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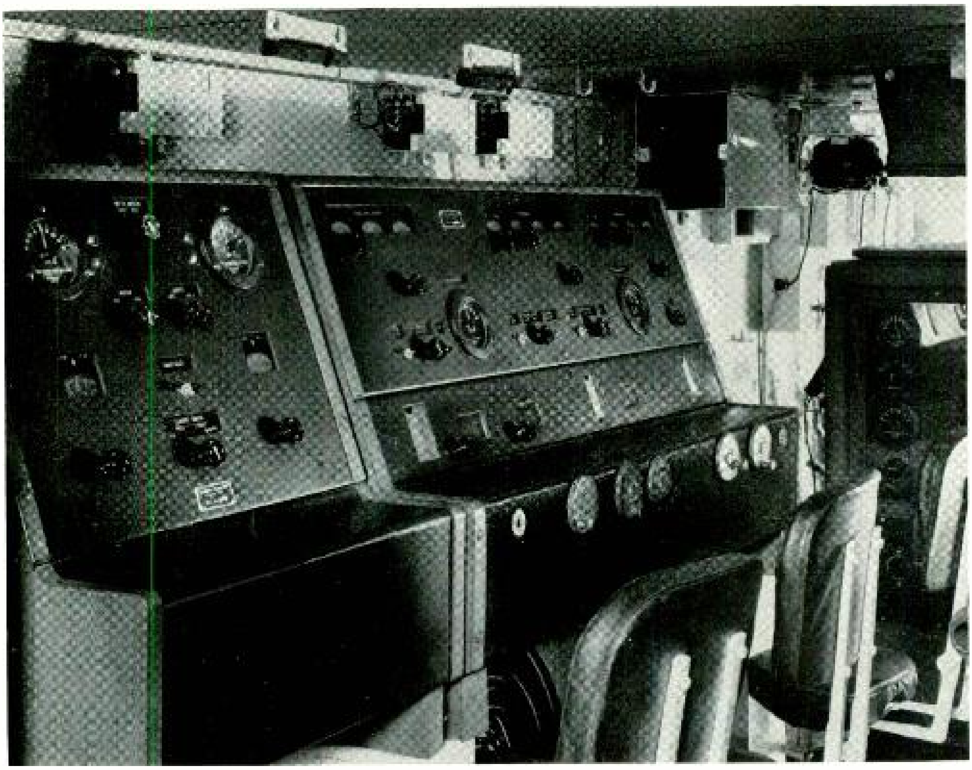

Computer for Coastal Guns

By H. G. OCH
Physical Research

RESULTS obtained from the M-9 Anti-Aircraft Director* were so satisfactory that the Coast Artillery Board asked for equivalent apparatus to guide the aiming of the more powerful coast defense guns. The largest anti-aircraft guns controlled by the Director were 5.25 inches in caliber, while the intermediate size coastal guns, to which this suggestion applied, range from 6 to 8 inches, inclusive. At first glance, it might seem that the M-9 Director itself could be used for controlling these larger guns merely by changing the ballistic data, but there are a number of reasons that make this impossible, and the M-8 Gun Data Computer was developed for this new application of electrical calculation.

One of the factors dictating a new design was the greater range of the coast defense guns, which is about two and a half times that of the anti-aircraft guns. A

*RECORD, *December*, 1943, *pages* 157 *and* 186; *January*, 1944, *page* 225; *October*, 1944, *page* 555.

The photograph above shows the interior of trailer housing the computer. The position generator is at left and the triangle solver adjacent and to the right of it, with the predictor unit partly evident in the rear.

greater range requires greater accuracy in all the calculations, and this need is increased by the difference in the shells fired by the two types of guns. Those of the anti-aircraft guns have timed fuses, while those of the coast defense guns have contact fuses. If an anti-aircraft shell explodes anywhere in the vicinity of a plane, considerable damage will be done, while a contact shell must actually hit its target to do damage. If a contact shell missed its target by being only a few feet too high, for example, it would probably do no damage at all, while an anti-aircraft shell missing by ten yards but properly timed might still wreck the plane. Thus much greater precision is required both in determining the position of the target and in calculating the firing data.

Moreover, a sea coast defense unit is commonly fixed in position, and is thus more subject to damage by enemy fire than are the more mobile anti-aircraft units. Emergency methods must therefore be made available to permit the guns to be controlled by telephone instructions should the automatic system be damaged. Also, it is preferable with coast defense guns to have the target tracked optically at the gun whenever the target is visible, and to have the computer calculate only the deflection angles required to allow for the lead of the target and the ballistics of the shell. A computer for coast defense guns should thus be arranged for several methods of operation, while the anti-aircraft guns are usually controlled completely by means of the Director.

Besides these differences in the requirements for the two types of computers, the input data differ, and thus require different treatment. For the anti-aircraft equipment, the bearing of the target is determined by the tracker, and the distance (range) is determined directly, commonly by radar. For the coast defense guns, on the other hand, the original data are two angles determined by azimuth instruments at the two ends of a base line of known length. From these two angles and the length and bearing of the base line, both direction and azimuth for firing the guns are determined by trigonometric solution.

Prior to the advent of the M-8 Gun Data Computer, firing data for intermediate coastal defense guns were derived at a large plotting table located at some convenient and secluded position. A number of accurately located points along the coast, some of them as much as ten miles from the guns, were used as observing stations, and at these positions the target would be tracked with azimuth instruments. At fixed time intervals, often 20 seconds apart, a bell is rung, and the azimuths of the target at that instant are phoned back to the plotting room. Here the azimuths from two of the stations are laid out on a plotting table radially from the points of the observing stations, and the intersection of the two azimuth lines is the position of the target at the time of the last bell. These "time interval" (TI) bells form a time base for the operation of the entire system. Besides setting the time of the periodic position spotting, they also mark the instants at which the guns are fired, and aiming data for the guns are calculated to be correct when the gun is fired at the next time the bell rings.

After a number of points have been plotted at successive TI bells, a line drawn through them gives the direction of travel of the target. Its speed is determined from the distance travelled between two or more

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successive intervals. From the speed and course of the target, its position at any desired instant can be readily predicted, and the bearing and distance of this predicted point from the gun is determined by swinging a gun azimuth and range arm to lie across the gun and the predicted position of the target.

With this information and the help of ballistic tables, it is possible to calculate the proper elevation angle and azimuth at which the gun should be set so that when it is fired at the next TI bell, the shell will hit the target.

It is inherent in this manual method of plotting and firing control that the guns be fired only at the TI bells. The interval between TI bells is chosen with reference to the time necessary to perform the calculations in the plotting room and to aim the guns, but if this is completed before the next TI bell, firing must be delayed until the bell rings. If, on the other hand, the necessary work is not completed when the bell rings, firing must wait till the next one, and be based on a new set of data.

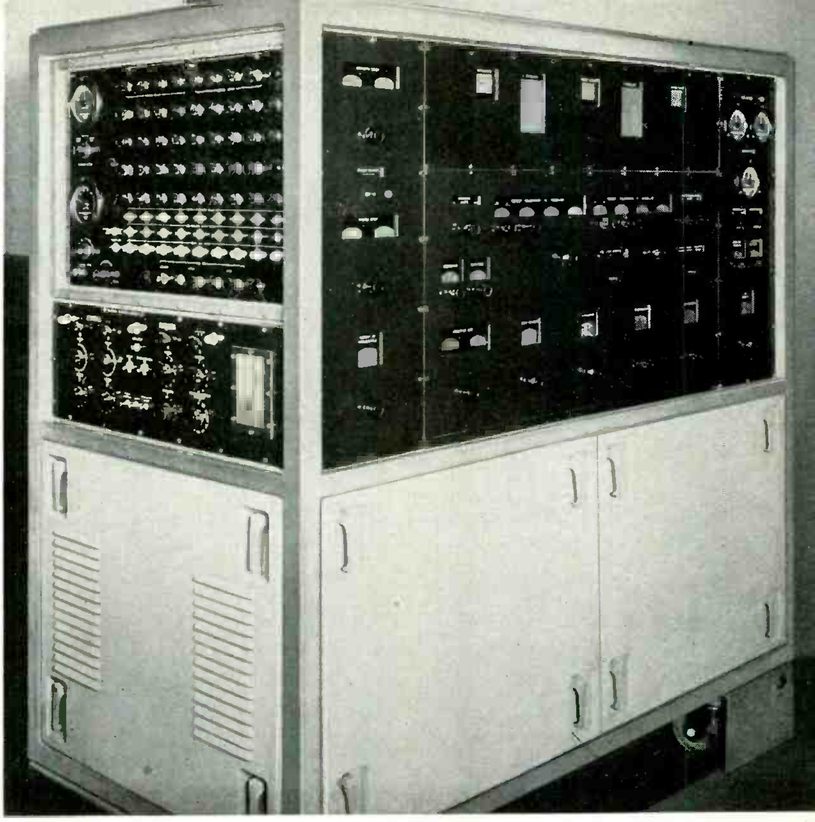


Fig. 1—The predictor is the main unit of the M-8 Gun Data Computer

Besides this necessary injection of a minimum of firing interval, the manual method of control introduces a possible inaccuracy of firing. The aiming is calculated on an estimated position of the target based on its position at the TI bell preceding that at which the gun is fired. During this period, called the dead time, the target may change its direction or speed of travel, and this change cannot be included in the aiming calculations.

One of the main objectives of the new automatic control system was to do away with these delays and inaccuracies of the manual method. With automatic control, the aiming calculations are carried out continuously, and the guns may be fired as soon as they are loaded and aimed. Moreover, the aiming calculations are based on the position of the target at the time of firing.

In converting to an automatic computing system, the general scheme of tracking and calculating is not changed basically, but some of the intermediate steps are carried out in a somewhat different manner. Five separate pieces of apparatus comprise the M-8 Computer: a line-balancing unit; a triangle solver; a position generator; a predictor; and a power supply. The latter unit was taken over intact from the M-9 Director and needs no further consideration, but all the other units are applicable solely to the new computer.

The triangle solver receives the azimuth angles by electrical signals from the two observing stations continuously, and from them, and the known length and direction of the base line connecting the observing stations, calculates the position of the target in terms of the X and Y coördinates from the gun positions. Electrical voltages representing the two angles obtained at the observing stations appear on two dials on the front of the triangle solver. As pointers on these dials tend to deflect, each of the two operators at the triangle solver moves

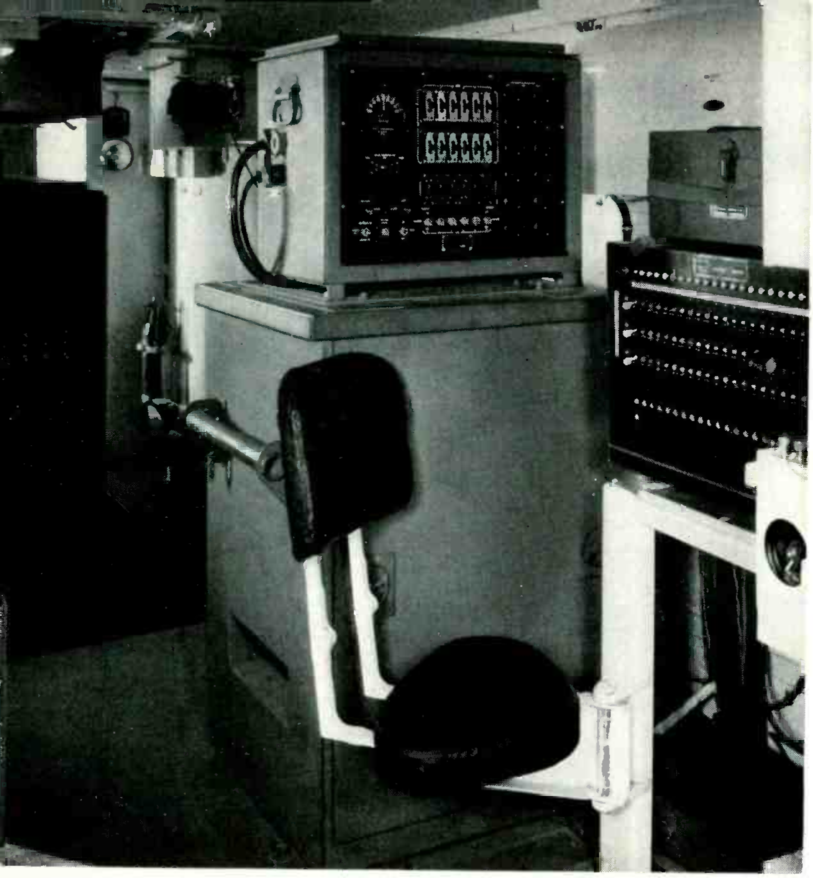


Fig. 2—Opposite the triangle solver in the trailer is the line-balancing unit resting on top of the power supply. To the right is a telephone switchboard, and in the rear is the predictor

a hand wheel in a direction to oppose the effect of the incoming signals on the dial pointers. By these hand wheels the dial pointers are kept on zero, and the motion of the hand wheels in doing this supplies the triangle solver with the necessary data for solving the triangle.

Since the magnitudes of the signals from the observing stations depend on the impedance of the lines over which they are transmitted, and since these lines may be of different lengths, the line-balancing unit is interposed between the triangle solver and the observing stations to adjust the inequalities in the lines. As already pointed out, there usually are several observing stations, any two of which may be used at a time, and the balancing unit includes switching equipment for selecting the stations desired and for balancing the lines of the pair that have been selected.

From the triangle solver, electrical voltages continuously representing the X and Y coördinates of the target are passed on to the predictor, shown in Figure 1. This is the main unit of the M-8 Computer, and it performs all the calculations needed to aim the guns under ordinary conditions. From the coördinates received from the triangle solver, it calculates the distance to the target, and then it determines from ballistic data incorporated in the circuit how long it will take for the shell to reach the target. Knowing this time interval, it must then predict from the present direction and speed of the target the point it will be when the shell reaches it. This predicted position is then used in the calculation of the aiming angles. All these various steps, of course, are carried on continuously, and thus aiming data are continuously available that are correct at the instant the gun is fired. The only prediction that can affect the accuracy of fire is that of a movement of the target while the shell is in flight. The long dead time essential with manual control has been entirely eliminated.

In making this calculation, the computer takes into consideration the variations in air density, the direction and velocity of the wind, the weight of the shell, the air temperature, the effect of the earth's rotation, the height of the tide, the height of the gun above water level and the muzzle velocity of the guns. A single computer takes care of the two guns of a coast defense battery and it carries out separate calculations for each, since in many cases the guns are far enough apart to make their firing data different.

The aiming data computed by the predictor are transmitted to two instruments at the guns, where they appear on a small pointer called a "bug." Operators at the guns control the elevation and azimuth movement by small hand wheels that also control a bug operating concentrically with those controlled by the predictor. As long as the two bugs line up, the gun is properly aimed and may be fired at any moment.

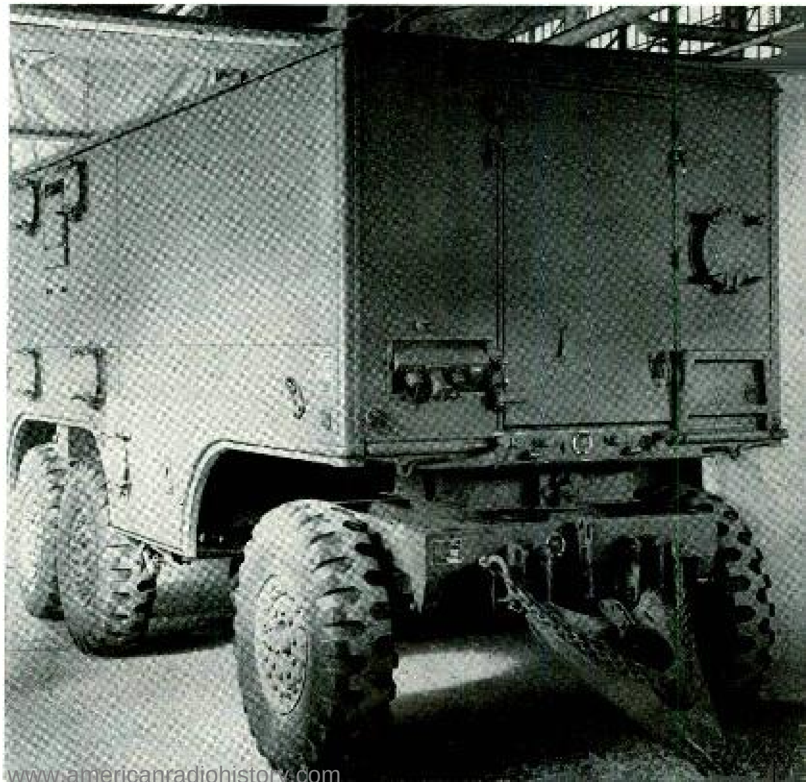
This is the normal method of operation when the firing is being controlled entirely automatically with the target visible from the observing stations. There may be intervals, however, due to smoke, fog, or other obstacles to tracking, or to the changing of the observing stations because of changed position of a target, when azimuth angles are not being received by the triangle solver. To provide for proper aiming during such intervals, the position generator is furnished.

This unit, shown in Figure 2, receives the coördinates of the target from the triangle solver by way of the predictor, and extrapolates them at the then current speed of the target to provide a continuous set of positions. As long as new data are being supplied, the operator at the position generator corrects the generated positions periodically to conform to the latest information. When the basic data are interrupted, however, the generated positions from the position generator are used by the predictor as a basis for its calculations. The predictor is thus enabled to supply continuous data to the gun positions for a limited period even when no original data are being received.

The work of the computer as a whole consists of two sets of calculations: one, done primarily by the triangle solver, determines the azimuth angle of the target from the gun positions, and the other determines the deflection angles that specify the deviation of the aim from this position. The latter are based on the distance to the target, the various ballistic corrections, and the travel of the target during the flight of the shell. In general, these latter angles are not large, and they are only very slightly affected by small errors in the position of the target at the time of firing. The azimuth angle determined by the position of the target, however, may be large, and it is changing continuously. Moreover, it will be affected by any error in the orientation of the system, such as a departure of the zero of the azimuth circle from the basic north and south reference line. Because of these facts, the preferred method of operation whenever the target is visible from the guns is to track it directly from the gun positions, and to take from the computer only the deflection angles. The predictor has dials on which these deflection angles continuously appear. When the target is being tracked from the gun position, these angles alone are transmitted to the gun positions either manually or automatically. When the target is no longer visible from the guns, full automatic control may be resumed.

There may also be times when accidents or enemy fire have interfered with the continuous automatic transmission of the azimuth angles from the observing positions. Under these conditions, the azimuth angles at each TI bell are phoned to the computer positions, and these angles and the speed of the target are supplied manually to the triangle solver, which proceeds to derive continuous positions during the interval between bells. At each bell, the two dial pointers are momentarily stopped

Fig. 3—Trailer for housing the computer used for controlling 155-mm guns



so that their indications may be checked with the new data being phoned in. Any error in either position or rate is then corrected in the solver. The computing mechanism is not stopped, however, while the pointers are held for checking, but merely absorbs the corrections set up and continues with its calculations. A continuous set of coördinates is thus supplied to the predictor as in ordinary operation. Should the automatic transmission to the gun position be interrupted, a similar procedure permits firing data to be telephoned to the guns, but under these conditions, the data will be periodic, and a dead period must be allowed for.

Still another feature incorporated in the M-8 Computer is the ability to accept corrections to compensate for observed inaccuracies in fire due to unknown causes. With manual firing, spotters watch the splashes of the shells, and if they are systematically appearing too far one way or another, a correction to the deflection angles is introduced. This spotting is also done with the M-8 Computer, and the predictor incorporates controls with which the desired corrections may be inserted manually as needed.

The gun data computer may also be used with input data representing the azimuth and range of the target obtained from a single observing station by radar. A simple switching rearranges the triangle solver to meet these changed conditions, and when this is done the two dials, instead of indicating the azimuth at two observing stations, indicate the azimuth and range from a single station. Operation of the solver proceeds as before, however, and voltages representing the X and Y coördinates of the target are supplied to the predictor.

At times there may be a number of possible targets, and it is essential, of course, that all the tracking stations be following the same one. After a particular target has been selected, therefore, and its azimuth determined at two positions, or its azimuth and range at one, it is necessary to transmit to the other tracking positions the correct azimuth of the selected target from their positions. The computer includes circuits that enable it to calculate these azimuths. After a target is selected, therefore, the proper azimuths for the other tracking positions are calculated one after another and transmitted to the various positions.

For the 6- and 8-inch coastal guns, the computer is installed in a protected casemate somewhere back of the gun position, but for the more mobile 155-mm guns, it is installed in the trailer shown in Figure 3. The arrangement of the various units in this trailer may be seen from the headpiece and Figure 2.

A number of M-8 Gun Data Computers have been manufactured and delivered to the Army. By adopting electro-mechanical computation, the work of the plotting crews has been greatly simplified, and because of this fact and the substitution of automatic rather than manual computation, errors are almost completely eliminated, and the accuracy and speed of fire has been increased. The continuous flow of data enables the gun crews to fire as soon as the guns are ready and aimed without waiting for the TI bell, and results in an increase of 30 per cent in the number of rounds fired in a given time. The advantages of mechanization over relatively crude plotting methods reflects itself in more scored hits, and has led the Coast Artillery to call this the best Gun Data Computer ever tested.

Rocket Spinner

ROCKETS are ordinarily stabilized with fins, and if the propelling charge is completely burned before the rocket leaves the launching tube, the dispersion, or deviation from the desired trajectory, is very small. If the propelling charge burns after the rocket has left the launcher, however, the dispersion may be large unless there is perfect alignment of the nozzle and the center of gravity of the rocket. When this alignment is not perfect, the line of force of the burning gas discharging through the nozzle does not pass through the center of gravity, and a tilting moment is developed that causes the rocket to deviate more and more from its original direction of travel. Such conditions are common with very high speed rockets where the burning cannot be completed before the rocket leaves the launching tube.

Spinning had been suggested to decrease the dispersion under such conditions, but preliminary studies had indicated that a high spin would be required to bring about a worth-while improvement. In 1918, Goddard and Hickman had devised methods for spinning rockets, but the war ended before these could be tested. After Dr. Hickman began his work with the N.D.R.C.,* he decided that an investigation should be made to determine the effect of various amounts of spin on rocket flight. R. F. Mallina, who was carrying on a number of rocket developments in the Laboratories at the time, suggested that a spinning launcher could be built that would permit rockets to be launched with any spin over a wide range. His suggestion was at once accepted, and the resulting apparatus built under his direction at the Laboratories is shown in use in the photograph above and in greater detail on the next page.

A rocket-launching tube was mounted in large ball bearings within an outer stationary tube attached to a tripod. Provisions were made for elevating the assembly and for turning it in azimuth. Supported beneath the rear end of the outer tube is a 1½-horsepower motor with a pulley that may be connected by a V-belt to a pulley on the rear end of the inner, or launching, tube. Three pulleys were provided for the

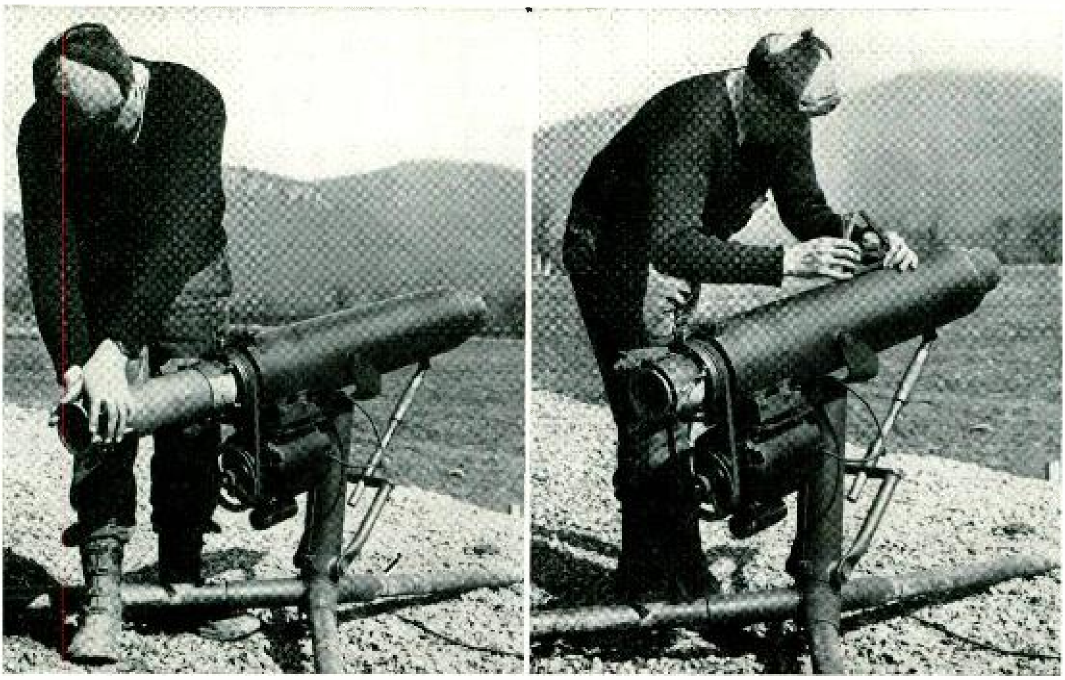
NOTE: The work described in this article was done under contract No. OEMsr-256 between Western Electric Company, Incorporated, and the Office of Scientific Research and Development, which assumes no responsibility for the accuracy of the statements contained herein.

*RECORD, *February*, 1945, *page* 37.

motor so that the launching tube could be driven at speeds of 900, 1,800, and 2,700 rpm. On the inner tube are two slip rings to which ignition current is carried by brushes that are mounted on the other tube.

With this arrangement, an extensive series of tests was carried out to determine the effect of spin on dispersion. It was found that a considerable decrease in dispersion was obtained with very moderate spins, and that the speed was not critical—essentially the same improvement was obtained with a wide range of spin. Without spin, the dispersion for the standardized rocket was 39 mils, that is, the rocket would deviate 39 feet in 1,000 feet of travel, while with spins of 800, 1,400 and 2,400 rpm the dispersion was reduced to 13, 11 and 9 mils, respectively. To test the effect of spin on rockets which normally have very bad dispersion, 25 such rockets were fired from the projector while rotating at a speed of 2,400 rpm. The dispersion was 13.6 mils. When these rockets were fired from an 11-foot non-rotating tube, the dispersion was 78 mils. The standardized rocket fired from the 11-foot tube gave 16.6 mils dispersion. The inferior rocket would have had over 200 mils dispersion if it had been fired from the 4-foot tube. The improvement due to moderate spin is therefore very great for rockets having large dispersions. The effect of the spin is to continuously change the direction of the tilting moment, and thus the rocket travels in a small spiral around its original trajectory.

The improvement in dispersion obtained from this experimental launcher resulted in intensive research programs being undertaken both here and abroad to find methods of spinning rockets that would be readily applicable under all conditions of use.



Loading the rocket spinner (left) and setting elevation with a gunner's quadrant (right)

Telephone Order-Wire Circuit for Type-K Carrier Routes

By A. V. WURMSER
Transmission Development

FOR long telephone circuits, which pass through many repeater stations, some form of ready communication between terminals and repeater stations is required to facilitate the work of the maintenance forces. These intercommunicating circuits are called order wires. Originally, the long voice circuits, and the carrier systems that followed them, used telegraph channels for this order-wire service. Later, when cable displaced open-wire facilities on these routes, it became economical to use telephone channels for this purpose. These were either idle circuits, or as at the present time, were telephone circuits set up specifically as telephone order wires. Connection was made to these circuits at intermediate offices through the monitoring windings of the telephone repeaters.

With the advent of the type-K carrier system for cables, the order-wire situation changed. Not only were many of these circuits long, but there were more repeater stations for the same distance, and thus more telephone sets that might be bridged simultaneously on the voice-frequency order wire provided for carrier-system maintenance. Each bridged telephone set is a source of loss to through transmission and of possible echoes. An order-wire circuit that was entirely satisfactory for a circuit a few hundred miles long with repeater stations every fifty miles might well prove unusable on a thousand-mile circuit with repeaters every sixteen or seventeen miles. The presence of auxiliary repeater stations between main stations also changed the maintenance arrangements, so that an entirely new system seemed desirable.

A study of conditions and the situations to be encountered indicated that there should be one complete circuit covering the entire route, with talking facilities at each main repeater station. This was to be called the express order wire. In addition, there should be means of communication between adjacent main stations and the intervening auxiliary stations. These would be called the local order-wire circuits, and each would normally be terminated at the main repeater stations. The arrangement of both of these types of circuit, however, should be such that in emergencies any section or sections of the express circuit could be replaced by patching in a local circuit.

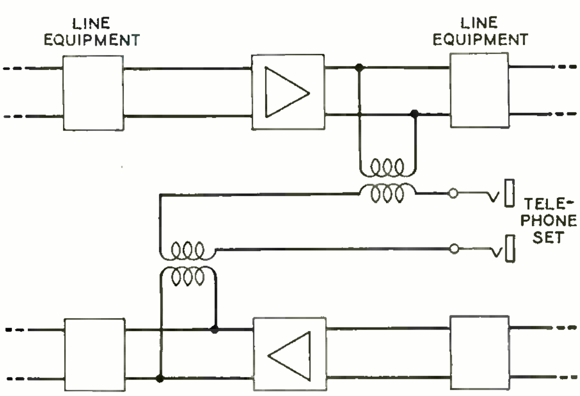


Fig. 1—Arrangement of four-wire order circuit used with some early type-K carrier systems of moderate length

Because of the possible length of a type-K carrier system and the number of possible repeater stations, it was decided to use a four-wire circuit, which would greatly simplify the echo problem. To provide for these circuits, two pairs of voice-loaded wires in each of the two cables are set aside for order-wire service. Ordinarily, the two pairs in cable A are used for express service and the two in cable B for local service. In case of failure of one cable, the circuit in the other cable can be used to restore service.

On some of the earlier and shorter systems, the method of bridging the telephone set indicated in Figure 1 was employed, which is known as a repeating coil bridge. The advantage of this arrangement is its simplicity, but it has a number of disadvantages which very soon made it evident that such an arrangement would not be satisfactory for the longer circuits. With a telephone set connected for talking, there is a fairly low-loss echo path through the two coils and the telephone set—the loss being only about 18 db. With the number of these bridging points that would be encountered on a long circuit, the echoes would be objectionable. Another disadvantage was the bridging loss caused by the telephone sets themselves. This, too, of course, becomes more serious on the longer circuits. Still another disadvantage was the low level on the line of the outgoing speech. With the single bridge connected to the output side of the repeater on each side of the four-wire circuit, the outgoing speech is some 18 db below the normal level, and since these order-wire pairs are in a cable with other voice pairs, the crosstalk to them under these conditions may be excessive. To avoid these many disadvantages, a new method of bridging the telephone sets was developed for use on type-K carrier routes.

The new bridging circuit with the telephone set not connected is as shown in Figure 2. When the telephone set is plugged in, a relay connects the set in place of the "a" resistance, and a balancing network in place of the "b" resistance. The bridge is connected to both sides of the four-wire circuit at each side of the amplifiers. Incoming speech to the local telephone set is taken from the output of the line amplifiers and passes through the H2 hybrid coil, while outgoing speech passes through the H1 hybrid to the input sides of the line repeaters. In this way the speech levels in the line can always be maintained at normal level.

With this double bridge circuit, there are two main echo paths, but the design of the circuit is such that by making the gain alike in the two line amplifiers, the echoes are kept low enough to avoid interfering with the satisfactory operation of the circuit. The losses over each path are alike, but the echo currents where they combine are of opposite phase, so that there is a large measure of cancellation. Speech at the input to the W-E amplifier, for example, may reach the output of the E-W amplifier either by passing through pad B, pad C, and the E-W amplifier, or by passing through the W-E amplifier, pad D, and pad E. The net loss along each of these paths is 55 db. Since there are two paths, however, the combined currents, if they were in phase, would be double that over each path or 6 db greater at the output of the E-W re-

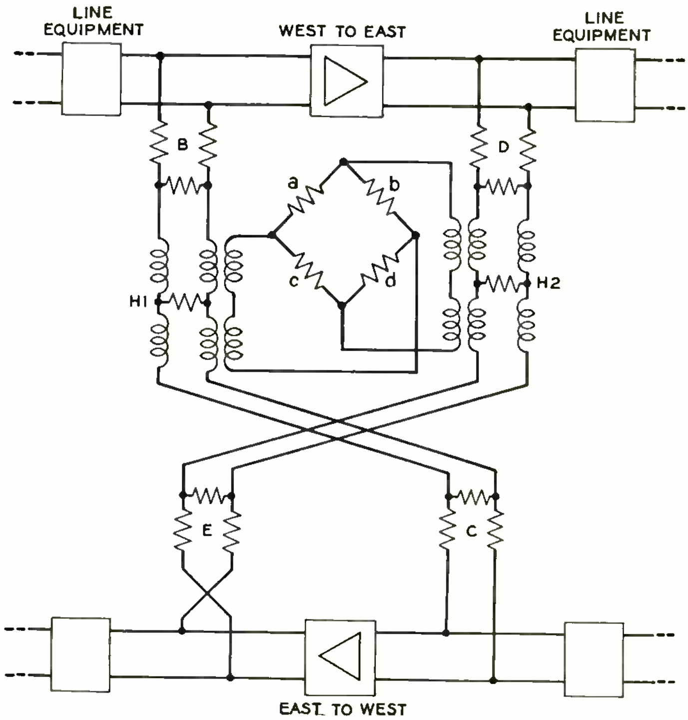


Fig. 2—Simplified schematic of new bridging circuit when telephone set is not connected

peater. The net loss would thus be 49 db. It will be noticed, however, that the wires of the bridge below the E pad are reversed, and thus the echo currents over the two paths combine out of phase. Due to some phase differences in the two paths, the cancellation is not perfect, but under normal conditions the echo is down 65 db.

Another echo path is through pad D, the H2 hybrid, the resistance bridge, the H1 hybrid, and pad C. This path has one loss when the telephone set is connected, and another when it is not. The loss is greater in the latter case. Under the worst conditions, however, it is 7 db better than that existing with the circuit of Figure 1.

With a double bridge circuit, there is a shunting, or possible singing, path around each amplifier, and the loss in these paths must be kept great enough to avoid interfering with the satisfactory operation of the amplifier. The loss from the "a" resistance, and thus from the jacks of the telephone set, through the H1 hybrid and the B pad is 24 db, and similarly the loss from the output of the amplifier in the W-E line through the D pad and the H2 hybrid to the "a" resistance is also 24 db. The complete loss around the amplifier is thus the sum of these two losses plus the loss across the network from "a" to "b." When the telephone set is not connected, this balance loss is 40 db and thus the total loss is 88 db. The net loss with an amplifier gain of 34 db is thus 54 db, which is sufficiently high not to affect the characteristics of the amplifier. With the telephone set connected, the balance loss is only 10 db, making the net loss 24 db. This is great enough, however, so that the effect on the transmission characteristics of the amplifier is only 0.5 db, which is not objectionable since, in general, telephone sets will be connected at only two or three offices at any one time. A similar situation exists for the E-W amplifier.

This circuit also has anti-sidetone characteristics because of the turnover of the bridge below the E pad. Speech from the telephone set divides at the H1 hybrid, half going through B and half through C. After passing through the two amplifiers, the two currents pass through D and E, but because of the turnover below E, they are of opposite phase, and tend to cancel. Sidetone through the H2 hybrid to the telephone set is thus reduced.

The bridging loss of this circuit is only 0.9 db, and patching in the telephone set does not affect it.

A typical arrangement of the new order-wire circuits between two main repeater stations is shown in Figure 3. The upper circuit is the express order wire, and the lower, the local. On the former, bridging circuits appear only at main repeater stations. Selective signaling is used over the express circuit with which any main sta-

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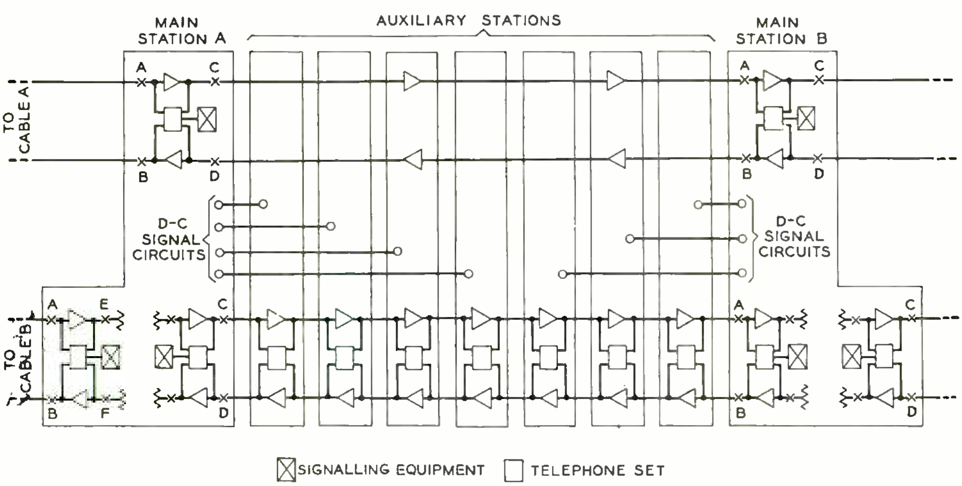


Fig. 3—Block schematic of new order-wire circuits between two main repeater stations. The upper circuit is the express order wire, and the lower, the local

Pre-Production—A War Service

By WILLIAM FONDILLER
Assistant Vice-President

In World War I, despite considerable expenditures of time and money in the development of new weapons and facilities, relatively few items representative of this effort were completed in time to be used in combat. In contrast, the success of Allied arms in World War II was closely related to the speed with which designs of new instrumentalities were translated into production deliveries. One of the factors contributing to this result was the realization by the Armed Services shortly after Pearl Harbor that it was of the utmost importance that means be provided for delivery of limited quantities of new weapons and devices in advance of mass production. These advance units were necessary for early training in maintenance and operation but—of greater importance—they made possible the development of tactics and requirements under combat conditions, and the reflection of this field experience in subsequent quantity production by the factory.

Although the amount of manufacturing such a program would entail indicated that the work should be carried on by the Western Electric Company, their engineering staff was so heavily loaded with the problems of planning for the manufacture of a vast amount of complex military equipment that it was agreed that as a war measure the Laboratories should expand its facilities for model building to the extent required. Thus was launched in the Laboratories a program of "pre-production" that established new levels of performance in translating preliminary designs into equipment for Government test and tactical use. So essential had this activity become that in the last full year of the war the total pre-production program of the Laboratories had risen to $24,000,000.

The Laboratories was not wholly unprepared for this undertaking. For a number of years the Systems Development Department had carried on a related operation in the Trial Installation Group which engineered the initial manufacture of a variety of telephone systems. This group, under R. H. Kreider, through the use of Western Electric Installation Department personnel as the main source of assembly and wiring capacity, and the use of the Development Shop and other Laboratories service facilities, was immediately effective. Supplementing the Trial Installation Group, the General Staff Department was able to bring to bear its experience in model building on a "project basis." In the following, the discussion will deal with the general plan of operation of pre-production and overall results accomplished.

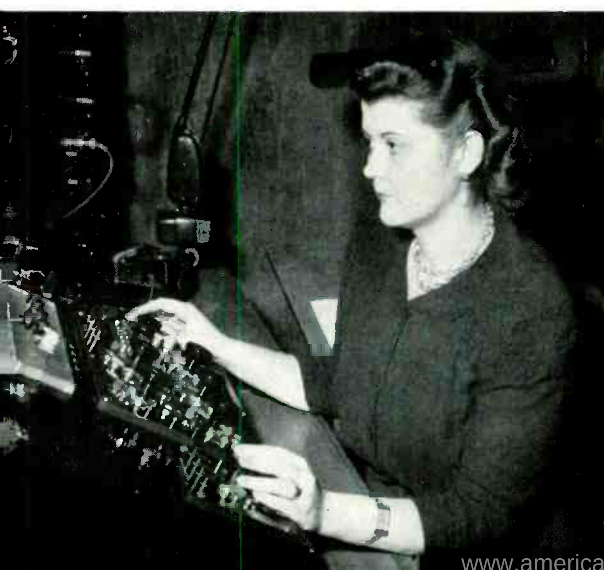
Between the methods of pre-production and factory production there are important differences. In the usual course of development, one or more experimental models are made for laboratory test prior to the preparation of manufacturing drawings for factory production. In pre-production, however, the intervals normally required for planning layouts and tooling are non-existent. Procurement is commenced about the time that development models are being assembled, and the design is rarely stabilized before the entire pre-production lot is completed.

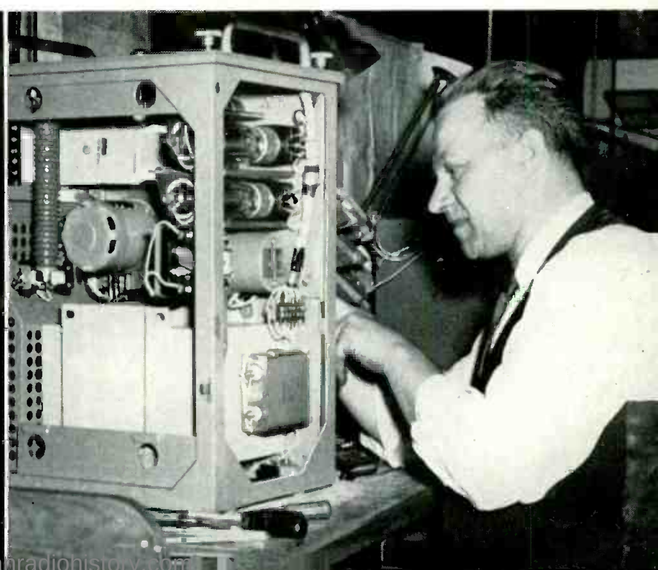
In order to deliver quanities of say ten to fifty units, which would from an operating standpoint be substantially equivalent to the factory-made product, something between the hand-made laboratory model and the tool-made factory product was required. In order to maintain the time advantage of the laboratory model, however, manufacture must be started concurrently with the development of the design. These conflicting requirements were resolved by adopting methods differing radically from those normally followed for a factory scale of output.

The procedure for pre-production has definite objectives and advantages. It permits the practicability of design to be established without the time intervals for making regular tools and fixtures. It enables advance delivery to be made to the Armed Services, thus permitting exhaustive field tests to be made, and even trials under combat conditions, before the final design is established. It also enables changes in design indicated by these tests to be introduced with negligible delay in factory production. In addition, it permits factory representatives to be in close association with the pre-production activities, and thus to be able to plan for large-scale production with a marked gain in time and cost. Factory personnel can be trained in the laboratories in testing techniques during the pre-production intervals and thus the design of factory test facilities can be carried through promptly and expeditiously.

The geographical distribution of the Laboratories' staff brings in problems of its own. The Development Shop operates in six locations in two states, also units were manufactured or assembled at various Western Electric factories and delivered to the Laboratories on development contracts for which we were responsible. These factors, together with a continually varying demand, resulted in the early establishment in the Commercial Relations Department of production control and scheduling procedures under H. A. Blake. Thus, through a periodic analysis of Laboratories commitments and capacity, it was possible to plan the allocation of overall facilities and to anticipate peak load conditions. As soon as the available information would permit, the Development Shops Manager, H. C. Atkinson, would determine, through his group of analyzers, the extent of sub-contracting necessary, and decide in which shops under his control production would be carried out. In some cases, three units of the Development Shop at widely separated points would participate in a single pre-production job because of special facilities with which they were provided.

Precision testing of deposited carbon resistors (left)—A unit of radar equipment nearing completion (right)





In the factory, project planning ordinarily begins when a major portion or all of a design is complete. On a pre-production project, however, active procurement commences as soon as the design engineer can furnish informal material or apparatus data. Thus, apparatus and raw materials are ordered before drawings are available. This advance ordering and the subsequent integration of records as drawings become available is a key step in pre-production planning. Since the success of model building is directly related to the availability of parts, and since parts procurement must reflect continual design changes, pre-production requires alert and vigorous effort in this area. As this activity increased in scope and volume, planning facilities were increased through additions to staff, a large portion of which was accomplished through the loan of Associated Company engineers to the Laboratories.

Despite the advance ordering of raw materials, the fabrication of component parts became a problem very early in our pre-production efforts. It became evident that the most rapid expansion of our capacity could be made by a greatly expanded sub-contracting program. This activity was carried on by a group of "field men," under A. F. Gilson, set up in the Development Shops, who negotiated for manufacturing services, mainly in New York and New Jersey. This sub-contracting group worked at all times in close coöperation with the Laboratories' Purchasing Department under H. W. Dippel. Certain phases of the sub-contracting activity entailed development and engineering services as well as manufacture by the contractor. Such services were handled under a special form of purchasing contract. In spite of the pressure of war work, costs were not lost sight of. Definite controls for outside contracting procedures were established which included a periodic audit of suppliers' accounting and billing for the work performed for the Laboratories.

It should be pointed out that sub-contracting along the usual lines would have been too slow to meet the requirements of pre-production. A study of the problem indicated two measures which would speed operation. The first had to do with the ordering of raw materials before the drawings were completed. We were thus able to negotiate a sub-contract for labor only, and supply the sub-contractor with the necessary raw materials and drawings. The second practice was to sub-contract with many small shops. Our orders frequently used the full capacity of such shops, and permitted control over their schedules that could not otherwise be realized. At the peak of this activity, three hundred sub-contractors were engaged in fabricating parts for Laboratories model activities.

Provision was made for the engineers to work in the closest possible relationship to the shop staff so that changes could be incorporated with the least possible delay. Those familiar with the development problem encompassed in the design of say, a radar system, will not be surprised at a figure of one to two hundred changes in design to be incorporated in a pre-production lot before shipment. It is essential that a pre-production shop, unlike the factory, be geared up for numerous changes, and that the engineers be given the run of the

Welding glass-tube relay parts (left)—Magnetron castings on a cooling bed (right)


Winding fine wire for thermistor unit (left)—Assembling coils and transformers at the West Street building (right)

shop so that they will feel at ease in asking for any changes they consider necessary. Such a procedure would be disastrous in factory production, though it constitutes an essential ingredient of pre-production.

As pre-production expanded in 1943, the Western Electric Installation Department personnel assigned to the Laboratories was extremely effective in supplementing Development Shop activity in assembling and wiring. By the end of 1943, however, it became clear that the work ahead would require a sharp increase in this type of activity. Accordingly, premises were leased at 157 Chambers Street, New York, totaling approximately 20,000 square feet, for the establishment of an Assembly and Wiring Shop. Substantial assistance from the New York Telephone Company permitted beginning this operation with a nucleus of experienced personnel while an extended employee training program provided for the balance of the staff.

In addition, training classes were established in coöperation with the Personnel Department in which new employees with no experience in shop work were given intensified training that enabled them to carry on the simpler types of production operations. This Assembly and Wiring Shop was in operation early in 1944, and it is of interest that the first major undertaking

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THE AUTHOR: WILLIAM FONDILLER, after graduating with a B.S. degree from the College of the City of New York, studied at Columbia University, where he received an E.E. in 1909 and later the M.A. degree. In 1909 he joined the Engineering Department of the Western Electric Company, which was incorporated as Bell Telephone Laboratories in 1925. His early work was concerned with loading coils, and it was under his direction that the compressed powdered core, now universally used, was developed. Later, he

was appointed head of the Physical Laboratory, and had a broad responsibility for electrical testing and materials engineering. At various times Mr. Fondiller was in charge of the design of panel and crossbar switching apparatus, station apparatus, and transmission apparatus, including electrical filters, transformers, varistors, and testing apparatus. He also had charge of apparatus drafting and specifications engineering. The modern combined telephone set was visualized by Mr. Fondiller, who initiated its commercial development. His engineering contributions are evidenced by the various technical papers he has presented, and he also has a number of inventions to his credit. In 1943 he was appointed Assistant Vice-President in charge of General Staff. Mr. Fondiller holds the Townsend Harris Medal, awarded by the Associate Alumni of City College, and the University Medal of Columbia.

of this unit was the pre-production of a number of military devices pictured on the front cover of the RECORD for last month.* Delivery was begun in March, 1944, and completed two months later. In reference to this performance, Capt. D. P. Tucker, of the Bureau of Ships, wrote in part:

"I should like to take this opportunity of expressing my admiration and thanks for the splendid way in which you have kept your accelerated schedule of deliveries. We have had to extend ourselves to the utmost in this case to meet your schedule."

Testing in pre-production varied substantially with the nature of the undertaking. Every effort was made to use testing gear designed and fabricated for later factory production and manned by factory trainees. Crash programs did not always permit this condition, however, and many close schedules were met because design engineers worked double shifts with improvised test set-ups.

No account of the pre-production services performed by the Laboratories during the war would be complete without reference to the various pilot plants which were operated for the manufacture of parts, components, and assemblies. Laboratories pre-production, as well as early factory production, often demanded substantial quantities of critical apparatus before the development work had been completed.

In carrying out these auxiliary manufacturing activities, two procedures were, in general, followed. One, which was applicable when the design was fairly well advanced, was to set up a special unit in the Development Shop. The other was to assign skilled mechanics to work directly under the supervision of the engineers responsible for the development.

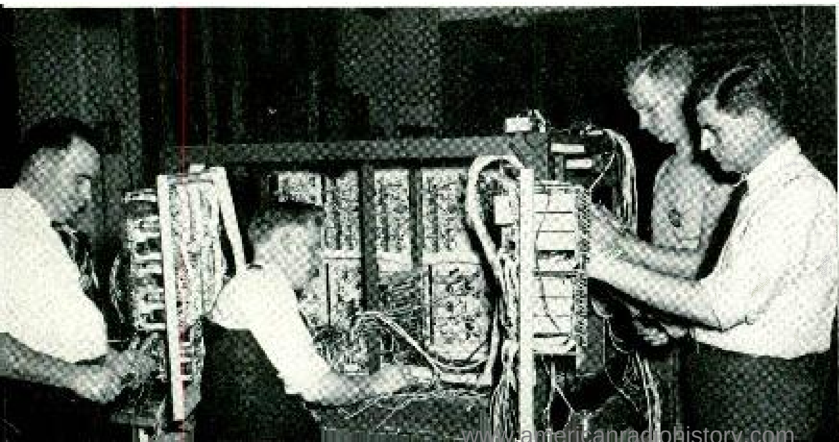
Despite the fact that sub-contracting was carried on to the fullest possible extent, the secret character of many of the projects necessitated that final manufacture and assembly be carried on with our own staff. This required an increase in the personnel of our Development Shops from about 230 to over 875 people during the war period.

Among the items on which pilot-plant production was undertaken were thermistors, electron tubes, deposited carbon resistors, glass tube relays, transformers, networks, and potentiometers. It is not easy to convey an idea of the difficult problems involved in the production of certain of these items, which in some cases required precision methods of manufacture. Were it not for the close association of the technical people with the model maker, it would not have been possible to achieve the results desired within the time available. The accompanying illustrations give some idea of the range of facilities used.

Our wartime experience of rapid translation of development into physical product has demonstrated that under the stress of a national emergency production could be advantageously carried through in the Laboratories on a scale not hitherto attempted. This production effort of the Laboratories, which reached a rate of two million dollars a month, represents a war contribution that has earned for the Laboratories a number of commendations from both the Army and the Navy. Pre-production activities, complementing our research and development work, thus formed an integral part of the war contributions that were made by Bell Telephone Laboratories.

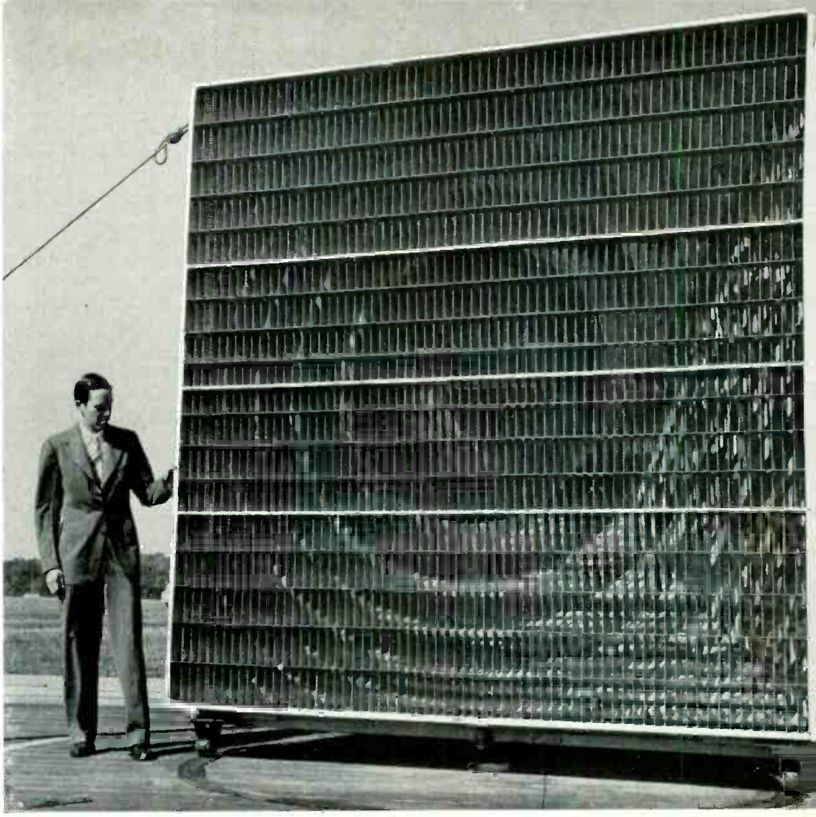
*RECORD, *April*, 1946, *page* 137.

Assembling and wiring of a unit at Chambers Street shop (left)—Winding potentiometer cards for a gun director (right)



Radio Lenses

By WINSTON E. KOCK
Radio Research



Antenna designed for New York-Boston radio-relay microwave system. Waves fed into horn through wave guide in the rear are projected as pencil-beam

ONE problem in developing microwave communication systems is transmitting and receiving the wave energy in the form of a narrow beam like a searchlight. For this purpose Bell Telephone Laboratories at its Holmdel branch has developed a lens, consisting of an array of metal plates which focuses radio waves as an optical lens focuses light waves. Such metallic lenses are expected to play an important part in radar and radio relay communication systems.

Everyone is familiar with the simple convex magnifying glass which can focus the sun's rays so as to burn a hole in a sheet of paper. The action of the glass is to delay the advancing wave front by an amount which is greatest at the center of the lens where the glass is thickest and least toward the tapering periphery.

As a result, the wave front, behaving somewhat like a line of soldiers, is reformed and headed so as to converge to a point. What happens in the glass is a reduction in the velocity of the wave front relative to its velocity in free space. All lenses operate by changing the velocity of the wave front; the specific focusing action depends on the profile of the lens.

Since radio waves are of the same electromagnetic nature as light waves, it has long been known theoretically that radio lenses could be built on the same optical principles. But up to the advent of microwaves there was an insuperable obstacle in the very much greater wavelength of radio waves. To be effective, a lens must have a diameter of at least several times the wavelength. With the infinitesimal wavelengths of visible light, the size of the lens presents no problem. But in order to focus, let us say, waves of the length used in radio broadcasting, it would be necessary to make a lens almost a mile wide.

One of the big advantages of microwaves is that they are short enough to be focused with devices of manageable dimensions; narrow beams realizable with microwaves concentrate energy in the desired direction so as greatly to economize transmitted power as well as reduce interference. For several years the possibilities of solid lenses of plastics and other dielectrics have been explored by the Laboratories as a part of their microwave studies.

As radar and radio relay communication systems developed during the war, they created a demand for more and more sharply focused beams of microwaves, which greatly stimulated the search for means of supplying them. The familiar "dish" antenna, in which a beam is projected in nearly parallel lines after reflection from a paraboloid, had certain disadvantages in the way of tolerance requirements and shadowing effects. Lenses could undoubtedly supply the needed in-

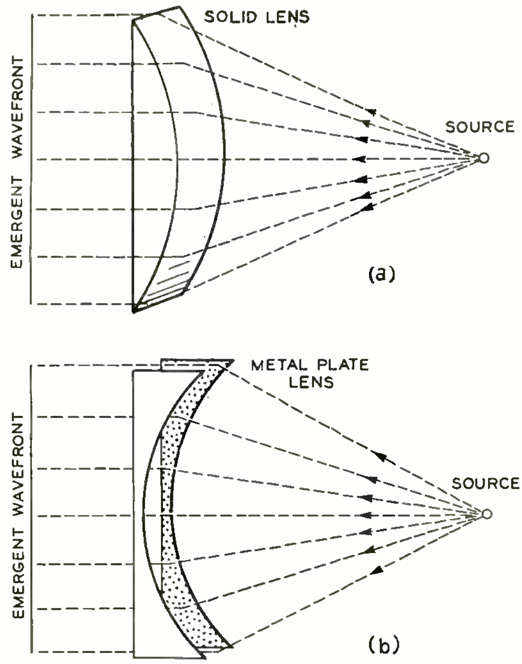


Fig. 1—(a) Profile of dielectric lens designed to focus waves from point source radiator into parallel beam. Wavelength and wave front velocity decrease in the lens. (b) Corresponding metallic lens must be of converse profile because wavelength and wave-front velocity increase in the lens

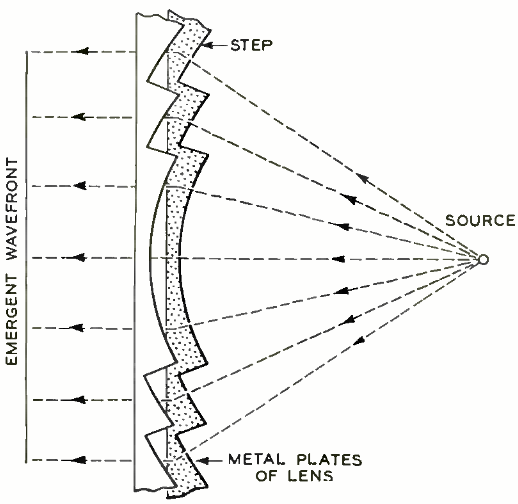


Fig. 3—In lens of "stepped" construction each of the concentric zones acts as an individual lens. Zones are coördinated to produce overall emergent wave front of desired shape

crease in beam-precision but in their existing solid form they were too massive for military uses.

It appeared that wave guides—those hollow tubes which had been devised back in 1933 to conduct microwaves and which, in war, were to play so vital a rôle in supplying a physical channel for radar signals—might hold the answer. It was known from wave-guide theory that radio waves undergo a speeding up (increase in wave-front velocity) when they pass along a tube or between metal plates, and that the total advance in the wave front may be fixed by controlling, in relation to wave length, the length and contour of the plates and the distance between them.

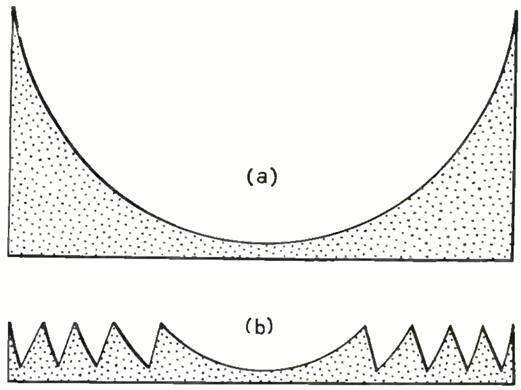


Fig. 2—Metallic lenses may be built with continuous profile (a) or "stepped" (b). Stepped construction saves size and weight and permits uniform transmission

It followed that an array of metal plates might be constructed so as to focus radio waves just as a solid lens focuses them, if due regard be given to the fact that the edges of the wave front would be advanced instead of retarded in transit. Such a structure would be inherently easier to build, move, and maintain in service than an equivalent solid-type lens. The necessary design theory was worked out in mathematical detail and systems of metal plates were built to duplicate the action not only of convex and concave lenses but also of other optical devices such as half and quarter wave plates and prisms.

The relative contours of a solid or dielectric lens and of a metal plate lens both designed to convert waves from a point source radiator into a parallel-sided beam are shown in Figure 1. Because of their opposite effects on wave-front velocity they must be built of converse shape to produce the same focusing effect. The spreading waves approach the lens on a curved wave front. To bring them into a parallel beam, the metallic lens speeds up the edges of the beam relative to the center so that the wave front is flattened. The plates are enough longer at the sides than at the center to bring the laggard edges up in line with the center.

In practice it is advantageous to build a metallic lens in steps rather than in continuous profile, Figure 2, as is also done in Fresnel lenses, familiar in lighthouses. Each of the concentric zones of plates operates as an individual lens and only on that portion of the wave train which passes through it, Figure 3. The wave front reaches the various zones from different angles and at different points in time, but the zones are designed with respect to the wave length and the phase relationships so that all effects combine to produce an over-all emergent wave front which is parallel to the front of the lens. Avoidance of long paths between plates through stepped construction, in addition to saving material and weight, results in uniform transmission over a wider frequency band, an important advantage in broad band microwave systems.

Developed toward the end of the war, the metallic lens had only limited use in military operations, most of them secret. Now, however, they are being steadily developed for radar and other microwave systems.

An antenna for the New York-Boston radio-relay microwave system, where the problem is to project and receive a precisely directed beam between relay points, is shown in the photograph at the head of this article. The lens, which is ten feet

THE AUTHOR: WINSTON E. KOCK received his E.E. and M.S. degrees at the University of Cincinnati in 1932 and 1933, and his Ph.D. degree from the University of Berlin in 1934. After a year as Teaching Fellow at the University of Cincinnati, he continued his graduate study at The Institute for Advanced Study at Princeton, and at the Indian Institute of Science in Bangalore, India. Following several years as Director of Electronic Research at the Baldwin Piano Company, he joined the Holmdel staff of the Radio Research Department in 1942, where he engaged in microwave radar antenna research. More recently he conducted research on antennas for radio relay circuits, during which time the metal lenses described in the above article were developed.

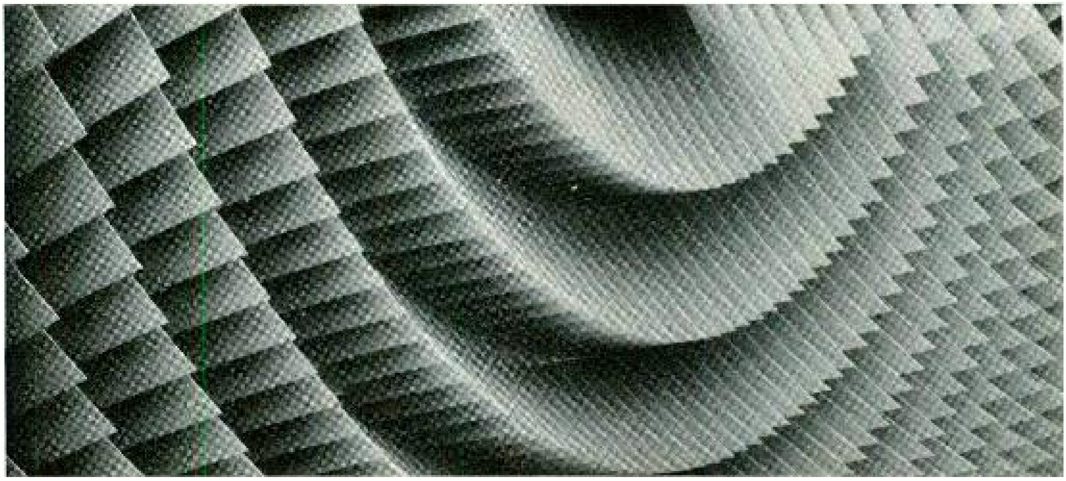


Fig. 4—Rear view of lens in antenna showing "stepped" construction

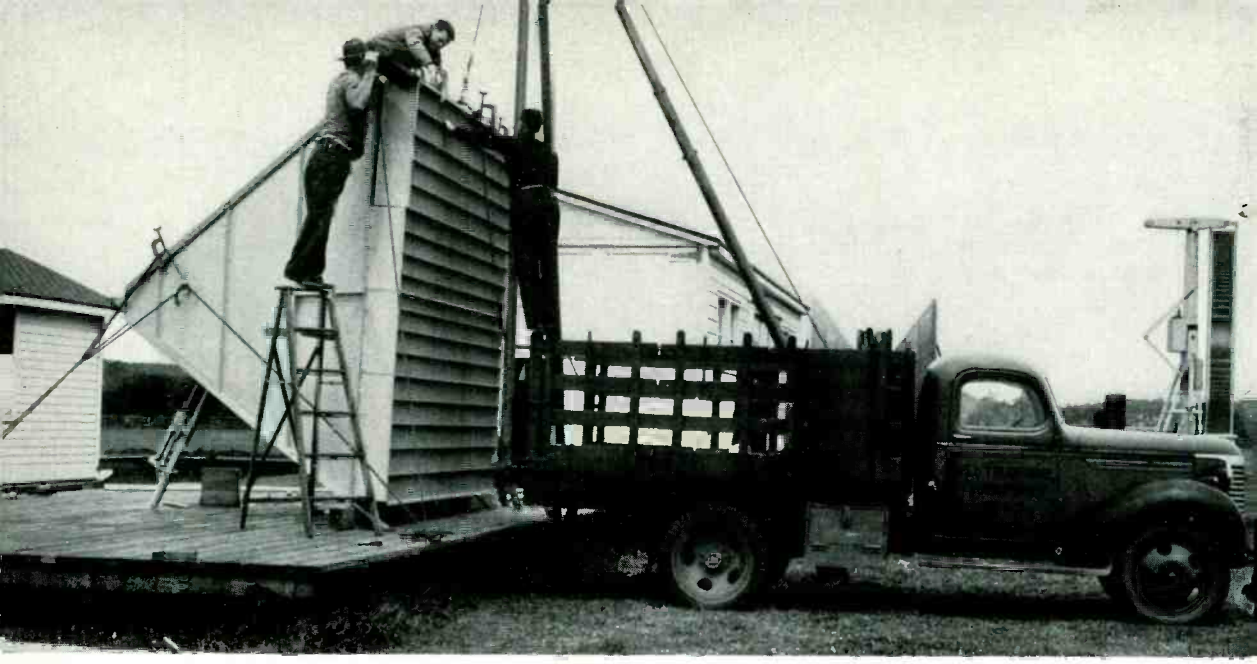
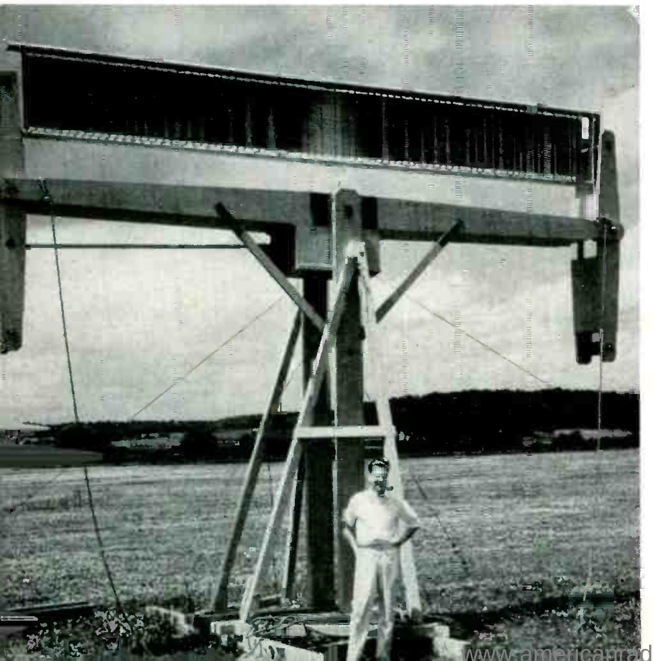


Fig. 5—Assembling the first successful full-scale model of the lens-antenna

square, has a stepped profile and operates on the wave front as shown in Figure 3. Fed in through a wave guide in the rear, the waves spread out along the horn-like shield to the lens, which focuses them into a pencil-beam. A rear view of a part of the lens appears in Figure 4. A similar combination of shield and lens at the receiving end takes in the waves and performs the reverse operation of focusing the energy into a wave guide from which it passes into the system for further disposal.

Fig. 6—The radio beam from this experimental metallic lens is sharper than an anti-aircraft searchlight



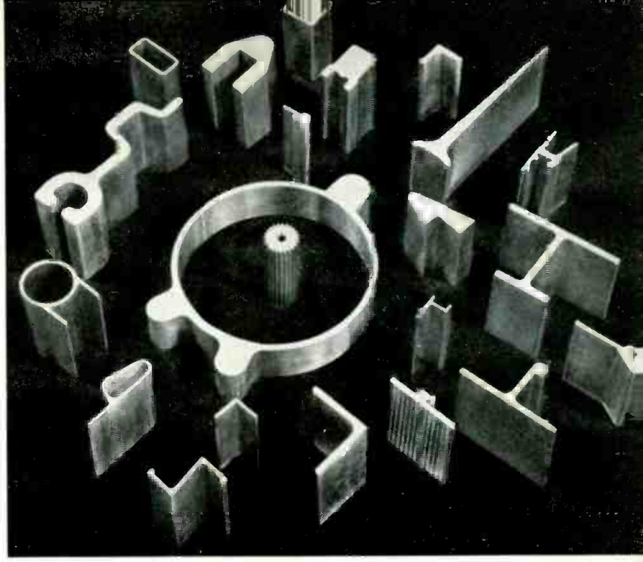
What is probably the sharpest radio beam ever produced was achieved with the experimental 20-foot metallic lens shown in Figure 6. Designed by W. M. Sharpless of the Laboratories, it serves as a precision test instrument in the study of microwave propagation in narrow beams. In its long dimension this lens has an aperture 40 inches larger than the 200-inch Mount Palomar telescope reflector. Sharper than an anti-aircraft searchlight, the radio beam it produces is only 6 minutes wide (1/10th of a degree).

Radio antennas in which the focusing action derives from metallic lenses have a number of advantages over antennas of the reflector type. Dimensional variations which would cause serious distortion if present in a parabolic reflector are unimportant when they occur in a plate lens which is accordingly easier to manufacture from the standpoint of dimensional tolerances. The use of a horn to shield the energy being fed into the lens materially reduces the rearward radiation present in reflector antennas. Also the front of such shielded-lens antennas may be readily enclosed and protected from the weather by a sheet of plastic.

Metallic lenses have contributed a great degree of flexibility to the radar antenna art and they are expected to find increasing popularity in radar as well as other branches of the microwave field.

Mg

By J. P. GUERARD
Chemical Laboratories



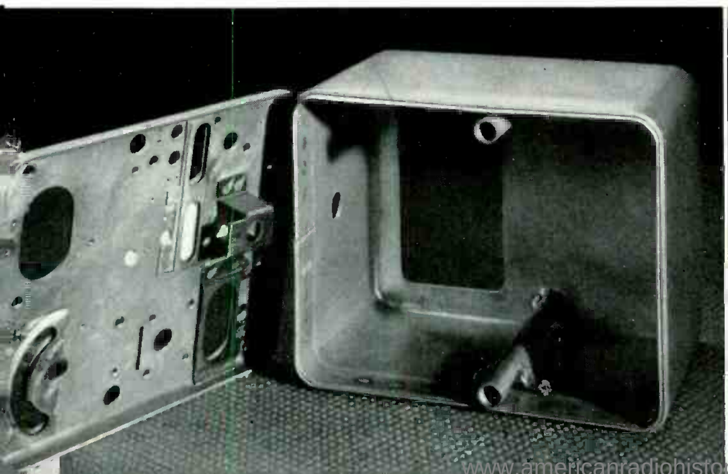
Shapes extruded from magnesium

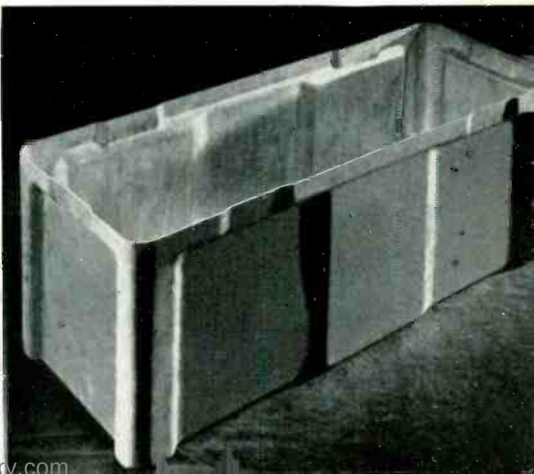
WITH the emphasis on air power in the recent war, demands for aluminum soon exceeded the supply, and its use was severely restricted. This affected the Laboratories, who were developing a wide variety of radio and other electronic devices for airplanes. Other light metals had to be found, and magnesium was by far the most promising. Although it had previously been employed to only a very limited extent, its production was now rapidly increased, and it soon became widely used wherever lightness was an important consideration.

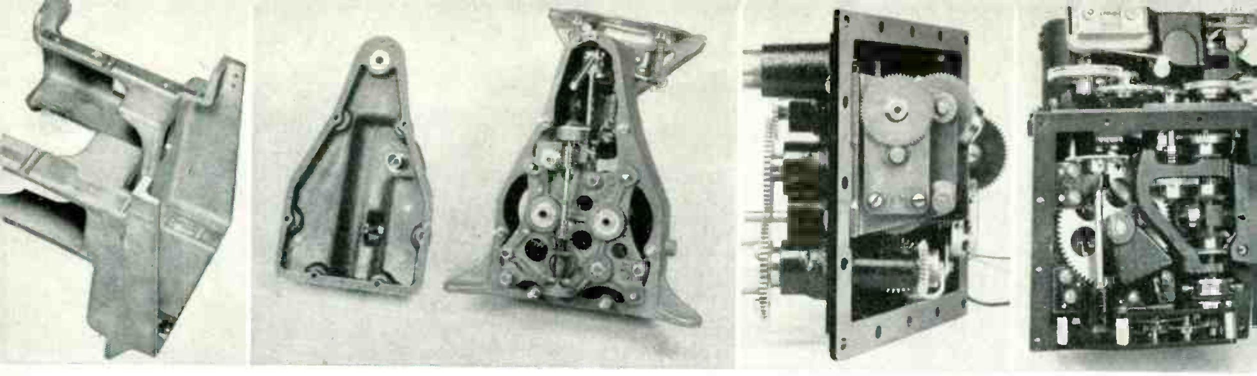
Magnesium is a silvery white metal with a specific gravity of 1.74 in the pure state—about a third less than that of aluminum. It is available in almost unlimited quantities, being the world's sixth most abundant element. In Russia and other European countries it is found in the form of carnallite, magnesite, and dolomite, but in this country it is produced almost entirely from brine wells and sea water. It forms about 0.38 per cent by weight of sea water, but since the amount of sea water is unlimited for practical purposes, there is an abundant supply. The richest sources in this country, however, are brine wells, which are available throughout the central section of the country. Brine from such wells often has 3 per cent of magnesium chloride by weight.

The commercial production of metallic magnesium in the United States was started around 1915. During the period of World War I, magnesium was considered useful primarily for the manufacture of flashpowder, flares, and other pyrotechnics. With the development of the magnesium alloys, its worth as a structural metal gradually became apparent. Prior to World War II, magnesium alloys were beginning to be used in a few household appliances and to a limited extent in industry. The advent of the war saw magnesium's meteoric rise as an important structural metal, particularly in aircraft assemblies and airborne equipment. The magnesium industry expanded its annual output from a little more than six million pounds in 1939 to nearly six hundred million pounds in 1944, an in-

Indicator box (left) of an airborne computer showing spot welded brackets and card retainers in the cover—note the arc-welded tube and bracket in the bottom section. Rocket container (right), 28¾ inches long, 11⅛ inches wide and 10¾ inches deep made from 0.084-inch magnesium sheet. This container, together with the stiffening ribs, was made in a single draw







Left to right: Magnetron support casting for an airborne radar; antenna support and gear housing for an airborne radar—note the use of inserts for threaded parts; horizontal range drive gear housing for a BTO bombsight radar; and slant-range drive-gear housing of cast magnesium used in BTO bombsight radar

crease of approximately 10,000 per cent.

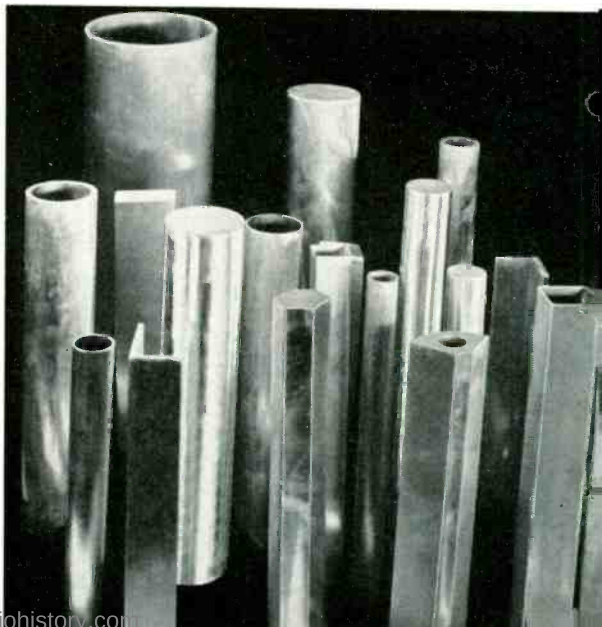
All magnesium-base alloys are characterized by lightness, being the lightest engineering metals used today. Castings made from them weigh only one-fifth as much as the same parts cast from steel, and about two-thirds as much as those of aluminum. From the standpoint of equal weight, magnesium alloys are a little over four times as strong as structural steel. By replacing a steel structure with one of magnesium having equal strength, a weight reduction of approximately 74 per cent can be obtained. On a basis of equivalent stiffness or rigidity, a weight saving amounting to 63 per cent can be realized.

Magnesium alloys have excellent machinability, and can be fabricated by practically all of the known methods. They are available as sand castings, permanent-mold castings, die castings, forgings, rolled sheet, extruded sections, and tubing. The efficiency of the fusion and electric-resistance welding processes make high-strength magnesium joints possible at low cost.

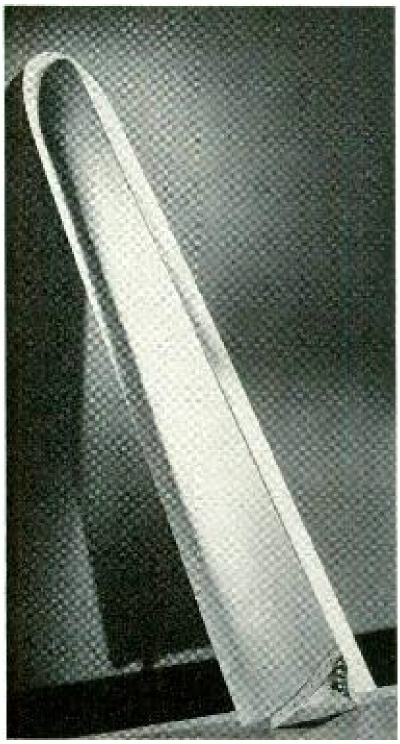
The ability of wrought magnesium alloys to form satisfactorily at room temperature is very limited. Their workability, however, is greatly improved at elevated temperatures. The general practice is to heat and maintain magnesium alloys at a temperature between 450 degrees F. and 650 degrees F. for most forming and drawing operations. Forming at these temperatures reduces spring back, and frequently results in greater accuracy and greater latitude in performing deep and intricate forming operations. Slow working speeds are preferred since the forming properties of magnesium alloys improve as the speed decreases. Unlike most common metals, which require several draws and intermediate anneals, magnesium alloys can be hot drawn into deep cylindrical cups having a depth of one and one-half times their diameter in a single draw. Representative examples of details fabricated in single draws are shown in several of the accompanying illustrations. The resulting savings in the number of dies and inter-anneals eliminated by hot forming permit magnesium to compete more than successfully in cost with less expensive materials. This is particularly true in small-quantity production since low-cost iron dies are generally used for this purpose.

Extrusions offer the advantage of unusual economy in the quantity production of many small details. Shapes requiring a minimum of machine work to produce accurate but inexpensive parts can be extruded. In

Tubes, rods, and other shapes that were extruded from magnesium



some cases a cutting-off operation may be the only machining operation necessary to produce the finished part. Literally hundreds of these shapes have already been developed, ranging from simple round sections to complicated interlocking shapes —all held to close dimensional tolerances. Examples of some of the various shapes possible by this process are shown in the headpiece and on the opposite page.



Tail fin section 60 inches long and 9 inches wide at open end, made in one draw in arc open end die

Probably the most undesirable feature of magnesium alloys is the ever present necessity to protect them against electrolytic corrosion wherever they come in contact with dissimilar metals. The high potential existing between magnesium and most common metals requires that all touching surfaces be protected with paint coatings or under more severe conditions with caulking compounds or gaskets. The use of sealed or pressurized containers permits more latitude in this respect, since it reduces the corrosion hazard to some extent by excluding moisture. Where it is necessary to insure proper electrical grounding of magnesium parts without corrosion in the joint, many devices have been tried with more or less success; 56S aluminum alloy, and cadmium or zinc plated steel, are recognized in this country as causing the least stimulation of attack at the junction, and are generally recommended for such metal-to-metal applications. In the presence of moisture, contact with wood also involves corrosion difficulties. These can be satisfactorily corrected by the use of sealing paints. In the unprotected state, the surface of magnesium alloys will gradually darken by the action of ordinary atmospheric exposures without, however, showing a loss in strength. Magnesium is markedly attacked by aqueous salt and most acids, but it is resistant to most alkalies and many organic chemicals.

Contrary to popular opinion, solid magnesium will not burn. The metal must be heated to a temperature above its melting point before ignition can take place. It is true that finely divided particles, such as turnings and filings, are a source of potential danger in machine shops. This is due to the relative ease with which they can be melted and subsequently ignited, coupled with their large relative surface area to support combustion. Coal dust, aluminum, flour, and wood powders are equally, if not more, combustible and dangerous. If reasonable precautions are observed in handling magnesium alloys in the foundry and in machine shops, it is as safe as any

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THE AUTHOR: J. P. GUERARD joined the Laboratories in 1925 and has been associated with the Materials Standards Department (now Metallurgical Research) since 1928. He was primarily engaged in investigating the physical properties of metals and alloys, and in preparing specification requirements for them. During the war he was chiefly occupied in consultation work regarding the application of metals to Government equipment. At present he is working on physical testing, specifications, consultation on metals and alloys, and on material substitutions in connection with reconversion to telephone manufacture. In recent years he has carried on active committee work for the American Society for Testing Materials.

other metal. Completed castings and machined or formed parts do not, in themselves, constitute a fire hazard.

In equipment designed by Bell Telephone Laboratories for the Armed Services, castings by far exceeded wrought magnesium products. In one of the airborne radars, the antenna support bracket and gear housing as well as the magnetron support were made of magnesium alloy castings. The weight limitations imposed upon the design of this equipment precluded the use of any other metal without sacrificing rigidity. The advantage of its high strength weight ratio coupled with wartime availability outweighed many other considerations in the selection of magnesium for some of our other airborne equipments. In an antenna, for example, the parabola support arms, yoke, and base castings were all made of magnesium alloys.

The excellent dimensional stability of magnesium alloys was used to good advantage in the many potentiometer drums in our airborne computers, which were made of castings or extruded tubing. Gear housings for drive assemblies, made of magnesium alloy castings, had the requisite stability to permit precision anti-backlash gear trains to be used with excellent results.

In general, it is not practical to substitute magnesium alloys in equipment designed to use other metals. This can be readily understood when consideration is given to the difficulties which may be encountered from a corrosion standpoint alone in making such a substitution. Good engineering practice demands that the initial design be predicated on the use of magnesium alloys. In this manner, the maximum benefits can be derived.

The photograph shown in the headpiece and the one at the bottom of page 198 are used through the courtesy of the White Metal Rolling and Stamping Corporation. The lower right photograph on page 197 and the one on page 199 are by Brooks and Perkins for the Pressed Metals Institute.

Telephone Order-Wire Circuit

(*Continued from page* 187)

tion may call any other by dialing a suitable code. A special code is also provided to permit all main stations to be called at the same time, if desired. Over the local order-wire circuit, 1,000-cycle ring-down signaling is usually employed between main stations. Auxiliary stations are called by d-c signals sent over separate pairs as indicated on the diagram (see page 187). On failure of the express circuit, the local circuit may be used in its place by properly patching between the various jacks marked A, B, and D on Figure 3. Two local sections may also be connected together. At station A, for example, the patching would be between jacks E-F and C-D.

THE AUTHOR: A. V. WURMSER joined the Laboratories in 1923 and acted as a commercial and technical assistant until 1928, when he became a member of the Technical Staff. In 1931 he received the B.S. degree in Electrical Engineering from Cooper Union. He has worked on the development of carrier telephone repeaters, carrier testing equipment, and voice transmission measuring circuits for toll line maintenance. He invented the feedback-amplifier rectifier and through its use developed the present 40B transmission measuring system, now standard in the telephone plant. Later he was engaged in the development of voice-frequency repeaters for open-wire and cable telephone systems. At the early part of the war he participated in the development of the Spiral-4 cable repeater system and transmission measuring facilities for the Army Signal Corps. During most of the war he was concerned with underwater sound projects for the Navy. At present he is engaged in the development of new synchronizing and switching circuits for radio telephone systems.

"It Helped Sink Six Jap Warships"

By ROBERT C. RASMUSSEN
Assistant Editor, "Wisconsin Telephone News"

Among the millions of magazine readers who saw the advertisement captioned as above was the father of a radar officer of the U.S.S. Boise. *His suggestion to the Editor led to the writing of this story.*

LIEUTENANT COMMANDER PHILIP C. KELSEY was assistant radar officer aboard the *Boise* during the famous night engagement—the second battle of Savo Island in the Solomon Island group—in which the six participating Jap warships were sent to the bottom by the accurate guns of the American men o' war in a furious fight that was all over in twenty-seven minutes.

Commander Kelsey, then a lieutenant junior grade, on duty at his ship's radar installation, was the first to determine, through the radar screen, the presence of the enemy in the pitch darkness.

"It was radar that saved the *Boise* in that battle," the commander reminisced, "and it saved us not once, but twice! First, it helped us to spot the approach of the Japs; and second, it saved us from running aground in the inky darkness. Even the task force commander had given us up for lost, but good damage control, a tough ship, plus radar, brought the *Boise* back to its squadron by dawn of the next day."

The second battle of Savo Island occurred during the grim autumn of 1942 when American Marines secured a toehold on Guadalcanal. The Japanese were sending escorted convoys of troop reinforcements to land at Cape Esperance, the northern tip of Guadalcanal. The Marine air base at Guadalcanal, Henderson Field, harbored only twelve planes with enough gasoline to put five into the air—inadequate to prevent the landing of Jap reserves on the northern end of the vital island. Thus, American cruiser task groups were detailed to the Savo Island area, about twelve miles north of Guadalcanal, to try and stop the Jap reinforcement convoys. The first attempt in the early dawn of August 9 was a failure when three American cruisers and one Australian cruiser were sunk in the first battle of Savo Island.

Lieut. Comdr. P. C. Kelsey, Radar Officer of the U.S.S. Boise

The second battle opened on October 11 when a Japanese task force was spotted bearing down on northern Guadalcanal. The American cruisers, *San Francisco, Salt Lake City, Boise,* and *Helena,* with a light destroyer screen, were instructed to intercept the Japanese flotilla. They neared the Japanese force about midnight in the vicinity of Savo Island, but in the intense darkness the *Boise* was able to contact the enemy with its surface search radar equipment, one of the earlier types of radar developed in the Laboratories and manufactured by Western Electric Company.

"We contacted the Jap ships at 13,500 yards, according to our surface search radar, and thus provided the fire-control party with initial target bearings," explained Commander Kelsey. "The radar screen showed a large enemy ship and several smaller units. Captain E. J. Moran, then commander of the *Boise*, told the radar operators to pick the biggest and get its bearings. The Japanese, apparently unknowingly in the thick darkness, moved closer and closer to the *Boise* until a scant 3,900 yards separated us."

The *Boise* opened fire at almost point blank range. The captain of the Japanese ship, possibly thinking that he was being fired upon by his own ships, turned on his red recognition lights. In twenty-seven short minutes the engagement was over. None of the Jap ships remained afloat.

Before the furious exchange of firing was over, the *Boise* was straddled eleven times by salvos from a Japanese cruiser.

"One enemy salvo set fire to the forward gun turrets," explained Commander Kelsey. "In all, the *Boise* was hammered by six eight-inch shells and five five-inch shells. With the crew trying to patch up the holes in the hull with pillows and mattresses, the burning *Boise* turned off toward the south in the direction of Cape Esperance.

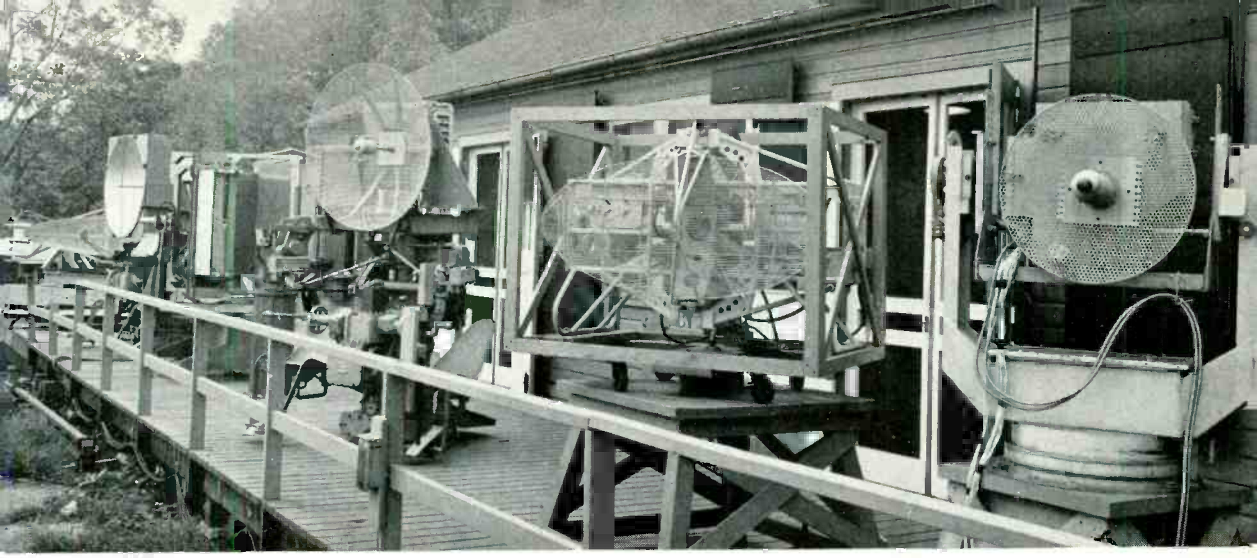
"There, for the second time that night," Commander Kelsey declared, "radar came to our rescue. This time it was the air search radar equipment that saved us. Our operators, constantly consulting the screen of this radar installation, discovered that we were heading straight for Cape Esperance and certain beaching—and it was not healthy for Americans to be found high and dry on Cape Esperance, where thousands of Japanese troops were based."

Veering away in time from the northern tip of Guadalcanal and getting the fire aboard the ship under control, the crippled but still moving *Boise* joined its task force before dawn. Radar equipment—Bell System developed and manufactured—had given the *Boise* its initial advantage over the Japanese units before the battle started and then had prevented the famous cruiser from running aground nearby.

By November, 1942, the *Boise* was home in the Philadelphia Navy Yard for needed patching up and overhaul. R. E. Poole of the Laboratories visited her with Commander (later Captain) Dundas Tucker of the Bureau of Ordnance to talk about the radar his group had designed. He came away with the promise of one of the magnetrons in exchange for a new one. Next day another engineer came down from New York, brought back with him from the radar of the ship's forward main battery director the magnetron that had gone triumphantly through the Second Battle of Savo Island. In 1943 she crossed the Atlantic and took part in the initial bombardment at the Sicilian invasions and at the Salerno beachhead in southern Italy. Just after the capitulation of Italy, the *Boise* claimed the honor of being the first major American ship to dock in Axis-dominated Europe when the battle-scarred cruiser, along with British units, tied up at Taranto on the arch of the Italian boot. Later the *Boise* again returned to the Pacific zone.

Commander Kelsey was assigned to the *Boise* just after the attack on Pearl Harbor. He was on board the submarine tender U.S.S. *Argonne* in Pearl Harbor itself, happily wrapping Christmas presents, when the Japanese struck on December 7, 1941. "We were lucky," he recounts, "the Jap torpedo planes roared past our ship at about fifty feet but they were after the bigger fleet units. I'm sure I could have hit the first Nip plane with a monkey wrench. They came in that low."

Atlantic Highlands Laboratory where some of Comdr. Kelsey's radar equipment was tested



Atlantic Highlands Laboratory

By J. W. SMITH
Commercial Products Development

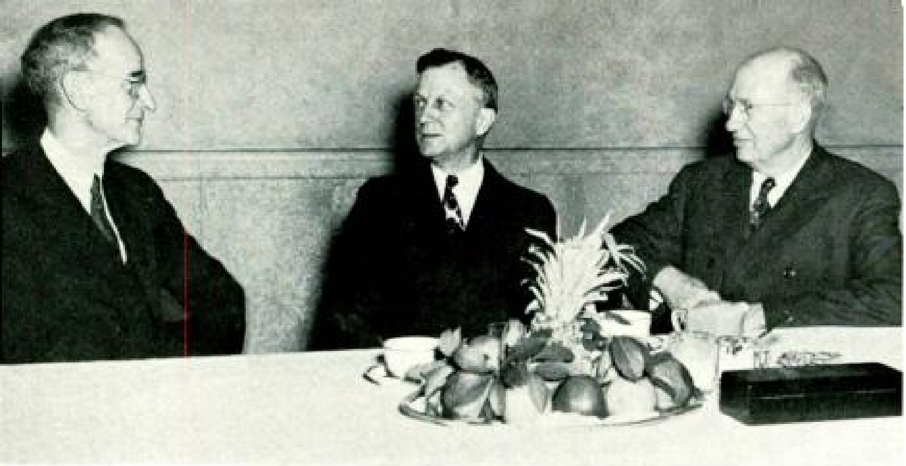
WHEN the Laboratories became actively engaged in the development of shipboard radar in 1939, the need for a testing site having an elevation of approximately 100 feet, and overlooking an active harbor, became immediately apparent. The selection and arrangements for the use of the site fell to the lot of W. C. Toole of Legal and R. E. Poole of Commercial Products. A small four-room bungalow overlooking Sandy Hook Bay and the entire New York harbor was leased. This property was outgrown soon after the declaration of war, and the building shown on the opposite page was constructed a few hundred feet east of the bungalow in the early spring of 1942.

Up to twenty engineers worked day and night at the Highlands during the hectic days of the war, testing and making improvements in models which had been constructed at West Street, Holmdel and Whippany. Among the twenty or more radars which were tested were several which later left their mark on our enemies. The antennas of some of these may be seen installed on the long veranda of the building which overlooks the harbor.

In connection with tests of a secret Army equipment, it was necessary to install an antenna atop a 100-foot tower. The erection of a structure of this type and the use of the property generally for industrial purposes involved securing an exception to the Zoning Ordinance of the Borough of Atlantic Highlands. The entire Zoning Commission gave full coöperation in obtaining this exception. At a meeting with the Board, at which the team of "Toole and Poole" discussed the war necessity for seeking the town's approval to disturb the beauty of the countryside, one of the board members remarked that "she wished she could be as useful every day to her country." To provide the necessary security, the antenna was enclosed in a simulated water tank. Several of the local inhabitants remarked that it was foolish to install our own water system since they had always found the existing municipal system adequate.

One property owner from whom land and his summer home was leased ferried Army bombers from aircraft factories to fields from which the planes eventually left for the battlefront. He said he would keep an eye on how well the Laboratories used his place by flying over it several times a week. We heard later that after doing this once or twice, the anti-aircraft batteries on Sandy Hook, in their characteristic fashion, persuaded him to discontinue this practice.

On several occasions the Laboratories' resident service manager, W. P. Smith, a



On March 28, H. S. Osborne (center), Chief Engineer of A T & T, addressed an executive conference at the Laboratories on problems incident to the rapid growth of the telephone plant. Another guest was O. B. Blackwell, Assistant Vice-President of A T & T. O. E. Buckley (right) presided

native of the section, collaborated with the FBI and Army Intelligence in policing the hills of Monmouth County for possible spy lookout locations. Mr. Smith has not told us of actual findings, but he does admit to some hair-raising nocturnal hunts.

These laboratories at Atlantic Highlands played a great part in the convincing of high-ranking naval officers, particularly those to whom radar was an unknown quantity in the early days of the war, of the fact that radar could direct accurately the pointing of ships' guns. The actual demonstration of fire-control radar was found to be a much more satisfactory method of instruction than countless words, charts and pictures could be. Now the usefulness of the location is in the past, and as if parting with an old friend, those of the Laboratories who were associated with it regret that a peacetime use is not indicated.

The Guest Register of the "Highlands" contains the names of practically all the radar-famous engineers, scientists and officers of this country and England.

Leo Montamat Recipient of Civilian Service Award

Leo Montamat, formerly Assistant Vice-President of the Laboratories, and now retired, has been awarded the Distinguished Civilian Service Emblem by Secretary of the Navy James Forrestal for outstanding services as a member of the Navy Price Adjustment Board's New York division.

In part, the citation reads: "Mr. Montamat conducted and participated in many of the most important renegotiations assigned to the board, and in performing this difficult task has shown outstanding diligence, ability, tact and devotion to the best interests of his Government.

"As chairman of the New York Division, his leadership . . . in negotiations with contractors and in supervising the activities of his division has been outstanding."

Photographic Exhibit

F. W. Webb's *Sonny Boy* was judged the best print of the show at the Twentieth Annual Photographic Exhibit of the Bell Laboratories Club. Of 120 prints submitted to the committee, comprised of E. Alenius, C. T. Boyles and J. Waddell, sixty-five were accepted for hanging in the auditoriums at West Street and Murray Hill.

K. L. Warthman, a returned veteran, submitted a Kodachrome, *Street Scene in Ober Ammergau*, which was judged the best slide from sixty accepted for showing out of 160 slides submitted.

Murray Hill Chorus

During Music Week, May 5 to 12, the Murray Hill Chorus will present its first formal concert at the Y.M.C.A. Auditorium in Summit and will give two recitals in the Arnold Auditorium of the Laboratories. The Y.M.C.A. concert, to be presented on May 10, will feature the harpist, Dorothy Coy Goodell. The other recitals will be held during the noon hours of May 6 and 7 at Murray Hill.

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

J. M. West Awarded Emblem for Meritorious Civilian Service

The Emblem for Meritorious Civilian Service was awarded to J. M. West of the Murray Hill Laboratories at a recent ceremony in the Pentagon Building. Major General H. M. McClelland, Air Communications Officer, Headquarters Army Air Forces, made the presentation.

Mr. West, former AAF consultant and a West Point graduate, received the award "for exemplary performance of his duties as Expert Consultant to the Air Communications Officer on electronics, with particular reference to radar countermeasures. . . . His imagination and devotion to duty and his ability to foresee and solve the technical electronics problems encountered during the tremendous expansion of the Army Air Forces have contributed materially to the successful employment of air power."

Quality Control Commendation

Tribute to the Laboratories' pioneering in quality control was paid recently by speakers at the Mid-West Quality Control Conference at Chicago, according to *The Wall Street Journal* of March 7:

"Men attending the meeting here said the system ought to be called 'Shewhart quality control.' Dr. Walter A. Shewhart, a mathematician of Bell Telephone Laboratories, originated the technique.

"The new quality control system was first used about 1925 by the Bell Telephone Laboratories. Westinghouse Electric & Manufacturing Company began applying it in 1937. But its rapid growth came with the war after the system was simplified by a committee appointed by the War Production Board.

"George D. Edwards, director of 'quality assurance' for Bell Telephone Laboratories, which originated the new technique, says consumers can buy with greater confidence. Applied to telephones, Mr. Edwards says it means there 'is less chance you will have to send for the repairman and fewer times when your phone conversation is interrupted by mechanical failures.'"

Examples of the applications of quality control to practical problems were given by speakers from a number of industries. It was stated that a course in statistics and quality control will be offered next fall at North Carolina State College—one of fifty colleges which now have, or plan to start soon, courses in this new subject.

Obituaries

Jacob W. Kelsch of the Plant Department died suddenly on April 1, after nearly twenty-nine years of service. Mr. Kelsch was a carpenter assigned to general maintenance work when, in 1926, he was assigned to build experimental equipment for the television group of the Research Department. In 1930, when television was being demonstrated between 195 Broadway and the Laboratories, he was responsible

Jacob W. Kelsch
1886-1946

Willard W. Eckner
1914-1946

for installation of the booths at both locations. Later he returned to the Plant Department where, as a cabinet maker, he worked on models of such apparatus as switchboards and telephone booths as well as on furniture repair. A Telephone Pioneer, Mr. Kelsch also belonged to the Western Electric Post of the American Legion.

Willard W. Eckner, a former member of the Laboratories, died on March 21 after a long illness. Mr. Eckner joined the Laboratories in 1930 as a student assistant. After receiving the B.E.E. degree at the evening college of New York University in 1938, he transferred to the Holmdel Laboratory where, until 1942, he engaged in work on ultra-high-frequency radio receivers and on the measurement of dielectric constants and losses of materials in the centimeter wavelength region. He was a brother of G. W. Eckner of Quality Assurance.

★ ★ ★ ★ We Welcome Back ★ ★ ★ ★

Edward J. R. Lang trained at the machinist mates school of the University of Minnesota for his work aboard the U.S.S. *Megrez*, which delivered supplies to the Marshalls, Saipan, Tinian, the Philippines and Okinawa.

Arne O. Christiansen, after six months' training, went to England. With the rating of T/5, he served with the 204th Signal Depot Company doing teletype work. He was to have sailed from France to the Pacific but had an appendectomy in Marseilles and then he sailed for home.

William F. Rauchle, after specialized radar training in this country, served with the Signal Corps in the South Pacific, where for twenty-five months he engaged in airborne radar repair.

Lieut. Paul Mallery's military career was highlighted by the Christmas he spent at Port Moresby with his father, a member of the Army Transport Service and veteran of three wars. Lieut. Mallery was attached to the Radio and Radar Repair Depot and to Aircraft Warning Headquarters during three and a half years of South Pacific service.

Seferin E. Pulis was attached to the Naval Technical Mission to Japan which located electronic gear and shipped it back to the Naval Research Laboratories. He served in Japan until January.

Lieut. Elwood N. Riker earned his wings as a B-24 pilot. Going overseas, he served as fighter control officer with the 13th Air Warning Group in the Philippines.

Major Fred B. Monell entered the Armed Forces as an Apprentice Seaman in World War I. Between wars he was active in the National Guard and the Organized Reserves and, in February 1942, was called to active duty and assigned to the Signal Corps Laboratories. He received official commendation for his work in introducing mobile FM radio communication equipment to the 4th Armored Division. Reassigned to General Bradley's headquarters in 1944, Major Monell participated in planning wire communications for the invasion of Normandy and for the European campaign. The "Certificate of Merit" was given to him by General Bradley for engineering long distance systems, including many carrier telephone systems, required to coördinate the General's four field Armies and the 9th Air Force. His final duty in Germany was with the Office of the Chief Signal Officer.

Major Arnold R. Bertels received a direct commission in 1942 and went to Ft. Monmouth, N. J., where he instructed in the Officers' School, teaching teletype, switchboard and carrier and repeater in the Long Lines Inside Plant course. Later he was in charge of instructors and course outlines. He became Chief of the Wire and Miscellaneous Division in the Signal Corps Publication Agency and continued in that capacity from February 26, 1943, to January 21, 1946. His work consisted of writing and collaborating with commercial firms on technical manuals covering wire, meteorological and power equipment. He was awarded the Meritorious Unit Citation.

John A. Zweig went to automotive machinist schools prior to his overseas assignment with the 4th Armored Division of the Third Army. During their campaigns, he worked with combat engineers building bridges and destroying mines. He reached Czechoslovakia by V-E Day and returned to Regensburg, Germany, for occupational duty.

Robert H. Meuser was in Italy with the Fifth Army and later made the invasion of Southern France, pushing up the Rhone Valley to the Vorges Mountains, the Alsatian plain, and acting as the southern salient in the Battle of the Bulge. He crossed the Rhine and entered Austria through Southern Germany. While in Stuttgart on occupation duty, he ran a post library for two battalions. He has the Combat Infantryman Badge, the Purple Heart and four battle stars.

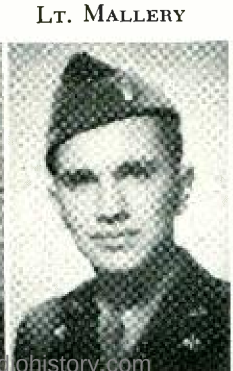
Lieut. Col. Allen L. Whitman was the assistant executive officer of the Camp Evans Radar Development Laboratory for the first year and a half after he entered service at the request of the Signal Corps. He was officer-in-charge of the Equipment Coördination Branch of Camp Evans Signal Laboratory before leaving for an overseas assignment in December 1943. For about three months he served on the staff of the U. S. Army Services of Supply Headquarters in Brisbane, Australia, and then transferred to New Guinea, where he was appointed base signal officer. Col. Whitman then left Lae, New Guinea, to go on the "M operation" and landed on Lingayen in Luzon on S plus 4 Day. There he was signal officer at a sub-base for a brief period and went on to Manila with an advance reconnaissance detachment. Their purpose

E. J. R. Lang

A. O. Christiansen

W. F. Rauchle

Lt. Mallery



S. E. Pulis

Lt. Riker


Maj. Monell


Maj. Bertels


J. A. Zweig


R. H. Meuser


Lt. Col. Whitman


J. H. McConnell

was to find and obtain facilities for officers and warehouses in preparation for the arrival of the main body of supply troops. He stayed in Manila six months as communications officer of the base section headquarters and later moved to Batangas to act as signal officer.

John H. McConnell, a commissioned Warrant Officer, was assigned to the Naval Air Base at Bermuda for most of his naval career. As radio matériel officer, he was responsible for installing and maintaining electronic equipment at the base.

Louis R. Bell did personnel work with the AAF for three years in the 2nd Ferry Group at Wilmington, Delaware, and later at Presque Isle, Maine. From August, 1945, until his release, he was at Hickham Field, Hawaii, where, as chief clerk, he was secretary to the Postal Officer.

Herbert J. Braun, who was an armorer with a T/4 rank in Ordnance attached to the Air Forces, spent a year repairing weapons in Amberley Field and at Darwin, Australia, earned battle stars for New Guinea and Luzon, and wound up his military career as a typist in Manila.

Robert J. Seymour was chaplain's assistant from May 1944, when he landed in England, until his recent discharge. With the 1st Army's 67th Evacuation Hospital he landed in France, and traveling through Luxembourg, Holland, Germany and Czechoslovakia, received five battle participation stars and a Presidential Unit Citation.

George A. Schiehser entered military service in 1941, was graduated from an E.E. course at Georgia Tech, and served in both theaters of war, doing telephone installation work in England, France and Germany, as well as in Japan.

Walter W. Grote, after extensive training in this country, spent six months on Talmyra, where he was responsible for naval electronic apparatus.

Arthur T. Olsson spent twenty-five months in various Pacific outposts, installing, maintaining and repairing land and radio teletype circuits.

Frank R. Monforte returned to the Development Shops, after 26 months of fighter control duty in the Pacific theater. Originally a Signal Corps man, he fought with the 5th Air Force.

Charles W. Deming, serving with the 9th Air Force, installed and maintained carrier and repeater equipment in the ETO during seventeen months of overseas duty.

Emil Ellingsen trained at Fort Monmouth and at Camp Crowder before shipping to England. From there he sailed to the continent, where he earned five battle stars as a repeater and carrier communications man.

John J. Naughton's military career was spent at Fort Knox and at Indiantown Gap processing men returning from overseas, bringing their pay up to date and calculating their travel allowances.

William C. Brossok held the rank of sergeant in the Air Forces. After he had received extensive training in airborne radar, he saw action in the Pacific as a radar mechanic with the 43rd Bombardment Group,

Lieut. Wm. B. Callaway, two days after joining the Navy as an ensign, landed in South America, where for nine months he was engaged in the development of special devices. Back in the States he instructed pilots and aircrewmen in anti-submarine warfare until he was assigned as an air combat observer with the rank of lieutenant, Air Group 90, on the U.S.S. *Enterprise*. He saw action off the coasts of Iwo, Okinawa, China and Japan.

Flight Officer Michael Collins went overseas early in the war and later was returned to this country for pilot training. On his second assignment in the ETO, he flew 23 sorties in a C-47, bringing cargo to front-line troops and evacuating their wounded.

Gottfried O. Voigt spent his military service as an engineering draftsman at the Naval Research Laboratories, where he worked on radar, sound and communications equipment.

L. R. Bell


H. J. Braun


R. J. Seymour


G. A. Schiehser


W. W. Grote


A. T. Olsson

F. B. Vreeland | Capt. Anderson | D. J. Maccia | A. V. Frolic | J. A. Joyce | W. J. Bitt

F. B. Vreeland went overseas to Algeria in August, 1943, and was assigned to a Signal Service Company, where he supervised incoming and typed outgoing teletypewriter messages. Mr. Vreeland spent fourteen months in Italy and was on a ship headed for the Philippines on V-J Day.

Capt. A. Eugene Anderson served with the Signal Corps at Evans Signal Laboratory, Belmar, N. J., where he was responsible for electron tube tests and standardization as well as for the development of electron tubes in reference to field improvement. Capt. Anderson also represented the Signal Corps Charter on the Joint Army-Navy Electron Tube Committee.

Domenick J. Maccia served overseas in the Pacific theater as a member of Cub No. 16. For several months he was Dockmaster in charge of the repair of small boats and later was given a rating of EM 3/c, in which capacity he was a generator attendant and also performed electrical repair duties on small boats.

Arthur V. Frolic has been discharged from the Navy after thirty-two months' service. He was stationed in the United States and was assigned to Shore Patrol at various points along the Atlantic Coast during the major part of his service. He spent two months at the Specialist Shore Patrol School at Farragut, Idaho.

Joseph A. Joyce, in over three years of military service, was an aerial engineer and later a crew chief. As such, he was responsible for supervising the maintenance of a B-24 which was used for pilot training missions, on which he accumulated over 1,000 hours of flying credit.

Walter J. Bittman has returned after twenty-seven months of Army service. His first assignment was as a repairman and electrician on 40-mm anti-aircraft artillery; then he did automotive mechanic's work on major overhauls. His outfit was the 298th Ordnance Maintenance Company, with whom he fought in four major engagements.

Carl W. Fleischer is a Technical Assistant, assigned to the Telegraph Development group. His military service overseas was with the Signal Corps in the Pacific theater, where he did telephone installation and repair work.

Edward J. Burns, ARM 2/c, was assigned to radio school and later to an aviation radio school to prepare him for his assignment as a radio operator on Navy blimps making patrols from Weymouth, Mass. He spent fourteen months in Brazil on similar work and then returned to Norfolk.

S/Sgt. John E. Galbraith was with the Keystone Radio School and then with the 136th Radio Security Detachment at Ft. Meade, Md. With this detachment he assisted in the monitoring of Army airways communications systems in the Caribbean area for two years at Trinidad and later in Jamaica.

Charles R. Storin fought with the 5th and later the 7th Army from Africa to Italy and through Germany. A telephone lineman, he also served for short periods with the Infantry and Artillery.

T/4 Cornelius J. Keyser completed his overseas military service as a dispatcher in Tokyo, having entered Japan with the first group of the first convoy. Prior to that, he had driven a truck in Manila and had won three stars for participating as a radio operator in engagements in New Guinea and the Philippines.

John Gris, after training to familiarize him with various administrations required by the Army, became Ration Estimator for all of Camp McClellan.

Joseph J. Rosato, who served a year and a half in the Western Defense Command Coast Artillery as a radar operator, was then assigned to the Combat Engineer Corps.

Alfred W. Johnson engaged in his former hobby, carpentry, while serving in the Seabees. Enlisting in 1942, he trained at three camps before being assigned as a carpenter's mate in the Aleutians.

George A. Seibel saw combat in France and Germany and holds the Victory Medal and the

C. W. Fleischer | E. J. Burns | J. E. Galbraith | C. R. Storin | C. J. Keyser | J. Gris






. J. ROSATO — G. A. SEIBEL — J. W. SCHAEFER — R. F. HEINRICH — D. R. SCHEIDERMAN — H. J. ROHR

European-African-Middle Eastern Ribbon with two battle stars for the Rhineland and Central European campaigns.

Jacob W. Schaefer was stationed at Frankford Arsenal in Philadelphia where he was Development Officer for anti-aircraft fire control and for guided missile systems.

Richard F. Heinrich, S 1/c, SAO, attended Optical School, Washington, and an advance optical school at the Norfolk Navy Yard, becoming a special artificer and optician in Mark 14 and 15 gun sights. He served as an optical repairman with a ship repair unit in Okinawa, and later worked in Personnel of the Military Government.

D. R. Scheiderman was in the service just a few days short of three years, fifteen months of which were spent overseas in New Guinea and the Philippine Islands. His assignment was the maintenance and major repair of all types of fire control instruments, such as range finders, aiming circles, battery commanders' telescopes and various non-optical instruments.

Howard J. Rohr recently received his discharge from the Navy after 16 weeks at an electrical school in Detroit, Mich.; 14 months in Norfolk, Va., as a maintenance hand in an electrical shop, and four months' service in electrical maintenance and repair work aboard the U.S.S. *Sciota*, a sea-going tug operating within 300 miles of the Atlantic Coast.

Wilbur Insull spent his military career as a surgical technician in the front lines, giving the first medical treatment to wounded brought directly from the battlefield. He was awarded the Bronze Star for meritorious service.

Robert H. Funck, aboard the destroyer *Melvin* with the 3rd Fleet, earned ten battle stars, eight on the Asiatic-Pacific bar and two on his Philippine bar. A Fire Controlman 2/c, Mr. Funck spent twenty-seven months on the ship and remembers Okinawa as the bitterest battle of all.

Charles F. Christoph's Navy career was divided between service on a refrigerator ship and the destroyer *Cone*. He served from Iceland down to the Caribbean and across to the Mediterranean.

Thomas P. Gannon's twenty-three months of naval service were spent for the most part on the destroyer escort *Rough*, first on convoy duty in the Atlantic and Mediterranean and later in the Pacific, where he participated in three major engagements.

T/5 George J. Wolters served with the 167th Infantry, 31st Division, almost from the time he entered service in 1942. Trained at Camp Shelley, he saw action in New Guinea, Morotai and Mindanao, and was awarded three battle stars.

Arthur Jackson, Jr., rose to staff sergeant in the Army and participated in three major engagements in the Pacific theater of operations. Mr. Jackson, an amphibious truck driver, was overseas for nineteen months.

Burton L. Jamison spent 46 months in service, mostly in the Pacific theater of operations, where, as a radio operator with the Infantry, he participated in three major campaigns.

Frank C. Kozac has returned after a year and a half of Pacific duty. A field artilleryman, he was attached to the 11th Airborne Division and was taking glider training when the peace was signed.

John H. Phillips, a Surgical Technician, served with the 1st Chinese Regiment and with Merrill's Marauders in Africa, India, Burma, China and French Indo China.

T/3 William R. Grant studied teletypewriter repair at Ft. Monmouth and the Southern Ohio Bell Telephone Company school. After a course in cryptographic repair in Washington, D. C., he sailed to Australia with the 832nd Signal Service Company and later served in New Guinea.

Peter Yurica, of the Development Shop, served aboard the repairship *Culebra Island* during most of his military service, repairing anything from LST's to aircraft carriers in the South Pacific.

W. INSULL — R. H. FUNCK — C. F. CHRISTOPH — T. P. GANNON — G. J. WOLTERS — A. JACKSON










. W. O'Hara J. D. Olesko W. P. Weiler R. D. Nostrand J. M. Sullivan G. J. Thiergar'

Edward W. O'Hara served with the Coast Artillery in Boston, went to Germany as an Infantryman and finally ended his military service at El Paso, doing personnel work in the General Hospital.

John D. Olesko holds the distinction of having been awarded the Purple Heart with an oak leaf cluster for having been wounded twice during his fifteen months in the South Pacific. A squad leader in the Infantry, he fought with the 6th and with the 8th Army and finally stood occupational duty in the Japanese home islands.

William P. Weiler was a Chief Ship Fitter aboard the *Briareus*, on which he spent two years in the South Pacific helping to repair every type of ship from destroyers to landing craft.

Robert D. Nostrand, upon release from the Navy, has returned to the War Emergency Facilities group. He spent twenty-seven months on a sub chaser in the Atlantic and participated in the invasion of Normandy.

James M. Sullivan, as central wire chief and repeaterman, fought in the ETO, where he installed, operated and maintained Spiral-4 carrier systems and voice-frequency repeaters.

George J. Thiergartner served with the Engineers Corps, doing drafting in the Solomons. Prior to that, he had been a Signal Corps repeaterman.

Martin E. Poulsen was awarded the Bronze Star for meritorious service in the ETO. A member of the Signal Corps, he fought with the 9th Army in the repair branch of telephone carrier and telephone radio.

Ernest M. Johnson's brief assignment in Guam was to maintain radar for naval aircraft. Prior to that he had studied under the naval cadet program and in radio and radar schools.

The Laboratories has employed 865 veterans of World War II

Vincent T. Decker served in the Navy aboard the destroyer escort *Key*. After convoy duty to Taranto, Italy, the DE headed back to New York and then sailed to the Pacific theater of operations, where it participated in three invasions.

Raymond S. Yerden utilized his specialized training in refrigeration while at New Caledonia, Guam and Pearl Harbor. His responsibility was to maintain refrigeration for food, storage and cooling systems for the United States Marine Corps.

Thomas J. Calvani, after training in Miami and Mobile, sailed on the Queen Mary to join the 8th AAF, serving as an airplane engine mechanic in England, France and Germany.

Lieut. Robert F. McLaughlin went overseas with the 1st Allied Airborne Army in an anti-tank unit. The Belgian Government awarded his division, the 101st Airborne, the Forragere with Palm, and the Dutch Government awarded the Order of Wilhelm. Later he was on occupation duty.

George G. Bailey, after radio and radar training, attended A.S.T.P. at Georgetown University. He went overseas with the Signal Corps, serving seven months in New Guinea and eight in Leyte and Luzon installing and repairing radio teletype.

Ludwig J. Bierl, a medical aide in Burma, served there twenty months while attached to the 38th Chinese Division. His foreign service earned for him two battle stars and took him around the world to India by way of California and Tasmania, then home by way of the Suez Canal.

Frank Navratil fought in the ETO with the Infantry in the 80th Division for a year, was hospitalized and then transferred to the Air Corps, where he served until his discharge.

. E. Poulsen E. M. Johnson V. T. Decker R. S. Yerden T. J. Calvani Lt. McLaughl





. G. BAILEY L. J. BIERL F. NAVRATIL J. C. STUHLMAN E. F. NOE LT. MANNINC

James C. Stuhlman, who served aboard the aircraft carrier *Hancock,* made 9 missions, accrued 450 flight hours in dive-bombers and earned the Air Medal during his naval career.

Emmett F. Noe's forty-two months in the Navy included nine months of sea duty. Most of his time was spent at fire-control schools and later at midshipman's school and ROTC at Yale.

Lieut. (jg) John P. Manning, entering service as a naval cadet, was commissioned at Pensacola. His Curtiss *Hell-Diver* supported the invasion of the Philippines and he accrued some 900 flying hours before reverting to civilian status.

Robert W. Tomb spent thirty-eight months in service, most of which were in submarine duty. He reports that the submarine on which he served sank twenty-seven Jap ships. He was stationed at Guam when the Japs surrendered.

Robert T. Lynch, of the Signal Corps, spent twenty-three months in the South Pacific, where he was responsible for the installation, repair and maintenance of radio-teletype receiver stations in New Guinea and Biak.

Capt. Kenneth L. Warthman, a reserve officer when called to the colors in 1940, served with the Ordnance Department for two and a half years and then transferred to the Air Technical Service Command at Wright Field. As project officer in the armament laboratory, he worked on fighter and bomber gunsights. For over six months Capt. Warthman was assigned to A2 Air Technical Intelligence in Europe.

William T. Quinn was an aerial gunner when he went overseas in May, 1943. After he had flown eight secret missions over enemy territory, he was assigned to ack-ack school in England and served as an ack-ack gunner until 1945, when he volunteered for the Infantry.

Charles M. Voss was awarded the Bronze Star Medal in the ETO. He served as a radio operator and radio mechanic with the 102nd Infantry.

Leaves of Absence

As of March 31, there had been 1,041 military leaves of absence granted to members of the Laboratories. Of these, 566 have been completed. The 475 active leaves were divided as follows:

Army 223 **Navy 179** **Marines 21**

Women's Services 52

There were also 14 members on merchant marine leaves and 1 on personal leave for war work.

Recent Leaves

United States Marines—Richard E. Norberg

United States Army

John Ferguson	Peter J. McEleney
Gerald A. Heid	Roy A. Metzler

Henry I. Stockli

United States Navy

Vincent W. Batti	Vincent J. Capitini
Neil I. Brohm	Frank M. Denton, Jr.

Robert Dryden held the rank T/4 when he was discharged from service after having been an instrument repairman with the 3rd Armored Division. He also did police work with the AMG prior to his homecoming.

Lieut. Thomas A. Pariseau, after first being a cavalryman, transferred to the Air Corps, where he was commissioned and assigned to the Ferry Division of the ATC in Alaska and the Aleutians. In 1,350 flying hours, he flew pursuit type planes and C-47's with the 54th Troop Carrier Squadron.

Members of the Laboratories granted personal leaves of absence to attend college under the GI Bill of Rights include E. R. CLARK, C. S. GRAHAM, J. L. FARBO, ELIZABETH FITZSIMMONS, W. J. FLAVIN, F. A. KODITEK, R. W. MCMURROUGH, J. H. ROONEY, W. B. SCHELLERUP, W. J. H. THOELE, and K. R. THOMPSON.

R. W. TOMB R. T. LYNCH CAPT. WARTHMAN W. T. QUINN C. M. VOSS R. DRYDE

Hosts to O. E. Buckley (right) during his recent visit to The Cincinnati & Suburban Bell Telephone Company were C. A. Boyd, Transmission, Protection and Outside Plant Engineer; B. S. Wagner, Chief Engineer; L. A. Young, Equipment Engineer; and W. A. Hammilrath, Plant Extension Engineer

News Notes

O. E. Buckley and E. I. Green were present at Winston Churchill's address at Westminster College, Fulton, Mo., upon his receiving an honorary degree at that institution. Dr. Buckley and Mr. Green were guests of Dr. F. L. McCluer, president of Westminster College, at a luncheon for President Truman and Mr. Churchill. Mr. Churchill's talk was delivered under the John Findley Green Lecture Foundation, established by Mr. Green's mother, Eleanor I. Green, in memory of her husband.

While in the Middle West, Dr. Buckley gave talks on Laboratories' technical developments before supervisory employees of the Southwestern Bell Telephone Company in St. Louis, and The Cincinnati & Suburban Bell Telephone Company in Cincinnati.

Dr. Buckley addressed a luncheon meeting of the Poor Richard Club, Philadelphia, on the subject of *Technical Trends in Telephony*.

Douglas F. G. Eliot, general purchasing agent in charge of purchasing and traffic for the Western Electric Company, has been elected a vice-president of that company.

War Experiences in Industrial Photography was the subject of an illustrated lecture by J. H. Waddell before the Raritan Photographic Society on April 3 at Rutgers University.

G. D. Edwards has been elected the first president of the newly formed American Society for Quality Control.

H. F. Dodge has been appointed a member of the Editorial Board of the American Society for Quality Control.

P. S. Olmstead has been elected president of the Society for Statistical Quality Control. He is also a director and a member of the Executive Committee of the American Society for Quality Control.

W. H. Doherty addressed the joint meeting of the American Institute of Electrical Engineers, the Institute of Radio Engineers, and the Engineering Institute of Canada, which was held on March 21 in Montreal. On March 23 he spoke before a joint meeting of the Royal Canadian Institute and the Toronto Section of the A.I.E.E. in Convocation Hall in Toronto. The subject of both talks was *Microwaves in Radar and Communication*.

G. R. Frost gave an illustrated talk, *Still Life Composition*, before the print group of the Manhattan Telephone Camera Club.

E. K. Eberhart and L. R. Montfort inspected station sites and reviewed with telephone company engineers problems concerning the eight-channel microwave radio system to be installed between Barnstable, Massachusetts, and Nantucket Island.

V. T. Callahan

"The Telephone Hour"

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

May 13	*Ezio Pinza*
May 20	*Oscar Levant*
May 27	*Helen Traubel*
June 3	*Benny Goodman*

visited the Duplex Truck Company in Lansing, Mich., where he discussed automatic gasoline and diesel engine sets. Mr. Callahan and J. M. Duguid were at the office of the Civil Aeronautics Administration in Washington on gasoline and diesel engine problems.

H. W. Purcell studied the performance of special banks and wipers on trial in step-by-step offices at Albany and Scranton.

D. F. Seacord has been in Cincinnati, St. Louis, Kansas City, Omaha, Chicago and Cleveland where, in association with operating company engineers, he made measurements to determine the effectiveness of measures for reducing noise in panel dial central offices.

R. L. Case, M. F. Fitzpatrick and N. Monk, with A. M. Dowling and C. S. Thaeler of O & E, visited Philadelphia to discuss telephone repeater problems with engineers of The Bell Telephone Company of Pennsylvania.

The April meeting of the American Chemical Society was attended by R. M. Burns, A. R. Kemp, F. S. Malm, V. T. Wallder, J. B. Howard, M. L. Selker, G. N. Vacca, C. S. Fuller, W. O. Baker, B. S. Biggs, G. H. Williams, C. J. Frosch, G. T. Kohman and D. A. McLean. Papers were presented by M. L. Selker and Mr. Kemp and by T. H. Crabtree and Mr. Kemp.

Robert Pope spent two weeks in Georgia and Alabama assisting the Long Lines Department to check corrosion conditions on the copper-jacketed cable recently installed between Atlanta and Birmingham.

S. B. Williams spoke on the general-purpose computing system to the Project and Research Engineers of Wright Field at Dayton, Ohio, on March 8. Mr. Williams was accompanied by S. F. Turner of the Western Electric Company and E. G. Andrews of the Laboratories.

H. M. Pruden, D. J. Gagne and H. B. Coxhead, at Norfolk and Richmond, studied problems involved in the operation of the Norfolk Marine Radio System.

K. E. Gould addressed the Hampton Roads Engineers Club on *Radar for Bombing* on March 22 at Norfolk, Va. Dr. Gould repeated this talk on March 29 to Engineers of the Virginia Peninsula.

R. H. Colley and C. H. Amadon went to Washington, Oregon and California to work with suppliers in the development of new species of treated pole timbers. They also visited mills in the Douglas fir producing areas. Mr. Amadon recently cooperated with the Mountain States and Western Electric Companies in studies aimed at increasing the supply of clean pressure-treated lodgepole pine poles.

W. E. Mougey inspected the installation of the Dallas-Fort Worth coaxial cable.

D. C. Smith, V. B. Pike and R. M. C. Greenidge were in Texas in connection with the development of methods of testing lightning-protected cable between Dallas and Tyler.

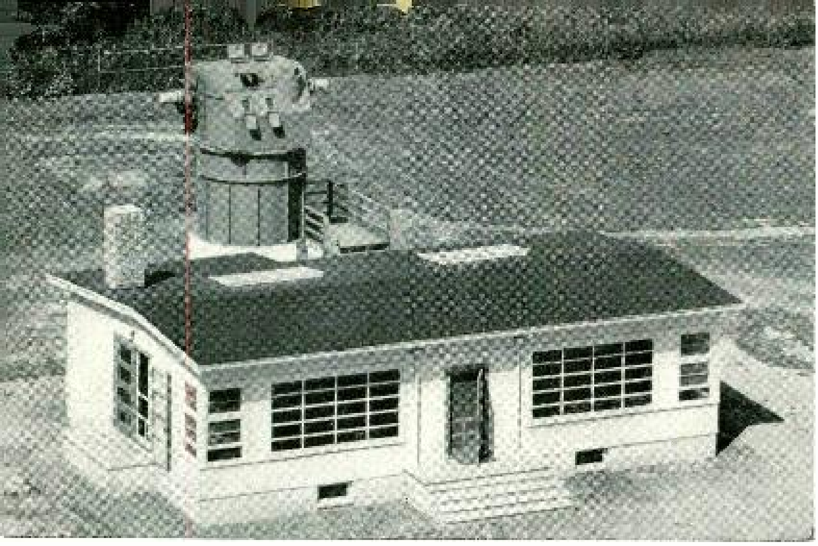
Engagements

*Herbert J. Braun—Marion Gruber
Arthur T. Dennis—*Ellen Thompson
Stephen Dorosh, U.S.N.—*Virginia Voskanyan
Harold Johanson—*Marjorie Lapham
Charles F. J. Kindle—*Loucille Brown
*Robert H. Meuser—Alyce Benjamin
*Robert J. Seymour—Mary Vanter
Joseph M. Trionfo—*Dorothy Footett
Robert Urie—*Veronica Moore
Gordon A. Welch—*Peggie Brady
*Kermit A. Williams—*Carol Vreeland

Weddings

Conrad Bly—*Eleanor Kirsch
James C. Brown, Jr.—*Mildred Haynes
*De Hays Butts—Lois Evans
*Charles A. Charity—Eveline Salter
John J. Ganci—*Elsie Pavlic
*William Grant—Alice Hofmann
William R. Jackson—*Marjorie Wright
*Lieut. (jg) Robert H. Light—Winifred Bothwell
Albert L. Martiny—*Elizabeth Belleri
Wallace A. McCann—*Mary Farrell
Elie J. Robert—*Betty Watson
*John P. Slickers, U.S.A.—Dorothy Carlson
*Frederick W. Starzer—Doris Hagmann

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



THE "LAND BATTLESHIP" AT WHIPPANY

To facilitate the development of an associated radar, the Navy has installed one of its standard gun directors adjacent to one of our laboratories at Whippany. Engineering is being done under the direction of J. W. Smith and S. C. Hight. Chief Fire-Controlman T. C. Buckner is in charge of the Navy equipment involved

C. SHAFER, JR., in Albany recently, was concerned with problems relating to studies of lashed aerial cable.

J. W. SCHMIED was at the Patent Office in Richmond and Washington during April.

R. M. BURNS delivered a lecture demonstration, *Ceramics in Communication Engineering,* at the New York annual section meeting of the A.I.E.E. on April 25 at the Engineering Societies Building.

L. A. MACCOLL spoke on *Non-Linearity in Servomechanism* at the New York A.I.E.E., Basic Science Group, *Servomechanism Symposium,* held April 25 at Pratt Institute in Brooklyn.

E. B. FERRELL delivered the fourth lecture of the *Servomechanism Symposium* sponsored by the A.I.E.E. New York Section, Basic Science Group, on April 4 at Pratt Institute. Mr. Ferrell's lecture was on *Frequency Spectrum Theories Applied to Servomechanisms.*

A. G. JENSEN's topic at the Deal-Holmdel Colloquium on April 5 was *Quality of Television Images.*

R. K. POTTER discussed *Visible Speech* during the broadcast of General Electric's Science Forum over radio station WGY at Schenectady on March 20.

S. D. ROBERTSON and A. P. KING are authors of *The Effect of Rain Upon the Propagation of Waves in* 1 *and* 3 *Centimeter Regions,* a paper appearing in the April *Proceedings of the I.R.E.*

L. P. BARTHELD has been appointed Assistant Plant Manager, reporting to Mr. Willard. Mr. Bartheld will continue with his primary work as Space Assignment Engineer for Murray Hill Project II, on which he reports to M. B. LONG. In his new capacity, Mr. Bartheld will, in addition, attend to general occupancy planning in New York, particularly as it relates to the Murray Hill move.

A. F. LEYDEN was appointed Plant Operation Manager at the Murray Hill Laboratories reporting to S. H. WILLARD, effective April 1.

K. K. DARROW delivered a talk, *Nuclear Energy,* before sections of the A.I.E.E. meeting jointly with other societies, at these places and times: St. Louis, March 18; Kansas City, March 19; Tulsa, March 21; Oklahoma City, March 22; and Wichita, March 25. He repeated it as an "O. M. Stewart Lecture" at the University of Missouri on April 1, and in the meantime attended several meetings of the A.A.A.S. at St. Louis.

CORD DESIGN problems took C. A. WEBBER and H. H. STAEBNER to the Point Breeze plant of the Western Electric Company. Mr. Webber also visited the Plastic Wire and Cable Company at Norwich, Conn., to discuss special cordages.

D. R. BROBST conferred with engineers at the Hawthorne plant of the Western Electric Company regarding enameled wire.

O. C. ELIASON discussed air-conditioning systems with engineers of The Bell Telephone Company of Pennsylvania at Pittsburgh recently.

C. C. TAYLOR and W. C. BABCOCK reviewed highway mobile radio-telephone plans with the New York Telephone Company at Albany.

C. R. ECKBERG, in St. Louis from February 17 to 23, reviewed with the Southwestern Bell Telephone Company engineers problems concerning the proposed installation of an urban mobile radio-telephone system. J. H. Craig, W. G. Schaer, F. J. Skinner and A. C. Thompson, with representatives of the Western Electric Company and of the O & E Department, assisted the associated company during installation of the system.

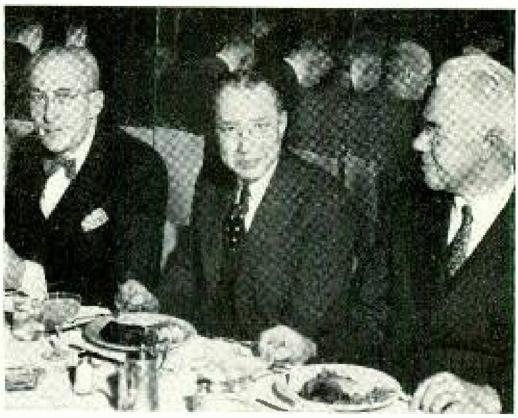
L. Y. Lacy, with representatives of the Western Electric Company, visited the Galvin Manufacturing Corporation in Chicago on February 26 to 27, to discuss mobile radio-telephone equipment for urban and highway services.

R. V. Dean and C. R. Eckberg discussed radio-telephone equipment with RCA engineers in Camden. L. Y. Lacy, accompanied by Western Electric engineers, also visited Camden in connection with this equipment for general mobile radio-telephone service.

B. E. Stevens conferred with Western Electric Company engineers at Haverhill on manufacturing problems of power transformers and voltage regulators.

A. J. Christopher and M. Whitehead visited the Sprague Electric Company in North Adams, Mass., on matters pertaining to electrolytic capacitors. Mr. Whitehead discussed electrolytic capacitors at the Aerovox Corporation, New Bedford, Mass.

B. Dysart and A. R. Kolding at New York and O. D. Grismore and H. E. Powell at Washington supervised a half-hour television demonstration on March 28 from the Harrington Hotel Studio in Washington to the Dumond Broadcasting Station in New York. The broadcast was picked up by radio and shown to a joint meeting of the Institute of Radio Engineers and the Radio Club of America.



At a farewell party for E. V. Mace, the guests included, left to right, G. W. Lees (toastmaster), Mr. Mace and S. H. Willard

Lloyd Espenschied's reminder of Lee de Forest's historic first electronic lecture appears in the Correspondence Section of the February, 1946, *Proceedings of the Institute of Radio Engineers.*

J. Leutritz and D. B. Herrmann are authors of a paper on *The Effect of High Humidity and Fungi on the Insulation Resistance of Plastics*, published in the January, 1946, issue of the *American Society for Testing Materials Bulletin.*

W. B. Ellwood is author of a paper in *The Review of Scientific Instruments* for March, 1946, *A New Magnetomotive Force Gauge and Magnetic Field Indicator.*

R. C. Wakefield, in an article *Communication: Implement to Peace* in the March, 1946, *Electrical Engineering*, refers to the Bell System's experimental radio relay systems. He uses as illustrations photographs of the AN/TRC-6 antenna towers, one of which, the cover design of the issue, is similar to the November, 1945, cover of Bell Laboratories Record.

Life at Murray Hill was satirized to the amusement of the victims and their associates in a skit, "Farewell, Farewell, Dear Mother Bell," presented at a dinner on March 25 at "The Brook" in Summit. Characters shown were: Earl Mace (*right*), *played by C. C. Lawson;* Whoopsi-Cola (*center*), *F. E. Dorlon;* Mother Bell (*left*), *M. Brotherton. Others in the play were:* Joat, *jack of all trades, J. H. Golden, and the chorus,* The Four Ill Winds, *A. F. Leyden, A. J. Akehurst, H. D. Bone, T. A. Durkin. Playwright and director was Henry J. Kostkos. The committee—G. W. Lees, P. V. Brunck, R. E. Sward, A. F. Leyden. The occasion was a farewell to E. V. Mace.*

May Service Anniversaries of Members of the Laboratories

40 years

E. D. Johnson

30 years

W. L. Betts
A. C. Gilmore
R. J. Hopf
Howard Kreft
F. A. Muccio
V. B. Pike
E. C. Wente

25 years

Prescott May
Ida Wiberg

20 years

Martha Bonifield
William Breslin
W. E. Campbell
America Cuervo
T. T. Hagen
E. V. Mace
J. J. Mahoney, Jr.
A. J. McGuiness
E. A. Perpall
J. C. Rylander
T. Slonczewski

15 years

J. E. Grygotis
Olaf Halvorsen
Harold Sagefka

10 years

Louis Bier
Evelyn Brundage
T. H. Chegwidden
Thelma Danielsen
J. R. Glaser
Paul Hannes
Doris Hogben
Helen Kehr
R. T. Monahan
Eleanore Pape
W. G. Sauer
G. W. Schuell
L. J. Scott
D. F. Skelton
B. C. Slack
G. J. Wolters

E. S. Willis is author of *A New Crystal Channel Filter for Broad Band Carrier Systems* in the March, 1946, issue of *Electrical Engineering*.

F. W. Clayden, in the Albany step-by-step central office, observed the field trial of noble metal bank contacts and wipers.

R. V. Terry, O. J. Murphy and A. A. Currie visited General Mills, Inc., at Minneapolis in connection with manufacturing problems on a Navy project.

W. Lemann and F. Hardy studied lubrication problems on a Navy project at the Doelcam Company of West Newton, Mass.

W. A. Bischoff, C. R. McIver and R. G. Koontz attended the meetings on March 12 and 13 of the Western Electric Company Drafting Coördination Committee to discuss drafting design practices between the Western Electric Company and Bell Telephone Laboratories.

E. T. Ball and J. E. Greene, at the Dahlstrom Metal Company at Jamestown, N. Y., discussed No. 5 crossbar frames.

J. G. Ferguson, with other members of the Laboratories at Philadelphia, Pa., discussed traffic studies with engineers of The Bell Telephone Company of Pennsylvania relative to a field trial of the No. 5 crossbar system.

A. H. Lince, in Pittsburgh on March 26, discussed the design of 100-foot towers for the Chicago-Milwaukee radio system with engineers of Blaw-Knox.

During the month of February the United States Patent Office issued patents on applications previously filed by the following members of the Laboratories:

T. L. Dowey
P. G. Edwards
W. C. Ellis
R. H. Gumley
H. Hansen
W. F. Kannenberg
F. B. Llewellyn
R. F. Mallina (3)
W. P. Mason
J. C. McCoy
D. Mitchell
E. R. Morton
J. R. Pierce
R. K. Potter
N. Y. Priessman (2)
A. M. Skellett
W. C. Slauson
A. G. Souden
H. M. Stoller (5)

Looking east from one of the towers on the present building at Murray Hill toward the excavation for the addition, where concrete foundations are being poured