is a sufficient cue for making these manner distinctions. The results of our spectrographic studies, a series of tape-cutting and -splicing experiments, and listening tests indicate that two acoustic factors are necessary to make the three-way manner differentiation: (1) the timing of the voicing onset that divides the stop series into two classes—aspirated stops (/p^h/, /t^h/, /k^h/) and unaspirated stops (/p/, /t/, /k/, /P/, /T/, /K/); and (2) the quality of the voicing onset that differentiates the lenis stops from the fortis stops. [*12 min.*]

5H10. Approach to Computer Speech Recognition by Direct Analysis of the Speech Wave. D. R. Reddy, *Computer Science Department, Stanford, California.*—A system for obtaining a phonemic transcription from a connected speech sample entered into the computer by a microphone and an analog-to-digital converter is described. The following features of the system are believed to be new: direct input of the speech signal to the computer without filters or spectrographs; the procedures for segmentation and pitch extraction; the procedure for prosodic parameter determination; and many procedures for phoneme classification. About 30 sounds of 1- to 2-sec duration were analyzed on an IBM-7090-PDP1 disk system. Correct identification of many vowel and consonanted phonemes was achieved for a single cooperative speaker. The time for analysis of each sound varied from 40 to 75 sec. For example, the sentence, "John has a book," resulted in a phoneme string output "J AA M AE Z EH (B D G) U K." The results encourage continuing the approach with a more powerful computer to achieve real-time recognition. [*12 min.*]

Friday, 4 November 1966 — Golden State Room at 2:00 p.m.

Session 6D. Noise Prediction and Analysis

Robert C. Chanaud, *Chairman*

Contributed Papers

6D1. Sound Propagation in a Shadow Zone. Robert C. Polly, *Vitro Services, Marshall Space Flight Center, Huntsville, Alabama.*—In this paper, the behavior of the sound field within a shadow zone is briefly examined. Under certain atmospheric conditions, ray acoustics can be used to derive a suitable relationship for the intensity of an "effective shadow zone." The solution obtained by the methods of ray acoustics is compared with the normal-mode solution of the wave equation, and the basic limitations of both approaches are pointed out. Acoustic measurements recorded during numerous engine tests have indicated that there are two major factors that affect the behavior of the sound field within the shadow zone. These are (1) the magnitude of the surficial velocity gradient, and (2) the surface wind conditions. These two factors have been incorporated into an empirically derived expression for the shadow zone attenuation rate. Using this relationship, it was found that about 90% of the calculated values were within ±5 dB of the measured values. [*12 min.*]

6D2. Measured Variation of Acoustic Parameters with Altitude. Richard N. Tedrick and James R. Alexander (nonmember), *Brown Engineering Company, Huntsville, Alabama.*—Measurements of the internal and external sound-pressure levels are reported from the flight of a Saturn IB space vehicle. These measurements show the differences in sound generation and transmission that occur as the vehicle rises from the launch site near sea level to several hundreds of thousands of feet. These changes are related to the variation in atmospheric and flight parameters (notably density and velocity) with altitude. [*12 min.*]

6D3. Launch-Vehicle In-Flight Acoustic-Environment Predictions. B. W. George, *Lockheed Missiles & Space Company, Huntsville Research and Engineering Center, Huntsville, Alabama.*—A state-of-the-art prediction of the in-flight external acoustic environment of a current launch vehicle was made for NASA–Marshall Space Flight Center. Representative predicted environment parameters are presented in the form of sound-pressure-level time histories and ⅓-oct-band spectra for each major stage or module on the vehicle. Methods used in the prediction are based on (a) wind-tunnel acoustic data on scaled models; and (b) normalized empirical curves available in the literature. Aerodynamic-noise sources on the vehicle and local areas with severe environments (e.g., near proturberances) are discussed. Highest noise environment over the launch flight period occurs on the nose cone. The predictions are compared with subsequent flight measurements and the results interpreted. The validity of scaling from model to flight data is demonstrated. Oscillating-shock-wave effects are found to contribute significantly to the acoustic signals recorded in flight in the transonic speed range. Comparisons are included of these data with recent published data on other types of flight vehicles. [*12 min.*]

6D4. Digital Analysis of Impulsive Noise. William W. Lang, George C. Maling, Jr., and W. A. Taylor (nonmember), *Acoustics Laboratory, International Business Machines Corporation, Poughkeepsie, New York.*—A digital recording of impulsive noise has been analyzed with the aid of a program written for an IBM-7094 data-processing system. The waveform of the impulsive noise is sampled every 32 μsec and digitized by an ADC. The resulting 10-bit data are written on magnetic tape in a format that permits timing pulses to be stored with each data sample. The digitized samples are processed to produce a new tape that is used as the input to a FORTRAN program. The values of the parameters most appropriate for characterizing impulsive noise are determined by the program in conformance with IEEE Recommended Practices for Burst Measurements in the Time Domain [IEEE Publ. No. 257]. The noise to be analyzed by the system can be either the unweighted sound pressure as a function of time, or the output of a filter. The analysis of amplitude and shape variations is completed without manual processing of the data. This method is applied to the noise generated by a card punch. [*12 min.*]

6D5. Computer Simulations of Highway Traffic and Associated Noise Levels. C. M. Fletcher (nonmember) and W. E. Clark, *Bolt Beranek and Newman Inc., Los Angeles, California.*—A set of computer programs has been developed that provides the capability to simulate highway traffic and to calculate the associated noise levels. Extensive measurements of vehicular noise have been classified and averaged to produce characteristic spectra for passenger cars, heavy