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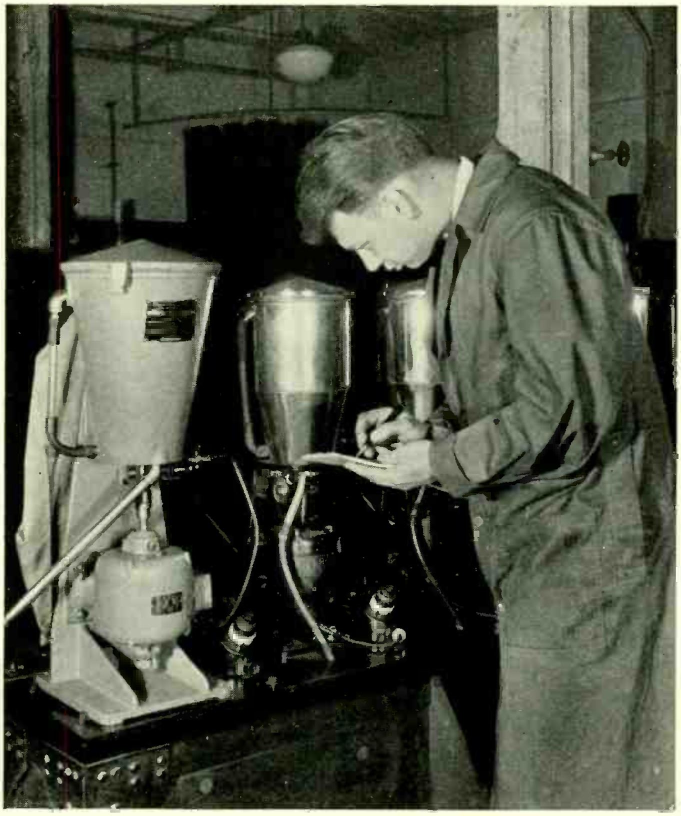

Testing wear-resisting qualities of finishes in the Laboratories

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Radio's Past and Future

From a Radio Address by
ROBERT A. MILLIKAN

WHAT is this miraculous thing, the radio, and how did it ever come into being? It is an altogether typical story of modern science, not of modern invention. Do not for a moment think that the radio was ever *invented.* It could not be. It has a long pedigree, as have all scientific advances. It grew step by step through the forgotten efforts of a long line of workers, few if any of whom could have been left out without causing the whole structure to collapse. I should like to tell the story backward, i.e., to start at the very latest end of this long history, just as I, myself, have seen and lived through it, for this part of it is only twenty-one years old. It was in the spring of 1910, twenty-one years ago, that Dr. F. B. Jewett, an old friend and associate of mine at the University of Chicago from 1898 to 1902, and at this time transmission engineer of the American Telephone and Telegraph Company, came out to Chicago to see his former associates at the Ryerson Laboratory and said, "My superiors have informed me that we must if possible get a telephone line to San Francisco by the time of the World's Fair there in 1915, and I find that to give good service over such a huge distance we need to develop a telephone repeater which will transfer the spoken word undistorted from one circuit to another, just as the telegraph repeater makes such a transfer with dots and dashes, so that when the voice has become so weak through transmission over a long line as to be almost inaudible, it can be transferred to a new, fresh circuit and boosted up by it to the desired strength. Now such a device," said Jewett, "in order to follow all the minute modulations of the human voice must obviously be practically inertialess, and I don't see that we are likely to get such an inertialess moving part except by utilizing somehow these electron streams which you have been playing with here in your research work in physics for the past ten years. Cannot you let us have three or four research men from your laboratory, who are more or less familiar with all this electronic technique, let us take them into our employ and assign them the job of developing such a telephone repeater as I have been suggesting." I responded favorably, and in the fall of 1910 sent Dr. H. D. Arnold to the Bell Laboratories in New York for this specific purpose, and a little later others followed. These men, with others in the Bell Laboratories, developed or perfected, within the first two years of their intensive effort, three different successful telephone repeaters, all

Reprinted from "Radio's Past and Future" by Robert A. Millikan. The complete address will be included in "Radio and Education," The Proceedings of the First Annual Assembly of the National Advisory Council on Radio in Education to be published by the University of Chicago Press in the Fall of 1931.

of them electronic, and these three with one mechanical device of earlier origin were given official tests, which I, myself, went from Chicago to Philadelphia to participate in in the early winter of 1914. The perfected DeForest three-electrode tube gave the best performance, and within a year of these tests a number of such electron-tube repeater stations had been installed on the telephone line connecting New York and San Francisco, and the job which the telephone company had set had been accomplished. And today every time I telephone from Pasadena to New York I marvel at the flawlessness of the speech that has been thus relayed and amplified several different times before it reaches its destination, the voice quality usually being so perfect that I am unconscious that I am telephoning farther than to the adjoining room. At the time of this first test, too, in 1914, the possibility, by the use of larger banks of such amplifier tubes and therefore larger energies, of shooting speech frequencies up into wireless antennae, already in use for dot-dash signaling, was realized, and a *radio telephone* station was soon hastily erected both at Montauk Point, Long Island, and at Wilmington, Delaware, and on Easter Sunday, 1915, in the midst of a terrific snow storm, this same group of men gathered at Montauk Point, shot up into the improvised antennae Lincoln's Gettysburg Address, which rippled through the ether and was picked up two hundred miles away at the Wilmington station, and from there by connecting wire lines came back to us so that we could listen to it at Montauk. Later in 1915, by using still more powerful tubes and more of them, spoken words, shot up into the ether from the Arlington station, had been heard by some of the group sent to listen at the Eiffel Tower in Paris, and by one lone listener—Espenschied—who was listening at Honolulu with the aid of a receiving wire lying on a hillside six thousand miles away, and all the essential steps had been taken which made world-wide radio-broadcasting of human speech a possibility.

I have thus told the story of the beginnings of speech broadcasting through the ether as I myself saw it. Completely unknown to this group until the spring of 1915, somewhat similar developments, at least so far as perfection of the DeForest three-electrode tube into a speech amplifier or repeater, had been going on in the laboratories of the General Electric Company at Schenectady. Who first made the three-electrode tube into a distortionless speech amplifier is not for our present purpose important—it has been decided differently by different courts.* But we are interested

* *EDITOR'S NOTE: At the time Dr. Millikan spoke these words the decision of the Supreme Court on the vacuum tube had not been rendered. In this connection see pp.* 513-516 *of this issue of the* RECORD. *A patent interference had been declared in* 1916 *between H. D. Arnold and Irving Langmuir. After various conflicting opinions by successive tribunals U. S. Patent No.* 1558436 *was issued to Langmuir in* 1925. *The question of priority of invention, "if invention was present", was continued, however, in the defense of the DeForest Radio Corporation to a suit for infringement of this Langmuir patent, brought by the General Electric Company in January,* 1926. *The District Court of the United States for Delaware, before which the suit came, held that the Langmuir patent was invalid for want of invention and novelty and because of prior use, and upon the ground that H. D. Arnold anticipated Langmuir. This decision was confirmed by the Circuit Court of Appeals for the Third District; and thereafter, upon a rehearing, reversed by a majority of that court which however did not mention the question of priority. Judge Woolley wrote a strong dissenting opinion in which he pointed out that Arnold's priority, among other things, made the patent invalid. The Supreme Court took the case up on writ of certiorari and on May* 25, 1931, *concluded that the Langmuir patent did not involve invention.*

here only with the fact of the development or commercialization at about this time of a new scientific device and with its applications. The essential device, not only for the whole broadcasting art, and not only for most of modern long-distance wire telephony, but also for all forms of speech reproduction and amplification, and this includes the greater part of the whole modern motion-picture industry — not to mention picture reproduction at a distance in all its forms — the essential underlying device for all this is simply one new instrument, the electron-tube, telephone repeater or amplifier. The multiplicity of the new and wholly unforeseen practical uses which one new device or principle introduced into physics seems invariably to find always astonishes even the physicist who alone realizes how small and often how simple is the fundamental scientific advance that has been made. Knock out that single instrument, the telephone-repeater, and much of the whole structure of modern long-distance telephony, and practically all of radio and talking pictures, comes crashing to the ground.

In front of the Bell System's radio telephone laboratory, Montauk Point, on April 4, 1915: *Front Row, H. Christopher, Plant Dept., N. Y. Tel.; O. B. Blackwell, Transmission and Protection Engineer, A. T. & T.; F. B. Jewett, Asst. Chief Engineer, W. E.; R. A. Millikan; J. J. Carty, Chief Engineer, A. T. & T.; H. F. Thurber, Vice-President, N. Y. Tel.; C. E. Scribner, Chief Engineer, W. E.; Bancroft Gherardi, Engineer of Plant, A. T. & T. Second Row, H. D. Arnold, Research Engineer, W. E.; John Mills, Eng. Dept., A. T. & T.; J. R. Carson, Eng. Dept., A. T. & T.; Lloyd Espenschied, Eng. Dept., A. T. & T., Colonel Samuel Reber, Signal Corps, U. S. A. From a snapshot photograph taken by R. A. Heising, Eng. Dept., W. E.*

The High Vacuum Tube Comes Before the Supreme Court

By WILLIAM R. BALLARD
Patent Attorney A. T. & T. Co.

ON May 25th, 1931, the United States Supreme Court handed down an opinion disposing of a controversy in which the Telephone Company has been continuously involved since the year 1915, and in which Dr. H. D. Arnold, Director of Research of Bell Telephone Laboratories, has had a leading role. It concerned the patentability and the paternity of what is now commonly referred to as the "high vacuum" tube, used in radio and telephone work.

The Supreme Court held that the difference between the "high vacuum" tube and the earlier vacuum tubes of Fleming and DeForest is not a patentable one, and it, accordingly, found the Langmuir patent of the General Electric Company on the high vacuum tube, invalid. In doing this, it has confirmed the original view of Dr. Arnold, and the Bell System patent attorneys, at the time the high vacuum telephone repeater was first produced by Arnold in 1912 and 1913. It is interesting to note, moreover, that the Court's finding of unpatentability is based in large part upon the directness and facility with which Arnold reached his results in producing the telephone repeater at that time. The Court's opinion does not take up the question of priority as between Arnold and Langmuir because it was unnecessary to do so after finding the patent invalid. The facts in the record of the case, however, make it quite clear that Arnold was first, both in appreciating the advantages of a higher vacuum in such tubes and in actually producing the tubes themselves. Indeed, the last court to discuss and decide this question of priority, so held; and the Supreme Court, in passing on the question of patentability impliedly gives Arnold a date for these accomplishments early in November, 1912.

While it would be difficult to overstate the credit that must be given Dr. DeForest for his invention of the three-electrode tube, the fact remains that the beginning of the revolution which his device has caused in modern communication and other industrial fields, dates from about the time when Arnold, fully conversant with the physical principles involved, had turned the DeForest tube into a commercially practical telephone repeater.

There is something of romance in the story of the development of the modern telephone repeater as well as in the marvels which the device has since wrought. It furnishes, moreover, a striking illustration of how intimately and directly the most abstruse scientific discoveries may affect commercial enterprises and rapidly change our daily habits. Scientists who had, prior to that time, been studying what went on inside an atom under the influence of heat and electrical charges, furnished the magic wand with which Arnold touched the DeForest audion and transformed it into a device which at once greatly extended the possibilities of communication and now daily performs miracles, alike for technician, schoolboy and housewife.

In 1910, T. N. Vail, President of the American Telephone and Telegraph Company, promised those who were then planning the Panama-Pacific Exposition that the Pacific coast should have telephone communication with the Atlantic coast by the time the exposition opened in 1915. This meant telephone communication over something like twice the distance then commercially practicable. It was a bold promise. Not only would it require the building of some thousands of miles of new telephone lines but it meant that there must be produced some altogether new instrumentalities not then even conceived. In particular, it required an entirely new form of telephone repeater,—one that would be free from distortion so that a number could be used in series.

The promise was made largely upon the assurances of Dr. Jewett, then Transmission Engineer of the Telephone Company; and upon his shoulders was laid the burden of making good the promise. He began at once to select the men to do the work. As to the repeater, he believed that the solution would be reached only by the application of the latest developments of physical research, to this specific telephone problem. He went to Dr. Millikan, then Professor of Physics at the University of Chicago, and already famous for his research work in the field of electron-physics, and laid the problem before him. Dr. Millikan replied that he had just the man for the work,—a young man named Arnold then working under him at the laboratories at the University; he was an expert in the field of electrical discharges in vacua. Arnold was employed, and early in 1911 he went to New York and was put to work in the laboratories of the Western Electric Company to produce a telephone repeater that would make possible transcontinental telephony.

After he had spent some time upon the problem and had perfected and patented a telephone repeater employing a column of mercury vapor, an incident occurred that changed the whole course of his plans. In October, 1912, Dr. Lee DeForest, then employed with the Federal Telegraph Company in California, came east in an effort to raise money for the rehabilitation of his own company. This he hoped to do by selling to the Telephone Company rights, under his audion patents, for telephone repeaters. John Stone Stone, formerly an engineer with the Telephone Company and a close friend of General Carty's as well as of DeForest's, introduced DeForest to the Telephone engineers and arranged for a demonstration of his audion as a repeater. The demonstration was made before Dr. Jewett and Dr. Colpitts on October 30th, in the latter's office on the 8th floor of the Laboratories building on West Street. The performance of the tube was far short of what, they knew, would be necessary for practical telephone repeater operation. Any attempt to handle loads comparable to those in commercial telephone circuits resulted in choking, blue glow and unintelligible reproduction. Nevertheless, they were greatly impressed with the performance of the audion when the power level was kept low and the variations of the voice currents were small.

They arranged to have the demonstration repeated the next day with Arnold present. Thus, on November 1st, 1912, Arnold first learned about the DeForest audion. He was, perhaps, more impressed than his associates, for his training had equipped him to appreciate the possibilities of this device as few others could have done. He understood at once the reason for the difficulties experienced at the higher power levels, and then and there he named the cure. He explained that the trouble was due to the erratic effects resulting from gas ionization within the tube, occurring at the higher voltages; and that a commercially successful telephone repeater could undoubtedly be made from the DeForest audion by such a thorough removal of the gas that the action would be purely electronic.

It was this ready and perfect appreciation by Arnold of possibilities dormant in the DeForest audion, which resulted in the creation of the high vacuum telephone repeater, destined not only to revolutionize the communication art itself, but to develop entirely new industries.

It is interesting to note how thorough was Arnold's acquaintance with the principles involved even at that early time. Colpitts, misled by statements made in a then recent paper by an engineer of another organization, questioned whether, if the gas were removed, the electrons would get out of the filament at all, and whether, if they came out, they would not all rush across the space under the slightest plate voltage, thus keeping the power output of the tube too low to be useful. Arnold assured him that the electrons would be emitted without the presence of gas and, because of the "space charge" effect, which he explained to Colpitts, a considerable voltage would be required to get the desired current across the tube.

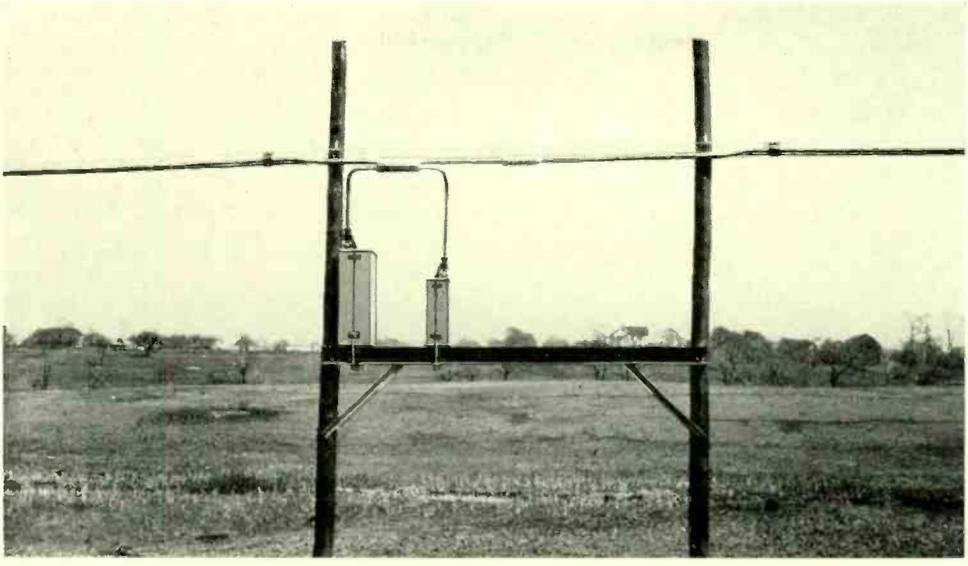
Arnold's grasp of the situation and his conviction as to the possibilities of the audion so impressed his superiors that he was at once given the job of converting the audion into a commercial telephone repeater. To make the tube a commercial repeater, it was necessary not only to improve the vacuum but to improve the mechanical structure of the tube as well, to perfect better and longer-lived filaments and make the internal impedances such as to match the telephone apparatus.

Exhaustive tests were then made to determine the operating characteristic and efficiency of the audion. In December, 1912, Arnold worked out mathematically the theoretical 3/2 power law covering the relation between current and voltage in such tubes, assuming the absence of gas ionization, and found that some of his experimental data conformed closely to this theory. His study of the "Efficiency of the Audion" made in December, 1912, was a mathematical ascertainment of the law of third electrode control of an electron stream. It was the first definite analysis ever made of the principle upon which the three-electrode tube produces its remarkable results. At the same time Arnold had his assistants working on new filaments and on the tube structure, devising new tools, perfecting themselves in the technique of tube manufacture and exhaust, and collecting the necessary equipment for manufacture of commercial repeaters.

On at least three occasions while Arnold was thus remaking the audion into a telephone repeater, he produced high vacuum tubes of the kind which the Langmuir patent afterwards purported to cover;—once in November, 1912, when he effected a "clean-up" in one of the original DeForest audions upon which he was performing tests, again in April and May of 1913 when trying out the new Gaede molecular pump ordered for use in manufacturing the repeater tubes, and again the following autumn when the first tubes to go into use were made.

A license under the DeForest patents was secured in July, 1913, and the manufacture of tubes for commercial telephone use began shortly thereafter. A field trial of high vacuum telephone repeaters under commercial service conditions was begun October 18th, 1913, at Philadelphia on the New York-Washington telephone lines. In the summer of 1914 these repeaters went into the new transcontinental telephone line, and with its official opening, the first of 1915, President Vail's promise of 1910 was fulfilled.

It was not until after the improved tubes had gone into commercial use that it occurred to Arnold or the Patent Department that an application for patent should be filed, and then only because they learned that the General Electric Company was attempting to patent such tubes in the name of Langmuir. Convinced of his own priority, Arnold then, upon advice of counsel, filed his application, so that the patent should issue, if at all, to the first inventor. However, Arnold and his counsel were so convinced that the subject matter was not of a patentable nature, that they afterwards made a strong effort in the Patent Office to have both applications rejected upon this ground, before the taking of testimony as to priority. As noted, the Supreme Court's decision comes as a confirmation of their original views as to patentability.



Welded Steel Cases for Loading Coils

By C. R. YOUNG
Telephone Apparatus Development

LEAD covered cables, which are carrying a rapidly increasing portion of the long distance communication traffic of the country, contribute much to the quality of the service by the freedom from external interference which they provide. Because of the closer spacing of the conductors than in open wire lines, however, and the resulting higher value of capacitance, cables are loaded to improve their transmission characteristics. Since cables are carried both on poles where they are exposed to all the vagaries of weather and temperature, and underground where subsoil water carrying a variety of chemicals may attack them, the adequate protection of their loading coils is a problem of major importance.

Consisting of layers of cotton insulated wire wound on annular cores of compressed powdered permalloy, loading coils* are easily damaged by mechanical abuse, and are particularly sensitive to the presence of moisture. In their manufacture the exclusion of moisture qualifies at every step as a precaution of first-order importance. The cases employed to house them, therefore, must of course furnish mechanical protection, but above all they must prevent the entrance of moisture under every condition of weather and surroundings over a long term of life.

Ordinary requirements of manufacturing economics and expedience do not permit a different type of case for each set of local conditions. As few types of construction as possible must serve for such extremes as sub-zero temperatures and snow, prevailing in the winter months in the northwest, extremely high temperatures in the

* RECORD, *Sept.*, 1927, *p.* 1.

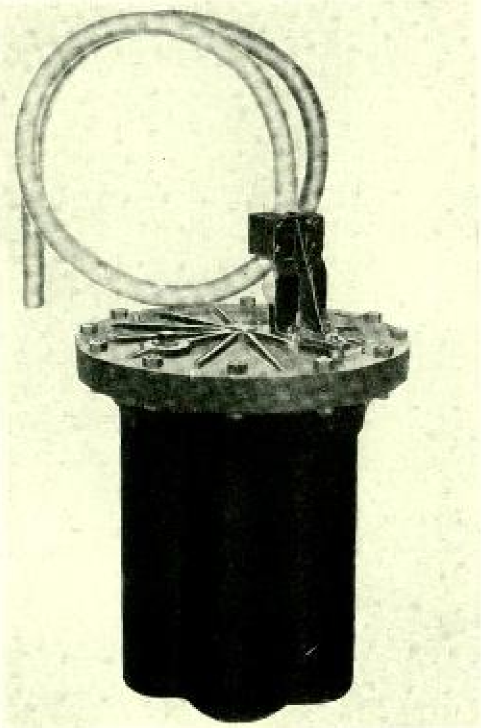


Fig. 1—*One of the smaller sizes of cast iron loading coil case*

deserts of the southwest, salt air and rain of the Atlantic or Pacific coast, or the various underground conditions, which may be manholes flooded with water for long periods or direct burial in the ground where various conditions of subsurface moisture and chemicals may be encountered. Cases must withstand all these extremes and even varying cycles of extremes. Variations at a single locality of from twenty or thirty degrees below zero to 120 degrees above may occur over a twelve-month period, with blizzards and driving rains thrown in for good measure.

For the past quarter of a century a cast-iron case, designed by H. F. Albright in 1905, has satisfactorily met the demands made upon it. The type of construction is shown in Figure 1, although the size varies. Only 49 coils are housed in the case shown while larger ones may carry as many as 252, as used for toll cables, or even —for inter-office trunks—as many as 600. To the layman there might not seem any reason why such a case could not easily be made water tight but actually there are three structural features which make it extremely difficult to do so.

To begin with it is not easy to get an iron casting which is completely impervious to moisture. The castings may be four or five feet high and weigh as much as 2800 pounds, and in pouring the molten iron into the moulds through the narrow space around the large sand core, slag gathers in small pockets, or bubbles of vapor may be entrapped which, when the casting cools, leave minute paths through the iron shell. Each case is tested under air pressure and the detecting and repairing of small leaks is a not inconsiderable task.

A second difficulty is the joint between cover and case. This must be so tight that even under extreme temperature changes, which expand or contract the clamping bolts, it will bar all entrance of moisture. The construction adopted is shown in Figure 2. As a first line of defense there is a crinkled copper gasket coated with red-lead paste which, under the high bolting pressure, fills in all crevices, and maintains a tight joint even

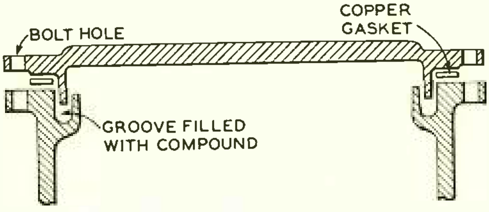


Fig. 2—*Moisture proof flange construction of cast iron cases* when the bolts expand under high temperature. A second barrier against moisture is formed by the tongue and groove. The latter is flooded with the asphalt compound when the case is filled, and with the tongue projecting into it forms a very effective defense.

A third point of attack for moisture is the entrance of the cable stub. This stub is the connecting link between the coils in the case and the cable in the field, and must, of course, be installed in the shop. A brass sleeve threaded at one end is screwed into the cover of the case and the lead sheath of the cable is "wiped" to its other end. Red lead is used to make the threaded joint tight but the heating necessary to make the wiped joint may seriously affect the tightness of the screwed connection. Only great care and painstaking inspection can insure satisfactory results.

Since the development of this cast iron case, manufacturing methods have changed. Electric welding has reached a high stage of perfection and the many advantages of the strong union it forms have made it desirable to replace bolted or riveted joints with welded ones. This has resulted in the substitution of low carbon steel for cast iron for many purposes because cast iron is not easily welded. Advantages, both in cost and quality, are usually gained. Realizing the possibilities of the newer method, the Laboratories, in cooperation with the Western Electric Company, have recently developed a new design of loading-coil case, which utilizes copper-bearing low-carbon steel as the ma-

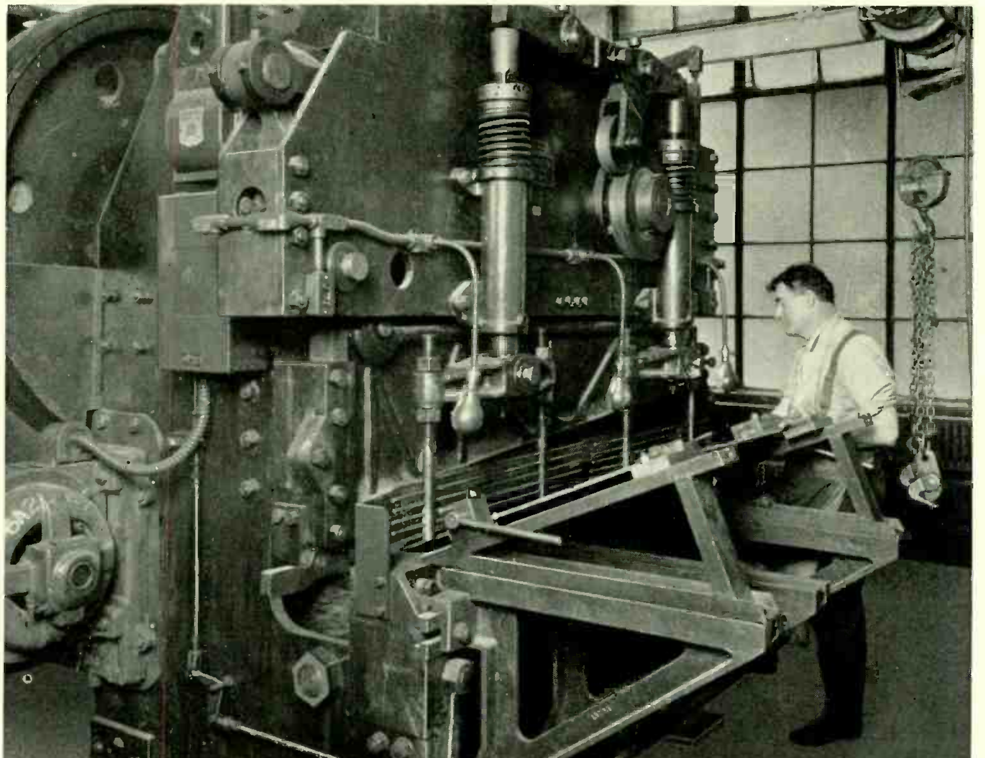


Fig. 3—Sheet steel for the new cases is sheared at a 30° angle before welding

terial and incorporates welded joints with their improved union.

Manufacturing methods for the new cases are much simpler than for those of cast iron. Steel sheets of the required thickness are beveled at a 30° angle by a large shearing machine, shown in Figure 3, as a preparation for welding. The sheets so beveled are then bent into "U" form on a powerful press. Following this, two of the "U" shaped sections are welded together by an automatic welding machine, Figure 4, to form a rectangular outer shell. The bottom plate is then welded in place by a semi-automatic welder. Certain small details that mount on the outside of the case are welded by hand welding equipment.

After the completion of this step, a temporary cover is clamped on the tank which is then tested under water with thirty pounds air pressure. At the successful completion of this test the casings are sprayed with red-oxide paint. Two coats are applied, and after each the case is baked for two hours at something over three-hundred degrees Fahrenheit. The welded and painted case is now ready to receive the loading units.

The new method is not only considerably cheaper than the old but has other very definite advantages as well. Porosity, which must be watched for in cast iron, is practically unknown in the rolled plate used for the new cases. Also the welded joint between case and cover is easily made and is far more satisfactory than bolting. The expensive construction which insured a water-tight joint at the cover with the old method has become unnecessary. The cable entrance also takes advantage of welded construction. The nipple that with the earlier

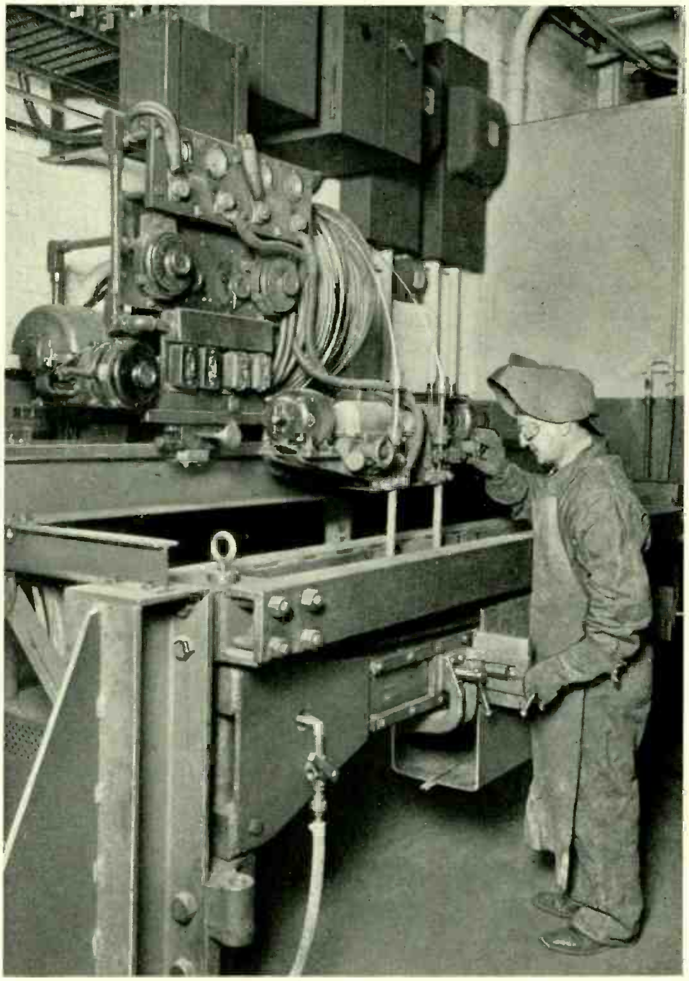


Fig. 4—Welding of the main butt seams is done on an automatic welding machine

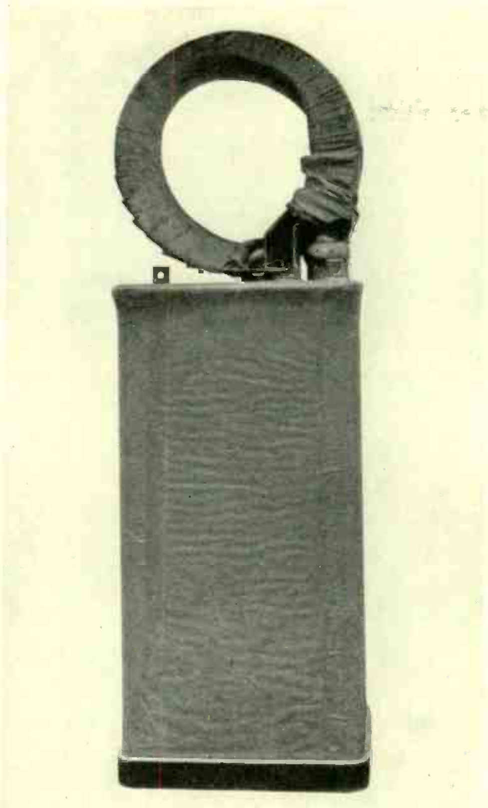


Fig. 5—The new welded case for underground use with top, sides, and bottom heavily coated to protect the steel from corrosion

construction was screwed into the top is now welded to it so that the heating that results from wiping the lead sheath to it does not affect the tightness of the joint. A considerable improvement is thus brought about in the three places where the older construction required the most attention.

In one respect, however, the comparison is not so favorable to the new cases. Cast iron is little affected by the presence of moisture. It can remain submerged for long periods with very little corrosion. This cannot be said of steel plate. If unprotected it rusts rapidly and even when carefully painted, a case made of it, if immersed in water or buried directly in the ground, would have a comparatively short life.

The treatment given the outside of the new cases as described above, forms an entirely adequate protection for those cases that are to be mounted in the open, but for those to be installed in manholes or to be buried directly in the ground an additional protection is necessary. Such a covering has been developed by our chemists, however, and so far has given complete satisfaction.

The completed cases are immersed for about ten minutes in hot coal-tar pitch and then wrapped with coarse cotton cloth which is ironed in place with a heavy electric iron. After a second and similar treatment, a steel pan containing three layers of coal-tar pitch separated by roofing felt is fast-

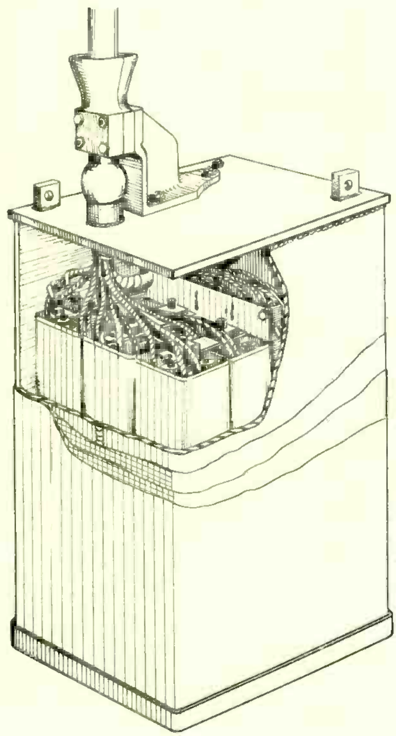


Fig. 6—One of the new welded cases showing the loading coil containers inside

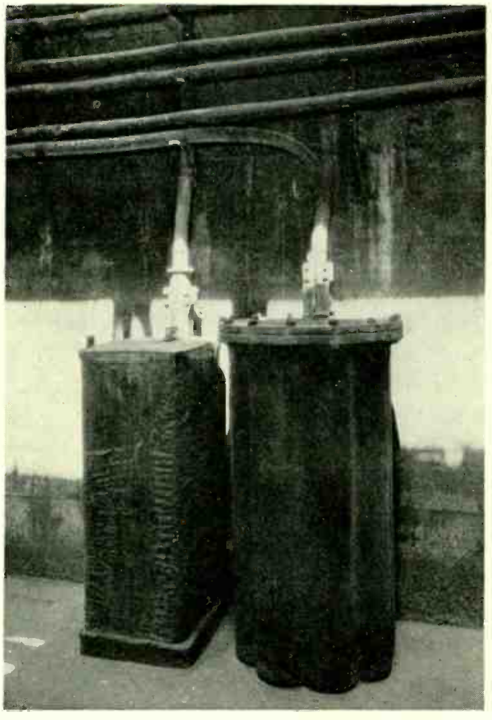


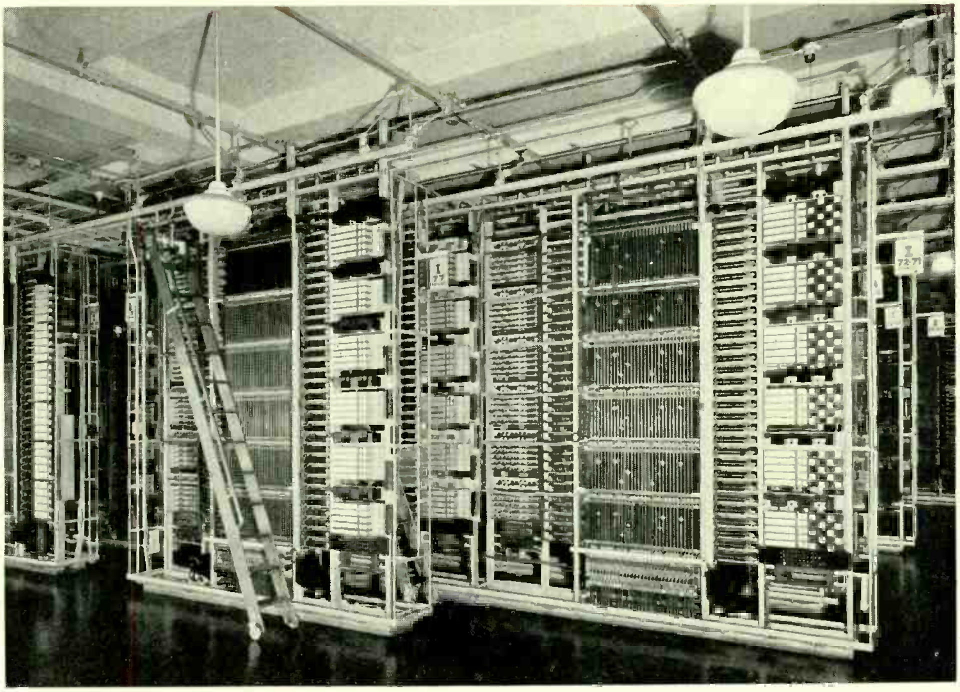
Fig 7—A typical manhole installation showing new and old loading coil cases

ened to the bottom. The cases are then given a third bath in a compound of higher melting point. To lighten the color of this outer coating and thus assist in preventing the sun's rays from softening it during transit, and to afford it a certain amount of protection, a heavy Kraft paper covering is glued to the sides and top. Figure 5 shows a representative underground case with its heavy coat, and with the stub-cable protector in place.

With the new cases a change is also made in the method of mounting the coils within the case. Rectangular containers of terneplate—sheet iron coated with lead—are used to hold each column of loading coils. These containers as well as the main case are filled with water-proofing compound as a further protection against moisture. The arrangement within the case is shown in Figure 6.

Throughout the entire assembly process, the exclusion of moisture is emphasized. The coils, spindle cables, and all wooden and fibre parts are carefully dried and given a moisture-proofing treatment under vacuum and the containers are filled also under vacuum. The final pressure testing of the case is done with chemically dried compressed air. In addition, the potting process is conducted in rooms equipped with air-conditioning apparatus so that the humidity may be maintained at a low value.

The average weight of the new cases is only about two-thirds that of the cast iron cases, and this reduction in weight, which is obtained without any sacrifice of either strength or rigidity, reduces the handling and transportation charges. Being rectangular in form, the new cases fit together more compactly in manholes and permit more coils to be contained in a given space. About four of the largest underground cases can be installed in the space required by three of the cast iron cases of the same capacity. This greater economy in space requirements has permitted the construction of a case for inter-office trunks which will house 900 coils: half as many again as the equivalent case of the old construction.



The Panel System

By R. E. COLLIS
Local Systems Development

ALTHOUGH many types of mechanical switching systems have been suggested, it is a curious and interesting fact that the two systems of dial telephony at present successfully used in this country are similar in principle to the first commercial manual switchboard—the New Haven board of 1878. The arrangement by which any two of the eight lines of that board could be connected together is shown in Figure 1. Two pairs of eight-point switches (A and B) were provided, with the rotating arms of each pair connected together. Each of the eight lines was connected to one of the eight points on all four switches. Should a subscriber on line 2 want to talk with a subscriber on line 6, the arm of one A switch would be put on point 2 and the arm of the B switch of that pair would be put on point 6, thus completing the connection. The ability to complete calls for a maximum of two separate pairs of the eight lines at a time would be known today as the provision of twenty-five percent trunking. Actually these switches were moved by hand, but by the application of a mechanism for moving them, either directly or indirectly under control of a dial, the essentials of an automatic telephone system would have been attained.

As the number of subscribers increases, however, difficulties rapidly multiply. With ten thousand subscribers, for example, an arrangement similar to the New Haven board would involve, among other difficulties, that of designing a single switch with ten thousand points — probably a practical impossibility. Furthermore, to provide for even ten percent trunking, the ten thousand lines would

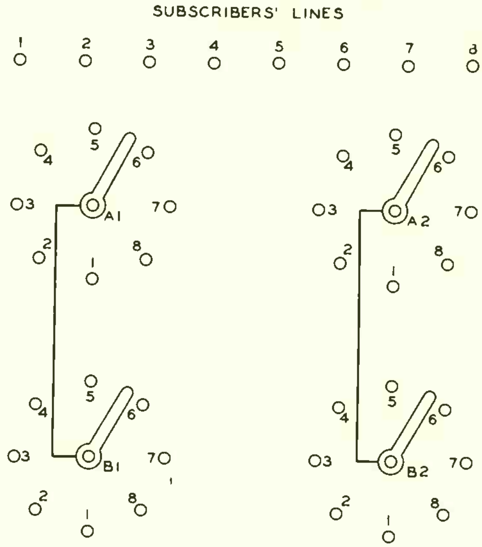


Fig. 1 — The earliest commercial manual switchboard completed connections by the use of two rotary switches

have to be multipled to each of two thousand switches — obviously an expensive process. The practical solution of these and other difficulties lies in dividing the subscribers into groups and providing more than two switches in series.

Assume for example, that the eight lines are divided into two groups of four lines each, and that the A switches, therefore, have only four points. Since provision is to be made for two conversations there would have to be two of these four point switches connected in parallel to each group of lines. The completing or B switch would be arranged in a similar manner. Between the A and B switches, however, another set of switches, C, is provided. The arrangement is shown in Figure 2. There will be as many C switches as there are A, and the arm of each A switch will be connected to one C switch. The number of points on the C switches will correspond to the number of B switches. The distinguishing features of this second system are the arrangement of the lines into groups and the employment of intermediate switches in the connecting train which, instead of directly connecting to the called line, select trunks to other switches which make the final connection.

There would be no advantage, of course, in using this method for such a small number of lines, but the comparison of the methods is more clearly brought out by doing so. The chief advantage of the second system is that less travel is required for each switch. If line 7 called line 8, for example, and the switch arms all started from the zero position, there would be a total travel of fifteen points with the first method. Switch A1 would be moved to point 7 and switch B1, to point 8. For the same call with the second method, switch A1B would be moved to the third point, switch C3 to the third, and switch B1B to the fourth: a total of ten points or a reduction in number of points passed over of 33-1/3 percent. With larger numbers of lines the gain is much greater. The gain to a large extent is a matter of time since the time required to complete a connection will vary with the total number of points that must be passed over in completing the connection.

The number of switches required in series and the size of the groups depend very largely on the type of switch used and on the maximum number of subscribers as well as on the percent trunking. The panel type of dial system was designed to meet the conditions of very large numbers of subscribers and high trunking ratios. Four or five switches in series are required. The contacts of each switch instead of being located in a circle are mounted one above another in banks, and multiple connections are provided in horizontal rows. The movable arms are brushes carried vertically across the contacts of each group by elevators. The switches are given names in place of the designations A, B, and C of Figure 2. That corresponding to the A switch is the line finder, and that to the B, the final selector. In between—in order from the line finder to the final selector—are the district selector, office selector, and incoming selector. The arrangement is shown in Figure 3. The entire number of subscribers' lines is divided into major groups called offices, each of which may have as many as ten thousand lines, as is the case in the manual system.

The subscribers' lines in each office are divided into groups of four hundred. Each group is associated with a line-finder frame which is composed of ten banks of forty lines each. Each line-finder bank, however, consists of 160 terminals since four are required for each line: two for the talking conductors and two for control purposes. The ten banks of a line-finder frame are mounted one above the other as shown in the illustration. The elevators carrying the brushes are mounted on both sides of the frame and as many as thirty may be used on a side. Thus as many as sixty calls may be made simultaneously by each group of four hundred subscribers, and this number can be increased when required by connecting the terminals of two or more line-finder frames in parallel.

Each line-finder elevator is directly associated with a district elevator, much as the movable arms of the A and C switches of Figure 2 are connected together. Also comparable to Figure 2, the terminals of the district frame are associated with the elevators of either office or incoming selectors, and, continuing the train, the terminals of the office frame with elevators of the incoming selectors, terminals of the incoming frame with the elevators of the final selectors. The terminals of the final frames are directly connected to the subscribers' lines. The five types of selectors in a panel office are used for three distinct stages in the setting up of a connection. The line finder connects to the

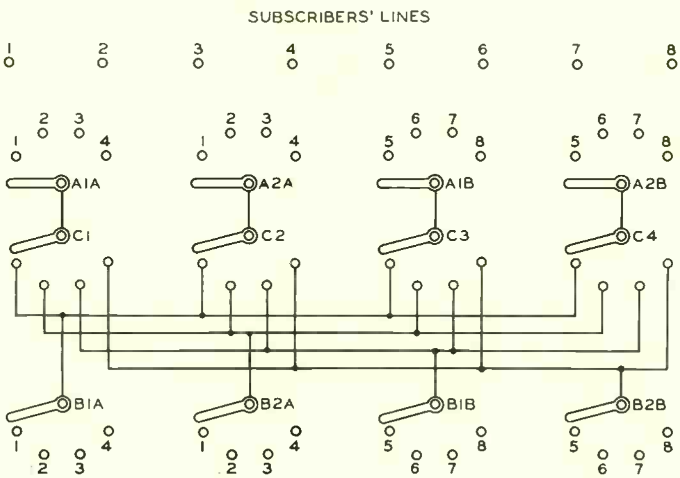


Fig. 2—For a larger number of subscribers a modification of this method would be desirable, which would employ a series of three or more switches for each call

calling line; the district and office selectors choose a trunk to the desired office; and the incoming and final selectors select the desired line in that office.

The district, office, incoming, and final frames are similar to the line-finder frame in general construction, but they are composed of five banks of one hundred sets of terminals each instead of ten banks of forty. Three terminals per set are required for these banks instead of four as for the line-finder banks. The district, office, incoming, and final frames also are arranged to mount elevators on both sides with a maximum of sixty elevators per frame.

District banks are arranged so that a maximum of ten separate groups of trunks may be connected to each bank. Eight of these groups have eleven sets of terminals, and two groups, six sets of terminals each. The top set of terminals of each group is used only to mark the end of the group so that a maximum of only ninety sets of terminals are available for trunks. Two or more adjacent groups may be combined, which makes it possible to have any number up to ninety trunks in a single group. The maximum number of trunk groups which can be secured on the district frames is fifty: ten groups in each of five banks. If two or more of the groups of terminals are combined, the number of trunk groups is correspondingly decreased. Office frames are used when the number and size of trunk groups required exceeds the capacity of the district frame. In this case the trunks of one or more of the groups on the district frames terminate in office selectors. The arrangement of the banks and terminals of the office frames is identical with that of the district frames so that each trunk group on the district frames may have access, by the use of office frames, to a maximum of 50 outgoing trunk groups. The use of office frames, therefore, provides, in the extreme, for 2500 outgoing trunk groups.

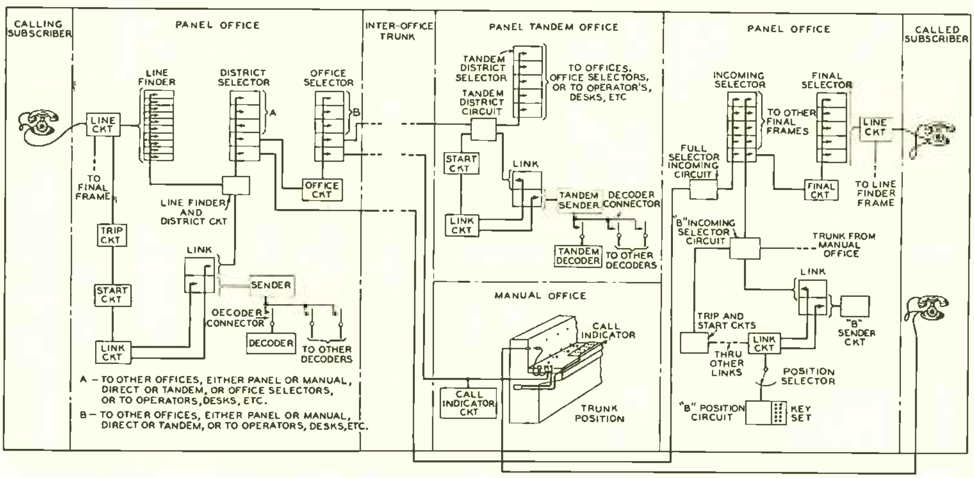


Fig. 3—In the panel system four or five switches, or selectors as they are called, are employed in series for each call. Each office has selectors of all types but only the line finder, office selector and district selector are shown here in the calling office, and only the incoming and final selectors in the called office

The number of incoming elevators is equal to the number of both local and inter-office trunks, and sufficient incoming frames are provided to accommodate this number of elevators. Since there is a maximum of ten thousand subscribers' lines in an office, and five hundred lines per final frame, in general twenty final frames are required for a complete office. Each incoming selector must be able to reach any one of the twenty final frames. The five banks of the incoming frame are therefore each divided into four groups of twenty-five sets of terminals per group. The last terminal of each group is used to mark the end of the group, which leaves twenty-four sets of terminals on each incoming frame available for trunks to each final frame. The number of final elevators used on a particular final frame will depend on the traffic, or number of calls that will terminate at one time in that group of five hundred lines. If the traffic is light, two groups of five hundred lines may be combined in a single final frame by "splitting" the banks vertically in the center. A maximum of thirty selector elevators is provided by this arrangement for each group of five hundred lines. If the traffic in some of the five-hundred line groups is too heavy to be handled by sixty final selectors, halves of "split" frames are multipled to such groups, thereby increasing the final selector capacity for those groups to ninety.

Each subscriber's line is connected to one set of multipled terminals on a line-finder frame and to one set on a final frame, so that control of line-finder and final-selector elevators must provide for stopping at a particular contact. The district, office, and incoming selectors, however, are first directed to a particular group of terminals and then guide themselves over these terminals until the first idle terminal of the group is reached. This process is called hunting and various methods of performing it have already been described in the RECORD[1].

In general, the progress of a call in the panel system is controlled by the sender. When a subscriber lifts his receiver from the hook to place a call, a line-finder elevator, by action of the trip and start circuits, is directed to the calling line. At the same time, a link circuit, described in an earlier issue of the RECORD[2], causes a sender selector to hunt for an idle sender. When both line and sender are found, the tip and ring leads of the line are connected through to the sender, and dial tone is returned so that dialing may begin. The dial signals, or impulses, are recorded[3] in the sender[4], which turns to the decoder[5] for information as to how to reach the office called, and then directs the action of the district[6] and office selectors. Incoming[7] and final selectors are also controlled by the sender.

When the call is to an operator, such as the Dial Svstem "A" operator or the toll or information operator, the connection is completed directly from the banks of the district or office frames. When the call must be completed through a manual office, a trunk to the office is selected in the district or office bank. The sender then transmits the number over this trunk as a series of pulses by what is

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[1] *September*, 1928, *page* 5.
[2] *May*, 1930, *page* 412.
[3] RECORD, *June*, 1929, *page* 400.
[4] RECORD, *December*, 1928, *page* 143.
[5] RECORD, *May*, 1928, *page* 273.
[6] RECORD, *June*, 1929, *page* 395.
[7] RECORD, *November*, 1930, *page* 127.

known as the call-indicator[8] method. The number is displayed before the operator, and the call is completed manually. If the call is to be completed through a panel tandem office, both office and number code are transmitted by the call-indicator method to the tandem office where they are recorded in the tandem sender. The sender at the originating office is then dismissed and the tandem sender controls the completion of the call.

Calls from a manual office to a panel office are trunked manually to the called panel office where they are received by a panel "B" operator who writes the number up on a key set. The call is then completed by the panel equipment.

The panel system, in principle similar to the early manual system of Figure 1, provides for very large numbers of subscribers by the use of groups of banks—equivalent to the eight-point switches of the early scheme — of four or five hundred terminals each. Provision for varying amounts of trunking is made by building in one bank structure the possibility of as many as sixty simultaneous connections. The number of simultaneous connections may be increased by connecting two or more banks in parallel or may be decreased by splitting the bank vertically into two or more sections. The arms of the early switch are replaced by elevators carrying brushes which are driven vertically by motors and clutches[9] while control of selection is exercised by the sender.

To allow for changes in arrangement of the trunk groups, and for the addition of new ones on the selector banks, the information used by the sender in controlling the selections for reaching the various offices is obtained from a decoder. Changes in this routing information are easily made by transferring cross-connections on groups of terminals in the decoder. This is one of the important features that gives to the panel system the easy flexibility necessary in systems suitable for large multi-office areas.

[8] Record, *December*, 1929, *page* 171; *July*, 1930, *page* 515; *March*, 1931, *page* 325.

[9] Record, *April*, 1930, *page* 367.

Field Laboratory for Outside-Plant Studies

By R. G. WATLING
Outside Plant Development

OUTDOOR testing is desirable and frequently necessary for the development of new apparatus and materials for the outside plant. To provide facilities for such work, the Laboratories rented a fifteen acre plant near Chester, New Jersey, some three years ago. This proved to be inadequate for certain test purposes not originally contemplated so that eighty-five acres of farm land, adjacent to the rented tract, were purchased in the early spring of 1930.

A variety of terrain is desirable to simulate the various field conditions under which outside plant apparatus is installed and used. The site selected meets all essential requirements and supplies as well an unfailing water supply needed particularly for work with cement and concrete in underground conduit systems. Approximately one mile east of Chester, the plot is a rolling piece of ground with an elevation of nearly 1000 feet at the highest point. The shape and location of the plot, together with the various pole and conduit lines installed for test purposes, are shown in Figure 1. A general view of the property, taken from a pole on the high ground in the south corner, is shown at the head of this article. The small single-story building in the right center of the photograph serves as a concrete and ceramics laboratory. To the left of it is a water-storage tank to which water is pumped from a spring-fed stream below it.

The pole from which this photograph was taken is one of a six-span line used at present for studies of open-wire spacings. Starting just outside a small building on the southern corner of the field, shown in Figure 2, this line runs over the top of the highest part of the property where

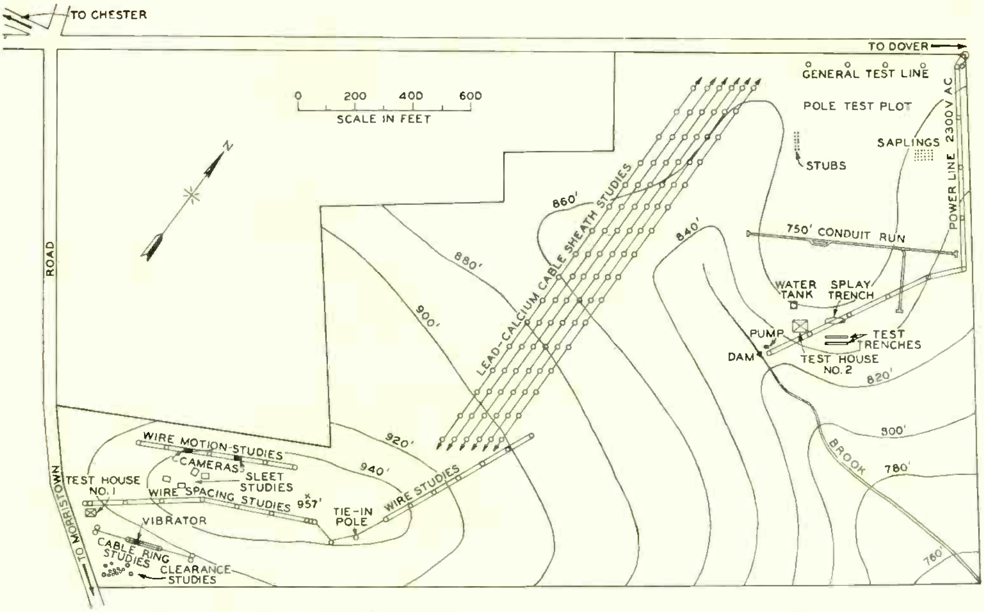


Fig. 1—*The Chester field laboratory, showing location of buildings and of the principal studies*

it is exposed to the greatest wind velocities. Twenty pairs of wires, of the standard sizes and with various spacings between the wires of a pair, are run on the five cross arms. The wires terminate in the test house where instruments are installed (Figure 3) for recording each time any of the wires swings into contact with any other, and for recording the direction and velocity of the wind. These latter instruments are associated with an anemometer and a wind vane mounted on the tops of two of the higher poles of the line. In addition to the simultaneous recording of contacts, wind velocity, and wind direction, measurements are made by the attendant of the sag of the wires, of the insulation resistance, of the radial thickness of ice, if present, and of the nature of the weather.

Other studies of open-wire lines are being made which include those of sleet accumulations on several sizes of wires, of the comparative merits of various transposition arrangements as they affect contacting, and of the actual motion of the wires under

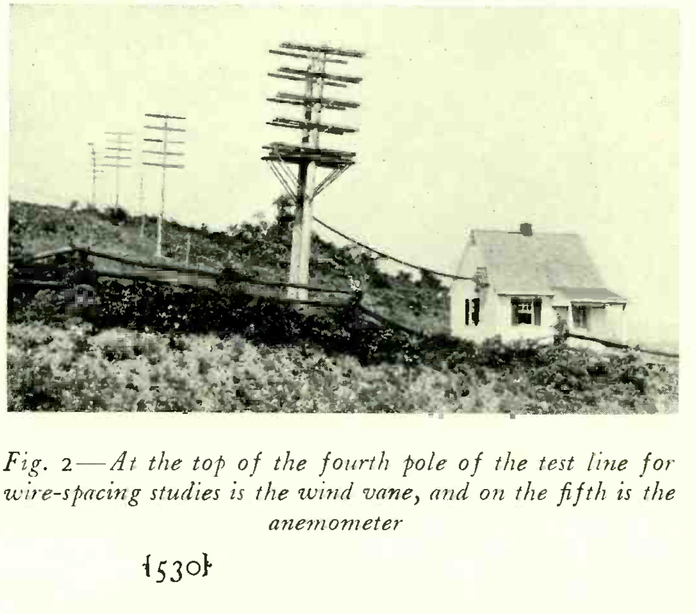


Fig. 2—*At the top of the fourth pole of the test line for wire-spacing studies is the wind vane, and on the fifth is the anemometer*

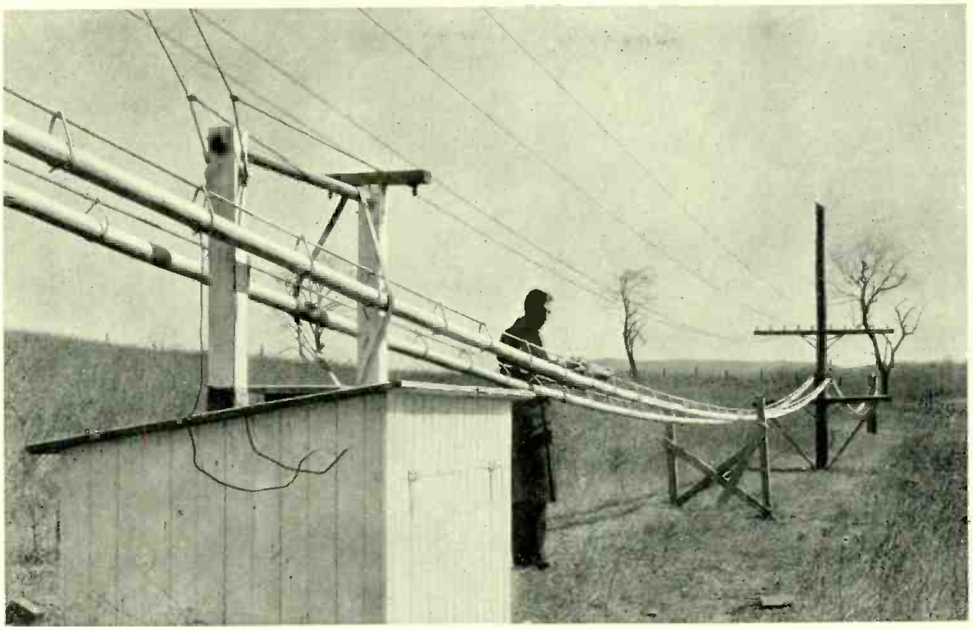


Fig. 4—An automatic swinging apparatus swings two adjacent cables to obtain an accelerated test on various types of cable hangers

various wind velocities. These latter are made, when there is a high wind blowing across the line, by modified motion picture cameras giving a continuous record on a slowly moving film of the displacement of the wires.

Just to the right of the Line Systems Laboratory, shown in Figure 2, a short experimental pole line has been erected for studies of methods for supporting aerial cable. Two messenger strands are supported about seven feet from the ground, and from each is suspended a standard cable with different types of cable rings. The arrangement is shown in Figure 4. A motor-driven mechanism causes the two cables to swing through an arc approximating that produced by a fifty-mile wind blowing at right angles to the

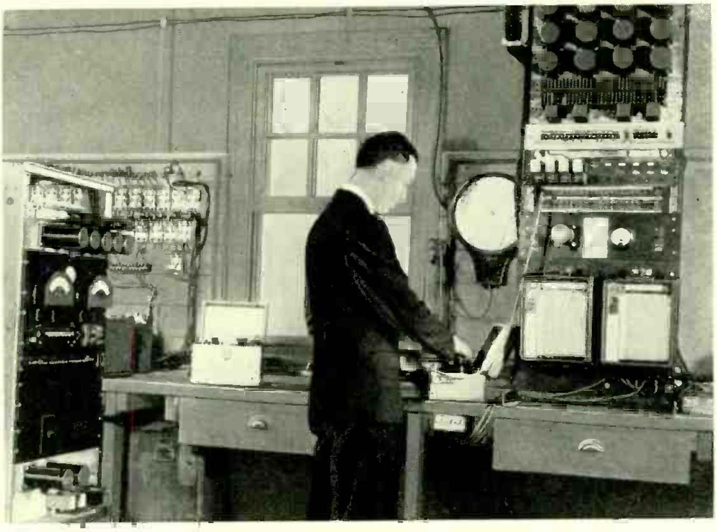


Fig. 3—H. T. Cavenaugh with line-contact recording apparatus in the test house

Fig. 5—G. Q. Lumsden securing a sample from a creosoted pine post

is expected that valuable data as to the relative merits of the lead-calcium and lead-antimony sheaths will be obtained in the near future, it is probable that it will be found desirable to extend this test over a period of years.

On the northeast section of the plot, tests are being run on the protective properties of various timber preservatives. Here treated pole-size posts are set in the ground in the usual manner (Figure 5) and periodical borings give a progressive record of the state of the wood. The tests here will supplement those being carried on concurrently under different climatic conditions both in Gulfport,

line. This violent swinging accelerates the wear at the cable supports so that comparative data on cable-sheath deterioration may be obtained in a reasonable length of time.

Preparation is being made for another aerial cable test to compare lead-calcium with lead-antimony cable sheaths. Six parallel lines of poles running due north and south have been set traversing the property diagonally. Each line will carry four cables with graded sheath thicknesses. There will be an equal number of cables with each of the lead alloys and the messengers have been strung with a tension to give considerable bowing to the pole supports under summer temperatures.

All cables will be maintained under gas pressure and mercury manometers with sealed-in electrical contacts will cause the operation of an alarm circuit when the pressure falls below a predetermined minimum. Although it

Fig. 6—S. M. Sutton making a mortar-bandage joint in underground conduit

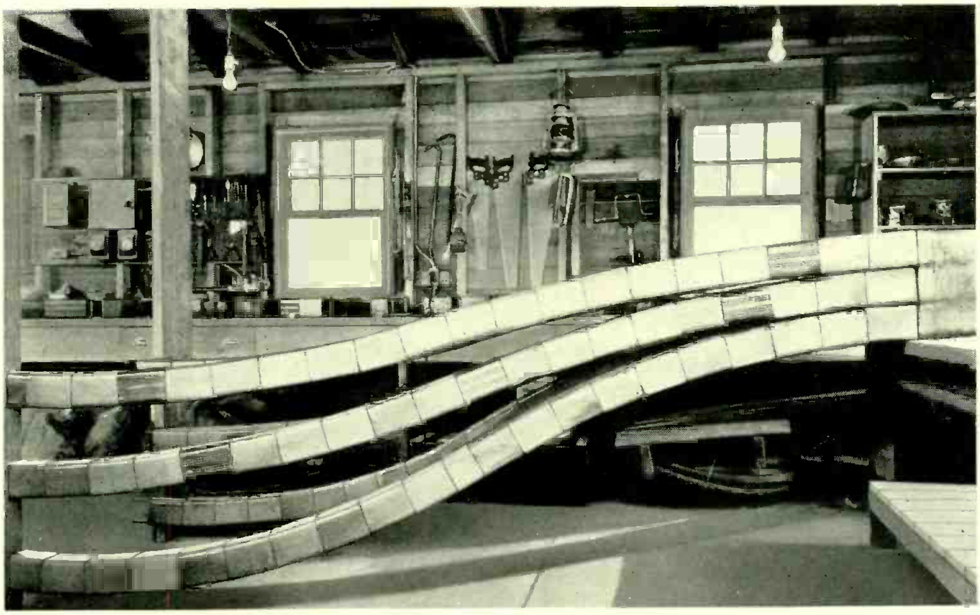


Fig. 8—An interior view of the ceramics laboratory showing an experimental structure of splayed conduit

Mississippi, and in Limon, Colorado.

A variety of underground conduit studies is also being carried on in the Chester field laboratory. Particular attention has been given recently to a mortar-bandage method of making conduit joints. As its name implies the mortar-bandage is made up of a plastic cement mortar with a covering of cheesecloth to form a flexible wrapping which is tied around the conduit joint as shown in Figure 6. This joint has the merit of effectively excluding ground water and silt from the ducts.

To evaluate the water-tightness of various experimental conduit joints, open concrete-lined trenches have been provided which are capable of being flooded. A line of conduit can be constructed in any experimental manner in one of these trenches. The trenches can be flooded so that the amount of leakage through the joints can be measured to gauge their effectiveness.

At the point where a conduit run enters a manhole, it is often desirable to spread or splay out the ducts so that they enter the end of the manhole in separated positions, usually near the sides. This minimizes the amount of bend-

Fig. 7—Concrete-lined trench for studying various types of splays

ing of the cables in the manholes and simplifies their arrangement along the walls. To permit studying the many problems relating to permissible splay curvatures, to the size and shape of duct holes, and other design features, concrete-lined splay trenches have been provided as shown in Figure 7.

A duct run, 750 feet long, has been constructed for studies of the forces required to pull cable through ducts around bends of definite degrees of curvature. Studies of duct construction are also made at times inside the conduit test house. The set-up for one such study is shown in Figure 8 which illustrates as well the appearance of the interior of the laboratory.

In addition to the studies briefly mentioned above, many others are in progress and still others are projected for the future. Studies are being made at the present time on several types of wire joints and their action under service conditions, on the aging characteristics of various types of bare and insulated wire, and on certain pole fixtures. For all this wide variety of tests the field laboratory at Chester with its varied terrain is an important adjunct to the Canal Street laboratories in the study of materials and methods to be used in the outside plant of the Bell System.

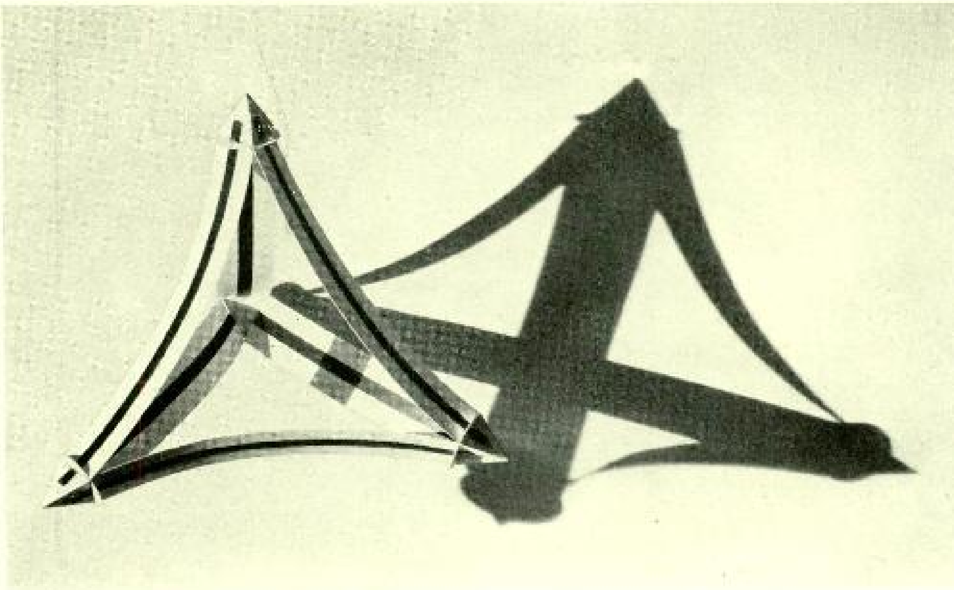
Reflection of Popular Interest in a Talk by S. P. Grace

This community will long remember the evening of miracles staged at Purdue University by Bell Telephone Laboratories, Inc., through Sergius P. Grace, master of modern magic, and his helpers, mechanical and human. The entertainment was packed with thrills, information and instruction, and left a large audience mystified, gasping and duly impressed.

It is a good thing for the public to know something of the research work carried on by the great agencies of inter-communication, and how adventures in telephony have resulted in astounding, epochal and invaluable discoveries and inventions in various and divergent fields.

It is interesting to be told of the latest devices for improving telephony, and at the same time it is a splendid thing to learn how research connected with communication has contributed priceless by-products to medicine, surgery, radio, motion and sound pictures and to human welfare.

—From the Lafayette, Ind., Journal Courier.



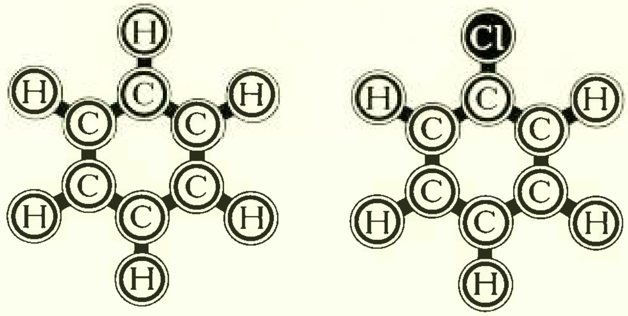
Dielectric Properties and Chemical Constitution

By S. O. MORGAN
Chemical Research

TO the electrical engineer, the amount of electrical energy which can be stored in an insulating material is one of its most important properties. From this amount, measured as the dielectric constant of the material, he can determine how large an alternating current will pass through it.

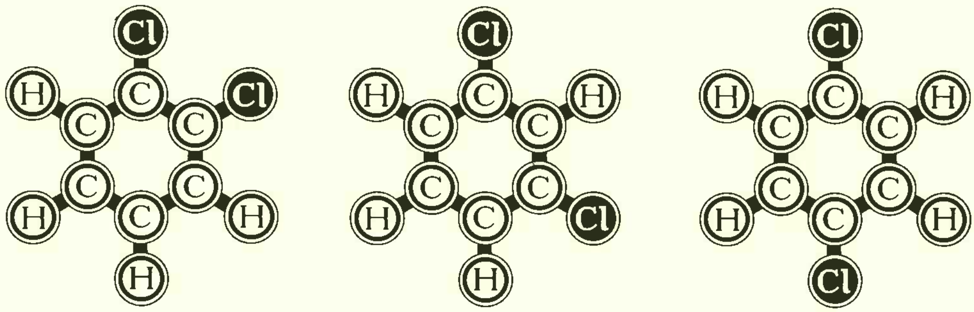
To the chemist, the dielectric constant is but one of the many properties of substances which vary both with their ingredients and with their physical state. Whenever the chemist encounters such a property, he suspects that there are relationships between it and the chemical constitution of the material. It is always important for him to discover these relationships if possible, for he can often use them to make a knowledge of the property of the material yield a knowledge of its constitution, or vice versa.

In the case of the dielectric constant these relationships have been worked out to an extent which encourages their application to special problems. On the practical side, electrical engineers are making use of the new knowledge to build up structures with predicted dielectric properties. On the purely scientific side, chemists are using dielectric data to settle disputes over certain features of chemical constitution.



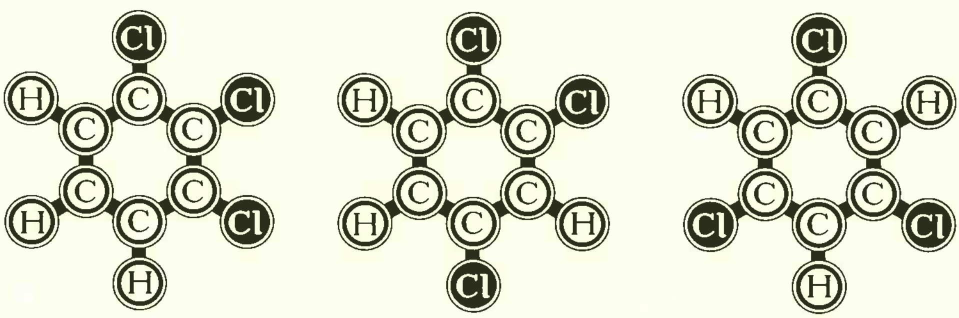
A B

Fig. 1—In benzene (a) each hydrogen atom is bonded to a different carbon atom and each carbon atom is bonded to two other carbon atoms. The replacement of any one hydrogen atom produces the same monochlorobenzene (b), since the hydrogen atoms are similarly linked in the molecule



A B C

Fig. 2—Differences in the separation of two chlorine atoms bonded to the benzene ring account for the three known dichlorobenzenes: (a) ortho, (b) meta, (c) para



A B C

Fig. 3—There are three distinct trichlorobenzenes

As was described in a previous issue of the RECORD*, the dielectric constant is for the chemist a measure of the polarization which occurs when a substance is stressed by a potential. The polarization is a result of a shifting of the component electric charges of the substance so that the centers of positive and negative charge do not coincide. It can be analyzed into three parts, related respectively to electrons, atoms, and molecules. Electronic polarization is due to shifts of electrons relative to the nucleus within each atom. Atomic polarization is accountable to shifts of atoms within each molecule. Molecular polarization, which occurs only in permanently dipolar molecules, is caused by their rotation from random to uniform orientation. To say that the latter rotations take place only with permanent dipoles is the same as to say that molecular polarization occurs only in "polar" substances — substances which are chemically, and therefore electrically, asymmetrical.

With the interior of the atom the chemist is not ordinarily concerned, and such a knowledge of electronic motions as a study of electronic polarization might disclose is not of immediate concern to him. Leaving to the physicist questions regarding the structure of atoms in terms of electrons and nuclei, he asks only that any proposed structure be consistent with his own speculations concerning the structure of molecules in terms of atoms. Thus even the fanciful structures of the carbon atom displayed as the headpiece and tailpiece to this article would be agreeable to the chemist, since they retain his idea that the forces binding a carbon atom into a molecule are four in number, directed toward the vertices of a tetrahedron. He is, however, concerned with the positions of other atoms relative to those of carbon in carbon compounds, and thus with the occurrence and magnitude of permanent dipoles in these compounds. One of the most interesting illustrations of the way in which a study of molecular polarization can supplement a chemical study is furnished by benzene and its derivatives.

*June, 1931, p. 462.

An ultimate analysis of benzene will disclose that its molecule is compounded of equal numbers of carbon and hydrogen atoms, dictating a formula C_nH_n. A molecular-weight determination will next show that *n* in the formula C_nH_n can only equal six. It then becomes a problem to discover how these twelve atoms are disposed in the molecule. The first step toward the solution of this problem is to cause benzene to take part in chemical reactions, from the nature of whose products can be inferred the structure of the original benzene.

Typical of the reactions which furnish valuable material for inference are those of benzene with chlorine. When chlorine gas is mixed with benzene, some or all of the hydrogen atoms of the benzene are replaced by chlorine, according to the conditions under which the reaction is conducted. Under certain conditions the product of the reaction is largely a single compound, C_6H_5Cl. If the conditions are changed, mixtures with the composition $C_6H_4Cl_2$ are produced. These mixtures can be separated into three distinct dichlorobenzenes, each with the formula $C_6H_4Cl_2$ but with different and characteristic physical properties such as boiling point, melting point, density, and refractive index. Under still other conditions analogous

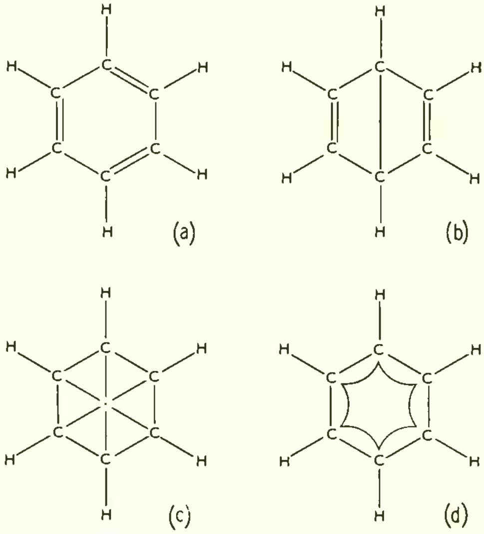


Fig. 4—Among the numerous structures suggested to dispose of the fourth valence of each carbon atom in the benzene ring are those proposed by (a) Kekulé in 1865, (b) Dewar in 1866, (c) Armstrong and Baeyer in 1887, and (d) Thiele in 1899. Each has certain chemical justifications

mixtures of three trichlorobenzenes with the composition $C_6H_3Cl_3$ can be prepared. The number of distinct chlorinated benzenes having each of the possible compositions is shown in Table I. Thus the structure of benzene must be such as to admit these and only these numbers of distinct structures for the different chlorinated compositions.

It is remarkable that before data of this sort was available, Kekulé was able to write a structure for benzene which remains substantially unchallenged to this day. Kekulé dreamed of a wriggling snake holding its tail in its mouth, and thence imagined the six carbon atoms as arranged, each with an associated hydrogen atom, at the corners of a regular hexagon (Figure 1-a). Since all the carbon atoms are in structurally equivalent positions, only one monochlorobenzene is possible (Figure 1-b), and the number of the polychlorobenzenes are the numbers of arrangements of chlorine atoms in differing separations about the molecule, as in Figures 2 and 3.

It is possible to decide which of the dichlorobenzenes has which of the possible structures by replacing with chlorine another hydrogen atom in the molecules of each of them and counting the number of trichlorobenzenes so produced. The *para* structure will be assigned to the dichlorobenzene from which only one trichlorobenzene (Figure 3-b) can be prepared, the *ortho* structure to that from which two (Figure 3-a and b) can be prepared, and the *meta* structure to that which can be chlorinated into all three.

But, refined and conclusive as it is up to a certain point, such reasoning poses a problem as large as that which it solves. Extensive evidence from a

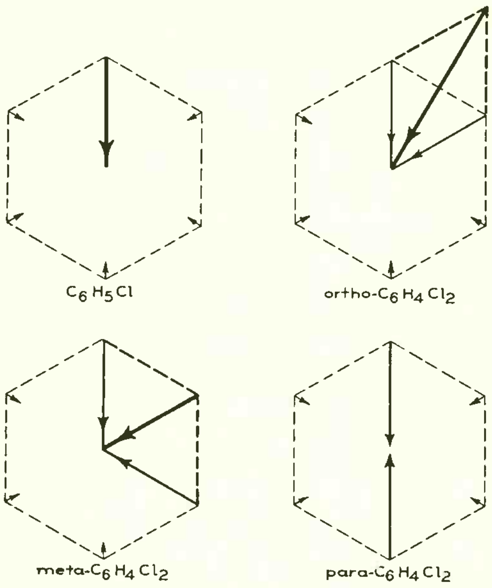


Fig. 5—The influence of each constituent of a benzenoid compound can be represented by a vector directed toward the center of the ring. The combined influence is then the vector resultant

TABLE I

Composition	*Number of Structures*
C_6H_6	1
C_6H_5Cl	1
$C_6H_4Cl_2$	3
$C_6H_3Cl_3$	3
$C_6H_2Cl_4$	3
C_6HCl_5	1
C_6Cl_6	1

Number of distinct chlorobenzenes of various compositions

wide range of carbon compounds indicates that carbon exerts, toward the atoms with which it is chemically combined, four binding forces directed toward the vertices of a tetrahedron. To accept the hexagonal formula for benzene is to accept a challenge to elaborate the formula in a way which disposes of the four bonds of each carbon atom, while leaving the carbon atoms each contiguous to only three other atoms. The effort to meet this challenge has resulted in the proposal of many special configurations for the atoms in benzene, disposing of the bonds in ways as various as those indicated in Figure 4 and necessitating in many cases the assumption that the atoms do not lie in the same plane. It is in helping to decide between these suggestions that dielectric investigations become valuable.

It is first interesting to notice how the dielectric data for the three dichlorobenzenes bear out in a qualitative way the hypotheses regarding the relation between polarity and asymmetry. Since the structure of the *para* compound is symmetrical, it would be expected to have the lowest dielectric constant of the three. The dielectric constant of the *ortho* compound, the most asymmetrical, would be the highest; and that of the *meta* compound would be intermediate. That these expectations are verified is shown by Table II.

TABLE II

Substance	*Dielectric Constant*
ortho-$C_6H_4Cl_2$	12.0
meta-$C_6H_4Cl_2$	7.0
para-$C_6H_4Cl_2$	2.4

Dielectric constants of liquid dichlorobenzenes at their freezing points

But such data as this can be put to more quantitatively precise use. From the observed dielectric constant of any substance there can readily be obtained the electric moment of its molecule:

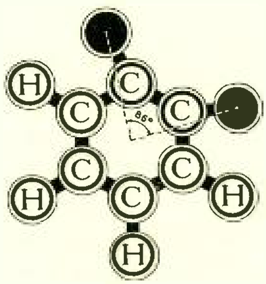


Fig. 6—*Repulsion between the two adjacent electro-negative chlorine atoms results in a distortion of the orthodichlorobenzene molecule*

the product of the separation of the centers of charge and the value of either charge. It is this "observed electric moment" that would be expected to have the most direct relation to the chemical structure of the substance. By scrutinizing the differences between the electric moments of molecules which differ by only one constitu-

TABLE III

Substance	*Calculated Electric Moment*	*Observed Electric Moment*
C_6H_6	—	0
C_6H_5Cl	—	1.56
ortho-$C_6H_4Cl_2$	2.68	2.25
meta-$C_6H_4Cl_2$	1.55	1.48
para-$C_6H_4Cl_2$	0	0

Observed and calculated electric moments of benzene, monochlorobenzene, and the dichlorobenzenes, checking a plane hexagonal structure ent, the electric influence of each constituent can be isolated. To correspond with any supposed molecular structure, an electric moment can then be calculated by combining the influences which the different atoms would exert in their supposed positions. Thence the possibly true structures of any molecule can be picked as those for which the "calculated electric moment" approximates the "observed electric moment" of the substance.

Since the electric moment of benzene is zero, the electric moment of monochlorobenzene must be contributed exclusively by the chlorine atom. This contribution is taken to be that which any atom of chlorine will contribute to any benzenoid compound. The combination of the electric contributions of several such atoms in a benzenoid compound is then effected by regarding them as vector quantities, directed toward the center of the benzenoid ring and calculating their vector resultant. When this is

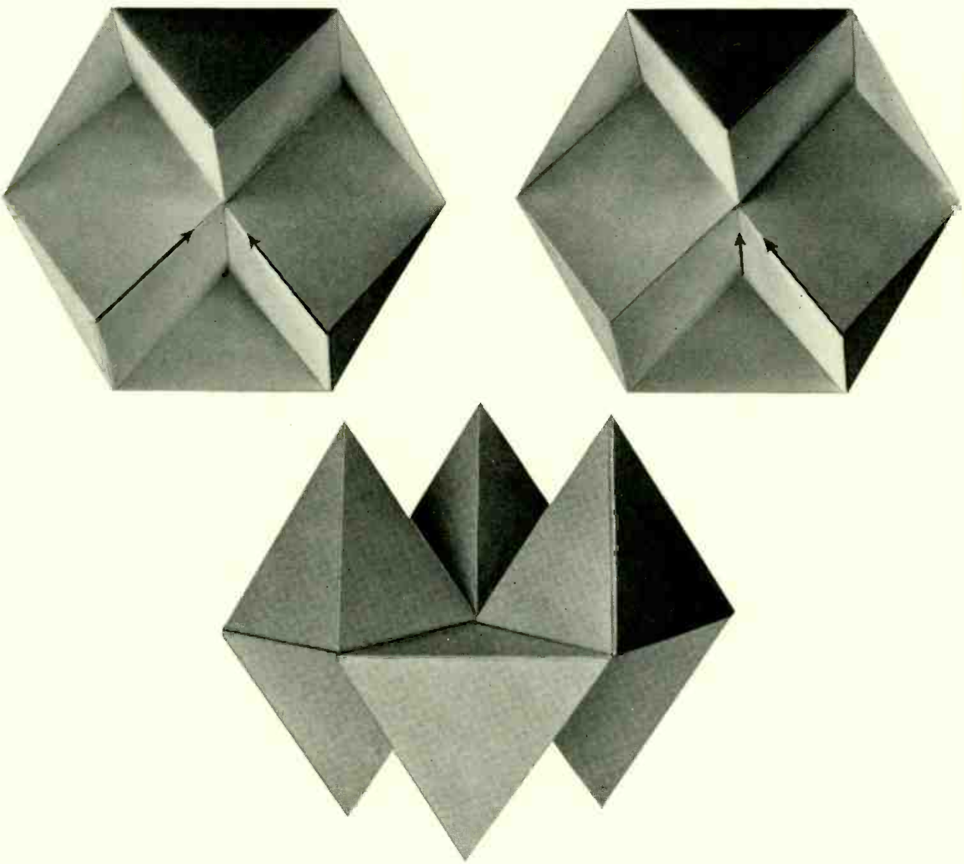


Fig. 7—In a spacial model of the benzene ring, proposed by Koerner, the carbon atoms are located in two different planes and the four valences of each are directed toward the corners of a tetrahedron. Vectors directed toward the center of the ring from the vertices at which the chlorine atoms are located form such angles that the resultants for the dichlorobenzenes give electric moments which do not correspond with those observed

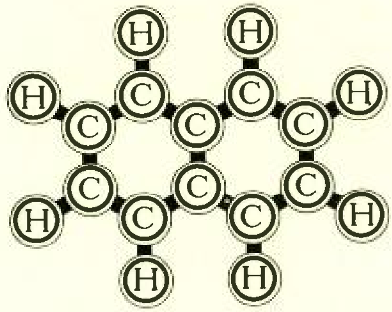


Fig. 8—From evidence similar to that for benzene, naphthalene is regarded as composed of two benzenoid rings

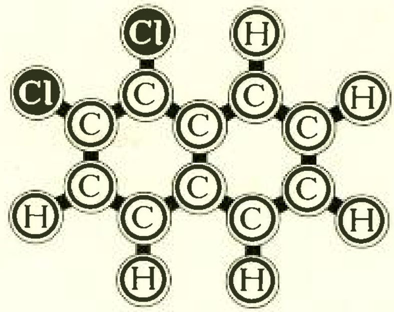


Fig. 10—This asymmetrical dichloronaphthalene has an electric moment about that of orthodichlorobenzene

done, as in Figure 5, for the three dichlorobenzenes, on the assumption that the benzenoid ring is a regular plane hexagon, the calculated moments are obtained which are compared with the observed moments in Table III.

The fact that the agreement between calculated and observed values is close except in the case of the *ortho* compound leads to the conclusion that the plane hexagonal structure is essentially correct but that some special complicating influence is operative in the *ortho* compound. Such an influence is not far to seek. Since the chlorine atoms are electro-negative, they repel each other, especially when close together as in the *ortho* compound, and thus the angle between the vectors tends to become larger and the resultant to become smaller. If the observed electric moment is taken as the resultant, the angle between the vectors can be determined as 86 degrees (Figure 6). The distortion in the *meta* compound would be slight, only slightly affecting its electric moment; and the distortion of the *para* compound, a mere elongation of the benzenoid ring, would not affect its electric moment at all.

The moments calculated for the dichlorobenzenes when various non-planar ringed structures are assumed do not correspond so nearly with the observed moments. In the ring of Figure 7, for example, where alternate carbon atoms lie in two different planes, it can be seen that the vectors

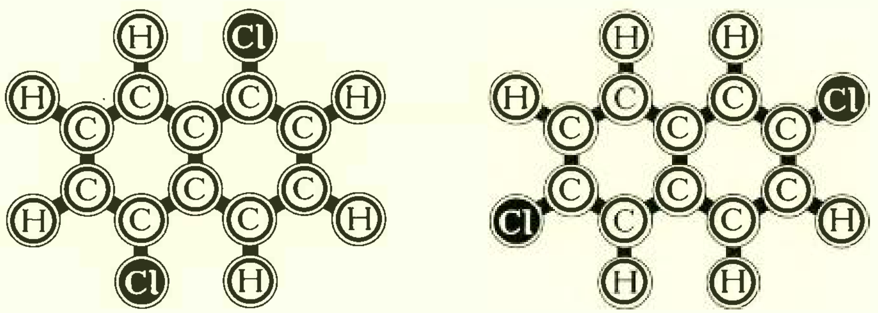
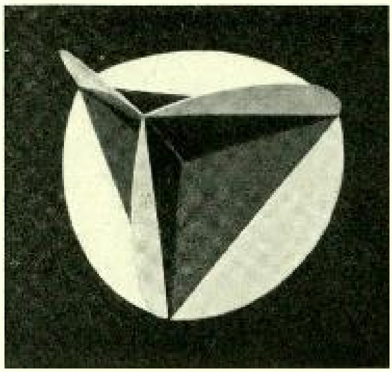


Fig. 9—Certain of the dichloronaphthalenes are chemically symmetrical and have no electric moment

for chlorine atoms in the *ortho* position, pointing one up and one down, would partly cancel and leave a moment smaller than the observed, while the vectors in the *meta* compound, both pointing either up or down, would give a moment larger than the observed. It has thus been concluded that in the benzenoid ring the carbon atoms must be nearly if not exactly co-planar.

Analogous conclusions have been reached from a study of the products obtained by chlorinating naphthalene, a substance to which, from reasoning similar to that for benzene, the structure shown in Figure 8 has been assigned. It is noteworthy that naphthalene itself, and two dichloronaphthalenes whose structures are shown in Figure 9, are symmetrical and have no electric moment. The dichloronaphthalene whose structure is shown in Figure 10, on the other hand, is asymmetrical and has an electric moment practically the same as that of orthodichlorobenzene.

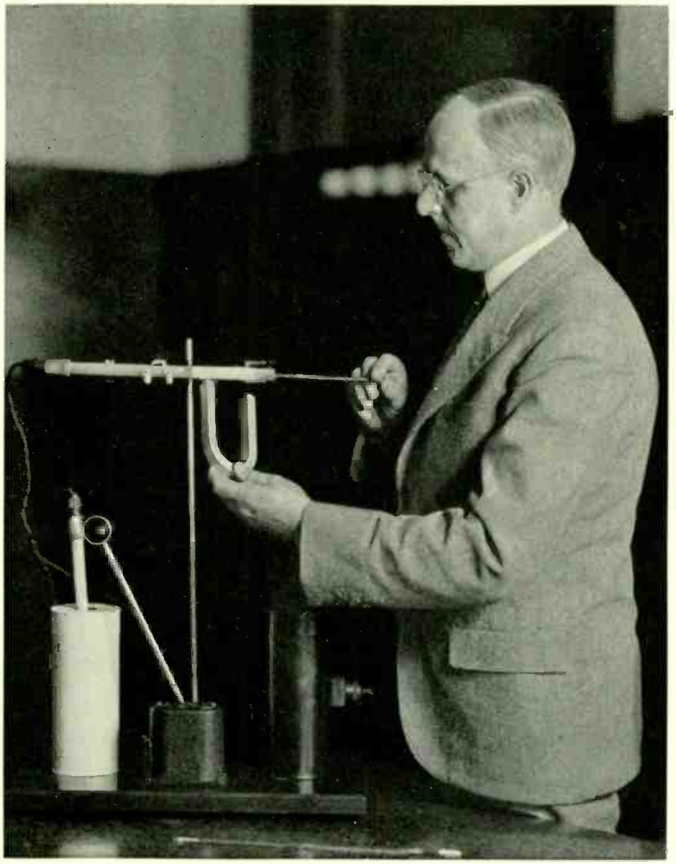
The chlorinated naphthalenes are of great practical interest to the Bell System because a complicated mixture of these compounds consisting principally of tri- and tetra-chloronaphthalenes and known as Halowax, is widely used for impregnating condensers. It is hoped that such dielectric studies as those described will determine which compounds are most suitable for use in condensers, and will furnish a guide to the practical selection of "dielectrics".



NEWS AND PICTURES

of the

MONTH



Dr. Arnold demonstrates the Barkhausen effect in his address before the American Association for the Advancement of Science at Pasadena

General News Items

BANCROFT GHERARDI ADDRESSES THE LABORATORIES ON THE BELL SYSTEM'S CONSTRUCTION AND OPERATION PROGRAM

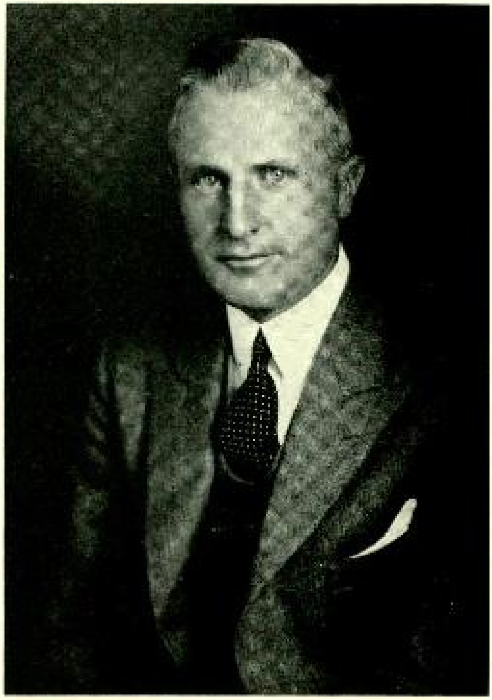
THAT BELL SYSTEM people have done an excellent job under difficult conditions was the keynote of a talk by Bancroft Gherardi, Vice-President of the American Telephone and Telegraph Company to supervisors of the

Bancroft Gherardi

Laboratories on Thursday, June 18. Basing his opinion on the generally-conceded belief that the present business level is less than that required for current consumption, to say nothing of the country's requirements for normal growth, Mr. Gherardi expressed confidence in the future average gain of the telephone business.

While public opinion seems to indicate general satisfaction with Bell System service, further improvements are still being striven for. Effort may take several directions, of which those involving improved methods and better training of personnel are much to be preferred.

W. H. Harrison, Plant Engineer, supplemented Mr. Gherardi's remarks by more specific data on the System's construction program. He also outlined the plans formulated by the American Telephone and Telegraph Company, the Associated Companies and the Western Electric Company



W. H. Harrison

for the stabilization of the manufacturing program.

Mr. Charlesworth, who had introduced the two previous speakers, then welcomed Dr. Jewett on his first appearance before a general Laboratories audience since his return from the West. Dr. Jewett spoke briefly on the Laboratories' relationship to the construction and manufacturing program of the Bell System and closed with a word of appreciation for the part all members of the Laboratories were playing in aiding to meet the present difficult situation.

Acoustic Advances Described by H. D. Arnold in Los Angeles

At the invitation of the American Association for the Advancement of Science, Dr. Arnold addressed a public meeting in the Greek Theatre, Griffith Park, Los Angeles, on the evening of June 16. Under the title *Science Listens*, he discussed recent discoveries in sound and its electrical transmission, and illustrated his remarks with many demonstrations.

Pointing out that recently developed apparatus enables us at will to convert acoustic energy into sound and vice versa, Dr. Arnold explained that the well-developed technique of electrical measurement was rapidly advancing the science of acoustics, which has hitherto lagged behind its sister-science, optics. After a brief explanation of the mechanism of hearing, he demonstrated how one tone can prevent the perception of another tone. He then let his audience determine for themselves how small a difference in pitch they could perceive for tones of equal loudness. Similar experiments were performed, comparing loudness for tones of equal pitch.

An explanation of the functions of filters followed, and Dr. Arnold showed how their elimination of certain tone-ranges affects our perception of complex sounds. Oscillograms were shown of these sounds before and after the filters had removed certain of the harmonics.

Oscillograms were effectively used again in a demonstration showing how relatively slight intrusion of unwanted sound will mar a broadcast program or a telephone conversation. That certain forms of noise are inherent in conductors and in magnetic materials was strikingly shown with the aid of a high-gain amplifier. Noise due to the random motions of electrons in a conductor, known as the Johnson effect, from its discoverer Dr. J. B. Johnson of the Laboratories, appeared as a steady roar when amplified some quintillion times. It was silent at the temperature of liquid air, and increased steadily with temperature. The Barkhausen effect was also illustrated; noise-currents were set up in a coil surrounding a wire whose magnetism is changing, because the change takes place in finite steps. Both of these effects are important as tending to set a lower limit on the feebleness of currents which can be amplified without being excessively contaminated by noise.

S. P. Grace's Telephone Talks Draw to Season's Close

The last of S. P. Grace's addresses for the season on modern developments in communication, which have been popularly received and attended by large audiences throughout the country, was given on May 25 in the gymnasium of Purdue University at Lafayette, Indiana. Four thousand persons listened to the talk and witnessed the demonstrations of telephonic research marvels. The address was sponsored by Purdue University, the Lafayette Telephone Company and the A.I.E.E.

During the season extending from last October which has just closed Mr. Grace addressed 32 meetings in 21 cities. Approximately 100,000 persons listened to his talks and witnessed the demonstrations at which he was assisted by R. M. Pease. The largest single meeting was at Austin, Texas, on March 31 which was attended by 9,000 persons. In addition Mr. Grace spoke on seven occasions at smaller meetings. The itinerary of Messrs. Grace and Pease extended as far west as Oklahoma and included a travelling distance of over 13,000 miles.

Honorary Degree Conferred on F. F. Lucas by Lehigh

At the graduating exercises of Lehigh University on June 9 at Bethlehem, Pennsylvania, the honorary degree of Sc.D. was awarded to F. F. Lucas of the Apparatus Development Department.

F. F. Lucas

Mr. Lucas was presented to President C. R. Richards of the University by Professor Bradley Stoughton, head of the metallurgical department, who enumerated his contributions to high-power photomicrography and cited the technical papers he has written on the subject. In awarding the degree President Richards stated: "In recognition of your distinguished contributions to the science of metallurgy and technical microscopy and of your inventions which have enabled man to see and to interpret things that had not previously been seen or clearly understood, the Faculty of Lehigh University, with the approbation and consent of the Board of Trustees, has charged me with the pleasant duty of conferring upon you the honorary degree of Doctor of Science."

Cooper Union Grants Degrees to Seven Laboratories Men

The class of 1931 of Cooper Union includes seven members of the Laboratories. G. Bittrich of the Research Department received a degree in Chemical Engineering; J. M. Rogie of the Research Department and A. V. Wurmser of the Systems Development Department were recipients of Electrical Engineering degrees; and R. F. Elliott and R. P. Muhlsteff, Apparatus Development Department, and C. F. Mattke, Research Department, were awarded degrees in Mechanical Engineering.

Noted Stage Designer Views Laboratories Developments

Norman Bel Geddes, celebrated designer of theatrical sets, and an advisory member of the Architectural Commission for the Chicago World's Fair of 1933, was a visitor to the Laboratories on May 28. Upon the invitation of the New York Telephone Company he spoke over the two-way television system and then visited our Sound Picture Laboratory. He was an interested observer of the apparatus used in sound picture developments and of the improved quality resulting from the new noiseless recording process.

Committee Memberships Are Listed in Report

A list of the committee memberships in technical societies held by members of the Laboratories has been assembled by the Bureau of Publication. The report shows that Laboratories men are active in the committee work of thirty societies. Not only are all of the major technical societies included on the report, but also numerous smaller organizations.

The wide scope of the Laboratories field of activities is suggested by a glance at the report which shows, for example, Mr. Charlesworth's prominent A.I.E.E. activities and membership of the Aeronautical Chamber of Commerce as well; W. Wilson's numerous committee activities in the C.C.I.R., the 1931 meeting of which he is now attending in Copenhagen; the prominent position of Herbert E. Ives on the Councils of the American Physical Society and American Association for the Advancement of Science.

Laboratories members are especially active in the work of the American Standards Association. R. L. Jones is chairman of the sectional committee on wood poles and numerous members of the Outside Plant are represented on other timber standardizing committees. Laboratories men are also engaged prominently in the committee work of the American Society for Testing Materials of which H. N. Van Deusen is member of the executive and other committees, and W. A. Shewhart and J. R. Townsend are included in the membership of several important committees.

Colloquium

The closing meeting of the season of the Colloquium was held on May 25. C. J. Christensen spoke on the subject, *Further Contact Studies and the Theory of Microphonic Action.*

In his talk Mr. Christensen pointed out that carbon contacts exhibit a breaking strength due to internal forces. If a contact is burned by a voltage above a critical value the conductance of the contact is decreased and the ratio of breaking strength to conductance is increased. The nature of the conductance is unaltered. This indicates, he said, that there is a nonconducting portion in the contact across which internal forces are effective. The area contributing to the internal force is greater than the conducting area.

Internal force decreases microphonic action, hence a contact with a minimum of internal force is desirable he asserted. A contact between the surfaces with geometrical roughness would probably exhibit relatively small internal force, but for such a surface to resist plastic deformation under contact forces the surface material must be hard.

Administration

F. B. Jewett is a member of the recently formed National Advisory Council on Radio in Education. The council is sponsored by eminent educators and philanthropists to further the development of educational broadcasting.

H. P. CHARLESWORTH addressed the Patent Department luncheon on May twentieth.

S. P. GRACE has been appointed a member of President Hoover's National Housing Conference, on the committee on Utilities for Houses. The committee is engaged in a broad study of home development, including such phases as financing, city planning, construction methods and materials and applying public utility services.

R. L. JONES and A. F. Dixon, accompanied by J. H. Bell, J. A. Mahoney, and H. T. Martin, visited the plant of the Teletype Corporation in Chicago for a discussion of problems in connection with printing telegraph apparatus and systems. Messrs. Jones and Martin also visited Hawthorne on various telephone apparatus design problems.

In the department of the Mathematical Research Engineer, T. C. Fry: Doris Raine, left, and Florence Curtin engaged in calculations

Departmental News

Apparatus Development
Special Products

R. F. Mallina made a trip to the Hawthorne plant to discuss the portable disc recording and reproducing machine. With L. A. Elmer he attended the recent meeting of the Acoustical Society at Camden, New Jersey.

W. L. Betts and H. M. Stoller visited Schenectady on an inspection trip of the General Electric plant held under the auspices of the New York Electrical Society.

The installation of a 1-kw radio-telephone broadcasting equipment and associated speech-input equipment for station WRR owned by the City of Dallas, Texas, was supervised by B. R. Cole. While in Texas he also visited Beaumont to inspect station KFDM of the Magnolia Petroleum Company.

C. B. Aiken testified as an expert witness before the Federal Radio Commission at Washington.

W. L. Black attended the convention of the Acoustical Society of America at Camden.

R. C. Carlton was at Wright Field, Dayton, to supervise the installation and testing of several of the new radio-telephone equipments recently developed by the Laboratories for two-way communication between pursuit planes of the U. S. Army.

A recent visit to the plant of the Hart and Hegeman Company in Hartford was made by I. R. Horn and C. B. McKennie together with R. M. Taylor of the Materials group on problems concerning reciprocating switches.

J. H. De Witt, Jr. inspected station WSM of the National Life and Accident Insurance Company at Nashville, Tennessee.

The installation of a 1-kw radio-telephone broadcasting equipment for station KOL owned by the Seattle Broadcasting Company, Seattle, was directed by O. W. Towner. He also inspected stations KVI at Tacoma, KLZ at Denver, and KNX and KTM in Los Angeles.

F. M. Ryan gave an illustrated lecture at the New England Conference of the American Society of Mechanical Engineers at Hartford.

L. C. Mueller completed twenty years in the Bell System on June 9.

C. C. Graves received on June 15 a five-star service button significant of twenty-five years in the Bell System. His engineering work began in 1907, when he entered the drafting department; two years later he became a designer, working on telephone receivers, signals, relays and the like.

During the war, as a Sergeant, First Class, in the Signal Corps, he was attached to the Division of Research and Inspection under Col. H. E. Shreeve in Paris. A clip for instant reconnection of wires severed by shell fire, which he invented at this time, was credited by the Army as materially lessening the time a repairman need be exposed in restoring service.

Returning to the Laboratories, Mr. Graves took up the mechanical design of special products, including the carbon-button and electromagnetic phonograph reproducers and the electrical stethoscope. He then transferred to the Radio Development group, where he has been responsible for the mechanical design of laboratory and testing equipment, notably the 44-A Test Set for radio field-strength measurement and a similar set for the long-wave transatlantic investigation.

C. C. Graves

Telephone Apparatus

W. Fondiller and W. J. Shackelton attended a meeting of the U. S. Sub-Committee on Magnetic Units of the International Electro-technical Commisssion. Mr. Shackelton also attended an ASTM sub-committee meeting on Magnetic Definitions.

L. E. Dickinson was at Atlantic City taking noise measurements on base-metal contacts. Also on base-metal contact investigations, C. E. Nelson was at Stamford, Connecticut, and Atlantic City.

T. S. Huxham visited the U. S. Tool Company at Ampere, New Jersey, to discuss molds for handset mountings.

Tests on telephone apparatus in explosive atmospheres were made by C. H. Wheeler and G. W. Burr at the Consolidated Gas Company's testing station in New York City.

Mr. Wheeler also discussed explosive atmospheres as prevailing in oil refineries with engineers of the Standard Oil Company of New Jersey.

J. M. Hayward of these Laboratories, who is a Major in the Air Corps Reserve, was assigned by the Air Office at Governor's Island to assist in the radio broadcasting of the recent manoeuvers of the Army Air Corps over New York City. His station was on the roof of the Whitehall Building at Battery Place.

P. Ward visited the Kearny Shop to discuss the manufacture of a new design of potentiometer for use in trial installations of a two-wire cable repeater.

Problems concerning the manufacture of the rapid-record oscillograph were discussed by A. C. Magrath in a recent visit to the Philadelphia Instrument Shop.

S. J. Harazim and H. W. Garbe visited Kearny in connection with the welding of aluminum boxes for testing apparatus.

In company with R. W. Chesnut of the Systems Department C. F. Swasey visited the Brown Instrument Company at Philadelphia to discuss the manufacture of indicating controllers for use in carrier telephone equipment.

J. F. Baldwin, Jr., rounded out twenty years in the Bell System on June 18.

Dial Apparatus

O. F. Forsberg and H. F. Dobbin were in Hawthorne for conferences on new dial apparatus developments.

FIELD STUDIES of step-by-step relays were made by G. B. Baker at Waterbury, Hartford and Worcester.

C. G. McCORMICK and V. F. Bohman visited Stamford for tests on step-by-step switches.

TRANSMISSION APPARATUS

A QUARTER of a century in the Bell System was completed by Robert T. Staples on June 10.

After attending Virginia Polytechnic Institute Mr. Staples entered upon telephone work in the Long Lines

R. T. Staples

Toll office at Philadelphia. Within a year he enrolled in the Western Electric student course here in New York and obtained a thorough training in telephone manufacturing activities. He later was assigned to tests on keys, switches and miscellaneous apparatus in the former physical laboratory.

In 1913 he began work on the development of condensers, both paper and mica. He carried on extensive activities in testing hermetically-sealed condensers and preparing them for field use. The problem of making stable and accurately adjusted condensers was particularly important at this time for use in telephone repeaters.

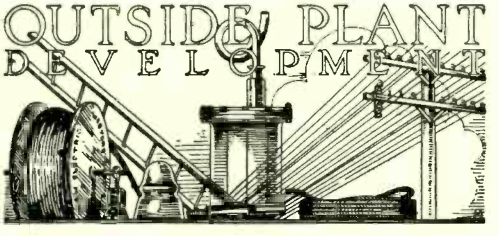
Mr. Staples in 1926 began his present work on the development of wire cables and switchboard cords. The fast dyes now used in cords and cables resulted from his investigations. Recently he has been engaged in the application of washed cotton to replace silk in central office apparatus and wiring.

C. A. BRIGHAM visited Hawthorne on work connected with the manufacturing and testing of neutralizing transformers.

DRAFTING AND SPECIFICATIONS

IN RECOGNITION of his scholastic excellence, R. F. Elliott was designated as salutatorian of the 1931 graduating class at Cooper Union. He was also honored for his participation in extra-curriculum activities.

F. W. MORRIS was graduated by City College of New York with the degree of Bachelor of Science, Cum Laude. He has been elected to Phi Beta Kappa. He was graduated from the Technical Assistants Course in the Laboratories in 1925.



THIRTY YEARS in the service of the Bell System have been completed by Charles H. Klein, who is engaged in the design of hardware used in outside plant work.

Mr. Klein joined the forces of the New York Telephone Company in 1899 as a repairman. After an absence from telephone work from 1901 to 1903 he returned to the Telephone Company, this time in the Installation Department. Within a year he transferred to the Equipment Engineer's office. The familiar receding-door telephone booth was developed by

C. H. Klein

Mr. Klein while attached to this office. In 1910 he was assigned to his company's Engineering Department and became engineer in charge of station and drop wiring, cabling for buildings, telephone booths and tools for installers and repairmen.

In 1910 Mr. Klein received the degree of B.S. in Civil Engineering after the completion of a night course in Cooper Union. Further studies in Cooper Union resulted in the degree of M.S. awarded to him in 1916. He became a member of the Laboratories in 1928 following his transfer from the New York Telephone Company.

A recent article by Mr. Klein describing the testing of earth anchors appeared in the February issue of the Record.

L. S. Ford and J. G. Brearley with representatives of the American Telephone and Telegraph Company attended a conference at Hawthorne. On this visit they also witnessed tests on cable sheaths.

R. H. Colley attended the summer meeting of the American Wood-Preservers' Association held in Ottawa, Canada. While there he discussed pole testing methods with the staff of the Canadian Forest Products Laboratory.

A trip to Hawthorne was made by C. S. Gordon and W. C. Kleinfelder in connection with the manufacture of tools and sleeves used in a new method of joining line wire. Mr. Gordon also looked into the production of a trial lot of machines for splicing conductors in cables and discussed the subject of zinc coatings for outside plant materials.

V. A. Nekrassoff has been admitted to full membership of the Russian Academic Union in Paris consisting of Russian scientific educational workers who left their homeland after the October Revolution of 1917 and now continue their work in various countries of the world.

O. S. Markuson completed twenty years in the Bell System on June 12.

Manual and Toll Equipment

J. A. Mahoney visited the Teletype Corporation in Chicago on work concerning teletypewriters and associated equipment.

A. Kenner spent several days in Greensboro, Charlotte, Winston-Salem and Durham in connection with the trial installation of repeaters for long four-wire circuits.

Special Equipment Development

R. B. Simon visited Albany to discuss with the telephone engineers various problems in connection with the PBX teletypewriter system which is being furnished for the New York State Police.

The toll offices at Newark and Princeton and Philadelphia, were visited by T. J. Greiser in connection with the trial installation of improved two-wire repeater equipment.

The installation of improved program transmission equipment in twenty-seven repeater stations between Chicago and San Francisco is being carried on under the supervision of Messrs. W. H. Bendernagel, E. O. Seiler, R. R. Andres and A. J. Hill.

Power Development

M. A. Froberg made tests in West Haven, Connecticut, of the effect of power plant location on noises in amplifier equipment.

In connection with the development of semi-automatic gasoline engines to furnish power for harbor-craft radio-telephone stations, V. T. Callahan was in Pittsburgh.

Local Central Office

S. B. Williams has been elected to membership in the Ohio State Chapter of Tau Beta Pi, honorary engineering society. The honor was conferred on a selected group of Ohio State alumni of high professional standing who were graduated previous to the establishment of the chapter.

L. M. Allen was at Boston in connection with the cutover of the new panel tandem office.

The twenty-fifth anniversary of Edward O. Cousins' association with the Bell System occurred on June 26. He is a member of the Local Systems group engaged in the testing of manual circuits.

For a number of years Mr. Cousins was in the manufacturing department of Western Electric inspecting relays, receivers, transmitters and special apparatus manufactured at that time at 463 West Street. When the first semi-automatic dial units of the panel type were installed in Newark he was engaged for nearly three years in setting up the equipment and aiding in arrangements for the first trials. When this task was finished he returned to the Laboratories on inspection work and in 1918 became a member of the Local Systems Department. During his early years with Western Electric Mr. Cousins took up special studies at Cooper Union and received in 1914 the B.S. degree.

E. O. Cousins

Toll Development

K. M. Fetzer spent a week in North Carolina inspecting the four-thousand-mile cable trial at Greensboro, Charlotte, and Durham.

A trip to Philadelphia was made by F. S. Entz and V. E. Rosene to investigate the possibilities of using the Leeds and Northrup controller for automatic transmission regulation in the cable carrier system.

F. B. ANDERSON visited Harrisburg and Reading in connection with the trial of a new Wheatstone bridge.

NOISE MEASUREMENTS on open-wire circuits were made by S. Rosen at Atlanta, Georgia and Greensboro, North Carolina, in connection with the development of a noise suppression circuit for use in the No. 8 Test and Control Board.

DIAL EQUIPMENT

CHARLES C. CARR has retired from the Laboratories and is now residing in Avon, Illinois.

Mr. Carr is a graduate of the University of Illinois and started on equipment engineering in 1906 with the Western Electric Company at Chicago. From 1909 to 1915 he was a member of the Western Electric

C. C. Carr

forces in Antwerp, Belgium. During the war he was at Hawthorne in charge of engineering in connection with the manufacture of rotary-type dial apparatus formerly carried on abroad.

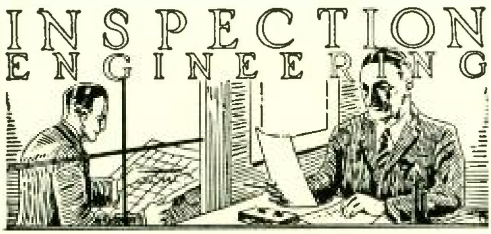
In 1924 Mr. Carr came to the Laboratories where he had been engaged on cost estimate studies of equipment engineering work until his health demanded that he withdraw from active service.

ON JUNE 22 U. S. Ford completed twenty-five years as a member of the Bell System. Having completed an

U. S. Ford

engineering course at Pratt Institute, for two years he was engaged in traffic and equipment engineering for the New York and New Jersey Telephone Company and later travelled throughout the country on field inspection and tests of central office equipment as a member of the Western Electric Company. When his department was moved from New York to Hawthorne in 1912 he still remained on inspection work and during the war had charge of installation of telephone and PBX systems in various military camps in the country.

In 1919 Mr. Ford became a member of the Engineering Department of the Western Electric Company in New York and was assigned to manual equipment engineering. For two years he was engaged in development work on manual switchboards. He also has worked on the toll line dialing project conducted in the Pacific Northwest a number of years ago, and the design of the power circuits on the first Key West-Havana carrier cable. During the past four years he has been a member of the group on panel equipment design.



DURING THE LATTER part of May, A. F. Gilson and R. M. Moody attended a quality survey on No. 506 PBX switchboards held at the plant of the Stromberg Carlson Telephone Manufacturing Company, Rochester.

A. J. BOESCH, Field Engineer, Philadelphia, E. J. Bonnensen, Field Engineer, St. Louis, and T. A. Crump, Assistant Field Engineer, Philadelphia, have recently returned to the Laboratories in connection with current problems.

EARLY IN JUNE, S. H. Anderson attended a quality survey on meters held at the plant of the Sangamo Electric Company in Springfield, Illinois.

C. K. MILNER left New York on May 27, 1931 to assume his new duties as Assistant Field Engineer in Cleveland.

A QUALITY SURVEY on sound picture apparatus at Hawthorne was attended by L. G. Hoyt and H. L. Kitts.

H. W. NYLUND, Field Engineer, San Francisco, recently visited the sites of the transpacific transmitting and receiving stations at Dixon and Point Reyes, California.

R. O. HAGENBUCK was at Hawthorne for a quality survey on zone and overtime charging equipment.

DURING THE LATTER part of June, W. A. Shewhart and H. F. Dodge attended a meeting of the Technical Committee on Interpretation and Presentation of Data held at Chicago in connection with the annual meeting of the American Society for Testing Materials. Mr. Shewhart, who is chairman, outlined a suggested program for 1931-32; and Mr. Dodge led a discussion on quality control in sampling inspection.

H. G. EDDY, in charge of Systems inspection engineering, completed thirty years as a member of the Western Electric Company and Laboratories on June 26.

Mr. Eddy is one of the veterans of the development of dial systems. When the rotary system of machine switching was in the development stage he was actively associated with that project. The rotary-type system,

H. G. Eddy

now widely used in Europe, was first installed in the present 463 West Street building for trial purposes, replacing a manual PBX. Mr. Eddy continued on dial systems development and had a prominent part in the creation of the panel-type semi-automatic system first set up at Newark in 1914-15. He then became engineering representative and in this capacity was at Dallas when the first step-by-step system was installed and at Omaha and Kansas City for the first dial installations of the full automatic type. He was also engineering representative at the Metropolitan Toll installation in New York.

For a number of years Mr. Eddy was in charge of the dial systems circuit laboratory. In his early years with the Western Electric he supervised central office installation inspection, first for the metropolitan division and then for the entire eastern zone.

Since 1923 he has been in the Inspection Engineering Department in charge of inspection engineering related to telephone systems. He is a graduate of Rutgers University.

PERSONNEL

G. B. Thomas is one of a group of engineers who, in recognition of their professional standing, have been elected to membership in Tau Beta Pi, Ohio State Chapter, honorary engineering fraternity.

With R. J. Heffner Mr. Thomas attended at Pratt Institute on May 9 the spring meeting of the Middle Atlantic Section of the Society for the Promotion of Engineering Education. Mr. Heffner recently attended the twelfth annual Industrial Conference at Pennsylvania State College.

M. L. Wilson has been elected president of the Physics Club of New York, an association of physics teachers in the high schools of New York City and vicinity.

PATENT

Hearings before the Examiner of Interferences at Washington were attended by J. W. Schmied, W. C. Kiesel, P. C. Smith and G. F. Heuerman. O. E. Rasmussen attended a hearing before the Board of Appeals.

A trip to several cities in the Middle West was made by A. G. Kingman on patent matters.

G. T. Morris was at Washington to appear before the United States Court of Customs and Patent Appeals.

The taking of testimony required the presence of G. T. Morris and F. H. Crews in Washington.

H. P. Franz was at Hawthorne on patent marking problems.

From February 1 to May 1 patents have been issued to the following members of the Laboratories:

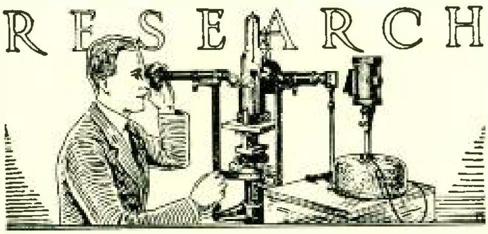
A. F. Bennett
B. G. Bjornson
H. S. Black
E. Bruce
O. Cesareo
A. J. Christopher
R. E. Collis
A. M. Curtis
A. C. Dickieson
B. G. Dunham
G. W. Elmen
P. B. Flanders
H. T. Friis
T. C. Fry
H. W. Goff
J. W. Gooderham
J. E. Harris
H. C. Harrison (3)
R. A. Heising
R. E. Hersey
L. B. Hilton
F. A. Hinshaw
A. W. Horton
H. Hovland
H. E. Ives
T. A. Jones
W. C. Jones
A. C. Keller
A. R. Kemp
F. S. Kinkead
W. A. Knoop
C. E. Lane
F. B. Llewellyn
R. L. Lunsford
J. A. Mahoney
R. F. Massonneau
W. P. Mason
D. W. Mathison
D. D. Miller
P. E. Mills
C. E. Mitchell
C. R. Moore
C. E. Nelson
E. L. Norton (3)
E. Peterson
W. A. Phelps
E. J. Pratt (2)
F. M. Ryan
O. A. Shann
H. O. Siegmund (3)
E. J. Sterba
R. S. Stokely (2)
R. L. Wegel
W. Whitney
H. Whittle (2)
A. Zitzmann

PLANT SHOPS

Edmond O'Donovan completed the instrument maker apprentice course on May 27. He is the son of

Michael O'Donovan, formerly a foreman in the Model Shop, who retired in 1926.

Edmond's certificate of graduation was presented to him at his home in Jersey City in the presence of his father and mother. The presentation was made by Personnel Director G. B. Thomas, A. H. Sass, who was associated with the young man's father for a number of years, and D. W. Eitner. In congratulating him on the completion of his course, Mr. Sass mentioned that much of his mechanical skill was undoubtedly a heritage from his father and stated that he would find few better examples of industry and craftsmanship to follow than that set by his parent.



Transmission Instruments

H. A. Frederick presented a paper, *The Development of the Microphone* at the Camden meeting of the Acoustical Society of America.

At the meeting of the Society of Motion Picture Engineers in Los Angeles W. C. Jones presented a paper describing the moving-coil microphone, written in joint authorship with L. W. Giles.

A. E. Peterson, an instrument maker in the Transmission Instruments Department, retired May 15.

Mr. Peterson became a member of the Western Electric in 1893 and worked for a number of years as a tool and die maker. In 1913 he went to Hawthorne to take charge of the manufacturing operation in connection with the one-piece lug holder for the deskstand. Formerly made from several pieces, the lug holder was redesigned to be manufactured by a rolling process from one piece and Mr.

A. E. Peterson

Peterson, previous to going to Hawthorne, had had a prominent part in the development of the tools and rolling process.

In 1920 he returned to the Model Shop in New York and in 1923 he was assigned to the Transmission Instruments Department where he has worked for several years as a special mechanic on numerous parts for the acoustic phonograph, the rubber damped recorder, and developments of improved recorders and phonograph reproducers.

Chemical Research

R. M. Burns attended in Washington a meeting of the Division of Chemistry and Chemical Technology, National Research Council.

Visits to Hawthorne were made last month by E. E. Schumacher, G. M. Bouton and C. W. Scharf. Messrs. Schumacher and Bouton conferred on manufacturing problems connected with lead-calcium cable sheath, and

Mr. Scharf inspected manufacturing processes for rubber tinsel conductors.

R. R. WILLIAMS and S. O. Morgan visited the Corning Glass Works to discuss the manufacture of glass insulators with Dr. J. C. Hostetter.

C. W. BORGMANN was at Wilmington studying cable corrosion.

C. C. HIPKINS and C. L. Hippensteel at Washington inspected the Bureau of Standards exhibit of ferrous and non-ferrous metals and certain protective-coating specimens which had been removed from forty-eight soil-corrosion plots after a period of six to eight years' exposure. Mr. Hippensteel also attended a conference of the Corrosion Session of the Bureau of Standards Metallurgical Advisory Committee.

Tests of insulated wire for subsoil installation, now under way at Forked River and Lawrenceville, were shown to C. L. Hippensteel and V. J. Albano, by I. C. Shafer, Jr., of Outside Plant, who is in charge of this work.

ACOUSTICAL RESEARCH

HARVEY FLETCHER, at Washington for the American Physical Society, attended an organization meeting of the American Institute of Physics.

J. B. KELLY visited the Clarke School for the Deaf at Northampton to look over an audiphone installed in the school. While there he also made a general survey of the requirements for apparatus to be installed in schools for the deaf.

RADIO AND VACUUM TUBE

W. WILSON is at present in Europe, where he attended the second meeting of the International Consulting Committee on Radio Communication at Copenhagen as a representative of the American Telephone and Telegraph Company, with Lloyd Espenschied and L. E. Whittemore.

Dr. Wilson also represented the American section as a delegate to the International Scientific Radio Union, which was in session at Copenhagen during the same period.

A MEETING OF the Boston Section of the Institute of Radio Engineers held at Harvard University was attended by J. Blanchard, J. G. Chaffee, C. R. Englund and R. C. Shaw.

AT CHICAGO, June 4-6, A. C. Beck, C. R. Burrows, E. Bruce, C. R. Englund, K. G. Jansky, F. B. Llewellyn and E. J. Sterba attended the sixth annual convention of the Institute of Radio Engineers. Papers presented included *Developments in Short-Wave Directive Antennas* by Mr. Bruce; *The Propagation of Short Radio Waves over the North Atlantic* by Mr. Burrows, and *Constant Frequency Oscillators* by Mr. Llewellyn.

A JOINT PAPER on *Radio Transmission Studies of the Upper Atmosphere* by W. M. Goodall and J. P. Schafer was presented at a meeting of the International Scientific Radio Union held in Washington. Also at this meeting R. A. Heising read a paper on *Effect of Shore Station Location Upon Signals.*

STAFF

H. W. DIPPEL attended the convention of the National Association of Purchasing Agents at Toronto.

PUBLICATION

W. C. F. FARNELL attended the annual meeting of the American Association of Museums at Pittsburgh.

PAUL B. FINDLEY was a guest of the Franklin Institute at the dinner in honor of its Medalists held on May 20 in Philadelphia.

Contributors to this Issue

C. R. Young received the B.S. degree in electrical engineering from the University of Vermont in 1900, and came in that year to West Street to join the Western Electric Company's Inspection Department. Three years later he was transferred to the apparatus design section of the Engineering Department where he has been in charge of various design work. At present he is in charge of the group that designed the welded steel cases for loading coils. This development has resulted in large reductions in the cost of loading.

R. E. Collis received the M.S. degree from Iowa State College in 1917 and came to the Laboratories the same year. From 1917 to 1922 he was engaged with the development of the printing telegraph. In 1922 he was transferred to the Systems Development Department, where he is now concerned with special problems relating to the panel type of dial telephone system.

R. G. Watling graduated from Occidental College in 1923 with a B.A. degree and the

C. R. Young

R. E. Collis

R. G. Watling

S. O. Morgan

W. R. Ballard

following year entered the Outside Plant Engineering Department of the Southern California Telephone Company. In 1926 he transferred to the Laboratories where, with the Personnel Department, he was an instructor in the Technical Assistant course for two years. He then transferred to the Outside Plant Development Department where he is at present Staff Engineer in charge of technical service.

William R. Ballard received the degree of L.L.B. from George Washington University in 1907. Before joining the Patent Department of the American Telephone and Telegraph Company in 1917 he had been an examiner in the United States Patent Office. For several years he was solicitor for the Patent Office and for a time Special Assistant to the United States District Attorney for the Southern District of New York in connection with cases arising in the Patent Office. He was admitted to the Bar of the Supreme Court in 1911, and is also a member of the New York State Bar and of several of the Federal District Court Bars. With the American Company he has been engaged in the controversies concerning vacuum tube oscillators, the superheterodyne, the high vacuum tube and other litigation.

S. O. Morgan of Chemical Research heads a group which has been investigating the physical chemistry of transmitter carbon and dielectrics. After receiving the degree of B.S. in Chemistry from Union College, he joined the Chemical Department of the Laboratories in June 1922. In 1924 he left to take graduate work at Princeton University, where he received the M.A. and Ph.D. degrees and returned to the Chemical Department three years later.