Measurement of Phase and Frequency (Lissajous Patterns)

It is interesting to consider the characteristics of patterns that appear on the screen of a CRT when sinusoidal voltages are simultaneously applied to horizontal and vertical plates. These patterns are called 'Lissajous Patterns'. When two sinusoidal voltages of equal frequency which are in phase with each other are applied to the horizontal and vertical deflection plates, the pattern appearing on the screen is a straight line as is clear from Fig.1.

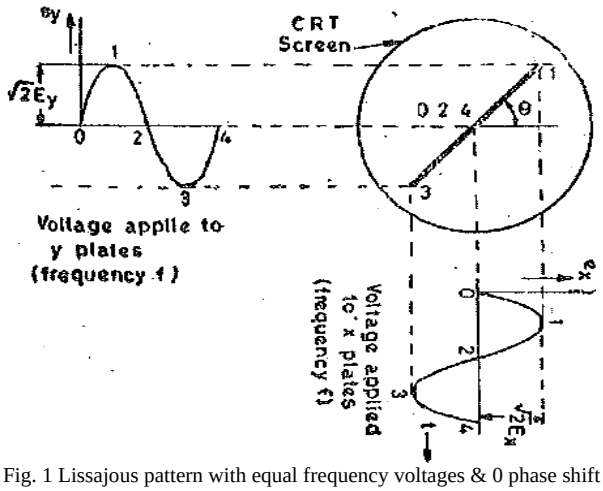

Fig. 1 Lissajous pattern with equal frequency voltages & 0 phase shift

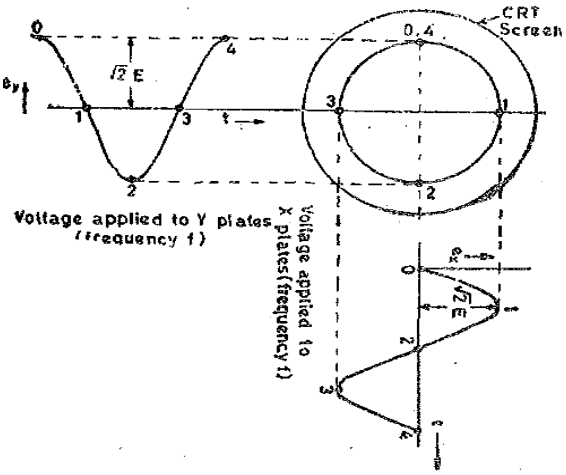

Fig. 2 Lissajous pattern with equal frequency voltages & a phase shift of 90°

Thus when two equal voltages of equal frequency but with 90' phase displacement are applied to a CRO, the trace on the screen is a circle. This is shown in Fig. 2.

When two equal voltages of equal frequency but with a phase shift ϕ (not equal to 0 or 90°) are applied to a CRO an ellipse as shown in Fig. 3 will appear. An ellipse is also obtained when unequal voltages of same frequency are applied to the CRO.

A number of conclusions can be drawn from the above discussions. When two sinusoidal voltages of same frequency are applied:

(i) A straight line results when the two voltages are equal and are either in phase with each other or 180° out of phase with each other. The angle formed with the horizontal is 45° when the magnitudes of voltages are equal. An increase in the vertical deflection voltage causes the line to have an angle greater than 45° with the horizontal. On the other hand a greater horizontal voltage makes the angle less than 45° with the horizontal.

(ii) Two sinusoidal waveforms of the same frequency produce a Lissajous pattern, which may be a straight line, a circle or an ellipse depending upon the phase and magnitude of the voltages. A circle can be formed only when the magnitude of the two signals is equal and the phase difference between them is either 90^0 or 270°. However, if the two voltages are not equal and/or out of phase an ellipse is formed. If the Y voltage is larger, an ellipse with vertical major axis is formed while if the X plate voltage has a greater magnitude, the major axis of the ellipse lies along horizontal axis.

(iii) It is clear from Fig. 4, that for equal voltages of same frequency progressive variation of phase voltage causes the pattern to vary from a straight diagonal line to ellipses of different eccentricities and then to a circle, after that through another series of ellipses and finally a diagonal straight line again.

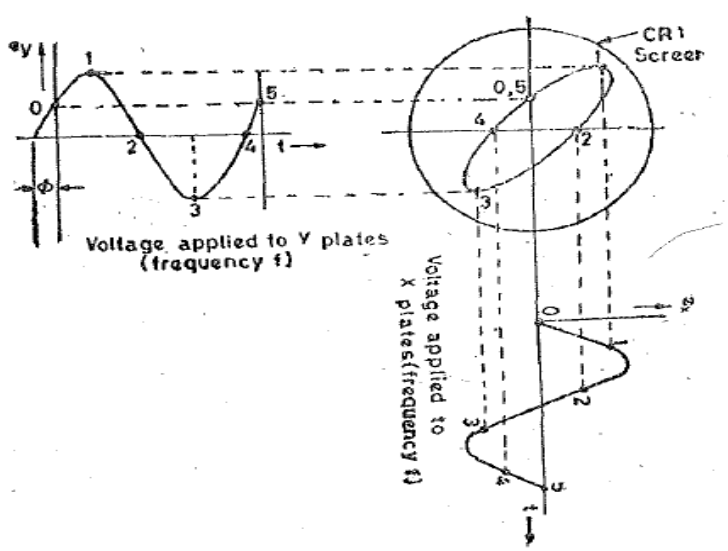

Fig. 3 Lissajous pattern with 2 equal voltages of same frequency and phase shift of ϕ

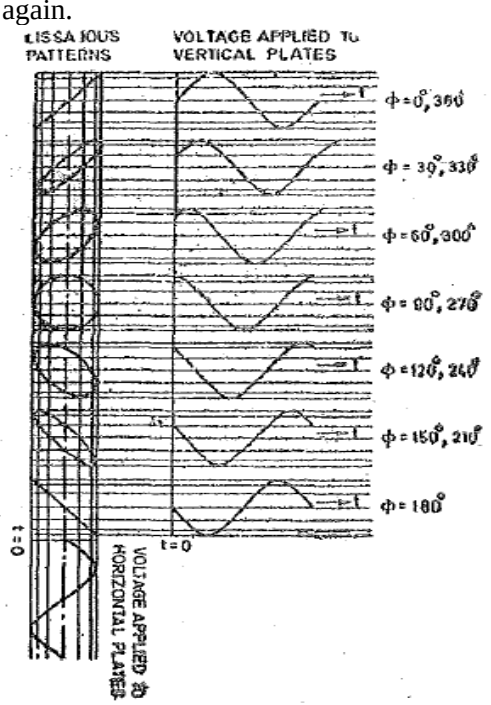

Fig. 4 Lissajous patterns with different phase shifts