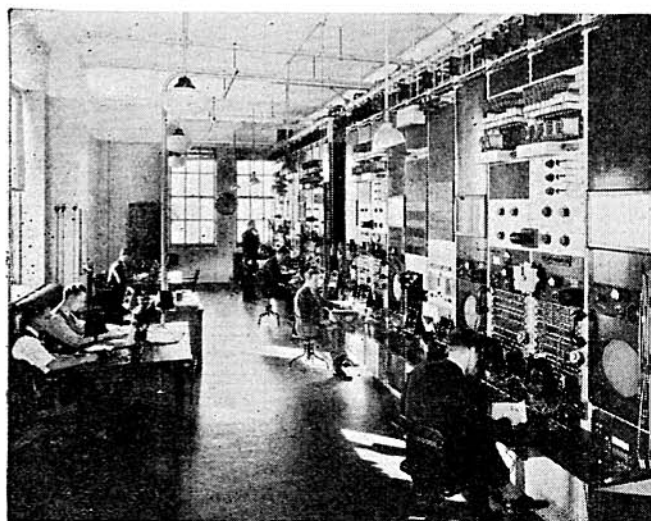


Cables are the "web" of radio networks.
(Bell Tel. Co.)

THE OPERATION OF BROADCAST NETWORKS

R. D. WASHBURN

Telephone lines and associated equipment are a most important item in broadcast operation. "Radio" programs often travel 10 times farther by wire than by "air"!

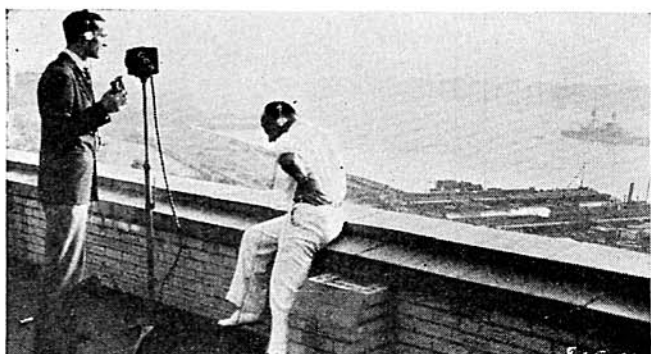


General Control Room, N. Y., supervises the nets.
(Bell Tel. Co.)



Modern studios are veritable super-theatres.
(NBC)

Remote pick-ups announced the arrival of "the fleet."
(CBS)



DOES it ever occur to you that the radio program which you hear may not originate from your favorite local radio station—perhaps 25 or 50 miles away—nor is it a radio broadcast from a station in which the program originates, perhaps 3,000 miles away?

New Yorkers, listening to the President at his desk in Washington, D.C., deliver one of his nation-wide broadcasts, little realize that the voice they hear from, perhaps, their local New York station, WABC, has to travel about 300 miles along special telephone or "program" wires, as they are called, before "going on the air." At the same instant, the program is going out over the network of special program wires that extend 3,000 miles to stations on the West Coast, and via arteries of copper that branch to intermediate broadcast stations in the network system.

If Mr. Jones, listening at his radio set in Los Angeles, let us say, tuned to station KNX in the same city, hears this program with full esthetic value, is the efficiency of transmission to be credited to the broadcast station, which has transmitted the program only a few miles to Mr. Jones' home, or to the telephone or program circuits which, sheathed in lead cables of 200 wires, have carried the program 3,000 miles over mountain and valley, and under river and lake, without losing a single syllable? A review of some of the factors involved in radio network operation may serve to show the importance of this web of highly developed telephone lines which join together in one great family every radio station in the land.

The Purpose of "Networks"

Three major functions are performed by the tentacles of copper that reach to nearly every square foot of the United States.

First, they serve to bring the program from the point of pick-up to a "General Control Office." Second, they carry the program from the General Control Office to all the broadcast stations within a wide area. And, third, they carry monitor messages, conversations, directions and orders over express circuits from pick-up to General Control Office, and to the broadcast stations.

The production of the studio program is another story, and one which has been interestingly told to the readers of *RADIO-CRAFT*, in the article, "From Microphone to Modulator" (January, 1930, issue).

The first "network" dates back to January, 1923, when WEA, New York, was tied to WNAC, Boston. The climb to the 11 basic networks that comprise our present broadcast system was an arduous one. Now, the web of this amazing institution consists of 74,000 miles of wire, requiring a maintenance personnel of almost 500 specially trained employees, in order to secure faithful sound transmission and reliable operation at all times. A network of about 50 stations now costs a sponsor approximately \$12,000 per hour!

Fidelity the Foremost Factor

It is little realized that there is one quality above all others which must be kept inviolate by every single device in the entire radio system. We refer to **FIDELITY**; unless the

quality of the received signal is of the highest order, the esthetic value of the entire program may be lost. The nuances in sound which originate in the studio are veritable gems of tonality—precious baubles of compound frequencies to be handled with more than silk glove tenderness.

Of course, some of the technical subtleties which have made American broadcasting the star followed by foreign broadcast interests do not require the acme in program transmission facilities.

We refer especially to Ed Wynn's popular "so-o-o," which, Robert West tells us in his latest book, was caused by "mike fright"—the word "so" was in the script and during rehearsal the comedian's voice, thinned by fear, went falsetto; it was so funny Ed kept it in his repertoire. Another trick of the successful broadcaster is the inclusion of innate mannerisms, proclaiming indubitably that so-and-so is on the air; we refer especially to Jack Pearl in his characterization, "the Baron." For dialectician Jack's script reads: "Was you there, Charlie?" But it is the Baron's metamorphosis of the line which doubles us up when we hear the challenging query, "Vass you dere—Sharlie?"

However, there are still other types of studio transmission which do tax to the utmost the fidelity characteristics of a transmission system.

For instance, when sound-effects technician Ray Kelly of NBC pours a liquid (?) into a glass, a "velocity"-type microphone is used to insure that the characteristic tinkle, a composite sound due to the cascading solution and ringing vibrations of the goblet, will be picked up with utmost faithfulness.

The broadcasting of symphony concerts, so that they would sound "natural," was at first regarded as impracticable due to technical difficulties in transmission. Today, the engineering factors are under the thumbs of studio experts who manipulate sliding, sound-proofed walls, sound-control manuals, echo and reverberation time periods, timing of cues to the second, and even the applause of audiences to meet the power and frequency limitations of network transmission lines. The modern studio not only resembles a theatre—it far surpasses it in the versatility of control over the acoustic characteristics. The final, highly polished program is entrusted to the copper lines that tie the network stations to each other, with the knowledge that the trust will be met.

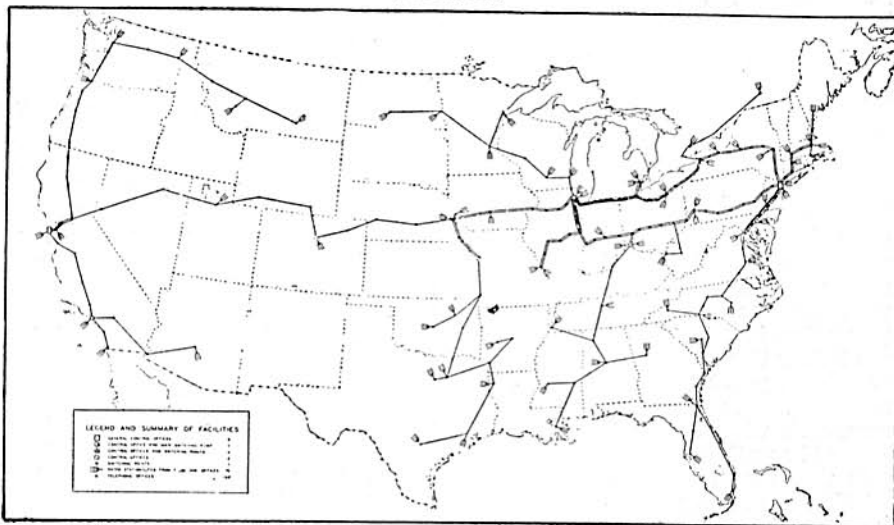
Not only must the esthetic value of novelty programs, and the texture of intricate orchestrations and musical gymnastics be unimpaired by any portion of the transmission system, but also the "spot" pick-ups from remote points must be transmitted with full fidelity.

Fidelity in Remote Pick-ups

When the United States Fleet sailed majestically up the Hudson river, Paul White of CBS directed—from a special

(Continued on page 180)

Typical operating layout of a coast-to-coast broadcast network.
(Bell Tel. Co.)



Seven Chinese dialects "spoke" from "Frisco" to N.Y.C.
(CBS)



Above. A tense moment, as Chicago's Stockyards went up in smoke. (CBS)

Below. "Sound effects" require utmost transmission-line fidelity. (NBC)



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THE OPERATION OF BROADCAST NETWORKS

(Continued from page 143)

master-control room in the headquarters of WABC, Columbia's key station—one of the largest operating crews ever assembled for a broadcast. He was in constant 2-way communication with numerous land, sea and air observation posts by means of an auxiliary short-wave circuit. As emergency set-ups of this nature ordinarily operate on the thin edge of speech intelligibility, any slight imperfection in the pickup would have impaired the program, but which turned out to be a tribute to chain broadcasting.

The 7,500 to 8,000 cycle band used by certain cleared-channel stations is utilized, and line transmission facilities are taxed to the utmost in certain pickups that feature the international slant. An excellent example was the recent CBS transmission over WABC, New York, in which the microphone was installed in a telephone exchange in San Francisco's Chinatown! The telephone numbers—or sometimes merely the names of the subscribers!—were shown by Loo Kern, Chinese manager of the exchange, to be called for in any one of 7 Chinese dialects!

Still another type of voice transmission, which requires for its efficiency the utmost fidelity in the entire network system, was the recent Chicago stockyards holocaust. The tensely gripping eye-witness story as told from atop the Illinois Bell Telephone Company's building, a half-block from the huge fire, was transmitted with all the spontaneous shadings of sound incident to the broadcast of what was a veritable national calamity. It was from this point that Chief Field Marshal Michael Corrigan told the world that the fire was under control.

Then there is that most remote of remote pickups, the Byrd Antarctic Expedition broadcasts from Little America, over 9,000 miles from New York, a half-hour program for which General Foods pays over \$7,000. Every artifice is used to secure perfect pickup, via Buenos Aires, S. A., and South Schenectady, N. Y. Radio and telephone engineering were recently put to a crucial test to present to the audience of the 59 stations in the Columbia network the voice of Admiral Richard E. Byrd, as he flew in his airplane aloft the Antarctic Ice Cap!

However, although this was a record-breaking achievement in radio, the most brilliant jewel in the crown of radio broadcast network operation was the coast-to-coast tie-up of over 600 broadcast stations in a recent Presidential address to the people of the United States! Complete coverage of the entire country, from a desk telephone in Washington, D. C.!

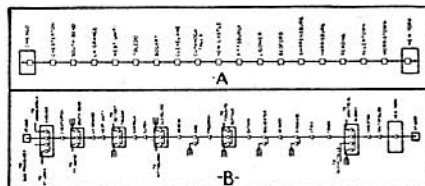
Inasmuch as our entire American broadcast structure depends for its efficiency upon the "mass" coverage that can be obtained by network operation, it follows that the thousands of miles of wire, and associated apparatus, required to join one station to another, constitute a most important link.

"Telephone" and "Broadcast" Cables

A telephone message circuit, such as Banker Smith would use in talking to New York and Chicago, inclusive, passes through 19 telephone offices, where "repeaters" or amplifiers renew the electrical energy lost in transit through the cable. To minimize the energy loss, 1,500 "loading coils" are located in the circuit at intervals of 6,000 ft. The two terminal offices are equipped to terminate or switch the circuit. The equivalent of only 1 employee's full-time services maintains this telephone or "private conversation" circuit. The wires can be arranged to provide a "phantom" circuit by means of which an additional "talking circuit" is obtained without the use of additional wires.

A program circuit designed only for carrying radio programs from point to point, on the

Comparative operation of cables.



other hand, requires the use of larger and heavier wires than those used for telephone conversations. Also, owing to the exacting requirements of the broadcasting network service, loading coils must be installed at 3,000 ft. intervals. In addition, the special amplifiers employed for network purposes total more than twice as many as do the ordinary amplifiers or repeaters in the message circuit—40 as compared to 19. At 10 of the 23 offices through which the program circuit passes, provision must be made to feed the programs to radio stations, terminate the circuits or switch them. The equivalent of 15 technical employees' full-time service is required to maintain a program circuit! Furthermore, neither phantom nor carrier circuits can be operated in connection with program circuits.

For everyday telephony, a circuit which will transmit a frequency range of 3,500 cycles is generally sufficient for full intelligibility of speech. Circuits for entertainment purposes, however, require that a range of frequencies at least 8,000 cycles wide be transmitted.

Also, circuits designed for radio program transmission must be designed to take care of a considerable variation in volume or loudness. Otherwise, cross-talk, overloading of the equipment in the circuit which would produce "blasting" of the reproduction, and the production of undesirable frequencies would result.

Still another effect encountered in broadcast network operation is "delay distortion," due to the different degree of time required for the high and low notes to travel over the same copper-wire circuit. Correction circuits must be used to compensate the distortion which otherwise would result.

These limitations have been surmounted in circuits that operate over an audio frequency band of 5,000 to 8,000 cycles, for ordinary broadcast network requirements. Also, for special occasions ("Third Dimension in Music," RADIO-CRAFT, May 1934, pg. 654), transmissions have been made over a band of 15,000 cycles. And short-distance demonstrations have been given of cable transmission over a frequency band width of 45,000 cycles.

A New Era in Radio

Whereas the Federal Radio Commission was limited to operation in the radio field, the newly formed Federal Communications Commission will rule the largest group of communications companies in the world—including regulation of telephone and telegraph, as well as radio.

Surely, this new regime of coordinated effort promises radio programs both sustaining and sponsored, more desirable than any that have gone before. The first step has been taken in the granting of experimental licenses to four organizations desirous of developing the newly-opened "high fidelity" channels which permit operation on a frequency band 10,000 cycles wide. Practical work in this new field is scheduled to start in September. The writer witnessed the demonstration of third-dimension in music (and speech), and is in position to forecast that with the advent of high-fidelity transmissions radio will enter a new era of unprecedented popularity.

It does not take a wide stretch of the imagination to foresee the use of these wide-frequency channels for all broadcasting, after the first experiments have been completed. A review of technical developments in recent years aptly demonstrates the demands of the American people when they are educated to appreciate better things. And there is little doubt that after certain technical difficulties have been surmounted, the vastly superior quality possible with wide-frequency transmission will be in great demand.

AN INTERESTING BOOKLET

Every radio fan is familiar with the well known insulating material known as Bakelite. However, there are many other uses for this material than the panels, knobs etc., with which we are familiar. The manufacturer has just printed a most interesting booklet entitled "Bakelite Synthetic Resins for Paints and Varnishes." It is written in easy flowing, non-technical style and it contains so many interesting facts that we recommend it highly to all of our readers. A copy of the booklet can be obtained by writing to RADIO-CRAFT—ask for booklet No. 539.