A VHF Dip Oscillator using push-pull JFETs*

A design which should be of particular interest to the radio amateur working on the VHF bands. It is useful to beyond the 420-450MHz band.

by A. L. MYNETT, BSc, G3HBW

The dip oscillator described here covers the band from 29 to 460MHz in four overlapping ranges, with plug-in coils or loops as tuning elements. It was designed to provide, in conjunction with the HF dip oscillator featured in the April 1966 issue of the RSGB *Bulletin* (and in the *Radio Communication Handbook* and the VHF-UHF *Manual*), complete coverage from 0.6 to 460MHz.

The ranges of the two instruments overlap from 29 to 150MHz, but the new model provides more satisfactory operation than the original one from 80 to 150MHz.

The dip oscillator employs two type 2N5245 (TIS88) junction-gate FETS in a Kalitron circuit, tuned with a split-stator 43pF capacitor (Figure 1). A balanced diode detector is used, to avoid introducing non-symmetrical loading on the oscillator, and this feeds a BCY70 DC amplifier which has a 1mA meter in its collector circuit. In common with the lower-frequency model, the oscillator DC supply may be switched off to convert the instrument to a sensitive wave-meter or, when phones are plugged into the collector-circuit jack, to a modulation monitor.

An internal PP3 battery provides the 9V at 6mA required by the unit.

A small aluminium box with a flanged lid serves to house the instrument, the battery being clipped inside the lid (Figure 2).

An attempt has been made to design the instrument so that it is possible simultaneously:

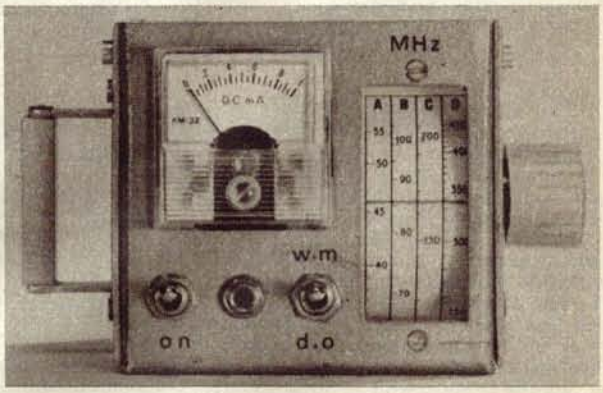
(a) to observe the meter and the dial,
(b) to operate the tuning knob, and
(c) to point the coil at the circuit under test, without either performing acrobatics or dislocating the shoulder.

This has been achieved by mounting the tuning capacitor laterally with a drum type of dial which may be viewed through a rectangular window at the front, where the meter is of course also situated. The tuning capacitor is operated via a 6 to 1 ball-drive by a knob on the right-hand side of the box. There is a small handle on the left-hand side and the coils are plugged into a socket on the back. It is possible to reverse the whole arrangement to suit a left-handed operator.

The DC amplifier transistor and the main components are mounted on a miniature 10-way ceramic tag-strip, with one tag removed to clear the dial-drum. This tag-strip is placed directly above the coil socket at the back of the unit, and, for those without the use of miniature soldering irons, it may to a certain extent be pre-wired. Two 18swg aluminium brackets support the ends of the tuning capacitor (Figure 3). The 6 to 1 reduction drive is bolted to the side-wall of the box. This particular side-wall is not made part of the box proper in order that the drum and drive may be more easily fitted to the tuning capacitor.

The four holes required for clamping the lid against the box should be drilled 6BA clearance in the lid first, and then marked through on to the box and drilled 6BA tapping size through the box and the flange behind it (Figure 2). The holes in the box should then be very carefully

*This article is reprinted from the September 1970 issue of "Radio Communication", the Journal of the Radio Society of Great Britain, by permission.



The completed dip oscillator, viewed from the operating side. The drum-type dial makes the instrument very convenient to use.

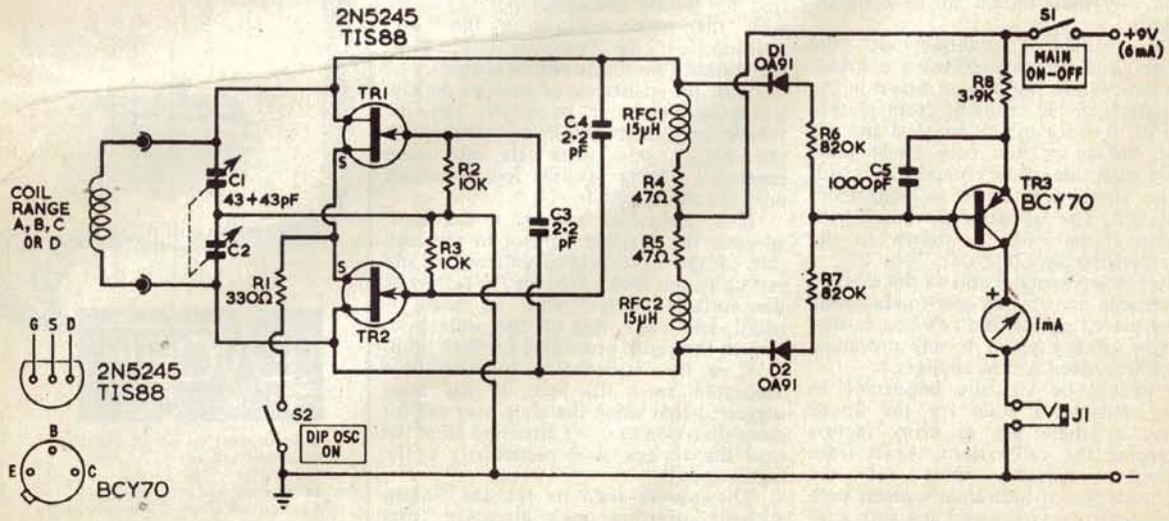


Figure 1: The circuit of the VHF dipper. Note the use of a balanced diode detector.

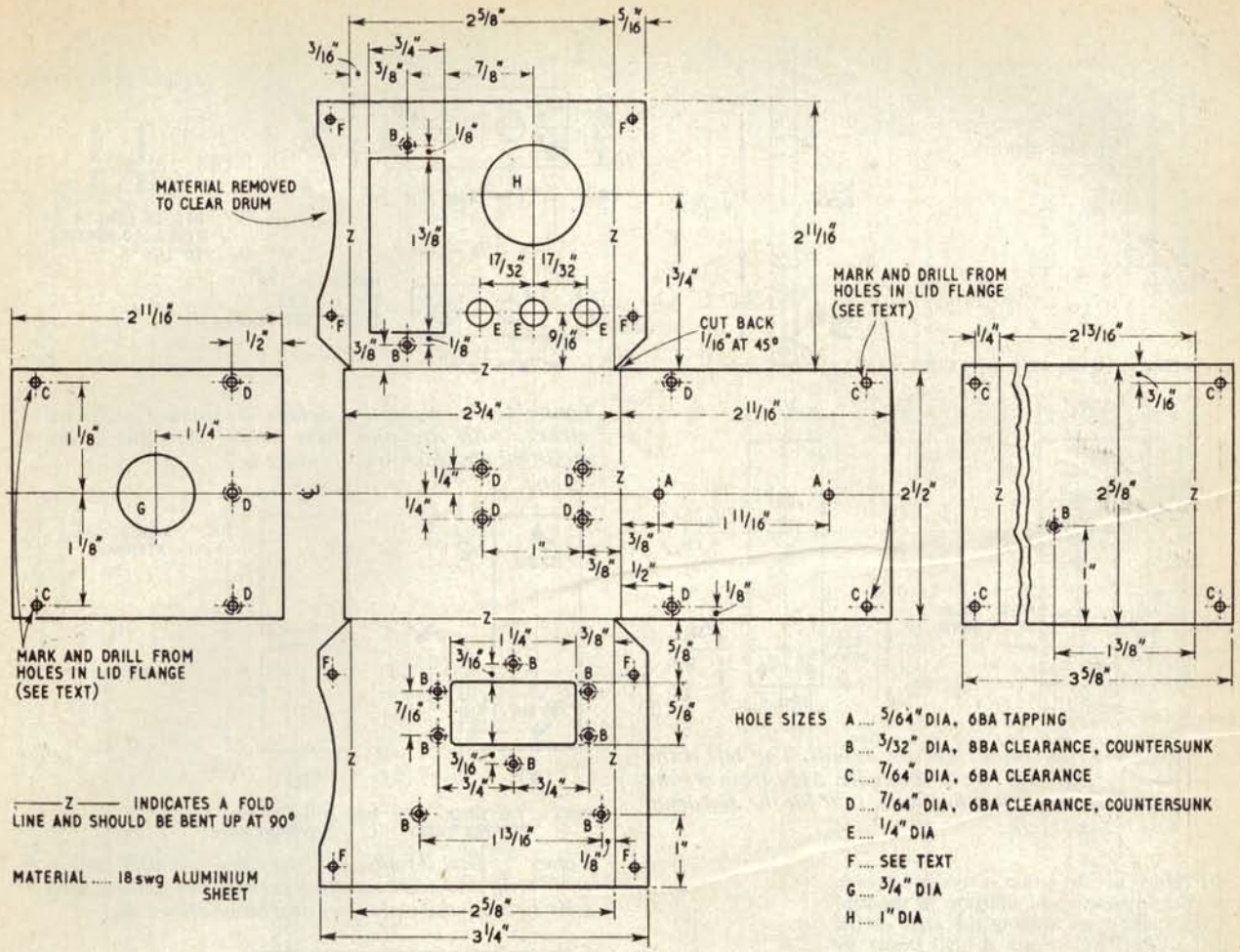
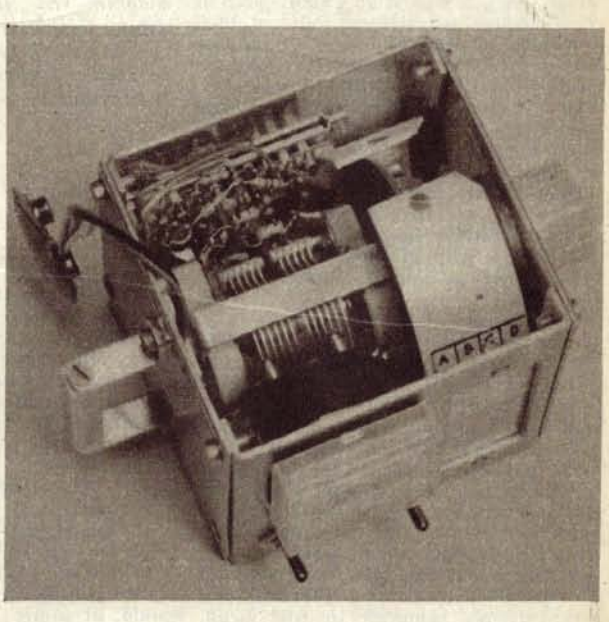


Figure 2: Metalwork details for the dipper case and lid. Note that the hole "H" is dimensioned to suit a small Japanese meter in which the barrel is threaded for a single large mounting nut.

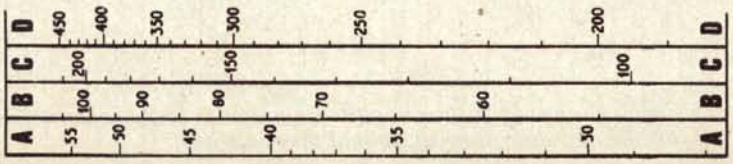
drilled for 6BA clearance, leaving the 6BA tapping size holes in the flange, which should then be tapped. A similar procedure should be followed with the holes in the bottom of the box, resulting in four 6BA clearance holes in the box and corresponding 6BA tapped holes in the flange behind each of them.

The coil socket and the coil mounting strips are made from 1/8in-thick PTFE sheet, although polythene or even polystyrene are acceptable (Figure 4). Two OZ-type wander-plug sockets are mounted on the socket strip. It is probably best to remove most of the plastic material at the open end of each socket by cutting carefully around it with a fine hacksaw and then cleaning up the remainder with a file. Two nuts will then be required per socket to fix it. The two fixing holes at the rear of the socket strip on the drum side of it should be countersunk to accommodate the 8BA nuts so that they do not foul the drum. Slightly undersized holes are drilled or reamed in the four coil-mounting bases and then the suitably-shortened OZ plugs are "self-tapped" into these holes.

In the prototype model, one 3mm and one 4mm plug and socket were used to obviate inadvertent reversal of the coils, but this precaution is not now thought to be absolutely necessary as the resulting



The dipper with its lid removed, showing the dial, split-stator capacitor and most of the RF wiring. Below is a full-size reproduction of the dial scale.



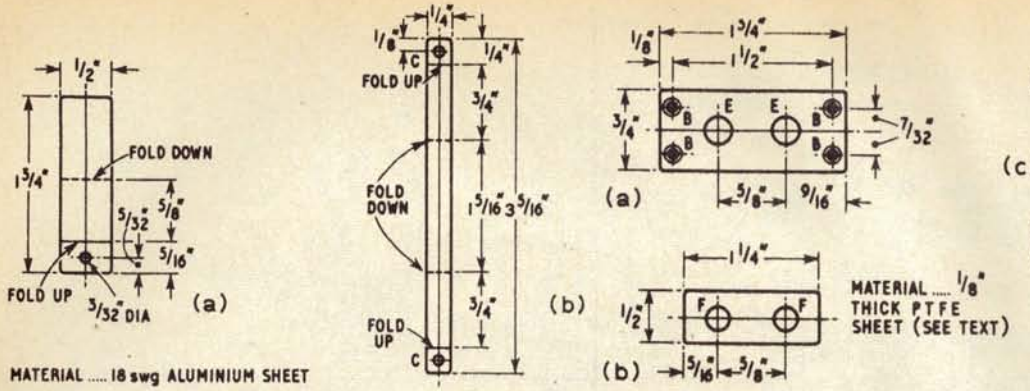


Figure 4: Coil mounting details. At top left is the coil socket, with the plug base below. At right is the modified plug pin used for range D.

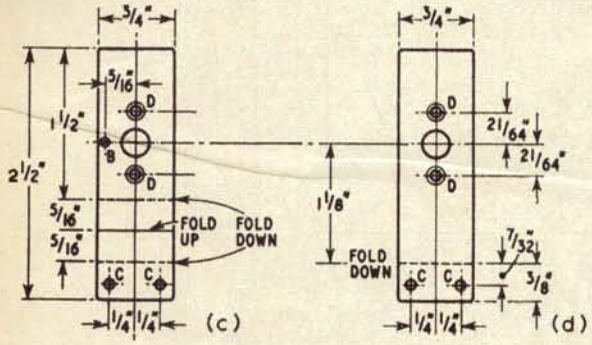


Figure 3: Minor metalwork details. Top left is the battery clip, top right the handle. At bottom are the capacitor mounting brackets, that for the dial drum side being at left.

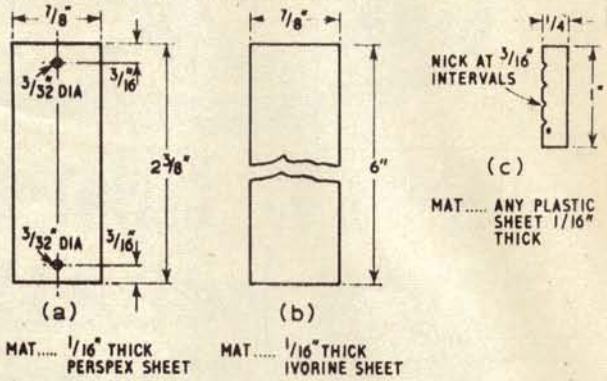


Figure 5: Dial details. Left to right, the dial cursor, scale strip and scale marking cursor. The latter is used only to draw the scale lines on a hand-drawn dial.

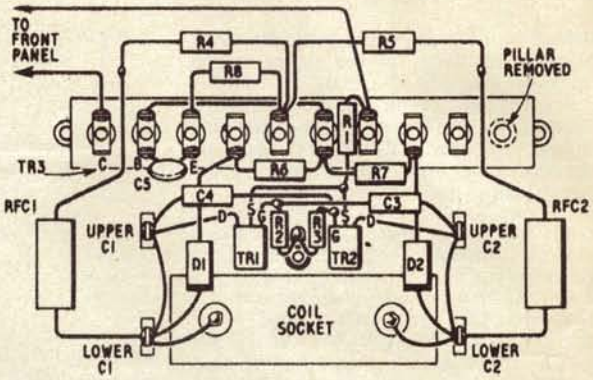


Figure 6: A wiring diagram of the dipper RF circuitry, which should be copied as closely as possible.

difference in calibration is very small, even on the top range. In addition to the four screws and nuts holding the ends of the coil socket, the centre is held firmly by stretching a length of 18swg wire between two soldering tags fixed to the box; the upper one of these is also used as an earthing point for the gate resistors.

The coil for the lowest frequency range, "A", is wound on a short piece of ½in-diameter polystyrene rod and then cemented in place (Table 1). Connecting and supporting legs each 1¾in long are made from 13swg enamelled copper wire. The next range, "B", is self-supporting and wound directly with 13swg wire, also with extension pieces 1¾in long. Range "C" has a simple rectangular loop of 13swg enamelled wire, and the highest frequency range, "D", requires the two plug sections to be still further shortened (see Figure 4), and then a strip of copper or beryllium copper sheet is soldered straight across their ends.

The scale drum is a standard 2-1/8in-diameter type, with a bush drilled ¼in diameter, and is intended for cord drives. However, for this application a 7/8in-wide strip of white plastic sheet or card is glued around its periphery (Figure 5). A couple of 8BA countersink screws in holes tapped in the edge of the drum assist in holding the scale strip in place while the glue is setting and may of course be left in place permanently. The writer used 1/16in thick Ivorine sheet for the scale and then, when the glue had set hard, the drum bush was held in a lathe collet and the scale was very carefully skimmed to true it up, which also helped to make a good surface for writing upon in Indian ink. *(A full-scale reproduction of the strip with the scale printed on it is given in this article. The reverse side carries no print so that it can be cut out by constructors.)*

It is essential in most cases that the miniature components specified should be used (see parts list). This applies particularly to

(a) the two drain-gate 2.2pF capacitors;
(b) the two gate-leak 10K resistors;
(c) the two OA91 diodes; and
(d) the two 15uF RF chokes.

The wiring in the main RF circuit should, of course, all be kept very short (Figure 6). This applies especially to the oscillator common-source lead (no more than ¼in long), the wires to the 2.2pF feedback capacitors, and the leads from the FET drain terminals to the tuning capacitor upper lugs. The upper and lower stator connections of the tuning capacitor are strapped together with a 3/16in-wide piece of copper foil. Also, the tuning capacitor main rotor terminal is connected to an 8BA soldering tag on the fixing bracket by means of a similar copper foil strap.

It cannot be too strongly emphasised that the above mentioned points and the wiring scheme shown in Figure 6 and in the photographs must be rigidly followed

(This space has been left clear of editoral matter to allow constructors to cut out the dial scale overleaf, should they so wish.)

LIST OF COMPONENTS

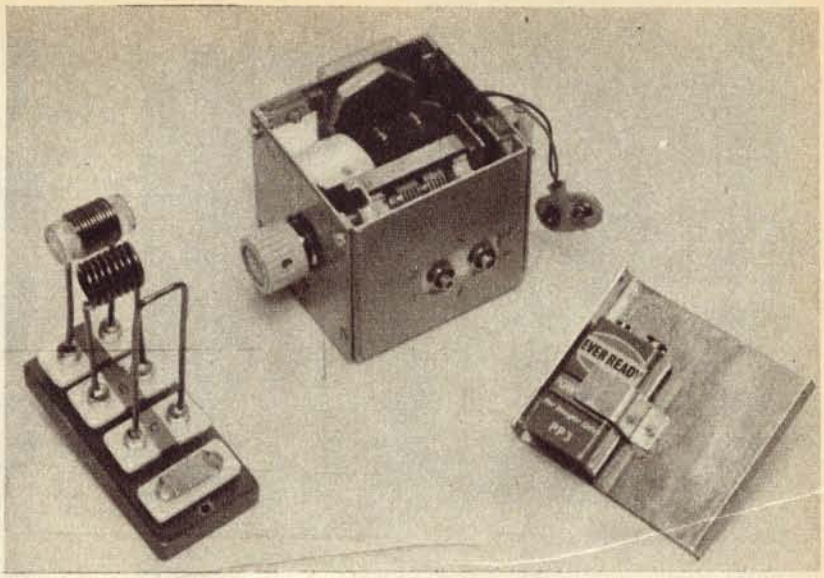
1 Metal case, 2¾in x 2-11/16in x 2½in, detail as in figure 2.
1 1mA meter, 1¼in square, single nut fixing.
1 3.5-43pF split-stator capacitor (Jackson type C808 or similar).
1 Planetary reduction drive, 6:1 ratio (Jackson type 4511 or similar).
1 2-1/8in diameter dial drim, for ¼in shaft.
2 Miniature SPST toggle switches.
1 3.5mm miniature phone socket.
1 Miniature 10-way ceramic tag strip.
1 Miniature 9V battery and connector (PP3).

SEMICONDUCTORS
2 2N5245 junction FET (TIS88).
1 BCY70 or similar silicon PNP.
2 OA91 or similar diodes.

RESISTORS
2 x 47ohm ¼ watt, 1 x 330ohm ¼ watt, 1 x 3.9K ¼ watt, 2 x 10K ¼ watt (must be miniature), 2 x 820K ¼watt.

CAPACITORS
2 2.2pF miniature ceramic.
1 .001uF ceramic.

MISCELLANEOUS
2 x 15uH peaking chokes; 4 x 4mm OZ plugs, 4 x 3mm OZ plugs; 1 x 4mm OZ socket, 1 x 3mm OZ socket; wire for coils;PTFE sheet for coil bases; connecting wire, nuts, bolts, solder, etc.



The dipper with its lid removed, showing the battery clipped to the lid underside. The plug-in coils are also shown, mounted in a storage holder.

TABLE 1: COIL DETAILS

Range A	29 to 55 MHz	12t 22swg enam c/w on ½in polystyrene rod (1in long), 1¾in drill, (13swg).
Range B	50 to 109 MHz	8t 13swg enam wound on ¾in drill, 1¾in legs.
Range C	97 to 220MHz	5/8in wide, 2 7/8in long loop of 13swg enam wire.
Range D	190 to 460MHz	5/16in wide, 11/16 long 26swg (or near) copper or beryllium copper strip soldered directly across plug ends.

if satisfactory operation up to the top of range "D" is to be obtained. The intrinsic problem of covering the top range with this type of design can perhaps better be appreciated if one thinks about making a GDO for 46MHz with a split-stator tuning capacitor 1ft 3in long. In the prototype, the top frequency could not be raised above 410MHz while simultaneously achieving satisfactory operation over the whole of the range until the strapping of the tuning capacitors stators was introduced. Incidentally, the oscillator circuit alone, without the tuning capacitor and with a fixed tuning loop, has been made to work well at over 650MHz.

The existence of spurious dips and "suck-outs" in the various ranges is, in this design, very much bound up with the quality of the two RF chokes. If troubles of this kind are experienced, other chokes should be tried. It is very difficult to find components with no strong resonances over the whole of such a wide band but, nevertheless, the prototype instrument using the chokes specified and with the two 47Ω series-damping resistors shows only a couple of very slight flickers on the top range, and no such effects lower down.

No difficulties should be experienced in getting the dip oscillator to perform satisfactorily if all of the precautions mentioned have been taken. With both switches "on", the meter deflection should be between ½ and ¾ scale at all points on all four ranges. The deflection may be accurately adjusted by changing the value of the 3.9kΩ resistor R8.

Calibration may be done by means of the usual combination of amateur band, television and short wave receivers. The author cheated and did his own instrument in about half an hour on a Polyskop! To prepare for calibration, remove the perspex cursor and fix the marking cursor inside the box in the appropriate position with sticky tape. The centres of the notches should be placed respectively 1/16in, ¼in, 7/16 and 5/8in from the left-hand side of the scale strip. Using Indian ink and a Uno "O" pen for preference, but a ball-point or even a pencil if these are not available, the four scale-marking circles may be marked on the strip. Two cross-lines should also be drawn, with the capacitor vanes respectively fully in and fully out. The actual calibration can then proceed in the normal way, being faintly pencilled in at first and then, after removing the drum, being finished in ink. When it is dry, a final spray with polyurethane varnish will protect the scale markings.

Before closing, mention should perhaps be made of possible substitutes for the components specified. If the full frequency coverage is required, the Motorola MPF106 should be capable of replacing the 2N5245 (TIS88) in the oscillator, although it has not been tested. Similarly, the TIS88A, which only differs from the TIS88 in its connections, should be satisfactory. If the 2N3823, 2N3819,MPF102 to 105 or BFW10, 11 or 61 are used, it is unlikely that correct operation will be obtained on the top range, unless exceptionally good samples of these devices are employed. However, all should be well up to 220MHz.

The BCY70 used in the dc amplifier may be replaced by almost any other silicon pnp device, provided, of course, that the value of the resistor R8 is adjusted to suit the gain. Suitable replacement transistors include the BCY71 and BCY72. Germanium devices are likely to exhibit excessive leakage and thermal drift, but carefully selected rf types may well work satisfactorily.

Any small point-contact germanium diode will probably work in the detector position, provided that its capacitance is sufficiently small. For this reason, gold-bonded types such as the OA7 and OA47, and whiskerless diodes like the BAX16, are to be avoided, but the OA90, GEX54 and probably the GEX34 will be acceptable. The GEX66 has rather too low a reverse impedance to perform properly in this circuit.

Sufficient comment has already been made on the subject of RF chokes and the use of miniature components in the critical positions.

Some constructors may desire to use one of the more normal sizes of miniature meters, such as the MR38P. If this is to be done, the box must be enlarged. This extension should be made in width and not in depth as, otherwise, it will probably not be possible to position the scale drum correctly. Any change in the size or shape of the box is likely to affect the ranges covered, particularly at the high frequency end.

Editor's Footnote: The 2N5245 (TIS88) is a Texas Instruments device, and should be available from Texas Instruments' distributors. In NSW the distributors are Electrobit Co, of 26-28 Kent Road, Mascot. The BCY70 should be available via trade suppliers from either Mullard-Australia or Philips Miniwatt; however the 2N3638 or TT3638 should also be suitable for the DC amplifier device. Local agents for Jackson Bros are British Merchandising Pty Ltd. ■