

PHYSICS

Music in Three Dimensions

Thrill of Great Symphonic Orchestra With All Its Depth and Breadth Is Now Brought to Empty Stage

By WATSON DAVIS

THE emotion-stirring quality of a great symphonic orchestra or the vibrance of an operatic or stage presentation can now be presented to a theater audience even though the stage be empty and the artists, musicians and conductors long since finished with their tasks.

Into the world of sound there has come a new perfection of sound transmission and recording, born of the telephone, phonograph and sound movies yet so different in quality and purpose as to constitute a new entertainment art.

Not many nights ago a distinguished audience in Carnegie Hall, New York, was entertained with that latest perfection of musical sound, stereophonic music. If you had been out front at that performance, if you had closed your eyes in the enjoyment of the music as one sometimes does at a symphony, you would not have known that there was no actual orchestra or choir before you on the stage, that the only persons back stage were the engineers running the sound film through their sound reproducing apparatus. You would have felt confident that the kettle drum was booming there, the violins were singing there.

3-Dimensional Sound

It was music with perspective, three-dimensional sound, with depth and breadth, the same kind of sound that issues from an actual symphony orchestra or a great choir present in person, or actors on the stage before you.

A more complex perfection of the sound that issues from your telephone, phonograph or radio, stereophonic sound achieves its illusion of reality by delivering to your ears the sort of sounds they would hear at a flesh-and-blood performance.

Instead of being limited in vibration range as are most of the electrically transmitted and reproduced sounds in practical use, the electrical system used has only the practical limit set by the range of the human ear which is from about 30 vibrations per second to about 15,000.

This makes possible reproduction of the full richness of music, which is far more than the tones which carry the

melody. There are overtones as well, and they extend several octaves above the highest note of any instrument. In volume, the stereophonic music runs the gamut of sounds from those just audible to an acute ear, up to those which begin to be painful.

Scientists have divided this volume range into 120 units, called "decibels." Below 20 decibels, casual noises in an auditorium will mask the music. Beyond 120 decibels, sound is too loud for comfort. Due to the limitations of its instruments, a symphony orchestra will leave unused the 10 decibels of greatest volume and also the 10 decibels of least volume.

Can Touch Up Masterpieces

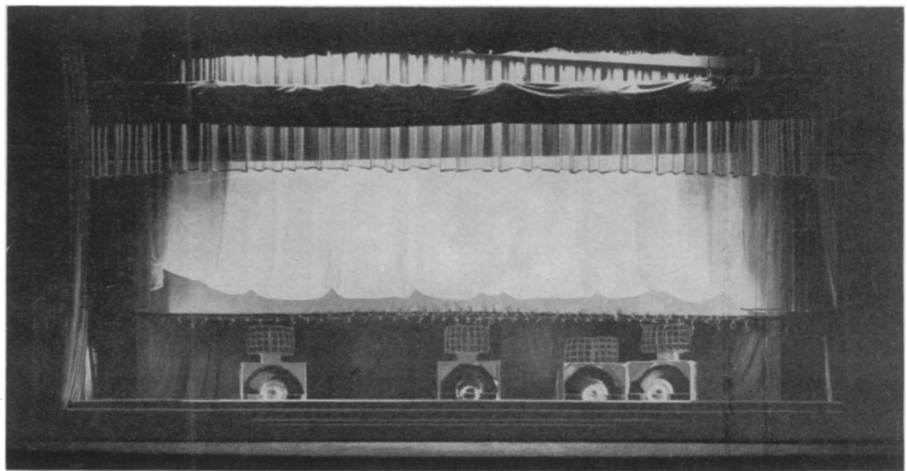
With electrical recording and reproduction of the new sort, a conductor can refine the product of his orchestra, changing its volume synthetically, making its music louder or softer than it was actually played. Great musicians who use baton or fingertips to manipulate the outpourings of great aggregations of fellow musicians have the opportunity of touching up their musical masterpieces in much the same way that a beautiful woman will enhance her charms before her boudoir mirror.

To this breadth of tonal quality and this desirable synthetic modification of the actual performance, stereophonic music adds the illusion that the music and the other sounds come not from one location, but from the whole stage. This perspective or breadth of sound is obtained by actually using three completely independent sound systems, one of which picks up and reproduces what is heard on the right of the stage, one for the center and one for the left of the stage. Sound engineers have found that three such sound systems are adequate for producing a satisfactory illusion of the real performance.

Research for 20 Years

For the last 20 years engineers of the Bell Telephone Laboratories, birthplace of improvements on the telephone, cradle of sound motion pictures, have worked in cooperation with musicians to produce faithful recreations of music. These researches have been led by Dr. Harvey Fletcher. More than 60 years ago music was first transmitted and recorded. But its electrical preservation and reproduction in a satisfactory manner is a development of the past few years.

Electrically cut phonograph records came in 1924; the first commercial sound pictures date from 1926. In a historic demonstration before the National Academy of Sciences in Washington in 1933,



LONG DISTANCE SYMPHONIES

With the aid of the new stereophonic reproduction of sound, an empty stage like this one with only loud speakers upon it can give a replica of the finest performance of the world's best symphony orchestra. Each loud speaker delivers the tones originally generated by different sections of the orchestra in its initial performance.



RETOUCHING MUSIC

Leopold Stokowski, noted orchestra conductor (center), enhances a symphonic production by electrical means, while Dr. Harvey Fletcher of the Bell Telephone Laboratories (left) looks on and W. B. Snow monitors the electrical currents.

stereophonic music of the Philadelphia Symphony Orchestra was transmitted over telephone wires from Philadelphia.

Two years later Leopold Stokowski used stereophonic reinforcement of his music in order to allow 25,000 people in the open air to hear with ease a program of vocal and instrumental music. This year's stereophonic accomplishment by the Bell Telephone engineers results in there being captured upon motion picture film the faithful record of whatever is presented to an audience: music, drama, speech.

A 2,000-foot reel of motion picture film will hold 22 minutes of recording, enough for nearly any single piece of music. On the same film are impressed photographically the sounds picked up by the three microphones, translated into electricity, then amplified and converted into light by a photoelectric cell as a trace of variable widths on the film, much as is done in sound motion pictures.

Two Refinements Possible

There are two refinements in stereophonic recording not used in ordinary sound pictures. The sound records on film have a limited range of volume. It was therefore necessary for the engineers to reduce the louder sounds before recording and to increase those sounds by a like amount in reproduction.

For this reason before the sound reaches the device that modulates the light which shines on the film, the sound current is measured automatically and instantaneously. Whenever this sound

current exceeds a predetermined amount, it is reduced so that the recording current never exceeds a certain level. At the same time that measurement of the sound current is made, an alternating current is recorded on the same film and the amount of this current is proportional to the reduction that it is necessary to make in the sound. In reproduction these control currents are used to vary the amplification of the sound currents so that the sound regains its original volume.

Can Modify Recordings

Whenever a conductor like Stokowski wishes to refine or modify or "gild" a recording of his orchestra from the standpoint of volume of sound, this can be done without reassembling the orchestra and repeating the performance. The engineers arrange a performance with the conductor as audience. As he listens he makes volume and even tonal changes by electrical control. Simultaneously a new stereophonic record is made of the music as thus "enhanced." This is the record which would go before the audience.

How stereophonic recording will be used in the future is not yet decided. Symphonic music could be taken to much smaller audiences and smaller communities that cannot now afford to maintain or import a symphony orchestra. The audience would have to gather in an auditorium in order to listen to the music just as they do in the case of a symphonic concert with live talent. The il-

lusion of sound perspective cannot be obtained in a small room or over the radio.

The combination of stereophonic recording with motion pictures is another possibility. Motion pictures are now available in color. When invention progresses to the point where motion pictures can practically be made three dimensional or stereoscopic, in addition to color being presented to the eye and stereophonic music to the ear, the recreation of a concert or stage performance—or even the recreation of a historical occasion—may come to practical reality.

Science News Letter, May 11, 1940

ECONOMICS—POPULATION

How Large Families Make Ends Meet

THE MORE children there are in a family in the United States nowadays, the larger is the part of the budget spent for food, and, by irony of fate, the lower goes the nutritional level.

So the Population Association of America was told at its meeting in Chapel Hill by Prof. Frank Lorimer of the American University, who reported an investigation of the economic problems of families of varying sizes.

As the urgency of eating to live presses more intensively on budgets of families with more children, these families meet the food problem by curtailing their spendings on such things notably as house furnishings, equipment, and transportation, recent analysis shows.

In United States cities, recent figures indicate that over 60% of families with five or six children, and over 90% of families with seven, eight, or nine children under sixteen years of age are in the lowest income classes.

From the standpoint of population policy, concerned with equalizing the economic situation of varying-sized families, one baffling problem is that the larger the family, the smaller the earnings of a working wife, Prof. Lorimer pointed out.

There is a strong tendency in contemporary society for many women to continue working after marriage, so long as there are no children in the family, but to drop employment and thus sacrifice the economic contribution as they become mothers, he stated.

In Negro families, the high proportion of working wives is attributed to poverty resulting from meager earnings of men, he has concluded from evidence that the proportion of Negro wives who work drops sharply when husbands' earnings rise above \$1,000 a year.

Science News Letter, May 11, 1940