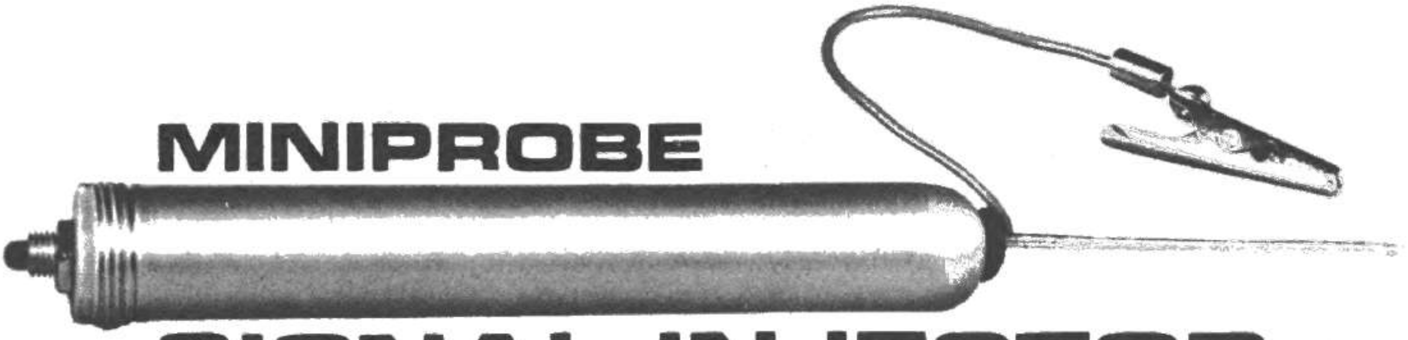


MINIPROBE SIGNAL INJECTOR

BY A.W. HARTLEY

One of the greatest aids to servicing a radio receiver, or audio amplifier, is undoubtedly a device which will provide a modulated signal for tracing the signal path through the circuit.

The best type of test equipment to do this is a modulated signal generator, but these can be expensive and bulky, also they are not always available at the time and place required.

A somewhat simpler solution is a device so compact that it may be carried around in the pocket, contains its own power supply and will give a modulated signal on frequencies well into the medium waveband. This instrument could be a transistor test probe or signal injector, such as the one to be described here.

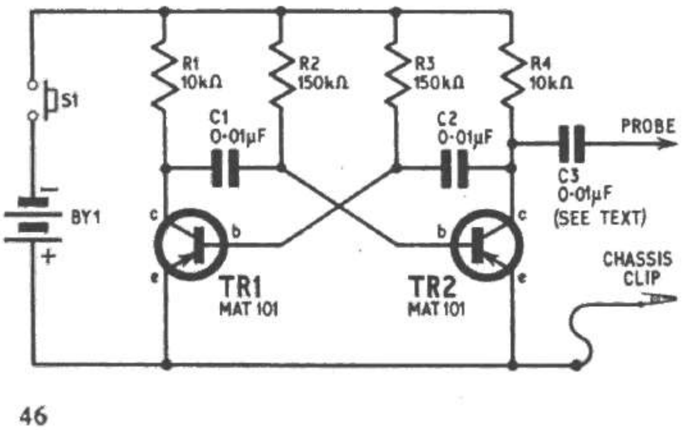
The instrument is basically a multivibrator using two transistors. The choice of these is important as they must be capable of generating harmonics of their fundamental operating frequency, which will extend as far as possible into the radio frequency band. The type of transistor which meets this requirement is in the micro-alloy range; for example, either a MAT 100 or MAT 101 (which gives slightly greater output). Other types may in fact suffice, but size is an important factor as well as performance.

CIRCUIT

The circuit used, and illustrated in Fig. 1, is an astable (free-running) multivibrator of common-emitter configuration, which produces at each collector a train of rectangular pulses without external triggering. The two waveform drawings (Figs. 2a and 2b) illustrate the type of signal output produced by this circuit.

In the circuit diagram the collector resistors R1 and R4 are of the same value, but because of component tolerances one transistor will conduct slightly more than the other, this being an essential requirement of this type of circuit. If TR1 conducts harder, more voltage will be dropped across R1 than R4, making the collector of TR1 more positive than the collector of TR2.

Fig. 1. Circuit diagram of the signal injector



At the moment of switching on, the base of TR2 will be almost the same potential as the emitter; the collector current of TR2 will be reduced, and the collector voltage of TR2 will become more negative. The base of TR1 also rises towards this value and causes TR1 to conduct harder. This action will continue to the maximum value determined by R1, at which time TR2 is completely cut off. The capacitors C1 and C2 have begun to charge as soon as the circuit became operative, with the result that a point is reached where a positive charge is applied to the base of TR1 and negative charge to the base of TR2, which causes an instantaneous switch-over of the transistors due to the changed base potential.

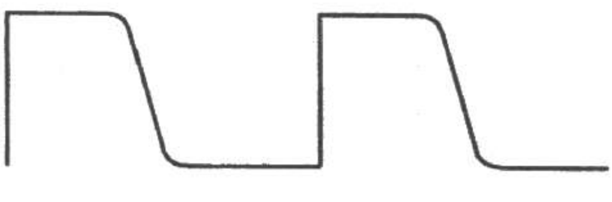
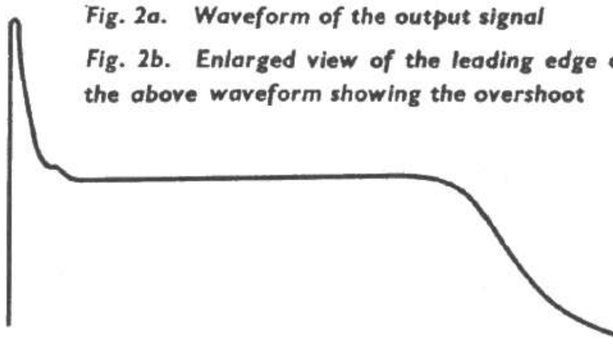


Fig. 2a. Waveform of the output signal

Fig. 2b. Enlarged view of the leading edge of the above waveform showing the overshoot



The frequency of the switching action is determined by the discharge of C1 through R2, and C2 through R3; the sequence of switching will continue as long as the power source is applied. The fundamental frequency is in the region of 460c/s.

The capacitor C3 is not an active part of the multivibrator circuit but provides d.c. isolation if the probe is inadvertently touched on a point of high d.c. potential in the apparatus being tested. The choice of a large value capacitor is important, but it must be physically small enough to be accommodated on the circuit board, and also be of sufficiently high capacitance to provide negligible reactance above about 200c/s. It must, of course, have the highest voltage rating possible consistent with size. The value of C3 shown in the circuit would be suitable for testing valve circuits. If used on transistor circuits, a higher capacitance (e.g. 8μF 15V) would be needed to allow the efficient passage of the fundamental frequency to a relatively low impedance load.

GENERAL CONSTRUCTION

The selection of a suitable container for the test probe provided some difficulty. In the first model the circuit board and battery was built into a pen-torch case. Whilst this was convenient for housing the battery and provided a suitable on/off switch, the unit was too tight a fit in the case and being metallic it was not easy to avoid short circuits through the case. Various plastics containers were tried and rejected as being too flimsy, too narrow or too small. The final choice was a discarded cigar tube 5in long and ¾in diameter. A fairly large-stocked tobacconist should be able to supply one at negligible cost. Although this tube was metallic, it was sufficiently large to accommodate the unit with a sleeve of polythene insulation wrapped round it.

Cut a piece of perforated eyelet board to size (3in long, ½in wide) using a fine hacksaw blade. Shape one end of the board (Fig. 4) with a fine file to suit the hemispherical shape of one end of the cigar tube. The 3in probe, made from stout tinned copper wire, is attached to this end of the board by fixing in place with a twin tag removed from a miniature component tag board. Solder one end of the probe to the tag's centre hole, then bend the two soldering ends of the tag so that they fit on either side of the eyelet board.

Wire is threaded through the soldering tag holes and the centre hole of the eyelet board at the rounded end. Solder the wire in place to the tag so that the probe assembly is securely held in place.

The remainder of the construction is straightforward if the illustrations are followed. Before fitting any components to the board drill a hole ⅜in diameter where shown, using a great deal of care to avoid splitting the board. Fit a grommet (with a ¼in inside hole) into the ⅜in hole. This functions as a battery

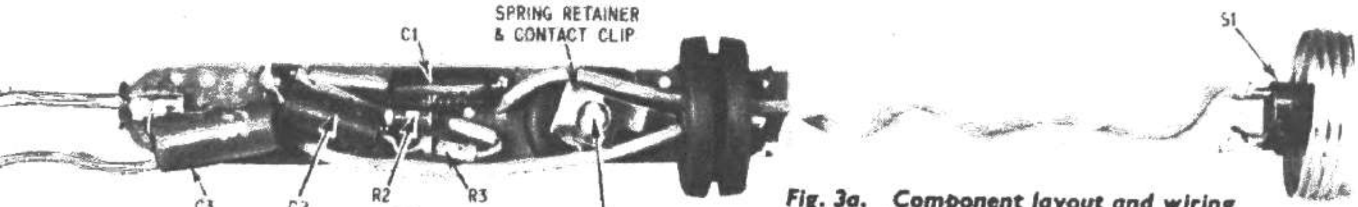


Fig. 3a. Component layout and wiring on the "transistor side" of the board

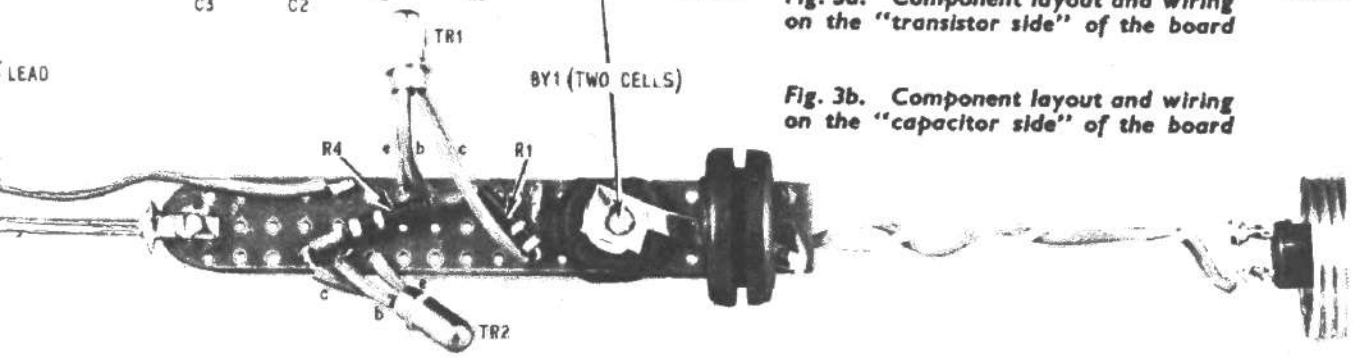


Fig. 3b. Component layout and wiring on the "capacitor side" of the board

COMPONENTS . . .

Resistors
R1 10kΩ   R3 150kΩ
R2 150kΩ   R4 10kΩ
All ±10% $\frac{1}{10}$ watt carbon miniature

Capacitors
C1 0·01μF paper 150V
C2 0·01μF paper 150V
C3 0·01μF paper 350V (see text)

Transistors
TR1 MAT 101 } (Sinclair)
TR2 MAT 101 }

Batteries
BY1 1·3V mercury cells (2 off)
(Mallory type ZM312)

Switch
S1 Miniature push button press on—release off. (e.g. Bulgin type MP1 ¼in dia. fixing)

Rubber Grommets
Hole diameter ⅜in, fixing diameter ¼in (1 off)
" ¼in, " ⅜in (1 off)
" 5/32in, " ¼in (1 off)

Miscellaneous
Eyelet board 3in × ½in with two soldering pins, 3in length of 12 or 14 s.w.g. tinned copper wire (probe); cigar tube 5in long by ¾in diameter or plastic case of similar size; two-way soldering tag (see text); small spring strips (e.g. ex-relay contact strips); flexible p.v.c. covered wire; crocodile clip.

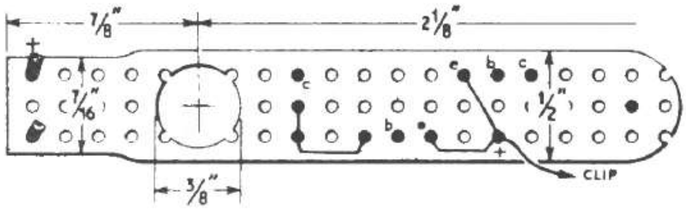


Fig. 4. Constructional details of the eyelet board and probe fixing

retainer for the two mercury cells which are inserted and contact-connected in series. It will be found that they fit snugly and securely if those specified in the components list are used. Observe the polarity of the cells.

Contact with the cells is achieved by using two spring strips, such as relay contact springs. Each strip is soldered to a pin pressed tightly into the "square" end of the component board. Pliers should be used to press each strip firmly to the board around the pins while soldering, thus ensuring a springy contact.

WIRING AND TESTING

The only difficulty in the wiring stage is the positioning of components, since the board area is so small. After some experiment the layout illustrated proved to be the most compact. No more soldering pins are used as it will be found that component leads are firmly held when drawn through the perforations in the board and soldered.

The press switch S1 is mounted in the screw cap of the tube and the flexible leads kept reasonably long (about 4in) for torsional take-up when the cap is screwed on. Before attaching these leads to the unit a grommet with a 3/8in diameter inner hole is slid over them. Then the leads are attached to the appropriate points and the grommet is passed over the perforated board so that it assists in pressing on the battery contacts (see photographs). However, the primary function of this grommet is to act as an insulating fender, and to retain the unit firmly within the case.

A 1/4in hole is made in the rounded end of the tube to take another smaller grommet. This acts as an excellent push fit retainer for the probe and earth clip lead, which should be about 6 to 9 inches long.

The unit is then pressed into the case and held firmly in place by the large grommet. Final positioning is made by pulling the probe out of the other end as far as possible. The cap, with press switch attached, is screwed on to the tube and the instrument is ready for testing.

It is a worthwhile safety precaution to fit a length of insulating sleeving over the probe to avoid short-circuit dangers. A tight fitting polythene sleeve or tape can be wrapped round the tube.

The finished model can be tested by connecting the probe and earth clip to an oscilloscope, or a working audio amplifier. Press the button S1 to switch on the battery and keep it pressed the whole time the unit is required to operate.

The miniprobe is designed to be used on high impedance inputs, such as valve grid circuits, of greater than 100 kilohms; if a lower impedance circuit is being tested, increase the capacitance of C3 as described earlier. ★