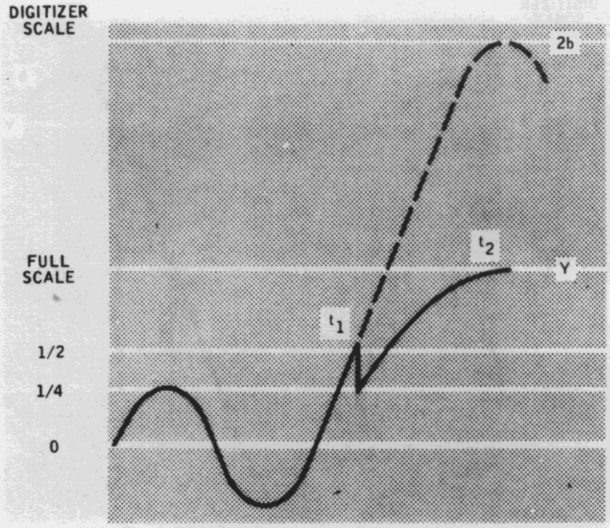

FIGURE 5

When the last sample digitized is just above half scale, the amplifier reduces gain immediately, and quarter scale becomes half scale on the lower gain level, as demonstrated by the solid line.

Starting with,

$$Y = b \sin \omega t_2$$

Transposing terms,

$$\frac{2b}{1/4Y} = \frac{2}{1/4 \sin \omega t_2}$$

This equation may be reduced to the following, expressed in terms of frequency:

$$\frac{2b}{1/4Y} = \frac{\sqrt{65-16 \cos \omega \times 10^{-3}}}{\sin \omega \times 10^{-3}} \quad (2)$$

The two equations of burst-out ratio are plotted against frequency in Figure 6.

The lower curve, plotted from equation (1), extends from a burst-out ratio of 24 db at 10 cps to 6 db at 200 cps. The upper curve, plotted from equation (2), runs from nearly 42 db at 10 cps to 18 db at 200 cps. Between the two curves, probability increases from 0 to 1 that one overscale will occur on the controlling channel.

When the signal is within the digitizer range (that is, when the burst-out is within the limits diagrammed), amplification is accomplished within the specified distortion of 0.1%. The burst-out sample is digitized and recorded to the same high standard of accuracy and precision as other signals running along at a relatively constant amplitude. In contrast, when conventional analog amplifiers are used, distortion increases rapidly as the amplifier attempts to follow a burst-out. Harmonic distortion goes from perhaps 0.5% to more than 2% as burst-out ratio increases.

If a burst-out occurs so rapidly that a sample exceeds full scale of the digitizer, that sample is still recorded as a full-scale number, as shown in Figure 7. The area of contribution to distortion is cross-hatched. This graphic burst-out analysis is based on the worst case for a 5-to-1 burst-out at 50 cycles. To make this example worst case, it was assumed that the peak value of the previous cycle was just short of half scale--thus holding the amplifier on the current gain level. Furthermore, data sample 1 on the burst-out is assumed to be just below half scale so that, once more, the current gain level continues. By time t_2, the burst-out exceeds full scale on gain n which is equal to ordinate 2. Data sample 2, therefore, is recorded as full scale on gain n. Since this sample is in excess of half scale on gain n, gain is shifted to n/2 by the next sample time, t_3. Full scale on gain n/2 is now equal to ordinate 4, and data sample 3 is within this scale. This data sample exceeds half scale, however, so gain is shifted to n/4 by the time of the next sample at t_4.

As indicated on the plot of burst-out ratio vs. frequency (Figure 6), the probability of one overscale occurring