Metal Detector

Many people make a hobby of using an electronic detector to search for buried metal, and some astonishing and valuable items have been found in this way. Apart from treasure seeking, such an instrument can have a more mundane use in locating concealed manhole covers and for similar purposes.

The metal detector shown in Figure 47 is intended to operate in the 95kHz to 105kHz region, and will prove to be an easy device to get working if the search and heterodyne coils are as explained.

L1 is the search coil, and is 6½ins in diameter. This is a useful size, without being unwieldy. TR1 is the search coil oscillator. R1 and R2 largely determine operating conditions for the FET, and L1 is tapped so that feedback from drain to gate is obtained

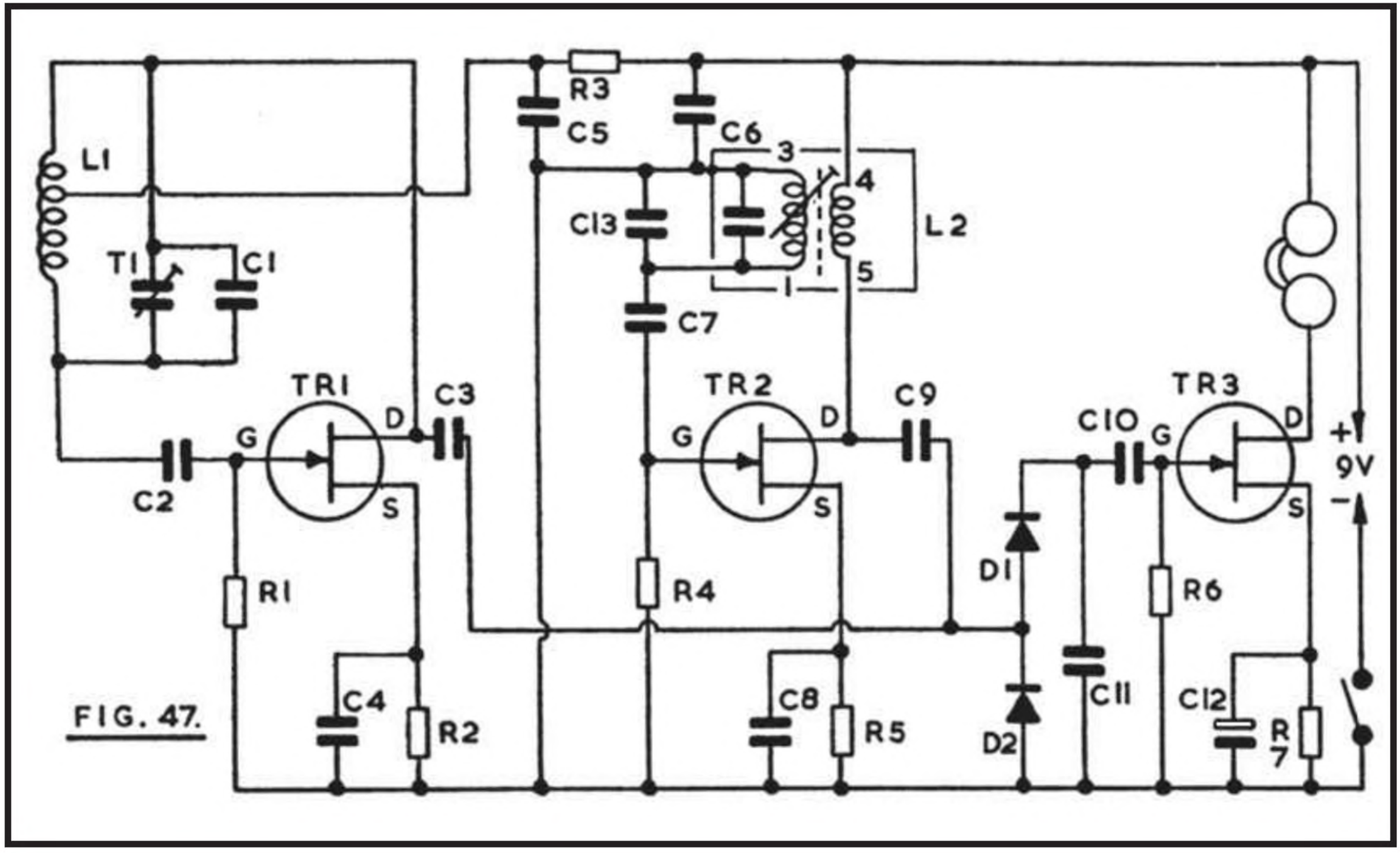
L1
T1
C1
R3
C5
C6
3
4
5
1
L2
C13
C7
TR1
D
G
S
C3
C2
R1
C4
R2
TR2
C9
R4
C8
R5
D1
D2
TR3
C10
C11
R6
C12
R7
+
9V
−

FIG. 47.

Components for Figure 47

C1	4.7nF silver mica	R1	680k
C2	100pF	R2	2.2k
C3	8.2pF	R3	2.2k
C4	4.7nF	R4	1 megohm
C5	47nF	R5	1k
C6	47nF	R6	1 megohm
C7	220pF	R7	2.2k
C8	4.7nF	TR1/2/3	2N3819 etc.
C9	8.2pF	D1/D2	OA91 etc.
C10	0.1uF	L1	see text
C11	1.5nF	L2	IFT14(Denco)
C12	47uF	Switch	
C13	6.8nF silver mica		

600 ohm phones, box, battery and clips, handle, etc.

via C2, in correct phase. The frequency of operation is determined by the inductance of L1, and parallel capacitors T1 and C1. This stage receives current through P3 and has the by-pass capacitor C5.

TR2 is the reference or heterodyne oscillator, L2 is an intermediate frequency transformer, with extra parallel capacitance to lower the frequency to 95/105kHz. Feedback to the gate of TR2 is by C7, and oscillation is obtained by correct phasing of the winding 4-5.

Output from TR1 is taken by C3, and from TR2 by C9, to the heterodyne detector formed by D1 and D2. TR3 is an audio amplifier, coupled by C10, and operating headphones. A 9v battery supplies current for the equipment.

When L1 and L2 are working on the same frequency, no audible beat note is produced. The presence of metal near L1 changes the frequency of this oscillator, so that an audio tone is heard in the phones, rising in pitch as the metal approaches L1. In a similar manner, when L1 and L2 are tuned to produce an audio tone, this will change in frequency when metal is near L1.

The search coil L1 consists of thirty-one turns of 32swg enamelled wire, 6½ins in diameter. The tapping is nine turns from the drain end. The coil is pile wound, turns occupying a slot 1/8in wide.

The search coil former can be made from three discs of 1/8in thick hardboard. Two discs are cut about 7ins in diameter, and one which is 6½in in diameter. These are cemented together, with the 6½ins disc between the larger discs, so as to obtain a slot to take the winding. An alternative method, where a lathe is available, is to turn a disc about 7ins in diameter from 3/8in or ½in thick wood, then machine a slot in its circumference 1/8in wide, and to such a depth as to give a winding diameter of 6½ins. In each case the former should be varnished or painted, before winding, to keep out damp.

C1 is 4700pF and T1 is 750pF, so there is reasonable latitude for adjustment of frequency.

T2 is a receiver type IF transformer, as mentioned, and is normally for 455/470kHz. It will be realised that this frequency could be reached by a wide range of inductance and capacitor values, so that the inductance of all 470kHz IFTs is not necessarily the same. With the Denco (Clacton) IFT 14, the extra parallel capacitor C13 is 6800pF. Pin connections are numbered for this IFT. Should an alternative component be used, connections to one winding may have to be reversed to obtain oscillation, and the value of C13 may need to be adjusted if tuning cannot be set up as described.

Various FETs were found satisfactory in these oscillators, including the 2N5459, MPF102, 2N3819, and BF244. TR3 can be any general audio or similar transistor, as described for audio amplifier circuits shown earlier.

When constructing an instrument of this kind, it is usually best to have all components except L1 in a case which also carries the battery. This box is mounted near the top of a wooden handle, some 2ft to 3ft long. L1 is fitted to the bottom of the handle,

so that it can be swept about near the ground, when walking forwards.

The frequency of L1 can be checked by placing a portable radio receiver, tuned to 200kHz, near L1, and rotating T1. At some setting of T1 a strong heterodyne, or audio note, should arise, and be heard with the 200kHz programme. Slightly detune T1, so as to avoid this, which could possibly cause interference.

The core of L2 should then be rotated, while listening in the phones for the audio tone. There will be a silent position, in which both oscillators are on the same frequency. Moving T1, or the core of L2, very slightly from this setting will produce an audio tone. If this is set at a low frequency, changes to it will be most apparent. If it is found, during searching, that the tone falls, then this can be avoided by setting L2 at the other side of the "silent" position described.

Should further details of the operation of such equipment be wanted, or the addition of a Faraday shield, reference should be made to "How to build your own Metal & Treasure Locators" (Babani Press No. BP32).