"Terrytone"

A RELAYLESS ALL-TRANSISTOR SINGLE CHANNEL TONE RX. Developed by Sqn. Ldr. S. W. Sarll, R.A.F. A.M. (Brit.) I.R.E., and produced in kit form by MacGregor Industries

It has been recognised for sometime now that the advantages of an all-transistor receiver such as lightness, small size, robustness, single-battery and no relay, have been somewhat offset by the uncertainty of the R.F. Transistors available at an economical price. Much experimental work has been done using the Semiconductor S.B.305 R.F. Transistor, but with the wide spread of characteristics in production, and the use of it at the very limit of its high frequency capabilities has made the standardisation of a simple yet reliable circuit impracticable.

New R.F. Transistors available both from Semiconductors and Mullards now provide a much more reliable performance at a more realistic price, coupled with the fact that these new transistors all have cut-off frequencies in the order of 70 mc/s to 100 mc/s. It is therefore now possible to provide a circuit for use at 27 mc/s with these transistors which do not need individual selection of close tolerance components, and therefore, in kit form with good quality components, will provide a receiver well within the capabilities of anyone to assemble—anyone, that is, who can make a neat soldered joint on a printed circuit panel.

Characteristics

The Terrytone Receiver weighs 1¾ oz. and measures 3⅛ in. x 2 in. x ¾ in. deep. The layout and size has been chosen for two reasons, (i) it allows components to be reasonably spaced and overcomes

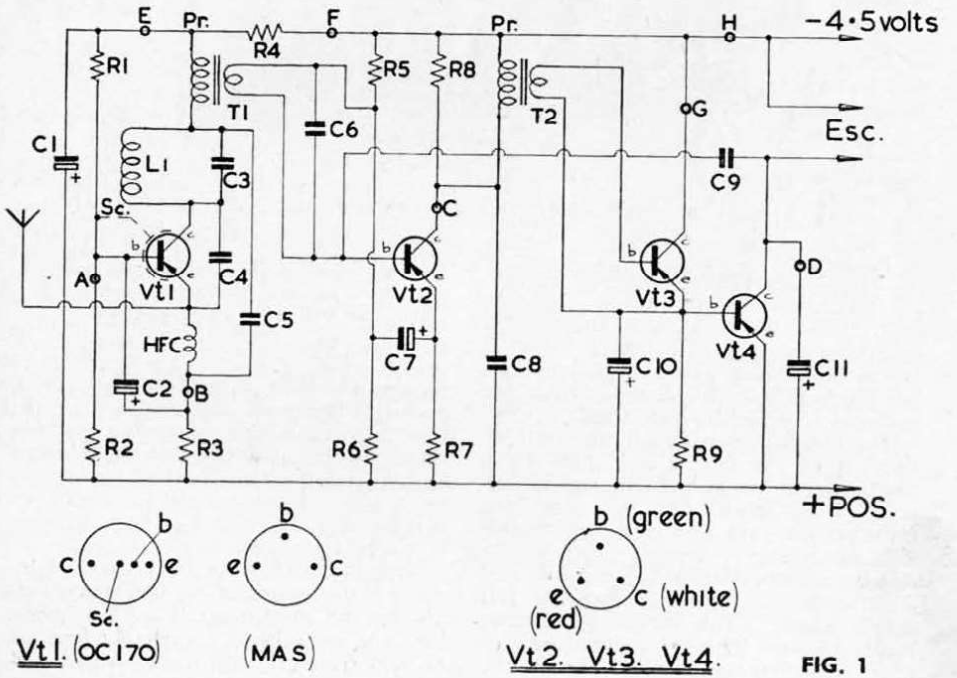


FIG. 1

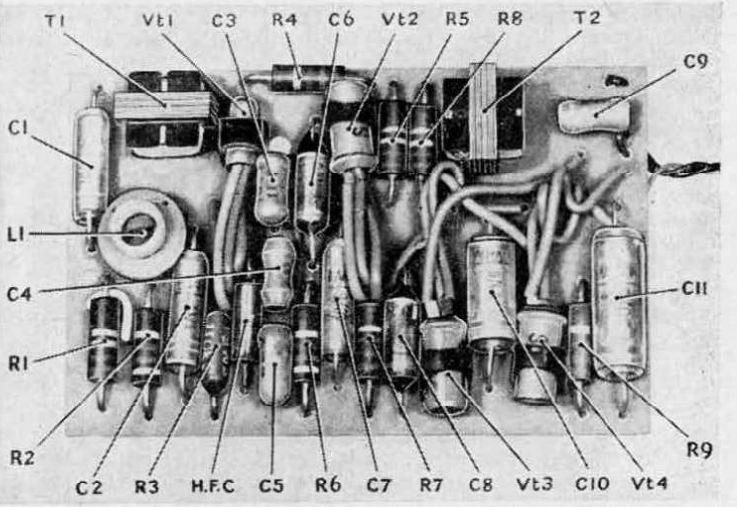
close proximity soldering, and (ii) it is considered that the average aeroplane fuselage or boat hull would not have a cross-sectional area less than the above size. No special shock-proofing is required, but securing the receiver to a bulkhead panel with a piece of foam-sponge between has proved a most convenient form of mounting. If the panel is sloping rather than vertical access to the single tuning slug is easier. The receiver will operate any of the rubber driven sequence escapements with an operating current from 200-400 m.A., dependant upon the resistance of the escapement coil and the battery used. Normally a 4½ volt dry-cell or 4 cell 225 DK DEAC pack may be used. A 3 cell 225 DK DEAC pack will operate most escapements—in fact the set has been found to work quite successfully on any arrangement between 3 and 7 volts. This latter figure must, however, not be exceeded. No special fixings are required for the components as the soldered joints provide all the security necessary. The coil is held tight by a special flange washer, the transistors are retained by plastic holders, and the transformers have pins moulded integral with the bobbin. A point worth noting is that all the transistors are soldered direct into the circuit leaving the full length leads. This makes for greater reliability, and by using a small pair of pliers, to create a heat shunt during the soldering operation, will obviate damage to the transistors. In addition to the R.F. Transistor, there are three G.E.C. medium power transistors—all three are the same type being used for audio amplification, switching and output stage which will pass at least 500 m.A. should it be required. (It must be pointed out, however, that dry batteries would soon run down if allowed to pass this current for long periods).

PREPARATION OF COMPONENTS

Printed Circuit

Description of making printed circuit panels has appeared in *R.C.M. & E.*, November, 1959, and December, 1960, and it is therefore not proposed to discuss at length the procedure in this article. The printed circuit layout shown in Fig. 2 is actual size and may be copied directly onto a panel of copper clad material by those wishing to make their own.

Drill No. 55 for the components, ⅛ in. dia. for the transistor holders and $\frac{9}{32}$ in. dia. for the coil former. The kit of parts, however, contains a completely finished printed circuit board ready drilled and



This annotated photograph of the completed receiver should be helpful in the final stages of the assembly.

printed on the reverse side (Fig. 3) showing the position of the various components and is available as a separate item.

Components

All the holes in the printed circuit panel have been planned to accept the specific components quoted in the Parts List, allowing for their wire ends to be bent at right angles with a $\frac{1}{16}$ in. radius. The standard small pocket screwdriver is ideal for this purpose. Wires on the little ceramic capacitors merely need straightening. Lengths of coloured P.V.C. sleeving, Red for emitter, Green for base, and White for collector should be cut and slipped on to the Transistor leads, leaving $\frac{1}{4}$" bare wire at the ends. As previously mentioned, do not reduce the existing length of the Transistor leads (Should the Mullard OC 170 or 171 transistor be used, there is an additional lead which is a screen connection and should be sleeved in another colour and soldered to the printed circuit in the hole marked "Sc".)

Soldering the Printed Circuit Board and Components

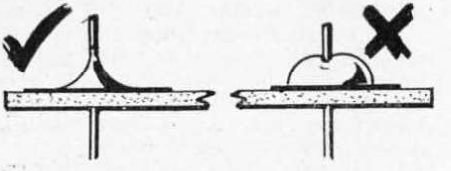
All wires on modern components are supplied pre-tinned, and should not require any cleaning prior to soldering. The printed circuit board itself, if home-made, should before soldering have the copper prepared by cleaning with kitchen scourer powder under running water, to make the surface bright and clean. Thoroughly dry after this operation but do not use excessive heat, as the bonding material could be damaged. In the case of the printed circuit board supplied in the kit, this **must not** be cleaned, as the surface has been coated with a self-fluxing varnish. As previously mentioned, excessive heat on the copper could ruin the bond to the panel, and it is unnecessary if the soldering iron is hot, clean and well-tinned. Thin resin-cored 22 s.w.g. solder should be used, and this, together with the soldering iron, applied to the copper and the component simultaneously. The solder and the iron should be removed immediately a joint is made. The resultant joint may be quickly cooled by blowing on same. A small, bright joint as shown in the sketch, should then be obtained.

FIG. 2

Assembly of Components

Assemble and solder components in the following sequence, referring to Fig. 3 and the annotated photograph of the completed receiver.

(1) Press the coil former into the $\frac{9}{32}$ in. dia. hole. Solder one end of a length of 28 s.w.g. enamelled wire into a hole marked "L.1" and wind on $9\frac{1}{2}$ turns. Slide the special flange washer on to the coil former and pass wire end up through, across and down through the holes in the flange. Pass the wire through the remaining "L.1" hold and solder. (*Note:* The enamelled copper wire supplied in the kit is self-fluxing and need not have the enamel removed prior to soldering.) Insert the tuning slug into the former together with the



P.C. Soldering

Good Bad

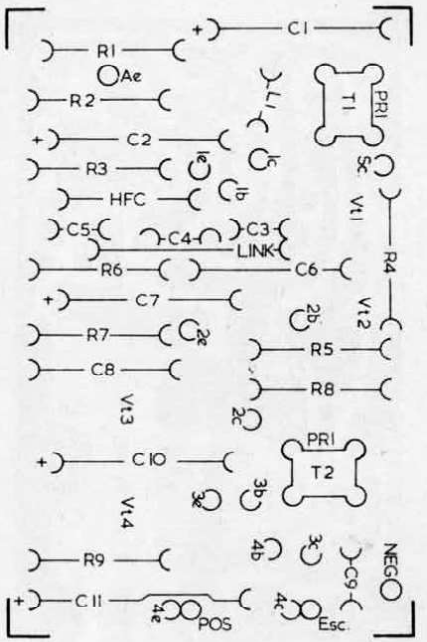


FIG. 3

HOLD THIS PAGE UP TO THE LIGHT TO REGISTER WITH P.C. PANEL OVERLEAF.

small piece of round locking rubber provided.

(2) Solder a piece of sleeved wire between the holes marked *Link*.

(3) Insert all the resistors and H.F.C. in their appropriate No. 55 dia. holes having bent the wire leads as previously described. (Check all the component values against the Parts Lists and colour coding). To obviate over-heating components during the soldering operation, the piece of plastic foam supplied for mounting the receiver should be damped and pressed against the components on the circuit board, and held in place with rubber bands. Solder all wires and snip off the surplus close to the joint.

(4) Insert all the capacitors except C.11, in their appropriate holes, making certain that the electrolytic capacitors are inserted with the positive (+) end nearest the (+) marked on the panel. Again check component values.

(5) Identify the Transformer primary windings (highest resistance) by the red mark on the bobbin. Insert one transformer into holes marked "T.1" with the red mark corresponding with the PRI mark on the printed circuit board. Insert the second transformer into the holes marked "T.2" again using the corresponding PRI mark on the printed circuit board. (*Note :* The transformers should lay at right angles to one another if inserted correctly.) Both transformers are soldered in a similar manner to the components, and the surplus wire snipped off.

(6) With the leads sleeved as previously mentioned, solder each transistor in place. Take great care to identify the emitter, base and collector wires. See sketch showing the base connections of the transistors (i.e. (4e) (4b) and (4c).

(7) Insert the plastic transistor holders in the four $\frac{1}{8}$ in. dia. holes on the printed circuit panel. Expand these holders with thin pointed pliers, moisten the transistors and slide them into their respective holders.

(8) Insert a 24 in. length of Yellow flexible wire, and 12 in. lengths of Red (battery positive). Black (battery negative) and Green (escapement), into the appropriately marked holes, and solder. Pass the wires through their adjacent spare holes, and twist together. **(Note :** It is advisable to slightly countersink or deburr the wire lead holes to avoid possible fracture of the P.V.C. covering at a later stage.) The aerial wire passes separately through its own hole.

(9) Now insert C.11 over the green or red wires with the (+) matched, and solder.

Testing and Tuning

Before connecting any battery supply, thoroughly check both sides of the panel for component positions, shorting, broken connections and above all, short circuits on the printed circuit side of the board. Connect an escapement between the ends of the Green and Black wires. Connect a **new** $4\frac{1}{2}$ volt battery positive to the end of the Red wire, and negative through a 0-10 m.A. meter to the junction of the Black wire and escapement.

WARNING ! Do not attempt to transmit at this stage. If the escapement tags are shorted, and the transmitter keyed, the output transistors could be damaged.

With $4\frac{1}{2}$ volts and type of R.F. transistor used there should be 1—10 m.A.

fluctuating from the noise of the super-regenerative detector. Replace the 0-10 m.A. meter with at least 0-500 m.A. meter. Key a tone modulated transmitter and turn the tuning slug with an insulated tool until a rise in current is obtained. This should reach about 300 m.A. Finally, adjust the tuning at 100 yards range to the mid-point between the two settings where the escapement will just not pull in. (A meter is not necessary for this tuning if the escapement can be heard to operate when the transmitter is keyed.)

Fault Finding

Providing instructions have been followed and all the correct components used in the construction, the receiver will operate as detailed. However in the event of any trouble or error of assembly, the following logical test procedure should locate the error :—

(1) Check that all components are correctly fitted of the correct value and are properly soldered into position.

(2) Check the battery voltage, **on-load;** and the battery leads.

(3) Check that the first stage is super-regenerating by listening with a pair of high resistance 'phones, connected across R8 or across T1 primary. Alternatively, by holding the receiver close to another super-regenerative receiver and tuning until the radiation affects this other receiver.

(4) If the set is not super-regenerating, having first checked as above, measure the voltage across R4 as shown in the table.

Voltage Checking Table

METER POSITION		VOLTAGE	CURRENT (m.A.)	
FROM	TO	IDLING	KEY/ TONE	IDLING KEY/ TONE
+ve Batt.	—ve Batt.	4.6v.	4.2v.	
+ve Batt.	A	.4v.	.4v.	
+ve Batt.	B	.3v.	.3v.	
+ve Batt.	C	4.0v.	3.6v.	
+ve Batt.	D	4.6v.	1.0v.	
—ve Batt.	E	.4v.	.35v.	
BREAK CONNECTIONS AND INSERT METER AT—				
	F		.35	.3
	C		.20	.18
	G		.10	15-50
	H		1-2 (Waveing)	380

(5) If all is well at T1 but not across R8 connect the 'phones across R9, and listen for clicks when a I K resistor is 'flick connected' between the top end of C6 and the negative supply.

NOTE.—All the voltage readings were obtained with a new 4½ volt dry battery, peak signal keying and with a 1,000 ohms/per volt meter.

COMPONENT LIST

COMPONENT	VALUE	MARKING CODE	
R1	22K	Red Red Orange Silver	a
R2	4.7K	Yellow Violet Red Silver	
R3	1.2K	Brown Red Red Silver	
R4	1.2K	Brown Red Red Silver	
R5	22K	Red Red Orange Silver	
R6	2.2K	Red Red Red Silver	
R7	2.2K	Red Red Red Silver	
R8	22K	Red Red Orange Silver	
R9	2.2K	Red Red Red Silver	
C1	10 mfd.	Electrolytic 6 volt wkg.	b
C2	5 mfd.	Electrolytic 6 volt wkg.	
C3	18 pf.	Ceramic.	
C4	15 pf.	Ceramic.	
C5	220 pf.	Ceramic.	
C6	.01 mfd.	Polyfoil or paper.	
C7	10 mfd.	Electrolytic 6 volt wkg.	
C8	.01 mfd.	Polyfoil or paper.	
C9	.002 mfd.	Ceramic.	
C10	25 mfd.	Electrolytic 6 volt wkg.	
C11	50 mfd.	Elec.rolytic 6 volt wkg.	
HFC	Miniature iron dust core wound single layer 38 s.w.g. en. copper wire.		c
L1	6 m/m Polystyrene former ½ in. long with iron dust core ¼ in. long. Wound 9½ turns 28 s.w.g. en. copper wire. Bakelite washer.		
T1, T2	5 : 1 ratio interstage miniature transistor transformer. Printed circuit version.		
	Alternative wire version ref.: D.1001		d
Vt 1	OC 170, OC 171		e
	MAS types, SB 305		f
Vt 2, Vt 3, Vt 4	GET 114, S1		g
	Finished printed circuit board.		
	Miniature P.V.C. covered flexible wire, sleeving, transistor holders, and solder, etc.		c

KEY

a Radiospares, LAB. All ¼ watt.
b Radiospares, LAB. Sub-min. sizes.
c MacGregor.
d Ardente.
e Mullard.
f Semiconductor.
g G.E.C.

The special components only in the above parts list made by MacGregor Industries are available as separate items upon request. No other components can be supplied unless purchased in the complete kit as advertised.

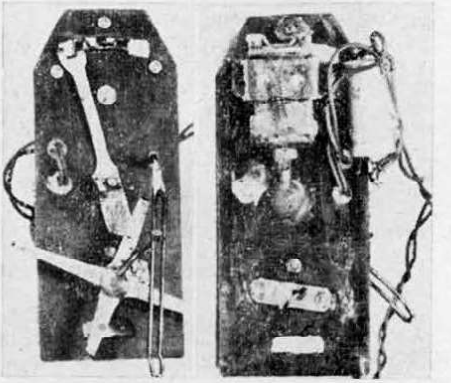
[Continued at foot of page 588]

Windy's Relaytor

A lightweight version of the Relaytor for sub-miniature models by "Windy" Kreulen.

WEIGHT saving, one of the most important factors in the design of ultra small R/C models has a definite influence on the selection of a suitable actuator. "Lil Bipe", the model selected by Windy Kreulen for the matchbox Rx. which appeared in last month's *R.C.M. & E. must* have the lightest of gear. The Rx. is, of course, relayless, but one must keep batteries to a minimum, and for really reliable relayless operation of the average escapement from the Rx. battery supply, it would be advisable to employ more than the 3 volt, pencell pack in the original model, in this case a prohibitive payload.

The Wright Relaytor system was the source of inspiration and Windy proceeded to build a really lightweight version of this. Readers may remember an article appearing in *Aeromodeller* (June, 1957) describing a do it yourself "Relator"; this Dutch economy version uses a modified relay for the coil and armature assembly. This cuts out a large share of fine workmanship and patience which would normally be required for this part of the mechanism. Choose a relay of approximately 75 ohm resistance and an armature capable of taking side loads without undue friction or becoming displaced. A balanced armature would be an advantage if a little on the large side.



Front and back views of the "Relaytor", note the dabs of Araldite to lock the components in place and the capacitor on the same panel.

Construction

All the other components are cut from odd scraps in the junk box; cut the main panel from $\frac{1}{16}$ in. Tufnol and fret out the slot for the lever. Drill the bearing holes accurately but leave the relay mounting holes until a preliminary line up has been made.

Break a small piece of thick razor blade to approximately $\frac{3}{8}$ in. x $\frac{3}{32}$ in. and grind to size, making sure the edges are square (an oilstone or even fine emery would serve the purpose). Offer

TERRYTONE Rx.

Transmitter Modification

Most "all transistor" receivers tend to "swamp" if operated close to a constant carrier. With the modern trend to use a hand-held transmitter this can prove inconvenient and deceptive when hand-launching model aircraft. When using this receiver therefore, it is advised to adapt if necessary the transmitter so

[Continued from page 587]

that the key completes the H.T. supply to both the tone modulator and power amplifier stages simultaneously. It is not recommended, however, that the crystal oscillator stage be keyed.

Extensive tests of this receiver were carried out using the Tommytone transmitter previously described in this journal. It is a simple matter to modify this transmitter circuit to meet with the above requirements.