APPENDIX XIV

MODULATOR DESIGN AND RATE OF RISE OF VOLTAGE IN MAGNETRON TESTING

1. THE MEASUREMENT OF RATE OF RISE OF VOLTAGE

The most convenient method of measurement of the instantaneous value of the rate of rise of voltage (as required by section 5.F.2.5.5.) is by means of a differentiating circuit, the amplitude of the output being measured on a cathode ray tube using a calibrated shift voltage. This avoids errors due to X-Y coupling and other defects in the C.R.T., the need for a linear time base with accurate time calibration, and the difficulty of accurate measurement of the slope of the resulting trace.

The most convenient type of differentiator is the CR circuit (Fig.1)

The type of waveform obtained is shown in Fig.2.

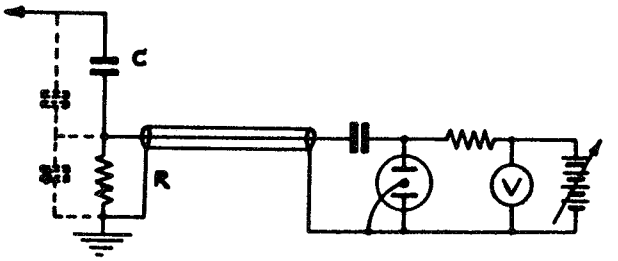


FIG. 1

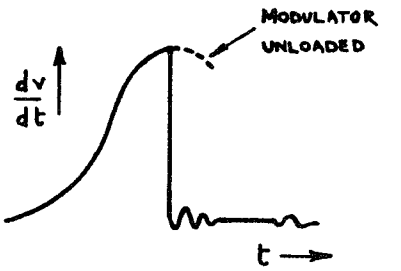


FIG. 2

Errors can arise due to the inductance of the resistor, stray capacitance across the resistor or the capacitor, and reflections in the cable (if any) connecting the C.R. circuit to the C.R.T.

Grade I Carbon Resistors Pattern CT3 of RCL 112 have been found suitable; the lowest wattage permitted by the conditions should be used. Errors due to the cable can be minimised by making R equal to the characteristic impedance of the cable.

It is an advantage to use a vacuum or oil-filled capacitor because the reduced bulk thus obtainable enables the stray capacitance across the resistor to be minimised.

The time constant of the stray capacitance with the resistor should not exceed about one tenth of the rise time of the pulse.

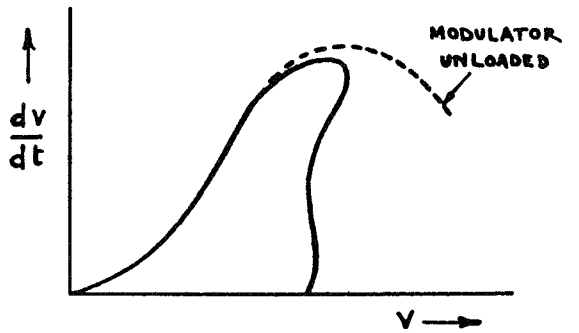
The differentiating capacitor should be screened to limit shunting stray capacitance from other conductors forming part of the high voltage circuit of the modulator.

The change in the rate of rise of the modulator due to connection or removal of the differentiator must be taken into account.

2. CORRELATION OF THE INSTANTANEOUS RATE OF RISE OF VOLTAGE WITH THE INSTANTANEOUS VOLTAGE.

To determine the instantaneous rate of rise at a particular voltage (as required by section 5.F.2.5.5) it is convenient to connect the output of the differentiator to one pair of plates of a C.R.T., with the voltage reduced with a potential divider, to the other pair. The type of trace is shown in figure 3.

FIG. 3



The measurements should be made using calibrated shift voltages.

The potential divider is required to pass the leading edge of the pulse without distortion; a capacitance divider with a suitably short connecting cable is indicated.

The total delay times of the X and Y paths must be made equal to a suitable degree allowing, in the case of very short rise times, for the transit time of the C.R.T.

3. THE DESIGN OF TEST MODULATORS HAVING DESIRED CHARACTERISTICS IN RESPECT OF RATE OF RISE OF VOLTAGE.

In network type modulators, the value of the rate of rise can be controlled by varying either the inductance in series with the discharge circuit or the capacitance shunted across the load. When it is permissible to neglect the effect of strays other than those which can be included in the total series inductance and the total shunt capacitance of the circuit so that the circuit becomes as shown in Fig. 4, the shape of the rate of rise/voltage characteristic is a function of $\sqrt{\frac{L}{C}} / Z_0$ as shown in Fig.5.

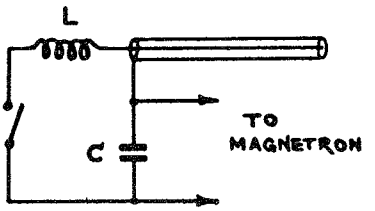


FIG. 4

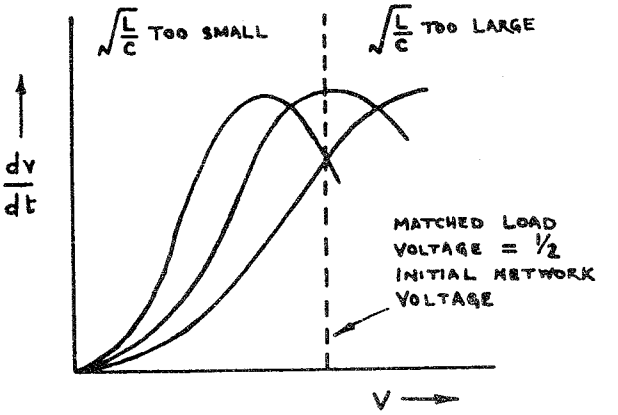


FIG. 5

The rate of rise/voltage trace may depart from the shapes shown in Fig.5 due to the effect of strays which have been neglected. In particular, excessive capacitances of the pulse forming networth to earth, together with too high a ratio $\frac{L_2}{L_1 + L_2}$ (Fig.6) can give rise to a superimposed oscillation, (Fig.7).

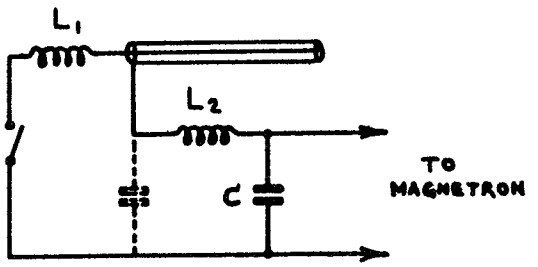


FIG. 6

FIG. 7

Fig. 6

Fig.7

Similar effects can arise from excessive distributed capacitance to earth of the pulse-transformer windings or excessive strays at other points in the circuit.