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Radio
Projects
Engineering

TERMINALS FOR THE NEW YORK-BOSTON RADIO RELAY SYSTEM

At each repeater station of the radio-relay system now operating between New York and Boston, equipment is provided which converts received microwave signals to an intermediate frequency of 65 megacycles, amplifies them, and then translates them back to the microwave range for transmission over the next link. At the two ends of the system, in New York and Boston, similar equipment is used to convert between the microwave and the intermediate frequencies, and to provide the necessary amplification. In addition, facilities are required at the terminals for accepting the signals to be transmitted, which may consist of television, multiplex telephone, or other broadband signals, and producing a modulated intermediate frequency wave to be impressed on the microwave transmitting equipment. Facilities are also required for detecting and distributing the signals at the receiving end of the circuit. This terminal equipment for the two relay channels, together with the necessary monitoring and testing facilities, is contained in three bays, as shown in Figure 1.

At each input point of the terminal, provision is made for connecting to either 75-ohm unbalanced or 110-ohm balanced video lines. Repeating coils are used where signals are accepted from balanced lines. Video or multiplex telephone signals are impressed on the transmitting video amplifier, which is adjusted to deliver signals of proper amplitude and polarity to the frequency-modulated oscillator. Here the frequency-modulation process takes place and automatic frequency control is provided.

Because of the nature of television signals, it is advantageous to regulate the frequency of the modulated oscillator to a fixed value at those periods corresponding to the tips of the synchronizing pulses, and to maintain this regulation regardless of the picture content of the television signals. To this end, the transmitting video amplifier contains circuits that abstract from the input wave a train of synchronizing pulses completely stripped of picture signals. These pulses are used to "gate" an automatic frequency-control circuit which consequently samples the transmitter fre-

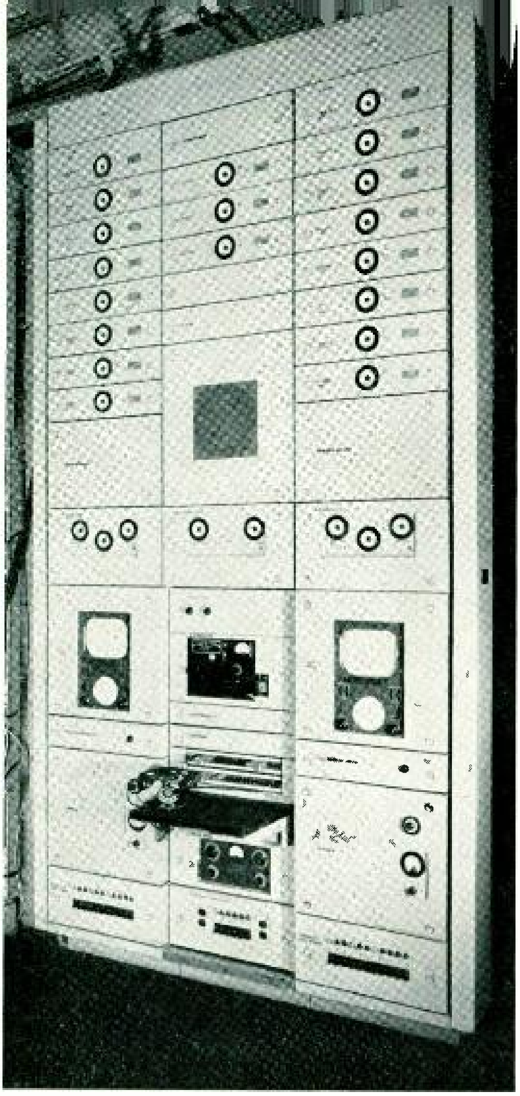

Fig. 1—Complete two-channel terminal bays for the radio relay system now operating between Boston and New York

quency only at the tips of the synchronizing pulses and holds it at a predetermined value.

When the input to the system consists of a block of telephone circuits, for example, the signal from a standard L1 carrier terminal, the circuits peculiar to television transmission such as the gating circuits are disabled, and the automatic frequency control is adjusted to control the average or mean frequency of the frequency-modulated wave.

Manual frequency control is also provided for the initial line-up, as indicated at the upper right of Figure 2, which is a functional block diagram of a complete terminal except for audio monitoring and order-wire facilities. The FM oscillator-amplifier finally delivers its output to the microwave transmitter at a level of 80 milliwatts. In addition, it provides an input for an auxiliary receiving system used for frequency monitoring.

At the receiving end of the circuit, the incoming wave is delivered to the terminal with its carrier frequency reduced to 65 megacycles. Here it is first passed through an amplitude limiter and then impressed on a discriminator-detector which recovers the original signal. After amplification, this signal is then delivered, either to the telephone multiplex terminal equipment or to the local television network.

To permit the operator to check the quality of the picture signal at various points within the terminal during a television transmission, a "picture monitor" displays the picture as it would appear in the ordinary home television receiver. This unit can be connected so as to display the transmitted picture as it exists at the point of application to the frequency-modulated oscillator, or the received picture as it is delivered to the local television network. In addition, the monitor can be connected to a point in the microwave equipment, where a special microwave discriminator and detector are located.

The picture monitoring unit is also equipped with an auxiliary oscilloscope which displays the television signal as it would be seen with the type of cathode-ray oscilloscope commonly used for laboratory testing. This oscilloscope can be made to display single lines of the picture (Figure 3) or entire frames. It is used primarily for observing and measuring the instantaneous frequency of the FM oscillator during normal operation. Energy derived from the transmitting oscillator is applied to the input of one amplifier of an electronic switch—a pair of 65-megacycle amplifiers connected in parallel and so arranged that they are alternately energized for equal periods of time by a multi-vibrator circuit—while the second amplifier is driven by an adjustable-frequency oscillator. The composite output of the electronic switch is then impressed on the monitoring FM receiver. Since the output of the monitoring receiver is proportional to fre-

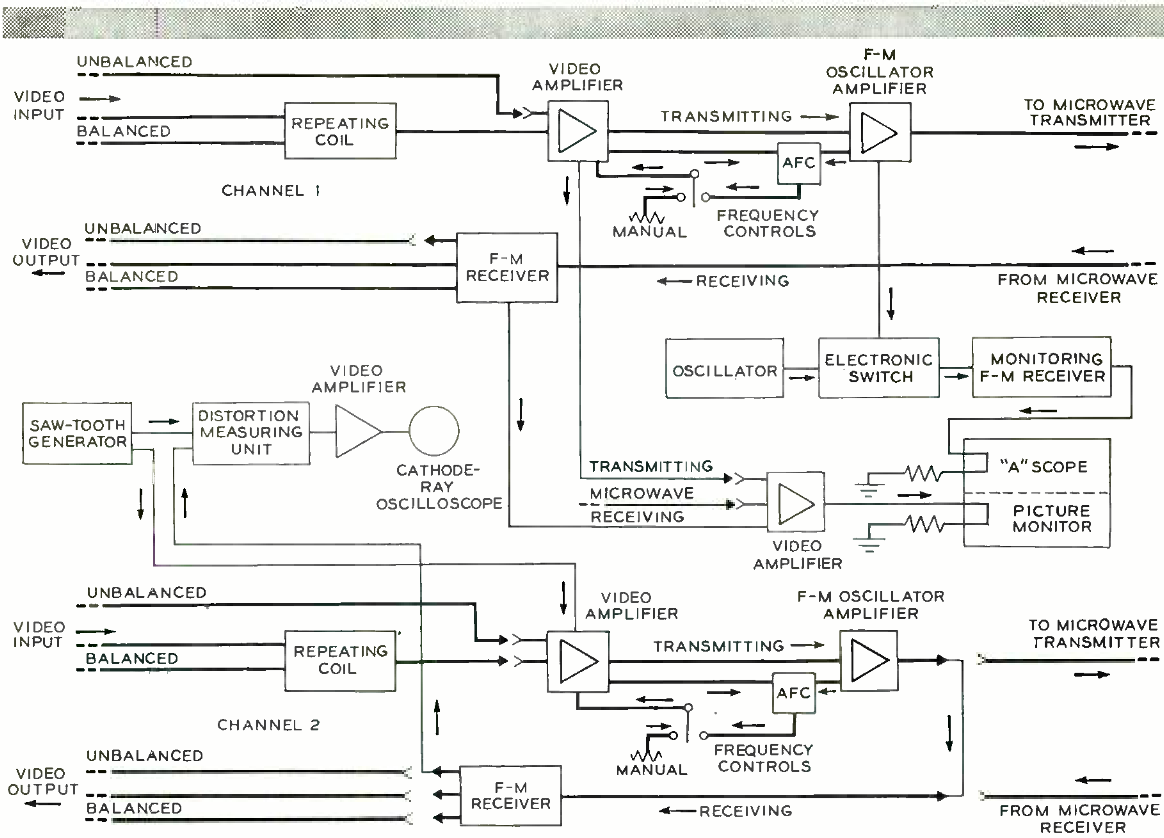

Fig. 2—Block schematic of terminal, including monitoring and distortion measuring circuits

quency, direct comparison of the frequencies of the two oscillators can be made on the screen of the oscilloscope of the picture monitoring set. In practice, the two traces representing the individual outputs of the two amplifiers in the electronic switch are made to appear superimposed upon the screen, one trace including the wave form of the modulation taking place in the transmitting oscillator, and the other a horizontal line which moves up or down as the frequency of the adjustable oscillator is raised or lowered, as indicated in Figure 3. In this way, the frequency excursions of the transmitted wave can be accurately adjusted within the proper limits. These observations can be made continuously without interrupting normal service.

Over-all distortion measurements are made by setting up a local loop consisting of a complete transmitter and receiver, im-

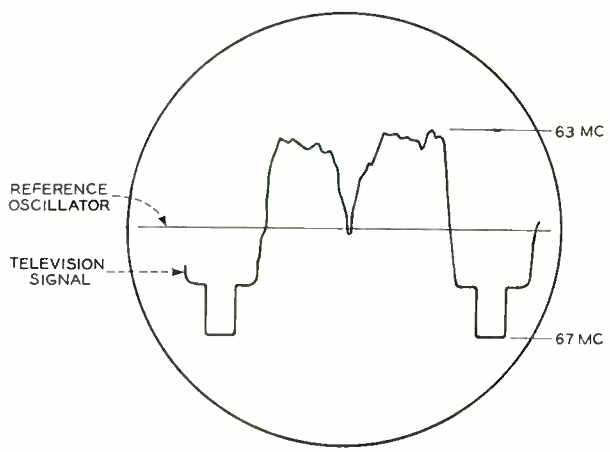

Fig. 3—Typical appearance of front of picture monitor tube while monitoring the frequency on a channel. The oscilloscope can be made to display single lines of the picture or entire frames

pressing a saw-tooth wave upon the transmitter, and comparing the wave delivered by the receiver with the original input wave. The comparison in the distortion measuring unit is made by impressing the input of the transmitter and the output of the receiver on the grid and cathode, respectively, of an amplifier tube. The output of this tube will be proportional to the difference between the two waves, and hence it is a true measure of distortion. Since all the receivers have stable and very similar distortion characteristics, it is assumed that a transmitter adjusted for minimum distortion with a local receiver will operate satisfactorily with the receiver at the other end of the circuit.

In Figure 2, the monitoring circuit is shown connected to monitor the incoming signal on Channel 1. The equipment associated with Channel 2, on the other hand, is shown connected for the local distortion test. Here the output of the transmitter is connected directly to the receiver. The source of saw-tooth waves feeds both the transmitter and one input of the distortion measuring unit. The second input of this device is derived from the FM receiver. The output of the distortion unit, which represents the difference between the input and output saw-tooth waves, is amplified and viewed by means of an external cathode-ray oscilloscope, which is used solely for test purposes.

Channel 2 equipment is, of course, normally set up as shown for Channel 1, and serves as a second or stand-by circuit. The electronic switch and its associated equipment used for frequency monitoring, as well as the distortion measuring apparatus, can be connected to either channel at the discretion of the operator.

THE AUTHOR: J. G. CHAFFEE has been a member of the Research Department since his graduation from the Massachusetts Institute of Technology in 1923, when he received the degree of S.B. At first he was with a group engaged in the early investigation of short-wave radio transmission and reception problems, and until 1930 was concerned largely with the development of receiving and field-strength measuring and recording equipment. After participating in the design and installation of the experimental ship-to-shore telephone equipment aboard the U.S.S. *Leviathan*, he became engaged in the investigation of radio problems at ultra-high frequencies, including an extensive study of frequency modulation. During World War II he worked on radar equipment and since then has been concerned with the development of terminal equipment for the New York-Boston radio relay system.

J. W. EMLING
Transmission
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TRANSMISSION FEATURES OF THE M1 CARRIER SYSTEM

Although carrier current transmission has been employed by the Bell System for many years, the development of the M1 carrier system for use on rural power distribution lines presented numerous problems not previously encountered. These were introduced by the transmission characteristics of the power line, the physical layouts of rural power distribution systems, and the necessity of using high-voltage lines carrying heavy currents.

Rural power lines usually consist of one or more phase wires operating at about 7,000 volts above ground, and a neutral, or return wire, which is grounded at frequent intervals. The spacing between these grounds is not over 2,000 feet and frequently the grounds occur at every pole, from 300 to 500 feet apart. On a single-phase line, the carrier terminals are connected through suitable coupling equipment to the phase and neutral wires, and it might be expected that the carrier currents would be confined to the metallic conductors. Tests have shown, however, that of the current supplied to the phase wire only 15 to 35 per cent returns through the neutral wire, the remainder returning through the earth. Thus these lines have some of the characteristics of a ground-return circuit, a type of line which the Bell System abandoned many years ago for voice transmission.

One result of using a grounded line is that the attentuation is considerably affected by the earth constants. This is illustrated in Figure 1, which shows the attenuation of single phase lines obtained at locations with various earth resistivities. Other factors, such as the type and size of conductor, the resistance of the ground connections, and the spacing of the neutral grounds also affect attenuation.

Another disadvantage of this type of line is that it behaves as a wave antenna. Carrier currents impressed on the line radiate electromagnetic waves that may interfere with radio reception, and similarly waves such as radio signals or static will be picked up by the line and may interfere with the carrier signals. Thus the possibility of interference from and with radio communication was an important consideration in selecting the frequency band to be used, and the avoidance of broadcast interference was one of the reasons for establishing the upper limit of 450 kc. Frequencies below 450 kc are, of course, used for radio

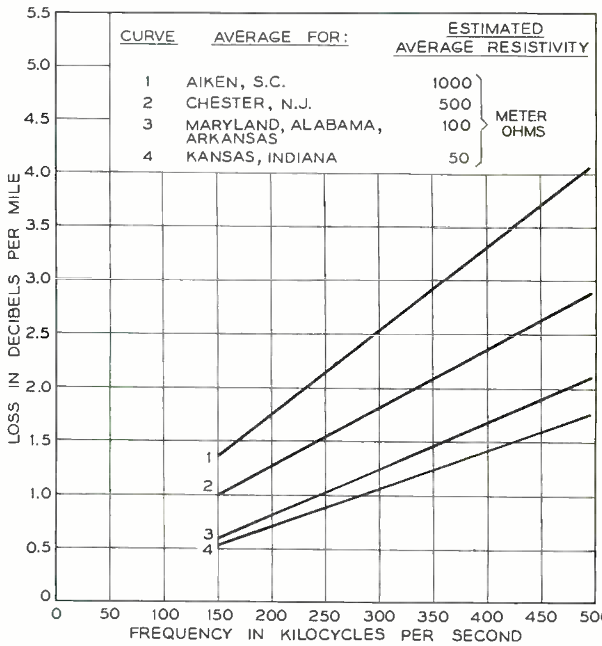

Fig. 1—Loss in db per mile against frequency for power lines at various locations

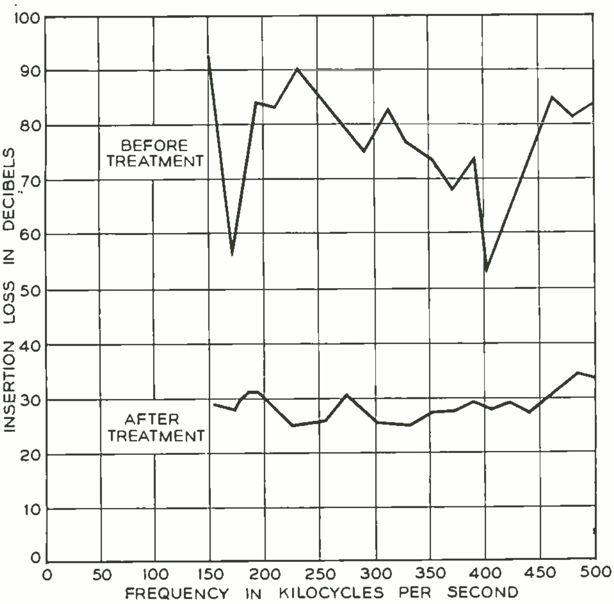

Fig. 2—Insertion loss in db plotted against frequency for a 14-mile power line before and after the line has been treated for use with an M1 system

transmission, primarily for air navigation aids which operate between 200 and 400 kc. The frequencies used for the M1 system, however, have been chosen to avoid interference at some of the more common radio frequencies, but the radio spectrum is so crowded that it is not practicable to eliminate all interference in this manner, since to do so would seriously reduce the number of available carrier channels. At any given location, however, the nearby stations usually employ only a limited number of frequencies, and interference from such stations can be avoided by using only those carrier channels remote from these frequencies. The particular channels which can be used will, of course, vary from location to location.

Atmospheric static, picked up by the antenna action of the line, has proved to be the limiting source of noise. Defective line equipment, such as cracked insulators or loose hardware, causes noise at carrier frequencies, but on a well-maintained line the

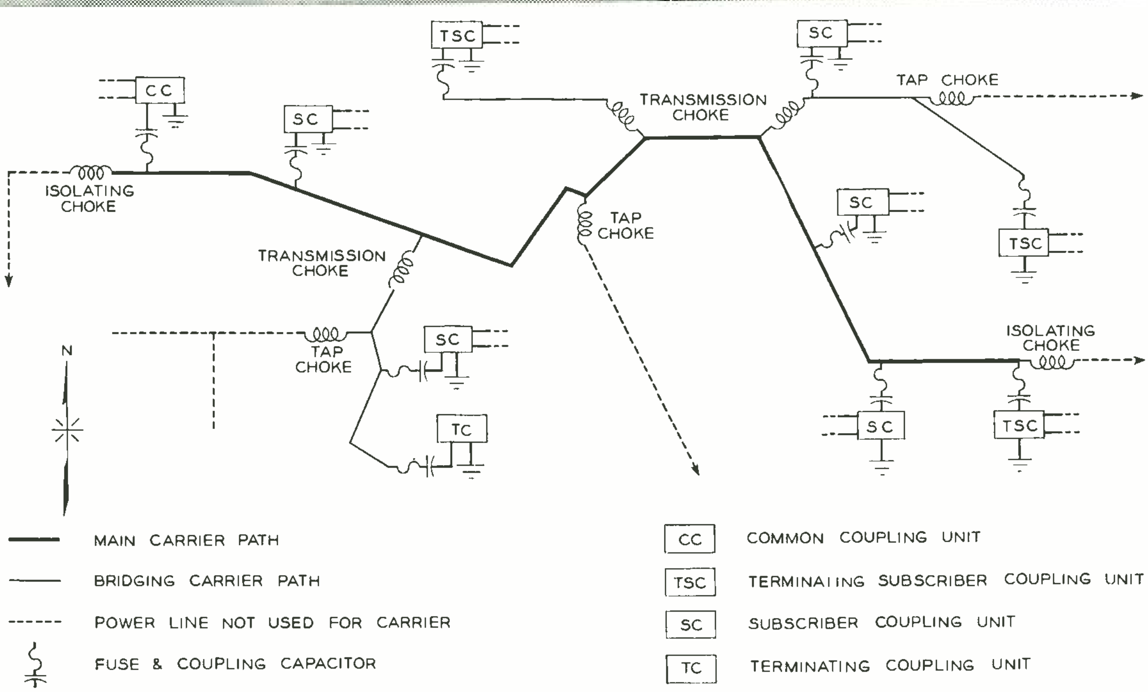

Fig. 3—A typical arrangement of an M1 carrier system showing the locations of chokes and coupling units of the various types

noise from power line sources is unimportant on a system designed to work in the presence of atmospheric static.

A power distribution system is usually a complicated network and is unsuitable for the transmission of carrier frequencies without some modification because of the effects of the many branch lines and taps, which may cause bridging losses. These taps are essentially open circuited at their distant end, since power transformers, which provide the only termination, are of high impedance at carrier frequencies. The impedance of such a tap will be close to zero at a quarter wavelength (or an odd multiple of a quarter wavelength) from its unterminated end. At carrier frequencies, wavelengths are short: about 2,000 feet at 450 kc. At some frequencies, unterminated taps as short as 500 feet can, therefore, effectively short circuit the line on which they are bridged.

Ordinarily, only a portion of a power network will be used for carrier transmission. The first step in modifying this network is to isolate all unused portions from the carrier section by inserting a carrier frequency choke coil in the phase wire of each unused portion of the line at the point where it joins the carrier section. The next step is to terminate all portions of the carrier section in their characteristic impedance (about 500 to 600 ohms). This termination, accomplished by some form of coupling unit, reduces impedance irregularities due to reflection.

After these modifications, the carrier section usually consists of a main section of line, to which the majority of subscribers is connected, with a number of bridged taps supplying subscribers at a distance from the main line. Even though these taps are terminated, they would, if numerous, cause excessive loss to transmission along the main line, since each one introduces a bridging loss of about 3.5 db. They also would cause an appreciable impedance irregularity. These effects are reduced by inserting a small choke in the phase wire of the tap at the junction point. These chokes, called transmission chokes, reduce the bridging loss but also introduce loss in transmission to the tap. Their inductance has been selected as a compromise between loss to the tap and bridging loss on the main line. The importance of properly modifying a power line for carrier transmission is illustrated in Figure 2, which shows the over-all loss of a 14-mile line with and without modifications.

A fully modified power line is illustrated in Figure 3. In addition to the chokes just described, the carrier equipment includes various coupling units connected to the line through high-voltage capacitors. At one end, a common coupling unit connects the

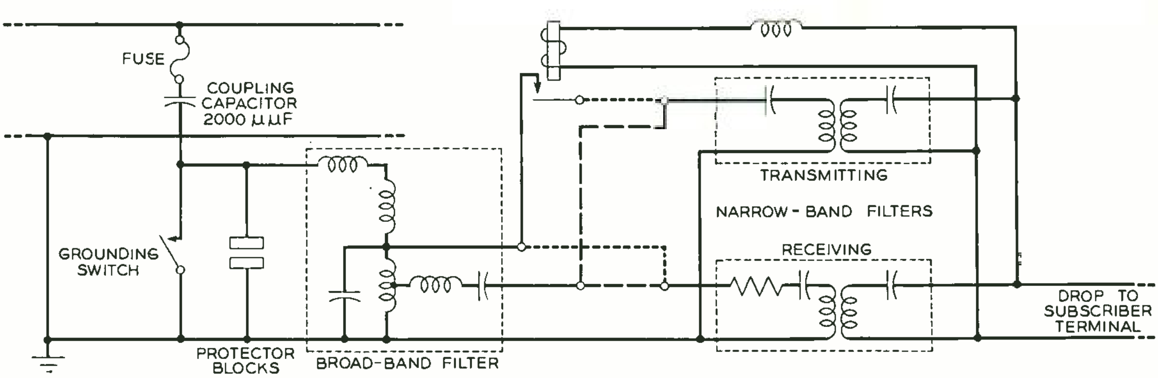

Fig. 4—Schematic of a subscriber coupling unit. Dashed wiring is used when the loss between the subscriber and the common terminal is very low and the dotted wiring for other conditions

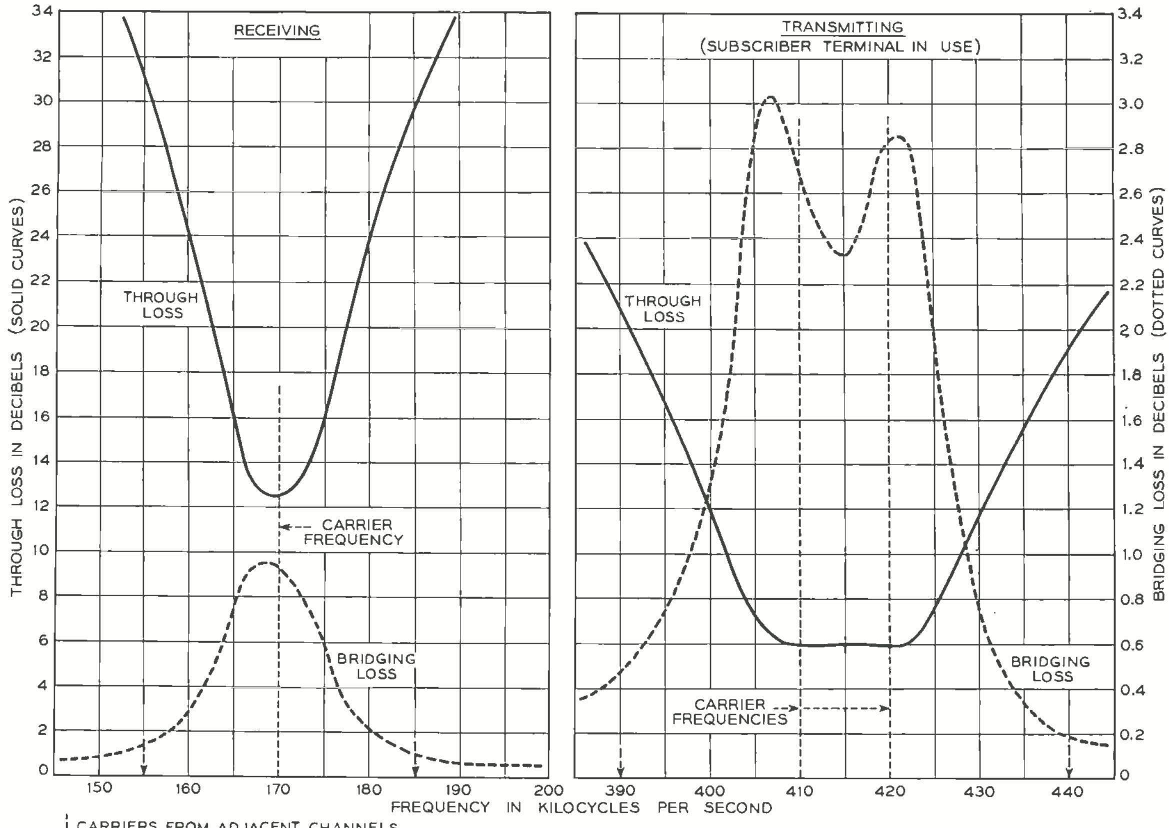

Fig. 5—Through loss and bridging loss plotted against frequency for a subscriber coupling unit when receiving and transmitting

line to a common carrier terminal. This coupling unit, together with the capacitor, is essentially a broadband filter, which acts as an impedance transforming network for matching the 100-ohm terminal to the power line. Only one unit is required regardless of the number of channels in the system, and it provides a suitable termination for the line as well as a connection between line and terminal.

At the other end of the line and at the ends of all transmission taps, terminations are provided either by a terminating coupling unit or by a terminating subscriber coupling unit. The former unit is used when no subscriber is located at the end of the line (or tap), and is the same as a common coupling unit with 100 ohms on the drop side to provide the proper termination. The terminating subscriber coupling unit is essentially a combination of the terminating unit with additional filters for connecting a subscriber terminal to the line as in the subscriber coupling unit.

The subscriber coupling unit, shown schematically in Figure 4, is used to connect a subscriber terminal to the line at any point on the carrier section except at its ends. It consists of a broadband, impedance-transforming filter which feeds into two filters in parallel, one of which passes only the transmitting frequencies and the other the receiving frequency. It is bridged on the line at all times and causes a bridging loss to transmission beyond the unit. The transmitting and receiving filters have, therefore, been designed to have a very high impedance outside their pass band so that bridging losses will be negligible except at the frequencies accepted. At the receiving frequencies, the bridging loss has been kept down to about 0.8 db by building the filter with a high input impedance. This causes a large loss to transmission through the filter but this is permissible since this loss does not affect the signal-to-noise ratio. Loss through the transmitting filter does affect signal-to-noise ratio and has been kept small. Consequently the bridging loss is large (3.0 db) at transmitting frequencies, and a relay has been provided to disconnect this filter from the line except when the terminal is in use. Characteristics for these coupling units, loss plotted against frequency for a subscriber coupling unit when receiving and transmitting, are shown in Figure 5.

Although the M1 carrier system was designed primarily for use on power lines, it can also be used on open-wire telephone lines. Under these conditions, metallic transmission over balanced pairs is employed, and consequently transmission is independent of the earth characteristics, and interference from static and radio stations is greatly reduced. The line equipment, consisting of chokes, capacitors, and coupling units is similar to that used with power lines except that it is balanced to ground. The chokes and capacitors are much smaller, of course, since they do not need to withstand the large power line currents and voltages.

The attenuation of copper or copper-steel telephone pairs at M1 frequencies is less than 1 db per mile. The attenuation of steel wire, however, may be as much as 5 to 7 db per mile, and thus steel conductors cannot be used except in short lengths as extensions or taps on the main carrier line. In most cases no re-arrangement of the line transposition will be required so long as only one carrier system is operated over the line.

THE AUTHOR: J. W. EMLING received the B.S. degree in Electrical Engineering from the Univercity of Pennsylvania in 1925 and joined the D & R of the American Telephone and Telegraph Company to work on exchange area transmission problems. He was particularly concerned with transmission standards and with developing a system of effective transmission rating. Coming to the Laboratories in 1934, he continued similar work until the war, when he undertook developments in the field of underwater acoustics. Since then he has been engaged in transmission and field engineering, including work on the M1 carrier system. At the present time, he is working on toll transmission systems.

TELETYPE REPERFORATOR TRANSMITTER FOR AUTOMATIC SWITCHING SYSTEMS

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Teletype
Corporation
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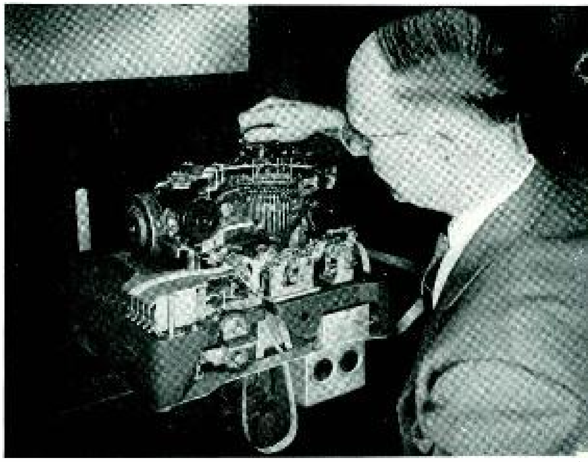
A novel and highly useful combination of typing, perforating, and transmitting features has been incorporated in the 14D reperforator transmitter unit developed by Teletype Corporation in coöperation with Bell Telephone Laboratories for use in the automatic relaying of printing telegraph messages.* By far the most outstanding feature of this unit is a pivoted transmitter which provides for the first time fully automatic mechanical apparatus that can retransmit every character of any message, including the last character, as soon as it has been perforated in the tape. This simplifies the problem of providing fully automatic relaying of telegraphic messages using a continuous tape, and promises to expand greatly the scope of high-speed, reliable, automatic-switching services for which there is a rapidly growing demand by large users of teletypewriter services.

To secure fully automatic switching and relaying of messages, it was highly desirable to improve the efficiency of the systems and to provide equipment designed particularly for this class of service. With earlier switching systems, undesirable delays and loss of useful line time were experienced. This was due mainly to manual handling of short message tapes, and the use of non-message perforations in the tape to make the first and last characters of a message available for retransmission. The new teletype unit was designed to provide in one compact structure the essential functional features of a group of units previously required. The resulting unit occupies about as much table space as one teletypewriter and makes possible greatly increased efficiency. A pivoted transmitter which is incorporated in the unit can move along the tape to read the last character perforated or can pivot away from the punch unit and permit a long message tape to accumulate, thus making the use of non-message perforations in the tape unnecessary. Increased flexibility was



T. L. Corwin checking one of the 14D reperforat[…] transmitters at the Laboratories

secured by providing separate independently controlled clutch operation of the transmitting and perforating features. This permits immediate relaying of a message or storage of a message in tape form until the desired outgoing line is available. The speed of the outgoing message may be faster, slower, or the same as the incoming message. A single character mechanical storage feature and a series of code-reading contacts associated with each of the five code elements were also provided. These features make it possible to route a message to any one of a number of circuits. It is obvious therefore that this reperforator transmitter should prove very valuable in the field of automatic switching and relaying teletypewriter messages.

The reperforator transmitter combines the operating features of a tape printer, a

*Record, *January*, 1948, *page* 20.

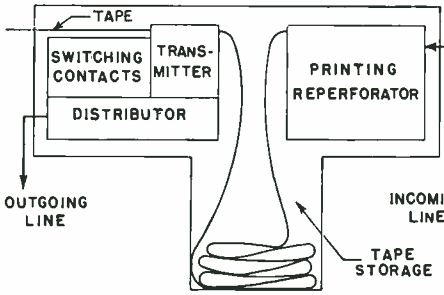


Fig. 1—Block diagram of reperforator-transmitter with associated tape storage feature

tape reperforator, and a transmitter distributor in a single unit only slightly larger than the conventional typing reperforator. This is shown schematically in Figure 1. In this combination a single receiver mechanism is used to control both the printing and perforating operations, while the code perforations in the tape are read by five feeler pins, and the corresponding electrical pulse pattern is transmitted to the signal line by a cam controlled contact assembly. Except for the new pivoted tape sensing feature and its automatic controls, the principles employed are essentially those commonly used in other teletype apparatus. The set itself is primarily a receiving tape printer set designed to provide additional facilities required for reperforating and transmitting messages concurrently with their reception.

Printing and perforating are controlled by a group of five code bars, each of which may be set in either of two positions as determined by a single-magnet receiving mechanism acting in response to the incoming message pulses. The setting of these code bars determines the character that will be printed and, by an appropriate system of levers,* the code holes that will be perforated in the tape. The printing of the character and the perforating of the holes are accomplished in a timed relation to each other by separate cams on the main shaft of the printing mechanism. To make the printing more legible, the punches for the code holes do not completely sever the punching from the tape—producing what is called chadless tape. The feed hole is punched in the tape at

*Record, *April*, 1942, *page* 209.

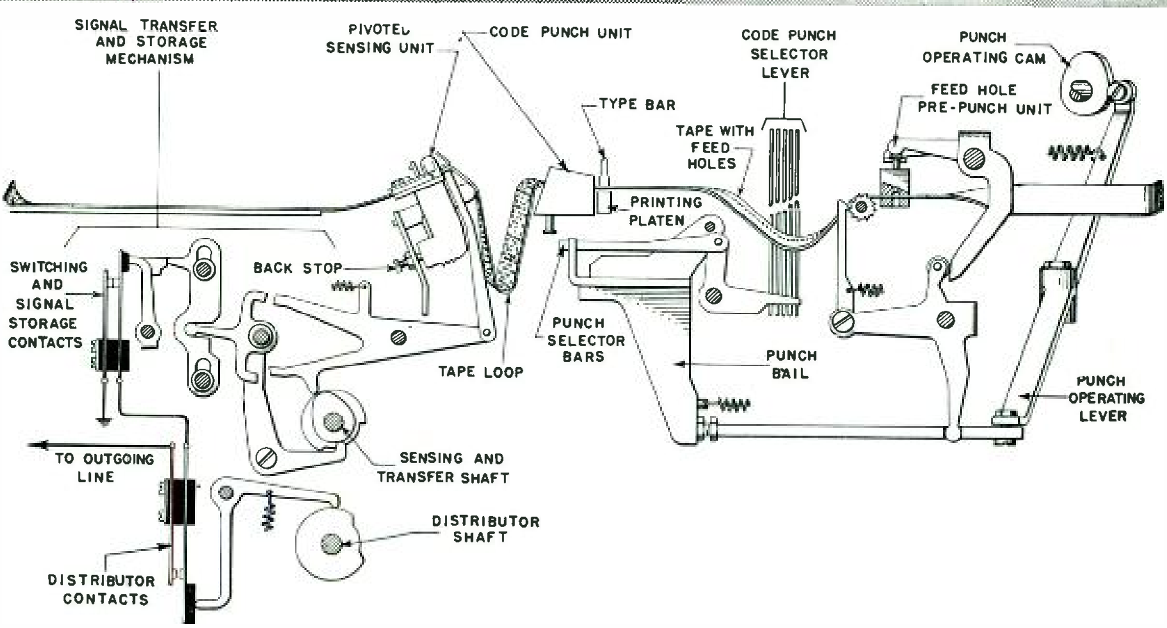


Fig. 2—Operating features of reperforator-transmitter—schematic arrangement

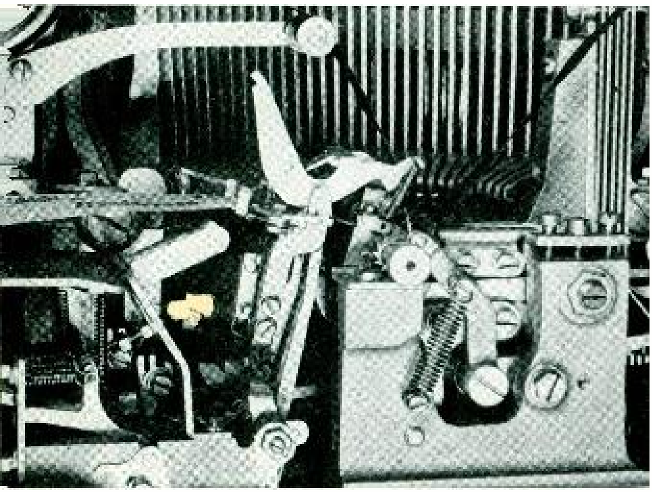


Fig. 3—Here the pivoted arm has moved almost to the reperforator. In the photograph on page 106 of this article it is way back and a loop of tape has accumulated

a pre-punch unit—both punching units operating simultaneously in each operating cycle. Accurate 0.1-in. spacing between perforations is adjustably controlled at the pre-punch unit.

Pre-punching of the feed hole in the tape is necessary because the last combination perforated in the tape may be read for retransmission at a point 0.1 in. from the code perforation point. The tape must, therefore, be pushed past the code perforating point by a feed roll which is a part of the code punch block. This is done during the last part of the perforating cycle so that the last combination perforated in the tape is advanced to a point at which it can be retransmitted. The typewritten character is printed on the tape just before the time that the tape enters the code punch block.

The pivoted portion of the tape transmitter is mounted so it can move toward or away from the code punch unit (Figures 2, 4 and 5) and at the same time maintain an uninterrupted retransmission of the message as it is being recorded. Since the last combination in the tape can be read 0.1 in. from the point at which it was punched, the reading of the tape has been arranged to follow the feeding portion of the cycle so as to avoid tearing the tape after the last combination has been transmitted.

Pivoted feeding levers, mounted in the pivoted frame that carries the sensing pins, feed the tape through the transmitter. If there is a loop of tape between the transmitter and the code punch block, the tape will be pulled through the transmitter. If there is no loop, the pivoted mechanism will be pulled along the tape toward the punch block. The mass has, therefore, been kept at a minimum, and a smoothly graduated acceleration of the feeding motion has been provided by careful design of the feeding cams. The tape feeding levers and sensing pins are pivotally attached to

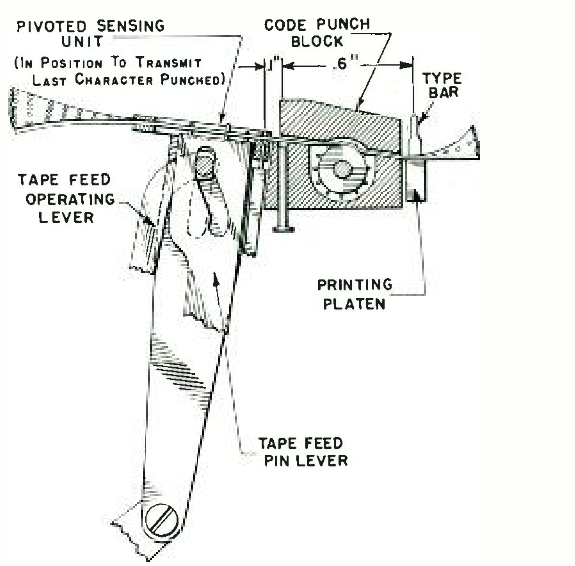


Fig. 4—Relative arrangement of printing, perforating, and transmitting features of the 14D reperforator-transmitter unit. The operating positions of the feeding mechanism are shown in Figure 5

cam follower levers so that their pivoting points are approximately in line with the pivoting point of the frame. Cams and cam follower levers move the feeding levers up and down. This motion, combined with a lateral motion secured by a cam-shaped slot in the lever that engages the tape, causes the tape feed pins to move in essentially a rectangular path. The corners of this rectangle represent the four fundamental operating positions of the tape-feeding mechanism, and are shown in Figure 5.

In the normal rest position, the feed pins are engaged in the tape, and the tape sensing pins have been withdrawn. At the beginning of a new transmitting cycle, the tape feed pins move the tape 0.1 in. to the left, thereby presenting a new set of code holes to be read by the sensing pins. While these pins are engaged with the tape, the tape feed pins are withdrawn from the tape and returned to the initial position ready to advance the tape again as soon as the sensing pins have been withdrawn from the tape. During the time the feed pins are out of engagement with the tape, the tape is held in place by a operate with external relays to perform desired message switching features.

Each of these groups includes a pair of contacts that are closed if the corresponding sensing pin enters a hole in the tape. This prepares a circuit which is completed by the closure of a corresponding contact in the transmitter. These transmitter contacts are controlled by cams which permit them to close sequentially in an accurately timed relation to each other in each transmitting cycle. Current and no-current pulses in the transmitter code combination are determined by the setting of the contacts associated with the storage slide bars.

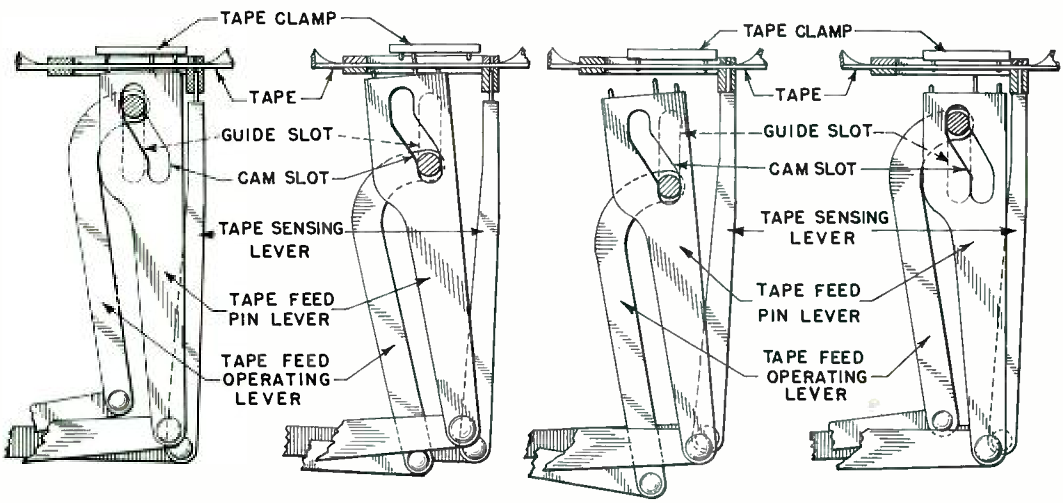


Fig. 5—Pivoted sensing unit showing the four operating positions of the tape feeding mechanism

A—Normal rest position. Tape Feed Pin engages tape.

B—Tape has advanced. Sensing Pins start up.

C—Sensing Pins up. Tape Feed Lever withdrawn.

D—Tape Feed Lever reset for next feeding step. Sensing Pins start down.

tape clamp. The cam follower levers, to which the tape sensing pins are attached as shown in detail in Figure 5, assume positions according to the code combination being read by the sensing pins. Immediately after these levers have been positioned, the code combination is transferred to five slide bars of a single-character mechanical storage mechanism by means of a simple cam-driven bail action. Each slide bar controls a group of contacts which co-

The operating cam assembly, which controls the tape-feeding levers, sensing pins, and signal transfer mechanism, and the transmitting cam assembly, which controls the transmitting contacts, are each mounted on individual shafts and are driven by magnet-operated clutches. The clutch of the operating cam is normally under the control of a contact which is always closed except when the pivoted unit is adjacent to the code punch block. Its transmitting

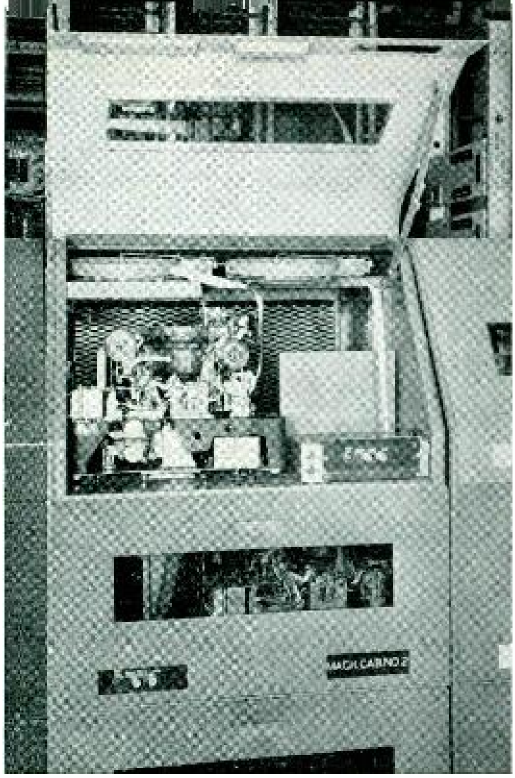


Fig. 6—As arranged in the Cleveland office of the Republic Steel, two reperforator-transmitters are installed in a single cabinet—one above the other

cam clutch is normally under the control of a contact which is closed at a predetermined time in the operating cycle by the operating cam assembly. If desired, the operating cam clutch can be suppressed, and the transmitter cam clutch can be operated from an external source. In this way a message can be originated at a remote point and transmitted to the line over the local transmitter. It is interesting to note that while this is taking place, an incoming message can still be received and stored in a loop of tape for future use.

It is obvious from the foregoing description that this reperforator transmitter makes possible greatly increased operating efficiencies and flexibility. Its ready response to remote and local control, and its fully automatic operation make it adaptable for use in a wide variety of tape message switching and relaying systems. Therefore, it readily meets the need for which it was developed; that is, to expand the scope of high-speed, reliable automatic teletypewriter message switching services.

THE AUTHOR: Ross A. Lake received his Bachelor of Science degree in Electrical Engineering at Purdue University in 1921, and joined Western Electric Company that spring. After three years he returned to Purdue for graduate work in Administrative Engineering. On receiving a Master of Science degree in Electrical Engineering in 1925, he spent two years in electrical contracting work and inspection methods before joining Teletype Corporation in 1927. For the last twenty years he has been connected with the Teletype Development and Research Organization and has been granted twenty-four patents on teletype apparatus and related mechanisms. He has been closely associated with the development of many of the teletype apparatus units familiar in the Bell System, including the 15 and 19 type sets, the 14 type typing reperforator, and the 14 type reperforator transmitter. He is now associated with the Teletype New Apparatus Development Program.

SUPERMALLOY

Permeability to a magnetic circuit is like conductivity to an electrical circuit, but instead of being constant for a given material, it varies with the applied field. In ordinary silicon steel, it ranges from an initial value of perhaps 500 to a maximum value of about 10,000. Where large currents are available to provide the high field strengths needed to operate the magnetic material over its region of maximum permeability, as in most power generating and transforming apparatus, the values of permeability obtainable are very satisfactory, although ways of securing higher values are the subject of continuing research. Where only very small currents and thus very low field strengths are available, however, it is the initial permeability that is of particular concern, and the low initial permeability of iron and silicon steel proves very disadvantageous in many applications.

Since telephone and communication circuits in general employ very small currents, high initial permeability has been a major objective in the communication industry, and in these Laboratories research into methods of securing it has been carried on continuously for nearly half a century. Step by step, the initial permeability has been increased. For Permalloy, it was about ten times that of iron; air-quenched Permalloy raised it to over fifty times; while molybdenum Permalloy brought it to 100 times. These were all spectacular improvements. Research culminating during the early years of the war, however, resulted in a greatly improved molybdenum Permalloy called Supermalloy (su-perm'-alloy), which has an initial permeability 500 times that of iron—far surpassing anything ever hoped for before. The progress from iron to Supermalloy is shown graphically in Figure 1.

The characteristics of Supermalloy are shown in the accompanying graphs, together with those of iron and of molybdenum Permalloy for comparison. Characteristics described have been obtained on samples made on a laboratory basis, since Supermalloy is not yet made commercially. B-H curves are given in Figure 2, with the characteristics below a field strength of 0.1 oersted, shown in the inset diagram. Saturation of Supermalloy occurs at about 8,000 gausses, slightly lower than that of molybdenum Permalloy, but for all values of induction up to about 7,000 gausses, the permeability of Supermalloy is higher. The relative values of permeability are shown in Figure 3, where permeability is plotted against induction in gausses. From these curves, it will be noticed that the maximum permeability of Supermalloy is about 1,000,000 as against 80,000 for molybdenum Permalloy. In general, high initial and high

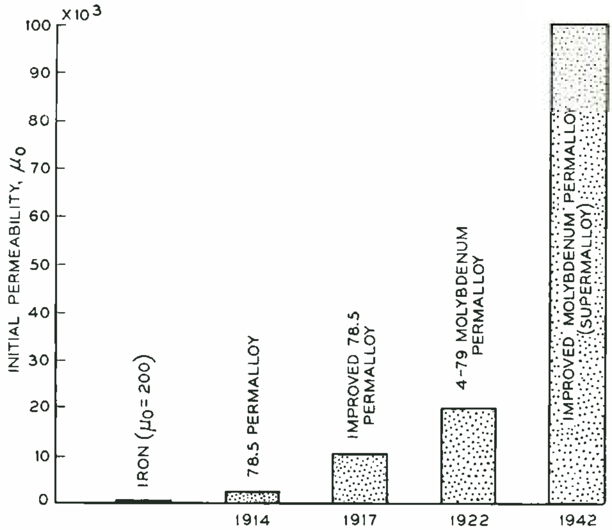


Fig. 1—Steps in the search for high initial permeability

maximum permeability require somewhat different heat treatments. Maximum permeabilities as high as 1,500,000 and initial permeabilities as high as 170,000 have been obtained for Supermalloy by properly selecting the heat treatment. Since in communication apparatus the induction is usually well below 100 gausses, however, the range of characteristics of importance is that applying to low values of field strength.

Besides its radically improved permeability, the hysteresis loss of Supermalloy is also better than that of molybdenum Permalloy, as shown in Figure 4.

All of these graphs show the characteristics for 0.014-inch uninsulated tape. The characteristics of cores made of thinner tapes insulated with magnesia are not quite

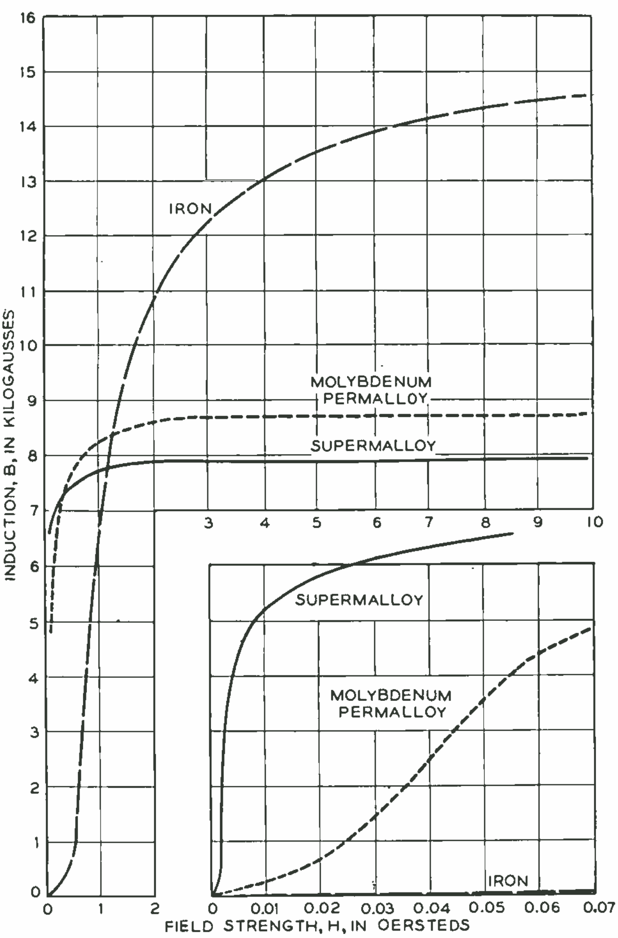


Fig. 2—B-H curves for iron, molybdenum Permalloy, and Supermalloy. Inset graph shows values for very low field strengths

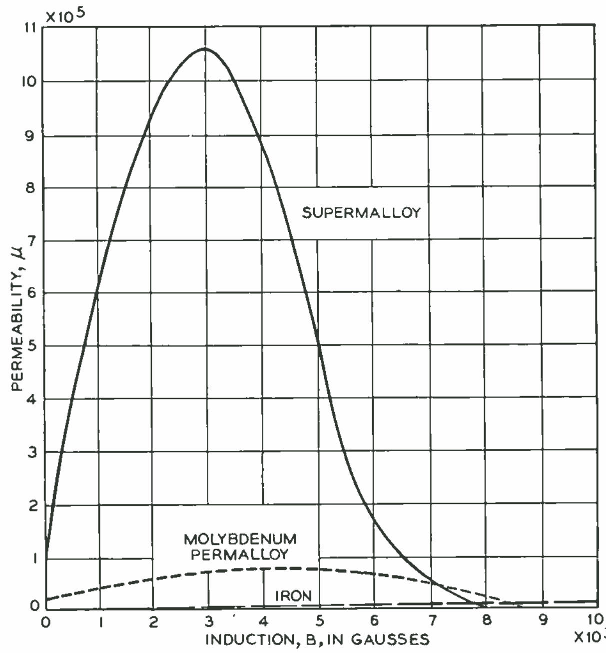
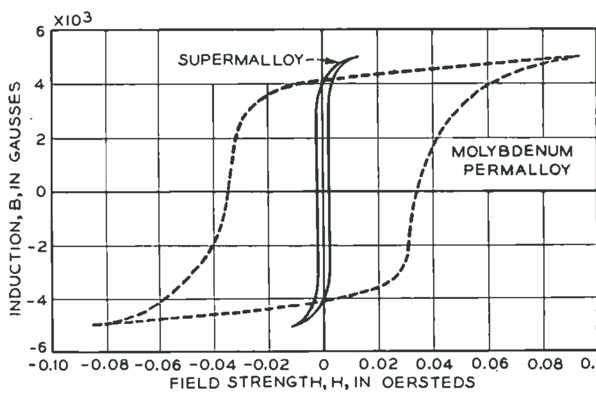


Fig. 3—Permeability of iron, molybdenum Permalloy, and Supermalloy are here plotted against induction in gausses

Fig. 4 (right)—Hysteresis loops for molybdenum Permalloy and Supermalloy



so good. Ordinary molybdenum Permalloy also has poorer characteristics when in the form of thin insulated tapes. The initial permeability is only slightly affected by tape thickness; it is primarily the maximum permeability that is lower in thinner tapes.

One of the advantages of materials of very high initial permeability in communication work is that transformers designed for wider frequency ranges may be made from them. The frequency band that a transformer will pass depends on the ratio of the mutual flux to the leakage flux, and this becomes higher, the higher the permeability. During the war, the availability of Supermalloy permitted transformers for radar apparatus to be made to pass a frequency band three times wider than had been possible with the best previous materials. It is thus for circuits requiring a very wide frequency band—coaxial-cable and radio-relay circuits as well as those for radar and television—that Supermalloy should prove particularly valuable.

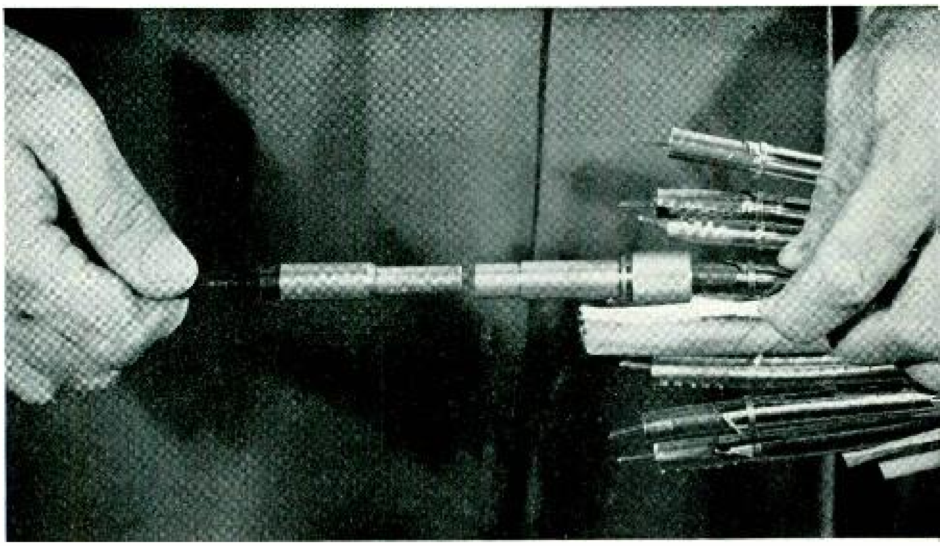
EMERGENCY CORD FOR COAXIAL CABLE

Coaxial cables carry large packages of telephone conversations. They are extraordinarily reliable and yet they may fail. It is important that the interruption of such a multichannel circuit be kept as short as possible. Cable repair facilities are therefore being supplemented with a light, single coaxial cord developed by the Laboratories to by-pass breaks in coaxial cable.

The cord is a flexible structure which is easily handled and can be laid out rapidly for immediate emergency restoration of service, since it weighs only 8.7 pounds per hundred feet. Where the main cable is damaged, repairmen patch around the trouble with the emergency cords before proceeding with the repair work.

The emergency cord has a 20-gauge center conductor and a braided outer conductor, both of copper, the two being separated by solid polyethylene insulation instead of the spaced disc insulation of the coaxial cable. A protective jacket of polyvinyl-chloride covers the outer conductor. The emergency cord terminates in a plug which fits a jack that is clamped to the regular coaxial unit with a friction-type chuck.

The transmission loss of the emergency cord is about three times as great as that of a regular coaxial cable, so the maximum length of cord that may be used is ordinarily limited to about 2,000 feet. The probability of requiring this length is small, however, and in most instances cords twenty-five feet long will care for the restoration of service.



The emergency cord terminates in a plug which fits a jack that is clamped to the regular coaxial unit with a friction-type chuck

MULTIVIBRATOR STEP-DOWN BY FRACTIONAL RATIOS

K. H. DAVIS
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Research

Frequency step-downs, where the lower frequency is accurately related to some higher frequency, are often needed in communication circuits. Such step-downs are required, for example, in testing filter characteristics, as already described in the Record.* Heretofore, moderately complex vacuum tube demodulating circuits have been employed, but for many purposes the multivibrator step-down offers considerable advantage. It gives a much simpler circuit employing fewer apparatus units, and thus is less expensive to build and occupies much less space. These advantages would have led to their wide employment, except that prior to the war, the step-down ratios that could be obtained were limited to integral numbers, and for larger ratios the number could not be a prime. This restriction was removed in the course of war developments by applying feedback to a multivibrator chain. Besides making prime ratios readily obtainable, it also permits the utilization of non-integral rational numbers such as $14\frac{95}{121}$.

A multivibrator circuit capable of acting as a step-down is shown in Figure 1. With both tubes passing current, the circuit is stable. Since the tubes are in a saturated condition, the voltages at points 1 and 3 will be zero, those at points 2 and 4 slightly positive, and capacitors C1 and C2 will have small charges. If anything is done that momentarily interrupts the flow of current in one of the tubes, however, the circuit at once starts to oscillate: first one tube passes current and then the other, and the beginning of current flow in one tube blocks the flow of current in the other.

Assume, for example, that the voltage at point 1 has been momentarily made highly negative, and that as a result tube *a* blocks, while tube *b* continues to pass current. There will be a negative charge on C1 because of the high negative voltage recently

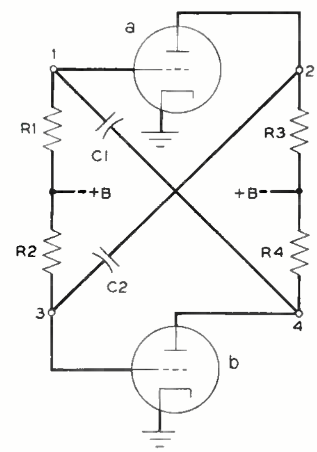


Fig. 1—Schematic of a multivibrator circuit capable of acting as a step-down

applied, but current from positive battery through R1 flowing into the capacitor will slowly raise the voltage at point 1. When the cut-off voltage is reached, tube *a* at once starts to pass current. While *a* was blocked, the voltage at point 2 had risen to full positive battery potential, and capacitor C2 had been fully charged. When *a* starts to pass current, however, the potential at point 2 drops suddenly to nearly zero, and the charge on C2 released as a result, passing through R2, momentarily decreases the voltage at point 3 to a high negative value, and tube *b* blocks as a result. Tube *b* then starts a cycle like that described for *a*, and when *b* starts to pass current, *a* will block.

The frequency of oscillation depends on the duration of the blocked periods of the two tubes, since the conducting period is

*Record, *March*, 1935, *page* 263.

stable and tends to continue indefinitely. The duration of the blocked periods of tube a is controlled by R1 and C1, and that for tube b by R2 and C2. With frequency depending on the values of resistors and capacitors, variation is likely, but by associating the output of an oscillator with points 1 and 3, the frequency of the multivibrator can be made as constant as that of the oscillator, but lower by some integral factor.

Suppose, for example, that the voltage of the oscillator, reduced to a small fixed value, were superimposed on the voltages at points 1 and 3. Instead of rising along a smooth curve, the voltages at these points would become as shown by the solid curve of Figure 2. Without the superimposed oscillator voltage, the tube would have started to pass current at t_0, but with it, it starts to pass at t_1—just four cycles of the oscillator frequency after the tube had blocked. Assuming similar constants and arrangements for the other tube, the frequency of the multivibrator would be one-eighth that of the oscillator, since each half cycle is four times as long as one cycle of the oscillator circuit itself.

Greater step-down may be secured by connecting several multivibrator circuits in series, as shown in Figure 3, where small capacitors link points 2 and 4 of one vibrator to points 3 and 1, respectively, of the next following vibrator. The resistors R1 and R2 and the capacitors C1 and C2 of each succeeding stage will be selected to give a suitably lower frequency than that of the preceding stage. During the blocked period of a_2, a small pip of voltage will be

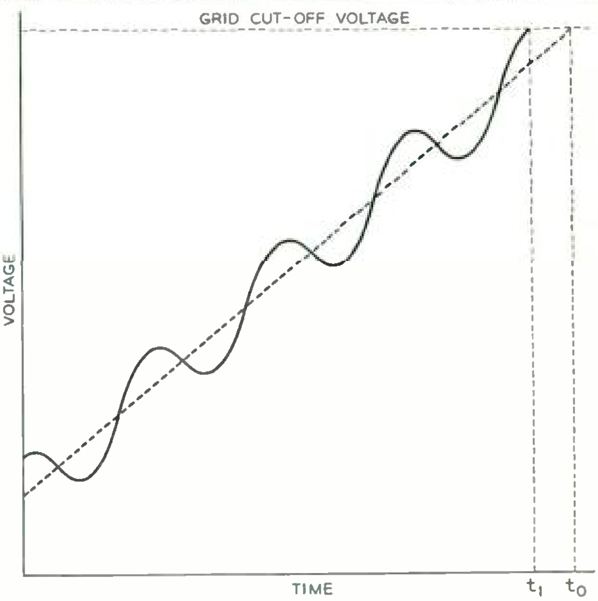


Fig. 2—Rising only because of flow of current through R1, the voltage follows the dashed line, but when an oscillator voltage is superimposed, the voltage follows the solid line

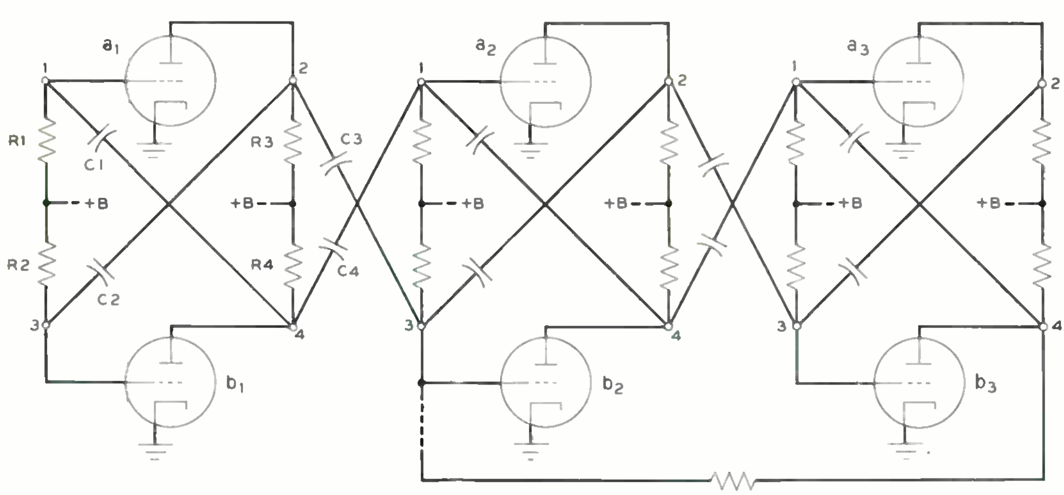


Fig. 3—Schematic of a three-stage multivibrator step-down

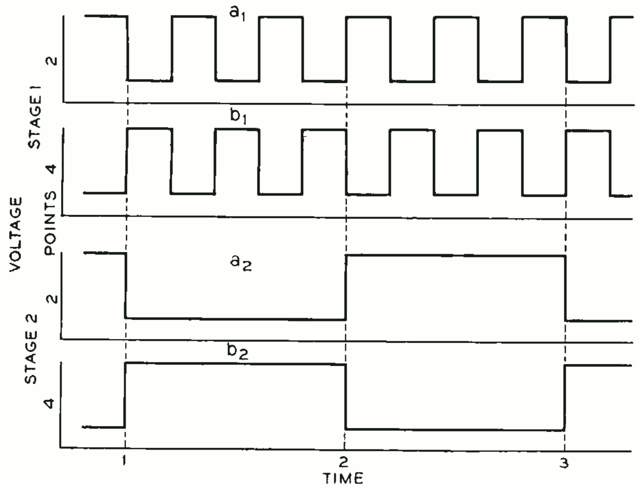


Fig. 4–Voltages across points 2 and 4 for the first few cycles of a multi-stage multivibrator step-down

superimposed on the rising voltage of its grid each time b_1 blocks, because of the sudden rise at this moment of the voltage at point 4 of the first stage. One of these pips will trigger the tube to pass current, much as do the positive waves of Figure 2. When a_2 starts to pass current as a result, b_2 will block, and it, in turn, will subsequently start to pass current after a fixed number of voltage pips from the C3 capacitor.

In Figure 4 are drawn the first few cycles of two stages of a multivibrator step-down. It is assumed that at TIME 1, a_1 starts to pass current and, in doing so, blocks b_1, causing a pip of voltage on the grid of a_2. It is assumed further that this is the pip that makes a_2 start to pass current and, in doing so, it will block b_2. At TIME 1, therefore, a_1 and a_2 start to pass current and b_1 and b_2 block. If both tubes of STAGE 2 trigger to passing on the third pip from the preceding stage, b_2 will start to pass at TIME 2, and thus block a_2 at the same time, and a_2 will subsequently start to pass current at TIME 3. The period of STAGE 2 is thus from TIME 1 to TIME 3, and comprises a blocked period for a_2 and a blocked period for b_2.

It may be seen from Figure 4 that the blocked period of b_2 includes three blocked periods of b_1 and two blocked periods of a_1, to which correspond two current-passing periods of b_1. Similarly, the blocked period of a_2 includes three blocked periods of a_1 and two of b_1. If the number of pips required to trigger b_2 to pass current is N_{b2} and the number to trigger a_2 to passing is N_{a2}, then–letting b represent the length of a blocked period–the lengths of the blocked periods of STAGE 2 may be expressed as:

$$B_{a2} = N_{a2} B_{a1} + (N_{a2} - 1) B_{b1}$$

$$B_{b2} = N_{b2} B_{b1} + (N_{n2} - 1) B_{a1}$$

The sum of these two blocked periods, which represents the period T_2 of the second stage, is thus:

$$T_2 = B_{a2} + B_{b2} = (N_{a2} + N_{b2} - 1)(B_{a1} + B_{b1}) = (N_{a2} + N_{b2} - 1)\, T_1$$

and the ratio of T_2 to T_1, R_2, is T_2 divided by T_1, and thus

$$R_2 = (N_{a2} + N_{b2} - 1)$$

A similar relationship holds between STAGE 3 and STAGE 2, and the over-all ratio is R_2 times R_3. If N were three throughout, the over-all ratio for the three stages would be $5 \times 5 = 25$. If a fourth stage with the same value of N were added, the over-all ratio would be $5 \times 5 \times 5 = 125$, and so on for any number of stages. Since the over-all ratio is thus the product of several factors, it can never be a prime. The ratio obtainable in a single stage is limited by the difficulty in distinguishing between the heights of successive pips from the preceding stage when N becomes too large. The maximum ratio for one stage is usually limited to about 15, for reasons of stability, and thus by using one stage any prime up to 15–3, 5, 7, 11, 13–can be obtained, but above 13 no prime over-all ratio is obtainable.

Suppose, however, that a feedback circuit be run from point 4 of STAGE 3 to point 3 of STAGE 2, as indicated by the dotted line of Figure 3. During the blocked period of b_3, current will be fed over this connection to increase the rate at which the voltage at point 3 of STAGE 2 is rising. As a result, b_2 will require fewer pips from a_1 before it passes current. The result of this feedback is shown in dotted lines on Figure 5, on the basis that N_{b2} with feedback is 1 instead of 3. The solid lines show the outputs of the various stages as they would have been without feedback.

While b_3 is passing current, the feedback voltage will drop so low as to have no effect, and thus the oscillation of STAGE 2 will follow one pattern while b_3 is blocked, and another while b_3 is passing. As a result, the half cycles of STAGE 3 will differ in length.

During the blocked period of a_3, while b_3 is passing current, there is no effect of feedback, and thus B_{a3} will be the same as without feedback. During the blocked period of b_3, however, each blocked period of b_2 will be shortened, since it will endure for only one pip from a_1 instead of three. Since the pips caused by a_1 blocking are one period of STAGE 1 apart, each unit reduction in N_{b2} reduces the length of the blocked period of b_2 by T_1. With a reduction of two in N_{b2}, as in the example assumed, each blocked period of b_2 will be $2T_1$ shorter than before. In general, if δ represents the number of units by which N_{b2} is shortened, each blocked period of b_2 becomes δT_1 shorter than without feedback. In a blocked period of b_3, however, there are N_{b3} blocked periods of b_2, and thus with feedback the blocked period of b_3 is shortened by $N_{b3}\delta T_1$. Without feedback, the length of a period of STAGE 3 was $R_2R_3T_1$ while with feedback, it will be $R_2R_3T_1 - N_{b3}\delta T_1$, and the over-all ratio with feedback, T_3 divided by T_1, will be $R_2R_3 - N_{b3}\delta$. For the figures assumed, the ratio without feedback is $5\times5=25$, while with feedback it is $(5\times5)-(3\times2)=19$, which is a prime. If an over-all ratio of 37 had been desired, which is also a prime, all the N's could have been made 4, and R_2 and R_3 would both be 7. Then, by making δ equal to 3, the over-all ratio would be $(7\times7)-(4\times3)=37$. In actual practice, it is generally preferable to keep δ as small as possible; in fact, it can be made equal to 1, and all integral ratios, prime or otherwise, can still be obtained by variations of the other factors.

Besides making a prime over-all ratio possible, feedback will also give a non-integral rational number. With feedback, the ratio of STAGE 3 to STAGE 2, R_3, is not changed, and thus the ratio of STAGE 2 is equal to the over-all ratio divided by R_3. Since with feedback the over-all ratio is $(R_2\times R_3)-N_{b3}\delta$, the ratio of STAGE 2 is equal to this expression divided by R_3. If R_2' represents the value of R_2 when feedback is present, $R_2' = R_2 - \frac{(N_{b3}\times\delta)}{R_3}$. For the factors already used $R_2' = 5 - \frac{3\times2}{5} = 3\ 4/5$,

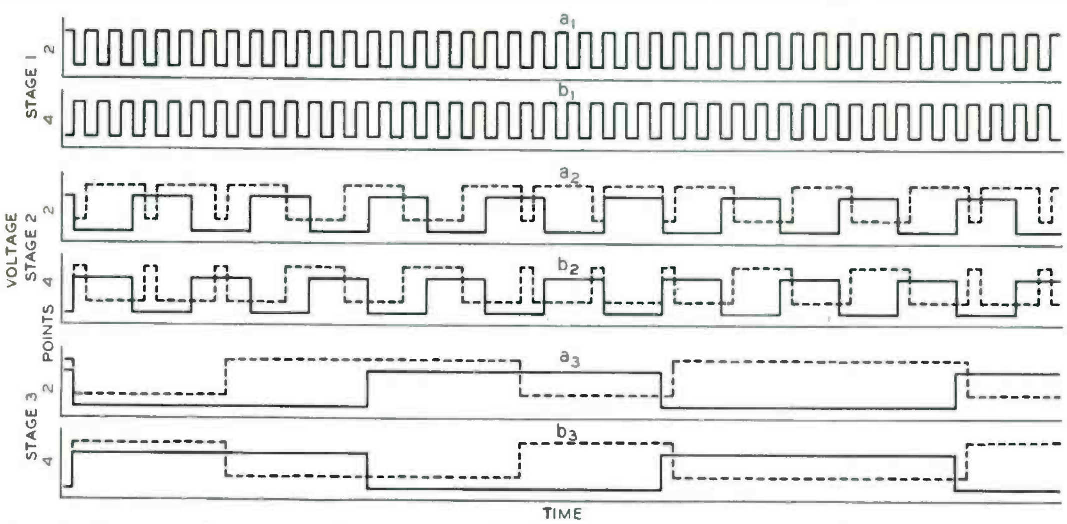


Fig. 5—Output voltages of a three-stage multivibrator circuit with and without feedback

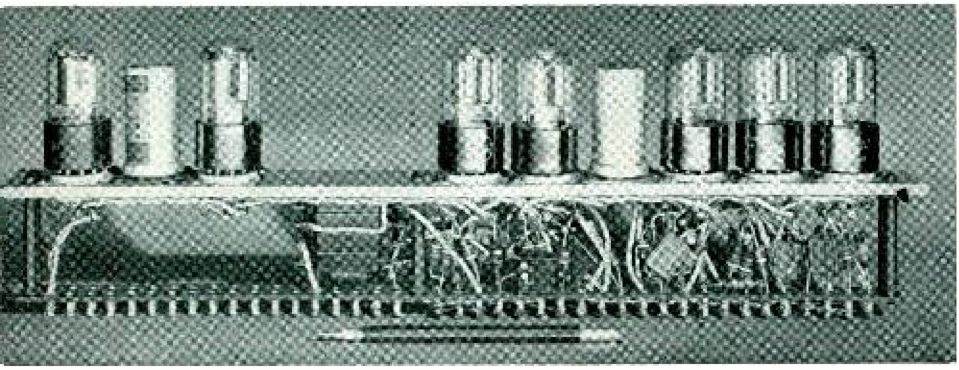


Fig. 6—The small space required is illustrated by the 2000-to-1, four-stage step-down mounted on the right half of the panel. Each tube includes two pentode units, and one tube serves as a driving unit and each of the other four as a step-down stage

and this non-integral ratio is obtained at the output of STAGE 2.

It will be noticed that the denominator of the fraction is R_3, and this fact indicates how any other ratio may be obtained. If a ratio of 4 3/7 were desired at the output of STAGE 2, for example, the equation would be $\frac{31}{7}=\frac{(7\times R_2)-N_{b3}\delta}{7}$, and thus $7R_2-N_{b3}\delta=31$. If R_2 is made 5, N_{a3} made 6, N_{b3} made 2, and δ is made 2, the result gives $(7\times 5)-(2\times 2)=31$, and R_2' would be $\frac{31}{7}=4\,3/7$.

On the assumption that no stage should have a greater ratio than 15, it would seem that no rational ratio with a denominator greater than 15 would be practicable. A ratio such as $14\frac{95}{121}$, for example, would appear unobtainable. If, however, a fourth stage is added and feedback is carried from the fourth to the second stage, such a ratio is readily obtainable at the output of the second stage. With such an arrangement, the over-all ratio is $R_2R_3R_4-\Delta$, where Δ represents the reduction in the length of B_{b4} due to feedback. Since R_3 and R_4 are not changed by a feedback from the fourth to the second stage, the ratio at the output of the second stage is $\frac{R_2R_3R_4-\Delta}{R_3R_4}$. By making R_3 and R_4 each equal to 11, the denominator becomes the desired 121, and it then remains only to select the other parameters to secure the desired numerator.

When the feedback spans two stages, the calculation of the reduction in the length of T_4, called Δ in the above example, becomes a little more involved, but is found by similar reasoning. In the examples taken so far, N_2 has been equal to N_b, but this is not at all necessary, and for the more involved ratios unequal values may be needed. By taking advantage of such possibilities, and of the possibility of using as many stages as needed, with feedback spanning any group of them, a very wide range of non-integral or prime ratios is possible. The output waves are flat-topped, useful for many purposes, but where sine waves are desired, they are obtained by passing the output through a filter.

THE AUTHOR: K. H. DAVIS graduated from Bowdoin College with a B.S. degree in 1929. He then joined the Transmission Research Department as a member of the Technical Staff. Here he worked on the terminal equipment for a transatlantic cable and later on various kinds of terminal equipment for radio circuits and long land lines. During World War II he was engaged in work of a secret nature for the Army. He is now working on automatic speech switching and speech printing problems.

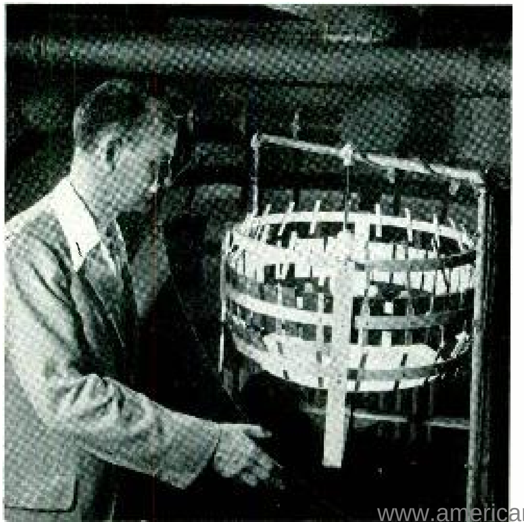
J. CRABTREE
Chemical
Laboratories

RUBBER AND THE WEATHER

Rubber is one of those commonplace modern essentials whose worth tends to be ignored by its very familiarity. Yet it is perhaps the most amazingly versatile material in the present service of man. Of little use in its natural form, by combination with sulfur and by mixing or compounding with other materials it is made to acquire a wide variation of physical properties ranging from the highly elastic form that we see in rubber bands or toy balloons to tough, chemically resistant hard rubber. Together with its water repellency and high electrical resistivity these characteristics lead to its use in such diversity as clothing, tires, hose pipe and wire insulation.

Unfortunately, however, it has a vulnerable "Achilles' Heel." It loses its valuable properties on long exposure to the weather, of which the important components in this connection are oxygen, sunlight, water and ozone.

The rubber molecule is a chain of a large number of units of isoprene, which is chemically quite highly unsaturated—a property which makes progressive vulcanization possible and results in the range of physical characteristics already referred to. However, this same feature renders it susceptible to deterioration by molecular oxygen.



One of the first results of this oxidation is to break the long molecules, which are the basis of the physical properties of rubber, into smaller units thereby degrading these properties to such an extent that less than 1 per cent of its weight of oxygen is needed to reduce tensile strength to negligible proportions. Further oxidation results in the formation of acidic and resinous products as a hard and brittle mass.

These changes proceed slowly in the dark but at an increasing rate with rise in temperature. They can be considerably delayed by addition of certain organic compounds known as antioxidants.

On exposure of rubber to sunlight, the blue-green, violet, and ultraviolet portions of the light are absorbed by the molecule in such a way that its chemical activity is greatly enhanced. Oxidation then proceeds at a much higher rate than in the dark and so intensively that antioxidants are almost powerless to prevent it. In fact, if a gum rubber compound such as a rubber band, is exposed to summer sunlight, a brittle resinous skin can be detected on the surface in as little as twenty-four hours and several days will suffice to harden the band. If at the same time it is exposed intermittently to rain, soluble products of oxidation are leached away and result eventually in the formation of a checked pattern on the surface. This "orange peel" or "alligator skin" effect is familiar to motorists in the white sidewalls of automobile tires, though here the process is slowed because part of the light is reflected by white fillers. At present, no way is known of preventing this

Fig. 1—To simulate one of the effects of weathering, rubber samples are exposed to a source resembling sunlight. C. V. Lundberg has removed the protective metal shield temporarily to show the interior of the apparatus

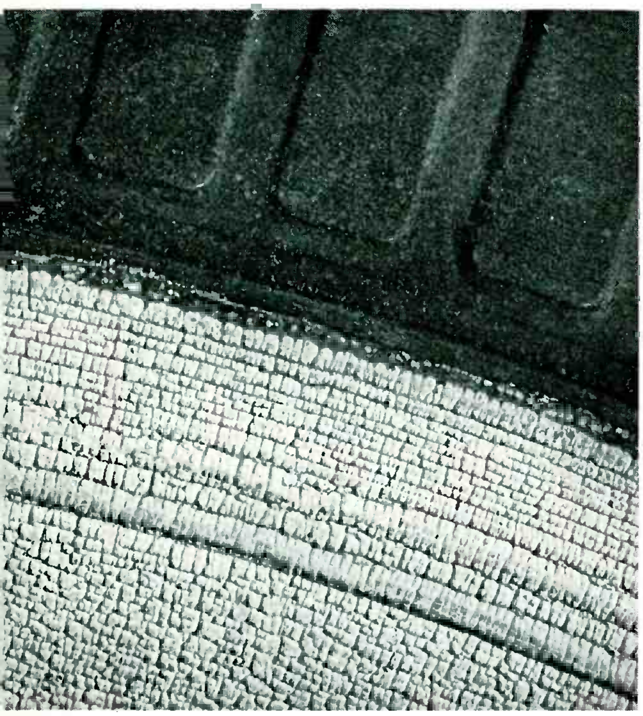


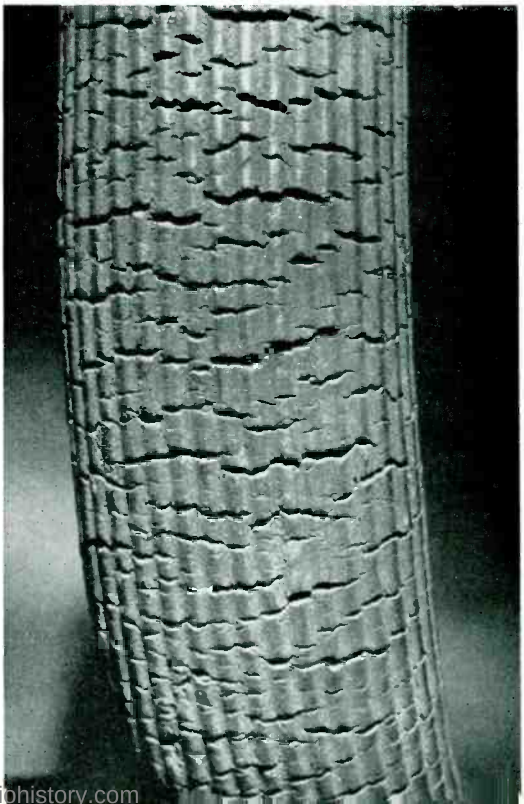
Fig. 2—Automobile tires with white walls tend to crack more quickly at the sides from the effects of sunlight than in the tread, because the dark filler in the latter prevents the light from penetrating much below the surface.

light-activated oxidation while still retaining the flexible and elastic properties of the rubber. If, however, the rubber is made completely opaque by incorporation of a light-absorbing filler, such as carbon-black or ferric oxide, light is prevented from reaching any but a very thin layer of rubber on the surface and the object is thereby effectively protected. This accounts for the striking difference in appearance between the tread and sidewall of a weathered white-sidewall tire, Figure 2.

Studies of the rate of oxidation of natural rubber compounds are fortunately simplified by the fact that the resulting increase in weight runs parallel to the amount of oxygen absorbed. Specimens of known area and weight are therefore weighed after suitable conditioning in a desiccator subsequent to a number of successive exposure intervals. Exposures to the particular light source chosen were made in some cases in the open, in others in closed glass or quartz vessels containing air or oxygen. When using an artificial light source, devices similar to that shown in Figure 1 are used in which the specimens are rotated around the source, equidistant from it. Results showed that the rate of oxidation under the influence of light is but slightly affected by humidity, that it has a low temperature coefficient, and that stretched specimens increase in weight in proportion to their increase in area; also that opaque fillers, such as carbon black and ferric oxide, protect rubber from light-activated oxidation for long periods by absorbing the light. Highly reflecting fillers like zinc and titanium oxides also afford some protection by reflecting most of the light, but white fillers having refractive indices approximating that of rubber, such as calcium and magnesium carbonates, have no protective effect whatever.

These changes, caused by oxidation, however, do not account for what is often the most damaging result of exposure to the atmosphere, viz., a splitting or cracking of rubber under tension. This type of damage will be most familiar perhaps to the average reader in reeled-up garden

Fig. 3—Rubber splits when under tension because minute amounts of ozone in the air weaken it. This piece of garden hose shows the result



hose, Figure 3, and is responsible for enormous loss in rubber-covered electrical wire and cable alone, Figure 5. It is a result of attack by minute amounts of ozone in the atmosphere. While vulcanized rubber in its relaxed state seems not to be affected even by high concentrations of ozone, stretching the rubber ever so little results in immediate attack, with the rubber cracking or splitting at right angles to the direction of the stretching force. A concentration of ozone around one per cent causes disintegration almost at once. At lower concentrations, the damage is less, but even at 10 parts per 100 million of air small cracks will appear in an hour's time and will break completely through the rubber with continued exposure. Still lower concentrations achieve the same result in proportionately longer times, Figure 4.

Information on the ozone content of the atmosphere has been meagre and often erroneous because of difficulties of measurement. During recent years, however, certain facts have been made plain. Ozone is formed in the stratosphere from the oxygen present by photochemical action induced by the short-wave ultraviolet sunlight. It is not formed at the earth's surface because the light of the required wavelength has been totally absorbed in its passage through the air mass. Consequently, any ozone reaching the ground must be brought down from the stratosphere by air circulation. At ground level its life is comparatively short, since it undergoes decomposition by light of visible wavelengths, by combination with organic matter and by catalytic decomposition at various surfaces. Because its replenishment depends on variable air currents, its concentration is also widely variable although the total amount of ozone in the whole atmosphere is relatively constant. The concentration at ground level varies from nothing to 5 or 6 parts per 100 million with an over-all average of about 3.0 parts and the changes are quite rapid. A calm day often shows no ozone, a windy one average or higher amounts, though not necessarily so, since ground disturbances may not parallel upper air currents. It is possible that ozone concentrations may be low where air pollution by smoke is high.

Of these weathering agencies, ozone is by far the most serious to the rubber products used by the telephone industry, since these are mostly wire and cable coverings containing enough carbon black to render them reasonably resistant to light-activated oxidation. A bend in a wire or cable stretches the covering, cracks then appear in time from ozone attack, progressing ultimately through to the conductor. Even the tensions induced in a span of wire by oscillation in the wind and by temperature changes have caused extensive damage in a few years' time, necessitating expensive replacements.

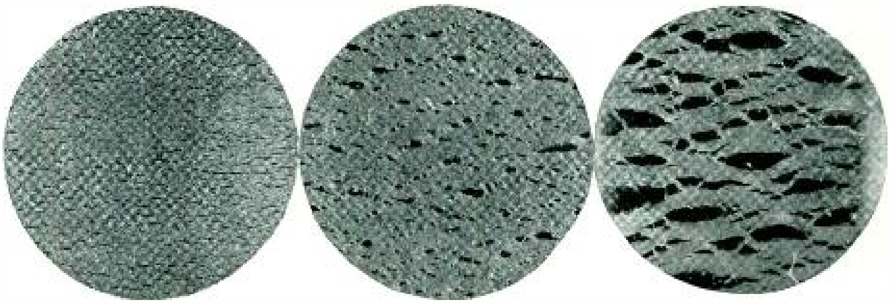


Fig. 4—Photomicrographs of stretched rubber specimens showing the progress of cracking by exposure to the weather for several months

A practical remedy fortunately exists for this kind of damage. If certain types of hydrocarbon waxes are incorporated into the rubber compound to the extent of three or four per cent, the wax slowly exudes forming a thin layer or "bloom" over the entire surface and acts as a barrier to the ozone, thus enormously prolonging the life of the rubber when exposed to the weather. This remedy, however, is applicable only under static conditions, since repeated flexings break up the surface film and nullify its effect. It cannot therefore be applied to such articles as automobile tires or belting but is of great benefit to rubber insulated wire and cable. Continuous search is being made in the rubber industry for a practicable additive which will protect rubber under dynamic stress and elevated temperature. While some such are known, they have other defects which prevent their competition with wax at the present time.

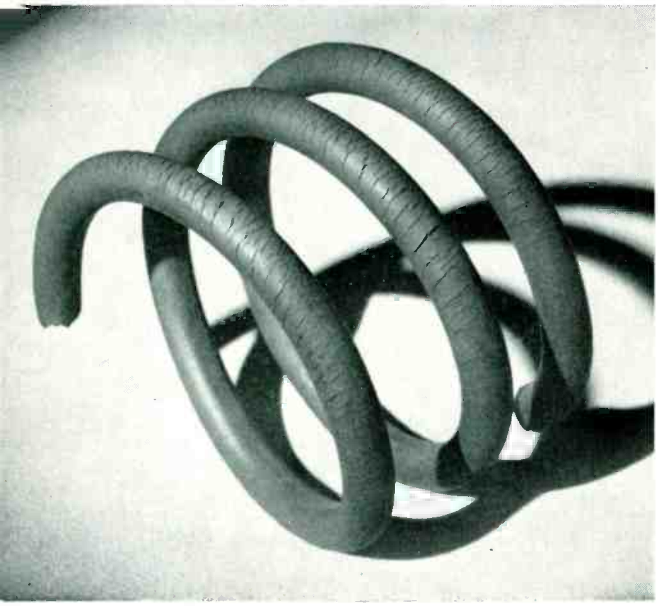
Of the synthetic rubbers which currently dominate the industrial field, GR-S and GR-N undergo changes similar to those of natural rubber when exposed to weather. GR-S, however, oxidizes more slowly, and, while equally susceptible to ozone attack, needs smaller quantities of wax for its protection. Butyl rubber, now being used for inner tubes, has only a small amount of chemical unsaturation, is consequently more resistant to oxidation and is practically unaffected by ozone. Neoprene also is much less reactive than natural rubber, due in this case to a protective chlorine atom in its structure. It is, however, not entirely resistant to ozone.

Until recently, the factors involved in the weathering of rubber were imperfectly understood, the breakdown being attributed principally to the effect of sunlight, and accelerated weathering devices were built on this principle. These devices, however, never duplicated the effects of outdoor exposures in the case of stretched rubber, so that laboratory testing of weathering effects was not possible and outdoor exposures gave information only for the particular weather conditions during such exposure. As a result of extended investigation in the Laboratories, the separate rôles of oxygen, sunlight and ozone have been defined and clarified with the result that it is now possible to duplicate in the laboratory the effect of exposure to any combination of weather conditions. This is achieved by simultaneous exposure to air, a light source simulating sunlight, moisture, and an atmosphere of very dilute ozone under controlled conditions.

One apparatus used is depicted in Figure 6 and schematically in Figure 7. It comprises a cylindrical tank T whose inner surface is waxed to prevent it from decom-

Fig. 6—Apparatus for exposing rubber specimens to ozone gas, which is produced by an ultraviolet lamp in the base of the container

Fig. 5—Bends in a wire stretch the rubber covering and induce cracks caused by atmospheric ozone



posing ozone and is open at the bottom; B_1 and B_2 are circular baffles; L is a loosely fitting lid with a central chimney in which is mounted a small electric fan, F; S is a mercury-arc source of ultraviolet light which forms ozone from the oxygen of the air; S_2 is a sun lamp that approximates sunlight in quality; and R depicts the samples of rubber to be tested. They are mounted on a cage-like structure which can be rotated about S_2 to insure uniform exposure of the samples. The ozone concentration is controlled by the speed of the fan F, the voltage on lamp S, and the height of baffles B_1 and B_2. It is usually maintained at 10 parts per 100 million by volume. Sheet specimens are exposed as strips stapled to a lacquered board and under from ten to fifty per cent elongation or as close loops. Insulated wires are wound on mandrels of the sizes required to produce the same range of elongations as in strips. Performance is gauged by the time taken for cracks to appear in comparison with standard compounds of known weathering characteristics. The degree of cracking is estimated visually under a microscope.

From results obtained by determining separately the light-energized oxidizability and the susceptibility to ozone cracking at different temperatures, reliable forecast can be made of the behavior of any particular rubber compounds under any known combination of weather conditions.

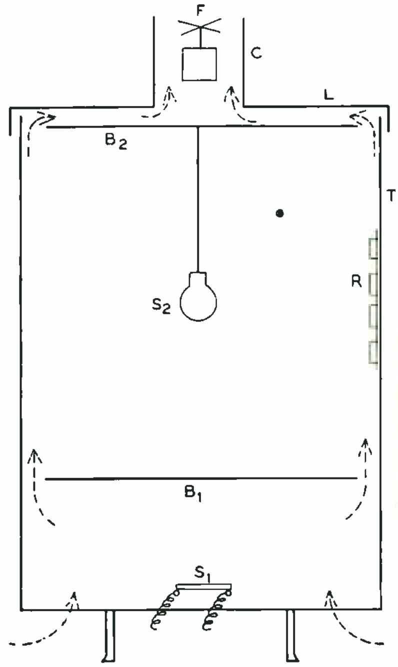


Fig. 7—Schematic of the ozone apparatus. The air is forced by the electric fan F in the central chimney past the mercury-arc source S_1 to convert some of it to ozone. The ozonized air passes the baffles B to the upper part of the chamber, where the specimens are located. The sun lamp S_2 subjects the specimens to conditions simulating exposure to sunlight

THE AUTHOR: J. CRABTREE graduated from Manchester University, England, in 1910, and received a M.S. there in 1914. He was engaged in Agricultural Experiment Station work of the Royal Agricultural Society in England and as Director of the Experiment Stations of the British Guiana Sugar Planters Association until 1927. Then he came to the United States. He spent two years with the Spencer Lens Company and joined the Electrical Research Products Company in 1929. The same year he transferred to the Laboratories with the inception of the Sound Picture Laboratory. Then followed several years in development of photographic theory and practice of sound recording on film and in sundry optical problems. Mr. Crabtree joined the Chemical Department in 1941, where he has since been occupied in a study of the degradation of organic materials, principally rubber, by the agencies of weather.

WILSON SUCCEEDS GIFFORD AS A T & T PRESIDENT

At the meeting of the Board of Directors of the American Telephone and Telegraph Company on February 18, Leroy A. Wilson was elected president and a member of the Board, Walter S. Gifford was elected chairman of the Board and Charles P. Cooper, vice chairman.

Mr. Gifford had been president since 1925, Mr. Cooper vice president since 1927 and executive vice president since 1946. Mr. Wilson had been vice president since 1944 and financial vice president since 1946.

The New President

Leroy August Wilson was born on February 21, 1901, in Terre Haute, Indiana. The circumstances of the small family—there were no other children – were pleasant but money was not plentiful, so when the youngster was old enough to want cash in his pocket he set out to get it for himself. Young Wilson obtained a newspaper route in 1915 and kept it for seven years. In the meantime he plunged into an astonishing variety of other jobs (but he had the presence of mind to sublet the paper route when necessary).

In the fall of 1918, Lee Wilson entered Rose Polytechnic Institute in Terre Haute. His activities now really began to multiply. For the next two or three years, off and on, he did surveying work on Saturdays and Sundays in the mines of a local coal company. As his engineering knowledge increased he worked for the Pennsylvania Railroad—one summer as engineer in charge of a line construction crew, another summer in designing bridges. In the same period he supervised considerable county highway construction and did various jobs for the Terre Haute water works. When the telephone company, which served Terre Haute, introduced a change in the method of ringing, Lee spent several weeks installing new instruments and changing over old ones on subscribers' premises. This occupation kept him from idleness between spells of shovelling ore, surveying coal mines and building railroads.

None of these activities, however, prevented him from winning membership in Tau Beta Pi, the honorary society in engineering, or from taking an active part in campus affairs. He was president of the college Y.M.C.A., member of the Student Council, member of the Staff of *Rose Technic*, the College monthly, and so on. He also became a major in the R.O.T.C. unit at Rose.

By the time Lee had become Mr. Wilson and was ready to leave college for the comparatively quiet life of a full-time businessman, he was offered jobs by two electrical manufacturers, three railroads, the Indiana State Highway Commission, the City of Terre Haute—which wanted him to be Chief Engineer of a sewer project—and the Indiana Bell Telephone Company. He chose the telephone job, he says, because he relished the idea of getting into a big organization which operated through teamwork, and in which he would learn how a service enterprise was managed. He graduated from Rose one Saturday in June, 1922, and reported for work as a traffic clerk and student in Indianapolis the following Monday.

Mr. Wilson spent seven years with the Indiana Bell, all of them in the Traffic Department. In 1923 he was appointed traffic chief in Muncie, and in succeeding years he had direct charge of the telephone operating forces in several districts throughout the state before returning to Indianapolis as district traffic superintendent in 1927. When he transferred to the Department of Operation and Engineering of the A T & T in New York in 1929, he brought with him a former member of the Indiana Bell—his wife, who before their marriage in 1928 was Miss Blanche Willhide of Marion, Indiana.

Mr. Wilson's first work as an engineer in New York was in Traffic, but he also gained experience in dial equipment engineering and in related fields. In 1939 he moved over to Commercial where he was placed in charge of the work on telephone directories, and in the following year he was made rate engineer. In 1942, soon after the United States entered the war, he was appointed to head the entire Commercial Division of O & E.

It was from this post that Wilson, in the autumn of 1944 was promoted to a vice presidency of A T & T. His new assignment was, in brief, to study the revenue needs of the Bell System, and to help promote understanding of the whole subject by telephone users, employees and the public generally.

Wilson is an unassuming man and he was rather startled at being made a vice president. He expressed the thought that his promotion was a lively illustration of the fact that America

Conway Studios

LEROY A. WILSON

really is the land of opportunity. Wilson believes profoundly in the democratic idea and unconsciously shows it. A characteristic that a good many people have noticed in him is an unusual ability to get others to give their utmost on a job and enjoy doing it. He is a tremendous worker himself and it is hard to be in his vicinity without catching some of this enthusiasm.

Wilson is a 32nd degree Mason and a member of Lamda Chi Alpha fraternity. His idea of a fraternity is that it is a means of spreading fellowship, consequently he has long been active in fraternity affairs and a few years ago served as chairman of the National Interfraternity Conference. For years he spent most of his vacations visiting colleges all over the country, talking to groups, studying fraternity problems and trying to help student organizations to become more useful to young people. He confesses that he has never had many genuinely loafing vacations, but says he has had ample returns in pleasure and enjoyment from the working vacations he chose instead.

A year and a half ago Wilson gave a little talk at Denison University. In it he included a few words giving his idea of what constitutes success. It is interesting to read them now. "Success," he remarked, "will not be measured by any particular achievement, or by your place in the social scale, or by the rank attached to your job. Rather, it will be measured by your own inner feeling when you ask yourself, 'Have I made full and able use of head, heart and hand in the thinking, the understanding of others and the action that could reasonably have been expected of me.' "

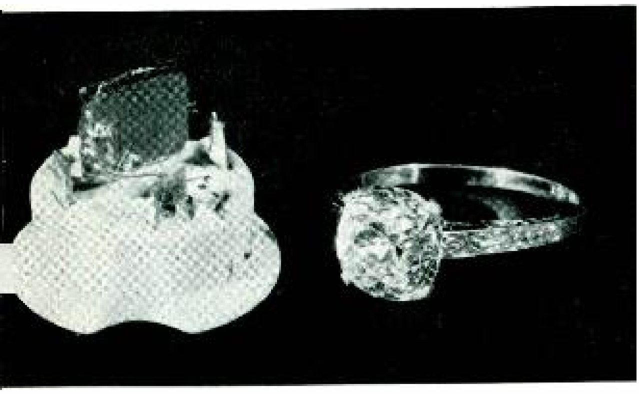
Mr. Wilson currently is a director of Long Lines, the Chesapeake and Potomac Companies, and Indiana Bell, and a trustee of the East River Savings Bank.

The Wilsons reside in Glen Ridge and have one daughter, Shirley Ann. A former president of the Glen Ridge Republican Club, Mr. Wilson was elected to the Borough Council in 1943, serving as chairman of the law and ordinance committee; reelected in 1946, he now heads the police committee. He is a member of the Glen Ridge Country Club and the Glen Ridge Battalion Forum, on whose executive committee he also served.

Quoting from the *Newark News* for February 19, "Now one of the leading business figures in America, Wilson remains democratic and quiet-spoken, living in an unpretentious home at 136 Essex Avenue (Glen Ridge). Although the pressure of his business duties prevents him from practicing many hobbies, he retains an interest in basketball and follows the fortunes of the Glen Ridge team closely. When an acquaintance expressed surprise a year ago at seeing the busy executive at a high school game, Wilson replied, 'Don't forget I'm a Hoosier—they live basketball out there.' "

Said the *New York Herald Tribune*, "He has said repeatedly that the philosophy of his working life has been to meet the challenge of one job at a time and to derive his satisfaction from performing the immediate task to the best of his powers. Each job in the list, and the list is a long one, he has found completely challenging, particularly in the aspect of working with people."

The *New York Times* characterizes him as "A practical philosopher, the new chief executive said the 'secret' of success depended on 'two simple things—first, the ability of the individual to analyze a situation and decide what should be done, and second, his capacity and courage to get it done.' "



QUEEN OF GEMS MAY HAVE RÔLE IN TELEPHONY

A radically new method of controlling the flow and amplification of electric current—one that may have far-reaching influence on the future of electronics—was described on January 31 before the American Physical Society by K. G. McKay of Physical Electronics. Part of the Laboratories' broad investigations in communications for the Bell System, this research has grown out of earlier work by D. E. Wooldridge, A. J. Ahearn and J. A. Burton.

The method is based on the discovery that when beams of electrons are shot at certain insulators, in this case a diamond chip, electric currents are produced in the insulator which may be as much as 500 times as large as the current in the original electron beam.

The technique holds promise, after engineering development, of opening up an entirely new approach to the design and use of certain types of electron tubes. It is not expected to replace existing electronic techniques but rather to supplement them.

In fact, there are indications that if certain engineering problems can be overcome, the technique may lead to the development of important new electron tubes which do not exist today. For example, the technique might profitably be applied to the development of an entirely new means of obtaining extremely high amplification.

The development is also expected to be of considerable theoretical value, for it provides a new and powerful tool with which scientists hope to learn more about the fundamental structure of solid matter and how it behaves under the impact of electrons.

Essentially, their research consisted of successfully causing an insulator—which by definition will not conduct electricity—to carry considerable amounts of it. Moreover, Dr. McKay has now succeeded in using such insulators, specifically diamond chips, to amplify electrical currents.

Methods of amplifying currents in gas or vacuum tubes have been known since the development of the first practical high-vacuum tube, also at Bell Telephone Laboratories, approximately 35 years ago, but this has never been done previously in solids. Such an accomplishment offers a wide variety of possible applications and opens up an entirely new field of electronics for investigation.

The process itself is somewhat similar to the technique of translating the energy of a beam of light into electricity, which underlies the operation of the well-known photo-electric cell.

The experiments reported by Mr. McKay stemmed directly from previous pioneer research in which current was induced in diamonds by bombarding them with alpha particles, those relatively heavy, positively charged bits of

K. G. McKay inspects the electron gun that beams electrons on the diamond chip matter shot off by radioactive substances. This earlier investigation, first successfully conducted at the Bell Laboratories and since verified by other workers, particularly those at the National Bureau of Standards, promises development of a new and improved laboratory tool for detecting and counting alpha particles. Such a device would do essentially the same thing as the familiar "Geiger counter." The new device, however, appears to offer a number of advantages, among them smaller size, lower operating voltage and a faster counting rate.

Inducing electric currents in diamonds by bombarding them with relatively light-weight electrons proved to be considerably more difficult. One of the major difficulties encountered came when the physicists found that as the current started to flow in the diamond chip, the electrons became trapped in the tiny imperfections which are present in all crystals. Thus, after the first fraction of a second, the induced current tended to waste away under the opposition of the trapped electrons.

To overcome this, the investigators applied an alternating voltage to the diamond chip so that alternately negative and positive charges were drawn through the crystal and some of each kind were trapped. The trapped positive charges cancelled out the effect of the trapped electrons, or negative charges, and the induced current flowed freely.

The diamond crystals used in the experiment are small chips or even so-called "saw-cuts" obtained from a natural diamond in shaping it for gem stones. They may be a quarter of an inch square and approximately twenty thousandths of an inch thick, roughly the size of a snowflake. Most of those used gave good results, although some did not respond at all.

Before the crystals are ready for use, gold is evaporated onto the two flat surfaces of the chip in films less than a hundred-thousandth of an inch thick to afford electrical connections.

In bombarding the diamond chips with electrons, the physicists used successive pulses of electrons lasting only a millionth of a second rather than a steady stream of electrons. Energies of approximately 15,000 electron volts were employed.

One of the most important features of this new technique is that the induced currents are produced within exceedingly short times. In fact, the time required is so brief that thus far it has not been possible to measure it. The investigators are certain, however, that it is less than one ten-millionth of a second.

E. I. Green, New Director of Transmission Apparatus Development

On February 9, Estill I. Green was appointed Director of Transmission Apparatus Development. After receiving an A.B. degree from Westminster College in 1915, Mr. Green spent a year in graduate work at the University of Chicago. The following year he taught at Westminster College. He was commissioned an Infantry Officer in the United States Army in 1917, and served overseas, being discharged with the rank of Captain. He then studied for two years at the Harvard Engineering School, receiving the degree of B.S. in Electrical Engineering. In 1921 he joined the Department of Development and Research of the American Telephone and Telegraph Company and came with that department to the Laboratories at the time of the 1934 consolidation.

Fabian Bachrach

Estill I. Green

For many years, Mr. Green was concerned principally in work on multiplex wire transmission systems. He became Carrier Transmission Engineer in 1938, and on April 22, 1946, Assistant Director of Transmission Development. His most recent responsibilities included short-haul carrier, general carrier and broadband carrier terminals, voice-frequency systems, and various types of transmission testing systems.

Changes in Organization

Effective on February 9, the following changes in organization were made in Apparatus Development Department I:

E. I. Green was appointed Director of Transmission Apparatus Development, succeeding the late R. G. McCurdy, and F. J. Given was appointed Assistant Director of Transmission Apparatus Development. Reporting to them are the following:

P. S. Darnell, Transmission Apparatus Engineer, responsible for condensers, resistances, power transformers, retard coils, loading coils.

A. R. D'Heedene, Transmission Networks Engineer, responsible for filters and networks;

A. G. Ganz, Transmission Apparatus Engineer, responsible for transmission transformers and magnetic studies;

E. B. Wood, Transmission Apparatus Engineer, responsible for switchboard cable, wire, lamps, lamp caps, sealed terminals, cords, batteries and air filters;

J. G. Ferguson, Transmission Measurement Engineer, responsible for electrical measuring apparatus;

R. A. Sykes, Piezo-Crystal Engineer, responsible for crystal units;

and R. O. Grisdale, Transmission Apparatus Development Engineer, responsible for special transmission apparatus development.

W. L. Casper was appointed Apparatus Consultant, reporting to D. A. Quarles. Mr. Casper will conduct special apparatus studies.

E. B. Payne was transferred from the Transmission Apparatus Development Department to the Transmission Engineering Department reporting to H. Nyquist.

The groups formerly reporting to Mr. Green in the Transmission Development Department will, until further notice, report to H. A. Affel.

On behalf of an enthusiastic audience, President Compton congratulated Mr. Gilman on his talk

M.I.T. hats, traditionally worn by Technology boaters, were presented to the Laboratories engineers who put on the show: Iden Kerney, Mr. Gilman, Smart Brand, Paul Blye and Herbert Fisher

G. W. Gilman describes microwave transmission to M. I. T. Alumni

A telephone conversation that traveled more than 5,000 miles by microwaves to establish a new record for long-distance transmission by this method was heard by nearly 1,000 alumni of the Massachusetts Institute of Technology at their mid-winter meeting in Walker Memorial on February 7, during an address by G. W. Gilman of the Laboratories.

Raymond H. Blanchard, president of the M.I.T. Alumni Association, presided.

The record-breaking telephone conversation was the climax of a demonstration by engineers of the Laboratories, as well as A T & T and the New England Company, of various types of long-distance radio telephone calls, which included communication with a trawler off Georges Banks, an automobile in Springfield, Mass., and with Honolulu, Nantucket Island, and a ranch in a remote section of Colorado. In the microwave call, the voice of P. W. Blye made twelve round trips, a distance of approximately 5,280 miles, on the microwave circuit between Boston and New York.

Mr. Gilman opened the demonstration by reproducing a telephone conversation typical of a transcontinental call thirty years ago, a striking contrast with the reproduction of a conversation by modern telephone transmission. Speaking of the early days of radio as an adjunct to wire telephony, he recalled that in 1915 Bell engineers transmitted speech for the first time in history by radio across the Atlantic to Paris, as well as across the continent to California and well out into the Pacific.

Demonstrating the effectiveness of modern transmission by wire and radio circuit, Mr. Gilman arranged a conversation between Dr. Compton and Dr. Gregg Sinclair, president of the University of Hawaii, in Honolulu.

Experiments which have led to the establishment of telephone service with automobiles began in Boston in 1934 when a group of Bell Telephone engineers began what is believed to be the first comprehensive study of communication by radio with automobiles at frequencies just above the short wave band.

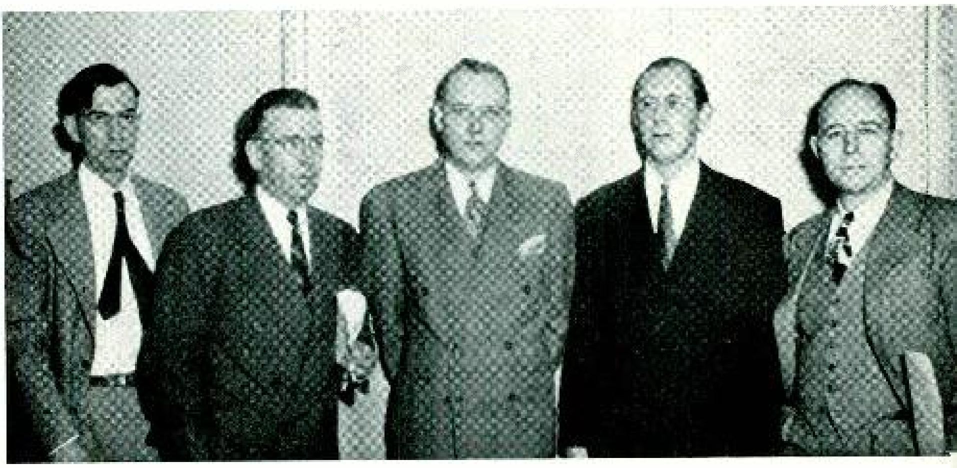
At present, telephone service to automobiles is being given in nearly seventy cities and towns in the country and nearly 5,000 automobiles can be reached from any telephone, a fact which was quickly demonstrated by a call to a car traveling in Springfield. Mr. Gilman suggested the possibility of more than 10,000 telephone-equipped vehicles in the New York City area alone within a few years. He added that telephone service is already available to trains on certain railroads operating between New York and Washington.

Radio telephone service to localities so remote that the construction of land circuits would not be economical are now being carried on and tests are being made on a radio telephone circuit to a number of isolated ranches in the vicinity of Cheyenne Wells, Colorado, and a demonstration call from Cambridge proved the effectiveness of this new and valuable service to remote settlements.

One of the first post-war applications of microwave radio was an installation linking Hyannis and Nantucket in 1946. This system was developed by the Laboratories for the United States Signal Corps during the war and was used during the invasion of Germany. A telephone call to Nantucket quickly demonstrated the effectiveness of this new method of communicating with the island.

High-Speed Photography Committee Meets at West Street

The initial meeting of the Committee on High-Speed Photography and Photographic Engineering of the Society of Motion Picture Engineers met at 463 West Street on January 27 to deal with problems of high-speed photography. M. J. Kelly extended greetings of the Laboratories to the fifteen members of the Committee who represented various organizations and laboratories. J. H. Waddell was chairman of the meeting, during which Dr. H. E. Edgerton of Massachusetts Institute of Technology was selected as vice-chairman and Arthur Neyhart of Douglas Aircraft Corporation, secretary. Plans were made for a symposium covering major phases of high-speed photography to be presented in October at the fall meeting of the Society of Motion Picture Engineers in Washington. Because of the widespread sources of data on high-speed photography, it was deemed necessary to garner all the information available and present it at this symposium. Various subcommittees were set up for the intensive study of lighting, education and improvement of the quality of the manufactured product.



Participants in the initial meeting of the Committee on High-Speed Photography and Photographic Engineering of the Society of Motion Picture Engineers, left to right, chairman J. H. Waddell; M. J. Kelly, who addressed the meeting; M. L. Sandell, of Eastman Kodak Company; J. A. Maurer, Vice-President of the S.M.P.E.; and H. E. Edgerton, of Massachusetts Institute of Technology

A.I.E.E. Convention in Pittsburgh

The Winter General Convention of the American Institute of Electrical Engineers, held from January 26 to 30 at Pittsburgh, was attended by a number of members of the Laboratories. A highlight of the meeting was the Eta Kappa Nu Recognition Dinner, at which R. R. Hough, J. R. Pierce and N. I. Hall (a member of the Laboratories from 1940 to 1947 and now with Hughes Aircraft) received awards for 1947 as outstanding young electrical engineers.

Papers presented by members of the Laboratories were: *Rectification Properties of Silicon and Germanium* by J. H. Scaff; *Quadrature Operation of Filamentary Thermionic Gas Tubes* by V. L. Holdaway; *Recent Improvements in Loading Apparatus for Telephone Cables* by S. G. Hale, A. L. Quinlan (Western Electric) and J. E. Ranges; *Attenuator Materials, Attenuators, and Terminations for Microwaves* by G. K. Teal, M. D. Rigterink and C. J. Frosch (including a demonstration of microwave attenuator materials by H. J. Kostkos. The paper and demonstration were repeated on a second day at the request of the sponsoring committee.); *Copper-Oxide Varistors in Communication Circuits* by N. Y. Priessman; *Network Theory Comes of Age* by R. L. Dietzold; *Crystal Filters Using Ethylene Diamide Tartrate in Place of Quartz* by E. S. Willis; *Design and Performance of Ethylene Diamide Tartrate Crystal Units* by J. P. Griffin and E. S. Pennell (including a demonstration of resonances and the showing of colored slides); *Growing Crystals of Ethylene Diamide Tartrate* by A. C. Walker and G. T. Kohman (illustrated by means of a colored motion picture entitled *Crystals While You Wait*, prepared and shown by J. J. Harley); and *Development of High Permeability Iron* by G. W. Elmen (retired) and E. A. Gaugler, both of the Naval Ordnance Laboratory.

Among those who attended the convention were O. E. Buckley and D. A. Quarles who attended a meeting of the Institute's directors; J. A. Becker who was appointed a member of the Committee on Basic Sciences and Chairman of the Basic Sciences Subcommittee on Electrical Properties of Solids; J. D. Tebo who presided at the Basic Science session; W. L. Casper who presided at the session on Synthetic Crystals; and R. K. Honaman who participated in meetings of the Publication and of the Summer Convention Committees.

Returning from the Eta Kappa Nu Award dinner at Pittsburgh, the Laboratories winners, J. R. Pierce (second from left), and R. R. Hough (fifth) exhibit the trophy to the runners-up: J. W. McRae, W. E. Ingerson, W. A. Depp, and J. A. Morton

A T & T Files Rates for 15,000-Cycle Program Channels

To meet the possible requirements of FM radio broadcasters, the American Telephone and Telegraph Company recently extended its offering of program channels by filing rates with the Federal Communications Commission for intercity channels with a frequency band extending from about 50 to 15,000 cycles. Program channels furnished by the Company, utilizing frequency bands with upper limits ranging from 2,500 to 8,000 cycles, are being used by AM and FM broadcasters.

The regular monthly rate filed by the Company for an intercity channel of the new 15,000-cycle band is $10 a mile. This compares with a rate of $6 a mile for a 5,000-cycle channel—the type most commonly used by radio broadcasters at the present time. For those who wish the service for short periods, the hourly rate for intercity service is 28 cents a mile for the 15,000-cycle channel, which compares with 15 cents for the 5,000-cycle channel. There are additional charges for station connections and local facilities.

O. E. Buckley Visits West Coast

O. E. Buckley visited telephone headquarters of The Pacific Telephone and Telegraph Company in Seattle, Portland, San Francisco and Los Angeles during January, where he spoke

Carleton Shugg, Manager for the Atomic Energy Commission at Richland, Wash., describes the Hanford Works to O. E. Buckley

to groups of telephone employees on new developments in the Laboratories. In connection with his trip, he also visited the Hanford Works of the Atomic Energy Commission at Richland, Washington, as a member of the Industrial Advisory Committee of the Commission. Dr. Buckley also visited the University of Washington, the Radiation Laboratory of the University of California, Stanford University, and the California Institute of Technology. Side trips were made in the State of Washington to the Coulee Dam and, in southern California, to the Palomar telescope.

Snow Breaks New York Traffic Record

Old Man Weather's influence on telephone traffic has seldom been more forcefully demonstrated than last December when, on Friday the 26th, the day of the Great Snow of '47, telephone calls in New York City reached an all-time high of 17,413,900. And on the following Monday, the 29th, the calls of snow-bound New Yorkers jumped nearly another million to 18,321,300, the fourth record-breaking day of the year. This all-time peak was about 25 per cent higher than the average. The New York Telephone Company's state-wide total for the 29th was 27,200,000 calls.

Whippany Radio Laboratory Goes Dial

On January 22 the cutover from manual to dial telephone service was effected at the Whippany Radio Laboratory despite the severe ice storm which had previously crippled that area and drained the manpower facilities of the New Jersey Bell Telephone Company in repairing storm damage. The new 701A dial P.B.X. with a 605A type switchboard, was cut over at 12:00 noon, with L. H. Brown of New Jersey Bell pulling the snivies which blocked the relays, while O. M. Glunt, Director of the Whippany Staff, and F. S. Willard of New Jersey Bell, stood by. Also present were R. D. Donaldson, Traffic Superintendent of Morristown, who coördinated the cutover; T. Wielette, District Equipment Supervisor; and H. G. Whittaker, District Maintenance Supervisor.

The sound-treated operating room at Whippany is now located in the new wing of the Administration Building. Its terminal room is immediately beneath. There are 312 equipped extensions, three working positions on the board and two blank ends. Fifteen pairs of cords are provided at each position as well

Ready to put through the first calls on the new Whippany P.B.X. board are Louise Norback, left, and Mariane Luckey. O. M. Glunt of Whippany, standing, left, P. M. Meany, center, and F. S. Willard, right, both of New Jersey Bell, watch with interest

as a dial for future use when ten dial tie trunks to Murray Hill will be added. There are fourteen tie trunks to New York locations of the Laboratories.

Louise Norback, who has been at Whippany since 1942, is chief operator; and Mariane Luckey and Agnes Palmer, the operators.

THE TELEPHONE BUSINESS IN 1947

A Digest of the 1947 Annual Report

By R. K. Honaman
Director of Publication

More telephones have been added to the Bell System since VJ Day than we had at the end of the first 40 years of telephone business. Indeed, the year 1947 saw the greatest expansion of telephone facilities in the history of the business. New construction throughout the country cost a record outlay of $1,185,000,000.

Thus Mr. Gifford's annual report of the American Telephone and Telegraph Company, which summarizes the business operations of the Bell System, sets forth the outstanding accomplishments in meeting the continued high demands the American people are making upon telephone service.

The number of telephones and the cost of construction do not tell the whole story. In 1947 the number of calls reached a figure of 166,000,000 a day, almost 50 per cent more than the daily rate at the end of the war.

This demand and this rate of use are in themselves evidence of the high quality of service which American telephony affords the public.

The quality of service fell off a little during the war. This was inescapable with manpower and material shortages under wartime conditions. It has been steadily improving and, while there is still progress to be made, the service was noticeably better in 1947 than it had been the previous year.

The dramatic increase in the amount of central office equipment added since VJ Day is illustrated by the fact that this new equipment would serve more telephones than the Bell System had before the war in the entire area west of the Mississippi River.

The work of the Laboratories is reflected in the new equipment installed. Our development of machine switching apparatus affords an excellent example. The number of dial telephones has gone up from 14,164,000 at VJ Day to 18,689,000.

How many people are required to operate this vast business? The number of Bell System employees was the largest in history at the end of 1947–663,000, which is nearly 46,000 more than were employed in 1946. Thus, while the number of telephones served by dial offices was at the highest point in history, the business has grown so that more employees than ever are needed to operate it.

While the number of employees was increasing, the number of owners of the business also continued to grow. The number of A T & T stockholders went up to 723,000, of which about 50,000 are employees. In addition more than 250,000 employees are buying stock under the employee-stock plan, 4300 of them members of the Laboratories. Altogether more than 1,330,000 people, or nearly one out of every hundred men, women and children this country wide, either work in this business or own a share in it.

The American people paid $2,224,000,000 for the services of our business in 1947. While this was about 6 per cent higher than the revenues of 1946, the cost of rendering this service went up by more than 12 per cent, mainly due to the increased wages paid in 1947. As a result, the total income available for interest and dividends to stockholders went down in spite of the very high level of activity in the business. These earnings were about $228,000,000. While this figure may sound large, it must be remembered that a vast amount of money, more than $5,000,000,000 has been invested in the business. In reality the total income is only 4.5 per cent of the capital invested in the business. If a small businessman were risking $1000 of his savings in his business and could earn only $45 on it, he and his business associates would agree the profit was pretty slim. As a matter of fact, this was the lowest rate in the history of the Bell System, except in the depression years of 1932 and 1933.

The problem of maintaining earnings at an adequate level is one of the most important confronting the business today. The building of new plant requires money and this money must be obtained chiefly from investors, from individuals with savings to invest where they can earn a fair return and from insurance companies and other institutions who hold funds for others. Investors will not put their money in a business unless they believe it will be able to earn them a fair return. That is one reason why the Bell System companies have been asking the state utilities commissions to approve increases in rates. Time and again it has been pointed out that fair wages, fair rates, and a fair profit for the investor are the three pillars upon which this business has grown and has consistently given the American public a high quality of service. Today's telephone rates, unchanged in many cases for more than 20 years, are a bargain and they will continue to be a bargain even under the higher rates we are seeking.

If good service is to be continued and given to all who want it, if the wages and jobs of employees are to be made attractive, there must also be a fair profit for the investor who entrusts his money to the business. It is mostly his money that buys the facilities that make our jobs and help us to provide good service. Increased rates have been approved in more than thirty states and other applications are pending. They will be needed if this business is to continue to thrive.

The 1947 report reflects again the importance of the Laboratories' work in the growth of the business. It is not an overstatement to say that the Bell System is placing great dependence upon the Laboratories' technical leadership to go forward in the days ahead.

"Our country's future technological progress and the continuation of our industrial preeminence depend on research," the report declares. "It is our policy to maintain a high level of research activity at all times, ever seeking new, better and cheaper ways to provide communication services."

Mr. Gifford's own words in the report sum it up this way: "Such developments, together with the continued demand for service and for higher grades of service which can be supplied as more facilities are installed and become available, indicate that the telephone is far from having reached its ultimate usefulness. Its future promises much."

This account of the operations of the business in which we all have so large an interest is necessarily rather brief. A reading of the full Annual Report is well worth while. Copies are available in the Library.

During the Months of November, December and January the United States Patent Office Issued Patents on Applications Filed by the Following Members of the Laboratories

T. Aamodt
H. M. Bascom
A. C. Beck
R. Black, Jr. (2)
R. R. Blair
W. H. Boghosian
W. L. Bond
L. J. Bowne
R. M. Bozorth
D. E. Branson
H. W. Bryant
H. T. Budenbom
H. A. Burgess
E. T. Burton
J. A. Carr
A. M. Curtis
J. Davidson
K. H. Davis
C. Depew
T. L. Dimond
S. Doba, Jr.
J. O. Edson
E. B. Ferrell
A. G. Fox (4)
A. L. Fox
C. S. Fuller
W. D. Goodale
H. L. B. Gould
R. E. Hersey (2)
W. H. Hewitt
H. A. Hilsinger
W. H. T. Holden
F. A. Hubbard
J. B. Johnson (2)
E. M. Julich
W. Keister
R. W. Ketchledge
F. S. Kinkead
R. J. Kircher
J. A. Krecek
E. Lakatos
A. G. Lang
G. A. Locke
W. A. Marrison
W. P. Mason (5)
B. McKim
D. A. McLean
H. J. McSkimin
L. A. Meacham
W. A. Mehmel
G. W. Meszaros
O. R. Miller
E. R. Morton
W. W. Mumford
P. Neill
F. R. Norton
H. G. Och
B. M. Oliver
R. L. Peek
W. G. Pfann (2)
T. J. Pope
R. K. Potter
D. A. Quarles
C. D. Richard (2)
F. F. Romanow (2)
J. H. Scaff
D. H. Schell
O. A. Shann
A. M. Skellett (3)
H. C. Theuerer
D. E. Trucksess
H. S. Wertz
A. H. White
H. T. Wilhelm
G. W. Willard
S. B. Williams

Young veterans, their wives and friends, at the Dance of Western Electric Post No. 497, standing, left to right, Mrs. George Wieland, Mrs. and Mr. W. C. Bengraff, Mr.* and Mrs. R. I. Nolan, Ralph Nelsen* and Alice Davison. Seated, left to right, R. H. Funck,* Julia Klos,* Walter Kennedy and Terry Macri in foreground; Mrs. and Mr. Wm. Brown, J. A. Ceonzo,* Jean McDonald,* J. B. Kennedy,* Jean Gorski, C. H. Dalm* and Marie Tighe**

*Members of the Laboratories.

Young Veterans Dance

Over ninety couples attended the American Legion Dance of Western Electric Post No. 497 on Friday evening, January 30, at the Grille Room of Hotel Taft. The dance, comprised for the most part of Laboratories' veterans of World War II and their wives, was the first undertaking of its kind and was a success. Music was furnished by Don Henri and his orchestra; entertainment by a dance team from "Finian's Rainbow" and by a novelty skating team, with audience participation. Members of the Laboratories who were active on the Dance Committee include C. A. Dalm, H. S. Hopkins, G. J. McArdle and R. C. Nance, who is Assistant Adjutant of the Post.

Other members of the Laboratories who hold office in the Post are D. H. MacPherson, vice-commander; H. S. Hopkins, finance office; and J. M. Marko, sergeant-at-arms.

March Service Anniversaries of Members of the Laboratories

35 *years*

W. W. Carpenter
J. E. Ranges
F. C. Willis

30 *years*

Vina Allan
A. G. Eckerson
E. L. Fisher
C. D. Hartman
A. L. Matte
Lawrence Messer
H. T. Reeve
R. J. Riley
J. C. Schelleng
Irene Spencer

25 *years*

E. H. Ackerson
Agnes Dowd
H. C. Essig
W. O. Fullerton
M. E. Krom
A. J. Munn
J. F. Neill
Raymond Rulison
H. W. Sanford

20 *years*

Joseph Baumgartner
A. R. Brooks
Patrick Byrne
John Darida
J. H. Hershey
W. H. Kamper
H. V. Kerr
G. P. Lenormand
Virginia Niemeyer
Frank Reck
G. A. Sander
A. J. Sarka
J. A. Schumm
F. W. Seibel
S. P. Thomson
Henry Watkinson

10 *years*

Enette Goddard
Josephine Monte
Mary Morrissey
L. L. Spangenberg
Elizabeth Watrous

Orientation Course

To brief those members of staff who have joined us since V-J Day in how the Laboratories is organized and how it operates, a series of talks and guided tours were held during the period February 3 to 10, inclusive. At the first session a brief introduction was given by R. A. Deller; a welcoming address was given by O. E. Buckley; the organization of the Bell System was outlined by R. L. Jones; and the Laboratories' various functions were described by M. J. Kelly. On February 4, a visit to the Systems Development laboratories was preceded by a talk on that department's work by A. B. Clark; similar visits to Research and Apparatus Development laboratories were introduced by Ralph Bown, D. A. Quarles and W. H. Martin. Local telephone service was discussed by F. J. Kurriss, Equipment Engineer of the New York Telephone Company. On successive days, the newcomers visited dial central offices of the New York Telephone Company and the Long Lines terminal and control rooms; at the latter location, they heard a discussion of long distance telephone service by E. Nichols, Circuit Layout Engineer.

Inventions and patents were covered by M. R. McKenney and R. A. Heising, the Laboratories as a business institution by W. Fondiller, transmission engineering and development by G. W. Gilman and H. A. Affel, and nation-wide dialing by F. F. Shipley. A visit to the Kearny Works was preceded by talks on the Western Electric Company by L. B. Butterfield, assistant superintendent of manufacturing engineering, H. A. Ewing, assistant superintendent of public relations, and H. H. Lowry. Personnel and publication policies, and the operations of these, were described by F. D. Leamer and R. K. Honaman.

A. S. Pinkus, Chess Master, competed with 19 *players in a simultaneous chess match on January* 30 *in the West Street Auditorium. E. Sobczyk received a prize for winning a game from Mr. Pinkus; J. R. Glaser, for cleverly executing a unique attach; and B. Stauss, for being the last man to be knocked out. Shown in the photograph, standing, outside the circle, H. G. W. Brown, Chairman of the Chess Club, and, inside, Mr. Pinkus. Seated clockwise from him are: R. Weihs, G. A. Ritzler, G. H. Weber, F. A. Anderson, J. R. Glaser, J. J. Nichik, E. Sobczyk, W. Gansz, M. A. Specht, W. A. Matson, P. E. Loux, E. C. McGuinness, W. C. Babcock, E. G. Andrews, L. E. Abbott, B. Stauss, H. C. Fleming, A. J. Gaborc and M. D. Brill*

We See by the Papers, That

New Delhi: Dr. W. A. Shewhart of Bell Telephone Laboratories, New York, who is known throughout the world as the father of the quality control movement, is arriving in Bombay on December 12.

The Indian Statistical Institute of Calcutta and the Indian Standards Institution will together arrange his tour to the various important industrial centers in India, after which Dr. Shewhart may make certain concrete proposals for the inauguration of a quality control movement in India.

Dr. Shewhart will be the guest of Sir C. D. Deshmukh, Governor of the Reserve Bank and President of the Indian Statistical Institute. He will stay in Bombay for about a week before his departure for Calcutta, and will contact important industrial interests.—A.P.I.—*Sunday News of India, December* 7, 1947.

American Physical Society Holds Its Annual Meeting at Columbia

The American Physical Society held its 1947 annual meeting at Columbia University from January 29 to 31. The following members of the Laboratories presented papers: H. J. WILLIAMS, *Ferromagnetic Domains;* E. A. NESBITT and H. J. WILLIAMS, *Measurement of Longitudinal Magnetostriction With Automatic Recording;* W. SHOCKLEY, *Energy Calculations for Domains;* H. J. WILLIAMS and R. M. BOZORTH, *New Magnetic Powder Patterns and Their Interpretation;* W. A. YAGER, *Ferromagnetic Resonance Absorption at Microwave Frequencies;* G. C. DANIELSON, *Orientation of Domains in Polycrystalline Ba Ti O_3;* C. H. TOWNES, D. B. WRIGHT and F. R. MERRITT,

Pure Rotational Spectrum of ICR; F. R. MERRITT and C. H. TOWNES, *Stark Effect in High Frequency Fields;* and G. L. PEARSON and J. BARDEEN, *Electrical Properties of Pure Silicon and Silicon Alloys.* At the meeting, J. R. PIERCE presided over the Electron Physics session, J. B. JOHNSON, over the Division of Electron Physics session, and W. SHOCKLEY, over the Solid State session. Other papers presented were by CONYERS HERRING, *Some Considerations Concerning Theories of the Oxide Cathode;* J. B. JOHNSON, *Secondary Electron Emission From Insulators;* K. G. MCKAY, *Conductivity Induced in Insulators by Electron Bombardment;* J. M. RICHARDSON, *On the Anomalous Dielectric Behavior of Ba Ti O_3 Near O^0K;* and W. SHOCKLEY, *Electronic Polarizability of O^- in Presence of Ti^{++}.* Those who attended the meeting included HARVEY FLETCHER, K. K. DARROW, W. S. GORTON, A. H. WHITE and S. O. MORGAN. Dr. Fletcher also participated in a meeting of the Council.

Retired But Active

C. J. DAVISSON, who retired from the Laboratories on November 1, 1946, after thirty years of service, is now a visiting professor of physics at University of Virginia. He is teaching both graduate and undergraduate classes and is supervising the research of some of the graduate students in physics.

GEORGE A. KELSALL is teaching freshman mathematics at Newark College of Engineering, including college algebra, trigonometry and analytical geometry. Previously he had taught mathematics at Seton Hall College in South Orange, and physics at Newark University. Mr. Kelsall's home is still in Belleville, New Jersey. He retired on November 1, 1945, following thirty-three years of service.

ARTHUR G. KINGMAN, who retired last August, is now engaged in general patent practice. His address is 60 Burnet Street, Maplewood.

News Notes

M. J. KELLY attended the Operating Vice-Presidents' Conference in New York from January 6 to 9. Dr. Kelly visited the Illinois Institute of Technology and the Armour Research Foundation during his trip to the Hawthorne plant, Chicago. He also visited the University of Missouri and the Missouri School of Mines and Metallurgy. During his visit to the School of Mines he addressed the local Chapter of Sigma Xi.

A. B. CLARK, with E. M. Deloraine of the International Telephone and Telegraph Corporation, conducted a colloquium on *Research and Development in Telecommunications* at the Industrial College of the Armed Forces in Washington.

D. A. QUARLES attended a meeting in Washington of the Committee on Electronics of the Research and Development Board. He visited Allentown with J. R. WILSON and V. L. RONCI for a conference on manufacturing problems on electron tubes.

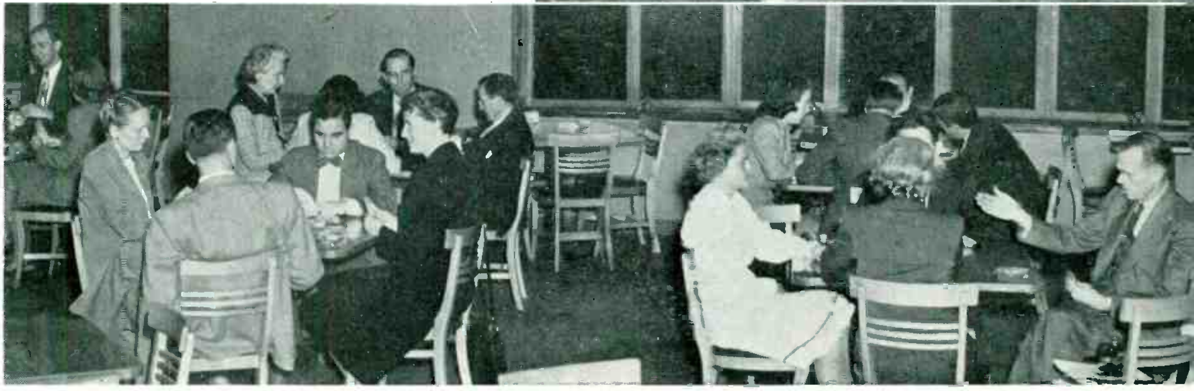
K. K. DARROW visited Brown University at Providence where he spoke before the Physics Colloquium on *The Physicist Looks at Metals.*

W. M. BACON visited the Teletype Corporation in Chicago for several days in January for discussions of teletypewriter apparatus to be furnished with teletypewriter switching systems.

Bridge at Murray Hill

With an active group of about fifty players, including fourteen women, the Murray Hill Bridge Club has been playing every Monday night since late September and will continue until the middle of April. Tournaments conducted include individual series, four-man team series and open-pair games. J. P. Griffin is chairman of the committee and he is assisted by Marie Wright, R. Black, H. W. Bode and W. H. Brattain.

The photograph at the top of the page shows the Murray Hill Bridge Club in one of its Monday night sessions; below that, left to right, A. P. Boysen, Dorothy Thom, F. H. Graham and G. F. Schmidt; then, M. E. Fine, Muriel Kossuth, W. H. Brattain and A. C. Pfister; and below, Ruth Haff, M. J. Burger, J. H. Ham, and Phyllis Taylor at the table on the left, and Margaret Ely, Margaret Packer (back to camera), F. Caroselli (partially hidden) and J. P. Griffin at the table on the right.

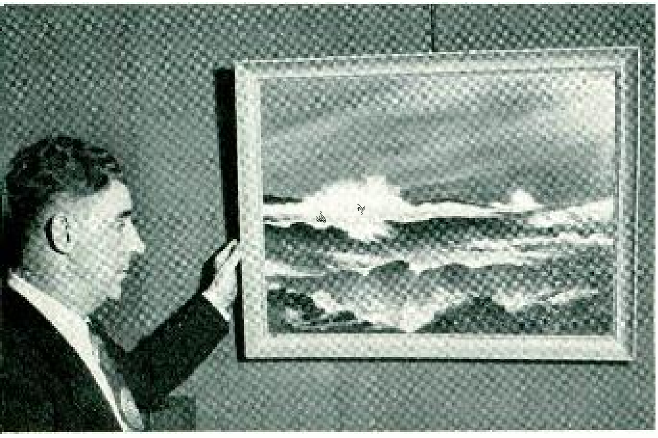


News Notes

W. Shockley spoke in Chicago on January 6 to a Colloquium Group at the Institute for the Study of Metals on *Slip Bands in Aluminum.* On the following day, Dr. Shockley gave the same talk at Case Institute of Technology in Cleveland. He also spoke at M.I.T. on *Ferromagnetic Domains.*

U. B. Thomas, Jr., and R. D. de Kay visited New Haven to discuss with The Southern New England Telephone Company the nickel-cadmium storage battery installed in the Yale University P.B.X.

J. R. Townsend attended a meeting of the Board of Directors of the American Society for Testing Materials in Philadelphia. He was recently appointed chairman of the Adult Education Committee, Essex Falls, New Jersey.



This Seascape *by Luke Murphy of the Plant Department, shown above, was deemed acceptable and hung in the Irish Art Exhibit at the De Motte Galleries in New York during January. Included in the exhibit were paintings and sculpture by such well-known masters as Sir William Orpen, Sir John Lavery and Andrew O'Connor. Mr. Murphy, who joined the Laboratories in* 1941, *is a native of Liverpool, England. He has painted most of his life, having studied in art schools in Liverpool and in Wexford, Eire*

A. N. Holden addressed the Princeton Section of the American Chemical Society on *Growing Crystals.* He spoke on the same subject before the Mineralogical Society of Philadelphia.

I. V. Williams was present at the Philadelphia meeting of the A.S.T.M. Committee on Structural Sandwich Materials.

J. B. Howard witnessed extrusion trials at Tonawanda of new compounds for inside wiring cable and switchboard cable.

R. D. Heidenreich spoke on *Electron Microscopy* in the *Extension Course Series* sponsored by the American Chemical Society in Newark.

G. H. Williams' trip to Kearny concerned problems of lead attachment for EDT crystals.

J. B. DeCoste and G. F. Brown, Jr., were at Kearny on alpeth cable material problems.

G. R. Gohn and W. C. Ellis conferred at Philadelphia on test methods on lead alloys with engineers of the Philadelphia Electric Company. Mr. Gohn also attended a meeting of the A.S.T.M. Papers and Publication Committee, held in Philadelphia.

T. S. Huxham visited the C. F. Church Manufacturing Company, Munson, Massachusetts, to discuss plastics molding.

K. G. Compton discussed finishes, enameled wire and plastics at Hawthorne. On January 19 he addressed the American Society for Metals at Newark on *Corrosion of Metals.*

C. J. Frosch attended the National Technical Conference of Plastics Engineers in Detroit and served as chairman of the Program Committee of that meeting.

H. W. Hermance, G. H. Downes, C. A. Webber, O. C. Eliason and J. O. Johnson discussed field test plans for studying the efficiency of air filtering systems in Pittsburgh and Ambridge, Pennsylvania, with The Bell Telephony Company of Pennsylvania. Mr. Hermance examined panel banks in Cincinnati. With T. F. Egan, he observed the performance of lubricated panel banks at Buffalo, where contact maintenance problems were discussed with New York Telephone Company engineers.

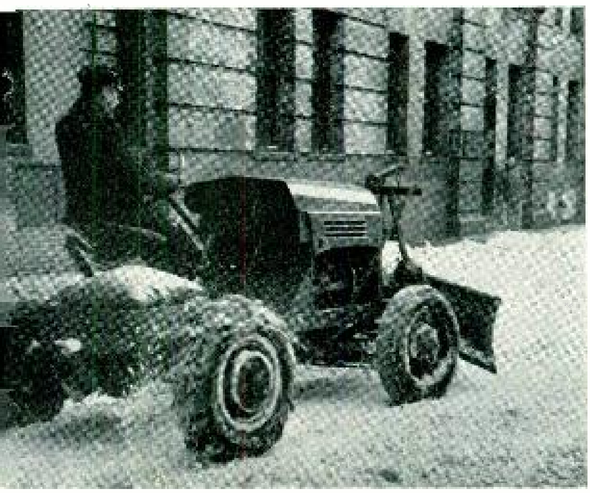
R. H. Galt spoke at the Y.M.C.A., Mountain Lakes, New Jersey, on *Problems Involving Sound Waves* before an audience of boys interested in science.

K. G. Jansky addressed a meeting of the Institute of Radio Engineers, Washington Section, in Washington on January 12. His topic was *Microwave Repeater Research.*

G. B. Baker attended discussions at Hawthorne on step-by-step relay problems.

H. N. Wagar, W. C. Slauson and J. E. Shafer conferred at Hawthorne on U relay and miscellaneous coil questions.

At the plant of the General Radio Company at Cambridge, the late R. G. McCurdy, E. I. Green, and H. A. Lewis with R. H. McCarthy and W. E. Burke of Kearny observed that company's methods of handling manufacture of precision electronic equipment.

› convince the Jersey contingent that there really was snow in New York, Cameraman Jack Stark took these ›tures of Martin Quinn (a) on the tractor plow pressed into service from Deal after the December 26 storm d of Christopher Flynn (b) with one of the two hand plows which have had plenty of hard use around 463 est Street this winter. Note that the Plant Department has kept the streets as well as the sidewalks cleared

THE SAME GROUP, with F. J. GIVEN and P. S. DARNELL, visited Haverhill to address approximately forty engineers of Western Electric's management and supervisory staff. The meeting was to repeat the high spots of talks presented at Kearny on December 10 and 11, 1947. These discussions covered current and future design and production problems on transmission systems and apparatus. An unusual feature of the meeting was a talk by M. J. KELLY in absentia by means of the playing of a recording of his speech at the opening of the December 10 meeting at Kearny.

H. E. VAIDEN visited the Burlington and Winston-Salem Shops in connection with hearing aid transformers.

R. A. SYKES attended a meeting at Wright Field of the Research and Development Board Sub-panel, on frequency control devices.

C. A. WEBBER and O. C. ELIASON consulted with telephone company representatives in Pittsburgh and Cleveland on air filtration for central offices.

R. E. POOLE went to Burlington to participate in a staff conference.

A. F. KANE was at the Patent Office in Washington during January in connection with patent matters.

AT WINSTON-SALEM recently were P. A. CIAMPI for conferences on *component drawings on military projects;* J. B. D'ALBORA, *local oscillator problems;* J. H. HERSHEY, *system testing of radar;* O. H. DANIELSON with C. A. CALHOUN, *discussions on the manufacture of radar;* E. T. MOTTRAM and J. R. HAVILAND, *radar conferences;* H. MORRISON, *production problems;* E. H. JONES, *standardization*; and J. J. SCANLON, *radar production.*

H. E. MARTING and K. G. COMPTON visited the Western Electric Company at Hawthorne to discuss improved insulating finish for wire holding devices.

D. H. SMITH visited the Race Street panel sender tandem office in Philadelphia in connection with the modification of senders for the No. 5 crossbar installation at Media.

V. T. CALLAHAN attended a meeting of the Society of Automotive Engineers at Detroit. He also took part in inspection tests of engine alternator equipment at the Duplex Truck Company in Lansing.

J. J. MARTIN and E. E. WRIGHT discussed insulating material problems with Hawthorne and Archer Avenue engineers.

G. DEEG conferred with the supplier of polyester molding compounds at the Libbey Owens Ford Glass Company in Toledo.

J. W. MCRAE, who was the speaker at the February meeting of the Deal-Holmdel Colloquium held at Deal on February 6, selected as his subject *Bell Telephone Laboratories Interests and Objectives in Television.* As a member of the Navy Industrial Association Visiting Committee, Mr. McRae observed the work of Radio Division I of the Naval Research Laboratory in Washington on January 8 and 9.

G. H. WILLIAMS attended the technical sessions of the Society of Plastics Engineers' meeting held at Detroit.

A. H. FALK was one of the speakers at the symposium on wear tests for plastics held at New York Naval Shipyard.

J. F. SWEENEY and W. A. FUNDA observed preflight tests of radar equipment during January at the Sperry Gyroscope Company in Garden City.

W. C. TINUS, W. H. C. HIGGINS and R. R. HOUGH attended a conference at Fort Monmouth. Mr. Hough and W. R. RUSHMORE visited Kuthe Laboratories to observe the manufacture of equipment for radar.

F. L. LANGHAMMER visited the N. R. K. Manufacturing Company, Chicago, and the Brooks and Perkins Company, Detroit, to confer on antenna problems. W. GABEL also visited Brooks and Perkins concerning the fabrication of material for military applications.

J. F. MORRISON attended the RMA meeting of a Television Standards Committee in New York. Mr. Morrison and B. H. KLYCE consulted with engineers of the Radio Corporation of America Laboratories at Princeton.

J. B. BISHOP and H. A. REISE made a trip to Pittsburgh for conferences at Station WPGH. P. H. SMITH attended a committee meeting of the I.R.E. in New York.

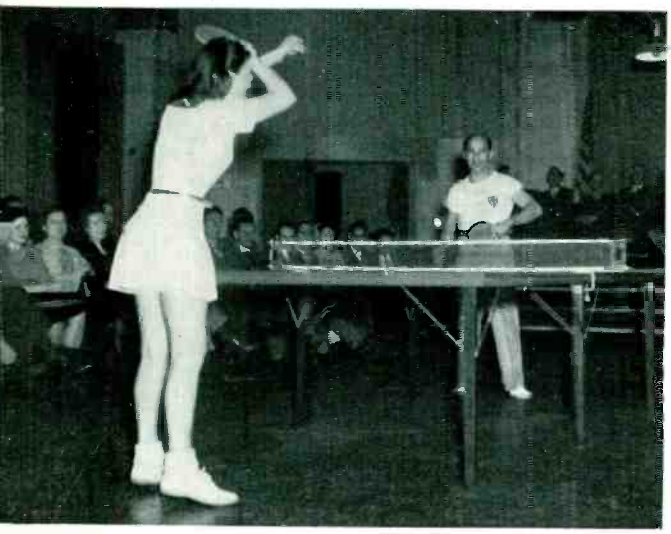
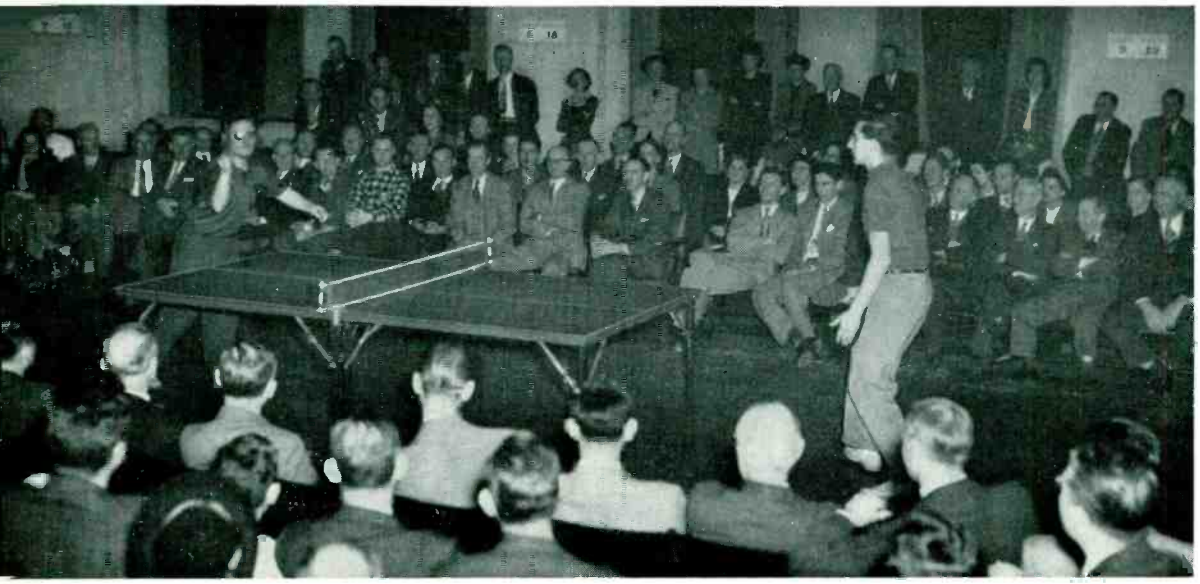


Table Tennis Exhibition

An enthusiastic group of Laboratories men and women gathered in the Auditorium on the evening of February 4 to see an exhibition of table tennis by champions in that field. Held under the auspices of the Bell Laboratories Club, the exhibition was attended by nearly two hundred people. The participants were Peggy McLane, Women's Singles Champion of Canada, and Laszlo Bellak, former U. S. and World Champion, shown at the left, and Edward Pinner and Cy Sussman, each a former U. S. Double Champion, shown below. Special arrangements were made for members of the Laboratories to bring their families in to see the matches. Afterwards, youngsters in the group received autographed balls from the participants.



The girl with the lovely smile is Adela Wojtaszek of the Apparatus Development Files who is charging a Western Electric Shop drawing to G. Dodd for reference. Adela's twin, Stanley, worked in the Commercial Relations Department before he was granted a leave for military service and subsequently a personal leave under the GI Bill of Rights to study engineering at Columbia University

R. A. CUSHMAN and R. W. BENFER were in Cleveland at the Warner and Swasey Company.

H. T. BUDENBOM participated in a conference of the RMA Wave Guide Committee at the Hotel New Yorker.

E. A. BESCHERER, F. C. WARD, H. A. WHITE and H. D. MADDOX participated in conferences at the Radio Condenser Corporation, Camden, on radar production.

J. H. COOK visited Douglas Aircraft in California on airplane radar.

O. H. DANIELSON conferred on military projects at Burlington.

J. B. D'ALBORA went to the Gorham Company, Providence, regarding balanced converters.

J. W. SMITH and E. F. NIMMCKE discussed the design of new fire-control equipment at the Bureau of Ordnance, Washington.

J. C. BAYLES visited Washington with Western Electric representatives for conferences on proposed specifications with the Bureau of Ships.

W. H. DOHERTY spoke before the Rotary Club of Morristown on the subject *Europe and the Marconi Congress*. The talk had previously been given by Mr. Doherty at the Whippany Laboratory and in the city of Summit.

A. J. BUSCH, R. C. DAVIS, J. E. GREENE, F. A. KORN, J. MESZAR and R. J. MILLER visited Philadelphia in connection with No. 5 crossbar.

G. W. GILMAN, A. C. DICKIESON, D. MITCHELL, W. R. YOUNG and K. BULLINGTON conferred with F.C.C. engineers in Washington on mobile radio problems. Mr. Bullington and C. C. TAYLOR attended meetings of the Radio Technical Committee for Marine Services, also held in Washington.

W. W. FRITSCHI, W. C. LUCEK and K. LUTOMIRSKI witnessed field trials at Philadelphia and Richmond.

R. W. HARPER and H. H. ABBOTT were in Washington in connection with the cutover of the tandem dialing switching system for interconnecting Government agencies.

W. A. DEPP and W. H. T. HOLDEN'S paper, *Cold-Cathode Glow Discharge Tubes and Their Circuit Application*, was presented on February 3 at the Specialized Electronics Meeting of the A.I.E.E. Communication Division in New York.

E. ALENIUS selected the topic *Composition* for his A.S.M.E. lecture on January 22.

J. G. FERGUSON, W. E. GRUTZNER and W. WAGENSEIL were at Media in connection with No. 5 crossbar equipment problems. Mr. Ferguson consulted Hawthorne engineers on equipment development problems concerning the No. 5 system.

W. L. TUFFNELL and R. R. STEVENS conferred in Chicago on handsets and coin collectors.

T. H. CRABTREE was in Burlington in connection with hearing-aid problems. He also consulted the Raytheon Manufacturing Company in Newton, Massachusetts, relative hearing-aid vacuum tubes.

A. W. DRING visited Point Breeze on cable terminal matters.

R. M. C. GREENIDGE and A. L. RICHEY discussed cable terminals at St. Paul, Minnesota.

R. C. EGGLESTON was at Montreal and Windsor, with representatives of the Bell Telephone Company of Canada, observing tests of dead-end crossarms and studying sleet storm damage on poles and crossarms.

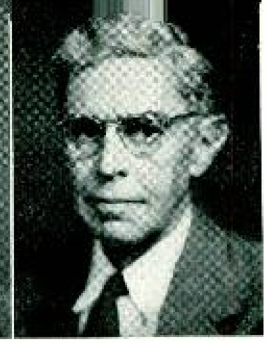
R. H. COLLEY continued development of non-pressure treatments of poles at Minneapolis. He conferred with the staff at the Forest Products Laboratory, Madison, Wisconsin, on the results of preservative evaluation tests.

C. S. GORDON and C. C. LAWSON were at Point Breeze in connection with development problems. Mr. Lawson also discussed thermoplastic jacketed inside wiring cable at the Western Electric plant at Buffalo.

RECENT DEATHS


Edward Montchyk
1876-1948


B. F. Merritt
1865-1948


C. J. Hendrickson
1879-1948

Edward Montchyk, January 17

Mr. Montchyk had completed 37 years of service when he retired in 1939. Before joining the Bell System's apparatus design group in 1902, he had received degrees from the University of Colorado and from Harvard, and he had also worked for the General Electric for two years. After joining Western Electric he was associated with the design of the toroidal coils and of cable terminals.

He went to Antwerp, Belgium, in 1907 for apparatus design work in the Bell Telephone Manufacturing Company, later becoming Chief Engineer and head of the Installation Department. In 1914 he returned to this country and for the next five years divided his time between New York and Hawthorne. Returning to Europe in 1919, he assisted in re-opening the Antwerp factory and then rejoined the Engineering Department in New York. In his work from then until his retirement, Mr. Montchyk was in charge of groups investigating insulating materials and physical properties of materials used in the telephone plant, and later of groups analyzing dial apparatus and developing improved methods for base-metal contact-noise control.

During World War II Mr. Montchyk was a member of the Naval Ordnance Laboratory and in 1945 was awarded the Meritorious Civilian Service Award for the development of underwater ordnance devices.

Benjamin F. Merritt, January 24

At the time of his retirement in 1927, Mr. Merritt was Assistant Curator of the Historical Museum. His career with the Bell System began with the New York Telephone Company in 1896. In 1907 when he was Superintendent of their Repair Shop, he left, but returned to the Bell System again in 1912 to work in the printing telegraph group at Western Electric. From there he transferred to the Apparatus Information Department and then to the Museum.

Since 1927 he had specialized in the repair of antique timepieces at his home at Towaco, New Jersey. He could make or replace any part of a clock, having learned his trade while a boy in Newton, Massachusetts, where he was born.

Charles J. Hendrickson, January 19

Mr. Hendrickson was a member of the Quality Assurance Department at the time of his retirement in October, 1945. He had been engaged in engineering complaint and quality survey work on central office apparatus, including step-by-step, panel and crossbar. His Bell System service began in 1914 when he joined the Western Electric machine switching development group. In 1917 he enlisted in the Army where he was commissioned a Second Lieutenant. After duty in the Air Service at Wright Field and Honolulu, he returned to the machine switching group. In the middle twenties he joined the newly formed Inspection Engineering Department (later Quality Assurance).

William E. Reid, January 23

A graduate of Columbia '15 with an E.E. degree in Electrical Engineering, Mr. Reid joined the D & R in 1920. He had previously been employed by the General Electric Company and the the Electric Bond and Share Company. His early work in the Bell System concerned pioneer studies on inductive coordination and on interference and noise in Type-C carrier telephone systems. Much of Mr. Reid's time was spent in the field in connection with the work of the Joint Subcommittee of the National Electric Light Association, now the Edison Institute, and the Bell System. In this connection he conducted carrier-frequency noise tests along the Mohawk Valley and in California and Colorado. He continued with the noise and crosstalk interference prevention group when the D & R was consolidated with the Laboratories in 1934. In the Dust Bowl area he made dust and precipitation static tests and visited weather stations from Oklahoma City to Albuquerque gathering data on the recurrence of dust storms for a study of the effect of dust on telephone lines. Later he was engaged in making crosstalk measurements in Missouri

W. E. Reid
1892-1948

L. C. Harff
1884-1948

and Nebraska for the Type-K carrier project.

During the war, Mr. Reid's work for the most part was on NDRC projects having to do with submarine detection. Since that time he had worked on the preparation of text material for *Bell System Practices* covering the apparatus used in radio mobile telephone systems.

Although physically handicapped since he was 21 years old, Mr. Reid was for many years a member, and later Fire Chief, of the local Fire Company at Hastings-on-Hudson, where he lived with his two sisters. He formerly bowled in the Laboratories' League, but more recently had devoted his free time, gardening.

Louis C. Harff, January 29

Mr. Harff had been a member of the Laboratories since 1944 when he joined the Plant Department Restaurant Service at Murray Hill. Having been self-employed in his own restaurant for many years, he was first assigned to handle meals for war workers on the night shift. Later he became known to many as the short-order cook who prepared and served them breakfast in the Cafeteria. He also serviced the Cafeteria counter during the noon hour. Mr. Harff is survived by his parents and two sisters.

Paul T. Sheridan, February 3

Mr. Sheridan of Western Electric was well known to older Laboratories people through his connection with public address system developments in the early 1920's. He joined the Western Electric Engineering Department in March, 1918, and later served in the Supply Department, in Electrical Research Products, Incorporated, and in the Specialty Products Shop before becoming a member of the Radio Division in June, 1942. He will be remembered for his pioneering work with public address systems and theater reproducing equipment for sound motion pictures, being active in many early installations. At the time of his death, in his forty-seventh year, which followed an extended illness, he was in charge of engineering and field service for the Hearing Aid Department of Western's Radio Division. Surviving are his wife, Mary, and daughter, Mary Frances.

News Notes

D. C. Smith and R. J. Nossaman visited the University of Massachusetts, Amherst, for a conference relative to the study of squirrel damage to aerial cables.

H. J. Kostkos attended A T & T regional conferences on displays and exhibits in Boston, Washington and Chicago, where he discussed the Bell Laboratories' part in the development of display equipments for the Bell System.

E. F. Smith has been appointed chairman of the Food and Fuel Oil Conservation Committee for New Providence Township, Union County, New Jersey. The committee's immediate principal task is that of Local Fuel Coordinator to obtain fuel oil for local emergency hardship cases from supplies to be made available by the State of New Jersey.

A. F. Bennett, C. F. Wiebusch and G. A. Wahl conferred at Archer Avenue on modifications of the coin collector.

H. I. Beardsley and C. L. Krumreich discussed telephone sets with Western Electric engineers at Archer Avenue.

R. Marino was at the Patent Office in Washington during January relative to interference proceedings.

E. B. Cave appeared before the Board of Appeals at the Patent Office relative to applications for patent.

A half-hour program of recorded music was given at the Arnold Auditorium on January 30 during the noon hour. Included in the program were a commercial recording by the Philadelphia Orchestra of Gershwin's "Rhapsody in Blue" and a special selection of "Student Prince" excerpts made as a hobby at home by H. C. Rubly. A. J. Akehurst and Phyllis Taylor were in charge of the program; E. C. McDermott operated the equipment.

At the West Street Art Exhibit Mary Ellen Buebe shows her Maine Coast, *the painting which received the most popular votes, to a group of her associates in the General Service Department. Left to right, are: Elizabeth Hall, Elizabeth Franklin, Muriel Munbrauer, Elizabeth Keane and Miss Buebe who had eleven pieces of work at the Exhibit.*

The Art Exhibit

Laboratories men and women, busy all day at desks, drafting boards, test sets and shop benches, go home in the evening to enjoy hobbies and avocations which, in many cases, are related to their work. Their art, sculpture and handicrafts were exhibited during the week of January 19 in the West Street Lounge. Phillip Reisman, who teaches the art class at West Street, judged the exhibit, of which Fred Frampton was chairman. The work considered best by members of the Laboratories was *Maine Seacoast,* a water color of the Portland Lighthouse, by Mary Ellen Buebe. Mr. Reisman awarded first, second and third prizes, respectively, for water colors, to C. E. Luffman, C. D. Richard, and J. Van Giesen, Jr.; monochromatics, one prize, to Mary Ellen Buebe, for oils, to J. C. Schelling, Fred Frampton and H. Erickson; and for sculpture, to Jewel Haege, Doris Ribett and P. Mertz. Six prizes, awarded for handicrafts instead of the usual three, were won by T. C. Rice, J. J. Reif, Sylvester Longo, H. C. Jonas, Fred Frampton and H. M. Elholme.

Murray Hill Sleet Storm Photograph

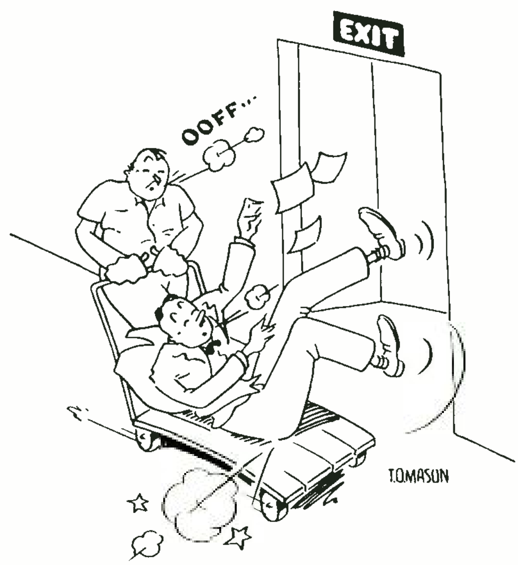
In response to several requests for copies of the February cover illustration, a limited number of reprints were made from the engraving, with a white border on all sides. Copies are available from Helen Trezza, Extension 234 on the West Street switchboard.

News Notes

Dr. Donald H. Menzel, Professor of Astrophysics at Harvard University, who visited Murray Hill on January 16, selected *Solar Activity in Communication* for the subject of his lecture in the Arnold Auditorium. Professor Menzel showed a motion picture of the movement of matter in the solar atmosphere. Dr. E. M. Purcell of Harvard also visited Murray Hill and spoke on *Nuclear Resonances at Radio Frequencies and Their Interpretation.*

The Laboratories were represented in interference proceedings at the Patent Office by N. S. Ewing before the Board of Interference Examiners and the Primary Examiner.

At a conference on the work of the Mechanics Research Group held at the Arnold Auditorium on January 21, W. P. Mason discussed *Torsional Crystal Method for Measuring Shear Viscosities and Elasticities in Liquids;* H. J. McSkimin, *Attenuation and Viscosity Dispersion in Polyisobutylene;* and W. O. Baker, *Strain Mechanisms.*



Don't be taken for a ride—use caution at exits