respect to time will be small and "ganged gain" is practical. Where spreads extend over large distances and inter-channel amplitude variations are large (many times in excess of 20 to 30 db) with respect to time, it is best to use "individual gain."

The 4-bit gain code (the output of the up/down gain control counter) is recorded on the magnetic tape in digital form once each scan, in the case of "ganged gain," and once each sample, in the case of group or individual gain.

Early Gain

The early gain selector switch permits the operator to set the initial gain at a low value and hold it there in spite of the fact that, with no signal coming in, the gain levels would automatically cycle up to a high value. The amplifier holds this early gain value until first break exceeds the trip sensitivity--also set by the operator--and releases full automatic gain control. The early gain switches have 12 positions ranging from 0 to -84 db (referred to full scale of 1 volt, in steps of 6 to 12 db). The early gain settings also provide a means of setting the AGR amplifier on 12 gain levels for test purposes.

Release Rate

In the case of a varying data signal which is crossing zero many times per second, it is apparent that some of the sample values of the signal would fall below the one-quarter scale set point which triggers the gain increase. Still, the signal peaks would be above the trigger level, and the existing gain level should be continued. A means is needed to delay the gain increase until all samples fall below the trigger level.

In this system, this end is accomplished by examining all samples of all channels (in a gain group) for a time period which is set by a release-rate switch. One of three maximum release rates, fast, medium, and slow, may be selected by the operator. The release rate is an expression of the speed, in decibels per second, at which an amplifier is capable of increasing gain to follow a declining seismic signal. The release rates are specified by the customer.

As soon as all samples are below the lower set point for an examination period, the gain is increased by 6 db at the next scan. Thus, with a 30-millisecond examination period, for example, the gain could be increased 6 db every 30 milliseconds or at a rate of 200 db/sec. This examination period is an asynchronous "sliding window" that finds the earliest possible time that the conditions for a gain increase are satisfied. Provision of three release rates permits the operator to select the one best suited to the data being received.

Attack Rate

The system is capable of reducing gain at a very rapid "attack" rate, 6000 db/sec. If any sample of any channel exceeds the upper (one-half) scale set point, the gain is reduced by one step immediately--that is, at the next scan. Thus, gain reduction can occur at a maximum rate of 6 db each millisecond (length of one scan) or 6000 db/sec.

As already pointed out in the discussion of quarter- and half-scale set points, an increasing signal, such as a burst-out, has 6 db of digitizer scale available before it would go off the top of the digitizer scale. Now, it may be noted, the digitizer scale may, in effect, be doubled (by halving the gain) in only a single scan of one millisecond. Thus, the system is capable of reducing gain at a dynamic rate of 6000 db/sec--fast enough to keep up with nearly any signal.

Gain Control Operation

An example of how gain control operates during a seismic run will make clear the relationships between early gain, trip sensitivity, gain levels, release rate, and attack rate. Figure 2 shows a plot of the envelope of a seismic-signal peak level, the level leaving the amplifier, and gain level--all plotted against the same