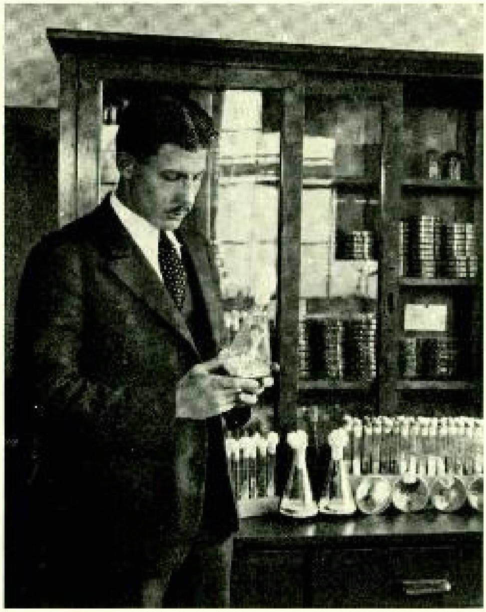
BELL LABORATORIES RECORD



Our Timber Products laboratory has among its equipment pure cultures of eleven fungi which cause decay of wood. These microscopic plants are used to study various preservatives for telephone poles

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1931

Dielectric Properties of Matter

By S. O. MORGAN
Chemical Research

IT is generally known that substances differ dielectrically. The most usual measure of the dielectric properties of any one substance is its "dielectric constant", defined as the ratio of the capacitance of a condenser filled with the substance to that of the condenser when the space between its plates is evacuated. The capacitance of a condenser is in turn determined by the quantity of electricity which flows into it, and thus into the material which fills it, under a given potential difference. It is also well known that the "dielectric constant" of a single substance is really not always strictly constant; notably it may vary with changes in the physical state of the substance between solid, liquid, and gaseous. To relate the dielectric properties of substances to their structure, a dielectric theory has been gradually developed in terms of current physical and chemical hypotheses.

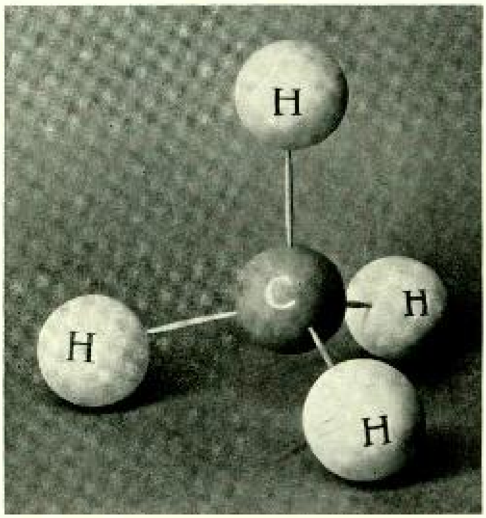


Fig. 1—Methane is symmetrical and therefore non-polar

It is commonly accepted that matter consists of various combinations of positive charges, to be found in atomic nuclei, and negative charges, the electrons. A single nucleus and its surrounding electrons constitutes an atom, and a stable combination of those atoms constitutes a molecule. Whereas atom and molecule are composite, both have, by virtue of their stability, a certain integrity, and in many phenomena can move about and behave as wholes. It is the structure, in terms of atoms, of its typical molecule which largely characterizes a substance from the chemist's standpoint.

It is a fact familiar to physical chemists that, when a sufficiently high potential is applied across a substance, ionization takes place. But if the substance is not ionized, the component charges move somewhat toward the plates of opposite polarity and the molecule is distorted. In other words the substance is itself temporarily polarized, since the electrical center of all the negative charges moves toward the positive plate and that of the positive charges toward the negative plate. The building up of this polarization constitutes an instantaneous current, and the ultimate polarization constitutes a charge on the material which opposes the potential across the plates of the condenser and prevents the further flow of current. It is the distance which the positive and negative centers move apart with reference to one another under a given potential difference that determines the quantity of electricity which flows into the condenser, and thus the capacitance of the condenser and the dielectric constant of the material.

From these considerations it can be shown that the only variation to be expected in the dielectric constant of a material with changes of temperature and state would be that due to the difference in the number of molecules between the condenser plates at different densities of the material. Thus the ratio of the dielectric constant to the density would be constant for any one material. It might furthermore be expected that different substances whose molecules were built up of the same atoms, even though in different ways, would have approximately the same dielectric properties. But whereas these expectations are fulfilled for many substances, they are not for most.

A study of the discrepancies led to the introduction, by P. Debye, of a special assumption into dielectric theory: that any substance can be classified as of a "polar" or a "non-polar" type (Figure 2). Non-polar substances are those with chemically symmetrical molecules, in which the centers of positive and negative charge coincide so long as the material remains electrically unstressed. Polar substances are those with asymmetrical molecules, whose centers of charge are permanently separated by an amount depending on the asymmetry. The magnitude of this "permanent dipole", its "electric moment", is of the order of 10^{-18} electrostatic units,—the product of unit charge, 4.77×10^{-10} e.s.u., and the interatomic distance, about 10^{-8} centimeters. Non-polar molecules thus behave dielectrically in the relatively simple manner first described: a potential induces a temporary dipole in them, and on the removal of the potential they return to their normal electrically neutral state. But the behavior of polar molecules is less simple.

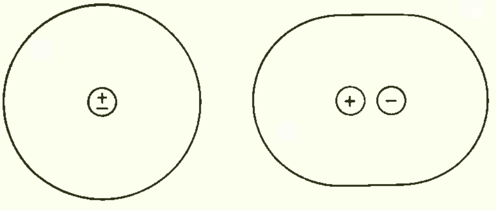


Fig. 2—In a non-polar molecule (left) the centers of opposite charge coincide; in a polar molecule (right) they do not

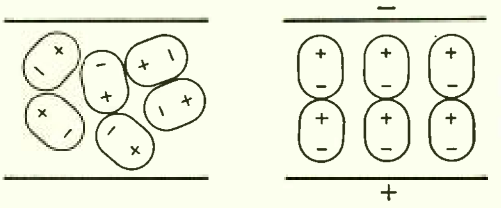


Fig. 3—A potential applied to a polar substance tends to shift its molecules from their random orientations (left) to a uniform orientation (right)

Because of the random orientation of molecules in a substance, the possession of permanent dipoles by polar molecules is not evidenced as a polarization of the material in gross so long as the material remains electrically unstressed. When a potential is placed across the material in a condenser, however, the molecules rotate into alignment with the electric field (Figure 3), if they are free to do so, and also suffer the further displace-

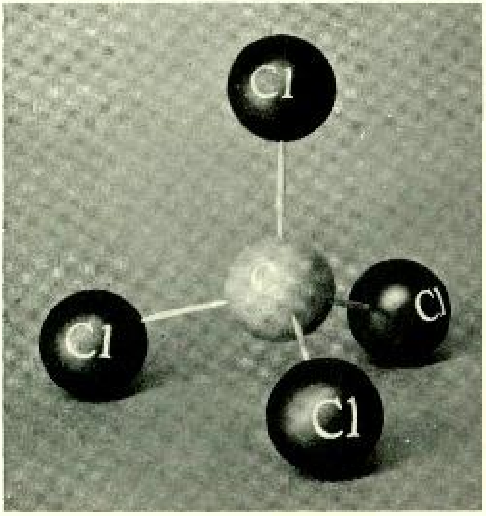


Fig. 4—Tetrachloromethane (carbon tetrachloride), like methane itself, is symmetrical and therefore non-polar

ment of their component charges previously described. The molecule is supposed to be constrained from this rotation when the material is solid, and free to rotate when the material is liquid or gaseous. The resulting total displacement of charges, and thus the dielectric constant, is much greater for polar substances, when in a fluid state, than for non-polar substances.

When the potential is removed, random orientation of the molecules is rapidly restored by the continual motion postulated in kinetic theory. Since this motion is continual, it is always tending to destroy any particular orientation. Thus, in the substance as a whole, the orientation is not perfect but statistical. As the temperature of a fluid rises, its molecules move more rapidly, and whatever orientation they are given by an electric field tends increasingly to be destroyed by their random motion. With increasing temperature, therefore, the dielectric constant of a polar fluid decreases more rapidly than its density, and more rapidly than the dielectric constant of a non-polar fluid.

These plausible assumptions regarding polarity have given a satisfactory explanation of the dielectric behavior of liquids and gases. Ex-

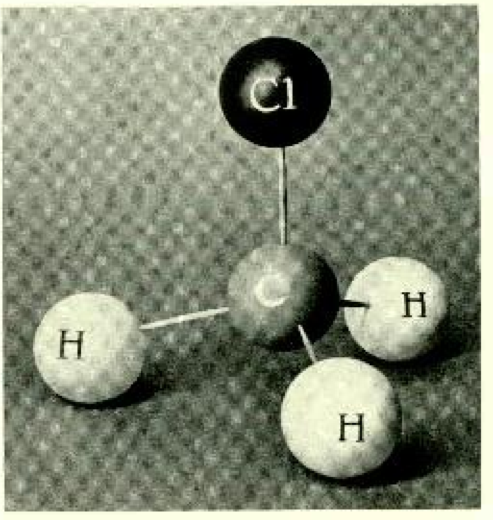


Fig. 5—Monochloromethane (methyl chloride) has an asymmetrical chemical structure and therefore a permanent dipole

perimental difficulties have delayed extensive application of the Debye theory to solids, but investigations here and elsewhere are now advancing the theory in this field also.

Good examples of the relationship between chemical symmetry and dielectric properties are furnished by methane and the compounds formed from it by replacing one after another of its hydrogen atoms by chlorine. Methane and carbon tetrachloride are symmetrical, with the molecular structures shown in Figures 1 and 4. The dielectric constant of the latter, 2.4 when frozen, decreases to 2.3 on melting, because of the decrease in density. When some but not all of the hydrogen atoms of methane are replaced by chlorine, asymmetrical molecules are produced (Figures 5, 6 and 7). The dielectric constants of the resulting chlorinated methanes, whose values, between 2.4 and 3.5 when frozen, are comparable to that of carbon tetrachloride, all increase greatly when melted, in spite of the decrease in density, due to the freedom and tendency of the molecules to rotate into alignment with the electric field. These increases are to about 6 in trichloromethane, to 12 in dichloromethane, and to 20 in monochloromethane.

Water, though one of the commonest substances, is yet one of the strangest known to the chemist; and in its dielectric properties also it preserves this uniqueness, by furnishing an extreme example of polarity. Its dielectric constant, 3 when frozen, increases to 80 when melted, a behavior indicating that it must possess an asymmetrical structure rather than the symmetrical one which most chemical studies leave equally likely.

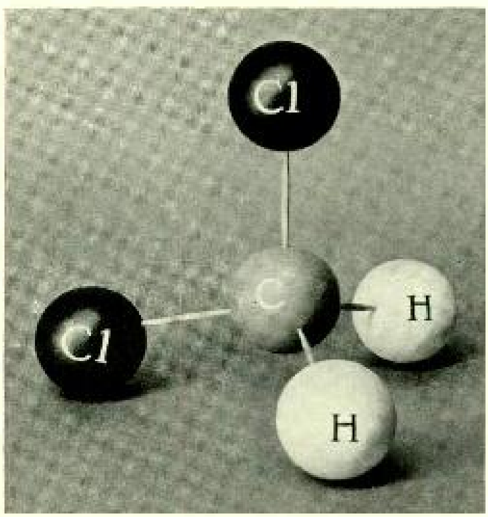


Fig. 6—Dichloromethane (methylene chloride) is asymmetrical, and therefore possesses a permanent dipole

The dielectric constants of all materials are subject to still another type of variation: when measured with an alternating rather than a constant potential, they vary with the frequency of alternation. It is supposed that in fluid polar substances the molecules, caused to rotate continuously by the continuously alternating potential, have natural frequencies of rotation determined by their masses and the elastic forces acting on them. Their rotations will also be impeded by resistances analogous to viscosity. As the frequency of an imposed alternating potential is increased, therefore, the molecule will ultimately fail to follow the alternations, and the dielectric constant will decrease with the diminishing contribution of molecular orientation. Thus for any fluid polar substance a frequency can be reached at which its orientation polarization vanishes, and its dielectric constant is reduced so as to differ from that of the solid substance only by the small amount due to a difference in density.

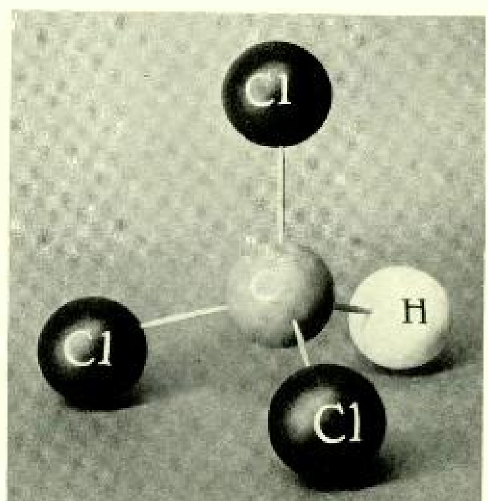


Fig. 7—Since trichloromethane (chloroform) has an asymmetrical molecule, it is a permanently polar substance

For even the extreme case of liquid water this is found true: its dielectric constant, 80 at low frequencies, is reduced by increasing the frequency until at 10^{11} cycles per second it is only 3.

It is difficult to make satisfactory measurements of the dielectric constant at frequencies so high. The effect can be quite readily observed at lower frequencies, however, in very viscous polar substances such as glycerine or resin oil. By dissolving in a viscous non-polar liquid the polar substance whose dielectric constant is to be measured, the frequency at which the polar molecule fails to follow the electric field can often be brought down within the carrier, the audio, or even the power range of frequencies.

There are, therefore, three conditions in which no orientation polarization results from placing a potential across a substance: when the substance is non-polar; when the substance is polar but in the solid state; and when the substance, though fluid and polar, is subjected to an alternating potential of a frequency too high for the orientation to follow. Under these conditions the dielectric constant depends solely on the formation of temporary dipoles by the motion of atoms with respect to each other and of electrons with respect to their nuclei when the substance is electrically stressed.

Like the rotations of molecules, these relative motions or vibrations of atoms and electrons have natural frequencies. Compared with molecules, the masses of atoms and electrons are so much smaller, and the elastic forces acting on them so much greater, that their natural frequencies of vibration are far higher. For atoms, in fact, the natural frequencies of vibration occur in the infra-red portion of the frequency spectrum, and for electrons in the ultra-violet. The measurement of the dielectric constant at these frequencies accordingly becomes an optical measurement of the refractive index. Like orientation polarization, then, the atomic and electronic polarizations vanish at appropriately high frequencies.

Thus it is possible to isolate three constitutents of the dielectric constant of a material, and to ascribe them to electrons, atoms, and molecules, respectively. The dielectric constant or refractive index for visible light is due to electronic motion alone. That for long infra-red rays or short radio waves is due to the sum of electronic and atomic motions. In the low-frequency dielectric constant of fluid polar substances there is added the contribution of molecular orientation.

These simple hypotheses go far toward explaining the dielectric behavior of matter. To go further they must be interpreted in terms of more exact notions regarding the structure of matter. At present such interpretations necessarily contribute precision only at a considerable expense of certainty, since there is great doubt regarding what are the structure and dynamics of atoms and molecules. But these dielectric hypotheses can be interpreted in terms of any of the current theories of the structure of matter. So well do they fit the facts, moreover, that any theory of the structure of matter seriously proposed will probably explain the dielectric properties of matter through these hypotheses rather than by developing others.

A-C. Busy Lamps for Toll Boards

By R. G. KOONTZ
Equipment Development

FOR a number of years magnetically operated signals have been used on toll boards to indicate busy lines. Lamps have been employed as signals to secure an operator's attention, but cabling and equipment difficulties arising from their large current consumption have until recently prohibited their use as busy signals. The magnetic signal consists of a coil which, when energized, pulls up a small white shutter behind a slot in a black background. The shutter returns to normal position by the action of gravity when the current in the coil is interrupted. The lower half of the front surface is utilized by the shutter while the upper half is used for designations.

A vertical mounting space of 7/8-inch is required for these signals, which is twice as much as is needed for a jack. Their appearance is shown in Figure 1. This space requirement is not of much importance where a small number of toll lines is involved but is of considerable importance where large numbers of lines are required. In a through switchboard, for example, the magnetic signal is used only for indicating busy lines and yet occupies one-half of the total space on the board. With the outward or CLR board, the magnetic signals, here used as busy signals, occupy two-thirds of the total space.

To meet the rapidly expanding toll traffic, development work was started several years ago to determine whether a busy signal could not be produced that would be better adapted to present requirements. The result is a busy-signal strip only 7/16-inch high employing a newly developed tungsten lamp of very low power consumption. The lamp mounting is arranged so that the designation card is placed in front of the lamp and the light illuminates a translucent spot on it about 1/16-inch in diameter. The remainder of the card is opaque and is available for designation markings. The arrangement is shown in Figure 2 and the relative space occupied by two types of busy signals in Figure 3.

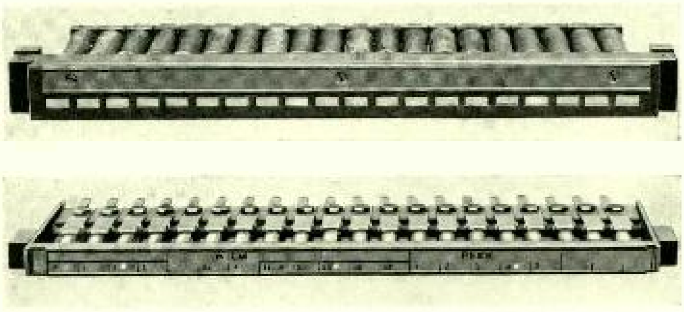


Fig. 1—(above) Until recently the common busy-indicator for toll lines has been the 42-A magnetic signal. Fig. 2—(below) In the new busy-signal strip a 1/16-inch translucent spot on the designation strip is illuminated by the newly developed E-1 lamp

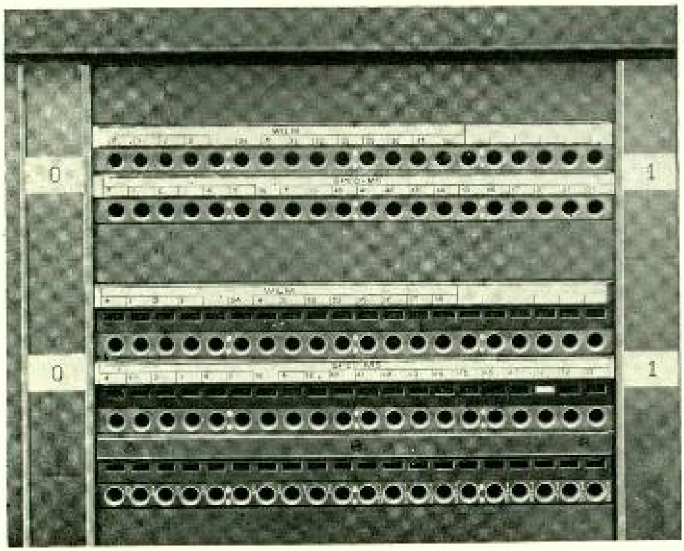


Fig. 3—The new busy strip, employing the E-1 lamp, occupies only half as much vertical space as the former magnetic type of signal

The principal feature of the new strip is the E-1 lamp. This lamp was designed for 6 volts but tests have indicated that satisfactory illumination and increased life are obtained by 4-volt operation. This new lamp, at its operating voltage, takes only .030 amperes, or a power consumption of only .12 watts, whereas the 42-A magnetic signal, rated at 6 volts, takes .060 amperes and .36 watts.

Although the new lamp will operate on either direct or alternating current, the latter is employed because of the economy and convenience of using the commercial power supply stepped down by transformers to the required voltage. Even with the marked decrease in voltage, however, careful design of the supply circuit is necessary because of the large number of lamps used and the close voltage regulation that must be maintained. Although but one-third as much power is required for the E-1 lamp as for the magnetic signal, the actual current for a given number of lamps is about twice that for the same number of the magnetic signals because while four of the latter are connected in series, the lamps are all in multiple. This change in method of connection was made so that the burning out of one lamp

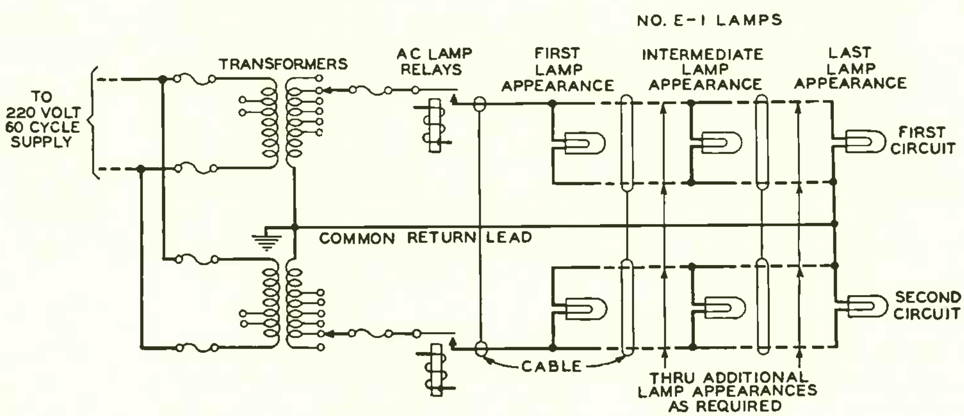


Fig. 4—Typical a-c. busy lamp multiple arrangement

of Electrical Research Products, Inc., have returned to this country. Mr. Palmer is now located in the Patent Department of the Western Electric Company at 195 Broadway, while Mr. Whitehorn has taken charge of the Patent Department at Hawthorne.

Hearings before the Examiner of Interferences at Washington were attended by H. A. Burgess, W. J. Crumpton, J. W. Schmied and C. A. Sprague.

S. B. Kent, W. C. Kiesel and E. C. Laughlin represented the Laboratories at hearings before the Board of Appeals.

F. E. Ward spent a few days making a special search through the patent files in the Government Patent Office.

A trip to Indianapolis and Chicago was made by A. G. Kingman.

STAFF

Twenty-five years of service in the Western Electric Company and the Laboratories were completed by

Miss M. A. Smith

Miss M. A. Smith on May 17. She is a member of the group winding small coils in the Development Shop.

Miss Smith has worked on small coils for many of the important communication developments that originated and were first tested here in the Laboratories. When the manufacture of step-by-step apparatus was undertaken by the Western Electric Company she worked on the coils for the initial switches which were wound by the small group in the Development Shop. She also was engaged on the windings of the first tool-made samples of the flat-type relay developed by the late E. B. Craft and now in extensive use in telephone central offices. Miss Smith has also done much work in transformer and retardation coil windings.

Until 1914 she was engaged on coil winding as part of the manufacturing activities formerly carried on at 463 West Street. When the work was transferred to Hawthorne she remained in New York as a member of the Development Shop.

General Accounting

A dinner given on May 8 at the New York Telephone building, 140 West Street, in honor of Dr. Egon S. Pearson was attended by H. H. Holland, C. W. F. Hahner, G. T. Selby, and K. M. Weeks. The dinner to Dr. Pearson was given by representatives of Bell System companies in the metropolitan area who are engaged primarily in mathematical and statistical work.

OUTSIDE PLANT

W. C. Redding gave an informal talk on telephone cables at a luncheon meeting of the Cooperative Club of New York.

Accompanied by Mr. H. J. Lang of the Cable Manufacturing Company of Bratislava, Czecho-Slovakia, J. G. Brearley was in Newark and vicinity to observe splicing practices on the new cable between New York and Philadelphia.

S. C. Miller made a trip to Boston with representatives of the American Telephone and Telegraph Company to witness tests made on new types of pole reinforcements.

Visits to Gulfport, Jackson, and Meridian, Mississippi; Spartanburg, South Carolina, and Birmingham, Alabama were made by R. H. Colley to develop improved methods for the empty-cell treatment of southern pine poles. Mr. Colley also visited Atlanta, Charlotte, and Meridian, in connection with the empty-cell preservation of southern pine conduit.

With representatives of the Long Lines and D. & R. Departments, E. St. John was in Syracuse to observe a trial installation of Blackburn duplex cable rings.

C. D. Hocker attended the inspections made in Pittsburgh, Altoona, and State College, Pennsylvania and Sandy Hook, New Jersey, by the A.S.T.M. sub-committees on galvanized sheet and hardware samples.

W. H. S. Youry made a trip to Philadelphia and D. T. Sharpe went to New Haven, both trips being concerned with a new design for body belts and safety straps.

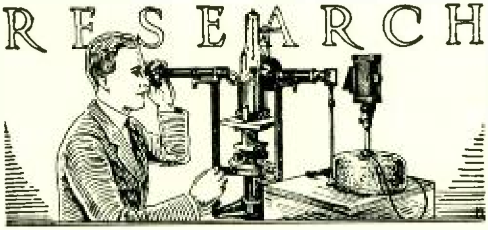
C. R. Moore was in Hawthorne in connection with details relative to the manufacture of the rolling-tool and sleeve used in a new method of wire joining. While there, he also discussed various phases of the manufacture of cable-splicing machines.

PERSONNEL

R. J. Heffner, with several other representatives of the Bell System, recently visited Massachusetts Institute of Technology to select candidates from the class of 1934 for the Communication Option of the Cooperative Course in Electrical Engineering.

PUBLICATION

G. F. Fowler attended the convention of the New York Electrical Society at Schenectady on May 15 as a member of the Annual Inspection Committee.



Transmission Instruments

At Massachusetts Institute of Technology, H. A. Frederick and H. C. Harrison addressed the Colloquium on *Storing of Sound.*

G. G. Muller was at Rochester to instruct in the use and observe the operation of the lapel microphone used at a meeting of the American Institute of Electrical Engineers.

Chemical Laboratories

The meeting of the American Chemical Society at Indianapolis was attended by A. R. Kemp, B. L. Clarke, L. A. Wooten, D. A. McLean, M. H. Quell and A. E. Schuh. Messrs. Clark and Wooten extended their trip to Hawthorne to discuss chemical methods and lubrication problems. Mr. Schuh also went to Hawthorne in connection with various finish problems.

Finishes on dial testers were investigated by C. L. Hippensteel and H. G. Arlt in company with J. Abbott of the Apparatus Development Department in a recent visit to the Philadelphia Instrument Shop of the Western Electric Company.

A-C. Busy Lamps for Toll Boards

By R. G. KOONTZ
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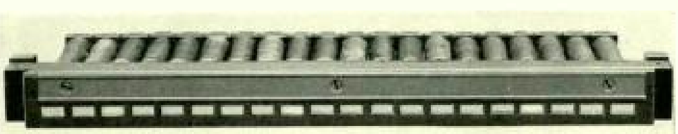

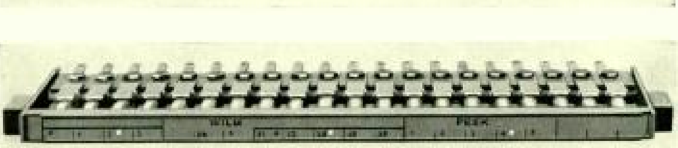

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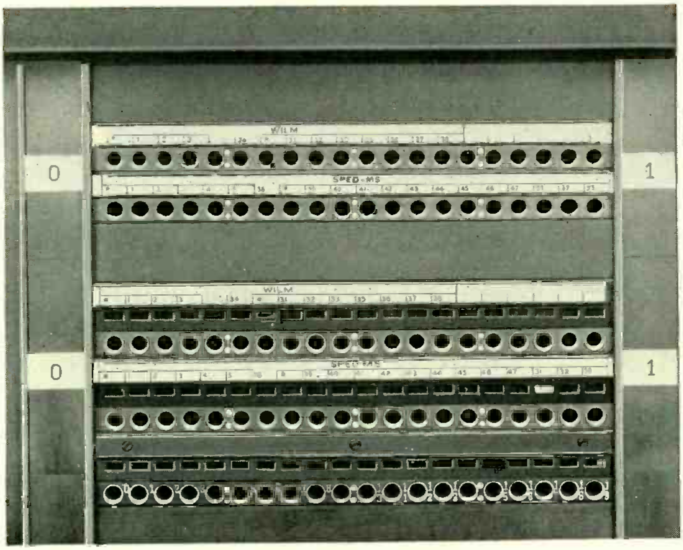

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Although the new lamp will operate on either direct or alternating current, the latter is employed because of the economy and convenience of using the commercial power supply stepped down by transformers to the required voltage. Even with the marked decrease in voltage, however, careful design of the supply circuit is necessary because of the large number of lamps used and the close voltage regulation that must be maintained. Although but one-third as much power is required for the E-1 lamp as for the magnetic signal, the actual current for a given number of lamps is about twice that for the same number of the magnetic signals because while four of the latter are connected in series, the lamps are all in multiple. This change in method of connection was made so that the burning out of one lamp

The principal feature of the new strip is the E-1 lamp. This lamp was designed for 6 volts but tests have indicated that satisfactory illumination and increased life are obtained by 4-volt operation. This new lamp, at its operating voltage, takes only .030 amperes, or a power consumption of only .12 watts, whereas the 42-A magnetic signal, rated at 6 volts, takes .060

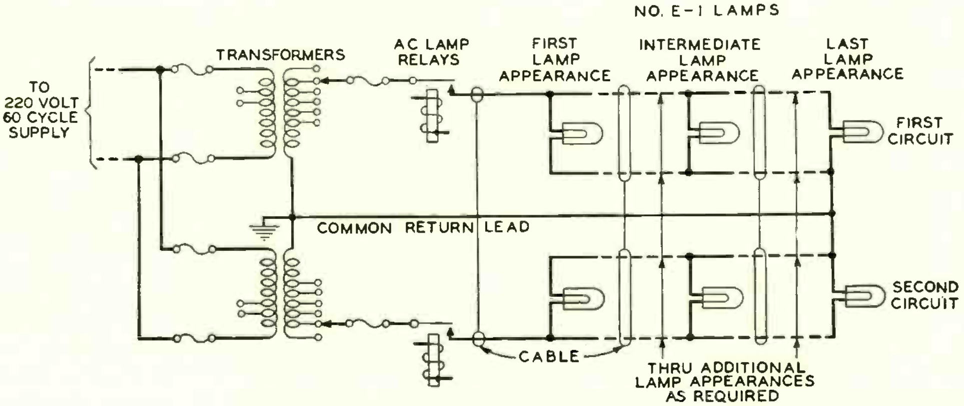


Fig. 4—Typical a-c. busy lamp multiple arrangement

would affect only one appearance.

The maintenance of satisfactory voltage regulation is particularly difficult because while the current required for four E-1 lamps is twice as great as that for four magnetic signals, the voltage is only 1/6 as great. The voltage drop, therefore, current times resistance, tends to be a much greater percentage of the lamp voltage and the seriousness of this fact is aggravated by the lamps' requiring closer regulation than the magnetic signals.

To obtain the required regulation a modified Edison 3-wire system is employed. The mid-point of the secondary of the transformer is grounded and the load is equally divided between the two sides of the circuit as shown in Figure 4. A two-wire multiple is used for each half of the circuit and the grounded or common connection is carried out to the far end of the circuit, which tends to equalize the voltages across the end and middle lamps. Since the voltage drop in the leads to various lines of switchboards will differ because of the unequal distances and currents, taps are provided on the transformer secondaries so that the voltages of various circuits may be varied from 5.0 to 11.5 volts in .5 volt steps.

To reduce still further the variation in voltage drop due to the length of circuit, the lamp leads are cabled directly from the alternating-current supply to the switchboard instead of running through the distributing frame as had been the practice heretofore. The power supply for each lamp circuit is controlled by a relay, called the a-c. lamp relay, which is operated by a battery supplying the toll-line relay equipment. In general, one lamp relay is used for each line of multiple in each switchboard. The a-c. lamp relays, fuses, and transformer units are all located on the same bay of relay rack as shown in Figure 5. Two types of bay layouts have been made available, one providing equipment for 480 lamp relays and the other for 600.

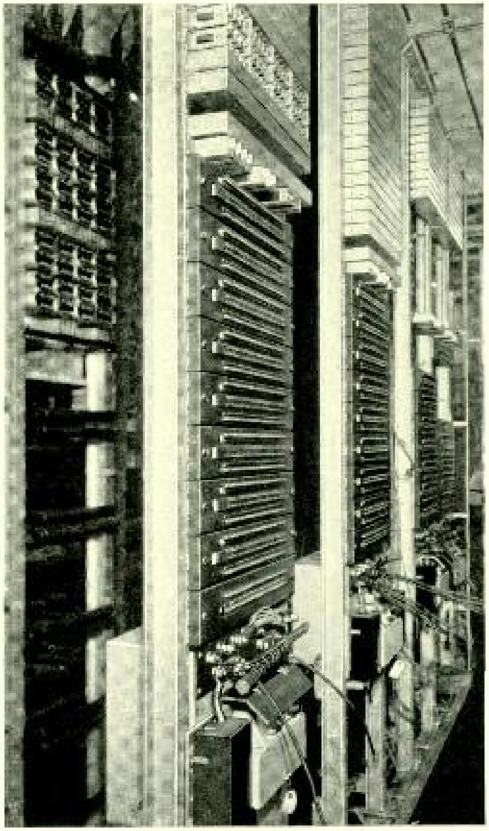


Fig. 5—A partially completed installation of relay-rack equipment to be associated with busy lamp signals

Compared with the 42-A type of magnetic signals, the E-1 lamp signals bring about a saving in space, a reduction in power-plant equipment, and lowered maintenance costs. The reduction in space not only produces an immediate saving but may postpone the time when it will be necessary in a given toll office to employ the tandem method to handle a rapidly growing traffic.

Molded Insulating Materials

By W. W. WERRING
Telephone Apparatus Development

MOLDED insulating materials have attained their present importance more because they are molding materials than because they are insulators. As molding materials they provide a new method of manufacture and assembly for telephone-apparatus parts. Large quantities of finished parts of intricate or irregular shapes may be more readily and economically produced by molding than by any other method. Unlike sheet insulating materials, which seldom have other than insulating uses, the molded materials have been frequently adapted for structural rather than insulating needs. Housings and casings — the cover of the new subscriber's set is a conspicuous example — are now molded from insulating materials, which have in many ways proved superior to wood or metals for the purpose.

The earliest molded insulating materials were porcelain and hard rubber. Both are excellent insulators and are still very important as insulating materials, but neither possesses the desirable molding characteristics of the more modern materials. After being molded from clay mixtures, porcelain parts must be fired at temperatures so high as to preclude the possibility of using metal inserts. Nor can parts be made to really close limits without grinding operations such as those performed on protector-block frames. Porcelain is generally used, therefore, where heat resistance or the necessity for minimum fire hazard are major factors. Its main shortcoming is its brittleness.

Parts for which porcelain was unsuited due to its brittleness or due to the necessity for closer limits were molded of hard rubber which readily lent itself to machining after molding. In hard rubber molding, the plastic rubber compound is forced into shape in molds and then vulcanized at temperatures of the order of 300° F. for several hours. The rubber compound has strong corrosive tendencies during vulcanization and therefore is usually molded in soft Muntz-metal or aluminum

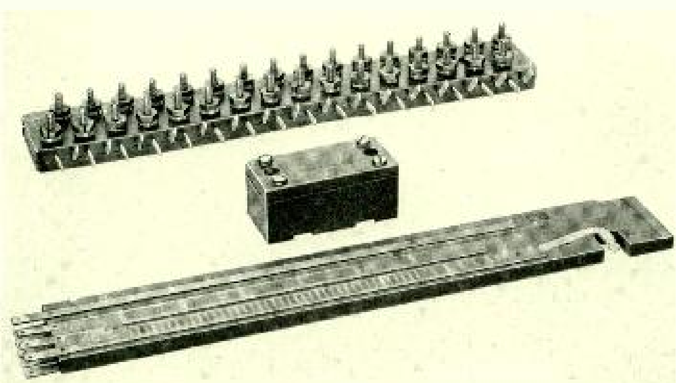


Fig. 1 — *Typical shellac composition parts with metal inserts embedded during the molding operation* molds. Because of this and the high shrinkage during molding, the process of manufacture is inherently not favorable to the production of completely finished parts, accurate to size and with metal parts molded in place. Though great quantities of sheet hard rubber are used for insulating purposes in the telephone plant, practically the sole use of molded hard rubber compound is in the desk stand receiver case. The case requires vulcanizing for a period of hours and then is completely machined and polished by means of highly-developed special equipment.

The striking advantages of molding as an advanced method of manufacturing were first emphasized with the introduction of the so-called "composition" materials. Shellac and other gums are used as binders, with the addition of a variety of filling materials such as mica, wood flour, or asbestos, which improve the mechanical properties and at the same time cheapen the mixture. These materials are soft when hot but rigid at ordinary temperatures and are molded by first being softened by heat, then pressed into dies of the required shape and cooled. The molding process in principle is no more complicated than placing a monogrammed seal on an envelope with sealing wax and a signet ring. The part hardens into the required shape merely by the cooling of the mold, and it will again become plastic on reheating to the molding temperature. This lack of heat resistance is a very serious handicap but, in spite of this, the ease and accuracy with which combinations of molded and metal parts may be assembled in one simple and rapid operation has resulted in widespread use of the various compounds of shellac.

In addition to their manufacturing advantages and excellent electrical properties, parts molded of shellac compounds because of the rapidity of molding are comparatively inexpensive. They are quite valuable in their proper place, which is limited by the brittleness and poor heat resistance of the compound. In the telephone plant, shellac-mica compounds are used for assembly and insulation of inserts in such parts as connecting blocks, key buttons and panel type commutators. Until recently the deskstand mouthpiece was also molded of a shellac-mica composition. Another well-known molded shellac product is the familiar phonograph record for which a shellac compound has long been used.

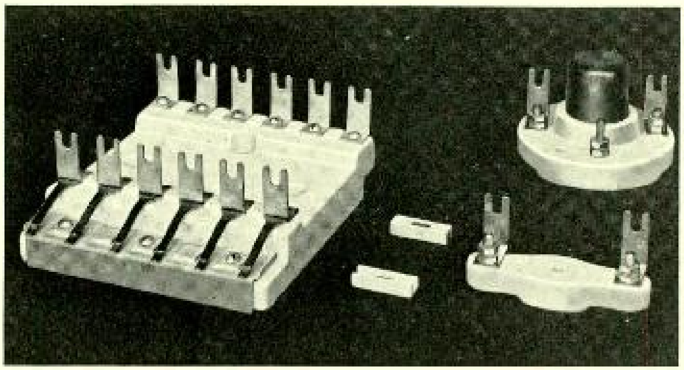


Fig. 2—In these assemblies involving porcelain bases, note how metal parts are attached by screws through molded holes in contrast to metal inserts molded in place

The success of the shellac-molding industry and the obvious need for a cheaper and more heat-resistant gum or resin lent new importance to certain interesting experiments of synthetic

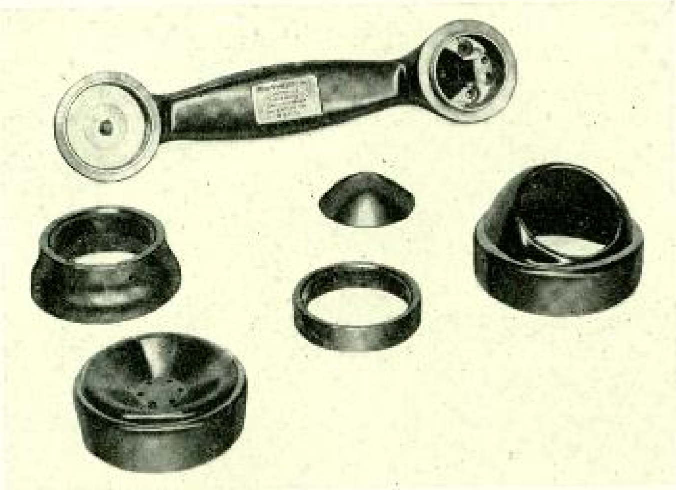


Fig. 3—Familiar handset parts of phenol plastic. All except the handle have molded threads

chemistry which produced hard resinous substances. Various investigators had been occupied with studies of the product of phenol (carbolic acid) and formaldehyde condensed in the presence of various catalyzers. It remained however, for Dr. Baekeland so to control this reaction as to develop an intermediate varnish-like substance which could be produced on a commercial basis. This material was patented and trade-marked "Bakelite" and molding materials utilizing the new synthetic resin binder came into widespread use under this name. Since the expiration of the original patents, other concerns have entered this field with similar materials advertised under new trade names. Within the Bell System, however, all molding materials using phenol-formaldehyde resins are known, regardless of trade name, as "phenol plastic", a companion name to "phenol fibre"* and "phenol fabric" which are used for laminated sheet materials using the same resins.

Phenol plastic molding compounds, like the shellac compositions, consist of a resinous binder combined with a filler. However, the phenol resin possesses a radically new and valuable property in that under the influence of heat the resin undergoes irreversible chemical changes which render it permanently hard, infusible, and practically insoluble in all ordinary solvents. This change occurs at an appreciable rate only at temperatures over about 200° F., and in commercial manufacture of molding materials the varnish or resin binder is brought but part way through this reaction and then mixed with the filling materials and dried. The material in powder form is then ready for molding and may be shipped and stored at ordinary temperatures without change. When this powder is held in a mold under pressures of 1000 to 2000 pounds per square inch at temperatures in the neighborhood of 350° F. it first softens and flows to the shape of the mold. Then under the continued application of heat the chemical reaction proceeds and the material hardens permanently into shape within 1 to 10 minutes, depending upon the size of the piece, type of mold, and other factors. Some cooling before removal from the mold is usually allowed though it is not essential to the molding operation. Cooling before ejection of the part does, however, improve the appearance and prevents warping and possibly blistering in instances where the chemical reaction

* Bell Laboratories Record, *October*, 1927, *p.* 53.

has not been carried to completion.

Phenol plastic is strong, hard, and resists heat to the extent of charring and burning without melting or softening. The compound chiefly used consists of approximately equal parts of phenol resin and wood flour with small amounts of pigments and dyes. Its electrical properties are not so good as those of new hard rubber, but are adequate for any ordinary use and do not deteriorate as do those of rubber. It is not subject to cold flow in the usual sense, though it is subject to slight shrinkage with drying. It has the advantage over metal of not requiring a protecting finish and retains its color and lustre in spite of handling and wear. The telephone user sees it frequently in the external parts of the subscriber's handset, but it is widely used in the telephone plant for a great variety of less conspicuous parts such as jack mountings, non-metallic coil cases, coil spools, and test strips.

It might seem that the phenol plastic materials with their outstandingly desirable properties could fulfill all essentials, but it would indeed be a magical material that would lack nothing in engineering, manufacturing, and cost requirements. Special and peculiar needs frequently are created by the complexities of telephone apparatus. Where, for instance, telephone apparatus is subject to accidental "flash over"—that is, arcs permitted by the accumulation of foreign conducting material on the surface—the insulating property known as "resistance to arcing" is a necessity. This property is indispensable likewise where apparatus must withstand the arc resulting from opening electrical circuits. Conspicuous in the first class is the 1-B test strip and in the second are a variety of interruptive apparatus such as ringing and pulse-machine drums, sequence-switch discs, multiple brushes, and panel-type dial-system commutators, in all of which the insulating properties of the material must not be destroyed by the searing effect of the arcing. Materials which leave a residue of conducting carbon in the path of an arc must be avoided where arcing is a factor.

Hard rubber combines resistance to moderate arcing with excellent frictional and wear characteristics and for complete resistance to severe arcing molded cellulose acetate has been used successfully. Cellulose acetate is, generally speaking, similar to the familiar celluloid (cellulose nitrate) but is free from the peculiarly dangerous fire and toxic fume hazard which makes the older material so undesirable in the telephone plant. Cellulose acetate, though quite expensive, has

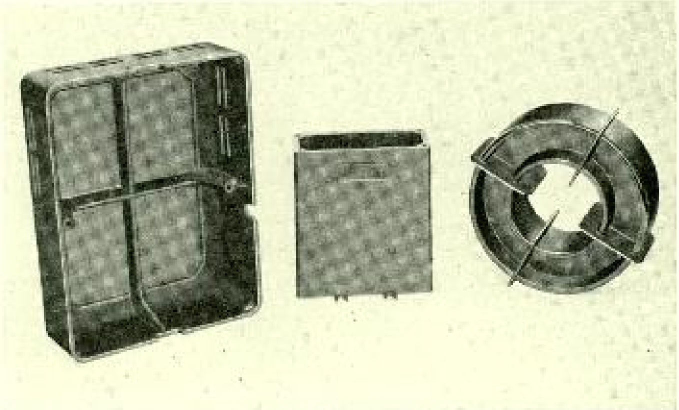


Fig. 4—Cover for small subscriber's set, non-magnetic coil case, and coil core, all large phenol plastic parts

tory for the basic structure of the test strip.

The demand for color in telephone sets creates another special problem. Subscribers' sets at present do not consist entirely of molded parts and since the associated metal parts must in any case be given a surface finish, the demand for color is best met by the use of finishes. With the anticipated extension in the use of molding, this situation may not be permanent.

The use of colors in molded telephone apparatus is an engineering problem of considerable magnitude as our apparatus must have long life and must meet a variety of rigid requirements. The addition of mineral pigments, as is usually necessary for light colors, changes the mechanical properties and even the weight of the material. As a result, very light-colored compounds frequently are found weak and unsatisfactory for our purposes. Many important materials, moreover, are not naturally clear and colorless, or even permanent in color and as a consequence are unsuited for binders in compounding bright or light colors satisfactory for our use. Therefore certain colors may require the selection or development of new materials which must be studied completely from such standpoints as stability or permanence of the material itself as well as from the standpoint of functioning of the apparatus when new.

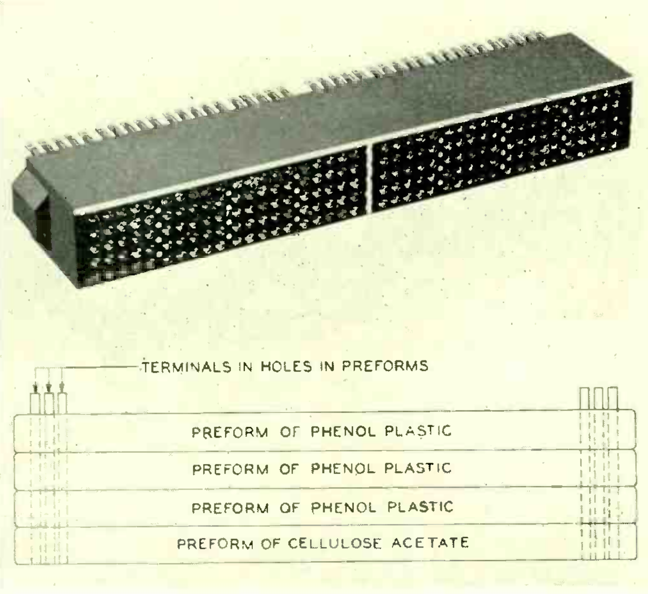


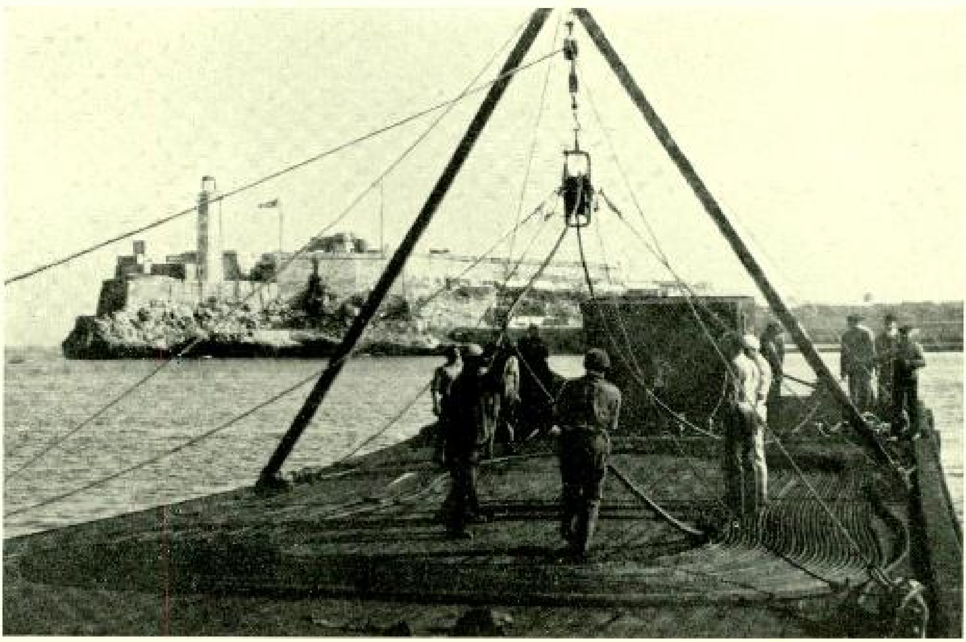
Fig. 5—The 1-C test strip, a difficult molding and engineering problem. It is now molded in one operation of phenol plastic with a veneer of cellulose acetate on the face subject to arcing

been available for some time in the form of flexible transparent sheet and has been used as a substitute for celluloid. Only in recent years has it been produced as a molding powder. It molds at temperatures from 250° F. to 400° F., but no chemical change occurs, and like shellac it can again be softened by heat. When burned by an arc no conducting material is produced and the insulating properties therefore survive any arc not so severe as to actually destroy the apparatus by fire. This valuable property is made use of in the 1-C test strip in which a molded veneer of cellulose acetate is applied where arcing might occur on a body of phenol plastic. This combination of materials is necessary as extensive soldering operations on two hundred closely-set terminals result in a temperature at the back of the part which makes the use of phenol plastic manda-

Casein products, cellulose acetate,

and various new synthetic resin materials may be obtained in a variety of bright and translucent colors, and all must be considered in the search for color. Practically all new materials are investigated as completely as their properties justify in the continuous study of materials necessary to cope with the needs of the Bell System.

Continued familiarity with molding materials and the molding process emphasizes the fact that the most effective use of the process lies in its complete substitution for complicated operations of machining and assembly rather than its use merely as an extension or addition to the older forms of manufacture. Apparatus designed to be produced by the older methods ordinarily will consist of a multiplicity of parts, each individually finished and later assembled with the others. Although substitution, part for part, of molding for machining will result in savings where the individual units are intricate, the really important economies are being achieved by redesign not of a single piece-part but of units of apparatus so that one molded part replaces several machined parts.



The barge used in laying parts of the Key West-Havana cable, under the shadow of Morro Castle, Havana

Here the Laboratories occupies seven floors

New Laboratories for Telegraph and Carrier Telephone Development

By S. W. SHILEY
Toll Systems Development

ON the tenth and eleventh floors of the Graybar-Varick Building, well-lighted quarters have been recently equipped for the carrier telephone, repeater, and telegraph activities of the Systems Department. Expansion had become imperative. The large number of important toll projects on hand in the latter part of 1929 had made the former quarters in the West Street building inadequate, and a similar increase in the activities of other departments combined to produce demands for space that could be met only by moving entire groups away from the West Street building. In designing the layouts of equipment for the new laboratories, it was kept in mind that the new quarters would be temporary. Ultimately the various scattered laboratory groups will be reunited in the present and proposed buildings at West and Bethune Streets so that, as far as possible, structures were used that could be moved with a minimum of inconvenience.

Relay racks on which the equipment under development and test is mounted are fastened to a permanent steel

Fig. 1—R. G. Loeffel, left, and C. A. Dahlbom with grounded telegraph equipment and open wire repeaters in the telegraph laboratory on the 11th floor. The fourth bay from the left is one of the permanent power panels

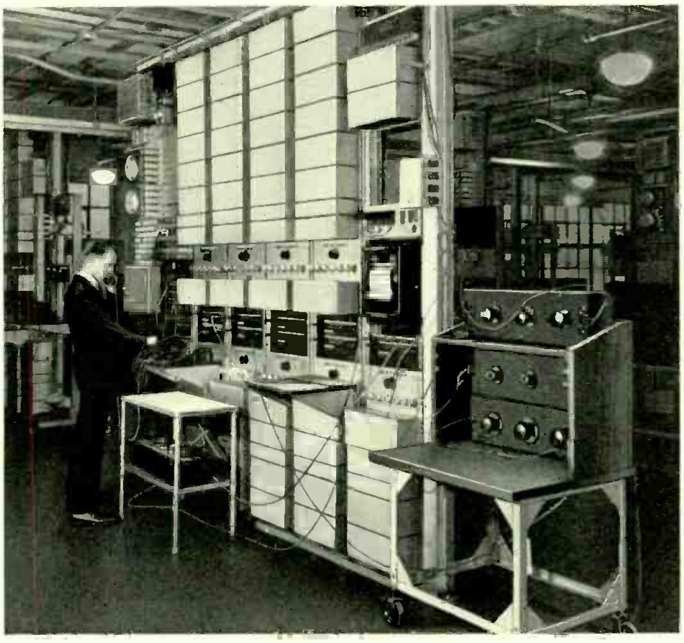


Fig. 2—G. P. Wennemer at a cable carrier-telephone terminal in the carrier laboratory on the 10th floor

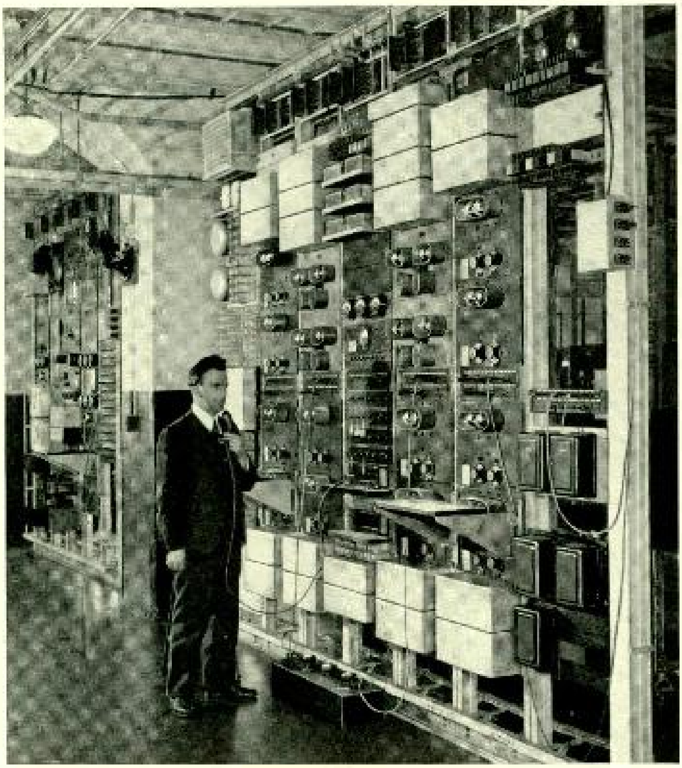


Fig. 3—F. A. Muccio at one terminal of a Type-C carrier-telephone system

between the lines of bays.

On both floors the lines of bays are spaced ten feet apart to give ample room in the aisles. In the old quarters in West Street the aisles were too narrow to make it possible to use an appreciable amount of portable equipment. A large amount of testing apparatus, however, has now been mounted on movable tables and racks, facilitating the various tests that must be made. The ten foot aisles allow liberal room for bridges, measuring circuits, oscillators, and all such portable apparatus.

In the eleventh floor laboratory, adjacent

framework from which they are readily removable. To avoid running supports to the concrete ceiling for this framework, a supporting superstructure is placed across the top of the upright framework and fastened to it. Cable racks are also carried above and supported by the permanent framework. The entire structure is self supporting, and independent of the building except for the floor bolts. With respect to the building columns, the location of the framework is slightly different in the two laboratories. On the tenth floor, devoted to carrier-telephone and repeater development, the bays are in line with the column centers while for the telegraph laboratory on the eleventh floor the building columns are in alternate aisles

lines of bays face each other following the standard central-office practice. This arrangement gives two lines face to face on one aisle and on the two adjacent aisles the lines of bays are back to back. On the tenth floor the experiment was made of facing all lines in the same direction. Experience with these two arrangements will determine which is the better for laboratory purposes.

Although the relay-rack bays carrying the test equipment are all removable, the various lines carry power and trunking-system bays which are permanently mounted. On the latter bays trunks are provided for establishing connections between different lines of relay bays and also to the various test rooms which include the sound-proof rooms and a program observing room. Trunks to the West Street Laboratories, to the Maltz Building, the New York toll office, and to the American Telephone and Telegraph Building make all parts of the Bell System readily accessible to the toll laboratory. The power bays serve as outlets for all the various types of power that may be required for the diverse undertakings of the two laboratories.

Because of the nature of the work carried on, it is necessary to have available practically all of the standard voltages and tones that are used by the Bell System. A joint power room supplying both laboratories is located on the eleventh floor. Batteries of sufficient capacity to supply the large amount of power required, and at the same time to meet the desired voltage limits, would be prohibitive both in cost and space requirements so that floating is resorted to. Charging

Fig. 4—A cross talk measurement being made in one of the sound-proof rooms

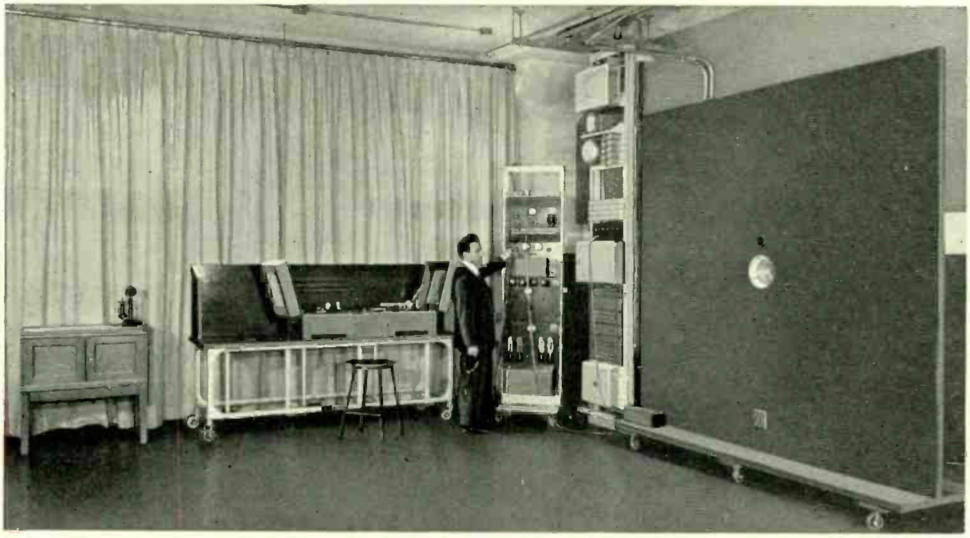


Fig. 5—Walls of the program observing room have been treated with rock wool to obtain a desirable reverberation time which may be varied by adjusting monk's cloth curtains at one end. In the background is a phonograph-reproducing set and on the right is a high quality loud speaker with baffle board

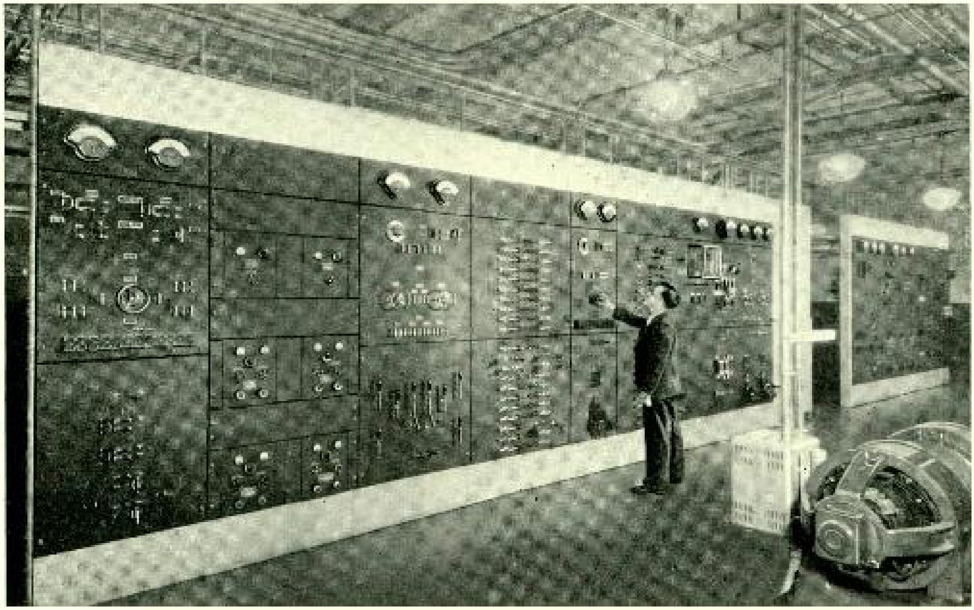


Fig. 6—S. Heid at the main power board. Audible and visual alarms warn the attendant of operating irregularities and direct his attention to their location

equipment is operated continuously in parallel with the batteries, and automatic regulators maintain the close voltage limits required.

The power room is divided in two by a long switchboard behind which are the various batteries and in front of which are the charging generators and ringing machines. The outside power supply is direct current and since many of the smaller batteries are charged by Tungar rectifiers, so as to use standard central-office units, a motor-driven alternator has been furnished to supply alternating current both for the Tungar chargers and for miscellaneous uses in the laboratories. A generator control panel faces the main switchboard, and at the end of the room is a patching board where the various power supplies may be connected through to different parts of the laboratories.

In addition to the small test rooms, sound-proof rooms, and the program observing room, there are dark rooms, wiring and assembly rooms, and a stock room. Office space also is provided for the various engineering groups engaged in carrier telephone, repeater, and telegraph development. The new laboratories provide not only a better layout throughout, than was available at West Street, but increased space and facilities as well, so that future development may be carried on with greater efficiency and dispatch.

Inductive Coordination Laboratory

By E. L. FISHER
Telephone Apparatus Development

THE growth of electrical power transmission at high voltages and the tendency toward electrification of railways has inevitably resulted in an increasing number of problems involving inductive coordination between power and telephone systems. To study under fully controlled conditions some of the various effects of voltages induced in telephone lines by disturbances in neighboring power circuits an assembly of equipment has been made in the Laboratories. Here such effects may be conveniently studied over a wide range of induced voltages and their periods of duration.

An artificial toll line has been set up with terminating-office and subscribers' equipment sufficient for the completion of a single call from either end, and the essential signalling and supervisory features have been included. The most important electrical characteristics of one pair of wires on a typical 100 mile open-wire line of 30 wires, are accurately reproduced. The metallic circuit is represented by a series of resistances and air-core reactance units supplemented with the proper capacitances and leakage resistances. The characteristics of the earth return circuit, over which disturbances pass by way of the line protectors, are represented similarly by resistances and reactances but the latter, with iron instead of air cores, have values of resistance and induc-

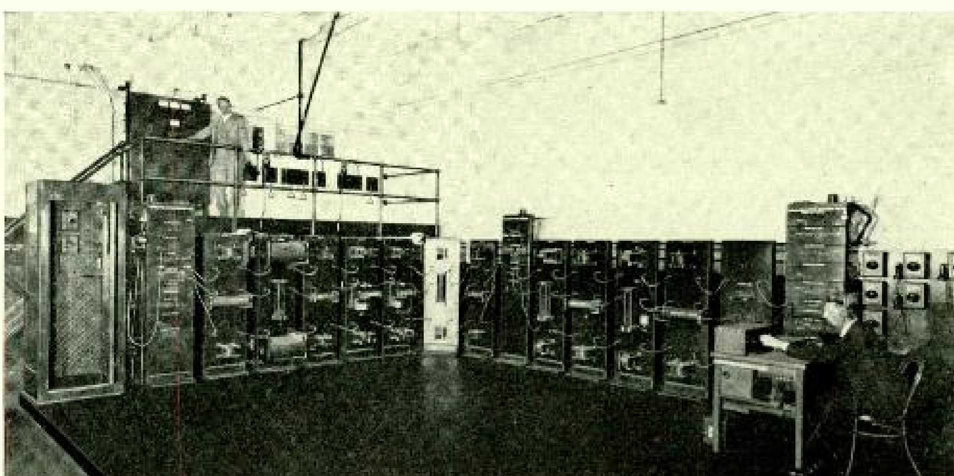


Fig. 1—An artificial line divided into sections is mounted along two edges of an insulated platform. From the control balcony at one end there is complete control of the application of all tests

tance higher than found in the normal ground return circuit of a single pair so as to introduce inductance equivalent to the shielding effect of the adjacent telephone wires. To approximate conditions on a real line, the artificial line is divided into eleven sections, each of which is arranged on a separate panel with terminals for interconnection and measurement, and the entire line is mounted on a wooden platform insulated from the building. The general appearance of the line and the control balcony from which all test potentials are supplied is shown in Figure 1.

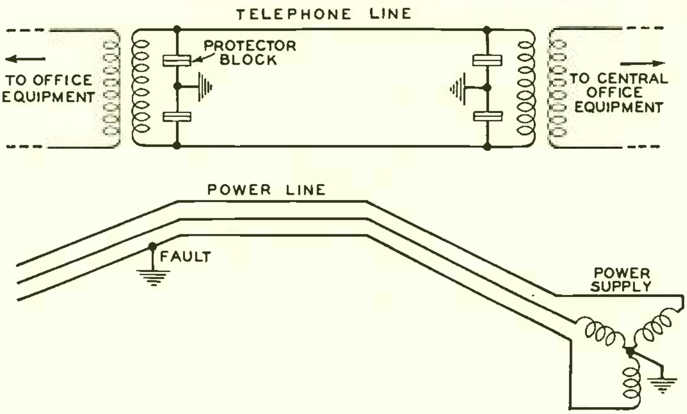


Fig. 2—Simplified schematic of one type of condition that might exist in the field

Under actual field conditions, a power line parallels a certain length of telephone circuit, and under fault conditions induces in each wire of the circuit equal voltages, known as longitudinal voltages. These in turn cause voltages between the line wires and ground which if high enough to break down the protectors cause current to flow through the protectors to the ground. A typical situation is given in Figure 2, where a star-connected bank of transformers, grounded at the neutral connection feeds a transmission line on which a ground fault occurs on a single wire. The large ground return current that flows as a result, induces voltages longitudinally in the two wires of the telephone circuit. These, if of sufficient magnitude, would cause a current to flow through the protectors on each side of the affected section, thus completing the circuit through the ground.

Corresponding currents are produced in the artificial line by inserting a test voltage directly in the conductor representing the ground as shown in Figure 3. Provision is made for introducing the disturbing voltage at either of two points: one near one end of the line and the other at about the middle. The disturbing voltage is introduced into the chosen section by connecting the power source, together with certain building-out impedances, in place of the ground impedance of that section. The building-out impedance is so selected that the combined impedance of it and the source just equals that of the ground sec-

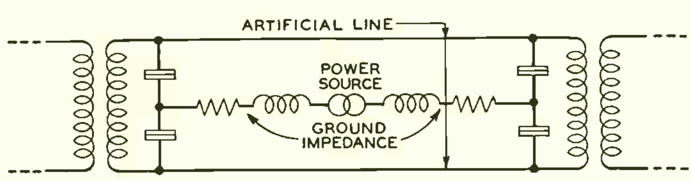


Fig. 3—Field conditions are simulated in the artificial line by inserting test potentials directly in the ground circuit

tion replaced. From the standpoint of the remaining sections of the line outside the "exposed" section this is an entirely adequate method of simulating the induction which sometimes takes place on a real line.

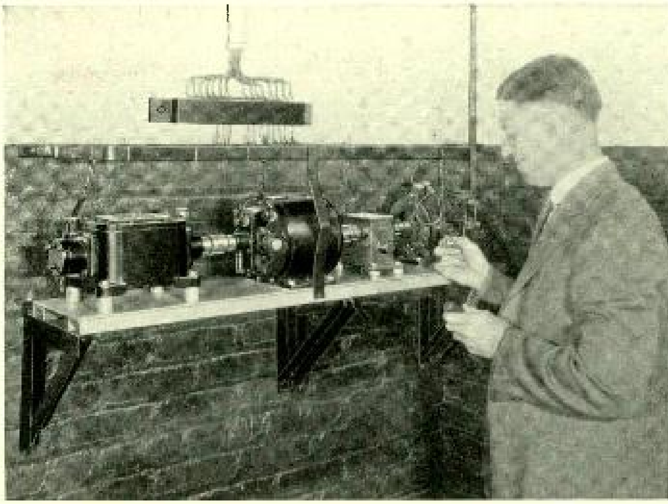


Fig. 5—A. Weller making an adjustment of the apparatus for timing the durations of disturbances

Two 1500-volt alternating-current generators are available as power sources. One is rated at 50 kv-a and operates at 25 cycles, and the other, rated at 150 kv-a, operates at 60 cycles. A transformer is also available from which 60 cycle potentials as high as 6000 volts may be obtained. Both generators are driven by 220-volt three-phase synchronous motors operated from the building supply, and voltage regulation by field control is available from 50 to 1500 volts on each generator, or from 200 to 6000 volts at sixty cycles when the transformer is used. The generators are located in an adjoining room, and the transformers and switching equipment, in a vault directly behind the control balcony.

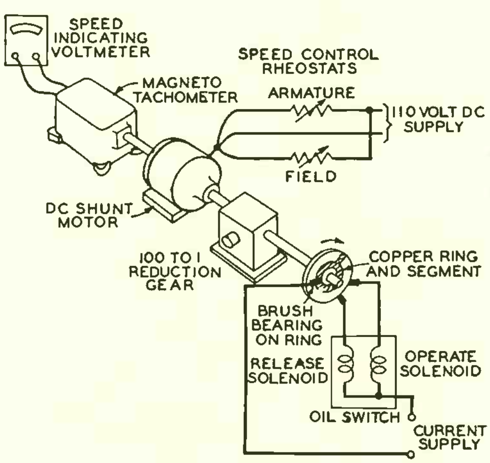


Fig. 4—Duration of disturbance is controlled by a motor-operated device which accurately times by .1 second intervals

From this balcony the operator in charge of the test has a clear view not only of the artificial line but into the switching vault through glass windows and into an adjacent test room to the left of Figure 1 where tests may be made on protectors, fuses, and other pieces of equipment. High-voltage connection changes, such as those pertaining to the point of application of voltages to the test line, are made by the operation of disconnect switches located in the vault by control handles passing through the wall to the control balcony. In addition to the usual current and voltage meters, the panels on the control platform have the control buttons both for regulating the applied voltages and for operating the oil switch that applies the test voltage.

The effect of a disturbance depends

not only on the voltage but on its duration, and part of the equipment in the vault is a specially designed piece of apparatus, shown diagrammatically in Figure 4, which permits accurate control of the duration of the applied voltage from .2 second upward in .1-second steps. The actual appearance of the apparatus is shown by the photograph of Figure 5. Two brushes running on a commutator with a single conducting segment are connected to the operating and release coils respectively of the oil switch that applies the voltage. The duration of the test is thus the time interval between the passing of the segment under the two brushes. A direct-current motor, with rheostats for both field and armature control, drives both the commutator and an electric tachometer. The time interval is directly proportional to the speed so that the tachometer reading, when multiplied by the proper constant, readily gives the duration of test voltage. The actual application of test voltage is controlled by a push button which, through a relay arrangement associated with the apparatus, applies a single complete impulse of the predetermined length.

A useful tool for the studies being made in the laboratory is a circuit for measuring the audible intensity of an "acoustic shock" or disturbance in a receiver by comparison with a disturbance of known magnitude. The apparatus, given schematically in Figure 6, is shown in its actual appearance in Figure 7.

Fig. 7—H. W. Giesecke making a measurement of acoustic shock

The comparison standard is a phonograph record on which has been recorded a series of disturbances of equal magnitude, which have been picked up from a line subjected to actual induction in the field. By an electromagnetic reproducer and an amplifier these disturbances of known value may be compared to those from the line under test. The operator moves the gain control

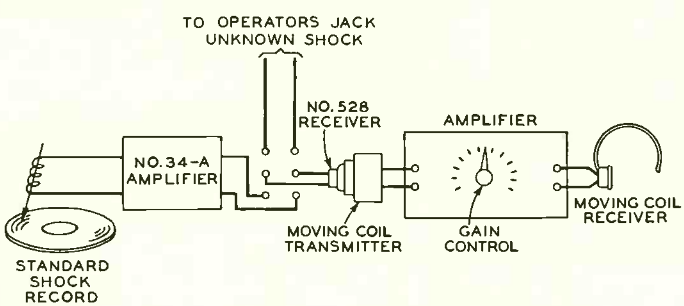


Fig. 6—Schematic diagram of acoustic-shock balance

dial until the sound in his receiver is the same for both standard and line, and under these conditions, the ratio of the disturbance from the line to that from the standard may be read from the dial. Both are reduced in intensity so that the volume of sound will not be painful to the observer.

In the design of the Laboratory, safety to personnel has been stressed throughout. Access to the more exposed parts of the test line and to the transformer vault is possible only through entrances which automatically and immediately remove harmful potentials when opened. "Stop" switches to remove harmful potentials, also, are located at the operating panel and adjacent to the test platform, and in addition there is a portable "stop" switch for the convenience of those working on the test line. Connection of high voltage is possible only when a hand-controlled switch is operated on the platform, and the position of this switch is clearly visible to those using the test line. The position of the switch is also indicated by green and yellow lights visible from any point in the laboratory.

The use of this laboratory will, in general, supplement the field work of the American Telephone and Telegraph Company by studies of some of the phases of induction problems under controlled conditions.

What the Sender Test Circuit Does

By E. W. FLINT
Local Systems Development

PERIODICAL testing of circuits has always held a prominent place in telephone practice, but it assumes unusual importance when the trained perception of a manual-system operator is no longer associated with every call to detect incipient irregularities or re-route a call when necessary.

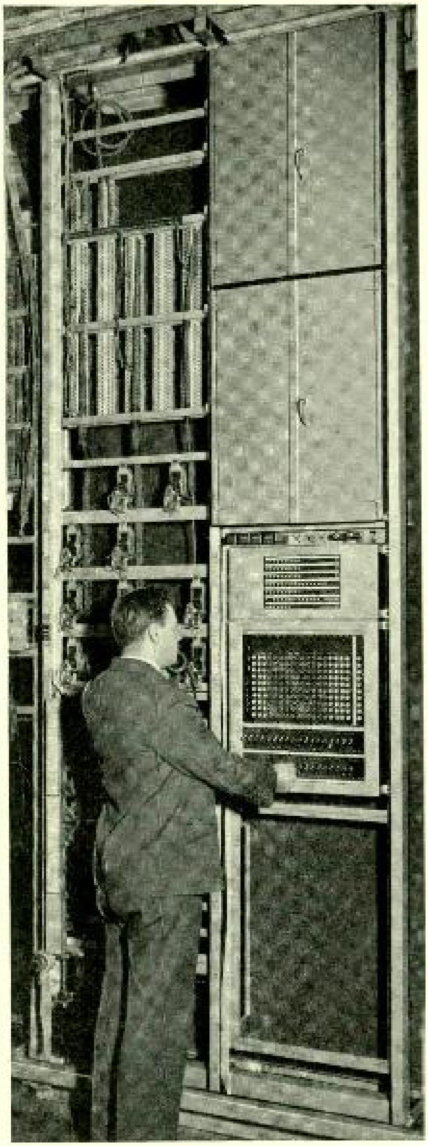
If the sender be likened to the brain of the dial system, it must not omit the duty of introspection, by which a human being senses that he is unfit for his task and tries to determine the cause. Since, however, this mechanical brain must be created and maintained by human hands, it is more convenient to isolate the scrutinizing functions in a separate system, which may then be charged with that responsibility for a large number of senders.

To test a circuit adequately, it is necessary to examine each function to see whether any non-standard condition is present. Although manual inspection and test is possible, the large number of circuits and of possible conditions make such methods impractical. Automatic testing circuits have been designed, therefore, which will check each function, and pass those that are operating correctly but which will stop the test and indicate the approximate location of an irregular condition when one is encountered. Typical of such testing circuits is one used for senders in the panel dial system which consists of a system of interrelated circuits so arranged that they cause the sender to perform all of its functions under conditions, wherever possible, slightly harder than those occurring in service.

To facilitate testing, these functions are divided into classes corresponding to the types of call the sender is required to complete. Tests are made of the ability of a sender to complete a call through panel selectors to a dial station, or to cause an overflow signal to be returned in case all trunks on the office or incoming selector frames are busy. Other classes provide means for testing the number-register circuit for its ability to record correctly digits dialed under extreme dialing conditions. Calls to the various operators are tested by other classes. When calls are to be completed to a manual station, the sender is tested not only for the correct pulses necessary to display the number in the call-indicator position, but for the presence or absence of the delay to allow for a possible party letter or fifth digit that might be required by the code dialed.

In each central office a sequence of performing these classes of tests is established. At the start of a routine test, the maintenance man determines the test to be made, and sets up on keys the code, number, and routing to be used. The operation of the start key causes the test circuit to seize the first sender, if it is idle, and to transmit to it the pulse train corresponding to the code and number over a network arranged to represent a subscriber's line. Other parts of the testing circuit then check the sender's response, under the conditions imposed upon it, and finally determine whether it has returned to normal in readiness for a service call. If all the functions check satisfactorily, the test circuit advances to the next sender. This cycle is repeated on each sender until all have been tested.

On reaching a busy sender, the circuit waits until the sender becomes idle, which should normally be in a few seconds. If the delay is excessive, however, the test circuit recognizes the condition and by means of alarm lamps calls attention to the fact that testing has stopped. By the operation of a key before the beginning of the test, however, busy senders can be passed after a short time interval. The test man also can omit any sender by operating another key which allows the test circuit to advance to the succeeding sender on the cycle. Similarly, with another key, he can repeat a test as long as is desired for observation of a sender recently adjusted or for other special purposes.



A standard test circuit for subscriber's senders in the systems laboratory

Progress of the sender action is indicated by a group of lamps which flash momentarily as certain stages of completion are reached. If a nonstandard condition is encountered testing stops, and an alarm is given. The lamps remaining lighted tell how far the dialing has proceeded, how far the checking has proceeded, and the selections which the sender attempted to make. By these indications the approximate nature of the condition is revealed, and ordinarily its definite location can be found at once. Certain conditions are indicated specifically by a lamp whenever possible.

Another use for the test circuit is with what are called particular - circuit tests. For these tests any particular sender can be selected by the maintenance men by means of keys. These keys, when operated and released a certain number of times and in a certain order, allow any sender to be connected to the test circuit. For such tests any code and number may be set up as a test condition, or several codes may be used.

A Universal Turret for Desk Mounting

By A. C. GILMORE
Equipment Development

FOR many telephone services, only small amounts of apparatus are used for switching and supervisory circuits. Since the quantity of apparatus does not warrant the use of a standard switchboard section, and in many cases it is desired to place the equipment on top of flat-top desks, a small cabinet is generally the most suitable type of framework. Because of the increasing number of uses for such a cabinet, an improved form was recently developed. This cabinet may be employed in place of a number of existing cabinets as well as for an increasing number which future developments might otherwise require.

To arrange a single cabinet so that it would mount the apparatus formerly placed in a variety of cabinets, it was necessary to design a front panel that would accommodate various types of keys, lamps, jacks, and such miscellaneous apparatus as electric clocks and meters. Certain features of switchboard-panel construction were used. Each side of the front opening, which is 11-3/16 inches wide by 10-1/2 inches high, is provided with switchboard jack-fasteners located at standard spacings for the entire height of the openings. These may be seen in Figure 1.

The width of the front opening and the spacing of the jack fasteners were chosen to take a standard strip of No. 49 jacks or the corresponding lamp-socket mountings and designation strips normally used in twelve-inch switchboard panels. For mounting No. 92 jacks with their corresponding lamp-socket mountings and designation strips, which are normally used with 8-1/2-inch switchboard panels, adapters are used. These are additional metal strips with jack fasteners, separated by horizontal spacing strips at the top and bottom. These adapters may be mounted so as to bring the jack strips in the center of the opening, as shown in Figure 2, or at one side, as shown in Figure 3. In either case the rest of the opening is filled out with fibre-faced strips. These strips may be used for mounting miscellaneous apparatus such as electric clocks or individually mounted jacks, lamps, or keys.

A fibre faced panel arranged to occupy the entire opening may also be used when more extensive provision is required for apparatus such as meters, electric clocks, or individual arrangements of jacks, lamps, or keys.

Universal type keys, such as used in the keyshelves of switchboards, may also be mounted by the use of adapters held in place by the jack fasteners. Since the universal keys have bases of several different lengths, the adapters are made in two parts which may be spaced a distance apart suitable to the particular keys being used. As many as twelve keys may be mounted in a row across the front.

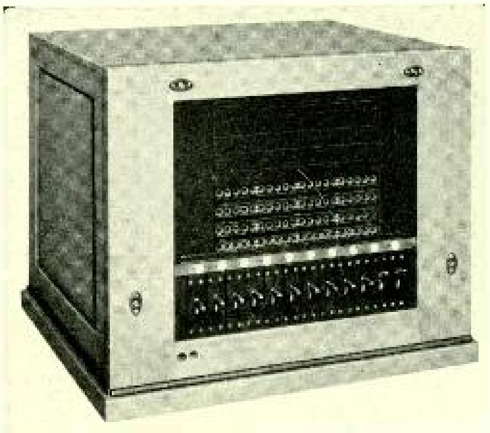


Fig. 2—A standard chief operator's desk turret using the universal cabinet

The cover and interior framework for this cabinet are the same as those for the No. 506-A PBX already described in the RECORD.* The upright end brackets which form a small relay rack, shown in Figure 1, are also standard and are drilled for regular relay-rack mounting plates. This permits the mounting of relays, condensers, or other apparatus in the standard manner. Terminal strips are required for ease in connecting the equipment within the cabinet to cables running outside, and adapters are provided to simplify the mounting. These adapters are merely two cross strips, with two end spacing strips drilled to match the drilling on the upright brackets at the ends.

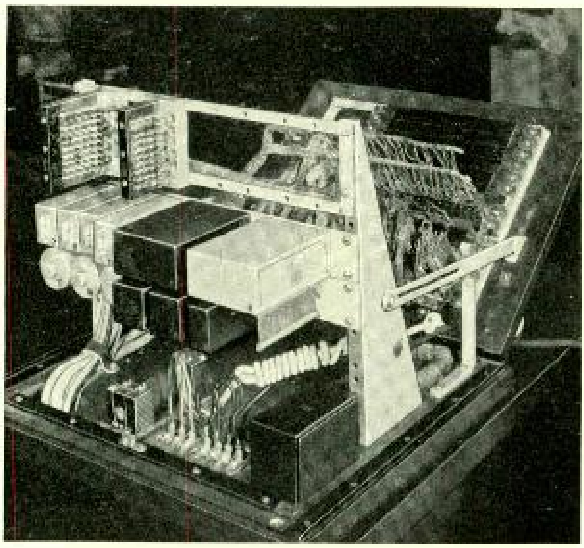


Fig. 1—The front of the new cabinet, which may be tipped forward 45 degrees, is equipped with jack fasteners on both sides of the equipment opening

* BELL LABORATORIES RECORD, *Apr., 1929, p.* 331.

The cover lifts off after being slid back slightly to unlock it. The front panel is hinged at the bottom and may be tipped forward 45° to make the connections to jacks, keys, and lamps easily reached. Accessibility to all equipment is greater than it ordinarily has been with cabinets of this type. A screw driver is the only tool required to open the cabinet or to mount the adapters or equipment in place.

Although the new cabinet is practically unlimited in application with regard to the type of equipment that may be mounted within it or on its face, it is limited in size, and thus in the amount of apparatus it may carry. The basic framework remains the same regardless of the equipment with which it is to be used. A few standard features and the use of adapters, however, make it suitable for such widely diverse service as for a ship-to-shore PBX, a test supervisor's desk, a chief operator's desk, or a time-announcement desk.

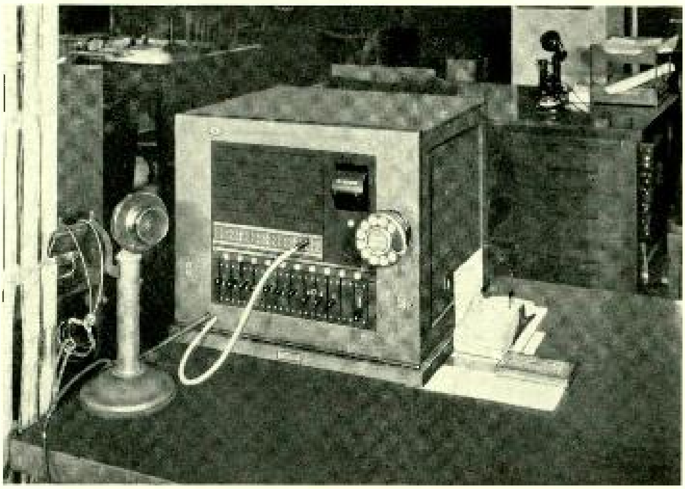
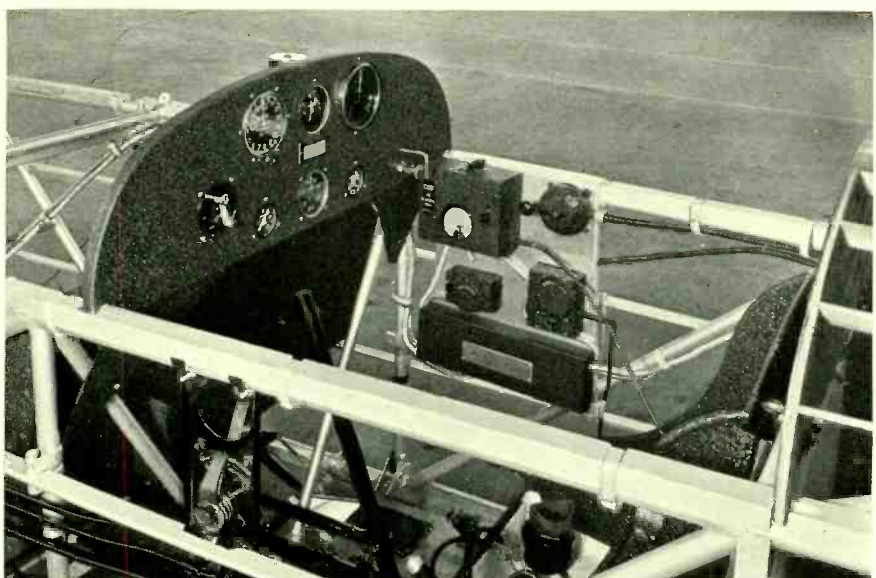


Fig. 3—Turret for test supervisor's private desk with No. 92 jacks mounted at one side

NEWS AND PICTURES

of the

MONTH



Western Electric radio-telephone equipment for itinerant flyers installed in Fairchild airplane

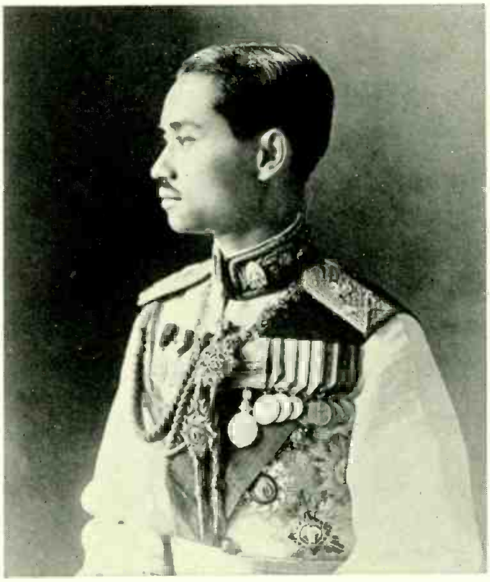
General News Items

King and Queen of Siam Are Visitors to Laboratories

Their Royal Majesties, the King and Queen of Siam, witnessed demonstrations of two-way television and sound pictures in the Laboratories on May 7. The King and Queen with their suite arrived at the building shortly after 3 o'clock and were welcomed by Vice-President Charlesworth. Then they were escorted to the auditorium where Mr. Charlesworth presented to the visitors the members of his staff. After a short explanation of the technical details of television by John Mills, Director of Publication, the King and Queen and their attendants spoke over the two-way system with other members of their party at the 195 Broadway terminal.

Her Majesty, Queen Rambai Barni of Siam

From the auditorium the visitors proceeded directly to the Sound Picture Laboratory. Inspection was made of the experimental studio, the film and disk recording rooms and the various development processes carried on in these departments. In the review room the Western Electric animated cartoon *Finding His Voice* was shown and was received with much interest by the royal party. A second film, illustrating the contrast between the old method of recording and the new noiseless process, was also witnessed with lively interest.



His Majesty, King Prajadhipok of Siam

As souvenirs of their visit Mr. Charlesworth presented the King and Queen with specially prepared replicas of Alexander Graham Bell's original telephone.

Franklin Institute Awards to Three Laboratories Men

C. J. Davisson and L. H. Germer were recipients of Elliott Cresson Medals at the annual Medal Day exercises of the Franklin Institute on May 20. As part of the same ceremonies the John Price Wetherill Medal was conferred on E. C. Wente for the development of the electrostatic transmitter. The award to Doctors Davisson and Germer was made in recognition of their outstanding work on the diffraction of electrons from the surfaces of crystals.

The work for which the Elliott Cresson Medals were awarded began as an investigation into electron scattering. This was in 1919 and Dr. C. H. Kunsman was during the early years associated with Dr. Davisson. In an investigation of atomic structure they directed a beam of electrons against the surface of a nickel target. It was believed that when the electrons passed into the strong electric field which existed inside the atom, the direction of the electrons would be changed and by studying where the electrons came out of the atom, it would be possible to learn something of the atom's structure.

For several years they continued on this investigation, making refinements in their apparatus and limiting the nickel surface to a single crystal of a desired shape and size. In 1924 de Broglie in France put forward the hypothesis that electrons can sometimes be regarded as waves instead of solid particles, and it was pointed out that this could be proved by observing the diffraction of electrons from single crystals.

About three years later Davisson and Germer, who were now associated, furnished this proof by demonstrating that electrons may be diffracted from a nickel crystal just as if these electrons were made up of

C. J. Davisson and L. H. Germer

waves, as light and x-rays are. They even were able to calculate the "wave length" of the electrons in these beams and the values obtained checked closely with those announced by de Broglie from theoretical considerations.

Dr. Wente's work on the electrostatic transmitter began in 1914 when he embarked on a study of sound waves here in the Laboratories. He soon discovered that in measuring and comparing the complex sound waves of speech, the apparatus available was inadequate for his purpose. He therefore set out to see if the electrostatic transmitter might not be pressed into service for this work.

Previous to this time, very little development work had been done on this type of transmitter because of the lack of suitable amplifiers to raise its extremely low output. The invention of the vacuum tube overcame this difficulty and made it possible for Dr. Wente to proceed with the development of a practical electrostatic transmitter. The most important effect

E. C. Wente

from his work on this device was the control of the vibration of the diaphragm by a thin film of air. Electrostatic transmitters of this type are now used widely for recording purposes throughout the sound-picture and allied fields.

Student Engineers Visitors to Graybar-Varick Building

On April 24, forty-one members attending the annual Student Branch Convention of the American Institute of Electrical Engineers, New York Section, visited the Graybar-Varick Building and made an inspection tour of our transmission, toll and radio laboratories.

The visitors reception was in charge of G. F. Fowler and P. M. Neave of the Bureau of Publication. On the visits to the various laboratories they were conducted by the following members of the technical staff from the Graybar-Varick Building: J. C. Bayles, R. R. Galbreath, R. C. Hersh, G. G. Lavery, J. G. Nordahl and H. Van der Raay.

In connection with the convention activities, John Mills acted as one of the judges at the presentation of technical papers by the student members.

Colloquium

Dr. Harold Bohr, Professor of Mathematics at the University of Copenhagen and during this semester a non-resident professor of mathematics at Princeton, delivered an address *On the Ideal Elements of Mathematics* on May 14. Describing an ideal element as a word or phrase which has no literal meaning and which receives precise meaning by definition, he outlined the reason for the introduction of ideal elements as the desire for keeping theorems unexceptionable, and illustrated this notion by the successive extensions of the number concept to include negative, fractional, irrational, and imaginary numbers. Pointing out that a limitation on such extensions was the necessity for preserving consistency of axioms, he described how Georg Kantor's infinite numbers introduced contradictions in the number axioms, and how the "metamathematics" of David Hilbert aims to rid mathematics of these contradictions by the introduction of "ideal" statements regarding infinite processes.

C. J. Davisson spoke before the Colloquium on April 13 on *Electron Lenses.* He showed that electrons or other charged particles, on passing through an aperture in a charged conductor, receive rather sharp deflections in the distorted field there encountered. Dr. Davisson further pointed out that for apertures of simple geometry, such as straight slits and circular holes, the magnitudes of these reflections are proportional to the displacements of the lines of approach from the axis or center of the aperture. The same law obtains for the deflections received by light rays on passing through cylindrical and spherical lenses. It thus becomes possible, he said, to regard the distorted fields about such apertures as electron lenses. They have definite and calculable focal lengths, and may be used to form real and vertical electron images in accordance with the simple laws of lens optics. Results of experiments to test these conclusions were exhibited.

Election of officers was held at the meeting on April 27. For the 1931-1932 season R. M. Burns has been named President; F. S. Goucher, Vice-President; and A. R. Olpin, Secretary. The speaker of the evening was Professor Arthur Haas of the University of Vienna who spoke on *J. Willard Gibbs and Modern Atomic Theory.*

Motion Picture Stars Witness Laboratories Developments

Rod La Rocque and Vilma Banky, noted motion picture stars, were visitors to the Laboratories on May 11. After speaking over the two-way television system at the invitation of the New York Telephone Company they made a brief tour of the building under the escort of G. F. Fowler of the Publication Bureau.

Of especial interest to the two cinema stars was their visit to the Sound Picture Laboratory. Here the technical aspects of sound pictures and the various development projects carried on in the laboratory in conjunction with this work were explained to them. They also visited the magnetic materials laboratories and witnessed demonstrations of the magnetic properties of permalloy and the operation of the cathode-ray oscillograph. Other developments which they saw in the building were the standard clock controlled by quartz crystals and the intricate mechanism of the panel dial system in the Systems Development laboratories.

Rod La Rocque and Vilma Banky, motion picture stars, are shown the details of television apparatus by A. O. Burling

ADMINISTRATION

Dr. Jewett is a member of the advisory board of the Third International Conference on Bituminous Coal which will meet at Carnegie Institute of Technology, Pittsburgh, November 16 to 21.

Mr. Charlesworth attended the Bell System Operating Conference which was held at the Seaview Golf Club, Absecon, New Jersey, from April 30 to May 6.

H. D. Arnold has been elected a member of the executive council of the Acoustical Society of America. Dr. Arnold is scheduled to speak at the summer gathering of the American Association for the Advancement of Science, Pasadena, June 15 to 22.

S. P. Grace addressed the Dallas Electric Club at luncheon in Hotel Baker, Dallas, on April 13. On May 7 and 8 he addressed large meetings at Buffalo on outstanding developments in communication. His Buffalo appearance was arranged through the New York Telephone Company and sponsored by the Buffalo Engineering and the affiliated technical societies.

On May 19 Mr. Grace in South Bend spoke at a meeting at Notre Dame University under the auspices of the Notre Dame section of the American Institute of Electrical Engineers. In each of the talks which were supplemented with demonstrations of Laboratories apparatus he was assisted by R. M. Pease.

The Executives' Conference was addressed after luncheon on April 23 by J. E. Otterson, president of Electrical Research Products, Inc. On May 15, Dr. Jewett was guest of honor on his return from the West, and Mr. Charlesworth gave a résumé of the Bell System Operating Conference.

TENNIS ENTHUSIASM

Constance Duffy showing to Ruth Kern and Lillian Blumberg her new tennis racket with which she hopes to do big things in the Club's tennis activities

Departmental News

Apparatus Development
Special Products

Accompanied by Director of Apparatus Development R. L. Jones, T. E. Shea and W. Herriott visited Rochester to discuss optical and photographic problems with representatives of the Bausch & Lomb and Eastman Kodak Companies.

D. T. Bell in Rochester attended a symposium on noise measurement at the district meeting of the American Institute of Electrical Engineers.

The meeting of the Acoustical Society of America in Camden was attended by C. F. Eyring, W. A. MacNair, W. B. Morehouse and R. L. Hanson.

On May 7, T. E. Shea, W. Herriott and J. Crabtree left for Los Angeles to attend the spring convention of the Society of Motion Picture Engineers. Prior to the convention they visited motion picture studios on the West Coast to observe sound-recording practices.

F. L. Hunt delivered a brief talk on sound pictures at the Greenwich House Music School, New York, on May 7, as part of the Greenwich Village Music Festival.

Telephone Apparatus

A talk on the Organization of Industrial Research was given by William Fondiller before the Student Chapter of the American Institute of Chemical Engineers of New York University.

Mr. Fondiller also gave a popular talk *The Art of Electrical Communication* before the Dunwoodie Lodge of Masons at Yonkers, New York, during the past month.

Transmission Apparatus

W. J. Shackelton was at the Bureau of Standards in Washington in connection with work on the new values of the electrical units.

Problems concerned with a dial-interference filter required F. J. Given's attention at Hawthorne.

C. D. Owens was also at Hawthorne, in connection with development work on improved permalloy cores for loading coils.

Various problems in connection with enameled wire occasioned a recent visit by E. B. Wheeler, H. H. Glenn, A. R. Kemp of the Chemical group and R. D. Jessup of the Western Electric Company to the Summit laboratories.

Materials

H. N. Van Deusen and J. R. Townsend attended a meeting of the A.S.M.E. Committee on Springs held under the chairmanship of Mr. Townsend at the New York Headquarters of the society.

Contact noise investigations were conducted by C. E. Nelson at Stamford, Connecticut, and Harrisburg and Wilkes-Barre, Pennsylvania.

In connection with condenser paper investigations W. W. Werring made visits to the Smith Paper Company at Lee, Massachusetts, and the Dexter Paper Company at Windsor-Locks, Connecticut.

J. R. TOWNSEND and C. H. Greenall were at Franklin-Furnace, New Jersey, where they inspected the plant of the New Jersey Zinc Company.

DIAL APPARATUS

G. W. FOLKNER visited Hawthorne to discuss new developments on panel multiple banks and brushes with members of the Manufacturing Department.

A VISIT was made by P. T. Higgins to the Automatic Electric Inc. in Chicago in connection with the compilation of replacement-part data on plunger-type line switches.

G. B. BAKER was at Worcester for a study of step-by-step relays.

J. ABBOTT visited the Philadelphia Instrument Shop on matters pertaining to dial testers.

RADIO DEVELOPMENT

A. R. BROOKS spoke before the Aeronautical Engineering Class of New York University. The title of the talk was *Practical Radio Applied to Aircraft Operation.*

W. L. TIERNEY was at Washington, where he gave testimony as an expert witness before the Federal Radio Commission.

ACCOMPANIED by Messrs. H. N. Willets of the Western Electric Company and C. D. Hanscom of the Bureau of Publication, Mr. E. P. Warner, editor of *Aviation*, witnessed a demonstration of Western Electric aircraft radio-telephone equipment during a flight in the Laboratories' Ford plane. The demonstration was conducted by D. K. Martin, J. B. Bishop and D. B. McKey. A. R. Brooks, P. D. Lucas and R. J. Zilch formed the crew of the airplane.

H. E. J. SMITH supervised the installation of 400-watt radio-telephone equipments for the Police Departments of Rochester and Pittsburgh.

A FLIGHT to Bellefonte and return, on which H. N. Willets and F. C. McMullin of the Western Electric Company accompanied Mr. C. I. McNeil of the Eclipse Aviation Corporation, was made to demonstrate the new radio-telephone equipment designed for itinerant fliers. The plane was piloted by Captain A. R. Brooks with R. J. Zilch as mechanic. R. S. Bair, J. B. Bishop, and D. B. McKey made the demonstration.

A TRIP TO Schenectady in the Lab-

First prize, still life group, Junior class, Club photo contest; by R. O. Bieling oratories' Ford plane was made by S. E. Anderson, W. E. Reichle, and D. B. McKey to observe the operation of a new beacon radio receiver. P. D. Lucas piloted the plane with R. J. Zilch as mechanic.

First prize, portrait group, Junior class, Club photo contest; by C. N. Nebel

A FIELD INTENSITY survey of the Universal Broadcasting Company's station, WCAU, of Philadelphia was conducted by J. F. Morrison.

BOTH OF THE Laboratories' planes were flown to Dayton, Ohio, to demonstrate Western Electric inter-plane radio-telephone communication to officers and engineers attached to Wright Field. The demonstration was made under the direction of F. M. Ryan. Problems associated with the development of radio-telephone equipment for aircraft applications in the U. S. Army were discussed with officials of the Signal Corps Aircraft Radio Laboratory.

F. M. RYAN, J. O. Gargan and Captain A. R. Brooks attended the International Aircraft Show at Detroit, Michigan. The Western Electric Company in their booth exhibited the new radio-telephone equipment developed by the Laboratories for itinerant fliers. The equipment was installed in the fuselage of a Fairchild airplane.

SEVERAL TIMES during the month the Laboratories' Ford airplane was used to make altitude flights to 18,000 feet in order to observe the operation of its telephone equipment at reduced air pressure. Captain A. R. Brooks piloted the plane on these flights while D. B. McKey and J. B. Bishop made the observations.

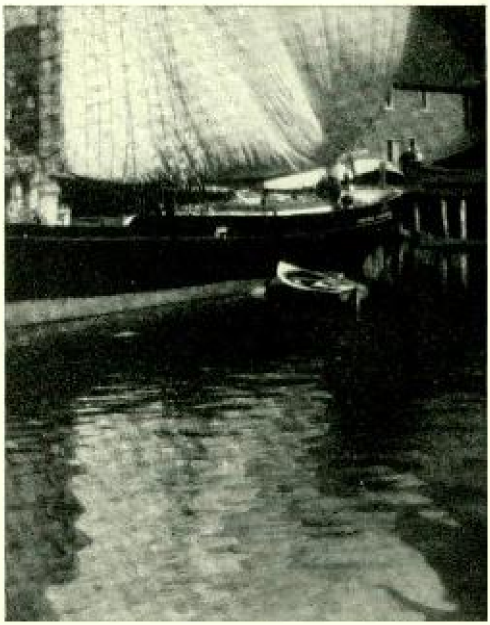
O. W. TOWNER supervised the installation of a 1-kw radio-telephone broadcasting equipment for station KOL of the Seattle Broadcasting Company, Seattle, Washington. He also visited Spokane to inspect the 5-kw radio-telephone broadcasting equipment at station KHQ owned by Louis Wasmer, Incorporated.

THE FOLLOWING members of the Laboratories made a flight in the Ford plane to Washington to make reception observations of the new combined beacon and broadcast transmitter at College Park, Maryland: D. K. Martin, J. W. Greig, D. B. McKey, Captain P. D. Lucas and mechanics R. J. Zilch and C. T. Garner.

C. B. MCKENNIE and A. Challenner were in charge of the installation of Western Electric radio-receiving equipment at the Hotel Biltmore, New York for the luncheon of the Pan-American Society. The Society met to hear the speeches of President Hoover, the Mexican Ambassador and and Secretary Stimson delivered on the occasion of Pan-American Day.

THE RADIO Development group provided a demonstration of airplane radio-telephone communication for the Board of Directors of the Aviation Corporation at a meeting in the Metropolitan Athletic Club, New York City, on April 29.

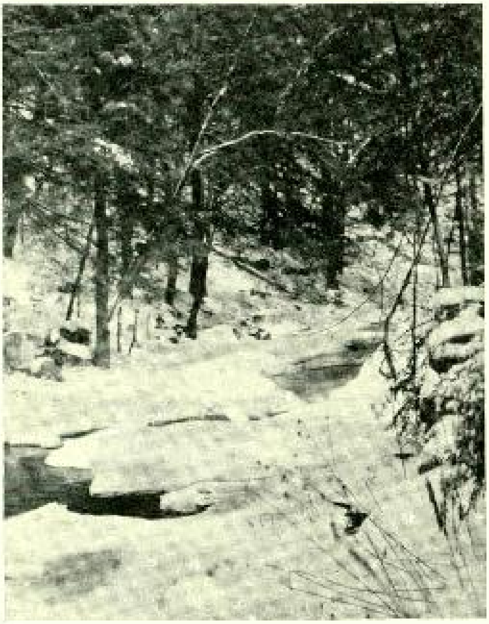
Communication was carried on from airplanes to ground stations of the Colonial Air Line at the Newark and Boston airports and was reproduced at the meeting through loud speakers. The signals were received at the Laboratories experimental ground station at Mendham and transmitted to New York over telephone circuits. Members of the Radio Development group who participated in the demonstration were: S. E. Anderson, D. K. Martin, P. Brake and J. P. Dolbear.



First prize, miscellaneous group, Junior class, Club photo contest; by C. N. Nebel

INSPECTION ENGINEERING

AT THE monthly meeting of the Conference Group of Corporate Statisticians, held during the early part of April, W. A. Shewhart presented a paper, *The Implications of Data.*



First prize, landscape group, Junior class, Club photo contest; by L. E. Cheesman

This Group, of which Dr. Shewhart is a member, is sponsored by the National Industrial Conference Board, and is composed of the chief statisticians of a number of large corporations together with a few other members. It was formed to facilitate interchange of views and ideas with regard to the technical aspects of current business and other conditions in their relation to individual problems, and to encourage discussion of the technical methods and statistical elements entering into the consideration of industrial problems.

PATENT

J. C. R. PALMER and H. A. Whitehorn, formerly of the Laboratories Patent Department and more recently in the European Patent Department of Electrical Research Products, Inc., have returned to this country. Mr. Palmer is now located in the Patent Department of the Western Electric Company at 195 Broadway, while Mr. Whitehorn has taken charge of the Patent Department at Hawthorne.

HEARINGS BEFORE the Examiner of Interferences at Washington were attended by H. A. Burgess, W. J. Crumpton, J. W. Schmied and C. A. Sprague.

S. B. KENT, W. C. KIESEL and E. C. Laughlin represented the Laboratories at hearings before the Board of Appeals.

F. E. WARD spent a few days making a special search through the patent files in the Government Patent Office.

A TRIP TO Indianapolis and Chicago was made by A. G. Kingman.

STAFF

TWENTY-FIVE YEARS of service in the Western Electric Company and the Laboratories were completed by

Miss M. A. Smith

Miss M. A. Smith on May 17. She is a member of the group winding small coils in the Development Shop.

Miss Smith has worked on small coils for many of the important communication developments that originated and were first tested here in the Laboratories. When the manufacture of step-by-step apparatus was undertaken by the Western Electric Company she worked on the coils for the initial switches which were wound by the small group in the Development Shop. She also was engaged on the windings of the first tool-made samples of the flat-type relay developed by the late E. B. Craft and now in extensive use in telephone central offices. Miss Smith has also done much work in transformer and retardation coil windings.

Until 1914 she was engaged on coil winding as part of the manufacturing activities formerly carried on at 463 West Street. When the work was transferred to Hawthorne she remained in New York as a member of the Development Shop.

GENERAL ACCOUNTING

A DINNER given on May 8 at the New York Telephone building, 140 West Street, in honor of Dr. Egon S. Pearson was attended by H. H. Holland, C. W. F. Hahner, G. T. Selby, and K. M. Weeks. The dinner to Dr. Pearson was given by representatives of Bell System companies in the metropolitan area who are engaged primarily in mathematical and statistical work.

OUTSIDE PLANT

W. C. REDDING gave an informal talk on telephone cables at a luncheon meeting of the Cooperative Club of New York.

ACCOMPANIED by Mr. H. J. Lang of the Cable Manufacturing Company of Bratislava, Czecho-Slovakia, J. G. Brearley was in Newark and vicinity to observe splicing practices on the new cable between New York and Philadelphia.

S. C. MILLER made a trip to Boston with representatives of the American Telephone and Telegraph Company to witness tests made on new types of pole reinforcements.

VISITS TO Gulfport, Jackson, and Meridian, Mississippi; Spartanburg, South Carolina, and Birmingham, Alabama were made by R. H. Colley to develop improved methods for the empty-cell treatment of southern pine poles. Mr. Colley also visited Atlanta, Charlotte, and Meridian, in connection with the empty-cell preservation of southern pine conduit.

WITH representatives of the Long Lines and D. & R. Departments, E. St. John was in Syracuse to observe a trial installation of Blackburn duplex cable rings.

C. D. HOCKER attended the inspections made in Pittsburgh, Altoona, and State College, Pennsylvania and Sandy Hook, New Jersey, by the A.S. T.M. sub-committees on galvanized sheet and hardware samples.

W. H. S. YOURY made a trip to Philadelphia and D. T. Sharpe went to New Haven, both trips being concerned with a new design for body belts and safety straps.

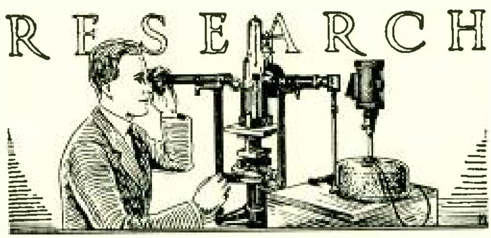
C. R. MOORE was in Hawthorne in connection with details relative to the manufacture of the rolling-tool and sleeve used in a new method of wire joining. While there, he also discussed various phases of the manufacture of cable-splicing machines.

PERSONNEL

R. J. HEFFNER, with several other representatives of the Bell System, recently visited Massachusetts Institute of Technology to select candidates from the class of 1934 for the Communication Option of the Cooperative Course in Electrical Engineering.

PUBLICATION

G. F. FOWLER attended the convention of the New York Electrical Society at Schenectady on May 15 as a member of the Annual Inspection Committee.



TRANSMISSION INSTRUMENTS

AT MASSACHUSETTS Institute of Technology, H. A. Frederick and H. C. Harrison addressed the Colloquium on *Storing of Sound*.

G. G. MULLER was at Rochester to instruct in the use and observe the operation of the lapel microphone used at a meeting of the American Institute of Electrical Engineers.

CHEMICAL LABORATORIES

THE MEETING of the American Chemical Society at Indianapolis was attended by A. R. Kemp, B. L. Clarke, L. A. Wooten, D. A. McLean, M. H. Quell and A. E. Schuh. Messrs. Clark and Wooten extended their trip to Hawthorne to discuss chemical methods and lubrication problems. Mr. Schuh also went to Hawthorne in connection with various finish problems.

FINISHES ON dial testers were investigated by C. L. Hippensteel and H. G. Arlt in company with J. Abbott of the Apparatus Development Department in a recent visit to the Philadelphia Instrument Shop of the Western Electric Company.

With W. L. Hammerquist Mr. Arlt was at the United States Bronze Powder Works at Closter, New Jersey, to examine bronze powders.

R. M. Burns attended the American Electrochemical Society meeting at Birmingham, Alabama.

Development problems on rubber-covered wire required the attention of C. W. Scharf and E. L. Dias at the Point Breeze plant.

H. Lathrop was at Hawthorne in connection with the insulation of molybdenum permalloy.

A committee meeting of the A. S. T. M. at Pittsburgh was attended by J. H. Ingmanson.

Electro-Optical Research

Herbert E. Ives attended the meeting of the American Philosophical Society at Philadelphia.

The meeting of the American Physical Society at Washington was attended by F. C. Nix, K. K. Darrow, A. R. Olpin and H. E. Ives.

An address *Waves and Crystals* was given by K. K. Darrow at the Spring Meeting, Middle Atlantic Section, Society for the Promotion of Engineering Education.

Radio and Vacuum Tube

A paper, entitled *Electrolytic Phenomena in Oxide Coated Filaments* was presented by J. A. Becker before the American Electro-chemical Society meeting at Birmingham. Dr. Becker has been notified of his appointment to the newly-formed committee on electronics of the society.

At the meeting of the American Physical Society in Washington he presented abstracts of a paper *Origin of Thermionic Electrons from Oxide Coated Filaments,* prepared jointly with R. W. Sears, and one entitled *Theoretical Interpretation of Experimental Richardson Plots* of which W. H. Brattain is co-author.

A paper *A Device for the Precise Measurement of High Frequencies* by F. A. Polkinghorn and A. A. Roetken was presented before the New York meeting of the Institute of Radio Engineers on May 6. A description of the device prepared by Mr. Roetken will appear in an early issue of the Record.

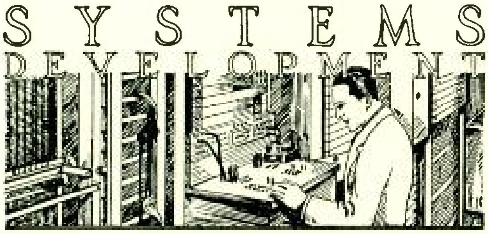
Transmission Research

T. C. Fry has returned from the Middle West where he delivered a series of addresses relating to the importance of mathematics. On April 29 he spoke before the Indiana University Chapter of Sigma Xi on *Science and the Man of Affairs.* He also gave this address before the Purdue Chapter on the following day. He gave a brief talk before the Rotary Club of Bloomington on April 29, and on May 1 addressed the opening session of the Mathematical Association of America, Indiana Section, in annual convention at Muncie on the subject *Mathematics Comes into its Own.*

H. Kahl is making a survey of radio interference from telephone dialing in various large cities. His trip will include Richmond, Philadelphia, and Cleveland.

Laboratory Engineering

C. A. Kotterman attended in Washington from April 30 to May 2, the meetings of the American Physical Society. At the same time he inspected the scientific exhibit maintained by the Laboratories at the National Academy of Sciences. He also attended the meetings of the Acoustical Society of America held at the RCA-Victor Company, Camden.



Equipment Development

H. D. Bruhn, with Mr. A. Tradup of the American Telephone and Telegraph Company, was in Pittsburgh to discuss questions connected with the 750-A PBX with engineers of the Bell Telephone Company of Pennsylvania.

Special Equipment Development

J. B. Daymont was at the Ocean Gate transmitting station of the ship-to-shore radio-telephone project to assist in the installation of improved measuring equipment.

A trial installation of toll-line busy signals required a visit to Harrisburg by C. A. Hebert.

At Chicago E. O. Seiler assisted in the installation of open-wire wide-band equipment for program transmission to be used on the transcontinental open-wire circuit.

J. W. Woodard discussed with Telephone Company engineers at Omaha changes in connection with the sender equipment in Atlantic-Jackson Office. While in that territory he made a visit to the new offices at North Platte and McCook, Nebraska, in company with T. L. Frank of Northwestern Bell Telephone Company.

Toll Circuit Development

Tests were conducted by B. A. Fairweather, T. C. McFarland and R. W. Chesnut at the telephone repeater station in Allentown, Pennsylvania, as part of an investigation of 12-C Program Supply Repeaters.

D. M. Terry visited Richmond and Selma, Virginia, to inspect the 2-A Carrier Pilot Channel Equipment at these places.

To study acoustic shock disturbances at the No. 3 toll and dial "A" switchboards J. B. Shiel made a recent trip to Worcester, Massachusetts.

R. A. Brader spent a week in Albany inspecting the trial of an arrangement for testing pad-control features of cord circuits.

Twenty-five years as a member of the Western Electric Company and the Laboratories were completed by E. D. Johnson on May 28. He entered telephone engineering after

E. D. Johnson

graduate work at Sheffield Scientific School, Yale University, from which a year previous he had been graduated with a Ph.B. degree.

In telephone work his activities have been concentrated for the most part on the development of repeater system. Repeaters were in the early stages of their development when Mr. Johnson first started on the work. He designed apparatus, developed circuits and worked on testing for mechanical repeaters, and assisted in the laboratory and field testing of the first vacuum tube repeater circuits. He also supervised the development and installation of mechanical repeaters put into service in numerous toll centers in the East previous to 1915.

In installing and testing repeaters Mr. Johnson has been associated with important telephone projects both here and abroad. In 1915 he was in San Francisco to assist in the opening of the transcontinental telephone line, the repeater circuits of which were built and tested under his supervision. At about this same time he installed and tested vacuum tube repeaters for a line established by the Pacific Telephone and Telegraph Company that linked Vancouver, B. C. with Los Angeles. For the telephone circuit between Rio de Janeiro and Sao Paulo, Brazil, he supervised the repeater installation and assisted in the inauguration of the service in 1918.

Since 1921 he has been in charge of a group of engineers engaged in the development and standardizations of telephone repeater and signalling systems. Included in this work have been such projects as wire line terminal circuits and equipment for the transatlantic radio-telephone circuits, both long and short wave; program supply circuits and numerous other toll developments. In addition he has been in charge of the drawing up of engineering recommendations for telephone and signalling circuits for numerous European long distance circuits.

Telegraph Development

R. G. Loeffel was in Pittsburgh and Indianapolis in connection with the combination differential duplex and two-path polar installations at these cities.

L. W. Wickersheim has been notified of his election to alumni membership of the University of Southern California Chapter, Phi Beta Kappa.

Dial Equipment Development

Panel equipment matters were discussed by D. H. Wetherell in a recent visit to Hawthorne. He also attended a meeting of the Quality Survey Committee.

Also at Hawthorne, A. H. Lince discussed equipment problems in connection with the new dial switching "A" switchboard.

Power Development

R. P. Jutson and C. S. Gray visited Netcong to witness tests on radio-telephone equipment for the new inward channel from Bermuda.

Local Central Office

Assisting in the conditioning of the call announcer machines for the new panel tandem office, G. A. Hurst spent five days in Boston.

To investigate circuit conditions on the combination toll and special "A" switchboard, W. J. Lacerte made a visit to Worcester.

J. W. Gooderham visited Philadelphia in connection with radio interference studies.

At Philadelphia F. K. Low discussed maintenance problems pertaining to cordless "B" and key-indicator type senders with the engineers of the local telephone company.

W. Rupp observed tests at Chicago of improved features in the link and district circuits and in the district test circuit associated with the new panel tandem office.

C. W. Keckler completed twenty years of service in the Bell System on May 15.

Vail Medal Awards for 1930

IN the Report of the National Committee of Award—Theodore N. Vail Medals—for the year of 1930, announcement is made of the award of three silver medals to employees of the Associated Companies of the Bell System for noteworthy public service.

To be selected for National Vail Medal recognition an act must have for its objective the accomplishment of something of real value in the public interest through the medium of Bell System facilities, organization, training or experience, and must reveal to a high degree many, if not all, of the positive qualities of intelligence, initiative and resourcefulness, and usually courage, endurance and fortitude.

The citations are:

HAZEL HILAH HAASE: For initiative, resourcefulness, and intelligent use of telephone service in protecting the public interest.

On December 16, 1930, at about 9:00 A.M. Miss Haase learned that five bandits had held up and robbed the Citizens' Bank at Clinton, Indiana, and were fleeing in an automobile, with the police in pursuit. Immediately taking a position at the switchboard she notified the county sheriff, the police departments and other civil authorities of all the towns located in the general direction taken by the bandit car. She gave a description of the car to the citizens of the countryside and requested that they assist the police in the apprehension of the bandits. She kept in constant touch with all movements made by the bandits, although on various occasions they commandeered other cars and frequently changed their course, and she quickly relayed this important information to the authorities. The bandits were never able to break through the spreading circle of intelligence which she kept ahead of their flight. After a pursuit of more than fifty miles, they were overtaken and surrounded. Three were killed, two captured and the loot recovered.

LEONARD J. STRANG: For initiative, resourcefulness and extraordinary courage in saving the life of a fellow-employee.

On October 14, 1930, Mr. Strang went to the assistance of a fellow-employee whose safety belt became detached from one of the window rings on the fifth floor of an unoccupied part of a building, leaving him dangling helplessly at the end of the safety strap. Mr. Strang found that the ring supporting the man had become dangerously weakened and realized the great strain to be placed upon his own belt by the added weight of the struggling man; nevertheless, he fastened one of his straps to the adjacent window and the other to the weakened ring from which the man was hanging and pulled him to a place of safety.

IVAN F. VANNOY: For initiative, resourcefulness and intelligent action in saving telephone central office equipment from fire and restoring the telephone service of a community.

On August 4, 1930, at about 11:30 P.M., when fire threatened to destroy the town of Gore, Virginia, Mr. Vannoy went to the scene of the fire, a distance of twelve miles, and found that the telephone central office of the connecting company was in danger. He relieved the operator on duty, with her consent, and for about an hour handled calls, summoning additional fire equipment and ordering dynamite to check the progress of the fire. At the same time he made preparations for moving the switchboard and its auxiliary equipment until the adjoining buildings had collapsed and one wall of the telephone office began to smoke. Then, with the assistance of several men, he moved the switchboard and other equipment across the road to an open field, with a magneto wall set and some batteries which he had laid aside previously for that purpose, he improvised a telephone station, and within twenty minutes, established service with Winchester, Virginia. The telephone office was completely destroyed by fire but through the use of the equipment which Mr. Vannoy had saved, local, as well as long distance service was reestablished from new headquarters the following morning.

Contributors to this Issue

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.

S. O. Morgan

R. G. Koontz received a B.S.E.E. degree from the University of North Carolina in 1923 and immediately joined the Technical Staff of the Laboratories. With the Equipment Development Section of the Systems Development Department he was first associated with the trial installation group in connection with the trial installation of the No. 3 Toll Switchboard. More recently he has been concerned with the development of equipment for toll central offices.

W. W. Werring came to the Laboratories in 1922 following his graduation from Cornell with an M.E. degree. For several years he was a member of the Apparatus Analysis and Materials group and later was assigned exclusively to Materials engineering. In this work he has specialized on studies of insulating materials. He has taken a prominent part in A.S.T.M. committee work on impact and insulating materials.

S. W. Shiley entered the Western Electric Company at the Clinton Street Works, Chicago, in May 1904. He held various supervisory positions in the Drafting Department and was in charge of telephone circuit drafting when transferred to Hawthorne in 1907. The following year he was transferred to the Engineering Department where he participated in the early development and standardization of telephone switchboards, distributing frames, and racks. He was Standardization Engineer in charge of switchboards and iron frameworks when transferred to the Laboratories in December 1915. Here he has participated in manual and toll developments and now is Laboratory Engineer of the carrier telephone and telegraph laboratories.

R. G. Koontz

W. W. Werring

S. W. Shiley

E. L. Fisher

E. W. Flint

A. C. Gilmore

E. L. Fisher entered the technical staff of the Laboratories in 1918, following a year as instructor in the electrical laboratory at Columbia and two years with the Crocker-Wheeler Company on the design of alternating-current machinery. Here he was first associated with the "Methods" group on vacuum tube development and later transferred to the physical laboratory, and engaged in apparatus analysis. For the last three years he has been occupied with problems of protection and inductive coordination. He holds the degree of B.S. in Electrical Engineering, received from Worcester Polytechnic Institute in 1915.

E. W. Flint is engaged in the analysis and testing of selector testing circuits. He received the degree of B.S. in Electrical Engineering from the University of Maine in 1922 and immediately following joined the technical staff of the Laboratories. Here he has been associated with the Local Systems department chiefly on laboratory work in connection with the panel system.

A. C. Gilmore joined the Laboratories in 1916 and became associated with the Materials Inspection group. Shortly after, however, he transferred to the Systems Department and for a number of years was engaged in equipment drafting. In 1923 he joined the Equipment Development group where he was first concerned with the analization of Hawthorne orders and later with trial installations. At the present time he is engaged in the development of equipment for manual central offices.