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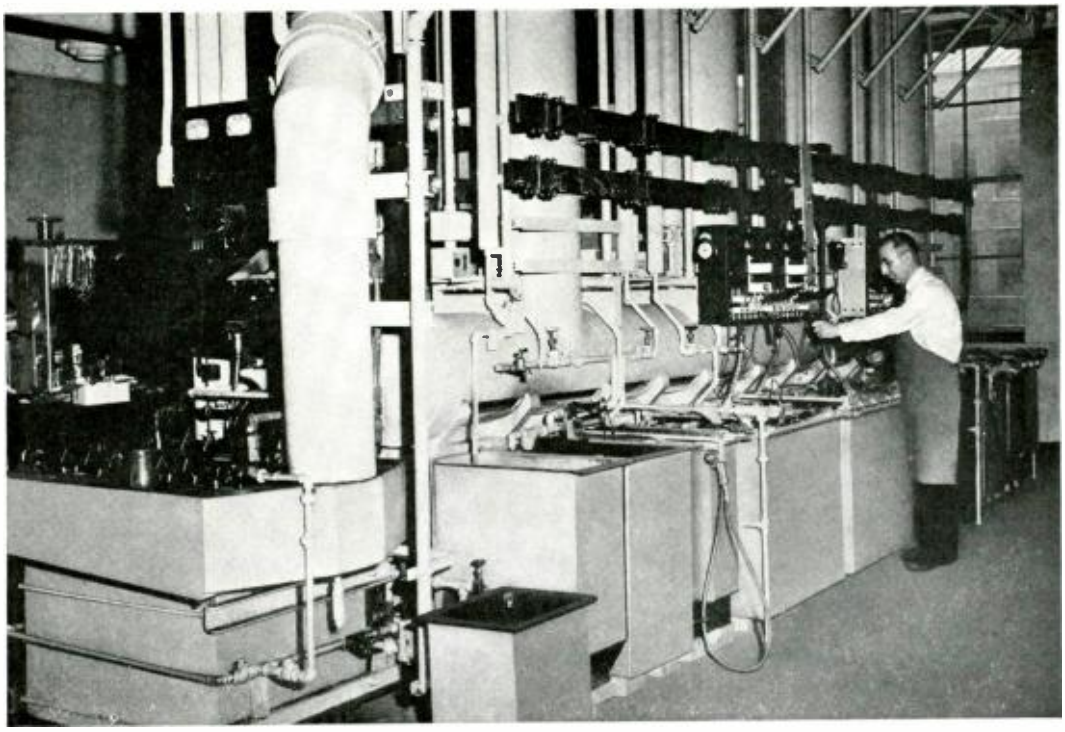

Electroplating Facilities at Murray Hill

By R. A. EHRHARDT

Chemical Laboratories

WHEN the electroplating laboratory was planned at Murray Hill, the facilities of the development group were combined with those of the plating shop in a single installation. This arrangement was chosen to permit rapid transition from development to production work and to encourage the exchange of ideas between the two groups. It also avoids duplication of equipment and saves considerable space.

The routine plating work is restricted mainly to coded finishes, as specified in Apparatus Standards. This includes the deposition of zinc, cadmium, copper, chromium, nickel, tin and silver, and the anodizing of aluminum. Phosphating, chromating and metal coloring are also supplied. The objects handled consist chiefly of models and details produced in the model shop which are diverse and frequently require changes in racking and handling that would not have to be made in manufacturing where a multiplicity of parts of the same shape and size are produced.

Experimental work is primarily concerned with the development of new finishes and processes and the correction of difficulties arising from some of the older processes. In addition to the metals generally deposited, facilities are available for plating gold,

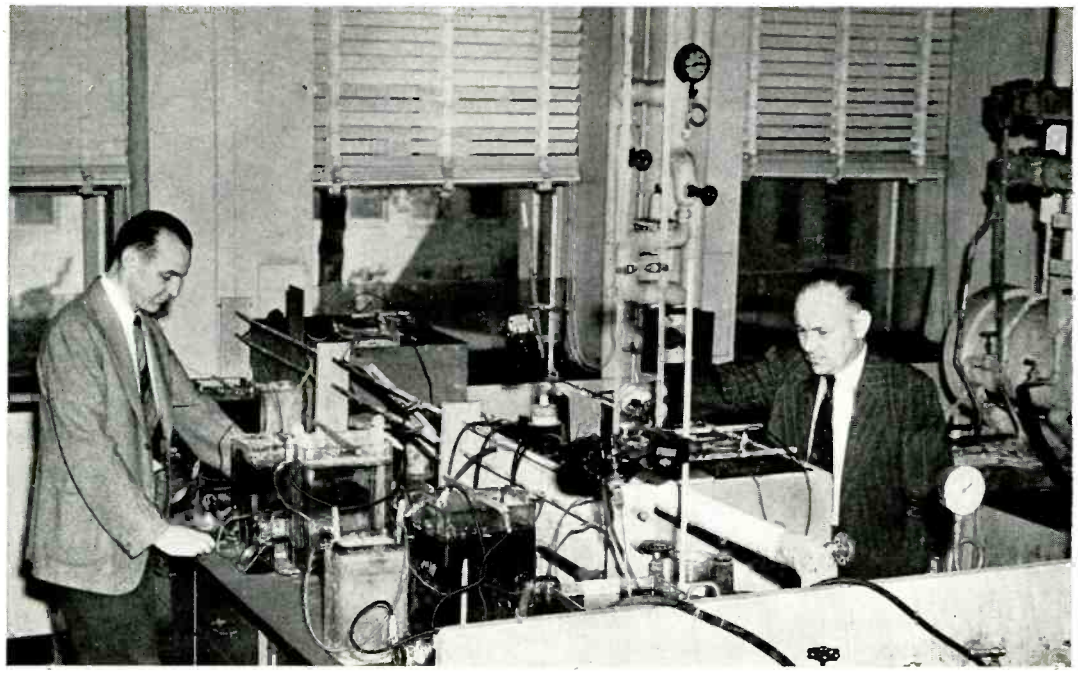

Fig. 1—Most of the experimental work is done in a separate section of the laboratory

Fig. 2—The preparation room is equipped with a polishing lathe and sand-blast machine; also a bench lathe, drill press and a spot welder. G. Bittrich is shown polishing a sample

platinum, rhodium, palladium and lead on a smaller scale, and for precisely controlled work on the more common metals. A large part of the program is devoted to the preparation for plating of some of the newer alloys that require more complicated cleaning procedures to secure a satisfactory finish.

The main plating tanks, which hold the solutions most commonly used, are installed in two parallel rows, A and B, Figure 3, in the center of the laboratory. Between them there is a ventilating hood, C, constructed of cylindrical transite, which is supported horizontally by a lead-covered steel channel on columns of acid-resisting brick. Fumes enter this hood through horizontal slots just above the rear edges of the plating tanks and are conducted through four vertical risers to the attic above, where they enter a separate exhaust system. The hood is braced from the ceiling by a tubular metal structure that also supports the plating bus and service piping.

Tanks shown in the headpiece, which are located at A, hold the solutions for cleaning and plating ferrous metals. These include an anodic alkali degreaser, spray rinse, acid dips and cyanide copper, cadmium and zinc plating baths. On the opposite side of the hood, B, are the solutions most commonly used for cleaning and plating of non-ferrous metals. These consist of a cathodic alkali degreaser for removing grease and oil films, a cyanide dip for stripping tarnish films, a spray rinse tank, acid dipping tanks for removing oxide films and scale and plating tanks for tin, copper, silver and nickel. The tanks were designed and dimensioned so that they can be rearranged easily. Duriron drains beneath them permit washing the floor frequently to remove drippings that occur when work is taken from the solutions for rinsing.

Associated with each tank and located above the duct there is a rheostat, an ammeter and a voltmeter to control the plating. Tanks that require elevated temperatures are heated by steam coils and can be regulated thermostatically. Most of them are made of steel, lined with hard rubber, but those used for hot alkaline solutions are uncoated steel and the acid dips are in earthenware crocks. At one end of this installation, D, Figure 3, there is a lead-lined tank for chromium plating with an independent exhaust system to remove the exceptionally corrosive fumes caused by its operation.

Separated from the main group by an aisle, there is another group of tanks, E, which includes a phosphating solution, a chromic acid rinse, an anodizing tank for aluminum, a barrel plating unit for handling small parts in bulk and a chromating tank.

A bench along the wall beyond these tanks, F, is used for the continuous plating of wire and tape. On it there is a machine for drawing the work through the various solutions and the plating and washing tanks. As many as four cleaning and plating tanks with their associated washing equipment have been used in series on some projects, but usually only one metal is deposited at a time. Also along the same wall, G, are the solutions used for dyeing and sealing aluminum-oxide coatings, solutions for blackening

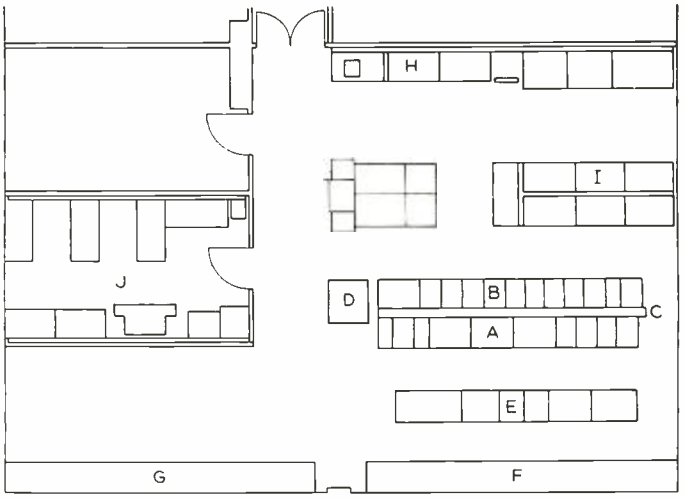

Fig. 3—Plan of the electroplating laboratory at Murray Hill. The main plating baths, A to E, are located in parallel rows near the center of the room. Continuous plating on wire is done at F; dyeing and sealing at G. The experimental work is largely carried out on benches at H and I; samples are prepared in a separate room, J

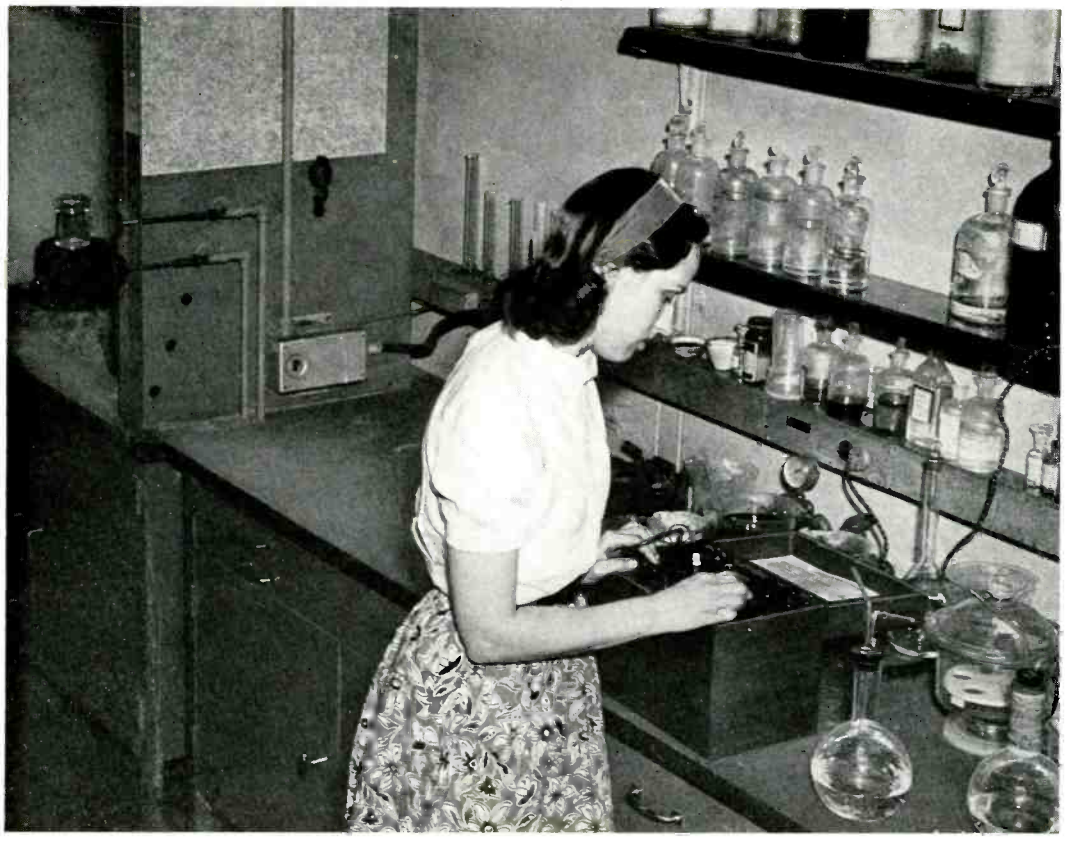

Fig. 4—Chemical fume hood and two benches for work not requiring plating current

metals, an analytical balance and a voltage breakdown test for anodized aluminum coatings.

Most of the development work is done on chemical benches, which are installed as a group in a separate part of the laboratory. A chemical fume hood and two benches, H, Figure 3, shown at the extreme left in Figure 4, are assigned to the testing of electroplated coatings and other work that does not require plating current; also to the preparation of solutions. Another group of six chemical benches, I, is used for experimental plating. These benches are shown in Figure 1.

Adjacent to the main plating laboratory there is a preparation room, J, with a polishing lathe, sand-blast machine, bench lathe, drill press and a spot welder, as well as bench space and hand tools as shown in Figure 2.

Electroplating power, with the exception of the chromium tank, which has its own 6-volt 750-ampere generator, is supplied from a 6-volt 2,000-ampere generator located in the attic above the main tanks. This generator has two 6-volt windings which are normally connected in parallel but it is

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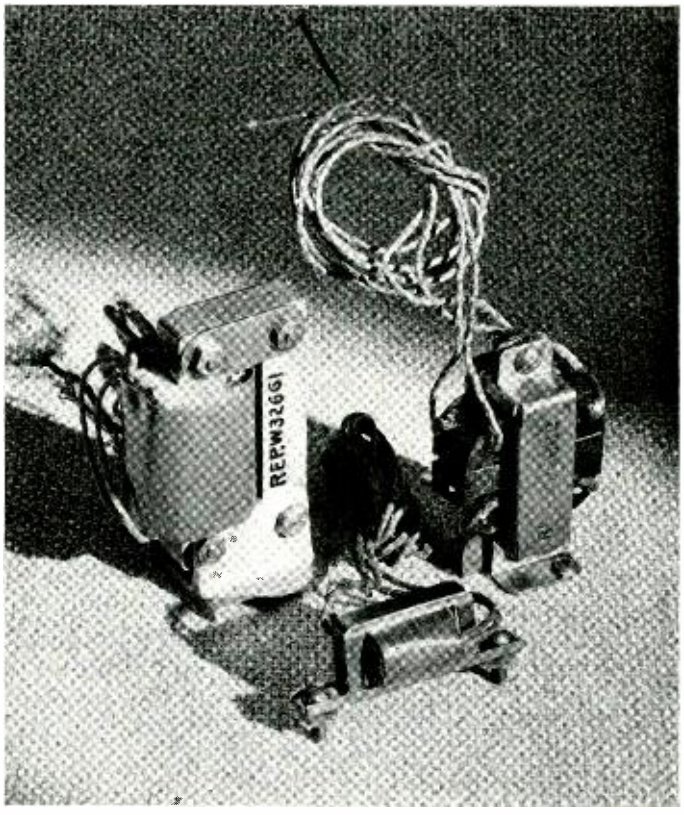
THE AUTHOR: R. A. EHRHARDT joined the Laboratories as a Technical Assistant in 1924. He attended the course for technical assistants for a year and then started night school at Cooper Union where he received the B.S. degree in Chemistry in 1930. While there he won the Dickinson Award for Scholarship. After spending short periods in the rubber, carbon, and analytical laboratories, Mr. Ehrhardt took up the work on corrosion and electroplating which has since occupied most of his time.

equipped with a switch to convert it to deliver 1,000 amperes at 12 volts by putting the windings in series. The control panel is mounted in the laboratory. This generator is connected to the main plating group by two pairs of 4-in. x ¼-in. copper bars. It also supplies the power for the wire-plating bench and for the other equipment in the laboratory.

The laboratory group makes many studies of test panels which require careful preparation and control for corrosion studies on finishing materials. They also brass-plate samples which are to be coated with rubber. Careful control of the composition of the brass is required to make the rubber adhere firmly. Studies are also in progress to develop a more satisfactory bath for this purpose. The electroplating of metal finishes on aluminum for soldering and to reduce its contact resistance has recently received great impetus, and methods of producing a satisfactorily adherent plate are being studied. The cleaning, plating and heat treating of spring steel parts, which are subject to hydrogen embrittlement, is also under investigation.

In connection with war projects, the laboratory group is now spending a large part of its time in producing special products for the Western Electric Company, particularly those relating to wire and metal tape.

Audio Frequency Transformers for Compact Assemblies



Transformer development created these little fellows for incorporation in special apparatus where space and weight are at a premium. Since the equipment assembly provides adequate protection, it was possible to dispense with the coil case usually required and to use flexible terminal leads instead of fixed terminals. Permalloy cores contributed greatly to the small size of these coils, the largest of which is only 2½ inches high

Handling Delayed Calls in Crossbar Toll

By F. F. SHIPLEY
Switching Engineering

IF ALL the subscribers connected to a central office were to place calls at the same time to subscribers connected to another office, and if there were to be no delay in completing these calls, there would have to be as many trunks between the offices as the first office has subscribers. Such a situation is conceivable, but practically the chance of its occurring is negligible, and so trunks are provided in sufficient number to insure satisfactory service under more normal conditions of traffic.

The criterion for determining the number of trunks which should be provided is the traffic during the busiest hour. Use is made of probability tables that have been calculated to show for various amounts of traffic the number of trunks necessary to insure that not more than a certain percentage of calls will find all the trunks busy. When, for example, there are on the average ten calls between two local offices throughout the busiest hour, nineteen trunks will give the desired grade of service.

The relationship of trunks and traffic, however, is not the same for toll as for local trunks. Toll lines are not only longer, but also cost more per mile than trunks between local offices. The ratio employed for toll lines varies with the length of the haul, the volume and nature of the traffic, and outside plant conditions on the route involved. On one of the schedules widely used for engineering toll lines, only eleven trunks are specified for an average of ten simultaneous calls, instead of the nineteen used for local trunks. Under these conditions, however, a much larger percentage of the calls in the busy hour finds all circuits busy.

When all circuits are busy, it is desirable that the operator be kept apprised of the condition so that she need not make repeated fruitless attempts to secure a circuit. It is also desirable to complete delayed calls as nearly as possible in the order of their filing time. This is facilitated in the crossbar toll system by overflow circuits associated with toll-line groups, and by a call-order board, known as the No. 5 toll switchboard, shown on the cover of this issue.

A simplified schematic of the overflow arrangement is shown in Figure 1. All toll-line groups have overflow trunks associated with them. Although on the same block relay, these do not form part of the toll-line group, but are tested separately. If the marker finds all lines busy, it automatically tests the corresponding overflow-trunk group—connecting the call to the first idle trunk. An overflow control circuit, associated with each group of overflow trunks, maintains a record of the all-trunks-busy condition by a lead multipled to each of the individual toll lines; and as long as all circuits are busy, it returns a slow flash to connected incoming circuits. When

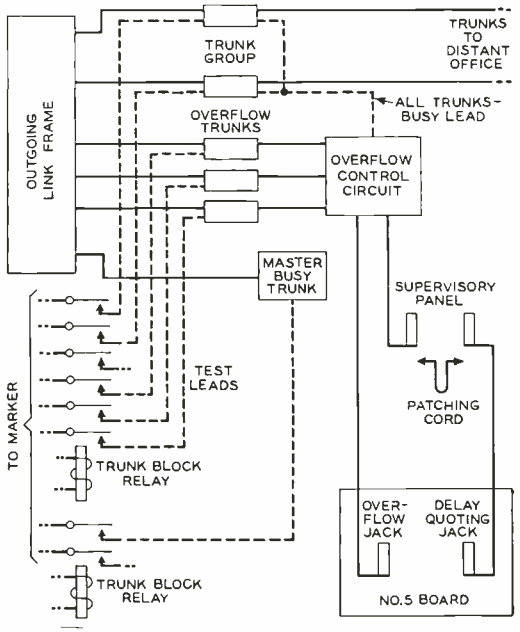


Fig. 1—Simplified schematic of connections to overflow circuit

a trunk in the group becomes idle, it returns a fast re-order flash signaling the operator to make another attempt.

The number of overflow trunks varies from one to four, depending on the size of the associated toll-line group. The intention is to allow only as many circuits to wait in overflow as have a reasonable prospect of obtaining an idle toll line within a period of about five minutes.

Besides the overflow trunks and control circuits associated with them, there is also a group of master-busy trunks that is common to the entire office. When a marker finds all the overflow trunks of a group busy, it releases the trunk block relay it was using, seizes a block relay associated with these master-busy trunks, and connects the call to the first idle one. These master-busy trunks return an irregular flashing signal to the distant calling operator to apprise her of the more extensive delay she is likely to encounter in making the call.

When an outward operator gets the slow flashing signal, indicating an overflow trunk, she usually holds the connection for a while, waiting for the quick flash indicating that a trunk has become idle. When she receives the irregular flash indicating she has reached a master-busy trunk, however, she usually turns the call over to a delayed-outward operator in her office, who will complete it as soon as she can get a trunk. As a rule, operators in distant cities who are attempting to establish a connection through a crossbar toll office do not hold toll trunks more than five minutes. If the operator reaches the crossbar toll office over a ring-down toll line, she leaves a call order with the No. 4 cordless operator as soon as delay is encountered. No further action is required on the call order if a circuit is secured within five minutes, but if a circuit is not secured within that interval, the call order is sent to the No. 5 board, the incoming circuit is released, and the originating operator sends her ticket to a delayed-outward operator in her own office.

If the distant operator reaches the office over a dial toll line, she holds the connection to overflow for five minutes, and then reaches the No. 5 operator over a code "151" trunk, and leaves a call order with her. Outward operators in the crossbar toll

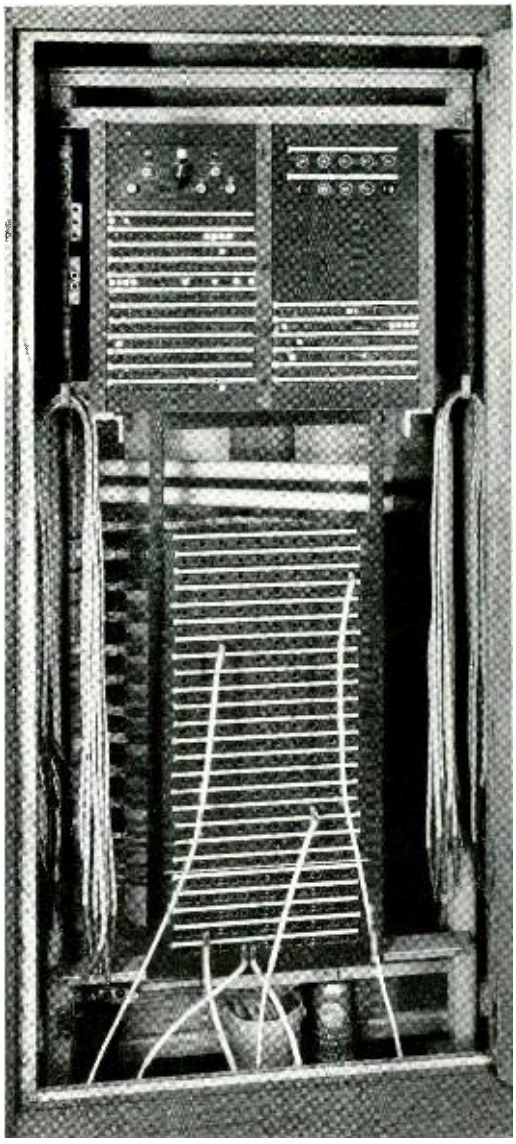


Fig. 2—Traffic supervisory panel used in connection with the handling of delayed calls in the crossbar toll system

office area may extend the waiting period to ten minutes, but when longer delays are encountered, the calls are always turned over to the delayed-outward operators who are associated with them.

To assist in handling calls that have encountered delays, the No. 5 switchboard has been provided. This board is of the cord type, and uses twin jacks and plugs to permit the connection to be made on a four-wire basis. Incoming trunks are known as "151"

trunks, since by dialing 151 on any trunk to the crossbar toll office, a No. 5 operator is reached. The outgoing trunks from the No. 5 board run to the switch frames as do all incoming trunks. Each position has a ten-button key set with which the operators can complete calls to any outgoing trunk. Both incoming and outgoing trunks appear in jacks, and four-wire cords are provided with which the operators may complete calls between two outgoing trunks or between a "151" trunk and an outgoing trunk.

In the face of the board there are also jacks associated with each overflow circuit. These are single jacks instead of twin jacks as used for the other trunks, and each position has four cords with single plugs with which the operator may connect to them. The operator plugs into each group in which she is interested, and lamps associated with these four cords remain dark while the toll lines are all busy, and these lamps will flash at the fast re-order rate when one or more toll lines are idle.

As delayed calls come in on the "151" trunks, the No. 5 operator makes out tickets and stacks them so that they may be completed in the order in which they were received. When she sees that there is an idle trunk in one of the groups she is watching, she plugs into one of her outgoing trunks and "writes up" the number wanted on her key set. If she finds an idle line, she plugs the other end of the cord into another outgoing trunk and dials the office originally placing the call. This call is then completed through the cord at the No. 5 board—passing through the toll switching train twice.

Each overflow trunk has a lamp on the traffic supervisory panel shown in Figure 2. By noting the action of these lamps, and by keeping track of the tickets at the No. 5 board, the chief operator can estimate the delays. When she sees that the delay on a certain group will be one-half hour or more, she puts that group on "delay quotation," and thereafter a different operating procedure is followed.

In the lower part of the supervisory panel are rows of jacks. The upper rows run to the various overflow control circuits, and the five lower rows are delay-quotation jacks, which are connected to the positions at the No. 5 board. These jacks are arranged in groups: one group for a half hour delay, one for an hour delay, and so on for the various delays that may be quoted. To put a group of trunks on delay quotation, a double-ended cord is plugged into the jack to the overflow control circuit for that group and into a jack for the particular delay to be quoted. Then calls coming into the markers for this group will be connected either to the overflow trunks directly or to the No. 5 board, depending on whether they are from local or distant operators. This is done whether there are idle trunks or not, since access to a group on delay quotation is denied to all but the operators at the No. 5 board. When a group is on delay quotation, notices stating the delay to be quoted for various trunk groups are "posted" where they can be seen by the operators at both the No. 4 and the No. 5 switchboards.

The delay-quotation jacks at the operators' positions have lamps associated with them which light every time a call comes in to an overflow group that has been patched to this particular delay-quoting trunk. After a delay has been posted, operators at the No. 5 board watch the lamps associated with the delay-quotation jacks at their positions, and whenever a lamp lights, an operator plugs in and quotes the delay. Any operators connected to that overflow circuit or to any other overflow group patched to the same delay-quoting trunk will hear these announcements.

THE AUTHOR: F. F. SHIPLEY received the B.S. in Electrical Engineering degree from Purdue University in 1925 and at once joined the Department of Development and Research of the American Telephone and Telegraph Company. Here he worked largely on general toll switching problems, but also devoted much time to certain patent studies. Transferring to the Laboratories in 1934, he continued work on toll switching problems—particularly those relating to mechanical methods that later resulted in the crossbar toll office.

When a group of trunks is on delay quotation, the markers are apprised of the fact by their route relays, and do not follow their ordinary procedure. A call from a distant dial operator will be connected directly to the No. 5 board where the operator will quote the delay and write a ticket for later completion. On the other hand, a call from an outward operator in the local area will be connected to one of the overflow trunks for that group, and will hear one of the No. 5 operators state the delay. The outward operator then turns the call over to her own delayed-outward operator, who may have other calls for the same group. She will inform the proper No. 5 operator from time to time as to the number of calls waiting.

The No. 5 board thus serves as a point of clearance for most of the calls that are seriously delayed. Since the operators at these boards are the only ones that have access to the group of trunks on delay quotation, and since they receive a flash as soon as the trunks become idle, they are able to complete the calls as rapidly as facilities become available and in the order in which the calls come in.

To the Solomons and Back

By E. H. SHARKEY
High-Frequency Development

CHRISTMAS Day will always have special significance for me, for it was on that day that I returned to the United States from a six-month trip into the Pacific war theater. Six days earlier I had been living in a Quonset hut in the jungles of the Solomon Islands and the sudden transition from the primitive conditions there to the abundance of things in the United States was entirely too abrupt to be soon forgotten.

A war development on which I was working was completed in the spring of 1943, and I was selected to help install certain equipment in Army planes, instruct the flying and maintenance crews in its use and follow it into service for a time. In midsummer, I donned the uniform of an Air Corps Technical Representative and in one of the squadron's ships flew across the Pacific. Shortly after arriving at our forward base the squadron began patrol operations while H. L. Clark, field engineer of Western Electric, and I stayed behind with the squadron maintenance personnel and "sweated out" the patrol crews and the equipment.

From the start, the squadron made a distinguished record for itself. Although we weren't able to go along on any missions, all of us back at the base used to get fully as big a kick out of successful missions as did the crews themselves. Returning planes, taxiing in, would be followed by a brood of jeeps full of ground personnel all anxious to hear the story of each flight.

Headquarters, * * * Bomber Command
17 June 1944

SUBJECT: Commendation.
TO: MR. EDWARD H. SHARKEY.
THROUGH: Western Electric Company,
195 Broadway, New York City.

Your performance of extraordinary and outstanding achievement has been noted by the Commanding General, * * * Bomber Command and the following commendation is extended in official recognition thereof:

COMMENDATION: Mr. Edward H. Sharkey, it is with great pride that I commend you for the splendid work accomplished in connection with the development and improvement of the special equipment and installations as used by an organization of this Command. Your unstinting effort and tireless endeavor has resulted in extremely valuable and significant improvements in equipment design, aircraft installations and training progress throughout the Army Air Forces.

(Signed) WM. A. MATHENY,
Brigadier General, USA
Commanding

At the beginning, it took a lot of hours on everybody's part to get into smooth operation. Field modifications were made, maintenance procedures worked out and operation procedures modified to fit existing conditions.

Everyone concerned was well pleased with the successful operation of the equipment. Certainly a very large share of this was due to the excellent job done at the Laboratories, in designing and turning out, on short notice, equipment which behaved as well as this did. It is unfortunate that the designers of equipment can't get out in the field and have the satisfaction of seeing their equipment do a real job.

The climate was nowhere near as bad as had been anticipated. It was hot in the daytime (shorts constituted the official uniform), but nights were cool enough for a blanket. But that was in the dry season (winter there—summer here). Any remarks about the climate during the rainy season are censorable for more than one reason but suffice it to say that it was wet.

There were no more Japs on our island base when we got there, but frequently their bombers came back for a call. On these occasions we repaired to our foxholes, first scoffed at and then deepened.

Rule No. 1 when an alert sounded was to get in the foxhole—fast. The main difference between alerts here and there is that there nobody worries about you except you. Not a single air raid warden. Standard procedure on retiring was to assemble coveralls, shoes, helmet, cigarettes and flashlight and lay them out in that order on the floor so that no time was lost in getting underground, fully clothed, with the necessities of life. The average foxhole, covered with logs and dirt, accommodated eight men, three land crabs, five lizards and assorted scorpions, spiders, etc. Most foxhole time was very dull but there were times when the impulse to try to pull your helmet down to your ankles became very strong.

Rule No. 2, covering mosquitoes, was to acquire a deep respect for that extremely shy little anopheles. You made yourself a little room over your cot with a mosquito bar, which you carefully tucked in on all sides. This protected you from mosquitoes but was liable to entangle you when you were trying to make a quick exit during an air raid.

By December, Mr. Clark and I had completed out assignment, which had been to work ourselves out of a job. The squadron maintenance had been running smoothly for some time without any assistance from us, so we pulled out, with regrets at leaving the squadron but not at leaving the general locality.

My general reaction to the Solomon Islands trip was that I wouldn't have missed it but have no particular desire to return there. The only feature of our part of the glamorous South Seas that I cared much for was the scenery, which was better than most travel folders show.

Six days after leaving the Solomons, the United States looked and was pretty wonderful to both of us.

EDITOR'S NOTE.—MR. SHARKEY entered the Laboratories in 1938 with a degree from Michigan in Electrical Engineering. He joined a group which was developing high-frequency electrical equipment for coaxial cable systems. A year later came the war, and the group put its knowledge to work on the project whose conclusion he recounts here. For the trip Mr. Sharkey was transferred to the Western Electric Company as a field engineer.

It was for this project that the Laboratories received the telegram from General H. H. Arnold published in our February issue in which he said:

"Directly as a result of the outstanding contribution made by your organization in the development of special electronic equipment and in the making of pre-production models thereof it has been possible for the Army Air Forces to take the offensive with telling effect against Japanese shipping in the South and Southwest Pacific areas at a much earlier date than would otherwise have been possible and under conditions which normally would have made such operations impossible."

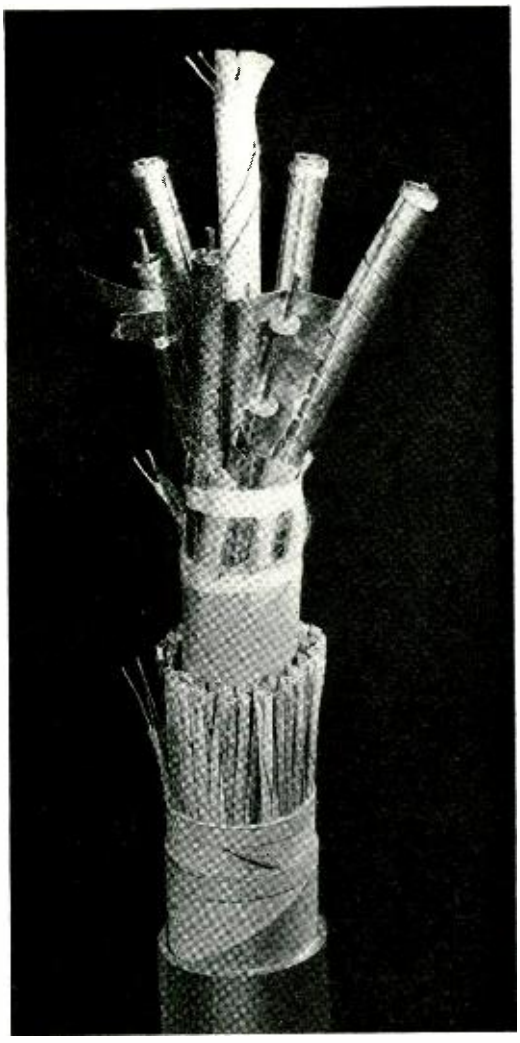
Coaxial Cables and Television Transmission

BELL System plans for the extension of the coaxial cable network, and the possibilities for inter-city transmission of television programs, were disclosed in an address to the Society of Motion Picture Engineers by Harold S. Osborne, Chief Engineer of A T & T. Significant excerpts from Mr. Osborne's talk follow:

"With equipment now used on coaxial cable, a television band of 2.7 megacycles can be transmitted. While this shades the full requirements for the standard 525-line transmission, the results are very satisfactory. This was demonstrated in 1940 in transmissions between New York and Philadelphia and in 1941 a transmission over a distance of 750 miles obtained by looping back and forth the coaxial units in a cable between Stevens Point, Wisconsin, and Minneapolis.

"Development work which was started before the war and is expected to be successfully concluded shortly after the war is over looks to improved equipment capable of transmitting a band of 7 megacycles. With this system, it will be possible to transmit a 4,000,000-cycle band for television plus 480 telephone channels simultaneously over the same conductors or to transmit a broader television band if the standards of television should be so raised as to require it.

"Whether the coaxial cable system will, in the future, be used with still broader bands of frequencies will be a question of economics rather than any inherent limitation of the cable. The spacing of repeaters is set by the top frequency transmitted over the cable. It is 5.3 miles with the present system and will be about 3.5 miles with the 7-megacycle system. The whole development is still young and we would not want to say now whether 7 megacycles will be the final step or whether further developments will lead to the use of a still broader frequency band over this type of cable. . . .



Coaxial cable now being installed between Terre Haute and St. Louis. It consists of 6 coaxial conductors, 21 quads and several service pairs

"While the coaxial cable system has been in service in this country for several years, its application up to the present has been narrowly limited. A section of cable between Stevens Point and Minneapolis about 180 miles long has been in service since 1940. Cables have been placed between New York and Washington and are equipped between New York and Philadelphia. Cables between Atlanta and Jacksonville and between Terre Haute, Indiana, and St. Louis are under construction.

"The development had reached a point

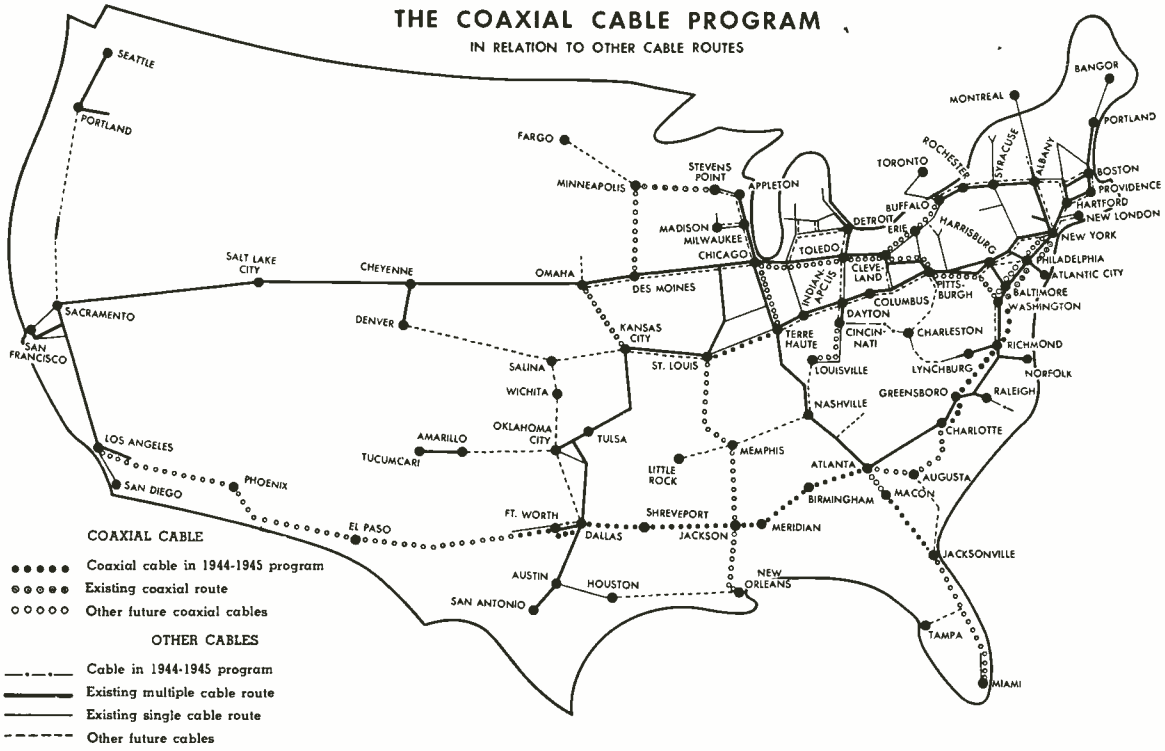
just before the war where we were prepared to go forward with its wide-scale use on heavy telephone routes. The exigencies of the war, however, have until now prevented placing the equipment into production on the large scale which would be necessitated by such use. Recently, manufacturing preparation has been made for such production and it is expected to be well under way by the end of this year.

"In order to guide the manufacturing preparations, a general study of the needs of the telephone companies for this type of cable in meeting the requirements of their present forms of service was made early this year. This has led to a tentative program for the next five years of construction of 6,000 to 7,000 route miles of coaxial cables. One feature of the coaxial cable network so proposed is a cable from Boston along the Atlantic Seaboard to Atlanta thence across the southern part of the country to Los Angeles and to San Francisco. Another main route will be from the Eastern Seaboard route west to Chicago and St. Louis with a connecting link south from St. Louis to New Orleans which will intersect the main east-west route. . . .

"The cable between Terre Haute and St. Louis is now being plowed in. Next year we expect to get a good start on the southern transcontinental route. . . .

"When this first program is completed, we expect to continue to place coaxial cables in other locations to meet the service requirements of the Bell System unless in the meantime, of course, some other better method of meeting these requirements should be developed.

"So far we have been talking of transmissions over long distances between cities. You will be interested, no doubt, to have me say a word regarding the possibilities of obtaining television transmission circuits within urban areas, particularly circuits between studios and pick-up points and between studios and television transmitters. We are already providing circuits of these types. Very fortunately we have been able to develop means for using, for moderate distances, the telephone cable plant already installed under our city streets. To do this requires very extensive adjustments and the installation of amplifiers and equalizers spaced at approximately one-mile intervals. Where desirable, coaxial units or special



shielded pairs can be provided, and this has been done in some cases. If a general demand for such circuits in the business sections of our large cities were to develop, the special shielded conductors might be built into a cable along with ordinary pairs. . . ."

Nobel Laureates Acknowledge Laboratories' Help

The interlinking of research in various fields is interestingly brought out in some recent correspondence between Dr. Jewett and Dr. Herbert S. Gasser, one of the recipients of the Nobel Prize for medicine in 1944. Dr. Jewett had written Dr. Gasser to congratulate him and his associate, Dr. Erlanger, and in reply Dr. Gasser wrote:

"We got very cordial coöperation from the engineers of the Western Electric Company in the days when we were getting started. In the beginning we knew only what we wanted to do, and it is hard to overestimate the value of the advice that was given so patiently to us in our uninstructed state. When Van der Bijl's book appeared in 1920 it became our forte. For more than ten years the telephone repeater tube was used in the amplifier design; and the Johnson oscillograph held its place until the development of high vacuum tubes."

This letter excited memories in J. B. Johnson of twenty years ago—a time near the dawn of the electronics era when he had just presented a paper on the low-voltage cathode-ray oscilloscope. It was evidently just what was needed for an investigation into the minute electric currents set up when a nerve fiber is excited. Dr. Gasser visited the Laboratories to learn more about its tube and associated amplifier circuits. From that time, electronic apparatus was an integral part of Gasser and Erlanger equipment; and through their publications it became widely known and applied to other lines of physiological research.

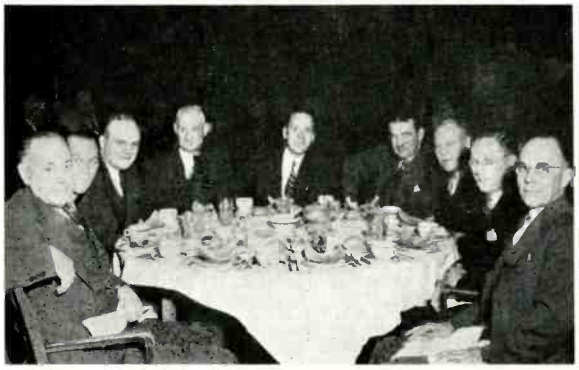
This midget Western Electric 8-watt radio transmitter and receiver, which formerly enabled the small boat owner to keep in communication with the Coast Guard, land telephone system and with other radio-equipped vessels, is shown installed aboard a Merchant Marine training ship

During the Months of September and October the United States Patent Office Issued Patents on Applications Previously Filed by the Following Members of the Laboratories

L. G. Abraham (2)
R. S. Alford
W. M. Bacon (2)
H. L. Barney
B. S. Biggs (2)
H. S. Black
W. L. Bond
C. E. Brooks
J. T. L. Brown
R. K. Bullington
C. J. Christensen
H. Christensen
C. A. Dahlbom
R. C. Edson
P. G. Edwards
R. A. Ehrhardt
E. W. Flint
H. W. Goff
R. H. Gumley
V. L. Holdaway
L. W. Hussey
R. J. Kent
W. C. Kleinfelder
C. E. Lane
B. F. Lewis
G. A. Locke
C. W. Lucek
J. B. Maggio
R. F. Mallina
W. A. Malthaner
C. R. Moore
C. V. Parker
R. E. Polk
O. A. Shann
G. R. Stibitz
G. K. Teal
E. A. Thurber
L. E. Van Damme
P. W. Wadsworth
W. D. Wagenseil
O. L. Walter
E. F. Watson
L. A. Wooten

AT THE ANNUAL DINNER OF AMERICAN LEGION POST NO. 497

About 170 veterans of World Wars I and II gathered at the annual dinner of the Post. Here we see two of the table groups and, left to right, O. H. Danielson, retiring commander, J. R. Bardsley, incoming commander, H. J. Delchamps, F. R. Lack of the Western Electric Company, George Dobson and H. A. Doll



American Legion Post

On the evening of October 17, American Legion Post No. 497 held its annual installation of officers at the Downtown Athletic Club, 18 West Street, N.Y.C. Because the year 1944 marked the 25th anniversary of the Post, a special program had been planned by the entertainment committee under the direction of Frank Meyer, Chairman. The meeting was attended by approximately 170 veterans of World Wars I and II.

Introduced by Commander O. H. Danielson, Herman M. Kahn, New York County Commander, installed the following officers for the year 1944-1945: Commander J. R. Bardsley; Second Vice-Commander J. E. Ranges; Third Vice-Commander L. H. Allen; Adjutant A. W. Dring; Assistant Adjutant J. J. Smith, all from the Laboratories; from the Western Electric Company, 195 Broadway, First Vice-Commander E. I. Pratt; from the Western Electric Company, 395 Hudson Street, Service Officer H. Bongard and Sergeant-at-Arms L. F. LaValley; from the Western Electric Company at 1495 Herkimer Street, Brooklyn, Chaplain K. J. Schneider. At the conclusion of the installation ceremony, Commander Bardsley introduced the toastmaster of the evening, H. J. Delchamps.

The Post was especially fortunate in having as its guest speaker Past National Commander of the American Legion Ray Murphy, who gave a report of the findings of the Foreign Relations Committee of the 26th National Legion Convention held at Chicago.

Personal messages from several of the Post members who are again in service were read by H. A. Doll, F. J. Given, E. G. Andrews and E. L. Erwin. Three of the members from the Laboratories who are again in service were able to be present: Col. J. M. Hayward of the U. S. Army Air Force, Lieut. Comdr. R. H. Miller, and Lieut. V. M. Meserve of the U. S. Navy.

Retirements

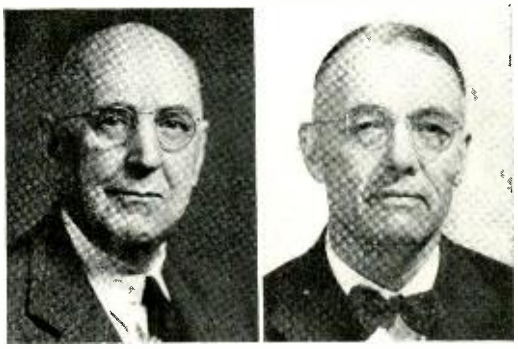
SIX MEMBERS of the Laboratories have recently retired from active service: JOHN MURRAY, A. E. PETRIE, and W. M. STUART, JR., under the Retirement Age Rule with Class A pensions, and C. R. ENGLUND, ELSIE MCKAY and CATHERINE O'BRIEN at their own request with Class A pensions.

* * * * *

GRADUATING with the degree of E.E. at Syracuse University in 1903, A. E. PETRIE had several years' experience in other companies and then joined the Western Electric Company at Hawthorne on April 10, 1911. His first work was in the Equipment Engineering Department, designing and developing power plants for central offices. In 1913 he transferred to the standardization group of this department to handle power plant specifications and drawings. Six years later he came to the Engineering Department in New York when he became Power Development Engineer in charge of the power group of the Systems Department.

Since that time the power development group under his supervision has developed power supplies needed for communication in the Bell System. This includes d-c power for talking, repeater plates, ringing, tones and signaling, etc., in the smallest PBX and community dial offices to the largest multi-office and toll centers. Many of these plants are automatic and require no power attendants for long periods of time. Gasoline engines and associated plants were developed for isolated areas having no commercial power. These were also automatic in operation, requiring no attendant for periods of four to six weeks. A line of gasoline and Diesel engines, portable and stationary, were developed for emergencies as standby power.

For a number of years Mr. Petrie has been intimately connected with the Committee



A. E. PETRIE C. R. ENGLUND

on Rotating Machinery of the American Institute of Electrical Engineers concerned with standard requirements and specifications for all rotating electrical machinery.

* * * * *

AFTER RECEIVING the degree of B.S. in Chemical Engineering from the University of South Dakota in 1909, C. R. ENGLUND went to the University of Chicago for two years of graduate study. He then went to Western Maryland College as Professor of Physics and Geology, and a year later to the University of Michigan as laboratory assistant. In 1914 he left academic work to join the Engineering Department of the Western Electric Company; since that time he has been concerned with radio research.

In 1915 he joined the newly formed radio group which was responsible for the early development of radio for telephonic purposes. Later he became engaged in the design of radio-frequency bridges and impedance standards. When the ship-to-shore radio program was inaugurated in 1919 he went out on field work and following this joined the group at the Cliffwood laboratory. Here he developed radio field strength measuring methods and apparatus and assisted the Department of Development and Research of the American Telephone and Telegraph Company in its development work at Riverhead, Long Island, on the long-wave transatlantic radio-telephone receiver equipment, including a quantitative

W. M. Stuart, Jr. John Murray

investigation of various types of antennas.

Mr. Englund, in 1926, began an ultra-short-wave investigation to survey the possibilities of this part of the radio spectrum and successfully extended the quantitative technique of high-frequency work to two-meter wave lengths. More recently he has been engaged in a study of the effect of earth and atmospheric irregularities on ultra-short-wave transmission. Since 1930 he has carried on this work at the Holmdel laboratory of the Radio Research Department. For the last two years he had been engaged on a war project for the N.D.R.C.

* * * * *

W. M. Stuart, Jr., joined The Bell Telephone Company of Pennsylvania in 1906, and served, first as a subscriber's station installer, and later as an inspector of this work. He was subsequently transferred to inspection work on PBX installations, and before joining the Western Electric Company in 1915, was special inspector for the city of Philadelphia. He came to West Street as a member of the circuit laboratory where he engaged in work on subscriber's station ringing circuits, for which his earlier experience had admirably fitted him. At the time of his retirement he was a member of the dialing and ringing group of Switching Development.

* * * * *

John Murray joined the Western Electric Company in 1907 as a porter in the West Street building. During the construction of tunnels under the Hudson River for the Hudson and Manhattan Railroad he engaged in building work on that project. In 1909 he returned to West Street. Since then he has been a porter, watchman and elevator operator, and for the past sixteen years a foreman in the building operation and maintenance group.

* * * * *

Elsie McKay joined the Western Electric Company in 1902. She left the company in 1910 and then, later in 1911, went to the Engineering Department of the American Telephone and Telegraph Company. Later she transferred to the Department of Development and Research and came to the Laboratories in the 1934 consolidation.

* * * * *

When Catherine O'Brien of the Development Shops Department retired on November 15, she could look back on forty years of varied experience with the Laboratories. Joining the manufacturing organization of Western Electric at West Street in 1902, she worked under both the manufacturing and engineering groups of that organization from 1902 to 1925, excepting for a two-year period during 1914 and 1915, and since 1925 as a coil winder in the Development Shops Department of the Laboratories. Under her capable hands many an experimental coil was wound for development projects of the Laboratories.

Catherine O'Brien Elsie McKay

$26,716 Contributed to National War Fund

This year 3,644 members of the Laboratories contributed $26,716.25 to the National War Fund, compared with 5,419 members contributing $28,402 last year. 2,960 cash pledges representing $20,410.75 were received and 684, for a total of $6,305.50, were on the Payroll Deduction Plan. The Drive this year was on a basis of circular literature rather than personal solicitation as it was last year.

Christmas Concert of Bell Chorus

The Bell Chorus of New York will present its annual Christmas concert on Tuesday evening, December 19, at Times Hall, 240 West 44th Street. Walter Olitzki, baritone, famous for his Wagnerian rôles at the Metropolitan Opera House, will be the guest artist for the occasion.

The Chorus will offer a program of Bach, Mozart, Handel and Praetorius in addition to a varied and interesting collection of traditional carols from many lands. Even a "Chinese Carol" is to be included and, of course, the beloved "Silent Night."

It will be the third Christmas concert to be given by the group in this, their twelfth season. The Choristers sang at The Riverside Church on November 12 and will give an invitation concert at the Princeton Club early in December.

Tickets ($0.90) for the Christmas concert may be purchased from any member of the organization or from Hilda Muller, Extension 1902.

News Notes

O. E. BUCKLEY, at a luncheon meeting of the Bell Telephone Club of Indianapolis, discussed the place of the Laboratories in the Bell System and what it is doing in the present war.

A. F. DIXON, who retired from the Laboratories in 1940, was elected to the New Jersey Assembly on November 7.

The Review of Scientific Instruments in its October issue says of JOHN MILLS' *Electronics, Today and Tomorrow* that "its language is simple and . . . makes for easy reading" and its "analogies are apt and lucid." It recommends the book "whole heartedly to a layman" as "an accurate picture of electronics in simple terms . . . guaranteed to hold the interest of the reader." It also says "the book should be required reading for scientists and engineers who are using electronic devices and have not yet had opportunity to delve into their 'innards'."

USING HIS BOOK's title as the title for a talk, JOHN MILLS spoke to the Brown University Engineering Association at a dinner meeting on November 9.

C. J. FROSCH visited Marion, Va., on matters pertaining to plastics. He also attended a meeting of the American Society for Testing Materials which was held in Atlantic City.

G. DEEG, JR., and L. SPIWAK conferred on molding problems at Great Neck, N. Y. Mr. Deeg also went to Philadelphia to discuss problems concerning moisture in plastics.

G. H. WILLIAMS was at Pittsfield and Springfield on matters pertaining to the development of adhesives.

R. W. WALKER was at the University of Louisville and the National Synthetic Rubber Company in Louisville in connection with synthetic rubber control methods.

Please put your RECORD in the "Correspondence-Out" box when you are through with it so that it can be sent to a Serviceman's family.

November Service Anniversaries of Members of the Laboratories

10 years

Maurice Ahern
John Bowens
Patrick Burke
Felix McGowan
J. J. Moylan
Walter Stanewicz
J. Z. Takacs

15 years

J. C. Bain
W. C. Bengraff
G. J. Bloeser
W. L. Bridges
P. G. Clark
R. F. Cook
H. B. Coryell
W. W. Davis
Lawson Egerton
W. A. Funda
A. J. Hannan
Catherine Henderson
W. H. Hewitt, Jr.
Albert Jost
John Leutritz, Jr.
Mary Loomis
J. M. McNamara
Thomas Mescal
J. D. Struthers
A. J. Stuart
Mary Studney
G. F. J. Tyne
Robert Van Luipen
Albert Wilson

20 years

A. C. Holetz
M. M. McKee
Ethel Millar
Catherine Pugh

25 years

James Abbott, Jr.
J. R. Bardsley
C. F. Boeck
W. T. Breckenridge
J. H. Cozzens
W. J. Crumpton
W. L. Dawson
A. O. Easton
R. K. Honaman
D. K. Martin
L. F. Porter
C. R. Post
Anna Ryan
D. C. Smith
T. J. Young

30 years

F. A. Bonomi

35 years

W. H. Bendernagel
S. H. Everett
J. S. Garvin
G. A. Johnson
Alfred Kaufmann
G. P. Tromp

40 years

S. B. Williams

In the Nation's Service

Lieut. Robert T. Rooney

One of the first boys to leave the Laboratories to go into the service, LIEUT. ROBERT T. ROONEY was back visiting at West Street recently. Lieut. Rooney, on leave from Walter Reed Hospital in Washington, was awarded the Purple Heart after being wounded at Saidor, New Guinea, in January, 1944.

Bob enlisted October 12, 1942, and was sent to Iceland for a year. When he returned to the States he attended Officers' Candidate School and received his commission in the Signal Corps. He saw action in the New Britain and New Guinea campaigns. When he was wounded he was taken to a hospital in Australia, and in May was evacuated to this country.

Raymond S. Troeller

MRS. RAYMOND S. TROELLER, a member of the Laboratories at Murray Hill, received word that her husband, who is on military leave from the Laboratories, was wounded in action in Germany on October 2 and is now convalescing in a hospital in England. The following letter was received shortly before this news came:

"The war here is not over yet, and if you were in our living quarters in the fields and in foxholes here in Germany you would soon realize that the missiles overhead are not birds flying. It is cold and damp, as it rains most every night. Don't receive mail as we have moved fast. Expect bigger things to happen, and I hope they determine a quick, decisive victory. One thing you have time to do here is pray, and that you do. May the sacrifices of the boys dead and wounded and fighting reflect back to the hearts of civilians to realize the importance of peace and good living. I was happy to be one of your employees in the great cause as a civilian and will do my best in the coming strategy to preserve myself and make for the rejoicing of the peace that will bring joy to all of us."

Lieut. Owen N. Giertsen

"I was knocked down by ack-ack over Rabaul last November (1943) and spent three months in the jungle but got out in fine shape and have been doing pretty well since. Several times, though, I wished I were back in the model shop," writes LIEUT. OWEN N. GIERTSEN to JAMES M. HOAGLAND, also on military leave of absence from the Laboratories. This portion of Lieut. Giertsen's letter was received by R. L. BEATTIE of the Laboratories from Aviation Cadet Hoagland.

Lieut. Arthur J. Palmer

LIEUT. ARTHUR J. PALMER of the 12th U. S. Air Force has been awarded the Purple Heart. Back in this country after action in Italy and France, Lieut. Palmer visited West Street recently. He was sent overseas as a fighter pilot last July. In September he was shot down over France. He had completed nine missions. He is now classed as an "Evadee," which means he was shot down while on a mission over enemy territory but was not captured.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Ensign David F. Greenhagen Killed in Action

ENSIGN DAVID F. GREENHAGEN, a "Hellcat" fighter pilot of the Naval Air Corps, was killed in action in the South Pacific. Ensign Greenhagen was graduated from Roosevelt High School, Yonkers, in 1940. He came to the Laboratories in March, 1941, and, after taking the course in Equipment Development Drafting, he became a drafting assistant. In January, 1943, he left the Laboratories on a military leave of absence and began his training in the Naval Air Corps at Ithaca, New York. He was transferred to Pre-Flight School at Chapel Hill, North Carolina, and from there went to Corpus Christi, Texas. After he received his commission at Melbourne, Florida, he visited the Laboratories prior to being sent overseas in September of this year. Ensign Greenhagen is the second member of the Laboratories known to have lost his life in World War II.

ENSIGN DAVID F. GREENHAGEN

Leaves of Absence

As of October 31, there had been 925 military leaves of absence granted to members of the Laboratories. Of these, 39 have been completed. The 886 active leaves were divided as follows:

Army 509 Navy 283 Marines 29

Women's Services 65

There were also 18 members on merchant marine leaves and 27 members on personal leaves for war work.

Recent Leaves

United States Army

Arthur Brandt — William H. Scheer
Robert M. Hulle — William G. Smith
Eunice E. Storey

United States Navy

George Behringer — Cecil G. Stewart
Ens. John V. Elliott — Nicholas Stuber
William F. Jappe — Ens. Frank E. Wollensack

Merchant Marine

Harold M. Bailey

Lieut. Stanley W. Erickson

"Things have been a bit rough lately, but I'm still around and kicking. I've completed half my tour of duty, but we are now on our fourth plane. The other three are lying in the scrap heap, mute testimony to the accuracy of Jerry's flak gunners. I've seen flak so thick that you could practically taxi over it.

"On one of my missions we were hit by fighters. As luck would have it, our escort was somewhere else, and the ME 109's made pass after pass at us until they ran out of ammunition. We managed to get two of them, but our wing man went down. After that interruption, we went ahead through the flak, and hit our target anyway.

"So far, I have the Air Medal with two Oak Leaf Clusters in line of decorations, and a whole skin, which I value more than the decoration."

Robert H. Meuser Wounded

"Just a few lines to let you know that they finally stopped me. A piece of German shrapnel went through my arm on September 29 and put me in the hospital. Sort of a relief to talk to girls who actually know how the English language should be spoken." In a later letter written on October 24, he said that "the bandage vanished as of today and all that remains is to get the kinks out."

LT. R. T. ROONEY
Washington, D. C.

H. V. BERLIN
South Pacific

Lieut. Col. R. W. Harper

"Since my last message to you, I have been up through British and Dutch New Guinea, where history is being made. Got close enough to hear our artillery banging away at the yellow monkeys.

"Here in Australia they have plenty of parades; their troops in 'Jungle Green' with their slouch hats look like 'HF' fighting men. The gals also parade—Wacs, Waves, Nurses, etc., come swinging down Queen Street proudly swinging their arms, and of course being led by a bagpipe band. I hope you folks back in New York won't think the show is over when Hitler and Co. are hors d'combat, because there will still be plenty going on over here."

Technical Observers in France

L. L. GLEZEN, R. B. HEARN and E. L. PEDERSEN, who are on a special assignment with the Western Electric Company, are in Paris as Technical Observers in the Signal Section of the Army. Mr. Pedersen recently wrote:

"Mr. Glezen and I are working together again and I must say we are both enjoying it after a long separation. The work, however, is quite a headache for both of us. We have for some time now been engaged in planning of forward communications networks. We have to tackle all phases of the problem, even to procurement of equipment and personnel. In addition, we attend to survey of open-wire lines, cables of all kinds, erection of buildings for repeater stations, deal with the French telephone officials and what have you. Would like to give you details regarding all this work, but it is all of a secret nature so the reports will have to wait.

"At times I feel that we are really contributing a good deal and again at times I feel like we are butting our heads against a stone wall. Dealing with the French is rather interesting; they have some very good men technically, and they are all anxious to coöperate with us. Have seen a number of interesting equipment features used by the French and must admit that the workmanship on some of their installations is really excellent.

"This overseas assignment has really been the most interesting work I have ever had. It has been hard work (too hard at times) but I expect we will come through O.K. It has been somewhat rough, but the only damage so far is a considerable reduction in my waistline. I have seen a great many things of interest which I hope I never will forget,

E. J. MOSKAL
Selman Field, La.

H. S. HOPKINS
Ft. Meade, Md.

but I have also seen many things which I hope I can forget. After all, this is war, and at times I have been closer to it than I expected to be.

"I was certainly glad to see R. B. Hearn arrive here a few days ago. Think I will arrange a trip up to the front with him to get him properly initiated. Both Mr. Ramey and Mr. Talberth from the Long Lines were welcome too. This addition to our group should relieve both Glezen and myself of some of our headaches."

Bartinelli and Indian Buddy Save Each Other in Italy Battles

The following story appeared in a recent edition of *The Herald Statesman* (Yonkers) about ANDREW BARTINELLI, one of our members on military leave of absence:

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

"An unusual story of the strong friendship and heroism of two Infantrymen on the Italian front—one a Yonkers soldier and the other a full-blooded American Indian from Lapwai, Idaho—is unfolded in a report from Fifth Army Headquarters on how the men saved each other's life while in combat.

"According to the Army report, Andrew F. Bartinelli and Clifford Blackeagle were members of the same unit of the 133rd Regiment of the 34th (Red Bull) Infantry Division. Both were riflemen.

"The two soldiers struck up a strong friendship and often volunteered together for missions which would take them to within a short distance of the German lines.

"During a heavy German counterattack near Cisterna, Italy, a German rifleman sneaked up to within fifteen yards of Private Bartinelli and tossed a hand grenade. It missed him and exploded beside Private Blackeagle. A fragment penetrated his neck, severing an artery.

"The Yonkers soldier rushed to his companion's assistance despite withering small arms fire. He placed his thumb over the torn artery to stop the bleeding and helped Blackeagle to a first-aid station.

Andrew Bartinelli (left), who retired in 1935, and his son who was wounded in Italy recently visited the Laboratories. Mr. Bartinelli now has his own business repairing clocks

"Two months later, Blackeagle and Bartinelli were together again with their platoon in the battle-scarred town of Trepola, below Pisa. An enemy shell hit a house and shell fragments struck Bartinelli in both legs. Blackeagle picked him up and carried the Yonkers soldier to a nearby house, where he dressed the wounds.

"Then, ignoring his own safety, the Indian youth carried his buddy outside to a shallow ditch. Down this he travelled with his burden, to get out of the barrage area, to a first-aid station. German artillery crashed perilously close to the pair, but Blackeagle kept going.

"When German machine gunners sprayed the path, they took cover in a culvert until darkness. When night fell, Blackeagle carried Bartinelli the rest of the way to the medical aid station."

LIEUT. KENNETH C. OESTREICHER

Lieut. Kenneth C. Oestreicher

LIEUT. OESTREICHER has recently been promoted to First Lieutenant and made lead navigator on a B-24 Liberator crew. He is attached to the 15th Air Force in Italy. In a recent letter he says that he vis-

G. B. Herblin
Europe

T. O'Sullivan
Cornell

ited Munich and left cards at Adolf's famous beer hall.

Kenneth's brother, Gerald, a former member of the Laboratories, is a staff sergeant in the Marine Corps and has been in the South Pacific for about ten months.

Edward J. Moskal

"I met Peter Hollod here at Selman Field, Louisiana. He is graduating this week and expects to visit the Labs soon. I am here for the final stages in my navigational training. In the program here we are taught the principal factors of navigation."

Guerdon B. Herblin

Guerdon B. Herblin is now overseas as a sergeant in the Army Engineers. While he was still a machinist in the Test Station at 32 Sixth Avenue he had taken some flying instructions and when stationed at Camp Gordon, near Augusta, Ga., he took every opportunity for further flying at his own expense. Before going overseas he had received a student pilot's license.

Joseph A. Fairbrother

Joseph A. Fairbrother of the Marines is now stationed in the Pacific. "The chow cannot compare with that of Oscar of the Waldorf; however, it is surprisingly good, considering the channels it must go through to reach its destination."

Commander R. D. de Kay

"Having been given command of a division of destroyer escorts, I am about to leave the *Lovelace*, which I have skippered for a year, and shift to another vessel."

Morgan F. Hickey

"Today I met W. O. Eickerson from the Model Shop and W. T. Quinn. In September our group celebrated completion of 200 combat missions in the European theater of operations. We also received the Presidential Citation."

Robert F. Rennick

"I am stationed 'somewhere in the Netherlands East Indies.' It certainly made me feel proud to know that the boys in A. D. Knowlton's department with whom I once worked helped design equipment used on the B-29's that raided Japan."

Robert R. Stephens

"I got a break and have been assigned to a squadron already. It is a Marine bomber outfit, the planes resembling the Army B-25. However, we call them PBJ's. As it stands now, I am the only man in the squadron who knows how * * * works. So I have my hands full. Besides having to maintain the present gear, I have to 'brief' plane crews in its operation and study a new piece of gun-pointing gear for the 75 mm cannon."

Ens. J. V. Elliot
Plattsburg, N. Y.

Lt. F. J. Fleischer
Atlantic

Lt. W. J. Rapp
Warrensburg, Mo.

C. T. Bolger
Drew Field, Fla.

Lieut. Comdr. R. H. Miller, Col. J. M. Hayward and Lieut. V. M. Meserve all spoke at the recent 25th anniversary dinner of the Western Electric Post of the American Legion

Lieut. S. Milton Ray

"I am now the Materials Movement Officer of the Bureau of Ships Spares Division at the Naval Supply Depot, Clearfield, Utah. This job has to do with the receiving, issue, packing and shipping of spare parts for vessels of the Pacific Fleet. These ships can certainly consume 'spares' too. The volume of work has been increasing and when the European situation eases we will rapidly rise to a peak load.

"It would seem that the world picture is brightening considerably and that this great conflict may be over sooner than had been expected. However, it will not be ended with the fall of Germany. From what we see and hear the battle of the Pacific will be a hard one. We therefore hope that everyone will stick to his task and work as hard or harder until it is completely over. If this be done, the sooner we will be able to return to our normal way of life."

George F. Brown

"As usual I can't say much as to my whereabouts or what I am doing. All I can say is that we are near the so-called front out here. As yet we haven't seen any Japs but we sure are looking forward to getting a crack at them.

"The work I am doing is very interesting as it takes a trend to the work you folks back at the Labs are doing. I have seen quite a bit of Western Electric and Bell Labs test equipment and it is tops in our estimation."

Raymond S. Yerden

"So far I have been one of the more fortunate Marines in the Pacific and I'm lucky for that. Had a pretty good trip a while back and I was glad to move because I don't like to be in one spot very long unless it's good old New York. This camp is really swell—excellent chow, and good liberty."

Walter A. Farnham

"Have completed eight missions so far. Hasn't been too bad as yet but I'm keeping my fingers crossed. One of the fellows in the formation shot down a Zero. It was good seeing him go down. The Japs aren't very well liked here due to their treatment of war prisoners."

C. E. Stone
Ft. Schuyler, N. Y.

E. E. Francois
Blytheville, Ark.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Richard G. Dolbear

"Army life is the same routine day after day in this branch of service. Our job is being a small cog in the vast supply system of the Army. A question sometimes arises in one's mind as to how we are helping the war effort. Being so far from the front lines here in England seems more like working back home with no disturbances.

"Congratulations on receiving the Army and Navy 'E' for the fourth time. It is a great feeling to know the gang back home is behind us 100 per cent."

Clifford N. Greene

"Have just finished primary flying school here at Albany, Georgia. This business of flying is really great. As for the South—I'll take New Jersey any time!"

John P. Robinson

"I have just returned to my outfit after having spent six weeks at an Ordnance School in Atlanta, Georgia. At the school I received instruction in field rigging, heavy wrecker and recovery operations. I'm in charge of the recovery section in my company and am responsible for the training of the men connected with it."

Military News

Lieut. Joseph M. Cook, son of M. H. Cook, Director of Specialty Products Development, has been reported missing in action over German on October 7. As pilot of a B-24 bomber of the 8th Air Force, Lieut. Cook began flying combat missions in July of this year.

Robert M. Hulle has been granted a personal leave of absence to cover the time he spent in the Signal Corps Training School from December 14, 1942, to May 5, 1943, and a military leave since the latter date.

S. G. Reed
Camp Crowder, Mo.

C. B. Brown
Sampson, N. Y.

W. P. Brander
Frankford Arsenal

M. J. Corley
New York City

James S. Devanney, Robert J. Nielsen and Casimir J. Osiecki, who have been on military leaves of absence, have returned to the Laboratories.

Warren Wheeler, with the Seventh Army in France, sends his regards and says his progress through France can be followed by watching the Seventh Army.

Harold V. Berlin has been promoted from Private First Class to Technician 5th Grade. He left the States for overseas duty in the South Pacific area last March. Upon arrival at an island base he was assigned to the dispatching section in the Office of the Adjutant General of the Island Command.

Captain Ernest C. Graunas writes: "Can't say I find New Guinea a pleasant place even though I'm not experiencing any hardships. Have been in New Guinea some time and am associated with supply work."

Frank Navratil is with the 80th Division somewhere in France; Michael F. Coffey is on active duty in the Atlantic; George Seibel is overseas; William R. Davis, who has been overseas for a year, was with the 4th Marines on Saipan and Tinian Islands.

Recent promotions to rank of: T/Sgt. James J. Viggers; SOM 2/c Andrew M. Kurutz; Technician 4th Grade Edward W. Karpen; Technician 4th Grade John P. Robinson; Ensign Warren S. Prall; Lieut. Robert I. Nolan; FC 2/c Robert H. Funck.

Ensign John V. Elliot has recently left on military leave of absence and is going for indoctrination at Camp MacDonough,

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Plattsburg, N. Y.; HOWARD S. HOPKINS stopped at the Laboratories recently on his way from Camp Wheeler, Georgia, to Fort Meade, Maryland.

RAYMOND ENGEL visited West Street after completing his boot training at Sampson, N. Y.

GERARD V. SMITH was recently promoted to Staff Sergeant at a B-24 Liberator base. As group communications technician, he is responsible for inspecting equipment throughout the base including all the plane radios and has played an important rôle in helping his group successfully complete over 100 combat missions. He has been overseas since last January.

BETTY KENNY of the Waves has been transferred to the Quonset Point Naval Air Station as Aerial Free Gunnery Instructor; WILLIAM DIMELLA is taking his basic training at Fort Belvoir, Virginia.

ANDREW M. KURUTZ has been on active duty in the Pacific aboard a destroyer for the past year.

LAURA CHAMBERLAIN of the Wac, serving with a signal service battalion in Washington, D. C., has received an honorary medical discharge.

PATRICK J. SMITH, E. A. LICHTENBERGER, LIEUT. CHARLES R. SCHRAMM, and LIEUT. THOMAS A. PARISEAU have all been sent overseas recently.

LIEUT. JOHN G. PHILLIPS received his "wings" and commission in the Army Air Forces recently in Sacramento, California.

ENSIGN WARREN S. PRALL is stationed at De Land, Florida, for operational training in dive bombing.

Louis Ramirez (left) and John Sus, formerly members of the Laboratories, recently visited West Street

Lieut. Thomas M. Pepe is at the Marine Corps Air Station at Santa Ana, Calif.

WILLIAM F. JOHNSON is stationed at Camp Polk, Louisiana, as a supply sergeant. "The job calls for volumes of very dull paper work and aspirin."

WILLARD A. REENSTRA is now back in the States after duty with Amphibious Forces on the British Isles. He is stationed at Rensselaer Polytechnic Institute in Troy, New York.

BOYD E. BROWN, JR., is "somewhere in Belgium"; CHARLES W. PETERSON has been sent overseas; JAMES G. VIGGERS is in France; and JOHN M. MARKO writes that he spent a little time in England before being sent over to France.

R. H. FUNCK of the Navy says: "*The Merciless Melvin* is still holding together out here after quite a few months' sailing."

CHARLES S. GRAHAM recently went overseas and is now in France.

ANTHONY A. LUCIANO is on active duty in the Pacific; ENSIGN ROBERT E. YAEGER is stationed at Princeton "learning how to be an electronic engineer."

CHIEF PETTY OFFICER C. E. STONE visited the Laboratories recently. He is stationed at Fort Schuyler, N. Y.

Military Addresses Wanted

Members of the Laboratories on military leaves of absence from whom copies of the RECORD have been returned due to incorrect addresses are:

James V. Cunningham
Paul Hopf
Gordon J. MacDonald
Joseph E. O'Keefe
John R. Sackman

News Notes

THE ROSTER of officers and committees of the American Institute of Electrical Engineers for 1944-45 includes the following members of the Laboratories:

Board of Examiners, H. W. WARREN (retired), chairman, and H. M. TRUEBLOOD; *Constitution and By-Laws*, R. L. JONES; *Edison Medal*, O. E. BUCKLEY; *Finance*, D. A. QUARLES; *Charles LeGeyt Fortescue Fellowship*, O. E. BUCKLEY, chairman; *Members-for-Life Fund*, F. H. COLPITTS (retired); *Prizes, Award of Institute*, H. A. AFFEL; *Publication*, JOHN MILLS; *Research*, M. J. KELLY; and *Standards*, R. L. JONES.

Members of technical committees are: *Basic Sciences*, M. J. KELLY and J. D. TEBO; *Communication*, H. A. AFFEL, chairman, S. B. INGRAM and R. G. MCCURDY; *Education*, G. B. THOMAS; *Electronics*, S. B. INGRAM; *Instruments and Measurements*, E. I. GREEN; and *Protective Devices*, P. A. JEANNE and A. H. SCHIRMER.

H. PETERS and W. MCMAHON visited the synthetic rubber plant of the General Tire and Rubber Company at Baytown, Texas, to inspect the process of incorporating pigment in the polymer during the latex stage.

W. O. BAKER spoke on the *Nature of Transitions in High Polymers* before the Lehigh Valley Section of the American Chemical Society at a meeting held in Palmerton, Pa., on September 22.

A. E. PETRIE, C. H. ACHENBACH and V. T. CALLAHAN visited The Chesapeake and Potomac Telephone Company in Washington where they discussed Diesel engines.

C. W. F. HAHNER has been appointed Contract Settlements Manager reporting to A. O. JEHLE, General Auditor. Mr. Hahner will be responsible for the coördination of procedures and operations within the Laboratories necessary to comply with the terms of contract termination orders received by the Western Electric Company from Government Agencies. In such matters, and in those relating to the acquisition and disposition of War Emergency Facilities, Mr. Hahner will act as the General Auditor's representative in relations with Western and with Government Agencies.

P. M. MAHER, JR., has been appointed Contract Settlements Engineer reporting to H. A. BLAKE, Assistant Commercial Relations Manager. Mr. Maher will coördinate necessary operations within the Commerical Relations Department as these may relate to contract settlements.

Pennant presented to the "Blues" who led the seven-team softball league at Whippany at the end of the regular season. A. A. Skene (extreme right), in charge of all athletic activities at Whippany, presented the pennant to H. T. Casey (extreme left), captain of the "Blues"

The "South Wing Slugs" won the Whippany softball league playoff which was conducted at the end of the regular season on the same basis as the Stanley Cup playoffs in hockey. Here we see R. E. Coram (right), as vice-president of the Bell Laboratories Club, presenting the trophy to S. E. Hardaway, captain of the "Slugs"

C. S. FULLER and C. J. FROSCH visited the Radiation Laboratory at M.I.T. to discuss special plastics problems.

I. E. FAIR, at the Hawthorne plant of the Western Electric Company, discussed the manufacture of quartz crystals.

W. P. MASON went to Washington in connection with N.D.R.C. work.

A. C. WALKER spoke on *Statistical Quality Control as Applied to Thread Abrasion Tests on Textiles* before the Statistical Quality Control Society in Newark on October 16 and before the mathematics statistics group at Princeton University on October 23.

K. G. JANSKY, in the November issue of the *Proceedings of the I.R.E.*, reviews the book *Radio Direction Finders* written by Donald S. Bond.

L. S. INSKIP, A. E. DIETZ and E. B. WHEELER visited the Underwriters' Laboratories at Chicago on October 16 and 17 to discuss station-fuse development and safety requirements for special station equipment for hazardous locations.

J. A. KATER was at Hawthorne during the week of October 23 to attend a Quality Survey on silvered mica condensers and to investigate problems associated with the manufacture of special condensers for military applications.

A. J. CHRISTOPHER was in Lincoln, Nebr., in connection with condenser problems of Spiral-4 cable. He also was in Buffalo on the drafting of the R.N.A. specification on silvered ceramic capacitors. At Erie, he discussed with engineers at Erie Resistor Corporation the production of silvered-mica capacitors.

A. D. HASLEY spent a week at Hawthorne where he conferred with Western Electric engineers on transformer problems.

J. H. BOWER discussed special battery problems at the National Carbon Company, Cleveland.

R. S. GRAHAM and D. T. BELL inspected the first model of a special computer at the Hawthorne plant of the Western Electric Company.

T. L. TANNER, at Elyria, Ohio, observed corona testing of cables.

C. A. WEBBER and W. J. KING, on a trip to Dayton and to Chicago, discussed high-voltage cables and connectors. Mr. Webber was also in Boston on similar work.

DR. A. E. JOHNSON of the Medical Department spoke on the development of pulmonary tuberculosis as the probable result of frequent exposure to altitudes above 40,000 feet at a meeting of AERO Medical Society of America held in St. Louis.

Distaff

DOROTHY ALLYN CARLSON has been a member of the Laboratories for 22 years. She came here directly from school and began working as a stenographer. Mrs. Carlson, better known to most members of the Laboratories as Dorothy Allyn, is now secretary to M. R. MCKENNEY and W. C. KIESEL of the Patent Department in the Davis building.

Dorothy is interested in music—she was at one time the soprano soloist for the Laboratories' Glee Club. She met her husband, a radio announcer with station WOR, while singing with a mixed quartet in church.

Before the war the Carlsons' favorite diversion was sailing. They had their own sailboat at Beechhurst, Long Island, but have given it up for the duration and have turned their attention to extensive Victory gardening with gratifying results.

* * * * *

HER UNUSUAL NAME is one of REINE LEVESQUE'S heritages from her French ancestors who originally came from Normandy and, more recently, from Canada. Her family speaks French at home a great deal, and she admits that at times she has a rather difficult time conversing with her French-speaking relatives, although she speaks some French herself.

Reine is the receptionist at Murray Hill. She was a secretary and bookkeeper until 1941 when she came to the Laboratories and went to Murray Hill as receptionist with the first group to go out there. When she began her work, she said, the group was small and it was easy to know everyone there, but now she finds it difficult to remember all the new faces that have appeared during the past few years.

She was born in Rhode Island, but has lived most of her life in Summit. Letter writing takes up most of Reine's free time, although she does find time to enjoy roller skating, movies, sewing, sketching, and collecting phonograph records.

* * * * *

ELEANOR BRELAND came to the Laboratories almost a year ago as a messenger girl at the Graybar-Varick building. Later she

DOROTHY CARLSON

was transferred to West Street as a mail girl, and is now doing typing and general clerical work at the Davis building. Some of her duties there, besides typing, include proofreading, ordering specifications and claims of cases, collating orders, and shaving Ediphone cylinders for the dictaphone.

Eleanor took a commercial course in high school and was graduated in January, 1944. Now she is continuing her studies by taking a course in stenography two evenings a week at a business college.

For relaxation and amusement Eleanor likes reading, ice-skating and dancing.

Reine Levesque, the receptionist at the Murray Hill Laboratories

MARION TROELLER took a war job at the Murray Hill Laboratories when she learned that her husband, RAYMOND S. TROELLER, also a member of the Laboratories who is now on military leave of absence, was to enter the service. A recent letter from him and the news that he has been wounded in action in Germany appears on page 624B. Mrs. Troeller is an assistant in the chemical storeroom at Murray Hill where she has charge of ordering chemicals and taking care of the stock there.

* * * * *

THE MAZE of wire shown here in front of EDYTH SHAW is no mystery to her. She is building cables for power supply equipment for the Armed Forces in the cable section of the Chambers Street shop. She was the

Marion Troeller in the chemical storeroom at Murray Hill working at a war job while her husband is fighting overseas

Eleanor Breland in the transcription group of the Patent Department at the Davis building is shown collating orders

third woman to begin working in the shop at Chambers Street when it opened last year.

Mrs. Shaw came to New York from North Carolina, where she was born. Before the war she did private concert singing and also concert singing for churches. She gave up this work when the war started and took a six-month training course in radio work with the U. S. Signal Corps in New Jersey. She continued her radio work there until she came to the Laboratories. Here she was trained in the building of cables. Typical of women replacing men in essential war work, she enjoys both her work and the fact that she is doing a necessary war job.

EDYTH SHAW

Russian Women Form Army Telephone Crew

The story of how Russian women helped to make possible the swift completion of airfields used by Allied shuttle bombers was told recently in *Yank*, the Army weekly.

One chilly morning, an Air Forces sergeant, waiting for a labor detail promised by Russian headquarters to help him plant telephone poles for the new airfield, heard the chant of feminine voices. Looking up, he saw a formation of women make a column-right around a brick building. They wore the Red Army uniform modified by a skirt. The formation halted near the sergeant and the marching song ceased with the final step.

A woman officer approached the sergeant and said in English: "These are the soldiers who will put up the telephone poles." A little ill at ease, the sergeant looked over his detail and his detail looked right back. The women, he noted, carried rifles slung over one shoulder and shovels over the other. Getting hold of himself, the sergeant explained to the woman officer how he wanted the job done. It was done exactly that way.

* * * * *

JANET HEBERTON, a technical assistant in one of the apparatus development laboratories at Murray Hill, is an ambitious young lady who has used her limited leisure time to obtain her private pilot's license.

Her interest in flying was first roused in high school, where she took a pre-flight aviation course. In this course she learned about engines and aerodynamics, and also that flying was to become one of her major interests in life. In April of 1944 Janet began her private flying lessons at the airport in

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There are now 185,000 *telephone operators in the Bell System—the largest number in history. This figure does not include approximately* 14,000 *PBX attendants—also the largest number in history. As telephone calls have increased, more people have been added to handle them*

Allentown, Pennsylvania. She had to rise early every Sunday morning in order to reach Allentown for her weekly lesson. In June she made her first solo flight, and received her pilot's license in October. Her biggest thrill came, she says, "One day when I was up doing 'spins'—the engine stopped dead and I had to land in a cow pasture. My instructor found me in a short time walking back to the field—he was more upset than I was!"

At Murray Hill Janet works on microphone designs. She helps build microphones and puts them through various tests.

Janet lives in Chatham, New Jersey. She likes all sports and music—belongs to the choir in church, and helps with entertainment at the Camp Kilmer U.S.O.

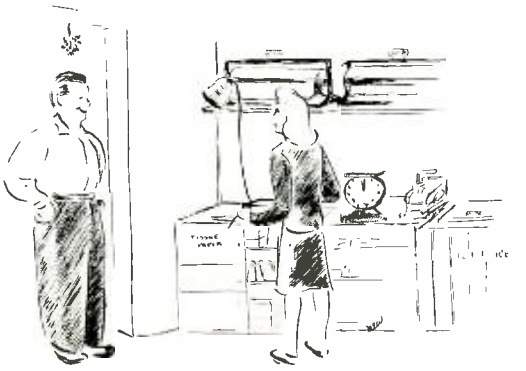
JANET HEBERTON

Do You Have a Fuel Problem?

According to a report by the Homemaking Specialists of the General Electric Consumers Institute, "Government authorities say the shortage on fuel is due not to the availability of coal and fuel oil, but lack of transportation facilities from mining and oil-producing centers. With fuel still on the list of critical shortages, it will be necessary again this year to practice the fuel conservation economies of previous years in order to make our supply stretch until spring."

Here are some of their suggestions on how to pamper your heat and make the most of it:

Reduce normal home temperature.
Lower heat when leaving the house.
Halt escaping heat.
Conserve hot water.
Shut off unused rooms.
Keep window shades drawn as much as possible.
Keep heating system clean.



"I'm sorry, lady, we're fresh out of tinsel cord—"

News Notes

R. H. COLLEY gave a talk on *Pole Problems of Today* at the annual meeting of the International Municipal Signal Association held in Boston.

DR. COLLEY attended a meeting of the Executive Committee of the American Wood-Preservers' Association in Chicago. He also visited the Forest Products Laboratory in Madison, Wisc., for conferences on wood preservation problems. Pole production and pole treatment methods were discussed with Forest Service representatives at the Lake States Forest Experiment Station, St. Paul, and in National Forest timberland in Michigan.

G. Q. LUMSDEN was in Hazleton, Pa., in connection with studies of ground line treatment of poles in line.

C. D. HOCKER and A. P. JAHN were at Sandy Hook on October 11 to make a semi-annual inspection of metal-coated samples undergoing atmospheric tests sponsored by the American Society for Testing Materials. Mr. Jahn also made similar inspections at Bridgeport, Pittsburgh and State College.

G. J. MAGGI has been in Princeton on matters pertaining to the trial installation of coaxial cable test equipment.

Engagements

*Frank DeMotte—*Jane Phillips

Weddings

*Walter B. Bachman—Juanita Frazee
*Arthur W. Daschke—Katherine Gorman
*Walter L. Filmer—*Harriet Barnett
Samuel Garry, U. S. Army—*Muriel Wagge
*Hansel Hodge—Veronica Miller
*Michael Konash—*Herta Modt
*James N. Walter—Vianna Wasson
*Lt. Robert S. Williams, U. S. Army—Amalie Debler

*Members of the Laboratories. Notices of engagements and weddings should be given to Miss Mary Ellen Wertz, Room 1103, Extension 296.

"THE TELEPHONE HOUR"

(NBC, Monday Nights, 9:00 P.M., Eastern War Time)

DECEMBER 4, 1944

Fingal's Cave Overture — *Mendelssohn*
Orchestra
Concerto in D Minor— — *Sibelius*
Second Movement
Jascha Heifetz and Orchestra
Gweedore Brae — *Trad.-arr. Crowther*
La Capricieuse — *Elgar*
Caprice No. 13 — *Paganini-Kreisler*
Jascha Heifetz and Orchestra

DECEMBER 11, 1944

Stars and Stripes Forever — *Sousa*
Orchestra
But the Lord Is Mindful of — *Mendelssohn*
His Own from "St. Paul"
Marian Anderson
Meditation from "Thaïs" — *Massenet*
Orchestra
I Am Bound for the Kingdom — *Spiritual-arr. Price*
In Dat Great Gittin' Up Morning — *Spiritual-arr. Brown*
Marian Anderson
Gate at Kiev from "Pictures at an Exhibition" — *Moussorgsky*
Orchestra
Pleurez, Pleurez, Mes Yeux from "Le Cid" — *Massenet*
Marian Anderson

DECEMBER 18, 1944

Danse Bohémienne from "La Jolie Fille de Perth" — *Bizet*
Orchestra
Cordoba — *Albéniz*
Toccata — *Ravel*
Robert Casadesus
La Fontana di Villa Medici al Tramonto from "The Fountains of Rome" — *Respighi*
Orchestra
Concerto in G Minor— — *Saint-Saëns*
Second Movement (Scherzo)
Robert Casadesus and Orchestra

DECEMBER 25, 1944

Adeste Fideles — *Traditional*
Helen Traubel
The Mendelssohn Glee Club and Audience
When Children Pray — *Fenner*
Toyland from "Babes in Toyland" — *Herbert*
Helen Traubel
Singers' Greeting—Ecce Quam Bonum
Wassail Song — *Williams*
Break Forth, O Beauteous, Heav'nly Light from "Christmas Oratorio" — *Bach*
Mendelssohn Glee Club
Overture to "Hansel and Gretel" — *Humperdinck*
Orchestra
The Omnipotence — *Schubert*
Helen Traubel and
The Mendelssohn Glee Club

Bell Laboratories' Club has no more tickets for these programs because its limited supply has already been distributed to applicants.

Obituaries

FRANCIS A. HUBBARD, Special Apparatus Development Engineer, died suddenly on November 6. Born in Cambridge, Mass., he graduated from Harvard with an A.B. degree in 1911 and received the M.E.E. degree from the same university in 1914. After a year's teaching at Cornell he entered the Engineering Department of the Western Electric Company in 1915. When the foreign business of Western Electric was sold to International Telephone and Telegraph Company, Mr. Hubbard joined its subsidiary, the International Standard Electric Company. As its transmission engineer and later assistant chief engineer, he laid out the Stockholm-Gothenburg long-distance telephone cable and a similar cable connecting Milan, Turin, and Genoa. He also established the first transandean telephone circuit in 1928. Later he became vice-president and general manager for the Mexican Telephone and Telegraph Company.

F. A. HUBBARD
1890-1944

In 1930 Mr. Hubbard returned to the United States as a transmission engineer for the American Telephone and Telegraph Company. He transferred to the Laboratories in the 1934 consolidation and became switching research engineer. During the present war he had charge of the preparation of operating and maintenance instructions for electrical directors for anti-aircraft guns. This involved first-hand studies of their performance in the field, and enabled him to make important contributions to their design, particularly with regard to their dependability in service.

* * * * *

EMANUELE SEGRETO of the Local Service Department died on October 23. Born in Italy, he came to the United States in 1920 and joined the Laboratories in 1926 as a general porter in the Plant Department. He was assigned to the sound picture laboratory in Section L when this was built. Later he became a porter and then advanced to utility service hand with the local service organization of General Service.

* * * * *

JAMES B. DOYLE of the Building Service Department died on November 2. Mr. Doyle joined the Laboratories as a cleaner in 1942 and since last April had been a night watchman.

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JOHN CUMMINGS of the power service group of the Plant Department died on November 12. Mr. Cummings joined the Western Electric Company in 1916 as a fireman in our power plant in the West Street building. He held this position until his death.

JOHN CUMMINGS
1893-1944

* * *

EDWARD O. COUSINS, who retired from the Equipment Development Department in 1940 after thirty-three years of active service, died on November 1. Before his retirement, Mr. Cousins was in the manual and step-by-step group where he had been engaged in the analysis and testing of circuits for these systems.

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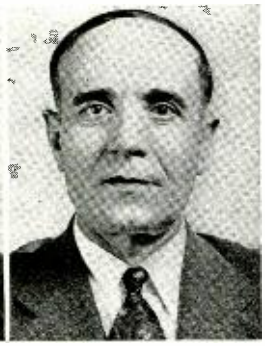
RUTH M. WALSH, formerly a general service clerk in the Central Service Department and who retired in 1943 after sixteen years of service in Bell Telephone Laboratories, died on October 21.

J. B. DOYLE
1903-1944



F. SEGRETO
1892-1944

Telephones at Salerno

A picture of an artillery command post in Italy, which was used on a telephone booth card, was the beginning or perhaps the ending of this story. Lieutenant William S. Jenks of Minneapolis was commissioned in 1941 and early in 1942 went overseas with his unit of Field Artillery. He took part in the African landings and campaign and later in the Salerno landing. Wounded on the Anzio beachhead, he returned to the United States and became a patient at Nichols General Hospital in Louisville. There, one of his fellow patients recognized his picture on the booth card, and Lieut. Jenks immediately remembered the occasion, and asked for some copies to send overseas to his unit. He wrote the Southern Bell's manager as follows:

"The time that the picture in question was taken of my two buddies and myself, we were firing a mission on an enemy target for the Infantry. Shortly after it was taken, we moved up to within firing range of Cassino. I remember clearly when the picture was taken by an officer from Washington, but at that time I did not realize or stop to think about the wide use that has apparently been made of it since then. This was not a posed picture at all but was actually taken as a candid shot during the operation of our Battery. The telephones in the picture represent one of the Army's most important pieces of equipment.

"While moving on the road or establishing a new position or an OP, radio must be used, but as soon as wire can be laid to the Batteries and to the Infantry that we are supporting as well as to our OP's, we immediately begin to use the telephone. The enemy can, of course, pick up a radio beam and listen in to the commands and instructions. However, he would be forced to get behind our lines in order to pick up a telephone conversation.

"The telephone was and is our basic communication. There was a time in Africa that I can remember very clearly when we were limited to the number of telephones per organization. When we lost one or had one go out of service, they were very hard to replace. At the present time in the Artillery

Artillery fire control crew uses field telephone sets to receive and pass along valuable directional data.

SIGNAL CORPS PHOTO

Telephone booth card on which Lt. Jenks recognized himself at the extreme left. The photograph appeared also on page 490 *of the* RECORD *for August,* 1944

Units we have a telephone at each gun pit connected to the Executives' Command Post from which the orders are given to the guns. When we first went into action, the Battery Executive would stand in back of his four guns and shout out his commands to the gunners. It was practically impossible for the gun crews to hear the commands most of the time because of the firing, the wind or the distance between the guns. Because of such uncertainty and interference, our firing was slowed down considerably. After begging, borrowing and stealing, we finally picked up enough telephones so that each gun had one and we immediately were able to improve the speed of firing.

"When I left Italy each gun crew had a telephone as part of its basic equipment. In addition to this, there are, of course, many of these same telephones being sent to our Allies and they need them as badly as we do.

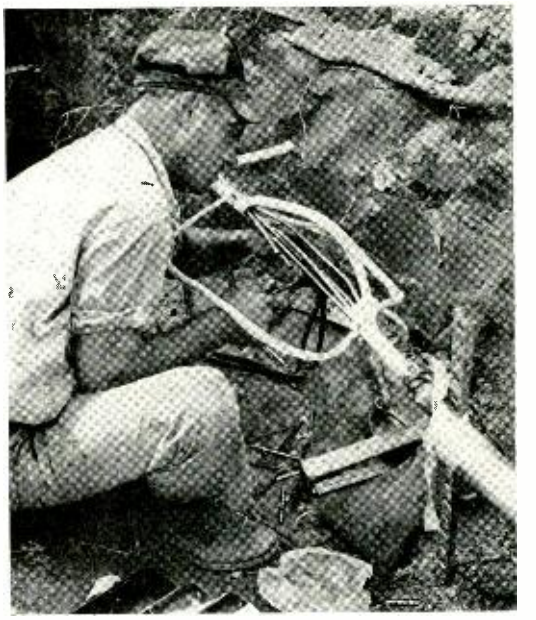
"Because of this first-hand knowledge that I have had of the use of this equipment, I wish that the people back home, who perhaps must wait to have a telephone in their home, might better appreciate the reason for the delay in securing it. The telephone is playing a great part in delivering the knock-out blow to the Axis."

Telephone Instrument Shortage to Be Alleviated

As Allied armies in Europe press forward, plans for some curtailment of war production and start of manufacture of peacetime products prompt the question: "How will Germany's defeat affect chances of getting a telephone?"

There are now about 190,000 families on the waiting lists of the New York Telephone Company. Approximately 55,000 of them live in areas where service could be installed if telephone instruments were available. The other 135,000 are in areas where there is a shortage not only of telephone instruments, but of switchboards and other central-office equipment as well.

So far as the "telephone instrument shortage" areas are concerned, the production and allocation of new instruments, recently authorized by the War Production Board, should enable us to begin reaching the 55,000 at a substantial rate some time next spring—and that it will be possible to install service for a large part of this group by late summer or fall. Those who have been waiting longest will get service first, and the rule of "proper turn" will be followed throughout the list.



Splicing a coaxial cable now being laid between Atlanta and Jacksonville

In the "switchboard shortage" areas the delay will be unavoidably longer. First, broad-scale production of switchboard and other central-office equipment to fill civilian needs has not yet been authorized; and when it is, the manufacture will require months. Second, unlike products that are ready for use when they leave the assembly line, new switchboard equipment cannot be put into service immediately. It must be fitted into existing central-office equipment before it can be used to connect new telephones with those already in service. This process will require still more months.

For these reasons the demand for home telephone service may take longer to fill than the demand for many manufactured products, as the country changes from a war to a peace footing. But families waiting for telephones may feel sure that, once restrictions are lifted on the manufacture of telephone service equipment, production and installation will proceed with all possible speed.

To Promote Farm Telephones

A Joint Committee of representatives of Bell and independent operating telephone companies throughout the United States has been formed to advance the nation-wide post-war programs which the various telephone companies have been working on individually to extend and improve farm telephone service. Co-chairmen of the committee are John P. Boylan, President of the United States Independent Telephone Association, the national organization of the thousands of independent telephone companies, and Keith S. McHugh, Vice-President of A T & T representing the Bell operating companies. A. B. Clark, Vice-President of the Laboratories, is a member of the Facilities subcommittee.

"Rural telephone service is more highly developed in this country, under the American system of private enterprise, than in any other country in the world," Mr. Boylan and Mr. McHugh said in a statement issued by them for the committee. "However, it is by no means as highly developed as we in the industry want to see it, and the industry intends to do everything in its power to provide more service, and better service, at a cost which the farmer can afford.

"Since operating telephone companies throughout the whole country have been working on this problem, a representative joint committee has been formed consisting of a number of their most experienced officials. We believe that the application of new facilities and methods which were under development by the industry before the demands of war interrupted our research and construction program will help to bring telephone service to many new farm customers. As soon as war demands are reduced, we propose to resume and expand our research effort.

"Over one-half million miles of telephone pole lines serving rural areas have already been built so that more than two-thirds of all rural families in the United States can be served from existing lines. Since 1935 more than 500,000 additional families in rural areas have become telephone subscribers—an increase of 35 per cent.

"A second major objective is to extend service at reasonable cost to families not now reached by existing lines. Telephone industry research in the last several years has successfully developed new construction materials and methods which substantially lower the cost of building wire lines to areas not previously reached. In addition, work was started by the industry in 1938 to develop a practical system of transmitting telephone conversations over electric power lines. A similar system can be used over telephone lines to increase their capacity. This so-called rural carrier system transmits a very high-frequency current over the wires. From 1940 on, experiments with this system for telephone service over rural power lines were carried forward in a coöperative effort by Bell Telephone Laboratories and the Rural Electrification Administration.

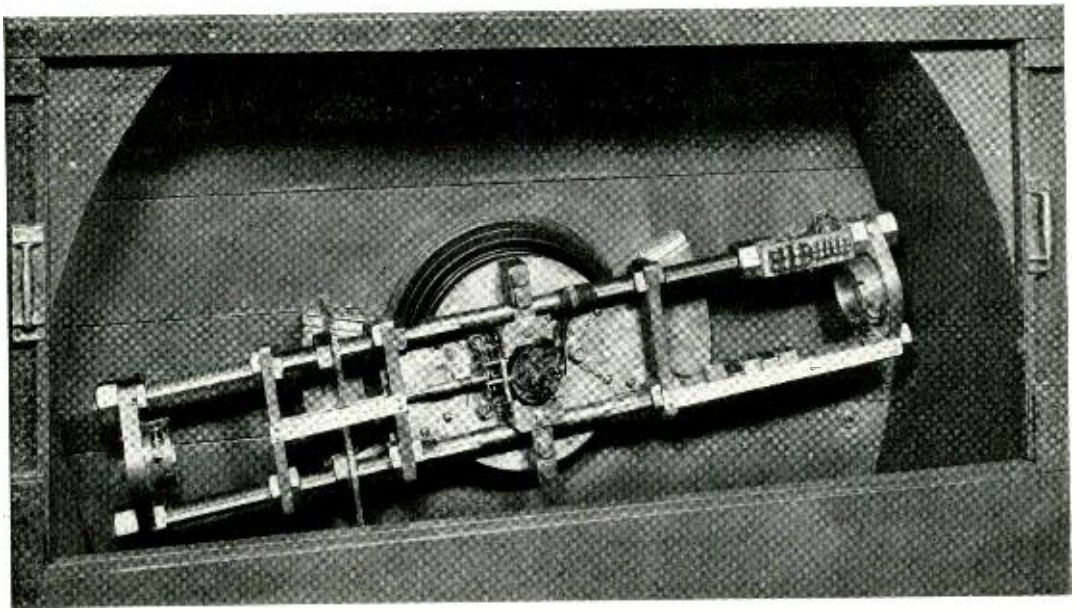
"One practical effect of these developments is to make it physically possible to furnish telephone service wherever there are rural power lines and no telephone lines. The telephone companies plan, in coöperation with R. E. A. coöperatives and with power companies serving rural territory, to determine the full extent to which rural carrier-telephone service can be used economically and effectively.

"The telephone companies also plan to study the possible application of micro-wave radio systems to rural telephone service and to make use of this and any other new methods which will be helpful in service to the farmer."

War Bond Record

A booklet in which War Bond serial numbers, dates of issue and other information can be recorded, has been procured by the Bureau of Publication and has been distributed by Mailing to all members of the Laboratories. When War Bonds are kept in a safe deposit box, as they should be, the booklet is a handy record to keep at home; in any case the record should be kept separate from the bonds, so that if the bonds are lost or destroyed you can furnish the information that is necessary for their replacement.

Anyone who has not received a copy may secure one on request—written, not telephoned—to the Mailing Department at West Street, Murray Hill or Whippany.



A 1,000-*g* Centrifuge

By R. M. PEASE
Transmission Development

IN ITS more usual form, a centrifuge is employed to separate materials of different specific gravities by the action of centrifugal force. At high rotational speeds, objects tend to be driven radially outward with an acceleration proportional to the square of velocity. Heavy particles in a rotated liquid, for example, may be separated from the liquid by this action, or on a mixture of liquids, the heavier may be separated from the lighter. The actual accelerations involved are of no particular concern so long as they will produce the desired separation.

In connection with some recent development work, however, the Laboratories designed a centrifuge not to separate objects, but to subject them to high accelerations under conditions that would permit the effects of the acceleration to be studied. Machines of this general type have been built before, but there was none available that would develop high enough accelerations. The earth's gravitational acceleration, generally represented by *g*, is 32 ft. per second per second, but for these tests an acceleration 1,000 times this value was needed. To secure such a very large acceleration, two parallel steel rods are clamped at their midpoint and rotated by an adjustable speed d-c motor. Fastened between the rods at their outer ends is a heavy steel plate to which is secured a mounting for the object under test. The acceleration imposed upon the test object is proportional to the product of its distance from the center of rotation and the square of the speed. The machine was designed by G. B. Engelhardt. A general view of the apparatus is shown in Figure 2 and a front view, with the arms stationary, is shown in the headpiece.

With the test object in place, this machine may be driven at the speed necessary to give the desired acceleration. After stopping the machine, the effect on the apparatus under test may be determined. Provisions are also made for observing the effect of the accelerations on the object as the speed of the machine is increased. A neon lamp is mounted to shine directly on the object when the arm is horizontal. At each rotation, this lamp lights for a few millionths of a second from an impulse generated in a winding on a permanent magnet when a small iron bar attached to the rotating arm passes the

pole pieces. For the rest of the time, the arm is in comparative darkness. This stroboscopic arrangement makes the arm appear to stand still in the horizontal position; and any distortion of the test object can be observed while the acceleration is being increased.

Such is the machine in essence, but many additional features and circuits are required to permit close control and measurement of the acceleration and to safeguard the operator, the machine, and the surroundings. One of the possibilities that has to be guarded against is a breakage of the rotating arm, since if it broke, one or both ends would fly off tangentially at a dangerous speed. Moreover, if only one end broke off, the arm would become very badly out of balance and there would be danger of the machine tearing itself apart.

To avoid such a possibility, the two rods are machined to a somewhat smaller diameter at the middle where they are clamped to the driving member. If the bars should break, therefore, they would break at the middle and both ends would fly out together, and thus avoid unbalancing the drive. To prevent destruction in the room in the event of such a break, the housing around the entire circumference of the rotating arms is filled with sand to a depth of 18 in. In case of a break, the two ends would bury themselves in the sand, and since they would fly off in opposite directions, the net force tending to move the case would be comparatively small.

When the test object is placed at one end of the arm and a similar object, or balancing weight, at the other, there will in general be a sufficient difference in their weights, or in the distance of their center of gravity from the center of the driveshaft, to cause excessive vibration when the machine is rotated at high speed. The rods are therefore threaded and carry heavy nuts that can be moved in or out to bring about balance. To avoid the necessity of stopping the machine and readjusting the nuts a number of times before final balance can be obtained, a small motor is geared to an adjusting nut on each arm opposite the test object, and is operated through slip rings on the driveshaft. By a simple control on the test panel, the nuts may be moved in or out by the motor as the machine comes up to speed. Other slip rings are provided to bring out test leads for making measurements or operating relays while the accelerating forces are acting.

A direct reading of the acceleration to which the test object is subjected is obtained by coupling a small magneto generator to the driveshaft, and connecting its armature leads to a thermocouple. The output current of this type of generator is directly proportional to the speed of the driveshaft, but the reading of a meter associated with a thermocouple is proportional to the square of this current, and thus in this application to the square of the speed. Since the acceleration is also proportional to the square of the speed, the thermocouple meter can be calibrated

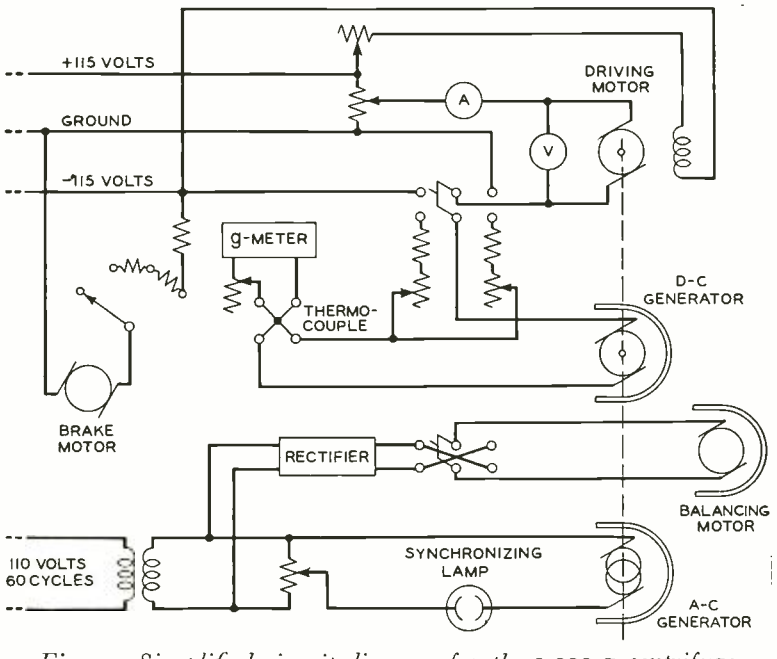


Fig. 1—Simplified circuit diagram for the 1,000-g centrifuge

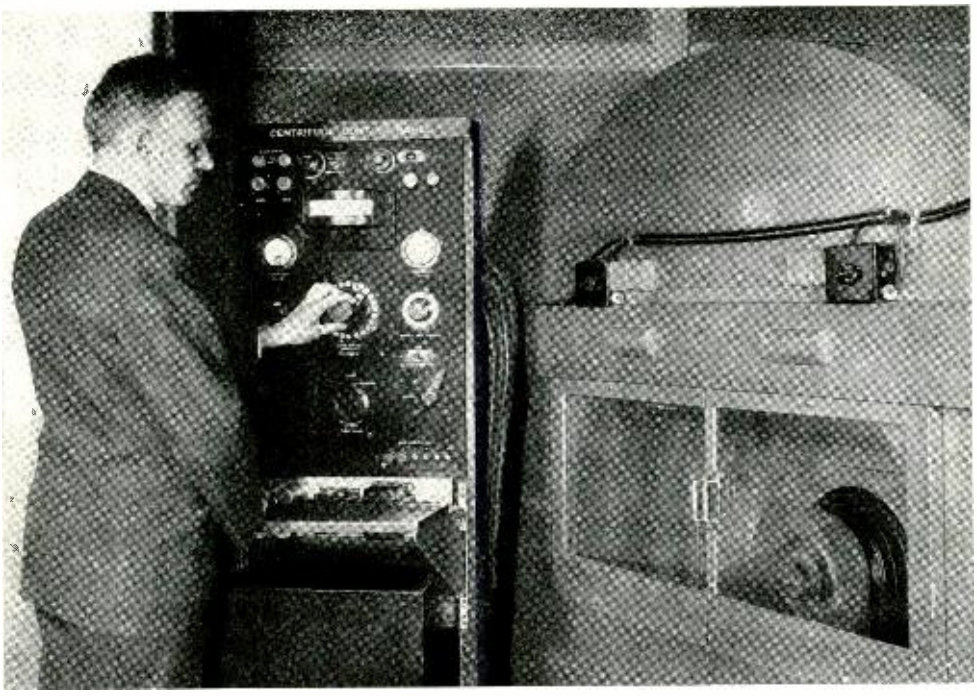


Fig. 2—General view of centrifuge in operation

with a linear scale in terms of the acceleration to which the test object is subjected. The actual calibration is in terms of *g*, the gravitational constant, and therefore the meter is called a *g* meter.

Besides these controls, provision has also been made for checking the calibration of the *g* meter at certain points, as will be described later. The circuit for this apparatus is shown in Figure 1 and the arrangement of controls on the panel in Figure 2.

Power supply for the motor is a three-wire d-c circuit with a grounded neutral. A potentiometer is connected between the positive lead and ground, and the positive side of the armature is connected to the movable arm. A double throw switch permits the negative armature lead to be connected either to ground or to the −115-volt lead. By use of this potentiometer and double-throw switch, therefore, the voltage applied to the armature can be varied from 0 to 230 volts. With the double-throw switch in the low-range position and the potentiometer arm at the grounded end, no voltage is applied to the armature. As the potentiometer arm is now moved toward the +115-volt end, the motor starts, and increases in speed until about half speed is reached. The double-throw switch is then opened, the potentiometer quickly returned to its original position, and the switch thrown to the high range. By once again moving the potentiometer arm up, the speed is further increased. The shunt field is connected across the two outside wires through a field rheostat. For very high speeds, or for fine speed adjustment with the potentiometer in any position, the field rheostat is employed.

To give more precise reading of acceleration, the *g* meter is provided with two scales: one used when the meter is operated on the low range, and one when on the high range. The proper resistance is connected into the circuit by the double-throw switch used for selecting the range desired, thus always keeping the *g* meter on the scale for the most accurate reading.

The 6-volt motor that slides the weights in or out along the rotating arm to adjust the balance is operated by a rectifier through a reversing key to permit the motor to be operated in either direction. With the key in the normal position, the circuits between the a-c supply and the rectifier and between the rectifier and the motor are both open.

When the centrifuge is to be stopped, braking is accomplished in two steps: dynamic braking is used for the initial period while the speed is high, and a motor-operated mechanical brake for the final stopping. To stop the motor, the starting operation is carried through in the reverse direction. The applied voltage is decreased from 230 to 115 volts by turning the potentiometer back, and then this process is repeated with the starting switch in the low-range position. As the potentiometer is turned back, the mechanical brake may be operated in order to bring the motor to rest more quickly.

To permit the reading of the *g* meter to be checked, a small 60-cycle a-c generator is also coupled to the driveshaft. The output frequency of this generator can be compared with 60-cycle commercial supply through a neon discharge lamp and a resistance. As the speed of this generator approaches that at which its output is 60 cycles, or some simple multiple thereof, the lamp flashes. When the lamp lights or remains out continuously, the frequencies are integrally related. By this means, it is possible to make a check at the point where the two frequencies are equal, or where one is one-half or double the other. This gives two check points on the calibration of each scale of the *g* meter, since one of the points occurs on both scales.

Studies with this machine have made possible new and improved apparatus which the Western Electric Company is producing for our Armed Forces.

THE AUTHOR: R. M. PEASE graduated from Brown University in 1921 with the degree of Sc.B. in E.E., and then entered Systems Development to work on the standardization of toll equipment. Later he transferred to Apparatus Development to assist in the development of power-line carrier systems. He subsequently became a "charter member" of the Sound Picture Laboratory, where he worked on sound recording. Later he toured this country and Canada for a number of years with Dr. Grace, demonstrating the lecture apparatus. Following these tours, he set up some of the apparatus at the Century of Progress Exposition in Chicago, and trained a group in its operation. He then joined the radio group, working on broadcasting and police radio equipment. At the present time he is with the transmission group, where he is concerned with television transmission. For the last three years, however, he has been engaged in confidential war work.

The Townsend Harris Medal

has been awarded by the Associate Alumni of the College of the City of New York to William Fondiller for post-graduate achievement. The citation reads:

"A time of war, though it does not fully reveal the high value of your service to society, does dramatize your rich contribution to the science of communication, which assures an organized society. For thirty-five years you have been an important research scientist and executive in a leading laboratory for the study of telephonic communication. There your improvements in loading coils and transformers have been basic."

The Identifier—A New Member of the Switching Family

By J. W. GOODERHAM
Switching Development

WITH automatic ticketing* now operating in a step-by-step office in Culver City, a major new problem is to identify the telephone number of the subscriber originating the call, which must be printed on the ticket. There may be as many as five or even more office units in one building, each with a possible 10,000 numbers. With five, there are a possible 50,000 numbers, and from this very large group it must be possible to determine in a very short interval which one is placing the call. It was chiefly to perform this function that the identifier was developed.

In reaching the ticketing trunk, moreover, one, two, or three digits of the called-office code have been used up. It is also necessary, therefore, to identify the office code originally dialed by the subscriber so that the sender can be told how to complete the call, and so that the called number also may be printed on the ticket. Since an identifier was to be provided to identify the calling number, it was also used to identify the called code.

Somewhat similar to the marker of the crossbar system, the identifier is an elaborate circuit comprising several hundred U-type relays, a few multi-contact relays, vacuum-tube detectors, an oscillator and cold-cathode-tube timers, together with the usual circuit elements such as condensers, resistors, and transformers. Because of the short time an identifier is held for a call, a group of two or three identifiers is usually capable of serving all the central-office units in a building.

When a sender† is seized by a ticketing trunk, it, in turn, seizes an identifier, and indicates to it which trunk circuit is being used. The identifier connects to this circuit through a multi-contact relay, and over one lead connects a low-frequency signal from its oscillator. In the trunk circuit, this signal is connected to the sleeve lead of the calling trunk, whence it passes back through the selectors and line finder to the connector terminal of the calling line. These terminals are arranged according to the directory numbers. Leads from the sleeves of all the connector terminals are carried to the thousand-number circuits, to which the identifier had also connected itself as soon as it was seized.

Here, each of these leads is connected to a condenser-resistance network shown at the left of Figure 1. The resistance sides of the networks for 100 consecutive numbers are all connected to the primary winding of a "hundreds" coil, and each group of ten consecutive hundreds-coils connects to the primary of a "thousands" coil. For each central-office unit, there are ten such thousand-number groups, each having 1,000 condenser-resistance networks, 10 hundreds-coils, and one thousands-coil. The secondaries of all these coils, which are really small transformers, pass to the identifier through the connector.

A group of ten vacuum-tube detectors in the identifier is first connected to the ten thousands-coils of one office. If the identifying signal is found on one of them, a register relay is operated in the identifier to indicate the thousands digit of the calling subscriber. A record is made also of the identity of the central-office unit of which the thousand numbers form a part. If no signal was found, the ten thousands-coils for another office unit are seized and tested in a similar manner. By such tests made in rapid succession, the office unit and thousands digit are determined and registered. The same ten detectors of the identifier are

*RECORD, *July*, 1944, *p.* 445; †RECORD, *October*, 1944, *p.* 550.

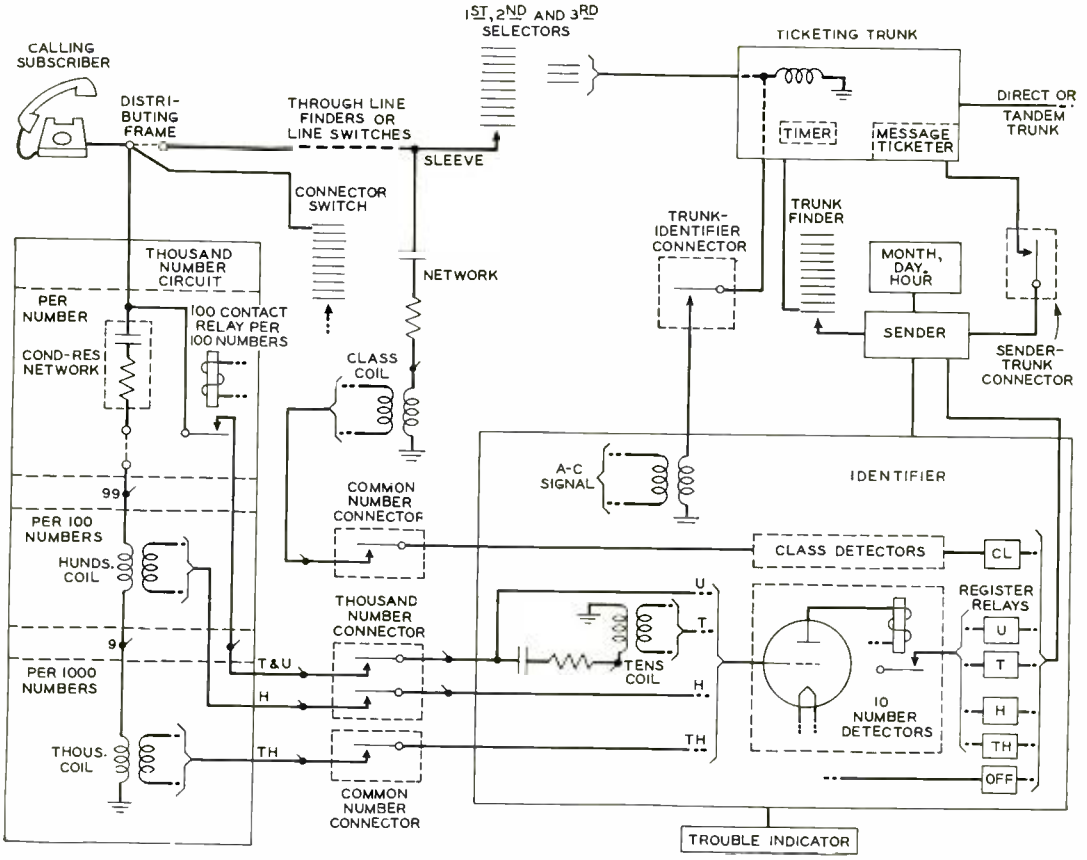


Fig. 1—Identifier circuit for the automatic ticketing system in Culver City, California

then connected to the hundreds-coils of the thousands group already identified, and the hundreds digit is similarly determined and recorded.

To determine the tens-digit, a similar method is employed, but to avoid using a large number of transformers, the tens-coils are placed in the identifier itself. After the hundreds group has been identified, the identifier connects to all the 100 sleeve leads of the group through a multi-contact relay, and connects its tens-coils and detectors to them to determine the particular tens group carrying the signal. Following this, it connects its ten detectors directly to the leads of this "tens" group, and determines and records the "units" digit. These digits are then transferred to the register relays in the sender to control the printing of the ticket.

This description has tacitly assumed that only single-party lines are involved, and thus that for each line there is just one number. Actually, however, each office usually includes two-party lines, and in a dial system each party on such a line has a different directory number. Each two-party line is connected to two connector terminals, one for each of its numbers, and thus the signal sent out by the identifier would be received on two of the hundreds-coils and possibly on two thousands-coils. To identify the proper one of the two numbers, two sets of hundreds and thousands-coils are provided for each group of 100 and 1,000 lines, and through a coördinate interconnecting panel, to be described in a forthcoming issue, each connector terminal is connected to one or the other of these coils depending on whether it is a "tip" or "ring" number. The sender tests the line on each call, as already described,* and at once informs the identifier whether it is the tip or ring subscriber that is calling, and the identifier—

*RECORD, *October*, 1944, *p.* 550.

guided by this information—connects to the proper hundreds and thousands-coils to make the test.

Besides determining the number of the calling subscriber, the identifier must also determine his class of service, which is to be printed on the ticket. Some exchanges, for example, offer "local" and "extended" rate schedules differing in the extent of the local charge area. The calling number does not indicate the class since, within limits, any number may be in any class. The two identifications must be made independently. Each line finder, however, serves only one of these classes of subscribers, and since the number of line finders is much smaller than the number of lines, the simplest way to determine the class is to identify the class of the line finder used for the connection. Condenser-resistance networks are therefore connected to the sleeve leads of the line finders, and all of them serving the same class are connected to a "class" coil similar to the thousands-coils of the thousands-number circuits. The identifier connects a separate set of vacuum-tube detectors to these coils to determine the class at the same time it determines the thousands digit.

Besides these classes that normally use the ticketing trunks, there may be calls from operators that, while passing through the ticketing trunk, do not require a ticket to be made, and a separate class identification is needed for them. Also, certain subscribers are supposed to place their calls through operators instead of through the ticketing trunks, but since calls from such sources may inadvertently reach the ticketing trunks, it is necessary to identify them so that they can be referred back to an operator. These latter lines are not connected to either the tip or ring hundreds-coils at the coördinate connecting panel, but instead are all connected to a separate "denied-service" coil, which the identifier tests at the same time it tests the thousands-coils. If it finds the signal on the denied-service coil, it notifies the trunk circuit, which transfers the call to an operator, or gives a proper signal to the subscriber, and the identifier is released. Operator calls are identified in the same way, but when a call of this class is found, the identifier notifies the trunk and the sender that the call should be completed without printing a ticket.

The identifier is also used to reconstruct the called-office code dialed by the subscriber, because the called-office digits are

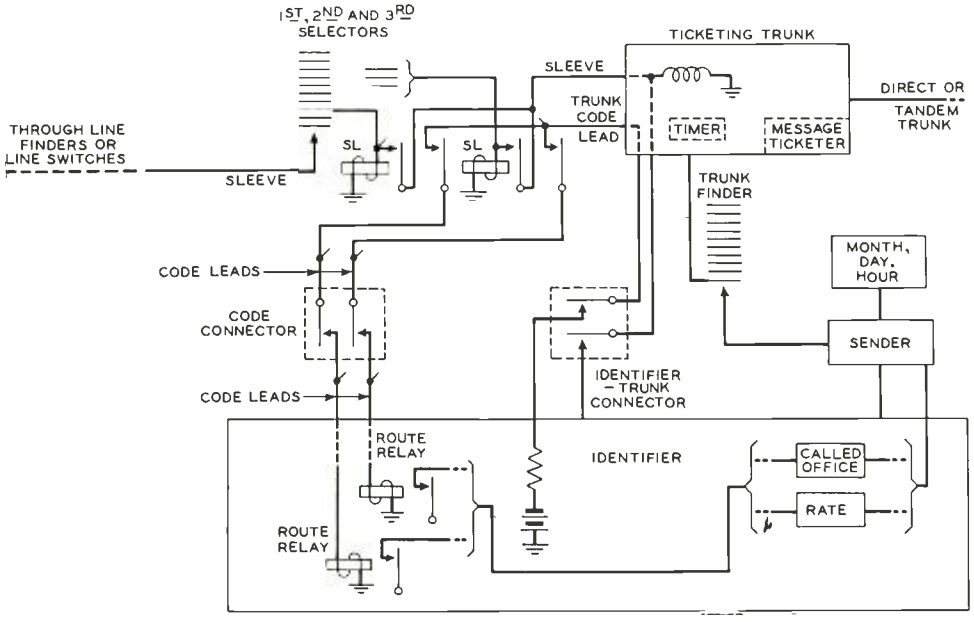


Fig. 2—Essential elements of circuit used in the automatic ticketing system to determine the called-office code dialed by the subscriber

not all registered in any one place. Either two-digit or three-digit office codes may be used, and the ticketing trunk may be reached from either a first, second, or third selector. The complete code can be reconstructed, therefore, only by knowing the selector level from which the trunk circuit was reached and any subsequent digits of the code that is recorded in the trunk circuit or sender.

To determine the selector level from which the trunk circuit was reached, a fourth lead, known as the trunk code lead, is run for each trunk between the trunk circuit and the selector levels from which the trunk may be reached as shown in Figure 2. At the selector level, it is carried through a contact of a sleeve relay associated with that branch of the trunk, and thence through a code connector to the identifier. After the identifier has seized the trunk circuit through the identifier-trunk connector, it connects battery to the code lead of the calling trunk, and current flows back through the contacts of the operated selector-level relay through which the trunk circuit was reached, and thence to a group of relays in the identifier. The particular code lead over which it reaches the identifier indicates the digit or digits of the called code that were dialed in reaching the trunk circuit. In the identifier, the code lead passes through contacts of relays controlled by the digits recorded in the trunk circuit and sender. The circuit is arranged so that depending on the code lead over which it reached the identifier and the particular relay contacts it passes through there, it will operate one of a group of route relays, of which the identifier has one for each possible route. The operation of this route relay sends signals to the sender to indicate how the call should be completed, and also the called code to be printed. From the called-office code and the office unit of the calling line, the identifier also determines the rate for the initial interval, and passes it on to the sender for printing on the ticket.

The automatic ticketing equipment is provided with a large number of safeguards to insure proper operation. In the pre-cut-over tests of the Culver City office, thousands of calls were made through the system without the identifier making one wrong identification. When the identifier fails or cannot identify the calling number, the sender will make a second trial with another identifier. If a failure occurs on the second trial, an operator will be brought in on the connection to obtain the calling subscriber's number before allowing the call to be completed. When an identifier fails on any call, it momentarily connects to the automatic trouble indicator, where it leaves a complete record of the progress of the call, together with a record of the principal circuits involved in the connection at the time of failure so that the trouble can be quickly remedied. These methods of continuously bringing incipient faults to light, together with arrangements for readily testing the numerous operating features, provide the maintenance staff with means for insuring a high degree of accuracy in the performance of the ticketing system.

THE AUTHOR: J. W. GOODERHAM entered the Bell System through The Pacific Telephone and Telegraph Company in 1902. He later was with the Seward Peninsula Telephone Company at Nome, Alaska, and the Independent Telephone Company at Seattle, where for five years he was wire chief at various offices. He attended the University of Washington from 1910 to 1914 and completed the Electrical Engineering course. Following this, he entered the Engineering Department of The Pacific Telephone and Telegraph Company, and later spent two years with the Interstate Commerce Commission at San Francisco. Since 1917, Mr. Gooderham has been continuously with the Western Electric Company and the Laboratories in the Systems Development Department. He was at Hawthorne for two years and then transferred to West Street where he was associated with the early development of panel system. For the past fifteen years, he has been engaged in special fundamental development studies of pulsing circuits, methods of registration, inductive noise in central-office circuits, radio frequency induction from the telephone plant, development of sub-station circuits, and automatic ticketing.

Effect of Chemical Structure on Physical Properties of Synthetic Plastics

By W. O. BAKER
Chemical Laboratories

IT IS now established that synthetic thermoplastics are composed of long chain-like molecules, each consisting of hundreds of atoms. Within these molecules there are groups of atoms that repeat again and again. The physical properties of a given plastic depend on the chemical structure of this repeating unit and on the number of them in a molecule. There have to be hundreds of atoms in each molecule to produce a material of high tensile strength.

In attacking the problem of determining the physical structure of these complicated organic compounds, progress has been made by studying, with X-rays, synthetic materials built from compounds of known composition. The simplest long-chain molecule occurs in paraffin compounds which have CH_2 groups as repeating units. Some X-ray patterns of fibers made from these compounds, Figure 1, show, near the top and bottom of the photographs, strong lines which are caused by reflections from planes through each two successive carbon atoms along one side of the zig-zag chains of which the fibers are made. This is illustrated schematically in Figure 2 by the structure of polyethylene. Higher order reflections, which are outside the area covered by the photographs, also show in the idealized diagram of Figure 2. The breadth of the lines in the pattern indicates that there are crystal-like regions in this molecule, 500 Ångstroms or less in length.

When other groups of atoms are introduced, by chemical action, at regular intervals along the polyethylene molecule, the X-ray pattern changes. If the two hydrogen atoms of some of the CH_2 groups and the entire CH_2 group next to each of them are replaced periodically with oxygen atoms, a less waxy and harder substance is obtained which gives, on cold-draw-

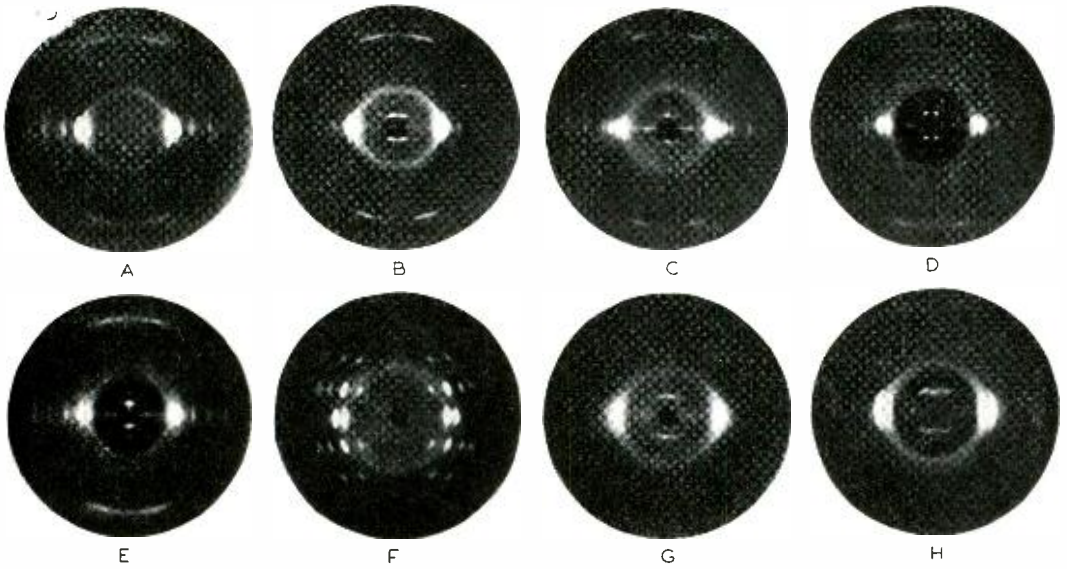


Fig. 1—X-ray patterns of synthetic plastics showing the effect of progressive changes of chemical composition and of heat treatment

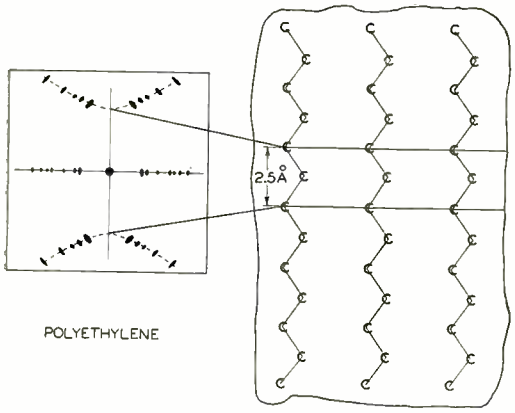


Fig. 2—Chain structure of the polyethylene molecule showing the location of the atoms which produce its X-ray pattern

ing, true synthetic fibers. The X-ray pattern then becomes that shown in Figure 1B. It differs from 1A in that there are additional reflections on both sides of the vertical center line near the top and bottom of the pattern. These and the other patterns are shown with the fiber axis vertical. The molecular structure which causes this pattern is pictured in Figure 3a. The pattern of Figure 1B proves that fibers drawn from this compound have numerous minute crystal regions within their molecules which are oriented along the length of the fibers. It also shows that the chains are zig-zag arrangements of atoms and that the C=O groups, which have been added to the original paraffin chain, have formed layers that are inclined to the fiber axis. This layer formation is general in synthetic thermoplastics and is responsible for their tensile strength and rigidity.

When the polyethylene chain is modified so that the number of carbon atoms in the chain between two similarly placed oxygen atoms is even rather than odd, the details of the layer formation are changed. Oxygen atoms then occur alternately on each side of the zig-zag carbon chain, as shown in Figure 3b. The X-ray pattern then becomes that of Figure 1C. Reflections now appear on the meridian line and show that the layers formed by the oxygen atoms are perpendicular instead of inclined to the fiber axis.

Further changes can be made by introducing two different groupings of CH_2 atoms along the chain molecule. Figures 1D and 1E show patterns obtained by this procedure from suberic and azelaic acids, respectively. Many of the lines in them are the same as from the original chain molecule, Figure 1A, but numerous other reflections also occur from planes through the oxygen atoms. The suberate ester, Figure 1D, has planes inclined to the fiber axis, as is illustrated in Figure 4a, but the azelate compound shows by the strong meridian reflections in Figure 1E that the layers of oxygen atoms in it are perpendicular to the axis. This formation is illustrated in Figure 4b.

As groups of other atoms continue to be added to the original chain molecule, its structure ultimately changes completely. When succinic acid is used instead of suberic the pattern of 1F is obtained. Interaction

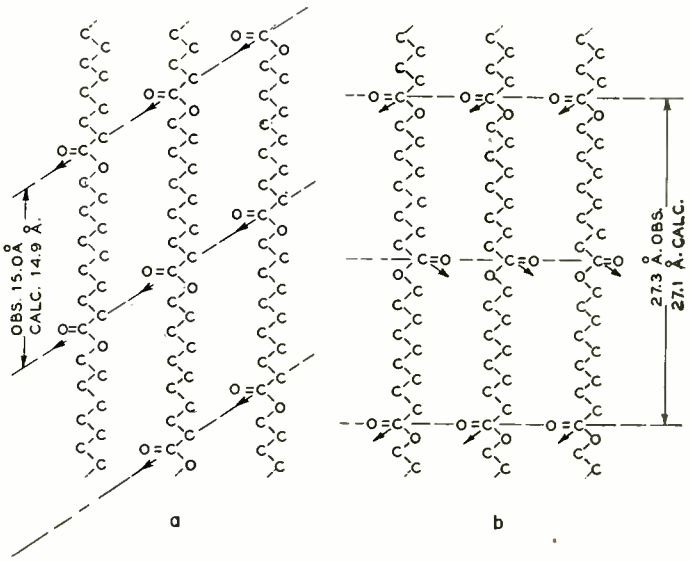


Fig. 3—Schematic of polyundecanoate (a) and polydecanoate (b) molecules showing the difference in frequency of occurrence and position of the active C=O groups which determine the strength of attraction between adjacent molecular layers and hence the strength of the plastic

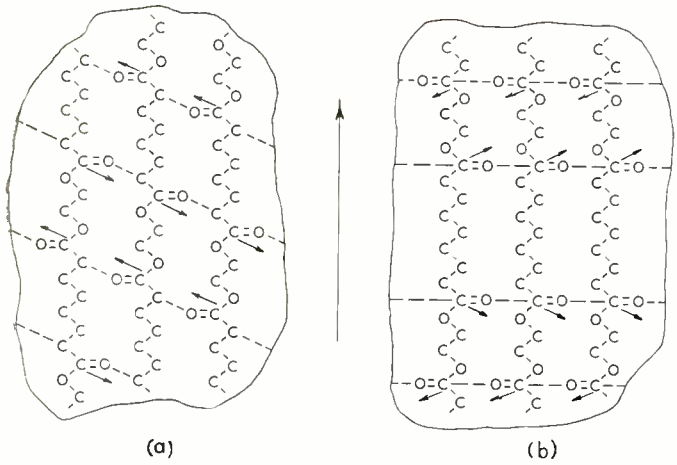


Fig. 4—Schematic of polyethylene suberate (a) and polyethylene azelate (b) molecules. The former has an even number of atoms between the C=O groups which permits stronger association with adjacent molecular layers and is therefore the stronger plastic

between electrically active atom groups on adjacent chains has apparently become strong enough to change the type of packing. Accompanying this marked change of structure there are abrupt changes in the melting point, density and elasticity of the compound.

Starting again with the simple chain molecule of the high molecular paraffins, other compounds can be made by substituting NH groups for CH_2 groups of atoms in the chain. A characteristic X-ray pattern, Figure 1H, shows that the structure of these polyamides is similar to that of the polyesters already described. They are composed of zig-zag chains of carbon atoms with the NH groups forming the "vertical" and "tilted" layers observed in the esters. In the polyamide structure, however, the NH and C=O groups in neighboring chains can bond tightly together. When cooled rapidly from their melts, this binding permits some of the chain molecules to freeze in strained states. Heating or annealing transforms the structure, however, more or less completely to an ordered condition. The existence of these two states is shown by comparing Figures 1G and 1H. The former, from a "quenched" specimen, shows less resolution of the spots than the latter, which was made after annealing.

These "quenched" fiber patterns are obtained in all other plastics when lateral forces are large between adjacent sections of their long molecules. Atomic spacings calculated from the X-ray patterns indicate that these polymer molecules tend to form bundles of parallel chains which are shorter than the molecules. Annealing orders the chains in each bundle by allowing them to rotate. This action in cellulose chains is illustrated in Figure 5.

Plastics of great commercial importance, derived from cellulose, further illustrate the generality of these principles of molecular chain packing. Their chemical structure is considerably more complicated than the simplified chains discussed above but the physical properties of these solids are governed by the same molecular interaction between groups of atoms, which exert strong lateral attractions and associate in layers.* Furthermore, the exact arrangement of atomic groups in these layers is of great practical importance. If it is very perfect,† as illustrated in the upper part of Figure 5, the

*RECORD, *Nov.*, 1943, *p.* 119; †*Feb.*, 1942, *p.* 157.

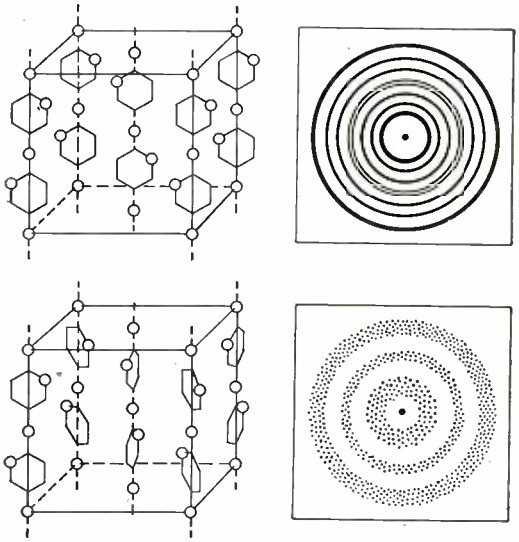


Fig. 5—Ordered (upper) and disordered (lower) cellulose chain molecules with the X-ray diagram of each. Sharp lines are obtained with an ordered specimen

plastic is hard but may be brittle. This holds for the simpler polyethylene and polyester plastics as well as for the cellulose derivatives. Similarly, if the long chains in the plastic are randomly rotated about their long axes, the attractive layers contain relatively disordered atomic groups; then the attraction within molecular layers is lower and the plastic is softer but tougher and more resistant to impact.

These studies show that there are two structural factors that determine the useful properties of plastics: First, the concentration or frequency of occurrence along the chain molecules of strong attractive centers, which may be regulated by chemical composition. Secondly, the degree of order of the molecules in these layers which may be modified by heat treatment, by added agents such as plasticizers, or by the introduction of side groups in the molecule.

THE AUTHOR.—After completing his undergraduate work at Washington College in 1935 with the degree of B.S., W. O. BAKER went to Princeton University for further study in Physical Chemistry. He held the Harvard Fellowship there and received the Ph.D. from Princeton in 1938. The following year, as Proctor Fellow, he engaged there in studies of solid dielectrics. Dr. Baker joined the Laboratories in 1939 to work on the physical properties and molecular structure of polymers and plastics. This work led to investigations of synthetic rubber which have recently demanded his full attention in connection with the U. S. Government rubber program.

Main Development Shop at Murray Hill. There are also many small shops in other locations to accommodate nearby projects