about ten (the actual speed-up depending on the setting of the timebase fine control) to enable waveforms to be studied in greater detail. The timebase-expansion circuit is shown in fig. 6.3. A portion of the negative-going sawtooth at the anode of the Miller valve is 'sliced' by means of diodes V22*a* and V22*b*, this portion being selected by the setting of RV7, the 'shift' control. A positive-going pulse is produced at the anode of V23*a*, which is coupled to the grid of V24*a*; when switch SW2 is ON, the cathode of V24*a* is coupled to the grid side of the Miller capacitor through a 33K resistor, R82 (see fig. 6.2), so that the discharge current of the capacitor is greatly increased.

11. At the beginning of the sweep, the grid of V23*b* is caught at earth, and, the grid of V23*a* being at the maximum level, V23*b* is cut off. During the first part of the sweep, before diode V22*b* cuts off, the anode of V23*a* tends to rise as the input sawtooth falls, though this rise is very much attenuated initially by grid-current limiting due to the grid resistor, R86. When diode V22*b* has been cut off, the two grids of V23 are falling together; but V23*b*, having no anode load resistor, takes most of the cathode current, the anode of V23*a* rising to about +190V. This rise is quite rapid when switch SW2 is ON, owing to feedback from the cathode of V24*a* to the Miller valve. When the sawtooth has fallen about 20V at the faster rate, diode V22*a* cuts on and holds the grid of V23*a* at ~~-20V~~ -10V; V23*b* thereupon cuts off sharply, and the whole cathode current reverts to V23*a*, whose anode potential falls again to the original level. The pulse at the pole of switch SW2 has an amplitude of about 150V, the DC-restoring effect of MR20 and MR21, and the choice of cathode resistors for V24*a*, ensuring that its base level is at earth, i.e. that the Miller capacitor discharges between pulses at the same rate as it does with SW2 OFF. There is, of course, a pulse on SW2 during the flyback, but this has no visual significance.

## Y-PLATE CIRCUITS

### Programmer's Display

12. The Y-plate circuits for the programmer's display and the engineer's display are shown in figs 6.4 and 6.5 respectively; they are nearly identical, and the circuit of fig. 6.4 will be described first. The digital information to be displayed is applied to the cathode of crystal diode MR27, and undergoes an AND operation with 'clock' and with a switching waveform from the cathode of V34 (fig. 6.1) which is positive (140V) during the sweep period and negative (-7 to -10V) during the flyback. The resulting clocked digits are applied to the grid of V25. The anode circuit of V25 contains a ringing transformer with a diode connected so as to suppress the ring induced by the back edge of 'clock' but to permit a single pulse to be formed by the front edge. The output from the secondary winding whenever a 'one' appears in the digit waveform is a 0.6$\mu$ sec. positive pulse, with its base level at earth and its peak caught by MR31 at about 8V (fig. 6.7); this pulse is capacitively coupled to the Y1 plate (pin 12) of the tube. The first displayed digit will appear about 0.75$\mu$ sec. after the start of the scan, as the scan is initiated by a *digit* pulse whereas the displayed digits are initiated by a *clocked* pulse.

13. A narrow pulse must be generated every digit-time to brighten up the 'ones' on the display and to show dots to represent the 'noughts'. This is done in V27, the