Broadcasting the Ohio State-Michigan Football Game Direct From the Field at Ann Arbor

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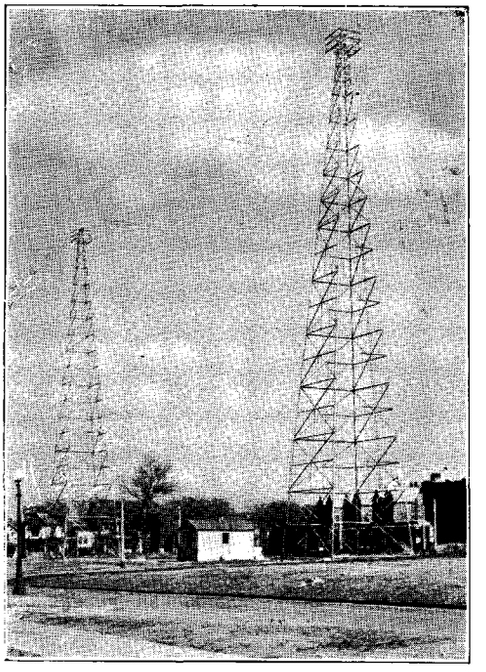
"THIS is WEAO, the Ohio State University, at Columbus, broadcasting the Ohio State-Michigan football game direct from the Michigan Stadium at Ann Arbor." How simple this sounded to the radio listener as he tuned in on that memorable Saturday afternoon. The cheers of the crowd, the bands, even the excitement and tenseness of the game seemed to come from the loud speaker as the teams battled on the playing field. But let's take a look "behind the scenes" at the broadcasting station and see the work necessary to bring these sounds 200 miles from the playing field to the radio transmitter where they are put on the air.

Preparations for broadcasting the game are begun in earnest about two days before the game, when the equipment arrives at the playing field. Lines must be run for the microphones, usually four, which pick up the cheering, the bands and the announcer, and the equipment set up and tested. The "mikes" are all terminated at a mixer where an operator can switch any one or all of them on at one time, regulate the volume of pickup from each one and pass this "mixed" pick-up to the amplifier. Thus you may hear only the announcer, or you may hear the announcer with the cheering or the band in the background, or you may hear cheering or the band with full volume, according to the will of the operator at the mixer.



WEAO, the Ohio State University Station

The output of the mixer is then passed to the line amplifier where the feeble microphone currents are amplified many times and then sent out on the telephone line to the distant broadcasting station. The amplifier is adjusted to give a certain output and this output or "level" is maintained by an operator throughout the entire broadcast. But if one ordinary line amplifier had to force these voice currents through 200 miles of telephone wire and cable, the current at the end of the line would be very, very feeble. In this event, noises on the line would probably be as loud or louder than the sounds we wished to hear so that the transmission would be very unsatisfactory and barely intelligible. An amplifier could be built which would force sufficient voice current through this length of line. However, it would be impractical, quite costly, and would probably break down the line insulation at the amplifier end. To overcome this line loss, due to the resistance of the line, we have repeater stations at intervals, where the voice currents are passed through amplifiers, boosted back to their original level, and then sent on to the next repeater station. In the Michigan broadcast repeaters were located in the American Telephone and Telegraph offices at Detroit, Maumee, and Columbus.

Another factor besides line or resistance loss which plays an important part in long distance voice transmission is the unequal attenuation of high and low frequencies. As you know, voice waves are made up of frequencies varying between 100 and 3,000 cycles per second, and music from 30 to 5,000 cycles per second. Due to the capacity effect between the telephone wires and between each wire and ground, these voice currents leak off or are attenuated. If the attenuation were the same for all frequencies all we would have at the repeater station would be the amplifier to step the current back up to the original level, as described in the preceding paragraph. But, the attenuation is not the same for all frequencies, as the higher frequencies are attenuated much more than the lower ones. And so, using the amplifier alone, we would find that at the end of the 200 mile line the voice would have such a preponderance of the lower frequency, or bass notes, that we could neither recognize nor understand it without a great deal of difficulty.

To overcome the effects of unequal attenuation the engineer uses an "equalizer." The equalizer is an electrical circuit containing inductance capacity, and resistance, which is tuned to a low frequency. It is shunted across the broadcast line at the end of each section and placed in the circuit ahead of the amplifiers. Since the low frequency notes are strong and the high frequencies weak, we adjust the equalizer so that it causes sufficient loss in the lower frequencies to bring them down to the same relative level with respect to the higher frequencies that was had originally. Thus we hear all frequencies in their proper relation to each other, we recognize the voice and have no difficulty

(Continued on Page 32)

BROADCASTING THE OHIO STATE-MICHIGAN FOOTBALL GAME

(Continued from Page 9)

in understanding what is being said. In other words we have good transmission.

The equalization of the line is the most difficult part of a remote broadcast and takes three or four hours, or longer, due to the fact that each section of the line must be equalized separately. Thus in the Michigan broadcast, lines were equalized from Ann Arbor to Detroit, Detroit to Maumee, Maumee to Columbus, and from the Columbus office to the radio station. An audio oscillator is set up at Ann Arbor having a frequency range of 60 to 10,000 cycles. This oscillator can be adjusted to give a constant output at all frequencies, and is first adjusted, to give a certain output at a frequency of 100 cycles. At the end of the first section (Detroit) the operator sets the equalizer at a value which he judges from his experience to be sufficient to equalize the line from Ann Arbor and reads the deflection of a volume indicator when the 100 cycle note is put on the line. The oscillator is then set at 500 cycles with the same output and the Detroit operator reads the volume indicator deflection at this frequency, leaving the equalizer unchanged. A series of readings is taken for frequencies of 100 to 3,000 cycles for voice transmission or 100 to 5,000 cycles for music. If the equalizer has been set at about the proper value the deflection of the volume indicator will be practically the same for all frequencies. However, if the line is not properly equalized some frequencies will be transmitted better than others and give a greater deflection on the indicator. A study of the variation in deflection of the volume indicator will tell the operator how to adjust the equalizer to more closely approach the correct equalization of the line. The equalizer setting is then changed and the run repeated. This continues until the line is equalized, that is, the deflection of the volume indicator is practically the same for all the points chosen between two limits, 100 and 3,000 or 5,000 cycles. When the first section has been equalized, the Detroit operator connects the equalized line through his amplifier to the Maumee operator, who equalizes with Ann Arbor. This process is repeated until the line is equalized throughout its length from the football field at Ann Arbor to the broadcasting station at Columbus.

After the lines have been equalized, a speech test is made with someone talking into the microphone. This gives a final check on the lines which are now ready for the broadcast. All of the preceding tests and adjustments have been made on the Thursday evening preceding the game, but the circuits are not left idle until game time. Ordinarily each circuit is carrying from one to sixteen simultaneous telephone and telegraph messages so after the tests have been made the circuits are "knocked down" and used for the usual commercial traffic. However, when a line is used for broadcasting it can only serve this one function as superimposing other circuits on the same two wires would cause objectionable noises. This fact accounts for the high cost of long distance circuits for broadcasting.