ELL LABORATORIES RECORD

Self-Denial for Victory

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NOT all of us can have the privilege of fighting our enemies in distant parts of the world. . . . But there is one front and one battle where everyone in the United States—every man, woman and child—is in action, and will be privileged to remain in action throughout this war. That front is right here at home, in our daily lives and in our daily tasks. Here at home everyone will have the privilege of making whatever self-denial is necessary, not only to supply our fighting men, but to keep the economic structure of our country fortified and secure during the war and after the war. . . .

"This will require the abandonment not only of luxuries but many other creature comforts. . . . All of us are used to spending money for things we want but which are not absolutely essential. We will all have to forego that spending. Because we must put every dime and every dollar we can possibly spare out of our earnings into war bonds and stamps. Because the demands of the war effort require the rationing of goods of which there is not enough to go around. Because the stopping of purchases of non-essentials will release thousands of workers who are needed in the war effort."

From President Roosevelt's Speech, April 28, 1942.

Transoceanic Telephone Cables

This article describing Bell Laboratories experiments on telephony through long submarine cables is excerpted from O. E. Buckley's paper, "The Future of Transoceanic Telephony," which was presented as the Kelvin Lecture of 1942 to the Institution of Electrical Engineers, London

A MAJOR advance [*in submarine telegraphy*] ensued with the introduction of the permalloy loaded cable in 1924. The advantages of inductive loading for reducing the attenuation in long circuits had been known for some time and some applications of the Krarup or continuous method of loading had been made to short submarine telephone cables. No practical means, however, of applying this principle to ocean cables was available, since for telegraph frequencies loading with iron wire was not advantageous because of its low permeability. The discovery of permalloy, a material with very high permeability at low flux densities, together with the invention of means for protecting the loading material from the severe stresses that it would otherwise encounter at the ocean bottom, made it possible to build a cable with many times the band width of corresponding non-loaded cables. The increase in traffic over the cable was, however, less than proportional to the increase in frequency range, because duplexing the loaded cable involves a greater sacrifice of one-way speed than is the case for the non-loaded cable. The fastest loaded transatlantic cable has an effective frequency band of over 100 cycles per second and can carry four times as much traffic as a non-loaded cable of the same size and length.

Development of permalloy loading for telegraph cables naturally led to consideration of the possibilities of a loaded telephone cable to span the Atlantic. Whether viewed as an extension of frequency from 100 cycles to the 3000 cycles needed for high grade telephony, or as an extension of distance, the step was a formidable one. The longest deep-sea telephone cable reached only 105 nautical miles from Key West to Havana, where three cables continuously loaded with iron wire were laid in 1921. The transatlantic span called for a minimum of 1350 miles via the Azores, or 1800 miles by the more direct route from Newfoundland to Ireland. It was obvious that such a step could not be accomplished by mere structural changes. New materials were required. For years, a systematic search had been made to improve the properties of electric and dielectric materials for use in submarine cables. By 1928 sufficient progress had been made in the development of materials and in the structure of the cable itself to permit seriously undertaking a transatlantic telephone cable. A decision was then made to embark on a test of a section of such a cable under practical conditions.

In determining the requirements for this cable, it was decided to engineer it for the Newfoundland-Ireland route rather than for the route via the

Azores. The longer link made the cable more difficult and its cost per mile higher, but the total cost and considerations of operation and maintenance favored the more direct route.

The structure proposed for the Newfoundland-Ireland telephone cable was of the single-core type with a continuously loaded central conductor and a concentric return conductor similar to that of the Key West-Havana cables, but different in materials and dimensions. Instead of a serving of iron wire or permalloy to provide inductance, there were used four layers of very thin perminvar tape. Perminvar is an alloy which, in the form of loading tape, has a permeability and resistivity suitable for telephone use and at the same time has very low hysteresis, which helps in preventing distortion of speech due to magnetic modulation. The loaded conductor was insulated with paragutta rather than with gutta percha. Paragutta is a mixture of specially purified and deproteinized rubber, deresinated balata or gutta percha, and some wax. It has a dielectric constant 15 per cent lower than the gutta percha in the Key West-Havana cables, and leakance at telephone frequencies about one-fifteenth as great.

The cable was designed on the basis of as high attenuation as would be permitted by considerations of noise at the receiving end and usable power at the sending end. Since the attenuation of such a cable increases rapidly with frequency, only the noise at the high-frequency end of the speech band is significant; here the noise is entirely of thermal origin, for static and other external interference are eliminated by shielding. The sending power is limited by magnetic hysteresis and there is little advantage in applying more than about 50 volts. Most of the power can be concentrated in the high frequencies by placing, at the sending end, part of the network which corrects the distortion of the cable. By these means, it is possible to set a permissible overall attenuation as high as 165 db for a top frequency of 3000 cycles. This far exceeds attenuation permissible in other wire telephone practice. The cable was designed to give this attenuation with the most economical disposition of materials within practical limits. Its core comprised a loaded central conductor of 800 pounds of copper and 95 pounds of perminvar per nautical mile, 720 pounds of paragutta insulation, and a concentric copper return conductor of 1700 pounds, making the cable much heavier than any that had previously been laid in great depths.

A 20-mile section of this cable was made in 1930 under the supervision of Bell Telephone Laboratories engineers by the Norddeutsche Seekabelwerke in Nordenham, Germany. There it was loaded aboard the cable ship Norderney and taken to a location in the Bay of Biscay where a depth of 2500 fathoms was conveniently available. This depth was greater than would be encountered on the proposed cable route. The 20-mile section was paid out on the sea floor and its open-end impedance measured over the telephone range of frequencies. From these measurements, changes in its electrical parameters could readily be deduced. The cable was then pulled in and carried to Frenchport Harbor near Belmullet, County Mayo, Ireland, whence it was laid out to sea to permit measurement of terminal noise. Measurements of impedance both from the ship and from the shore showed the cable to be quite unimpaired both at 2½ miles depth and after recovery and relaying in shallow water. Measurements of noise from shore, however, showed that the location was unsuitable for this type of cable because of the rocky bottom. Such a cable is somewhat microphonic on account of the strain sensitivity of perminvar and the terminal sections of the cable must lie quietly on a soft bottom if a low terminal noise level is to be assured.

Simultaneously with the experiments on the cable, experiments were conducted with the terminal apparatus in the laboratory in New York. An artificial line had been built closely simulating the proposed cable in electrical performance, and over this speech was transmitted at the levels intended for the cable. The method of operation was extreme as well as novel. The high attenuation made it impossible to balance the simulated cable for two-way talking, and voice switching had to be used. At both ends the receiving apparatus was normally connected to the line. The speaker's voice currents caused his end of the line to be switched to the transmitting apparatus. Arrangements were devised to avoid loss of speech during the switching interval, and to minimize interference due to the persons at the two ends of the cable speaking almost simultaneously. The time required for speech to travel over such a cable is not negligible. In this case it was about a tenth of a second. This is long enough to be noticed but not serious enough to count as a major disadvantage.

All of the measurements in the laboratory, at sea, and from shore joined in giving assurance of the technical soundness of the proposal to install a cable of this type. Its performance would have been superior to that afforded by radio. The cost, however, would have been much greater than that for a radio circuit. The cable system from Nova Scotia via Newfoundland and Ireland to Great Britain promised to cost about $15,000,000. When the project was first considered, the radio connection had been subject to frequent interruption and the cable was regarded as an economically justified supplement to the radio services as they then were.

Postponed temporarily because of general business depression, the cable project was later postponed indefinitely because, in the face of improvements in transatlantic radio communication, so expensive a cable to carry a single conversation could no longer be justified. Today it seems improbable that such a cable will ever be laid across the Atlantic. Fortunately, other cable possibilities have in the meantime been developed which look more attractive....

A single-channel cable such as we projected in 1929 would be of little value in supplementing a radio telephone service of so many channels as there may be in the future. To be of any real value in this situation, the cable also must be capable of carrying a considerable group of telephone channels. It was toward such a possibility that we turned when the project of a single-channel cable was suspended. We have made considerable progress in that direction, and I would like to tell you about it, if you will excuse my presenting a proposal which has still many elements of speculation in it.

It was obvious at the start that a multi-channel telephone cable to cross the ocean would have to be provided with intermediate repeaters since even a single-channel cable without repeaters required going to practical extremes in structural design. Consideration of mechanical difficulties ruled out locating the repeaters elsewhere than on the ocean bottom. Problems of laying and lifting made it obvious that the repeater housing should, if possible, be incorporated within the cable structure and treated as a part of the cable rather than as an appendage to it. Hence we were led to develop a small-diameter cylindrical housing to be incorporated as a part of the cable underneath its armor. The whole structure had to be flexible so that it could be bent around a cable drum and passed over the bow or stern sheave of a cable ship.

The structure of the repeater housing which was devised comprises first a succession of pressure-resisting steel rings each having a diameter of about 1½ inches and a width of ¾ inch. Over these is slid a succession of thinner steel rings of the same width but so placed as to overlap the joints of the inner rings. So assembled, the rings form an articulated cylinder about seven feet long. To exclude water, there is placed over this cylinder an annealed copper tube with water-tight seals at its ends. The details of the seal are of the greatest importance. It combines a strictly hermetic seal, in which the conductors are brought out through glass, with a plastic seal through which diffusion of water vapor would be extremely slow, should the glass seal fail. Joined to the copper cylinder, and extending over the cable core for several feet, is a tapered copper sheath which serves to distribute bending strain and protect the conductor joint at the seal. Containers of the type described have been tested at pressures considerably higher than would be encountered in a transatlantic cable. They have been subjected to repeated bending around a six-foot drum without failure.

Within the repeater housing the elements of the repeater are separately contained in plastic cylinders about six inches long, loosely fitting inside the inner steel rings. Connections between these units are made with flexible conductors.

A repeater must, of course, be supplied with power and, as it is impracticable to provide a primary source of power in such a small housing, power must be fed to the repeater over the cable from a direct-current supply. The supply voltage is one of the limiting considerations in the design of such a cable system. It must not be so high as to endanger the insulation of the cable or repeater elements. An operating potential-to-ground of 2000 volts oppositely poled at the ends of the cable was assumed. Power would be supplied on a constant current basis so that fluctuations of earth-potential would not cause variations of current supply. The repeater elements were designed to withstand the anticipated voltage-to-earth. Tests of cable core and joints over a long period of time have shown no observable change under this impressed voltage.

The difficulties of lifting a deep-sea cable for repairs are such as practically to prohibit frequent access to the repeaters for maintenance. Hence, the repeater must be provided with elements which will rarely, if ever, require attention. A period of twenty years without replacement of parts was assumed as a reasonable requirement.

The problem of life and maintenance is principally the problem of a rugged long-lived vacuum tube. Ordinary vacuum tubes have limited service life on account of evaporation of material from thermionic cathodes. By making the level of transmitted signals relatively low, the space current may be kept very small. By making the cathode surface relatively large, this small current can be obtained at a temperature so low that the cathodes of the tubes may be expected to last for a very long time. This is a different approach to the tube problem than has ordinarily been made. New types of tubes based on these principles were developed and put on life tests more than five years ago. As yet they have shown no evidence of deterioration and one now may be reasonably sure from their behavior and from physical considerations of a life of at least ten years. There is good reason to think that they should last several times that long, but further observation will be required before a life of as much as 20 years' steady operation can be confidently predicted. The tubes must also be more rugged than ordinary vacuum tubes since the cable will be subjected to considerable vibration and perhaps to heavy blows in the course of laying and lifting, though the tubes can be protected to some degree by resilient mountings.

Other elements of the repeater structure such as coils and condensers are also subject to special requirements both electrical and mechanical. These requirements have been met in a preliminary way and the assembled repeater in its housing subjected to mechanical tests in the laboratory.

Although the electrical requirements of such a cable are very severe, there are some respects in which the submarine telephone repeater is simpler than a land-line repeater. The temperature at the bottom of the ocean is nearly constant; consequently, the repeater does not have to be regulated to compensate changes of cable characteristics with temperature. Also, once the cable is laid, it is in a very quiet place, and except in shallow water near shore is not likely to be disturbed. True, the electrical characteristics of the cable may show effects of aging, but over a long period of time changes are not great, and they can be allowed for by providing some margin in the electrical design.

In the circuit of the repeater the heating filaments of the amplifying tubes are placed in series with the central cable conductor. The fall of potential through the heater filaments provides the plate potential for the tubes. Appropriate networks compensate for variation of cable attenuation with frequency. A negative feedback circuit gives a high degree of stability over a wide band of frequencies and minimizes the effect of variations of tube characteristics. It is interesting to note that the amplification provided by a single tube could drop to a tenth its normal value with scarcely appreciable effect on the performance of the repeater.

The number and spacing of repeaters depends of course on the length and design of the cable. For a cable 2000 miles long to connect Newfoundland and Great Britain there was calculated a core comprising 516 pounds of copper per mile insulated with 370 pounds of paragutta, surrounded by a return conductor of 600 pounds. This is like the core of the 1930 Key West-Havana telephone cable but somewhat smaller. Paragutta was assumed as the insulating material because of extensive experience with it. By using for the calculation the characteristics of one of the newer synthetic insulating materials, a somewhat more favorable design would have been obtained. On this cable 47 repeaters spaced 42 miles apart would provide the transmission of a band 48,000 cycles wide.

The repeater is a one-way device and to provide two-way conversations two cables have been assumed, one directed eastward and the other westward. This is the simplest solution of the two-way problem but it is not inconceivable that the problem could be solved with a single cable. Using two cables, each transmitting 48,000 cycles, the number of telephone circuits will depend on the band assigned per channel. If we adhere to the present best land-line practice, and assign 4000 cycles per channel, there would be room for 12 telephone circuits. For a small sacrifice of quality the number could be materially increased. Even as many as 24 fairly satisfactory circuits could be provided by assigning only 2000 cycles per channel.

Although in Bell Laboratories we have gone a considerable distance in the design of a broad-band repeatered submarine telephone cable, and have developed many of the essential parts, I would not wish to give the impression that all the problems of such a cable have been solved, or that the time has come to proceed with its construction and installation. Indeed, it is only by building trial sections of such a cable and subjecting them to repeated punishment more severe than a cable is likely to encounter, that the problems can be fully recognized. Extensive electrical tests will also have to be made on a complete assembly of repeaters with artificial lines simulating sections of cable. These steps have yet to be taken.

A submarine cable requires a degree of care and precaution in engineering such as is required in few other situations. It is usually not possible to provide large factors of safety, and yet failure of a single part such as a break in the conductor or a leak in the insulation completely destroys the operation of the whole system. Experiences of over eighty years since the failure of the first attempt at an Atlantic cable have led to the development of practices which give good assurance of the reliability of cables of simple construction, but when a device such as the proposed repeater is made a part of the structure a new set of hazards is introduced. Whether these hazards can be guarded against well enough to justify the risks of such a cable project remains to be seen, but I am optimistic that by a sufficiently thorough job of cable manufacture and a well-planned program of trials, the hazards can be reduced to an acceptable degree. It will take some years to reach this point, and at best some degree of hazard will still remain. Submarine cables, like all things that go to sea, can never be completely dissociated from some chance of disaster. . . .

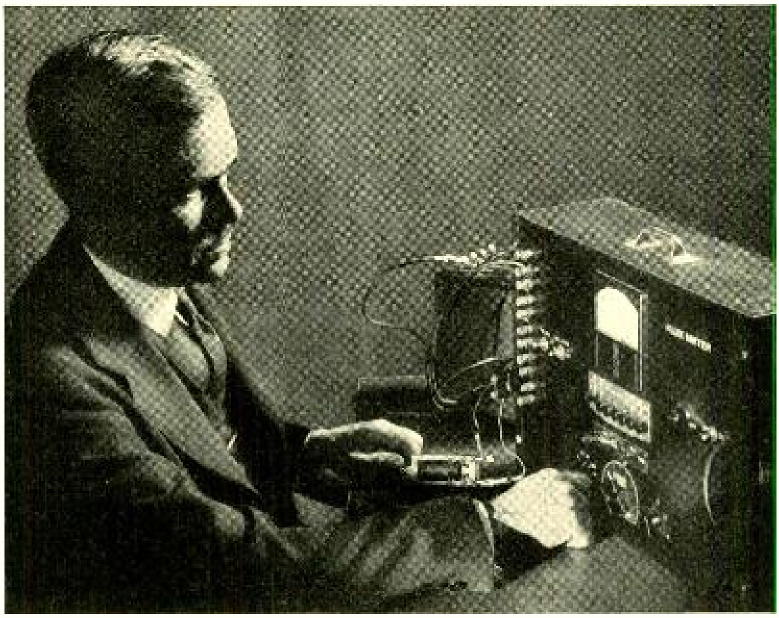
As to the costs of such a cable project for establishment of broad-band wire telephony to England via Newfoundland, only the roughest sort of estimates can be made at this time. However, even applying annual charges somewhat higher than have commonly been used for cables, it appears that the total cost per telephone circuit for the system of two cables with associated equipment will be comparable with that of prospective short-wave radio systems. A considerable increment of cost of cable over that of radio would be justified by the better quality of transmitted speech and the very significant advantage of privacy. Added to this is the value of the cable as a supplement to radio systems to provide against their failure. Indeed, it is possible that once the cable were in service radio would be looked on as a supplement to it. . . .

It may not be necessary to wait until the growth of transatlantic telephone business provides enough traffic to utilize fully a cable of the type described. When once the engineers are ready to give reasonable assurance of the cable, I believe that it will not have to await complete economic justification, because of the tremendous importance which it would have in insuring privacy and continuity of transatlantic telephone service. . . .

RESEARCH IS THE EFFORT OF THE MIND TO COMPREHEND RELATIONSHIPS WHICH NO ONE HAS PREVIOUSLY KNOWN. AND IN ITS FINEST EXEMPLIFICATIONS IT IS PRACTICAL AS WELL AS THEORETICAL; TRENDING ALWAYS TOWARD WORTHWHILE RELATIONSHIPS; DEMANDING COMMON SENSE AS WELL AS UNCOMMON ABILITY.

—Harold de Forest Arnold

This quotation from an address by the former Director of Research of the Laboratories is engrossed on the wall above the entrances to the Auditorium in the Acoustics Laboratory at Murray Hill



Magnetic Fluxmeter

By E. L. NORTON
Circuit Research

MEASUREMENT of magnetic field strength due to current in a coil is usually made by changing the current and observing the voltage induced in a search coil or in the coil itself. This voltage is proportional to the rate at which the magnetic flux varies; and it fluctuates in magnitude and direction, if the field pulsates or alternates. For rapid flux alternations a galvanometer will show no deflections; but a steady reading can be obtained if the connections to the galvanometer are reversed as the induced current reverses. The deflection is then a measure of the strength of the magnetic field under consideration.

A practical application of this method is the measurement of voltage induced in a relay by the operation of a neighboring relay. The magnetic flux in the active relay changes as indicated by A of Figure 1 and the voltage induced in the other relay varies as shown by B. By reversing the meter connections at *a*, *b*, *c* and *d*, the voltage applied to it becomes unidirectional, as illustrated by C, and gives a steady deflection on a damped direct-current instrument.

A fluxmeter operating on this principle has been developed in the Laboratories. It has a pulse-generating device with high-speed relays which reverse simultaneously the current producing the flux and the meter connections. Pulse rates of 30, 15, 7.5 and 3.75 per second are obtained from gas tube discharges as submultiples of 60-cycle alternating current. The measuring circuit includes a bridge

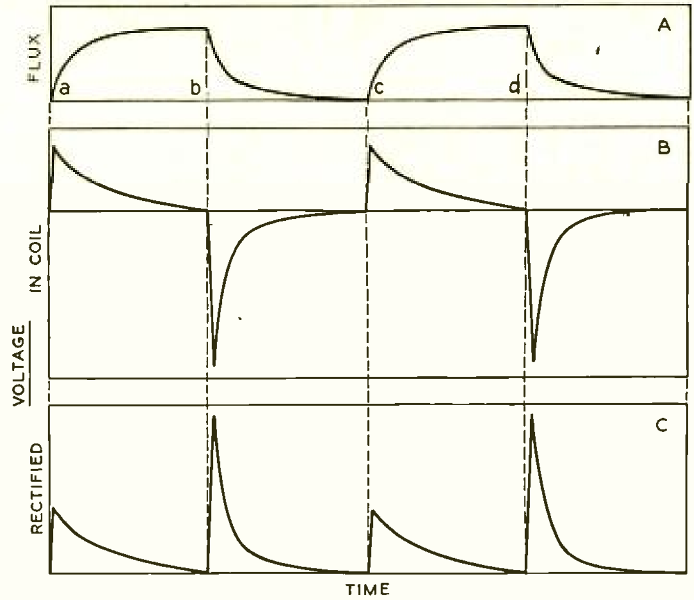


Fig. 1—*For magnetic flux changes illustrated by curve* A, *the voltage induced in a neighboring coil varies as indicated at* B. *By reversing the voltage at* a, b, c, *and* d *it becomes uni-directional and will give a steady deflection on a damped direct-current meter. The reading is proportional to the magnetic flux in the coil*

or one-tenth of the actual current.

Two push buttons at the left shunt the meter and reduce its readings to one-tenth or one-thousandth of the current in the coil tested. These shunts can be used in combination with the loss pad to measure currents up to two amperes with the micro-ammeter supplied with the flux meter. The two push buttons at the right are used when balancing the bridge for flux measurements. One push button inserts a 10,000-ohm resistance in series with the meter for a rough balance and the other button shunts the meter directly across the bridge.

which is used when flux is measured by the voltage induced in the coil itself.

A schematic of the circuit when used with a search coil is shown in Figure 2 and that for bridge measurements in Figure 3. The pulsing circuit operates the high-speed relays A and B which act as reversing switches. When not pulsing the bridge can be balanced by closing both switches and using the meter as a galvanometer. The bridge has arm ratios adjustable from 1 to 100 and a 100-ohm decade box with a 12-ohm rheostat for balancing. There are two key switches below the push buttons, as shown in the headpiece; one selects a bridge or a search coil measurement of magnetic flux and the other connects the meter directly in the test circuit or introduces a loss pad which makes the meter read one-third

A switch marked "PULSE" can be set for uni-directional or reversed pulses. "SPARK COND" connects a condenser across the contacts of the bat-

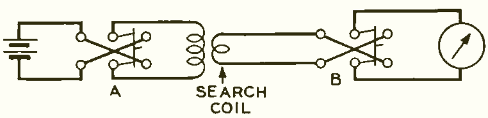


Fig. 2—*Schematic of the fluxmeter circuit for testing with a search coil the magnetic field strength near another coil*

tery relays to protect them under heavy loads. Terminals marked "COND" are used when the fluxmeter is to measure capacitance for which it has a range from a few hundredths to several microfarads.

The pulsing circuit, Figure 4, has four stages in each of which there is a pair of argon filled tubes. Power to operate them and their high-speed relays is supplied by the rectifier tube R. A sharp voltage peak is obtained to fire the first stage by connecting the gas tube T across the rectifier R so that T fires only on the half cycle when the rectifier does not conduct. This voltage, applied to the small condenser C-2, starts one of the two tubes in stage one, for example A-1.

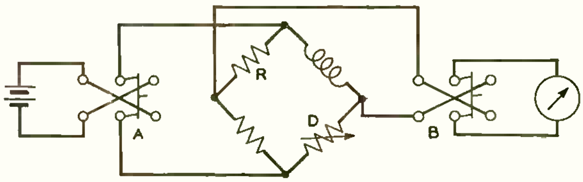


Fig. 3—Schematic of the fluxmeter circuit when magnetic flux is measured with a bridge circuit. The current through the meter, caused by the inductive effect in the coil tested, measures the flux. A *and* B *are reversing switches which keep the uni-directional current in the meter*

When the next cycle applies a pulse to this stage the second tube A-2 fires. At the same time the condenser C-3 decreases the voltage across A-1 below that required to maintain a discharge and extinguishes it.

Each tube fires thus on alternate cycles, operating the high-speed relays P1 and P2 thirty times a second. Voltage in lead L, which starts the second stage, is high enough to fire the tubes B1 and B2 for only a very short time when the tube A1 of the first stage begins to conduct. Then it fires one of the tubes of the second stage. Tubes B1 and B2 fire alternately, as in the first stage, and operate relays P3 and P4 every other pulse of the first stage, that is fifteen times a second. Similarly, a third and a fourth stage produce pulses 7½ and 3¾ times per second.

Four push buttons permit selecting any one of the four pulse frequencies. On depressing a button a pair of high-speed relays is connected in the cathode circuits of the two tubes in that stage. Operated from each of these relays are four others which serve as reversing switches. One group reverses the connections from the battery to the coil under test and the other those to the micro-ammeter used to measure the magnetic flux. To prevent switching meter connections when the magnetic flux is changing, operation of the relays in the battery circuit is delayed by shunt condensers for a period of from one or two milliseconds after the meter relays have operated.

This apparatus gives readings more conveniently and accurately than previous magnetic fluxmeter readings usually made with a ballistic galvanometer. In addition, it has the added advantage of being as portable as a small suitcase.

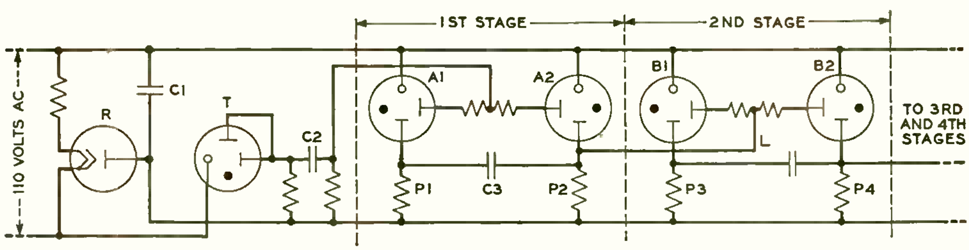
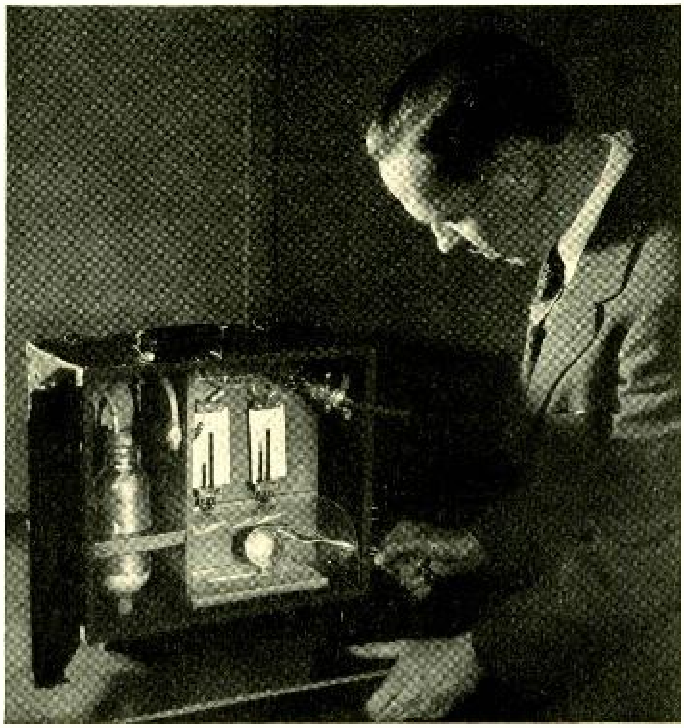


Fig. 4—The fluxmeter includes a pulsing device, operated by gas-filled tubes which supply pulse rates of 30, 15, 7.5 *and* 3.75 *per second from* 60*-cycle alternating current*



Lead Calcium Test Castings

By G. M. BOUTON
Chemical Laboratories

CLOSE control of the calcium content is required in the manufacture of lead-calcium cable sheath. This is not easy to attain because the calcium content is small and a variable amount is lost by oxidation while it is in the molten state despite special techniques used to minimize contact with the air. Conventional chemical procedures of determining this loss of calcium are slow and costly.

A new procedure arises from our laboratory studies of lead-calcium alloys which have shown that the surface of ingots, chill-cast with little agitation, become progressively duller with increasing calcium content. Fissuring then sets in and leaves bright areas exposed which depend in extent on the amount of calcium present. Under controlled conditions these markings provide a quick and accurate estimate of the calcium content in the ingot.

The sample is melted in a small hemispherical iron crucible. The lip of the crucible can be brought close to the surface of the mold, as shown in the headpiece, before the metal starts to pour, thus minimizing exposure to the atmosphere. The mold itself is an iron plate, with a tapered depression about four inches long and ⅝ inch wide milled in its surface.

To insure reproducible results the

casting is done in a cellophane chamber through which passes air of known content of carbon dioxide and moisture. Since both affect the results, they are first removed by passing the air supply through bottles located at the back of the portable kit, Figure 1, which contain potassium hydroxide and calcium chloride. A definite percentage of moisture is then introduced by bubbling the air through water in the bottle at the left in Figure 1. Carbon dioxide, obtained from dry ice in the vacuum bottle shown at the left in the headpiece, is allowed to enter the casting chamber under control by the escape valve on the bottle. Rates of flow are indicated by manometers connected across capillary tubes in the supply lines.

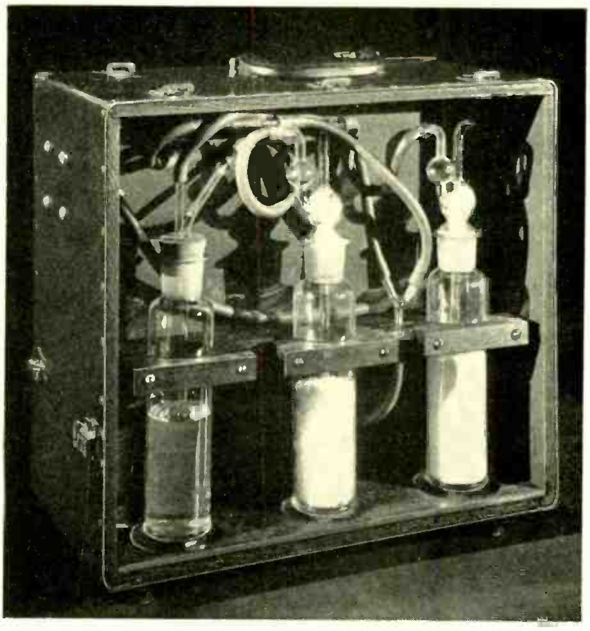
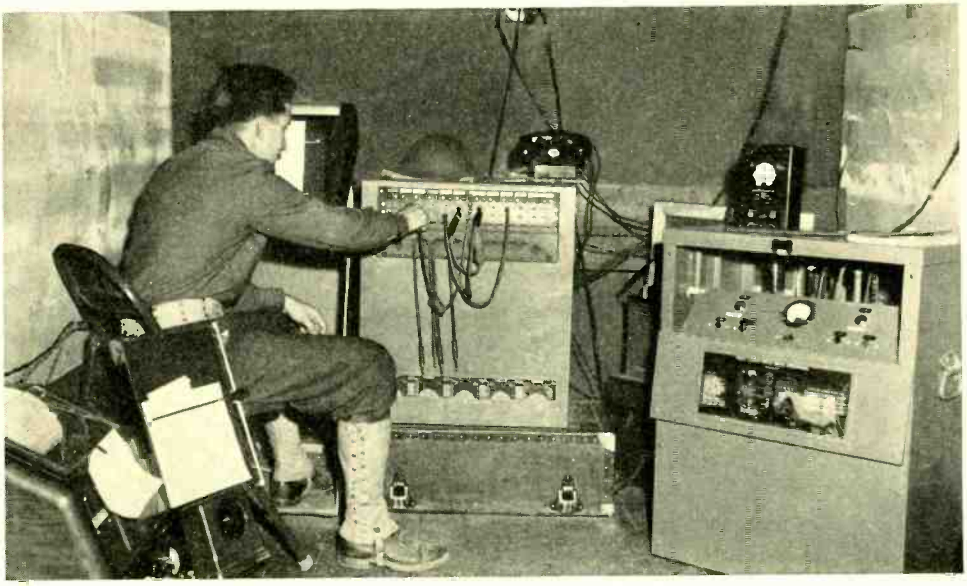


Fig. 1—The casting is done in a cellophane chamber to control the moisture and carbon dioxide content of the air, which affects the results

The surfaces shown in Figure 2 were obtained in an atmosphere with 50 per cent humidity and 0.02 per cent carbon dioxide. Decreasing the moisture and increasing the carbon dioxide makes the surfaces brighter and vice versa. Alloys of calcium content outside the range of the method can be tested by diluting or enriching them with lead-calcium alloys containing appropriate amounts of calcium.

This method of determining the calcium in cable sheath is reliable and more rapid than chemical analysis or metallographic techniques.

Fig. 2—The surface of test ingots becomes progressively duller and fissuring is more pronounced with increasing calcium content. From left to right these ingots contained from .021 to .030 per cent calcium



Portable Teletypewriter Equipment for Army

TO PROVIDE the Army with teletypewriter switching and station equipment that can follow tactical units in the field, the Laboratories have designed a portable form of switchboard, a power supply unit, and station sets. All these equipments, as well as the teletypewriters involved, have specially designed cases for transportation.

In the Carolina maneuvers of last fall a switchboard and several teletypewriters were set up in a "horse portier"—a semi-trailer unit used by mechanized cavalry—and effectively handled a considerable volume of message traffic such as arises in the regular business affairs of an army.

Above—Setting up a connection through the 69C1 switchboard; the power supply unit is at the right

Right—Station sets were mounted on the truck wall above the teletypewriters

Volunteering for Service

In war when small groups are needed for extra hazardous assignments commanders sometimes call for volunteers from the ranks. The volunteer who is accepted usually undergoes considerable personal inconvenience in addition to risking a horrible death.

From the civilian population of our country the President and Secretary of the Treasury are now calling for subscribers to U. S. War Savings Bonds to the extent of ten per cent of one's income.

For some of us such a subscription will mean personal inconvenience and self-denial of things we would like to buy; but it does not mean personal danger. It is a negligible sacrifice as compared to those which are being made daily by the members of our Army, our Navy and our Marine Corps and by those who man the ships of our Merchant Marine.

Will we answer the President's call with a volunteer purchase of more War Bonds?

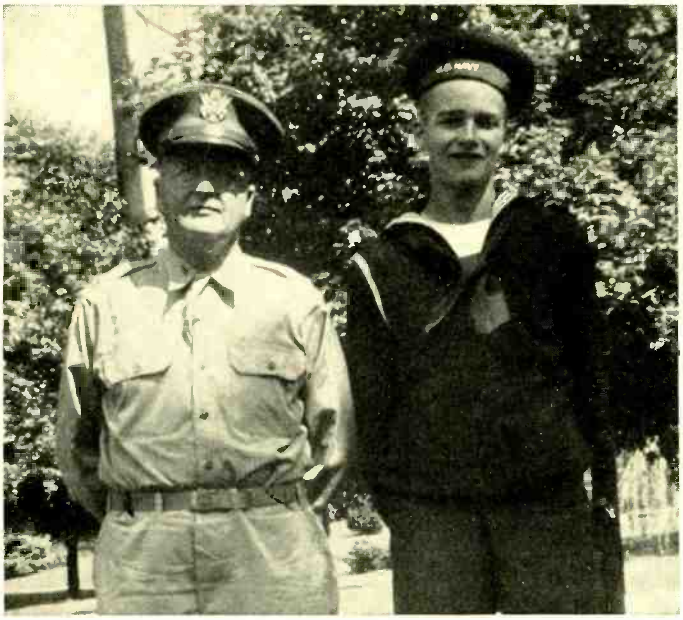
Yes! To the honest limit of our abilities.

News and Pictures of the Month

On May 7, Dr. Buckley sent the following telegram to Henry Morgenthau, Jr., Secretary of the Treasury:

"Replying to your telegram of May 2. In Bell Telephone Laboratories with over five thousand employees ninety-five* per cent now subscribing for War Bonds by payroll deduction. Present subscriptions total over five per cent of gross payroll. Laboratories War Bond Committee is continuing its activity and initiating campaign to pass your goal of ten per cent payroll. All employees will be personally solicited by Committee. Bell Laboratories' magazine next issue will carry portion of President Roosevelt's speech displayed on front page and, in center spread, editorial referring your telegram and urging subscription to the limit of each employee's ability."

*As this issue goes to press, the percentage is 96.7.



Major William R. Lyon with his son, Petty Officer William R. Lyon, Jr., who is in the U. S. Navy, Air Patrol Wing

News From Men in Service

"At the present," writes Sergeant Joseph F. Daly, "I am on an island operating electrical equipment. This equipment was partially developed by our organization. That alone is a saviour for a boring and lifeless place.

"However, we do have a short-wave receiver which enables us to pick up KGEI. Through that station I hear the 'Telephone Hour' every week. Quite a sensation, to hear the program so many thousand miles away."

* * *

John M. Hayward writes from Wright Field: "On April 2 I was promoted to the grade of Lieutenant Colonel. My activities as Liaison Representative for N.D.R.C. projects has required coördination of research work in many fields, including Bell Laboratories. A recent trip to the West Coast was made to study the research facilities and the Materiel Center Liaison Office at the Ames Aeronautical Laboratory, Moffett Field, near San Francisco.

"In connection with other duties, as Chief of Foreign Development Projects, I was appointed Technical Advisor to the Training Film Laboratory which has been producing films used primarily for instruction in identification of aircraft. Being also on the Technical Staff of the Experimental Engineering Section, I have been associated with the Aircraft Radio Laboratory at Wright Field and have assisted in some of their flight tests of equipment designed by the Laboratories."

* * *

From Fort Sam Houston, Texas, Thomas J. Doherty writes: "It's been nine months since I was first inducted, and I've done and seen a great many things. I was first sent down to Fort Monmouth to study signal communication. While there I studied cryptography, encoding and decoding messages and teletype. I was there for two and a half months and then was shipped to Camp Bowie, Texas, where I studied radio code. Four months later a War Department order transferred me to

Thomas J. Doherty, Headquarters Detachment, 8th Corps Area, Fort Sam Houston, Texas

G. B. Graeff (left) seems skeptical of some of the stories told him by Raymond O. Ford, who was commissioned a Lieutenant Colonel on May 1

ing the same kind of training, except in a climate much more to my liking."

* * *

MAJOR WILLIAM R. LYON, Air Corps Resident Representative in the South Bend Area, has now under his command about one hundred people who are doing the work of inspecting, auditing, property checking and Air Plant Protection activities for a large number of manufacturing establishments working on Air Force orders. The territory covered by these establishments embraces Northern Indiana and Southern Michigan. The photograph shown on page ii was taken several months ago in Cincinnati when his son was on furlough from the West Coast.

* * *

LIEUTENANT FRANK A. PARSONS, Headquarters Bomb Disposal School, Ordnance Training Center, Aberdeen, Maryland,

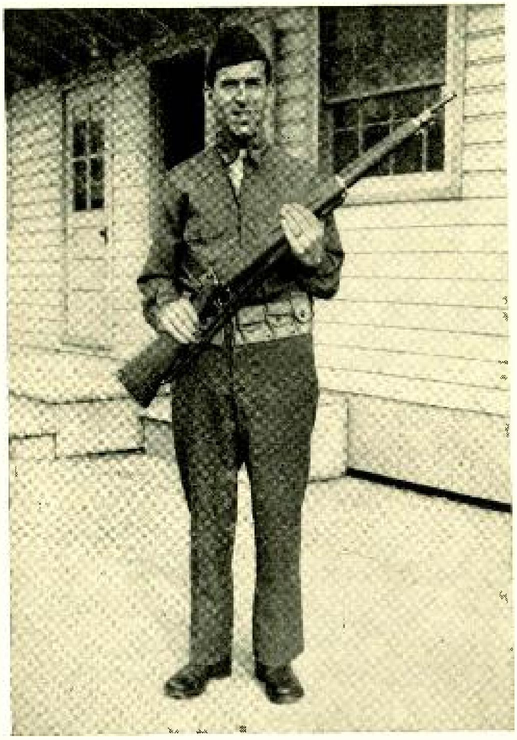
Fort Sam Houston, Texas. I am now doing the type of work I did in the Laboratories—machine accounting. We make all changes in Army personnel in the 8th Corps Area.

"It is comparatively much easier here than it was when I was in the Signal Corps. We don't have to stand any inspections, reveille or bedcheck. The best part is that we don't get any K.P. or guard duty. Those two are the dread of every soldier."

* * *

SINCE CHARLES T. BOLGER has been in military service he has been in three camps, first at Fort Riley, Kansas, then at McChord Field, Washington, and now in Florence, South Carolina. He writes: "At Fort Riley I went through a very rigorous training in the cavalry. Nine weeks later I was transferred to the Signal Corps at McChord Field. Here I trained in all phases of Air Raid protection including chemical warfare, camouflage and signaling. Almost continuous rain made my three and a half months there rather dismal. On March 5 I came to Florence where I am continu-

Helen Adams congratulates Stephen Duma upon his being commissioned a Second Lieutenant in the U. S. Marine Corps Reserve



William Meehan is now in the Quartermaster's Regiment at Camp Lee, Virginia

writes: "I was interested to read in the February issue of the RECORD of MR. BOWN'S trip to England. I just returned from one myself and his reads very much like the one I had. On New Year's Day I received orders to proceed to England on a secret mission for the War Department. We left by Pan American Clipper from New York and proceeded via Bermuda, the Azores, Lisbon and then to London. On our first attempt to leave Bermuda we left at six at night and were supposed to be in the Azores at seven the next morning. You can imagine everybody's surprise when we landed at four in the morning and found we were back in Bermuda. We were about halfway across when the weather got so bad that we had to turn back.

"The next bit of excitement came when we were in Lisbon. We were traveling in civilian clothes and were nearly interned when the customs found our bags full of uniforms. We finally made London, the last leg of the trip being made on a Royal Dutch Airline ship that had been flown out of Holland at the time of the blitz in 1940. The stay in England was quite interesting and we were there about ten weeks.

"Coming home the Military Attaché in London thought it better in view of what had happened coming over that we return by ship and take our chances with the tin fish. We left on a boat from Scotland and came across to Canada. We were attacked three times by subs and according to reports or rumors we sank one of them with depth charges, but we probably never will know. To say the least it was an exciting trip and I sure was glad to set my foot on solid ground again."

* * *

"You've asked of me to whip a line,
Of what I'm doing all the time.
I can't write much of how it's done,
But I will say, 'It sure is fun.'
I'm happy here with 'Buddies' true,
And I'm recommending the same for you,
and you and you and you . . ."

STAFF SERGEANT NILS H. ANDERSON,
Fort Lewis, Washington.

* * *

THE APRIL ISSUE of *The Flash*, magazine of Western Electric Post 497 of The American Legion, was prepared by MAJOR ALBERT J. ENGELBERG, past Commander of the Post. Major Engelberg is at Turner Field, Georgia.

CHARLES E. MERKEL is now a technician at Fort Knox, Kentucky.

ROBERT J. KOECHLIN and CHARLES R. SCHRAMM are taking officers training at Fort Benning, Georgia, and at Fort Bragg, North Carolina, respectively.

RAYMOND O. FORD has recently been commissioned a Lieutenant Colonel, Ordnance Department. He is now in command of the 41st Ordnance Battalion with headquarters at Governors Island, New York.

ALBERT M. ELLIOTT has also received his Lieutenant Colonel's commission. He is with the Signal Corps at the Headquarters of the 1st Army, Governors Island.

JOHN F. GULBIN is now an aviation student at Maxwell Field, Alabama.

CLAYTON W. RAMSDEN, who was given a leave of absence on March 3 to enter military service, returned on May 1 and has been reinstated as a member of the Apparatus Development Department.

Members of the Laboratories who have been granted leaves of absence to enter various branches of the nation's services since the last issue of the Record are:

Military Service

Lieut. A. R. Bertels	Frank C. Kozak
Edward R. Clark	Lieut. Louis T. Miller
Robert J. Erny	John M. O'Neill
Lieut. Wm. J. Flavin	Lieut. J. W. Schaefer
Lieut. B. M. Froehly	Major Wm. E. Stevens
Morgan F. Hickey	August Uhl
Edward J. Hughes, Jr.	Capt. Daniel H. Wenny

Naval Service Lieut. Harry C. Hart

U. S. Merchant Marine Cadet Corps

Edward J. Chance   Austin R. Suneson

National Defense Research Committee

Eginhard Dietze	Mary E. Quinn
Frank H. Graham	William Shockley
Erhard Hartmann	Richard J. Tillman

Genevieve D. Weldon

Laboratories Club Organizes House Committee

A House Committee has been appointed by the Bell Laboratories Club composed as follows:

R. C. Carrigan, *Chairman*

Edna Aamodt	R. L. Shepherd
H. L. Bowman	J. J. Shindle
Hazel Mayhew	Christine Smith
M. D. Redmond	Dorothy Storm*
A. E. Ruehle*	J. G. Walsh

*Murray Hill Laboratory representatives.

In the West Street buildings, the Club Lounge and Game Room, the Club Store and the Laboratories Restaurant are now all closely associated in Section 1H. The new committee will represent the Club in connection with all of these facilities except in so far as the Executive Committee of the Club as a whole may wish to act. In particular, the House Committee will have responsibility in connection with the use by the Club members of the Lounge and Game Rooms and will make comments and suggestions regarding the Club Store and the Restaurant, based on their own experience with these facilities or on statements that have been received from other members of the Laboratories.

"The Bell Telephone System,"

the interesting and authoritative book by A. W. Page, Vice-President of the American Telephone and Telegraph Company, has been reprinted in an inexpensive paper-bound edition.

The Laboratories has obtained a number of copies of this new printing. These are available without charge to employees as long as the supply lasts.

Apply to
The Library,
Telephone Ext. 565 at West Street,
and Ext. 485 at Murray Hill

Army Stresses Need of Communications Equipment

All sorts of Signal Corps equipment, from the simple five-pound "walkie-talkie" sets used by parachutists and riflemen in advanced positions, to parts for the great stationary sets which speed communications from Washington to far-flung bases throughout the world, are needed as rapidly as they can be turned out. American tanks, which have proved their worth in the Libyan campaign, and American "Flying Fortresses," flying at very high altitudes in Europe and over the Pacific, depend for their effectiveness on radio communication, the Signal Corps has pointed out.

Vehicular radio units, traveling with the ground forces, keep the Infantry in contact with the Air Corps and Armored Force. Men carrying five-pound receiving-transmitting sets carry on conversations with their comrades two miles away. Parachute units are now radio-equipped down to the platoon; rifle units down to the company.

The maneuverability of tanks and armored cars is dependent on the organization of their communications, periodic broadcasts of information vital to all, time signals, and weather reports.

Army teamwork today is not only between officers and men, and between Infantry, Air Corps and Armored Force, it is between the soldiers in the field and the soldiers in the factories back home, as well.

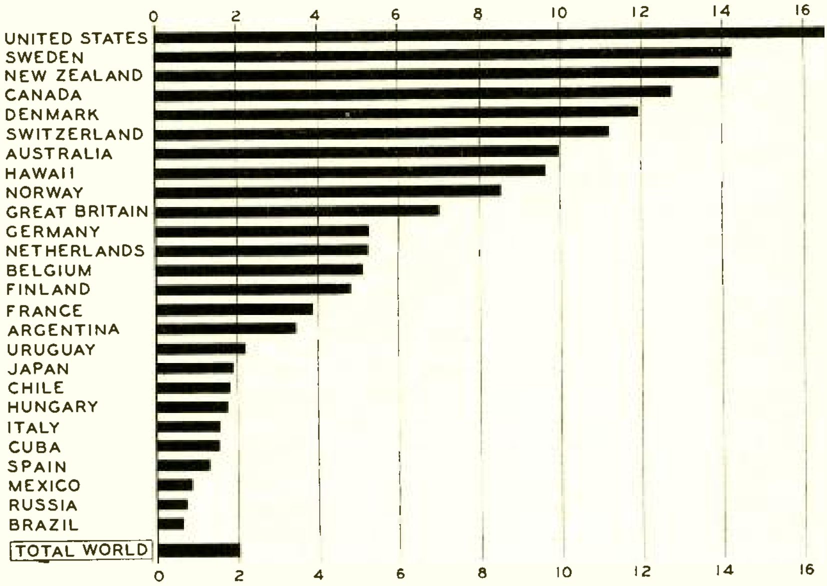
In all this work, American engineers and American labor play a vital rôle. If the Army has anything to say to the nation's industrial workers, it is: "Stay on the job where you are needed most. Don't envy the soldier in the field when you can perhaps do more in your own station to help win the war. Wait your turn and come only when you are called. Do your bit at your machine or bench, and try not to waste materials or time. In this way, you can contribute your full share to the cause in which we all believe. For your past efforts and those you will make in the future, the Signal Corps of the United States Army salutes you!"

Keep Your War Bonds Safe

Purchasers of War Savings Bonds will be interested to know that their bonds will be held for them in safe keeping and without charge by Federal Reserve Banks. This will be a convenience and a saving to those who do not themselves maintain safety deposit boxes. All that is necessary is to advise the Payroll Department that you wish the bonds for which you are paying to be deposited for you with the Federal Reserve Bank of this district. You can then obtain it merely by writing for it and it will be sent to your address. If in case of emergency you wish to present the bond for redemption, the bank will, on request, send you a form to be filled out and will then redeem the bond, sending you the cash proceeds. Or, if you own a bond of larger denomination than $25.00, the bank will redeem the bond, spend part of the money for you in purchasing one or more bonds of smaller denominations and send you a check for the difference. The Assistant Treasurer of the Laboratories, W. C. Burger, will be glad to advise and assist any members of the Laboratories who wish to have their bonds on deposit with the Federal Reserve Bank.

The World's Telephones

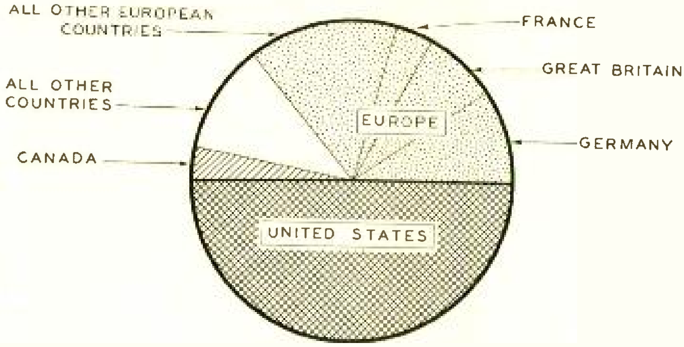
Using estimates in the case of those countries for which no recent official data are available due to the war, a world total of 44,189,669 telephones is indicated as of January 1, 1941, according to *Telephone Statistics of the World* recently released by the A T & T. The countries having over a million telephones are the United States, 21,928,000; Germany, 4,226,000; Great Britain, 3,348,000; France, 1,623,000; Canada, 1,461,000; Japan, 1,368,000; and Russia, 1,272,000. At the present time it is likely that over 46 million telephones are in service, with more than one-half being in the United States and about one-third in Europe. The net gain in the number of telephones in the world during 1940 was more than one and a half million, of which 1,100,000 were accounted for by the United States. During the year 1941 the net telephone gain in the United States alone was 1,593,-



Telephones per 100 *population*

000, bringing this nation's total to 23,521,000.

Telephones operated by private companies account for more than 60 per cent of the world's total. Close to 58 per cent are now operated from automatic central offices. When the population of the respective countries is taken into consideration, the leadership of the United States in point of telephone development is striking. On January 1, 1941, the ratio of 16.56 telephones for every 100 of the population in this country was followed by 14.26 for Sweden, 13.96 for New Zealand and 12.78 for Canada. The relative telephone density in the major countries of Europe—7.00 telephones per 100 population in Great Britain, 5.28 in Germany and 3.86 in France—is considerably below that prevailing in small towns and rural districts in this country.



Distribution of the world's telephones

News Notes

O. E. Buckley and R. R. Williams have been elected to membership in the American Philosophical Society in recognition of their achievements in their respective fields. Other members of the Laboratories who had previously been elected are K. K. Darrow, C. J. Davisson, H. E. Ives and F. B. Jewett.

Harvey Fletcher received the honorary degree of Doctor of Science from Stevens Institute of Technology on May 2, from Kenyon College on May 11 and from the Case School of Applied Science on May 17.

Telephone communication between the United States and Paramaribo, Dutch Guiana, was opened on May 4. The service will be handled over a short-wave radio telephone circuit operated by the A T & T in New York and by The Netherlands Colonial Government in Paramaribo. For the present, the daily period of operation will be from 8:30 a.m. to 6 p.m.

There was a gain of about 93,700 telephones in service in the principal telephone subsidiaries of the American Telephone and Telegraph Company included in the Bell System during the month of April, 1942. The gain for the previous month was 105,700 and for April, 1941, 112,500. The net gain for the first four months of this year totals 416,200 as against 483,800 for the same period in 1941. At the end of April there were about 19,254,800 telephones in the Bell System.

The Executive Committee of the Edward J. Hall Chapter of the Telephone Pioneers of America has appointed the following Nominating Committee: Chairman, W. P. Elstun, General Departments, A T & T; H. A. Frederick, of the Laboratories; P. M. Hall, Long Lines. This committee will prepare a slate of officers that will be submitted to the Chapter members at the annual meeting to be held in the auditorium at 195 Broadway on Wednesday, June 17.

K. C. Black spoke on *Coaxial Cable Development* at the convention of the Petroleum Industry Electrical Association that was held in Shreveport.

B. H. Jackson appeared before the Board of Appeals at the Patent Office in Washington relative to an application for patent.

W. E. Campbell and A. H. White attended meetings of the Electrochemical Society held in Nashville from April 15 to

A Rumor:

You didn't start it

But you can stop it

By not repeating it

18. At the business meeting of the Society, R. M. BURNS was reëlected Treasurer. Mr. Campbell presented a paper *Statistical Methods Applied to Corrosion Research* and Mr. White, a paper on *The Rate of Oxidation of Copper at Room Temperature* of which L. H. GERMER was co-author.

MR. CAMPBELL has been appointed a member of the subcommittee on Lubrication, Friction and Wear of the committee on Power Plants of the National Advisory Committee on Aeronautics.

G. T. KOHMAN attended a conference on the use of mercury in mercury power plants held at Schenectady in connection with the Northeastern District meeting of the A.I.E.E., April 29. Later he discussed contact problems with engineers of the New York Telephone Company at Albany.

K. G. COMPTON visited Hawthorne during the week of April 25 on finish problems associated with war production.

C. L. LUKE went to Perth Amboy to discuss problems relating to chemical analysis with chemists of the American Smelting and Refining Company.

C. J. CHRISTENSEN and M. D. RIGTERINK attended the meeting of the American Ceramic Society in Cincinnati, April 19 to 22. M. D. Rigterink presented a paper on *The Relation Between Composition and Dielectric Properties of Some Low-Loss Ceramics*. R. O. GRISDALE and S. O. MORGAN were co-authors of this paper. Following this meeting Mr. Christensen and Mr. Rigterink visited the plant of the American Lava Company in Chattanooga.

The man who has "the low-down" feels important; and he IS important—to The Enemy, unless he keeps his information to himself.

R. M. BOZORTH, at the final meeting of the season of the A.I.E.E. Pittsfield section held on April 21, spoke on *Magnetism*.

AT A MEETING of the American Chemical Society held in Memphis on April 20, two papers by A. R. KEMP and H. PETERS were presented. The subjects of these papers were *Cryoscopic and Viscosity Studies of Polyisobutylene—Cryoscopic Deviation of Polyisobutylene Solutions from Raoult's Law*, and *Viscosity and Cryoscopic Studies of Polystyrene*.

M. E. MOHR discussed the *Work of the Laboratories* before the Young Married Peoples' Group of the Central Presbyterian Church, Summit, N. J., on May 10.

More than two hundred signatures of Jack Toomey's friends had been written on this scroll before Dr. Buckley presented it, with loud acclaim from the signers, at a testimonial dinner. Mr. Toomey retired, after forty-eight years of Bell System service, on April 30

O. B. Blackwell (left) and A. B. Clark (right) present H. J. Christopher's certificate of life membership in the Telephone Pioneers of America. Mr. Christopher retired on March 16 after forty-four years of Bell System service

In the April issue of *The Review of Scientific Instruments* R. W. Sears reviews the book *Principles of Electron Tubes* by Herbert J. Reich, and C. S. Fuller reviews the book *High Polymeric Reactions—Their Theory and Practice* by H. Mark and R. Raff.

H. E. Ives delivered the Annual Spring Meeting lecture before the Union College Chapter of Sigma Xi on May 1. Dr. Ives' subject was *A Physicist Looks at Painting.*

In the March 28 issue of *Nature* (London) two short articles in the October Record were discussed. The first, *Magnetostriction in Permalloy*, covers work done by R. M. Bozorth, H. Christensen and H. J. Williams and the second, *Torque on Silicon Iron Crystal in a Magnetic Field*, by Messrs. Bozorth and Williams.

E. L. Schwartz visited Chicago to discuss transformer problems with the Western Electric Company and other manufacturers in that area.

R. L. Jones, on April 14, spoke on *Man and Minerals* at the Laboratories' Design Forum. In a description of the earth's mineral resources, Mr. Jones described the distribution between the so-called "have" and "have-not" nations. A lively discussion followed.

A. C. Ekvall went to Easton in connection with transformers being manufactured by the Magnetic Windings Company.

R. W. DeMonte went to the American Transformer Company in Newark with members of the Western Electric Company from Point Breeze to discuss the manufacture of transformers.

During April R. M. C. Greenidge visited Hawthorne to discuss filter problems and C. A. Webber, cable problems.

D. R. Brobst was in Wilmington to discuss wire insulating problems with the engineers of the duPont Company.

Members of the Laboratories completing twenty years of service during the month of May were:

Research Department

C. A. Bieling — A. W. Horton, Jr.
R. M. Burns — Ernest Sanchez

Apparatus Development Department

R. W. Bogumil — F. W. Morris
D. R. Brobst — R. V. Terry
Miss Mae Keefe — Henry Walther

Systems Development Department

B. R. Blair — L. D. Fry
A. P. Goetze

General Service Department

Miss Mary Fitzsimmons — Miss Madeline Merker

Plant Department

H. C. Atkinson — G. E. Marriott
F. J. Prachnaik

Some Members of the Laboratories

THIS MONTH the RECORD presents the following biographies of members of the Laboratories chosen by lot.

* * * * *

YOU CAN GIVE JOE BERKA of Plant Operations credit for being a plugger—he has been going to C.C.N.Y.'s evening school for eight years and it will be three years more

Joseph Berka

before he gets his degree in electrical engineering. But persistence is a Berka trait; his brother Howard of Power Plant Development traveled the same rocky road.

Born in Brooklyn, Joe migrated to Queens and graduated from Bryant High School, then in 1934 entered the Laboratories in the Mailing Department. Transferring to Plant as a junior draftsman, his responsibilities have grown with his ability. At present he is one of a group who engineer changes in the Laboratories' physical plant. For instance, if anything shows signs of trouble, Joe Berka will investigate, make up his mind as to what should be done, and secure the necessary approvals on his sketches and work orders. Then he will keep in touch with the job and finally o.k. its completion.

Joe lives with his mother in Jackson Heights. He is pretty serene about gas rationing and rubber shortage because he lives near the subway and plays tennis and golf summers and roller skates and bowls winters.

* * * * *

TWENTY YEARS AGO there weren't so many materials used in telephone apparatus that the individual designer couldn't reasonably know all he needed about them. Within these two decades not only have dozens of new insulating and metallic materials appeared, but the requirements of the apparatus have grown steadily more severe. In the early "Twenties" the Material Engineering group began to take form and JOHN J. MARTIN was one of its first members.

"J. J." joined the Laboratories in 1923 soon after graduating from Clarkson College with the M.E. degree. At first in the old Physical Laboratory on apparatus testing, he gradually has become a specialist in flexible and rigid sheet insulating materials. Much of his information has come from personal contacts, sought because he likes people. For the same reason, he is well liked himself, so his suggestions on insulating materials are well received by the engineers whose apparatus designs he reviews. A hard worker, "J. J." is known for his habit of hanging onto a problem until he licks it. It was his idea to make the filler for molding plastics out of materials which have been partially converted to cellulose acetate. His patent says "The partially acetylated cellulose brings about a decided improvement in the molding process since this material flows more freely in the mold than do the ma-

Don't repeat rumors

terials used heretofore and hence can be molded at lower pressures."

With the onset of war, "J. J." was busy finding substitutes for scarce materials; now he is even busier finding substitutes for the substitutes.

* * * * *

ONE DAY AS GEORGE STIBITZ was turning over a telephone relay in his hand, he was struck by the idea that its two positions (open, closed) were a lot like the two numbers (1, 0) in the binary system. Just in case you've forgotten, you can have a complete arithmetic with only 1 and 0; there's nothing sacred about 2, 3, 4, 5, 6, 7, 8, 9; probably we use the decimal system because we have ten fingers. Anyhow, George decided to make an adding machine out of telephone relays using the binary system. Before he and S. B. WILLIAMS got through,

John J. Martin

they had a machine that would handle imaginary numbers ($\sqrt{-1}$, remember?) as fluently as the real numbers that appear on your pay slip. Imaginary numbers are "real" enough to network designers, and their computers work out hundreds of problems every week with the "complex computer."

Two years after George was born he forsook the Pennsylvania Dutch in York for the up-and-coming town of Dayton. He graduated from Denison in 1926; got his M.S. at Union College at Schenectady and his Ph.D. at Cornell in 1930. His luckiest day was in Ithaca, for there he met Miss Dorothea Lamson, the girl he married. From Cornell he came to the Laboratories,

George Stibitz

where he joined the Mathematical Research group. He has worked on all sorts of problems to which mathematics can be applied—vacuum tube circuits, modulation, probability, gear ratios, smoothing out the jerky motion of movie film. He has even applied Boolean algebra to relay circuit theory!

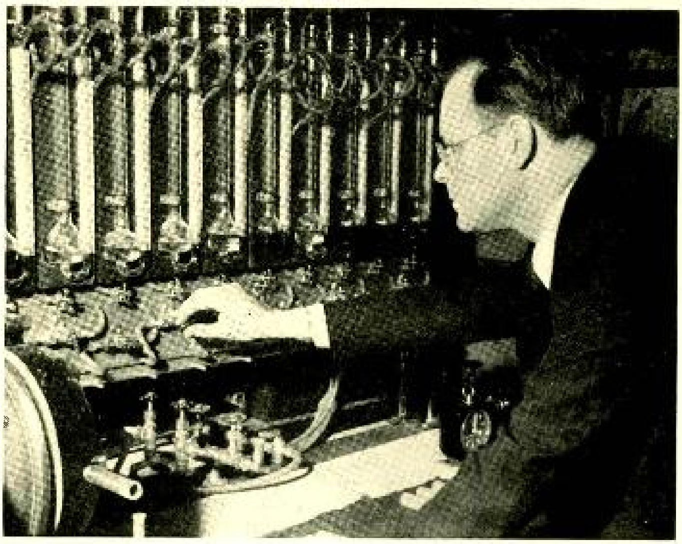
George and his wife live with their two children—Mary, 10, and Martha, 5—in Boonton, New Jersey. Given the chance, there's nothing he likes to do better than build something—an addition to his house, or an aerial tramway in his hilly backyard or even a windmill to heat water by splashing it around in a barrel.

* * * * *

SINCE JOINING the technical staff of Bell Telephone Laboratories in 1937, W. VAN

Roosbroeck has been concerned with the various research investigations that are carried on by the Carbon Laboratory of the Physical Research Department. To prepare for this work in which he is intensely interested he attended Columbia for six years, receiving his A.B. degree in 1934 and his A.M. in Physics degree three years later.

Born in Antwerp, Belgium, Van soon moved to England and then, a year later, came to the United States where the family lived in Minneapolis until in 1923. His late father's work in the field of French literature brought the family to Chicago, Baltimore, and finally, in 1925, to New York City. Van, who is still a bachelor, commutes from his New York City residence to the new Carbon Laboratory at Murray Hill, in the planning of which he has been an enthusiastic collaborator. He enjoys good music and attends various concerts such as those given by the New Friends of Music at Town Hall. As a hobby he plays an early type of flute known as the recorder, or fipple flute. He is also interested in photography, builds radio phonographs, and, on the more serious side, keeps abreast of his work by reading, particularly various mathematical subjects.



W. van Roosbroeck

* * * * *

H. H. Glenn, R. T. Staples and H. H. Staebner were at Point Breeze to confer on cord-development problems.

At the Northeastern District Meeting of the American Institute of Electrical Engineers, held in Schenectady during the latter part of April, H. F. Dodge spoke on *Quality Control in Relation to Engineering Tolerances;* J. R. Townsend, *Use of Substitute Materials in the Telephone Field;* and D. E. Trucksess, *Regulated Rectifiers in Telephone Offices.*

Mr. Dodge, at a meeting of the Society of Industrial Quality Statisticians that was held in Pittsburgh on April 18, spoke on *Sampling Inspection and Quality Control—Some Applications.*

E. St. John visited the Haydon Manufacturing Company, Forestville, Conn., in connection with the study of production problems related to resetting timers.

H. B. Brown was in Washington to discuss the development of some special selector apparatus.

G. A. Ritchie and E. Graf were at Hawthorne to discuss switching devices.

F. Hardy and D. H. Mann visited Schenectady in connection with the lubrication of switches.

C. S. Gordon and C. D. Hocker went to the Point Breeze Works in connection with wire-production problems.

S. C. Miller visited the Western Electric Company in Hawthorne and the National Telephone Supply Company in Cleveland to discuss outside plant materials.

A. P. Jahn recently attended an inspection of hardware, sheet and wire samples undergoing exposure tests at Bridgeport, Sandy Hook, Altoona and State College sponsored by the A.S.T.M.

Two ears, two eyes
But only ONE mouth
Get it?

S. M. Sutton spent three days in Havre de Grace, Maryland, in connection with the construction of auxiliary repeater housings of the Philadelphia-Baltimore coaxial cable.

W. E. Grutzner has been at Hawthorne in connection with engineering questions on communications equipment.

T. J. Grieser was in Edgerton, Wisconsin, and in Orlando, Florida, on communications equipment.

R. L. Lunsford, at Washington, discussed problems with the Signal Corps.

A. E. Gerbore visited the repeater station at Princeton in connection with the type-L carrier installation.

C. H. Achenbach and C. S. Knowlton visited the Western Electric Company at Chicago. Mr. Knowlton also visited the General Electric Company at Schenectady and Fort Wayne.

J. B. Thorn Retires

J. B. Thorn's twenty-four years of service in the Bell System were brought to a close by the Retirement Age Rule on the thirty-first of May. Before joining the Laboratories Mr. Thorn had worked successively with the American Express Company, Borden's Condensed Milk Company and the Harriman Estate at Harriman, New York. With the Harriman Estate he was first in the power plant during the construction of the home and later in charge of the electric substation and an electrically operated inclined railway. When the home was closed during World War I he was transferred to the Harriman Industrial Corporation which at that time was making shipping cases for the Remington Arms Company.

In March, 1918, Mr. Thorn joined the Plant Department here at West Street and his first work was installing apparatus for the manufacture of vacuum tubes for war purposes. Later he assembled and installed radio equipment for Radio Stations WEAF and WLWL when these were at West Street. When our power plant changed over to purchased power he worked as an electrician on the switchboard. Mr. Thorn transferred to the magnetic materials group of the Physical Research Department in 1928 and for most of the time since then has been concerned with the mechanical phases of the work done by the group. During the experimental work on the submarine telephone cable he served the magnetic tape on the cable and then heat treated it. In this connection he holds a patent covering a method to relieve strains in the magnetic tape following heat treatment in which a cotton string is included with the copper during serving. When heat treated the string reduces to ashes, leaving a small space between the tape and conductor. He also did much of the heat treating of all of the magnetic alloys that were under development. A short time before his retirement Mr. Thorn transferred to the acoustics group to work on the compressed air type of siren.

J. B. Thorn

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V. T. Callahan and C. L. Deelwater were at the Century Electric Company, St. Louis, and the Duplex Truck Company, Lansing, on the development of a gasoline-engine set.

H. M. Spicer discussed control apparatus and equipment at the General Electric Company at Fort Wayne and Schenectady.

F. T. Forster attended a conference at Trenton, New Jersey.

J. H. Sole spent part of April at Fort Wayne on machine design. He also visited Wright Field and the Western Electric Company in Chicago.

H. J. Berka observed tests of a new power unit at Old Point Comfort, Virginia.

H. T. Langabeer visited the Telephone Company at Washington on power plant questions.

C. W. Van Duyne was at Detroit, Flint and Owosso, Mich., on machine design problems.

A. E. Petrie attended the Northeastern District meeting of the A.I.E.E. at Schenectady and also discussed power equipment with General Electric Engineers.

C. H. McCandless visited

“Confidential” or “Secret” means just that

Philadelphia to discuss future testing of the No. 4 Philadelphia toll crossbar office.

C. R. Gray visited central offices in Harrisburg, Altoona, Allentown, Bethlehem and Easton to study the operation of step-by-step switches under service conditions.

W. H. T. Holden went to the Teletype Company in connection with automatic sorting and billing problems.

C. O. Cross, C. H. Gorman and E. S. Wilcox have been in Ogallala, Nebraska, making crosstalk balancing tests on sections of the Omaha-Denver cable.

O. D. Engstrom spent several days at the U. S. Navy Radio and Sound Laboratories at Point Loma, San Diego.

Twenty-Five-Year Service Anniversaries

Clinton J. Davisson, in 1937 Nobel Laureate in Physics for his investigations which gave the first direct proof of the undulatory properties of matter, entered the Research Department of the Western Electric Company in 1917. Shortly thereafter he began his research work on thermionics, thermal radiation and electron scattering. The investigations on scattering, in which he was ably assisted by L. H. Germer, led eventually to the discovery and demonstration of the fact that under certain conditions electrons behave as beams of waves might be expected to behave. In recognition of this discovery, Dr. Davisson was awarded the Comstock Prize of the National Academy of Sciences in 1928, the Elliott Cresson Medal of The Franklin Institute in 1931, the Hughes Medal of the Royal Society (London) in 1935, the Nobel Prize in Physics in 1937 and the Alumni Medal of the University of Chicago in 1941. He also has received honorary degrees from Purdue, Princeton, the University of Lyon (France) and Colby.

From 1930 to 1937 Dr. Davisson devoted his studies to the theory of electron optics and to applications of this theory to engineering problems. Since then he has been investigating the scattering and reflection of very slow electrons by metals and more recently has been working on the theory of electron devices developed for war purposes.

Dr. Davisson received a B.S. degree from the University of Chicago in 1908. In 1910 he was awarded a Fellowship in Physics at Princeton, where he was an instructor, and during that school year completed requirements for the degree of Ph.D. which he received in 1911. For the next six years he was an instructor in the Department of Physics at the Carnegie Institute of Technology.

He is a member of the National Academy of Sciences, American Philosophical Society,

C. J. Davisson

W. J. Scully

B. R. Eyth

American Academy of Arts and Sciences, Phi Beta Kappa, American Physical Society, Optical Society of America and several other scientific and technical societies and associations.

For many years the Davissons have lived in Short Hills, N. J., where they have reared a family of four children, three sons and one daughter. One son is working at the Point Breeze Works of the Western Electric Company, another is a graduate student at M.I.T., and the third is now completing his last year of studies at Darrow School (Albany) and expects to enter M.I.T. next September. Dr. Davisson's main diversion is reading.

JACOB WEBER, JR.
of the General Service Department completed forty years of service in the Bell System on May 22

FRANK FRASCA
of the Development Shop completed thirty years of service in the Bell System on the sixth of May

* * *

FROM 1905 to 1910 WALTER J. SCULLY was associated with the cable-testing laboratory of the National Conduit and Cable Company at Hastings-on-Hudson. He then spent ten months with the cable-testing department of the New York Telephone Company but left to join the New York Fire Alarm and Telegraph Bureau.

Mr. Scully returned to the Bell System in 1918, coming to West Street, where he was first engaged in making contact metal studies and later had charge of the group doing this work. In this connection, with the introduction of No. 1 metal for contacts, a survey was made of all the principal machine switching and manual circuits in use and recommendations were made as to the proper contacts to use on the associated apparatus. Later he spent a year or so in charge of a group on relay studies, after which he actively engaged in the testing of panel circuits and apparatus for a year. He then participated in circuit design, particularly on the senders for the panel system.

In 1928 Mr. Scully transferred back to the panel testing laboratory where he was in charge of a group responsible for testing circuits and apparatus used in the panel system. Since 1933 he has been in charge of the crossbar laboratory group of the Switching Development Department where he has been responsible for handling the testing of circuits and apparatus involved in the crossbar development program. His most recent work has been testing the No. 4 toll switching system, the first installation of which will be made in Philadelphia.

* * * * *

TESTING VARIOUS TELEPHONE APPARATUS in the old Physical Laboratory of the Western Electric Company's Engineering Department was B. R. EYTH's introduction to the Bell System. During the latter part of World War I he was associated with the development and testing of submarine detection devices. Later he transferred to the Apparatus group responsible for the development of testing methods and for setting up the requirements for telephone apparatus.

Mr. Eyth joined the Inspection Engineering Department, now the Quality Assurance Department, soon after this was formed in 1924. Since then he has been concerned with complaint investigations and with quality surveys. Complaints involve the investigation of instances where unsatisfactory performance is reported and the guidance of steps taken to prevent recurrences of such cases. Quality surveys are undertaken to ascertain the clarity and completeness of the engineering requirements and the adequacy of the inspection procedures to insure satisfactory quality of telephone apparatus. In this work Mr. Eyth has been primarily concerned with outside plant tools and with lead-covered cables.

Mr. and Mrs. Eyth, who lived for a number of years in Yonkers, now reside in Hollis, Long Island. They have two daughters, one a junior in High School and the other in eighth grade. Mr. Eyth has a small woodworking shop, his specialty being the making of pictures or plaques by inlaying different kinds and colors of wood veneers. He is a Telephone Pioneer.

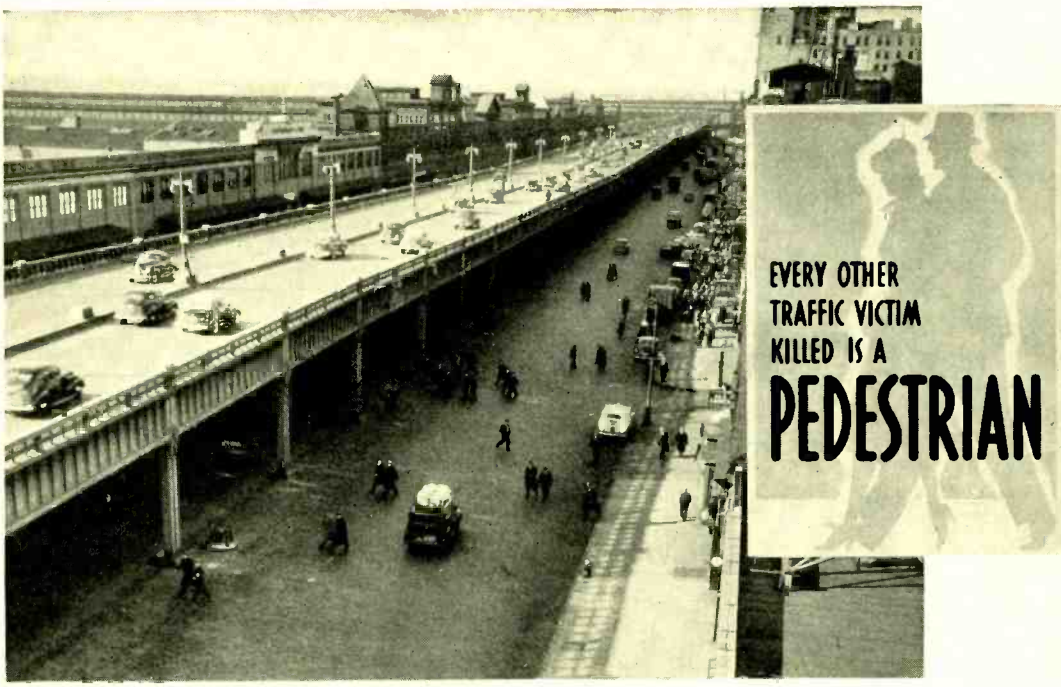
* * * * *

A. R. BERTELS entered the Engineering Department of the Western Electric Company in 1917 as a laboratory assistant. He was concerned with the wiring and subsequent testing of new circuits and equipment used in manual and dial telephone systems. In 1923 he became a member of the Technical Staff and for the next few years his work concerned the design and development of central-office circuits. During this time he studied at Cooper Union for two years. Since 1929, Mr. Bertels has been engaged in the solution of special problems of central-office installations and the design of special telephone circuits, working closely with engineers of Western Electric's manufacturing organization. During this time he designed the operators' training equipment now used in central offices throughout the Bell System. During World War I he served in the United States Navy as a signalman aboard a mine layer in the North Sea. On May 5, Mr. Bertels was commissioned a First Lieutenant in the Signal Corps and is now at Fort Monmouth.

Mr. and Mrs. Bertels live in Tenafly, N. J., with their eleven-year-old daughter. He has been a member of the Bowling League for a number of years and plays golf. He is a Telephone Pioneer.

* * * * *

L. E. PARSONS came to the Engineering Department of the Western Electric Company in 1917 after two years as a coal mining engineer in West Virginia and five years with the Westinghouse Electric and Manufacturing Company. His early work on the design of special apparatus was followed by the design of submarine detection equipment during World War I. When the Apparatus Specifications Department was organized he was placed in charge of one of its groups and became Assistant Specifications Engineer in 1930. One of his early jobs was a comprehensive study to establish the duties and line



A. R. Bertels

L. E. Parsons

L. L. Glezen

of responsibility for the Department. This was followed by his reorganization of the card-catalog group.

In 1929 Mr. Parsons established a new system for rating apparatus which effected the standardization for manufacturing purposes of a large number of coils, condensers and other apparatus used only in production and resulted in savings in merchandising, sales and cataloging. A year later he submitted a complete new specifications and drawing plan (LA and LP), obtained its approval and placed it in operation with the assistance of the Apparatus Drafting Department. In 1935 he was responsible for the preparation of a complete instruction book on how to prepare and issue specifications, including a description of the different kinds of specifications and of special routines. His recent specification activities have concerned chiefly type-K2 and type-L carrier projects and currently they involve war projects almost exclusively.

A bowler for the past twenty years, Mr. Parsons helped organize the Men's Bowling Club and served as its third chairman. In 1930 he was chairman of a committee that revised the constitution of the Bell Laboratories Club. Two years later, while president of the Club, he established budget and audit committees. He also organized a committee which assisted former members of the Laboratories who had been laid off because of the depression, arranging for financial assistance and placement with other concerns.

Mr. and Mrs. Parsons live in Atlantic Highlands, N. J., with their nine-year-old daughter. Active in civic affairs, Mr. Parsons is a councilman for the borough, past president of the Civic Association and past member of the Board of Adjustment. At present he is also Chairman of the Communications Committee of Civilian Defense. Mr. Parsons' recreations are golf and bowling and he is a Telephone Pioneer.

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L. L. Glezen joined the Long Lines Department of the American Telephone and Telegraph Company at Denver in 1917 immediately after completing his studies in the Electrical Engineering School of Colorado College. Early in 1918 he attended the Signal Officers Training School and received his commission as Second Lieutenant in the Signal Corps Reserve. Following the war, he came to New York to participate in the first transmission school given by the A T & T and then returned to Denver as District

Engineer. He served in this capacity until 1922 when he transferred to the Department of Development and Research in New York where his work concerned the design of telephone repeaters, signaling systems, public address systems, toll test boards and the development aspects of toll maintenance.

Since the 1934 consolidation Mr. Glezen has been engaged in problems of transmission maintenance of toll systems. A large part of this work has concerned long term observation of the transmission performance of the various types of toll facilities, particularly of the latest types of open wire, cable and coaxial carrier systems. The results of these studies led to improvements of the facilities and in the maintenance methods applying to them.

The Glezens live in the Wyoming section of Millburn, New Jersey, with their daughter and two sons. The daughter is just completing a course in secretarial work and the boys are in the Millburn High and Grade Schools. For a number of years Mr. Glezen has been active in civic affairs, particularly on township educational matters. He is mostly interested in outdoor activities and is a Telephone Pioneer.

* * * * *

AFTER STUDYING for two years at Princeton, 1909 to 1911, CHESTER H. HAYNES worked as a draftsman with the Atlantic Terra Cotta Company for five years and another year with the Jensen Creamery Company. In 1917 he joined the Engineering Department of the Western Electric Company as a draftsman in the mechanical design and drafting group of the Research Department. In 1919 Mr. Haynes became a design engineer and five years later a member of the Technical Staff. He is now in charge of the mechanical design and drafting group of the Research Staff Department.

During Mr. Haynes' twenty-five years of service, he has been associated with a large number of projects involving apparatus used in research studies pertaining to telephone wire and radio transmission, such as transoceanic telephone transmitters and receivers, telephoto picture machines, submarine cable terminal equipment, and apparatus used in the central and toll offices. He was responsible for the mechanical design of telegraph equipment used in the New York-Azores-Emden cable and for certain parts of the apparatus employed in public address, sound picture and television systems.

Residents of Cranford, N. J., Mr. and Mrs. Haynes have one son who is in High School. Mr. Haynes is fond of outdoor life—gardening, fishing and hunting—and has a delightful summer camp on the Seventh Lake of the Fulton chain in the Adirondacks. He is a member of the Telephone Pioneers.

* * * * *

CONRAD J. DIETZ's first work for the Bell System was with the Installation Department of the Western Electric Company on the installation of central-office switching systems in the Metropolitan area. In 1920 he transferred to the Engineering Department and for the next four years was with the wiring group of the Systems Development Department. After a short period with the testing group he joined the relay requirements group of the present Switching Development Department. Since then he has been concerned with the design and application of all types of relays used in step-by-step, panel, crossbar and toll switching systems. In this connection he developed the requirements for the marginal relays in the sleeve circuits of the crossbar system. Recently he has also worked on the conservation of materials used in relays, particularly the replacement of silk and permalloy. In 1927 Mr. Dietz completed a three-year course in electrical engineering at Pratt Institute.

Mr. and Mrs. Dietz, who live in the Bronx, have two sons—one in the Bronx Boys' School of Science and the other in grade school. Mr. Dietz has been a member of the Laboratories Club's Bowling League since 1925 and occasionally plays golf. Vacations are usually spent at the shore. He is a member of the Telephone Pioneers of America.

* * * * *

JACOB W. KELSCH joined the Engineering Department of the Western Electric Company in 1917 as a carpenter. A year later he joined the 22nd Infantry of the U. S.

Walls, doors and guards are useless, if YOU talk!

C. H. Haynes

C. J. Dietz

J. W. Kelsch

Army, training at Plattsburg, on active duty in Washington and later on special assignment at Port Newark where he remained until June, 1919. He returned to the Building Shop and for the next few years was on general maintenance work as a carpenter throughout the West Street building. Mr. Kelsch was then assigned to the television group of the Research Department, where he was concerned with building experimental equipment. In the two-way television demonstration between the Laboratories and 195 Broadway in 1930 he was responsible for the installation of the booths at both locations. He continued in this group for several years, building up apparatus as required by the engineers. He then transferred back to the Cabinet Shop where he has since worked on models of switchboard equipment, telephone booths, radio cabinets and similar apparatus. He also repairs furniture.

Mr. and Mrs. Kelsch live in Bellerose, Long Island. He is very much interested in baseball and other sports and is a fishing enthusiast. Mr. Kelsch is a charter member of the Western Electric Post of the American Legion and is a Telephone Pioneer.

* * * * *

After William Orvis graduated from Ripon College in 1916 with an A.B. degree, he spent a year as instructor in the Physics Department of the University of Wisconsin. He then came to West Street where his first work was on the design and development of telephone receivers. During the latter part of World War I he was assigned to Camp Merritt in New Jersey on the development of instruments for the detection of sapping operations. In 1920 Mr. Orvis transferred to the transmitter carbon development group of the Research Department of which he was later placed in charge. Except for two years on submarine cable development, a part of which was spent in London, he was associated with granular carbon studies and the development of transmitters for handsets, operators' sets and audiphones until 1937.

Since then Mr. Orvis has been in the materials standards group of the Switching Apparatus Development Department, first on ceramic and silicon-carbide varistor development and more recently on plastic materials. He is now responsible for mold design and molding technique. Much of his work involves consultation with other engineers designing molded parts.

At Mountain Lakes, N. J., where Mr. and Mrs. Orvis live with their eight and twelve-year-old boys, Mr. Orvis is Police Recorder and a baritone in the Men's Glee Club. He is fond of gardening and cabinet making.

* * * * *

James R. Irwin, who received his E.E. degree from Bucknell University in 1914, entered the Engineering Department of the Western Electric Company in 1917 and his first work was in the Non-Western Inspection Department which handled items such

William Orvis

J. R. Irwin

William Belits

as poles, crossarms and outside plant tools that were not manufactured by the Western Electric Company.

Later Mr. Irwin transferred to the Apparatus Development Department and since then has been engaged in engineering work having to do with the selection and development of contact materials and contacts used on relays, dials, keys, selectors, switches and the like. In this connection, he was concerned with improved contacts for the 209-type telegraph relay, and later, with the substitution of No. 1 contact metal for platinum on a majority of our standard telephone keys and relays. He carried on investigations leading to the introduction of larger size contacts for the relays used in the panel system; and was associated with the development of new forms of contacts for the crossbar system. For the past few years, with the exception of the last six months which have been spent on war activities, his time has been spent wholly on observation and analysis of contact performance in crossbar equipment.

Mr. and Mrs. Irwin, who live in Montclair, N. J., have a daughter who was married a year ago and a son in Junior High. Gardening and flowers are his main interest. Historical Virginia has always intrigued him and many of his vacations are spent in this state pursuing this avocation. Mr. Irwin belongs to the Edward J. Hall Chapter of the Telephone Pioneers of America.

William Belits of the Plant Department's Development Shop joined the Engineering Department of the Western Electric Company in 1917 after being employed by various experimental shops—one year of which was with the Hemming Manufacturing Company, Garfield, New Jersey, making dies for the cold-molding of plastics.

His first work here at West Street was in the Development Shop as a mechanic, and one of his first assignments was to make the initial molds for telephone handsets. During the latter part of World War I he was engaged in making various parts of radio apparatus for government use. Mr. Belits then became a foreman in the Development Shop and until last fall had been in charge of several different groups — instrument makers, loading and retardation coils, heavy machine work, milling machines and punch presses, and the cabinet shop.

Last November Mr. Belits joined the group which supervises the placing of shop work—beyond the capacity of the Development Shop—with outside suppliers. This involves agreeing on methods to be used in order that our requirements, time of production and cost are met, and supervising the work with the outside suppliers.

Mr. and Mrs. Belits, who live in Dumont, N. J., have four daughters and three sons. Mr. Belits is fond of both surf and freshwater fishing and occasionally goes hunting. He is a Telephone Pioneer.

Factors Controlling Man-Made Radio Interference

By R. A. SHETZLINE
Inductive Coördination Engineer

WHENEVER there is a sudden change or interruption in current in an electric circuit, such as results from the opening or closing of a relay or switch, a series of alternating voltages is generated at frequencies which extend over a very broad range. Thus when any wire transmission circuit, whether used for power or communication purposes, is in the vicinity of a radio receiver, voltages may be set up which may cause noise in the radio receiver. The influence of these voltages depends on their magnitudes at the frequencies covered by the radio channels affected, and the values of these voltages, in turn, depend on the amount of current change involved and the circuit constants. The importance of any such disturbance as a source of radio noise is thus a complex function of the voltages and frequencies involved, but in general it is measurable, and called the noise-influence level, designated "NI."

In any study of methods of controlling man-made noise in radio receivers, it is necessary to know the manner in which the noise influences under consideration reach the radio receivers. For purposes of illustration, a generalized situation is shown in schematic form in Figure 1. This generalized situation as will be seen covers the special case in which the noise influence is assumed to arise within the telephone plant, such as in a telephone central office at point X, and the radio antenna and receiver are some distance away at point Z. The radio receiver, it is assumed, is in

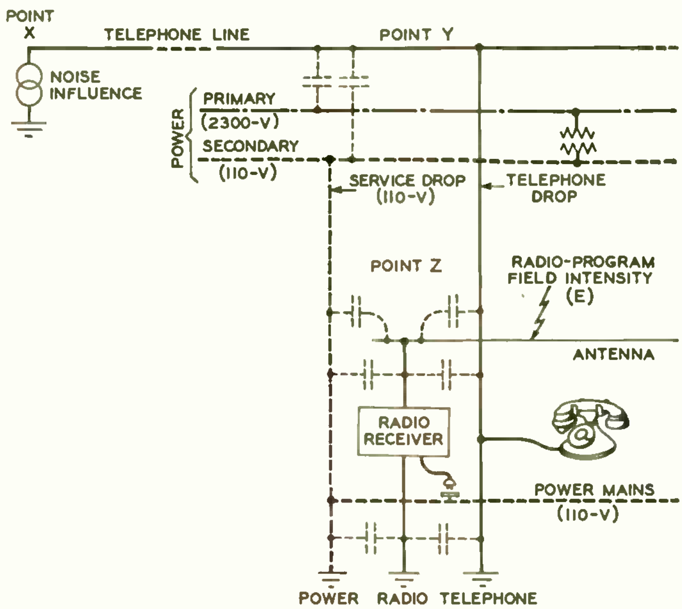


Fig. 1—Schematic representation of circuit elements involved in the transmission of noise disturbances to radio receiving antennas

a house that has a telephone served by the central office at point X, and an electric power service also runs to the house from a power line running along the same street and possibly on the same pole line as the telephone circuit. This power line may run parallel with the telephone line for some distance, and as a result will have a certain amount of noise disturbance induced in it from the telephone line, in addition to any disturbance which may originate in the power circuit itself. The radio an-

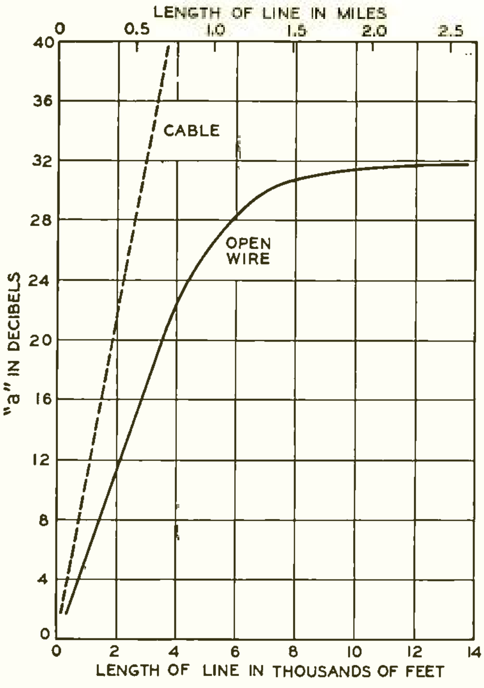


Fig. 2—Average circuit attenuation for radio disturbances (broadcast frequencies)

tenna is picking up a radio program of field intensity E, but the noise disturbance on the adjacent section of the power and telephone lines is also inducing voltages in it through the couplings that are indicated by dotted condensers on the diagram.

Of primary importance is the ratio at the radio receiver of the radio carrier intensity to the noise intensity. This ratio may be called R, and the problem is to find how the value of R is affected by the various circuit conditions indicated in Figure 1. In the first place, the strength of the radio signal in the receiver depends on the strength of the radio field, E, and on the effectiveness, h, of the antenna system in picking up the signal, which is controlled by the effective height of the antenna and impedance relations between antenna and receiver. If these terms were given in arithmetic units, the radio carrier voltage at the receiver would be Eh, but since it is generally more convenient to express these terms in db, the radio signal at the receiver is stated as $E+h$. To evaluate the strength of the noise disturbance at the receiver, it is assumed as starting out at strength NI at the central office. In passing down the line from point X to point Y, however, it is attenuated by an amount that may be called "a." Expressed in db, the noise intensity on the telephone line at point Y is $NI-a$. Between the telephone line and the receiver the noise disturbance suffers a further coupling loss, which may be designated "c." The noise intensity at the receiver is thus $NI-a-c$. Since all elements are expressed in db, the value of R becomes: $R=(E+h)-(NI-a-c)$.

As a matter of convenience, it has become common practice in laboratory studies to combine h and c in the above expression, and to denote the combination by U. With this change, and by removing the brackets from the above equation, the value of R is expressed as: $R=E+U+a-NI$.

A brief study of this expression will show that the best radio reception is obtained when E, U, and a are as large as possible, and NI is as small as possible. The strength of the radio field at the point of reception, E, is fixed under any given set of conditions, and while important, not much can be done locally about this factor.

The factor U is determined by the local conditions. This factor includes the efficiency of the antenna in picking up radio signals and the coupling loss between antenna and the power and telephone lines. The range of values of U found in limited field tests is indicated in Figure 3, where the ordinates show the per cent of installations having a value of U less than the abscissa of the curve. A well-designed antenna, placed as remote as possible from telephone and adjacent power lines and with a radio-frequency transmission line from antenna to receiver, may have a U as high as 70 db. An inefficient antenna, on the other hand, closely coupled to the power and telephone lines, may have a U as low as 0 db or less. Another factor over which a certain control can be exercised is NI. Some of the steps taken by the Bell System to reduce the generation of noise disturbances by their equipment are described in the following article.

The value of "*a*," the attenuation along the telephone line, depends on whether the line is in cable or open wire. Figure 2 shows the general range of values as determined by field measurements. These curves represent the mean of a range of values, and irregularities have been evened out. The standard deviation of the irregularities is about 7 db. The attenuation of cable is approximately linear with distance, but that for open wire falls off rapidly after about a mile. Even where open wire is involved, however, radio reception will be some 20 to 30 db quieter at distances of a mile or more from the source of the disturbance than in its immediate vicinity.

Besides the paths along the telephone and power lines from the disturbing source to the antenna, there is also a path of direct radiation. For

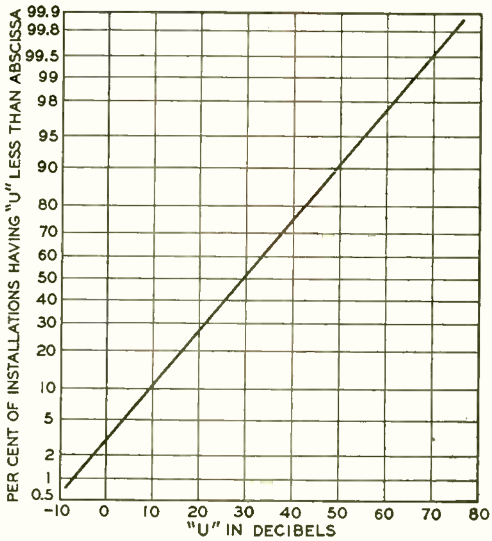


Fig. 3—Range of values of U *found in various installations (broadcast frequencies)*

such a path the formula for R becomes R = E − E′, where E′ is the field intensity of the noise disturbance at the antenna. Disturbances of this type become of importance only when the source is close to the antenna, such as when the noise-producing apparatus is on the same premises as the radio receiver.

Experience has shown that in many outlying districts where noise with radio reception has been reported, the chief difficulty is that distant stations are frequently sought. With field strengths of reasonable values, and with a suitable antenna circuit, preventive measures such as those described in the next article should prevent telephone apparatus from causing annoyance to radio listeners.

Suppressing High-Frequency Disturbances from Telephone Apparatus

By M. E. KROM
Switching Development

RADIO broadcasting has made rapid advances during the past few years. Not only are the programs increasingly enjoyable but they are available to an ever-widening audience because of the development of receiving sets that can perform well on low signal strengths. With the tendency to use lower signal strengths, however, it is not surprising that noise arising either from natural or man-made sources sometimes becomes the limiting factor in satisfactory reception. Among the various man-made sources of radio noise are switching and commutating devices which are widely used in power and communication services.

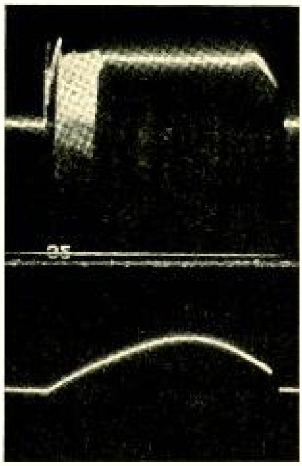


Fig. 1—Above, oscillogram of voltage across dial contacts as they open; below, voltage across same contacts when they are equipped with a dial filter

Any sudden change of current may be represented by an infinite number of alternating currents of different frequencies extending up through the entire radio spectrum. Corresponding to these oscillations in current will be corresponding oscillations in voltage. The voltage oscillations resulting from the opening of the contacts of a telephone dial are shown in the upper part of Figure 1. Although the total length of this record is only 1.9 milliseconds, the chart speed was not fast enough to separate all the individual oscillations. Such disturbances may reach radio receivers by direct radiation through the atmosphere, by coupling between the telephone line and the

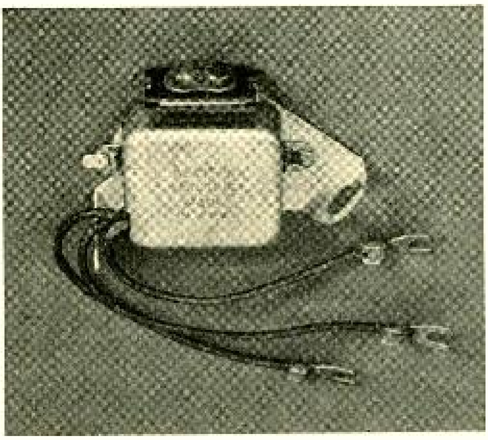


Fig. 2—By use of various mounting brackets, the 61-type dial filter may be applied to any of the existing types of subscriber sets to reduce dialing harmonics

radio receiving antenna, or by secondary coupling by way of some outside electrical system such as a power line. An analysis of the process by which noise in radio receivers occurs, and a discussion of the various factors involved, is given in the preceding article.

There are two general types of suppression devices available to limit noise influence. One, located at the source of the disturbance, tends to reduce the radio-frequency voltages developed, and the other—usually at some distance from the source—is functionally a low-pass filter.

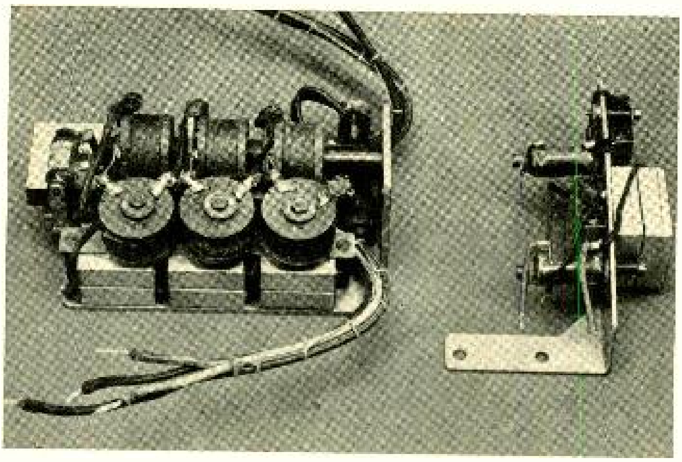


Fig. 5—The new teletypewriter filter, shown at the right, although more effective in suppressing disturbances, is much smaller and of simpler construction than the former type, shown at the left. It provides suppression from 200 to 3000 kilocycles

Of the former type, one of the most commonly used in the telephone plant is the 61-type dial filter, shown in Figure 2. This consists of a small inductance and capacitance connected to the dial contacts as shown in Figure 3. The inductance prevents too rapid a build-up of current as the contacts close, and the capacitance reduces the voltages on the telephone line as the contacts open. As a result of the filter action, the voltage curve, instead of consisting of a series of high-frequency surges as the contacts open, is a slowly increasing curve as shown in the lower part of Figure 1. The inductance also protects the contacts by limiting the surge of current as the contacts close. This filter may be adapted to all types of subscriber sets by use of several types of mounting brackets, and provides suppression of from 40 to 55 db.

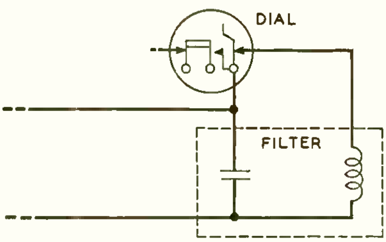


Fig. 3—Method of connecting the 61-type dial filter across the dial contacts

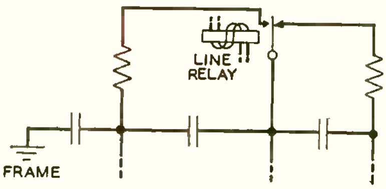


Fig. 4—Method of connecting teletypewriter filter to the line relays

Another filter, similar in function to the 61-type but of different characteristics, is used to suppress radio-frequency voltages from the contacts of the line relays of various types of teletypewriters, and is connected to them as shown in Figure 4. This filter replaces one of earlier design and although simpler in construction, smaller in size, and considerably less expensive, is much more effective than the older type. Figure 5 shows both the old and new filters. The new filter provides suppression in the order of 50 to 60 db through the range of from 200 to 30,000 kc.

Power machines used in the telephone plant are ordinarily not very closely coupled with any radio receiving equipment, and radio disturbances caused by them can usually be suppressed sufficiently by simple condensers. These condensers provide 20

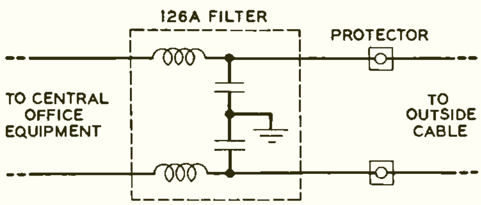


Fig. 6—Method of connecting line filter in central-office line

or 25 db suppression to interference arising from motor commutation, and this has been found to be adequate.

Where the individual sources of radio-frequency noise are numerous, the second general type of suppression device—the low-pass filter—is used to treat all of the sources as a unit, and to provide some form of overall protection. A typical example of such a situation is the small unattended dial office. Such offices are commonly located in remote residential areas, possibly even in a room in a private dwelling, where there may be many radio receivers in the vicinity. In addition, some radio receivers may be operating at high gain because of their remoteness from the broadcasting stations.

The line radio filter has been developed for use in such situations. One of them is placed in every line, trunk, PBX feeder, or signaling pair leaving the office. A schematic diagram of the filter is shown in Figure 6. Its connection in a circuit is shown in Figure 8. In addition, capacitance filters are connected to the power leads to prevent radio frequencies from being radiated from the power equipment or conducted out from the office over the commercial power system. These filters greatly attenuate the radio-frequency noise voltages that pass out to the telephone lines. To make the protection more effective, the disturbing apparatus is sometimes shielded to prevent direct radiation of the radio noise. The earlier type filter used for this work in telephone circuits consisted of the retardation coil and condenser, shown at the left of Figure 7. A new unit designed for this service, shown at the right of the illustration, incorporates both the inductive and capacitive elements in a single unit. It is designed to provide low loss to audio frequencies and high loss to radio frequencies, and as used in unattended offices results in a loss of 0.5 db at telephone frequencies and 40 db at radio frequencies.

When an inductive element is used in a radio filter, it is desirable that it

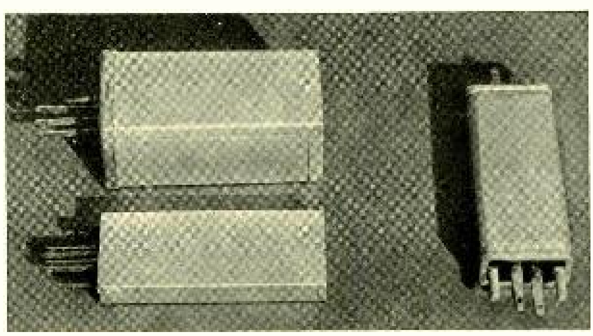


Fig. 7—The new line filter, shown at the right, is only a simple unit and occupies much less space than the former filter, shown at the left

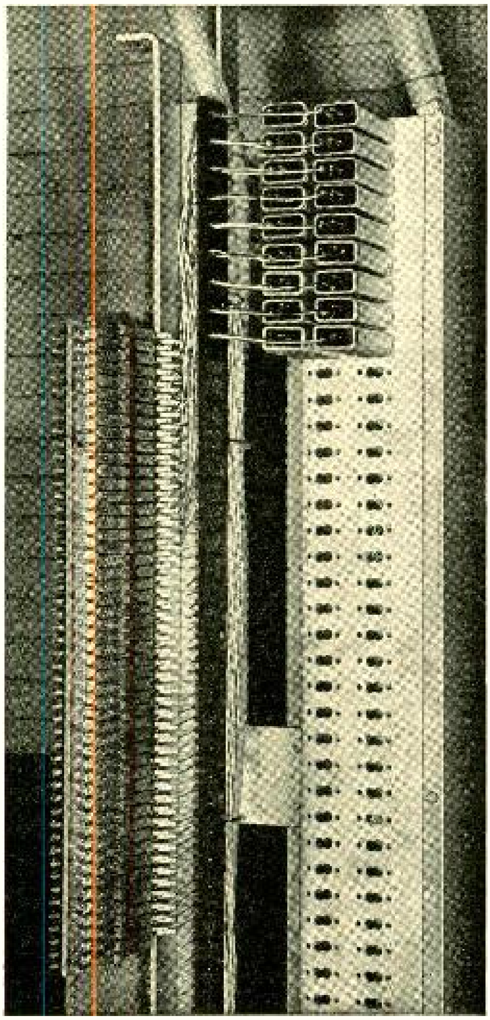


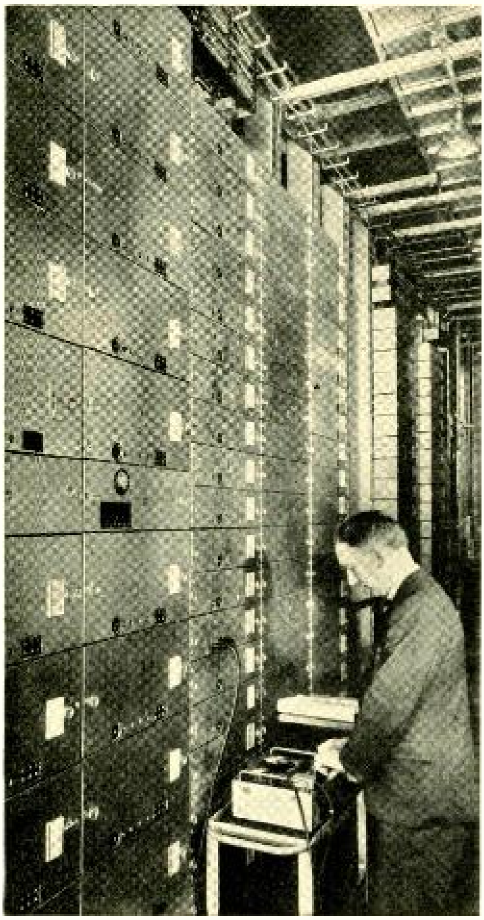
Fig. 8—New method of mounting line filters on main distributing frame

have a high effective resistance over a wide band of frequencies instead of a peaked impedance at the resonant frequency. Also it is desirable to avoid excessive inductive discharges that might cause contact trouble. In some of the filters these requirements have been met by providing a relatively high inductance and a short-circuited turn or layer in the inductive element to increase the effective resistance. In others, the effective resistance has been secured by inserting a small iron core in the inductive element. Although these constructions decrease the effectiveness of the inductive elements at resonant frequency, they result in an overall improved performance of the filters.

Television and frequency-modulation reception are affected to a lesser degree because under present conditions they are inherently less subject to extraneous disturbances, and because the disturbances attenuate with distance over wire facilities much more rapidly at the high frequencies employed for these systems than at broadcast frequencies.

Besides this effect of telephone apparatus on radio reception, radio broadcasting may have an effect on the telephone system. This occurs through the demodulation of a radio program in the telephone set. Although it is not very common, the subscriber may hear radio programs in his telephone receiver when it does occur. This effect occurs in areas near radio transmitters where the radio potentials in telephone wires may be high. This may result in an appreciable magnitude of radio-frequency current in the transmitter, where it is demodulated. The demodulated frequencies are then induced in the receiver through the induction coil.

One of the simplest methods of reducing this effect is to connect a small condenser across the transmitter to by-pass the radio-frequency current. If this step is insufficient, condensers may be connected from each line to ground at the telephone station protectors. Other types of filters may be employed in those cases where the conditions are extremely severe.



A Pilot-Channel Regulator for the K-1 Carrier System

By J. H. BOLLMAN
Transmission Development

[*Using thermistors as the controlling elements, the regulator described in this article is applied only to long circuits as a supplement to the regulating system which normally takes care of the greater part of the changes in gain due to temperature variations. While the latter system provides the same adjustment for all the pairs in a cable, the system described here is individual to each pair. It takes care of the accumulation of minor variations of the individual pairs, which become appreciable only on the longer circuits.*—EDITOR.]

VARIATIONS in attenuation of the cable conductors used for the K-1 carrier system are compensated by corresponding changes of gain under control of a pilot-wire regulating system, as already described in the RECORD.* Since these changes in attenuation are due primarily to changes in temperature, and since all the pairs in the cable are at approximately the same temperature, a pilot-wire regulating system—in which the gain over the various pairs is adjusted to conform to the temperature of one pair of wires in the cable—is a simple and satisfactory way of handling the regulation. There are, however, certain minor deviations from pair to pair that such a system will not provide for. This was recognized during the development of the K system, and it was realized that for long circuits—say over 500 miles—some additional regulation would be needed to take care of these residual deviations. As a result a new deviation regulator has been developed that operates on pilot channels rather than on a pilot wire. Currents of single frequency are transmitted over each pair of conductors, and the gain is regulated in accordance with the changes in attenuation of these pilot channels. Regulation is thus directly associated with the

*January, 1939, page 160.

carrier system operating on that pair.

With paper-insulated toll cable the change in attenuation that occurs with variations in temperature may be considered as divided into three components: two depending and the other not depending on frequency. A typical cable temperature-coefficient characteristic is shown in the upper curve of Figure 1. This may be divided into flat, slope, and bulge components as shown. This division is arbitrary since it is obvious that there are other combinations of three such components that will simulate the total effect.

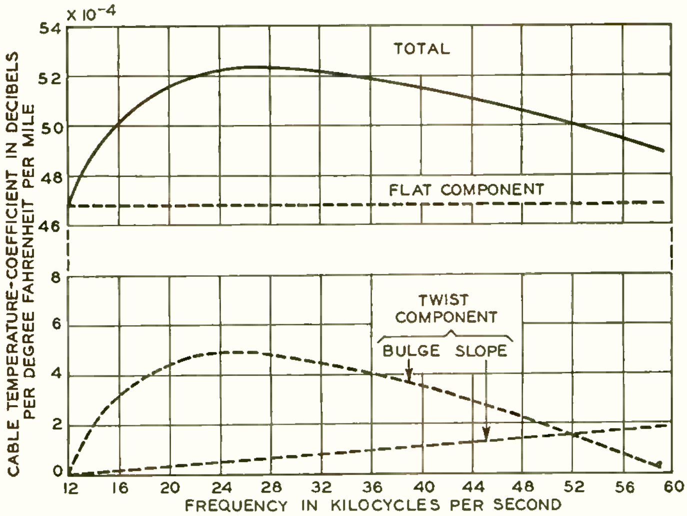


Fig. 1—*The total change in gain, upper curve, may be divided into a flat component, a slope component, and a bulge component, as indicated by the three lower curves*

With the new deviation regulator, each of the three components—flat, slope, and bulge—is regulated by a separate pilot as indicated in Figure 2. Each pilot controls the temperature of one thermistor.* Pilots of 12, 28, and 56 kc, accurately controlled in level, are applied at the transmitting terminal to each cable pair. At repeater stations chosen as deviation regulation points, these three frequencies are picked off by filters, and used to operate a control circuit that sends heater current to the three thermistors in inverse relation to the received level of the three pilots. In the flat-gain regulator, controlled by the 56-kc pilot, the thermistor bead is used as a shunt element in the negative feedback* circuit of the amplifier. The control circuit is so designed that a decrease in the 56-kc pilot will cause an increase in thermistor heater current. This increase in current will cause the bead resistance to decrease, and the resulting increase of loss in the feedback circuit will increase the gain of the amplifier. The change in gain is the same at all frequencies. For slope and bulge control, the thermis-

*Record, *December*, 1940, *p.* 106.

*Record, *June*, 1934, *p.* 290.

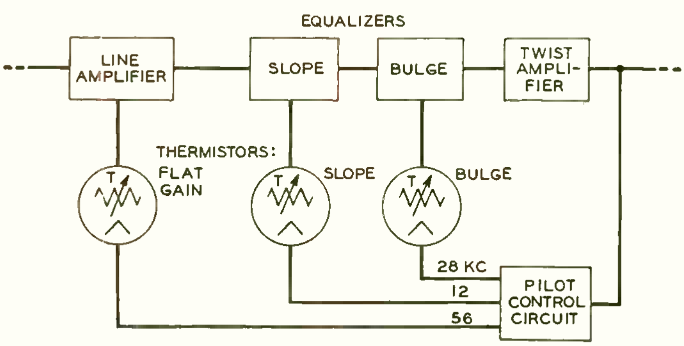


Fig. 2—*Block schematic of the new deviation regulator* tors are used in the reactive equalizer networks shown in Figure 2 to give the proper shape to the loss-frequency characteristic.

A simplified schematic of the control circuit is shown in Figure 3. The pick-off filter separates the control pilots from the regular transmission and possible noise voltages on the line, and feeds them to a common amplifier tube. At the output of this tube, three tuned transformers separate the three pilots and pass each to a separate varistor rectifier circuit. Each rectified pilot, in series with a "bucking" bias voltage, is then applied to the grid of a control tube. The plate resistances of these control tubes change with variations in the grid voltage, and thus pass more or less current to the thermistor heaters from an a-c supply.

The circuit is designed so that the thermistor resistance is critically dependent on the level of the pilot at the output of the twist amplifier. A change in level of the pilot of only 0.5 db will cause a resistance change of ten to one. The characteristic of the thermistor itself accounts for part of this sensitivity. As shown in Figure 4, a small change in heater current produces a large change in thermistor resistance. A considerable increase in sensitivity, however, is secured by using the "bucking" voltage in series with the rectified pilot voltage. With no bucking voltage, the negative voltage on the grid would change up or down a maximum of about 3 volts (5.5 per cent) from 55 volts, but with the 50-volt bucking voltage, the negative grid voltage is only 5 volts, and the change of 3 volts now represents a 60 per cent change. It is this change in negative grid voltage that controls the change that occurs in heater current to the thermistors.

The regulator circuit

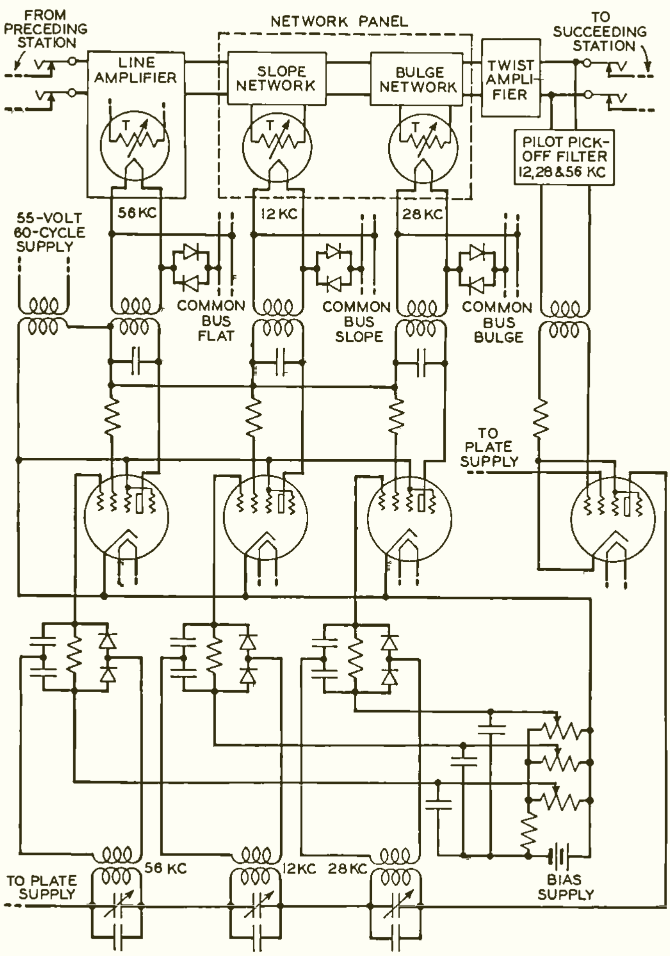


Fig. 3—Simplified schematic of the control circuit of the deviation regulator

is also arranged to prevent the gain from being increased to the maximum value should the pilot be lost for some reason or other. There is a regulator for each carrier pair operating in the cable, and the circuits supplying thermistor heater current for each of the three types of regulation are all connected to a common bus through a varistor circuit. This is indicated in Figure 3. There is one of these common busses associated with the heater current supply controlled by the 56-kc carrier, one for that controlled by the 28-kc carrier, and one for the 12-kc carrier. A varistor offers a very high resistance when the voltage across it is low, and a low resistance when the voltage is high. Under normal conditions, the difference in voltage between the various heater-supply circuits and the common busses is low, because since all pairs in the cable are at approximately the same temperature, the voltages on the various heater-supply circuits will be approximately the same, and the common busses will be at approximately the mean value. The voltage across the varistors is thus small and very little interchange of current takes place between the common busses and the individual circuits. Should one pilot fail, however, the voltage on the heater circuit it supplies would rise to a high value. As a result there would be a large difference between it and the voltage of the common bus, and the resistance of the varistor would drop to a low value. Under these conditions the heater current of that circuit would be fed into the common bus; the other circuits, which are operating normally, will slightly decrease their output to absorb this extra current, and the voltage on the common bus will remain substantially unchanged. The voltage across the thermistor in the circuit that has failed will then be the bus voltage plus the small drop across the varistor so that regulation will be substantially maintained in spite of the pilot failure.

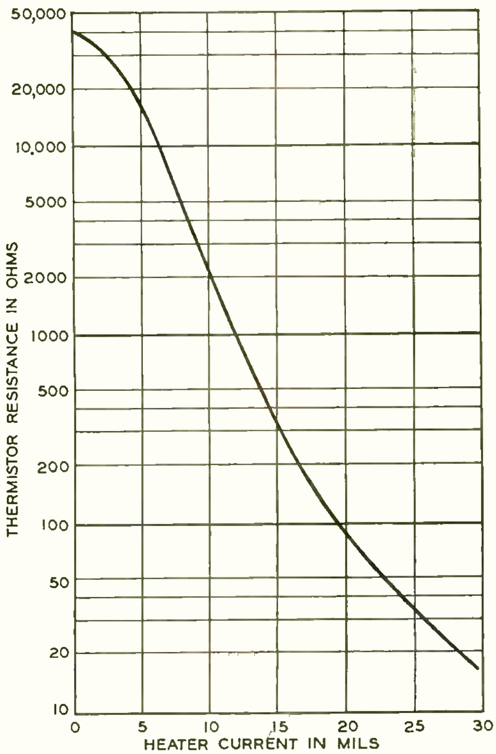


Fig. 4—Current-resistance characteristic of a thermistor with an ambient temperature of 86 *degrees Fahrenheit*

The regulator as designed is used not only to compensate for residual errors in regulation of a 300- to 500-mile circuit, but also to take care of the flat regulation of the preceding repeater section (12 to 20 miles) and the slope and bulge regulation of the preceding twist section (50 to 300 miles). At stations where it is installed, therefore, the regular pilot-wire flat and twist regulators will not be used. A model of this deviation regulator was installed in Toledo at the terminal of a 600-mile circuit looped back and forth between Toledo and South Bend. Measurements over a four-month period, using continuous recorders, showed that variations in the net losses of the twelve channels due to changes in line loss were not more than 0.5 db. This is an improvement of better than two to one as compared to the performance previously available without the deviation regulator. On most longer systems, and also on shorter systems that have not been as carefully adjusted as were the trial systems between Toledo and South Bend, the improvement may be several times more pronounced. It is expected that this regulator will be applied generally on long type-K cable carrier systems at intervals of 500 miles or less as determined by layout requirements.

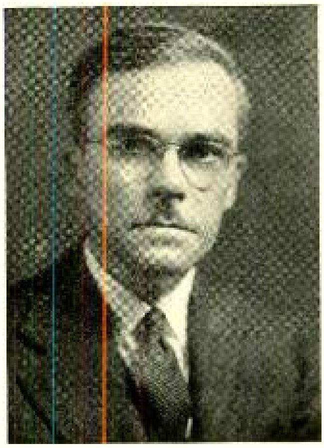
The Mendel Medal for 1942 has been presented by Villanova College to Joseph A. Becker in recognition of his contributions to the knowledge of thermal emission of electrons and to the behavior of electrons at rectifying junctions

Contributors to this Issue

E. L. Norton received the S.B. degree in Electrical Engineering from the Massachusetts Institute of Technology in 1922 and an M.A. from Columbia University in 1925. He joined the Engineering Department of the Western Electric Company in 1922 and continued with Bell Telephone Laboratories when it was established in 1925. Mr. Norton has been engaged in the study of network and transmission problems. Recently, his work has been in connection with signaling apparatus of the electromagnetic type.

G. M. Bouton immediately joined the Chemical Laboratories following his graduation from the Polytechnic Institute of Brooklyn with a degree of Chemical Engineer in 1926. Since that time he has been engaged primarily in research studies on metals and alloys including lead-cable sheath and solders. He has been closely associated with field investigations of cable failures, both aerial and underground, the development of soldering technique for joining cables, and of lead coatings to replace tin and zinc. Mr. Bouton also holds several patents covering the extrusion of metals. At present he is concerned with the substitute material program and in this connection is a member of the War Products Advisory Committee of the American Society for Metals.

O. E. Buckley was graduated by Grinnell College in 1909, obtained his Doctorate from Cornell in 1914, and entered the Laboratories in the same year. In 1927 he became Assistant Director of Research and Director in 1933; in 1936 Executive Vice-President of the Laboratories, and in 1940 President. After his service in World War I, in charge of the Research Section of the Signal Corps in Paris, he took up the problem of increasing the message-carrying capacity of transoceanic telegraph cables. This resulted in the permalloy loaded cable and associated terminal apparatus which is described in his Kelvin lecture. In spite of increasing executive responsibilities he has maintained personal contact with the cable development studies and particularly with those looking toward transoceanic telephony. Associated with him in this work have been J. J. Gilbert, W. S.



E. L. Norton

G. M. Bouton

O. E. Buckley

J. H. Bollman

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M. E. Krom

Gorton, J. F. Wentz, O. B. Jacobs and A. M. Curtis, as well as members of the Chemical Laboratories and the Magnetics Research group.

J. H. Bollman joined the Engineering Department of the Western Electric Company in 1922 as a messenger. He completed the technical assistant course in June, 1927, and was made a member of the Technical Staff in 1929. He graduated from the Polytechnic Institute of Brooklyn in 1939 with the degree of B.E.E. After two years in various positions in the Service Department, he was transferred to the Circuit Research Department, where he was engaged in the development of systems for the transmission of pictures over telephone lines and submarine cables. Later he worked on the development of the Bell System reference standard of frequency. Since 1930, in the Systems Department, he has been associated with the development of carrier repeaters, particularly the theory and practical development of thermistors as circuit elements in automatic gain regulating equipment.

R. A. Shetzline received a B.S. degree from the University of Pennsylvania in 1915 and a B.S. in E.E. from the same University in 1917. He joined the Engineering Department of A T & T in 1917, and began making coördination studies between electrified railways, power transmission lines and telephone systems. From 1924 to 1929 he was in charge, for the Bell System, of a coöperative field study, with the National Electric Light Association, of power and telephone circuit coördination. Since 1929, he has been in charge, in the Transmission Development Department, of studies of telephone apparatus from a noise and crosstalk standpoint, including the evaluation of noise and crosstalk effects and the establishment of suitable standards.

M. E. Krom was graduated from Purdue University with the degree of B.S. in E.E. in 1923. He joined the Laboratories immediately after graduation and spent the first two years in the panel-dial laboratory. Then followed six months of relay design after which he was transferred to a laboratory group which handled ringing and tone studies. Nearly four years were spent in this work. Then he worked on means of measuring and suppressing radio interference. In 1932 Mr. Krom transferred to the ringing and tone studies group and became responsible for radio interference tests and the development and application of radio filters to telephone equipment. He transferred to the Transmission Development Department last November and since then has been engaged in the design and testing of electronic circuits.