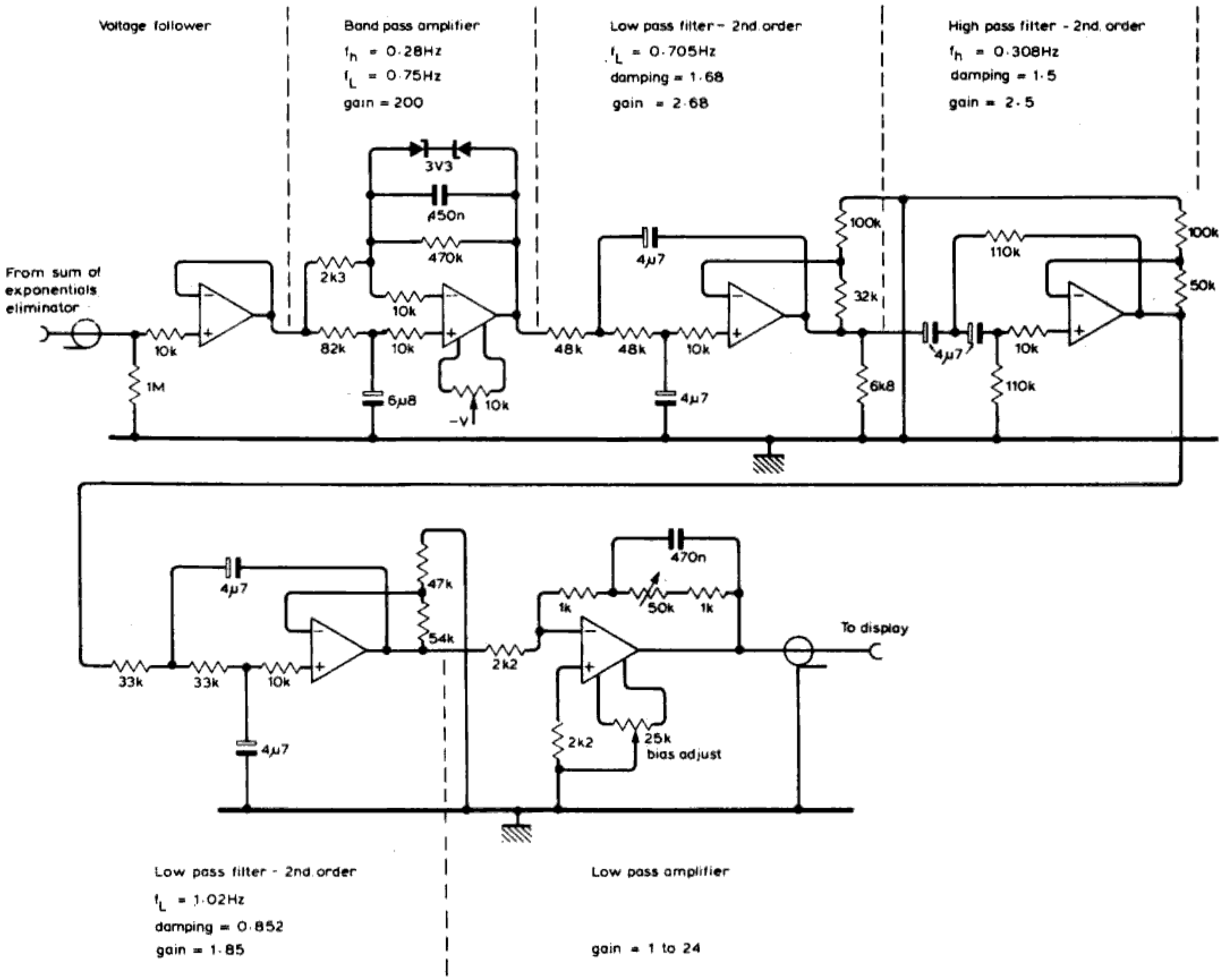
Pulse Induction Metal Detector - 2

by J. A. Corbyn

The bandpass amplifier in Fig. 11 extracts possible signals from background noise caused mainly by transients in the circuits. To permit a gain of up to 8000, a narrow pass-band from 0.2 to 0.6 Hz is used with a high-order filter for sharp roll-off. The circuit also has a limited overshoot with a step function as shown in Fig. 12.



The output is displayed by a voltmeter, and an audible signal is provided by amplitude modulating a 1400 Hz oscillator for positive signals and a 900 Hz oscillator for negative signals, see Fig. 13. All of the main timing pulses are generated by the circuit in Fig. 14. The prototype used a variable c.m.o.s. RC oscillator with four switched ranges of 40 to 175µs, 160 to 700µs, 640 to 2800µs and 2.56 to 11.2ms for Δt. The oscillator drives a counter and decoder which provide a division of 32 and produce the following waveforms:

A, the receive interval with a duration of 6xΔt and separated from the on pulse by Δt.

B, a reversing signal for the synchronous detector and also used to provide the two on pulses.

C, the last period of the receive interval.

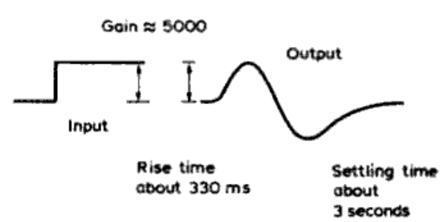


Fig. 12. System response to a step function.

D and E, alternating on waveforms to provide the magnetic field pulses. D and E drive two pulse generators as shown in Fig. 15 which, with a BU 326A non-saturating common emitter output, can supply up to 1.5A. Two transmit coils were used in the prototype because a rugged high-voltage p-n-p transistor was not available at a reasonable price. The regulated power supply is shown in Fig. 16. As well as the capacitors shown, extra decoupling should be provided on each circuit.

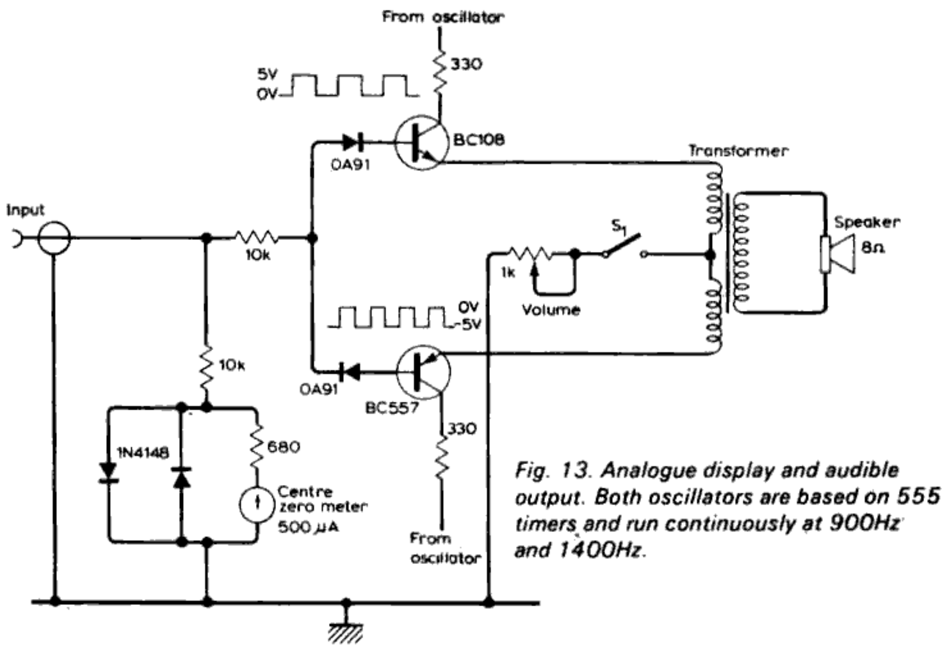
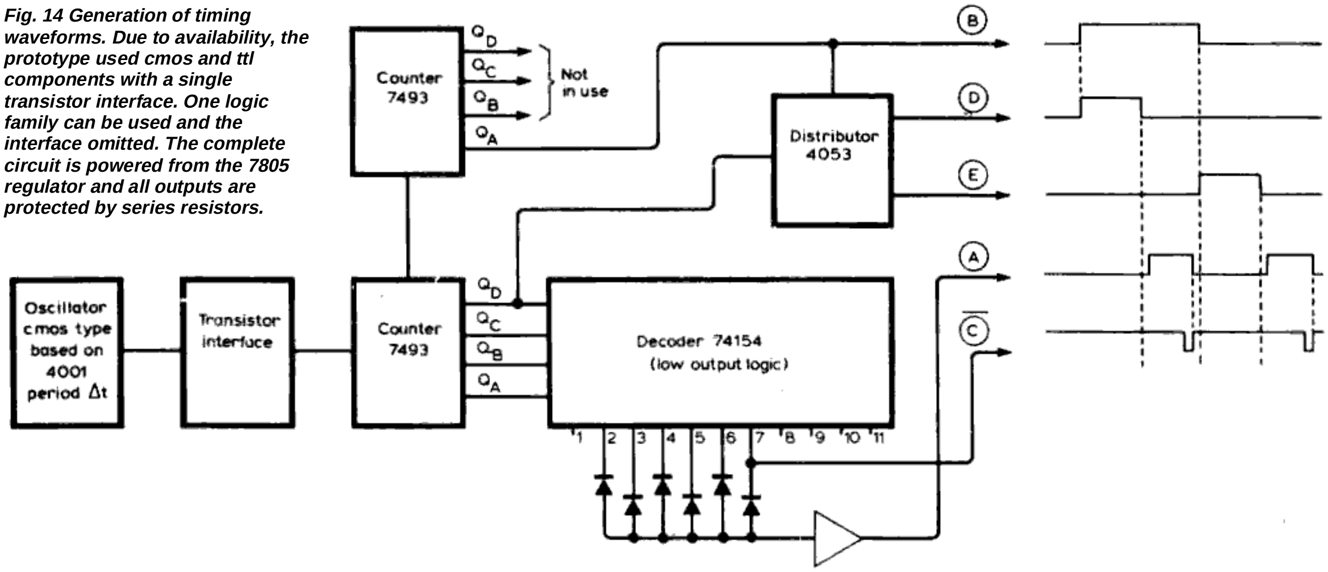


Fig. 13. Analogue display and audible output. Both oscillators are based on 555 timers and run continuously at 900Hz and 1400Hz.

Construction of the metal detector is not critical and the prototype was built in module form with jack plugs and sockets for interconnections. Selection of damping resistors for the transmit and receive coils is best carried out with an oscilloscope, although I found that the values chosen were generally in agreement with the theoretical values.

Fig. 14 Generation of timing waveforms. Due to availability, the prototype used cmos and ttl components with a single transistor interface. One logic family can be used and the interface omitted. The complete circuit is powered from the 7805 regulator and all outputs are protected by series resistors.



Conclusion

This metal detector is essentially dynamic because it only responds to a target when it is moving in relation to it. In practice this system is better than the static type because any maladjustments, in connection with the magnetic viscosity effects, are not important with a reasonably uniform ground. Slow variations of amplifier offsets are also unimportant.

Due to magnetic viscosity effects and possible feedback loops, metal detectors need to be tested in operation to determine their sensitivity. A 600 mm radius coil assembly, as shown in Fig. 5, satisfactorily detected a piece of brass 50 mm in diameter at a depth of 750 mm, and a 15 mm diameter brass target at a depth of 50 mm. In both cases a peak transmit current of 1A was used with a Δt of 250 µs and a ground speed of 1 m/s.

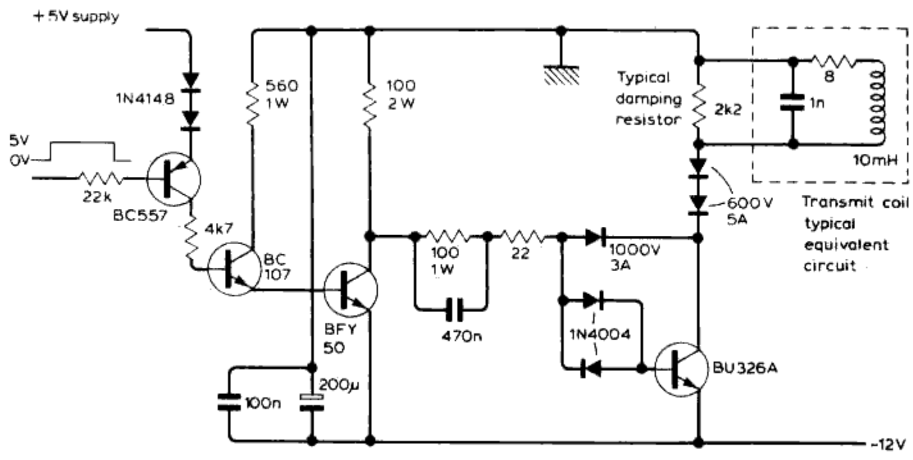


Fig. 15. Pulse generator. Two circuits are needed, one for each polarity input.

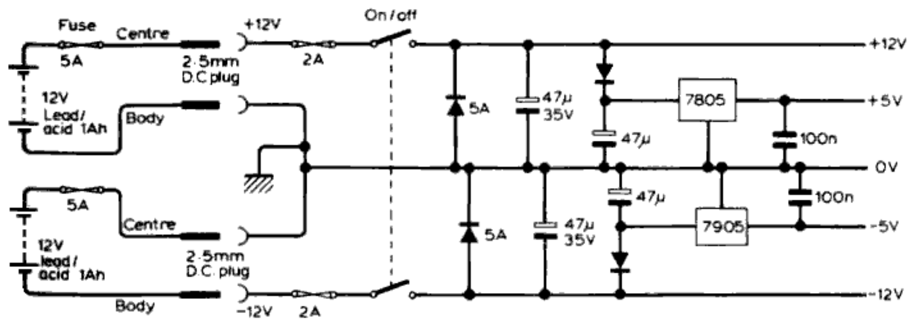


Fig. 16. Power supply.