THE TELEPHONE IN BROADCASTING

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INTRODUCTION

Until 1923, radio broadcasting, despite its potentialities, had shown very little growth. Since then, and most particularly since the first demonstration of the feasibility of remote pick-up in 1923, its growth has been extraordinarily rapid. To differentiate between cause and effect is outside the scope of this article but it will be sufficient to note several important stimulants that were then acting.

Listed in the order of importance and development these stimulants were:

1. A desire for a better class of entertainment.
2. The dissemination of unique programs.
3. The broadcasting of athletic events.
4. The use of the radio as a means of commercial advertising.

The out-of-studio pick-up of broadcasting material met the demands for these stimulants for a short time but even this gave way to the more satisfactory multi-station chain-programs.

As this development took place many problems were presented such as those of efficient pick-up systems, reliable line connections, better line characteristics, and maintenance.

SOLUTIONS OF THE PICK-UP SYSTEM PROBLEMS

When the broadcaster realized that it would no longer be possible to bring to his studio the type of program that the people were demanding, he turned his attention to devising a means of moving his studio to the entertainment. Of course, he could not move the entire transmitter, so he chose to take the pick-up system only. With the aid of the telephone engineer he found it possible to satisfactorily pick up a program of several hours duration, and to relay this program to the transmitter proper over telephone wires, with no more equipment than could be carried in a truck. A period of design and re-design reduced the size of this equipment to that which could be carried in a large suitcase. With the matter of size and portability solved, the radio engineer turned his attention to improving the frequency characteristics of the pick-up system. By the use of the condenser microphone and multi-stage resistance coupled amplifier it was found possible to include practically all of the average audible sound range (i. e., from 50 to 10,000 cycles). With the addition of a visual volume indicator (such as a vacuum tube voltmeter) to show the pick-up operator that he was putting sufficient energy into the lines to satisfactorily reach the transmitter, the matter of pick-up was practically solved.

THE WIRE LINE REQUIREMENTS FOR GENERAL BROADCASTING

The broadcaster had solved for himself the problem of out-of-studio pick-up for short distance relays without any great assistance from the telephone engineer. He could do this because he could easily rent or build a short distance line (1 to 10 miles) having suitable characteristics. True chain-program inter-connections were a different problem and it was to eliminate this difficulty that the telephone engineer was called into service.

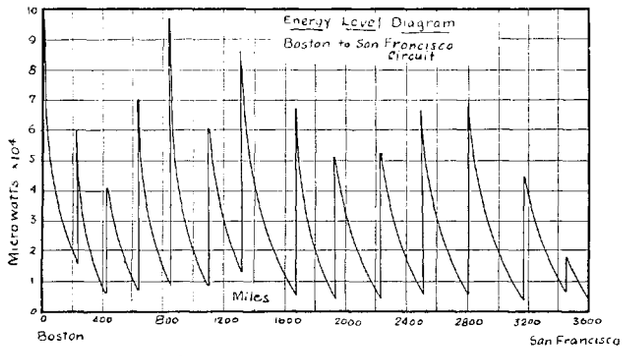
The research departments of the telephone companies were well acquainted with the electrical characteristics of their lines and therefore ready to recommend to the broadcaster the use of unloaded open-wire pairs wherever possible. Of course, within the larger cities this was impossible. Here the next type of line, namely the loaded cable, had to be used.

The two-way vacuum tube repeater as commonly used on commercial telephone lines required considerable revamping before it would give satisfactory service for the distribution of broadcasting material. In the first place, there was no need of two-way service, since the system was required to carry a program flowing only in one direction.

However, although free from the problems of two-way working, the design and operation problems of program transmission circuits are by no means easy compared with those of message telephone circuits. On the contrary, in many respects, these problems are considerably more difficult since it is far more difficult to approach absolute fidelity of reproduction than for message telephone circuits. A frequency band width of 2,500 cycles furnishes, if properly utilized, a telephone circuit over which speech is transmitted very clearly so that conversations may be easily carried on. This band is not adequate, however, for program transmission because of the different character of the transmitted material. To reproduce music, and particularly high-grade music, in a pleasing manner calls for a materially widened band. This wider band also gives a high degree of naturalness to speech which is particularly desirable when loud-speakers are used for reception.

At the present time in the United States the frequency band which is transmitted over the long distance program chains extends from about 100 cycles to about 5,000 cycles. It is, of course, possible to transmit an even wider band than this, although the cost of the circuits will, of course, increase as the band is widened. In considering how wide the band should be, the complete system, including pick-up apparatus, wire transmission line, radio transmitters, radio transmission paths through the ether, radio receiving apparatus, and loud speakers must be considered. It seems probable that as the art progresses, a band wider than the above will be found desirable. On the wire line systems, development work is going forward looking toward the possibility that such wider bands may be found desirable in the future. At the lower frequencies, where most people consider that improvement is particularly desirable, consideration is being given to the possible extension of the band down to 50 cycles and possibly lower. Consideration is also being given to the possible addition of two or three thousand cycles to the top of the band.

Because of the danger of marring the transmission by extraneous noises such as cross talk,



Transcontinental Energy Level

microphonic repeater tube noises, and induced current noises coming from adjacent power lines, it is found necessary to transmit at an energy level which will insure a predominance at all times of the program over the noises. This means, first of all, individual lines. Lines on which phantom circuits are superposed or pyramided are not satisfactory. Secondly, the distance between repeater stations must be reduced. The above chart shows the energy level in a typical transcontinental circuit. It can be seen that repeaters every 200 miles must be used to insure a minimum of 350 microwatts at the receiving end.

In addition to a higher over-all level of energy, program transmission circuits must be designed to handle wide ranges of volume, particularly for the transmission of musical programs. Much of the enjoyment in listening to good music appears to come from the ranges of volume, so that in order to deliver such musical programs properly these ranges of volume must be preserved in large part at least. At the present time the volume ranges are "compressed" somewhat by adjustment of amplification under control of an operator at the pick-up point. This tends to make easier the radio transmission problem as well as the wire transmission problem. The range of volume which is now delivered, as read by a volume indicator, is of the order of 30 decibels, which means that during the fortissimo parts of programs the power which is transmitted is about 1,000 times as great as it is during the pianissimo portions.

In setting up the program transmission circuits, an important part of the work consists in making measurements at different single frequencies within the band which it is desired to transmit over the circuit. Before making such over-all measurements, the amplifiers and auxiliary apparatus are so adjusted locally as to compensate for the amount of distortion which theory and experience indicate should be expected. Then, final adjustments are made by certain specially provided adjustable parts in accordance with the over-all measurements. Such over-all tests and adjustments are, in general, made daily.

Another important consideration is that each amplifier carry its proper load or, in telephone parlance, each amplifier deliver to its associated line the proper output level. To insure this, diagrams are prepared in advance, showing the desired transmission levels at each repeater. In setting up the circuits, the repeater gains are first set to values which theory and experience indicate should result in conditions as shown in the prescribed transmission level diagram. Testing current is then applied to the sending end of the circuit and sensitive measuring devices are applied at the output of each repeater. If the results of these measurements do not accord with the transmission level diagram, suitable adjustments are then made.

For maintenance, during actual transmission service, the monitor's amplifier is used. At the origin point, at each repeater station, and at the receiving end, an amplifier is connected to the circuit, the output of which operates a loud speaker. An operator stationed at the loud speaker keeps in touch at all times by means of telephone or telegraph order wires with the previous monitoring stations and the pick-up point.

Established broadcasting networks follow essentially the main trunk lines of the country's commercial telephone circuits. It has occurred to the telephone companies as well as others that they might introduce a new type of toll service in connection with their present telephone service. For lack of a better name this new means of dissemination of program materially has been called "wired-wireless." It differs from radio broadcasting in that the entire path of the transmission, even into the home, is over wire lines. This takes place without interfering with the normal telephone service.

This system is at present being tried out on a small scale in Cleveland, Ohio, and although no official data is at present available on the subject, the method seems to show interesting prospects for further advancement.