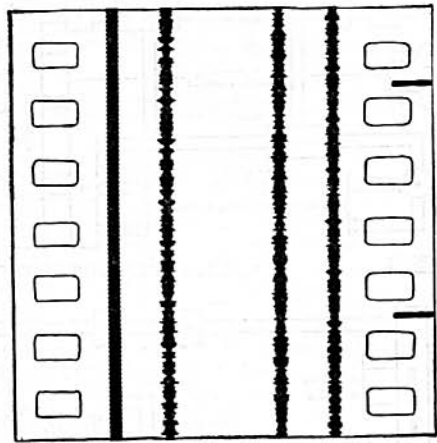


Invisible, behind a gossamer curtain, to the thousands of persons interested in sound who attended the demonstration of Enhanced Stereophonic Sound at Carnegie Hall last month were the 4 special loud-speaker combinations shown above. Each combination consists of a folded-back horn for low notes and a multi-cellular horn for the "highs." (The curtain was bathed in light that slowly changed color.)



Enlarged view of negative film after initial recording. On the left is the control channel; on the right, the 3 sound channels. (Also see photo at right, pg. 712, June Radio-Craft.)

## "ENHANCED" STEREOPHONIC SOUND

*A development having far-reaching implications is a new system for controlling the volume of sounds recorded on film; and automatically controlling the playback volume. It was demonstrated by Bell Telephone Laboratories last month, to an invited audience at Carnegie Hall (New York City), that orchestral music for example can be reproduced from film recordings at whisper level or at 10 times normal volume!*

R. D. WASHBURNE

IN the hands of a competent conductor, as Dr. Leopold Stokowski last month ably proved, the new "Enhanced" Sound-on-Film technique which the latest application of radio tubes makes possible can afford hitherto unattainable sound effects. These effects reach a zenith when combined with a previously-shown 3-Dimension Sound (Stereophonic) method\* applied to film recording and playback.

An immediate application of Enhanced Sound (with or without benefit of the 3-Dimension technique) which comes to mind is in talking motion pictures. Acoustic effects "quite beyond the capabilities of instruments or artists" are conveniently and automatically achieved. Audience psychology can be played upon, as never before, with the intense throb of jungle drums, great crashes of thunder, wide ranges in voice and orchestral volumes, etc. Many other applications soon will be found.

\*See "The Third Dimension in Sound," by the writer, in Radio-Craft for May, 1934.

Anent the consensus of opinion concerning the auditorium demonstration we quote a heading from the *New York Times* of the following day, to wit:

*Sound Waves 'Rock' Carnegie Hall as 'Enhanced Music' Is Played*

*'Stereophonic Reproduction' Demonstrated by Bell Laboratories—Tones Near Limit That the Human Ear Can Bear*

### WHY "ENHANCED" STEREOPHONIC SOUND?

Why is it that symphonic music, for example, heard over a radio set or the loudspeakers of a public address or sound-movie system fails to produce the same effect we experience when listening to the original production in an auditorium? The answers, that lead to the conclusion that certain improvements in sound technique are in order, are interesting.

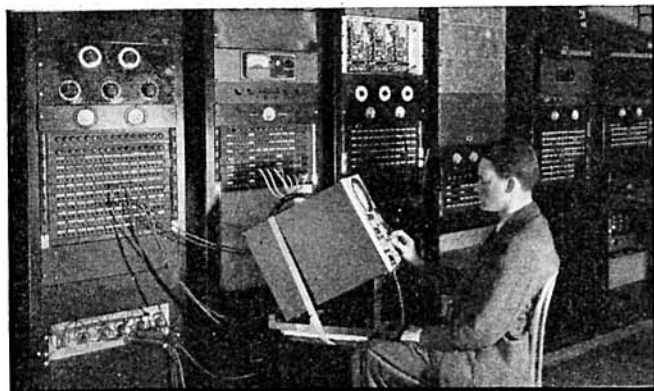
A full symphony orchestra utilizes air

vibrations at nearly all the frequencies the ear can hear, and it uses volumes of sound from about the lowest that can be heard in an ordinary hall or auditorium to volumes 100 million times greater. The frequency range of such an orchestra, in other words, runs from the neighborhood of 40 cycles per second to perhaps 14,000 cycles; and the volume range extends from about 30 db. above the threshold of hearing to 110 db., a total range of 80 db.

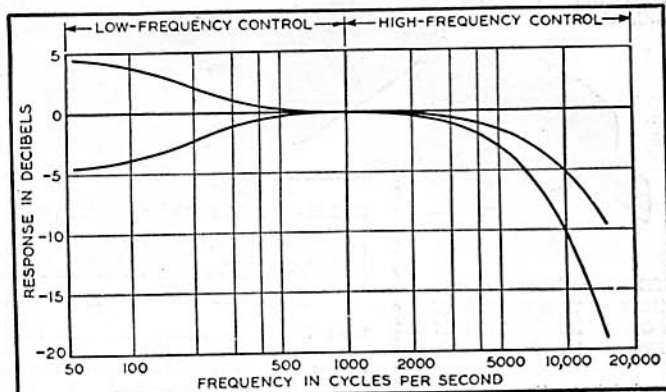
In contrast with these ranges radio and sound-picture systems have frequency ranges only from 5,000 to 8,000 cycles wide; and volume ranges from 35 to 50 db.

Moreover a listener in an auditorium receives an added effect from the distribution of the sound in space, i.e., a recognition of different sounds coming from different sources.

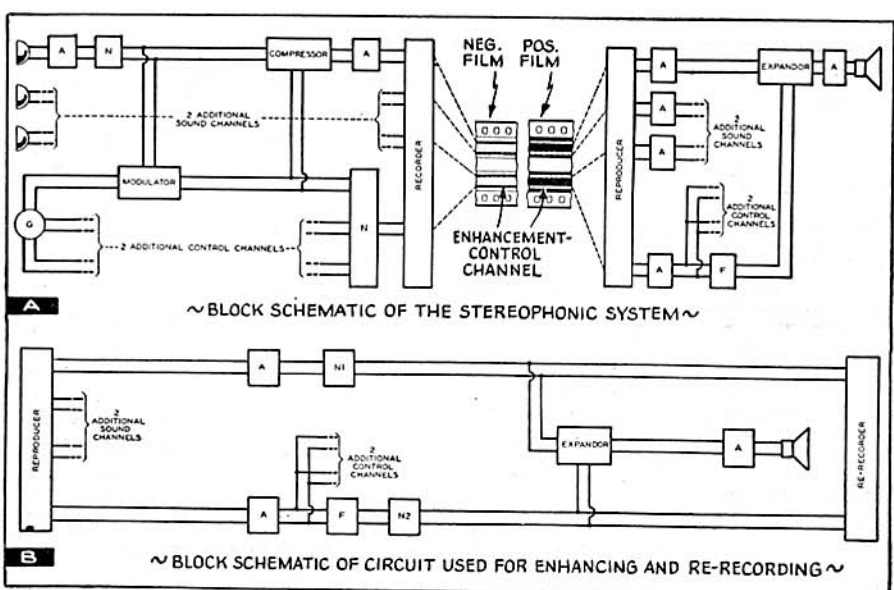
The following technical description of the new sound technique which tends to solve these problems is adapted from "Stereophonic Reproduction from Film," by Dr.



Amplifying and control equipment of the stereophonic system. A. R. Soffel of Bell Telephone Labs. is shown observing the channel levels on a cathode-ray tube monitor.



The frequency characteristics, above, of the stereophonic system are controlled by the 6 keys atop the enhancement control unit. (See photo at left, on pg. 712, June Radio-Craft.)



Harvey Fletcher, Director of Physical Research at the Labs., writing in the May, 1940, issue of *Bell Laboratories Record*.

**MORE PROBLEMS**

Ordinary recording and reproduction places no such demands on the equipment as does the stereophonic system. Sound-picture systems transmit a frequency range of less than 8,000 cycles, while the stereophonic system employs a band nearly twice

as wide. The entire recording and reproducing system had to be designed for this greater range.

In addition much greater precautions had to be taken to reduce noise and distortion. An extremely quiet system is required so that music at very low volumes, much lower than used in sound-picture systems, is not marred by the noise, and this is made more difficult because of the wider frequency range, which gives a wider band for the entrance of noise.

Finally, there is the matter of increased volume range. The maximum volume range that can be placed on a film is less than 50 db., while the stereophonic system, with the 10-db. increase and decrease provided by the enhancement control, requires a range of 100 db.

The seemingly impossible task of recording a program having a volume range of 100 db. on a film that will receive only a 50-db. range was accomplished as follows.

**SEQUENCE OF OPERATIONS**

The music as it is picked up by the microphones is passed through a *compressor*, one being provided for each of 3 channels. These allow the music currents to pass to the film-recording equipment in their normal volume range up to about 45 db.; higher volumes are reduced by the compressor so that the limit of the film recording is not overstepped.

At the same time an "enhancement" record is made on another track on the film of just the time and extent of these reductions.

At the reproducing end the music currents generated in photoelectric cells from a light beam passing through the film are carried through an *expander* before reaching the loudspeaker. The action of the expander is controlled by the signal obtained from the additional (or "enhancement") light-track. At any point where the original program was reduced in volume by the compressor, this signal will cause the expander to increase the volume by just the right amount. (See Fig. A.)

**THE "ENHANCEMENT" CHANNEL**

To control the compressor at the recording end, a small amount of the program current is taken from the circuit just ahead of the compressor and is rectified. This rectified current modulates a single-frequency current, which then controls the compressor and also forms the signal placed on the 4th track on the film.

Since there are 3 channels, and the amount and time of compression will vary from one to another, 3 control signals must be recorded on the film, one for each of the 3 channels. These are all recorded on the same track on the film by allowing the 3 rectified currents to vary independently the strength of 3 alternating currents of different frequencies! These 3 modulated currents control their respective compressors and are then combined and recorded as the 4th track on the film.

A positive of this first film is reproduced while the original conductor listens and manipulates the *enhancement controls* (see left-hand photo, bottom of pg. 712, June *Radio-Craft*) to modify the frequency and volume ranges of the 3 channels to secure an effect that more nearly conforms to his interpretation. As the conductor listens to the reproduction of the original recording, and manipulates these controls, a *second film is made* of the enhanced program.

A block schematic for this phase of the operation is Fig. B (which shows only 1 channel, however).

On the new film, the 3 program *sound* tracks are the same as on the original film except for the frequency modifications. The *control* track, however, has been modified by the manipulation of the enhancement control so as to cause greater or less expansion when the program is subsequently reproduced.

The new film made as a result of this process thus represents the enhanced program, and is the one used for all subsequent reproductions.

In conclusion, we ask: Will Motion Pictures soon accept this opportunity to raise the standard of its film entertainment?



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