the original sum of the two sine waves. Essentially, the approximation is the replacement of the original wave by a triangular one. This process, mathematically seen as a sine modulation of an unit triangular curve, reduced harmonic distortions to 12% instead of 75% as in normal infinite clipping.

**M2. On the Power Gained by Clipping Audio and Single Side-Band Speech Signals.** WEIANT WATHEN-DUNN AND DAVID W. LIPKE, *Electronics Research Directorate, Air Force Cambridge Research Center, Hanscom Field, Bedford, Massachusetts.*—Available statistical distributions of instantaneous speech amplitudes have been examined, and an arbitrary but reasonable peak factor has been chosen for a clipping reference level. The power increase in the audio wave (and hence the AM or DSB side bands) due to peak clipping in the audio band has been calculated by using the standard deviation of the clipped and unclipped distributions as a measure of the root-mean-square voltage. A curve will be presented showing the power gain as a function of clipping, and the relation of this to the intelligibility will be pointed out. Statistical distributions of the envelope of a single side-band speech signal have been run and compared with those taken by others, and these have been treated in a manner similar to the audio case to determine the power gained by clipping the single sideband signal. A curve of the power increase under these conditions will also be presented. Unfortunately, there are no data on the intelligibility of clipped single side-band speech to which the computed curve may be related.

**M3. Peakpicker: A Band-Width Compression Device.** EUGENE PETERSON AND FRANKLIN S. COOPER, *Haskins Laboratories, New York, New York.*—A vocoder of the usual channel type has been used as the basis for a comparatively crude form of resonance vocoder. Supplementary equipment—the Peakpicker—is located between analyzer and synthesizer of the vocoder to carry out two functions, namely, to select spectrum channels containing voltage maxima and to establish connection from analyzer to synthesizer for the selected channels. All circuits of the vocoder proper are retained and used without change. The spectrum information to be transmitted can now be reduced, since at any moment only those channels are utilized in which voltage maxima are detected. The Peakpicker and an 18-channel vocoder have been tested for selection of three, four, or five spectral maxima at sampling rates of 30 or 60 per sec. Under the best conditions thus far, nonsense syllable articulation scores in the 60% to 70% range have been realized, corresponding to high sentence intelligibility scores. It is estimated that this level of performance can be had with an over-all information rate well below 1000 bits per second. Illustrative recordings will be presented. (This work was supported by the Department of Defense in connection with Contract DA49-170-sc-1642.)

**M4. Speech Research Devices Based on a Channel Vocoder.** JOHN M. BORST AND FRANKLIN S. COOPER, *Haskins Laboratories, New York, New York.*—Three tools for analysis-synthesis research on speech have been developed, employing an 18-channel vocoder as the basic speech processing device. One is a vocoder-playback (Voback) which produces speech sounds from hand-painted spectrograms. Frequency zones of the spectrogram corresponding to the pass bands of the channel filters are scanned by 18 multiplier phototubes to provide control voltages for the vocoder synthesizer. Two additional phototubes provide control of pitch and buzz/hiss switching. A second device (Intonator) permits arbitrary manipulation of the pitch of real speech as it passes through the vocoder. The speech is supplied to the vocoder from a loop of magnetic tape which runs in step with a variable-area pitch-control tape and a reference spectrogram. Phototubes supply pitch and buzz/hiss voltages to the vocoder synthesizer. A closely related device (Amplituder) permits instant-by-instant control of output level. A control voltage obtained from a phototube and variable-area tape is used to regulate a variable-gain output stage. Recordings from the three devices will be presented. (This work was supported in part by the Carnegie Corporation of New York, and in part by the Department of Defense in connection with Contract DA49-170-sc-1642.)

**M5. Some Sources of Characteristic Vocoder Quality.*** FRANKLIN S. COOPER, EUGENE PETERSON, AND GERALD S. FAHRINGER,† *Haskins Laboratories, New York, New York.*

* The abstract of this paper was printed in the November, 1956, program and in J. Acoust. Soc. Am. 29, 183 (1957), but the paper was not presented at the Los Angeles meeting.

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**M6. Normalization of the Voice Spectrum.** CALDWELL P. SMITH, *Air Force Cambridge Research Center, Bedford, Massachusetts.*—Measurement of the spectrum pattern of voice signals by a method that normalizes (i.e., makes the measurement unresponsive) with respect to amplitude fluctuations offers some powerful advantages. The relative amplitude at all frequency positions in the voice spectrum pattern is significantly correlated with the particular speech event; therefore a measurement of the total spectrum pattern offers a means of maximum utilization of the speech signal information. Normalization has the effect of slowing down the rate of change of the signal parameters that specify the voice spectrum, abstracting the common-mode fluctuation due to voice amplitude and specifying it as a separate parameter. Further, a specification of the normalized spectrum patterns of speech offers in principle a more economical specification than one in which formant frequencies are specified as independent parameters. The normalizing method has been reported previously [C. P. Smith, J. Acoust. Soc. Am. **28**, 159 (1956)]; some speech data taken with normalization are presented.

**M7. Effect of Third-Formant Transitions on the Perception of the Voiced Stop Consonants.** K. S. HARRIS, H. S. HOFFMAN,* P. C. DELATTRE,† AND A. M. LIBERMAN,* *Haskins Laboratories, New York, New York.*—The pattern playback was used to generate synthetic syllables consisting of a wide range of second- and third-formant transitions in initial position with the vowels *i* and *ae*. It was found that third-formant transitions affected the perception of the stop consonants. (The effects of the second-formant transitions were as previously reported.) When the third formants and their associated transitions were added at the frequency levels appropriate to each of the two vowels, positive transitions strengthened the perception of *d* at the expense of *b* or *g*, while negative transitions had the opposite effect. There was some evidence that variations of the steady-state level of the third formant changed the effect of a given third-formant transition. The results suggest that the effect of third-formant transitions is largely independent of the second-formant transitions with which they are combined. (This work was supported in part by the Carnegie Corporation of New York, and in part by the Department of Defense in connection with Contract DA49-170-sc-1642.)

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**M8. Some Cues to the Voiced-Voiceless Distinction among the Intervocalic Stops in English.** LEIGH LISKER,* *Haskins Laboratories, New York, New York.*—Phonetic description and evidence from spectrograms suggest that (1) perception of the voicing distinction among stops involves several acoustic features; and (2) these features are likely to be of unequal importance in different contexts. The contrast between *p* and