selected by Mr. Nathan, intoning the lines, to the accompaniment of a first class symphony orchestra. I should do this, not to improve the movies, which can go straight into the sewer for all I care, but purely for the benefit of the few who care for that sort of thing. The Napoleonic wars forming the background of Hardy's great epic, the transparent tentacles of the Immanent Will, moving irresistibly those great columns of soldiers wearing the expression of men in a dream, could only be portrayed in the medium of the cinema.

Similarly, some day, somewhere, a millionaire with *American Mercury* tastes may endow a radio broadcasting station to disseminate material which is agreeable to him. If so, I shall be pleased to oil the generators for same, and to be counted among its listeners. Mr. Nathan might buy an eight-tube "super" on that remote to-morrow. In the meantime, radio is neither as good as the publicity artists would have us believe, nor as bad as Mr. Nathan has painted it.

Technical Routine in Broadcasting Stations

1. *Wire Lines*

LAST month, in our discussion of "Personnel and Organization in Broadcasting," we took up in some detail the responsibilities and functions of the various employees, program and technical. However, the bulk of the discussion was on the problem of securing programs, rather than broadcasting them. In this issue we shall get down to the actual business of putting the program material out on the air. with all the technical preliminaries involved.

The technical staff, as we have seen, is divided into transmitter, control, and field divisions, all reporting to an engineer-in-charge or chief technician of some sort. These men work with the announcers and the studio manager during the actual broadcasting. First, however, we shall take up the technical routine which precedes it.

This technical routine, in many respects, is not radio at all. For example, the testing of wire lines is no more characteristic of broadcasting than of wire telephony, but it is equally important in both. Practically every large broadcasting station finds it necessary to go after its programs by means of telephone lines. These lines are in a few cases owned outright by the broadcasting company, but as a rule they are leased from some pre-existing telephone or telegraph company. Lines are costly and one does not generally buy them outright, any more than one buys a railroad in order to commute. When the lines are leased from some public service corporation, they are usually maintained by the owners. Such a system will consist of certain trunks running through the principal part of the town, possibly in the form of a ten-pair cable devoted exclusively to radio, for it is important that these wires should not be subject to inductive disturbances and that they should not interfere, in turn, with other public services.

A week or more before the time scheduled for broadcasting, the program department sends a list of projected field events to the line company. On a certain day, for example, a musical comedy is to be broadcast from a theatre. The wire company then runs a twisted pair from a convenient terminal box on the nearest trunk, over housetops and streets, to the theatre in question. This lead is called a "lateral." If the broadcasting company is leasing an adequate wire system these laterals are normally only a few blocks long. The expense of work and material is charged to the broadcasting company, so it is wise for the latter to balance trunk costs against additional construction in order to get a minimum total for the two. When the wire is placed in the theatre, with a long lead left in a coil so that the broadcasting operators can set up at a convenient point in the house, the telephone or wire company's lineman calls up the station, using an ordinary portable telephone, and tests through. He rings the station with a magneto, causing a telephone relay to release a drop on the station switch board, and says to the control operator who answers. "This is——at the Criterion Theatre. Will you test this loop?" The operator then puts 110 volts on each side of the line through a voltmeter to ground. If the loop is properly insulated the meter will read only a few volts, the resistance in series with it being of the order of many megohms. The ends of the pair are then short-circuited at the theatre and a continuity test is made to locate high resistance joints and the like. If the line is in good shape, the meter will read practically full voltage, the line resistance being negligible compared to the resistance of the voltmeter. So far we have merely the standard procedure which thousands of wire chiefs go through every day on telephone and telegraph lines. However, a further test is now made in which radio standards are rather more critical than those of the older services. The men on the line listen for noise. If they can hear any noise at all with an ordinary pair of telephones bridged across the line, they are apt to run into trouble during quiet intervals in the broadcasting.

Noise comes in from various sources, such as stock-tickers, parallel Morse circuits, elevator motors, etc. Each of these machines has a characteristic sound, and men who work on lines become familiar with the various types. Usually noise interference is due to some unbalance of the line. It is necessary to have the circuit accurately symmetrical, electrically, about an imaginary reference line in the middle. Fig. 1 shows this condition, the line terminating at either end in repeating coils, or 1:1 transformers, with grounded midpoints. Each side is assumed to measure 60 megohms to ground. If, now, one side of the line should be opened or grounded, a roar of noise would probably come in, although in the balanced condition the circuit might be perfectly quiet. But it is not sufficient to have the two sides of the line equal in insulation resistance. It is also necessary to transpose or interchange the two wires frequently, so that induction picked up in one stretch is neutralized in the next stretch of equal length. On an open wire line running on crossarms fastened to poles, each pair of wires will be transposed at, say, every tenth pole. Likewise, in a cable, the various wires must be "paired." "Twisted pair" is used, never simply a pair of wires lying side by side. In a properly paired cable several miles long, a few hundred feet of "straight-laid" conductor will ruin the entire circuit for broadcasting purposes, because of the excessive noise picked up. The telephone engineers put it this way: "A telephone circuit balanced in all respects, including balance to other circuits, is immune to inductive interference."

When trouble is encountered on wire circuits, it is hunted down by the process of "localizing." On long lines it is necessary to use special tests which show the distance of the fault from the testing point, but on short local circuits the lineman simply cuts out a section and by proceeding in this way sooner or later reduces the trouble to one section. He usually knows the weak spots in each section—here the wire runs through a damp cellar, and there it rubs against a roof coping, and so on; and sooner or later he finds the particular spot which is causing the trouble.

Of course no circuit of any length is ever exactly balanced, in practice, and in the presence of very powerful inductive fields noise will inevitably be picked up. For example, nearby lightning will register on the best lines; high tension leaks, power plant troubles, certain types of automatic and multiplex telegraph circuits, will interfere on almost any loop near them. Even if a man has armor on, you can probably kill him with a sledge-hammer or an elephant rifle. The only answer is to keep away from trouble-making types of service as much as possible. However, various devices, such as shielded, paired cables; anti-noise sets, which slow down electrical impulses to a point where they no longer interfere, have been used with considerable success. Again, some types of interference clear themselves through the cessation of business activity in the early evening. Ticker noise encountered on a morning test of a certain circuit, which is to be used in the evening for broadcasting, may be ignored if it

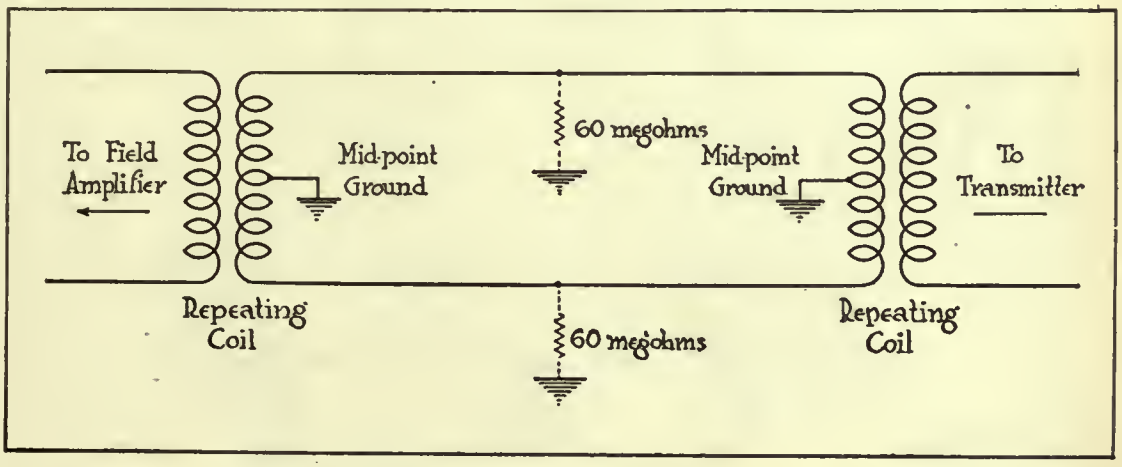


FIG. 1

Electrically symmetrical lines are necessary in outside "pick-ups." The diagram shows the circuit used. The field amplifier is controlled by an operator at the actual point of broadcasting

is known to come from certain financial houses which close down at 4 p. m. In case of emergency, it is sometimes possible to shut down parallel, interfering circuits during the period of broadcasting.

Broadcast operators and the lineman who work with them know all these kinks and utilize them in their work. The organization chart shown last month did not include a lineman among the technical employees, but as a matter of fact, although this man is usually not on the broadcasting station's payroll, he works in the closest coöperation with the station staff and is to all intents and purposes a member of it, and, if he knows his business, no mean asset.

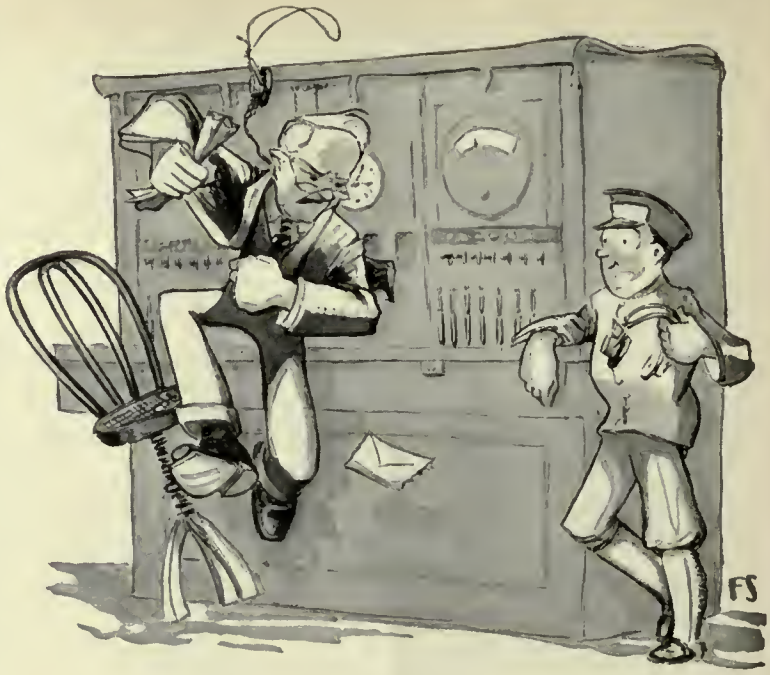
Regardless of previous tests, it is important that every wire circuit which is to be used on a certain day for broadcasting, should be tested on that day some hours before the event is scheduled. Accidents often happen at the last minute. If the event is a very important one, such as a presidential broadcast, or a major prizefight, if may even pay to have the lineman around till the job is done on the air. For these occasions, also, it is quite necessary to have two or three pairs, one for broadcasting, one as a breakdown pair, and one for an "order wire." For ordinary jobs a single pair is generally sufficient. The operators talk over it until it is time to take the air, and use it for post-mortems afterward. Sometimes the wire is simplexed or used for telegraph conversation during the broadcasting without interference between the two functions. This is not very common in local work, but it is the usual thing on long out-of-town circuits, where the cost of the line is so great that all its potentialities must be utilized.

Wire tests must not be left to any one's memory, but a log book, as shown in Fig. 2, is kept, showing the condition of the circuit at the time tested, and who is responsible for the observations.

It is possible to have one control operator in the station who is exclusively detailed for wire line work, but the usual procedure is to have the men rotate, so that everyone takes a turn at it. Often the station is on the air in the morning and the operator who runs the control room at that time also takes care of the wire line tests for the day, since as a rule the observations are quickly made, and there are long intervals between tests while the lineman goes from one remote point to another. In a large station one operator may be "on the channel," as the saying is—watching what goes out on the air and making necessary adjustments—while another man handles the wire tests and does maintenance work in the intervals.

One point that should not be neglected is the removal of all laterals not in use on any given trunk. Otherwise the laterals pile up, increasing the capacity of the line to the point where the higher frequencies are lost and quality of transmission is adversely affected. These sections hanging on uselessly may also bring in noise. In a properly maintained wire system the trunks are stripped of laterals at frequent intervals—and that does not mean every few weeks.

If the lines pass through telephone exchanges or telegraph offices the utmost care must be taken to avoid interference by employees who don't know what is going on. The broadcasting lines should be red-tagged and a special notice sent around cautioning all unauthorized people to keep away. Most telegraph and telephone men have little notion of what broadcasting quality is and they will sometimes innocently break up a circuit in order to get a little amusement during idle periods. At one station it was noticed that music coming over a long line (some five miles) was curiously tinny—lacking in the lower frequencies. This was just the opposite of what one would expect—the suppression of the higher frequencies by the line capacity. The engineers were somewhat puzzled until one day one of them happened to be at the main telegraph office in the city in question and saw an idle operator plug a 60-ohm telephone into the jack panel of the broadcasting station, in order to listen to the music. The circuit was one terminating in 500-ohm impedances, so this low inductance was effectively by-passing all the lower frequencies. The engineer sent a 2000-ohm headset down to the telegraph office with a polite note to the wire chief suggesting that if the operators wanted to listen in they could use the high impedance telephones without ruining quality on the air. But the wire chief, receiving this epistle, flew high up in the air, returned the 2000-ohm phones with thanks and apologies, and posted a notice informing his staff that any one who plugged anything into those circuits without authority would be summarily fired. Then there was peace.



"THE WIRE CHIEF WENT UP IN THE AIR"

Radio Lingo, Past and Present

SOMEWHERE in his writings or conversations Anatole France compares a synthetic language to a doll, while a natural language, with its centuries of use, growth, and development, he likens to a living woman. On a more modest scale, the technical terminology of an art or science, as it reflects the achievements and changes of years of effort on the part of many men, takes on an almost organic meaning and color. We usually think of objects like antennas and microphones as purely inanimate and lifeless, forgetting that they are the tools of human aspirations and carry with them an emanation of human emotions. The names of these tools, and of the scientific ideas which they embody, and the way in which people talk about them, all change with time. Not only do they change, but they show a tendency toward poetic figures of speech, and many terms which we use daily in the most matter of fact way, if we stop to examine them, show an interesting technical and literary history. This is particularly the case with radio terms, and I purpose to classify and discuss some of these now popular expressions in the light of their origin and history.

Radio, contrary to the notion of many of its devotees, did not start in 1920. It had its period of development in the minds of men like Maxwell, Henry, Heaviside, and Hertz, it was born three decades ago, and it is now past its infancy. It has borrowed from all the older engineering arts both words and ideas. If, as someone has asserted, one can understand a thing only by understanding how it became what it is, an examination of the technical jargon of radio should be as instructive as an article on hook-ups and super-circuits—and a little more out of the ordinary.

Physical Characteristics

As in every field, the obvious physical characteristics of objects suggest suitable names. We speak of cat-whisker detectors, bulbs, tubes, condenser plates, plugs, knobs, etc. Position in space acts in the same way; *aerial* is the most prominent instance. The types of aerials are all named in the same way: umbrella, harp, fan, V, inverted-V, flat-top, inverted-L, and T. In these cases the name, or the figure of speech, was suggested by the physical appearance. Somewhat the same process occurs with inductance coils. We refer to inductance spirals and helices, and to honeycomb, latticework, basket-wound or cellular coils where the criss-

FIG. 2

A typical test report made by broadcast operators on the condition of an outside wire used for picking up programs

LOOP NUMBER	TO	LEAKS TO GROUND		CONTINUITY	DATE	OPERATOR
		Tip	*Sleeve*			
465	Criterion Theatre	8	8	118	9/15/25	GN
...	....	.	.	...	....	....
...	....	.	.	...	....	....