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Automatic adjusting machine for C-type ringers

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A ringer must do more than just ring when 20-cycle ringing current comes over the line. It must not respond at all to signals connected with dialing, switching or party line identification. The correct sensitivity is secured by counterbalancing the magnetic forces on the armature with a spring tension.

At one time, ringers were adjusted by the installer who varied the tension on a bias spring in relation to signals from the central office. In the B-type ringer for the 302 combined set, the spring tension was adjusted at the factory to provide three tension settings one of which was selected by the installer to fit the service conditions.

In the C-type ringer for the new 500 type set, the number of settings has been reduced to two. In addition, the optimum balance is more closely approached by adjusting the magnetic forces as well as the spring tension and the entire adjustment is performed by the automatic machine shown in Figures 1 and 2.

As shown in Figure 3, the armature is held in its "non-operated" position near the left hand pole face by a mechanical force. This mechanical force is opposed by magnetic forces which tend to move the armature toward its "operated" position at the right hand pole face. The mechanical force must be large enough to prevent motion of the armature when non-ringing signals such as dial pulses flow through the coil, but it must not be so large as to prevent response to minimum ringing cur-

Fig. 1—A. F. Conk connects ringer to automatic adjusting set.

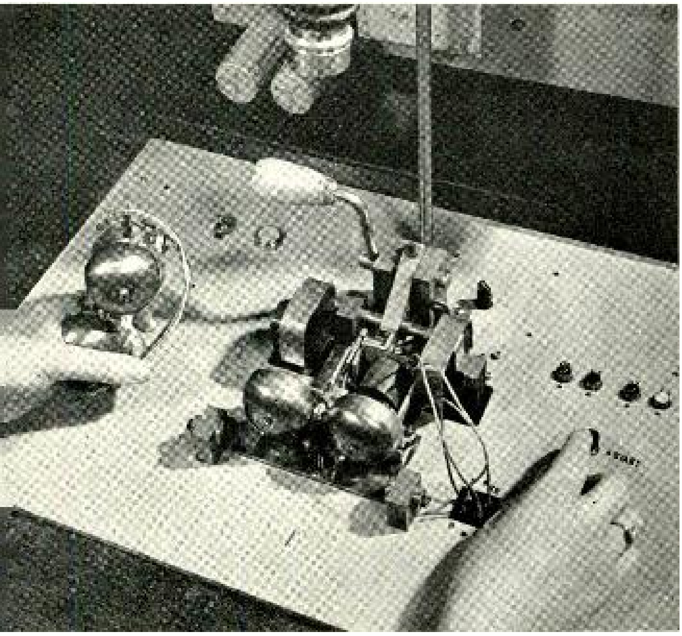

Fig. 2—C-type ringer in position for adjustment. Lights at right signal success or failure.

rents. Furthermore, the forces must be balanced so that the armature will be restored to its "non-operated" position on completion of ringing.

The situation is complicated by the fact that the mechanical force arises in part from the bias spring and in part from the armature reed spring, and the forces contributed by each are dependent upon the position of the armature. There is the added complication that the magnetic forces also vary with the armature's displacement. Because of the interrelation of these variables a virtually simultaneous adjustment of the mechanical force and the magnet strength is required to secure the combination of forces which will cause the armature to behave as required at both its operated and its non-operated positions. It is this combination which the mechanism, shown schematically in Figure 4, establishes.

Before adjustment, the magnet strength and mechanical force are purposely made greater than needed, and the adjusting process consists of reducing them alternately and in small amounts. By making each reduction sufficiently small a simultaneous adjustment of both is approached.

Reduction in magnet strength is accomplished with an external field obtained by discharging a capacitor through a pair of demagnetizing coils. To reduce the mechanical force, the bias spring is bent by rotating a forked shaft which projects upward through a hole in the ringer frame. When rotated, the two prongs of this shaft engage the bias spring making a small bend near the armature. After the shaft has bent the spring, it is rotated back to its rest position to free the spring and armature for subsequent tests.

The amount of rotation of the shaft is controlled by a potentiometer which forms two arms of a bridge circuit. The movable contact of the potentiometer rotates with the bending shaft. As the bridge approaches balance a thyratron fires, reversing the motor driving the shaft and returning it to its rest position. The bridge circuit is arranged so that between bends the balance point shifts and each successive shaft rotation is slightly larger than the previous one. Thus, each time the shaft rotates it makes a slight increase in the total bend in the bias spring until the required curvature is reached.

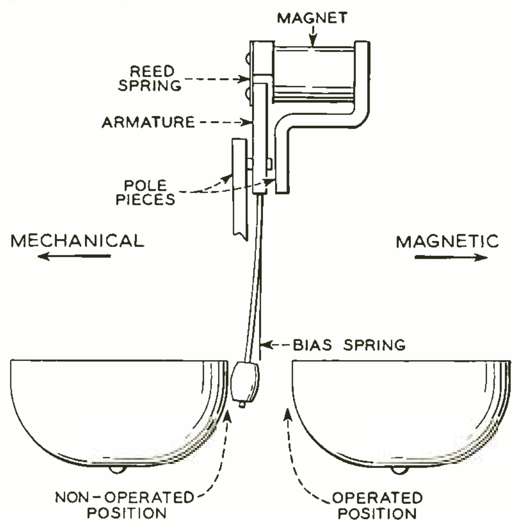

Fig. 3—Diagram showing forces acting on ringer armature at rest.

At each stage of the process, the machine must decide whether the ringer has reached adjustment and, if not, whether the magnet strength or the spring force should

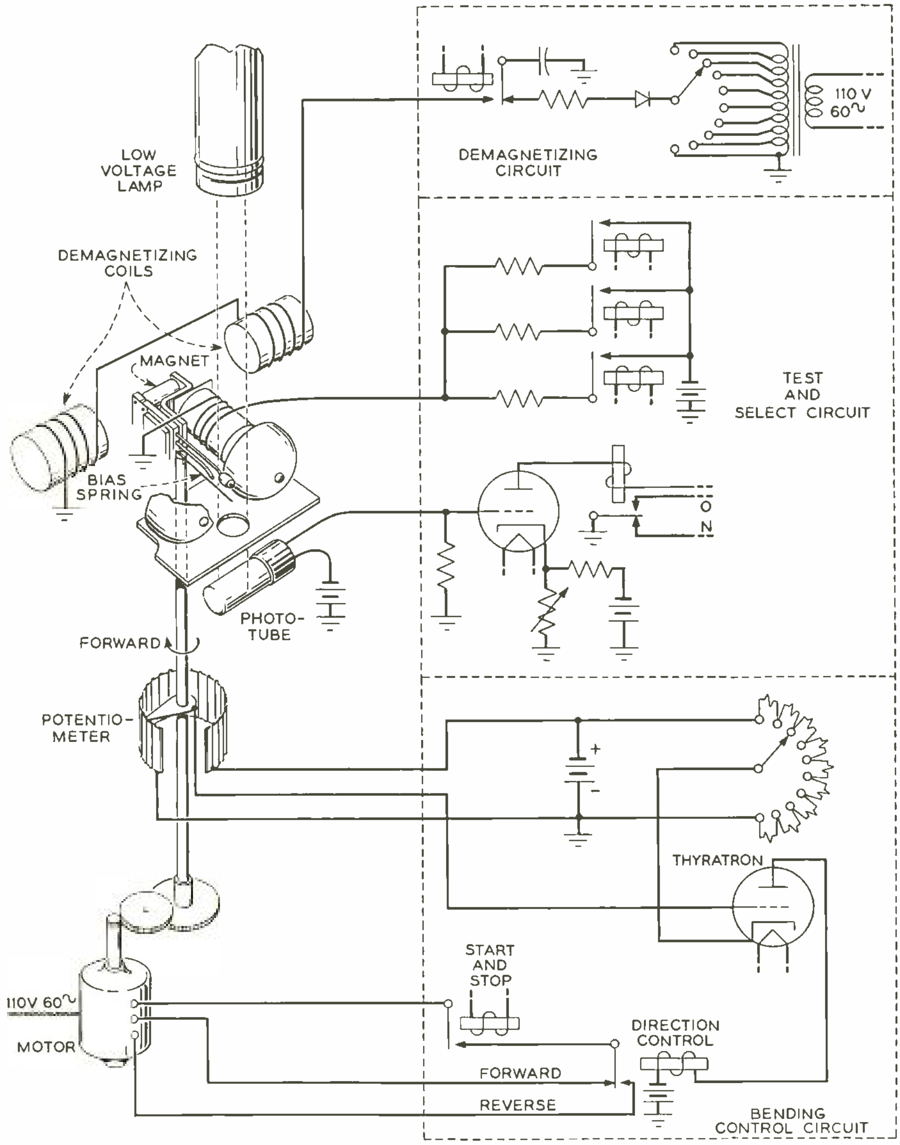

Fig. 4—Diagram showing operation of ringer adjuster.

next be reduced. To determine the condition of the ringer, the machine observes by means of a light and a photoelectric cell the response of the armature to test currents passed through the ringer coil. With the armature in its non-operated position the path of the light is interrupted by the clapper ball but is not interrupted when the armature is in its operated position. By this means the machine can determine, first, which of the two positions is occupied by the armature, and secondly, the change in position by comparing positions before and after application of the test current.

Two types of test are used to determine the condition of the ringer. One is a "release test" in which the machine applies a current large enough to move the armature to its operated position; it then reduces this current to a small value and observes whether the armature falls back to its non-operated position. Failure to fall back indicates that the magnet is too

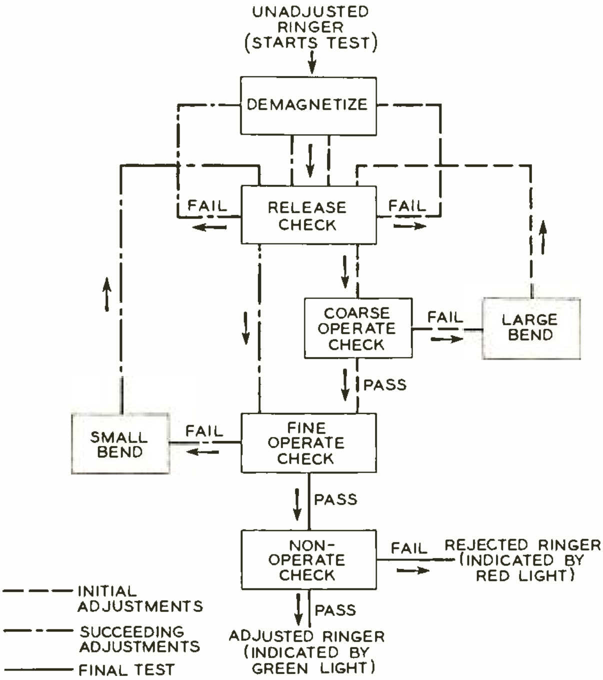

Fig. 5—Flow chart of ringer adjustment process.

strong. The other is the "operate test" in which the machine observes whether the armature moves in response to a certain minimum ringing current. Failure to respond indicates that the mechanical force on the armature is too high.

The accuracy with which the force on the armature can be set depends on the increment by which the bias spring is bent. If small changes are made, the required value can be more closely approached than if large changes are made; but the smaller the change, the greater the number and so the longer the time required to complete the adjustment. Without sacrificing accuracy the machine was made to work faster by having it make coarse adjustments at first and then fine ones as the desired optimum is approached.

The sequence of operations is shown in the flow chart in Figure 5. First of all the magnet is demagnetized by a predetermined and relatively large amount in order to stabilize its magnetization, rendering it invulnerable to line surges passing through the ringer winding or to the effect of nearby magnetic objects. Next a release test is made. Whenever a release test is not met, the magnet strength is further reduced by applying a slightly greater demagnetizing field to the ringer. As soon as the release test is satisfied, an operate test is made. If this is not met, a relatively large reduction in the mechanical force is made by bending the bias spring. After each change in the bias spring another release test is made since the force may have been reduced so much that the armature will no longer return to its non-operated position. Once the coarse operate test has been passed, a fine operate test is made. If the test is not met a small reduction in bias spring force is made and the release test is repeated. After the fine operate test has been met, a non-operate test is made and, if this is satisfied, the machine signals the fact by lighting a lamp and makes itself ready for another ringer. When a ringer proves unadjustable the machine automatically stops trying after a predetermined number of operations and signals accordingly. Also, the machine

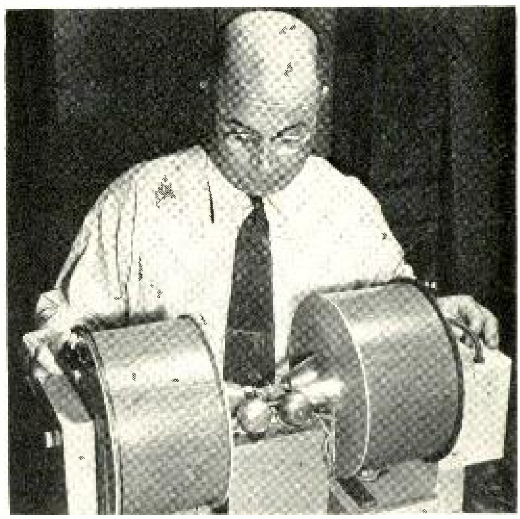

Fig. 6—To insure prescribed magnetization and to avoid the picking up of ferrous particles, ringer magnets are magnetized after assembly.

immediately recognizes a ringer with an open or reversed winding and makes no attempt to adjust it.

An average adjustment cycle involves eight to ten demagnetizing operations, eight to ten coarse tests, six fine tests and the complete cycle takes about 30 seconds.

The nature and number of the operations automatically reflect the character of the unadjusted ringers presented to the machines, and thus provide a measure thereof which could be conveniently summarized by automatic registering equipment. Data on trends in the averages could be used to monitor the assemblies before adjustment. For example, lower numbers of demagnetizing operations indicate weak magnets, and higher numbers of coarse operate tests indicate excessive mechanical forces.

This article has described a machine developed by the Laboratories, and the Western Electric Company is now employing several machines, adapted from this design, on their assembly lines. In addition to incorporating a winding insulation breakdown test and providing a semi-automatic loading carriage the machine has been arranged so that the control circuits may be located at some distance from the assembly line to conserve space and facilitate maintenance. Currently, each operator is operating three machines since they require no attention other than loading, unloading, and operating a start key.

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The cold cathode glow discharge tube

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Cold cathode glow discharge tubes of the two-element or diode type have become relatively familiar devices in many types of industrial control circuits and communication applications. Some of these tubes are used for such purposes as visual signals, polarity indicators, and marginal operating devices; other forms make use of the constant voltage drop across the tube as a voltage regulator or voltage reference element.

The cold cathode tube consists of a glass envelope into which is sealed an inert gas, usually neon or argon, or a combination of these gases under low pressure, and two or more electrodes. These electrodes terminate in pins or wiring terminals extending from the tube base.

Ionization of gases continually takes place due to the presence of radioactivity or cosmic radiation. When two metal electrodes having a potential difference between them are enclosed in a vessel with a gas at low pressure, electrons will be drawn to the anode, giving rise to a small current. Additional ionization of the gas will also occur from photo-electrons emitted from the cathode due to light rays. Considering first the diode, the current versus voltage characteristic is shown in Figure 1(a), using the circuit of Figure 1(b). Electrons resulting from the ionization make many collisions with the neutral gas atoms, as the voltage is increased. A value E_1 will be reached at which most of the electrons emitted will arrive at the anode, but increasing the voltage still further will not change the current until a voltage E_2 is reached, where the electrons originating from ionizing influences will have sufficient energy to ionize the neutral atoms with which they collide. As a result of these collisions positive ions and new electrons are produced, the ions moving toward the cathode and the new electrons moving toward the anode. More ionizing collisions are made, further increasing the supply of ions and electrons, causing the current-voltage curve to rise; mathematical analysis shows that the current increases exponentially between E_2 and E_3. It is important to note that, although the original current is amplified many times, it is still necessary that the original ionizing means be supplied. If the light or other radiation is cut off from the cathode, the anode current falls to zero, even though the voltage is unchanged.

If the voltage is increased beyond E_3, then the current begins to increase at a rate faster than the exponential rate given by the process of ionization by electron collision. Above a certain current, the source of light or other original ionization may now be cut off and the discharge will be self-sustaining. This is due to the positive ions striking the cathode and causing emission of electrons. Since the number of positive ions has been increasing as the anode voltage increased, a point is soon reached where

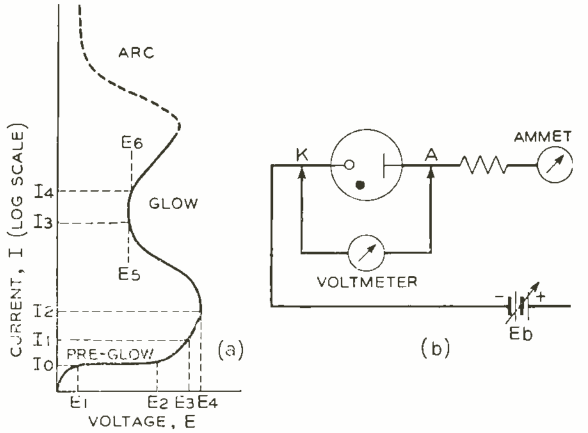


Fig. 1—(a) Current versus voltage characteristic of a diode. (b) Circuit used to obtain characteristic shown in (a).

the additional source of electrons becomes equal to the original photo emission. This leads to instability, the current rising sharply, and the voltage-current characteristic becomes that of a negative resistance from E4, the breakdown value, to some point E5, at a much higher current. The negative resistance then falls to zero and becomes positive again at a voltage E6.

Between currents I3 and I4 the discharge is at nearly constant voltage, but since the tube has no resistance to the flow of current, it is necessary to operate the tube with an external resistive load to limit the current through the tube. The normal operating range is between I3 and I4.

As mentioned previously, the photoelectric current* is indispensable for tube operation, but for proper tube performance when functioning as a relay, this current must be kept within satisfactory limits. To prevent the current from becoming excessive, with consequent false tube operation, it is necessary to protect the tube electrodes against strong sunlight or artificial illumination by coating the tube with a fairly opaque paint. On the other hand, if the tube is used in the dark, long breakdown times might result after several minutes of standing idle, because of lack of this photoelectric current. To insure reliable behavior, therefore, Western Electric cold cathode tubes have a small quantity of radioactive material within the tube envelope to serve as an additional source of ionization.

Aside from its use in initiating the discharge, the photoelectric part of the tube characteristic is not generally useful. It is of such small magnitude that for most practical purposes in telephone circuit design, the input impedance of the tube in this range can be considered infinite.

The three-electrode tube is simply a combination of two diodes, and is made with two anodes and a common cathode. One anode is closely spaced to the cathode, forming the so-called "starter" gap. The other anode is more distantly spaced from the cathode, forming the main gap; this gap has a substantially greater breakdown voltage than the starter gap, largely because of the difference in gap length. Use of the triode as a relay depends upon the mutual or transfer characteristic of the tube, whereby a small signal current flowing in the starter gap will ionize the tube sufficiently to lower the main gap breakdown voltage and cause the tube to function on its main gap.

The transfer characteristic for the Western Electric 313C tube is shown in Figure 2. The transfer current is obviously a func-

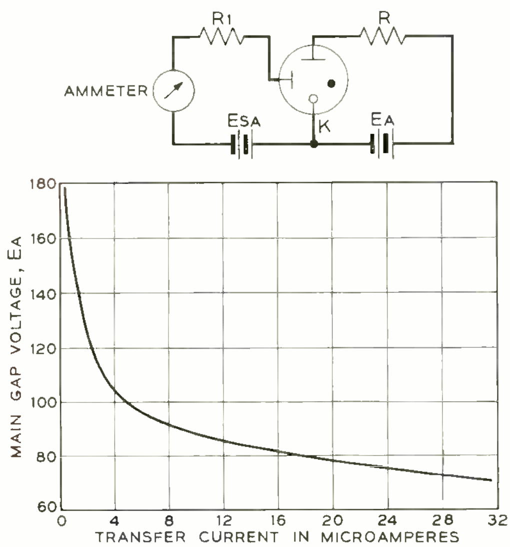


Fig. 2—Transfer characteristic of Western Electric 313C cold-cathode tube.

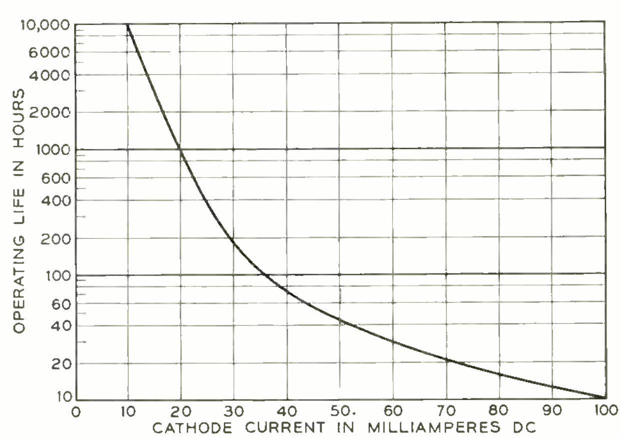


Fig. 3—The life of a Western Electric 313C tube depends on the amount of current through it.

* The current resulting from ionization caused by light rays, radioactivity, etc.

tion of the applied anode voltage, since a self-sustaining discharge cannot take place to the main anode no matter how high the starter anode current might be, if the main anode is below its sustaining voltage. On the other hand, assuming a source of preliminary ionization, no current would be needed in the starter gap to cause anode current to flow if the anode voltage is above the breakdown value of the main gap.

Although the current flowing in the starter gap at voltages below the starter gap breakdown is insignificantly small, the current flowing at breakdown is not insignificant, even though only a few microamperes are required for transfer to take place. The tube cannot, therefore, be looked upon as a purely voltage operated device and the impedance of the associated input circuit must be limited to a value which will provide the current needed to insure reliable anode transfer.

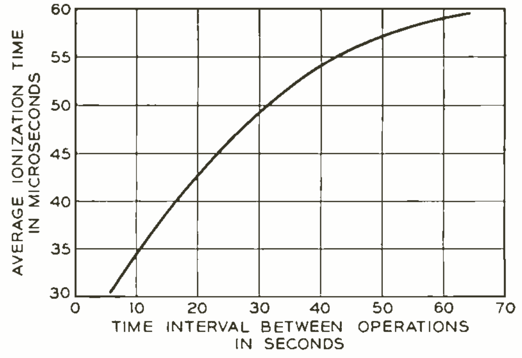


Fig. 6—Ionization time increases when the interval between operations is lengthened.

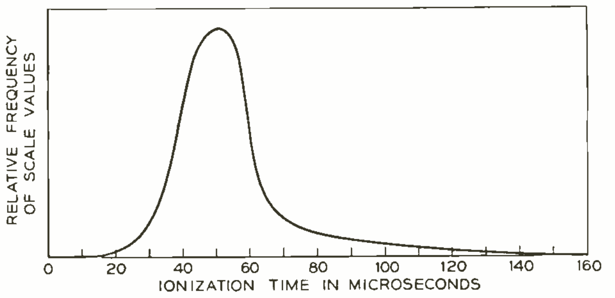


Fig. 4—Distribution of ionization times of a Western Electric 430A tube

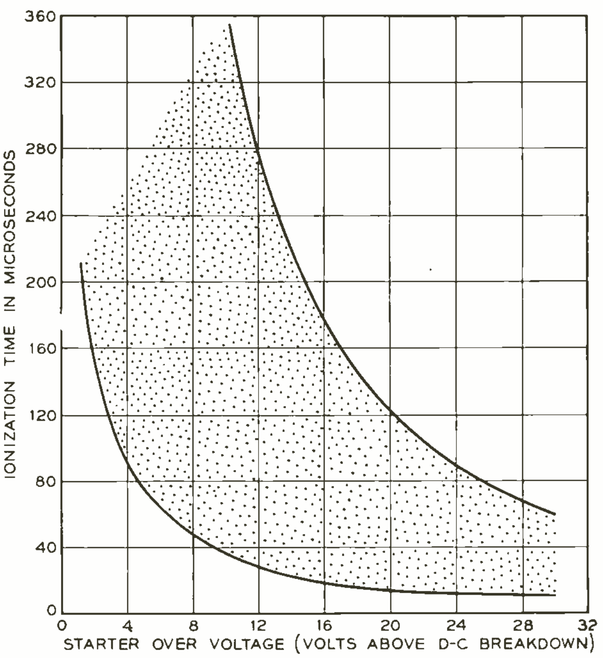


Fig. 5—Range of ionization times of a 430A tube.

It should also be noted that, in common with other gas-filled tubes such as the thyratron, the control element, or starter anode, can cause the main gap to conduct fully, but it cannot thereafter control the discharge. Once the tube has been operated, it cannot be extinguished unless the tube gap voltages are lowered below the sustaining values.

Conducting life of the tube depends upon the magnitude of current through it. Figure 3 shows the life characteristic for a 313C type tube as a function of this current. When the tube is subjected to relatively high current pulses of short duration but operated at a low rate, it is entirely practicable to work in the region where the tube life is only a few hours, but where the service life is many years.

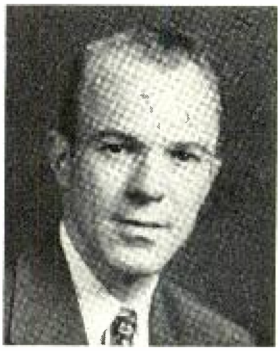
Ionization in the gas after voltage application, and the building up of this ionization to the self-sustaining discharge, takes a measurable amount of time. These times may range from a few microseconds to as long as several milliseconds. Because of this variation, continued development work has resulted in the use of a larger and more accurately controlled amount of radioactive material in some tubes. For example, the 430A tube recently developed is similar to the 313C tube except for this single change.

Investigations into the ionization time of the 430A tube have resulted in obtaining a fairly satisfactory group of factors to be considered in circuit applications of this tube. Figure 4 shows the distribution of measured ionization times of a typical tube. Since, as indicated by this distribution, some ionization times may be expected to be somewhat above the test limit of 150 microseconds, a figure of 200 micro seconds has been established as being the probable maximum time for design purposes.

Rapid ionization is most easily obtained by providing an applied voltage well over the breakdown voltage of the tube. The range of ionization times shown in Figure 5 indicates the improvement to be gained, both in value and consistency, by increasing the over-voltage on the starter gap.* This range includes variations between tubes and covers a range of time intervals between successive breakdowns. The dependance of ionization time on the interval between operations (over a large number of operations) is given in Figure 6, a typical curve of tests at 15 volts over-voltage. The percentage change is apparently the same at other over-voltages.

The 430A tube is an example of how an existing tube can be modified to control a certain characteristic—in this case, ionization time—by closer manufacturing controls and additional tests to insure meeting the desired requirements. As use of cold cathode tube continues to expand, new requirements, or restrictions on existing ones, may be anticipated. Increased experience regarding manufacturing processes, together with close liaison between tube and circuit engineers should, however, result in solving these problems.

* The impedance of the input circuit must, of course, be low enough to avoid excessive voltage drop in that circuit when the transfer current flows through it.



THE AUTHOR: D. S. PECK received a B.S.E. degree in E.E. from the University of Michigan in 1939 and an M.S. in E.E. the following year. He then worked for the General Electric Company in Schenectady until 1947, when he joined the Laboratories. Here he has been concerned with the design for production of gas-filled electron tubes such as rectifiers, thyratrons, and cold-cathode tubes used in ringing, switching, and miscellaneous relay applications.

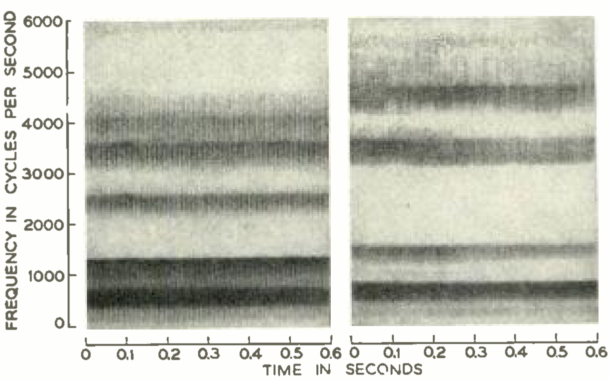
A. J. Prestigiacomo adjusts the magnetic tape record of the model sounds transmitted to a loudspeaker in the free space room. Each sound is repeated at 2.5 second intervals.

Exploring hidden factors in speech

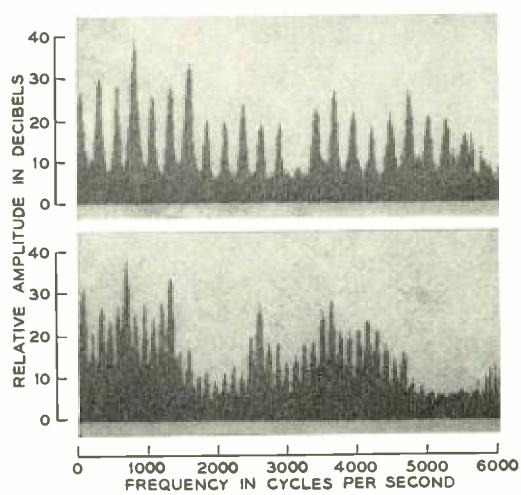
No two of us talk alike. In voicing the same words, as G. E. Peterson showed in his article,* adults differ noticeably from children, men from women, the young from the old. The reason is that our speech mechanisms are different in size and shape. Consequently the vocal cords, for example, in which vowel sounds originate do not generate exactly the same frequencies; sounds from the vocal cords get a different treatment on the way out because of differences in the resonant cavities of mouth, nose and throat.

With frequency composition varying from person to person, research workers in sound would like to know how we all manage to converse in the same language, at once recognizing a sound like "ah" no mat-

* Record, *November*, 1951, *page* 500.



Above—(Left) Mr. Peterson's version of the vowel sound "uh" as in "up". (Right) His daughter's version. Each horizontal bar reveals a resonance in the vocal cavities. The child's resonances are pitched higher because her speech mechanisms are smaller; pitch drops as child grows.



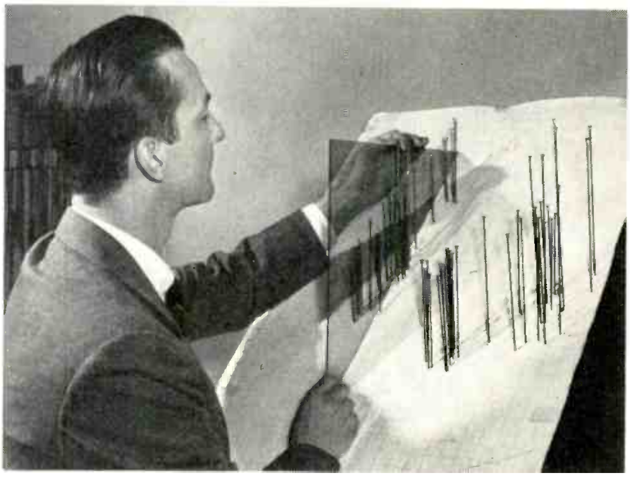
Right—Here, the sound is plotted in a different way to show the relative energy of the resonances. Energy peaks are closer spaced in frequency for the lower pitched man's voice (bottom) than for the child's voice (top).

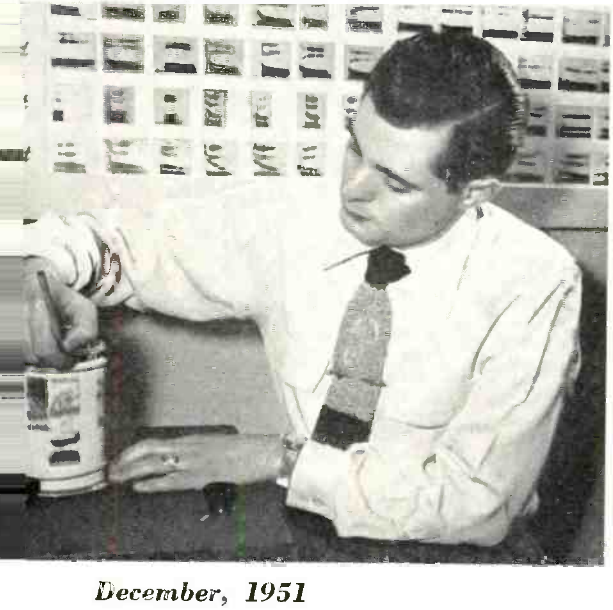
Left—In the free space room, test subject Jo Helen Peterson helps her father locate the correct position for the microphone. In rear are seen reflectionless walls which eliminate interfering echoes. Microphone is suspended to escape vibration of the reflectionless floor made of stranded cable under tension.

Below—To isolate clues to recognition of word-sounds, data must be plotted in three dimensions, which is difficult to do on paper. Knitting needles stuck through graph paper mounted on cork provide a quick, flexible plotting method. Two of the dimensions are supplied by the paper, the third by the height of the needle. Each group of needles applies to a distinctive vowel sound.

ter who says it. What is it about a word-sound that tips us off as to its identity?

To find out, Laboratories' acoustic scientists are studying the sound spectograms of people who display marked differences in their voicing of familiar word-sounds. Test subjects are asked to listen to a model sound coming out of a loudspeaker, then to give their own version of it. Picked up by a microphone the individual interpretations are piped to a sound spectrograph for analysis. Steps in the test are shown in the accompanying illustrations.





Left—By means of filters, the sound spectograph breaks a sound up into its dominant frequency groups. Then by means of an electric spark, it plots (burns) each group as a shaded bar on a rotating paper cylinder with low frequencies at bottom, higher ones above. Here, an interval of special interest in a subject's spectrogram is being marked for further study. For ready reference, spectrograms of typical speech sounds are mounted on the wall.

Local wire video television networks

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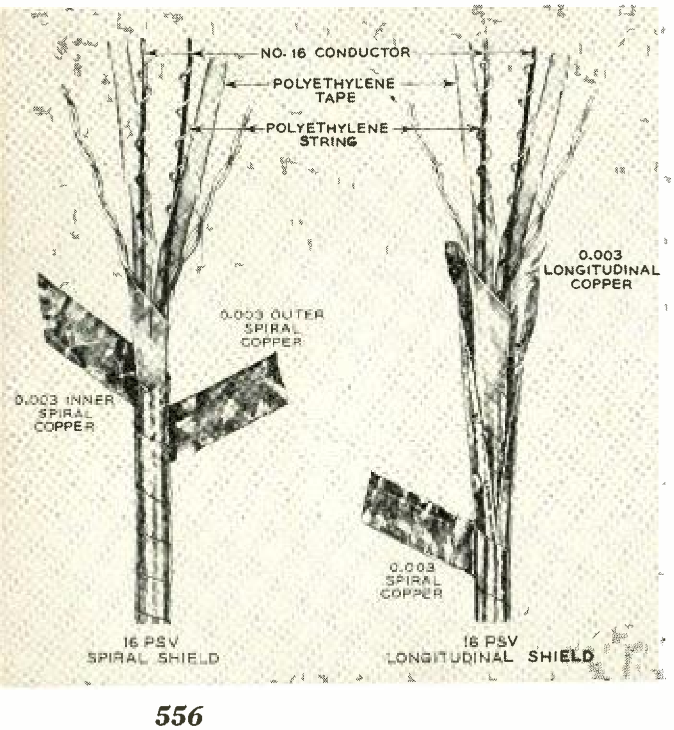
The usefulness of a nationwide television broadcast network may be measured in terms of the flexibility in arrangement which it offers to the broadcaster. An important facility contributing to this flexibility is the local wire video distribution system, which interconnects television studios, transmitters, and pick-up points within a city. Microwave radio facilities are also used in some areas to connect the broadcaster with local pick-up cameras, but since they depend on line-of-sight paths, their application is more limited.

The local wire video system now being used by the Bell System consists of cable circuits with intermediate repeaters installed in telephone central offices. Circuit terminating equipment such as line transformers and clamper amplifiers are installed at the customer terminations of the circuits. The system was developed to make use of existing cables and other plant facilities wherever practical. A wide variety of balanced circuits are to be found in the existing telephone plant in the form of paper insulated inter-office trunk and subscriber cable pairs. These existing facilities were fairly extensively used in the initial stages of this video plant development. The paper pair circuits are unshielded, however, and are, therefore, subject to high interference from office impulse noise, such as caused by relay operation and dialing, by induction from nearby power circuits, and by crosstalk from other video circuits within the same cable sheath.

Fig. 1—The No. 16 PSV shielded video pair of the earlier type, left, and of the latter type, right.



To avoid some of these difficulties, a new shielded video cable pair, known as No. 16 PSV*, was developed to meet the demands of the local backbone circuits. The high-frequency attenuation has been kept low by the use of large conductors and polyethylene insulation. The office impulse noise and crosstalk have been reduced by shielding the balanced pairs. Attentuation is 18 db per mile at 4 mc. These No. 16 PSV shielded pairs may be placed in their own lead sheath or placed among paper pairs in large interoffice trunk cables. In its original form, the two copper tapes were wound spirally around the polyethylene insulation in opposite directions. A modified design is now being manufactured in which the inner copper tape is run longitudinally and held in place by the outer tape wrapped spirally. These two constructions are shown in Figure 1.

This new design has 1 db lower attenuation and about 25 db greater crosstalk loss

* RECORD, *May*, 1948, *page* 201.

at 4 mc than the earlier design. The office impulse noise is also expected to be considerably lower on the new design. Attenuation-temperature change for a seasonal underground temperature range of 26 degrees F. is given by the lower solid-line curve on Figure 2. It is seen to be 0.45 db per mile at 4 mc, which is much less than that for the paper pairs indicated, and is specifically 13 per cent of that for the 22 gauge paper pair.

Experience to date indicates that for the average crosstalk loss of 120 db for the spiral shield cable, 10 tandem repeater links of about 85 db each at 4 mc should result in substantially no impairment in picture quality due to crosstalk and office impulse noise. This assumes that the gain and equalization in each repeater is sufficient to make up for the preceding length of cable. However, office spacings and especially repeater spacings of such great lengths and numbers are not expected to occur frequently. Therefore, it should be satisfactory to operate with an occasional longer repeater spacings.

In addition to these cable facilities, the A2 video transmission system is made up of transmitting and receiving terminals and the necessary number of intermediate repeaters for the length of the cable circuit to be used. The line equalization and most

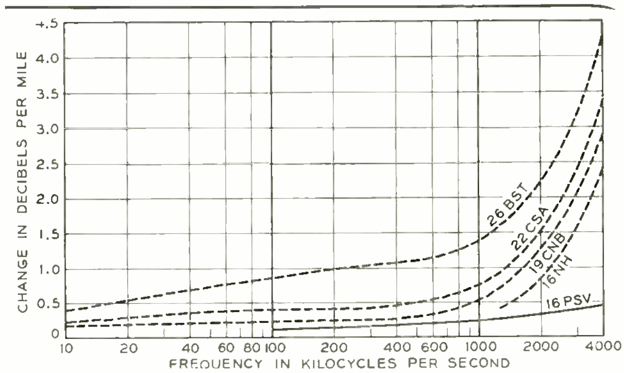


Fig. 2—Attenuation change for a seasonal temperature range of 26 degrees F for the No. 16 PSV and other types of pairs.

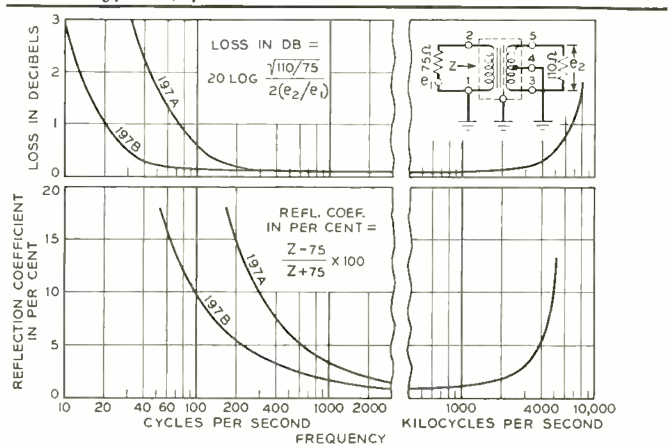


Fig. 3—Characteristics of the 197-A and 197-B repeating coils.

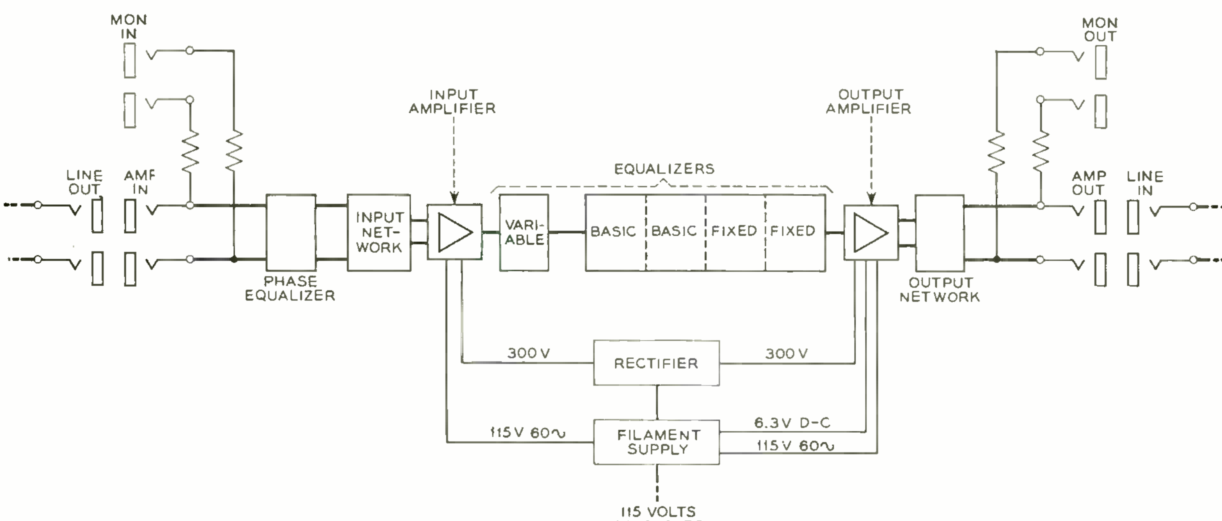


Fig. 4—Block diagram of the repeater for the local wire A2 video transmission system.

of the circuit gain is furnished by the intermediate repeaters.

The transmitting terminal consists simply of a repeating coil and associated jacks for most operational cases. The impedance ratio of the repeating coil is 75:110, and the coil is used to connect the 75-ohm unbalanced impedance of the broadcaster's signal circuit to the 110-ohm balance transmission line. These repeating coils are of the 197 type; the 197-A was originally used, but a newer design, the 197-B is now taking its place. Characteristics of these two coils are shown in Figure 3. The use of repeating coils which remove the dc and distort the low frequency signal components is permissible since these signal components are reconstructed at the receiving end.

The receiving terminal consists of a repeating coil to connect the balanced cable pair to the 75-ohm unbalanced circuits, a clamper-amplifier and associated jacks. The clamper-amplifier has a maximum gain of 18 db, adjustable in steps 1 db, and provides a 31 db reduction of 60-cycle interference. It is used in the receiving terminal for gain and to restore the low frequency signal components after transmission through video repeating coils or over circuits whose lengths are such that increased low frequency amplitude or phase distortion may result.

Intermediate repeaters are installed in central offices to provide the equalization for the cable loss characteristic and the gain necessary to amplify the equalized signal to a suitable level for retransmission over succeeding cable links. The repeater arrangement is shown in Figure 4. It consists of four principal elements, the input amplifier, the cable equalizers, the output amplifier, and the regulated power supply.

A simplified schematic of the input amplifier of the repeater is shown in Figure 5. It consists of an input network, shown at the lower left of Figure 6, and a balanced input stage followed by a cathode output stage connected directly to the line equalizers. The response characteristic of the input network is utilized as part of the cable equalization. Provision is made to remove the network when it is not needed as equalization or gain for short cable lengths. The balanced input stage is provided with sufficient longitudinal feedback and balance to reduce 60-cycle and other longitudinal currents from the cable below visual interference limits. The voltage gain of the input amplifier without the network and terminated in the 1000 ohm impedance of the cable equalizers is 14 db.

A simplified schematic of the output amplifier is shown in the upper part of Figure 6. The output of the cable equalizer is terminated by the 1000 ohm input impedance of this amplifier. This amplifier has

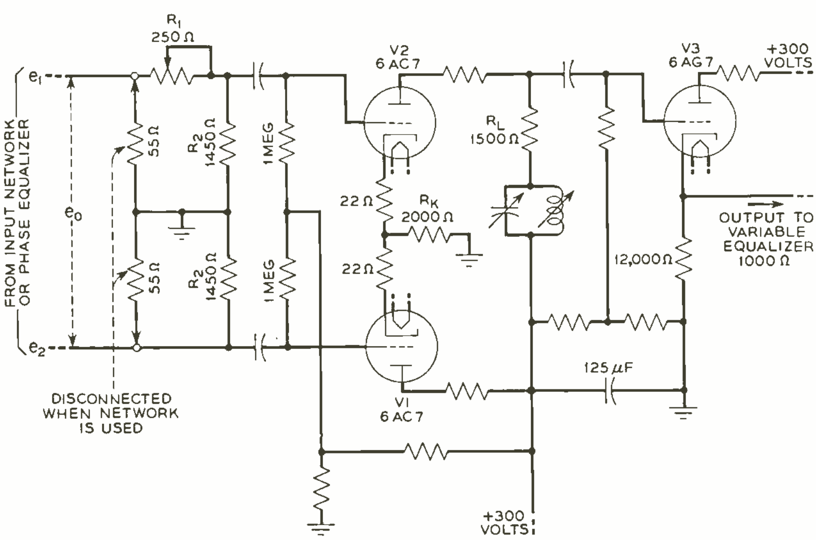


Fig. 5—Simplified schematic of the input amplifier of the repeater.

three unbalanced gain stages followed by a phase inverter and a balanced output stage. The balanced output stage feeds the balanced cable pair either through the amplifier network shown in the lower left, which may also be used with the input amplifier as mentioned above, or through one of the other two networks shown. The voltage gain without the output network, but terminated in 110 ohms is 30 db. The normal output operating level is 2 volts peak-to-peak consists of two sections in tandem—each independently adjustable to give 12 proportional 1 db steps. On its 10 db step it has the same characteristic as the fixed equalizer unit. The sum of the characteristics of these two sections gives the desired loss characteristic.

Space for five cable equalizer units is provided on a panel located between the input amplifier and the output amplifier. A variable unit and the correct number of basic

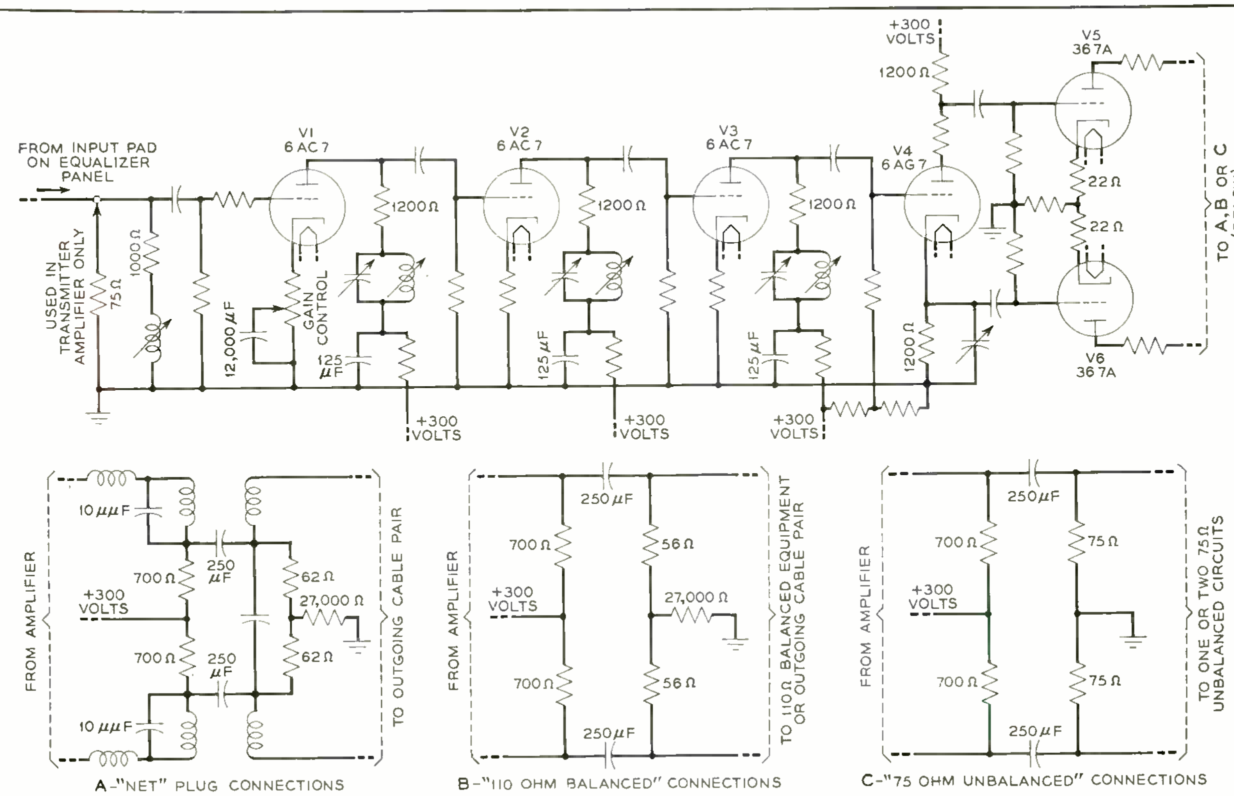


Fig. 6—Simplified schematic of the output amplifier, above and of the various output networks below.

which may be increased 3 db for a maximum of three tandem repeaters in a circuit.

Equalization of the cable characteristic is accomplished by using multiples of three constant-resistance equalizer units located between the input and output amplifiers as shown in Figure 4. These equalizers are referred to as basic, fixed, and variable.

The basic equalizer is always associated with an amplifier network. The fixed equalizer will equalize 10 db of No. 16 PSV cable loss at 4 mc. The variable equalizer unit and fixed units are thus connected in tandem to equalize a given length of cable preceding a repeater. Since there can be a maximum of two amplifier networks per repeater link, a maximum of two basic equalizers may be utilized per repeater. The first of these two networks to be utilized in equalizing a line is the output network at the preceding repeater. If the 4-mc line loss is 50 db or greater the repeater input network is then added. Fixed and variable equalizers are then added as needed for

Fig. 7—An installation of repeaters for local wire television networks in a central office.

longer lengths of cable. The gain of the amplifiers with the equalization that is provided allows for a maximum repeater spacing of about 3.5 miles of spirally shielded No. 16 PSV or 63 db cable loss at 4 mc.

The general result of the equalizer loss is to attenuate low frequencies more than high frequencies and in the proper amount so that the over-all response of the line and equalizer is uniform to a transmitted signal. The office impulse noise, originating at the receiving end of the cable, with the cable and amplifier input noise, become attenuated with the low frequency signal components. Therefore there is a noise reduction in the low frequency region and a concentration of noise at the high frequency end of the band where the equalization loss is low. There is also a reduction in the interfering effect of the noise due to its concentration in the narrow high frequency band. The use of the output network at the preceding repeater as part of line equalization increases the high frequency sending level 13 db on the cable without increasing the overloading in the output amplifier. This results in an added noise improvement of 13 db.

THE AUTHOR: C. N. Nebel joined the Laboratories after graduating from the University of Missouri in 1926 with a B.S. degree in engineering. He was first engaged in the development of power line carrier systems with voice operated circuits, where a single transmission path was adapted for use in both directions. Later he worked on similar voice-operated circuits for proposed transatlantic submarine cable. Other work consisted of development work on the K carrier channel group and its application to the L1 coaxial carrier system. He is now engaged in television transmission problems and in development work on the video transmission system for use on local telephone circuits. During World War II Mr. Nebel helped in the development of radar equipment for the Air Force.

The LD-T2 radio transmitter

N. F. SCHLAACK
Transmission Development Department

Recently, a new multi-channel single-sideband radio transmitter designated the LD-T2 has been designed as one of the units of the new LD radio telephone system. It has a peak envelope power output of 4 kw, twice that of the earlier transmitter used for this service, and includes a number of other improvements such as the automatic selection of any of ten pre-selected output frequencies, the use of varistors instead of vacuum tubes for modulators, and the ability to utilize automatically its full output whether it is transmitting only one or all four of the voice channels it provides. In addition, the performance of the transmitter with respect to extraband emission and interchannel crosstalk has been improved, as compared to the earlier transmitter, at the same power output per channel.

The new LD radio telephone system, of which the LD-T2 radio transmitter is one of the units, also includes the LD-R1 radio receiver* and the LD-B1 branching amplifier.† Primarily intended for long distance point-to-point service such as the Bell System provides to all continents of the world, it permits transmission of a multi-channel single-sideband radio-frequency signal in the range from 4 to 23 mc. The transmitter accepts and the receiver delivers two independent voice-frequency bands from 100 to 6000 cycles which appear as upper and lower sidebands in the radio-frequency signal. A reduced carrier is transmitted for automatic frequency control and automatic volume control at the receiver. Two voice-frequency circuits may be used for program channels or for group transmission of several narrower channels for telephone or voice-frequency telegraph circuits. The channel grouping must be accomplished by suitable equipment located at the terminal.

* Record, *April*, 1951, *page* 169.
† Record, *January*, 1951, *page* 21.

Any type of control terminal and privacy suitable for single-sideband circuits may be used with the LD equipment.

The LD-T2 radio transmitter employs a low amplitude triple modulation system followed by a six-stage linear amplifier. Like the earlier D-156000 radio transmitter, it utilizes filters for selection of the desired sidebands instead of the Hartley balanced-phase system* because of the increased stability and greater selectivity obtainable with them. Each of the ten pre-selected frequencies, after a calibrating adjustment, will remain within ± 0.003 per cent of the assigned frequency for long periods of time.

A block schematic of the LD-T2 radio transmitter is shown in Figure 1, where

* U. S. Patent No. 1666206; application filed January 15, 1925.

Front view of the LD-T2 radio transmitter.

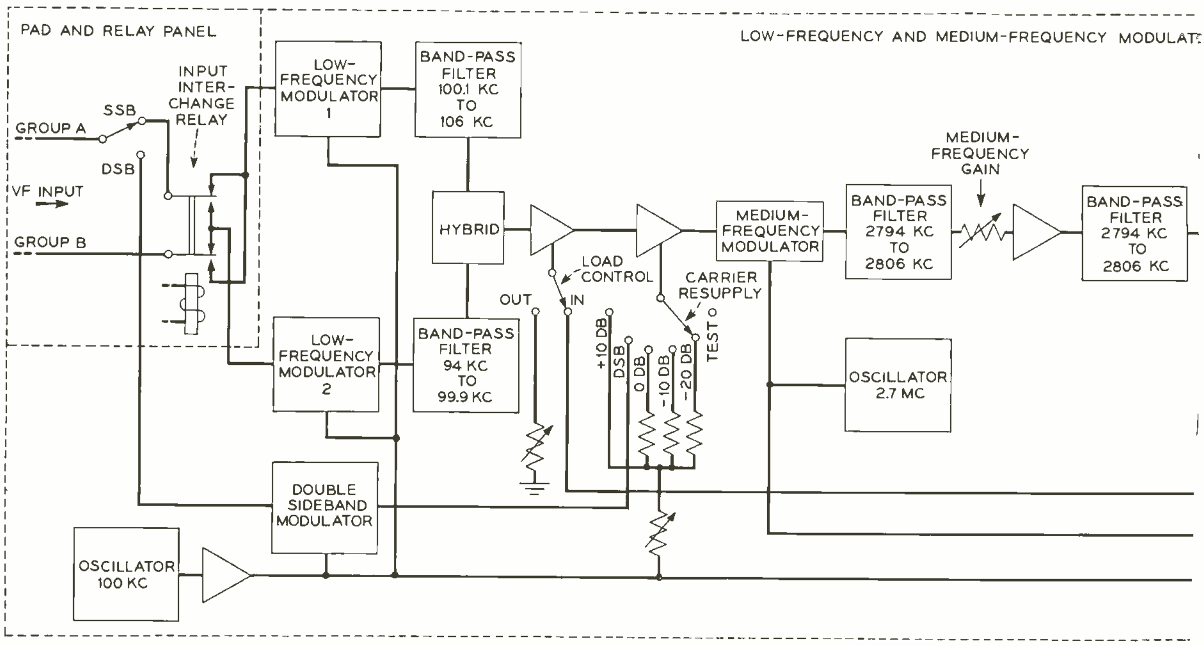
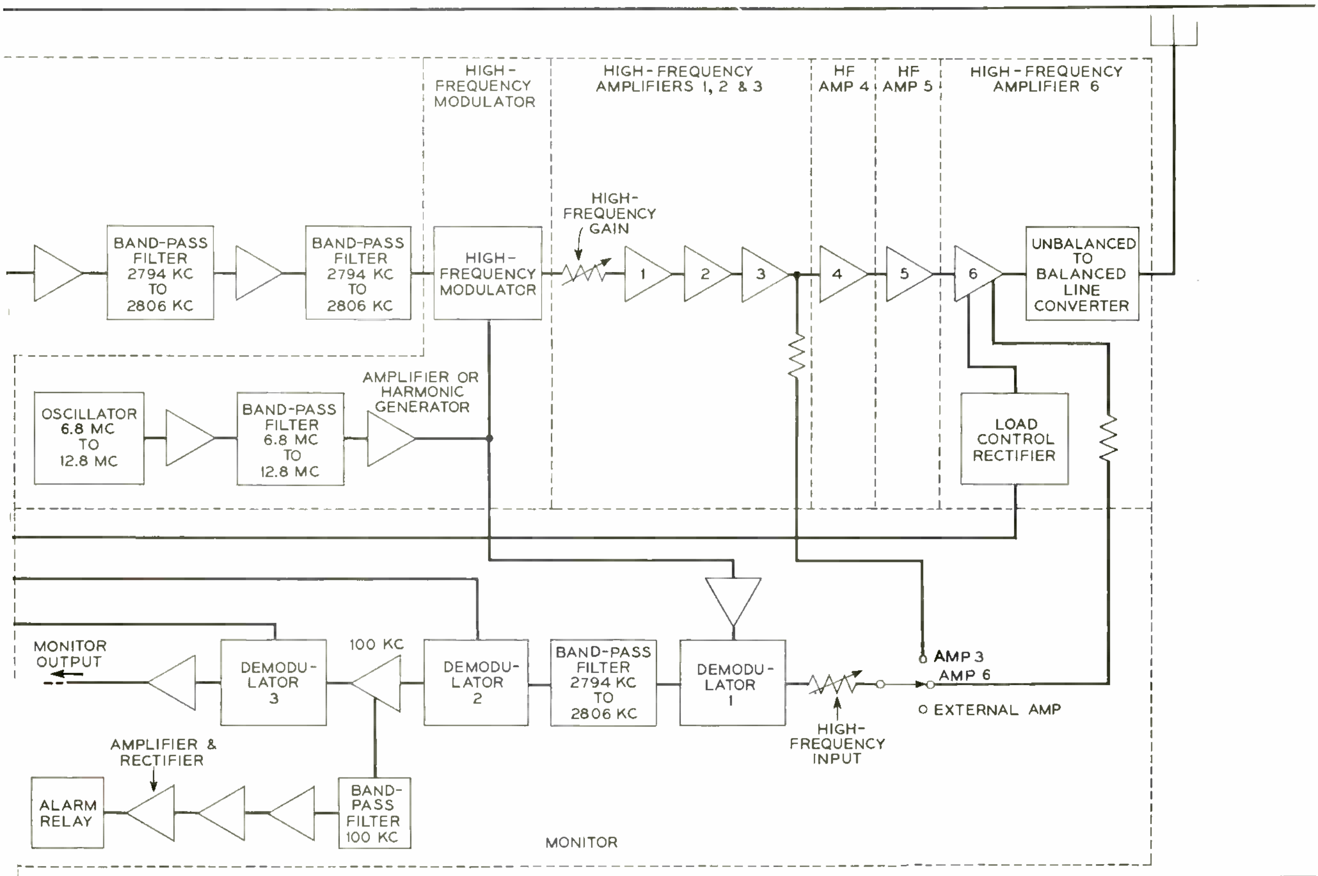


Fig. 1—Block schematic of the LD-T2 radio transmitter.

dashed lines are used to outline the major divisions of the circuit. The two voice-frequency inputs are shown at the top left as GROUP A and GROUP B. Gain adjustment on the PAD and RELAY PANEL, not indicated in the diagram, allows the voice frequency inputs to the two modulators to be adjusted to the proper value, and a relay allows them to be interchanged when necessary to comply with established international practices relating to single sideband transmission.

In the LF modulator, the two voice frequency inputs are used to modulate the 100-kc carrier in separate modulators. The upper sideband extending from 100.1 to 106 kc is selected by a crystal filter from the output of modulator No. 1, while the lower sideband extending from 99.9 down to 94 kc is selected by another crystal filter from the output of modulator No. 2. The outputs from these filters are combined in a hybrid coil and impressed on the load-control amplifier. This is a variable gain device that can be used with its gain controlled by the magnitude of the combined sideband peaks or with its gain fixed. When its gain is variable, the bias is obtained from the load-control rectifier, which is located at the output of the transmitter, and the bias varies with amplitude of the output signal. The gain reduction rate is very fast, whereas the gain recovery rate is much slower. This is very advantageous from the standpoint of cross-modulation and extra-band radiation, since it virtually prevents the transmitter from being overloaded at any time. Its effect on quality and intelligibility has been found to be unnoticeable by rapid comparison with and without the device.

The output of the load-control amplifier is impressed on the combining amplifier where it is further amplified and combined with the desired amount of carrier. Since the carrier is introduced into the signal after the load-control amplifier, the action of the load-control amplifier has no direct



effect on it. One of the positions of the carrier level control switch permits the transmitter to be used for double-sideband transmission should that ever be desirable.

Following this re-introduction of the carrier, the signal is impressed on the medium-frequency modulator, where it is used to modulate a 2700-kc conversion frequency. The upper sideband resulting from this modulation, with the carrier originally at 100 kc now at 2800 kc, is selected by a series of band-pass filters in tandem with three medium frequency amplifiers. All of the equipment up to this point in the circuit remains fixed regardless of the final operating frequency.

The signal is next impressed on the HF modulator where it modulates a conversion frequency in the range from 6.8 to 20.2 mc depending on the desired output frequency. Positions are available for ten crystals in the band from 6.8 to 12.8 mc, and the proper crystal for each operating frequency is connected when required with an oscillator circuit to provide the correct conversion frequency. Since at the input to the third modulator the original 100 kc carrier is at 2800 kc, it will be at 4 mc when the lower sideband of a 6.8 mc conversion frequency is employed, and it will be at 10 mc when the lower sideband of a 12.8-mc conversion frequency is employed, which is obtained by use of the highest frequency crystal. For higher conversion frequencies, a harmonic of one of the crystals is employed.

The HF modulator is followed by a six-stage linear amplifier, and the tuned circuits associated with this amplifier are set to select the upper or lower sideband as desired. The first four stages of the amplifier employ pentodes, the fifth stage tetrodes, and the final stage employs a 2.5 kw forced-air-cooled triode operating with its grid grounded. The complete amplifier accordingly requires no neutralization. A shielded dummy load which will dissipate the full

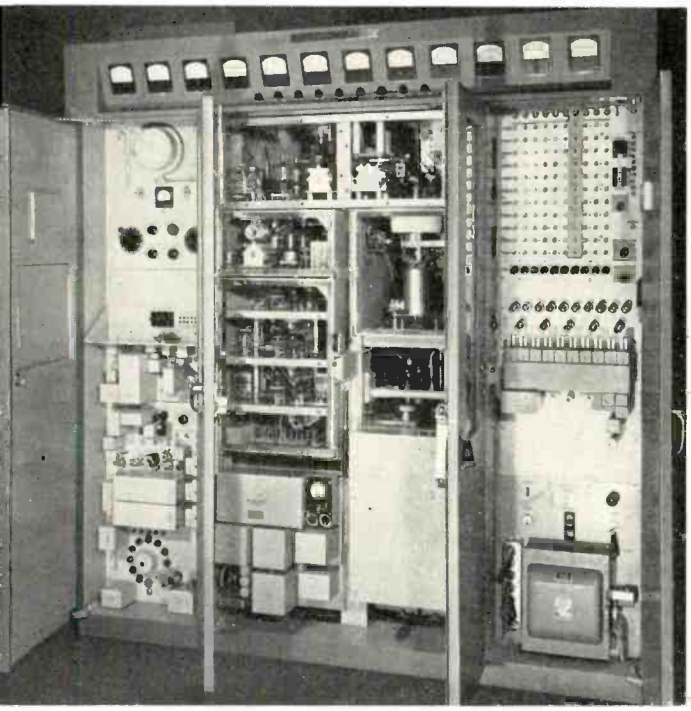


Fig. 2—Front view of the transmitter with doors open.

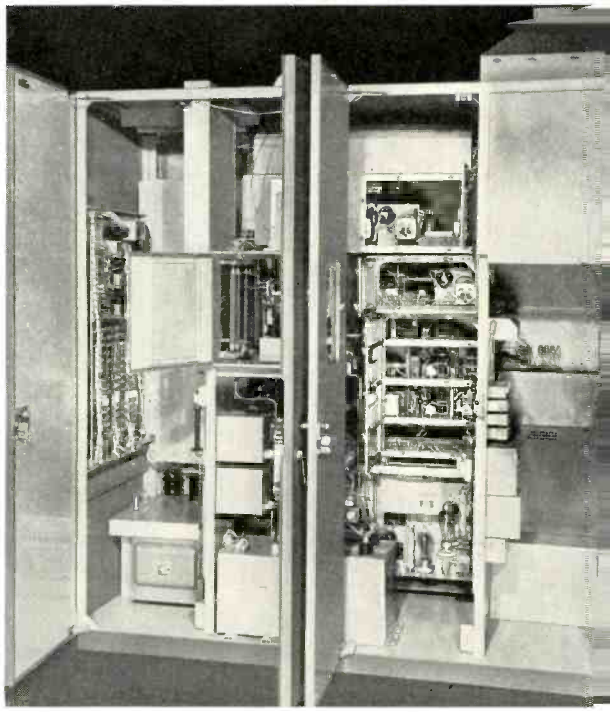


Fig. 3—Rear view of transmitter with doors open.

output of the transmitter is provided in the final amplifier compartment for checking the performance of the transmitter before connecting it to an antenna.

A monitor is associated with the transmitter, and consists of a simple form of single-sideband receiver with three demodulators that utilize the conversion frequencies and carrier source in the transmitter to demodulate the signal back to the original voice frequencies. The monitor incorporates a carrier alarm device which will give an alarm if the amplitude of the carrier falls below a predetermined value.

Selection of the operating frequency is carried out by a servo system with push-button control. About fifteen seconds is required to select any one of the ten available frequencies, and about the same time is required to put the transmitter into standby condition or to remove it from standby condition. Ten continuous servos and six switching servos are employed. The transmitter will operate under temperature and humidity conditions encountered in a normal station building. This includes locations in the tropics. It will operate satisfactorily in ambient temperatures between 15 degrees and 50 degrees c (60 degrees to 122 degrees) and at altitudes up to 5000 feet.

The complete transmitter, weighs about 4500 pounds. It is housed in a four-bay, floor supported, steel-frame, metal-enclosed cabinet 84 inches long, 96 inches high including a 12-inch air intake hood, and 42½ inches deep. The over-all depth with the doors open is 84½ inches. The exterior of the transmitter is finished in dark aluminum gray lacquer whereas the interior is finished in light gray lacquer. Access to both the front and rear of each bay by means of doors provides for easy maintenance. A motor-driven blower is provided to cool the transmitter. Incoming air is drawn through the hood on the top of the transmitter which is provided with a removable spun glass air filter. Exhaust air is also discharged at the top of the transmitter. The whole transmitter cabinet is under slight air pressure to prevent dust and dirt from entering. Facilities are provided for measuring the vacuum tube currents and most of the dc, ac, and radio frequency voltages.

(*Continued on page 570*)

Recording on AMA tape in central offices

H. D. CAHILL
Switching Systems Development

With the new Automatic Message Accounting system*, the basic information that will later be used in the accounting center for computing and printing subscribers' bills is recorded on AMA tapes in the various central offices. These tapes are punched by perforators† but the perforators are controlled by a "recorder" or by a recorder and a transverter working together. For each call, three separate entries are made on the tape. The first entry includes all the information needed except the time for the beginning and ending of the call; the second gives the time the conversation begins; and the third, the time the call ends. Each entry requires only a fraction of a second of the recorder's time, and since each recorder may serve as many as 100 trunks, the three entries pertaining to any one call may be separated by entries pertaining to other calls. Each entry includes the number of the trunk involved, and it is this trunk number, that identifies the three entries for any one call.

The information perforated in the tape for these three types of entries is indicated in Figure 1. For the initial entry, either two or four lines are required: four when the office and number of the called subscriber is required, and two when it is not. In a two-line entry, the first line includes the calling office and number, while the second line includes the message index and the call identity index, which is the trunk number in the No. 5 system, and the district junctor

* RECORD, *September*, 1951, *page* 401, and *October*, 1951, *page* 454.
† RECORD, *November*, 1951, *page* 504.

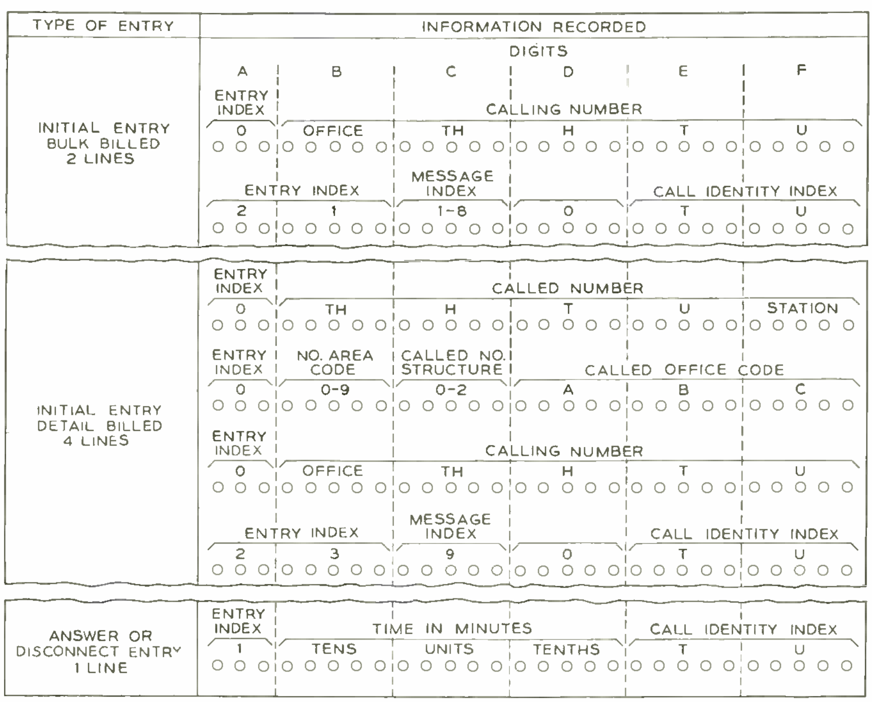


Fig. 1—The three types of entries perforated on a central office tape for each completed call.

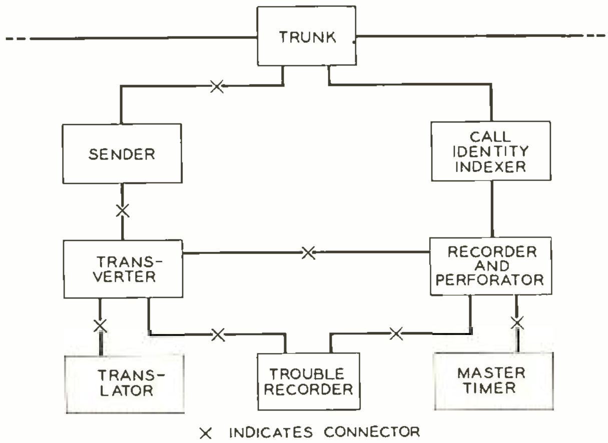


Fig. 2—Block diagram of circuits used for AMA recording in central offices.

in the No. 1 system. In a four-line entry, the called-line information is given by the first two lines; the last two lines include the information contained in a two-line entry. The two time entries for each call are identical except for the time indicated.

A block diagram of the circuits employed in making these recordings in a No. 5 crossbar office are shown in Figure 2. When a call is placed, a marker establishes a connection from the calling line to a suitable trunk, associates a suitable sender with the trunk, and transfers to the sender all the information it will need in handling the call. After the sender has recorded this information, it seizes the transverter, and transmits to it the identification of the calling line and certain other information. This identification of the calling line is in terms of the position of the line on the line link frame, however, and since this identification is not suitable for billing purposes, the transverter seizes a translator* to secure the directory number of the calling line. Having secured this information, it then seizes the recorder to make the initial entry.

If this initial entry requires four lines, the sender as well as the transverter will be used in controlling the recorder. The method employed is indicated in simplified form in Figure 3. Six groups of leads—five of five leads each, and one of three—connect the transverter with the recorder, and eight groups of five leads connect the transverter to the sender. As soon as the recorder is seized, relay C4 in the transverter is operated, and connects through to the sender the five sets of leads that will control the perforation of the last five digits of the first line. Relays in the sender are already operated to close two leads of each set of leads to cause the perforation of a thousands, hundreds, tens, units, and station digits of the called number. The A digit of the entry is controlled by contacts on relay C4 in the transverter, and serves to indicate that the line being perforated is not the last line of the entry.

Immediately after this line of digits has been perforated in the tape, the recorder will release relay C4 in the transverter, and operate relay C3. Digits A, B, and C will be controlled directly by relays in the transverter, while the leads for digits for D, E, and F will be closed through to the sender, where relays, already operated, will close two out of each set of five leads to indicate the three digits of the called office code. As before, digit A indicates that the line of entry is not the last line. Digits B and C give the number area code and the called number structure, and relays in the transverter will have already been operated by the sender to indicate the proper digits that are to be used.

As soon as this line has been perforated, the recorder will release relay C3 and operate relay C2. The six digits for this line are the entry index, the calling office number, and the thousands, hundreds, tens, and units digit of the calling number. Relays in the transverter have already been operated by the translator to record the proper values for these digits.

Perforation of the fourth line follows at once by the release of relay C2 and the operation of C1. The first four digits of this line are determined by relays in the transverter. These are the entry index, which requires two digits, and indicates the last line of a four-line entry, the message index, and a zero to fill up a position not required. The E and F digits of this line are the tens and units designation of the trunk. The leads that control the perforation of these latter two digits are cut through from the call-

* RECORD, *February*, 1951, *page* 62.

identity indexer by a relay in the recorder that is operated at the same time as relay C1 in the transverter. Immediately after this four-line entry has been perforated, the recorder is released by the transverter and is ready to proceed with another call.

A call identity indexer is permanently associated with each recorder, and identifies the trunk through a group of tens and a group of units relays to indicate the tens and units digits of the trunk. These relays in simplified form are indicated at the lower right of Figure 3. When a trunk has been seized, and while the first line of an initial entry is being perforated, the trunk grounds its DJ lead to the call identity indexer. Through a back contact of a tens auxiliary relay, this causes one of the tens relay T0 to T9 to operate and lock, thus identifying the tens digit of the number of that particular trunk. The operation of the tens relay places ground on the proper tens leads on a two out of five basis to the perforator, and also operates the tens auxiliary relay through one of whose back contacts it has been operated. When the auxiliary relay operates, it closes the ten DJ leads to the group of units relays, and one of them

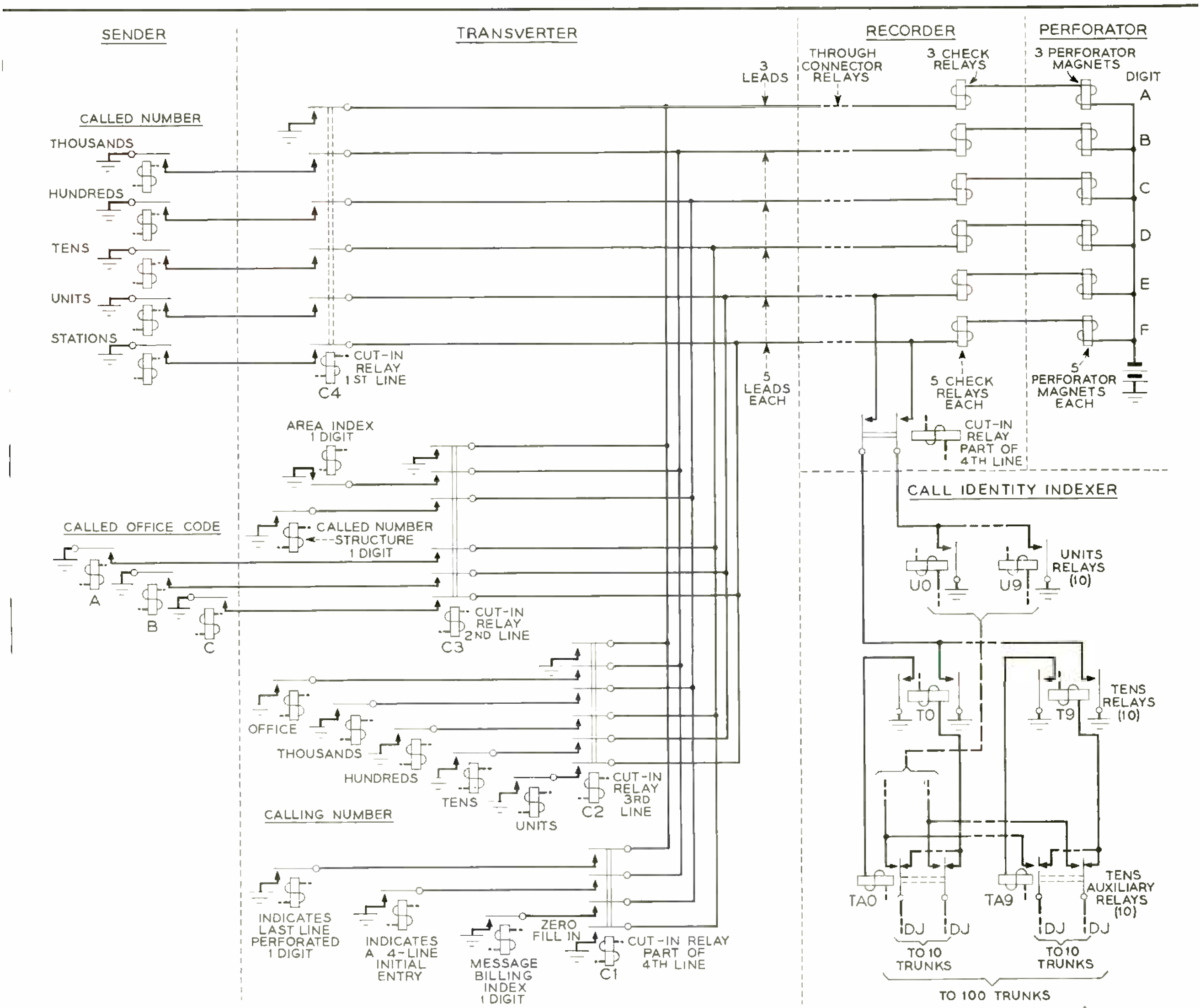


Fig. 3—Simplified schematic of circuits used in perforating initial entries.

operates and places ground on the proper units leads to the perforator. The connection to the DJ lead in the trunk will then be opened, but the tens and units relays will remain locked until after the cut-in relay to the recorder has been operated and the trunk number has been perforated.

For answer entries or disconnect entries, the operation of the indexer relays is the same. For these entries, however, the start signal over lead DJ is under control of the supervisory relays in the trunk instead of relays in the transverter, and the recorder makes the answer or disconnect entry in response to the operation of the relays in the call identity indexer.

The rapid perforation of four lines of initial entry outlined briefly above is accomplished by a relay circuit of which the principal components for perforating three of the four lines are shown in simplified form in Figure 4. Relays C4, C3, etc. of this diagram are the cut-in relays in the transverter already referred to in connection with Figure 3, but for simplification the six sets of leads that are cut through by their contacts have been reduced on the diagram to one lead for each relay.

When the recorder is connected to the transverter, ground on a spring of relay PTO operates relay P4 in the transverter. Relay P4 holds itself operated through a front contact on one of its springs, and through ground on another spring, and through a back contact of P4A, operates C4. This perforates the first line as already described.

Through another contact, C4 also operates PTC in the recorder, which in turn operates the paper advance magnet and closes the operating circuit of PTO. Since this latter is a slow operate relay, there is a short interval before it operates. Operation of the paper advance magnet pulls back the pawl on the operating drive of the paper so that when the operating magnet is released, the paper will be advanced one line.

When the perforating magnets operate as a result of the operation of C4, relay CK is operated, thus closing a connection over lead P1 to the transverter and opening the connection over lead P. Circuit PTO is given slow-operate characteristics to allow a short

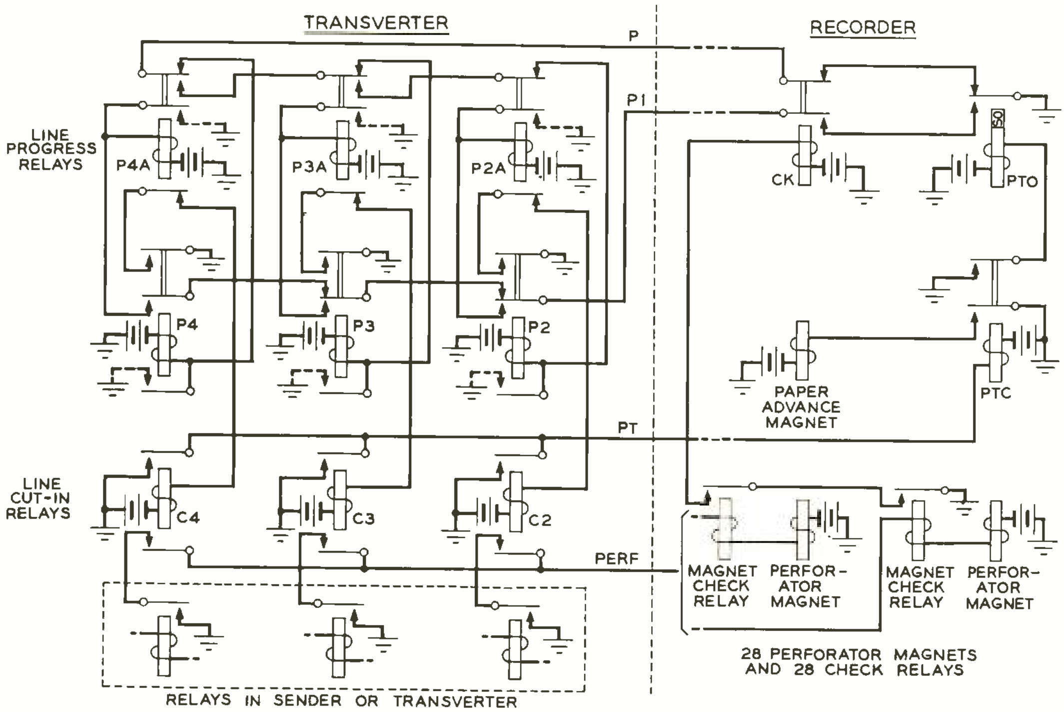


Fig. 4—Simplified schematic of line progress control circuit.

time interval to insure that the perforating magnets have time to operate fully. When PTO operates, ground is applied to lead P1 and this operates P4A in the transverter through back contacts of P2, and P3 and a front contact of P4. As P4A operates, it locks itself in and releases C4, and this in turn releases PTC in the recorder. This releases the paper advance magnet and thus advances the paper one line and also releases PTO, thus again placing ground on lead P to the transverter and removing it from P1. In the meantime, the release of the perforating magnets has released the CK relay.

Since relay P4A is now locked operated, ground over lead P operates relay P3. The sequence of operations resulting in the perforation of the second line is now exactly similar to that of the first line, and in a similar manner, after the second line has been perforated, relay P2 is operated and the third line is perforated, and so on for the fourth. After the last line, the recorder is released.

The sequence of operation of the various relays is given in the time chart shown as Figure 5. Relays P4, P4A, P3, and P3A, etc., once they are operated remain operated until the sender is released, but the other relays are operated for brief intervals only to carry out the various steps in the process. For calls requiring only a two-line initial entry, relays C4 and C3 are not operated. Whether or not these two relays are used depends on the information given to the transverter by the sender.

For the two time entries of each call, the transverter is not employed at all. At the

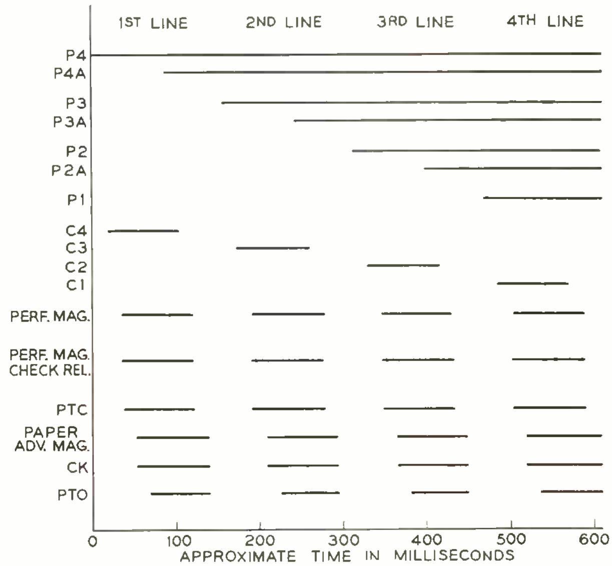


Fig. 5—Time diagram for operation of the relays of Figure 4 in perforating a four-line initial entry.

proper moment, the trunk signals the recorder through the call-identity indexer—operating the cut-in relay shown in Figure 3—so that the trunk number may be recorded in the last two positions. The perforation of the A digit, giving the entry index, is controlled by the recorder, and digits B, C, and D—giving the time in tens, units, and tenths minutes — is also controlled by the recorder using information passed to it by the master timer. The hour is not required because a separate hour entry, giving tens and units digits for the hour, is perforated on the tape at the beginning of each hour under control of the

THE AUTHOR: After graduating from the University of Maine in 1923 with a B. S. degree in E. E., H. D. CAHILL joined the Installation Department of the Western Electric Company. For almost a year he installed new dial equipment. In 1924 he transferred to the Engineering Department of the Western Electric Company, now Bell Telephone Laboratories, where he was concerned with the design of various telephone switching circuits for both manual and dial exchanges. During World War II, he designed equipment for the Armed Forces and trained military personnel in its use. Immediately following the war, he assisted in the design of mathematical computers. For the past few years, he has been designing central office circuits for AMA.

master timer. A set of switches in the recorder carries a running record of the time in tens, units, and tenths minutes, and when a time entry is to be made, this group of relays controls the perforation of the B, C, and D digits. Each tenth of a minute, the master timer transmits a pulse to each recorder and thus maintains the proper indications on the time switches in the recorder.

The AMA circuits are designed so that they are self-checking to a large extent. The recorders, for example, include means for checking the closure of two-out-of-five perforator magnet leads as well as detecting opens, crosses, and trouble grounds. If trouble is encountered, a trouble recorder circuit is brought in and a trouble record card is perforated, which will aid in locating the trouble. Under some conditions a trouble entry is placed on the central office tape for the use of the accounting center equipment. In addition to the ability of the circuits to detect trouble on service calls, there is also provision for making various test calls. A circuit called the master test frame has direct access to the transverters for miscellaneous tests and for checking translator frame cross-connections. Also built into the master test frame are facilities for testing the transmittal of AMA information through the senders and transverters, and for checking the associated trunks for the start signal in preparation for an answer or disconnect entry.

(Continued from page 564)

Careful attention has been given to the protection of operating personnel and equipment. Mechanical interlocks and electrical door switches are provided to prevent entrance to the interior of the transmitter before the high voltages are removed and grounded. High voltages cannot be reapplied until all doors are closed. Fuses and relays are provided to protect apparatus from all destructive overloads and to give indications regarding the location of the overload.

Seven different rectifiers are required in the transmitter to provide the necessary dc voltages. Six of these rectifiers employ tubes and one is a dry type rectifier. Three of those employing tubes are of the self-regulating type.

THE AUTHOR: N. F. SCHLAACK joined Bell Telephone Laboratories in 1925, after receiving a B. S. degree in E. E. from the University of Michigan. His first assignment was in the field of radio research, where he took part in experiments with high power short wave transmitters and in the study of short wave transmission. In 1927 he began to work in a radio development group, where he has been since except for the war years. His chief concern has been with single sideband short-wave and ultra-short-wave transmission equipment. During World War II, Mr. Schlaack worked on radar, countermeasures, and frequency shift telegraph equipment for the United States government.

Mayor M. Leslie Denning (right) of Englewood, New Jersey, talking to Mayor Frank P. Osborn of Alameda, California.

Englewood Begins Long Distance Customer Dialing

Starting November 10, telephone subscribers in Englewood, New Jersey, are now able to dial directly other subscribers in thirteen widely scattered localities throughout the nation, covering areas served by 800 central offices. With ten pulls of the dial—three more than the usual number—the Englewood subscriber is able to reach the following cities and many of their suburbs: Philadelphia, Boston, Providence, Pittsburgh, Cleveland, Detroit, Chicago, Milwaukee, Oakland, San Francisco, and Sacramento. These cities were selected because their present telephone numbering plans and current equipment installations are particularly suitable for this trial of new extended dialing facilities. One of the reasons why Englewood is being used in the new setup is because its new No. 5 crossbar offices were suited to this type of service.

Basis of the trial is the division of the United States into areas designated by a three-digit code. San Francisco, for example, is in area 318, so that an Englewood customer calls San Francisco merely by dialing 3-1-8, followed by the San Francisco customer's regular telephone number. Similarily, a preceded code of "6-1-7" will speed a call to a Boston location. *(Continued on next page)*

Ceremonies at Englewood, November 10, 1951, marking the opening of nationwide dialing were attended by civic leaders, public officials and telephone officials. While Mayor Denning talks on the telephone, Raymond Nelligan, Englewood local manager, stands by the table.

Mrs. Hortense Kessler, member of the New Jersey Public Utility Commission, tries out the new dialing plan. Looking on are (left to right) H. S. Osborne, Chief Engineer, A T & T, F. R. Kappel, Vice President of A T & T, and J. B. Rees, Vice President of New Jersey Bell.

Connections are set up entirely by switching mechanisms under the control of the customer's dial. Even the timing and ticketing of all the calls are done automatically. Although Englewood subscribers can place calls directly from their telephones, customers in the thirteen areas will not at this time be able to dial Englewood direct, even though they can receive direct dial calls from Englewood.

Telephone operators, of course, have been dialing calls across the country for several years. At the present time, one out of every three long distance calls is dialed directly by the operator, but Englewood marks the first time that customers themselves are able to dial calls covering so wide an area.

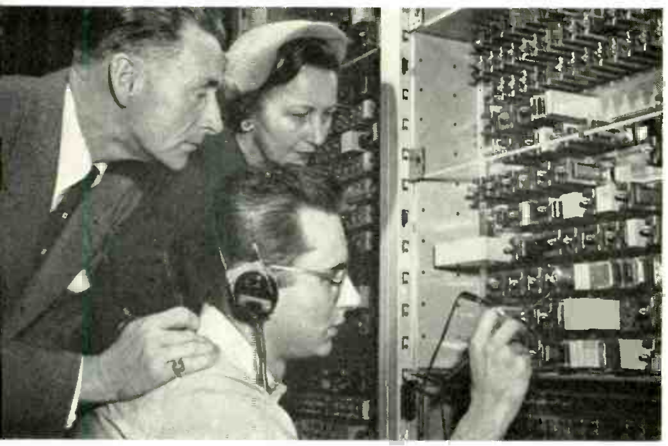
Ceremonies inaugurating the opening of transcontinental dialing by telephone subscribers took place in Englewood, when Mayor M. Leslie Denning of that city completed a call directly to Mayor Frank P. Osborn of Alameda, California. Seconds after Mayor Denning picked up the telephone in Englewood, the two mayors were talking across the nation. This was in sharp contrast to the speed of completion of long-distance calls thirty years ago, when it took an average of fourteen minutes to complete a call—even today the average is nearly two minutes.

Members of the Laboratories attending the ceremonies were E. L. Getz, R. K. Honaman, G. A. Hurst, W. I. McCullagh, M. B. McDavitt and O. H. Williford.

TV Link to Canada

Authority to build the U. S. end of the first international television link, between Buffalo, N. Y., and Toronto, Canada, has been granted to the Long Lines Department of the American Telephone and Telegraph Company by the Federal Communications Commission. Antennas will be added to the Bell System's microwave station at Buffalo to beam U. S. network programs across the border to a projected Toronto-Montreal radio-relay system.

Feature of "The Telephone Hour" of November 12 was a home interview with Mr. and Mrs. Howard J. Cox, selected as typical Englewood subscribers. In preparation for the broadcast, Mr. and Mrs. Cox visited the central office where (left) switchman William Rainey explained how the equipment stores each digit as it is dialed. Wire Chief Frylinck showed them the "trouble" recorder, right.



What Made the Princess Smile?

When Princess Elizabeth emerged from her plane immediately upon arrival at Montreal, Canada, from London, her manner was pleasant but reserved and formal. An hour and a half later, as her train drew away from a siding to begin an extensive tour of Canada, many in the crowd who stood in a drizzling rain to see her noticed a remarkable transformation—the Princess had become a smiling, happy woman.

An alert reporter for the *Toronto Telegram*, Allan Kent, discovered the reason for Princess Elizabeth's sudden, gay mood—a telephone call to her mother.

Princess Elizabeth was hardly on the royal train before an aide picked up a special telephone installed by the Bell Telephone Company of Canada. He said just four words, "Buckingham Palace, the Queen!"

For a few moments the princess waited patiently in silence while the overseas call was being put through. Then when the telephone rang she bounded across the sitting room to snatch up the ivory colored instrument. The phone jangled only once before she reached it. She spoke for 10 or 12 minutes, standing all the time at a telephone desk between vases of red and yellow roses.

It obviously was a happy conversation. Many times she smiled as she talked. Once, in a movement of her hand, she motioned for her husband, Prince Philip, to "shush" as she pressed the receiver to her left ear.

As soon as the call was finished, Princess Elizabeth walked to the rear platform of her railroad car and waved happily to the cheering crowd as the train pulled away.

Princess Elizabeth talks to her mother by overseas telephone shortly after arriving in Canada —Federal News Photo.

TWX 20th Anniversary Recalls Its Birth During Depression

The 20th anniversary of teletypewriter exchange service on November 21 (1951) was marked quietly by a relatively small but busy group of Bell System employees who each day handle about 68 thousands calls. It was also marked by a number of Laboratories people who had to do with the system's birth.

TWX service was inaugurated in 1931, only two years after the stock market crash and when many businesses were retrenching for the great depression. This might not have seemed to be an opportune time to start a new venture. However, the Bell System had studied the prospects of a teletypewriter exchange service and believed that two-way connections between teletypewriter customers could create new business—good times or bad. During the next 20 years TWX service fulfilled those expectations. From 870 stations listed in the first teletypewriter directory, TWX grew to about 30,000 stations today. Among the customers of this written message service are government agencies, newspapers, manufacturers, truckers, and many others.

Among Laboratories people who helped develop the original system may be mentioned John Bell and R. D. Parker, both now in retirement; L. A. Gardner, A. D. Knowlton, G. A. Locke and F. J. Singer.

Twenty years later teletypewriter exchange service has grown to a nationwide network linking 30,000 stations over which 68,000 calls flow every day.

Dr. C. J. Davisson Honored on His 70th Birthday

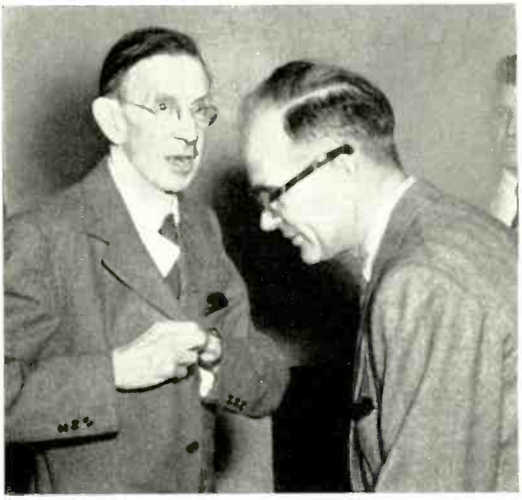
October 22 marked the 70th birthday of Dr. C. J. Davisson: Laboratories' Research Physicist from 1917 to 1946 and winner of the Nobel Prize in Physics for 1937. In honor of the occasion *The Bell System Technical Journal* prepared a special issue—commonly known as a Festschift—containing papers on Dr. Davisson, his work, and on recent research in allied fields contributed by sixteen of his friends and former associates.

To further celebrate the occasion, a luncheon was given at Murray Hill on October 24 with Dr. Kelly presiding and "Davy" as the guest of honor. Some thirty-two members of the Laboratories were present—including the contributors to the Festschift and a number of those closely associated with him while he was at the Laboratories. A copy of the Festschift issue of the *Technical Journal,* bound in dark blue morocco, was presented to Dr. Davisson by Dr. Kelly, and later autographed by all the contributors. In the course of his acceptance remarks, the guest of honor said:

Dr. Davisson receives the special issue of The Bell System Technical Journal *from Dr. Kelly.*

"I was fortunate in an interview I had with the late Harold D. Arnold in 1918. I had come to the Laboratories the year before on leave of absence from Carnegie Tech. Finding that I preferred New York restaurants to those in Pittsburgh I decided to stay on indefinitely. I resigned my job at Tech. It was some time after that that H.D. called me to his office. He reminded me that I had come on to do war work, mentioned that the war was now over, and surmised that now I would probably like to get back to my teaching. And here my good fortune came to my rescue. Before I could think how to handle that one, H.D.A. added that if I should happen to prefer staying on at the Laboratories it might possibly be arranged. They had got rather used to seeing me about, he said, and it might possibly be arranged. That was but one of many lucky breaks which came my way during the years. The most notable, of course, were those connected with the discovery of electron diffraction. For some years we had been working at the scattering of electrons by metals. Naturally we had developed certain techniques and gained a certain facility in work of this kind. So, by good

J. R. Pierce greets Dr. Davisson on his arrival at the luncheon. L. H. Germer in center.



W. Shockley talking with Dr. Davisson prior to the luncheon.

fortune, we were well set in 1926 to observe diffraction, an effect already vaguely foreseen as a possibility, and one which was due to be discovered somewhere by somebody—and soon. Even so a lucky accident was needed to point the way, and even more so the skill and patience of George Reitter and the invaluable collaboration of Lester Germer were needed to bring the phenomenon finally into view.

"I want you to know that I am very deeply touched by this wholly unexpected compliment and tribute you are paying me. Other honors I have received have come from comparative strangers—people with something to award and the job of finding someone on whom to pin it. This is different—intimate, personal and special. I appreciate it very much indeed. I thank all of you most sincerely and especially those of you who have contributed eulogies, portraits and learned articles to this festive number of *The Bell System Technical Journal.* I thank also the editor and staff of the *Journal* for the trouble and care they have taken with this so-called 'Festschift' and for their kindness in publishing it in English rather than in German."

Technical Societies' Educational Activities

A course entitled, "Applications of Modern Communication Theory" is being given jointly by the New York Sections of the A.I.E.E. and I.R.E. Started October 8, the course consists of six lectures having the following titles: *Basic Aspects of Communication Theory; Communication Theory Applied to Acoustics; Applications to Circuit Design; Coding as Applied in Telegraphy and Telephony; Coding Processes for Bandwidth Reduction in Facsimile and Television;* and *Communication in the Presence of Noise.* W. R. Bennett of the Laboratories gave the lecture on October 29 which was entitled *Coding as Applied in Telegraphy and Telephony.*

The Basic Science Division of the New York Section, A.I.E.E., is conducting one of its Annual Symposia on topics of fundamental nature. This year, the Symposium is entitled "Transistor Electronics," in which several Laboratories' engineers and scientists are taking part. The lectures are as follows: *A Summary of the Present Status of Transistors* by Dr. C. B. Brown, Naval Ordnance Laboratory; *The Engineering Physics of Transistors,* by Dr. John Bardeen, formerly of the Laboratories, and now at University of Illinois; *Transistors in Linear Continuous Wave Systems,* by R. M. Ryder, Bell Laboratories; *Salient Properties of Transistors in Pulse Circuits and Systems,* by A. E. Anderson, Bell Laboratories; *Circuit Design and Applications of Transistors to Pulse Circuits,* by H. L. Owens, Signal Corps Engineering Laboratory; and *Application of Transistors to Switching and Computing Application,* by J. H. Felker, Bell Laboratories.

Southwest's Telephone and TV Circuits to Ride Microwaves

Intercity television channels and about a thousand additional long distance telephone circuits for the Southwest will ride microwaves from city to city on a new radio-relay system now planned, and under construction at some points, by Long Lines. The relay routes, in addition to providing more telephone message circuits, will enable Oklahoma City, Tulsa, Dallas, Ft. Worth, San Antonio, and Houston to be added to the nationwide video network.

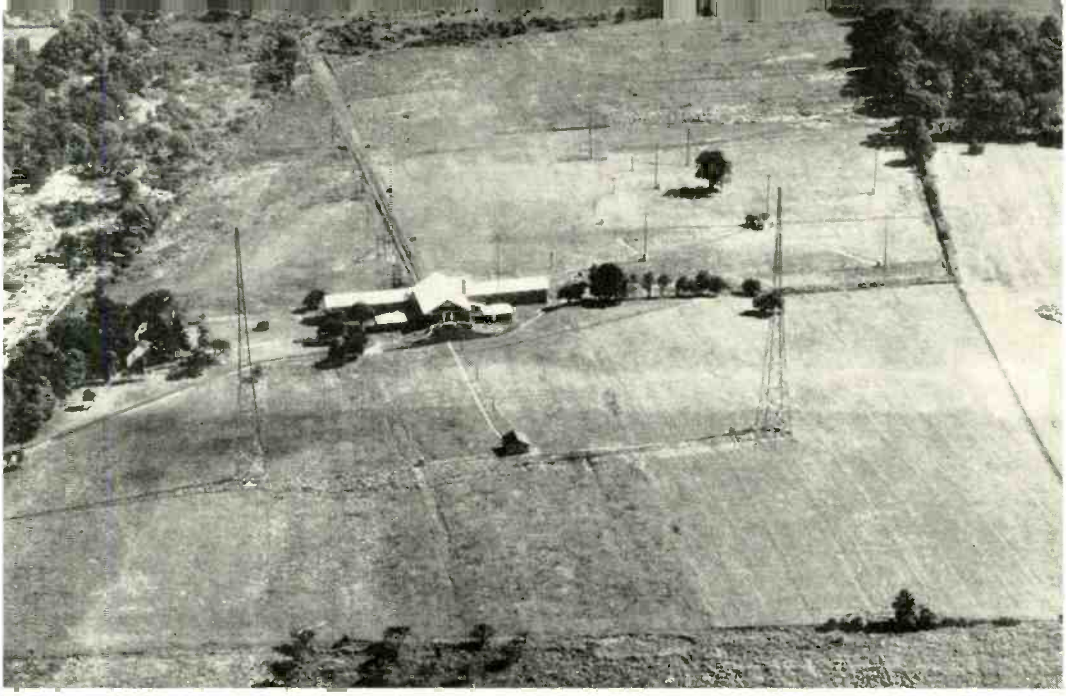
Nearing completion is the Austin-San Antonio section which is scheduled to start handling message traffic in January, 1952. By early summer, the Oklahoma City-Dallas portion of the system should be ready for telephone use with the Kansas City-Oklahoma City section opening for message service late in the year. Network TV programs are expected to be winging along the backbone relay route all the way from Kansas City to San Antonio by the end of 1952 with microwave spurs tentatively planned to carry TV into Tulsa and Ft. Worth early the following year.

From Kansas City, five intermediate relay stations will carry the microwave signals along the route to Wichita. With two more leaps they will cross the state line into Oklahoma City. There the antennas will be mounted on a 25-foot structure atop the Southwestern Bell building at 405 North Broadway. Four more stations, at Norman, Wayne, Davis, and Marietta, respectively, bring the route to the Texas border and with another three jumps it reaches the Telephone Building in Dallas.

The new 1,000-mile system will be joined to the recently opened coast-to-coast microwave route via existing coaxial cable between Kansas City and Omaha.

Change in Organization

H. N. Wagar has been appointed Switching Apparatus Engineer reporting to A. C. Keller, Director of Switching Apparatus Development. In his new capacity, Mr. Wagar will be responsible for the development of relays and relay-type apparatus.



Whippany Passes Its Quarter-Century Milestone

About fifty of the early workers at the Whippany Laboratory assembled recently for their second quintennial celebration to commemorate the founding of that station. The dinner, which was held at the Spring Brook Country Club near Morristown, was also attended by M. J. Kelly. He recounted, quite informally, the stages leading up to the present, and commended those in attendance for their share in the Whippany Laboratory's growth and development. Characteristics mentioned were conditions favoring adaptability to new work, including good housekeeping and a unified drive that pervades the whole place.

The Whippany Radio Laboratory was located out in the country to avoid interfering with broadcast reception while developing high power in radio transmission. A dairy farm, buildings and all, was acquired July 12, 1926. In the residence was installed a maintenance care-taker and the barn was turned into a laboratory; old timers say the memory of its former tenants persisted for some years. Two 250-foot towers were built five hundred feet apart to support various antennas to be tested. Transmission tests commenced.

One of the early projects involved the modification of a radio broadcast transmitter to provide for transmission of television images. The demonstration, which occurred on April 7, 1927, showed images transmitted by radio from Whippany to 463 West Street, New York and by wire from Washington to the same destination. Later the development work on radio equipment for two-way communication between ground and aircraft in flight was undertaken. At that time there was no communication with air transports, but Bell System executives had the vision which saw that air-to-

Speakers and some of the guests at the 25th Anniversary Dinner of the Whippany Radio Laboratory. Seated, left to right, W. C. Tinus, M. J. Kelly, R. E. Coram, F. M. Ryan, W. H. Doherty. Standing, J. W. Smith, W. L. Black, F. W. Cunningham, E. L. Nelson and A. W. Kishbaugh.

ground telephony would be essential to large-scale passenger transport. As the industry grew, Western Electric equipment was ready for it.

Meanwhile, development of broadcast transmitters went on. Starting with a 5000 watt set, the Whippany group pioneered in transmitters up to 50,000 watts. Many of the well-known stations were equipped with Western Electric sets designed here.

During World War II the Whippany Laboratory was engaged exclusively on military projects. Its personnel are known as the Military Electronics Development Department. Its war work was largely in radar, and its designs made their mark on the enemy in every theater. This and related work continues, as our country rearms itself against any contingency.

Dr. Buckley Presents Mr. Lilienthal for Welfare Medal

At the Autumn Meeting of the National Academy of Sciences in New Haven on November 6, Dr. Buckley presented David E. Lilienthal, nominee for the Public Welfare Medal, to the President of the Academy. Mr. Lilienthal, unanimously elected to receive the award, given for "eminence in the application of science to the public welfare," has been a public figure for many years. In reviewing Mr. Lilienthal's career, Dr. Buckley spoke of his affiliation with the Tennessee Valley Authority, first as a director, and later as Chairman; his plan proposed in 1946 for international agreement on the control of atomic energy; and his service as Chairman of the Atomic Energy Commission. In honoring Mr. Lilienthal, he said, the National Academy of Sciences honors itself. Dr. Buckley concluded his presentation by reading from Mr. Lilienthal's book, *This I Do Believe,* a few words which "show his extraordinary understanding of the spirit and purposes of science."

National Service Life Insurance Following Discharge

The National Service Life Insurance Act has been amended to permit veterans who have served on active duty with the Armed Forces since June 27, 1950, to apply for insurance under a new type of policy following their discharge.

The new policies are level-premium, five-year term policies and are renewable at the completion of each five years. Policy holders do not participate in any dividend declaration. The maximum insurable amount is $10,000 including any other government insurance which veterans of World Wars I and II may have. Active duty after June 27, 1950 must be for a period of 30 days or more and application for the new insurance must be made within 120 days following separation from active service.

The Laboratories has arranged to make payroll deductions for the payment of premiums for those who apply for this new type of insurance, and the necessary forms for these deductions may be obtained from the Accounting Department by calling Ext. 622 or 1772 at West Street.

Playtime in the Hill home finds Donald Lloyd raring to leave Grandfather Hill's arms to play with his brother David's mechanical truck. Grandmother Hill watches happily.

Mr. Hill likes to watch television at night with this huge tabby on his lap.

"Best cook in North Jersey" is Mr. Hill's recommendation of his wife, Grace. Fresh from a stint of raking leaves, he's nibbling crackers to take the edge off his appetite, while she prepares baking powder biscuits for a creamed chicken luncheon.

Edward F. Hill— Golden Jubilarian

It is difficult to realize that Edward Foster Hill of the Drafting and Specifications Department is celebrating his golden jubilee at the Laboratories. There is scarcely a gray hair in his head and his humor and light-heartedness are infectious. Mr. Hill claims that the past twenty years at the Laboratories were the happiest of the fifty he has spent here.

Like the previous golden jubilarians, Marguerita G. O'Brien and the late Mary Douglas, he is a product of Public School No. 3 on Hudson Street, known locally as the Grove Street School. He came to work here "temporarily" because his brother Bill, now retired from Western Electric, was a foreman in the Repair Shop. "Ed" Hill was not yet fifteen years old when he reported for work on December 6, 1901, at 463 West Street. He wore high shoes, long black stockings, gray knickers and a navy pea jacket. His shirt had been boiled and starched stiff by his mother, he recalls, and he wore a celluloid collar and a red tie.

West Street was brand new back in 1901 when Ed came to work as a messenger in Incoming Mail. Manufacturing was done on the first eight floors, nine and ten were for offices, eleven and twelve for executives, with drafting rooms on the thirteenth. "There was a restaurant 'for ladies only' on the tenth floor," he remembered during his interview. "Susie Trigg was in charge." After lunch the young ladies sat out on a little balcony overlooking the Hudson to rest and refresh themselves. Below on West Street, along with horse cars, were freight cars drawn by "dummies"—locomotives boxed in to prevent horse-drawn traffic from being frightened. Each train was preceded by a man with a red flag and lantern on horseback. The "Dolly Varden," a passenger day coach, made one run a day past the door to Canal Street to keep the franchise.

Ed worked dilligently for the munificent sum of $3.50 a week from which his mother gave him only 25 cents allowance because he was able to run home at noon for lunch. He managed to save enough money and energy after attending Mechanics Institute at night to have an occasional little fling at the Barrow Street Pier. "It was a wonderful recreation center and all summer there was music and dancing," he said. "Liked to take my girl down there. We used to dance 'The Grape Vine' and the two-step, tricky little numbers, and waltzes too." A member of the Perry Street Methodist

Church, Ed was as active in his church then, particularly in the choir, as he is to this day.

Edward Hill's career in the Laboratories has to a large extent been in the drafting departments. In 1906 he became a draftsman and for six years remained at the board. Next came a transfer to accounting and then to the building and maintenance group where he was responsible for fire protection and building repairs. With the advent of World War I, he transferred back to drafting where he contributed to the design of wind-driven generators for airplane radio. During all those years he had studied with the American School of Correspondence. As a result of his drafting experience he transferred to the Card Catalog Files after the war, supervising the making of catalog drawings. He remained there for two years. This was followed by his appointment as Technical Information Editor, responsible for the out-of-hours booklets and material published to cover the many manufacturing courses given in those days by Western Electric. When manufacturing was discontinued here, he transferred back to the apparatus drafting group, where he has remained. Today he is a consultant on loading coil cases and divides his time between Murray Hill and New York.

Mr. Hill was born upstate in Greenbush, New York, the son of a coastwise sea captain. His family moved to New York when "Ed" was a baby. He grew up on nearby West Tenth Street in an era when there were many fine homes there. He has sung in the choir since his boyhood, and he has always been interested in it. "I met my wife, Grace Alice, in the choir," he says, "and ours has remained the romance of the church choir." After thirty-six years of

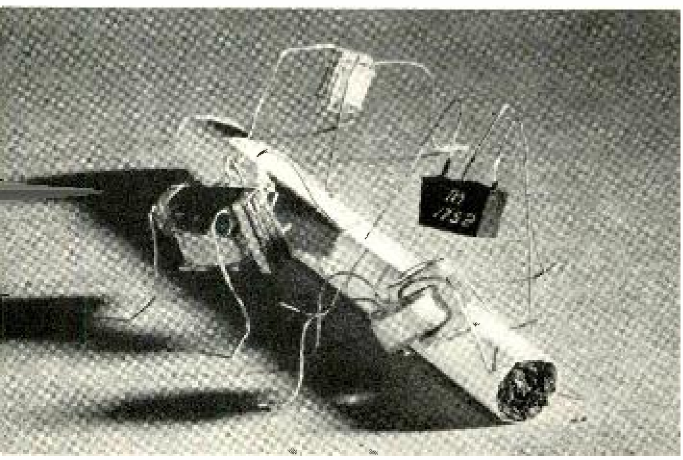
Christmas Eve will mark the thirty-sixth wedding anniversary of Mr. and Mrs. Hill. During all those years they have seldom missed singing together at church services. They were photographed in the Arcola Methodist Church, a quaint gray stone chapel, to which they have belonged since 1919.

Over-all view of the newly renovated Drafting and Specifications Department working area in Section 4D at West Street, showing the new fluorescent lighting and gray metal drawing boards with reference tables between each pair of boards. E. F. Hill is third from the left in the foreground.

married life, they still sing side by side in the Arcola Methodist Church each Sunday. They have raised a son, Edward, a physicist at Oak Ridge, and a daughter, Dorothy Lloyd. The Lloyds and their two sturdy little boys, David and Donald, live with the Hills in Maywood, New Jersey. "Grandfather Hill," as he is called, is active in various committees of the Mens' Club at church and is a soloist in the club. He is treasurer of a Boy Scout Troup Committee. His other hobbies are model railroading, photography and carpentry.

Miniaturization of Components Faces Bright Future

The miniaturization of circuit components was the subject of out-of-hour lectures by P. S. Darnell at West Street, Murray Hill, and Whippany. Mr. Darnell pointed out that reduction of apparatus size is limited by power level, as well as available materials and the techniques of using them. All of these limitations have been greatly reduced by the technical advances of recent years. The advent of the Transistor permitted operation at greatly reduced power levels, and much progress has been made in developing new materials and the methods of their utilization. In addition, smaller terminals have been devised as well as improved potting techniques such as that of plastic encasement. Recent advances in coils, capacitors, resistors, transformers, varistors and crystals were illustrated by Mr. Darnell by means of suitable slides.



These miniature circuit components were used by Mr. Darnell to illustrate his talk. The object at right is a junction Transistor. The other three items are transformers produced by the deft fingers of Marion Wohlhieter of the transmission transformer group.

William Shockley Awarded Morris Liebman Memorial Prize

William Shockley has been awarded the Morris Liebman Memorial Prize "in recognition of his contributions to the creation and development of the Transistor." This award is given annually to a member of Institute of Radio Engineers who has made an important contribution to the radio art.

Dr. Shockley was born in London in 1910, and came to this country in 1913. Graduating in 1932 from the California Institute of Technology, he continued his studies at M.I.T., receiving his Ph.D. degree in Physics in 1936. He came to the Laboratories that year, and until World War II, was engaged in the research on the physics of metals and alloys. During the war, he became Director of Research for Anti-Submarine activities under an OSRD contract at Columbia University, and later became an expert consultant in the office of the Secretary of War. Since returning to the Laboratories, he has been in charge of a department concerned with Transistor physics.

Plan Pittsburgh-St. Louis Radio-Relay Route

Plans for a radio relay system between Pittsburgh and St. Louis were revealed in an application filed recently by Long Lines with the Federal Communications Commission. An existing relay system which now connects Columbus, Dayton and Indianapolis would make up the central section of the proposed route. When completed, the system, including the Columbus-Indianapolis section, will represent an investment of about $9,000,000.

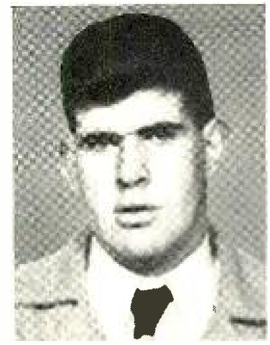
The new system, which would have a total of 24 microwave stations, would be the second East-West microwave route across the Midwest. It will augment cable and wire facilities now providing communications in that area and would tie in to the coast-to-coast microwave highway at Pittsburgh.

Ready for use in mid-1953, the new route would provide, initially, hundreds of telephone message circuits.

R. J. DREISS

J. R. MARCELLO

J. J. BROSNAN



D. M. BUDD

CALLED TO ACTIVE DUTY

JOHN J. BROSNAN, who formerly ran one of the elevators on the Bethune Street side of the building, is now in training at the Marine Corps base at Parris Island. Mr. Brosnan joined the Laboratories three years ago shortly after emigrating from Killarney.

DANIEL M. BUDD was inducted into the Army on October 31. A Marine reservist, he had been an assembler in the Electronic Apparatus Department at Murray Hill since he entered the Laboratories a year ago.

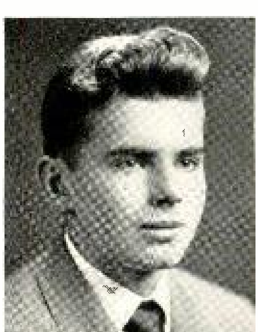
ROBERT J. DREISS has reported for active duty with the Navy at Bainbridge, Maryland. One of three brothers in that branch of service, Mr. Dreiss is a member of the Equipment Drafting Department.

JOHN R. MARCELLO enlisted in the Army and is now at Fort Belvoir with the Engineers in Officers Candidate School. Mr. Marcello received special Army training at the University of Buffalo in 1944 and 45, following his graduation from high school. When that program of aviation cadet training was discontinued, he studied aircraft and engine mechanics before he mustered out in late 1946.

RONALD J. MESSINGER of the Naval Reserve has been called to active duty as a seaman recruit. Following graduation from high school in 1950, he joined the messenger group at Graybar and later transferred to West Street. Meanwhile he had begun a pre-engineering course at C.C.N.Y. evenings, and was recently promoted to a clerical position in Central Files.

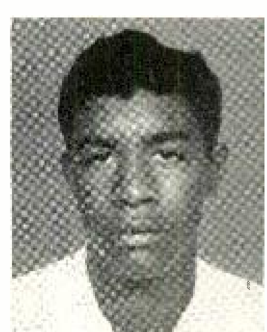
FRED J. SCHWETJE, Publications Department illustrator, has been called to active duty with the Marine Corps at Floyd Bennett Field. Captain Schwetje, who has been a member of the Laboratories since 1936, was commissioned in 1944 and served for ten months on combat duty in the Central Pacific area. He had been active in the organized reserve for some time before his recall to service.

J. WILLIS SMITH, who had been a restaurant helper at the Murray Hill Laboratories, has enlisted in the United States Army.



R. J. MESSINGER

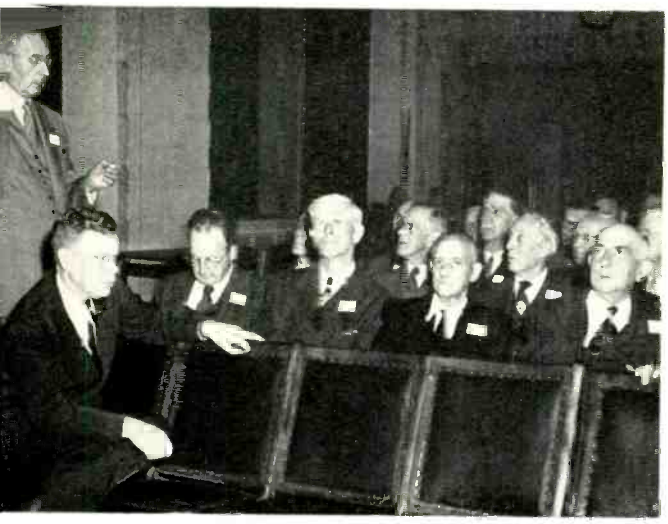
F. J. SCHWETJE



J. W. SMITH

H. J. Delchamps (below) conducts a meeting of the Pioneer Life Member Club.

Other speakers at the meeting were H. E. Marting and J. A. McRae (below).



Life Member Club Meeting

Over eighty Life Members of the Frank B. Jewett chapter met in New York on October 24 to attend a short meeting in the Auditorium, followed by a luncheon and social gathering in the service dining room. During the meeting, speakers included H. J. Delchamps, president of the Chapter, J. A. McRae, vice president of the Laboratories, and Heber Marting, editor of *Doings,* the Life Member news sheet.

En route to the dining room at 11.30, Life Members met many of their former co-workers whom they might not have had a chance to see otherwise. Life Members enjoyed a delightful luncheon and, after visiting with their friends in retirement, returned in most cases to visit their former associates in the various laboratories. N. H. Thorn coordinated the meeting and luncheon arrangements.

Open House at West Street

Laboratories headquarters at 463 West Street will be host at an open house to the Frank B. Jewett Chapter of Pioneers on Thursday evening, December 6. The program will include dinner; demonstrations of recent technical developments; observation of improvements that have been made in plant, shop and service facilities; and entertainment features in the Auditorium. The combination of instructive demonstrations, entertainment and repast offers a fine opportunity for an evening of good fellowship to both active and Life Members of the chapter and their guests.

Frank B. Jewett Chapter Pioneer Activities

The Hobby Committee of the New Jersey Council has added several activities to those already claiming Pioneer attention.

Ceramics classes meet every Tuesday evening at Murray Hill, with 26 Pioneers registered and active. J. G. Whytock and his committee scheduled the course which started on October 9 and will continue for ten sessions.

The Garden section held another of their noon-hour meetings on October 17 in the Arnold Auditorium. About 150 Pioneers and interested non-Pioneers attended. S. O. Morgan introduced E. G. Christ, Associate Extension Specialist in Pomology of Rutgers University College of Agriculture, who spoke on *Fruit Growing as a Hobby.*

Pioneers and guests were "in the groove"

when E. L. Fisher introduced the first square dance session at Murray Hill on October 25. Six sets energetically responded to the calling and instruction of J. D. Person, Jr., a professional caller.

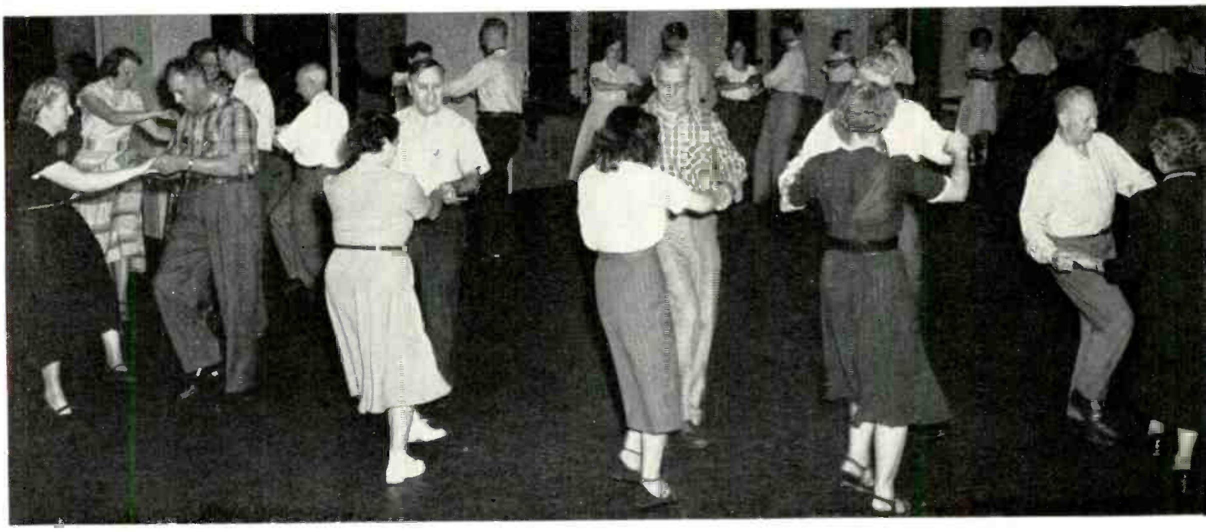
The Hobby Committee also plans to activate a class in photography under A. H. Hearn and one in woodworking under H. A. Flammer, both at Murray Hill. R. A. Devereux of Whippany will start the woodworking class at that laboratory.

R. C. Carrigan and T. A. Durkin are forming a committee and laying plans for a Pioneer Hobby Show to be held at Murray Hill in early 1952.

The Entertainment Committee anticipates a repeat on last year's sell-out Theatre Party. K. P. Hansen and L. G. Kersta have completed arrangements with the Paper Mill Playhouse of Millburn, N. J., for the performance of Sigmund Romberg's *Desert Song* on Wednesday evening, December 12. Drawing for door prizes will again be an intermission feature.

At ceramics classes at Murray Hill twenty-six Pioneers are learning a new skill.

"Duck for the oyster" echoes at Murray Hill as Pioneers at that location enjoy square dancing classes.



Out-of-Hour Courses

Out-of-Hour courses are being given again this fall. As in the past, the purpose of these courses is to provide educational opportunities in the field of communications technology, and are presented by specialists well qualified through years of experience.

Supplementing the Out-of-Hour course program, a series of informative lectures dealing with selected phases of the Laboratories' work is being arranged for presentation in New York, Murray Hill and Whippany locations during the fall and winter months. Announcement of these lectures will be made at a later date.

The Out-of-Hour courses with names of instructors are as follows:

Analysis of Data, M. M. Atalla. At West St.

Theory of Servo Mechanisms, R. E. Graham. At Murray Hill.

Carrier Telephone Systems, L. R. Montfort and members of Transmission Engineering II Department. At West St.

Electronic Circuits–Term III, R. W. Ketchledge. At Murray Hill.

Electron Tubes and Semiconductor Devices, G. H. Robertson and M. C. Waltz. At Murray Hill.

Switching Circuit Design by Symbolic Methods, Members of Systems Department Training Staff. At West St.

Fundamental Circuit Theory, R. J. Watters, At Whippany.

Problems in Radar System Design, S. C. Hight and Members of Whippany Staff. At Whippany.

Introduction to Transistors, M. M. Bower, J. H. Felker, H. H. Bailey, J. R. Logie, W. L. Mraz and C. C. Willhite. At Whippany.

Fundamentals of Good Writing, C. G. Miller. At Murray Hill.

First Aid–Standard Course, Under the direction of L. E. Coon. At New York and Murray Hill.

Fall Concert at West Street

The West Street Chorus presented its fall concert in the Auditorium on November 8, at 12:30. Several well-known selections were rendered by the chorus, with R. P. Yeaton conducting and Grace Wagner accompanying at the piano. Miss Wagner played one of Chopin's famous compositions. The program consisted of *Great Day,* Youmans; *Halls of Ivy,* Russel and Knight; *Joshua Fit De Battle Ob Jericho,* Arr. by Gaul; Piano Selection by Miss Wagner, *Fantasie Impromptu,* Chopin; *Bless This House,* Brahe; and *The Lost Chord,* Sullivan.

The Chorus is now busily engaged in rehearsing the various Christmas selections which are to be presented for the Laboratories on December 21. In addition, they have again been invited to present a program of Christmas music as one of the choral groups participating in the annual Christmas Festival held during the week preceding Christmas by the New York Savings Bank at Eighth Avenue and 14th Street in New York City.

Fall General Meeting of A.I.E.E.

The third of the three Annual General Meetings of the A.I.E.E. was held in Cleveland October 22 through 26. Among the technical papers presented were the following by members of the Laboratories: *Polyethylene for Wire and Cable,* (V. T. Wallder, author) presented by F. W. Horn; *Bell System Cable Sheath Problems and Designs,* by F. W. Horn and R. B. Ramsey (presented by Mr. Ramsey); *Lumped Circuit Filter Design,* F. Hallenbeck; *Rectangular Guide Filters,* M. D. Brill; *Principles of Converter Design for High Frequency Measurements,* D. A. Alsberg.

Presiding at technical sessions were: L. G. Abraham, *Wire Communication Systems;* and John Meszar, *Communication Switching Systems.* Several Committee and Sub-committee meetings were held during the week. Laboratories' members who attended a number of these were: *Edison Medal,* R. I. Wilkinson; *Public Relations,* J. D. Tebo; *Wire Communications,* L. G. Abraham, chairman; *Safety and*

Protective Devices, L. S. Inskip; *Magnetic Amplifier Materials, Magnetic Amplifiers,* and *Magnetic Amplifier Definitions,* A. B. Haines and B. E. Stevens; *Communications Division,* H. A. Affel, vice chairman, L. G. Abraham, and John Meszar; *Communication Switching Systems,* John Meszar, chairman; *Forum of Technical Committee Chairman,* H. A. Affel, E. I. Green, John Meszar, L. G. Abraham and J. D. Tebo; *Technical Advisory,* H. A. Affel and J. D. Tebo; and *Energy Sources* and *Basic Sciences,* J. D. Tebo.

J. F. Lewis

F. Haese

E. F. Hill

J. B. Shiel

SERVICE ANNIVERSARIES

Members of the Laboratories who will receive Service Emblems on the December dates noted

50 Years

E. F. Hill 6th

45 Years

J. F. Lewis 5th

40 Years

F. Haese 4th
G. J. Seltzer 8th

35 Years

Matilda Goertz . . 14th
M. O. Kastner 19th
J. B. Shiel 11th

30 Years

F. A. Blanpied 7th
H. L. Falkenstein . . 27th
H. H. Felder 1st
P. P. Kashtelian . . . 24th
W. G. Laskey 2nd
Veronica Salis 6th

25 Years

L. E. Cheesman 5th
M. T. Dow 2nd
C. E. Fisher 1st
A. L. Jones 21st
L. G. Kersta 6th
Florence McGuire . 20th
W. R. O'Neill 20th
E. A. Potter 8th
W. G. Smith 21st
W. B. Vollmer 11th

20 Years

N. B. Balcom 14th

15 Years

V. G. Chirba 3rd
J. F. Clifford 16th
J. Hill 29th
H. K. Meyer 7th
C. F. Phelps 8th
J. J. Sabin 2nd
G. O. Voigt 1st
G. E. Weeks 17th

10 Years

G. R. Benson 30th
R. G. Brandes 29th
P. R. Brockett 8th
J. J. Chocolate 22nd
C. Damico 30th
N. J. Flynn 1st
R. H. Gertz 4th
E. G. Goranson . . . 18th
P. T. Haury 7th
E. W. Hubbard . . . 19th
Evelyn Karski . . . 16th
J. D. R. Keller 8th
L. A. Kramer 29th
F. L. Langhammer 15th
E. A. Leadbeater . . 26th
D. Lowney 11th
S. Martinkovic . . . 16th
J. F. Nachazel 8th
J. Orost 2nd
R. E. Porter 15th
Carmela Santore . . 17th
W. E. Satter 15th
I. S. Sickles 18th
F. E. Smith 28th
Ethel Stevens 1st
T. J. Stymacks 22nd
J. C. Van Gieson . . 16th
F. W. Whiteside . . 15th

Matilda Goertz

M. O. Kastner

G. J. Seltzer

RETIREMENTS

Among recent retirements from the Laboratories are W. W. Carpenter with 38 years of service and E. G. Fracker, 35 years.

Warren W. Carpenter

In 1910, following two years of study at Nebraska Wesleyan University, Mr. Carpenter became interested in the development of printing telegraph equipment and formed his own company to carry on this work. Three years later he joined the Engineering Department of the Western Electric Company and worked on testing of the semi-mechanical panel apparatus then being installed in the Mulberry, Waverly and Branch Brook offices in Newark. Later in 1917 Mr. Carpenter returned to West Street to take up fundamental development of dial systems.

W. W. Carpenter

E. G. Fracker

He had an active part in the development, after World War I, of the panel dial system for large cities. A vital feature was the furnishing of information to the senders as to how to route each call. Mr. Carpenter attacked this problem in terms of common circuits employing relays and a field of cross-connections. The device, known as a decoder,* was a major contribution to the panel art, and in a few years the decoder entirely replaced the earlier translator.

While the Bell System's greatest need was in large cities, there was also a field for dial service in smaller places, for which the step-by-step system had been adopted. A major improvement, made when Western Electric took up its manufacture, was in the method of connecting to a line on which a call was being originated. The line finder† developed for this purpose employed Mr. Carpenter's idea of combining a "slipped multiple" with a circuit for starting the finder which could reach the line with the least delay.

* Record, *May* 1928, *page* 273.
† Record, *February* 1929, *page* 236.

Attention after a while became focussed on the crossbar switch* and Mr. Carpenter took up the problem of common control and extended the marker principle to crossbar operation. Two basic patents record his major contributions. To insure that such complex systems would perform satisfactorily he promoted the concept of straightforward self-checking relay control circuits with trouble indicators to record the condition of the circuit when stopped by trouble and a second trial to enable the traffic to be handled in many cases in spite of the trouble.

In the late Thirties the possibility occurred to Mr. Carpenter that all toll calls might be billed mechanically, if a method were found to assemble the three basic records: number calling and called, time of answer and time of disconnect. A record on paper tape seemed logical and he set about to build the basic machines: a perforator and a reader. He did the work in his own home and did not bring his models into the Laboratories until satisfied that they and the system were workable. The four basic patents on the Automatic Message Accounting System are his.

Since July of this year the Carpenters have been residents of Albuquerque; he has been working as a member of the Laboratories on the staff of the Sandia Corporation nearby. Mr. Carpenter's life pass and Pioneer Life member certificate were presented to him by M. J. Kelly at a luncheon attended by D. A. Quarles, H. J. Wallis, R. E. Poole and C. N. Hickman, as well as others of his recent associates at Sandia.

Edward G. Fracker

Among Ed Fracker's reminiscences is one of Victory Way, the first demonstration of public address systems. It was on the central mall of Park Avenue in the Fifties, and was to develop enthusiasm for the Victory Loan of 1920. Mr. Fracker was one of the engineers in charge of radio transmitting and receiving.

Then transferring briefly to specifications, Mr. Fracker joined Commercial Products Development in 1922 and took charge of the mechanical design of radio receivers. For most of the time since 1928 he has been associated with the development of public address, music reproducing and sound picture systems, together with the mechanical design of amplifying and other apparatus for these systems and for speech input equipment. During World War II

* Record, *July* 1937, *page* 338.

he worked on battle announcing systems and tracking radars for use by the Navy. Returning to audio facilities after the war, he was a member of the Audio Facilities Department and in addition to miscellaneous audio developments for the Radio Division of the Western Electric Company he worked on the telephone recorder connector and transcribed message services equipment including telephone answering devices; also electronic controls for guided missiles.

Owner of a Star-class yacht, Mr. Fracker has been an ardent racer for years. His son, for whom he crewed, is now in the Army in Japan, so the Star is in eclipse. The Frackers live in Grant City, Staten Island; their daughter and her two children live in Great Neck. Mr. Fracker owns to no hobby except sailing, but he does have a well equipped workshop in his cellar, so when he gets to work on the technical problems that intrigue him, he'll not have time hanging on his hands.

News Notes

D. A. QUARLES took part in a panel discussion on *Industrial Standards for Defense Production* sponsored by the American Ordnance Association at the Second National Standardization Conference October 22-24 at the Waldorf-Astoria Hotel in New York City. This conference was held by the American Standards Association in conjunction with its 33rd Annual Meeting.

J. R. TOWNSEND, Past President of the American Society for Testing Materials, represents that Society on the Standards Council of the American Standards Association. At the annual meeting of the American Standards Association at the Waldorf-Astoria on October 24 Mr. Townsend was elected chairman of the Standards Council. He saw previous service as chairman of the Survey Committee of the ASA which drafted a plan of organization and work which was adopted. He also served for three years as chairman of the Board of Review which acts to review all Standards promulgated by ASA. Mr. Townsend was one of thirteen metallurgists in the New York Area honored by appointment as American conferees to the World Metallurgical Congress held in Detroit from October 14 to 18. Representatives from thirty countries attended the meeting, which was sponsored by the American Society for metals. The Congress was the first international meeting on metal resources of the free world. Among the metallurgists who attended

Over 150 members of the Standards and Drafting Department honored Helen Matej, A. T. Calvano, F. Colantuoni, and C. B. Swenson on October 4 at a dinner dance at the Domino Restaurant. The occasion was their twenty-fifth service anniversary with the Laboratories. In the large group picture are the late diners who were not on the dance floor when the photographer arrived. In the smaller picture are Mr. Calvano, Supervisors H. Hansen and R. J. Koontz, Mrs. Matej, Mr. Swenson and Mr. Colantuoni during ceremonies at West Street where the quartet received their service pins.

Santa Claus is coming to town, and he's up to his ears in TB Christmas Seals. Pretty Margaret Conrad of Central Files decorated her gifts with Santa Claus TB Seals to show you how bright and merry they can be on a Christmas gift box. Seals are America's most popular gift. More than 12,000,000 families give them, because their sale makes possible the greatest gift of all, health.

were E. E. SCHUMACHER, J. H. SCAFF, W. C. ELLIS, M. E. FINE and R. G. TREUTING. Mr. Fine presented a paper on *Thermal Variation of Young's Modulus in Some Iron-Nickel-Molybdenum Alloys,* co-authored by W. C. ELLIS. R. G. TREUTING gave a lecture on the *Nature and Origin of Residual Stress,* the introductory lecture of a series of four on various aspects of residual stresses arranged by the Educational Committee of the American Society for Metals.

G. R. GOHN and J. P. GUERARD attended the Washington meeting of Committee B-5 of the A.S.T.M. on Copper and Copper Alloys. The principal problems of this Committee are a study of new alloys of lower nickel content, such as the 12 instead of the 18 per cent nickel-silver alloys, and standard methods for measuring such things as thickness, width and length.

MR. GOHN is Chairman of the Building Committee of the Port Washington School Board. Port Washington has under construction six different buildings, including three new elementary schools, one new high school, a new administration building and an addition to the junior high school. D. D. HAGGERTY has been treasurer of the School Board for the past four years.

RECENT PAPERS by Laboratories' engineers include K. B. MCAFEE's *Pressure Dependence of the Zener Effect* presented before the Chicago meeting of the American Physical Society and H. D. HAGSTRUM's *Ionization by Electron Impact,* before The Symposium on Mass Spectroscopy in Physics Research at the National Bureau of Standards in Washington. Mr. Hagstrum participated in the informal discussion on instrumentation. At the Chicago meeting of the Optical Society of America W. HARTMANN presented a paper entitled *The Quantitative Spectro-Chemical Determination of Sodium in Alkaline Earth Carbonates.*

G. K. TEAL discussed *The Chemistry of Semiconductors and Transistors* at the monthly meeting of the Delaware Section, American Chemical Society, October 17, held in the Du Pont Country Club, Wilmington, Delaware.

K. K. DARROW attended a meeting in Washington of the International Council of Scientific Unions and the twentieth-anniversary meeting in Chicago of the American Institute of Physics. At the latter meeting Dr. Darrow spoke on *Physics as Science and as Art.* While in Chicago, he also attended a meeting of the American Physical Society held in conjunction with the Institute meeting.

On the occasion of his retirement late in October, Magnus Froberg was presented with a Pioneer Life Member Certificate by E. L. Rudd.

IN DETROIT, L. E. ABBOTT participated in meetings of the American Welding Society, and J. R. BOETTLER, meetings of Committee B-9 on Powder Metallurgy of the A.S.T.M.

W. MCMAHON, G. T. KOHMAN, L. EGERTON, K. G. COUTLEE and C. A. BIELING attended a Conference on Electrical Insulation at the National Research Council in Washington.

AT THE DEDICATION of the new William F. Halloran Elementary School in Elizabeth, J. J. KUHN, president of the Elizabeth Board of Education, delivered the dedication address.

Males Versus Females

One of the outstanding social events of the season took place recently on the lawns of Murray Hill. In answer to a challenge by the young ladies of the files and the drafting department, their male colleagues agreed to meet them during the lunch hour in America's favorite outdoor sport—baseball.

LINEUP FOR THE BASEBALL GAME OF THE YEAR

	Mustangs	*Sweet Violets*
Pitcher	Johnny Gerhard	Millie Greco
Catcher	Don Schultz	Pat Latella*
First Base	Don Guapner	Janet Mauro
Second Base	Al Christensen	Audrey Muller, Capt.
Short Stop	Joe Verdino, Capt.	Jean File
Third Base	Bill Lynch	Flora Velletri
Left Field	Bob Schultz	Jerry Mansfield
Center Field	Tom Landis	Joan Thompson
Right Field	Phil Smiecinski	Barbara Veith
Short Field	Don Viemeister	Frances Kunz

Umpires—Al Kobylarz and Hank Baarens

* Man

Batting and throwing left-handed and giving themselves only two strikes at bat, the men chivalrously played the dungaree-clad Misses. Throngs of people who ordinarily would drive to Summit, walk in the country, or sleep in the lounge gathered for the occasion. The air was snappy; it was also tense. Scouts from the National League were on hand.

Batter up! Whew . . . Man on first. Batter up! Another whew . . . One man in; two men in. Pretty soon it was the girls turn at bat. The excitement mounted. The clock ticked on. The runs piled up. No one dared argue with the umpires (they were supervisors). Tension. It was gay, it was mad. The Mustangs were in the lead, then the Sweet Violets! Fun!

Final score: 18 to 7. Who won? Who else? The Mustangs.

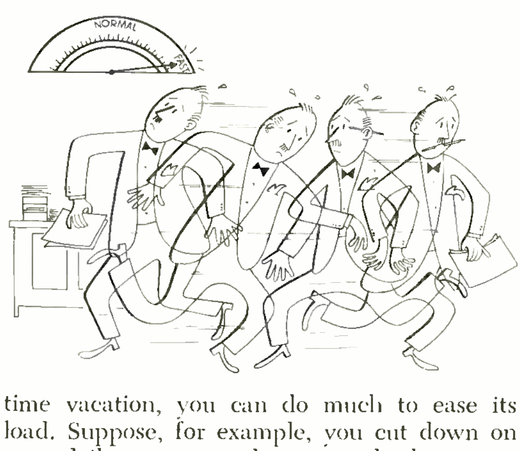
Pulse Rates and Death Rates

BY DR. M. H. MANSON
Medical Director, A T & T

When a pretty nurse takes a man's pulse, chances are the patient is more interested in her big blue eyes than in his pulse rate. Few people think that a "fast" or "slow" pulse is of any great importance. Actually, as the speedometer which indicates how fast your heart is working, your pulse beat is something to watch pretty carefully.

At Johns Hopkins University in Baltimore, Dr. Raymond Pearl has discovered through study of thousands of pulse records that there is a definite relationship between pulse rate and length of life. Long-lived persons averaged two fewer heart beats a minute than short-lived persons. The healthy heart in an adult pumps about 70 times a minute, producing a pulse rate of 70 beats a minute. This adds up to 4,200 beats an hour, 100,800 a day, 36,792,000 a year. Nine to ten tons of blood go through the blood vessels, day in and day out.

Although you can't give the heart a full-



time vacation, you can do much to ease its load. Suppose, for example, you cut down on your daily pace enough to save the heart two beats a minute over a year's time. This would actually give your heart the equivalent of a ten-day vacation. And a good night's sleep—eight hours—will save about 7,000 beats a day.

RECENT DEATHS

Three retired members of the Laboratories, F. E. Anderson, Josephine D. Barry and Mary Colleran, and one active member, G. H. Day, died recently.

JOSEPHINE D. BARRY—*November 2, 1951*

Miss Barry passed away suddenly on November 2. Except for a short period when she first joined the Western Electric, she had been supervisor of the outgoing mail in the General Service Department at West Street. Her outside interests centered on her family and on Democratic Club activities in the Bronx, where she was a district captain.

JOSEPHINE BARRY

MARY COLLERAN

MARY COLLERAN—*October 26, 1951*

Miss Colleran passed away in her sleep on October 26. She had retired in 1949 after thirty-six years of service, mostly in the secretarial field, and had worked with men like S. P. Grace and W. L. Casper. She was active in church and bridge clubs in Jersey City where she made her home with her sister, Margaret, who survives her. Miss Colleran was also interested in the Pioneer Life Member Club and had attended its luncheon at the Laboratories on October 18.

GUERNSEY H. DAY—*October 20, 1951*

Mr. Day had been a member of the Transmission Research Department at Murray Hill since he rejoined the Bell System in 1943. A technical assistant in the multiplex telephony group, Mr. Day was engaged particularly in circuit testing in connection with the development of pulse code modulation. His earlier service had been from 1926 to 1933 with A T & T in the Morristown repeater station.

Born in 1908, Mr. Day was graduated from Morristown High School and had attended Pratt Institute. He was particularly interested in amateur radio and was communications director for the Morristown Civil Defense Council. The new Civil Defense Radio Station has been designated the Guernsey H. Day Memorial Station. His other special interest was the Morristown Volunteer Fire Company. His wife, Mary Johns Day, and a son and daughter survive.

G. H. DAY

F. E. ANDERSON

FREDERICK E. ANDERSON—*October 19, 1951*

Mr. Anderson died in Rockland County following ten months of confinement due to the infirmities of his age. Mr. Anderson joined Western Electric in 1898 and became a member of the technical staff in the Switching Systems Development Department. In 1932 after thirty-four years and nine months, he retired from the System. Mr. Anderson, who is survived by his daughter, Mrs. A. H. Fay, travelled in this country and Europe during his retirement.

News Notes

W. H. MARTIN spoke on *Industrial Use of Analysis for Administration* at the Fifth Annual Conference on Administration of Research held at the University of Michigan.

J. A. MORTON spoke on *Recent Developments in Transistors* at the Columbus, Ohio, meeting of the IRE on October 30. His talk was given in Campbell Hall at Ohio State University.

G. N. VACCA has been elected vice-chairman of the New York Rubber Group of the American Chemical Society.

GROWING CRYSTALS was the topic of talks by A. C. WALKER at Bryn Mawr College and at the University of Connecticut. I. V. WILLIAMS selected *Metals Engineering in Communications* as the subject of his talk before a joint meeting of the Rome and Utica Chapters of the A.S.T.M. in Rome, New York.

W. T. READ gave a talk on *Role of Dislocations in Crystal Growth and Grain Boundary Phenomena* before the meeting of the American Institute of Metallurgical Engineers, Detroit.

J. B. Johnson was chairman of the program committee for the Fall meeting of the Division of Electron Physics of the American Physical Society held at the National Bureau of Standards in Washington. Seven papers by Laboratories' members spotlighted the continuing search for a better understanding of electron activity on the surfaces of Transistors, cathodes and relay contacts: *Atomistic Theory of the Metallic Surface* by C. Herring; *Secondary Electron Emission from Germanium* by J. B. Johnson and K. G. McKay; *Ejection of Electrons from Molybdenum by Helium Atoms* by H. D. Hagstrum; *The Production of Sr Metal in the Reduction of SrO by Methane* by H. W. Allison and G. E. Moore; *The BaSrO Cathode Supported on an Insulator* by G. E. Moore and H. W. Allison; *The Use of Field Emission in the Study of the Adsorption of Ba on Tungsten* by J. A. Becker; *Arcing at Electrical Contacts on Closure. Part III—Development of the Arc* by L. H. Germer and J. L. Smith.

M. R. McKinnon was at the Patent Office in Washington during October relative to patent matters.

Identifying the calling line for billing purposes is done in the AMA system by circuits which must be installed in each central office. The other features of AMA can be made available by installing the system in a tandem office. In such a case an operator is brought in who asks the calling subscriber's number and keys it into the AMA system. G. V. King recently visited Washington to discuss the applicability of this method to handle calls to suburban points and Baltimore.

Last fall a course in switching was given to graduate students at M.I.T. by A. E. Ritchie. This year the course is being given by Prof. S. H. Caldwell, using as text the book *Design of Switching Circuits* by Keister, Ritchie and Washburn which has just been published by the D. van Nostrand Company in the Laboratories series. John Meszar and Mr. Ritchie were at M.I.T. to get Prof. Caldwell's comments on the course and were gratified to learn that more than 30 were enrolled in it.

W. C. Ball, E. H. Gelson and J. H. Harding spent several days near Baltimore investigating the effect on N1 carrier power supply circuits of low-frequency induction from commercial power feeders.

Newton Monk presented a paper *Public Train Passenger Radio Telephone Service* at the Annual Meeting of the Communications Section, Association of American Railroads, which was held at Quebec.

F. K. Harvey discussed *The Focusing of Sound and Microwaves* at a technical meeting of the Engineers' Club of Dayton, Ohio, October 8, the opening session of the season. Mr. Harvey explained the action of the metallic wave guide lens and delay lens as directional antennas used for beaming the extremely short radio waves over the nation.

A. F. Pomeroy is attending a conference on Electrical Graphical Symbols at Montreaux, Switzerland. This conference is being held under the auspices of the International Electro-Technical Commission, which is now engaged in revising International Electrical Standards. Mr. Pomeroy is co-chairman of the sectional committee on Graphical Symbols of the American Standards Association, and was recently named Industry Liaison Member of the Standard Drawing Practice Committee of the Munitions Board Standards Agency in Washington.

Rifle Club News

At the annual meeting of the Bell Laboratories Rifle Club the following officers were elected for 1952: *Chairman,* R. E. Strebel; *vice-chairman,* A. C. Peterson; *secretary,* D. Westbrook; *small-bore captain,* R. E. Porter; and *big-bore captain,* C. C. Rock. The Rifle Club has again entered the New Jersey Civilian Rifle League and will welcome more shooters. Beginners are also welcome. Practice night is usually Thursday at the Summit Range. Mr. Porter will be glad to answer any further questions on Extension 2397 at Murray Hill.

A. G. Jensen attended the semi-annual convention of the Society of Motion Picture and Television Engineers in Hollywood during October and presented a paper on a continuous projector film scanner for television. Following the convention he gave talks on color television at I.R.E. and A.I.E.E. meetings and to groups of television engineers in Los Angeles, San Francisco, Denver, and Kansas City.

W. E. Kock gave a lecture entitled *The Electrical Production of Music* at the Columbia University Club on November 15. This meeting was the annual smoker of the Engineering School Alumni Association. A demonstration of the electronic organ accompanied the talk.

The current importance of measurements at high frequencies was reflected by three papers presented by Laboratories members at the National Electronics Conference at Chicago. The subjects were *A Sweep Frequency Method of Q Measurement for Single Ended Resonators* by E. D. Reed; *Measurement of the Relationship Between Baseband and Radio-Frequency Amplitude in FM Systems* by J. P. Schafer and L. E. Hunt; *Charts for Coaxial-Line Probe Measurements* by P. H. Smith. Also in the high frequency vein, G. T. Ford and E. J. Walsh presented *High-Transconductance Tubes for Broad-Band Telephone Systems*. M. D. Fagen spoke on *Performance of Ultrasonic Fused-Silica Delay Lines*. In this method, electrical signals are delayed by making them travel in a silica rod in the form of their acoustical equivalents. This technique proves in where delays of more than a few micro-seconds are required.

Engagements

May Lipsey*–Pfc. Murdock H. Merchant*
Mary McDermott*–Joseph P. Kennedy
Barbara Morrison*–Staff Sgt. R. E. Sinclair
Margaret Naughton*–Sidney Christianson
Pamela Scull*–John Standbridge Smith

Weddings

Jeannette Brazinski–Joseph A. Folio*
Bernice Merkle Keith–S. R. King*
Catherine Nealon*–Diego D. DiPieto
Patricia Thomas–Reginald Morse*
Mary Williamson*–Frederick Wibiralske
Edna Wojciechowski–Joseph Pietrucha*

Births

Nancy Deborah, September 8, to Mr. and Mrs. William P. Slichter. Mr. Slichter is a member of the Chemical Laboratories.

Bruce Richard, October 14, to Mr. and Mrs. B. B. Heigh. Mr. Heigh is a member of Switching Systems Development.

*Members of the Laboratories. Notices of engagements, weddings and births should be given to Mrs. Helen McLoughlin, Room 1321, Ext. 296.

"The Telephone Hour"

NBC, Monday Nights, 9:00 p.m.

December 3	Pia Tassinari, *soprano*, and Ferruccio Tagliavini, *tenor*
December 10	Lily Pons, *coloratura soprano*
December 17	Jussi Bjoerling, *tenor*
December 24	Blanche Thebom, *mezzo soprano*
December 31	Robert Casadesus, *pianist*
January 7	Lily Pons, *coloratura soprano*
January 14	Zino Francescatti, *violinist*
January 21	Clifford Curzon, *pianist*
January 28	Ferruccio Tagliavini, *tenor*

At the American Physical Society in Chicago P. W. Anderson spoke on *An Approximate Quantum Theory of the Anti-ferromagnetic Ground State* and B. T. Matthias on *Isotope Effect in* RbD_2PO_4. R. M. Bozorth presented a paper on *Effect of Stress on the Curvature of Domain Boundaries* which was co-authored with H. J. Williams. The New England section of the society which met at Trinity College, Hartford, heard W. H. Brattain on *Physics of the Transistor*.

S. O. Morgan, E. J. Murphy and W. A. Yager attended a meeting of the National Research Council Conference on Electrical Insulation at the Bureau of Standards, Washington, D. C. Mr. Morgan acted as discussion leader.

The photograph on the facing page was directed by N. C. Norman of Quality Assurance, using a professional studio and model. It was syndicated by A T & T to all Bell System magazines.

The photograph in the advertisement on the back cover was posed in a West Street class room of the School for Communications Development Training. Left to right, O. H. Williford, M. M. Hower, L. Zarins, C. L. Beckham and W. R. Rupp. Mr. Beckham who joined the school in 1948 now assists H. F. Dodge as an instructor in probability and statistics.