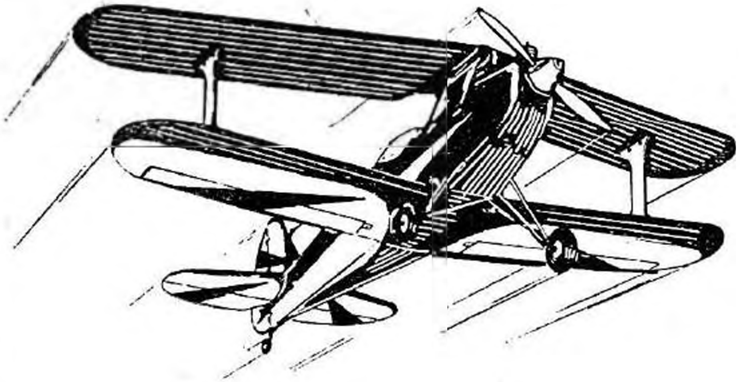
In an attempt to speed up motor cut-out operation a 5.6 K. resistor was placed in series with C1 (see photo). Although operation was quicker, relay action was rather less positive and this has now been removed.

Application to Aircraft

The switch unit will hold the relay for all modes of operation of the Galloping Ghost system, so by linking the relay to a suitable cut out, a measure of engine control is obtained together with proportional rudder and elevator, and all on single channel at that! The system is particularly useful in this application since it will automatically cut the motor in the case of radio failure. Again it is desirable to have a two-pole relay with one pole in the actuator circuit to centralise rudder and elevator if and when the radio fails. If this system is used it is essential that the pulse box is still pulsing properly at full left and right rudder; some pulse circuits use limited sections of potentiometer tracks and beyond these sections the pulsing relay will hold on or drop right out, which would obviously cut the motor.

Next Month . . . HIGHLIGHTS OF THE ISSUE INCLUDE :

FAULT FINDING CHART to pull out ★ Famous "Ivy" Single Valve Receiver with super-sure construction for beginners ★ Two-Channel Simultaneous Proportional by Lovegrove ★ Circuits from Overseas Latest Equipment ★ C.R.T. Oscilloscope, Part 3 ★ Transistors, Part 3 ★ McQuery Column ★ Here, There and Everywhere.



FRED DUNN'S

"ASTRO-BIPE"

(FULLY AEROBATIC)

WING SPAN— 54 IN (UPPER), — 48 IN (LOWER)
TOTAL WING AREA — 790.4 SQ. IN. OR 5.49 SQ. FT.
WING LOADING — 17.8 OZ. PER SQ. FT.
GROSS WEIGHT — 98 OZ. (8 CHANNEL)
OVERALL LENGTH — 45.5 IN.
AIRFOIL — ORIGINAL, 15%, 8 IN. CHORD
UPPER WING SWEPT 10° PER HALFSPAN

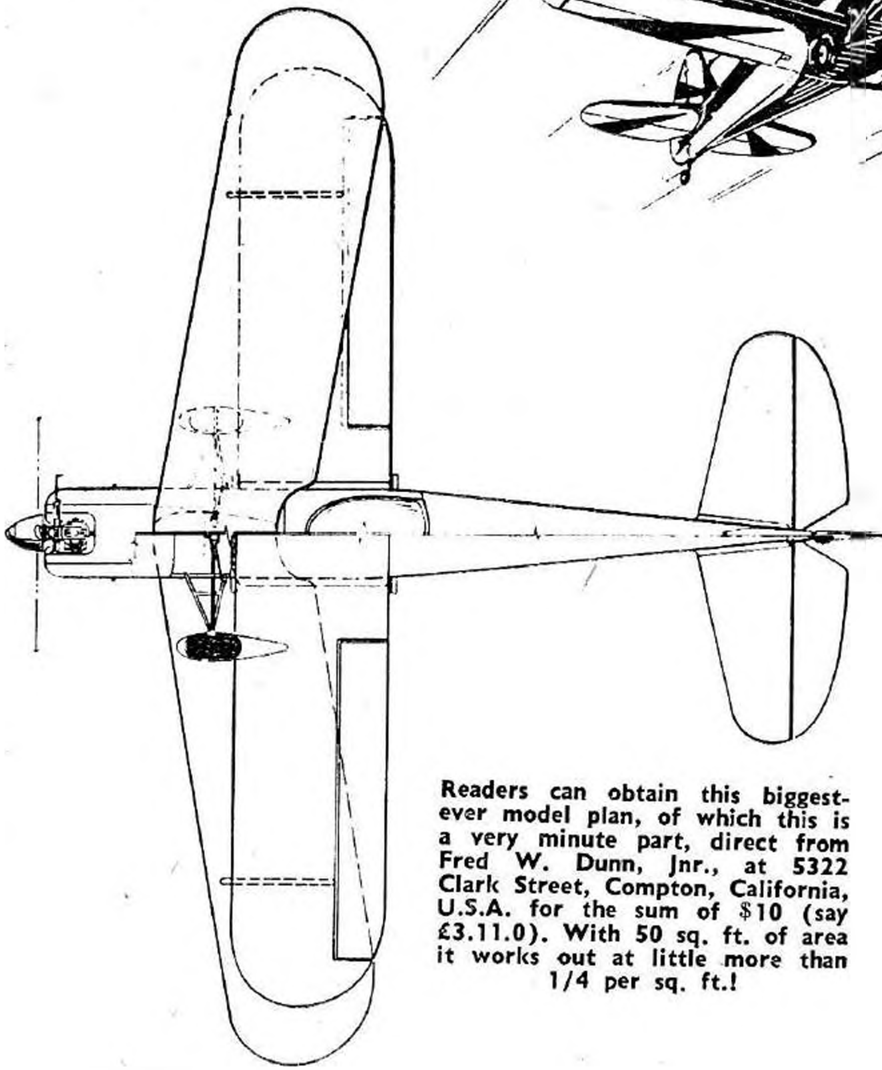
ENGINE — TORP .45 RC

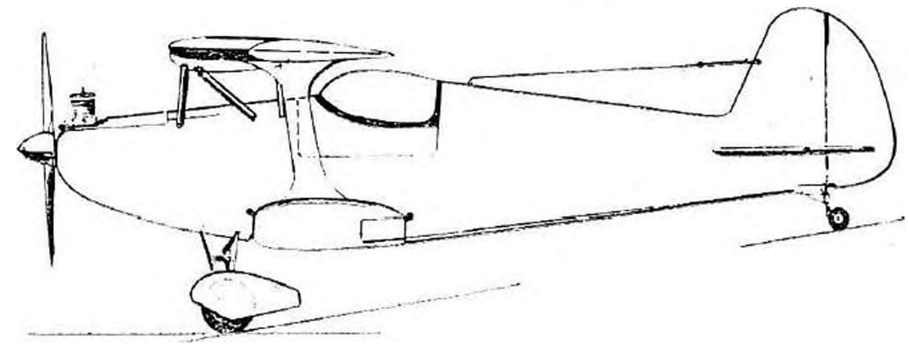
SERVOS — BONNER, DURAMITE

RADIO — ORBIT; 8 CHANNEL

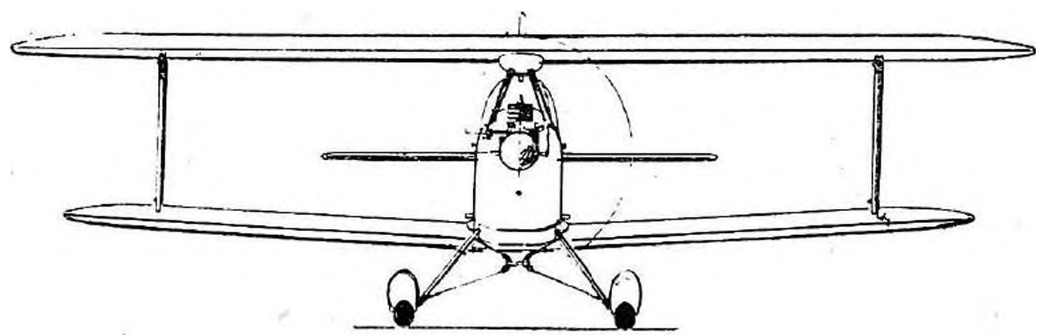
DESIGN BY Fred Dunn 1959

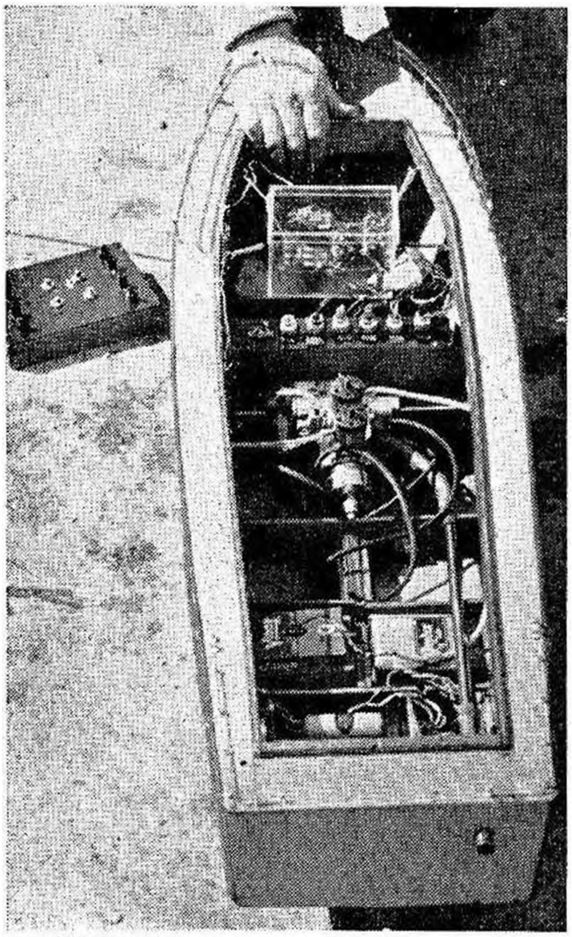
DRAWINGS BY F. Dunn 3-25-60

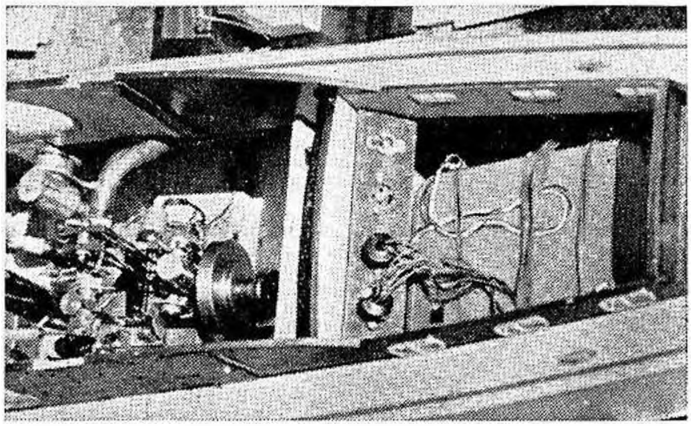


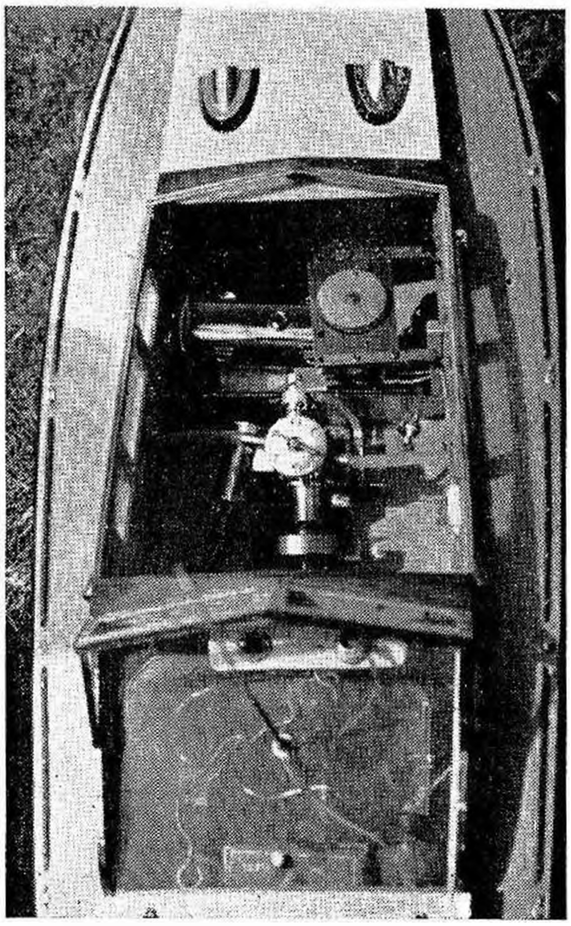


Readers can obtain this biggest-ever model plan, of which this is a very minute part, direct from Fred W. Dunn, Jnr., at 5322 Clark Street, Compton, California, U.S.A. for the sum of $10 (say £3.11.0). With 50 sq. ft. of area it works out at little more than 1/4 per sq. ft.!









Looking Inside

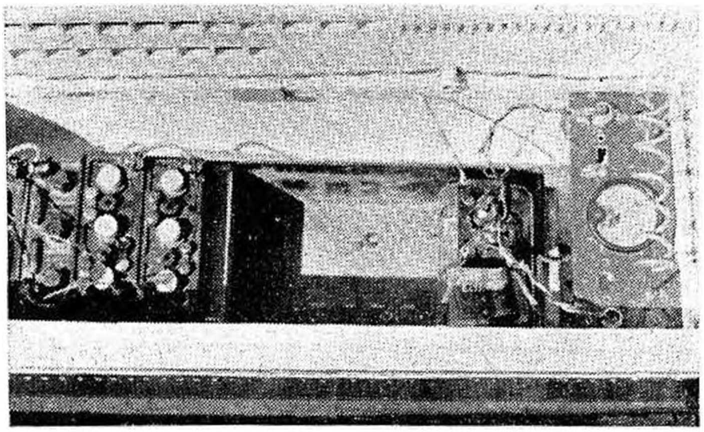
THE pictures on this page are fairly representative of the internal installations used by many of the regular competition entrants. They vary from the veteran to the brand new and the intending radio boat modeller can learn quite a lot.

Top left is Ivor Morgan's *Miss Isle*. Receiver is well forward in a Perspex box hung on springs. Leads, with plenty of slack, plug into the various actuator circuits and test meter sockets etc. are easily available. The batteries are carried well aft (this is a question of the correct location of the boat's C.G.) and the rudder actuator can be seen at the stern. The throttle actuator is mounted slightly below and ahead of the tank which is visible behind the engine.

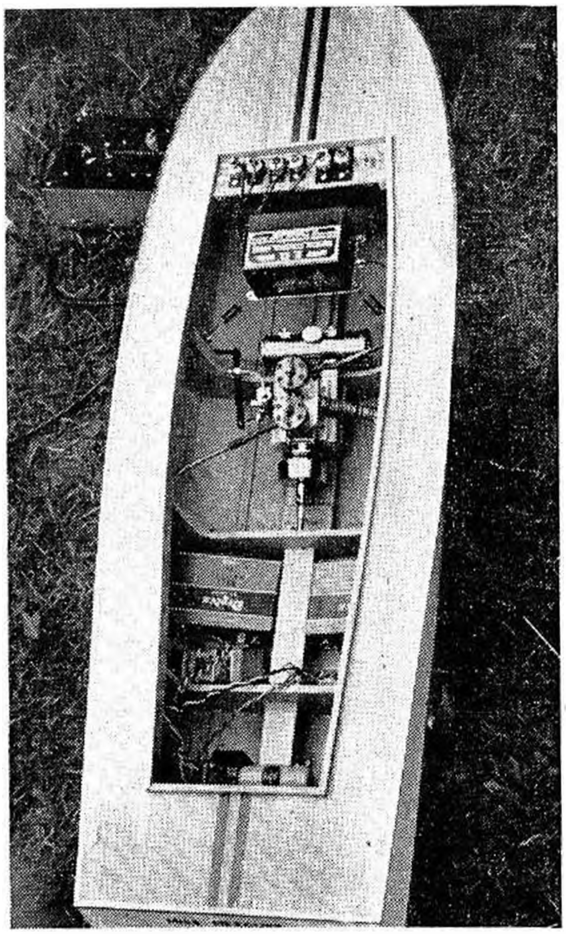
Below is a neat installation in a *Sea Commander* which at 34 in. is the smallest boat shown here. Owner P. Murphy has many home-built accessories and several ingenious ideas in this model. A plastic box is again used to cover the radio, protecting it from spray; the aerial can be seen emerging vertically at the bottom of the picture. The engine (E.D. 346) has a double butterfly throttle operated by an E.D. clockwork escapement rigidly mounted as seen in the picture.

Centre left above is Alex Macdonald's *Andy*, a very fast boat powered by a Gannet. Here the radio is mounted astern of the engine in rubber foam which in turn is held down by rubber bands. Plugs for the actuator circuits, meter socket, and switch are again fully accessible on an inclined panel.

C. Archer's *Britannic* (centre right) is a veteran model which manages to place



SOME OF THE BOATS AT POOLE REGATTA

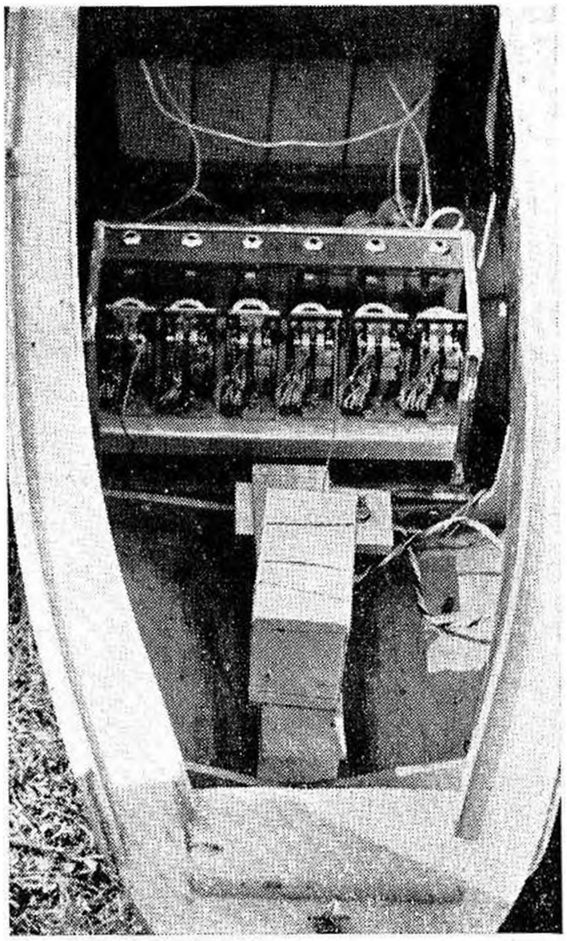


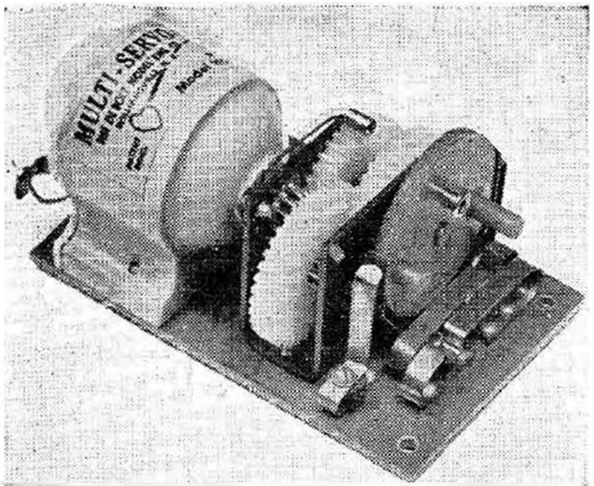
very well in competitions with regularity. Its cavernous inside reveals an almost microscopic radio, again hung on springs, which is all that is required for the method of control of this model. Built-in meter, etc., can be seen at right; the spiral is actually the aerial. Transmission of a signal stops both the electric motors of this boat and the rudder moving into position switches in the appropriate motor astern, which gives the model a peculiar, but most efficient, steering effect.

Top right is Henry J. Nicholls' new boat, a *Speranza,* with, again, the radio equipment hung on springs ahead of the engine. Throttle motor is tucked behind the bulkhead and rudder actuator can be sen aft. Note the very clean and tidy layout.

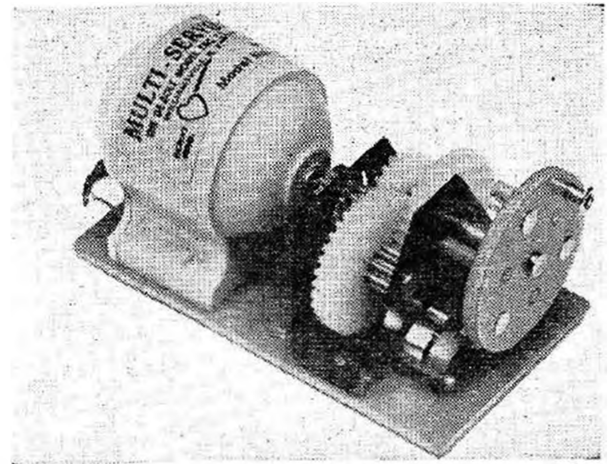
The last picture is a seven-year-old boat, *Maranty;* this one is electric powered and has a fair turn of speed. Note massive accumulators just visible. The radio receiver is in an aluminium case which is hooked to a wood frame by means of rubber bands, and it just perches there! Note the 6 in. aerial extending vertically from the box. The half dozen enormous relays look a little incongruous against the small receiver, but this is a very reliable model which seems to stand remarkable abuse without ever giving trouble.

What does one learn from this reasonably typical selection? Firstly, that vibration is just as much to be guarded against in boats as in aircraft, but that impact precautions are less stringent. Slung receivers on rubber bands or springs, now passing out of favour with aircraft, are still very suitable for boats. Finally, neatness pays off!





At left, the MCR servo for multi channel operation, requiring two channels/relays. It can also be pulsed and is very powerful thanks to 80:1 gears. Circuits are made and broken by contacts touched by "bumpers" on disc face and sides. At right is the type 3P3NX which moves forward one stage from a neutral each time a signal is sent and has three definite positions with three intermediate rest, or neutral, positions. It would be ideal for motor control plus rudder, following the new technique in the U.S.A. of having a powerful engine in a small design.



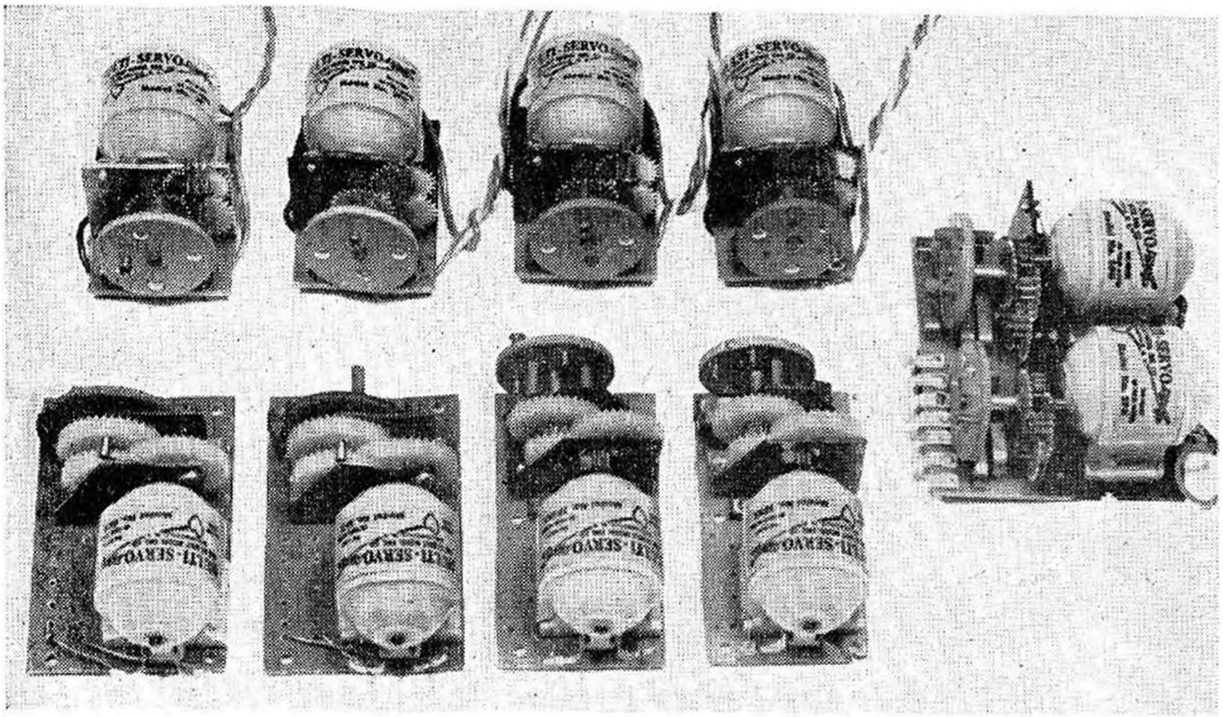
DE BOLT MODEL ENGINEERING CO. SERVOS

TYPE	ACTION	PURPOSE	GEARS	SIZE	POWER	WEIGHT	PRICE
3P	3 positions no neutral	Engine Speed, brakes, flaps	Brass & Stamped Steel 28 : 1	$1\frac{1}{4}$ x $1\frac{1}{4}$ x 2	1 lb.	2 oz.	£4 7s. 6d.
2PN	2 positions and one neutral	Single channel Rudder	Brass & Stamped Steel 28 : 1	$1\frac{1}{4}$ x $1\frac{1}{4}$ x 2	1 lb.	2 oz.	£4 15s. 6d.
2P2N	4 positions incl. 2 neutrals	Slave servo for elevator (single channel)	Brass & Stamped Steel 28 : 1	$1\frac{1}{4}$ x $1\frac{1}{4}$ x 2	1 lb.	2 oz.	£4 15s. 6d.
3P3N	6 positions incl. 2 neutrals	Slave servo for engine control (single channel)	Brass & Stamped Steel 28 : 1	$1\frac{1}{4}$ x $1\frac{1}{4}$ x 2	1 lb.	2 oz.	£4 15s. 6d.
MCR*	2 positions plus one neutral	Rudder (2 channel) or pulsed (single channel)	Brass & Nylon 80 : 1	$1\frac{1}{3}$ x $1\frac{5}{8}$ x $2\frac{1}{2}$	4ft./lbs.	2 oz.	£7 11s. 3d.
MCE*	2 positions plus trimable neutral	Elevator (2 channel)	Brass & Nylon 80 : 1	$1\frac{1}{3}$ x $1\frac{5}{8}$ x $2\frac{1}{2}$	4ft./lbs.	2 oz.	£7 11s. 3d.
3PNX*	3 positions plus one neutral	Rudder plus slave circuit (single channel)	Brass & Nylon 43 : 1	$1\frac{1}{4}$ x $1\frac{3}{8}$ x $2\frac{1}{2}$	2 lbs.	2 oz.	£5 19s. 6d.
3P3NX*	6 positions incl. 3 neutrals	Engine or control surface trimmer	Brass & Nylon 43 : 1	$1\frac{1}{4}$ x $1\frac{3}{8}$ x $2\frac{1}{2}$	2 lbs.	2 oz.	£5 19s. 6d.
5PN	5 position selector plus one neutral	Boat Rudder and motor control (single channel)	Brass & Stamped Steel 28 : 1 & 52 : 1	$1\frac{1}{4}$ x 2 x $2\frac{1}{2}$	$\frac{1}{2}$ lb. plus	3 oz.	£9 19s. 0d.

All servos use Rowe Ind. Inc. motors, 3 volt. Switch contacts are wiper type operated by cam wheel pegs. Neutralising by brake tension aid, 100% except MCE type.

* Printed circuit base.

Harold de Bolt's range of servos for single and multi-channel are now imported for British distribution by Henry J. Nicholls and should be well known by their fine reputation in the U.S.A., to be appreciated by modellers this side of the Atlantic. The full 9 model range covers all possibilities, with a 3PNX plus 3P as the more popular choice for single channel rudder/engine operators. The boat enthusiast will like the 5PN, an ingenious two motor combination which offers great possibilities from so compact a unit—able to fit quite small models. All are to be commended — highest drain of any type is 400 m.A. (3 v.).

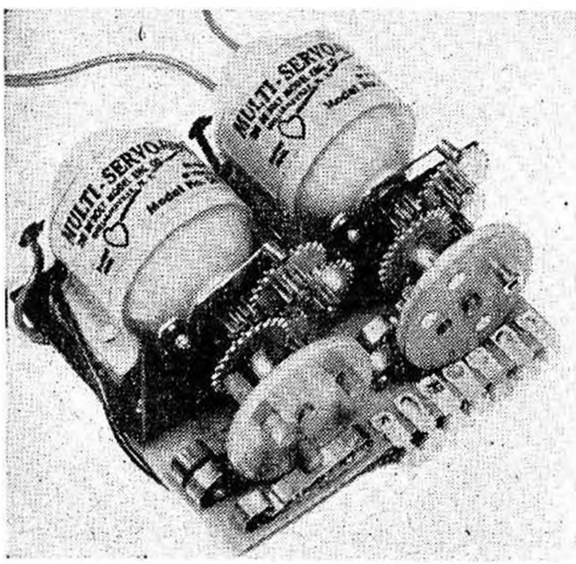


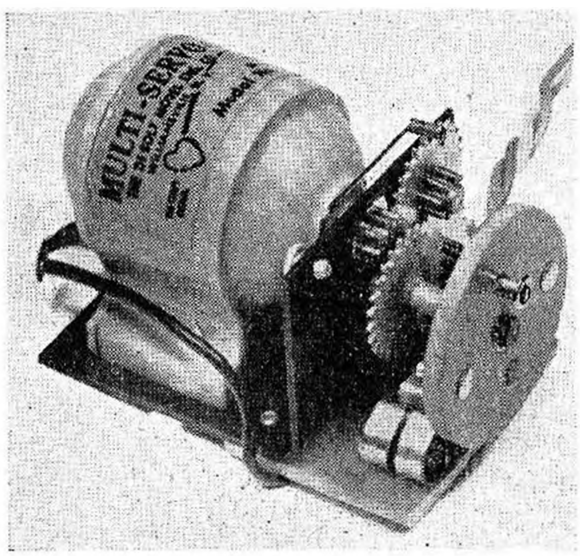
DE BOLT SERVO SERIES

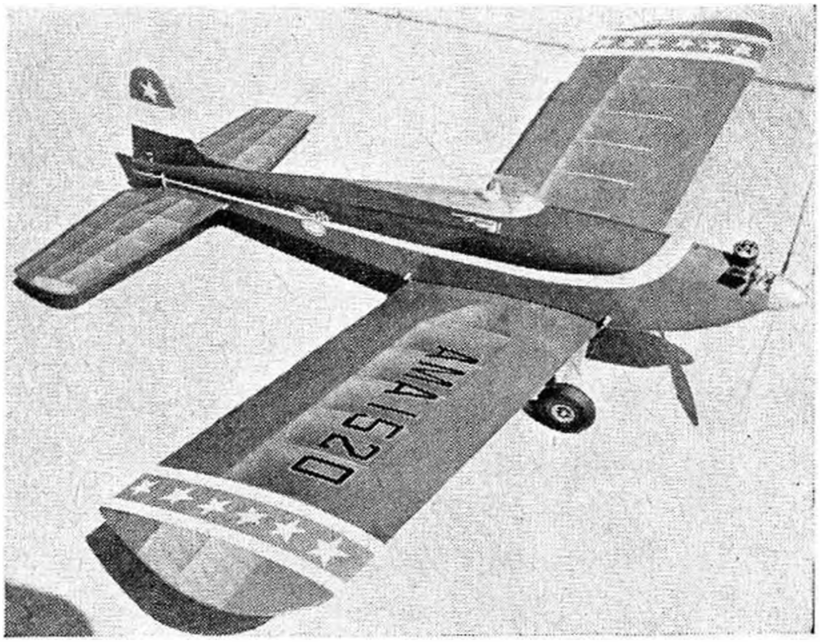
WELL TESTED UNITS FOR SINGLE- OR MULTI-CHANNEL NOW AVAILABLE IN GT. BRITAIN

NINE different servos, only two of them actually for multi-channel operation, is the range of the De Bolt Company in Buffalo, N.Y. Henry J. Nicholls Ltd. is now importing these units, all of which have the Rowe motor but onto which is applied a variety of gear ratios as can be seen in the table opposite. In all cases, the switching is actuated by make and break contacts from bumpers or cam action in the final drive disc. The servos are firmly mounted on a paxolin fibre base, the underside of which carries a

Below left, the 5PN, a two motor combination for nautical enthusiasts covering five positions plus a common neutral. One motor is slaved off the other's switchgear. Below right is the type 2P2N with all metal gears 28:1 ratio, faster in operation than the latest types but less powerful it is suitable for use on the elevator of a single channel model, in a cascade circuit.







Latest in the long line of successful De Bolt kits is the "Live Wire" Pursuit, a multi-channel following after the style of De Bolt's earlier Cosmic Wind. It is likely that Harold will be flying one of these in the World Championships. Note that he does not use exhaust throttle, only carburettor throttle.

printed circuit for some types, particularly those for Multi, with the prefix MC.

For the single channel enthusiast the range offers compound effect in the 3PNX with commendable slow timing to allow the most sluggish of button-pushers to master the selection of Right-Left-motor.

Harold De Bolt has always been known for his practical attitude to aeromodelling ever since he started his factory in the immediate post war years when discharged from the U.S. Navy. In this range of servos he covers every possible requirement known to date and thus he offers the most comprehensive range available.

Final drive is taken from the disc projection which is in the form of a hollow rivet and so the units have to be mounted across the fuselage but this is no disadvantage.

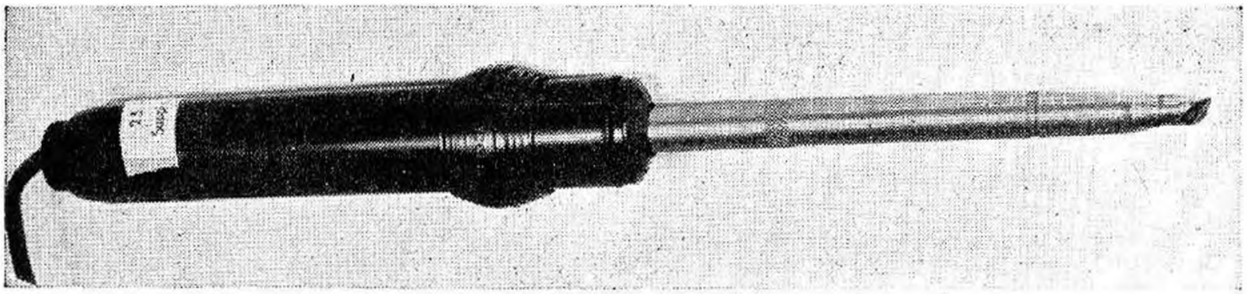
TWO GOOD R/C MEETINGS TO ATTEND

Aloft . . .

Here are promised details of Southern Counties R/C Rally at Army Air Corps, Middle Wallop, near Andover, on August 21st (located alongside Andover-Salisbury Road). No-refund pre-entry of 5/- per competitor, who must produce proof of insurance and R/C licence on the day (no show—no fly!) Contests start at 10 a.m. prompt but prompt, flying order published 9.45 a.m. No test flights, no "non-R/C" models, no trespassing, no litter. Flying to *new* S.M.A.E. Rule Book, based on F.A.I. schedules. Intermediate class to attempt multi schedule. Come early, stay late! Prizes: Cash for first six in each event. Challenge trophies presented by Model Aircraft (Bournemouth) Ltd. and Radio Control Models & Electronics. Pre-entries to: D. Grocott, 12 Wyndham Rd., Salisbury. Limited entry so get in early.

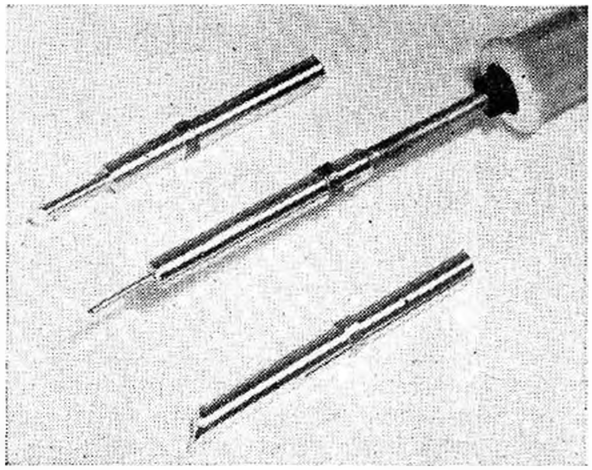
Afloat . . .

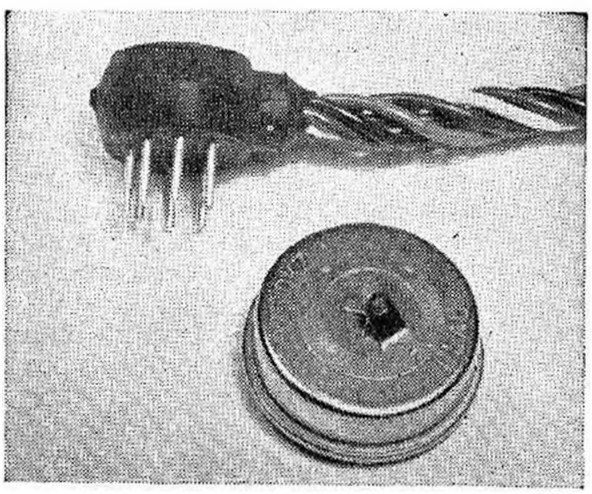
For boat people N. Western R/C Power Boat Regatta takes place at Fleetwood on August 21st, organised jointly by Fleetwood M.Y. & P.B.A. and Manchester Group I.R.C.M.S. This is a "trial horse" for a future two-day event in the future, but this year offers: (1) Two-lap speed; (2) Slow speed steering—no time limit; (3) Timed speed steering (limited five min. to cover course as often as possible). Club member or "lone hands" equally welcome who should contact Competition Secretary, G. M. Tipton, 20 Beamsley Drive, Woodhouse Park, Wythenshawe, Manchester 22, for details, entrance forms, etc., by return. The North has been starved of this sort of event in the past—this is a chance to show how much it is welcomed!



Trade Review

SUITABLE and efficient soldering equipment is as vital to the successful R/C man as a mike is to a "pop" singer—though we have heard of a certain nameless one who twists the wires together and still gets results! Ed. Johnson has just let us see a couple of very interesting irons he is handling. First is a real godsend to the unfortunate with trouble on the flying field, since it can be run off a car battery on two to five volts (be careful not to give it the full twelve!) Fixed thus with a couple of crocodile clips the bit heats up to soldering temperature in six seconds! Weight is only $3\frac{1}{2}$ ozs. so that it makes a light and delicate instrument. For mains use a transformer is available. The iron sells at 39/6d., transformer at 35/6d. and answers to the appropriate name of Superspeed. The other little iron we have been playing with is the Precision, which sells at 35/6d. plus 3/- each for interchangeable bits. These range from about $\frac{1}{16}$ in. dia. to $\frac{5}{32}$ in. dia., and really make even transistors a pleasure to solder. The Precision iron runs direct off mains, and is available in voltages from 200/250.





Latest items in the immense Graupner collection include DEAC 225 DKZ and 500 DKZ types which can stand higher loads and have a minimum of inner resistance. Of special interest is the addition of soldering tags, which can be seen in the illustration. Also from Graupner is the handsome little seven-pin plug which is being used on a number of continental receivers these days.

An important aspect of trade supplies is tied up with the problem of where to get bits and pieces of constructional projects appearing in the magazine. As a new venture these sources of supply must necessarily grow up with us. We are happy to have old friends like Radio and Electronic Equipment providing kits of parts for popular receivers; in the North Dockerty of Harrogate does a similar service for the Hill Receiver—and now the Hill Transmitter. Cuttriss & Sons of Doncaster can supply parts for last month's "305" which evoked a very popular response. Newcomers in this field are PJ Products of Erith, who in addition to offering panels and cases for well-known receivers and transmitters are open to quote for any chassis bending or cases to readers' requirements, which should surely take the stint out of their difficult bending problems.

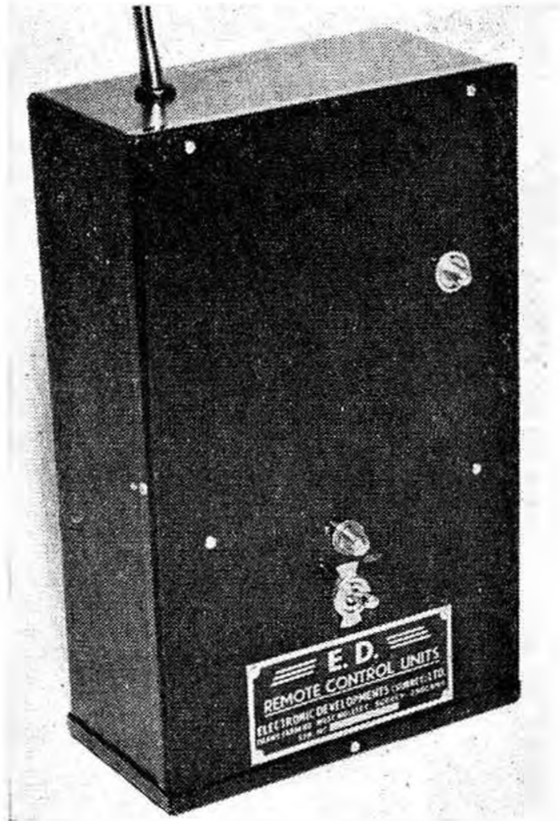
R.C.M. & E. TEST REPORT No. 3

E. D.

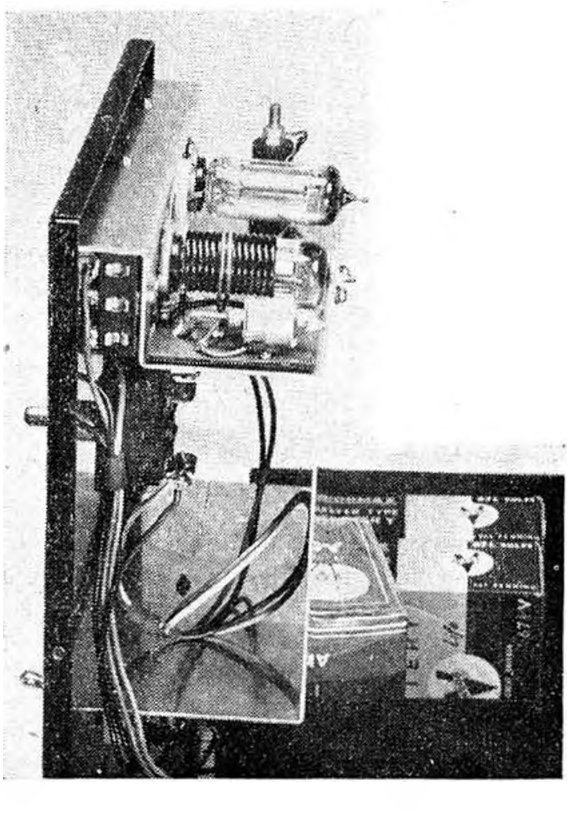
BLACK PRINCE & BLACK ARROW

Single Channel Receiver and Transmitter

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.



THE Black Prince/1 transmitter and Black Arrow/1 single channel units are the latest offspring of a new E.D. family, employing stabilized tone modulation and transistorised amplifiers. The



elegant black anodized finish distinguishes the E.D. equipment from others and this plus the robust internal assembly of both units deserves full marks for thorough workmanship. My part of this review is concerned only with electrical testing; further tests under flying or sailing conditions will be carried out by another contributor.

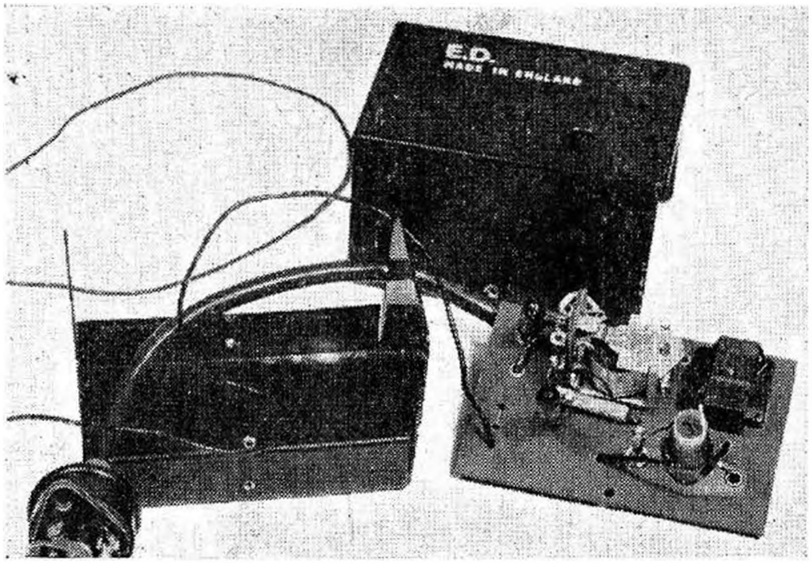
The Transmitter

Like a previous multi-channel Black Prince, that came to me for testing, it is well designed, compact, and is, of course, a hand-held transmitter complete with inductively loaded chrome plated telescopic aerial. There is ample space inside for both L.T. (AD4—1.5V.) and H.T. (2 x B101—67.5V.) batteries. The transmitter employs two valves in an exclusive E.D. circuit design which provides a single tone modulated 27 Mc/s signal, the modulation frequency being 390 c.p.s. The modulator oscillator is frequency stabilized by the use of a ferroxcube cored inductance.

A detachable base enables new batteries to be quickly replaced without disturbing the transmitter chassis and tuning. Controls are simple and comprise an on/off switch, which brings on the carrier only, and a spring biased button which switches on the modula-

Standard "black box" of the series is used for the single channel Tx., complete with valuable neon warning indicator to show working current.

On the right: Neat receiver unit showing relay side of panel. Small and compact the Rx. is totally enclosed for safe custody in quite heavy crashes.



tor. A warning neon indicator shows that the transmitter is on but ceases to glow when H.T. falls below a safe operating voltage.

A test showed that although the transmitter continued to function perfectly at only 70 volts H.T. the neon was by this time extinguished, so that ample warning is given.

Various tests were made to ascertain the efficiency of the r.f. and modulator circuits, for example the modulating tone frequency was checked and found to be 390 c.p.s.; the waveform is good and although r.f. modulation is 100% it is in the decrement sense, i.e. the r.f. power decreases under full modulation. I am not sure whether this should be regarded as detrimental to efficient radio control operation, because although a fully modulated signal would reach the receiver, the decrease in r.f. power during modulation would in fact, mean a reduction in carrier signal level at the receiver.

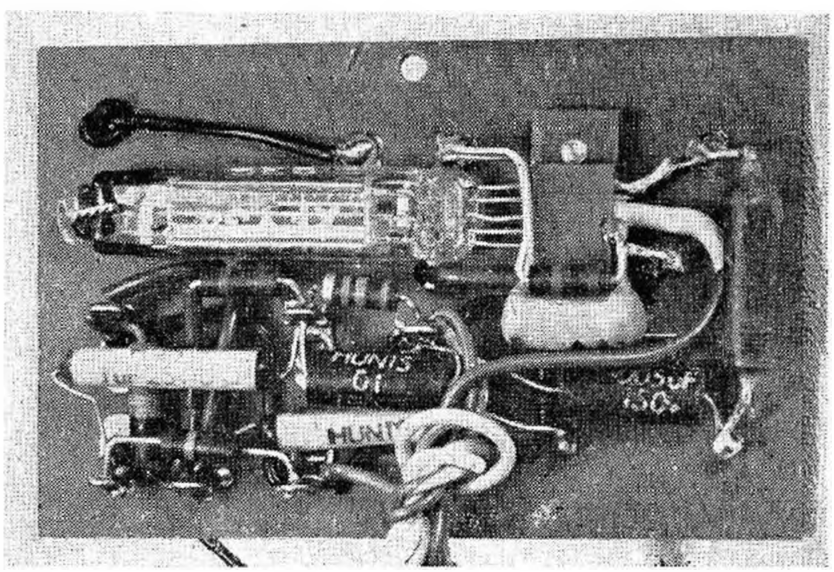
The loaded aerial system is efficient as it could be since no ground connection will normally be made to the transmitter except via the person holding it. H.T. current consumption at 135 volts was measured at 10 m.A. (unmodulated) and 11.5 m.A. (modulated), L.T. consumption at 1.5V. being 75 m.A. The weight of the transmitter complete with batteries is 5 lbs. and the case is 9$\frac{3}{4}$ in. x 6$\frac{1}{4}$ in. x 3$\frac{1}{8}$ in.

The Receiver

The E.D. Black Arrow/1 receiver employs an XFY.34 miniature valve as superegenerative detector, followed by two transistors in a fully temperature stabilized amplifier circuit, again an exclusive E.D. design, which the makers claim will operate satisfactorily at tem-

Left: Looking into the Tx. Everything is secured mounted at the top, with ample battery space below, which puts the weight balance just right for convenient hand operation.

Right: Underside of the receiver panel, showing the tidy arrangement of components, many being subminiature to enable this small Rx. to be assembled in the space.



peratures between 30° and 130°F. Control of the relay is in the 'current rise' mode and an increase from 1.5 m.A. to 5 m.A. ensures that the relay is well and truly closed during a command signal. Operating H.T. voltage is 22V. and L.T. 1.5V., the L.T. current being only 25 m.A.

The makers recommend that the receiver is used in conjunction with the Black Prince/1 transmitter, but I see no reason why it should not operate satisfactorily with any well designed single tone modulated transmitter of another make or home constructed.

Tuning is simple and can be accomplished accurately with a m.A. meter in the negative H.T. supply lead, although I found that very little adjustment was required since the tuning had obviously been checked at the factory before despatch. Tuning may also be carried out by means of headphones or by simply watching the relay actuator.

The receiver is robustly constructed and would, I imagine, withstand a crash shock, providing reasonable shock absorbing mountings are provided. It is fully protected against oil and water spray by a tight fitting cover. Weighing only 3 ozs. the Black Arrow/1 is suitable for lightweight work and for this Ever Ready B122 and U12 L.T. batteries are recommended, whilst for normal work and boat control the heavier but larger capacity types, such as the B110 or B115 (H.T.) and U.10 or D18 (L.T.) may be used.

Various electrical tests showed that operation is precise and efficient and although no long range checks were carried out, a full current increase (to 5 m.A.) was obtainable with the transmitter aerial only partly extended and the receiving aerial coiled up, the test range in this instance being approximately 100 ft. H.T. current consumption by the receiver for the 'no carrier' condition is 1.5 m.A. which falls to 1.5 m.A. idling current when the transmitter carrier is on. Current increases to 5 m.A. during command although the relay closes long before the maximum current condition. Tuning is not critical and only slight adjustment of the tuning coil slug was found necessary after connecting up.

The layout of the receiver, wiring, and so on is neat and components are securely held in their respective positions. I could detect no change in operation due to frequency drift or other effects, associated with transistor circuitry. All connections to the receiver are made via a B9A plug and socket, all connecting tags being clearly identified from the instructions supplied with both transmitter and receiver.

From an electrical point of view I found nothing that warrants criticism except the modulating condition of the transmitter which I commented upon earlier.

Both transmitter and receiver will, of course, be tested again in a working model and the receiver concerned may, of course, find that not all is to his liking. For my part, however, I was perfectly satisfied with the results of the electrical tests and on this score can recommend this equipment to those who require an efficient single channel R/C equipment.

MODELLERS' VIEWPOINT

Transmitter

The technical report deals with this unit adequately and the practical tests confirmed the findings.

Receiver

As in the case of the Multi reviewed in the May issue this unit was well up to E.D. standards. Tests were made under normal flying conditions with servo and all batteries connected.

The technical report was found to be well justified with one minor exception which seemed to make no difference to performance. This was not the fact that the D.C. temperature stability of the first transistor was not 100%. Increasing the temperature of the transistor (i.e. holding it between finger and thumb) resulted in an increase in standing current to 4.5 m.A. With the Tx. carrier switched on, however, this was reduced to .5 m.A. and normal operation on modulated signal followed.

The following points were noted:—

(1) Relay resistance was approx. 3,750 ohms. This accounts for the high current change on signal.
(2) Relay make at 2.5 m.A. and break at 1.5 m.A.
(3) No signal current 1.5 m.A. (rising with temperature as stated).
(4) Current with Tx. carrier only 1 m.A.
(5) Current with Tx. carrier modulated 5 m.A. plus.
(6) Range aerial retracted—67½ volts H.T. on Tx. 150 yds.; 135 volts H.T. 200 yds.

Range aerial extended—67½ volts. 200 yds.; 135 volts. 400 yds. plus.

The receiver was found to be extremely simple to tune and provided the maker's instructions are followed success is assured.

Some interference from a motorised actuator was experienced and suppression of the relay contact points is desirable.

The following criticism arises:—

The unit did not follow accurately pulsing at frequencies up to approx. 4 p.s. and above this would not respond at all. Without modification therefore it is not recommended for proportional control by the pulse method.

Apart from this the receiver was found to be very sensitive and even with the aerial lying across the servo circuit no loss of sensitivity was found. Also there was no appreciable falling off with old batteries. It can therefore be recommended with every confidence.

NEXT MONTH'S REVIEW: METZ BABY ALL TRANSISTOR RX.

McQUERY COLUMN

CONTINUED FROM P. 181

I WISH to build some tone equipment, i.e. single channel Tx. and Rx. I have in mind the Simpletone Tx. ("Aeromodeller" March 1960) and either Quetone ("Aeromodeller" August, 1959) or Cuttriss Rx.

What would your advice to me be, and also please, where would I obtain kits of parts?—H. B. S., LEEDS.

The parts for the Simpletone and the Quetone can be obtained from F. Rising, Whissendine, near Oakham, Rutland. B. Cuttriss & Sons advertised parts for their Rx. in the July issue. The Simpletone will require modifying for use with the Cuttriss to provide for carrier keying simultaneously with the tone. The mods. are:

1. Replace the present push button with an ON/OFF switch.
2. Connect the push button in the H.T. negative lead to the chassis. To tune switch off the tone, press the button and tune for the dip in anode current. To use switch on tone and press button.

I AM particularly interested in transistors, transmitters and receivers, and was taken up by the six transistor superhet made by J. W. Ford of S. Rhodesia and would be grateful if you would answer a query in relation to this receiver.

What is the frequency of the required transmitter. What is a D.C.C. 90 type transmitter, is it made in America?—N. S. T., MELBOURNE, AUSTRALIA.

With reference to your query, the Tx. frequency should be 27.12 Mc/s ± 0.6% (26.96—27.28 Mc/s is the authorised band in the U.K.).

By a 'D.C.C. 90' Tx. Ford was referring to the valve type used which is similar to a 3A5. The circuit would be that of a push pull oscillator (not Xtal controlled).

I WANT to make a Simpletone Tx. to work an Ultraton Rx. I have a 27.12 megs. crystal from an old Triang Tx., and wonder if it will be suitable, the one specified being 13.48—13.64 or 8.99—9.09 m/cs.

Also I have a collapsible aerial, 3 ft. 9 in., which I wish to use instead of the 3 ft. of 10g. piano wire. Have I to alter the coupling?—P. T. W., BRIDGEND.

With reference to your query:—

1. Plug your Xtal in, it will oscillate on its fundamental frequency—9050 Kc/s approx., whence your actual output frequency will be about 27.150 Kc/s—still in the band.
2. Reduce the aerial coupling capacitor from 20 pF. to 10 pF.

I WOULD be grateful if you would give me further information on the receiver TR 4.5:—

1. *Transformer. Size, winding details (no. of turns, wire gauge, etc.).*
2. *Choke. Size, winding details, wire gauge.*—P. D., WEYMOUTH.

1. Transformers—not critical 4.5:1 transformers subminiature obtainable from Messrs. Henry's at 7/6d. each are suitable.

2. The one specified is a 300μ H wavewound type.

You can make a suitable one by rewinding a "Radiospares 1 amp. TV1 choke" (from any radio dealer). One layer closewound full 40 G. enamelled.

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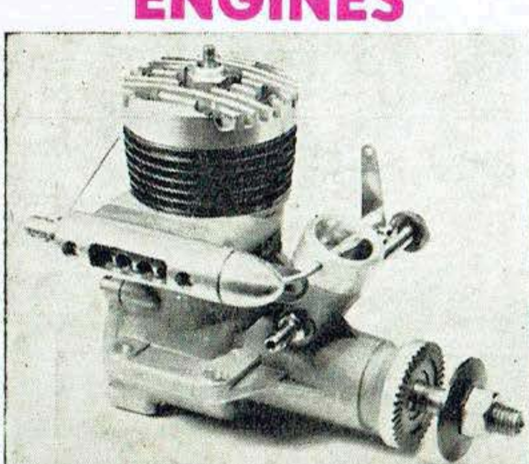

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