BELL LABORATORIES **RECORD**

VOL. XXVII • NO. 5 • MAY 1949

The new look in telephone instruments

A new telephone instrument with better hearing and speaking qualities, an improved dial and a volume control for its ringer is in final stages of development at Bell Telephone Laboratories. Incorporating new scientific principles, new technical art in applying them and new materials, pre-production models are still undergoing tests. It is expected that several thousands of the new sets will be manufactured this year and installed on a trial basis.

While nearly all of the more than 400 separate parts making up the set are of entirely new design, the new telephone will be completely interchangeable with telephones now in use and when the new set is connected with one of the current design, users of both telephones will benefit.

Major objectives in designing the new telephone were to provide, as economically as possible, better all-round service. An important feature is a novel "equalizer" which automatically adjusts the sound-level to compensate in part for the distance between the telephone and the central office. The dial on the new set has the numbers and letter prefixes outside the finger wheel and is sloped at a lower angle, affording better visibility.

Users are expected to be particularly pleased with the new instrument's ringer tone, which is both lower pitched and more resonant than that now in use. The unique volume control will permit the subscriber to adjust the loudness of the ringing tone to suit his needs. At its loudest, the tone carries further than the present one; when muted, it is softer.

Weight of the new telephone's handset—the transmitter and the receiver and the handle on which they are mounted—has been reduced 25 per cent. Slightly smaller than earlier models, it is designed to provide a better fit to the head. All parts save those in the handset are mounted on the base, with the housing serving only as a cover. This arrangement of parts on the base is expected to facilitate manufacture, installation and maintenance.

Denise O'Neill with the new 500-*type telephone set*

A microwave triode for radio relay

J. A. MORTON
Electronic Apparatus Development

In developing microwave relay systems for frequencies around 4,000 megacycles, one of the major problems is to provide an amplifier tube that will meet the requirements on gain, power output, and distortion over very wide bands. As the number of repeaters is increased to extend the relay to greater distances, the requirements on individual amplifiers for the system become increasingly severe.

For the New York to Boston project, a microwave amplifier was developed using already available velocity-modulation tubes. This amplifier, using four stagger-tuned stages, proved satisfactory for this service and, in fact, tests indicated that this system could be extended to considerably greater distances and still give good performance. It was apparent, however, that these amplifiers would not be satisfactory for a coast to coast system.

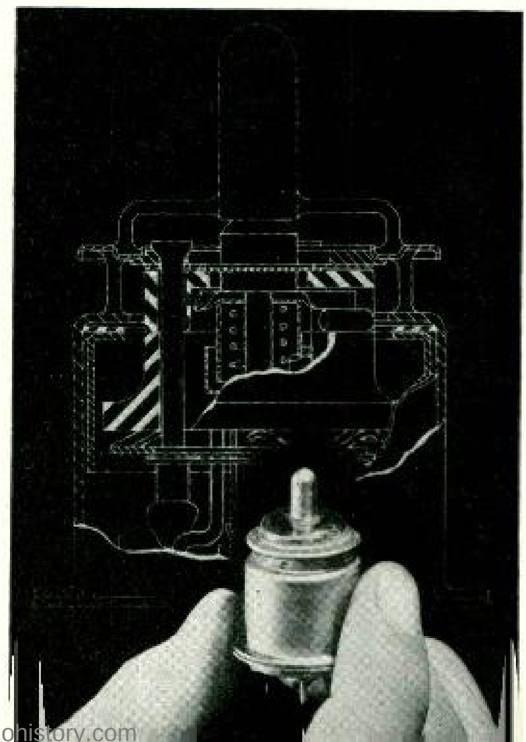
When this limitation became clear several years ago, a study was undertaken to determine which particular type of electron-tube amplifier then known had the best possibilities of being pushed to greater gain-band products. The results of this study indicated that a very promising way was to build, for operation at 4,000 megacycles, an improved planar triode, that is, one in which the active elements are on parallel planes.

In arriving at this conclusion, two general types of devices were considered: velocity-modulated, as in a klystron, and current-modulated, as in a triode. In the usual velocity-modulated devices, the bandwidth is limited equally in both the input and output cavity resonators; in the grounded grid triode, on the other hand, essentially only the output resonator limits, the input being very broad. Consequently, as the band is widened, the klystron loses gain at 6 db per octave of bandwidth, while the triode loses only 3 db per octave. If the two devices start with equal gains at some narrow bandwidth, the triode rapidly pulls ahead in gain as the bandwidth is increased.

The relative possibilities of increasing the gain, or transconductance, also seemed better with a triode. According to the simplest klystron bunching concept, the transconductance of a klystron may be increased indefinitely simply by making the drift time longer. Unfortunately, this simple kinetic picture does not take account of the mutually repulsive space-charge effects which set an upper limit to the useful drift time by debunching the electrons after a time. For a 2,000-volt beam in the 4,000-megacycle range, this upper limit is approximately three micromhos per milliampere. The 402A tube used in the New York to Boston system has already approached this limit within a factor or two.

In a triode there is also an upper limit to the transconductance that can be achieved

Fig. 1—The BTL 1553 *microwave triode with a cross-section drawing of it in the background*



by spacing cathode and grid more closely. This limit would be reached if the spacing were so close that the velocity produced by the grid voltage were of the same order as the average thermal velocity of cathode emission. The triode limit of some 10,000 micromhos per milliampere is, however, many times greater than that for ordinary klystrons. What is still more important is the fact that previous microwave triodes were still a factor of twenty to twenty-five below this limit, leaving considerable room for improvement. Thus, if mechanical methods could be devised for decreasing the cathode-grid spacing and at the same time maintaining parallelism between cathode and grid, it seemed highly probable that great improvements were available from a new triode.

Improvements are possible in a klystron by lowering the drift voltage, to whose three-fourth power the transadmittance limit is inversely proportional. To get transadmittance values anywhere near the triode, however, would require low voltages and close spacings somewhat like the latter. Furthermore, the tube would be more complex, having several grids instead of one, and would encounter difficulties involved in handling large currents in low-voltage drift spaces. A number of modifications of klystron operation was considered, but all looked more complex mechanically and more speculative theoretically than a triode.

By translating the known requirements on gain, bandwidth and power output into specifications for the actual triode dimensions, it was found that the input spacings of existing commercial tubes would have to be reduced by a factor of about five. In addition, cathode emission current densities would have to be increased about three to four times. A design was evolved in which the required close spacings could be produced to close tolerances by methods consistent with mass production requirements. The BTL 1553 tube was the result.

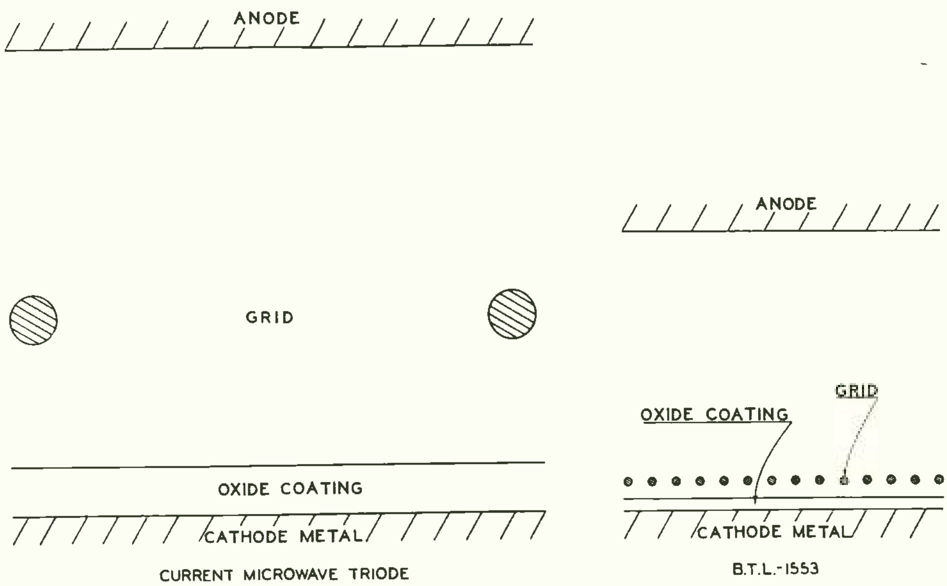


Fig. 2—Comparison of the spacings of the 1553 triode at the right with a previously existing microwave triode at the left

The electrode spacings of this tube and of a commercially available microwave triode are shown in Figure 2. In the 1553, the cathode-oxide coating is ½ mil thick, the cathode grid spacing is 6/10 mil, the grid wires are ⅓ mil in diameter, wound at 1,000 turns per inch, and the plate-grid spacing is 10 mils. It is interesting to note that the whole input region of the 1553 including the grid is well within the coating thickness of the older triode.

The arrangement of the major active elements of the tube are shown in Figure 3. This perspective sketch has been made much out of scale so that the very close spacings and small parts would be seen. The nickel core of the cathode is mounted

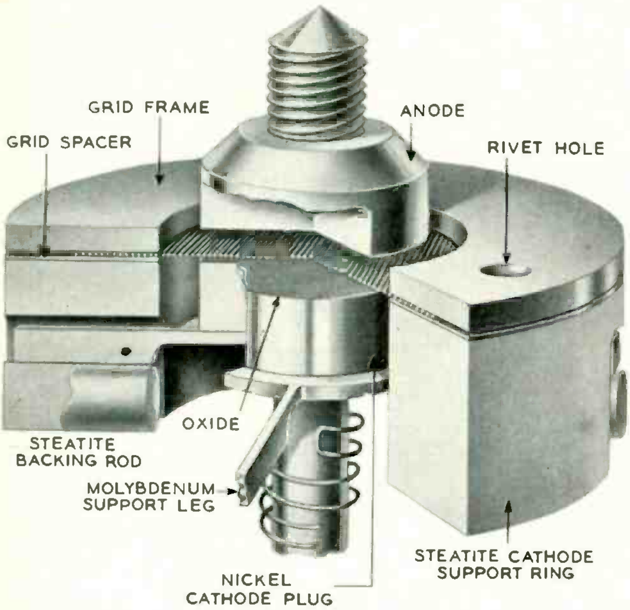
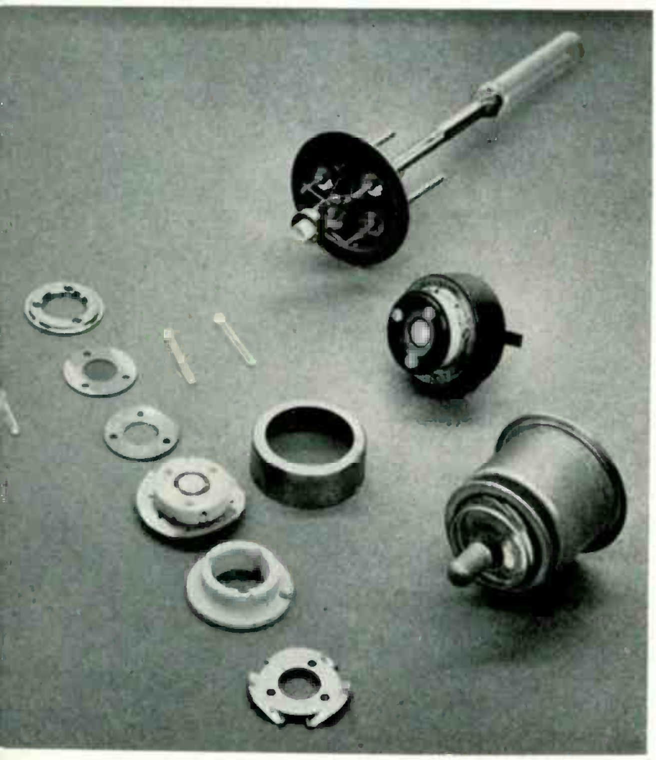


Fig. 3—Perspective drawing of the active elements of the 1553 *close-spaced triode*

Fig. 4—Physical appearance of the elements comprising the 1553 *triode*



in a ring of low-loss ceramic in such a manner that the nickel and ceramic surfaces may be precision ground flat and coplanar. A thin, smooth oxide coating is applied to the upper surface of the cathode by an automatic spray machine developed especially for this tube. With this machine, a coating of ½ mil ±0.02 mil may be put on under controlled and specifiable conditions. To insure long life with such a thin coating, it was necessary to develop coatings from two to four times as dense as those used in existing commercial practice.

The grid wires are wound around a flat, polished molybdenum frame that has been previously gold sputtered. The winding tension is held within ±1 gram weight to about 15 gram weight, which is about sixty per cent of the breaking strength of the wire. This is accomplished by means of a small drag-cup motor brake, a new method which was developed especially for these fine grids. The grid is then heated in hydrogen to about 1,100° C, at which point the gold melts and brazes the wires to the frame. The mean deviation in wire spacing is less than about ten per cent, and in fact these grids are fine enough and regular enough to be diffraction gratings as is shown in Figure 5. In this figure, a fourth order spectrum diffracted by one of these grids can be seen. The third order, which should be absent because the wire size is about one-third of the pitch, is much less intense than the fourth. Proper spacing of the grid is then obtained by a thin copper shim placed between the cathode ceramic and the grid frame. Its thickness must be equal to the coating thickness, plus the thermal motion of the cathode plus the desired hot spacing.

The cathode, spacer, and grid comprising the cathode-grid subassembly are riveted together under several pounds of force maintained by the molybdenum spring on the bottom of the assembly. The rivets are three synthetic sapphire rods fired on the ends with matching glass. In Figure 4, the parts comprising this assembly are shown in appropriate pile-up sequence at the left, and the completed cathode-grid subassembly is shown at the right between the bulb and the press. The grid-anode spacing of 10 mils is easily obtained by means of an adjustable anode plug whose surface is gauged relative to the bulb grid disc.

The high current density of 180 milliamperes per square centimeter, the thin, dense cathode coating, and the very close spacings posed a problem in obtaining adequate emission and freedom from particle shorts, and had to be solved by quality control methods because of the large number of factors involved and the precision required. Tubes, subassemblies, and testers have been made in batches and studied by statistical methods. To achieve a state of statistical control on emission, and freedom from dust particles, it is necessary to process the parts and assemble the tubes in a rigorously controlled environment. Completely air-conditioned processing and assembly rooms operating under rigorous controls have been found necessary, and will be described in a forthcoming article. Under such controlled conditions, good production yields with satisfactory cathode activity have been obtained, whereas without such conditions not only was the yield low but it was difficult to ascertain just what factors were operating to inhibit emission and to cause cathode-grid shorts.

A summary of the pertinent low-frequency characteristics of the 1553 triode is given in Table 1. It should be noticed that at plate currents of 25 milliamperes, the transconductance per milliampere is about 2,000, that is, about one-fifth of the theoretical upper limit. At lower currents this figure is higher: at 10 milliamperes, for example, it is 3,000 micromhos per milliampere. Diodes with the same spacings have about twice these values of transconductance per milliampere, showing that the grid is fine enough to obtain fifty per cent of the performance of an ideal grid.

A waveguide amplifier circuit for this triode, developed by A. E. Bowen and W. W. Mumford, provides resonant cavities and coupling windows such that the amplifier may be tuned and matched to waveguide over a frequency range from 3,700 to 4,200 megacycles per second.

With the d-c operating conditions given in Table 1, the 4,000 megacycle amplifier performance is as given in Table 2. The performance of the 1553 triode in a modulator circuit developed by Mr. Mumford is given in Table 3. This performance is to be compared with the 10 db loss obtained in the New York to Boston relay with crystal modulators requiring some 750 milliwatts of beating oscillator power.

The tube also works well as a harmonic generator. In the present New York to Boston system, reflex oscillators are employed to provide the local and transmitting oscillator power. Buffer amplifiers are necessary to provide frequency stability and to raise the oscillator power level to that needed by the crystal modulator. As an improvement on this, D. M. Black has produced enough power for use as a 4,000 megacycle transmitting oscillator from a chain of multipliers beginning with a piezoelectric crystal oscillator at 40 megacycles. The last stage of his array is a 1553 doubler going from 2,000 to 4,000 megacycles with a gain of from 0 to 3 db at an output level of 300 milliwatts.

TABLE 1—1553 LOW-FREQUENCY CHARACTERISTICS

For $V_p=250$ V, $I_p=25$ ma, $V_g=-0.3$ V

$g_m=50{,}000$ μmhos	$C_{kg}=10$ $\mu\mu$f
$\mu=350$	$C_{gp}=1.05$ $\mu\mu$f
$r_p=7{,}000$ ohms	$C_{kp}=.005$ $\mu\mu$f

TABLE 2—1553 AMPLIFIER AT 4,000 MEGACYCLES

Bandwidth	120-170 megacycles	
Class A	Gain	7-10 db
	Noise Figure	16-18 db
Class B	Gain	4-6 db
	Power Output	0.5-1 watt

TABLE 3—1553 MODULATOR—65 TO 4,000 MEGACYCLES

Bandwidth	70-90 megacycles
Gain	6-8 db
Power Output	10 milliwatts for less than 0.2 db compression
Local Oscillator Power	150-200 milliwatts

The properties of this new triode and its ability to serve as amplifier, modulator, and harmonic generator will make possible long-distance radio-relay systems with improved repeaters. Such new repeaters will require no excessively high voltages and fewer types of radio-frequency tubes, and will use about half the power while providing transmission characteristics which have not heretofore been obtainable.

The triode is, of course, an old device. This new type, however, well illustrates how old ideas may sometimes be resurrected by means of new materials and techniques to yield revolutionary results compared to those of the past. The new methods and techniques developed for the 1553, such as those for finer grids, metal-ceramic assemblies, closer spacings, and higher emission densities, are not limited to triodes at 4,000 megacycles. These methods seem likely to find use in building better tubes at low frequencies, and moreover to aid in the development of newer tube types at still higher frequencies.

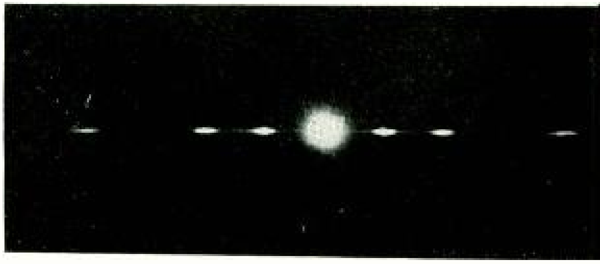


Fig. 5—Spectrum formed by the grid of the 1553 *micro-wave triode*

The development of this microwave triode has required not only the expert and highly coöperative services of a large team of electrical, mechanical, and chemical engineers but the indispensable assistance of skilled technicians, all of whom worked smoothly together to develop these new materials and techniques to a point where they are specifiable and amenable to quantity production. It is not practical to mention all those who have made significant contributions to this development. The contributions of R. M. Ryder, R. L. Vance, H. E. Kern and L. J. Speck, however, are of such outstanding nature that mention of them cannot be omitted. The laboratory model described in this article has more recently been redesigned for production by L. F. Moose and C. Maggs, and the production model, the WE 416A, will probably first be used in the radio-relay system between New York and Chicago.

THE AUTHOR: Jack A. Morton graduated from Wayne University in 1935 with a B.S. degree in electrical engineering followed in 1936 by the M.S.E. degree from the University of Michigan. He joined the Laboratories in September of 1936 to work on coaxial cable and microwave amplifier circuit research, and continued his studies in graduate physics on a part-time basis at Columbia University until 1941. During the first half of the war he was a member of a group engaged in improving the signal-to-noise performance of radar receivers. In 1943 he transferred to the Electronic Development Department to work on microwave tubes for radar and radio relay. Last year he was made electronic apparatus engineer responsible for the development of Transistors and other semiconductor devices.

*Cover sheet for technical memoranda**

An organization as large as the Laboratories has problems of internal communication that do not appear in smaller groups. It is important that the individual scientist be able to bring his knowledge and personal views before his associates outside his immediate area of work and of location. A practical solution has been found in the Laboratories through the use of the "Cover Sheet for Technical Memoranda."

Starting in a small way about twenty years ago in a small research group† working on carrier transmission, the use of the Cover Sheet for Technical Memoranda, or "MM" as it is now commonly called, has spread to the Department, the General Department, and finally to all of the technical General Departments. With such a cover sheet, the status of an MM is that of a technical exposition of his work by the individual engineer, and it carries only his personal authority. There is no indication that a supervisor is or is not in full accord with all of the ideas expressed, although his advice may have been sought before routing it. The memorandum becomes a part of departmental policy only when sent with a covering letter and to the extent set forth in the letter.

The routing list on the cover sheet cuts across all department lines. Here the author lists the names of individual engineers in his own or other departments to whom he believes the subject is of direct interest. There may be only a few or there may be several dozen. If he believes that a certain group is or ought to be interested, but he does not know the individuals concerned or their responsibility, he may route a copy to the group head. The engineer may confer with his immediate supervisor as to the general coverage of the list, but departmental organization is ignored. The list may include all ranks from a General Department head to an individual engineer.

In this way, no time is lost through the inevitable delays due to pressure of other work and questions raised, which would occur if interdepartmental transmission were accomplished only by way of top levels. Personal contact is encouraged because an engineer, on reading a report of special interest to him, will reach for the telephone to make an appointment for a personal conference with its originator. His object may be to seek further information or to argue a divergent point of view, but either way a new friendship or an improvement in mutual interests generally results.

Our Filing Department keeps a complete file, originally of cover sheets only, but now on 3x5 cards, arranged by subject or class of work. This makes available to an engineer reviewing or reopening a line of work a good brief guide to the more important memoranda available. He also sees from the names of the authors of the various memoranda whom he should seek out first for personal discussion. Adequacy of distribution is further insured by monthly circulation of a list of titles and authors of all Technical Memoranda. Several sets of circulation file copies are maintained for use on a reference basis to take care of requests resulting from this circulation list. This freedom of circulation is only rarely restricted at certain stages of special jobs and, of course, with work being done on classified Government projects.

From the independent status given to the Technical Memoranda, there are derived benefits in addition to the original objectives of dissemination of opinion. They become to the individual engineer a medium of internal publication to a large group of his associates, not only of the results of work done but also of his judgment of the significance of his work and of his plans and hopes for the future. They serve the individual much as a radio set does the isolated mariner, permitting him not only to disseminate information that others may need, and apprising others of information that he himself requires, but enriching his life and widening his field of interest by a greatly extended range of personal associations.

---

*Excerpted from a discussion prepared by R. C. Mathes for presentation at the National Electronics Conference in Chicago on November 5, 1948.

†R. V. L. Hartley recalls that the first routing sheet came from a discussion with J. Warren Horton of this group.

Mobile radio antennas for railroads

W. C. BABCOCK
Radio Transmission Engineering

At the conclusion of World War II, the Laboratories embarked on a program of providing radio-telephone service to all types of mobile equipment. Although the major emphasis of this development effort has been directed to providing this service to automobiles, substantial progress has also been made in making it available to railroads as well. Experimental service between New York and Washington, for example, was inaugurated* on August 15, 1947. It utilized land station equipment operating in the frequency band from 152 to 158 megacycles that had already been located at sites suitable for providing urban radio-telephone service† in the cities between New York and Washington. It was evident, however, that such a system could not be employed for railroad systems whose tracks neither traversed nor passed near cities spaced at regular intervals and having urban mobile installations. Such service was practical, however, where the railroad routes paralleled highways over which radio-telephone service,‡ operating in the frequency band from 35 to 43 megacycles, had already been provided. At these lower frequencies, however, the antennas are inherently longer, while the available height above the top of the car is severely limited by tunnels and other structures under which the trains must pass.

To tie in with either the existing urban or highway radio-telephone systems, it is necessary for the antenna to be an efficient radiator of a vertically polarized wave having a uniform pattern in the horizontal plane. The simplest type of antenna to meet these electrical requirements is a vertical rod or whip approximately a quarter of a wave length in height at the operating frequency, and mounted over a flat conducting surface. This would require a height at urban frequencies of about eighteen inches, and at highway frequencies of about sixty-eight inches for transmitting and eighty-three inches for receiving. These heights are all too great for railroad use, but methods of somewhat reducing the height are known.

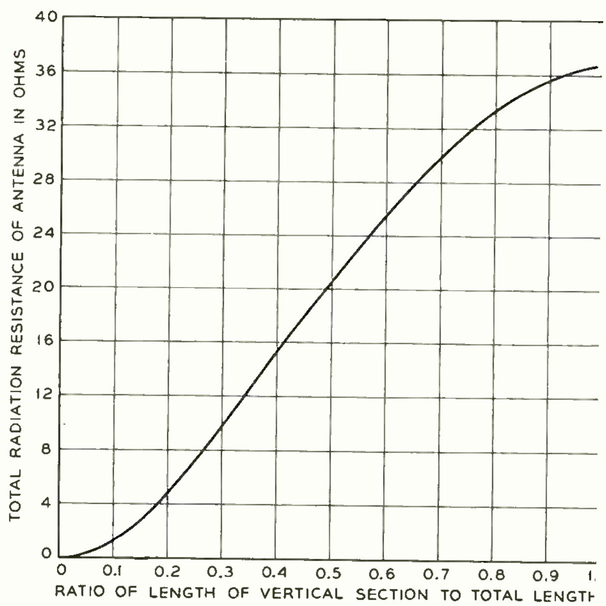


Fig. 1—Relationship between total radiation resistance of an inverted L antenna and the ratio of the length of the vertical section to the total length

For the first railroad application, between New York and Washington, sufficient height was available for a special vertical antenna by mounting it at the end of the car where the top slopes downward, but there was no assurance that there would be room for this antenna on all lines even at urban frequencies. At highway frequencies, an antenna of this type was entirely unsuitable.

*Record, *January*, 1948, *page* 9.
†Record, *April*, 1947, *page* 137.
‡Record, *December*, 1948, *page* 491.

Permissible heights above the top of the car are rarely over sixteen inches and may be considerably less. They vary with different roads and with the particular routes over which the cars will be operated. Height, however, is not the only restriction. Railroads commonly require that any structure on top of the car be strong enough to support a man's weight, and on electrified roads, the antenna must be well grounded to the car and must have sufficient cross-section to carry safely the large currents that might flow should the overhead trolley wire come in contact with it. With such requirements to be met, flexible whip or spring-mounted rod antennas are ruled out on all three counts of height, strength, and size.

One of the earliest problems in radio broadcasting was to develop an efficient vertically polarized antenna that was considerably shorter than a quarter wave length at the operating frequency, since at broadcast frequencies a quarter wave length may be upwards of 400 feet and hence structurally difficult. One of the simplest solutions to this problem turned out to be a vertical mast considerably shorter than a quarter wave length, insulated at the bottom, and capacitance loaded by a horizontal element at the top of the mast. Such arrangements are known as inverted L-type antennas.

Their over-all length, including both horizontal and vertical sections, is about one-quarter wave length. They are resonant antennas, which means that the input impedance is essentially a pure resistance. For such antennas, which were considered for railroads at an early date, the input impedance is nearly the same as the radiation resistance. The bend in the antenna, where it changes from vertical to horizontal, may be made at any point, but its radiation resistance varies with the relative length of the vertical section, as shown in Figure 1. Regardless of the position of the bend, practically all the radiation takes place from the vertical section; as a result, antennas of this particular type are suitable for railroad application.

On mobile installations, it is usually desirable to connect the antenna to its associated equipment by some form of standard flexible coaxial cable. Such cables of 50-ohm and of 70-ohm nominal impedance are readily available commercially. With an inverted L antenna operating at highway frequencies, however, the vertical section would have to be less than one-quarter the total length to secure a low enough height, and with the bend occurring so low, the resistance is very low.

Fig. 2—A folded antenna developed for the frequency range from 152 *to* 158 *megacycles*

Some form of transformation is required, therefore, to match a low impedance inverted L antenna to its connecting cable. One means of accomplishing this is to double the length of the inverted L antenna, bending it back on itself in such a fashion as to provide two spaced parallel elements and bonding the end that is not connected to the equipment firmly to the ground plane. This procedure results in an antenna like that shown in Figure 2, which was developed for railroad use in the band from 152 to 158 megacycles. Folding an antenna back on itself in this manner increases its input impedance approximately as the square of the number of parallel elements, and thus four times for the antenna shown.

To match a 50-ohm line, the inverted L prototype of such an antenna would have to have an input impedance of 12.5 ohms, and from Figure 1, it will be seen that this resistance is obtained when the vertical

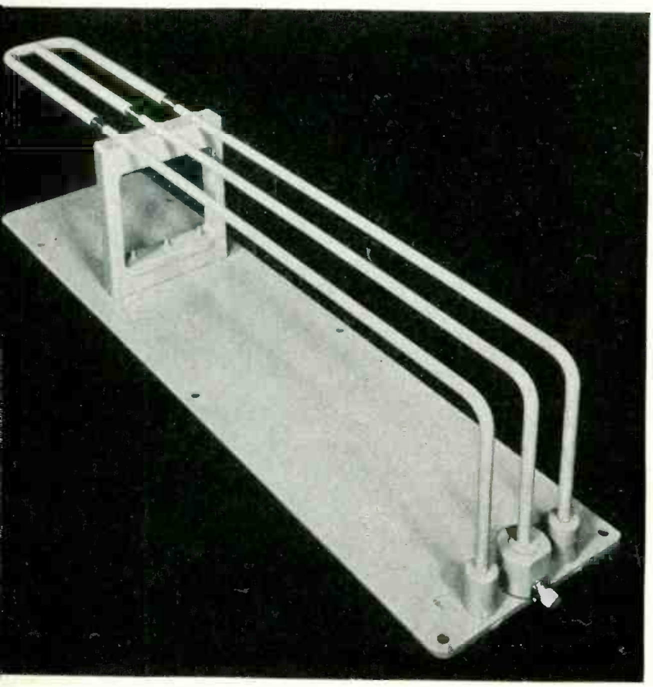


Fig. 3—For the frequency range from 35 to 43 megacycles a three-element folded antenna was developed

length is about thirty-five per cent of the total length. For urban frequencies, where the over-all length is about nineteen inches, this gives a satisfactory height and the antenna of Figure 2 is of approximately these proportions. It is in use at the present time on the *Broadway Limited.*

An antenna designed in similar fashion for highway frequencies would exceed two feet in height and thus could not be used. It was necessary, therefore, to devise some way of obtaining a higher transformation ratio. By using three parallel elements, as shown in Figure 3, a transformation ratio of about nine was obtained. This required an impedance of 5-5/9 ohms for the inverted L prototype in order that the folded antenna might match a 50-ohm coaxial. As may be seen from Figure 1, this input impedance is obtained with an antenna having a vertical section about twenty per cent of the total, and this brings an antenna for the highway frequencies within the required limits of height. When actually built, the antenna impedance was found to be somewhat higher than the design value and consequently a 70-ohm coaxial is used to connect it to its associated equipment.

As evident from Figure 3, the two outer legs of this antenna are firmly grounded to the base, while the middle leg is insulated and connected to the coaxial lead connector. All three legs are connected together at the far end, and since the over-all length is very critical, a trombone section is employed to give the necessary adjustment. After the proper adjustment has been secured by sliding the end section in or out, it is soldered in the proper position. An antenna of this type on a car of the *20th Century Limited* is shown in Figure 4.

In this rather extreme design, where the vertical elements make up such a small proportion of the total antenna, the radia-

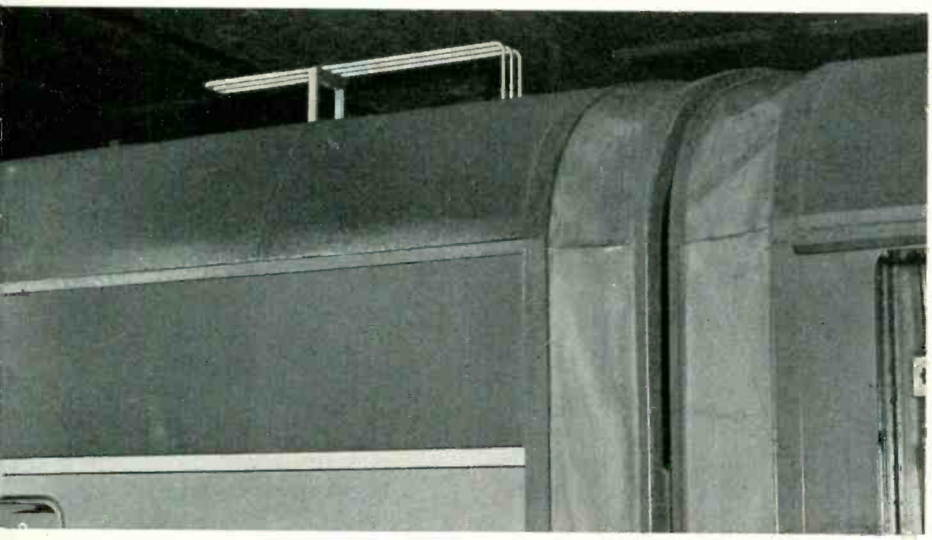


Fig. 4—A three-element antenna on the top of one of the cars of the 20th Century Limited

tion efficiency of the antenna is down 1 db with respect to a quarter wave whip because of the fact that part of the radiation resistance is developed in the horizontal portion of the antenna. In addition, it is down 0.4 db because its pattern is essentially that of a vertical antenna that is short compared to a quarter wave length. Tests have indicated that the over-all radiation efficiency of the antenna is about 1.5 db down with respect to a quarter wave whip. A corresponding figure for the folded antenna for the range from 152 to 158 megacycles, shown in Figure 2, is 0.5 db.

THE AUTHOR: W. C. Babcock received an A.B. degree from Harvard University in 1920 and a B.S. in Communication Engineering from the same university in 1922. He joined the Development and Research Department of the American Telephone and Telegraph Company in 1922, coming to the Bell Laboratories with that organization in the 1934 consolidation. His work has been largely concerned with inductive interference problems between open-wire telephone circuits. During the war he was engaged in radio countermeasure problems for the National Defense Research Committee. Since that time he has been working on antenna development problems in connection with mobile radio systems.

Post-war growth equals first 45 years

In the three and a half years since World War II, the Bell System has gained more than 10,000,000 telephones. This compares with the more than 45 years it took the System to attain its first 10,000,000 telephones, and brings to approximately 32,000,000 the total number of Bell telephones in service at the end of March.

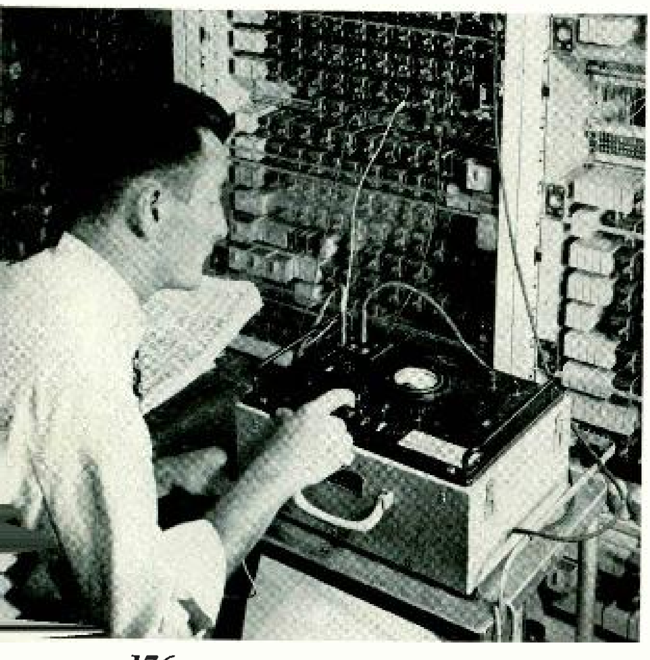
The 10,000,000 mark in post-war gain is a significant milestone in the Bell System's biggest expansion and service improvement program in history. Despite the fact that telephones are being added at the rate of some 200,000 a month, the continuing heavy demand for service is such that more than 1,000,000 orders still remain to be filled. Of the 10,000,000 Bell telephones added since V-J Day, more than 1,000,000 have been installed in rural areas, where the net gain has averaged about 1,000 every working day. In the last eight years, the proportion of farm homes with telephones has nearly doubled. About forty-five per cent of all farms in the country now have telephones, as compared with twenty-five per cent in 1940.

Electronic timing test set

M. E. KROM
Switching Development

Almost every switching circuit in a local dial office requires at least one timed interval. Typical examples are charge delay, which prevents falsely charging the subscriber when a line-busy or overflow condition is encountered; permanent signal timeout, which prevents senders and registers from being held busy indefinitely; and coin collect and return, which insure sufficient timing for coin magnet operation. A large common-control circuit may employ ten or twelve different timed intervals. A 10,000-line central office of the No. 5 crossbar type may have 3,000 or more delay circuits to provide these timing intervals. Since such circuits are subject to variation as their tubes and thermal structures age, it has been felt desirable to develop testing apparatus that would permit time intervals to be measured as part of the central-office maintenance routine. The set developed is shown in Figure 1. Its usefulness is not limited to maintaining timing circuits, however. Another important application is in measuring the operate and release times of relays. Wherever short time intervals are to be measured, the electronic timing test set provides a fast and convenient method.

Fig. 1—W. H. Burgess using the electronic timing test set in the crossbar laboratories



In the course of developing a slow-acting relay a few years ago, it was necessary to make a large number of measurements of operate and release times. Since the available methods of time measuring were not entirely satisfactory for this work, E. R. Morton of Switching Apparatus Development designed an electronic timer that gave a direct reading of time in milliseconds on an indicating meter. Its operation was based on charging a capacitor from a constant current source. Ten or twelve of these test sets were built for use in the Laboratories, and one is shown in operation in Figure 2.

Based on the same general principles, but arranged for a somewhat different set of conditions and time intervals, the new timing test set was developed for more general application. It is arranged to connect directly to any 48-volt central-office circuit, and its timing is started and stopped by the various potentials encountered on the contacts of the apparatus under test. These are −48-volt, ground, or open-circuit, and the new test set is designed to start and stop timing with any of the six possible permutations of these three conditions. The only power connection required is 48-volt central-office battery, which is available from test jacks on all frames. Two miniature B batteries and one flashlight cell, incorporated in the set, complete the power requirements. Time ranges provided are 0-20, 0-100, 0-500, and 0-5,000 milliseconds.

The essential elements of the timing circuit are indicated in Figure 3. Timing is

Fig. 2—The original electronic timer used in laboratory testing

started by applying ground to the grid of the CH tube and is stopped by applying −13 volts. Plate voltage on CH consists of 90 volts from one of the B batteries in the set minus the voltage across the capacitor C, which increases as the capacitor charges. Except at low plate voltage, plate current of the pentode CH increases very little with increase in plate voltage, and the change in the plate voltage due to the change in the voltage across the capacitor as it charges is made small enough, relative to that of the B battery, so that the plate current remains constant to within the precision of the set throughout the charging of the capacitor. With negative voltage on the grid of CH, no plate current is flowing, and the capacitor is fully discharged through contact S so that the voltage across it is zero. At the start of a time measurement, contact S is opened, and ground is applied to the grid of CH, thus starting the flow of the constant plate current through the capacitor which is in the circuit.

The voltage across the capacitor at any time is equal to its charge Q, divided by its capacitance: $V=Q/C$. When the capacitor is charged at constant current, the charge, in turn, is equal to the constant charging current times the time during which it flows: $Q=IT$. By substituting this expression for charge into the above expression for voltage, it will be seen that the voltage is given by the expression: $V=IT/C$. Since both I and C are constant, the voltage increases linearly with time.

This voltage is measured by the vacuum-tube voltmeter circuit shown at the right of Figure 3. The meter M indicates time directly on the 100-millisecond scale; a constant multiplier is used for the other scales. At the end of the time interval being measured, −13 volts is applied to the grid of CH, which at once stops passing current, and the indication of the meter at this time gives the duration of the time interval being measured.

The time indicated by the meter M will be correct, of course, only for one value of charging current, and it is necessary, therefore, to provide some means of insuring that the charging current is of the correct value before a set of measurements is made. A very ingenious method of calibrating was suggested by J. T. L. Brown of the switching research group.

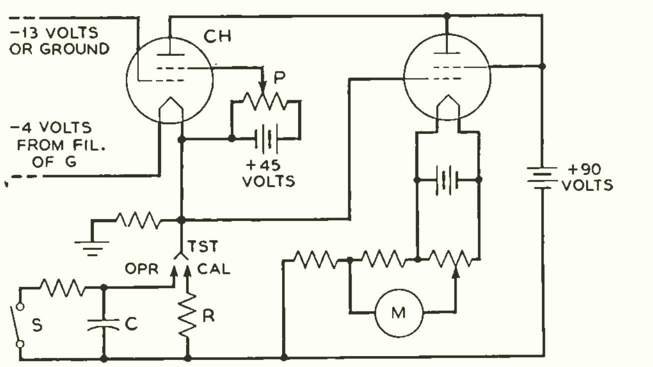


Fig. 3—Diagram of the timing circuit section of the electronic timing test set

In the equation for the voltage drop across a resistor with a constant current flowing through it, $V=RI$, the values of V and I will be the same as in the expression for the voltage across a capacitor after it has been charged for a time T at a constant current I, $V=IT/C$, if R is made equal to T/C. If, therefore, a resistor of value T/C is put in place of the capacitor in Figure 3, the meter will indicate the time T when the current through the resistor is I.

In taking advantage of this fact for calibrating the test set, a resistance of the above value is put in place of the capacitor by operating the TST key to the CAL posi-

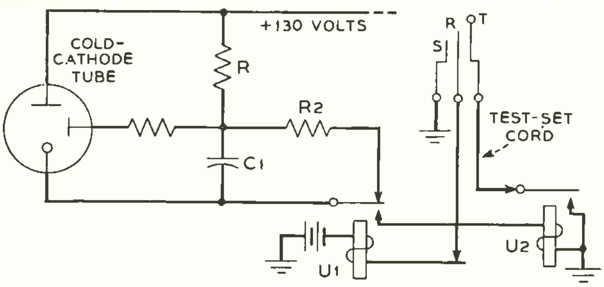


Fig. 4—Typical arrangement with which the timing test set might be used

tion, and then adjusting the potentiometer P until the meter indicates T—full scale being used for this value of T. In the actual test set, there are functionally four capacitors and four resistors corresponding to the four ranges of the indicating meter, and a voltage-range selector on the front of the test set connects in the desired pair according to the time interval to be measured.

Connections to the circuit to be tested are made by a three-conductor cord with clips on one end to connect to the circuit to be tested and a plug on the other to connect to a jack on the test set. Two of the conductors of the cord are used for starting the time cycle in the apparatus, while the third, or tip lead, will be connected to a lead in the circuit under test on which will appear the conditions that indicate the beginning and end of the time period. How these leads of the cord would be connected to one type of electronic timing circuit is indicated in Figure 4. Normally, the cathode and starting anode of the cold-cathode tube are held at the same potential by the back contact of relay U1, and the tube will not be conducting. When relay U1 is operated, however, the starting anode is disconnected from the cathode, and capacitor C1 will start charging through resistor R1 from 130-volt battery. The voltage across the capacitor is applied to the starting anode of the tube, and when it reaches the ionizing potential, the tube will pass current and thus operate relay U2.

The beginning of the time period is marked by the closing of the operating circuit of relay U1, and at this instant the tip lead of the cord will be open-circuited. At the end of the time period, ground will be applied to the tip lead. In other types of circuits, the indications for the beginning and end of the time period may be any of the six combinations already referred to, and the beginning of timing may require the opening of the ring and sleeve leads instead of their closing as in Figure 4.

In its normal position, a key marked TST on the front of the test set closes the contact S on Figure 3 to hold the timing capacitor discharged, and the CH tube will be non-conducting. When thrown to its CAL position, the TST key sets up the calibrating conditions to permit the constant current to be adjusted as already described. When it is thrown to its OPR position, it connects the timing capacitors instead of the calibrating resistor into the circuit, opens the contact S, operates a relay that either opens or closes the ring and sleeve leads of the

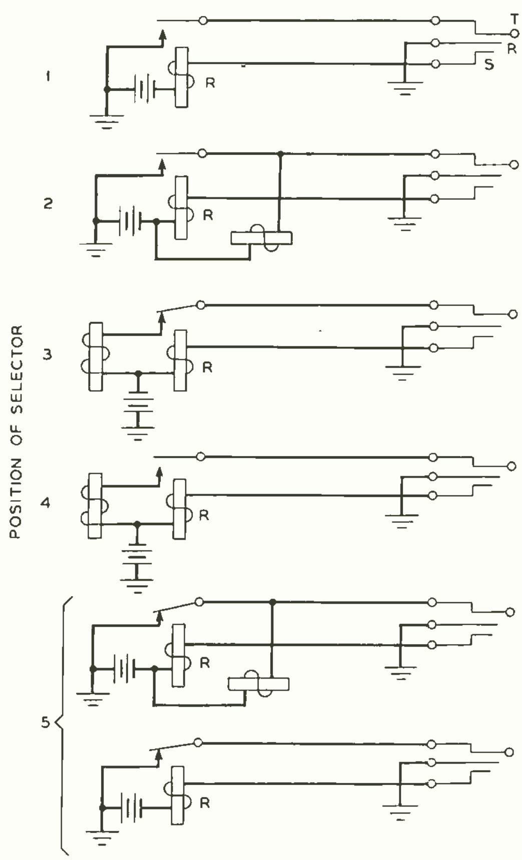


Fig. 5—Typical circuit conditions requiring the five selector positions

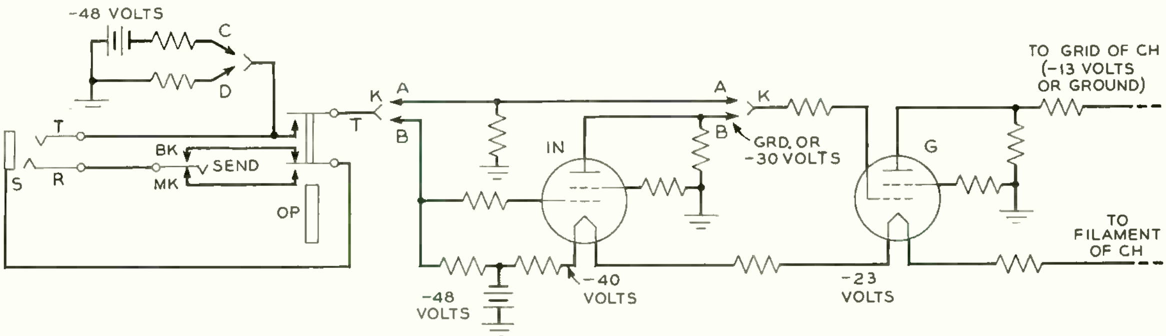


Fig. 6—Input circuit for the electronic timing test set

test cord, depending on whether a SEND key is in the BK or MK position, and closes the test set, there are functionally four capacitors and four resistors corresponding to the four ranges of the indicating meter, and a voltage-range selector on the front of the test set connects in the desired pair according to the time interval to be measured.

Since the capacitor of Figure 3 must begin or stop charging when any of the six possible permutations of ground, open-circuit, and −48 volts are encountered on the test lead, circuit elements are incorporated in the test set in addition to those shown in Figure 3 to convert the ground, open-circuit, or −48 volts to either ground or −13 volts on the grid of the CH tube. These include two tubes marked G and IN and are shown in Figure 6.

Before starting a test, the test-condition selector on the front of the test set is moved to the position corresponding to the start and stop-timing conditions that will be encountered in the circuit being tested. Although there are six such conditions possible, the selector has only five positions, since the fifth position takes care of two situations. Table 1 shows the five positions of this selector, and the six start and stop conditions they take care of. In Column 4 of this table is given the position of K in Figure 6 that the selector establishes.

With the selector in positions 2, 3 and 5, the start and stop-timing conditions that are encountered in the circuit under test are correct to start and stop the charging of the timing capacitor of the test set. With the selector in positions 1 or 4, however, the stop-timing conditions are correct, but the start-timing condition in both cases is open-circuit, and when the T lead encounters an open circuit, the timing capacitor is not charging, as already pointed out. In these two positions, therefore, the selector closes either the C or D contacts of Figure 6, as indicated in Column 5 of Table 1. When the starting of timing requires that the operation of the OP relay close the connection between the ring and sleeve conductors, key SEND of Figure 6 will be in the MK position, while when it requires that the ring and sleeve connection be opened, the SEND key will be in the BK position.

Typical connections and the corresponding positions of the condition selector for measuring the operate and release times of relays are shown in Figure 5. For conditions 3 and 5, the SEND key will be in the BK position, while for the others it will be in the MK position.

A front view of the test set is shown in Figure 7. The condition selector is at the left, and the meter-range selector at the right. In the lower center are three keys: the TST key at the left, a battery key to connect power to the set in the middle, and the SEND key at the right. Just above these keys at the left and right are two potentiometers. One controls the adjustment of

TABLE 1—CIRCUIT CONDITIONS FOR THE FIVE SELECTOR POSITIONS

Position of Selector	*Begin Timing*	*End Timing*	*Switch K*	*Auxiliary Contacts*
1	0(−48)	G	A	C
2	−48 v	G	A	—
3	−48 v	0	A	—
4	0 (G)	−48 v	B	D
5	G	−48 v	B	—
	G	0	B	—

the charging current while the set is being calibrated, P of Figure 3, and the other permits adjusting the meter to read zero when there is zero voltage across the timing capacitor. At the extreme upper left are four jacks: two for the test cord, one for the power connection, and one used in testing the ring-up time of 1,000-cycle toll ringing.

The set also provides means for testing the operation of its three tubes by using the TT position of the SEND key, and for measuring the time interval between the closing or opening of the ring and sleeve leads and the connection of the T lead of Figure 6 to the tip lead of the jack. The OP relay is adjusted so that this latter connection always precedes the closing or opening of the ring and sleeve, but the interval is short and need be taken into consideration only in special cases. The MCF key, which is shown at the extreme upper right of the test set, is used for this purpose.

The applications illustrated above are only a few of the many for which this set may be used, and are given primarily to show the application of the test set to the measurement of time under typical and varied circuit conditions.

Fig. 7—Close-up of the top panel of the electronic timing test set

---

THE AUTHOR: M. E. KROM was graduated from Purdue University with the degree of B.S. in E.E. in 1923. He joined the Laboratories immediately after graduation and spent the first two years in the panel dial laboratory. Then followed six months of relay design after which he was transferred to a laboratory group which handled ringing and tone studies. Then he transferred to a group concerned with means of measuring and suppressing radio interference. In 1932 this work became a function of the ringing and tone studies group. Mr. Krom was transferred at that same time to continue radio interference tests, and the development of radio filters and their application to telephone equipment. This, in combination with ringing and tone studies, occupied his time until the summer of 1941 when he was assigned to a defense project. Shortly before the outbreak of war, he was transferred to the Transmission Development Department, where he was concerned principally with the development of radar test equipment. In October 1945 he returned to the Systems Development Department, and has since been associated with the design of No. 5 crossbar.

Television I-F coil design

Various nomographs, charts, and calculators are available for the calculation of the inductance of coils, but most of these graphical aids do not cover the range of values of interest to the designer of coils for television, f-m, and radar i-f frequencies. The nomograph shown below, reprinted from an article by J. H. Felker in the March issue of *Electronics*, has been designed to fulfill this need. Unlike other coil nomographs, it gives in one operation the number of close-wound turns required to get a desired inductance.

The nomograph is based on a modification of H. A. Wheeler's inductance formula:*

$$L = \frac{r^2\ n^2}{9r + 10l}\ \text{microhenrys} \qquad (1)$$

where r is the radius of the coil in inches, l its length in inches, and n the number of turns. In close-wound coils, l is a function of n. Substitution of nd, where d is the diameter of the wire in inches, for l in Equation 1 gives an equation which can be solved for n to give:

$$n = \frac{10dL + \sqrt{100d^2L^2 + 36r^3L}}{2r^2} \qquad (2)$$

The complexity of Equation 2 accounts for the unusual structure of the nomograph and indicates the computational labor avoided by its use.

D. Pollack† has shown verification for the formula:

$$L = N^2D/\ (102\ S + 45)\ \text{microhenrys} \qquad (3)$$

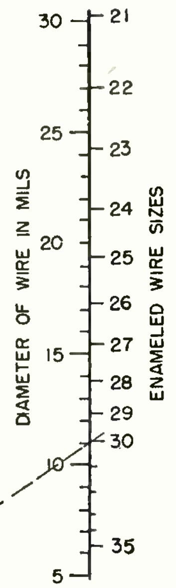
where D is the diameter of the coil in centimeters, N is the number of turns, and S is the ratio of the length of the coil to its diameter. Changing the centimeter dimensions of D in Equation 3 to inches and employing Wheeler's symbols gives:

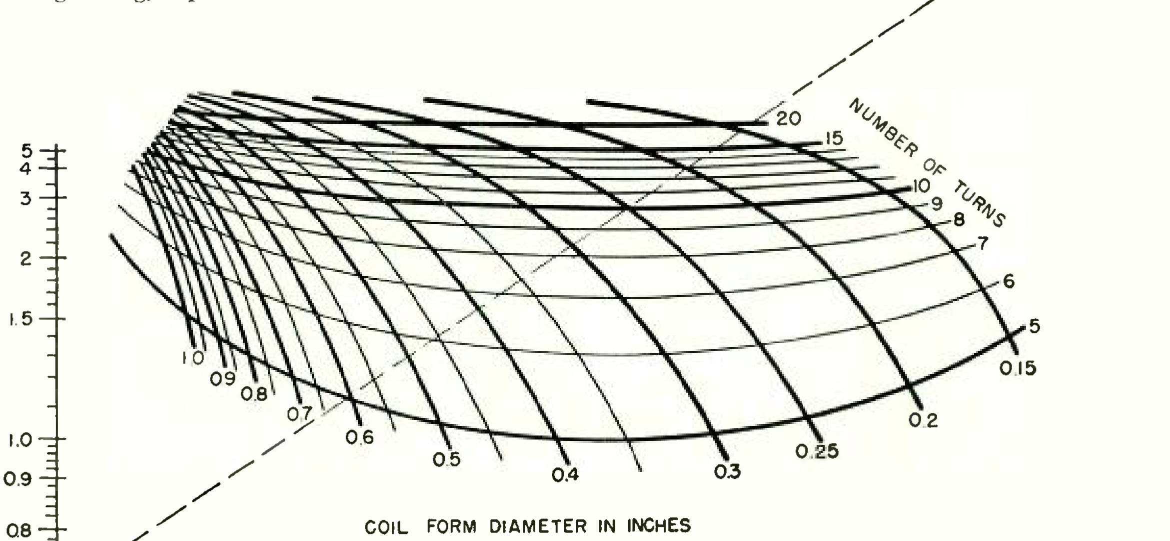
$$L = r^2n^2/(8.85\ r + 10l)$$

verifying Equation 1.

*H. A. Wheeler, Simple Inductance Formulas for Radio Coils, *Proc. I.R.E.*, p. 1,398, Oct., 1928.

†D. Pollack, The Design of Inductances for Frequencies Between 4 and 25 Megacycles, *Electrical Engineering*, Sept. 1937.





How to use the nomograph—Place straightedge on desired values of inductance and wire size on the two vertical scales. Where curve for diameter intersects straightedge, read required number of turns on other set of curves.

Example—How many turns of number 30 wire are required on a 0.25-inch diameter coil form to obtain 0.7 microhenry? Run straightedge between 0.7 on left-hand vertical scale and 30 on right-hand side of right-hand vertical scale, as indicated by thin dashed line. Trace upward along 0.25 diameter curve to straightedge, and read 10 turns as value of other curve passing through this intersection.

A tube test set for the L1 carrier system

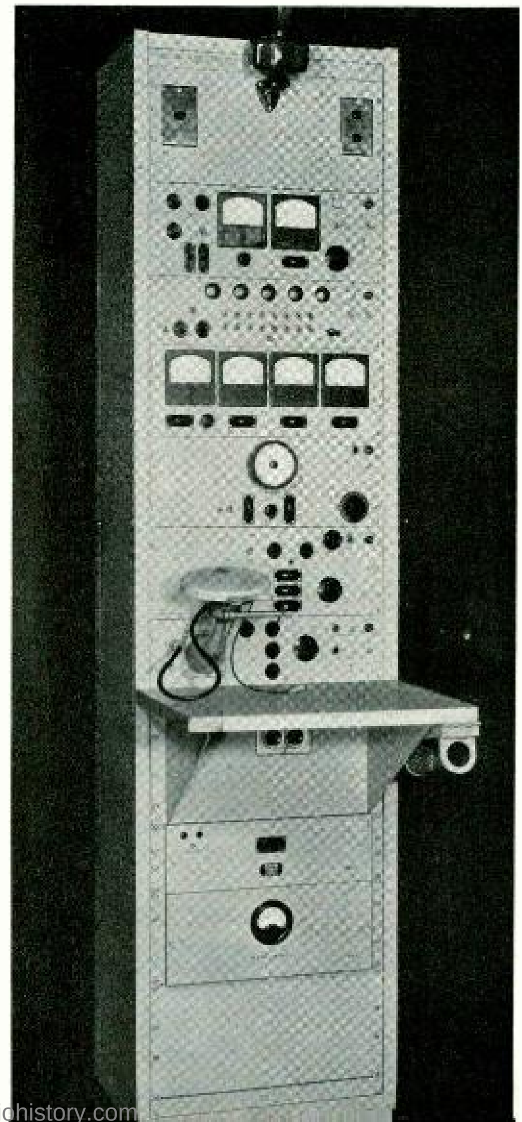
A. A. HEBERLEIN
Transmission Development

Amplifiers for the L1 carrier system* are mounted in sealed containers of the plug-in type, and the repeaters of which they form a part are mounted in huts or manholes about eight miles apart. Maintenance procedures used with voice or low-frequency carrier circuits, where the repeaters are mounted on open panels in repeater stations, are not applicable because of the frequency band involved and the critical adjustments required. When trouble occurs in an L1 amplifier, a spare unit is plugged in its place, and the defective amplifier is taken to a regional amplifier servicing center, where the necessary test sets and tools are available to permit the amplifiers to be unsealed, inspected, repaired, and completely tested before they are returned to spare stock. Careful checking of the vacuum tubes and the replacement of defective or worn-out tubes is an important part of the servicing procedure. The recently developed J68798C vacuum-tube test set which is shown in Figure 1 is provided for this purpose.

Below the writing shelf of this unit are two regulated rectifier panels serving as power supplies, while at the top is a power distribution panel, where the a-c power is connected to the test set through a voltage regulating transformer, and where the lighting fixture at the top of the bay is controlled. Immediately above the shelf are the six major testing panels, shown in greater detail in Figure 2. The basic tests are for transconductance, plate current, cathode activity, and grid-to-cathode insulation, and they are all carried out by the first four panels above the shelf.

The lowest of these panels is the amplifier connecting panel, which carries a bracket-mounted circular shelf with a receptacle to take the power plug of the amplifier. After an amplifier to be tested has been unsealed and its cover removed, it is plugged into this shelf and clamped in position. The shelf is connected to its mounting bracket through a ball-and-socket joint to permit the amplifier to be turned or tipped to any position that will give easiest

Fig. 1—The J68798C vacuum tube test set for testing L1 amplifiers



*Record, *January,* 1942, *page* 127.

access to the internal leads to which the test voltages will be applied. This permits any tube soldered in its particular stage location in an amplifier to be tested in place. A flexible cord connects the power receptacle of the shelf to the amplifier connecting panel, and other test cords, plugged into jacks on the oscillator-detector panel, are used to connect to the necessary points in the amplifier circuit. This feature facilitates screening of tubes in an amplifier under repair, and avoids the unnecessary removal of tubes good for further service.

Tubes that have been removed from the amplifier may be tested by inserting them into sockets in the individual tube test panel—which is between the amplifier connecting and the oscillator-detector panels. An adapter is provided that allows unbased tubes of the 384A and 386A types also to be tested. In addition, means are provided on this panel for measuring the grid-to-cathode insulation. Plate and screen-grid voltage, grid bias, heater voltage, and d-c plate current for a test are indicated directly on the meter panel.

The principal test circuit, shown in Figure 3, is provided on the oscillator-detector panel—third above the shelf. It includes an oscillator generating a 4-kc signal that is fed through a fixed pad to the grid of the tube under test and also to the CAL point of the COMP key. A 10 db pad, controlled by a second key on this panel, is also provided in the oscillator output circuit for measuring higher transconductance tubes with a reduced input signal to the tube under test.

The detector circuit consists of an amplifier, a varistor for rectifying the output signal, and a d-c milliammeter calibrated from −6 to +2 db. During a measurement, the DB-GM dial is turned until the meter reads within 0.5 db of zero, when the transconductance may be read directly from the dial. Meter readings other than zero are used when the transconductance is less than 1,000 micromhos or greater than 30 db above 1,000.

Two other essentially independent test panels complete the test bay. A short-open tube test panel immediately above the meter panel provides means of detecting an internal short or open circuit within a tube and indicates the fault path. The positive identification of the nature of internal faults within a specific tube removed from an amplifier is often useful in isolating troubles in the amplifier circuit elements associated with such a tube. The essential features of this circuit are indicated in Figure 4. The circuit consists of five 313C gas-filled tubes which have one electrode of their starter gap connected through resistors to one side of a 120-volt a-c power supply, and the other electrode of the starter gap connected to one of the elements (except the cathode) of the tube under test. The other side of the 120-volt a-c circuit connects to the cathode and also to the moving arm of a six-point selector. Points 2 to 6 of this selector connect to the same tube elements as do the gas tubes, while the No. 1 point is left unconnected. The tube to be tested is inserted into one of the available sockets on the panel and heater current applied.

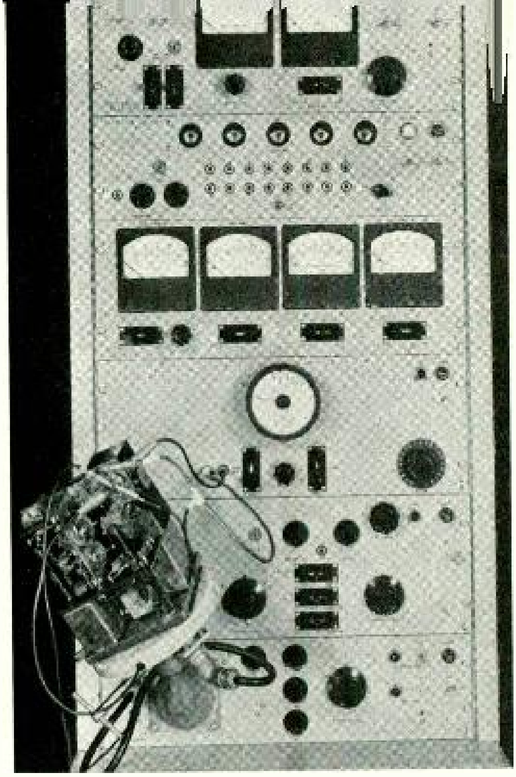


Fig. 2—The six major test panels of the test set. Reading up from the writing shelf, they are designated: amplifier connecting panel; individual tube test panel; oscillator-detector panel; meter panel; short-open tube test panel; and cold-cathode tube test set

The starter gap of the 313C tube consists of two semi-circular electrodes visible from the end of the tube. The main anode,

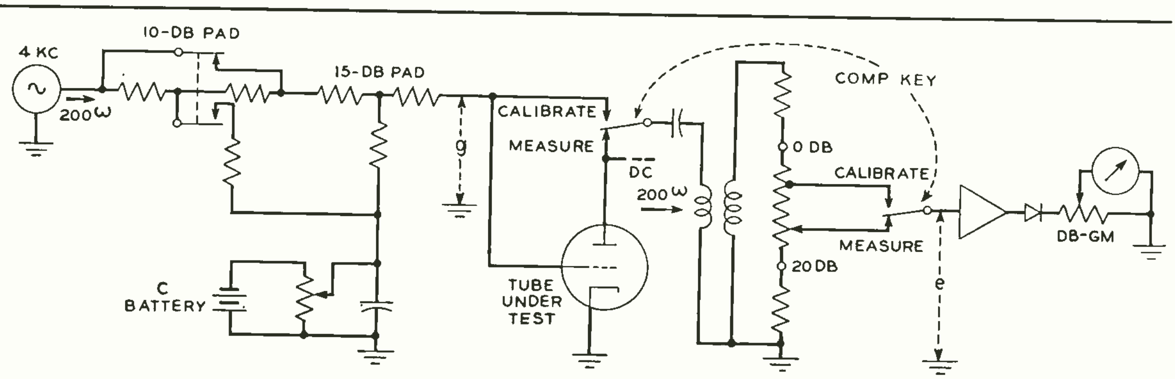


Fig. 3—Simplified schematic of the circuit of the oscillator and detector panel

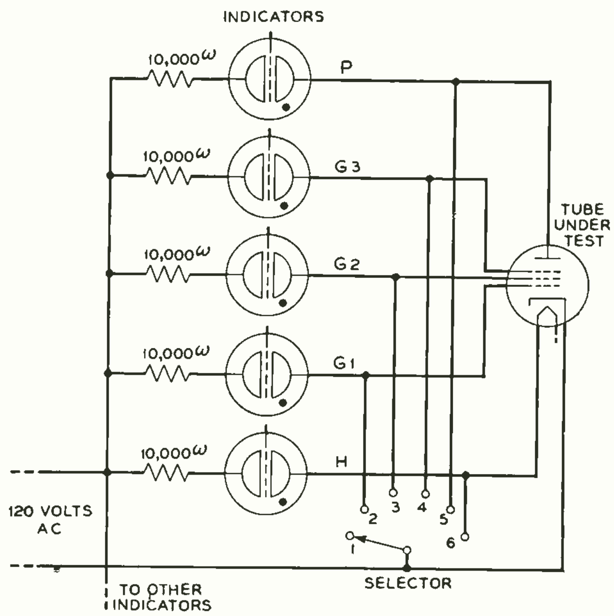


Fig. 4—Circuit of the short-open tube test panel

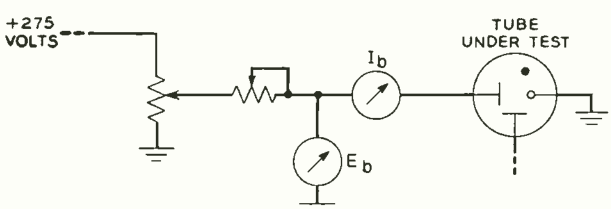
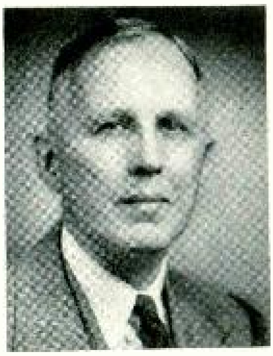


Fig. 5—Circuit of the cold-cathode tube test set

in the form of a wire, projects between the other two electrodes in a glass tube, but is not used for this test circuit. When a voltage above the ionizing potential is applied across the starter gap, current passes, and the positive electrode will glow. With these indicator tubes connected as in Figure 4, with the selector switch in position 1, and with no shorts or opens in the tube under test, the left-hand anode of the indicators connected to the plate and the grids will glow, since the indicator tube will conduct only during the half cycles of the power supply voltage that make the left-hand electrode positive. Current flow in the opposite direction is blocked by the rectifying action of the tube under test. Had any of the elements been open-circuited, the indicator tube associated with that element would not have glowed. Had any of the electrodes been short-circuited to the cathode, however, both electrodes would have glowed, since the rectifying action of the tube under test is by-passed by the short circuit. Shorts between one element and any of the others except the cathode are determined by rotating the selector successively through its six points. If, for example, there were a short between the plate and G1, both sides of the indicators for G1 and P would glow with the selector on either step 2 or 5. A table is provided for use with the set that shows the glowing conditions for indicator tubes for all possible short or open-circuit combinations that can occur.

The remaining auxiliary panel tests Western Electric cold-cathode and voltage regulator tubes, both octal and miniature based, and a hot-cathode diode (381A), which is



THE AUTHOR: A. A. HEBERLEIN received the B.S. degree from the City College of New York in 1921 and then took graduate work at Brooklyn Polytechnic Institute, receiving the E.E. degree in 1923. In 1922, while completing his studies at the Brooklyn Polytechnic Institute, he joined the D & R where he engaged in the development of carrier systems and in vacuum-tube testing problems. Since 1932, he has been concerned with special long-range field trials of improved tubes in voice frequency and carrier systems, vacuum-tube test sets, and in general vacuum-tube application, testing, and field maintenance problems.

used in L1 carrier systems. This test circuit, indicated in Figure 5, supplied with high voltage from one of the rectifiers, makes simple d-c breakdown and sustaining voltage measurements of a tube, while a milliammeter with potentiometer controls enables conduction current to be evaluated.

The test set was designed with a dual objective in view: first, to provide sufficient tube tests to insure satisfactory field performance of the tubes in repaired coaxial amplifiers, and second, to provide essential tests under standard operating conditions that are similar to manufacturing tests and may be used for acceptance tests by the Operating Companies. Experience with this set in various amplifier servicing centers in the field has demonstrated its usefulness in insuring dependable tube performance in repaired coaxial amplifiers.

Patents Issued to Members of the Laboratories by the United States Patent Office, December to March, Inclusive

J. T. Acker
A. E. Anderson
G. E. Atkins
W. M. Bacon (3)
E. L. Baulch
F. H. Best
D. G. Blattner
W. H. Boghosian
A. E. Bowen (2)
E. Bruce
R. B. Buchanan
E. T. Burton
H. T. Carter
C. J. Christensen (2)
H. Christensen
S. I. Cory
L. R. Cox
H. C. Curl
A. M. Curtis (2)
R. W. DeMonte
A. R. D'Heedene
A. C. Dickieson
A. S. Dubuar (2)
J. O. Edson
W. A. Edson
L. Egerton
W. B. Ellwood
C. B. H. Feldman
E. B. Ferrell (2)
J. S. Garvin
C. E. Germanton
H. A. Giroud
E. H. Goldsmith
E. I. Green
A. B. Haines
C. W. Harrison
R. V. L. Hartley
F. E. Haworth
G. Hecht
H. W. Herrington
F. H. Hibbard
G. H. Huber (2)
L. W. Hussey
S. B. Ingram
A. E. Joel, Jr.
J. B. Johnson (2)
H. C. Jonas
H. G. Jordan
W. F. Kannenberg
E. H. Karleen
D. H. King
J. J. Kleimack
J. D. Kleinkauf
B. H. Klyce, Jr.
A. R. Kolding
F. A. Korn
J. P. Laico
J. B. Little
G. R. Lum
J. J. Mahoney, Jr.
P. Mallery
Y. A. Mao
W. P. Mason (4)
L. A. Meacham
V. F. Miller (2)
N. C. Moore
J. A. Morton
E. E. Mott
W. A. Munson
H. G. Och
B. M. Oliver
K. M. Olsen
J. R. Pierce (2)
R. K. Potter
W. T. Rea (2)
R. H. Ricker
J. W. Rieke
M. D. Rigterink
D. H. Ring
V. L. Ronci
A. L. Samuel
J. W. Schaefer
R. W. Sears
O. A. Shann (2)
T. E. Sippel
G. C. Southworth (4)
L. J. Speck
R. V. Terry
C. H. Townes
A. W. Treptow
H. N. Wagar
A. C. Walker
C. A. Warren
E. F. Watson
J. W. West
L. A. Wooten
G. W. Willard

News and Pictures of the Month

L. A. Wilson Visits the Laboratories

Recently, L. A. Wilson, President of the American Telephone and Telegraph Company, visited the West Street Laboratories and was shown some of the latest technological achievements by O. E. Buckley. Gus Pasquarella, staff photographer for *The Saturday Evening Post,* took advantage of the visit to make pictures of the pair for an article on Mr. Wilson which appeared in the March 19 issue under the title *The World's Biggest Business Gets a New Boss.* R. L. Shepherd of Publication made this picture of Pasquarella photographing Mr. Wilson and Dr. Buckley as they inspected automatic message accounting equipment.

Pasquarella is an old friend of the Laboratories, for he spent two weeks at West Street and Murray Hill, taking the pictures used to illustrate the series of three articles which the *Post* published concerning the Laboratories in May 1947, under the title *Ma Bell's House of Magic.*

Jack Alexander, an associate editor of the *Post,* who wrote the article on Mr. Wilson, also visited both West Street and Murray Hill in assembling material and talked with, among others, Dr. Buckley, W. H. Martin, Ralph Bown, J. W. McRae, A. F. Bennett, R. K. Potter, R. M. Burns, J. R. Townsend, Harvey Fletcher, H. T. Friis and R. K. Honaman.

Frank B. Jewett Fellowships

Winners in this year's Frank B. Jewett Fellowships are:

Dr. Harish-Chandra of Allahabad, U. P., India, who has done considerable research on the theory of elementary particles at the Institute for Advanced Study, Princeton, N. J.

Dr. James A. Jenkins of Toronto, Ontario, who has been engaged in research on matters related to topological mapping problems at Harvard University.

Dr. Robert Karplus of West Newton, Mass., who has been participating in nuclear research at the Institute for Advanced Study, Princeton.

Dr. Joaquin Mazdak Luttinger of New York City, who has been doing research work in Zurich, Switzerland, on the theory of the superconductive state and who plans to continue these studies in this country.

Dr. David Emerson Mann of Minneapolis, who has been engaged in quantum mechanics research at the University of Minnesota.

Harvey Winston of Tottenville, Staten Island, who plans to do crystallographic research.

The Jewett Fellowships are designed to stimulate and assist research in the fundamental physical sciences and particularly to provide the holders with opportunities for individual growth and development as creative scientists. They are awarded on recommendation of a committee consisting of seven members of the Technical Staff of the Laboratories. Primary criteria are the demonstrated research ability of the applicant, the fundamental importance of the problem he proposes to attack and the likelihood of his growth as a scientist. The awards are designedly post-doctorate and only scientists who have recently received doctors' degrees or who are about to receive them are normally considered.

I.R.E. Honors Three Laboratories' Men

Claude E. Shannon received the 1949 Morris Liebmann Memorial Prize of the Institute of Radio Engineers on March 9 at the award dinner which culminated the Institute's annual convention.

The award is a cash sum of money and is regarded as one of the outstanding honors of the scientific world. It was presented to Dr. Shannon by Stuart L. Bailey, president of the Institute, "for Dr. Shannon's original and important contributions to the theory of the transmission of information in the presence of noise."

Also honored at the award dinner were Dr. Ralph Bown, Director of Research, who was named last fall to receive the Institute's highest honor, 1949 Medal of Honor; and H. A. Affel, who was made a Fellow of the Institute. Dr. Bown received the award* "for his extensive contributions and substantial and important advancements in the art of radio communications."

Dr. Shannon, who has been a member of the Technical Staff of the Laboratories since 1941, is a native of Gaylord, Michigan. He received a B.S. degree in E.E. from the University of Michigan in 1936. In 1940, he received an M.S. degree in E.E. and a doctor's degree in mathematics from Massachusetts Institute of Technology. Prior to joining the Bell System, he was a National Research Fellow at Princeton University, and served as a National Defense Research consultant.

C. E. Shannon of Physical Research receives the Morris Liebmann Memorial Prize from Stuart L. Bailey, president of the I.R.E.

In 1940, Dr. Shannon was awarded the Alfred Nobel Prize by the American Institute of Electrical Engineers. He is a member of Sigma Xi, national scientific honorary fraternity, of Phi Kappa Phi, the American Mathematical Society and the I.R.E. His work in the Research Department has been concerned with switching and communication theories and with computing machines.

*RECORD, *October*, 1948, *page* 427.

New Sound System at Murray Hill

A new sound system in the Murray Hill Listening Room and Auditorium was recently completed, and on March 11 a noon-hour program was given to demonstrate the facilities. On this occasion, doors to the Auditorium had to be closed to many because of the standing-room-only interest in the affair, and critical approvals, following the half-hour musicale, were pointed to the effect that the new system is the best that exists in the eastern section of this country.

Inspecting a 310-type switchboard plug with molded insulation are F. W. Hennessey of Western Electric, D. G. Blattner, J. F. Baldwin and R. A. Hecht of Bell Telephone Laboratories

To show the range of the tonal values, playbacks were made from recordings of recent Telephone Hour broadcasts. These included full orchestra, violin and speech. Highlight of the demonstration was a piano solo presented from the Auditorium stage by W. F. Kannenberg. The Chopin "Polonaise" which he played was recorded and then immediately played back over the system with complete fidelity to the original.

Audio facilities people in charge of the sound facilities were W. J. Brown, L. B. Cooke, J. Z. Menard and E. V. Kuzela.

Bennett Talks About New Telephone

On March 28 at West Street and on March 31 at Murray Hill, A. F. Bennett, director of Station Apparatus Development, told of the work which led up to the new 500-type combined telephone set which is described on page 165 of this issue. Its predecessor, the 302-type, which went into production in 1937, represented the state of the fundamental arts up to perhaps 1935. By the end of World War II, enough advances had been made to justify integrating them into a new model. While Mr. Bennett's department carried most of the load, they drew heavily on Transmission Apparatus for coils, capacitors, ballast lamp, and cords, on Electronic Apparatus for varistors and thermistors, on the Materials engineers for the latest information on plastics and finishes, and on the Magnetics people in connection with the receiver and the ringer. Many contributions to the final design were made by Western Electric engineers, as a result of discussions of the manufacturing and design problems with the Laboratories' engineers.

Technical Societies Meet at Murray Hill

The Northern New Jersey Section of the I.R.E. held an evening meeting on March 23 in the Arnold Auditorium. H. T. Budenbom was program chairman for this event and K. K. Darrow the chief speaker. He chose for his subject *Nuclear Fission and the Atomic Pile.*

On March 25, over one hundred members of the Metropolitan Section of the American Physical Society attended the spring meeting at Murray Hill, where they were welcomed by O. E. Buckley. Following Dr. Buckley's address, a series of papers was given, including one by W. E. Kock on *Wave Propagation in Dipole Arrays.*

W. H. Martin in New England

W. H. Martin talked to a group of the headquarters organization of the New England Telephone and Telegraph Company on March 31 in Boston. His general topic was the operation of the Laboratories on a development project, and he used the new combined set as the illustration.

Results of X-Ray Examinations

Although it has long been the Medical Department's practice to offer a chest X-ray to all who have a general physical examination, it was thought desirable to conduct a survey of all our people with the aim of discovering any unknown cases of infection. A rapid-fire technique has been worked out for these surveys, and so arrangements were made for the New York City team to come to West Street and the State Department of Health's team to visit the

Camera crew of Willard Pictures, Inc., prepares to shoot a scene in the movie "Talk Jury," under direction of John M. Squiers, Jr. (left of camera). Assisting are M. Brotherton, J. W. Pollio, and J. N. Bornholdt of A T & T (seated). At the blackboard (right), J. M. Fraser briefs a group of representative telephone subscribers during the filming of the movie made for four New Jersey locations. Results in the two states were not significantly different.

For the Laboratories as a whole, 5,795 employees were available for testing, and of them 98.5 per cent were actually X-rayed. The findings indicated that a few should have further study, and they were photographed on our regular machine. Only two cases of active tuberculosis were found, an incidence of 0.035 per cent, as compared with the general Bell System rate of 0.12 per cent and a rate of 1.5 per cent found in many industrial groups.

As a check on the survey, the few known cases of arrested tuberculosis were included. All were identified and reported. While they will always carry the scars of healed lesions, they are no menace to their associates, and they have a normal expectancy of life.

All in all, we are members of about as healthy a group as can be found, at least from the standpoint of pulmonary tuberculosis.

Mobile Telephones Help to Mine Copper in Utah

The world's largest open-cut copper mine, located in Bingham Canyon, near Salt Lake City, is using the mobile telephone to facilitate operations of its electric ore-carrying and maintenance trains. The private mobile system furnished by The Mountain States Telephone and Telegraph Company for the Kennecott Copper Corporation consists of four land stations, and mobile telephone equipment installed in six electric locomotives, two rail "speeders," and in the mine superintendent's automobile.

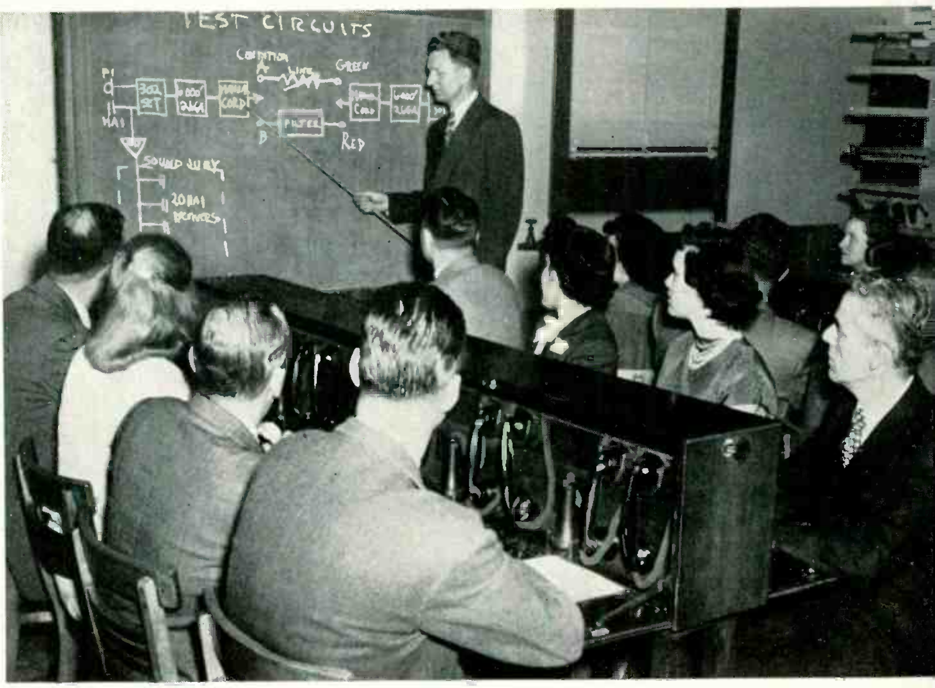
Another private mobile system is being provided for Kennecott's railroad which takes ore from the mines to the Garfield and Magna mills, some 15 miles to the north, on the south shore of Great Salt Lake. Seven low-powered land stations and 16 mobile units are included in the project.

Chemists Sail for England

S. O. Morgan and A. N. Holden sailed for England on April 2, where they are attending an international conference of the Faraday Society on crystal growth. Mr. Holden will present a paper on methods developed in the Laboratories. Later, Messrs. Morgan and Holden will visit several laboratories in England and on the continent to discuss matters of interest in the crystal and dielectric fields. They will return on May 26.

Out-of-Hour Course at Whippany

J. H. Felker is instructing forty-six students at Whippany in the first term of Course 236 on *Electronic Circuits;* the remaining two terms of the course will be presented in the fall of 1949 and the spring of 1950. The course is the first in the Out-of-Hour series to be given at Whippany since the end of World War II.



the A T & T's "Telephone Screen Review" series. "Talk Jury" tells how listening tests made by the Transmission Standards laboratory keep watch on the quality of the many varieties of talking circuits used in the Bell System. Laboratories' people who served on the jury were: Marguerite Hutchinson, Christine Scanlan, Esther Rentrop, Claire Ohl, L. Pinter, and J. L. Doncourt

J. A. Morton, in his home town, Detroit, addresses telephone people and their guests, the local sections of A.I.E.E. and I.R.E., on the Transistor. Mr. Morton was introduced by E. C. Balch, chief engineer of Michigan Bell

atmospheric changes which result in turbulent motion in the lower atmosphere.

The tests and observations reported were sponsored jointly by the Laboratories and the Naval Electronics Laboratory and were conducted at Gila Bend, Arizona. Working on the problem, besides Mr. Crawford, were L. R. Lowry and S. E. Reed of Radio Research, and J. B. Smyth and L. J. Anderson, of the Naval Electronics Laboratory.

Mr. Crawford's investigation of "angels" was undertaken as part of fundamental studies of microwaves which are being increasingly used to carry telephone messages and television programs over the Nation's communications networks. Most radar equipment operates in the microwave region.

On one of his numerous trips to Detroit in connection with the 81-C-1 *Teletypewriter Switching System for General Motors, W. M. Bacon was photographed with Fred Rogers, TWX engineer of the Michigan Bell*

In his communication, Mr. Crawford wrote that he was led to the conclusion that the reflections were caused by insects "when all attempts to synthesize 'angels' by artificially producing boundaries of temperature, humidity or turbulence failed completely and when visual observations of insects coincided strikingly with the radar observations."

In their attempts to synthesize the strange patterns on the radar scopes, the scientists exploded a small charge of nitro-starch in the air, 500 feet above their radar antennas. They flew a plane low over the radar and looked for reflections from the exhaust gases. They built bonfires, upwind, so that the hot combustion

Murray Hill Moves

R. O. Grisdale and his group in Transmission Apparatus Development have moved from Building 1D and 1E at Murray Hill. Mr. Grisdale will be in 2C-271 and the group in 2B-301, 302, 303 and 308. D. R. Brobst and his group have moved to 2D-428 and 460.

N. Y. Priessman and his group in Electronics Apparatus Development have moved to their new quarters at Murray Hill. Mr. Priessman will be in 2A-324 and the others on the same floor in 2A and 2B.

J. P. Guerard has moved from West Street to 1A-158 at Murray Hill. C. M. Hebbert has moved to 2C-375.

F. J. Boyle, H. J. Stewart and K. H. Guerard of Financial are now in 2C-257-A.

R. E. Ressler has transferred to Filler Development and is located in Room 2C-137.

"Angels" and Radar

Mysterious radar reflections which have baffled the world's electronics experts both during and since the war have been explained by scientists of Bell Telephone Laboratories. The cause: flying insects.

Nicknamed "angels," the heretofore unexplained "blips" have shown up confusingly on many radar scopes as sharp echoes of short duration, observable most frequently below heights of 3,000 feet.

The explanation that the "angels" are caused by flying insects is contained in a communication to the April issue of the *Proceedings of the Institute of Radio Engineers* from A. B. Crawford of Radio Research. The strange reflections were discovered during the war by M. W. Baldwin, Jr., of Television Research.

Since that time, they have been the subject of considerable research. A number of observers have suggested they were due to

To Union College, where he graduated in 1915, *journeyed H. J. Delchamps to represent the Laboratories in a series of interviews with members of the senior class. With him in the recruiting party were representatives of Western Electric, Long Lines, and New York Telephone. Mr. Delchamps has recently become president of Union's Northern New Jersey Alumni Association*

gases and steam clouds formed by pouring water on heated rocks billowed into the beam. In all these experiments, the phenomenon was never observable.

Later, working at night, they threw out a strong searchlight beam, and stationed observers at different levels of a 200-foot tower. While the observers counted insects, the radar operators counted the appearance of "angels" on their scopes. For example, in one fifteen-minute period, twenty were counted, fifteen coinciding with the sighting of an insect.

Mr. Crawford points out that insects fit most of the descriptions which have been applied to the mysterious reflections on radar scopes. They are small, they move at a speed comparable to wind velocity, sometimes with and sometimes against the wind, they are present both day and night, and there are more of them in warm weather than in cold.

News Notes

O. E. Buckley attended the Mid-Century Convocation and Inauguration of President Killian at the Massachusetts Institute of Technology early in April. He was a guest at an official reception for Winston Churchill.

During March, M. J. Kelly spent a week at the Los Alamos Laboratory of the Atomic Energy Commission, New Mexico, and later visited the Northwestern Bell Telephone Company, where he talked to management and engineering groups. Dr. Kelly spoke on *The Position of Universities With Respect to Industrial Research* at the Symposium on Coöperative Engineering, conducted by the Institute of Technology of the University of Minnesota, with the coöperation of the Minnesota Branch of the American Society of Engineering Education and interested industries, through the Center for Continuation Study. He also went to Washington in connection with Research and Development Board activities.

A. B. Clark visited Atlanta on March 2 and 3, where he talked to Southern Bell supervisory people on *Laboratories Developments*.

W. H. Martin talked to the Deal-Holmdel Colloquium on March 18 about the development of the new combined telephone set.

Harvey Fletcher attended the meeting of the Governing Board of the American Institute of Physics. As a member of the Advisory Board of the Research Council, he visited Rutgers University on March 16. Dr. Fletcher has been elected to Honorary Membership in the Acoustical Society of America.

W. Fondiller was guest of honor at the first annual dinner of the American Technion Society, Philadelphia Chapter, on March 19.

C. S. Demarest has transferred from Patent and has been appointed Apparatus Consultant, reporting to W. H. Martin.

L. P. Johnson witnessed the installation at Troy of No. 5 crossbar systems in that city.

G. W. Gilman, G. D. Edwards, E. F. Watson, and E. G. D. Paterson discussed teletypewriter development and quality assurance matters with the Teletype Corporation in Chicago in February. During the same month Mr. Gilman, Mr. Edwards and Mr. Watson also visited Detroit in connection with operation of teletypewriter switching systems in that area.

W. M. Bacon, W. Y. Lang and M. N. Smalley visited the Teletype Corporation in Chicago for conferences on new teletypewriter apparatus. Mr. Bacon also conferred in Detroit on the 81-C-1 switching system in service for the General Motors Corporation.

T. L. Corwin analyzed certain teletypewriter troubles at Philadelphia's accounting center.

R. Marino interviewed the Primary Examiner at the Patent Office on a patent application.

G. T. Morris attended a hearing before the United States Court of Customs and Patent Appeals in Washington in various interference proceedings.

D. W. Phillion was at the Patent Office during March relative to patent matters.

H. M. TRUEBLOOD

W. C. KIESEL

RETIREMENTS

Recent retirements from the Laboratories include W. C. Kiesel and Frank Waldman with 40 years of service; E. H. Goldsmith, 35 years; and H. M. Trueblood, 31 years.

HOWARD M. TRUEBLOOD

During H. M. Trueblood's 31 years of service with the Bell System, he has been intimately associated with the development of methods and procedures for the protection of telephone service, plant, and personnel from the effects of induction from power and electrified railway circuits. For the past ten years, as Protection Development Director, he has also been in charge of development work on protection from lightning and from corrosion damage to cables. He has been a member and secretary, since its organization, of the Joint Subcommittee on Development and Research of the Edison Electric Institute (formerly the National Electric Light Association) and the Bell System. This committee has published several volumes of reports that have been of fundamental importance in the coördination of paralleling telephone and power circuits for the avoidance of interference. In the railway electrification field, Dr. Trueblood has been concerned with the Pennsylvania, New Haven, Norfolk and Western, Virginian, Lackawanna and other electrifications from the standpoint of preventing inductive interference with communication circuits. In the fields of his professional interests, he has been active as coauthor of several papers.

During the war, Dr. Trueblood directed work on cathode-ray oscilloscopes of various types for use in the development, manufacture and field testing of radar systems.* He was also concerned with the development of radar indicators, and with other war assignments. At the end of the war, he returned to the work on electrolysis prevention and protection with which he had previously been concerned.

Dr. Trueblood received B.S. degrees from Earlham College and Haverford College; spent five years as field officer with the U. S. Coast and Geodetic Survey; attended M.I.T. and then Harvard, from which he received his Ph.D. in physics; and was instructor and then assistant professor in the Electrical Engineering Department of the University of Pennsylvania. He joined the Engineering Department of the A T & T in 1917 and a few months later went to the U. S. Naval Experimental Station at New London in research work in connection with submarine detection. He returned to the A T & T in 1919, becoming a member of the D & R and came to the Laboratories during the 1934 consolidation. Since 1947, he has served as Chairman of the Program Committee of the Laboratories' communications development training for new members of the technical staff.

At retirement, he was Assistant Director of Transmission Engineering.

Dr. Trueblood is a Fellow of the A.I.E.E. and a member of its Board of Examiners; a Fellow of the A.A.A.S. and of the Acoustical Society, and a member of the American Physical Society. He is a director of the National Association of Corrosion Engineers and Chairman of its Policy and Planning Committee. He is a member of Sigma Xi.

WILLIAM C. KIESEL

Since the practice of patent law not only involves knowledge of the law but also requires a grasp of technical matters, members of the Patent Staff all have a technical background and some of them have practiced engineering. One of the latter was W. C. Kiesel who, before entering our Patent Department in 1917, had graduated from the University of Kentucky (B.M.E., 1908; E.E., 1911), had then done equipment engineering for Western Electric, and had been chief engineer of Western's affiliated company in Vienna, Austria. When the United States' entry into World War I was imminent, Mr. Kiesel returned, but soon went back to Europe, where he served as a first lieutenant in the 307th Field Signal Battalion, and participated in the St. Mihiel and Argonne drives.

That war over, Mr. Kiesel took up patent work, because he liked the opportunity it afforded for individual effort and the exercise of the imagination insofar as foreseeing trends of development was concerned. His first work was on manual circuits and later on dial cir-

*RECORD, *February*, 1948, *page* 68.

E. H. GOLDSMITH   FRANK WALDMAN

cuits and equipment. In 1925 he became a supervisor, and had charge of substation apparatus, vacuum tubes, microphones, and loudspeaking devices for reproducing sound. In 1936, outside plant matters were added, and in 1945 switchboard and submarine cables. During World War II, he also handled antennas and anti-submarine devices.

Having been admitted to the bar after night study in New York Law School, Mr. Kiesel's civic interest led him to become a judge of a minor court in his home town of Florham Park, N. J. For a number of years, he was a member of the Zoning Board there. Once a breeder and exhibitor of dogs, he is still a judge for the American Kennel Club; so that he is doubly entitled to his friends' greeting, "Good morning, Judge!"

Mr. and Mrs. Kiesel will make their home in Coral Gables, Florida.

ELSWORTH H. GOLDSMITH

In World War I, Elsworth Goldsmith went to France as a master signal electrician. When active service was denied him in World War II, he did the next best thing—he returned to the Laboratories for war work.

After graduation from Yale in 1910, he worked for General Electric at Lynn for a year, then at the suggestion of his friend, J. N. Reynolds, he came to Western Electric to help design panel apparatus. With that background, he transferred in 1916 to New York Telephone, where he became an equipment engineer. From then until 1938, he was the Telephone Company's representative in connection with the engineering work of every central office in New York as "panel" spread over the city. Then for four years he was concerned with fundamental plans; and for another four years in the Laboratories he wrote instruction manuals and instructed military teaching personnel on radar, gun directors, bomb computers, depth charges and submarine detectors. That task completed, he transferred to Patent, where he has been preparing applications on various subjects, including automatic message accounting systems.

Since Mr. Goldsmith's two hobbies—sailing and the collection and repair of antique watches—can be practiced hereabouts, he expects to remain in New York.

FRANK WALDMAN

In a little shop in Building T, a milling machine is learning the ways of a new master. Unlike its neighbors, the lathe and the drill press, it is strictly a one-man machine, for Frank Waldman carried the key in his pocket right up to April 8, when he retired.

Mr. Waldman was born in Czechoslovakia and came to this country with some experience as a machinist. He entered the Western Electric shop at West Street in 1906, worked elsewhere for three years, returned during World War I and has been one of us ever since. One of his early jobs was on printing telegraph equipment; he built the power rectifier for the long-wave transatlantic radio station at Rocky

May Service Anniversaries of Members of the Laboratories

40 years

W. H. Long

35 years

F. H. Graham
R. H. Miller

30 years

J. L. Agterberg
F. G. Colbath
P. B. Fairlamb
R. H. Galt
F. J. Given
J. L. Hysko
F. A. Kuntz
G. T. Lewis
M. B. Long
J. T. O'Leary
Eugene Peterson
Leonard Vieth
J. F. Wentz

25 years

C. E. Fordham
L. W. Giles
W. F. Kannenberg
W. D. Mischler
N. C. Youngstrom

20 years

J. M. Acker
L. T. Anderson
H. L. Bowman
Patrick Coleman
John Connor
E. B. Destler
T. A. Durkin
Ludwig Fichter
F. G. Fossetta
O. R. Garfield
William Gulker
Ernest Guzmich
W. L. Hardardt
Francis McConville
J. F. Middleton
Theodor Olsen
D. T. Osgood
E. L. Owens
R. E. Ressler
R. A. Sykes
G. W. Turner
David Westbrook
J. F. Wursch
C. S. Yeutter

15 years

Daniel Breen
Franklin Dermond
C. R. Hornby
C. M. Jason
T. W. Mackey
P. F. McGann
Albert Rodel
Frank Schuler
W. C. Sturzenegger
Elena Tighe
H. S. Wertz

10 years

W. O. Baker
Ethel Blocker
L. W. Lott
Lorraine Moss
Mary Roberts

Point; helped set up WEAF on the eleventh floor at West Street; the television radio transmitter at Whippany in 1927 and the sound-picture equipment in Section L. For the last three years he has been a laboratory mechanic in Electronics Development, working principally on tube parts and waveguides. Along with those jobs, he is guide, counsellor and friend to the engineers on all sorts of mechanical problems.

Mr. Waldman expects to occupy his leisure with work around his house and garden near Port Washington, or perhaps to get a job in some nearby machine shop.

News Notes

R. E. POOLE was appointed an A.I.E.E. representative to American Standards Association Sectional Committee C16 on Radio as a replacement for W. Wilson, deceased.

W. S. GORTON attended the Safety Convention held on March 31 in New York.

A. G. JENSEN has been appointed chairman of the Institute of Radio Engineers Television Systems Committee, and vice-chairman of the Institute's Standards Committee as of May 1.

B. S. BIGGS is chairman-elect of the High Polymer Group of the North Jersey Section of the American Chemical Society.

L. H. GERMER has been appointed to the A.I.E.E. Subcommittee on the Electrical Properties of Gases.

A. MENDIZZA has been appointed chairman of a special committee to study accelerated tests for supplementary finishes for zinc, A.S.T.M. Committee B-8, Subcommittee V.

C. E. SHANNON appeared on the televised radio program *We, the People* on March 22, participating in the discussion of some aspects of electronic computers.

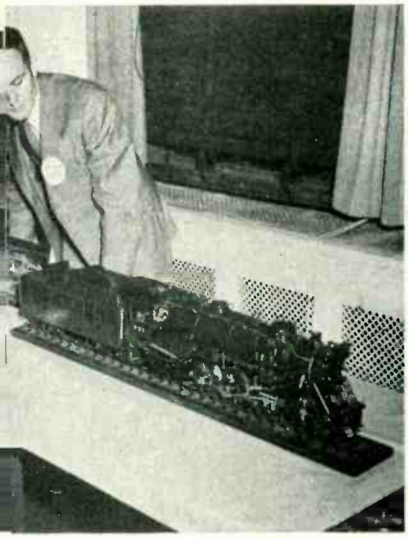
AMONG THOSE who attended the American Physical Society meeting in Cleveland were W. P. MASON, A. J. AHEARN, K. G. MCKAY, G. H. WANNIER, R. M. BOZORTH, F. S. GOUCHER, J. M. RICHARDSON and W. SHOCKLEY.

K. K. DARROW visited Cleveland from March 9 to 12, where he spoke before the Lambda Club of Case Institute of Technology on *Magnetic Resonance* and the American Physical Society on *Linguistics of Solid State Physics.*

B. MCMILLAN gave the second lecture entitled *Characteristics of Information* in a series of six, and C. E. SHANNON the fourth entitled *Communication in the Presence of Noise,* in a course on Recent Developments in the Theory of Communication given by the A.I.E.E. Communication Division in New York, jointly with the New York Section I.R.E.

Younger members of the Laboratories and their friends generously supported a party and dance sponsored by the Hospital Visiting Committee of the Legion Bell Telephone Post No. 497 to obtain funds for airfoam cushions for veterans' wheelchairs. Included in the group below are, standing: J. Smith, his wife, Helen, E. Strubing,* Gloria Ryan,* Claire King, S. Robertson, Anne Pfeiffer,* Jane Nichol and J. P. Larimer;* seated: Carman Abascal, C. W. Peterson,* Clotilda Abascal,* F. X. Sullivan,* Nancy Nelson,* C. Dalm,* Dorathy Sherry,* J. A. Ceonzo,* Maeve Kelly,* Marilyn Winters* and R. L. Newby**

*Member of Laboratories



Heart of the show of the Model Railroad Club was this portable layout (above, right), borrowed from the New York Society of Model Engineers. H. H. Hagens (above, left), director of the show, looks over a live steamer, which took three years of spare time to build. Folks at Murray Hill brought the children in to see the show (right).

Model Railroaders' Exhibit at Three Laboratories

The Model Railroad Club, which has yet to celebrate its first birthday, exhibited the craftsmanship of its members at West Street in early March to thousands who visited the Auditorium not once but several times to enjoy its displays. Then, under the director of the show, H. H. Hagens, the entire set-up moved to Murray Hill and later to Whippany. Heart of the show was a portable HO layout, borrowed from the New York Society of Model Engineers and operated during the hours the show was open with equipment entered by club members. Trains varied in size from HO gauge cranes made to scale while in the Pacific from a tin can by Paul Mallery, chairman of the club, to a giant live steam model locomotive which C. Karthaeuser helped to make. Many steamers entered were made from scraps; others from modelcraft kits. Posters on display everywhere showed such things as the technique of building various models, the popularity of various gauges. The accompanying photographs tell a graphic story of interest in the show.

News Notes

J. R. Townsend spoke on *Materials in the Modern World* before the Pueblo and Denver, Colorado, Chapters of the American Society for Metals on March 17 and 18, respectively, and The Mountain States Company.

A. W. Treptow and M. D. Rigterink discussed porcelain enamel problems at the Ingram-Richardson Manufacturing Company, Beaver Falls, Pennsylvania.

J. B. DeCoste conferred at the National Lead Company Laboratories in Brooklyn on stabilizers for polyvinyl plastics.

C. V. Lundberg at the Tonawanda Plant witnessed a demonstration of the use of high-frequency heating equipment in conjunction with the extrusion of plastic jackets on cable.

Whippany Men's Glee Club

During a spring concert given at noon in the restaurant, the Whippany Men's Glee Club, under the direction of B. J. Thomas, with the bass viol, gave out with a few hillbilly numbers just for fun. Vocalist for the occasion was M. H. Gilson with his ukulele at the microphone, assisted by F. F. Gruber and F. E. DeMotte, guitarists, and W. H. Thatcher, accordionist of the Club

L. L. Spangenberg (below), the accompanist in the Whippany Men's Glee Club, was photographed playing a piano solo during a portion of the program

SEVERAL DIFFERENT PLANTS of Western Electric were visited by members of the Laboratories recently. At Haverhill, J. W. MCRAE, E. I. GREEN, F. J. GIVEN and R. M. C. GREENIDGE discussed the manufacturing processes for transformers, coils and resistors. At Allentown, N. Y. PRIESSMAN, G. T. KOHMAN, C. J. FROSCH, C. B. GREEN, J. A. MILLER and G. K. TEAL discussed thermistors; J. P. MESSANA, glass seal terminals; and E. B. WOOD, N. INSLEY, L. L. LOCKROW and T. L. TANNER, equalizer problems. At Burlington, W. L. BLACK examined tool-made sample of the 22E speech input equipment. At Winston-Salem, H. A. FREDERICK and A. C. KELLER discussed vibrating reed selectors; J. E. CORBIN, airborne equipment; and C. W. RAMSDEN, pulser networks. At St. Paul, V. F. BOHMAN attended a Quality Survey on step-by-step switches. Mr. Bohman also visited the Hawthorne plant, where he discussed various problems relating to step-by-step apparatus.

W. J. KING attended the meeting at Wright Field, Dayton, of the Committee on Pulse Cables of ANRFCCC.

A. W. Westling of the L. M. Ericsson Company, Stockholm, and H. J. B. Nevitt of the New York office of that company visited Murray Hill recently.

West Street Girl to Sing in Italy

Muriel Warren of the Building Department is sailing for Naples on May 26 to sing in operatic performances in Italy and to consider the offer of the Roman Cinema Company to sing in its productions. Professionally known as Dea Lovati, Miss Warren has studied the piano since she was nine and voice since she was thirteen, when she came to New York to be taught by masters from Italy. A lyric-coloratura, she made her debut at eighteen as Gilda in *Rigoletto* in the Young Stars Grand Opera Company and after that sang with the New York Civic Grand Opera, the Monte Carlo and Hippodrome Grand Opera Companies. A native of Portland, Oregon, Miss Warren came to work at the Laboratories during the war.

Sculpturing is a comparatively new hobby of Laboratories' members in New York, who have evinced a fine interest in the art. The instructor, Irma Rothstein, standing, assisting girls at a table, left to right: Pat Caruso, Elizabeth Bates and Dorothea Albanese

News Notes

J. W. Smith, F. E. Nimmcke and J. B. D'Albora observed performance tests of fire control equipment at Syracuse.

D. G. Blattner and J. H. Waddell visited the Eastman Kodak Company and Wallensak Optical Company in Rochester in connection with industrial cameras.

C. R. Taft and H. A. Baxter participated in conferences on the coördination of subcontractors' designs of submarine projects at General Mills, Minneapolis.

H. L. Rosier has completed a month's assignment at the Naval Air Test Center, Patuxent River, Maryland, where he assisted Navy personnel in the tests of aircraft radio equipment.

W. J. Kiernan attended a course on Appearance Measurement at the Henry A. Gardner Laboratory in Bethesda, Maryland. He also attended recent sessions of the Optical Society of America in New York.

A. C. Walker discussed construction of steel bombs for growing quartz crystals at the Watertown Arsenal, Massachusetts. He also discussed quartz crystals with members of the Department of Geology of Harvard University.

A. G. Ganz visited Carnegie Institute at Pittsburgh, and the University of Chicago and Northwestern University during the week beginning March 7 to interview prospective employees. He also visited the Hawthorne Works in connection with magnetic problems.

R. A. Sykes attended a committee meeting of the Research and Development Board subpanel on frequency control devices at the Georgia Institute of Technology.

G. D. Johnson, A. A. Lundstrom, R. W. Sears, R. G. Stephenson and P. H. Thayer made visits to several organizations such as Massachusetts Institute of Technology, the Bureau of Standards, Moore School of Engineering and the Naval Research Laboratory, where they discussed computers.

A Scientific Look at Weight Control

by ELENORE NEASHAM
Chemical Laboratories

Aside from how you look, you are taking a risk when you are too fat or too thin. For the overweights there is a greater chance of high blood pressure, strained heart and kidneys, a higher incidence of diabetes and gall bladder trouble. Underweights tire quickly, become easy victims of nervous disorders and diseases, such as tuberculosis, resulting from under-par conditions. And, of course, there *is* the matter of looks—vital to women, especially in the summer, and of some importance, even to men. So check your weight in the table below, and if it's out of line, start working on it now.

If You Are Overweight

Exercise will help take off some poundage, but ignoring hunger pangs will bring quicker results. Remember that appetite is a habit pattern, and often a faulty guide to the foods your body needs. Since authorities agree that most excess fat problems are caused by too much eating and drinking, try to curb your appetite.

If You Are Underweight

It is strange, yet true, that the same foods recommended for overweights—but in different proportions—can be used to add extra pounds by those whose weight is too low. To stimulate your desire for food and to help you to utilize it better, your doctor may prescribe the B complex with a high dosage of vitamin B_1.

Food Groups

For simplicity, you may divide the food factors into the following groups:

Proteins . . . . for building muscles and repairing body tissues that wear out daily

Vitamins and Minerals . . . . for catalyzing your internal workings

Fats and Carbohydrates . . for energy

All of these food factors are necessary, but the fat and carbohydrate group can be increased or decreased according to your energy needs. (You still get some calories for energy from fats and carbohydrates present in sup-

[*Editor's note—Miss Neasham graduated from New York University in* 1947 *after specializing in nutrition. The table at the bottom of this page was taken from Metropolitan Life's booklet,* Overweight and Underweight. *Suggestions for future articles on health will be welcomed.*]

Desirable Weights for Men and Women of Ages 25 and Over

These tables are based on numerous Medico-Actuarial studies of hundreds of thousands of insured men and women.

MEN

Weight in Pounds According to Frame
(as ordinarily dressed)

Height (with shoes on) Feet	Inches	Small Frame	Medium Frame	Large Frame
5	2	116-125	124-133	131-142
5	3	119-128	127-136	133-144
5	4	122-132	130-140	137-149
5	5	126-136	134-144	141-153
5	6	129-139	137-147	145-157
5	7	133-143	141-151	149-162
5	8	136-147	145-156	153-166
5	9	140-151	149-160	157-170
5	10	144-155	153-164	161-175
5	11	148-159	157-168	165-180
6	0	152-164	161-173	169-185
6	1	157-169	166-178	174-190
6	2	163-175	171-184	179-196
6	3	168-180	176-189	184-202

WOMEN

Weight in Pounds According to Frame
(as ordinarily dressed)

Height (with shoes on) Feet	Inches	Small Frame	Medium Frame	Large Frame
4	11	104-111	110-118	117-127
5	0	105-113	112-120	119-129
5	1	107-115	114-122	121-131
5	2	110-118	117-125	124-135
5	3	113-121	120-128	127-138
5	4	116-125	124-132	131-142
5	5	119-128	127-135	133-145
5	6	123-132	130-140	138-150
5	7	126-136	134-144	142-154
5	8	129-139	137-147	145-158
5	9	133-143	141-151	149-162
5	10	136-147	145-155	152-166
5	11	139-150	148-158	155-169

plementary amounts in the other groups.) The principal sources of proteins, vitamins, minerals, fats and carbohydrates are to be found in the foods listed below. These foods should be the backbone of a daily diet for the overweight and underweight, as well as for the normal person.

To insure a good appetite for the foods you need, go easy on hard and soft drinks, cakes, cookies and crackers, pies and pastries, candy and chocolate, sugar and other sweets. They supply mainly calories. And calories alone, even for the underweight, will not put curves and muscles where you want them.

The Principal Sources of Proteins, Vitamins, Minerals, Fats and Carbohydrates

FOODS	GIVE Your Body		Notes for		
	Mainly	Also	Normal Weights	Overweights	Underweights
Meat Poultry Fish Eggs Dried Beans Dried Peas	Proteins	Vitamins B Complex A from Liver Minerals Iron	Adults need one to two portions a day.	Lean pieces only. No oily fish. Cooking and preparation without butter, fats and oils.	Take extra portions for body building.
Milk Cheese or Other Milk-Containing Foods	Proteins Mineral Calcium Vitamins A B_2	Other Minerals and Vitamins (D if added to milk)	To help meet a grown-up's daily calcium requirements: 3 glasses of milk or its equivalent in other foods; e.g. 3 glasses of milk approximately equals ¼ pound of cheese.	Avoid sweet and sour cream, as well as ice cream. Use skim milk, buttermilk, cottage cheese; and make up for their lack of vitamin A by eating more dark green leafy and yellow vegetables, also apricots.	Use cream as well as whole milk. Mix powdered whole milk into milk and other foods. Eat whole-milk cheeses.
Citrus Fruits or Tomatoes	Vitamin C	Vitamin A from Tomatoes	At least one generous serving.	Unsweetened citrus fruit or juice.	Sweetened if desired.
Fruits in Addition to Citrus	Vitamins Minerals	Mineral Iron from Dried Fruits	One other a day recommended.	Select fruits (unsweetened) for desserts.	Eat fruits for between-meal snacks.
Vegetables—Especially Dark Green Leafy and Deep Yellow	Minerals Vitamins	Vitamin A from Dark Green Leafy and Yellow Vegetables	Two big helpings or more.	No oil on salads. No butter or fat on vegetables. No cream sauce, Hollandaise or mayonnaise.	All the butter, sauces and dressings you want.
Potatoes	Carbohydrates Minerals Vitamin C	Vitamin B	One serving.	Not more than 1 small potato, with no butter, fat or cheese.	More than 1 portion, with butter, fat or cheese.
Whole Grain or Enriched Breads and Cereals	Carbohydrates	Vitamin B_1	2-4 slices of bread a day or equivalent in whole grain cereals.	Only 2 slices a day.	As much as you like.
Butter, or Oleomargarine with Vitamin A	Fats	Vitamin A	2 tablespoonfuls (or 6 teaspoonfuls)	Each tablespoonful omitted means 100 calories less.	Add as much as you can.

Drink four to six glasses of water a day.

Lunch time at Murray Hill

News Notes

P. B. Drake visited the Teletype Corporation to discuss questions in connection with the production of readers and perforators for the AMA system.

At the Hawthorne plant in Chicago, C. C. Barber and M. Fritts discussed new designs of crossbar switch; A. C. Gilmore, equipment units for common systems; C. C. Hipkins, W. J. Kiernan and R. J. Phair, general finishes; W. Babington and I. V. Williams, raw materials; E. T. Ball, cost production studies for No. 5 crossbar equipment; W. E. Grutzner, testing equipment for No. 5 crossbar system; H. N. Wagar and E. G. Walsh, production of UB relays; J. W. McRae, H. A. Frederick, J. J. Kuhn, A. C. Keller, H. O. Siegmund, R. C. Davis, B. F. Runyon and H. M. Knapp, crossbar switch and wire spring relay problems; T. A. Marshall, the automatic message accounting system; R. R. Stevens and C. E. Mitchell, granular carbon for the transmitter unit in the 500-type set; W. L. Tuffnell and L. Vieth, the manufacture of the new telephone set, and coin collector problems; A. C. Ekvall, components for the new subscriber set; V. T. Wallder, polyethylene on alpeth cable; and L. W. Giles, at Hawthorne and Haverhill, problems relating to economic studies of the manufacture of old apparatus.

P. H. Smith conferred on the design of submarine projects at the Bureau of Ships, the Navy Department and the Naval Research Laboratory in Washington.

J. D. Sarros participated in a symposium on Navy equipment at the Naval Research Laboratory in Washington.

R. C. Newhouse, R. F. Lane, F. C. Ward and E. A. Bescherer visited Watson Laboratories in connection with procurement of radiotelephone equipment for the U.S.A.F.

S. C. Hight spoke on *Naval Air Defense Problems* before the Volunteer Ordnance Division W1 at the Bureau of Ordnance in Washington.

K. O. Thorp, R. V. Lohmiller and P. F. Reckenzaun of Manufacturing Relations, Burlington, were visitors in Whippany during March, and H. C. Brearley, also of Burlington, during the first week of April.

J. N. Shive gave demonstration lectures on Transistors before I.R.E.-A.I.E.E. groups in Washington and Baltimore. He also addressed the Physics Colloquium at Johns Hopkins University on the same subject.

T. C. Fry, O. Myers and C. E. Brooks visited the Pacific coast during the month of March, stopping at Los Angeles, San Francisco, Seattle and Portland.

G. A. Hurst, A. A. Mayer, D. H. Pennoyer and F. F. Shipley discussed switching matters with the Michigan Bell Telephone Company people in Detroit.

H. M. Spicer conferred on motor-driven autotransformer designs with the Superior Electric Company at Bristol, Connecticut. He also discussed engine control equipment designs with the Duplex Truck Company at Lansing.

R. D. de Kay observed a new type ringing interrupter at the plant of the Stromberg-Carlson Company in Rochester. He also observed the new power plant for the 7A2 system built by Federal Radio and Telephone Company for the Rochester Telephone Company.

L. S. C. Neeb discussed new designs for thermal operated relays with the Struthers Dunn Company at Philadelphia.

"He's homesick for the Lackawanna ferry"

M. A. Froberg studied the effect of variable power service upon the rectifier inverters in the L carrier station at Knoxville, Alabama.

H. T. Langabeer visited the St. Louis office in connection with the 301C power plant.

A. E. Gerbore and R. V. Bruckmann were in Media in connection with the Laboratories' trial of reed keyset equipment and Class AR changes in the AMA central office equipment.

G. H. Duhnkrack made a study in the new No. 5 crossbar central office, Vineland, New Jersey, of the application of Plant training material to central office maintenance.

At Point Breeze, D. G. Blattner, J. F. Baldwin and R. A. Hecht discussed the manufacture of manual apparatus; F. S. Kammerer, central office cords; C. A. Webber and H. H. Staebner, cord development; D. T. Eighmey, cording problems in connection with the new station telephone set; and G. H. Williams, Jr., switchboard plugs.

W. R. Goehner was at the Audichron Company in Atlanta regarding the application of standard Western Electric audio facilities to special announcing systems.

R. A. Miller and L. B. Cooke attended two meetings of the Radio Manufacturers' Association, TR-10, Audio Facilities Committee. They also attended a RMA Committee meeting on AM broadcast transmitters. Mr. Miller and H. W. Augustadt participated in a joint meeting of the newly formed committees of the Audio Techniques, Video Techniques and Sound Recording and Reproducing Committees of the I.R.E.

F. A. Coles attended conferences on magnetic tape recorder-reproducers in Chicago at the Magnecord Company.

W. J. Brown inspected voice frequency recorder systems at Media.

J. M. Duguid and V. T. Callahan observed the first pilot model of the new automatic diesel engine set at the General Motors plant in Detroit. Mr. Callahan also visited several K carrier stations in the vicinity of Toledo.

W. L. Betts made tests at Cleveland on charging generators.

H. J. Berka discussed, with the Crouse-Hinds Company at Syracuse, problems in connection with air navigation obstruction lighting and its control for the TD-2 microwave equipment. He also visited St. Louis with R. H. Tweedy of the O & E to confer with the Southwestern Bell and the Daybrite Manufacturing Company on central office lighting problems.

G. E. Dustin conferred at Scranton with local telephone engineers on method of dressing four-wire solderless connectors in step-by-step offices.

K. M. Fetzer and J. G. Ferguson, while at Albany and Baltimore, made studies of No. 5 crossbar equipment after which they visited Hawthorne to discuss with Western engineers installation schedules for this equipment.

A. B. Clark, H. H. Lowry, T. C. Fry, W. A. MacNair and A. J. Busch inspected a No. 5 crossbar office at Vineland, New Jersey.

B. McWhan visited Media in connection with the trial of the reed keyset.

L. A. Weber's visit to Madison and Milwaukee concerned the trial of the N signaling system.

The Laboratories were represented in interference proceedings at the Patent Office by F. Mohr before the Primary Examiner.

This Month's Ad

In the facing advertisement, Rae MacEvoy is shown in the free-space room at Murray Hill. The sounds she hears are transmitted from an adjacent room where F. M. Wiener (above) is seen watching message registers as they record her judgments. Transmission of the test sounds is automatically controlled by the perforated tape shown in the foreground.

Engagements

*Betty Anderson—Edward Hayward
*Carmela Arfuso—Dominick Liantonio
Ann Frustaci—*Frank B. Catalanello
Joan Gilmartin—*Gregory W. Fiederowicz
*Jean Grusha—John Gaydos
Betty Jane Harrison—*Philip E. Hogin
*Ann Iapalucci—Frank L. Bonasia
Elizabeth Kradell—*Charles J. Mataka
*Virginia Lent—DeWitt C. Gedney
*Jean McDonald—*J. A. Ceonzo
Kristine Mortensen—Harold C. Hotaling
*Catherine Roth—William E. Potter

Weddings

*Eugenia Anthes—Charles J. Schell, Jr.
*Marie Coltri—Felice Giarratano
*Anne Connell—*Anthony Sprink
*Louise Costella—Remo Del Maestra
*Caroline Doubrava—Victor Gentile
*Helen Fraedin—William Nagin
*Elizabeth Minerowicz—Anthony Y. Yavorski
*Mary Elizabeth Moore—*Claude E. Shannon
Catherine Oppel—*Leo Ehrmann
*Margorie Pfeifer—Karl F. Koch
*Grace Robertson—Eamon J. Devlin
Marion Roth—*Walter Strack
Shirley Smith—*James Z. Menard
*Marie Tighe—*Ernest J. Guzmich
Elizabeth Uptegrove—*Warren E. Mathews

*Members of the Laboratories. Notices of engagements and weddings should be given to Mrs. Helen McLoughlin, Room 803C, 14th St., Extension 296.

Murray Hill Chorus Concert

The Murray Hill Chorus has extended a cordial invitation to all Laboratories' personnel, their families, and friends to attend its annual Spring Concert on Tuesday evening, May 24, at 8:30 p.m., in the Summit, New Jersey, High School Auditorium. Their program will include a wide variety of selections, Negro spirituals, a Russian liturgical chant, a sea chantey, and several semi-popular numbers. L. A. Meacham, playing the violin, will be accompanied by the Chorus in his own arrangement of an *Andante* by von Diffendorf. Further information about tickets will be announced later.

In addition to this performance, the Chorus plans to present selected parts of the program at the Veterans' Hospital in Lyons, New Jersey, on Sunday evening, May 15. Daniel Kautzman, Summit High School music director, will conduct both performances, and Miss Capitola Dickerson, of Summit, will be the accompanist.

Retired but Active

E. C. Molina was a guest speaker at the Quality Control Conference held at Georgia Institute of Technology on March 25 under the auspices of the Georgia Section of the America Society for Quality Control and the Atlanta Chapter of the Society for the Advancement of Management.—*The Atlanta Journal.*

A number of letters have been received in Publication from Stanley Watkins, who retired last fall and is living in Kent, England. In one letter he says:

"The sunsets are unbelievable. In the house we are occupying temporarily, we see them to full advantage as we look across a wide field (young onions) to the sea, which is prevented from invading us by chalk cliffs about 40 feet high. The fact that behind these sunsets there is a naval base or something, which indulges in spasmodic gun practice at odd moments, doesn't detract too much from their beauty. This is a little corner of the realm which rejoices in maximum sunshine, minimum rain, and practically no fog.

"Living far enough from any large town to be beyond the commuting belt to all intents and purposes, the austerity annoyances are almost non-existent. No queues or anything like that. Things are very much better throughout the country than they were a year ago. There is still a great shortage of certain kinds of material, notably, of course, building stuff and the things we are exporting, such as anthracite, but if one can overcome the irritation at not being able to get just what he wants when he wants it, life isn't so bad."