Bell Laboratories Record

Ship-to-Shore Radio Receiver for use on the S.S. Leviathan

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Vice-President Gherardi Addresses the Laboratories' Supervisory Staff

ON November 8th, Bancroft Gherardi, Vice President of the American Telephone and Telegraph Company and in charge of the Department of Operation and Engineering, in an inspiring address to the supervisory staff of the Laboratories, discussed the present position of the Bell System and its immediate prospects for even greater growth and a wider field of usefulness. The growth of the business during the past few years and the estimated trend for the next half decade — both as indicated by number of stations, growth of plant, or dollars of revenue, and as expressed in calling rates or variety of service — were brought out in detailed discussion and exhibited graphically by slides. The growth for the past five years has been very large but that predicted for the next like period is expected to far surpass all previous experience.

As a fitting preface to such a survey, Mr. Gherardi quoted from the annual report to the stockholders of the American Telephone and Telegraph Company for 1927, in which President Gifford had said: "The American Telephone and Telegraph Company accepts its responsibility for a nation-wide telephone service as a public trust. Its duty is to provide the American people with adequate, dependable, and satisfactory telephone service at a reasonable cost." In its effort to provide adequate facilities, the Bell System is making gross additions to plant at the rate of approximately $500,000,000 a year. In the actual building of adequate plant the Laboratories plays no direct part but in making the service more dependable and more satisfactory, and in rendering it at a lower cost, a great deal depends on the activities of these Laboratories. The fact that every working day some two million dollars worth of plant is built emphasizes the importance of getting the improvements resulting from these activities completed and into the plant as rapidly as possible.

Figures indicating the phenomenal growth of the Bell System may be taken from almost any branch of the service; they are startlingly large. The net gain in number of stations has recently averaged well over 700,000 per year, and substantially greater gains are looked for during the five year period, so that by 1933 there will be — according to estimates — some eighteen and one-half million Bell stations in service as against about fourteen million at the end of 1928. Large upward trends also exist for the net additions to plant; — 1929 will represent an increase of nearly 40% over 1928, and still larger programs are foreseen over the next five year period. During this period it is expected that growth in toll business, for example, will be equal to the entire business handled up to the year 1925. In other words, the growth for the next five years will be as much as for the first forty-eight years of the System's existence. Greatest of all are the increases in the Long Lines Department. Based on circuit miles, the growth from 1923 to 1928 was over 100% and from 1928 to 1933 is expected to be 250%. These almost unbelievable figures are proof, if any were needed, that the telephone has become an essential part of our modern life; that the immense value of a unified communication system to the social, business, and political life of the country is ever increasingly recognized.

That telephone service may be both dependable and satisfactory, it is not alone sufficient that the plant be adequate, but particular attention must be given to every phase of the service rendered. In considering service it is essential to think of it from the standpoint of all departments, and not simply in its narrower sense relating to the completion of telephone connections. Also the type of service taken by our subscribers should be consistent with the overall problem. For example, the highest grade of service is not compatible with too many multiparty lines, and the best efforts of the Bell System will fall short of the desired objectives if our subscribers are not induced to take the highest grade of service consistent with their requirements.

In connection with the general matter of telephone service, Mr. Gherardi presented a picture of the possibilities of still further improvements ahead. In this connection, he reviewed the progress already made in the operations of the Plant, Traffic, Commercial, and other departments and discussed many of the interesting problems on which these departments are working at the present time with a view to still further advancements.

Among the factors tending toward improvement in service under the increasingly complicated operating conditions, Mr. Gherardi discussed the gradual substitution of the dial for manual operation. While this service naturally grew slowly at first, it is now increasing at a rapid rate, and by 1934 it is expected that more than one-half of the stations in the Bell System will be operated on a dial basis. He also referred to the interesting possibilities for improvement in service by the work going on in connection with private branch exchange operation, which has such a direct bearing on the whole telephone service problem. Reference was made to the important part which the Laboratories will be called upon to play in connection with these and the many other improvements which were referred to.

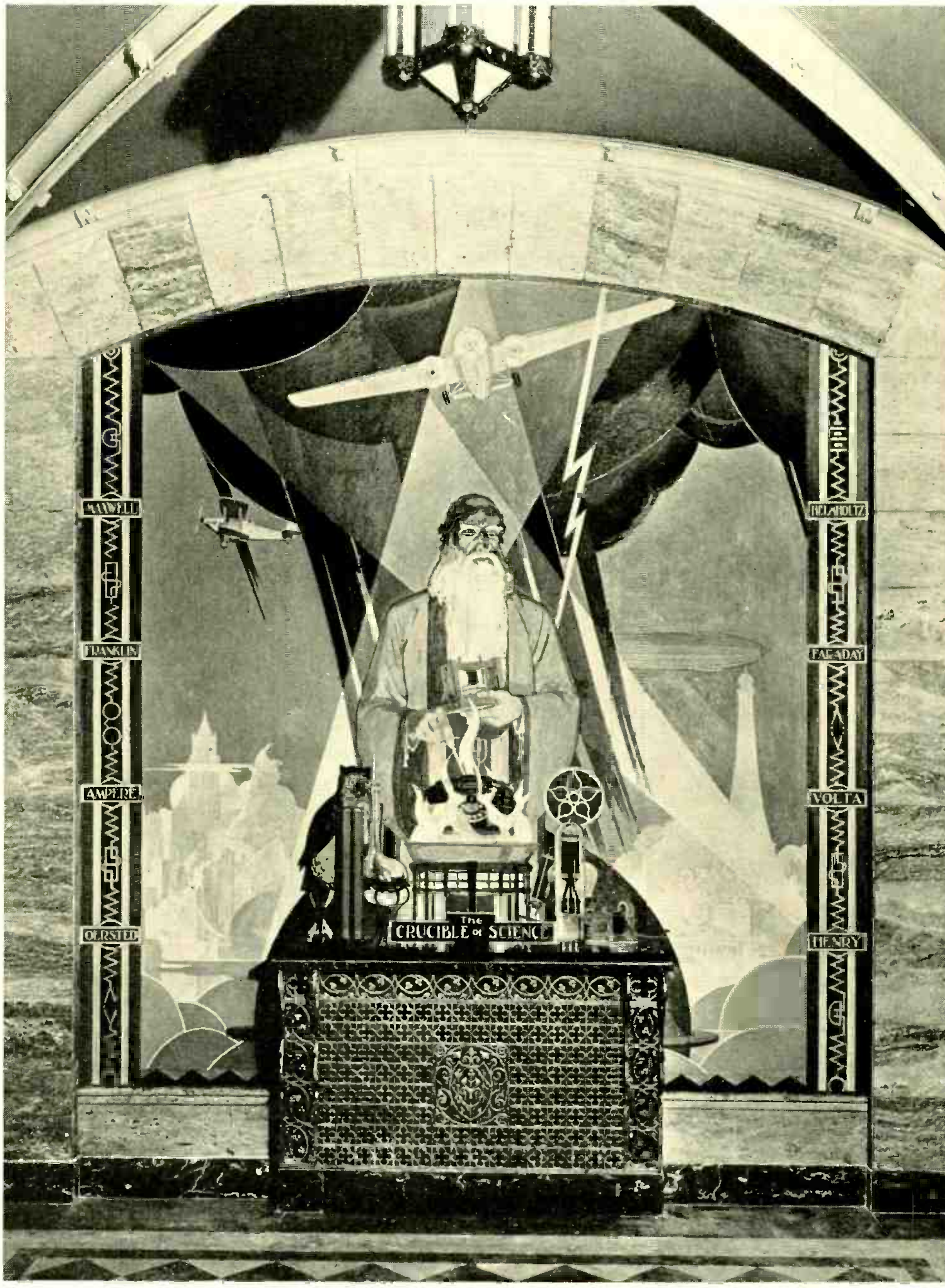
Among other interesting prospects for improved service brought out by Mr. Gherardi was the use of by-product facilities. Some are already in use but many more are visioned for the future. There is, of course, the leased-wire service that has been common for many years. In addition, there is the telephone-typewriter service, and the "time" service which had been given up as a war measure but has recently been resumed in many locations with considerable success. These are but a few of the many possibilities of by-product service; others are still in the experimental stage, and undoubtedly still others lie in the future, awaiting only a general recognition of the need and the most fitting methods of providing for them.

An essential part of rendering satisfactory service is that it shall please our customers. Every contact should leave in the subscriber's mind the impression, not only of adequacy and efficiency of the service, but that behind every effort is the desire of the telephone company to please him. The extent of the Bell System should be evident in the breadth and scope of the facilities it offers, but in the contacts with subscribers there should be a personal note of individual interest and of ever increasing readiness to serve. The importance of the will to please cannot be overestimated; the best interests of both the Bell System and the subscriber lie in the recognition of mutual interest.

Communication Progress Symbolized

A striking feature in the entrance lobbies of the new Telephone Building in Denver is the series of mural paintings symbolizing the progress of communication. Two Indians send signals with a blanket and a smoky fire; a pony-express rider swings into his saddle; a line crew is at work in the Rockies; while a cable gang guides a cable into a manhole. "The Crucible of Science," reproduced on the opposite page, is of particular interest to us for its symbolization of our work and because these Laboratories were a source of the artist's inspiration. Allen True, who painted all the murals, was our guest for a day while he was planning his work. Readers of BELL LABORATORIES RECORD *will recognize the border of the picture as similar to that of the panel on the front cover of the* RECORD*—a series of circuit symbols. Holding a replica of Bell's first telephone—a familiar object in our Historical Museum—the alchemist produces with his wand a dial hand-set from his flaming crucible. The owl, the hourglass and the retort—symbols of the past—are balanced by the microscope, the vacuum tube and the loudspeaker. At the top of his composition, Mr. True shows a Ford monoplane—presage, no doubt, of the recent purchase by the Laboratories.*

The border design of telephone symbols has itself an interesting bit of history. When BELL LABORATORIES RECORD *was being planned, an artist noted for pen-and-ink technique was sought for the cover design. Found in the person of Thomas M. Cleland, he was invited to visit the Laboratories that he might absorb some of the atmosphere of our organization. It was stipulated that the design need not contain any direct reference to the character of our business, but that it would be highly desirable to include unobtrusive features which could be recognized as peculiar to our work in the development of communication apparatus. One suggestion was the use of symbols of circuit emblems, and a border of this sort was designed for the central panel.*


MAXWELL
FRANKLIN
AMPERE
OERSTED
HELMHOLTZ
FARADAY
VOLTA
HENRY
The CRUCIBLE of SCIENCE

Taking Chances in Inspection-by-Sampling

By H. F. DODGE
Inspection Engineering

APPARATUS and equipment entering the Bell System plant has its quality safeguarded by inspection at every step of production and at the completion of production as well. The major role of inspection is that of a detective whose business is to detect the existence of irregularities that affect quality, to follow up clues given by inspection data or other information that will lead to the discovery of either human or mechanical causes of trouble, and—in cooperation with proper authorities — to remove them. Inspection conducted in the regular course of production is, however, not supposed to be carried on in a stand-offish way, waiting for serious troubles to occur before taking action with a club, but instead to detect trends in undesirable or costly directions before they go too far, and to whisper friendly counsel in the ears of those who may subsequently be held to task if the erring tendencies are unchecked.

Neglecting possible errors in inspection itself, one hundred per cent conformance with certain requirements may be insured by one hundred per cent inspection. Every loading coil manufactured, for example, can be measured on a test set and if necessary adjusted to give an inductance value within prescribed limits. The satisfactoriness of product in respect to some requirements, on the other hand, can only be determined by taking a sample. Thus the tensile strength of a shipment of nickel-silver sheet, used in making relay springs, can be estimated only by taking a number of sample strips and testing them. As quality is a variable, these samples will exhibit differences among themselves, and it can only be hoped that by taking a large enough number of samples the group of measurements may be assumed to represent faithfully the quality of the entire shipment. Or again, heat coils can be measured for their "time of blowing" only by destroying a sample. In such cases, where inspection itself is destructive, complete inspection is obviously out of the question.

When inspection is not destructive, the product may be inspected either completely or by sampling. There are many places in the intermediate stages of production where sampling is resorted to as a matter of economy, providing it is consistent with the requirements for final quality. It is seldom economical to produce material which conforms one hundred per cent with all requirements. In many of the internal stages it may cost less, all things considered, to turn out material in which a large majority of the pieces fall within the engineering requirements, and then to depend on inspection or subsequent assembly steps to weed out the few slightly defective ones. How much defective material can economically be passed along, depends on the relative costs of weeding out defects by two different methods; by inspection on the one hand and during subsequent assembly or installation processes on the other. If the average percentage of defectives turned out in one of the earlier stages of production is held quite low, the segregation of the defective pieces can often be done most economically by the operatives in the subsequent processing stage, and the intermediate inspection can be conducted on a sampling basis to eliminate any lots of distinctly subnormal quality.

When only a sample is taken, the true quality cannot be discovered. Sampling inspection involves taking chances, for according to the laws of chance a sample will occasionally err seriously and make a bad batch of product appear quite satisfactory. Chance plays no favorites of course and will just as readily make good product appear bad. For a lot of a particular degree of badness and for a given size of sample, the two sectors of Figure 1 represent the relative chances of getting a correct or incorrect indication. A single random sample may indicate the lot to be either good or bad but the result is as much a matter of chance as is the place where the pointer of the diagram would stop after it had been spun. Under these circumstances it is important to recognize that chances must be taken, and it remains only to regulate and control them by agreeing at the start what order of magnitude of risk may economically be taken. In so doing, it is recognized that probability theory has a definite place in the scheme of things. With its aid, one can choose a size of sample and establish just what shall be considered an indication of good quality, so that the desired proportion between the shaded and unshaded sectors of the diagram may be obtained.

One of the purposes of certain routine inspections is to determine whether individual lots submitted for inspection should be accepted on the basis of the findings in a sample. Suppose that relays are submitted to an inspector in lots of 2,000. Suppose, in addition, that he extracts a random sample of 100 relays from one of these lots, examines the individual relays for some important feature, and finds two defective. What should he do,—pass the whole lot, examine it further, or send it back to the production group for reconditioning? To be sure he is really interested in knowing the percentage defective in the entire lot of 2,000 but this is denied him unless he makes a complete inspection. Although his sample has indicated a 2% defective condition, it does not indicate the quality of the entire lot with a very high accuracy. The lot itself may be only 1% defective or it may be 10% defective, for it is entirely possible to find two defects in a sample of 100 in either case.

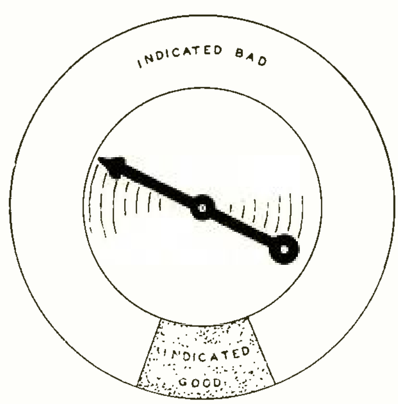


Fig. 1—Sampling inspection spins the pointer and depends on chance to give a correct indication

To illustrate, it may help to invert the problem and to discover what the indications may be in samples drawn from a lot which is definitely known to contain 1% of defective relays. If a number of independent random samples of 100 relays each were to be taken from this

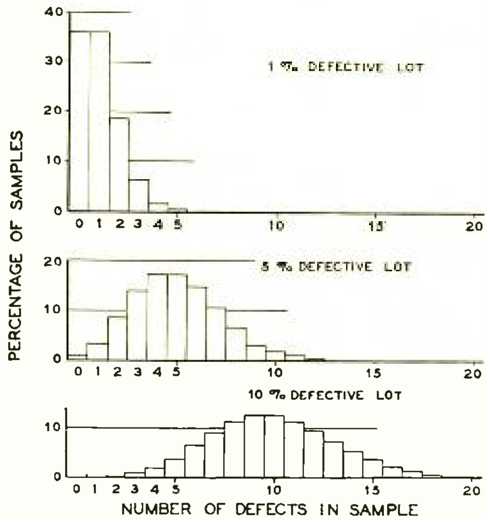


Fig. 2—Distribution of number of defects expected in random samples of 100 *pieces drawn from lots of different quality*

lot, theory shows that one might expect to find no defects whatever in 37% of them, exactly one defect in another 37% of them, two defects in 18% of them, and so on as shown in the upper diagram of Figure 2. In like manner, the middle and bottom diagrams show the expected percentage of samples of 100 relays each that would show various percentages of defects if drawn from a 5% and from a 10% defective lot respectively.

Now what is the chance of accepting lots of these various degrees of defectiveness that are submitted? Suppose the instructions were to accept any lot if the sample drawn from it contained two or less defects. The diagrams of Figure 2 indicate that in a sampling experiment an inspector would expect to find two or less defects in 92% of the samples from a lot containing 1% of defective pieces, in 12% of the samples from a lot containing 5% of defective pieces, and in 0.3% of the samples from a lot containing 10% of defective pieces. Expressed in another way, the chances of accepting any 1% defective lot submitted to him are 92 in 100. In like manner, the chances of accepting a 5% defective lot are about one in eight, and the chances of accepting a lot 10% defective are only three in a thousand. This is illustrated in Figure 3 for a submitted lot having 5% of defective pieces. Here the sizes of the sectors correspond exactly to the heights of the rectangles in the middle diagram of Figure 2, and represent the probability of finding various numbers of defects in a sample of 100 pieces.

This is a use of probability theory which is employed quite widely in setting up sampling schemes to determine the acceptability of product. It provides a basis whereby the planning organization may select criteria of acceptance so as to fix the chances of accepting submitted product of any

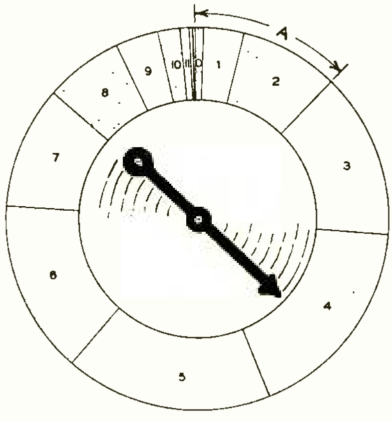


Fig. 3*—Sector "A" represents a* 1*-in-*8 *chance of accepting a* 5% *defective lot* designated quality. A further extension of the use of probabilities makes it possible to establish an inspection routine which involves a minimum of inspection cost for a risk of acceptable magnitude.

Although a considerable amount of inspection work involves comparing magnitudes with some engineering requirement and making records of the percentage of failures to meet that requirement, there are many places where the actual measurements of such characteristics as resistance, inductance, and tensile strength, are recorded and analyzed. A set of such measurements shows not only what the general level of quality is but also indicates the degree of variability from piece to piece about the average quality.

Suppose, for example, a lot of several thousand bolts supplied for use in the construction of telephone lines are disposed as shown in the left-hand diagram of Figure 4 (a so-called "Normal Law" distribution), such that 99% of them fall within the range from 18,000 to 26,000 pounds breaking strength. If the inspector tests samples of four, the average of the four observations may be expected to lie anywhere between 20,000 and 24,000 pounds, only one half ($1/\sqrt{4}$) of the original range which includes 99% of the bolts themselves. One time in a hundred a sample might be below 20,000 pounds or above 24,000 pounds and thus give an indication quite wide of the mark. For samples of 100, a much smaller variability in averages could be expected. Ninety nine times in 100 the averages would fall within the band from 21,600 to 22,400 pounds. This is one-tenth

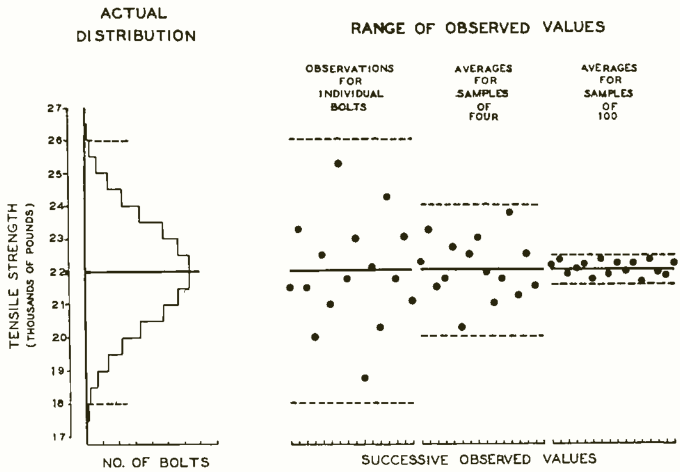


Fig. 4—The size of the sample affects the variability in the results observed

($1/\sqrt{100}$) of the variability for the individual bolts.

In practical inspection work the true quality of the lot is not known, and the inspector, on the evidence of his inspection, must pass or reject each lot as it comes to him. His criterion of acceptance must make due allowances for the fact that the results of sampling may differ widely from the true value and it must be so chosen that the chances of failing to detect unsatisfactory material will be reasonably small. When quality varies erratically, this very uncertainty indicates the need for precaution in routine inspections,—often provided by setting up a barrier in the path of defective material which will not break down more than one time in ten. On the other hand, when variations in the quality of product are well controlled, it is permissible to take greater chances.

A New Emergency Power Supply Unit

By V. T. CALLAHAN
Equipment Development

RESERVE power supply units for telephone and telegraph power plants have been standardized to secure uniformity in design, and even though there are large differences in load in the various plants, four types of reserve units using six sizes of engines have been found adequate. Some form of internal combustion engine is used as the prime mover in all of the standard plants. In the smaller plants these engines drive directly the battery-charging generators; for the larger offices it has been found more satisfactory, however, to have the engine drive an alternator which supplies current to drive motor-generator sets, or other converting apparatus. The three smaller types of engines have already been described in the RECORD* and the series has now been completed by large units using Buffalo type ATT vertical engines.

Although reliability is always the principal consideration, different factors have greater or less influence on the design depending on the size of the plant. With the newly developed engine which drives an alternator rated at 150 kilovolt-amperes, efficiency is of much more importance than it has been with the smaller sets.

The fuel used is, of course, an important matter. Formerly the engines used in the larger offices ran on illuminating gas, either natural or artificial; in some cases the units were designed for either gas or gasoline. Because of the different qualities of the illuminating gases used in different parts of the country, it was economically impossible to design engines which would be equally efficient in all locations. In designing the new reserve plant, therefore, it was decided to arrange it, as in the case of the types R and BA engines, for the use of gasoline exclusively. Final tests may then be made before shipment

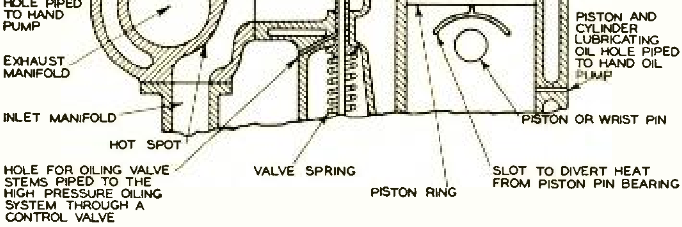


Fig. 1—A cross-section of the head and part of the cylinder of the new ATT engine reveals many of the improvements incorporated

* BELL LABORATORIES RECORD, *p.* 318, *June,* 1928; *and p.* 21, *September,* 1928.

with assurance that the results can be duplicated since the quality of gasoline throughout the country is fairly uniform.

The ATT engine has an L head of a modified Ricardo type which maintains the turbulence of the gas, set up as it enters the inlet valve, until ignition takes place. This is important because the rate of combustion depends on the turbulence. Rapid combustion is aided also by locating the spark plugs near the center of the firing chambers which gives the shortest possible distance of flame travel. With a stagnant mixture at the time of ignition the flame propagation would be slow and a large part of the mixture would not be burned by the time the exhaust valve opened. This would result in the formation of carbon, burning of the exhaust valves, and a decreased efficiency.

With the larger engines, vibration also required more attention. To reduce it to a minimum a large and accurately balanced fly-wheel of the disk type is used, and its large mass smooths out the effect of the torque impulses. To reduce further the vibration, by decreasing the weight of the reciprocating parts, aluminum alloy pistons are used. An oversize cam shaft is employed to permit the use of heavier valve springs, thereby reducing the possibility of spring breakage, and it was found that this, too, contributed considerably to quiet operation. It was found that mounting the entire sub-base on the floor on springs as done with some of the smaller sets was not satisfactory with the larger weight of the ATT engine. To make sure, however, that any vibration that may exist will not be transmitted to the building, the concrete foundation is separated from the building floor by cork slabs.

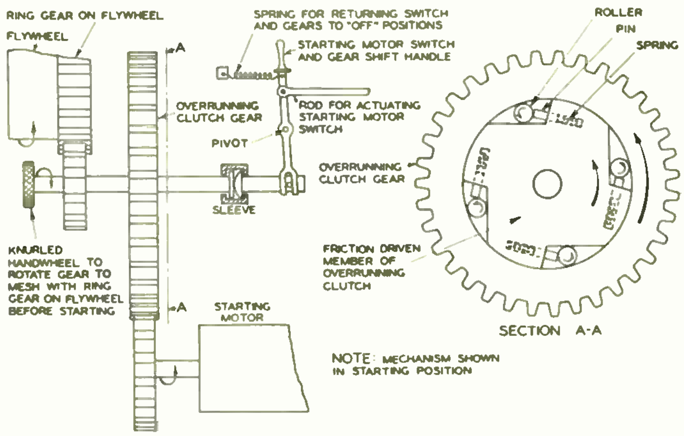


Fig. 2—An over-running starting mechanism makes for certain operation and freedom from trouble

Aluminum alloy pistons offer decided advantages over cast iron pistons due to their lightness and higher thermal conductivity. Reduction in the weight of reciprocating parts of internal combustion engines, consistent with safe operating conditions, is desirable because of the consequent reduction of the unit pressure on the bearings at normal operating speeds. In addition the high thermal conductivity of aluminum alloy pistons insures that the heat in the piston head will be quickly conducted to the cylinder walls and dissipated, thereby preventing difficulties due to preignition. To prevent scuffing or scoring of these pistons, the oiling system is arranged for lubrication of the pistons and cylinder walls before starting, as indicated in Figure 1, and the gasoline system was changed so that a small amount of gasoline may be injected into the intake manifold just before turning the engine over. These two changes insure that the pistons are properly lubricated and that excessive

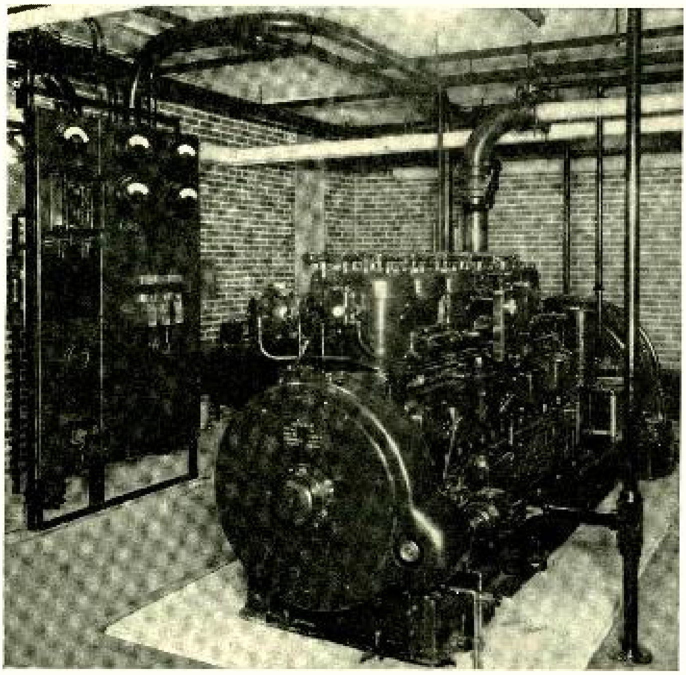


Fig. 3—The knurled knob for engaging the driving pinion with the ring-gear on the fly-wheel is shown to the right of the fly-wheel. The exciter and alternator panels are on the left

gasoline will not wash the lubricant from the cylinder walls before the engine starts.

The starting motor is similar to those used with the intermediate size engines described in a previous number of the RECORD, but instead of using a Bendix drive which automatically engages a pinion with the ring-gear on the fly-wheel at starting, an over-running clutch mechanism, shown in Figure 2, is provided. Provision is made for manually engaging the gears before starting so that jamming, which occasionally occurs with Bendix drives on larger engines, will not occur. The starting motor switch handle when pulled part way to the right meshes the gears as shown and when pulled further to the right, closes the circuit to the starting motor, turning the engine over.

The clutch-gear forms the outer part of the starting clutch and inside of it is the friction-driven member with four slots containing rollers as shown in section AA, of Figure 2. The friction-driven member is on a shaft carrying a pinion that meshes with the ring-gear on the fly-wheel. The clutch-gear is driven directly by a pinion on the starting motor. This gear at starting rotates as indicated by the arrows and drives the friction member through the rollers. As the engine fires, turning over under its own power, the friction member moves ahead relative to the clutch-gear and the rollers disengage. This releases the clutch and no excessive strains can be imposed on the starting-motor gears or shafting.

As soon as the operator releases his hold on the starting lever, a spring, provided for the purpose, disengages the starting gears and through a connecting rod opens the starting switch. It is impossible, therefore, to make a wrong move during starting that could cause trouble. Provision is also made for barring the engine over by hand for inspection and adjustment purposes.

The control equipment for the engine is mounted on it but the alternator and exciter panels are mounted separately as shown in Figure 3. Here the voltage regulator and suitable meters and switches are conveniently arranged.

Duplicate high tension magnetos are provided, and an overspeed trip device grounds the ignition to stop the engine in case of excessive speed. The main gasoline supply is in a tank buried beneath the floor or in some other safe location and a fuel pump, mounted on and driven by the engine, lifts the fuel to a small auxiliary reservoir on the engine. A centrifugal governor maintains a speed regulation of five per cent from no load to full load. City water is used for cooling.

With the development of this ATT engine a range of power plants is completed for all sizes of central offices. Safety and reliability have been the keynote in the design of all of them to insure that at no time will telephone service be curtailed because of lack of power.

Income and Expense Record

Booklets for personal income and expense record will again be distributed in all departments this year. Members of the Laboratories who signed the blank in last year's booklet will receive the 1930 *edition through the company mail some time during December. Those who have not signed these blanks and wish to receive the books should notify their immediate supervisors or call Employee Service. As the result of suggestions offered by past users, numerous improvements have been incorporated in the coming issue*

Lacquering and Plating in the Laboratories

By W. G. KNOX
Assistant Plant Superintendent

THE importance of the finish of metals in the telephone plant is apparent from the extent to which it is found. Affecting both appearance and function, finish of one or another sort is almost universally applied to metal telephone apparatus. Materials for finishing purposes are investigated, sometimes developed, and specified to the Western Electric Company, by these Laboratories.

To meet the needs of the Laboratories for finishes which would be the equal of those produced by the Manufacturing Department at Hawthorne, and for a means of applying special metal coatings to models of new telephone apparatus and equipment constructed in the Shop from engineering sketches, the Laboratories' metal-finishing facilities were reconstructed in 1919. The room and the equipment constituted what was at that time a model layout for plating, with the recognized cleaning, plating and drying features generally used by industrial firms and with added refinements in structural details and in the excellent quality of the equipment.

Plans for the room were developed by engineers of the Plant Department. Walls were lined to the height of six feet with acid-resisting tile and floors were covered with acid-proof brick, on top of concrete; the whole was made water-tight with an asphaltic filling. Suitable drains were built in

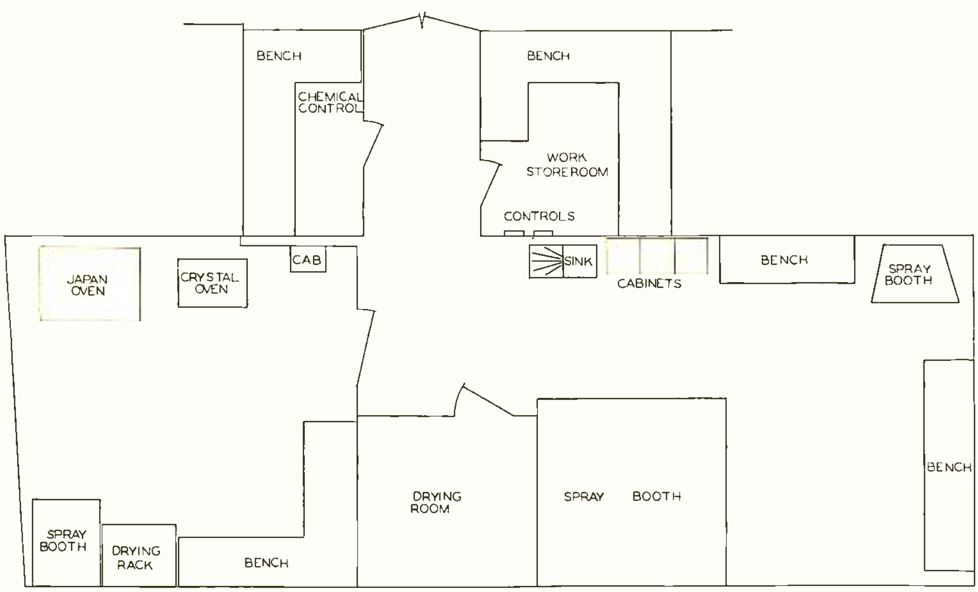


Fig. 1—The lacquer and japan finishing rooms are located in section 3-E

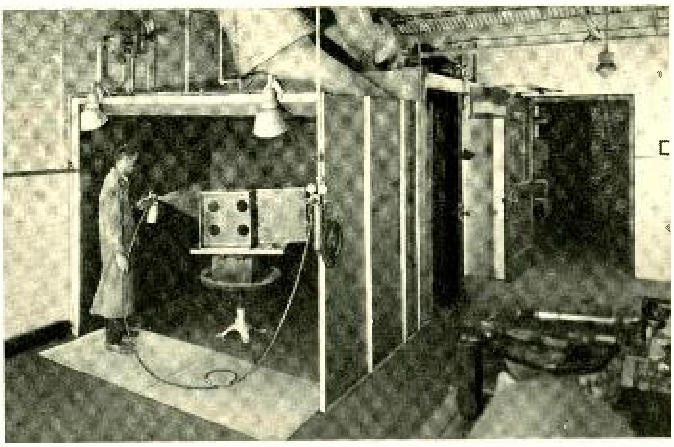


Fig. 2—Mounted on a turntable in the large power-ventilated spray booth, big apparatus is sprayed by Thomas Cassidy. The apparatus is later dried in the oven directly behind the booth

at several points. That the job was thorough is attested by the fact that after ten years the floor and walls are still in excellent condition.

The plating solutions heretofore most largely used in finishing telephone apparatus were copper, nickel and zinc; these three metals were applied to more than ninety-nine per cent of all parts receiving a metal finish. A limited demand for baking japan and lacquer finishes was taken care of by the installation of a small spraying unit and a baking oven in one end of the plating room.

For the past several years, however, it has been recognized that the available facilities were inadequate for carrying on some of the various types of work which were constantly being requested by the engineers. There was also a demand for a somewhat more careful control of finishes, particularly of their weight and character, since in many cases close tolerances limited the amount of metal that should be applied. Furthermore it was desired to have the same facilities and technique available at West Street as at Hawthorne for producing standard finishes.

The general rapid growth of the Laboratories made apparent the necessity of providing facilities for future as well as for present requirements, and plans were drawn up to this end. Space limitations prevented a full realization of the contemplated enlargements, but the new departments, which have re-

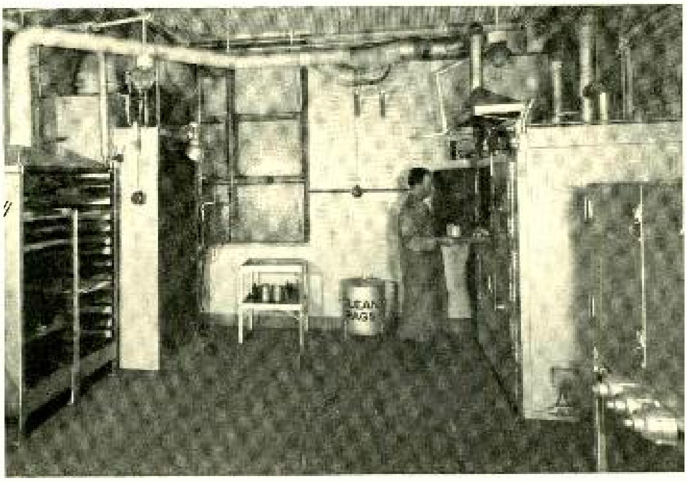


Fig. 3—The japan room. Left to right: drying rack, small spray booth, baking oven (into which Charles Stone is placing equipment he has just sprayed), and crystalizing oven. Exhaust systems are coupled to all these units

cently been completed, are expected to take care of the requirements for some time to come. The new Finishing Department is divided into two main sections; one is used for the application of japans, lacquers, paints, varnishes and enamels, and the other for metal plating, facilitating a considerably increased diversity and refinement of finishing.

The japan and lacquer section is located on the third floor, in section "E," and is divided into two large rooms with a fire wall between them. Of two more small adjoining rooms, one is used to take care of all incoming work and finished outgoing work, and the other for a laboratory where chemical control analyses are made.

In one of the large rooms, used for the application and baking of japan and varnish coatings, there is a three-by-three-by-seven foot DeVilbiss spray booth, with a direct exhaust system removing spray fumes at the rate of about 1000 cubic feet per minute. Next to this booth is a steam-heated drying oven which is used for semi-drying the freshly applied films. There are also two electrically heated ovens for baking japan and crystalline varnish or lacquer films. The three ovens are connected with a small central blower which removes the fumes from these units at a gentle rate, thus preventing the accumulation of excessive amounts of volatile solvents. Metal containers with self-closing doors are used for storing cans of paint and lacquer materials; safety cans contain solvent thinners and cleaning solutions. Ample bench space assists the operator to handle all incoming apparatus.

In the adjoining room, somewhat larger in size and used mainly for lacquer spraying, there are two spray booths, eight-by-seven-by-seven and three-by-three-by-two feet. The larger is equipped with an indirect exhaust system of the latest type: an outlet flue, free of fans and motor shafts, removing about 5000 cubic feet of air per minute. This booth meets a long-felt need by enabling the operator to spray very large apparatus and frame-

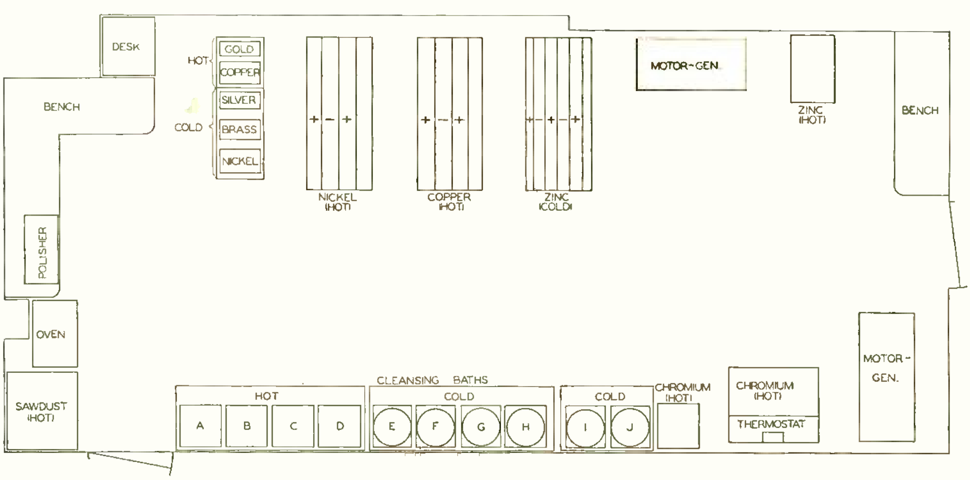


Fig. 4—The plating room is located in section 3-B. The cleansing baths are: A—clean water; B—soap solution; C—preliminary wash water; D—alkaline electrolytic cleaner; E—bright acid dip; F and G—hydrochloric acid pickels for (F) steels and (G) brasses; I—cyanide dip; H and J—clean running water

work parts without the danger of lacquer spray blowing around in the room. The smaller booth copies the Western Electric Company's design for repair shops, with a series of built-in baffles to remove solids and pigments from the excess lacquer spray before it passes into the outer air.

A particularly excellent feature of the Lacquer Department is a built-in concrete drying room (eight-by-ten-by-seven feet) with steam heat controlled by a motor valve. Thermostatic control actuates the motor valve and permits very careful regulation of the temperature. Like the baking ovens of the japan section, this oven has a blower for removing volatile fumes.

For protection against fire or explosion, lights and light switches are provided with vapor-proof covers, and power switches and relays for the ovens are installed in an outer room.

The plating room has been greatly altered and, like the japan and lacquer rooms, is considered a model of its type. The equipment includes apparatus and machinery for preparing and plating the surfaces of articles in a variety of ways.

Since the best plate can be secured only upon surfaces that are chemically clean and free from rust or tarnish, every effort has been taken to provide the necessary tanks and materials for cleaning metal surfaces. Acid, alkali and steam fumes are removed through a new type of exhaust system designed and built by engineers of the Plant Department. It is constructed of a special alloy to prevent corrosion, and draws all fumes away from the operator so as to free him to work over the tanks without discomfort.

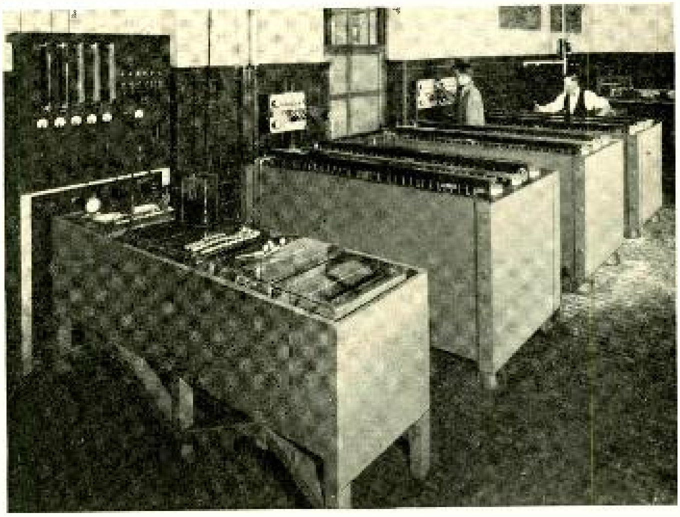


Fig. 5—In the plating room, of which C. E. Wenzel (right) is foreman, current for the large plating baths is controlled from individual switchboards, at one of which is A. B. Celner. Current for the smaller baths is controlled at the switchboard in the foreground

Replacing the old plating solutions which have been modified or discarded for newer types, the Department now has available a selection which includes almost every metal that is in commercial use today. The solutions available are: nickel for ferrous and non-ferrous metals; zinc (acid and cyanide); copper (acid and cyanide); chromium; silver; tin; gold; cadmium; brass. Steam heat has been installed for heating those solutions which practice has shown to operate better when warm.

The electric equipment consists of two motor-generator sets, each designed to give six or twelve volts.

One generator is rated at 500 amperes capacity and the other at 2000 amperes capacity. The latter is used exclusively for chromium plating.

To keep the cleaning and plating solutions in good working condition, frequent chemical tests are made. In the case of the gold plating solution, for instance, which involves a high investment, tests for free sodium cyanide and for gold are made almost daily. This frequent testing is necessitated by the great quantity of work which is plated in a bath of such small proportions: sometimes as many as a thousand parts are plated weekly.

Chromium plating requires especial attention,—the temperature of the solution and the "current density" used for depositing the metal must be carefully controlled. Special "racking" of parts also aids in securing a good chromium deposit. For removing the fumes generated during chromium plating operations considerable care has been used in designing an exhaust hood which will be effective yet in no way interfere with the operator's access to the tank.

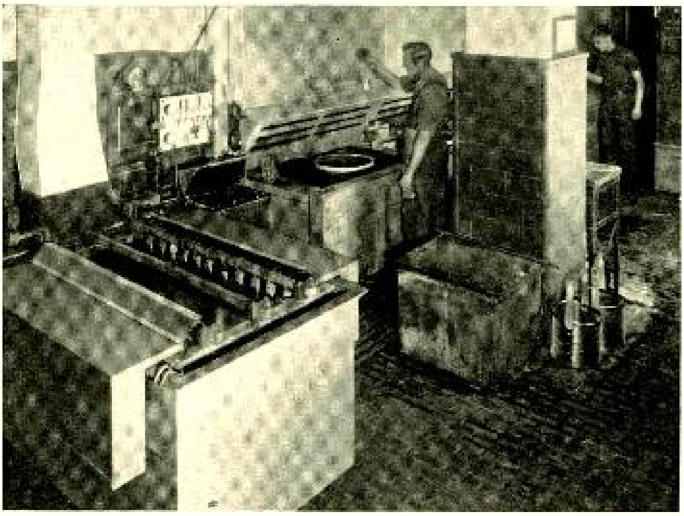


Fig. 6—The large and small chromium baths are supplied with current from a special motor-generator out of the picture to the left. At the cleansing baths are W. Frees (left) and P. Ferrarotto

The magnitude and variety of work constantly passing through the new Finishing Department is great: practically every unit is in constant use, and during many weekly periods about 20,000 parts are given a finish of one kind or another. In many cases the parts to be finished require two or three separate metal coatings and in other cases five or six coats of japan or lacquer.

The Finishing Department cooperates with engineers of the Laboratories in applying finishes to parts used in the assembly of special apparatus and of finishes which are employed for comparative test purposes. Every care is used in applying special finishes in accordance with the wishes of the engineer or with standard practice. In producing many finishes, the data gathered from the work carried on by the Finishing Department has been useful as a basis for formulating specifications issued to the Manufacturing Department or the Repair Shops of the Western Electric Company.

Impedance Bridges

By S. J. ZAMMATARO
General Apparatus Development

When Sir Charles Wheatstone in 1843 devised the bridge method for comparing resistances, he paved the way for the elaborate bridge family of today. The early bridges were used only for measuring resistances but it was natural that investigators should employ the same principle to measure inductance and capacitance when the use of variable currents in electric circuits made these properties significant. Because resistance, inductance, and capacitance may be combined in various ways to form bridge networks, a large variety of circuits have been proposed for the measurement of impedance but only a few have proved worthy of careful refinement for precise measurements.

The earliest and commonest impedance bridge is the direct comparison bridge which, like the simple Wheatstone balance, compares the unknown against a standard of the same kind. The network is a pair of resistance arms—of unity ratio for the highest accuracies—and adjustable standards of resistance and, depending on whether the unknown is inductive or capacitive, standards of inductance or capacitance. Since inductive impedances are generally defined in terms of the equivalent series components, the standards of resistance and inductance are arranged in series as shown in the simple network, Figure 1-A. Shunt components, on the other hand, are more desirable in the case of capacitive impedances and to measure them the standards of resistance and capacitance are arranged in parallel as shown in Figure 1-B. In this case the unknown is shunted by a fixed resistance to reduce the usually high resistive component of the unknown to a value within the range of the resistance standard.

Although the comparison bridge has the advantage of determining the unknown directly in terms of a like quantity, it is handicapped for the same reason, when measuring very large impedances since the standards would have to be equally large. This is particularly undesirable in the measurement of large inductances as the

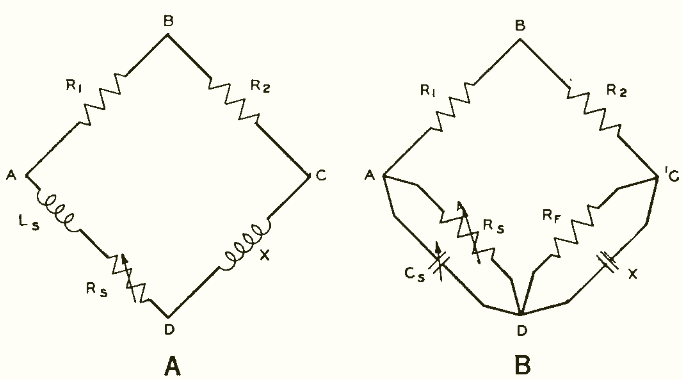


Fig. 1—With the comparison type of bridge the unknown impedance in one arm is balanced against a standard of similar nature in the other

required standards would be prohibitively unwieldy and expensive to maintain in constant calibration.

To avoid this, large inductances are usually measured in terms of capacitance standards by means of the resonance bridge. This method combines the Wheatstone principle with the principle of resonance. The bridge network, shown schematically in Figure 2-A, consists of a pair of equal ratio arms, an adjustable resistance standard in the standard arm and, in the opposite arm, an adjustable capacitance standard in series with the unknown inductance. The bridge is balanced by adjusting the standard condenser and resistance until the reactance of the condenser nullifies that of the inductance, leaving only a resistance in the unknown arm to be balanced by the standard resistance. The value of the unknown inductance is computed from the standard capacitance setting and the frequency at which the balance is made by the familiar resonance formula, $\omega^2LC=1$. It is evident from this relationship that very large inductances can be measured with correspondingly small condensers, the only limitation to the maximum inductance being the degree of precision with which the smallest standard capacitance is known.

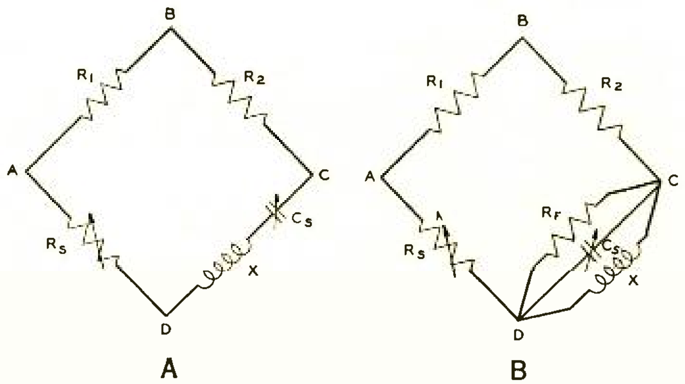


Fig. 2—With the resonance bridge the unknown inductance is resonated by an adjustable condenser in the arm with it, and the unknown resistance is balanced by a standard resistance in the opposite arm

As the standard condenser and the unknown inductance are arranged in series, this method is further qualified as the series resonance method. When the ratio of the inductance to the resistance of the unknown impedance is small, however, it is preferable to arrange the standard condenser and the unknown impedance in parallel, as in Figure 2-B. Then the method is known as the parallel resonance method. As with the comparison capacitance bridge, a resistance is shunted across the unknown to reduce the resistive component to a measurable value.

Due to the fact that condenser standards are very stable and can be calibrated with greater precision than inductance standards at the higher frequencies the resonance bridge has

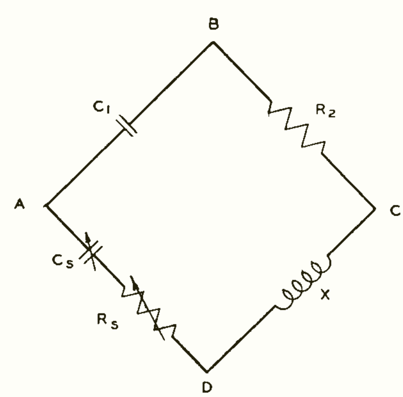


Fig. 3—The Owen bridge has a skewed balance: a capacitance measures resistance, and a resistance measures inductance

almost entirely displaced the comparison bridge for high precision work above the audio range even though it involves computations for obtaining the unknown. Especially is this true for measurements in the radio frequency range where it is practically impossible to obtain satisfactory inductance standards. Another advantage of the resonance bridge is that it can be readily converted into a comparison bridge for measuring capacitances by switching the capacitance standard from the unknown arm into the standard arm. In this way both inductive and capacitive impedances may be measured with the use of capacitance standards only.

Because of the frequency factor, which enters into the computations, measurements by the resonance bridge require that the frequency be known to an accuracy consistent with the precision desired. There are cases where this is impossible or inconvenient. Another restriction on the use of this type of bridge is the limitation in size of the precision type of condenser standards which can be obtained. This fixes a range of inductance magnitudes that may be measured by this method.

To fill the gap left by the comparison and resonance bridges, the circuit devised by D. Owen in 1915 has been utilized. This method measures inductance in terms of resistance and capacitance and does not involve the frequency in the balance relation. Unlike the more common bridges, the ratio arms consist of a condenser and a resistance and, because these elements represent impedances that are not in phase, the bridge is commonly referred to as a skew bridge. As shown in Figure 3, resistance and capacitance standards are contained in the standard arm much the same as in a capacitance bridge of the comparison type, but their relation to the unknown impedance is different.

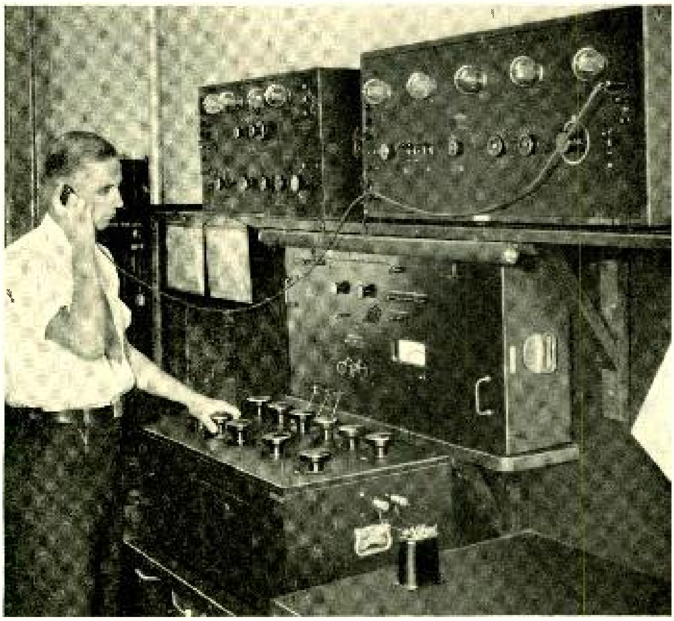


Fig. 4—W. Johnson measuring an inductance on a resonance bridge

In the comparison bridge the unknown inductance is given by the quotient of R_2 by R_1 times the standard inductance, and the unknown resistance by the same quotient times the the standard resistance, thus:

$$L_x = \left(\frac{R_2}{R_1}\right) L_s \text{ and } R_x = \left(\frac{R_2}{R_1}\right) R_s$$

With the skew bridge, however, the constant factor instead of being the quotient of the ratio arms is their product, and to obtain the unknown inductance this product is multiplied by the standard resistance, and to obtain the unknown resistance the product is divided by the standard capacitance:

$$L_x = (C_1R_2)\,R_s \quad \text{and} \quad R_x = \frac{(C_1R_2)}{C_s}.$$

It is this relationship—whereby a resistance measures the inductance component of the unknown and the capacitance measures the resistance component—that constitutes the special peculiarity of the Owen bridge.

A suitable shielding scheme has been developed for the Owen bridge and the circuit has been sufficiently refined for use in the audio frequency range with high precision. In one form of Owen bridge developed for shop testing, the constants have been so chosen that the bridge reads effective resistance and inductance directly and from its appearance could not be distinguished from an equivalent comparison bridge except that it is considerably smaller.

The comparison, resonance, and Owen bridges constitute the more important types of bridges employed in the Laboratories and in the Manufacturing Department of the Western Electric Company for testing impedances. The specific conditions of the tests determine which of these three types is most suitable for obtaining the desired measurements.

For Next Christmas

To those who like to look forward to the merriment of the next winter holiday season, the Employees' Savings Plan is suggested. A very small sum deposited regularly for you will grow to a surprisingly large amount by Christmas, 1930. *The Financial Department will be glad to explain the details of the plan*

Evolution of the Call-Indicator System

By E. H. CLARK
Local Systems Development

IN changing from manual to dial operation there is usually a period, which in the larger cities may be of considerable duration, during which both manual and dial offices will be in use. When this situation exists, calls are originated in an office of either type to be completed in one of the other. Among other things, therefore, equipment must be provided at the manual office to indicate to the operators the numbers dialed to their office for completion. Apparatus developed to accomplish this—a group of numerals which light up to indicate the number wanted—is known as a call indicator. The circuits and equipment used have, like the rest of the dial system, undergone a large amount of development since the first experimental call indicator was installed in the Cortlandt office in 1910.

The revertive pulsing method, used for selecting numbers wanted in dial offices of the panel type and already described in the Record,* was also employed in the first call-indicator system. Power driven sequence switches at the manual office were utilized to return pulses to the subscriber's sender much as the selector commutators do on calls completed in a dial office. Six of these sequence switches, one for each of the possible digits and letters of a number called, constituted a complete register. The time required to completely record the number was about five seconds on the average. If but one such register were provided this recording time of five seconds would seriously affect the number of calls that an operator could handle, so that several of them were furnished for each call-indicator position.

When a number had been completely recorded on a register, the operator was given an indication by the lighting of an assignment lamp associated with the plug of the trunk over which the call was coming, and the

* Bell Laboratories Record, *June*, 1929, *p.* 395.

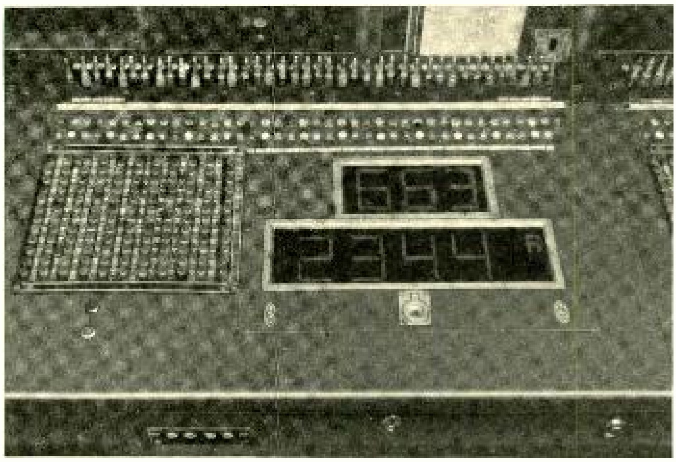


Fig. 1—When used in a "tandem" position a second call indicator with only three digits is required to display the number for the office code

number recorded was displayed on her indicator. The time required to transfer the record from the sequence switch to the call indicator was so short that there was no appreciable delay in operating. When the plug was inserted in the jack of the line called, the register would release and the number would disappear from the call indicator. Both the register and the call indicator were then ready for another call, and if one were waiting on another register, it would be immediately displayed on the call indicator.

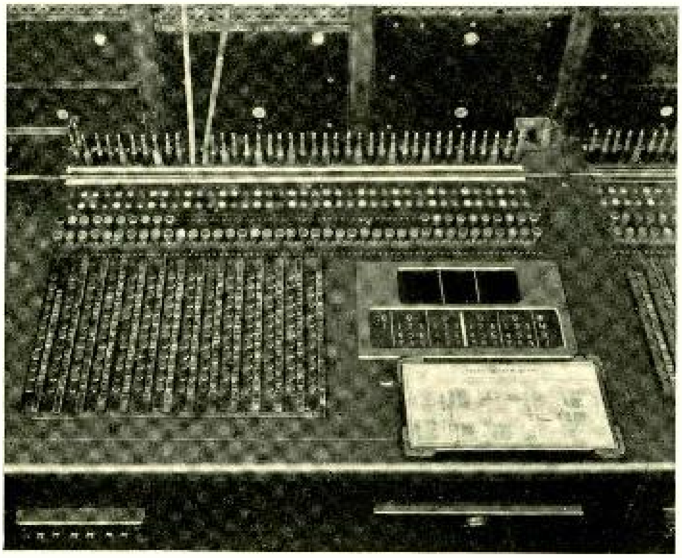


Fig. 2—With the call indicator of the relay type only a single lamp is lighted for each digit of the number called

Although this method was very satisfactory it required power driven equipment at the manual office, which it was desirable to eliminate. This is accomplished by using relay registers which were operated by pulses transmitted by the sender. A faster pulsing method was also developed which made it possible to use only one recording device for each call indicator, the operator receiving the numbers directly from the senders at the calling office.

This method is called the relay call-indicator system because only relays are used at the call-indicator positions to record the number wanted. The first plan developed was based upon a system of ground return pulses. This method was not adopted however because of the disadvantage of the high potential that would be necessary to overcome earth potentials. A metallic signaling method was developed instead which was capable of transmitting signals at the required speed.

Even with the faster method of pulsing, an overlapping method of operating was necessary to prevent a drag on the operator. With this method an operator picks up the proper plug when the number is first displayed and then presses a display key for the next number. While she is inserting the plug into the desired line the next number is being displayed. If no call were waiting, the insertion of her plug would extinguish the number displayed.

The call indicators used with the first system, installed in Cortlandt Office in 1910, and in Newark in 1914, made use of universal figures similar to the carriage call devices used in front of theatres, and for this reason were termed "carriage call-indicators". The arrangement is shown, installed in a keyshelf, in Figure 1.

From two to seven lamps must be lighted for each digit. There was no particular objection to this for the early system because the contacts on the sequence switches are relatively numerous and could easily serve for selecting the required combinations of lamps.

With the relay call-indicator system, however, these contacts are not obtained so economically. A new type of indicator was developed, therefore, which used only one lamp per digit. A unit of this type is shown in Figure 2. With this indicator one of the digits between each of the parallel lines lights to show the number wanted.

A recent development is the automatic display type of call indicator, which displays the calls automatically as soon as the operator presses a master release key. The overlapping operation on the part of the operator is retained but a master release key replaces the individual display key associated with each trunk.

This system was developed to provide certain equipment advantages, such as the simplification of its introduction in existing manual switchboards. It also provides an advantage from an operating standpoint, by requiring only one disconnect key and by making the assignment automatic, instead of by means of a display key associated with each trunk.

All the circuits described above were designed for use with the panel system. Call-indicator equipment, however, was required also for the step-by-step system; the first installation of which was completed in Minneapolis in 1920. In the step-by-step system there are no senders nor any apparatus corresponding to them in any installation in this country, so that storing the calls at the indicator becomes necessary. A number of registers are provided for each position for receiving the pulses directly from the subscriber's dials. When a trunk to a call-indicator position is selected, a register automatically connects itself to the trunk in time to receive the first digit of the number. The call is displayed by the operator's depressing a display key, and the general method of operating is similar to that described for the relay call indicator.

Call-indicator equipment will, of course, be needed less and less as the manual offices are changed over to the dial type.

An Outline of Step-by-Step Operation

By E. D. BUTZ
Local Systems Development

ALMOST since the birth of the telephone those interested in its development have realized that the time would come when some form of mechanically obtaining a connection between subscribers would be desirable. Some of the early suggestions have already been described in the RECORD.* From all the proposals put forward, from all the developments and trials made, two systems have survived in the United States and both are used extensively in the Bell System. One, known as the panel system, was developed primarily for large areas. The other, known as the step-by-step system, was the earlier development but is being used now chiefly in the smaller or medium size areas.

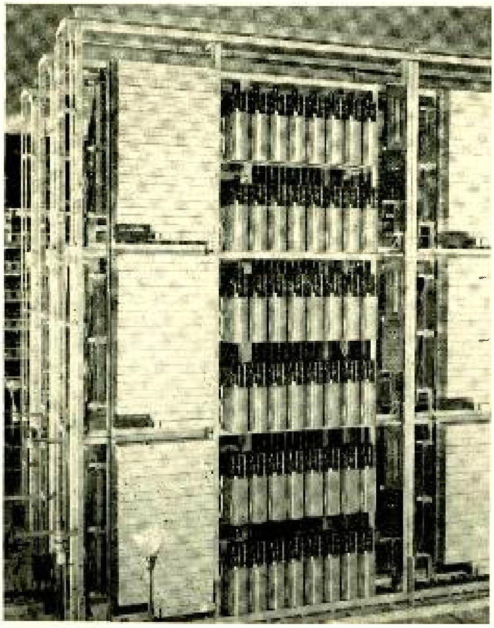


Fig. 1—Line finders are arranged in groups containing a maximum of sixteen, twenty, or thirty; each group being mounted on two shelves. The above photograph shows three groups of sixteen with their associated relays under covers

From a subscriber's point of view the method of obtaining a connection with another subscriber in the dial system is a simple matter and is the same whether the central-office equipment is of the panel or step-by-step type. On lifting the receiver from the hook he hears, almost immediately, a low pitched continuous tone known as the "dial tone". It is the equivalent of the operator's "number please" and indicates that he may begin to dial. After the last digit of the number wanted has been dialed, the ringing tone is heard showing that the bell of the number called is being rung.

From the standpoint of central-office apparatus, equipment, and circuits, however, the step-by-step is radically different from the panel system, and takes its name from the method of making the various selections of trunks and lines necessary to establish the connection. These selections proceed step-by-step; each digit or letter dialed controls one selection.

The operation of the system requires the use of many relays and miscellaneous equipment, but the major elements—the apparatus that ac-

*BELL LABORATORIES RECORD, *March,* 1929, *p.* 265.

tually makes the successive selections —are of three types: line finders, selectors, and connectors. In general appearance these are all very much alike—as may be seen from Figures 1, 2 and 3—but in details of construction, methods of mounting and operating, and in circuits, there are important differences between them.

Line finders—previously described at some length*—locate the line that is originating a call and connect it through to the first of a series of selectors. Selectors, varying in number depending on the size of the area, make the intermediate selections and after the second from the last digit is dialed connect the calling line to one of a group of connectors. The connector makes the final connection to the line called and rings the bell if the line is not busy. Were the line already in use, a busy tone would be returned to the calling subscriber to apprise him of the fact.

Assume, for example, that a subscriber in an area in which there is only one central office, wishes to call number 8249. The act of lifting the receiver from the hook starts one of a group of line finders searching for the calling line. With each group of line finders, as many as 200 lines may be associated, and the finder that starts to act is one of those that has the line of the calling subscriber associated with it. Controlled by associated relays, the line finder moves up rapidly step-by-step till it reaches the level containing the calling line and then around to the particular line itself. The location of the calling line by the line finder causes a connection to be made to the first selector, and immediately "dial tone" is returned to the subscriber. The speed with which this connection is made may be judged by the fact that dial tone is usually heard by the time the receiver reaches the subscriber's ear.

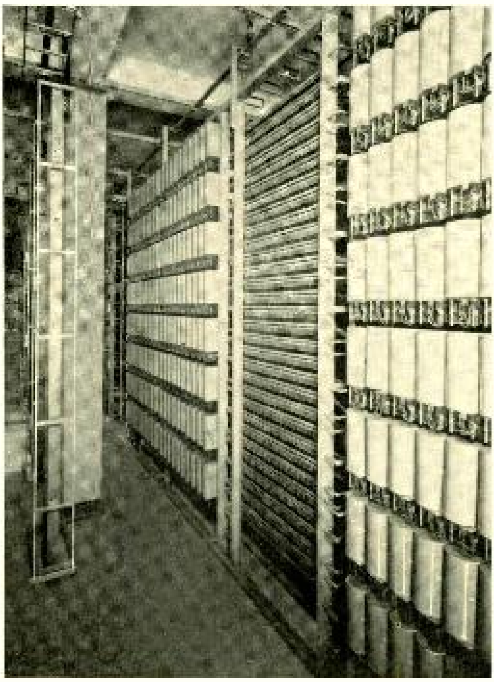


Fig. 2—Selectors are mounted twenty on a shelf, and two groups of eight shelves are arranged on one frame with cross connecting terminals between the groups

To the terminals of each first selector are connected one hundred trunks which, except those to operators or out-trunk switches, go to second selectors. The selector terminals, like those of the line finders, are arranged in ten levels each serving ten trunks. (Although the line finder has twenty lines per level there are only ten positions in each level—there being a choice of two lines for each position as described in the article to which reference has already been made.) The selectors differ from the line finders, however, in having the

*Bell Laboratories Record, *February,* 1929, *p.* 236.

motion of the wiper up to the proper level controlled by the operation of dialing. For the first selector the first digit dialed determines the level—in the example given the wiper would take eight steps up and stop at the eighth level. The motion around on the level is not controlled by the subscriber but occurs immediately after the digit has been dialed. This motion around on one level is called hunting and the wiper stops at the first idle trunk, which continues the connection through to a second selector.

The hunting action of the wipers is controlled by another magnet which keeps stepping the wiper around till a line is found which has no ground potential on its "sleeve" lead. Each position of a selector or connector has three leads; two are used for the talking circuit and the third, known as the "sleeve" lead, is used for control purposes. This sleeve lead of busy trunks or lines is grounded to allow the selection of idle positions.

The operation of the second selector is similar to that of the first but is controlled by the second digit dialed. For the number chosen—8249—the wiper will step up twice and select the first idle trunk on the second level. The upward motion of the wiper is controlled by a magnet operated by a relay connected to the line from the calling subscriber. The pulsing contacts in the base of the dial, as the dial returns to its normal position, opens the circuit a number of times corresponding to the digit dialed. If the dial is pulled back to the number 2, for instance, it will open the dial contacts twice in returning to normal. Each opening of the circuit causes the magnet controlling the upward motion of the wiper to operate and move the wiper one step up.

Connectors are like the selectors except that the horizontal as well as the vertical motion is controlled* by the subscriber's dial. The second selector has located a trunk to an idle connector and as the subscriber dials the third digit the connector moves up a number of steps equal to the digit dialed—in this case 4—and waits there till the fourth digit is dialed. Dial-

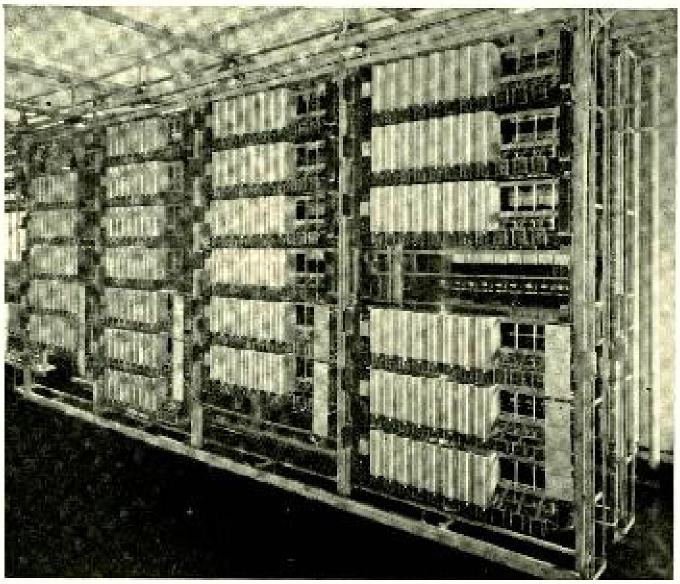


Fig. 3—Connector frames carry seven shelves on each of which may be mounted a maximum of either eleven or sixteen connectors. One connector on each shelf is a test connector and is not used by the subscribers

* *Except for hunting connectors. See* Bell Laboratories Record, *March,* 1929, *page* 291.

ing of the last digit moves the wipers of the connector around on the fourth level to the ninth position. To the terminals of this position are connected the wires running to subscri-

used depends on the trunk chosen by the second selector. Similarly the banks of the selectors are arranged in groups and their "bank contacts" multipled together. The number of

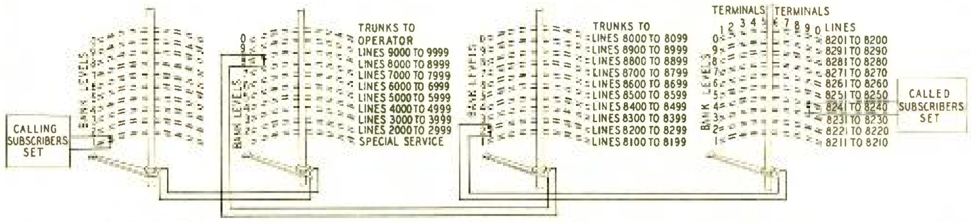


Fig. 4—The progress of a step-by-step call in a single office area may be followed on this schematic diagram

ber No. 8249. If this line were in use —indicated by a ground connection on the sleeve—a busy tone would be returned to the calling subscriber but if not, connection would be made to the line and ringing applied.

The arrangement of the line finder, first and second selectors, and connectors to complete such a call is shown in Figure 4. It must be remembered, however, that each of the switches shown is only one of many that might have been used to complete the connection. Each subscriber's line is multipled to a number of line finders and the first idle finder in the group is used for each call. Each line is also multipled to a number of connectors and which is

each employed depends largely on the amount of traffic through the office.

In areas having more than one central office, an office code of one or more digits will be used and a corresponding number of additional selectors are required between the selector on which the digit 8 is dialed and the line finder. These are used to select the office in which the called subscriber is located.

Provision is made for all kinds of services such as coin box or message rate lines, party lines, and toll calls. For the most part, however, these services are obtained by the operation of relays and accessory equipment which are developed to fit in with the regular plan of step-by-step operation.

A Method for Estimating Audible Frequencies

By W. A. MARRISON
Transmission Research

IT is often desirable when making calibrations and other frequency measurements to be able to estimate the frequency of a tone without the aid of elaborate standards or measuring apparatus. By a simple use of musical intervals which nearly everyone can learn easily to recognize, any frequency in the range from approximately 50 to 4000 cycles (roughly 7 octaves) can be estimated by ear with considerable accuracy, given a single frequency in this range.

The single frequency may be obtained from a fork, reed, or pitch pipe, Some people with an "absolute ear" can recognize certain pitches without any auxiliary means; violinists frequently can tune their instruments to standard pitch without any outside aid. In the absence of any of these aids, however, one can have an approximate standard in his own voice or whistle. The lowest notes one can sing and whistle are quite definite and can usually be relied upon to within 10 per cent. These lowest notes may conveniently be used as reference standards in terms of which the frequency of any other musical tone may be estimated.

For men, the lowest singing tone will range with individuals from 60 to 120 cycles and the lowest whistle from 500 to 700 cycles. For women the singing tone is approximately one octave higher. One may readily calibrate his "standards" by means of a piano with the aid of the accompanying chart in which the frequency of every note of the equally-tempered scale is given in a range of eight octaves. The note known as middle "C" has a frequency of 258 cycles. One must be sure, in making this test, that the sung tone is identified with the correct piano note, and not with one an octave higher or lower. Strange as it may seem, one who has had some experience with singing is likely to make this mistake since men are accustomed to sing an octave lower than the air is usually played.

A violin tuner, consisting of four small reeds tuned to G, D, A, E, is a convenient reference standard to use for estimating frequencies. The frequencies of the four tones are 194, 290, 435 and 652 respectively. With an error of only about three per cent these may be assumed to be 200, 300, 450 and 650, which are sufficiently good approximations for our purpose.

Having one's standard of frequency, all that remains is to learn to recognize musical intervals and to know the corresponding frequency ratios. This is easily done because the frequencies which, sounded together, are the most pleasing bear the simplest frequency ratios to each other. This is characteristic of pairs of tones in both the major and minor scales. These scales were developed because they were capable of pleasing musical combinations; the simple relation between the frequencies was discovered long after the scales were invented.

Bach's invention of the equally tempered scale did not change this situation. Although in the equally tempered scale the intervals corresponding to the simple frequency ratios are not perfect, they are sufficiently good approximations to satisfy most ears. In the equally tempered scale the maximum deviation from a perfect interval is less than one per cent or a fifth of a semi-tone.

In referring to intervals it is best to retain the usual musical notation. The notes, or degrees, of the scale are known as the 'first', 'second', etc., to the 'eighth' in rising pitch. The musical interval between the first degree of the scale and any other is called by the name of the higher degree. Thus the interval between the first and fourth degree of the scale is known as a 'fourth'. The intervals thus defined which are the most easily recognized are listed in the following table with the corresponding frequency ratios:

Interval	*Frequency Ratio*
Eighth (octave)	2:1
Fifth	3:2
Fourth	4:3
Third (major)	5:4
Third (minor)	6:5

Intervals a whole tone or a semitone apart may also be estimated quite accurately. The frequency ratios corresponding to these are as follows:

Interval	*Frequency Ratio*
Whole tone (large)	9:8
" " (small)	10:9
Semi-tone	16:15

The frequency ratios between the

Table of Equally Tempered Scale, $A_3 = 435$

	C_1-C_0	C_0-C_1	C_1-C_2	C_2-C_3	C_3-C_4	C_4-C_5	C_5-C_6	C_6-C_7
C	16.17	32.33	64.66	129.33	258.65	517.31	1034.61	2069.22
C ♯	17.13	34.25	68.51	137.02	274.03	548.07	1096.13	2192.26
D	18.15	36.29	72.58	145.16	290.33	580.66	1161.31	2322.62
D ♯	19.22	38.45	76.90	153.80	307.59	615.18	1230.37	2460.73
E	20.37	40.74	81.47	162.94	325.88	651.76	1303.53	2607.05
F	21.58	43.16	86.31	172.63	345.26	690.52	1381.04	2762.08
F ♯	22.86	45.72	91.45	182.89	365.79	731.58	1463.16	2926.32
G	24.22	48.44	96.89	193.77	387.54	775.08	1550.16	3100.33
G ♯	25.66	51.32	102.65	205.29	410.59	821.17	1642.34	3284.68
A	27.19	54.37	108.75	217.50	435.00	870.00	1740.00	3480.00
A ♯	28.80	57.61	115.22	230.43	460.87	921.73	1843.47	3686.93
B	30.52	61.03	122.07	244.14	488.27	976.54	1953.08	3906.17
C	32.33	64.66	129.33	258.65	517.31	1034.61	2069.22	4138.44

Fig. 1—This table is based on the International Standard Pitch, A′=435 vibrations per second. This pitch was established by law in France in 1859 and subsequently was adopted to a large extent throughout the musical world. At present the tendency is toward Concert Pitch which is about a fifth of a semi-tone above International Standard. In the interval from the year 1500 up to the present, A′ has had values of frequency ranging from 506 vibrations per second to 393—a range of nearly half an octave. A pitch based on C′=256, sometimes known as Philosophical Pitch, is convenient to use in physics because the frequencies of all the C's are powers of 2. It is not, however, in general use by musicians

successive notes of the major diatonic scale occur as follows:

Degree	1	2	3	4	5	6	7	8
Ratio		9/8	10/9	16/15	9/8	10/9	9/8	16/15

The ratios given in the first table may be checked by taking the product of all the ratios between the separate degrees of the scale from the first up to the degree in question. For example the product 9/8 x 10/9 x 16/15 x 9/8 = 3/2, is the ratio corresponding to the interval, a 'fifth'. A minor third is the interval between the first and third degrees of the minor scale or between the sixth and eighth degrees of the major scale.

It is thus a simple matter to compare the frequency of any tone with another of which the frequency is known, when the musical interval is recognized. For example, suppose the standard at hand is 500 cycles, and we listen to a tone which is, as nearly as we can judge, half way between the intervals called a fourth and fifth above it. This means its frequency is roughly half way between 4/3 of 500 and 3/2 of 500 which is about 708 cycles. In such a simple case the error could hardly exceed 5 per cent, which is 35 cycles.

If the unknown frequency is more than an octave away from the standard the only additional step required is to pick the nearest tone to one frequency which is an even octave from the other. Remembering that for each octave removed we must use a multiplying factor of two (if above) or a one-half (if below), the process is the same as before.

As an example of this, suppose the unknown frequency is found to be two whole octaves and a major third below the standard, assumed to be 500 cycles. A tone two octaves below 500 cycles has a frequency of 500 x 1/2 x 1/2 = 125 cycles. A major third below that corresponds 4/5 of 125, that is, a frequency of 100 cycles. This is then our estimate of the unknown frequency.

A tone an octave above 500 cycles has a frequency of 1000 cycles, which is the most popular standard of frequency used in the laboratory. It is evident then that a 1000 cycle tone is just three octaves and a ma-

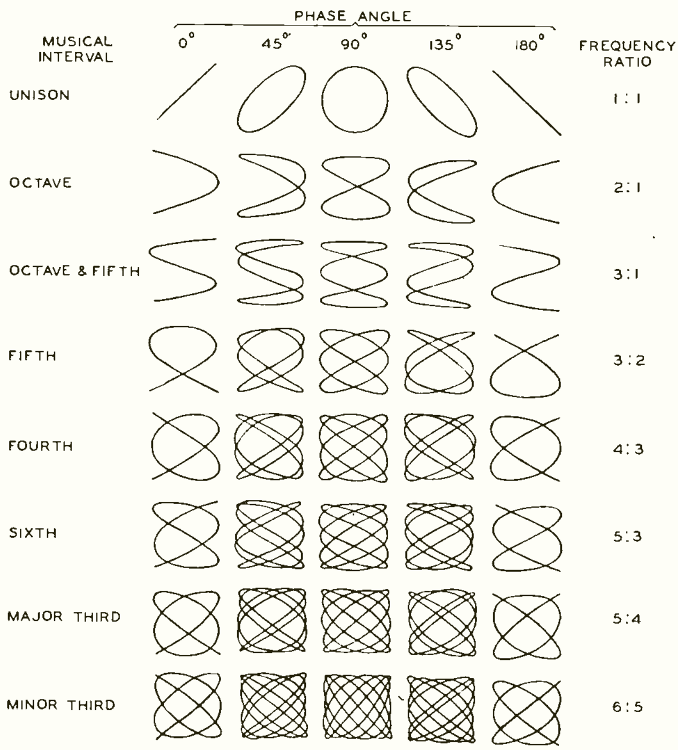


Fig. 2—Typical Lissajous figures with corresponding frequency ratios and musical intervals

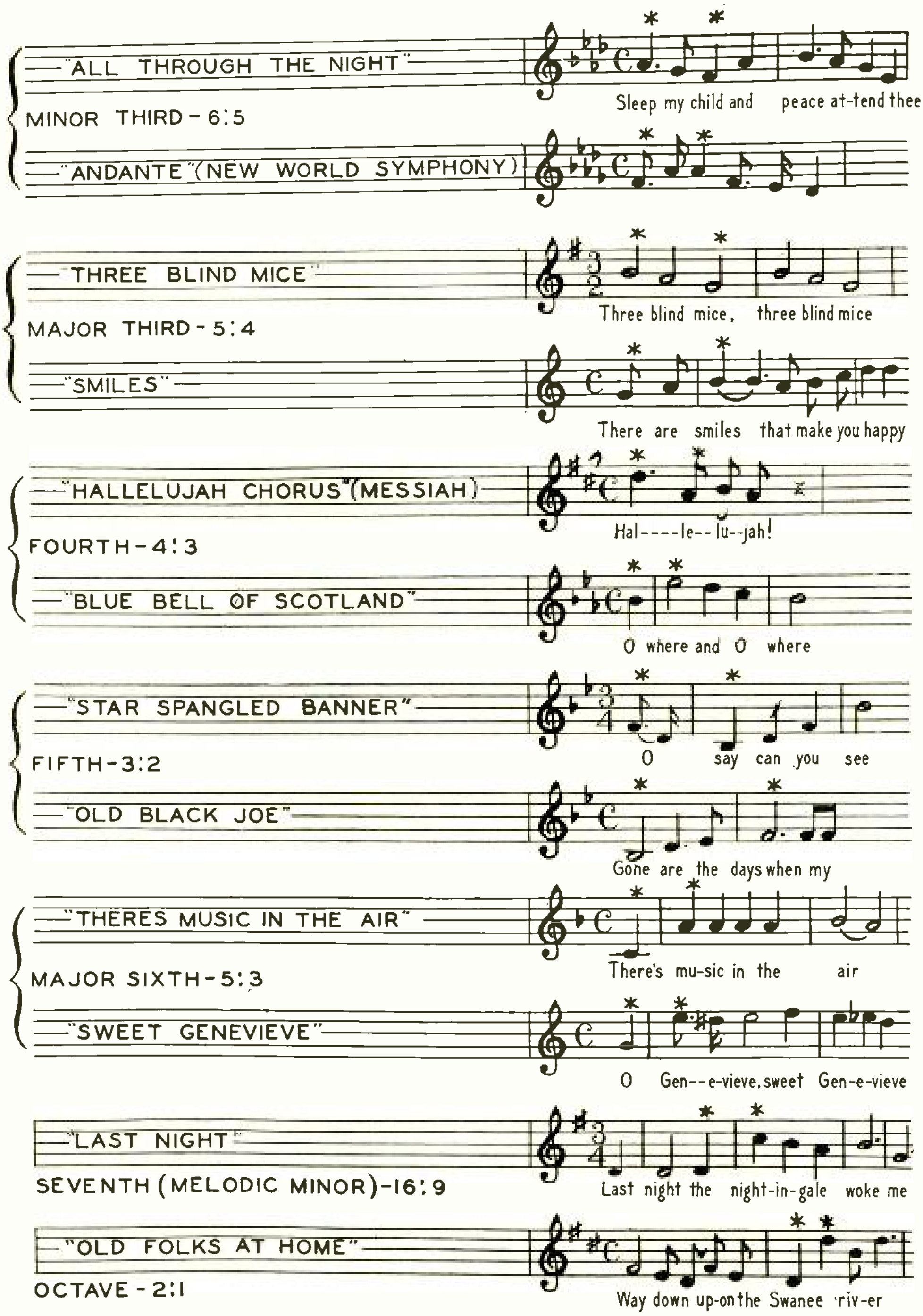


Fig. 3—Examples of musical intervals with corresponding frequency ratios

jor third above 100 cycles. This is true of any two tones having frequencies in the ratio of 10 to 1.

A knowledge of the simple frequency relations corresponding to musical intervals is of value when making frequency comparisons by means of the Braun tube. It is common knowledge that simple Lissajous figures are produced when frequencies related by a simple fraction are compared on the Braun tube. The fact that the intervals between frequencies which form simple Braun tube figures can easily be recognized by ear is of considerable value in making such measurements. In Figure 2 the Lissajous figures are shown corresponding to the simpler frequency ratios for five different phase angles, referred to the higher frequency in each case. If the ratio of the frequencies is not exactly the value of the fraction indicated, the figure will change slowly through all of the configurations shown. Each of the figures shown corresponds to a definite and easily recognized musical interval. In Figure 2 the musical intervals are indicated beside the corresponding Lissajous figures.

The relations just pointed out are of value both in estimating unknown frequencies and in making actual calibrations. If for example a fairly open stationary figure is observed on the Braun tube, and the musical interval is recognized as a major third, the exact ratio of the frequencies will be found to be 5:4. It may in some cases be difficult to recognize the difference between 5:4 and 6:5 Lissajous figure, but if the frequencies being compared are in the audible range they can be positively identified by ear. If it is desired to adjust a variable frequency to, say, 400 cycles in terms of a fixed frequency of 300 cycles, it will be found convenient first to adjust the variable frequency by ear to a 'fourth' above the fixed frequency, after which only a very slight adjustment will be required. The adjustment made by ear should be so close that the desired Braun tube figure will be obtained, although it may be moving rapidly. The final adjustment is made by changing the variable frequency until the figure remains stationary.

A convenient way to visualize musical intervals in question is to note simple melodies in which they occur. In Figure 3, a number of familiar melodies are indicated which illustrate the intervals mentioned above, giving the names of the intervals and the corresponding frequency ratios. Intervals of the sixth and seventh are also given. These are easily recognized although the frequency ratios are not so simple as the others. Intervals visualized in this way are instantly available for comparing by ear any two tones in the audible range.

The Month's News

INCLUDING

NOTES AND ELECTION NOTICES

OF THE CLUB

Colonel Robert Bradford Marshall conversing over the telephone with the aid of an artificial larynx

Vice-President Charlesworth Addresses the Telephone Pioneers in Minneapolis

EMPHASIZING the indispensability of research to the attainment of the Bell System's announced purpose of giving the best and most comprehensive service at the least possible cost, H. P. Charlesworth outlined to the Convention of Telephone Pioneers some of the more recent achievements of telephone development. He contrasted the cramped space and meager equipment available to Dr. Bell in the small room in Boston, where the telephone was born, to the present Laboratories with their personnel of nearly 5,000 people and budget of over fifteen million dollars a year. The same spirit of research that enabled Bell to override all obstacles still vitalizes the activities now being carried on with the enormously greater facilities.

Among the many developments touched upon, Mr. Charlesworth referred briefly to the improvements in loading coils, condensers, relays, vacuum tubes, carrier, cables, and other forms of apparatus and materials which have made possible the great strides in local and long distance as well as the transatlantic telephone service.

Recent progress in television and developments leading to talking motion pictures, aids to hearing, the artificial larynx, and other by-products of telephone research were also mentioned.

The rapid extension of the dial system was discussed, and it was pointed out that according to estimates about one-half of the stations in the Bell System would be operated on a dial basis by 1934. Connected with this growth of dial telephony is the interesting extension of automatic testing methods. As an example of this, mention was made of a part of the panel system which tests its own circuits before the call is advanced to other apparatus. If trouble exists, other equipment is automatically substituted, and the subscriber, knowing nothing of this rapid testing and substitution of apparatus, gets his number with no apparent delay. In cases of persistent trouble, an alarm is sounded and lamps lighted to indicate its location.

Among the many developments connected with the dial system, reference was also made to the "call indicator"—used to indicate to a manual operator a number called from a dial office. As the latest apparatus for performing this function under certain conditions, he demonstrated the new "call announcer". A number dialed, instead of being flashed to the operator by illuminated numbers as with the call indicator, is spoken to her by mechanical methods. In demonstrating this equipment, Mr. Charlesworth called the Laboratories in New York and requested that someone dial a telephone number. When the number was dialed, equipment translated the number into words, and the Pioneers in the Auditorium e rd a mechanical voice clearly calling out the number dialed.

Among the other developments described was the transatlantic radio, and Mr. Charlesworth told of a recent test in which he had taken part, involving a combined radio and land line connection of 15,000 miles between New York and Australia by way of London. "How truly this indicates that we are becoming a world of neighbors," said Mr. Charlesworth, "It recalls to my mind a statement made by General J. J. Carty. These were his words:

"It is the mission of the Pioneers, their successors, and their associates among all nations, to build up a telephone system extending to every part of the world, and connecting together all the people of the earth.

"I believe that the art which was founded by Alexander Graham Bell, our first Pioneer, will provide the means for transmitting throughout the earth a great voice proclaiming the dawn of a new era in which will be realized that grandest of all our earthly aspirations—the brotherhood of man."

While discussing radio developments, an interesting demonstration of an airplane radio telephone was staged for the benefit of the audience. Captain Brooks, flying over New Jersey, placed a call for Mr. Charlesworth in Minneapolis, and the ensuing conversation was heard by the entire audience through the use of loud speakers. Captain Brooks was asked to have Mr. McCulloh, President of the New York Telephone Company, brought in on the connection, and the Pioneers had the interesting experience of hearing from their incoming President in this very unusual manner.

The talk throughout was illustrated by slides, and in many cases improvements that have resulted from development and research were shown by the presence of the actual equipment and apparatus on the platform. In concluding his talk, Mr. Charlesworth quoted:

"There is a great thought underlying the wonderful developments of the world's greatest telephone system. Since Dr. Bell's discovery and invention opened the way, the progress of the electrical transmission of speech and the expansion of the system have been something more than a great commercial enterprise. It has been tinged throughout with idealism, and its history is replete with the romanticism of the knight-errant and the patient zeal of the ancient alchemist.

"It has been developed out of nothing by wresting from Nature's boundless store her hidden secrets and applying them to the problems of speech transmission. The future is assured, for lying outside the boundaries of our present knowledge, away off in the infinite, is a store of resources which will be moulded to the use of mankind by the men and women of the Bell System."

News Notes

H. P. Charlesworth has been appointed a member of the Edison Medal Committee of the American Institute of Electrical Engineers to fill out the unexpired part of Mr. Craft's term. The Edison Medal is awarded annually for meritorious achievement in electrical science, engineering or the arts to a resident of either the United States or Canada.

Mr. Charlesworth has also been notified of his reappointment for a three-year term to the Board of Trustees of the United Engineering Society. In addition he has been appointed a member of the group of Directors of Industrial Research.

On October 15, the members of Mr. Charlesworth's former staff in the Operation and Engineering Department of the American Telephone and Telegraph Company presented him with a gold watch and pencil.

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What is believed to be the longest telephone conversation carried on with artificial voices occurred on October 13. Using the artificial larynx and bellows, S. P. Grace talked from his office in the Laboratories to Colonel Robert Bradford Marshall, who was using similar apparatus at the office of F. L. McNally of the Pacific Telephone and Telegraph Company at Sacramento. Colonel Marshall, who is State Landscape Architect and Engineer of the Department of Public Works at Sacramento, was rendered mute through an operation in which his larynx was removed.

Colonel Marshall called on Mr. Grace in San Francisco last spring and asked for a demonstration of the new experimental type of artificial larynx. Since his operation he was accompanied on his travels by his wife who had learned to read his lips and thus conveyed his ideas to others. He had attempted to use the commercial type of larynx which he found unsatisfactory owing to the peculiar configuration at the opening of his throat. Within a few minutes he was able to talk well with the new type instrument and Mr. Grace arranged to have one sent to him from the Laboratories.

Colonel Marshall was formerly Chief of the United States Geographical Survey, and had to give up his position because of loss of his voice. He is the author of the Marshall Irrigation Act and is considered an authority on irrigation matters.

* * * *

The Boeing Air Lines have announced that they are about to install Western Electric radio telephone equipment on their transcontinental mail and passenger transport airplanes. Twenty-two ground stations will serve the Chicago-San Francisco and the Los Angeles-Seattle routes. Apparatus will be that developed by these Laboratories and will include, for the planes, a long-wave receiver for weather and beacon signals, a short-wave receiver, and a fifty-watt transmitter for communication with the ground station.

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The regular meeting of the Colloquium was held on October 28. A. R. Olpin spoke on *Use of Dielectrics* *to Sensitize Photoelectric Cells to Red and Infra-red Light.*

* * * *

AT THE instance of P. L. Schauble, General Information Manager of the Bell Telephone Company of Pennsylvania, members of Mr. Schauble's department engaged in publicity work made an inspection tour of the Laboratories under the guidance of G. F. Fowler during the latter part of October. Mr. Schauble accompanied the second of the two groups of his men that visited the Laboratories.

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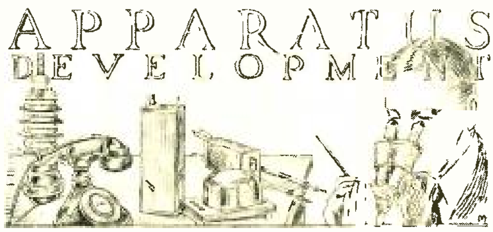
ON NOVEMBER 12, President-elect Robert Gordon Sproul of the University of California made an inspection tour of the Laboratories and was entertained at luncheon by Mr. Charlesworth and his staff and members of the Educational Department. Dr. Sproul was later a guest at a dinner given at the Western Universities Club by California alumni employed in the Laboratories. Those present included P. J. Brownscombe, C. J. Christensen, S. A. Clark, F. A. Coles, R. C. Dehmel, R. J. Heffner, W. A. Munson, F. A. Polkinghorn, W. J. Thompson, C. S. Yeutter, N. C. Youngstrom and Edgar Tourraine of Western Electric at Kearny.

* * * *

GROUP HEADS of the Department of Development and Research were guests at two of the recent Executive Conference luncheons. Introduced by Mr. Charlesworth, L. F. Morehouse spoke October 24 on equipment development, and O. B. BLACKWELL November 7 on transmission development. Mr. Morehouse was accompanied by H. M. Bascom, B. C. Bellows, I. W. Green, R. W. Morris, and R. D. Parker of his staff, and Mr. Blackwell by J. R. Carson, A. B. Clark, Lloyd Espenschied and W. H. Martin.



ACCOMPANIED by G. H. Downes of the American Telephone and Telegraph Company, O. C. Eliason visited Washington to inspect the trial installation of a new type of distributing frame wire.

H. H. GLENN inspected switchboard cable being installed in the new telephone exchange in Roselle, New Jersey.

C. A. WEBBER visited Baltimore in connection with the splicing of distributing frame wire at the Point Breeze plant of Western Electric.

H. S. SMITH made a trip to the General Electric plant at Schenectady regarding the development of special cable for use in high frequency telephone circuits.

DURING the early part of the month E. B. Wheeler visited Hawthorne to discuss enameled wire and textile development, and the National Carbon Company at Cleveland to discuss several matters pertaining to dry batteries.

While on this trip Mr. Wheeler attended the twenty-fifth anniversary of the honorary electrical engineering fraternity, Eta Kappa Nu, of which he was one of the founders at the University of Illinois in 1904.

L. A. ELMER was at Hawthorne conducting experiments and tests in connection with the 707-A Drive.

G. W. FOLKNER attended the annual meeting of the Telephone Pioneers at Minneapolis, as a delegate of the Edward J. Hall chapter.

L. N. Hampton and C. G. McCormick visited Hawthorne and Kearny to study recent manufacturing developments in connection with the presentation of an out-of-hour course on *Manufacturing Methods*.

B. Freile visited the Automatic Electric Company and the Hawthorne plant for discussions of step-by-step apparatus problems.

H. Broadwell visited the step-by-step office at Stamford, Connecticut, to obtain data in regard to the redesign of the Automatic Electric testing interrupter.

F. S. Kammerer visited the North exchange of the Chesapeake and Potomac Telephone Company at Washington in connection with the installation of new type detachable feeder brushes on No. 266 type selectors.

J. R. Irwin visited the Illinois Bell Telephone Company toll office in Chicago in connection with relay contact investigations. He also discussed recent contact developments with the Manufacturing Department at Hawthorne.

F. C. Kuch spent a week at Hawthorne for engineering training.

R. Burns was at Hawthorne to discuss problems on finishes and compounds. He also visited the experimental station of the Dupont Company on similar investigations.

W. W. Werring attended a meeting of the American Society of Mechanical Engineers at Akron in connection with the formation of a joint A.S.M.E-A.S.T.M. committee for the study of impact. While on this trip he visited Hawthorne to confer on problems of molded insulation and on his return attended the meeting of the A.S.T.M. committee on insulating materials at Pittsburgh.

F. W. Cunningham made a trip to the Pacific Coast with A. J. Eaves of the Graybar Electric Company and H. E. Young of the Western Electric Company visiting western broadcasting stations.

A. B. Bailey supervised the installation of speech input equipment in the Boston studio of the Matheson Radio Company of Gloucester. He also made a field strength survey of Station WEEI of the Edison Electric Illuminating Company of Boston.

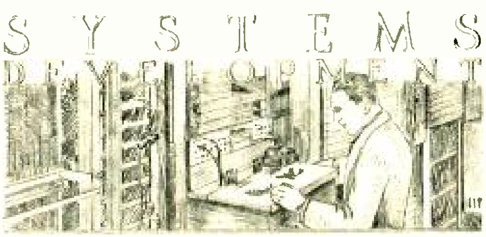
W. L. Black recently visited Station WHAM operated by the Stromberg-Carlson Telephone Manufacturing Company in Rochester. He later directed the installation of speech input equipment for the Chicago Daily News at Chicago.

J. C. Herber recently supervised the conversions to crystal control and high percentage modulation of the 1 kw. transmitter of the city of Jacksonville, Florida, and the 5 kw. transmitter of WJR, Inc. of Pontiac, Michigan. He also supervised the installation of a 5 kw. broadcasting equipment for the Milwaukee Journal.

F. A. Hinners made surveys for 1 kw. broadcasting equipments for the American Broadcasters, Inc., of Detroit, Gimbel Brothers, Pittsburg, and the Monumental Radio Company of Baltimore. He inspected the 1 kw. station of the Woodmen of the World, Omaha, Nebraska, and supervised the installation of 1 kw. broadcasting equipment for the Commercial Radio Service Company of Columbus, Ohio.

W. L. Tierney has returned to the Laboratories after a stay of fifteen months on the Pacific Coast. He concluded his visit with a survey for a 1 kw. radio broadcasting equipment for the Pickwick Broadcasting Company of Los Angeles, California, and an inspection of the 1 kw. broadcasting equipment operated by the Tenth Avenue Baptist Church of Oakland, California. He has begun a survey for the location of a 50 kw. radio telephone broadcasting equipment purchased by the Columbia Broadcasting System for their station WABC.

O. W. TOWNER supervised the installation of 1 kw. broadcasting equipments for the Mona Motor Oil Company of Council Bluffs, Iowa; the Texas Air Transport Broadcasting Company of Fort Worth, Texas; and the Pickwick Broadcasting Company of Los Angeles. He converted to crystal control and high percentage modulation the 1 kw. broadcasting equipment of the Pickwick Broadcasting Company at Oakland, California.



V. T. CALLAHAN and F. F. SIEBERT visited the Buffalo Gasoline Motor Company at Buffalo to discuss several new design elements for gasoline engines.

R. P. JUTSON inspected trial installations of new power plant features at Greensboro and Durham, North Carolina.

H. T. LANGABEER went to Syracuse to inspect the installation of a large automatic power plant at office 8 there.

D. R. FENLON was at the Hartford step-by-step central office in connection with a trial being made on line switches to reduce double connections.

J. R. LAFFERANDRE visited the short wave radio receiving station at Forked River, New Jersey, now an experimental service for ship-to-shore radio telephone communication with the steamship Leviathan.

F. R. JEFFREYS has been at Netcong supervising the installation of voice frequency terminal equipment used in connection with the short-wave transoceanic radio telephone channels to England and South America.

H. D. KELSO went to Philadelphia in regard to test splicing of quadded cable in toll offices.

R. PETERSEN and H. E. MARTING visited Worcester, Massachusetts, in connection with the first installation of a new type of mezzanine platform which has recently been standardized.

E. J. KANE and J. E. GREENE were at Stamford, Connecticut, in company with American Telephone and Telegraph and Western Electric engineers to observe results on several recent changes made in the step-by-step equipment to facilitate installation and maintenance.

D. S. MYERS and R. PETERSEN visited Wilmington on matters concerned with a new design of superstructure which was installed at Wilmington main office.

W. J. LACERTE made several trips to Stamford, Connecticut, in connection with the initial installation of message rate trunks with delayed interval. He also spent some time at Syracuse in connection with a preselector trial, and visited Hartford on a trial of modifications to reduce double connections.

F. A. KORN visited Pittsburgh to study circuit conditions at the Herminie step-by-step central office.

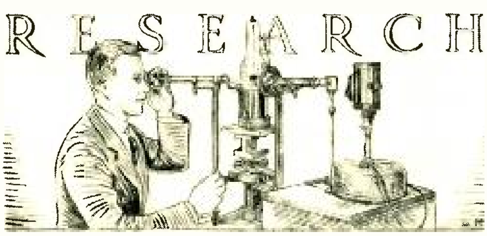
H. M. PRUDEN has sailed for Buenos Aires where it is expected he will stay for six months in connection with the installation of the Buenos Aires to New York radio channel.

J. G. Walsh was in Hartford and Springfield, making field studies on pulse correctors.

E. L. Baulch made a trip to Chicago where he observed the operation of terminal repeaters with pad control apparatus.

W. F. Kannenberg visited Darlington, South Carolina, in connection with the installation of the new automatic pilot channel equipment for new repeaters here. He later spent several days checking adjustments of the automatic pilot channel equipment installed at Denmark, South Carolina, and Savannah, Georgia.

C. M. Hemmer was also out on the automatic pilot channel job at West Palm Beach and Jacksonville.



H. R. Clarke, L. W. Giles and W. C. Jones were in Hawthorne in connection with the high quality receiver for the deskstand. Mr. Jones also attended the convention of the United States Independent Telephone Association at Chicago.

H. A. Frederick left on October 30 for Hollywood to visit sound picture studios in regard to work on recording and reproducing instruments.

H. A. Larlee attended the convention of the United States Independent Telephone Association at Chicago. While on this trip he went to Hawthorne to review the handset job in company with engineers of the Northern Electric Company.

G. M. Bouton visited New Castle, Pennsylvania, during the latter part of October to observe the installation of a new type of cable.

R. M. Burns has been at New Orleans studying the corrosion of cable sheath.

R. M. Burns, C. C. Hopkins and A. E. Schuh made an inspection tour of the General Research Laboratories of the Du Pont Company at Wilmington.

J. M. Finch and A. C. Walker attended the meeting of the American Society for Testing Materials at Pittsburgh.

A. N. Gray visited the H. L. Scott Company at Providence to confer on new uses of the rubber compression machine.

H. E. Haring and C. L. Hippensteel were at New Orleans during the month of September and part of October studying the corrosion of cable sheath.

C. C. Hipkins attended a meeting of the American Society for Testing Materials sub-committee on raw material testing for lacquers at Washington.

A paper on short-wave telephone conversation with England was read by J. C. Schelleng before the meeting of the Institute of Radio Engineers on November 6.

Herbert E. Ives gave a talk before the Optical Society meeting at Ithaca. He spoke on *Television in Color by the Beam Scanning Method.* The meeting was also attended by Messrs. Olpin, Kingsbury, Johnsrud, Darrow and Germer.

J. A. Becker presented before the National Academy of Arts and Sciences, meeting at Princeton, November 18, a theory of the increase in electron emission due to adsorbed ions. This theory explains a number of experimental facts and has been used to predict a number of later-verified phenomena.

E. Peterson has returned from California where with A. G. Landeen he has been making studies on the Catalina cable for future use on the transatlantic telephone cable. Mr. Landeen is still in California engaged in further tests.

During the period from October 6, to November 6, 1929, members of the Patent Department visited the following cities in connection with the prosecution of patents: Washington: H. A. Burgess, H. A. Flammer, E. V. Griggs, J. F. McEneany, P. C. Smith; Toronto, E. W. Adams; Chicago, G. M. Campbell; Philadelphia, J. G. Roberts.

E. J. Bonnesen has been appointed field engineer in the St. Louis area replacing H. W. Nylund who is now in New York on special assignment work.

R. J. Nossaman visited New Haven in connection with routine supervisory work, where he attended the current field review conference.

G. Garbacz and I. W. Whiteside, field engineers in the Cleveland and Philadelphia areas, visited New York to confer with members of the department on field engineering activities.

During October and the latter part of September, the members of the Field Engineering force made a number of trips on routine and special investigation work.

D. S. Bender and A. M. Elliott visited New Haven and Albany, respectively, where they attended field review conferences.

G. Garbacz made a trip to Ashtabula, Canton, Columbus and Youngstown, Ohio.

C. A. Johnson, Jr., visited Milwaukee and Kenosha, Wisconsin; and Champaign, Decatur, Peoria and Zion City, Illinois.

R. C. Kamphausen was in Center Line, Flint, Grand Rapids, Howell, Kalamazoo, Plymouth, Pontiac, Trenton and Wyandotte, Michigan; Bloomington, Illinois; and Indianapolis, Indiana.

I. W. Whiteside visited Wilmington, Delaware and Washington, D. C.

W. E. Whitworth made trips to Des Moines and Sioux City, Iowa; Duluth and Minneapolis, Minnesota; Fargo, North Dakota; and Denver.

T. L. Oliver visited Birmingham, Alabama; New Orleans, Louisiana; and Memphis, Chattanooga and Nashville, Tennessee.

J. A. St. Clair was in Portland, Oregon; Seattle, Washington; and Los Angeles, California.

E. J. Bonnesen visited Cisco, Dennison and Wichita, Kansas; Oklahoma City, Oklahoma; Little Rock, Arkansas; Abilene, Dallas, Houston and Fort Worth, Texas; and Greenville, Maud, and Kansas City, Missouri.

Publication

During the week of November

18-23, John Mills delivered a series of talks on the organization of research and development activities before a special class of electrical seniors at Pennsylvania State College.

P. C. Jones delivered an address *Recording and Reproducing of Sound Pictures* before the Technology Club at Syracuse.

Outside Plant Development

C. D. Hocker and F. F. Farnsworth went to Washington during the early part of October to attend the Fall meeting of a sub-committee of the A. S. T. M. on ferrous metals. During the latter part of the month Mr. Hocker attended a committee meeting of the A. S. T. M. held at Pittsburgh and Altoona in connection with inspection of zinc-coated samples exposed outdoors.

J. M. Hardesty was in Montreal, Canada, investigating the feasibility of the manufacture of vitrified clay conduit in Canada for use by the Canadian Bell Telephone Company.

J. G. Brearley, G. M. Bouton, W. J. Farmer, in company with Western Electric and American Telephone and Telegraph engineers, made a trip to New Castle, Pennsylvania, on October 23 and 24 to observe a trial installation of some experimental cables. Mr. Brearley continued to Chicago on October 25 for a discussion of experimental handling tests on some new types of cables.

Staff

Andrew A. Schwinn, H. H. Hall, and O. Lingel have been elected to membership in the Edward J. Hall chapter of the Telephone Pioneers of America.

Albert Kronenfeld, an Instrument Maker in the General Shop, died October 26, 1929, at the age of 61 years. Mr. Kronenfeld's service with the Western Electric Company and the Laboratories dated from September 26, 1905. For a number of years he was engaged in the manufacture of telephones when our present building was one of the manufacturing units of Western Electric.

Contributors to this Issue

H. F. Dodge, S.B., Massachusetts Institute of Technology, 1916; Instructor, Electrical Engineering, 1916-17; A.M., Columbia University, 1922; Engineering Department, Western Electric Company, 1917-25; Bell Telephone Laboratories, 1925-. Mr. Dodge was earlier associated with the development of telephone instruments and allied devices, and is now engaged in development work relating to the application of statistical methods to inspection engineering.

W. G. Knox received the B.S. degree from the State College of North Carolina in 1906 and a special degree from Lafayette College in 1907. After a year as Assistant Chief Chemist for the Northampton Portland Cement Company, he joined the Shop Chemical Laboratory of the Western Electric Company. Transferred to the Chemical Laboratories of the Research Department in 1912, he took charge of the investigation of finishes. Among his contributions to the field are the metal plating tables now published by Lefax, and the method of depositing a gold spot on thin aluminum and duralumin diaphragms, used first in the war for submarine-detecting microphones and now in condenser transmitters for a variety of purposes. He assisted in the development of the baked aluminum finishes now used on control office equipment, and of the specially finished colored handsets. Last fall Mr. Knox transferred to the Plant Department as Assistant Superintendent in charge of metal, japan, and lacquer finishing.

Two years in the Royal Air Force interrupted W. A. Marrison's attendance at Queens University, but eventually he received the B.Sc. degree from his alma mater as of the Class of 1918, and a master's degree from Harvard in 1921. Then entering the Laboratories, his early work was on frequency-analysis. This led into studies of methods and apparatus for production of constant-frequency current, and in particular to the study of piezo-electric crystals. An outgrowth of this was methods of synchronizing distant devices by accurate speed control; these methods were of great value in picture-transmission and television.

After graduating from Pratt Institute in 1916, V. T. Callahan took the Student Course with the Diehl Manufacturing Co. and later similar work with the Public Service Electric Corp. In 1917 he went with the Lake Torpedo Boat Co., where he was engaged in the design, construction, and testing of both electrical and mechanical equipment. Following five years service in this field he joined the Laboratories where he has been engaged in the design of reserve power plants for Central Offices.

Before graduating from Cornell, S. J. Zammataro spent three summers on coil design with the Engineering Department of the Western Electric Company. After getting his E.E. degree in 1921, he joined the Technical Staff of what has since become Bell Telephone Laboratories and for four years was engaged in testing work and in the Special Products Laboratory. He later became interested in alternating current bridge measurements and now is supervisor in charge of this field.

W. G. Knox

W. A. Marrison

H. F. Dodge

S. J. Zammataro

E. D. Butz

E. H. Clark

E. D. Butz entered the employ of the Western Electric Company a few months after graduating from the Pennsylvania State College with the degree of B.S. in 1911. A year was spent in educational work with the Installation Department in Chicago, and in 1912 he was transferred to the Transmission Laboratory at 463 West Street where he engaged in transmitter and loud-speaking receiver development for seven years. After the war he was transferred to the Systems Development Department where he has been interested in the design and testing of step-by-step systems. For five years he has taught the step-by-step system in the out-of-hour classes and is at the present time engaged in designing circuits for use in dial system "A" switchboards.

V. T. Callahan

After some experience in the independent field, E. H. Clark entered the Engineering Department of the Western Electric Company in Chicago in 1905. In 1913 he was transferred to the Systems Development Department in New York and shortly after took part in tests of the first semi-mechanical office in Newark. Later he was assigned to the Circuit Development group and during the war he spent much time in Pittsburg expediting completion of much needed equipment. At present he is associated with the Fundamental Circuit Development group.

Notes of the Club

THE score of 187 made by Leona Feil still occupies first place in the women's bowling. Its position is somewhat precarious, however, judging from the rate our bowlerettes are improving, and it soon may be known as just another high score. Such is the March of Progress! The bowlerettes have reached hitherto unsuspected heights and are constantly improving.

The substitutes, bowling at the Shelton, are coming along nicely. One finds quite a few Hudson Street girls at the Shelton mastering the fine art of bowling. After a few hours of strenuous exercise the swimming pool is also an attractive feature. Occasionally we meet Alma Wyckoff there. Miss Wyckoff is one of our swimming instructors at the Carroll Club and she is always ready to give expert advice. All in all, the Shelton is *the* place to go on Friday nights.

Marion Kane, extension 774, has charge of the Substitute Committee.

Rhythmic Dancing

Starting November 11 and continuing through January, the course of ten lessons offered to the women of the Bell Laboratories Club at the Noyes School of Rhythm is now in full swing.

Rhythm brings a lack of effort—rest—in all activities. The principles on which true dancing are based also underlie every other activity which has to do with movement. This is especially applicable in our everyday work where relaxation is so important to our well-being. The tensed feeling that comes from sitting hunched over a typewriter for a few hours would soon disappear if we knew how to relax our muscles. This is what the Noyes School endeavors to teach us.

Through the Club we are given the course of ten lessons for $3.50. Miss Neill Clare on extension 1382 will be glad to give further information.

Indoor Golf

ARE YOU a good putter? If you are you should enter the two indoor golf tournaments arranged by the club for the season 1929-1930. The first will be held on the evening of December 5, the second on the evening of January 30, at the Miniature Golf Course of America, 41 East Forty-Second Street, New York City.

The same rules as in previous successful tournaments will prevail: thirty-six hole medal play qualifying round and eight flights of match play for those who qualify. One prize for low medal score in qualifying round and one prize for the winner of each flight, or nine prizes in all, will be awarded.

The entire course will be reserved for the club from 5 o'clock until the tournament is ended. Previous tournaments have ended around 9:30 o'clock which allows commuters to catch a fairly early train.

The same entry fee will prevail— $1.50 payable upon entry to D. D. Haggerty, Room 164.

Glee Club

From the beautiful harmonies which come floating down from the eleventh floor Rest Room on Wednesday evenings, we know that the Glee Club members are busy practicing new songs and perfecting old ones.

Quite a few new tunes have been added to their repertoire and by all indications a bigger and better Glee Club is in the making. An added feature this season is a five minute recess during which time one of the more gifted members of the Club entertains with vocal or instrumental selections. This is purely voluntary on the part of the members and quite a lot of talent has been unearthed in this way.

One of the parties for which the Glee Club is famous will be held the first part of December. Our genial director, Mr. Richards, will be master of ceremonies and a good time is expected. If you are interested in singing, it is not too late to join the Glee Club. Phone Miss Van Riper on extension 775 and she will give you full particulars.

Swimming

The month of December ushers in last of the women's swimming classes held on Monday, Wednesday and Thursdays for the autumn season. All of the girls who attended these classes have felt that it has been beneficial to them.

Because of the Holidays, the winter classes will not start until January when a fourth class will be added to take care of the large attendance. The interest which has been shown in these classes has been very gratifying and we hope that such interest will continue.

Basketball

To all girls who have played basketball—this is a call to arms. The Bell Laboratories team has an enviable reputation to uphold and this can only be done by cooperation and faithful attendance on practice nights. A team will be chosen to represent the Laboratories and, as was the custom last year, this team will meet teams from other commercial houses. Mr. Gittenberg will be our coach this season and if we were as sure of the calibre of this year's team as we are of "Charley's" coaching, we could start singing our Victory Song. However, a lot of hard work has to be done before we can hope to hold our own in open competition.

All positions on the team are open and it's a case of "the best woman wins".

Call Marianne Grimm on extension 1153 for further particulars concerning women's basketball.

Election of Club Officers

THE candidates for Bell Laboratories Club officers for the year 1930 have been selected by the nominating committee. Ballots will be mailed to all club members on Friday, December 13, and must be placed in the ballot boxes Monday, December 16, between the hours of 8:30 A.M. and 6:00 P.M. Ballot boxes will be located in prominent places in each section on all floors of the building. No employee who is not a member of the club will receive a ballot. Club membership application forms may be obtained from department representatives or from the club secretary. Applications received after December 12 will not entitle the members to vote in the current elections.

The nominating committee which selected the candidates consists of O. M. Glunt, D. D. Haggerty, H. F. Dodge, Miss M. F. Kane, S. J. Stranahan, G. Rupp, T. C. Rice, P. B. Fairlamb, J. C. Kennelty, F. W. Hultqvist and W. D. Stratton. The candidates are as follows:

For President

Mervin J. Kelly
Daniel R. McCormack

For First Vice President

Leslie P. Bartheld
Thomas C. Rice

For Second Vice President

Miss Mary Reddington
Miss May Murtagh

Departmental Representatives, two year term

Apparatus Development

W. J. Means
G. E. Kellogg

Patent and Inspection

J. A. Hall
J. H. Cozzens

Plant and Shops

W. E. Wandell
F. Metzger

M. J. Kelly

D. R. McCormack

The Candidates

MERVIN J. Kelly and Daniel R. McCormack, candidates for the office of president, are members of the Research and Staff Departments respectively. Mr. Kelly received the B.S. degree from the University of Missouri in 1914 and pursued post graduate studies in the University of Kentucky and the University of Chicago where he received the Ph.D. degree in 1918. Soon after completing his work at the University of Chicago he entered the research branch of the Western Electric Engineering Department. He is now Vacuum Tube Development Engineer and Vacuum Tube Shop Manager. Mr. McCormack came into the Engineering Department of the Western Electric Company as a clerk in 1919 after studying at Drakes' Business School and Cooper Union. He is now Office Manager of the Laboratories.

The candidates for first vice-president of the club are Leslie P. Bartheld and Thomas C. Rice. Mr. Bartheld's first work in the Western Electric Company was in the Systems Development Department as an engineering assistant. He came to the Western Electric Company directly after his graduation from Iowa State in 1921. Mr. Rice has had considerable experience in telephone work before he entered the inspection

T. C. Rice

L. P. Bartheld

May Murtagh

Mary Reddington

branch of the Western Electric Company in 1916. With the exception of four months which he spent in the Systems Development Department, he has since then been a member of the Inspection Engineering Department.

Miss May Murtagh and Miss Mary Reddington are the candidates for second vice president of the club. Miss Murtagh is a member of the Apparatus Development Department and Miss Reddington of the Bureau of Publication. Both the candidates have been active workers in the club.

W. E. Wandell

W. J. Means

C. E. Kellogg

F. Mezger

J. H. Cozzens

J. A. Hall