by a decrease of amplitude, is identified by comparing the initial and final fractions of the vowel affected. By a similar comparison we identify the Danish "falling loudness of the voice" (the so-called stød), which is due to a decrease of amplitude often accompanied by a decrease of frequency (19).

The prosodic opposition long vs. short (distinguishing either simple from sustained or simple from reduced phonemes) is based on the relative, not absolute, length of the phonemes in the given sequence. Their absolute duration is a function of the speech tempo. For instance, in the Czech pravá práva/prava: pra:va/ "true rights", the first vowel of the first word is identified as short in relation to the second, long vowel, while the second word displays the inverse relation.

<h2 align="center">1.5 THE DISTINCTIVE FEATURES COMPARED TO
THE OTHER SOUND FEATURES</h2>

The smallest meaningful unit in language is called morpheme. A root, a prefix and a suffix are morphemes. A root word is a one morpheme word. The distinctive features and the phonemes possess no meaning of their own. Their only semantic load is to signalize that a morpheme which, ceteris paribus, exhibits an opposite feature is a different morpheme; cf. /gip/, /gib/ and /gid/. This discriminatory function may be assumed by more than one feature (and phoneme), as in the case of /bit/ and /sed/.

There is no difference in function between diverse features (and phonemes). For instance, the question of what is the specific denotation of nasal consonants or, in particular, of /m/ in English, makes no sense. /m/ in map, mess, aim has on the semantic level no common denominator which would set it off from /n/ or from /b/. This lack of semantic difference between diverse distinctive features makes them purely discriminatory marks which are otherwise empty. It separates them from all other sound features functioning in language. Only these, purely discriminatory and otherwise empty units are used to construct the whole stock of morphemes of all languages of the world.

Configurational features are features which signal the division of the sound chain of the utterance into grammatical units of different degrees of complexity. For instance, in languages where the stress is bound to the initial (or final) syllable and, consequently, cannot serve as a distinctive feature, it functions as a border mark which denotes the beginning (or end) of the word. On the contrary, in a language where the stress is free (i.e. can fall on any syllable in the word), its place performs a distinctive function and contains no specific denotation.

From the various redundant and expressive features of English intonation, Z. S. Harris (20) has extracted three configurational units: "/?/ for rise, /./ for fall, /,/ for middle register (as against low register) base-line". /./ denotes the end of the sentence, /,/ the end of a phrase in a sentence to be continued, and /?/ the question, which in configurational terms means the end of a sen-

<p align="center">- 14 -</p>

tence to be supplemented by an answer; i.e. the potential completeness of the utterance but incompleteness of the dialogue. When used as distinctive features, rise and fall have no other function than discrimination between morphemes, but when they serve as configurational features they carry a specific denotation; e.g. fall signifies the completeness of a sentence, and a rising intonation, even if superposed upon a mere nasal murmur, is immediately identified by English listeners as a question.

Expressive features are features which signal emotional attitudes of the speaker and the emphasis he puts on some of the particulars conveyed by his utterance. To use D. Jones' example (1), in the pronunciation of the English word enormous the emphasis may be effected "by an increase of strength coupled with an increase in the length of the vowel and the use of a special intonation" (a greater extent of the fall). In the expressive features, we deal with a special kind of relations. A neutral, unemotional variety is paired with the expressive variety which presents a "grading gamut" according to the term of Sapir, who defined this type of relation distinctly (21). Like the configurational features, the expressive features carry their specific denotation. In English the intensified stress, as opposed to the normal stress, denotes an emphatic attitude, and a further reinforcement of stress, a still more emphatic attitude.

The distinctive and the configurational features refer to the meaningful units of the utterance; the expressive features, to the speaker's attitude, and the redundant features (see 1.2) refer to other sound features: e.g. the redundant "clearness" of the English /l/ denotes that a vowel follows. Possession of a specific denotation unites the redundant features with the configurational and expressive features and separates them from the distinctive features. The "emptiness" of the distinctive features sets these apart from all other sound features.*

The following survey is confined to the inherent distinctive features. The prosodic features and other problems involving the sequential arrangement, in particular the segmentation of the sequence will be treated separately.

* In certain cases single distinctive features can assume an additional configurational function. In this function they obtain a positive denotation. For instance, in certain Scottish dialects where nasal vowels occur and are opposed to the oral vowels in the first syllable only (5), the occurence of a nasal vowel denotes the beginning of a word, but within the limits of the first syllable the opposition of nasal and oral vowels remains a "void" distinctive means.

II A TENTATIVE SURVEY OF THE DISTINCTIVE FEATURES

2.1 PREFATORY ACOUSTICAL REMARKS

In the sound spectrograms* the frequency-intensity pattern of speech is portrayed as a function of time. In this "running frequency analysis" the statistical properties of the speech wave are sampled within time intervals that are short compared to the duration of a phoneme. The spectrograms and the supplementary "cross sections" of intensity vs. frequency provide a source of information that may be rather confusing unless an optimal set of parameters is used in the analysis. These parameters can best be discovered by an analysis of language into distinctive features.

The speech wave may be considered as the output of a linear network; i.e., the vocal tract coupled to one or more sources. The speech wave has no other properties than those of the sources and the network. This relation may be written

$$W = T \cdot S$$

where W represents the speech wave, T the transfer function of the network, and S the source. Two simultaneous sources may be handled by superposition:

$$W = T_1 S_1 + T_2 S_2$$

Speech analysis shows that only a very limited number of characteristics of the source and of the transfer functions are utilized in the various languages of the world for semantic discriminations. These characteristics are described in the following paragraphs.

2.11 Properties of the Source Function Utilized in Language

2.111 Type of Source. There are basically two kinds of sources, periodic and noise sources. A periodic source is manifested by a characteristic harmonic structure in the spectrogram. A noise source, on the other hand, causes an irregular distribution of energy in the time dimension. These two sources can be simultaneously active in the production of a single phoneme.

2.112 Number of Sources. Some sounds such as [v] or [z] have two sources. One of these is located at a point of maximum stricture in the vocal tract, while the other, i.e. the so-called voice, is located at the larynx and is more or less periodic. A source which lies above the larynx in the vocal tract produces anti-resonances in the transfer function (cf. 2.122).

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* The sound spectrograms to which reference is made in this report either are of the type produced by the Kay Electric Company Sonagraph or are from the book Visible Speech by Potter, Kopp, and Green (1).