A Nation Tests Its Hearing

BELL SYSTEM EXHIBIT

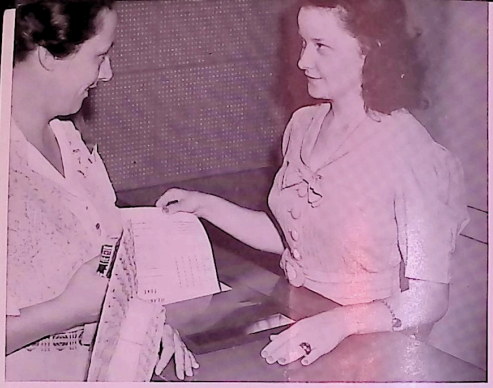
WORLD'S FAIR OF 1940 IN NEW YORK

A Bell System Exhibit visitor listens to spoken instructions before taking the hearing test.

HOW WELL DO YOU HEAR?

To get an accurate answer to that question, over two million people in 1939 tested their hearing at the Bell System Exhibits at the New York World's Fair and at the Golden Gate International Exposition in San Francisco. Millions more are taking advantage of the unique testing equipment at these exhibits in 1940.

While the individuals taking these tests have a personal interest in determining their own hearing ability, the Bell System, too, has a vital interest in the results of the tests. The ultimate gauge of the Telephone job is the utility of the sounds heard by the telephone listener. Hence if the Bell System is to provide the nation with the best telephone service, at the lowest possible cost, it is important that reliable data on



After the test has been made, the results are photographed automatically, for research purposes.

the hearing characteristics of the American people be available.

The hearing test equipments installed at the Bell System Exhibits offer two types of tests with separate booths for each type. In one, the "Hearing Test for Spoken Words," the visitor hears spoken words, from a telephone receiver, which consist of groups of two numbers, such as "eight-six, four-one, two-two." In the other, the "Hearing Test for Musical Tones," these spoken numbers are replaced by pure musical tones, each being sounded from one to three times and the listeners write down the number of times they hear the tone.

Of the millions of visitors who took advantage of the testing equipment in 1939, many permitted photographic copies of their tests to be taken and have thus made possible the widest survey of hearing that has ever been made.

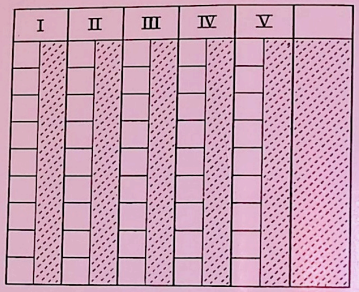
Pertinent information regarding each individual test was recorded at the time the test was taken. The sex and approximate age of the individual, and the date and time of the test were among the data taken. Thus, the information recorded was capable of being analyzed in several different respects.

The photographs of the test cards made at the Fair are run through this projector and the girl transfers the information on them to punched cards which can be handled by sorting and tabulating machines.

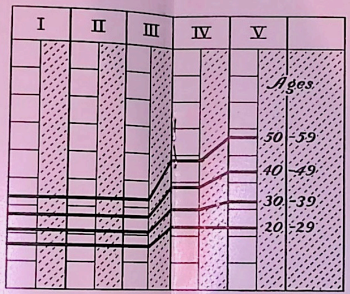
HEARING TEST FOR MUSICAL TONES

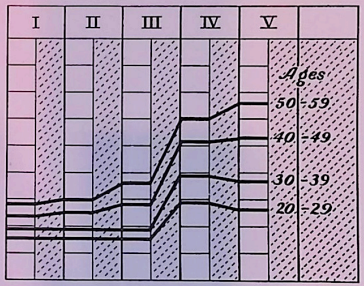
Five tests are given each with a different tone. Each test consists of a series of nine tone signals, each succeeding signal in the series being sounded at lower volume. The visitor records on his test chart the number of times he heard the tone in each signal. The tone used in the first column of the test is violin A, or the A above middle C on the piano, with a vibration frequency of 440 cycles per second. Each following test is one octave higher in pitch, and thus the hearing is tested at 440, 880, 1760, 3520 and 7040 cycles. The first three tones are in the pitch range that is most important in speech and music. The pitches below 440 cycles are also important, especially in music, but it is rare that a person who hears well at 440, cannot also hear lower pitched tones equally well.

It is not unusual for an individual to find quite a difference in his ability to hear the various tones in the test. This is, in fact, quite normal, but on the average the tones in the first three columns are



Section of the test sheet for musical tones. Visitor: hear musical tones of the same pitch which come in groups, one, two or three at a time. Successive groups sound farther and farther away. Those taking the test note the number of tones heard. The five columns represent the five different pitches used.





Test cards showing how far down each column the average man, (chart on right) or woman, (chart on left) is able to hear.

heard about equally well. One person in 12 of those taking the test is able to fill in every square in at least one of these columns and 60% are able to go at least as far as the third square from the bottom of the column. Nine out of ten are able to go halfway down the column. One person in 100 is unable to fill in more than the first two squares.

The higher pitched tones in the last two columns are much less important in hearing speech and music. In fact, a person may be quite deaf for these tones and still understand speech fairly well and enjoy music. Loss of acuity for these tones has much the same effect as the tone control on a radio set in reducing the brilliance of music and weakening such speech sounds as "f" and "s", which are composed chiefly of sounds in this pitch range. It is fortunate that hearing is more likely to be impaired for these pitches than for the medium pitch tones which compose the bulk of intelligible speech sounds. We find that only 30% of those taking the test get as far as the third square from the bottom of the last two columns, and only seven out of ten are able to go halfway down. Fifteen out of 100 are unable to fill in even the first square in the last column. *Less than one person in 100 can fill in every square in all five columns.*

On the average, older people do not hear as well as younger people although there are, of course, many individual exceptions to this trend. At the lower pitches, the average person 20 years old is able to go about one square farther down the column than the average person 50 years old, while for the two highest pitches the difference is about three squares.

It is interesting that women can hear the tones in the fourth column much better than men. Their average difference is about one square for younger people and two squares for older people. The same difference, although in lesser degree, is found in the fifth column but in the first two columns the effect is reversed and men hear a little better than women on the average.

Ability to hear the tones in the first three columns of the test is closely related to ability to hear speech. The results of the test for these tones indicate that about one out of 25 persons have difficulty in hearing in auditoriums; one in 125 have some difficulty in direct conversation and one in 400, over the telephone. These averages were determined from the tabulation of questionnaires which a part of our visitors were requested to fill out, concerning their own hearing.

During part of the summer of 1939, visitors at each Fair were asked to indicate whether they lived in the vicinity or not, so that information would be available to determine sectional differences in hearing acuity. Studies of these answers, however, did not reveal any significant difference between New York and San Francisco. The time of day at which each test was taken was marked on the card by the attendant, thus permitting a comparison of the results for different periods of the day. No consistent difference was found, however, even between early morning and late afternoon. There is thus no indication of any effect of fatigue on hearing.

HEARING TEST FOR SPOKEN WORDS

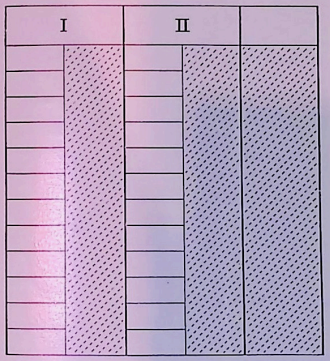
The hearing test for spoken words gives a general picture of ability to hear and understand speech.

A person who can hear every word in the test has exceptionally acute hearing. Only one person in fifty is able to do this. Persons with approximately normal hearing will hear seven or more pairs of numbers in each column. Over half of those taking the test were able to hear down to the third square from the bottom of the test blank. One person in twenty could go only as far as the sixth square, and would thus appear to have slightly impaired hearing for speech.

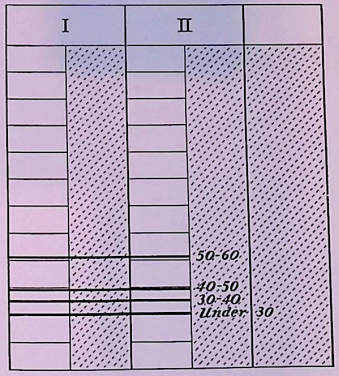
Older people do not in general hear as well as younger people. This fact is brought out in the chart on Page 7, which shows how far down the columns the average person in different age groups is able to hear. The differences in hearing between men and women are too small to show on the scale used in this chart.

Although the number-pairs which are on the same line in the two columns are of equal difficulty on the average, individuals will often find that they can hear further down one column than the other. This is due to individual differences in the ease of hearing and understanding the various numbers. In such a case it may be assumed that the lowest number-pair heard indicates the hearing ability.

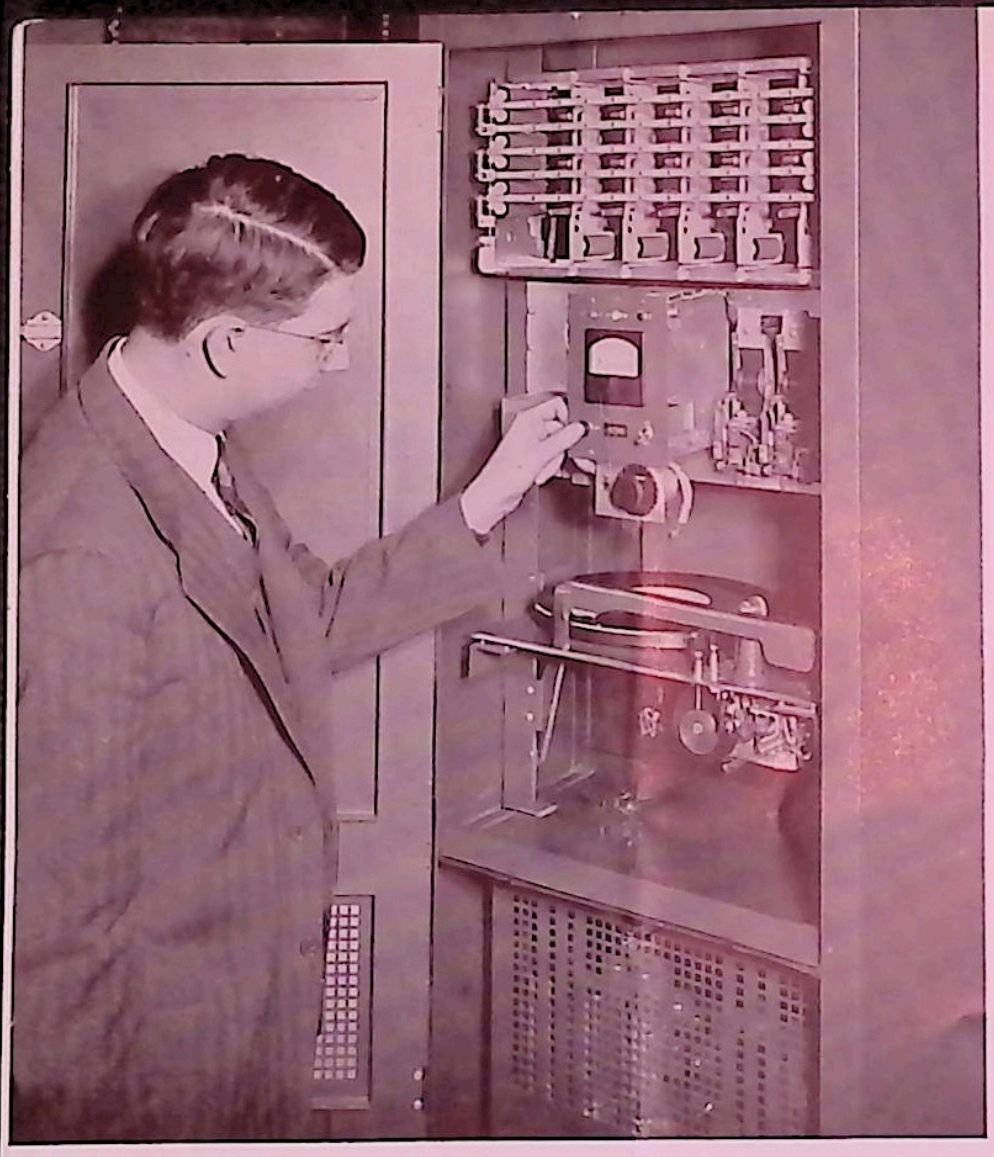
It will be realized that, although a very large number of people took the hearing test last summer, the visitors to the exhibit were not in all respects, representative of the population at large. Allowance



Section of the test sheet for spoken words. Visitors hear spoken numbers, two at a time, as for example, "eight-four." Successive groups of numbers sound farther and farther away. Those taking the test write the numbers as they are heard. The second column is similar to the first except that different numbers are spoken.



Test card showing how far down each column the average person in each age group is able to hear.



The musical tones and the spoken words heard by those taking the test are reproduced from phonograph records. The picture above shows a test being started.

must be made for these differences before the results of the survey can be applied to the population in general.

A more complete description of the hearing tests has been given in The Scientific Monthly for April, 1940, p. 335 and in The Bell Laboratories Record for December, 1939 and June, 1940. It is expected that a detailed analysis of the 1939 tests will be published sometime during the latter part of 1940 in the Journal of the Acoustical Society of America.

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The telephone equipment used to test your hearing was developed by Bell Telephone Laboratories and, like your telephone, was manufactured by the Western Electric Company.