Twenty Years at West Street

By AMOS F. DIXON
Systems Development Engineer

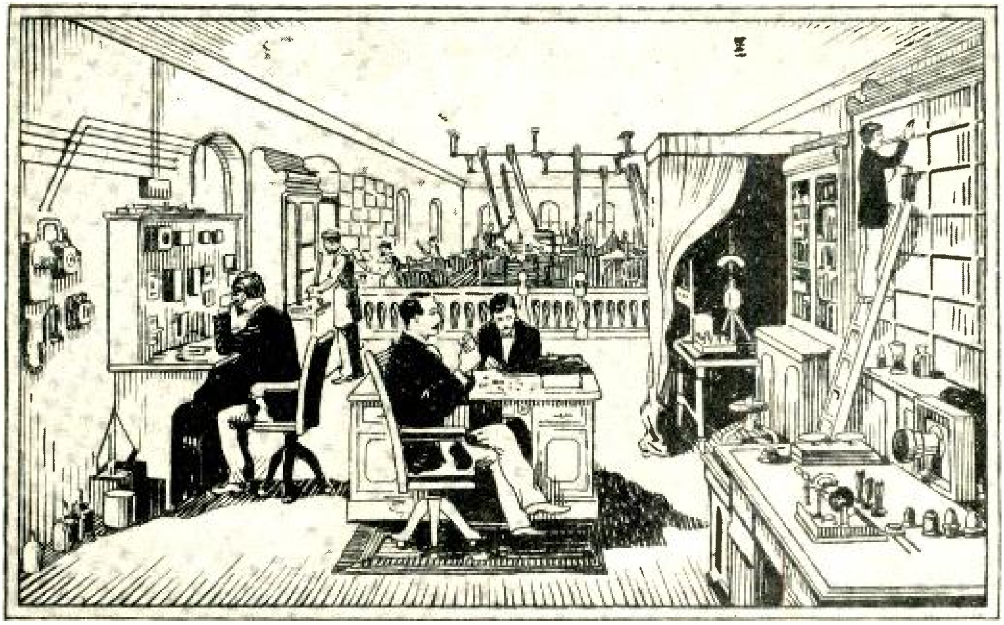
THE close of 1927 marked the twentieth anniversary of the establishment of the Bell System development laboratories at the present West Street location. This laboratory is the outgrowth of Bell's original laboratory in Boston where he, with Doctor Watson, produced the first telephone.

Prior to the issuing of Bell's patent in 1877, the Bell Patent Association was organized by a few men whom Bell had interested in his inventions. This association soon assumed corporate form and after several changes in organization to take care of the rapidly changing situation, the American Bell Telephone Company was born, early in 1880. This Company at once carried more generally into effect the policy already formulated of licensing Associated Operating Companies. The contracts with these Companies gave the licensees the exclusive right to operate within specified territory, and to use apparatus and equipment made under the Bell or any other patents owned by the American Company.

In those early days the officials of the Bell System had clearly in mind the vision of nation-wide telephone service, and felt it necessary to closely supervise the development and manufacture of transmitters, receivers, and induction coils because this transmission apparatus, which was leased but not sold to the Associated Companies, was the heart of the System and must be uniform and of the best quality in order to give high grade, uniform service. The development work on these instruments was done in a laboratory in Boston which kept pace with the needs of the System. Other apparatus, however, was bought from several companies manufacturing it under their own or Bell Company patents and supervision. The development work on this apparatus was carried on at widely separated points, and could not be as closely supervised as the work at Boston; consequently each manufacturing company incorporated in its apparatus many of the ideas of its own engineers.

The advantages to be gained from centralized manufacture of telephone apparatus for all of the licensed Operating Companies were becoming apparent and in 1882, the American Bell Telephone Company bought the plant and manufacturing business of Charles Williams of Boston where the original telephone had been made and where much of the apparatus then in use had been produced. It also bought an interest in the Western Electric Manufacturing Company at Chicago in order to merge the two in a consolidated company large enough to handle the demands of the business and operating under such centralized supervision that the highest standards could be maintained. This marked the beginning of the present Western Electric Company.

The American Bell Telephone Company had accepted the obligation to test new inventions, to improve apparatus and to furnish consulting engineering services to its licensees. To do this, it maintained the engineering department and development laboratory at Boston. The Associated Companies also had engineering departments whose function was to make possible better handling of operating problems. As the engineers of each company became more thoroughly acquainted with the technical problems of the telephone business, they naturally gave some attention to the development and improvement of apparatus so necessary at that stage of the art. The engineering department at Boston supervised this scattered development work of the Associated Companies by sending Dr. Watson and other engineers to visit them at regular intervals for the purpose of coordinating requirements and designs. The work grew rapidly, however, and it became increasingly difficult to assure adequate coordination in this way. During this period, the Western Electric Company became dominant in the field of telephone manufacture and to assist in the solution of technical problems arising in the art, it established special departments to carry on development and engineering at both its Chi-



AN EARLY TELEPHONE LABORATORY

maintained by the American Bell Telephone Company in Boston. The illustration is taken from one in "Scientific American" for September 20, 1884; *of the laboratory, we read, "the company employs a corps of expert mechanics and others skilled in the principles and practice of electricity and its allied sciences, and has provided an experimental shop, a chemical laboratory, and an electrical testing-room, fully equipped with the necessary machinery and apparatus. The experimental shop, . . . is remarkably well supplied with such tools as are required for producing and altering electrical apparatus"* cago and its New York factories.

By 1907 the Associated Companies had been well consolidated as operating units in the Bell System, and it was apparent that if all the requirements for a certain type of service could be gathered from all the companies, standardized equipment satisfactory to each could readily be developed.

When John J. Carty in 1907 became Chief Engineer of the American Telephone and Telegraph Company (the successor of the American Bell Company), he recommended that in the interests of economy and efficiency the telephone laboratory in Boston be merged with the laboratory of the Western Electric Company at New York, and that its Chicago laboratory be also brought to New York for consolidation. He recommended further that the Associated Companies be requested to submit their suggestions and requirements for new apparatus and equipment to the engineering department of the American Company which would study them and then make definite recommendations to the newly created development and engineering department maintained by the Wester Electric Company in New York. General Carty's recommendations were adopted and in October, 1907, the central laboratories for the Bell System became a reality.

To a staff of 119 persons with Mr. Craft at its head was assigned 23,000 square feet of floor space on the eighth, ninth and thirteenth floors of Section A of our West Street building. This made a large laboratory compared with that shown in the accompanying illustration which depicts the Boston laboratory as it existed in 1884 after seven years of growth. The development organization, thus consolidated, found so fertile a field in which to work that it grew even more rapidly than before. Great advantages and economies arose from this centralization of development work. In an organization equipped with the most modern laboratory facilities and staffed by trained scientists and engineers gathered from every part of the system and from other available sources, these advantages soon began to manifest themselves in a material way to the Associated Companies.

By 1917 the laboratory was occupying 237,000 square feet of floor space, with an organization of 2,120 people. In 1925 it became a company unit in the Bell System with the name "Bell Telephone Laboratories, Incorporated." Today, with a staff of 3885 people, it occupies the entire West Street property, comprising 488,000 square feet of floor space; a part of the Hudson Street building, comprising 30,000 square feet of floor space; and over 4,000 square feet of floor space in other buildings.

As the Laboratories starts on its twenty-first year of consolidated operation, it has leased for one hundred years the northeast corner of West and Bank Streets, comprising all the remaining property in its city block. This adds approximately 28,000 square feet of ground area, which will provide space for the future growth that is certain to come.

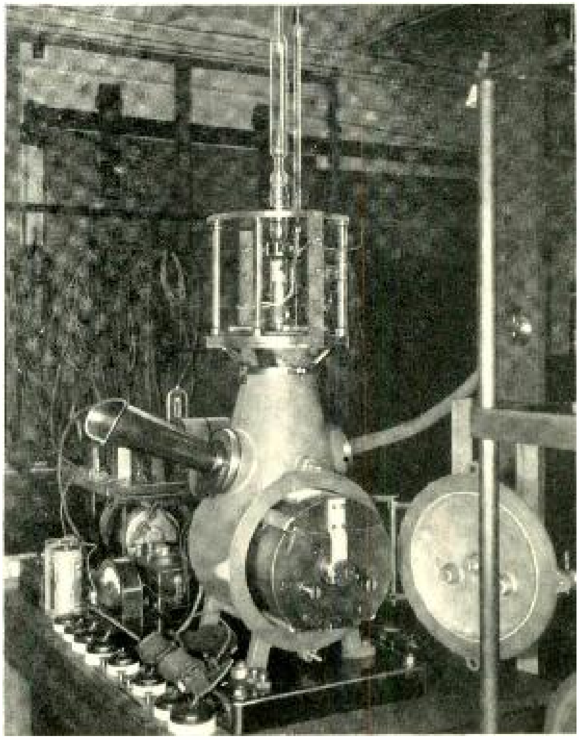
The Dufour Cathode-Ray Oscillograph

By J. E. COLE

Apparatus Development Department

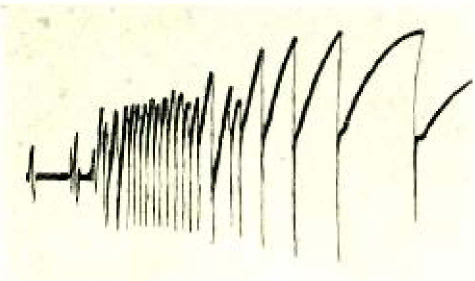
EARLY last year the Laboratories were requested by the American Telephone and Telegraph Company to make an investigation of protective devices and to study their performance when subjected to transient electric waves such as might occur on telephone lines during electrical storms. From an analysis of the problem it appeared that there would be required a device capable of recording without appreciable distortion electrical waves of frequency one million cycles or higher. This was obviously out of the range of electromagnetic oscillographs whose limit is about ten thousand cycles a second. The Western Electric cathode ray oscillograph could not be considered because it makes no record of a single, non-recurring wave. It appeared that the only instrument suitable for the work was the Dufour cathode ray oscillograph, of which one or two had just been brought to this country. Accordingly a Dufour oscillograph was imported and we set to work to learn how to apply it to our problem.

This oscillograph is one of the comparatively recent progeny of the classical Braun tube. It was developed in 1914 by a French scientist, Alexandre Dufour. His researches were interrupted by the World War and by lack of funds so that it was not until 1922 that he was able to produce a machine free enough from troubles to be of general use. Differing from the Western Electric oscillograph, its outstanding feature



A close-up of the Dufour oscillograph with the film container partly withdrawn. Above can be seen the cathode tube, and inside the housing, the deflection-tube is the placing of a photographic film inside the vacuum chamber so that the cathode stream may impinge directly on the sensitive surface and record its trace photographically with a single traversal.

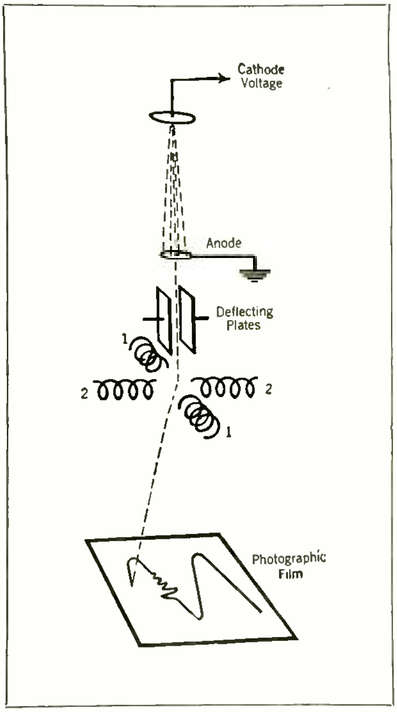
The oscillograph proper begins with a glass tube holding an aluminum disc cathode and a pierced anode. This tube is fitted by a ground joint to a glass deflection tube which is in turn fitted into a large bronze chamber that contains the photographic film holder and a fluorescent viewing screen. The bronze chamber has a carefully fitted door which may be opened to remove the film container, and also a pair of windows through which the viewing screen may be observed. The door has three handles fitted through it that are used for operating the film changer and for moving aside the viewing screen which also serves as the cover of the film container. The joints between



Voltage across a contact in series with the winding of an E-type relay. After the contact opens, twenty-three oscillations take place in about 450 micro-seconds

these various parts must be kept sufficiently air-tight to hold a pressure of ten microns, the normal working pressure, for a considerable period, since the pressure is very critical.

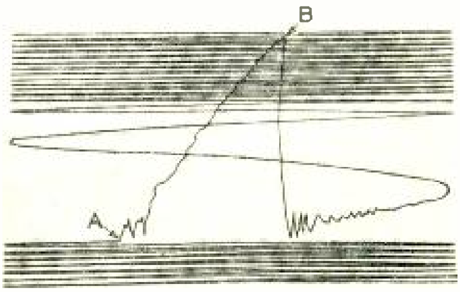
Six films about five inches square may be placed in the film container and exposed successively. After the container is placed in position, the air must be pumped from the interior of the oscillograph to allow the cathode ray to pass. The Holweck molecular



Schematic diagram of the apparatus

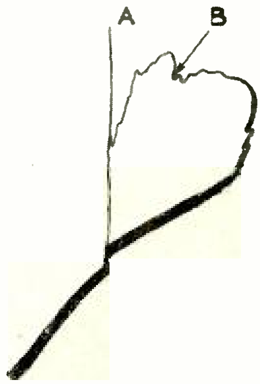
pump backed by an oil-immersed impeller pump will produce a sufficient vacuum in about twelve minutes. The ray consists of a stream of electrons drawn from the cathode by a potential of fifty to sixty thousand volts. Some of the electrons, moving at 80,000 miles a second, pass in a fine stream through a small hole in the anode and down through the deflecting tube. There the stream is swerved by the electric field between one or more pairs of metal plates, or by the magnetic fields of external coils, or both. Passing on down into the lower chamber, the stream generates its trace by impinging upon either a film or a fluorescent screen. A good trace may be obtained when the electron stream sweeps across the film as rapidly as one hundred miles a second.

Many different techniques have been developed for using this instrument, each particularly suited to some special investigation. The simplest one is that used for a transient wave slow enough to be shown clearly on a rectilinear time scale of the order of 5 microseconds per centimeter. This requires that the cathode stream be given a straight motion or sweep across the film at the rate of about one mile per second. It also requires that the transient be



This trace was secured by Mr. Cole's second technique. A 500 kilocycle timing wave is swept across the film. At the instant A, a surge was applied to one pair of plates, sweeping the trace up to B. Almost instantly the voltage fell back nearly to zero. An ingenious circuit arrangement then displaced the timing oscillations to leave a clear space on the film

precipitated shortly after the stream strikes the film. This is accomplished by a synchronous switching device built in this laboratory. A synchronous motor drives a switch which applies to the primary of a transformer a single half-wave of 60-cycle alternating current. The transformer has a ratio of 110:60,000; its secondary is connected to the cathode and anode. To the same 60-cycle source is connected a coil which, placed near the deflecting tube, will sweep the stream across the film in any desired time;



Voltage across a gap (vertically) and current (horizontally) are illustrated above. The peak (A) was reached in 0.07 microseconds and the point B less than a microsecond later. The rest of the path was traversed more slowly

practical limits are fifty to five hundred micro-seconds. An adjustable contact-disc on the shaft of the synchronous motor precipitates the transient just as the stream is swept across the film.

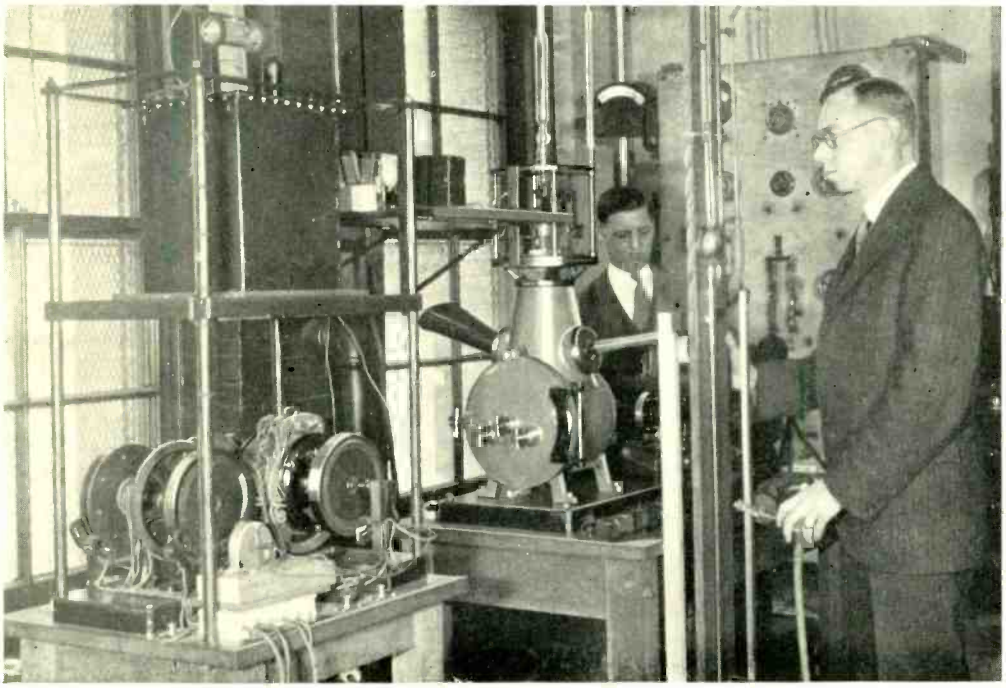
For those transients which pass too quickly to be recorded as described, the line of traversal is made, not a single straight line across the screen but a sinusoidal trace. The transient under investigation is then applied in a direction parallel to the axis of the timing wave, so that its zero line is the trace of the timing wave. Such a record appears rather involved to one accustomed to the usual oscillograms with rectilinear axes, but it may readily be replotted to the more familiar coordinates.

The timing wave commonly used in our tests has a frequency of 500 kilocycles; a half cycle then is just one micro-second.

In a study of the performance of protector blocks, we wished to obtain a curve showing the current through the protector plotted against the voltage across the gap. The starting point of such a curve was located in one corner of the film by the effect of a constant magnetic field. From this point, the stream was swerved in one direction by a coil in series with the current and in the perpendicular direction by the voltage across the gap applied to a pair of deflector plates. The resultant trace was a closed loop. Time was measured by applying a small "ripple" of 500-kilocycle current to the other pair of plates.

Another technique was used to determine the form of a transient shorter than one micro-second. The magnetic field was used to deflect the spot to the bottom of the film and a 500 kilocycle wave of about ten centimeters amplitude was applied to a pair of deflecting plates so as to cause the spot to trace a zero line along the bottom of the film. The transient was applied to another pair of deflecting plates perpendicular to the first pair and was thus plotted to a sine scale. This curve was then easy to replot to a uniform time scale with rectilinear coordinates.

Methods here described give only a hint of the uses to which this instrument may be put. So versatile and sensitive it is that it may well be described as the microscope of the electrical sciences.



Mr. Cole (right) reads the pressure gauge while A. Weller (left) adjusts the timing oscillator associated with the Dufour Oscillograph. On the table at the left is the synchronous switch and its high-tension transformer

A Brake for Rolling Ladders

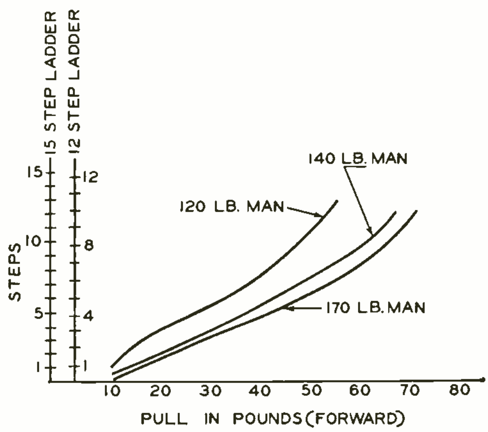
By L. N. HAMPTON
Apparatus Development Department

MOST of us have seen rolling ladders in shoe stores, where their usefulness in giving access to long upper shelves established them many years ago. In telephone offices there is a similar need of reaching high equipment, part of which extends almost to the ceiling, usually twelve feet six inches high. Slanting ladders, supported by small wheels on the floor and by a hanger rolling in a track at the ceiling, have therefore become indispensable equipment in terminal rooms.

Constant extension of dial systems has brought into greater prominence many questions about ladder equipment, for the switching frames have greatly increased the amount of central office equipment necessarily placed beyond reach from the floor. More complete standardization of ladder design and further development of trolley hangers to facilitate installation in rooms of differing height were among the first changes. At about the same time design of a safeguard to prevent unintentional movement of the ladder while in use was undertaken. Although difficulties here were greater on account of varying conditions to be encountered on the thousands of ladders already installed, such a device is now available. Its automatic operation is not only a great convenience but a valuable safety measure in addition, since it prevents the possibility of forgetting to apply the brake.

The brake, which acts on the trolley track, holds the ladder firmly while in use but at other times releases it completely without attention from the user. The brake mechanism is out of the way of maintenance men, and does not hinder their movements or their work.

At the lower end the ladders are unchanged*, but at the top they are supported by a combined hanger-and-brake assembly which, allowing vertical movement of about a half inch, applies and releases the brake as needed. In effect the mechanism makes each ladder a lever pivoted at the bottom, free to swing between limiting stops at the upper end. A coil spring on the hanger holds the ladder up when unoccupied; when a user steps on, his weight overcomes tension of the spring and pulls the upper end



How the braking increases as the user climbs

* *Except for the substitution, where necessary, of wheels lubricated by grease cups.*

Service Honors during 1927

THIRTY-FIVE YEAR GROUP

Louis Barbieri
Wood Finisher,
Building Shop

W. O. Beck
Relay Design, Apparatus
Development Department

E. P. Clifford
Vice-President

C. A. Finley
Telephone Instrument
Standards, Research
Department

C. E. Forsberg
Instrument Maker,
Research Department

W. C. Just
Assembly Foreman,
Vacuum Tube Shop

THIRTY-FIVE YEARS

E. R. Lundius
Circuit Design, Systems Development Department

Otto Muller
Instrument Maker, Engineering Shop

THIRTY YEARS

W. C. Calmar
General Foreman, Plant and Shops Department

F. A. Cox
Installation and Maintenance Requirements, Systems Development

J. E. Devany
Laboratory Maintenance, Systems Development

H. F. Kortheuer
Manual and Toll Systems, Inspection Engineering Department

R. H. Phillips
Supervisor of Blueprint Room, Commercial Department

TWENTY FIVE YEARS

Thomas Barton
Elevator Operator, Plant and Shops Department

John Bickler
Pipefitter, Building Shop

C. A. Bolin
Drafting Supervisor, Systems Development Department

Bessie Brophy
Coilwinding Forewoman, Engineering Shop

Tessie Clancy
Coilwinder, Engineering Shop

E. B. Craft
Executive Vice-President

A. F. Dixon
Systems Development Engineer

C. D. Dusheck
Drafting Supervisor, Systems Development Department

J. G. Dusheck
Complaint Statistics, Inspection Engineering Department

W. C. F. Farnell
Curator, Bell Telephone Historical Museum

G. B. Joslin
Order Analysis, Systems Development Department

F. F. Lucas
Microscopic Laboratory, Apparatus Development Department

H. W. MacDougall
Patent Attorney, Patent Department

W. H. Matthies
Local Central Office Circuit Development, Systems Development Department

Margaret Meyers
Coil Winder, Engineering Shop

Edward Montchyk
Apparatus Analysis, Apparatus Development Department

J. E. Moravec
Commercial Manager and General Auditor

P. M. Neave
Reprint and Publication Distribution, Bureau of Publication

R. I. D. Nicoll
Manual Circuits, Systems Development Department

J. G. Roberts
General Patent Attorney

G. K. Smith
Step-by-Step Equipment Design, Systems Development Department

H. W. Ulrich
Manual Circuit Development, Systems Development Department

O. F. Vollheim
Heat Treater, Engineering Shop

TWENTY YEARS

C. E. Boman
K. B. Doherty
C. C. Graves
D. D. Haggerty
R. W. Harper
*Elizabeth Lorenzer**
W. E. Mougey
R. E. Noble
W. A. Schuler
W. G. Wagner
E. J. White

* *Pensioned January* 18, 1927.

New Rubber Compression Testing Machine

C. L. HIPPENSTEEL
Research Department

SINCE the Bell System uses some one and one half billion single conductor feet of rubber-insulated wire annually, its quality is of considerable economic importance. This wire is used in extending the telephone circuits from the nearest telephone cable terminal to the subscriber's premises and for house wiring. Great care must be exercised in its inspection to insure a satisfactory service life, and particularly to minimize the maintenance charges on aerial lines. A new compression testing machine has recently been developed to aid in determining the ability of the rubber insulation to meet service conditions.

Probably the two most frequent types of failure of rubber insulation are side-cutting and cracking. A tough rubber is needed to prevent them. Side-cutting is the tendency of the conductor to cut through the rubber insulation. This occurs where one wire crosses another in a twist, at an insulator or other support, when an excessive load arises. Sleet is a prolific cause of such failures. Cracking occurs at sharp bends due to a lack of flexibility of the insulation. This is caused by a deterioration of the rubber which occurs with age or from improper compounding.

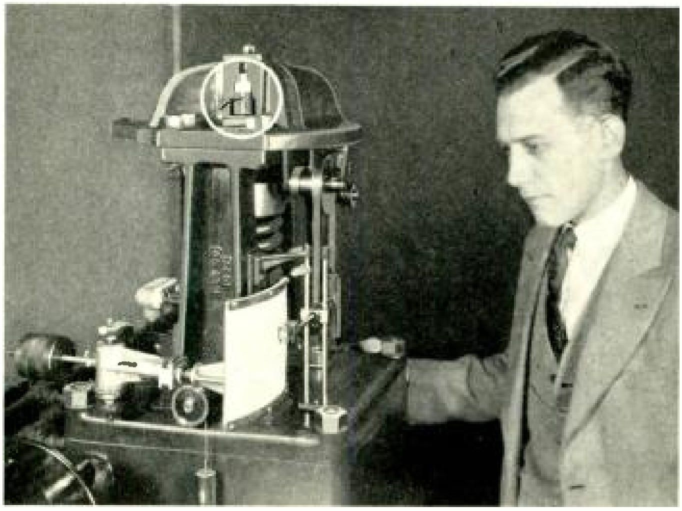
Toughness and flexibility of materials are usually gauged by the tensile strength and elongation, and numerous modifications of tensile tests have been used for judging the quality of rubber insulation. However, they are of somewhat doubtful significance. It is difficult in the first place to secure representative samples, and in the second place no ordinary tensile and elongation test approaches the actual service conditions, which subject the insulation to more than simple tension.

The Western Electric Company has for some time used two tests for inspection purposes as criteria for judging the ability of insulated wires to resist the types of failures which have been described as most common in the field. Ability to resist side cutting by the underlying conductor is at present determined by means of a "penetration test." In this test a taut steel wire of definite size is pressed against the rubber insulation at right angles to the conductor. Both the pressure and the time of application are specified. Establishment of electrical contact is used to indicate complete penetration of the cutting wire. To judge whether or not the insulation is too brittle for satisfactory service, it is given a wrap test. The wire, after the braid is removed, is wrapped about itself three times, left for sixteen to twenty-four hours, and rewound again in the reverse direction. The insulation is required to show no signs of rupture.

Although these tests have been of great use in judging the quality of new rubber-covered wire, they are not entirely satisfactory. Neither test affords a numerical measure of the *relative* quality of one sample compared with another, and consequently we are unable to detect reliably samples which may be close to failure and which would probably fail after a relatively short life, owing to gradual deterioration due to aging. Another important and inherent defect of the penetration test is that the sample submitted to test is very small, being limited to rubber lying immediately under the cutting wire. Consequently, the resistance to penetration obtained may be due to local conditions which are not at all representative of the wire as a whole

The new machine designed by the Laboratories will make a test which may advantageously replace both the wrap and penetration tests. It compresses a two inch length of insulated wire, from which the outer cotton braid has been removed, between a pair of parallel steel jaws. As the rubber on the wire is compressed it assumes an elliptical form. The layer of rubber between the conductor and the jaws grows thinner as the pressure increases until rupture occurs. Means are provided for recording simultaneously the pressure and the corresponding thickness of the insulation. A frame is mounted on the machine into which may be slipped white cards about five by six inches. As the test is made a pen operated by the machine plots a stress-strain curve. The final break is recorded on the chart by a sudden drop of the needle as rupture occurs.

A unique feature of the machine which may adapt it for the measurement of small deformations is that thickness is accurately recorded mechanically on the chart with a magnification of thirty times. Until the development of this machine magnifications had not been applied to testing machines of more than three- or fourfold.



E. M. Noll testing a sample of rubber-covered wire on the compression machine. The sample is shown in the circle in the upper part of the picture

The first experimental machine, built in the Model Shop, has been on trial by the Inspection Department at Hudson Street for nearly two years. In the construction of the improved machine the Henry L. Scott Company collaborated with the Laboratories.

The new compression test gives a numerical measure (in pounds) of the ability of rubber insulation to resist cutting by the conductor. An adequate length of wire is used and the rubber is tested in place on the conductor in a way which it is believed is closely comparable to the conditions of strain occurring in service. The tendency toward brittleness of a compound may be detected by an abnormally large thickness at break. A typical set of curves is shown as Figure 2. Curve A depicts a very distensible high-grade rubber compound. Curve B illustrates the average run of rubber compounds for aerial wire, both sides of the insulation rupturing simultaneously. In Curve C, the conductor being somewhat eccentrically located two distinct breaks are shown: first of the weaker wall, then of the stronger. Curve D is typical of a brittle compound and curve E of very soft rubber compounds and plastic or cold-flowing insulating materials. Thus from a test made on this machine much may be learned as to the character and quality of an insulating material.

Such a machine can be adapted for testing all kinds of insulated conductors and for making compression tests on variously shaped rubber specimens, or sections from such articles as tires. The outer braid might be left on the wire to give some sort of overall test if desired. Since many

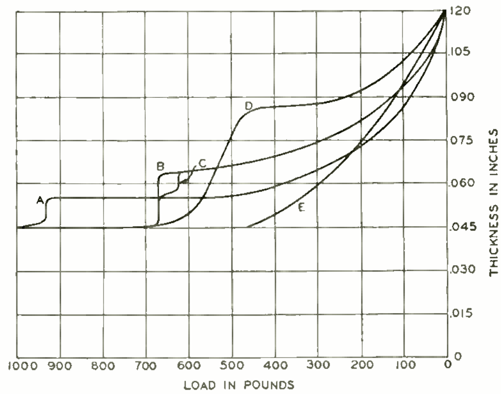


Fig. 2. A typical set of stress-strain curves for rubber insulation

structural materials, such as steel, concrete, or wood, are often subject to compressive rather than tensile strains in service, there is a possibility of usefully extending the application of the machine to a wide variety of materials.

Saving Days and Dollars With Shears

By S. W. ALLISON
Systems Development Department

In every telephone office an adequate power plant consisting of batteries, charging generators, and their accessory equipment is an essential adjunct. In order to calculate the size of this power plant and its associated distributing leads it is necessary to know the current required to perform the various switching operations. "Current drain" studies are made, therefore, for those circuits which naturally affect the power plant. These studies provide basic information which, used with the maximum number of calls of each type that the office may be required to complete, enables the power engineer to design a suitable plant.

The "current drain" is a summation expressed in ampere-seconds of the power required to complete each call. On circuits with long holding times and comparatively few switching operations the "current drain" can be calculated from the characteristics of the relays and the known times of operation. On circuits such as the senders of the panel system, however, which have short holding times, and involve from seventy-five to one hundred and eighty relays with from two to five hundred current changes, calculation becomes difficult. Current drain data for such circuits are much more easily obtained by actual measurements which are generally made in the laboratory.

The sender is so designed that its action, once started by the removal of a receiver from a switchhook, continues automatically till a path has been prepared to receive impulses of a subscriber's dial. Following this is a delay dependent on the subscriber's speed of dialing which in turn depends on the time for searching for letters or numbers as well as the time to operate the dial. Time is an important element of the "drain" so that in artificial laboratory tests precautions must be taken to insure that the time waits and speed of dialing closely approximate average conditions. Accordingly time constants have been worked out based on observation and experiment which are accepted as those an imaginary average person would use in operating the dial.

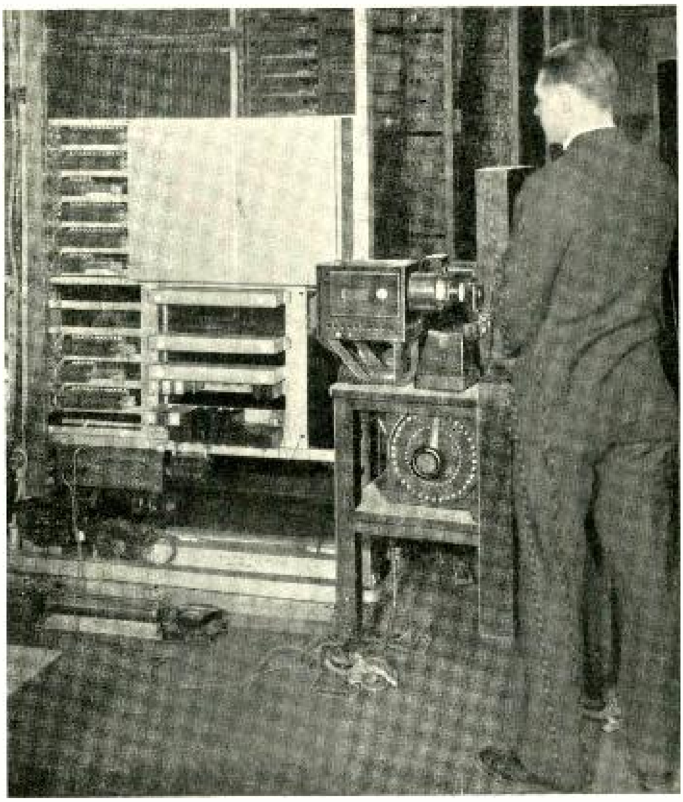
In order that current drain tests may be made under laboratory conditions which include these accepted times, an automatic dialer was designed which will dial any desired number in accordance with these time limits. Similar devices were constructed to measure intervals equivalent to average times for operators' actions wherever these affect the holding time of the sender.

The actual "current drain" is measured with an oscillograph. The one used has three elements each of which deflects a spot of light by an amount proportional to the current flowing through its circuit. All three spots fall on a sensitized strip of paper a little over two inches wide which travels about fifteen inches per second. An electrically driven timing mechanism marks short lines on the strip each hundredth of a second. As it is used the Number One element is left open circuited and draws a straight base line on the moving strip. The Number Three element is energized by a constant current controlled by a rheostat to give a maximum deflection and draws a line parallel to the base but near the other edge of the strip. This serves as the calibrating line because the amount of current causing the deflection is known. The Number Two element is in the sender circuit and traces a line which at all times is proportional to the sender current.

A short section of a strip from a "current drain" test is shown in the accompanying illustration with the timing marks evident along the upper edge. At the extreme right all three light spots fall on the same line. Shortly the steady calibrating current is connected and the Number Three spot rises abruptly and draws its trace parallel to the base. The second element, recording the sender current, makes its trace between the base and the calibrating line, following the actual variations of the sender current.

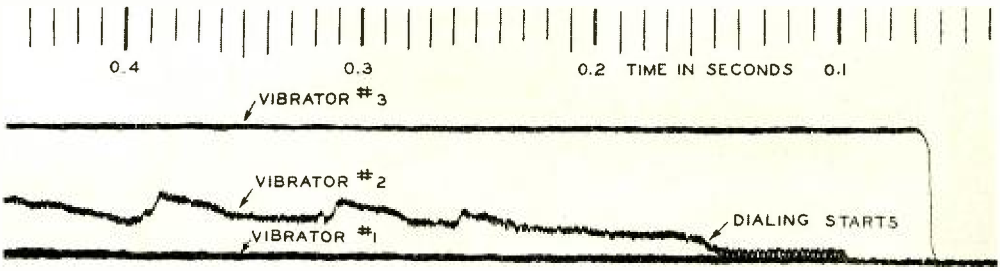
As the result of a single calling test which may take thirty or thirty-five seconds there is some forty feet of tape on hand with its record of current. The "current drain" is the current at any time multiplied by the time it flows. It is represented on the strip by the area between the line corresponding to the sender current and the base line. To measure this area with a planimeter is impractical because of the length of the strip. A method was devised, therefore, which requires only a pair of shears and a chemical balance.

The strip is first trimmed along the base line and also along the calibrating line corresponding to the known current flow. The strip thus trimmed is then weighed. The ampere-seconds corresponding to this weight is the product of the calibrating current in amperes and the total time marked



M. G. Bailey with three-element oscillograph shown plugged into a sender circuit, ready to measure battery drains on the upper edge of the strip. By dividing this calibrating current drain into the weight of the strip a calibrating unit in terms of ampere-seconds per gram is obtained. The strip is then cut along the line representing the variable sender current and the resulting strip bounded by this line and the base line is weighed. When this weight is multiplied by the ampere-second value of a gram obtained from the previous weighing the "current drain" is obtained for the particular dialing sequence that was used.

This method is accurate. Any variations in the thickness or weight of the paper at any point tend to offset each other as they enter both the weighings. "Current drain" data determined by this method compare favorably in accuracy with computed drain data and are obtained at a substantial saving in time and expense. The time required to complete a study on all types of calls is now a matter of days rather than of weeks.



Short section of oscillogram from an actual current drain test

For Next Christmas

To those who like to look forward to the merriment of the next winter holiday season, the Employees' Savings Plan is suggested. A very small sum deposited regularly for you will grow to a surprisingly large amount by Christmas, 1928. *The Financial Department will be glad to explain the details of the plan.*

The 5-A Audiometer

By L. G. HOYT
Apparatus Development Department

MOST of the large manufacturing concerns of today require a medical examination of the applicants entering their employ. One of the tests which is receiving more and more attention is a measurment of the sensitivity of the applicant's hearing. Perhaps the neglect of this test previously has been due to there being no simple and accurate way of making this measurement in definite readings for the records.

The 5-A audiometer, recently developed by Bell Telephone Laboratories, provides a means of accurately yet quickly measuring a person's hearing sensitivity and the result obtained is a direct percentage of hearing loss. At some later time, if readings are again made, the difference between this and the previous test would show the change of hearing during the interval.

The principle underlying all audiometers manufactured by the Western Electric Company is the same. A sound is generated which can be controlled in volume, and the loudness at which a person just ceases to hear it is noted. The sound, called a tone, is given out by a receiver which the person undergoing the test places against his ear. Two general types of apparatus have been used. In one the tone used is a single frequency which may be adjusted so that the sensitivity of hearing is measured at a large number of different pitches covering the range of audibility. This furnishes a complete audiogram, or hearing-sensitivity chart, for each ear. It is unnecessarily refined for many purposes, however, and so the second type was developed. In this the tone is complex — including a whole range of frequencies united in the one tone.

In one form of this latter type, a phonograph record is used on which has been recorded a series of numbers spoken with decreasing loudness. It is commonly used for school tests in which the children write down the numbers they hear. Later their papers are checked against a standard sheet. In another form the tone is generated by means of a buzzer and dry cells. The loudness at the receiver is adjusted by a potentiometer arrangement of the receiver circuit. Both of these forms lack simplicity to some extent as they depend on mechanically moving parts which may get out of adjustment, or on dry cells which must be replaced.

The 5-A audiometer departs from these methods and embodies a new principle which eliminates possible mechanical failures and the replacement of worn-out batteries. It is compact, portable, and operates on 110-volt, 60-cycle alternating current. All of the parts are enclosed in a black metal box provided with a handle for carrying, and a cover which when opened exposes the necessary apparatus to be used in making a test. It is only necessary to connect the plug of the power cord to a 110-volt alternating current supply and turn the snap switch in this cord to put the set in operation.

The power supply is connected to a transformer having a toroidal silicon steel core with one primary winding and two secondary windings (Fig. 1). One of the secondary windings is wound directly over the primary and supplies energy to a signal lamp. The other secondary winding is wound on the opposite half of the core so as to introduce a high leakage reactance. It is connected to a repeating coil with a one-to-one ratio winding on a core of a few permalloy laminations. The voltage delivered to this coil from the transformer is sufficient to highly saturate the permalloy core. To make the air-borne noise from the highly saturated permalloy core inaudible, the core and winding are packed in felt and placed inside a lead case which in turn is packed in felt and mounted in a cast iron box.

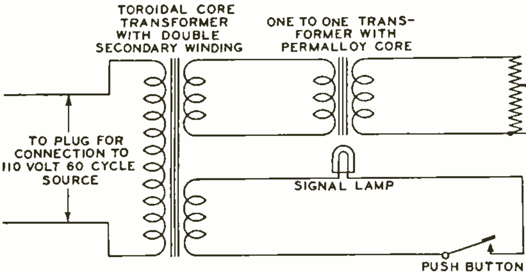


Fig. 1
Circuit diagram of audiometer

The electrical design problem was to convert the smooth wave of the 60-cycle power circuit to a flat-top one which, as can be mathematically proven, contains all harmonics of the fundamental. The ingenious solution, worked out by J. A. Berrian, utilizes only the two transformers already mentioned. No moving part or batteries which may need replacement are used. The highly saturated permalloy core of the one-to-one ratio transformer in conjunction with the limited current output of the power transformer with its high leakage reactance serves to flatten down the top of the input sine wave. This action can be better understood by reference to Figure 2. The dotted curve represents the 60-cycle wave of the power circuit and therefore also that of the voltage applied to the primary winding of the permalloy transformer. The current in this latter transformer follows the form of the voltage wave up to some low value "a" at which the core becomes saturated. From this point the current rises rapidly, in an effort to increase the flux above the saturation value, to the point "b," which is the maximum possible current that the power transformer, with its high re-

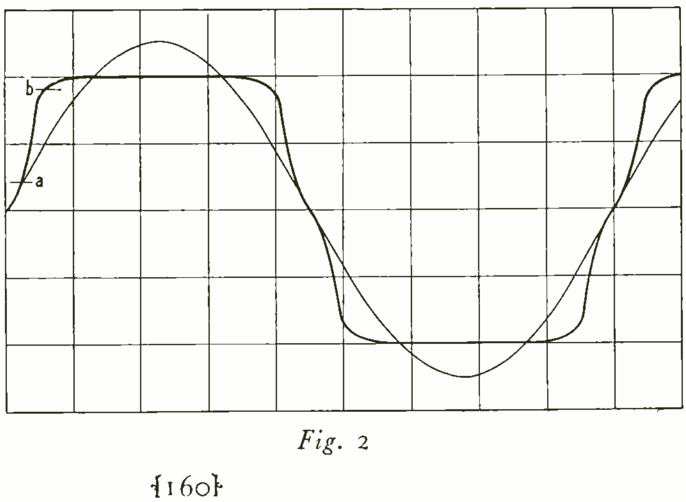


Fig. 2

actance, can deliver. It remains at this value therefore until the voltage has again dropped below the value required to saturate the permalloy core. Thus the current rises rapidly, making the steep side of the flat top wave, due to the early saturation of the permalloy core, and flattens out, making the top of the wave, due to the high leakage reactance of the power transformer.

The complex tone in the receiver may be varied in intensity in steps of five transmission units by a potentiometer capable of covering a range of 120 TU. The graduations on the scale plate of this potentiometer are in terms of percentage hearing loss so that direct readings are obtained. Minimum loudness corresponds to that just imperceptible by a person of hearing twenty per cent better than the average.

The person to be tested is instructed to hold a telephone receiver, furnished with the audiometer, snugly against one ear and to signal the operator when he no longer hears the tone. A signalling system is provided for this purpose, consisting of a button which lights a lamp in the audiometer. The person is instructed to hold the button depressed all the time a tone is heard. As the pointer of the potentiometer is slowly turned towards zero, the tone becomes fainter and fainter until a point is reached where it can no longer be heard. This fact is signalled to the operator. The setting of the pointer of the potentiometer when the tone could just not be heard is the percentage of hearing loss. It may have been on step 20 which means that the person under test has a hearing loss of twenty per cent or that his hearing is eighty per cent normal.

L. G. Hoyt and J. A. Berrian using 5-A Audiometer

It is possible that the setting for a person with more acute hearing will be 10 below zero which indicates that his hearing is ten per cent above normal. It is important that the test be made in a quiet place as external noises will result in a higher percentage of hearing loss than is actually the case.

To prevent deception by a person pretending to hear when he actually does not, a cutoff key is provided with which the operator may interrupt the tone. If this is done before the signal for failure to hear has been given but at a tone value which is actually not being heard, no notice will be taken of it by the person being tested. If he is signalling truthfully, however, he will indicate at once when the cutoff switch has been operated.

There are other places such as schools, colleges, doctors' offices, where this audiometer may be used but the intended use is in industrial plants to provide an accurate means for determining the sensitivity of hearing of employees. It is essential in certain positions that a person have very acute hearing to perform his duties safely and efficiently and a simple test with this audiometer will prevent the assignment of a person with subnormal hearing.

A recent development of the Laboratories, the Type D single channel carrier system, played a prominent part in restoring telephone service in the New England flood area. The initial lot of terminal equipments was just being completed at Hawthorne when the flood occurred. Release was obtained from the Associated Companies for which they had been manufactured, and five were shipped to Boston on November 12, where certain modifications were made to fit the systems to the offices at which they were to be installed. Then the five systems were shipped to five different points in the flood area where each provided an additional voice channel between two telephone centers. The terminal equipments came from the factory completely tested; this as well as their compactness expedited their installation. In the emergency no work could be done on the lines to prepare them for the carrier frequencies, yet service was in all cases satisfactory.

High Voltage Storage Battery

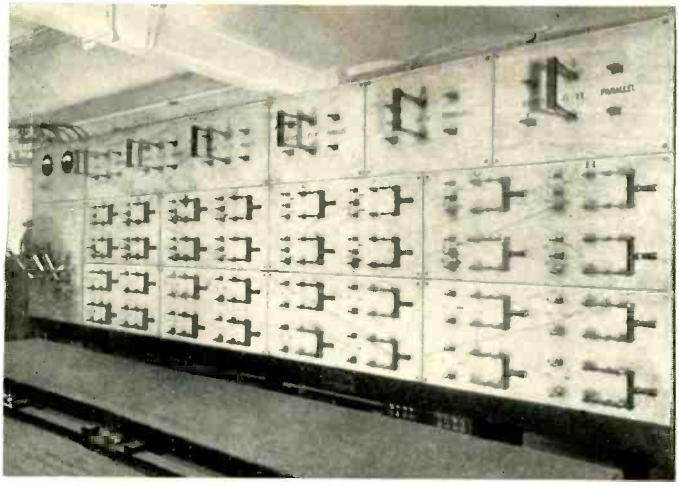
By L. E. DICKINSON
Apparatus Development Department

IN the development of fuses, protector blocks and other pieces of protectve apparatus for telephone use, a source capable of delivering for a few seconds direct current of several hundred amperes at high potential is extremely useful. To provide such current a storage battery is best; on account of its low internal resistance it will deliver, for the time needed to test a fuse, current at many times its normal discharge rate and at voltage very close to normal. The battery provided in the Laboratories for such testing has found use as well for investigations of resistances, electrolytic condensers and lead-covered cable. At an early stage in the development of water-cooled vacuum tubes it was used to maintain a plate potential of four thousand volts. It has even been used for magnetizing permanent magnets for loud speakers used with talking moving pictures and elsewhere.

One-twelfth of the battery. These two racks, like all the others, hold eighty-eight cells each

The high-potential battery dates from 1915, when the Electric Storage Battery Company installed 2112 cells on the first floor of the old Section H building on Washington Street. When this building gave place to the present Section H the battery was dismantled, and after overhauling was reinstalled in the room which it occupies today on the first floor of Section G. The floor, of concrete, is covered with a layer of hard acid-proof bituminous compound about an inch and a half thick, and the walls are painted with a light acid-proof paint instead of the black asphaltum paint sometimes used in battery rooms. Each cell is of sixty ampere hours capacity, and consists of thirteen lead plates about four inches square. The cells are permanently connected into groups of forty-four, and these units may be connected together as wanted.

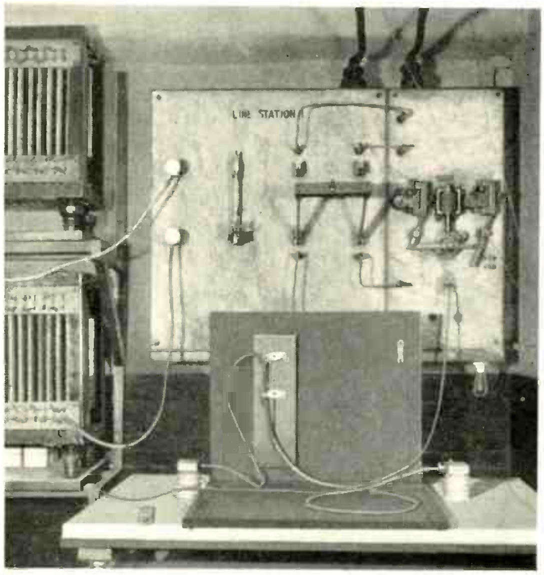
Because of the fine spray thrown



The cell groups are mounted in series or in parallel by these knife switches. At the left are the oil switches for completing and breaking connections

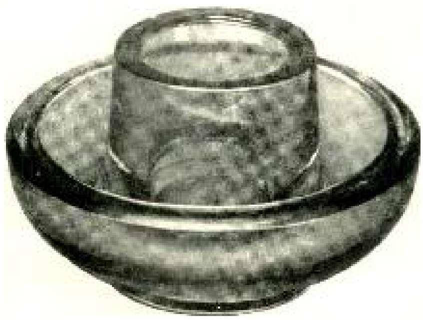
Each group of forty-four cells is connected to a knife switch on the main panel of a switchboard in an adjoining room, whereby it can be connected in series or in parallel with other groups. Any voltage between 90 and 4320 can thus be obtained, in steps of 90 volts. On another panel are oil-switches by which the battery is connected and disconnected to start and stop testing, and on the third panel connections are arranged for charging. With all the cells connected in series about a thousand amperes flow during the small part of a second required for a fuse to operate. The current is correspondingly greater

off by the cells during charging and of the "sweating" on the outside of the jars in humid weather, requirements are most exacting for the insulators on which the individual cells and the cell groups are supported. The wooden uprights supporting the racks of cells are mounted on double tiers of glass insulators separated by lead discs, the lower insulators resting on tile blocks set in the floor. Each group of four cells rests on a plate of wire glass ⅜" thick, supported by small glass insulators resting on the wooden rails of the rack. Each insulator, large or small, consists of a glass body surrounded by a steep, funnel-like wall of glass; between is a circular trough filled with transformer oil. The whole insulator is protected by a lead cap, covering the top and extending down around the sides, but not touching the glass of the insulator.



Fuse ready for trial, mounted on the test table. Current is restricted to the desired value by the resistances at the left when the battery is connected to give 540 volts. This arrangement is commonly used in testing carbon block protectors, since it is close to the standard trolley voltage. In any case the circuit is opened by the oil-switches, operated manually; though a circuit breaker might be used, none has been provided, lest its operation might mask the performance of apparatus under test at the time.

From the main oil-switch, conductors of comparatively large size lead to the test table, where fuses and other protective devices are mounted during testing. Adjoining it on the left is a grid resistance for regulating the current, made up of nichrome ribbon mounted on transite cores. Sections of ribbon are connected in series or in parallel by means of small knife switches at the bottom. At the right of the table is a magnetic contactor to close and open the circuit for tests requiring currents of less than twenty-five amperes at voltages under one thousand. After the oil-switches are closed the tester presses a button which closes the contactor, and as soon as the test is finished — in a second or so—he releases it, opening the circuit. Then the oil-switches are opened. During all testing a man is detailed by the Plant and Shops Department to operate the knife switches, connecting the cell groups as wanted by the engineer making the test, and to stand near the oil-switches, closing and opening them as is necessary.



Glass insulator such as those supporting the cells and the rack

News of the Month

Dr. Jewett spoke December 1 at the seventh annual meeting of the Highway Research Board of the Division of Engineering and Industrial Research in Washington on the subject, "Engineering Research — a Retrospect and a Prospect of Scientific Investigation in Industry." On December 7 he spoke on "The Present in Engineering — 1927" at the fiftieth anniversary of the organization of the Engineers Club of Philadelphia.

Mr. Craft addressed the Division of Engineering and Industrial Research of the National Research Council on "Selling the Research Idea" at its annual meeting, held November 18 at the University Club.

Mr. Craft entertained Captain Ralph Earl, President of Worcester Polytechnic Institute, at luncheon and a visit of the Laboratories December 8th.

* * * *

A. R. Olpin addressed the Colloquium on December 5 on the topic "Photoelectric Phenomena in Crystals," and on December 19 Professor L. W. McKeehan of Yale University spoke on "The Experiments and Theories of David Evans Hughes Concerning Ferro-magnetism."

Research

C. J. Davisson delivered an address, "Diffraction of Electrons by a Crystal of Nickel," on December 28 at the joint meeting of the American Physical Society and Section B of the American Association for the Advancement of Science held at Nashville, Tennessee. He spoke informally on the same subject at the meeting of the American Physical Society held in Chicago, November 26.

C. J. Davisson and L. H. Germer presented a paper, "Diffraction of Electrons by a Single Layer of Gas Atoms Adsorbed upon a Nickel Crystal," and J. A. Becker and D. W. Mueller a paper, "On Electrical Fields Near Metallic Surfaces," at the December 28 session of the annual meeting of the American Physical Society held at Nashville.

H. H. Lowry discussed the subject "Adsorption" at the Physical Chemistry Colloquium of Princeton University on December 13.

R. A. Heising delivered a paper on "Experiments and Observations Concerning the Ionized Regions of the Atmosphere" before the Institute of Radio Engineers on December 7.

J. W. Horton addressed the Cleveland Section of the American Institute of Electrical Engineers, and H. M. Stoller the Fort Wayne Section, on December 15; both spoke on television.

K. K. Darrow attended the annual meeting of the American Physical Society, held December 28 to 30 at Nashville.

F. F. Farnsworth and C. D. Hocker visited the P. H. Murphy Company at New Kensington, Pennsylvania, and the American Sheet and Tin Plate Company at Vandergrift, Pennsylvania, on December 5 and 6, in connection with their work on Subcommittee A-5 of the American Society for Testing Materials. At Vandergrift they observed methods of galvanizing sheet iron with zinc, and at New Kensington watched fabrication of the galvanized material.

D. G. Blattner demonstrated high-power sound reproduction on November 26 before the Amusement Park Convention, held in Chicago.

A. R. Kemp and E. M. Honan attended the meeting of Committee D-11 of the American Society of Testing Materials, dealing with rubber products, at Buffalo.

R. M. Burns returned recently from the Pacific Coast after having conducted corrosion tests on telephone cable and underground structures of telephone plant at several points there and, on the trip back, at New Orleans.

Apparatus Development

F. R. McMurry returned the end of December from Chicago, where he had been inspecting and testing models of the 15-type telegraph printer since October.

F. F. Lucas addressed a joint meeting of the American Institute of Mechanical Engineers and the Optical Society of America held in the Engineering Societies Building on December 7, on the development of high-power photomicrography.

An Exhibit at the International Radiotelegraph Conference in Washington was a set for measuring radio field strength developed in these Laboratories. It was installed in a test car of the Department of Commerce by C. C. Graves and L. F. Bockoven.

J. W. Greig retuned the one kilowatt radio transmitter at D. W. Flint's station, WDWF, in Providence, Rhode Island, early in December.

H. S. Price made surveys for installation of five kilowatt transmitters for Moody Bible Institute, Chicago, Saenger Amusement Company, New Orleans, and the University of Florida, Gainesville, during October. During November he made a survey for a similar transmitter for the Churchill Evangelistic Association, Buffalo, and early in December for a five kilowatt installation to replace the five hundred watt equipment of the Congress Square Hotel of Portland, Maine.

Since returning from South America, D. H. Newman took a vacation trip to the Pacific Coast. On the return he stopped at Chicago to make a survey for a five kilowatt broadcasting transmitter for the Chicago Daily News.

W. L. Tierney was in Tulsa, Oklahoma, early in November, making a survey for the installation in a new location of the one kilowatt transmitter owned by the Voice of Oklahoma. He later went to Philadelphia, where he retuned the transmitters of Gimbel Brothers and John Wanamaker to the new frequencies assigned by the Federal Radio Commission.

H. B. Arnold is at Cincinnati making a study of the Union Gas and Electric Company's power line carrier telephone system.

Systems Development

A. C. Dickieson conducted tests on the initial lot of Type D carrier telephone system at Hawthorne.

K. Lutomirski made crosstalk tests on the office cabling at the new Cleveland toll office.

E. P. BANCROFT has returned from San Francisco, where he had been engaged in testing picture transmission systems since July. C. E. White, who was at Chicago for the same group of tests, has also returned.

J. JULEY inspected clamps for multiple banks which are being tried out in one of the dial offices in Chicago.

B. W. KENDALL and H. H. Lowry attended the cutover of the new toll office at Cleveland on November 12, and W. H. Matthies and F. J. Scudder, the cutover of the new panel type dial office there on December 3.

V. T. CALLAHAN has been testing gas engine-generator sets at Buffalo.

A. KENNER visited Detroit early in November to discuss pneumatic tube equipment with engineers of the Michigan Bell Telephone Company.

J. L. LAREW conducted noise tests on the power plant for the step-by-step office and toll office at Utica, New York, early in November.

NOVEMBER 24 to DECEMBER 10, R. P. Jutson inspected a current supply set of new type for small toll repeater installations which is being tried out at Lexington, Kentucky.

E. J. KANE and E. H. Smith visited New London, Connecticut, during December to inspect the step-by-step line finders being installed there, one of the first such installations in the east.

D. M. TERRY visited the Brown Instrument Company in Philadelphia on November 16 in connection with a special indicating control instrument for pilot channels.

OUTSIDE PLANT DEVELOPMENT

R. L. JONES, S. C. Miller and V. B. Pike visited Allentown, Pennsylvania, with W. C. Redding, R. E. Alberts and C. Kreisler of the Apparatus Development Department and with engineers of the American Telephone and Telegraph Company, November 23 to observe the installation of a trial section of special aerial cable.

C. S. GORDON and I. C. Shafer conducted tests on protective coatings for copper wire in Boston on December 12.

R. C. EGGLESTON visited Philadelphia November 1 in connection with an investigation of eastern white cedar poles.

C. D. HOCKER and W. A. Hyde visited the plant of the General Electric Company at Lynn, Massachusetts, on November 26.

L. W. KELSAY visited New Haven and Hartford during the latter part of November, making investigations in connection with terminals for underground cables.

C. D. HOCKER was in Pittsburgh on December 5 for committee work of the American Society for Testing Materials.

E. ST. JOHN visited the plant of the Bethlehem Steel Company at Lebanon, Pennsylvania, on November 30 for investigations on interchangeability of certain threaded parts of outside plant hardware.

J. A. CARR examined sections of the aerial cable between Goshen and Liberty, New York, with engineers of the American Telephone and Telegraph Company on December 13, to obtain data on the cutting of cable sheath by aerial cable rings.

INSPECTION ENGINEERING

G. D. EDWARDS, D. A. Quarles, W. A. Boyd, H. G. Eddy, H. F. Kortheuer and R. M. Moody represented the Laboratories at a conference held at Hawthorne during the week of Novembr 28 regarding the schedule of Survey Conferences for 1928.

O. S. Markuson, R. M. Moody, H. G. Eddy, and P. S. Olmstead attended regular Survey Conferences at Hawthorne during November and the early part of December. R. M. Moody and H. F. Kortheuer attended similar conferences at Kearney.

G. D. Edwards visited the Field Headquarters at Chicago and Cleveland during the first week in December.

R. J. Nossaman visited the headquarters of Local Field Engineers at Cleveland, Chicago, St. Louis and Omaha during December.

P. B. Almquist, Local Field Engineer at San Francisco, was in Los Angeles the first week in December for regular field work.

S. C. Miller and E. G. D. Paterson visited the Whitney-Blake Company in New Haven on December 16 to discuss problems connected with the manufacture of telephone wires.

E. F. Helbing observed the operation of a six cylinder type "T" Foos gas engine installed in a new step-by-step office in Utica, New York.

Patent

H. A. Burgess, E. V. Griggs, J. A. Hall, W. C. Kiesel and M. R. McKenney visited Washington during the period from November 10 to December 12 for the prosecution of applications for patent.

General Staff

S. P. Grace delivered a lecture on developments of the Laboratories, particularly those dealing with speech and hearing, to the twenty-third annual convention of the Illinois Telephone Association at Springfield, Illinois, on November 18.

At a conference on personnel relationships conducted by men from fields of education and business, John Mills spoke on "A Mutual Requirement for an Employer and an Employee." The group met on November 16 at the University Club, Boston.

R. W. King described television apparatus and its operation to the Cincinnati Section of the American Institute of Electrical Engineers on December 8.

M. B. Long spoke on television before local sections of the American Institute of Electrical Engineers at Boulder and Denver, Colorado, and at Lincoln and Omaha, Nebraska, the middle part of November.

L. S. O'Roark spoke December 20 to the Louisville, Kentucky, Section of the American Institute of Electrical Engineers on recent developments of Bell Telephone Laboratories, particularly television. That afternoon he spoke on the same subject to a student group at Speed Science School.

E. U. Condon spoke November 17 to the phvsics colloquim at Princeton University on "Recent Advances in Knowledge of the Hydrogen Molecule," and to the physics department meeting at Columbia University on the same subiect December 2.

J. S. Hartnett, A. J. Daly and D. R. McCormack visited Hawthorne recently to discuss various commercial matters.

R. A. Deller gave a group of lectures on television at Ohio colleges, December 12 to 17, speaking at Wooster College, Denison University, Ohio, Wesleyan University, Ohio State University, and Oberlin College.

Club Notes

On Monday, December 19, when more than 3500 members of the Laboratories expressed their choice by ballot, Donald A. Quarles was elected president of the Club for the coming year, George F. Fowler first vice-president and Marie Boman second vice-president. S. James Stranahan will represent the Apparatus Development Department during the next two years, and Thomas C. Rice the Patent and Inspection Departments. The Plant Department is to be represented by George Rupp. The new terms start at the January meeting of officers and departmental representatives.

Winter Dance

The orchestra has now been engaged for the Club dance — Don Marcotte's Vagabonds, whose playing as broadcast by station WEAF has been so popular. Those who have not yet bought their tickets are urged to avoid disappointment by securing them at once from departmental representatives, since the number of tickets has been limited to prevent crowding. Tickets for box seats should also be bought immediately, since only a hundred and eighty are available. The dance is to be held in the Hotel Pennsylvania, as announced before, on Thursday, February 2; dancing will start at nine, and will continue until two. Tickets are $1.10 each, and box seats $1.65 each.

Chess

Our team in the Commercial Chess League of New York has still to find a team that can break its string of victories. Having won the Commercial Championship for four successive years our players are now on their way to a fifth championship. This season they have won all five of the matches played so far and have only lost one game out of twenty played. In previous seasons five or six men have carried the burden of these matches but this year our players were markedly better, and ten of them took part in league games.

We are especially proud of the fact that our team defeated by a score of 3½ to ½ that of Western Electric, one of the strongest teams in the league. The Western Electric team is composed of the best chess players that can be found in the various branches of the Western Electric Company in the metropolitan district.

Picture Contest

Since the Picture Contest is to be held in February, it is quite time for intending participants to get busy. The extent and excellence of last year's exhibits surprised everybody, and this year the contest should be even better. Sheets telling of the classes of pictures and all conditions of the contest will be sent to everybody within a few days.

Golf

Sixty players took part in the indoor golf tournament, the first of the season, held December 12 at the

Vander-Built-In Golf Course. So great was the interest that another tournament has been scheduled for the same place January 25, and plans for a March tournament are under way.

In the qualifying round, divided into two groups, R. Koernig and F. B. Blake tied for first place in Group 1 and divided the prize. In Group 2, E. J. Johnson carried off the medal prize with a score of 79, the lowest of the evening.

The finals brought out some excellent golf, and some disappointments as well. In Class A, Group 1, R. Koernig beat W. H. Harvey on the eighteenth hole after a round of heart-breaking golf. In Group 2 of Class A, F. D. Smith, a man who promises our golfers keen competition in future contests, won from E. J. Johnson. L. G. Hoyt was the winner, for the third consecutive tournament, in Group 1 of Class B; Group 2 of this class was won by W. C. Burger, who eliminated G. E. Kellogg, one of our star golfers. E. H. Chatterton defeated D. D. Haggerty in Group 1 of Class C, and H. L. Downing won from R. E. Merrifield in Group 2, after Mr. Merrifield had played thirty holes to win the semi-final round. In Group 1 of Class D, A. I. Crawford won from D. A. Danielson on the eighteenth hole, and in Group 2 I. R. Goshaw defeated H. Leicht.

Hiking

Though the fall hikes are now only pleasant memories, the records show enthusiastic participation on the part of the members. R. W. Bogumil is first in the distance covered, 146 miles, and W. C. Buckland and F. R. Stansel are next with 134 miles and 112 miles respectively. The men are not the only walkers, though—Phyllis Barton also hiked 112 miles, in spite of the fact that sickness kept her from some of the hikes. Evelyn Brisbane, 107 miles, is second among the women, and Elizabeth Mains, 95 miles, third. In addition, Margaret Brisbane has qualified for the 75-mile hiking emblem of Bell Laboratories Club.

Women's Club Activities

Dancing

The holiday rush had its effect on the attendance of the dancing class as on many of our other regular activities, but those who continued with Mr. Vecchio found the class as enjoyable and invigorating as ever.

Conforming with the present popular demand for Spanish dances, Mr. Vecchio has been spending quite a bit of time recently on various steps of the Tango. Just what the class will specialize in during the next ten lessons will depend on the wishes of the girls who sign up in the class now forming.

Women's Bridge Club

In the first tournament of the Women's Bridge Club, completed last month, the highest score, 5509, was made by May Lynch, who also carried the honors for having the highest score for one evening, a plus score of 2002. The two next highest in the tournament were Virginia Crim with a score of 3770 and Elizabeth Pritzkow, who made 2968. There were thirty-one players, most of whom intend to continue to play on Tuesday evenings in the Women's Rest Room. Others wishing to participate should call Katherine Munn.

Swimming

The new classes begin on the ninth

and the eleventh of this month at the Carroll Club, and presumably will be as popular as ever. Those interested can get full information from Eleanor Bolan.

Bowling

A bowling club will be started if enough women are interested. Some have said already that they would join. Others who wish to participate should communicate with the new Second Vice President.

Christmas Poster Contest

There were fifteen posters submitted in the Christmas contest, all well worth the attention of the judges. Several were so good that it was with difficulty that a choice was made. After thorough consideration the judges picked for reproduction and display on the bulletin boards the poster prepared by Alice Pease, and awarded to her the ten dollar gold piece offered as prize. Honorable mention was given the poster designed by Fred Frampton.

Final Standing in Bell System Basketball League

1927 Season

TOTAL POINTS SCORED

Bell Laboratories	222
Long Island	209
Hudson Street	197
Headquarters	182
Southern Manhattan	179
Installation	157
Westchester	152
Northern Manhattan	93

FINAL STANDING

	Won	*Lost*
Bell Laboratories	6	1
Long Island	5	2
Hudson Street	5	2
Headquarters	5	2
Southern Manhattan	3	4
Westchester	3	4
Installation	1	6
Northern Manhattan	0	7

POINTS SCORED BY THE FIRST TWENTY MEN

1.	Abruscati, Installation	74
2.	Hasior, Bell Lab.	57
3.	Maurer, Bell Lab.	54
4.	Stevens, Headquarters	54
5.	West, Long Island	53
6.	Hickey, Hudson Street	52
7.	McFarland, Long Island	50
8.	Burkhard, So. Manhattan	44
9.	Cronkite, Hudson Street	37
10.	Gittenberger, Bell Lab	37
11.	Dittmar, Headquarters	36
12.	McGeeny, Long Island	35
13.	Rossi, Hudson Street	34
14.	Bedingfield, So. Manhattan	34
15.	Booth, So. Manhattan	33
16.	Steinmetz, Bell Lab	32
17.	O'Neil, Bell Lab	32
18.	Gunderson, Westchester	32
19.	Redmond, Westchester	31
20.	Bobenreith, Long Island	31