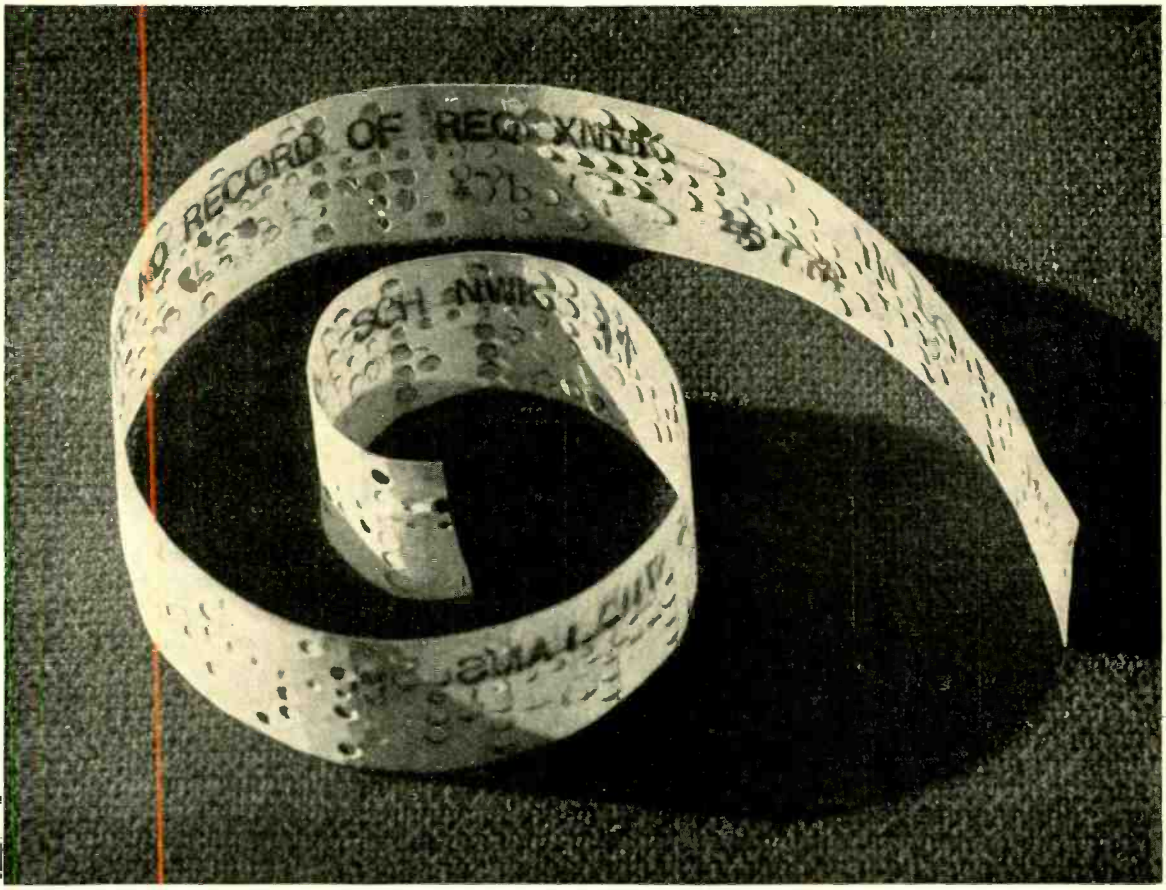
ELL LABORATORIES RECORD



Teletypewriter tape with the message typed as well as perforated

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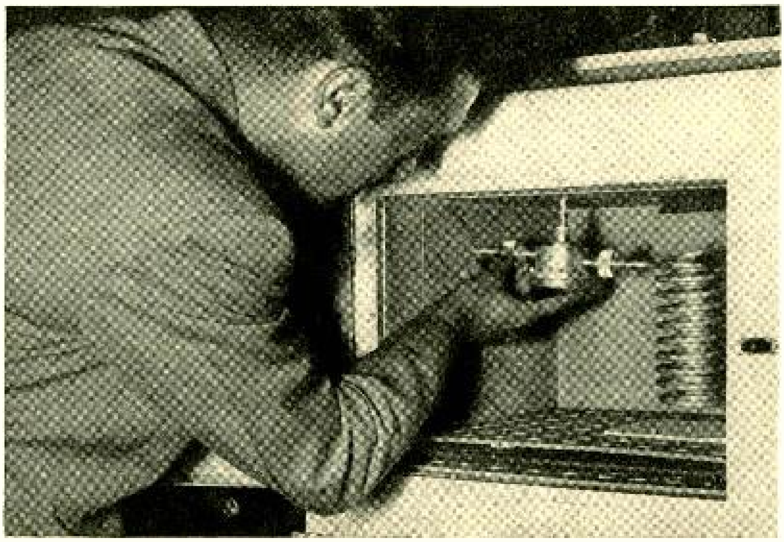


Behavior of Sulfur in Rubber

By G. G. WINSPEAR
Organic Chemical Research

SINCE Goodyear's discovery of vulcanization over a century ago, sulfur has been an essential ingredient in practically all commercial rubber compounds. The word vulcanize, deriving from Vulcan, the fire god, is connotative of the process, because heat is applied to the mixture of rubber and sulfur to produce a permanent elasticity or hardness that rubber alone does not possess. According to the accepted theory, the sulfur in a rubber-sulfur mixture, under suitable temperature conditions, chemically combines with the large rubber molecules. It is this modification that converts plastic rubber into a useful engineering material which is essential to our modern civilization.

Vulcanized rubber may have a wide variety of characteristics depending on the amount of sulfur, the period and temperature of vulcanization, and the other substances compounded with it. It has been found, moreover, that identical rubber compositions, vulcanized for the same time and at the same temperature, do not always develop the same characteristics. One of the unsatisfactory conditions that sometimes appears is a spottiness of the vulcanized rubber, indicating a lack of homogeneity in the product. The rubber may appear as in the center and right-hand photographs of Figure 1 instead of as in the left-hand photograph as it should. The obvious implication is that the mixture varies from point to point, and in the interest of securing a more uniform product for the many applications of rubber in the Bell System, an investigation was undertaken of the various factors affecting the even distribution of sulfur in the rubber throughout the processing cycle.

Before the sulfur assumes a position in the rubber molecule, it dissolves,

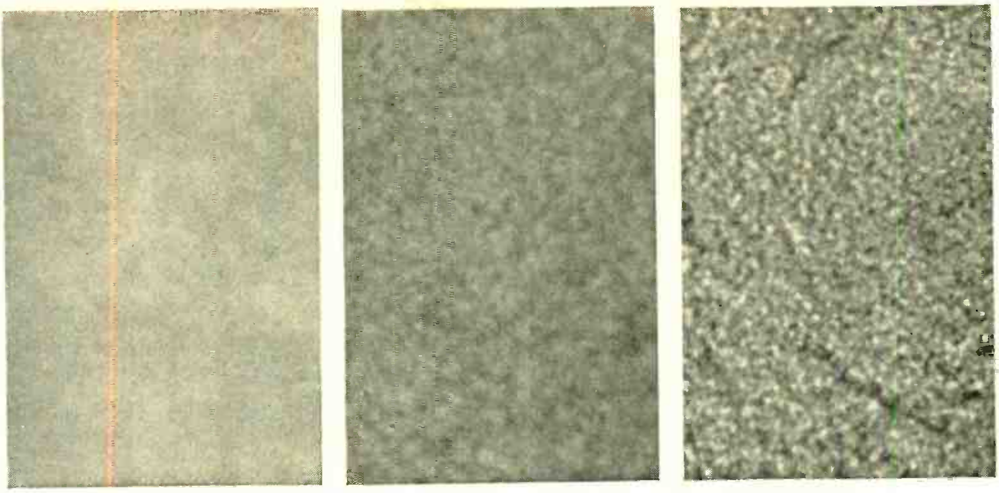


Fig. 1—Photograph of rubber sheets with 3 per cent sulfur: cured immediately after mixing, left; cured after 1 day storage, center; and cured after 11 days storage, right

and to secure uniform solution, the sulfur is first dispersed evenly throughout the rubber mass, and thus the factors to be studied are the dispersion, diffusion, and solution of sulfur during the mixing and vulcanizing processes. Many studies had been made of these processes, but the results were not all in agreement. Fundamental studies seemed desirable to determine the rates of diffusion of sulfur in rubber and the extent of its solubility so that processing specifications could be more accurately prepared in order that they would insure a more uniform and satisfactory product.

For one of these studies a one-inch cubical mold, Figure 2, was provided. It was lined with cellophane and then filled with rubber of specified type milled according to a definite procedure. One face of the mold and cellophane was then removed, and sulfur was packed against the exposed rubber surface. This assembly was then held at a fixed temperature for various periods. After heating, the unabsorbed sulfur was removed, and the test cube was cut parallel to its exposed face into four sections of

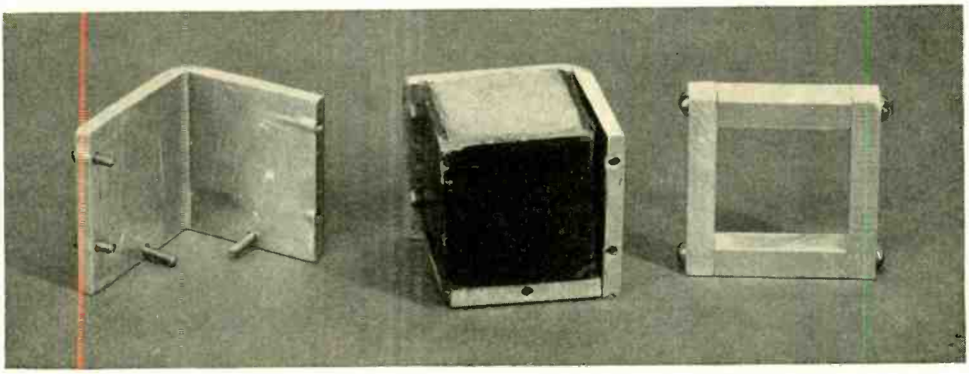


Fig. 2—Mold for rubber cube built for diffusion studies

approximately equal thickness. The total sulfur in each of the four sections was then determined. The sulfur distribution after a heating period of 500 hours at 56 degrees Centigrade (about 133 degrees Fahrenheit) is shown in Figure 3. From an extrapolation of this curve it was found that the sulfur passed into the rubber at a rate of about 0.0056 centimeters per hour at this particular temperature.

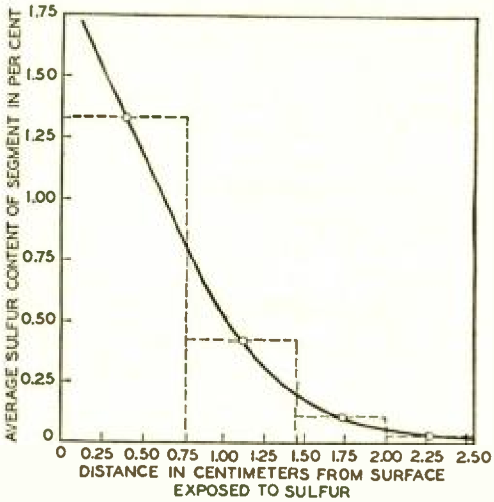


Fig. 3—Sulfur diffusion at 56° C as determined by the "cube" test after 500 hours

In another form of test, the apparatus shown in Figure 4 was employed. A cylindrical receptacle is filled with sulfur and covered by a thin sheet of rubber. This assembly is then placed in an outer temperature-controlled container, and a stream of dry nitrogen is passed across the upper surface of the rubber sheet to remove the sulfur that is diffused through it. The loss in weight of the sulfur after definite periods of time gives the amount of sulfur that has diffused through the rubber sheet. Some of the results obtained are given in Figure 5. From such results and from the area and thickness of rubber in contact with the sulfur, the temperature of the chamber and the vapor pressure of sulfur under the test conditions, it is possible to calculate for any temperature the diffusion constant, or the grams of sulfur diffused through unit area per hour per unit thickness.

When sulfur and rubber are mixed on a mill, the sulfur is dispersed throughout the rubber mass, but most of that dispersed is in particles of measurable and tangible size. Although the particles may be small, and perhaps even invisible to the unaided eye, they are still very large compared to the sulfur molecule, so that the mixture is far from one where all the sulfur is in immediate contact with the rubber molecules, which is

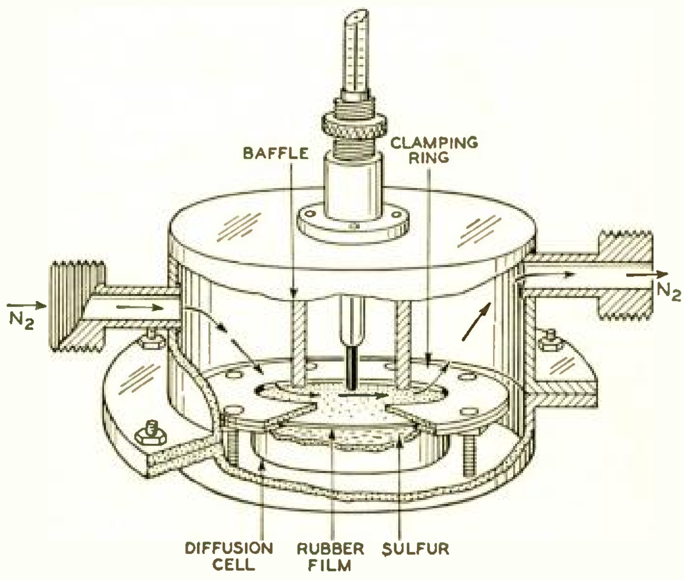


Fig. 4—Apparatus for determining diffusion of sulfur through thin rubber sheets

the theoretical state required to give a homogeneous solution of sulfur in rubber. Such an intimate mixture results from a diffusion of the sulfur of each particle following the dispersion on the mill. The results of the tests already described indicate how rapid and thorough this subsequent diffusion may be.

To round out these studies, it seemed desirable to secure data on the solubility of sulfur in rubber at different temperatures. If rubber including a small percentage of sulfur is thoroughly mixed and then held for a long enough time at a high enough temperature, the sulfur will all go into solution. From its original particles, the sulfur will diffuse until the whole mass of rubber is thoroughly permeated, and if the temperature is high enough, the sulfur will all be dissolved. Rubber in thin sheets with completely dissolved sulfur is clear and transparent, while if it contains undissolved sulfur crystals, it will be cloudy. After a known amount of sulfur has all been dissolved in a sheet of rubber, some

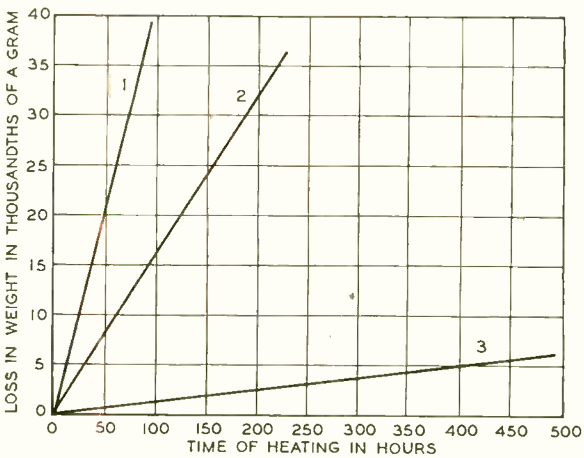


Fig. 5—Diffusion of sulfur through thin masticated crepe rubber sheets: (1), *temp.* 96° *C, thickness of sheet* .0305 *cm;* (2), *temp.* 86° *C, thickness of sheet* .0305 *cm;* (3), *temp.* 58° *C, thickness of sheet* .0279 *cm*

of the sulfur will begin to crystallize out if the temperature is lowered sufficiently, because the lower the temperature the less sulfur will the rubber dissolve. This precipitation

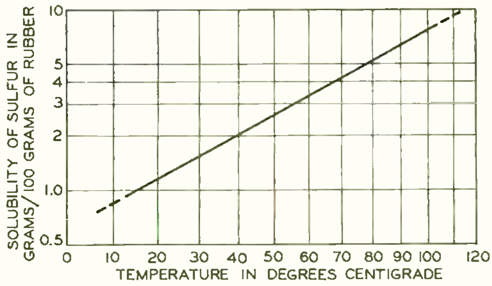


Fig. 6—Effect of temperature on the solubility of sulfur in masticated crepe rubber

of sulfur will be evidenced by the fact that rubber will take on a cloudy appearance.

Cycles of this sort were used to determine the amount of sulfur soluble in rubber at different temperatures. Definite percentages of sulfur were milled into the rubber, and the milled sheets were then held at a temperature high enough to insure that all the sulfur went into solution. The temperature would then be lowered a little at a time, and held at each lower temperature long enough for stable conditions to be reached. At some temperature the rubber, originally clear, would become cloudy, indicating that precipitation was taking place. The temperature would then be slightly raised until complete solution was obtained, and this cycle might be repeated over a narrower and narrower temperature range until a satisfactory determination was secured of the temperature at which the given amount of sulfur would just go into solution. In this way the temperatures at which rubber will dissolve various percentages of sulfur were determined. Similar data were secured for the milling time required at various temperatures to bring about complete solution of various percentages of sulfur. Some of the results

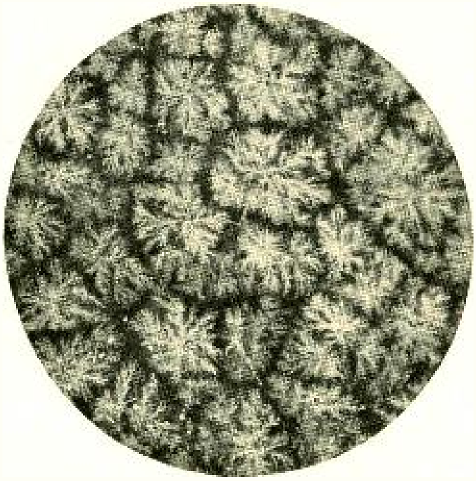


Fig. 7—Dendritic sulfur crystallizing in masticated crepe rubber

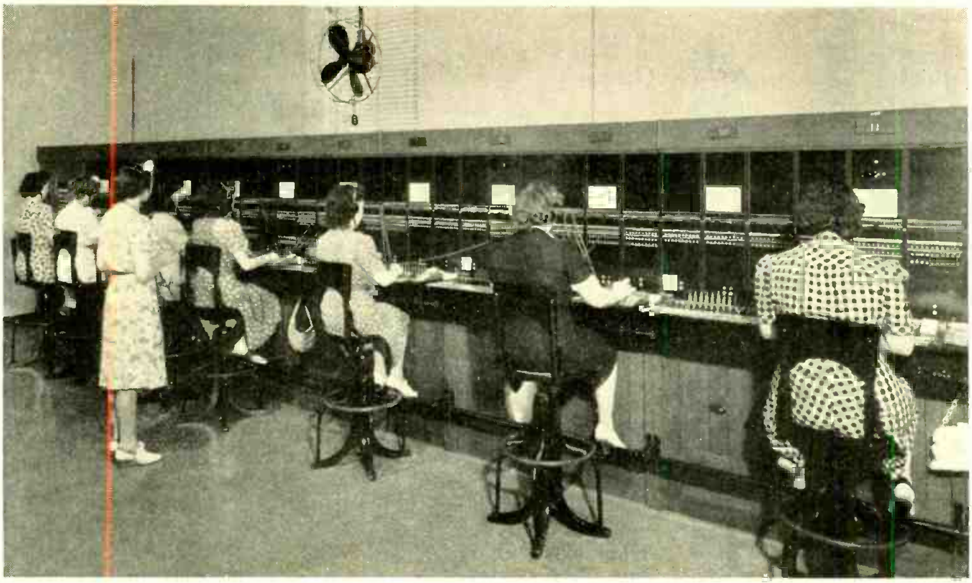
obtained are shown in Figure 6. These solubility studies were made well below the temperature range of vulcanization (275-325 degrees Fahrenheit) where chemical reaction between sulfur and rubber occurs.

Another factor of importance is the interval between mixing and vulcanization. At the end of the mixing period, the rubber is at a fairly high temperature, and the amount of sulfur in solution will correspond to this temperature. If the rubber is now set aside, it will cool, and in cooling some of the sulfur will crystallize in dendritic form as shown in Figure 7. These crystals are of very fine structure, and when the rubber is again heated in the vulcanizing process, they readily go back into solution. If the rubber is allowed to stand for a more extended period before vulcanization, however, the dendritic crystals gradually change to rhombic sulfur, as shown in Figure 8. These rhombic crystals are much larger than the dendrites and so when the rubber is vulcanized, the sulfur thus crystallized cannot as readily get back into solution because of the time required for completely dissolving these larger crystals. The formation of these rhombic crystals is undoubtedly the cause of some of the spotty conditions sometimes found in vulcanized rubber.

These studies give the rubber chemists more complete information than has been available before on several

Fig. 8—Dendritic sulfur transforms into the larger rhombic crystals when stored for a longer period

of the fundamental factors affecting the satisfactory vulcanization of rubber. The information secured will thus serve as a basis for improving present compounding practices and raw material specifications, and to this extent will improve the rubber products of the Bell System.



Developments in the DSA Board

By S. J. BRYMER
Switching Equipment Department

IN RECENT years the number of local calls handled on the Dial System A board has decreased as subscribers have gained experience in the use of the dial, but operators are still needed to perform certain functions as an essential adjunct to dial service. These functions have already been described in the RECORD,* and while there has been no change in their number, the amount of operator time required for each has changed with the passage of time and the change in switching equipment. Subscribers, for example, do not as frequently have difficulty in completing calls as when the dial system first came into general use, but on the other hand there has been a trend toward having the DSA operator handle a greater portion of the toll traffic. The advent of crossbar switching has also modified to some extent the work of the A operator. As a result, a series of changes have been made in the arrangement of the DSA board, either to accommodate this change in the distribution of the operator's time and effort, or to enable her to work more efficiently.

The original DSA boards, the 13C used in the panel system and the 14C in the step-by-step, were modified to give the 13D and 14D, and these then gave way to the 15C. The latest changes are accommodated in the 15D, an installation of which in the Forest Hills office is shown in the photograph at the head of this article. To those concerned with switchboard equipment, the nature and sequence of these changes and the reasons for their adoption are of interest.

**August, 1931, page 576.*

Early practice required the DSA operator to write tickets for and complete only toll calls for offices accessible to the DSA board either directly or by way of a tandem office. For calls to points reached only through the toll office, where the subscriber dialed zero instead of the long distance code, the DSA operator would extend the call to the outward toll board for its completion. On calls from coin box lines, however, the DSA operator controlled the collect or return of coins for calls that passed through the toll operator, as well as for those she completed directly.

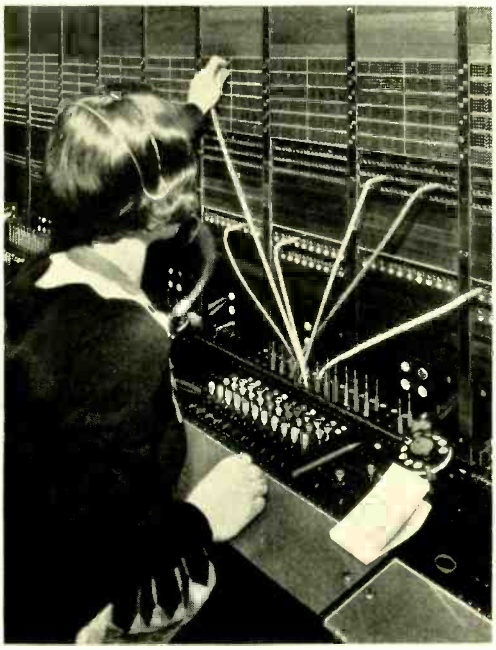


Fig. 1—A special-service position of the 13D *board showing the additional space at the front of the key shelf, and the number-checking test strips in the upper part of the vertical sections*

As toll traffic increased, it seemed desirable to decentralize the outward toll switchboards by using the DSA boards as combined outward toll and DSA positions with the toll trunks reached directly by way of a toll tandem board.* This method would require more ticketing at the DSA board, and since space and facilities at the switchboards that were then in use were limited, a number of changes seemed desirable.

Fig. 2—A typical sender-monitor position of the 13C *board*

The 13C switchboard was similar to the A positions of the manual switchboard in general construction, and had very little room on the key shelf for writing tickets. The switchboard section had eight vertical panels in the upper part of the section, and three operators' positions, the key shelf of each position being two and two-thirds panels wide as shown in Figure 2. Along the rear of the key shelf were the plugs for the cord circuits, and in front of them there was a lamp rail carrying the line and supervisory lamps. Most of the rest of the

*Record, *June*, 1930, *page* 473.

key shelf was taken up by the coin, ringing, and talking keys, of which there was one set for each cord circuit. It was largely to secure additional room that the 13D board was developed, although it also incorporated high-impedance monitoring and listening-key dialing. Additional space on the key shelf was secured by incorporating the lamps in the key strip without increasing its overall length. This change is evident in Figure 1.

Both the 13C and 13D boards were originally made with a combined upper and lower section. Since the operators' positions were each arranged for different types of service, such as sender monitoring, intercepting, or special service, such combined construction was not very flexible. The number of positions of the various types could not very easily be changed after the original installation had been made. The next equipments developed after the 13D board, therefore, were separate upper and lower sections for both the 13C and 13D boards. Part of the relay equipment for the cord circuits was mounted in the rear of the positions, and thus each could be used only for one type of service, but this development permitted the lower sections to be rearranged or changed as desired without affecting the upper sections, which contained the trunk multiple and answering jacks.

Both the 13C and 13D boards were equipped with a dial, and to complete a call to a dial subscriber, the operator had either to operate the dial or to extend the call to a key listening or call-distributing* B operator in the office called. With the development of key pulsing, however, it seemed desirable to incorporate this more rapid method of completing calls in the DSA board. The 15C board was the result. It was provided with a key shelf similar to that of the 13D except that it was arranged to accommodate a ten-button key set when key pulsing was to be employed, and thus could be used for either key pulsing or dialing. Arrangements were also provided for call-distributing B equipment. Both straight B positions and combined A and B positions were provided so that operators at the DSA board could also handle B traffic, which is sometimes desirable, particularly during light-traffic periods. In addition, the purely intercepting cord circuits were abandoned, and a so-called "combined" cord was developed that could be used for both intercepting and special service. A position was also arranged for central-office observing. A 15C central-office

*RECORD, *December*, 1930, *page* 162.

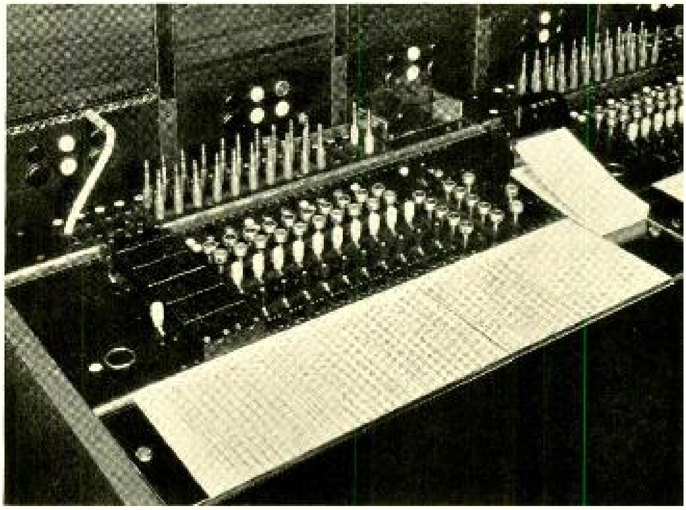


Fig. 3—A central-office observing position of the 15C *board*

observing position is shown in Figure 3, where the ten-button key set for key pulsing is evident just to the right of the cord keys, and the display panel for central-office observing may be seen at the left. The positional wiring for these new cord circuits was identical, and since there was not room in the rear of the section for all of the relay equipment, none of it was mounted there, but it was all arranged in units for relay-rack mounting. With this arrangement, it was possible to provide a universal position, and to equip this as desired by use of the proper relay-rack units.

Although the key shelf of the 15C board provided additional depth for bulletin and writing space, it did not provide either a calculagraph or room for storing tickets during the conversation period, for which additional width was needed. This space could have been secured by using a nine-panel section, as the No. 11 manual board does, which would give a key shelf three panels wide instead of two and two-thirds panels. This, however, would require an increase of one-eighth in the equipment and cabling of the upper sections. In DSA boards for the panel system, a "checking" multiple is required in the upper section to enable the operators to insure they have recorded the correct calling number. An eighth increase in this checking multiple as well as in the other equipment of the upper section represented a greater cost than could be justified by the additional space that would be secured on the key shelf.

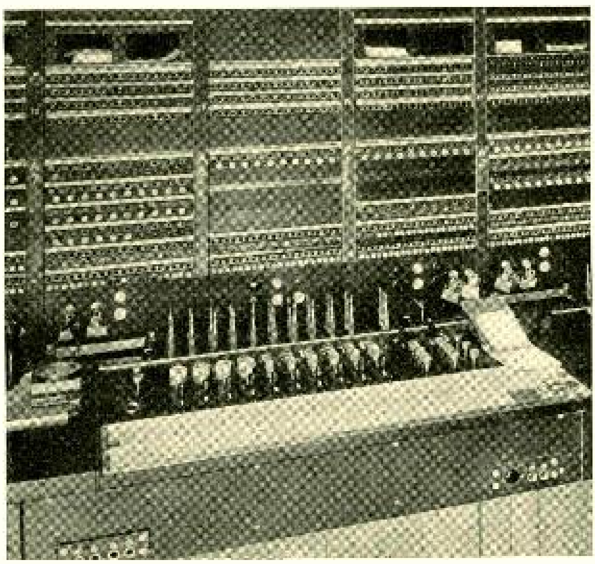


Fig. 4—A 15D position showing calculagraph at the left and ticket boxes between the cord keys

In the crossbar system, however, the checking multiple is not required, since number-checking circuits, controlled from the key shelf, are incorporated in the crossbar equipment. An additional panel width to the section under these conditions was found not to be too expensive to offset the advantages of a wider position, particularly since some additional key shelf space was required for the number-checking equipment. The wider position, moreover, provided sufficient space for the cord-circuit relay equipment, thus saving relay-rack space and the cabling between the relay rack and the switchboard. A new DSA board—the 15D—was thus developed for use with the new crossbar system. Since there was no need for a number-checking multiple, the height of the section could be reduced, and a section only six feet two inches high was made available as well as one of seven feet eight and one-half inches, which had been the height previously used.

New cord circuits, both of the

special-service and combined types, were developed for the 15D to incorporate such features as key pulsing on both ends of the cord, cord splitting, and number checking. Two series of lower units were made available for this board: one for use when not over twelve cords were required at the special-service positions, and the other for boards requiring up to fifteen cords. Units of the first series include a calculagraph shelf with a new and compact calculagraph, while the second series omitted the calculagraph — the additional space being required for the extra cords. In both series, small ticket boxes are mounted between the cord keys to permit tickets to be stored during conversations. Besides the special-service and combination positions, each series includes sender-monitor, central-office observing, single and double call-distributing B positions, and also combined A and B special service, and combination and sender monitor positions. The calculagraph, as shown in Figure 4, appears only at every other position, since it is common to two positions.

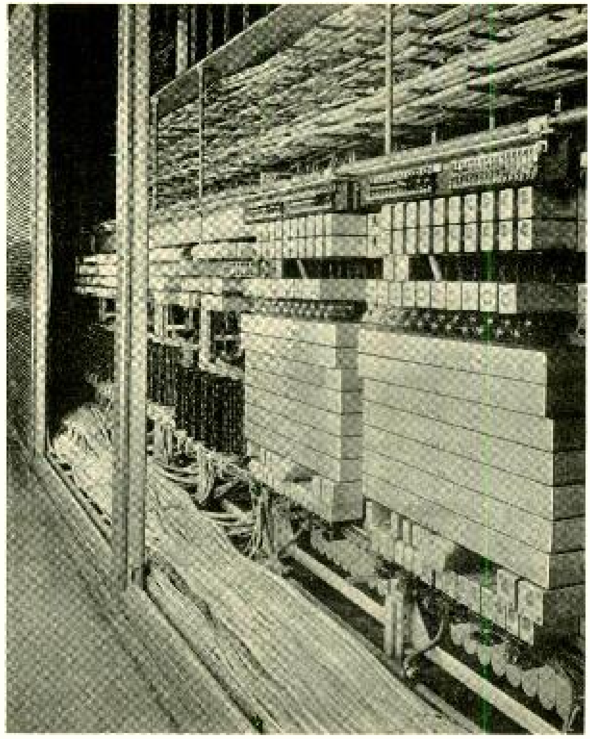
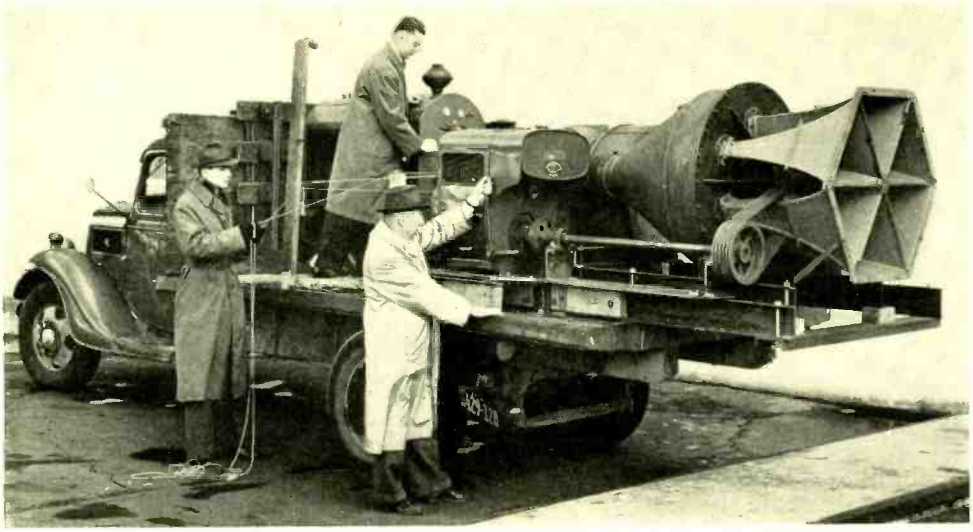


Fig. 5—Rear view of 15C *board at the left, where the positions do not carry relay equipment, and of* 15D *board at right, where they do*

Relay equipment for twelve special-service cord circuits is mounted in the rear of the special-service positions. Since these positions constitute about three-quarters of the line-up, this materially reduces the amount of cabling between the switchboard and the relay rack. With this location of the relay equipment, it was advantageous to provide fuse panels in each position, and a filter for the talking battery in the cable-turning section. The difference in appearance of the rear of the sections of the 15C positions, which do not include the cord-circuit relay equipment, and of the 15D, which do, is shown in Figure 5.

The 13C and 13D boards were designed primarily for panel offices, and a parallel development provided local DSA boards—the 14C and 14D—for step-by-step offices. The 15C board, on the other hand, could be used for either step-by-step or panel offices. The 15D board was developed to provide improved service for crossbar areas and will be used for panel also. With the step-by-step system, the trend has been to install the DSA positions in line with the toll board, and new trunk circuits have been developed to permit DSA traffic to be handled at regular toll positions.



Air-Raid Signal Demonstrated

PLACED on Manhattan Bridge and pointed toward City Hall, New York, an air-raid signal developed by the Laboratories had an effective demonstration on Wednesday, March 4. Its sound was heard plainly above midday traffic in most of the downtown skyscraper area. As can be seen from the photograph, the device consists of a blower driven by one gasoline engine, a "rotor" driven by a second engine, and horns to direct the sound. By varying the speed of the second engine, the typical siren "wail" could be produced, but that was not done, lest the test be mistaken for an air-raid alarm. Laboratories engineers with sound meters were stationed at nine points in the area to be covered; they observed sound levels as much as fifteen decibels above the background of city noise. The engineers were satisfied that a wide area can be covered from a single source if it is well above nearby rooftops.

The equipment was developed by the Laboratories for the National Defense Research Council. Manufacturing information has been turned over to a number of concerns who will build it.

A few days later the apparatus was taken to Detroit for inspection by the engineering staff of a prospective manufacturer. Tests made from a rooftop and from the Ambassador Bridge elicited favorable comments of which the following from the *Detroit Times* is characteristic:

"Detroit officials today were enthusiastic after the first trial of a new air-raid siren which, 'on the beam,' could be heard as far away from the downtown district as the Eight-Mile road."

"Fire Chief Edward C. Rumsey and Fire Commissioner James J. Mahon were enthusiastic, calling it the first 'real' siren tested here."

In the photograph F. K. Harvey holds the speed controls of the two engines, T. L. Dowey is at the "rotor" clutch and R. C. Jones, Jr., at the blower engine.

News of the Month

22—48—88—*100!*

Our country is now engaged in an all-out war whose outcome depends on the efforts of every American. Several score members of the Laboratories are serving with the armed forces; more than half the technical personnel is working on military projects, and all the rest of us are backing up their efforts. To implement our patriotic desire to contribute to the national effort, a campaign is under way whose goal is hundred per cent participation in the plan to buy Defense Bonds by payroll deductions.

Payroll deductions have the advantage of regularity and convenience. Over 8,000 companies report monthly to Washington on the per cent of their personnel who are subscribing by that method, and the returns are one indication of the unity with which wage earners are supporting the war effort. Other Bell System Companies whose campaign started earlier are 99 plus in percentage.

Late in February a representative group met at the invitation of John Mills, to whom had been given the general direction of the campaign. This committee was greatly increased by the appointment of "adjutants" to insure coverage of all groups and locations. On Monday, March 2, as members of the Laboratories came to work they were greeted at every point of vantage by Defense Bond posters which had been put up over the week-end by W. O. Waldecker and many willing helpers.

At the end of February more than a thousand men and women were already subscribing for Defense Bonds through our long-established Payroll Deduction Plan. To enlist the others, a desk-to-desk distribution was made of a government leaflet describing E series bonds and a slip to indicate to Payroll Department the intention to participate. At the end of the first week Payroll furnished names of all those who were not subscribing. Those cards were sorted by D. D. Haggerty, secretary of the Club, and his assistant, Mrs. Christine Ackerman Smith, for individual solicitation by the adjutants.

As the authorizations for payroll deduction come in, Payroll arranges to make the deductions. When these have equalled the cost of the designated bond, the Financial Department, which is an authorized issuing agent, will arrange with Payroll to imprint the names desired by the subscriber. Then the bonds will be delivered to their owners.

In the second week of the campaign an emblem was distributed to each subscriber for display at his or her place of work. It was designed by the Bureau of Publication with advice of a sub-committee that was composed of P. B. Findley, Mrs. Christine Smith and C. J. Hay.

Insignia distributed to members of the Laboratories subscribing to Defense Bonds through the Payroll Allotment Plan

On March 2 when the campaign started, 22 per cent of our personnel were sub-

Defense Bond Committee Members and Adjutants

Miss E. G. Aamodt*
Mrs. M. M. Ahrens
A. J. Akehurst
R. S. Alford
Miss D. M. Allyn

H. Anderson
Miss J. Angelo
R. W. Apetz
Miss L. Arata
H. G. Arlt

L. H. Bachmann
G. E. Bailey
A. Ballesteros
C. C. Barber
Miss M. L. Bergen

C. S. Biggs
W. C. Boerckel
W. A. Bollinger
G. M. Bouton
A. E. Bowen

W. A. Boyd
Miss A. Brangaccio
W. T. Breckenridge
Miss M. A. Broderick
A. R. Brooks

C. O. Brosch
M. Brotherton
J. R. C. Brown
J. T. L. Brown
W. C. Burger*

W. K. Burke
C. F. Campagna
J. A. Carr
R. L. Case
A. J. Christopher

Miss A. T. Connor
J. E. Conwell
F. A. Cox
J. H. Cozzens*
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C. H. Dagnall
A. J. Daly
W. L. Daly
H. J. Delchamps
C. S. Demarest

J. F. DeZavala
L. E. Dickinson
R. L. Dietzold
W. C. Dorgan
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T. A. Durkin
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E. C. Erickson
J. W. Farrell
P. B. Findley*
C. Flannagan

E. Flannery
L. S. Ford
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K. Haller
R. L. Hastings
C. J. Hay*

W. L. Heard
F. W. Hecht
R. A. Hecht
A. I. Heitzman
G. J. Herbert

F. J. Herr
A. Hobbs
G. V. Holler
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H. R. Jeffcoatt*

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E. D. Johnson
A. L. Johnsrud
H. C. Jonas

Miss M. E. Joyce
W. E. Kahl
R. C. Kamphausen
J. B. Kelly
G. A. Kelsall

Miss A. Kennedy
Miss A. Kiernan
Miss V. Kilpatrick
Miss A. King
T. G. Kinsley

W. A. Knoop
A. B. S. Kvaal

E. L. LeBright
J. Leutritz, Jr.
G. Q. Lumsden
I. MacDonald
J. F. Maquire

Miss M. Marcus
O. S. Markuson
J. F. Martin
R. P. Martin, Jr.
C. F. Mattke

Miss C. C. Maull
Miss H. B. Mayhew*
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C. G. McCormick
J. S. McDonough

Miss E. McKay
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G. A. McNeill
J. McTaggart
W. A. Mehmel

A. E. Melhose
F. T. Meyer
W. F. Miller
John Mills*
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H. Morrison
A. Muller
Miss H. R. Muller
E. Neubert
N. D. Newby

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H. G. Raupp
S. M. Ray
F. J. Reilly
A. L. Richey

R. R. Riesz
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H. Rohr
Miss R. Rovegno
H. C. Rubly

Miss E. M. Ruckner
A. E. Ruehle

T. Ryan
R. M. Ryder
J. A. St. Clair
Miss V. Salis
R. M. Sample

G. A. Sander
A. R. Saunders
E. S. Savage
J. J. Scanlon
W. G. Schaer

J. P. Schafer
Miss J. E. Scherr*
N. F. Schlaack
H. Schmitt
H. F. Schreiber

H. Schucht, Jr.
R. W. Sears
C. F. Seibel
G. T. Selby*
Miss L. D. Servoss

R. B. Shanck
A. H. Shangle
O. A. Shann
Miss M. Shaw
H. S. Sheppard*

R. A. Shetzline
S. W. Shiley
R. B. Simon
A. A. Skene
Mrs. C. A. Smith*

W. S. R. Smith
L. J. Stacy
Mrs. E. S. Stehle
A. L. Stillwell
M. Sultzer*

G. F. Swanson
R. E. Sward
C. F. Swasey
J. E. Tarr
J. D. Tebo

E. J. Thielen
Miss M. Tighe
Miss Louise Van Bergen*
Miss M. M. Van Bergen*
K. G. Van Wynen

Miss L. V. Vogel
H. L. Walter
F. C. Ward
C. A. Webber
Eric Weil*

J. G. Whytock
G. J. Wolters
S. B. Wright

*Committee member.

scribing; on March 10, when the adjutants started personal solicitation, 48 per cent; and on March 20, as the RECORD goes to press, 88 per cent. One hundred per cent is the goal. Hence the title that has been given to this news item.

Dr. Buckley Honored by British Engineers

AT THE INVITATION of The Institution of Electrical Engineers, O. E. BUCKLEY will present its Kelvin Lecture on April 23. His subject will be *The Future of Transoceanic Telephony;* he will disclose recent Laboratories developments pointing toward underseas cable telephony over transoceanic distances.

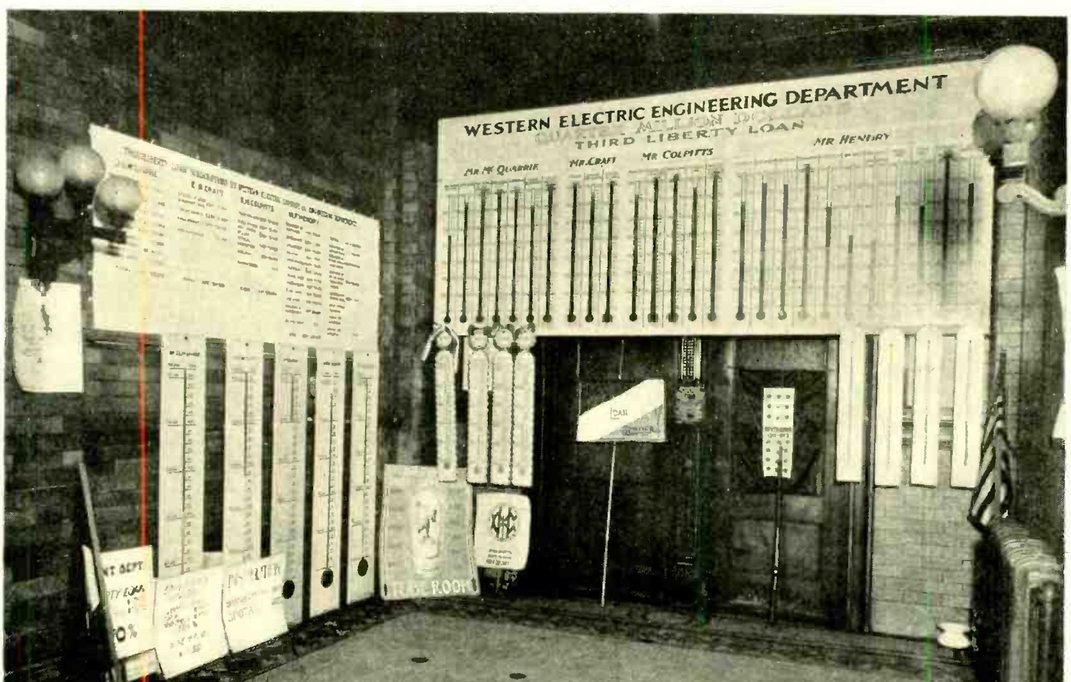
Pressure of his war work and uncertainties as to the time required for the trip make it impracticable for Dr. Buckley to appear in London in person. He has, therefore, delivered before microphone and camera short introductory remarks in which he pays respects to the Institution and Lord Kelvin, illustrious contributor to early cable technique, regrets his inability to be present and introduces the member who will read his paper. This film record will be projected at the meeting before the paper is read.

Special Signal Corps Service

SINCE THE Laboratories is the largest pool in the country of telephone development engineers, it is only natural that the Signal Corps should turn to it to fill their need for men of that type of training. Recently, at the request of the Chief Signal Officer of the Army, a group of engineers has been selected and recommended for officers' commissions. M. M. BOWER, J. W. MCRAE and A. L. WHITMAN have been chosen for the development and use of radio locators and associated equipment; R. W. HARPER, J. A. MAHONEY, T. A. MCCANN, III, for the Coordination and Equipment Divisions; and W. H. EDWARDS and A. D. SOPER in the Materiel Branch. Each of these men will be commissioned an officer in the Signal Corps.

Bell System Technical Journal

FOR THE DURATION OF THE WAR, the *Bell System Technical Journal* will be published less frequently than the four times a year which have marked its regular publication



How Liberty Bonds were sold during World War I schedule. The reason is that the demands of vital military work falling on the shoulders of Bell System technical people, plus the need for secrecy concerning their achievements in this field, make it impossible to prepare and publish as much scientific material as has heretofore appeared in the *Technical Journal*. It is hoped, however, that publication of the magazine will not be completely interrupted. Paying subscribers have been offered the choice of having their subscription payments refunded, or extended to cover future issues as they appear.

"Telephone Hour" Broadcast Time to Change April 6

Beginning April 6, the "Telephone Hour" will be broadcast one hour later over the NBC Red Network every Monday evening, except over Pacific coast stations, which will carry the program at the same hour as formerly. The new broadcast times will be from 9 to 9:30 Eastern War Time, 8 to 8:30 Central War Time, and 7 to 7:30 Mountain War Time. For west coast listeners, the program will continue to be re-broadcast from the New York NBC studio starting at midnight, which is the same as 9 p.m. Pacific War Time.

On Monday evening, April 27, the "Telephone Hour" will inaugurate a new "Great Artists" series of broadcasts, during which leading artists of radio, opera and the concert stage will make guest appearances.

Jascha Heifetz, violinist, will be the guest star on April 27. Soprano Grace Moore will appear on May 4; Charles Kullman, tenor, on May 11; Lansing Hatfield, baritone, on May 18; and José Iturbi, pianist, on May 25. Announcement of performers in succeeding weeks will be made later. Donald Voorhees will continue to conduct the Bell Symphonic Orchestra, and, as at present, Warner Anderson will do the announcing and Floyd Mack the narrating.

Under the new set-up, with different stars appearing each week, instead of the same singing stars and chorus, it will be possible to present an even wider variety of music than has been featured during the "Telephone Hour's" first two years.

Members of the Laboratories Recently Granted Leaves of Absence for N. D. R. C. and for Military and Naval Service

(All Commissions known at time of going to press included)

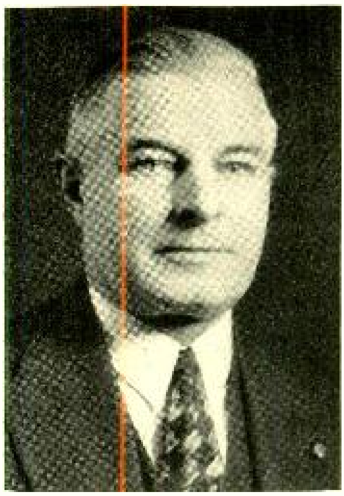
National Defense Research Committee

Walter H. Brattain
William B. Callaway
Paul V. Dimock
Max S. Richardson

Military Service

Lieut. Dick S. Barlow
Louis R. Bell
George Bickard
Capt. M. Maxwell Bower
Capt. Charles R. Brearty
Lieut. Sherman T. Brewer
Capt. Francis A. Coles
Maj. William H. Edwards
Thomas J. Gilchrest
Maj. Charles H. Greenall
Maj. Robert W. Harper
Alexander Howitt
Lieut. Glover D. Johnson
Lieut. William R. Lichtenberger
Capt. Stanley H. Lovering
Maj. Joseph A. Mahoney
Lieut. Paul Mallery
John Marrero, Jr.
Lieut. Roderick K. McAlpine
Maj. Thomas A. McCann, III
Corp. Charles J. McDonald
Peter F. McGann
James W. McRae
William J. Meehan
Lieut. Frederick B. Monell
Lieut. Orving C. Olsen
Lieut. Edwin H. Perkins
Capt. Clayton W. Ramsden
Capt. Herbert A. Sheppard
Lieut. Frederick J. Skinner
Maj. Walter F. Smith, Jr.
Maj. Arthur D. Soper
Capt. Donald E. Thomas
Maj. Allen L. Whitman
Lieut. Robert C. Winans
Lieut. James E. Zendt

Naval Service, Lieut. Thomas H. Neely



Edmund B. Smith
of the Switching Development Department completed thirty-five years of service in the Bell System on March 3

Herbert Vadersen
of the Commercial Products Development Department completed thirty years of Bell System service on March 11

L. P. Collins
of the Apparatus Specifications Department completed twenty-five years of Bell System service on March 26

New York-Philadelphia System in Commercial Service

It was on February 26, 1936, that the Federal Communications Commission authorized the construction of a coaxial cable system between New York and Philadelphia for use in the development of this type of system. A cable consisting of two coaxials and two nineteen-gauge quads was placed between New York and Philadelphia and this was equipped with repeaters and terminals for handling a one-megacycle band. Subsequently these repeaters were replaced by two-megacycle repeaters and these in turn by repeaters capable of transmitting either a two-megacycle telephone band or a three-megacycle television band.

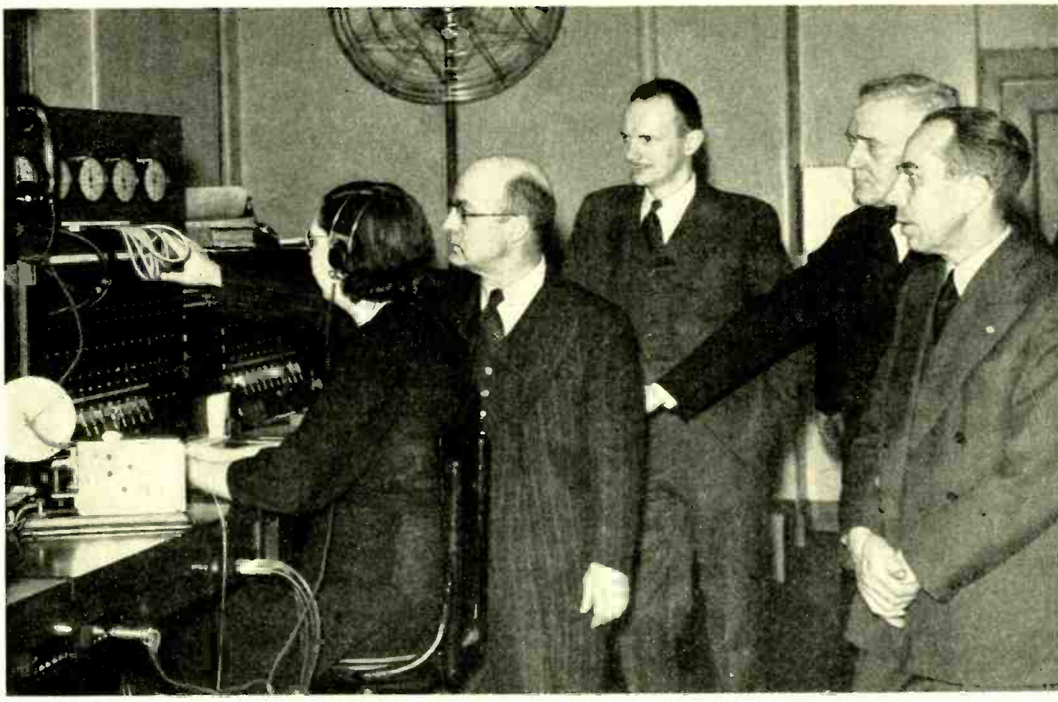
During the entire time since 1936 the New York-Philadelphia system has been in continuous use for experiments in telephone and television transmission. On December 15, 1941, it was placed in commercial service under temporary authorization of the F.C.C. Of the maximum capacity of 480 circuits, a total of 48 circuits are equipped and in use.

Colloquium

R. D. Parker spoke on *An Automatic Teletypewriter Switching System Employing Message Storage* at the February 9 meeting of the Colloquium. Mr. Parker described a new private wire automatic teletypewriter switching system which has been recently developed and applied in the field. A fundamental feature of this new system is the automatic control of a message through various switching points to its destination by coded characters which precede the message. Messages are stored in perforated tape form and are "switched" from one station line to another as the preceding coded characters indicate. These features cause systems of this type to differ widely from the usual switching practice in telephony.

Mr. Parker also discussed the automatic teletypewriter switching system now in service which handles over 100,000 words each business day over hundreds of miles of circuits. The operation of this system is practically 100 per cent perfect; *i.e.*, only one or two messages out of every 1000 require any attention due to false operation of lines or equipment.

At a special business meeting held on February 14 the following resolution was passed: "Be it resolved that, in view of the emergency situation as it now exists, regular bi-weekly meetings of the Colloquium be suspended and that the present officers continue their duties until such time as the emergency has passed, arranging for meetings at suitable times and places at their



Inspecting apparatus installed by the Laboratories for studying the dialing habits of telephone users of The Southern New England Telephone Company in New Haven. With the information secured from such studies, central-office switches may be adjusted to handle maximum load, which is of paramount importance with the heavy traffic resulting from war activities. Left to right: Miss Florence Lynch, Service Observer, New Haven; L. J. Stacy of the Laboratories; W. F. Robb, Traffic Engineer, New Haven; George Sandalls, Jr., of the Laboratories; and W. L. Gockley of the Operation and Engineering Department of the A T & T

discretion." This resolution will become effective after the March 30 meeting. Present officers are L. H. Germer, president; H. E. Ives, vice-president, and R. O. Grisdale, secretary.

* * * * *

A. W. Page, a Director and Vice-President of the A T & T, and M. R. Sullivan, Vice-President of the A T & T and a Director of the Laboratories, visited the Murray Hill Laboratory on March 12. Accompanied by O. E. Buckley and M. B. Long, they particularly observed the work being done in the Carbon Laboratory of the Physical Research Department by F. S. Goucher and R. O. Grisdale; in the Outside Plant Development Laboratory on the reduction of use of strategic materials in cables and drop-wire insulation under the direction of R. A. Haislip, C. D. Hocker and C. S. Gordon; and in the Metallurgical Laboratory on the casting of very powerful permanent magnets and the rolling of permalloy tape under E. E. Schumacher, H. T. Reeve, J. H. White and J. H. Scaff.

* * * * *

According to a recent issue of *Newsweek*, Britain's virtual freedom from heavy Nazi air raids isn't entirely explained by the concentration of the Luftwaffe on other fronts. It can now be revealed that Britain for months has had scores of highly efficient new-type radio-beam aircraft detectors spotted in strategic places along the coast to pick up approaching raiders. They are the same type as the one at Pearl Harbor which picked up the Jap planes 130 miles out. Developed by the British in collaboration with American scientists, these detectors, considered a military secret until the Roberts report was made, have a range of 250 miles under perfect conditions.

When the Academy of Motion Picture Arts and Sciences made its 1941 sound recording award for the picture *The Hamilton Woman* it was the twelfth consecutive "Oscar" given for motion pictures recorded on Western Electric equipment. *How Green Was My Valley*, also recorded on Western Electric equipment, was the Academy's choice for the outstanding production of the year, the tenth consecutive year that a picture so recorded had won top honors. The integrating sphere densitometer, developed by engineers of Electrical Research Products, was given an award for outstanding scientific contribution to the art.

* * * * *

Special authority has been granted by the Federal Communications Commission to A T & T to install a point-to-point radio telephone station for communications with the telephone administration of the U.S.S.R. at Moscow, Russia. At the present time, there is no radio telephone service between the United States and the Soviet Union.

* * * * *

O. E. Buckley has been elected a member of the Board of Directors of the Welfare Federation of the Oranges and Maplewood for a term expiring on December 31, 1944.

R. M. Burns discussed *Chemistry of Corrosion Processes* before the Connecticut Valley section of the American Chemical Society at a meeting held in Middletown.

Dr. Burns also visited the University of Pennsylvania on matters relating to the recruiting of new college men.

F. C. Nix and D. MacNair presented a paper, *The Thermal Expansion of Pure Metals—II*, before a meeting of the American Physical Society held in Detroit on February 20 and 21.

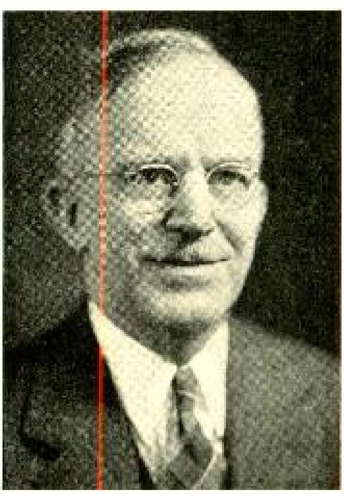
At a meeting of the Society of Rheology at the Polytechnic Institute of Brooklyn, W. O. Baker spoke on *Viscosity of Large Molecules in Solution*. C. S. Fuller also attended the meeting.

A. C. Thompson spent several days in Baltimore in connection with the initial installation of a-c key pulsing between the toll office and a local crossbar office.

A. R. Kolding spent the month of February at Hawthorne in connection with testing procedures on apparatus being manufactured by the Western Electric Company.

C. C. Fleming has returned after working with the Western Electric Company at Kearny for the past eight months.

F. F. Lucas, on March 3, showed his motion picture entitled *Brownian Motion of the Rubber Latex Particle* before the Associates in Science of the Graduate School of Harvard University in Cambridge, Mass.



Thomas C. Rice
of the Quality Assurance Department completed thirty-five years of service in the Bell System on March 19

William L. Heard
of the Equipment Development Department completed thirty years of service in the Bell System on March 4

At a symposium devoted to the subject of the *Solid State*, held under the auspices of the New York Academy of Sciences in New York City on February 27 and 28, papers were presented by S. O. Morgan, *Molecular Rotation in Some Mixtures of Crystalline Organic Solids*, and by W. O. Baker, *Disorder in Polymeric Materials*, with C. S. Fuller as co-author. L. H. Germer, A. R. Kemp, J. J. Lander and E. J. Murphy also attended this Symposium.

J. P. Schafer discussed the current development work of the Laboratories before the Oakhurst (New Jersey) Manor Club on February 13.

J. M. Finch, in Philadelphia, attended a meeting of A.S.T.M. Committee D9 on Insulating Papers and, in New York City, a meeting of A.S.T.M. Committee D6 on Paper Testing Methods.

C. J. Christensen, M. D. Rigterink and S. O. Morgan visited the Lenox Company in Trenton, in connection with the manufacture of ceramics.

C. J. Christensen, M. D. Rigterink, A. D. Shaw and W. F. Janssen visited the plant of General Ceramics Company at Keasby, N. J., to inspect their facilities for ceramic production.

D. A. McLean and H. A. Sauer were in Pittsfield and Westfield, Massachusetts, where they discussed insulating paper and impregnating compound problems with engineers of the General Electric and the Stevens Paper Companies.

W. J. Hahn Retires

W. J. Hahn

W. J. Hahn's service in the Bell System was brought to a close by the Retirement Age Rule on the thirty-first of March. Mr. Hahn, for many years in charge of the restaurant and more recently responsible for purchases for the restaurant, had many varied and interesting experiences in his years of active service. Born in Austria in 1877, he passed through an extensive apprenticeship leading to restaurant and hotel management. This was interrupted by a period of compulsory military training, but even here he became a mess sergeant. Completing the finishing course to become a qualified restaurateur, he worked successively in hotels in Vienna, Berlin, Paris, Brussels and then London. From London he entered the service of the Cunard Lines and as chief steward on many liners traveled all over the world. Returning to England he married and became manager of a racquet and tennis club in Liverpool. In 1915 he came to this country to assume the management of the Piping Rock Club on Long Island. In 1921 he joined the Engineering Department of the Western Electric Company as assistant manager of the restaurant, soon becoming manager.

Mr. Hahn is interested in fraternal activities and is a member of the Stewards' Association of America.

* * *

W. E. Campbell served as chairman of Subcommittee 5 of the A.S.T.M. Committee on Statistical Analysis and Planning of Corrosion Tests which met at the National Bureau of Standards on February 4.

H. E. Ives gave a talk at Princeton University on February 9 the subject of which was *The Scientific Simplification of the Artist's Palette.*

H. C. Rubly and W. J. Means visited Kearny to discuss an improved design of apparatus housings.

A. H. Volz, at the International Resistance Company's plant in Philadelphia, discussed wire-wound potentiometer problems.

W. T. Booth visited the Underwriters' Laboratories in Chicago, the Chicago Distributing House, the Western Electric Company at Hawthorne, and the Mallory Company in Indianapolis. At the Underwriters' Laboratories, where he was accompanied by E. L. Fisher, Mr. Booth discussed fuses.

F. R. Stansel spoke on *A Secondary Frequency Standard Using Regenerative Frequency-Divider Circuits* before the New York Section of the I.R.E.

E. St. John visited the Haydon Manufacturing Company, Forestville, Connecticut, on matters relating to timing devices.

L. N. Hampton, at the General Electric Company at Pittsfield, discussed production problems related to soldering coppers.

R. C. Platow, on February 25, spoke on *High-Speed Motion Picture Photography* before the A.I.E.E. at New York University.

R. J. Guenther was at the Patent Office in Richmond interviewing the Examiner of Interferences in interference proceedings.

J. E. Cassidy appeared before the Board of Appeals at the Patent Office in Washington relative to an application for patent.

J. A. Hall and I. A. McCorkendale were at the Patent Office in Richmond during February on patent matters.

Report of Employees' Benefit Committee

The close of 1941 marked the completion of seventeen years of operation of the Laboratories' Plan for Employees' Pensions, Disability Benefits and Death Benefits. During this time total payments of $3,796,000 have been paid to members of the Laboratories or to their dependents. Payments made under the Plan in 1941 were:

Pensions	$201,326.66
Accident Disability Benefits and Related Expenses	13,123.76
Sickness Disability Benefits	146,372.84
Death Benefits	57,487.95
Total	$418,311.21

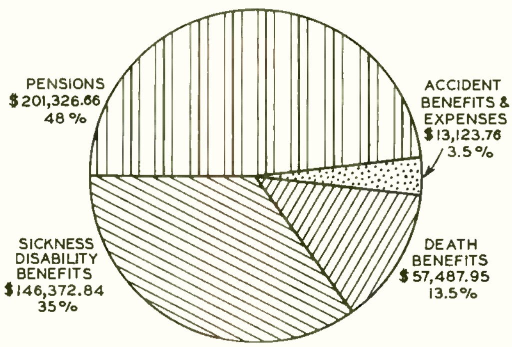
Fifteen members of the Laboratories were retired during the year 1941. Of these, five were retired in accordance with the Retirement Age Rule, four because of disability and six at their own request. Ten pensions were completed in 1941 due to death, and one disability pension was terminated. At the close of the year, 109 retired members were receiving service pensions and in addition eighteen were receiving disability or special pensions.

Fourteen deaths occurred in 1941 of active members of the Laboratories, all but two of whom were survived by qualified dependent beneficiaries to whom Death Benefit payments were authorized.

Forty-nine accidental injuries involving payment of benefits or medical expenses occurred at the Laboratories during 1941. This is an increase in frequency rate of approximately fifty-eight per cent as compared with the preceding year and twenty-one per cent with the average for the five preceding years. Payments per $1,000 of payroll were higher than last year and also above the average of the preceding five years. However, of the forty-nine injuries during the year, four accounted for fifty per cent of the total lost time and for thirty-eight per cent of the total payments.

From a sickness standpoint, 1941 was a good health year. Sickness disability benefits were paid, to employees eligible under the Plan, for 717 absences of more than a week's duration. This was a reduction in number of cases over the preceding year; the working days lost per 1,000 eligible employees were decreased by ten per cent and payments per $1,000 of payroll were decreased by twenty-eight per cent. In addition, departmental sickness payments totaling $212,507 were made to employees for short absences of less than a week's duration, for first week absences of benefit cases under the Plan, and for absences of more than a week of employees not eligible to benefits.

Special Benefit and Supplementary and Special Pension payments amounting to



Total Expenditures under the Laboratories' Employees' Benefit Plan made during 1941 *amounted to* $418,311.21

$10,186 were paid to active and retired members of the Laboratories in 1941 in need of special assistance.

At the beginning of 1941 there were 32 employees on leave of absence. During the year, 87 leaves were granted and 25 were completed, making a total of 94 outstanding at the end of the year. Of those in effect at December 31, 1941, 73 were on military leave.

The Benefit Plan is administered by a Committee consisting of R. L. Jones, Chairman, E. W. Adams, A. B. Clark, J. W. Farrell, M. J. Kelly, L. Montamat, G. B. Thomas and W. Wilson. J. S. Edwards is Secretary of the Committee and G. A. Bradley is Assistant Secretary.

J. S. Edwards, *Secretary,*
Employees' Benefit Committee.

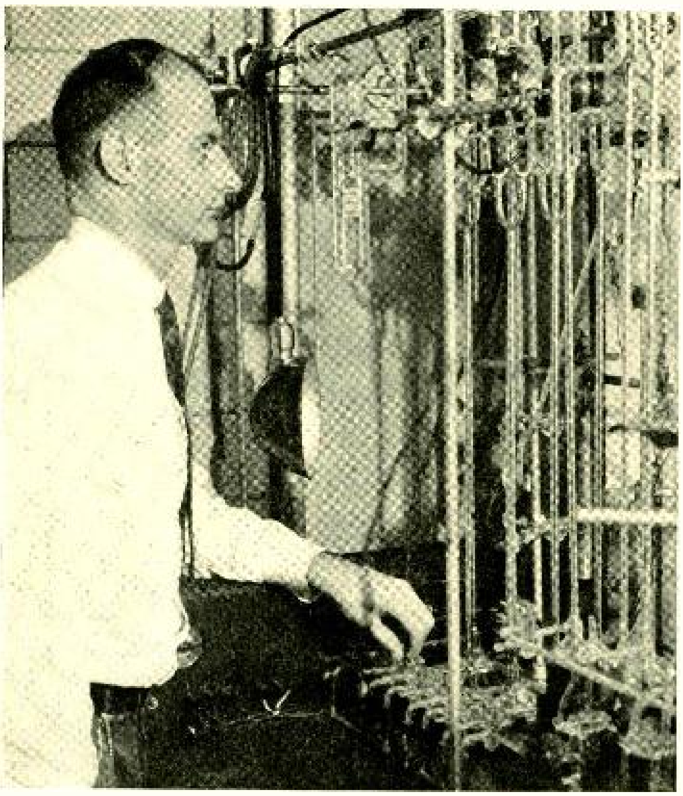
Some Members of the Laboratories

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

* * * * *

A HIGH SCHOOL TEACHER of chemistry started BILL GULDNER on his career by suggesting that he get a job at Boyce Thompson Institute as a laboratory assistant. After two years and a half on plant chemistry, Bill came to the Laboratories as a "T.A." in the analytical laboratory. At the time he was studying chemistry and physics at New York University and when he received his B.S. degree in 1935, he became an "M.T.S." About that time he transferred to Physical Chemistry, where the detection of minute amounts of gases was being studied. All this work must be done in a vacuum, and Bill's latent skill as a glassblower supplemented his technical understanding of the problem to enable him to build up elaborate systems of glass tubing. Those systems make possible the determination of the nature and amounts of gases found in vacuum tubes—knowledge which underlies the technique of getting rid of the gases. By combining them with materials put into the tube for the purpose, the gases are taken out of circulation. Since the quantities are small, great care has to be taken with the manipulations of the apparatus that is involved and with the meter readings, and Bill is esteemed in his group in both those respects.

Three years ago Bill married Beatrice Holland, then a member of the Laboratories. Their son, aged four months, is already looking forward to 1964 when he hopes to chase the elusive CO_2 molecule "like his daddy used to do." The Guldners have continued Bill's southward progress, from Northville where he was born, to Yonkers where he grew up, to the Bronx where they now live. They have a summer home on Candlewood Lake where they will often be found sailing a "Moth" class sloop.



William G. Guldner

* * *

WHEN CHARLIE ENGELBART came back to the Laboratories in 1933, he had done considerable knocking around on land and sea. But he had been smart enough to lay up a good solid training as an instrument maker, as well as several years' Bell System service.

First joining us in 1920 as a shop apprentice, Engelbart kept on with his studies at Dickinson High School in Jersey City. He then took a number of subjects at New York University, as well as some of our out-of-hour courses. After completing the apprentice course, he worked in a number of places, including a couple of years with Western Electric. In 1933 he got a job here as an instrument maker, and in 1941 he was made a group supervisor, in charge of the Development Shops in the Graybar-Varick building.

Having settled down, Charlie married, and now lives in Union City. He belongs to a number of men's organizations; in them and with his two boys (ages 1½ and 2½) he finds his leisure time well occupied.

* * *

Stanley J. LaRoche

Born at Webster, Massachusetts, "Stan" LaRoche started to work at fourteen as an office boy. Then he went to General Electric at Pittsfield and learned his trade of electrician. The Boston and Albany Railroad was changing over to electricity for locomotive lights and Stan went to their Springfield Shops to wire the engines. Then for more than four years he was an electrical contractor until disaster overtook him: a general contractor absconded and Stan never was paid for a sizable job. Chin up, he and Mrs. LaRoche came to New York to make a fresh start. He found it with Westinghouse, where for four years he was a field inspector in the service department. Entering the Laboratories in 1928, he was for eight years an electrician in the Plant Shops Department. Transferring to the Chemical Laboratories, he made varistors for several years; two years ago he went to Insulating Materials as a laboratory mechanic on molded plastics. An incidental duty is the care of the laboratory insects, who are occasionally set to chew on insulating materials for subscriber sets; humorists in the vicinity profess to see significance in the similarity in names.

Charles C. Engelbart

Stan lives near the Yankee Stadium. As he looks over the neatly fenced yards round about, he owns to a personal pride because most of the fences are his handicraft. In his basement is a well-equipped workshop, where he makes up the fence in sections. Also he cares for a garden of his own. Vacations he spends with relatives on their farm in Vermont. One of his daughters has recently married; the other is working and lives at home.

* * * * *

R. H. Colley, G. Q. Lumsden, W. McMahon and J. G. Segelken attended the annual convention of the American Wood Preservers' Association held in Minneapolis from January 27 to 29. At the business meeting Dr. Colley was elected First Vice-President of the Association. Papers presented by members of the Laboratories during the technical sessions were *Kiln Drying Southern Pine Poles* by Mr. Segelken; *Greensalt Treatment of Poles* by Mr. Lumsden with A. H. Hearn, co-author; and *Greensalt—A New Preservative for Wood* by Mr. McMahon with C. M. Hill and F. C. Koch, co-authors.

Dr. Colley and Mr. Lumsden visited Hibbing and Virginia, Minnesota, for observation of production of northern cedar poles and northern pine crossarms.

J. W. Kennard of the Outside Plant Development organization at Point Breeze was in Murray Hill for discussion of toll-cable development problems.

W. E. Mougey went to Wyoming to observe the installation of the transcontinental cables in connection with problems of design of buried toll cables.

Members of the Laboratories who completed twenty years of service during the month of March were:

Research	*Apparatus*
V. C. Williams	C. J. Hay
Systems Development Department	
A. J. Busch	Paul Winsor, Jr.
Personnel	*General Accounting*
Miss C. C. Maull	P. P. Harvey
General Service	*Plant*
Robert Kieran	H. A. Rosenbohm

W. J. Lally was in Hawthorne to discuss problems relating to drop wire attachments.

R. J. Nossaman, in company with representatives of the Southwestern Bell Telephone Company and the Long Lines Department, visited the University of Missouri, University of Kansas and Kansas State College for the purpose of recruiting new college men for work in the technical departments of the Laboratories.

G. D. Edwards has been appointed a consultant on the Ordnance Staff of the War Department. In this capacity he will be in Washington a part of each week.

W. M. Bacon was in Cleveland from February 21 to 26 supervising tests and changes in the 81B1 automatic teletypewriter switching system installed for the Republic Steel Corporation.

A. C. Gilmore, W. G. Schaer and T. J. Grieser were in Hawthorne in connection with information centers. D. H. Wetherell discussed dial equipment.

R. G. Koontz was in Cincinnati where he discussed additions to crossbar offices with engineers of the local operating company.

J. W. Geils visited Pittsburgh, Pa., to discuss equipment problems with engineers of Westinghouse Electric and Manufacturing Company.

Twenty-Five-Year Service Anniversaries

C. A. Sprague, after graduating from Syracuse University in 1904 with a B.S. degree, taught physics for several years in the North Carolina State College at Raleigh. He then entered the Patent Office in Washington where for six years he examined applications in the classes of radio signaling and telephony. Meanwhile he studied law at George Washington University and received the degree of LL.B. in 1916. He also holds the degree of M.P.L. for courses taken at Georgetown University. He is a member of the Bar of the District of Columbia.

In 1916 Mr. Sprague took a position as assistant to Cornelius D. Ehret, a patent attorney of Philadelphia, and the following year entered the Patent Department of Western Electric Company. From 1917 to 1923 he was in charge of the patent work on radio and wire carrier systems. He next supervised the work on permalloy and its applications and on submarine signaling until formation of the Laboratories' Patent Department in 1925, when he became head of its application division. Upon discontinuance of that division in 1927 he took up his present work as head of the department formed to handle television and telepho-

M. R. McKenney

J. W. Woodard

C. A. Sprague

tography. His department is responsible also for the work on photoelectrics, photography, optics, gain and volume control, and voltage regulation. While handling the patent work in these different fields he has occasionally contributed an invention of his own; sixteen patents have been granted to him for inventions in signaling.

Mr. and Mrs. Sprague, who live in Summit, New Jersey, have one son, a senior in High School. At home, Mr. Sprague finds diversion in reading and in a home workshop. Stereoscopic photography is another of his interests.

* * * * *

AFTER M. R. MCKENNEY, Patent Attorney, received his degree of B.S. in Electrical Engineering from the University of Maine in 1915, he remained there as an assistant instructor most of the next school year. He then spent ten months on patent work with the Splitdorf Electrical Company in Newark. He joined our Patent Department early in 1917 and was assigned to work on patent matters relating to automatic switching systems and apparatus. In May, 1918, he entered military training at Camp Devens and shortly thereafter was transferred to the Field Artillery Officers' Training School at Camp Taylor. Before his course had been completed the Armistice was signed, and shortly thereafter he returned to the Patent Department.

Since that time, with the exception of a period of a little more than two years from 1930 to 1933, when he was on special assignment as counsel in litigation proceedings, Mr. McKenney has been continuously concerned with panel, step-by-step and crossbar systems and is now, as a department head, in charge of patent questions relating to telephone exchange systems and equipment. He is a member of the Bar of the State of New York.

The McKenneys, who live in Summit, New Jersey, have a daughter who is a sophomore at Wellesley and two sons, one attending Pingry School in Elizabeth and the other in primary school. On week-ends during most of the year one will find Mr. McKenney on the course of the Braidburn Country Club in Madison enjoying his favorite pastime. He is a Telephone Pioneer.

* * * * *

J. W. WOODARD's telephone career began in 1911 with an independent step-by-step dial system operating company in New England. In 1913 he spent nine months with the New England Telephone and Telegraph Company and then returned to the independent field. He entered the Hawthorne plant of the Western Electric Company late in 1917 and here was concerned with central-office equipment engineering.

Since 1920, when he came to West Street, Mr. Woodard has been in the Equipment Development Department where he is now in charge of the current development group. This group provides engineering services to the Western Electric Company and the

Associated Operating Companies in connection with the various types of central-office equipment being manufactured by the Western Electric Company for the operating plant of the country. Involved in this work are numerous projects relating to the National Defense effort.

The Woodards, who recently moved from South Orange to Short Hills, have three sons—one a senior at the University of Virginia, another a junior at Georgia Tech and the third a freshman at the University of North Carolina—and a daughter who is private secretary to the chief engineer of the Wallace and Tiernan Company in Newark. Golf is Woody's main recreation and he normally plays in the eighties. He is a Telephone Pioneer.

* * * * *

J. J. Curley joined the Engineering Department of the Western Electric Company as a porter and watchman in 1917. Four months later he transferred to the vacuum tube shop where he operated vacuum pumping apparatus for various types of small tubes used by the Signal Corps during the war. After the Armistice he spent two years in the Financial Department assisting in the clerical work involved in the purchase of bonds subscribed to during the Liberty Loan campaign conducted by the Company.

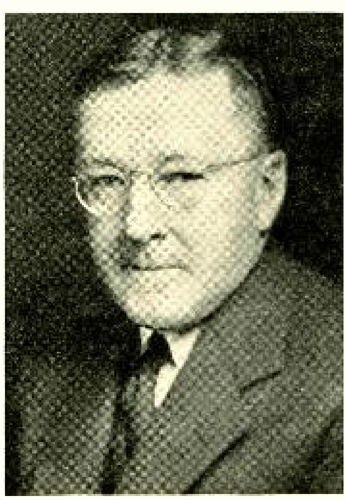
Mr. Curley then returned to the vacuum tube group and since then has been concerned with the construction and maintenance of the various glass parts used in the apparatus for evacuating vacuum tubes. He was in the Tube Shop at Hudson Street for a time, returned to West Street in 1929 and for the past seven years has been with the group in Building R.

Mr. and Mrs. Curley live in the upper section of Manhattan. They have eight children, five sons and three daughters, and three grandchildren. Their oldest son and daughter are married. Two sons are in the Service, one has just been accepted as an aviation cadet following four years in the Marines and five and a half months in the Army, and the other has been in the Marines for a year. The other children are in school. Mr. Curley is an ardent fisherman and, as time permits, will be found out around the Peconic Bay section of Long Island. He is a member of the Edward J. Hall chapter of the Telephone Pioneers of America.

* * * * *

E. H. Chatterton's first contact with the Bell System was in 1905 when he joined the Manufacturing Department of the Western Electric Company. After two years in the invoice group he left and for the next ten years worked for the American Locomotive Company in New York City on cost estimating. In 1917 he came to West Street and for a short time prepared specifications covering relays and keys and then purchased supplies for war work. Going back to the American Locomotive Company in 1918 he spent two years writing locomotive specifications.

J. J. Curley



E. H. Chatterton

Since 1920 Mr. Chatterton has been concerned with preparing and checking specifications in the Apparatus Development Department. He first covered carrier and transmission testing apparatus and, later, apparatus developed by the Commercial Products Department. Late in 1936 he went to the Graybar-Varick building where he was in charge of the group handling the specification work for the Commercial Products Department. Since 1939, when he returned to the Apparatus Specifications Department at West Street, he has been in the methods and general engineering group and has been concerned with the preparation and arrangement of new routines and with the checking of special specifications.

For the past twenty-eight years he has spent his vacations at Lake Minnewaska in Ulster County, New York. The Chattertons live in Castle Village in Upper Manhattan overlooking the Hudson River. Mr. Chatterton is fond of tennis and bridge and for many years has been a member of the Men's Bowling League. He is a member of the Telephone Pioneers of America.

* * * * *

N. R. Zucconi

Michael O'Connell

N. R. Zucconi completed a quarter century of service with the Western Electric Company and the Laboratories on the twenty-third of March. Mr. Zucconi joined what is now the Development Shop as an instrument maker back in the days when this was on the Eighth Floor. During World War I he made tools and dies for the manufacture of vacuum tubes for the Army and Navy. Following the war he worked on the general run of material going through the Development Shop. Later he was associated with the construction and assembly of the two-way television apparatus demonstrated between the Laboratories and 195 Broadway in 1930. More recently he has been concerned in the making of elements for vacuum tube assembly.

Mr. and Mrs. Zucconi live in Hollis, L. I., with their three children. Their son works for the Sperry Gyroscope Company and their eldest daughter is with *Newsweek*. The other daughter is now attending high school. Mr. Zucconi is very fond of music and in the early days of the Bell Laboratories Club, and its predecessor the Western Electric Engineers Club, he sang in several shows that were staged. He and his son have a fine collection of symphonic and operatic phonograph recordings.

* * * * *

Michael O'Connell of the Switching Apparatus Development Department joined the Engineering Department of the Western Electric Company in 1917 and immediately worked on the design of naval communication systems and of camp switchboards and telephone sets for the Signal Corps. He also had several years' experience in technical shop work and attended evening engineering courses at Cooper Union. For several years he has been concerned with design and development of central-office apparatus such as plugs, jacks, jack mountings, terminal strips, and vacuum tubes and lamp sockets together with their mountings. More recently his work has been directed toward the application of this type of apparatus to war needs and to the use of substitute materials for telephone parts.

Native New Yorkers, Mr. and Mrs. O'Connell own their home in the Bronx where they live with their six children, four sons and two daughters, the youngest being ten-month-old twins—a boy and a girl. The oldest boy is in Fordham Prep. Vacations and many week-ends find them enjoying the country in Putnam County where they have a bungalow in Patterson Township. Mr. O'Connell is a member of the Edward J. Hall chapter of the Telephone Pioneers of America and is now completing an advanced course in First Aid.

* * * * *

H. T. Langabeer was at the Superior Electric Company at Bristol, Conn., on questions pertaining to rectifier equipment.

F. T. Forster attended conferences on

storage batteries at Philadelphia, Buffalo, Trenton and at Butler, N. J.

J. H. Sole, on a recent trip to Fort Wayne, discussed machine design.

V. T. Callahan was at the Duplex Truck Company, Lansing, and D. W. Onan and Sons, Minneapolis, regarding the design of engine alternator sets.

C. S. Knowlton discussed voltage regulator problems at the General Electric Company, Schenectady.

J. A. Potter spoke before the Men's Club of the Methodist Church in Lyndhurst.

R. G. Bowen, with W. C. Schultz and J. V. Moses of the A T & T, visited New Haven to discuss maintenance problems of defense equipment.

F. B. Llewellyn, F. A. Polkinghorn and E. W. Houghton discussed high-frequency vacuum tubes at the General Electric Company at Schenectady.

* * * * *

Horace Whittle, 1896-1942

Horace Whittle of the Apparatus Development Department died suddenly on February 18. After receiving his B.S. in E.E. degree from the University of Pennsylvania in 1918 he served as an ensign in the U. S. Navy during the latter part of World War I. Mr. Whittle joined the Engineering Department of the Western Electric Company in 1919. His first work was concerned with the design and development of transformers. After a short time he was placed in charge of a group and later was responsible for all transformer work.

In 1929 Mr. Whittle transferred to the development of filters and networks and at the time of his death was in charge of three groups in the Transmission Apparatus Development Department handling networks and equalizers, carrier filters and equalizers, and network computations. He was responsible for the development of the filters and networks for the type-H carrier telephone system and to a large degree for those used in the type-C and type-K systems. During the immediate past his work had been primarily on transmission networks for various war projects. Mr. Whittle personally made many contributions to the art of transformer and transmission network development as shown by the fact that twenty-three patents had been issued to him in this field.

Mr. Whittle was a resident of Maplewood where he was active in church and Boy Scout work. He was a member of the A.I.E.E. and of Eta Kappa Nu. He is survived by his wife, two sons and a sister.

* * *

A. P. Goetze was at Hawthorne to discuss contact protection problems of central-office systems.

M. E. Krom went to Fort Monmouth to confer with Signal Corps engineers on communication equipment matters.

F. B. Blake has been elected to a two-year unexpired term on the Wayne Township (New Jersey) Board of Education.

E. F. Vaage visited the type-K repeater stations between New York and Harrisburg in connection with tests on the New York-Pittsburgh systems.

L. L. Lockrow and G. C. Reier, at Philadelphia, discussed transmission problems with engineers of The Bell Telephone Company of Pennsylvania.

A. J. Aikens made tests on type-K carrier repeaters in Harrisburg.

C. O. Cross, C. H. Gorman, H. Kahl and E. S. Wilcox have been in Fort Collins, Colorado, for trials of crosstalk balancing methods on type-K system cables.

G. P. Wennemer recently went to the Hawthorne plant of the Western Electric Company in connection with the production of carrier equipment.

J. Maurushat, Jr., at Pittsburgh, removed type-K carrier program channel equipment which had been on trial.

H. E. Crosby, J. R. P. Goller, Dr. M. H. Manson, Mrs. J. B. McIlwraith, C. Erwin Nelson, Miss M. Portelroy, Miss R. Robinson, G. Scott and R. L. Young, on March 5, attended the dinner held in connection with the annual convention of the Greater New York Safety Council.

New Exchange Area Cable

By N. V. FIRTH
Outside Plant Development

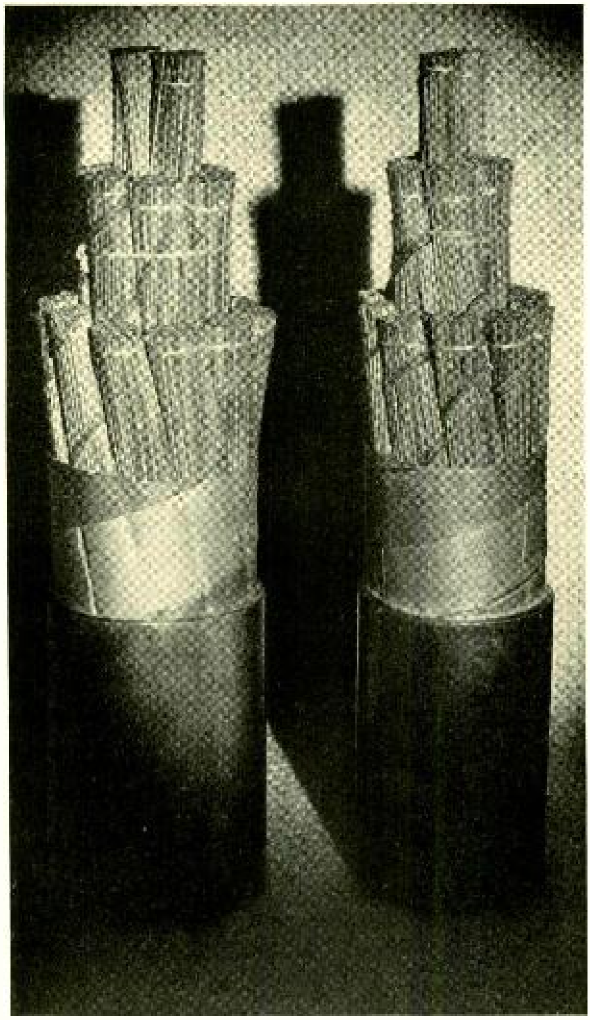


Fig. 1—Improved telephone instruments have made possible the use of cables with higher capacitance and thinner insulations. This has made practical a substantial decrease in the size of exchange area cable. Each of the cables shown above has 1818 *pairs of* 26 *gauge conductors*

APPRECIABLE savings in the first cost of cable may be realized by increasing the number of pairs in a sheath of given size or by reducing the sheath diameter for the same number of conductors. These savings may be effected by decreasing the size of the conductors or reducing the amount of insulation. Each step in this direction, however, presents increasing difficulties in manufacture and in maintaining satisfactory circuit integrity.

There has been a distinct trend toward the greater use of cable with smaller conductors. This has been accentuated in recent years by the introduction of new telephone instruments* of increased transmission efficiency and by the extended range of ringing and signaling facilities. Experience with pulp insulation† on cable conductors has made reductions in the amount of material possible and the Laboratories has recently carried out developments along these lines.

Exchange area cable has employed, since 1928, four standard gauges. The maximum number of pairs in a full-sized sheath of two and five-eighths inches outside diameter has been 455, 909, 1212 and 1818 pairs of 19, 22, 24 and 26 gauge conductors respectively. To determine whether the most economical series of new cables would result from reductions in the diameters of cables of 24 and 26 gauge conductors together with the addition of a cable with conductors of a smaller size such as 28 gauge, or whether the 24 and 26 gauges should be super-

*Record, *July*, 1939, *page* 347.

†Record, *April*, 1932, *page* 270.

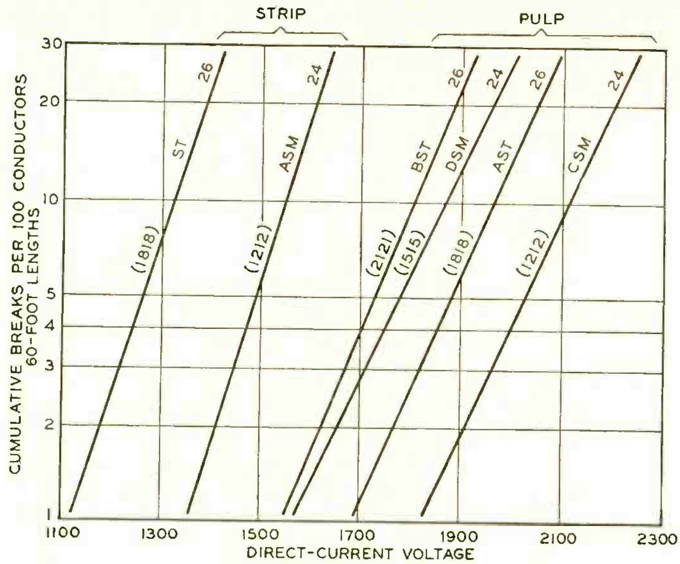


Fig. 2—The new cables have somewhat less dielectric strength than pulp insulated cables previously used but more strength than satisfactory older types which had strip insulation

seded by 25 and 27 gauges, experimental lengths of cable were manufactured with conductors of each of these sizes. They all had reduced amounts of pulp insulation and studies of dielectric strength were made on each type. Data obtained from this work, together with those available from earlier tests on standard cable, made it possible to establish the relation between breakdown voltage, insulation thickness and wire size.

Thickness of pulp insulations used for full-sized cables containing 1515 pairs of 24 gauge, 1818 pairs of 25 gauge, 2121 pairs of 26 gauge, 2424 pairs of 27 gauge, or 3030 pairs of 28 gauge provide satisfactory dielectric strength. No major alterations in the cable manufacturing equipment would be required for the introduction of any of these new types. Having determined that they could all be manufactured without difficulty, it remained to select the optimum series of cables for the exchange-area cable plant. A study of overall savings indicated that the greatest advantage would result by retaining the four existing standard gauge sizes and increasing the maximum number of pairs in 24 gauge and 26 gauge cables to 1515 and 2121 pairs respectively.

Thinner insulations of the new cables have somewhat lower dielectric strengths than those of the previously standard 24 and 26 gauge pulp-insulated cables. Tests made on them indicate, how-

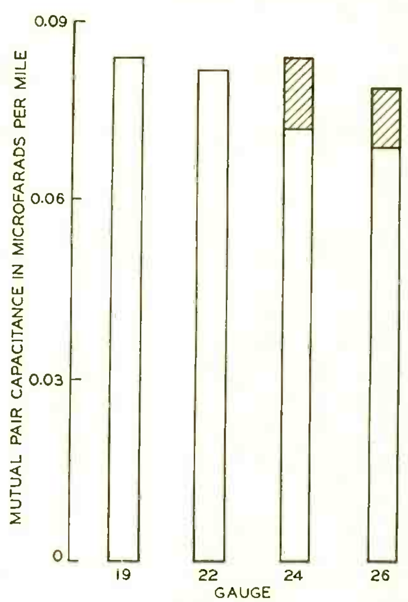


Fig. 3—The mutual capacitance per pair of the new cables is somewhat greater than that of cables previously used. The shaded areas show the increase in capacitance of the new 24 and 26 gauge cables, due to the reduction in space per pair

ever, that they are at least as good as the corresponding strip-insulated 24 and 26 gauge cables which form a large part of the existing plant. Figure 2 shows the relative dielectric strengths of the new cables and the older types which have been superseded.

Mutual pair capacitances of the present standard series of exchange area cables are given in the chart of Figure 3. The values for the cables which were standard immediately prior to the changes in design of the 24 and 26 gauge cables are unshaded. The shaded areas represent the increases in capacitance of the 24 and 26 gauge cables which result from the reductions in the space per pair. Although the higher transmission loss of these cables compared to the types they replace will have a slight effect on cable layouts, the lower cost results in an overall economy.

For assembling the required number of 24 or 26 gauge pairs into cables the method is the same as that for the previously standard 24 or 26 gauge designs. Cables ranging in sizes from 11 pairs to 101 pairs are stranded as a single unit. Those larger than 101 pairs and up to 303 pairs are first built up in small units of 50 or 51 pairs which are then assembled in long spirals to form the completed cable. All sizes larger than 303 pairs are formed similarly from units of 101 pairs each. The color code for the groupings of pairs remains the same in the new designs as in other unit type cable in recent years.

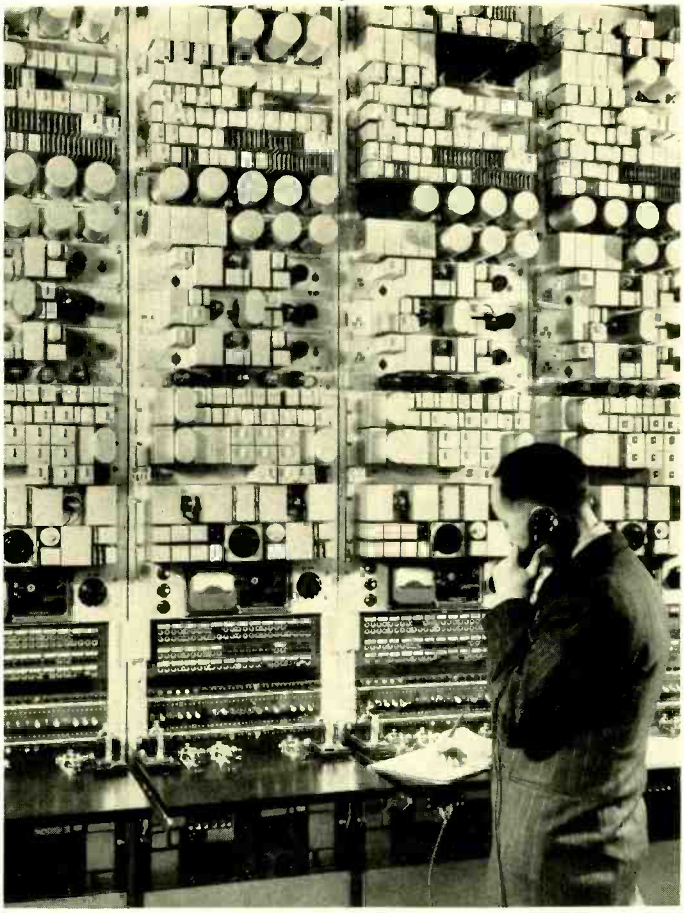
The larger number of pairs obtainable in the full sizes of these new designs will in some instances prove economical in plant rearrangements incident to central-office cutovers and should be advantageous in making additions to plant where there is underground conduit congestion. The major savings, however, are expected from the reductions in sheath diameters for cables of the same numbers of pairs as formerly.

A Blow in the Battle for Freedom

"*There's so much to be done to win the war and protect the liberties we so dearly cherish that every one of us must do his part to the utmost. Our men in uniform have the toughest job. But there is more than plenty for the rest of us to do. We must fight complacency, selfishness and disunity. We must make more guns and tanks, bombers and ships, and shells and torpedoes than our foes ever even dreamed of making and we must make them in a hurry. To help pay for them each and every one of us must buy Defense Bonds and Stamps and keep on buying them.*

"*Employers all over the country have established payroll savings plans. Our company was one of the first to do so and over* 200,000 *telephone employees are saving regularly and buying Defense Bonds. . . . Every Defense Bond bought is a blow struck in the battle for freedom; and victory in that battle is worth any sacrifice—even life itself.*"

—Walter S. Gifford,
in a "Minute Man" radio talk, March 16, 1942.



The C2 Control Terminal for Radio Telephone Circuits

By J. O. SMETHURST
Transmission Development Department

WHEN a long radio link is connected to the wire circuits of the regular telephone plant, it is necessary to employ certain special connecting equipment to enable the transmission capabilities of the radio link to be used to their fullest extent. The radio control terminal performs this function. It also provides facilities to enable special technical operators to test, monitor, and, if necessary, adjust the system while it is in operation.

One of the chief functions of the control terminal is to reduce the range of speech volumes applied to the radio transmitter, thus permitting it to be loaded more fully at all times, and so make possible the use of a smaller transmitter than would otherwise be required. If means were not taken to prevent it, such adjustments of the outgoing speech volumes might result in net gains large enough to cause singing around the hybrid coils. Accordingly, a device called a vodas,* "voice-operated device anti-singing," is included in the control terminal. It normally holds the outgoing path blocked, and keeps the incoming path clear so that signals may be received. A sensitive control circuit connected to the outgoing path will reverse these conditions under the influence of outgoing speech; that is, it will clear the outgoing path and place a high loss in the incoming path.

A radio terminal equipped with a transmitting volume control and a vodas is shown much simplified in Figure 1. Speech from the toll office will pass through the hybrid coil to the transmitting volume control which is adjusted by observing the reading of a volume indicator. It then passes to the transmitting part of the vodas where a small portion of it will be diverted through a second hybrid coil to a detector. Here this portion of the speech will be rectified, and will operate the TV and TE relays to make the outgoing path operative and the incoming path inoperative. If only speech had to be considered, the vodas could be made very sensitive, and the desired action would be secured. Actually there is always noise on the line, however slight, and if the vodas relays were sensitive enough to operate on noise the incoming path might be held permanently blocked. For this reason a sensitivity control is incorporated in the vodas circuit.

This is not the only condition that must be attended to, however. Incoming speech from the radio receiver passes through the hybrid coil to the toll office, but a certain portion of it will be reflected back to the transmitting path. If no steps were taken to avoid it, peaks of incoming speech reflected back to the transmitting path would be of sufficient strength to operate the vodas, thus momentarily cutting off the incoming speech. These interruptions would seriously affect intelligibility. The vodas therefore includes a disabling circuit which operates on incoming speech or noise, to block the output of the transmitting detector so the TV and TE relays cannot operate to interrupt incoming speech. The disabling circuit is also given a sensitivity control because it must not be permitted to lock up on circuit noise.

The latter two sensitivity controls must be readjusted recurrently so that circuit noise will not operate them, but the weakest speech above the noise level will. The two noise levels will be different, of course, because one is that of the land line and the other

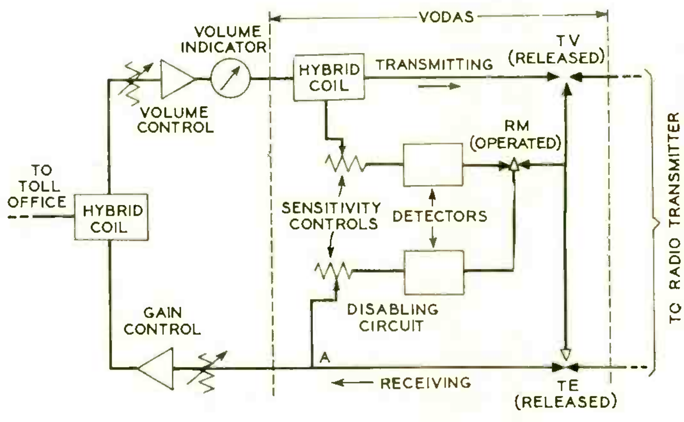


Fig. 1—A simplified form of a radio control terminal indicating the function of the vodas

*Record, *Nov.*, 1927, *p.* 80.

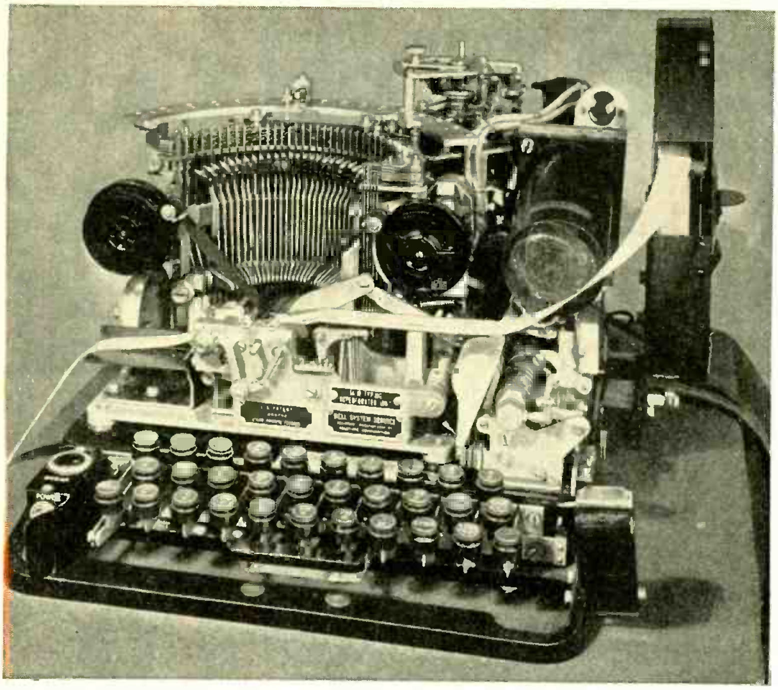
the vogad, that is, the sensitivity of the vogad regulating circuit, as measured from point A, must always be less than the receiving detector's sensitivity. For this reason, the R detector has been added in the pilot path to make certain that the control circuit will reduce the gain between point A and the vogad to maintain the sensitivity requirement. Either R or T detectors will control the gain; the one that has the higher output will assume control. When the gain in the vogad is low, thus permitting a higher gain in the control circuit without danger of operating the vodas, the R detector assumes control, and allows the received gain to remain just as high as it can be without causing the gain of the vogad to increase.

The R detector is also useful when the radio link is connected to a long land line using echo suppressors. All signals above a certain amplitude flowing toward the distant end of the land line will operate the echo suppressor to disable the opposite path and prevent the return of echoes. If there is high gain in the receiving path the sensitivity of the echo suppressor, as seen from point A, might be higher than the sensitivity of the receiving detector and the echo suppressor might hold the return path disabled on noise. The R detector prevents this condition by adjusting the receiving gain so that the sensitivity of the echo suppressor, as seen from point A, is always less than that of the receiving detector. In this way, the outgoing path of the signal is never blocked by the echo suppressor unless it is also blocked by the operation of the receiving detector.

With these automatic control features, only occasional attention will be required of the technical operator, and for this reason the C2 terminal has been equipped with alarm and indicator circuits to facilitate operation. Monitoring circuits are available for the technical and traffic operators, and talking keys are provided to enable the technical operator to talk to the distant radio terminal or to the traffic operator. The terminal is mounted on a single eleven and one-half foot relay rack, and thus occupies considerably less space than previous terminals. It is arranged to work with either No. 1 or No. 3 toll switchboards, and the terminal may be located either in the same building as the switchboard or at a considerable distance from it. An installation in the Long Lines building in New York City is shown in the photograph at the head of this article.

Dr. Buckley has accepted the invitation of The Institution of Electrical Engineers to present the Kelvin Lecture on April 23. *His subject will be* The Future of Transoceanic Telephony. *The Kelvin Lectureship was created by the Institution in* 1908 *as a memorial to William Thomson, Baron Kelvin of Largs.*

Due to the pressure of war work, it will be impracticable for Dr. Buckley to appear in London in person, and the paper will be read by the vice-president of the Institution, Sir Stanley Angwin



Typing Reperforator

By T. L. CORWIN
Telegraph Development

IN TELETYPEWRITER service there are receiving instruments, known as reperforators, which serve to relay messages from one circuit to another. The incoming message perforates a tape which is then used to re-transmit the message. Recently, with the extended usage of teletypewriter service by large industrial concerns and by the government, there are more occasions for relaying messages and for getting from the code on the tapes addresses and other information. To meet this need the typing reperforator shown above has been developed. It types the characters corresponding to the code punchings on the same tape, so that the destinations or contents of messages can be read quickly. The machine, which was developed with the collaboration of the Laboratories, is manufactured by the Teletype Corporation.

On receipt of an incoming signal the code bars of the reperforator are positioned as in other teletypewriters* to type the character called for. At the same time, to perforate the tape, the corresponding code combination is set up by a mechanical linkage which positions the punch fingers. A punch arm then drives the punch pins through the tape into the die block while the corresponding character is typed. Details of the linkage motions for the perforating operation are shown in Figure 1. The bell-crank

*Record, *May*, 1939, *page* 281.

levers A are to the rear for spacing and to the front for marking. Levers B carry this motion to the bell-crank levers C and D which pull the selector fingers E to the right for the marking position so that a high part is presented to the punch pins P. This permits the punch bail to push the pins through the tape into the die block. When a code bar is in the spacing position the finger E associated with it is provided with a depression which is under the punch pin, thus preventing the pin from being driven through the tape into the die block.

A new perforating mechanism leaves the punchings partly attached to the tape. This prevents impairing the legibility of the record, which is typed in the same part of the tape. It also obviates the need of disposing of punchings. The perforating and typing are done simultaneously but the perforations precede the typed characters by six spaces. Perforations of this type also permit the splicing of one tape to another with a special splicer which forces the hinged sections of the bottom tape through the partially perforated holes in the top tape. A continuous tape can thus be made from separate pieces.

Typing reperforators use the same tape as keyboard perforators; and tapes from either of these machines may be transmitted from the same transmitters without readjustment. This permits the customer to stock only one type of tape and to use the same transmitters for relayed messages or those originating at his office.

These machines can feed out "letters," or fully punched tape, either manually with a lever on the machine or by a magnet for remote control. Feed-out is used when messages must be cleared from the reperforator for manual handling and also to clear the end of a message through a transmitter, if the tape is fed directly into it from the reperforator in a continuous piece. In automatic switching systems the feed-out is automatically controlled. A "tape-out" bell sounds when the end of the tape approaches

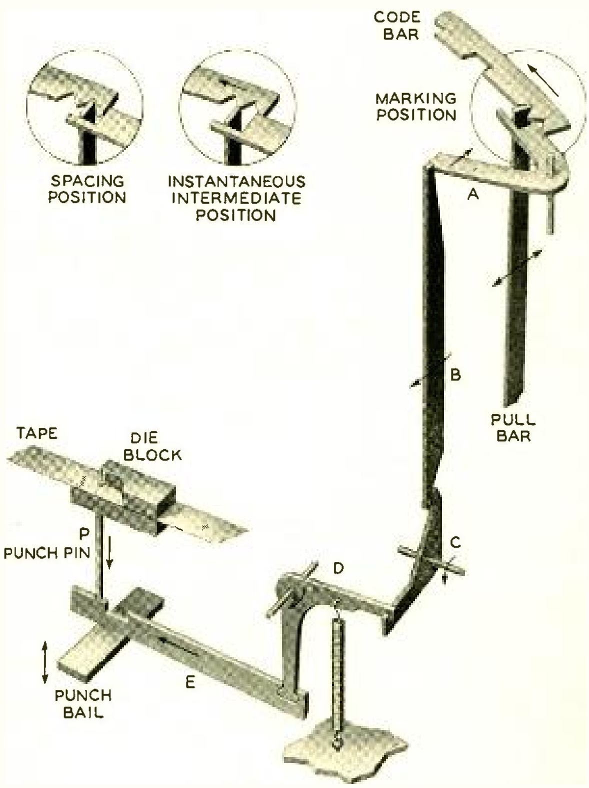


Fig. 1—Perforating mechanism of the No. 14 typing reperforator. Bell-crank levers A *are positioned forward for marking and to the rear for spacing. Levers* B, C *and* D *carry this motion to the selector fingers* E *which present a high part to the punch pins* P *for marking. The punch bail then pushes the pins through the tape into the die block. No perforation is made when a pin is over the cut-away part*

and a visual signal is also given by a red section near the end of the roll.

Typing reperforators with back spacers can be obtained to permit the operator to step the tape back for re-punching. This feature is useful with keyboard machines when an error is made in the tape which should be corrected before the message is transmitted. Back-spacing to the error and "rubbing it out" with "letters" combinations which have no effect on the typing accomplishes this purpose. Contacts for operation on receipt of certain characters can be mounted above the type pull-bars and operated by any one of them. A bracket with one contact is shown on page 209.

The No. 14 typing reperforator may be equipped for receiving only or for sending and receiving. In appearance it is similar to the 14 type teletypewriter and it is mounted on a table in customers' offices or, without base and cover, in cabinets when used in switching offices. The exacting requirements of telegraph switching systems as well as those of office applications have been satisfactorily met by these machines. At the present time there are about three hundred in Bell System service.

Contributors to this Issue

George G. Winspear upon graduation from Pratt Institute School of Industrial Chemical Engineering in June, 1929, spent eight months as chemist with the duPont Rayon Company. In April, 1930, he joined the Laboratories as a technical assistant and for five years was engaged in the testing and experimental compounding of soft rubber insulation. In April, 1935, he was made a member of the Technical Staff, and shortly thereafter became associated with the general rubber problems group engaged in research on hard, soft, and synthetic rubbers and their adaptation for telephone system use.

J. O. Smethurst immediately joined the Technical Staff of the Laboratories after he graduated from Tufts College in 1929 with the B.S. degree. With the Systems Development Department he has been engaged in the development of various radio telephone control terminals and voice operated equipment. More recently he has been concerned with the adaptation of type-K carrier equipment to multi-channel high-frequency radio telephone circuits.

George G. Winspear

J. O. Smethurst

S. J. Brymer entered the Laboratories as a technical assistant upon the completion of his studies at Brooklyn Boys' High School, N. Y., in June, 1920. His first nine years were spent in the drafting room of the Systems Department whence he transferred to the special equipment engineering group working on trial installations and current development problems. For the last four years he has been engaged in the development of common systems equipment such as switchboards,

S. J. Brymer

T. L. Corwin

N. V. Firth

desks and similar equipment. In 1933 Mr. Brymer received the degree of Electrical Engineer from the Polytechnic Institute of Brooklyn.

T. L. Corwin received the B.S. degree in Electrical Engineering from Georgia School of Technology in 1923 and joined the Installation Department of the Western Electric Company that summer. After five months he transferred to the Engineering Department to work on operating methods for manual telephone circuits. In 1925 he wrote specifications to cover installation and maintenance of telephone apparatus. The following year Mr. Corwin joined the relay design group where he remained until 1931. He then began designing and testing teletypewriter switchboards and subscriber sets. Since 1935 he has been engaged in design and development problems connected with teletypewriter apparatus of which the typing reperforator described in this issue of the Record is a recent example.

N. V. Firth graduated from Park College in 1927 with an A.B. degree. He held a graduate assistantship in physics at Missouri University the following year while continuing studies there in physics and mathematics in the graduate school. Mr. Firth joined the Laboratories in 1928 to work on lead-covered cable development problems. At first he was stationed at Hawthorne but transferred to Kearny in 1929. There he was concerned primarily with exchange area cable development including the studies on pulp insulation which led to the improvements described in the current issue of the Record. Mr. Firth was transferred to Point Breeze in 1940 to continue these studies and undertake various phases of coaxial development.