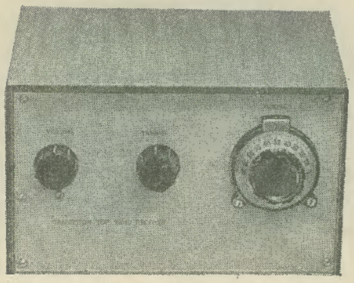

TRANSISTOR SUPERHET FOR TOP BAND

by

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Designed specifically for reception on the amateur 'Top Band' of 1.8 to 2.0 MHz, this receiver incorporates seven transistors and one diode. It may be used on its own or in conjunction with the transmitter described last month, and it can be operated from a 9V dry battery or a 12V car battery

MINIATURE OR SEMI-MINIATURE SOLID-STATE RADIO receivers are always of interest and may be particularly so to the Amateur transmitting and listening fraternity, many of whom require items which are inexpensive to construct and which are useful for either portable or mobile working.

The receiver to be described is in the semi-miniature class but could with ingenuity be made much smaller. 'Top Band' has always been popular for /P and /M working and a low-consumption receiver that can work either from a 9V dry battery or from a 12V car battery can be handy. Considerable amateur activity of the 'ragchew' type takes place on '160' at week-ends and this frequently provides interesting and informative listening material!

The transistors used in the receiver are available very cheaply and work well at the comparatively low frequencies involved. Quiescent current drain is 15mA.

Briefly, the receiver to be described is a 'Top Band only' affair completely transistorised and with an audio output of about 1 watt. Increased audio output could be secured by using a different type of amplifier and various inexpensive and ready-built items are available, should an alternative amplifier be desired.

Other amateur bands could doubtless also be catered for by revamping the front-end circuitry a little. The term 'amateur bands' should be noted; since the design permits of limited frequency coverage only, the circuitry shown cannot be made 'general coverage'. 'Top Band' extends from 1,800 to 2,000 kHz but since amateur QSO's rarely take place near the band edges partial band tuning is adequate. The receiver is intended for listening to 'Phone' QSO's mainly but if it is desired to tune additionally to either c.w. or s.s.b. transmissions a b.f.o. must be added. Single-sideband transmissions are not over-plentiful on the band but a fair amount of c.w. is to be heard; for completeness the circuit of a practical transistorised b.f.o. is included.

Physically the receiver is built as two units—an r.f. section and complementary a.f. section—and each of these is assembled on a small Paxolin panel or board.

THE R.F. BOARD

As may be seen from the r.f. board circuit diagram shown in Fig. 1, a total of five semiconductors constitute the r.f., mixer/oscillator, both i.f. amplifiers and demodulator stages. Signal frequency coils are provided by L1 and L2. The oscillator coil is L3 and is tuned higher than the signal frequency by the value of the intermediate frequency—in this case approximately 470kc/s—the converted signals being amplified by TR3 and TR4 in the i.f. strip. Since the bandwidth of the r.f. and mixer signal frequency circuits is sufficient to accept signals throughout the 'Top Band' range these may be preset, with a simple 'peaking' variable capacitor for the interstage signal frequency coil. In consequence, it is merely necessary to vary the oscillator tuning to produce the desired intermediate frequency and thereby tune the receiver. Main tuning via a reduction drive mechanism is thus associated with L3 only and permits the use of a small single-gang panel-controlled tuning capacitor.

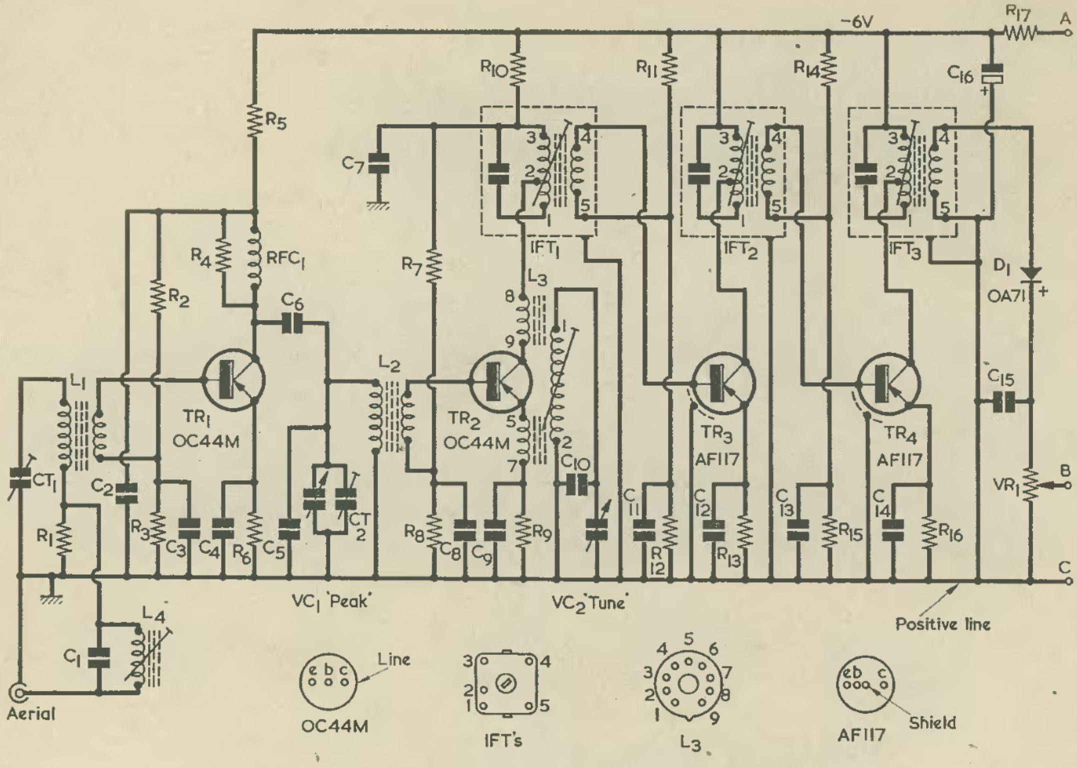


Fig. 1. The r.f., mixer/oscillator, i.f. and detector stages of the receiver

Simple calculation shows that a signal received at a frequency of 1,810kHz can be converted to 470kHz by tuning the oscillator to 2,280kHz whilst a 1,990kHz aerial signal can be selected by retuning the oscillator to 2,460kHz. Such a variable oscillator frequency range can be secured using a variable capacitor of about 50pF, and a suitable commercially made coil for the inductance is readily available. Aerial and inter-stage coils are home-made.

As already stated, a panel-controlled 'peaking' capacitor is associated with the interstage signal frequency coil and this is provided in the form of VC1.

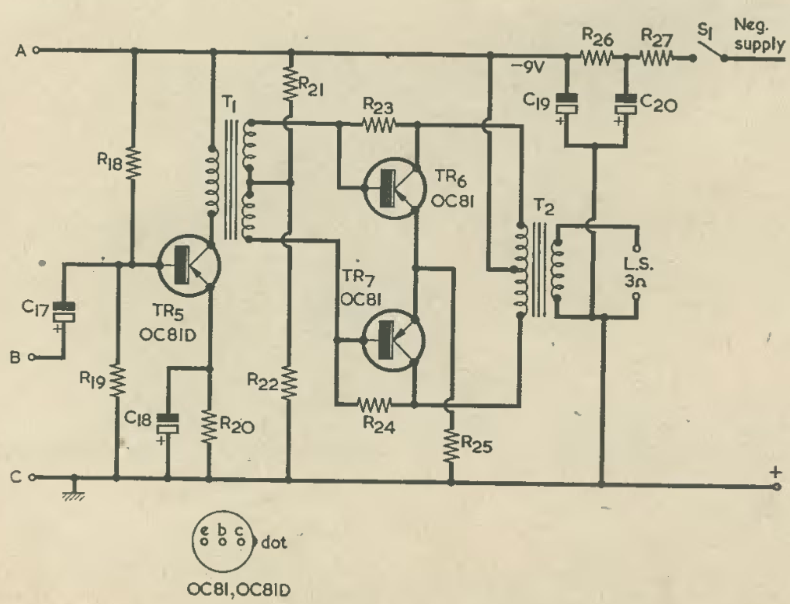


Fig. 2. The circuit of the a.f. amplifier stages

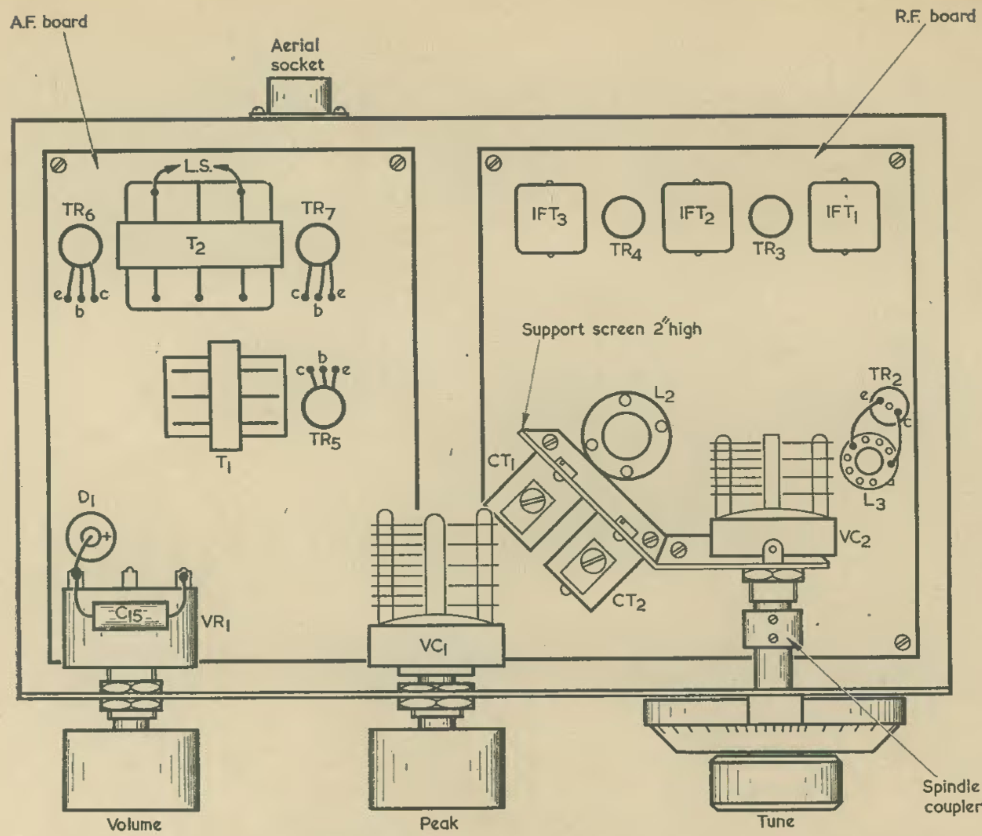


Fig. 3. View above the chassis assembly, showing the layout of principal components

In practice, coils L1 and L2 are pre-tuned to the mid-band position and VC1 permits of optional frequency variation within narrow limits. Trap coil L4 is tuned to approximately 2,840kHz since strong second channel signals around this frequency could otherwise break through to the mixer/oscillator. Any small inductor of around 75μH with an adjustable iron dust core may be used here, a suitable choice being the tuned winding of a medium wave oscillator coil such as the Osmor Q05. This can be easily resonated using either a grid-dip oscillator or a signal generator.

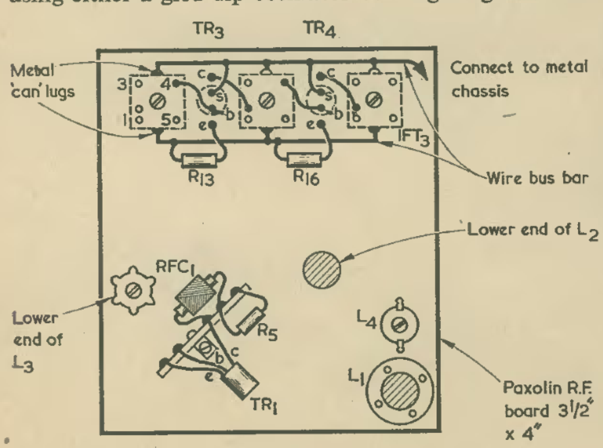


Fig. 4. Layout underneath the r.f. and i.f. board

Although the possibility is doubtful, it might be necessary to slightly alter the value of C1 to obtain resonance at the correct frequency with some coils in the category just mentioned.

The i.f. stages are conventional, with a.g.c. omitted to secure maximum gain. The On/Off switch can be external (as in the writer's receiver) or, if desired, may be made integral with a.f. gain control VR1.

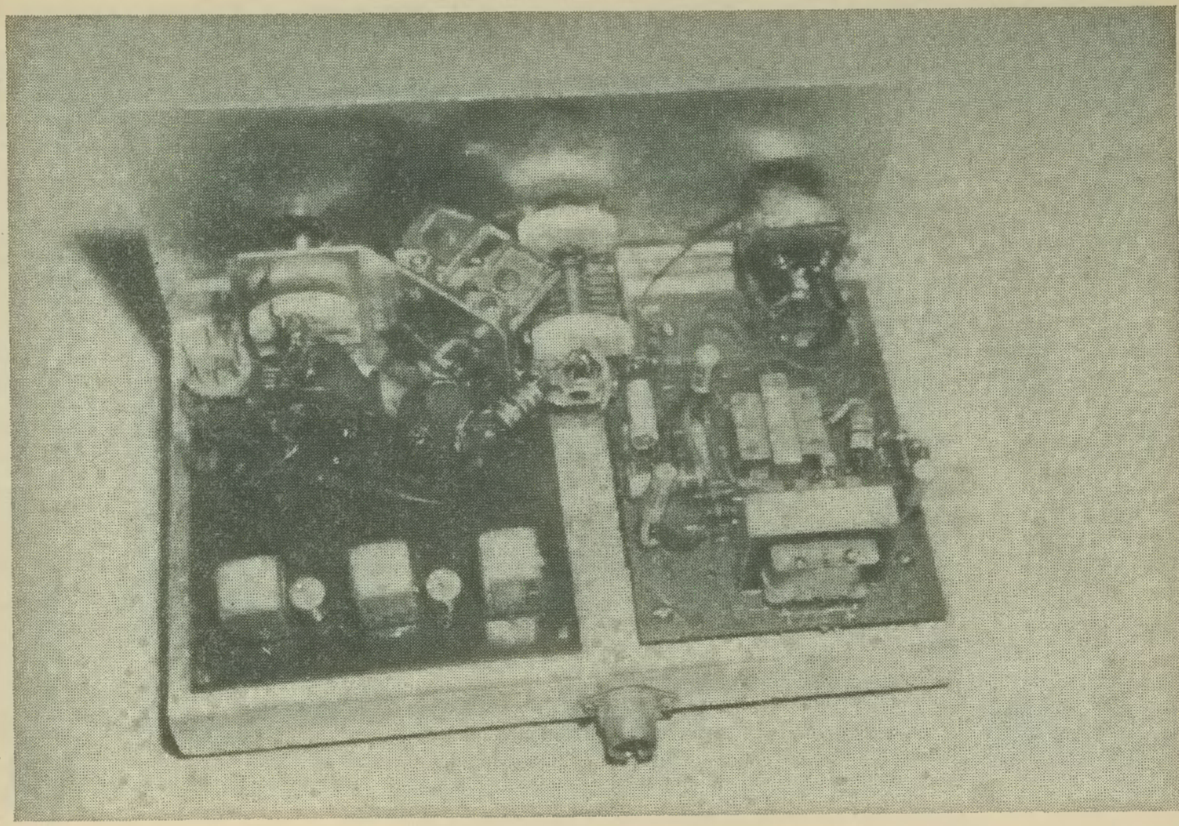
THE A.F. BOARD

The circuit for the a.f. board is given in Fig. 2, and it consists of a straightforward push-pull type of audio amplifier. This requires little comment, and it uses ready made and easily available components throughout. To prevent overheating, TR6 and TR7 should each be provided with a cooling fin having a surface area of approximately ¾ by ⅝in. The output transformer, T2, is available from Alpha Radio Supply Co. Ltd., 103 Leeds Terrace, Wintoun Street, Leeds. Again, in the interests of gain no degenerative feedback is introduced.

As mentioned earlier a ready-built transistorised amplifier can be employed here instead if preferred.

CONSTRUCTION

To provide rigid support, the two Paxolin board assemblies are located side by side on a metal chassis. Large cut-outs in the chassis main plate permit of access to the underside of each board; and the



Above-chassis view of the receiver

boards are prevented from fouling the metal by using small spacers. The above-chassis layout is given in Fig. 3.

The r.f. board requires greatest care in construction and some of its wiring is shown in the underside layout of Fig. 4. A total of eight holes are required for each i.f. transformer and a suitable drilling 'pattern' is given by pressing the pins of one against a piece of paper. The resulting impressions, if pricked with a pin, form an excellent template. Modern miniature capacitors and resistors must be used throughout. Note, too, that a bracket has to be made; this should be some 2in. high to carry the tuning capacitor VC2 and trimmers CT1 and CT2. The best way of coupling the tuning capacitor to the vernier drive is via a flexible insulated coupler. A normal coupler *can* be used, as in the prototype, but this necessitates more careful mechanical alignment of the tuning capacitor spindle.

COIL WINDING

Coils L1 and L2 are wound directly on to 1in. lengths of $\frac{3}{8}$in. diameter ferrite rod. These lengths may be obtained from a longer rod—say 8in.—the surface being scored with a hacksaw at the appropriate place and the required section broken off, being tidied up afterwards with a file. See Fig. 5. Paxolin cheeks, each with four tags, are force-fitted over the ends of the rods. These cheeks may be home-made or obtained from Alpha Radio Supply Co. Ltd. The tuned windings of L1 and L2 each consist of 43 turns closewound of 30 s.w.g. enamelled copper wire, these being laid on centrally over a layer of plastic insulating tape. The base coupling windings are next wound on, these being centrally positioned over the tuned windings and separated from them by a double layer of Sellotape. Each base winding consists of three turns of the same gauge of wire closewound, connections being made after winding to the tags on the end cheek. The two completed coils are located by pushing them through $\frac{3}{8}$in. holes in the r.f. board and additional rigidity is effected by using

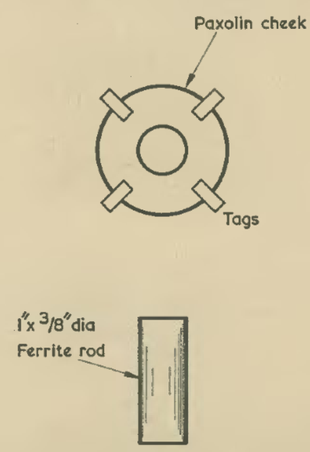


Fig. 5. Details of the ferrite rods and paxolin cheeks used for L1 and L2

stiff copper wire for connections. The coil locations can be seen in the diagrams.

If the audio amplifier is to be constructed, as in Fig. 2, the main layout given in Fig. 3 can be used as a guide. The correct windings of transformers T1 and T2 can be found by using an ohmmeter to locate the primary in each case and remembering that the secondaries show very low resistance readings. The transformers may be affixed by bending their spills close to the board on the underside. With regard to this section, consideration must be given to the way in which the receiver is to be powered and capacitor C20 and resistors R26 and R27 are required only when a 12V car battery is to be used; R26 is then selected experimentally to provide a potential of 9V measured across C19 under no-signal conditions. (When finding the value of R26, remember that the terminal voltage of a 12V car battery in use is usually of the order of 13.5V. For a quiescent current of 15mA, R26 would be 300Ω.—Editor.) The method of picking up the supplies is really one for individual consideration.

The dimensions of the metal panel and associated chassis plate employed in the prototype are given in Figs. 6 and 7 respectively. These are self-explanatory.

ADDITIONAL B.F.O. STAGE

Although not provided in the prototype receiver, the inclusion of a b.f.o. to facilitate c.w. or s.s.b. reception may be considered worthwhile by some readers, and adequate constructional space for a b.f.o. stage is available. The b.f.o. pitch control and its In/Out switch may be placed symmetrically on the panel below the other controls. A practical b.f.o. circuit with component values is given in Fig. 8, the i.f. transformer used being the same as that specified for IFT3 in the Components List. Sufficient stray coupling of the b.f.o. signal into the receiver circuits should result, with no additional coupling components being required.

CHECKING AND ALIGNMENT

Usually, the best time to get the receiver working well is on a Sunday morning, for not only are QRM and QRN then less troublesome than at other times, but also amateur activity is normally plentiful.

When aligning the receiver the precise value of intermediate frequency is not too important and although the transformers used are designed for a frequency of 470kHz, erring on the high side will do nothing but good. The main requirement is to get the i.f. strip in line throughout and if the core ends are towards the open ends of their formers as seen from below little difficulty should be experienced.

Initial adjustments consist of seeking a signal of some sort by adjusting VC2 and/or the core of L3. On receipt of a signal the cores of IFT3, IFT2 and IFT1 are adjusted, in that order, to peak the signal to maximum. Thereafter attention is given to L3 to obtain adequate band coverage. If a reasonably accurately calibrated grid-dip oscillator is available, all coils can be easily pre-tuned before the receiver is switched on, whereupon considerable time is saved. At mid-band position the vanes of VC1 should be about 50% enmeshed; trimmers CT1 and CT2 are adjusted accordingly. If bandspread is inadequate insert a capacitor of, say, 100pF in series with the

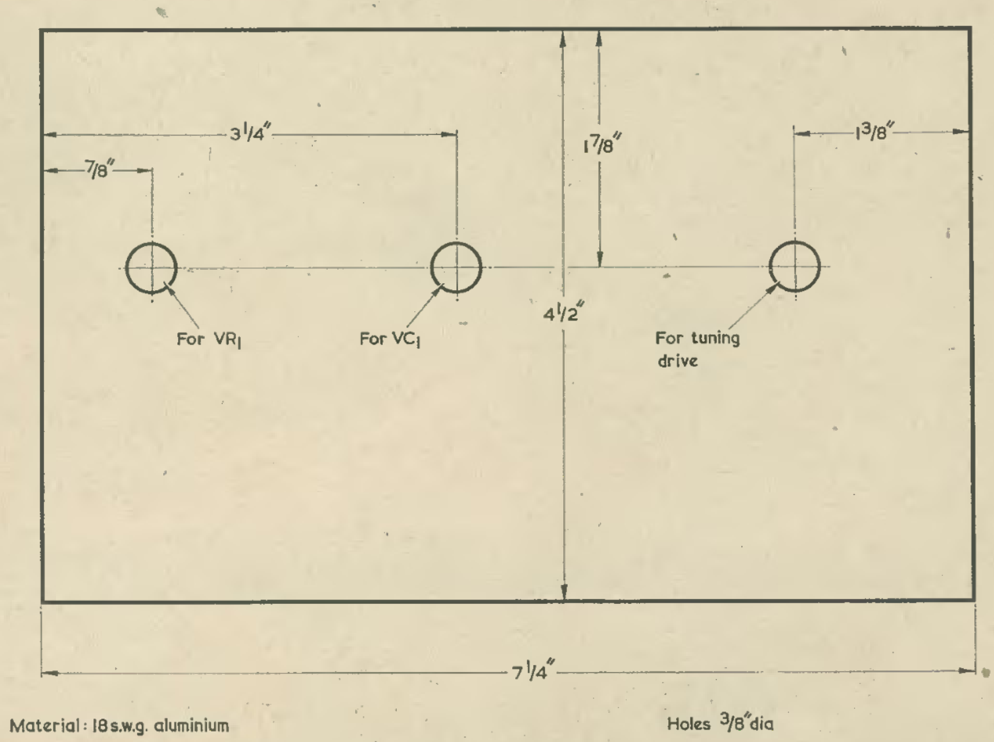


Fig. 6. Main drilling dimensions for the front panel

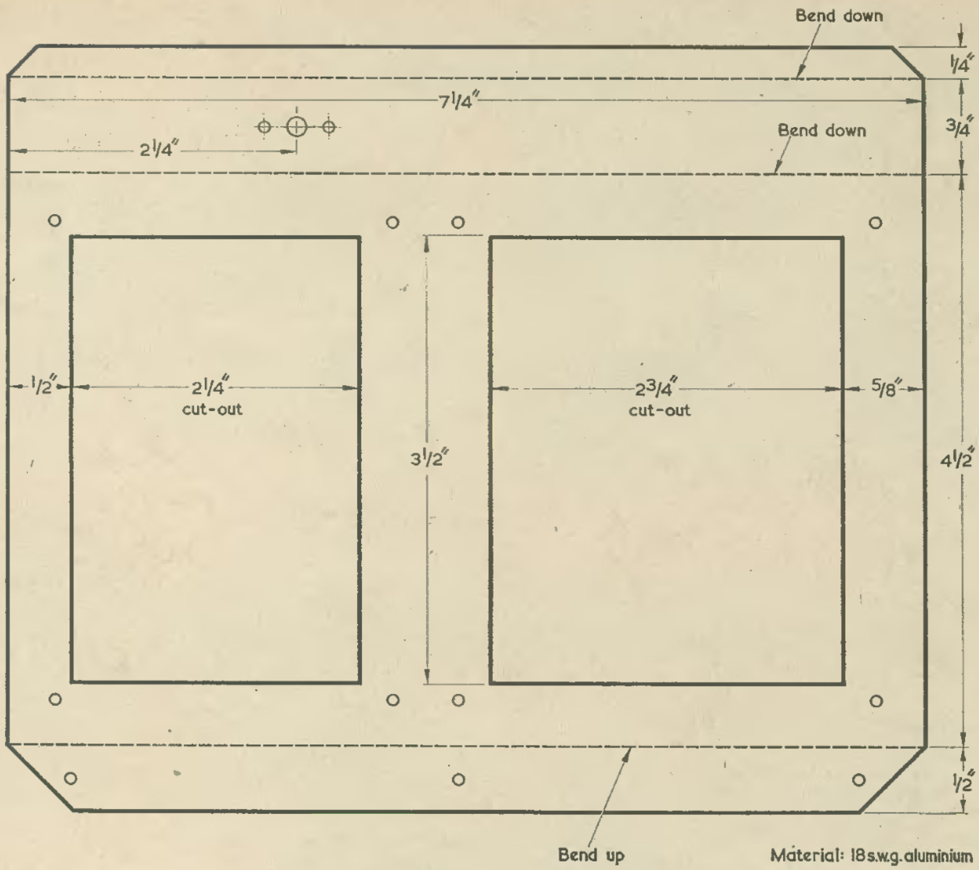


Fig. 7. Dimensions of the chassis plate

non-earthy terminal of VC2 and readjust the core of coil L3.

DEBUGGING!

Receiver circuits using transistors do occasionally tend to be more temperamental than their valve contemporaries and it is easy to become discouraged when a newly built item fails to perform! Also, transistor and component tolerances can make it difficult to specify firm component values and in a 'One-Off' design it is but possible to state values as used in the test model; some debugging may or may not thus be required.

A complete lack of signals may be due to non-oscillation of the circuitry around TR2 and L3 but if all connections are correct and adequate voltage is applied, oscillations should be present. Squegging may occur if capacitor C9 is overlarge in value whereupon its value should be reduced. If fierce oscillation results, suspect i.f. instability, the stage responsible for the trouble can sometimes be found by temporarily by-passing the lower member of a base bias potentiometer network—R15 for example—with a 3.3kΩ resistor. Spurious oscillation can also be caused in the TR1 circuit if a minor proportion of the r.f. present at choke RFC1 is fed back inductively to L1. To prove this stage disable TR1 by disconnecting R5 and connect the aerial to the fixed vanes of VC1 via a 100pF capacitor.

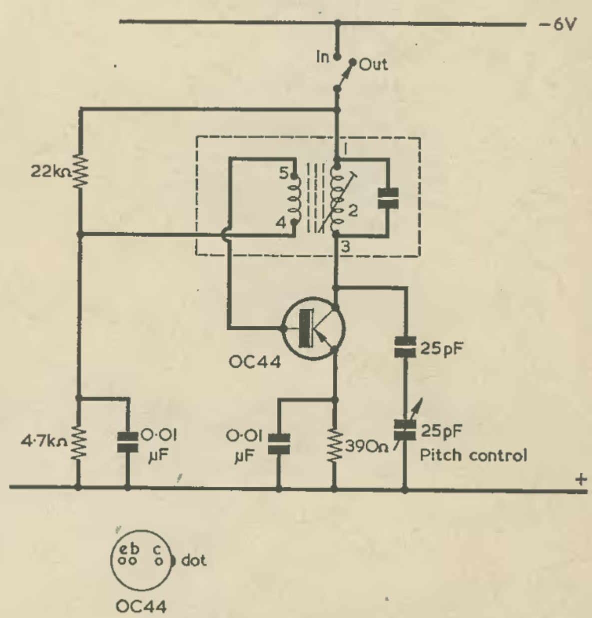


Fig. 8. Circuit of an optional b.f.o. stage

COMPONENTS

Resistors

(All fixed values ⅛ watt 10% unless otherwise stated)

R1	10kΩ
R2	10kΩ
R3	2.2kΩ
R4	5.6kΩ
R5	1kΩ
R6	1kΩ
R7	10kΩ
R8	2.2kΩ
R9	1kΩ
R10	1kΩ
R11	56kΩ
R12	8.2kΩ
R13	470Ω
R14	27kΩ
R15	3.9kΩ
R16	1kΩ
R17	470Ω
R18	100kΩ
R19	10kΩ
R20	390Ω
R21	4.7kΩ 5%
R22	33Ω 5%
R23	8.2kΩ 5%
R24	8.2kΩ 5%
R25	4.7Ω 5%
R26	see text
R27	10Ω (see text)
VR1	10kΩ pot., log track (with optional on-off switch, see text)

Capacitors

(N.B. Undesignated capacitors in Fig. 1 are part of i.f. transformer assemblies.)

C1	47pF silver mica or ceramic (see text)
C2	0.04μF ceramic or paper
C3	0.01μF ceramic
C4	0.04μF ceramic or paper
C5	47pF silver mica or ceramic
C6	25pF silver mica or ceramic
C7	0.04μF ceramic or paper
C8	0.04μF ceramic or paper
C9	0.01μF ceramic
C10	47pF silver mica
C11	0.01μF ceramic
C12	0.04μF ceramic or paper
C13	0.01μF ceramic
C14	0.04μF ceramic or paper
C15	0.01μF ceramic
C16	100μF electrolytic 15V wkg.
C17	2μF electrolytic 6V wkg.
C18	100μF electrolytic 6V wkg.
C19	100μF electrolytic 15V wkg.
C20	100μF electrolytic 25V wkg. (see text)
VC1	50pF variable, type C804 (Jackson Bros.)
VC2	50pF variable, type C804 (Jackson Bros.)
CT1	40pF trimmer, mica
CT2	40pF trimmer, mica

Inductors

L1	See text
L2	See text
L3	Oscillator coil, Transistor Dual Purpose Coil Range 2T White (Denco)
L4	75μH (see text)
RFCI	Miniature r.f. choke, 2.5mH, type CH1 (Repanco)
T1	Driver transformer type LFDT4 (Weyrad)
T2	Output transformer type OPT2 (Weyrad)

Semiconductors

D1	OA71
TR1	OC44M
TR2	OC44M
TR3	AF117
TR4	AF117
TR5	OC81D
TR6	OC81 } matched pair
TR7	OC81 } matched pair

Switch

S1 s.p.s.t. on-off (may be part of VR1—see text)

Miscellaneous

1 vernier dial drive type T502 (Eagle)
1 small flexible spindle coupler
2 knobs
1 coaxial aerial socket
⅜in. ferrite rod and end cheeks (for L1, L2)
Paxolin, 18s.w.g. aluminium sheet, etc.

CONCLUSION

If the receiver is to be used close to a transmitter a means of 'killing' it during 'Transmit' must be considered otherwise transistors TR1 and TR2 may be destroyed. Normally the station 'Operate' switch —or a relay—interchanges the aerial between receiver and transmitter as appropriate and it is usually not difficult to arrange for a spare set of contacts on the switching device to break supplies to the receiver completely on 'Transmit'. (It will be recalled that it was suggested that an extra pole be provided in the function switch for the transmitter described last month. This extra pole may be used to break the supply to the receiver when transmitting.—Editor.)

Final tidying-up activities consist of housing the receiver, lacquering the panel and affixing suitable legends alongside the controls. Suitable lettering is given with Panel-Signs transfers, Set No. 3 white or 4 black, available from Data Publications Ltd.

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