THE ORCHESTRA ON THE AIR

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TO attempt to compose music within present broadcast limitations seems altogether ill-advised since most of these conditions are extremely temporary. On the other hand the apparent aim of radio technicians to bring the art and science of music broadcasting to a point where original and replica will be indistinguishable to the expert ear disregards the great esthetic possibilities of this new art. Broadcasting as a means for the dissemination of sound replicas is in itself a purely utilitarian device. Scientifically commendable as it is to overcome intricate technical difficulties this should be a first step rather than a goal.

The very defects of present methods and apparatus have shown that broadcasting has an immense future as a medium of expression apart from its function of transmission. Erratic amplification has revealed that it is feasible to accentuate or diminish any part of the orchestra far more flexibly than by actual playing while unintentional resonance shows that it is practicable to suppress or exaggerate any part of the pitch range of a given instrument or a group of instruments. Furthermore, it is readily possible to make sudden and tremendous variations in loudness of the whole or part of the orchestra. The additional tone qualities and technic obtainable by manipulating the apparatus itself are innumerable. Broadcasting can contribute to the interpretation and even the substance of music. The time will probably come when the composer will indicate in his score, as an integral part of the music, instructions for manipulation of the transmitting apparatus.

To take a single instance, it is well known to musicians that the quality or timbre of most instruments changes radically with different registers and degrees of loudness. It is impossible for example to obtain the same quality of tone in a given register of a wind instrument played pianissimo and fortissimo. With am-

plification or attenuation it would be easy to achieve any degree of loudness with any timbre of which the instrument is capable and further than this the timbre itself could be changed by controlled unequal transmission of its partials. Multiply this instance by an entire orchestra and the new combinations are incalculable.

The players as we now know them will be only a part of the performance and additional specially trained artists will operate the broadcast control apparatus under the direction of the conductor. Under such conditions an orchestra would bear the same relation to the received broadcast music as part of the orchestra bears to the whole today.

Some of the major difficulties associated with orchestra broadcasting as it is now practised together with general methods for overcoming these obstacles will be outlined here. As a result it will be apparent, I hope, that music should not be adapted to broadcasting but that broadcasting should be adapted to music.

To make these points clear it is advisable first to take up briefly the more immediate problems involved in replica broadcasting. In the realm of acoustics it is convenient to speak of the three qualities: pitch, loudness and timbre. The modern orchestra varies in pitch from the lowest notes of the organ to the highest of the piccolo. Above the highest must be added about two octaves for the important upper partials of the high pitched tones. The entire gamut is about ten octaves.

The fluctuation in loudness is also large. Between extremes of pianissimo and fortissimo for the modern orchestra is a ratio of one to one-hundred-thousand. Every musician knows the importance of this immense dynamic range.

Timbre, or the peculiar individual quality of different instruments, choirs and groups of choirs, is more varied in the orchestra than in any other form of music. It is well known to physicists that timbre is determined by the number and distribution of the upper partials associated with the pitch tones of any given instrument. There have been so many explanations of the theory of timbre in recent literature that none will be given here.

Obviously, to obtain a perfect replica of sound over a reproducing system it is necessary that each note from the lowest tone to the highest audible partial shall be heard with all of its com-

ponent parts in the same proportion as in the original and with the ratio of loudness of successive tones preserved.

Let us consider some of the factors that render perfect orchestral reproduction at present impracticable. Orchestras broadcast either from the concert auditoriums in which they normally play or from specially constructed studios. First, we will regard orchestras which broadcast from concert auditoriums when a regular audience is present. It has been customary to place the microphones either very near the orchestra or among the players in order that noises unavoidably produced even by a quiet audience shall not be appreciably transmitted. These noises are far more disturbing on the radio than when directly heard in the concert hall where we are accustomed unconsciously to compensate for them. They become quite intolerable in a living room, for example, where extraneous sounds are not normally generated. Placing the microphones near or in the orchestra naturally leads to distortion since this is equivalent to placing the ears of the audience at those positions. It must be readily apparent that an orchestra sounds entirely different in the body of the auditorium from on the stage and since it is adjusted to be heard by an audience, when one is present, there will be an unbalance of sound at the stage microphones. If on the other hand the auditorium is empty and the microphones are placed in the hall at some distance from the stage, the acoustics of the empty auditorium (which is, in general, entirely different from one filled with an audience) will usually be quite poor. Frequently this condition results in excessive reverberation. What is more to the point, the acoustics of an already constructed auditorium cannot be altered and controlled to suit the requirements of broadcasting.

If the orchestra broadcasts from a studio specially built for the purpose, conditions are quite different. Frequently technicians try to make the studio broadcasting as nearly as possible like auditorium broadcasting. This policy is stupidly reactionary. Since studios can be constructed to control acoustic properties in almost any chosen way, many of the inherently undesirable characteristics of auditoriums can be eliminated. Researches are in progress to determine the effect on broadcasting of the size, shape, materials and disposition of apparatus of broadcasting studios. To be considered is the number of microphones, their arrange-

ment, the distribution and reflection of sound within the room and the number of pieces in the orchestra. The present tendency is toward the use of a few microphones, in many cases only one; moderate reverberation, somewhat less than is found in concert auditoriums; and small orchestras. With a small orchestra there is a gain in clarity and a corresponding loss of solidity.

It is important to mention that the art of broadcast receiver design has advanced far beyond the available commercial products. Radio manufacturers, apparently for reasons of competition, are not building nearly as good receivers as they know how. And in all probability they will not until the public demands them.

With respect to the transmission of the full range of pitch, even the best commercial broadcast receivers available today have serious limitations. The lowest tone produced with appreciable intensity by the average broadcast receiver is more than two octaves above the lowest of the orchestra, and the highest is approximately two octaves below the highest of the orchestra. Furthermore the transmittable range is not reproduced evenly. Certain tones and groups of tones are accentuated out of proportion to the original. This is truer of receiving apparatus, especially loud speakers, than of transmitting apparatus.

The limitation of the range of loudness is still greater; the power transmitted is only one-hundredth of the original range produced by a full orchestra. This is because pianissimi must be amplified disproportionately to be audible over static and apparatus noises; and fortissimi must be diminished disproportionately in order not to overload the transmitting and reproducing apparatus nor to cause "cross-talk" in the cables between studio and transmitter and key and chain stations.

Due to the requirement of compressed loudness range it is necessary for a technical operator who is thoroughly familiar with the music to be played, to operate controls which permit him to increase or decrease at will the amplification of sounds picked up from the orchestra by the microphones. As the orchestra is approaching pianissimo he gradually increases the amplification to prevent this pianissimo from falling below the noise level of the radio system. As the orchestra approaches fortissimo he gradually reduces the amplification to prevent excess energy from overloading the apparatus and producing harsh, unpleasant, ex-

traneous sounds in the radio receiver. These operations seriously compromise the intention of the composer and conductor. They require not only technical skill but esthetic understanding. The spontaneity of a performance is materially limited since the conductor's performance must be exactly as in rehearsal or he will upset the pre-calculated manipulations of the control operator.

In some experiments the conductor himself manipulates the controls. To do this satisfactorily while conducting requires practice and skill but it will probably afford a temporary solution until the dynamic range is widened. Apparatus of larger capacity and cables specially designed to carry broadcast concerts could extend the limits of loudness, relieving orchestral broadcasting of its most serious limitation.

Assuming for the moment that the transmission and reproduction be mechanically perfect from the broadcasting source up to and including the loud speaker or sound radiator, we are met with the final problem of the room in which the broadcast is heard. Here the distance from the sound radiator, the loudness of the sound radiated with respect to the shape and size of the room and the materials used within it, all affect the quality of the received broadcast. Certain types of distortion will produce the illusion of naturalness when an accurate reproduction will not, because of acoustic differences between the sound source room and the sound reception room. We must also remember that in an auditorium the sound comes from a source of large volume; it is three dimensional. With the usual broadcast receiver the sound comes to us from what is virtually a point source and hence loses much of its important dimensionality. This last difficulty can be largely overcome by the proper use and distribution of sound radiators in the receiving room.

It is thus seen that under special conditions the major faults of broadcasting can be overcome to a great extent and it remains for organizations commercially interested in broadcasting to bring about these changes. The major portion of this burden falls upon manufacturers of broadcast receivers. When they have assumed their full responsibility in these matters we shall reach a position permitting the development of the broadcast mechanism as a powerful medium of creation in orchestral music.