when $t = 0$, and increases linearly to 10ft/sec² when $t = 1$ sec real time. VS1 can be used to adjust the magnitude of a when $t > 0$. Also, if OA1 initial conditions are inserted, in a similar manner to OA2 and OA3, many other time functions of a can be generated.

UNIT "C" FUNCTION GENERATOR

UNIT "C" contains two diode-resistor networks, one for positive input voltages, and the other for negative inputs. The characteristics of each network can be adjusted separately by means of miniature pre-set potentiometers to give a wide range of possible functions, and optimum accuracy. The function generator is designed to be used in place of a normal computing resistor, at the input or in the feedback loop of an operational amplifier.

When employed for squaring an input voltage, with both networks operating in parallel, the function generator will accept input voltages of 0–±10V, and yields amplifier outputs of up to ±10V. Accuracy can be within 2 per cent of the indicated value, depending on the care taken in setting up a function, for input voltages between 0·2V and 9V.

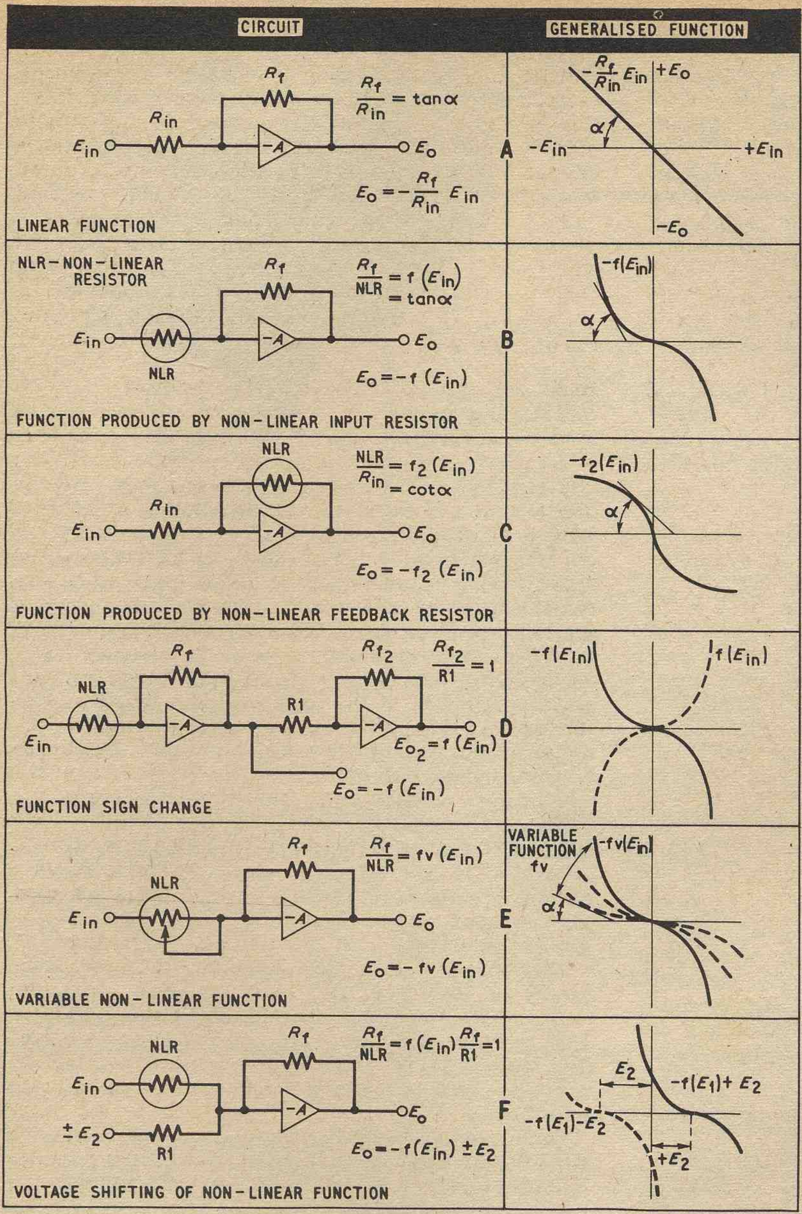

Fig. 7.7. Generating non-linear functions with a voltage dependent resistor

NON-LINEAR FUNCTIONS

Quite often some non-linear function of an applied voltage is needed in analogue computer work, two simple instances being the square or square root of a number. An arbitrary function may also be encountered, perhaps arising from experimental data for which no analytic expression is available.

Servo driven potentiometers and circuits consisting of biased diodes are widely used for generating non-linear functions, but the latter is deservedly popular because it can be adjusted to cater for a range of functions, and does not suffer from a severely limited frequency response.

To show how a diode function generator can give rise to non-linear functions, when allied to operational amplifiers, use is made here of the parallel which exists between the discontinuous behaviour of a biased diode network, and the smooth response of a voltage dependent resistor. Both can display a fall in resistance with an increase in applied voltage.

Consider first of all the circuit and generalised curve of Fig. 7.7a. Input and feedback resistors R_{in} and R_f are not influenced by applied voltage, therefore a straight line function is generated, while amplifier gain and $\tan\alpha$ remains constant. However, if some form of non-linear resistor, or biased diode network, is substituted for R_{in} (NLR in Fig. 7.7b) the gain of the amplifier tends to grow with an increase of E_{in}, and the tangent to the curve will vary according to some function $f(E_{in})$, arising from the characteristic of NLR. A related function $f_2(E_{in})$ results when NLR is exchanged for R_f, as in Fig. 7.7c, but here the amplifier gain falls off with an increase of E_{in}. The curves of Fig. 7.7b and Fig. 7.7c only occupy two of four possible quadrants, but four quadrant operation can be achieved if the function is inverted by a sign changing amplifier, depicted in Fig. 7.7d.

Fig. 7.7e shows how curves, of widely differing slope and magnitude, may be generated if the characteristic of NLR is alterable. Finally, any fixed function will find wider application if its $E_{in} = 0$ datum is shifted, as in Fig. 7.7f. Moreover, as a voltage shift can also be applied to the E_0 axis, it becomes a simple matter to locate any portion of a curve in any quadrant.