BELL LABORATORIES RECORD

Volume two MARCH, 1926 *Number one*

CLEAR AS CRYSTAL

By L. W. MCKEEHAN

ALL of us, I suppose, can remember our earliest active interest in crystals.* These delectable crystals were kept in sugar-bowls for the most part, although rock-candy was still a possibility. Later on we began to dream of more lasting crystals, set in gold or platinum, given in moments of enthusiasm and paid for, if at all, only by months of toil. Those of us who have progressed even farther along the usual course of events are especially concerned this winter in crystals of still a third sort which we hoard in lamentably over-sized coal bins. Even the big butter-and-egg men from the west who, according to tradition, warm themselves only at the fires of love, must depend for half of their stock-in-trade upon the preservative effect of salt crystals. If we believe everything we hear we must expect, when ghosts, to gather about every crystal sphere held by a member in good standing of the clairvoyants' union.

Besides these ways, so nearly universal, in which crystals arouse our interest, there are some less noble matters in which we look to (or through) them for enlightenment. Here we must descend from psychic and psychological questions to more easily spelled, and less thrilling, physical questions. In making the descent we notice at once a great decrease in the number of people who are deeply interested and a great increase in the complexity of the questions. From here on it becomes harder to justify the title under which this is written; but let me try, nevertheless.

A favorite way for pedants to give an illusion of clearness is to clutter the paths of their discourses with definitions. An example will show the absurdity of the scheme in this case. I quote from the Standard Dictionary:

> "crys'tal, *n.* 1. *Chem. & Mineral.* (1) The solid mathematical form included under plane surfaces, systematically arranged, and connected by angles of fixed and definite value, which a chemically homogeneous substance tends to assume by undisturbed growth.
>
> 8. A fine quality of durance or tammy.

** I omit reference to talcum powder and other less obvious crystals which surrounded our infancy.*

These two definitions and the half-dozen I have omitted may be of some use to cross-word puzzle solvers, but we will do well to forget them as irrelevant mental tangle-foot. It is a good deal safer to assume that anything solid enough to pick up in one piece contains one or more crystals, and to leave the burden of proof on anybody rash enough to uphold the contrary. Having thus, like Francis Bacon, taken all knowledge for his province, the crystal physicist has no rival except the colloid chemist—I like to think that the first noun may help to describe the second in both cases —-who is equally anxious to annex the visible universe. In the conflict of these champions it would ill become me, an interested party, to act as referee. Much doubtless remains to be said on both sides.

FIG. 1—*Diffraction pattern due to same sort of crystal as in Fig. 3, but in this case rotated about the tetragonal axis. This crystal gives the row of faint lines just below the center of the picture. The strong lines just above this row and many other strong lines on the plate are due to a crystal of calcium carbonate treated in the same way for comparison. Molybdenum X-rays were used, the beam passing through narrow slits before striking the crystal. The photograph was taken on a plate. It determines the exact dimensions of the unit whose shape is determined by Fig. 3*

The interesting thing about crystals is then that the more we know about them the more we know about solid bodies, and since all our well-known world—including the telephone plant and its operators—would flow gently (like Sweet Afton) into a kind of cosmic mush if solid bodies did not stay that way, a study of crystals ought to help us in keeping the aforesaid world — particularly its telephone plant—in working order.

With this important end in mind, a part of Bell Telephone Laboratories has been set apart for the study of crystals. Mr. F. F. Lucas has assembled in Room 552 the lamps, microscopes and cameras used in the study of crystals by light of all wavelengths. Room 829 is the place where X-rays are used to unravel crystal structures. This laboratory, which was started by the author of this note, was enlarged and more fully equipped by Richard M. Bozorth, who is now in charge of it. The two methods of study are entirely different in operation, and tell us different things. A notion of the difference can be drawn from a fairly close analogy.

A balloonist a mile above the earth might find out something about the shape of the land beneath him by sounding a horn and listening to the echoes. If he were very skillful he might even detect the difference between the echo from paved streets and that from open country. But a searchlight would tell him much more. He would still, to be sure, be observ-

FIG. 2—*Diffraction pattern due to* 0.5 *mil rolled permalloy sheet. Molybdenum X-rays as in Figs.* 4 *and* 5. *Photograph, taken on plate, shows very small crystals and a preferred position for their axes as indicated by non-uniformity of circles in the pattern. Nature and degree of preference can be determined from this picture*

ing echoes of a sort, but light echoes have more detail in them than sound echoes, mainly because the waves of light are so much shorter than the waves of sound.

There is a similar difference in scale between X-rays and light, although here the two sorts of waves differ only in wave-length, and even in this respect are nearer alike than are sound and light waves. Where examination by light can tell us that adjacent metal crystals in a polished specimen are differently attacked by etching agents, examination by X-rays can tell us the spacing and arrangement of the atoms in a single crystal and exactly how adjacent crystals differ in these respects.

A pressing reason for being so inquisitive about the internal workings of crystals, especially metal crystals, is that metal "piece parts" so often differ in quality for mysterious reasons. There are two ways of dealing with such differences. The time-honored way is to remember at all times that strength, magnetic permeability, resistance to corrosion or what-not may vary between limits more or less well known, and to make sure that we do not specify the quality in question too exactly. This is, of course, the right way as long as the average quality is plenty good enough, but apparatus people, particularly telephone apparatus people, have a nasty habit of wanting the shop to make everything better than average, if I may be permitted the bull. In order to do this it becomes necessary to know just how the best

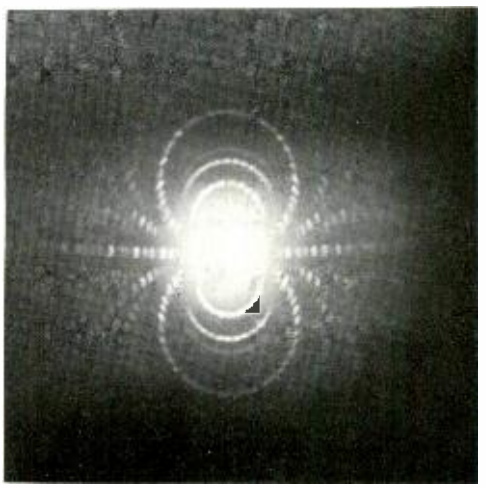


FIG. 3—*Diffraction pattern due to a single small crystal of manganese platinocyanide hydrate. Fourfold axis of crystal set vertical. Photographs taken on a plate. X-rays from a tungsten target covering a wide range of wave-length. This so-called Laue photograph determines the angles between atomic planes in the crystal and therefore the shape of the unit, which in this case is a tetragonal prism with size much greater in length than its height. Variations in intensity between spots at the same distance from the center give information regarding the distribution of atoms in the unit*

FIG. 4—*Diffraction pattern due to steel rod ¼" in diameter. X-rays and method of exposure same as in Fig. 5. Arrangement of atoms similar but dimension of unit not determined accurately. Spotty appearance is due to larger crystals than in Fig. 5*

piece differs from that which is not so good. All the methods of study have advantages and limitations. Consider some of the former.

Mechanical and magnetic tests measure differences of the same kind as those to be explained and are therefore ideal for inspection purposes. Chemical analysis tells what kinds of atoms are present, and how many of each kind, and is capable of extreme refinement in distinguishing different materials. Optical analysis tells how many different materials are present in visibly separate bits and what some of them are in a chemical sense. Since "seeing is believing," this is an especially convincing method of study. X-ray analysis tells how the atoms are put together in each bit and whether the separate bits are arranged in any special way. It gives the most fundamental information of all. When the story is complete it may be found that successful duplication of an accidental triumph requires only one of the many steps in manufacture to be closely controlled. If we keep our wits about us we may find that a much higher degree of some desirable property can be attained by going deliberately a little farther in a direction where accidental differences show improvement to be possible.

Some day we may be able to make metals to order so that they suit a particular need as closely as the telephone instrument on your desk suits your need for conversation with distant persons. Before that time comes there is much to be found out about what statisticians like to call the correlation between crystal structure and physical properties. The whole subject is less than fifteen years old, and it is too soon to say how much use may yet be made of the method. The pictures with this note give a notion in what form the data for X-ray analysis appear.

FIG. 5—*Diffraction pattern for a piece of 75% iron 25% nickel hammered to a thin strip. X-rays of molybdenum principally of wave length* 0.708×10^{-8} *cm. Photographic film bent over a quadrant of cylinder. Pattern shows body-centered cubic arrangement with edge of cube* 2.90×10^{-8} *cm. and also shows that the individual crystals are very small*

Developments and Savings in Contact Materials

By J. R. Irwin

COMPARING what is today with what was yesterday is the obvious method for determining what progress has been made. The difference between the conditions of yesterday and those of today equals the total progress. In so far as the difference is one of material welfare, it can be measured; but if it is a matter, for example, of happiness, it cannot be measured, for what would it mean to be twice as happy?

Although the progress of our civilization can be felt and recognized, it can only be measured when there is something which can be counted. Thus we may count the number of cases of typhoid per thousand of population in 1914 and compare that with the smaller count for 1924, crediting the difference largely to the development of an anti-typhoid inoculation and to improved sanitation. We cannot, however, express the gain in human happiness which this has meant by its reduction of mental anguish, physical suffering and death.

In the development of telephone service we can count the miles which were once the limiting distance over which transmission was possible, and compare with the present essentially limitless distance. We may compare the number of telephone users in one year with those in the next. But for the gain in human convenience and happiness which has resulted from this extension of the communication system there is no unit of measure.

In evaluating an engineering accomplishment the convenient and commonly used unit is the "dollar per year." We compare with the actual expense what would have been the total annual expense provided the development had not been made.

Careful and extensive development work is continually leading to annual savings in many of the plant necessities of our Bell System. Although savings on any individual item may be small, because of the large number of times each single item of equipment enters into the total plant of the System, the gross annual saving may amount for any item to millions of dollars. Contact metal is a case in illustration.

Each contact point of a relay must have physical and chemical properties such that it will stand the severe mechanical and electrical service to which it is put. Precious metals are used for this purpose. Although the amounts of metal and consequently the cost of each contact point are relatively small, the total is very considerable. If certain developments in contact metal and in its use had not been made, our System would have had to spend for the telephone plant it has installed since 1914 much more than it did. During these eleven years there has been a saving amounting to over $28,000,000. And this is but one, although it is a spectacular one, of the savings which have resulted from the continuous research and development work of the

Bell System in which our Laboratories play so important a part.

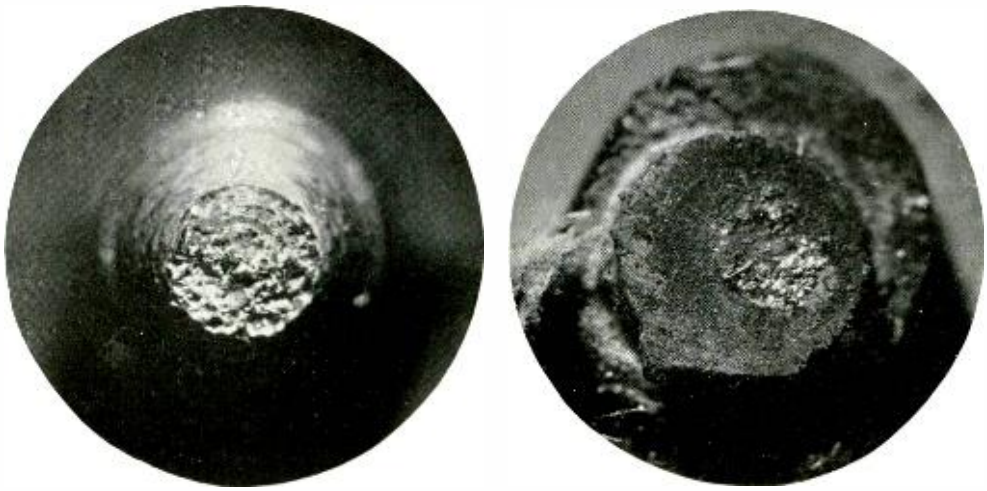
From the very beginning in making telephone equipment platinum was apparently used as a contact material. In fact, the use of platinum for points making electrical contact antedates the invention of the telephone. By how much it does so our records do not show, but in our Museum there is a telegraph key which was manufactured prior to 1859, and it is equipped with platinum contacts.

Of the world's available stock of platinum, approximately ninety per cent. has been mined in the Ural Mountains. The most recent discoveries of this metal are in the Waterburg district of the Transvaal of South Africa, where there are deposits which promise to be equal or better than those of the Ural Mountains.

Platinum was at one time used in coinage, but this was discontinued, due in part to the high cost of making the coins owing to the difficulty which was encountered in melting the metal. The limited supply and the unstable price also rendered platinum unsuitable for coinage.

As the physical properties of platinum became better known, its use was extended to the jewelry, dental and chemical industries as well as to the electrical industry. The demand for platinum increased with the extended uses. With the increased demand the price materially increased. The quotation for platinum in 1889 was $18.00 per troy ounce, while the corresponding quotations in 1918 and 1924 were $105.00 and $118.00.

The rapidly increasing demand for platinum, in which the telephone industry took its part, and the rapidly rising price emphasized the fact that it was highly desirable to have a platinum substitute which would be available in greater quantities and could be purchased at a lower price. Accordingly, as early as 1906 and 1907 fundamental work on the problem of satisfactory substitutes was started in what was then the Physical Laboratory of the Engineering Department of the Western Electric Company. In this investigation, carried on in

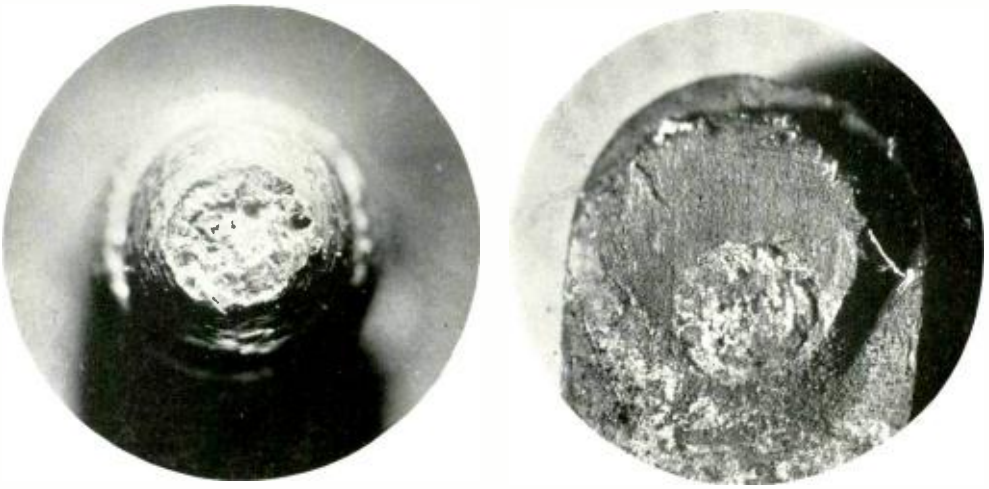


Photomicrograph of point and disc of contact metal No. 3 showing erosion of point and build-up of disc

conjunction with the American Telephone and Telegraph Company, approximately one hundred alloys, covering various binaries and ternaries of gold, silver, platinum and various base metals, were developed and individually investigated.

In these early fundamental studies those most intimately concerned were Edward B. Craft and two scientists who have since been lost to our laboratories by death, namely, Allison Akin and John W. Harris. The method employed was first to develop a new alloy composed of metals whose physical constants satisfied one or more of the requirements for a contact metal and then to test contacts made of this alloy under circuit conditions corresponding to those which would be met in actual telephone systems. The circuits which were used were comparatively simple, some involving only inductively-wound equipment such as relays and retardation coils, some involving non-inductive equipment such as lamps, and others including capacities and subject to condenser discharge across the contact points. Contacts made of these various alloys were operated under all the various typical conditions of circuits and several fundamental observations were made. For example, they were measured for contact resistance, that is for surface films which would tend to reduce the current flow. Observations were made on the pitting of the contacts and erosion. The sticking which tended to prevent contacts from releasing was also carefully observed. This effect is the result of an electric welding of the contacts by the current passing through them, and is favored by circuit conditions where a condenser is discharged by the closing of the contact.

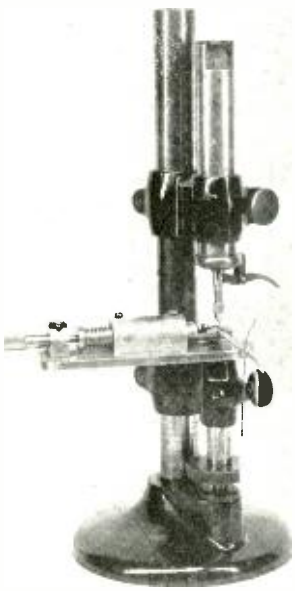
The ideal material, of course, for contacting purposes in telephone practice is one which will not readily be affected by corrosive agents, atmospheric or otherwise, either normally or under the action of an electric arc. This characteristic means the avoidance of a high resistance at the contact due to the formation of surface films. The material should



Photomicrograph of point and disc of contact metal No. 4 showing erosion of point and build-up of disc

be malleable and ductile enough to be worked without difficulty. It should be no softer, however, than necessary in order to meet this requirement, because it is an advantage to have the contact as hard as possible in order to minimize mechanical wear. High fusing point and high volatilization point are necessary to reduce the erosion caused by the heat generated at the contacts by the spark which occurs when they interrupt a circuit. It is desirable to have as low resistance a material as possible. The chief advantage of this quality is the reduction of the welding action when the contact is closed and an appreciable current flows in the circuit. Otherwise resistance is not an appreciable factor owing to the relatively short lengths of material in the path of the circuit.

In the development of platinum substitutes, which was undertaken about 1906, there were found three materials of considerable promise. These became known by numbers. An alloy of gold, silver, and platinum in specified proportions, apparently possessing desirable features, constituted the Number 1 contact metal. Number 2 was palladium, and Number 3 an alloy of gold and silver. Number 1 contact metal was a joint invention by Mr. Craft and Mr. Harris.



This adaptation of the minimeter gauges pitting to a ten-thousandth of an inch

The data, which were obtained by trial of these materials under the circuit conditions previously described, indicated that the Number 2 metal could be widely substituted for platinum in the telephone industry. In the case of Number 1 metal the indications of the tests were that it would be the equivalent of platinum only under certain conditions such as would exist in a somewhat limited number of types of telephone circuits. The circuits in which it might be satisfactorily used, however, represented a very large portion of telephone equipment, for they included those which were controlled by switchhooks, by ringing keys, by jacks, and by line and cut-off relays.

The results of these tests were so favorable that the American Telephone and Telegraph Company arranged for trial installations, in which equipment constructed with contacts of Number 1 metal should be under observation in actual service in telephone exchanges. For this purpose twelve representative manual-switchboard circuits were selected, among which were the subscriber's line circuit, the toll-switching trunk-circuit, the supervisory circuit, and the flash-back circuit. Trial installations on these circuits were made in eleven tel-

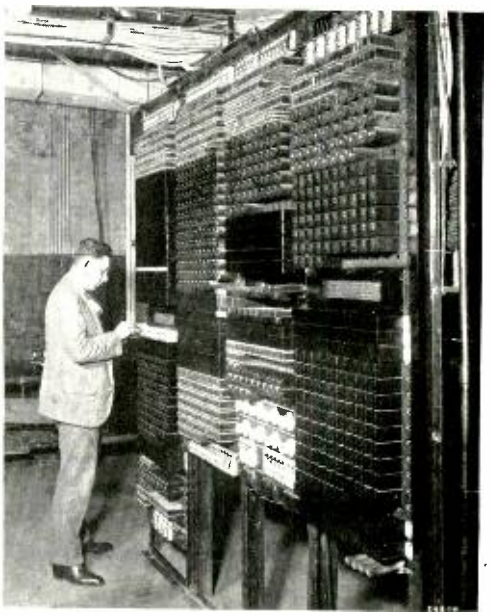
ephone exchanges in New York, Philadelphia, Chicago and in New England.

In the meantime laboratory studies on these same telephone circuits were carried on by Mr. Akin and included a comparison of three metals, Number 1, Number 2 and platinum. Observations were made as before for erosion, for sticking of contacts, and for failures to make contact.

These further laboratory tests proved conclusively that it would be permissible to substitute Number 2 metal for platinum in contacts in all the circuits and equipment then in use. They also verified the earlier conclusion that Number 1 contact metal could be substituted within certain limits such as have been previously outlined. These laboratory tests were completed during 1912. The fields trials were limited to a comparison of Number 1 contact metal and platinum. These trials continued over a period from 1912 to 1917, and were followed for the Laboratories by Daniel D. Miller. The results of this extended trial verified the early laboratory findings, and gave further assurance.

In the meantime another development was taking place. It was proposed by the Methods Department at Hawthorne that the contact metal should be spot-welded to the springs instead of riveted. An investigation of spot-welded contacts indicated that they would be satisfactory. It was therefore decided about 1912 to adopt the method of spot welding for contact points. One enormous advantage of this change was the smaller amount of contact metal which was required. In fact, it introduced an immediate saving in contact metal of almost fifty per cent.

The most critical situation in the supply and demand of platinum arose during the World War. The Russian production, which was our chief



Testing contact metals in eight hundred circuits; Donald C. Bowne at the left

source of supply, was reduced fifty per cent in 1915 and a similar decrease took place in 1916; so that in two years' time the output of platinum was reduced to approximately one-quarter. This brought about a situation which, but for the long series of earlier investigations, might have seriously affected the quality of telephone equipment. As it was, it only emphasized the value and foresight of the previous work and served as a stimulus to an immediate expansion of the program of utilizing platinum substitutes. In accordance with information from the various tests this expansion appeared perfectly safe, and programs were launched for introducing Number 1 and Number 2 contact materials very extensively. During 1917 and 1918 the

crisis was met and a serious situation very considerably relieved by the use of these materials in the equipment of manual telephone systems.

Later the use of the same materials was extended to portions of the machine-switching equipment. The result is that at the present time it would be fair to say, on a rough estimate, that Number 1 contact material is being used in ninety to ninety-five per cent. of all telephone relays and keys. The majority of the remainder of the contacts in both manual and panel-type machine-switching equipment is the Number 2 contact material.

About 1920, and during the years immediately following, fundamental investigations of contact materials were again undertaken, this time by Herbert E. Ives and Edwin F. Kingsbury. They worked in conjunction with Henrik Boving, James E. Harris, and Howard T. Reeve who developed the new materials or insured the purity of the elemental ones. Approximately two hundred materials, both pure metal and alloys, were covered during these investigations. A result was an accumulation of important fundamental data on electrical contact-phenomena and the verification of the findings of the earlier investigations. This corroboration of the former data permitted a still further extension in use of Number 1 contact-material. That was the immediate effect of these recent studies: the other effects will follow as time goes on, for several new ideas of importance were evolved and are undergoing the necessary studies in order to determine the practicability of their adoption.

Another outstanding development from the 1920-1923 study is that of the so-called Number 4 contact metal. This is an alloy of palladium which is suited to particular conditions. It is used in the Number 209 relay, a high-speed relay, which has important functions in metallic telegraph circuits and in carrier-current telegraph systems. Prior to its development, in the course of the investigations just mentioned, a special alloy of precious metals had been used. This was the product of an outside manufacturer, and its cost was excessive. Contact points for these relays made from the Number 4 material are roughly one-quarter as expensive. In addition to high cost the material would not meet all the conditions for satisfactory service in the field. The use of our new alloy reduced the cost of maintenance in the field by several dollars a year for each relay involved. This saving is due mainly to the need of less frequent adjustment, and to the decrease in number of heat coils which are blown. The time between successive adjustments of the contacts is about two hundred and fifty times as long as before.

In addition to the investigations of new materials continued studies have been necessary with a view to meeting new requirements for contacts such as would be encountered with the introduction of machine-switching equipment. Obviously a contact which is satisfactory for five hundred thousand operations in the control of a given circuit will not be large enough if the required number of operations is increased tenfold to five million. This numerical illustration gives a fair idea of the average increase in the number of contact operations which are required in machine switching as compared to manual

operation. In order to meet such a situation it is necessary to know the characteristics of the equipment which is involved and the contact wear which will correspond to these various characteristics for various given numbers of operations. When these factors are known it is possible to predetermine for given conditions the size necessary to insure that the contacts will not be worn down to an unsatisfactory operating state during the normal life of the apparatus.

In some cases where it is impracticable or inadvisable to make the contact points sufficiently large to last through the useful life of the apparatus it is customary to relieve them of certain functions.* When the contact points separate, opening a circuit, there must be dissipated at the contact some of the kinetic energy of the electric current which is stored in the coils and electromagnets of the circuit. In these cases, to prolong the useful life of contacts, it is customary to connect a network, consisting of a capacity in series with a resistance, in parallel with either the contact or the load. This network because of its capacity does not allow steady current to flow, and operates only to absorb the energy of the transient currents.

In determining the proper network to use under any given circuit condition a peak-voltmeter of the vacuum tube type may be used. This device will accurately measure the voltage rise across the contact when the circuit is interrupted. By varying the components of the network it is possible to control the transient currents; and the degree to which the contacts are protected may be governed entirely by engineering considerations such as the comparison of the cost of the network with the desired gain in contact life. In making these studies the vacuum-tube peak-voltmeter is particularly qualified because it absorbs practically no energy from the system and consequently gives correct readings of instantaneous voltages.

Much has been done in the study of contact problems and the development of materials. Perhaps the total figures of savings are a better indication of the magnitude of this work than the cursory account which has preceded. These savings, of course, do not accrue to the Western Electric Company for they result in a lower cost of apparatus to the associated companies of our Bell System and so ultimately in economic benefits to the public.

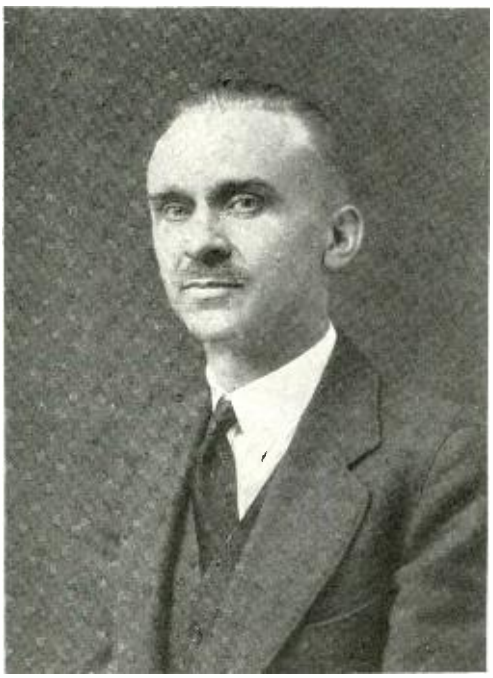
But the work is not finished: new problems are met each day, and fundamental investigations of the present are maintained in order that the problems of the future may be met as successfully as those of the past.

**In fact, the limitations imposed by contact operations and the possibilities of economies of contact material have for years been factors taken into account by the circuit designers of telephone systems. But that is another and longer story for another writer.*

Sound—A Problem in Education

By George B. Thomas

AN interesting situation has developed in university education in connection with the subject of sound. Twenty or more years ago, and in fact up to the present time, the engineering student met this subject only in two or three chapters of the text in his general course on physics. The student in physics found the earlier interest in sound and light,



Raymond L. Wegel

which had led to special courses therein, rapidly giving way to X-rays, radioactivity and the developing field of electronic physics. Sound could not compete in research interests with electronic physics, and because of its few practical applications it made no appeal to the engineering student.

To us in the Bell System sound has always been an important and necessary study; and in recent years this study has been cumulatively more productive. A large number of scientists have been engaged in the work, and they have been greatly assisted by the development of the thermionic vacuum tube and its use in the amplification and measurement of sounds which have been telephonically converted into electrical currents. A new technique for sound experimentation has been developed; and fruitful analogies and new methods in the mechanical problems of sound have arisen from the studies of electric phenomena. The classical theories and methods of Lord Rayleigh, usually familiar only to the intense student of the subject, have been expanded and new devices have been developed until one might almost say that there had been evolved a new science of sound. Certainly there has been a scientific development with many important practical applications in the modern art of electrical communication.

The interest in the practical applications of the theory of sound which is felt by the student of communication engineering, the aurist, the otologist, the psychologist, and even by the general practitioner of medicine, as the reader of the articles on heart sounds in previous

issues of the RECORD will recognize, seems to be forcing in our universities a revival of interest in the subject itself.

Coincident with the last few years of these developments there have been conducted in our Laboratories out-of-hour courses through which members of the technical staff were able to obtain from each other a theoretical training in the subject and a first hand knowledge of the new methods and technique. Several courses on various phases of the subject have been given from time to time to large classes. Some of the material thus presented has, at the same time, been reaching university audiences through the technical papers which members of the Laboratories have published.

The net result of all this is a growing demand in several academic institutions for a modernized course in sound which will tie together the classical theories, and their more recent extensions, with the most recent experimental work. Such courses are being given in the out-of-hour program of the Laboratories. Educators have suggested it would be a helpful contribution if some of this course material could be repeated in universities by members of our technical staff.

This was done, in the case of theories of telephone transmission, by K. S. Johnson at Harvard. With the publication later of his text on that subject other institutions have been assisted in their courses in that field. At the University of Chicago, H. J. van der Bijl* gave a course on thermionic vacuum tubes and his text has been widely used in universities and technical schools. At the University of Michigan last summer Harvey Fletcher gave a short course on speech and audition. And now at Massachusetts Institute of Technology Irving B. Crandall and Raymond L. Wegel are giving a course on sound which includes part of the material previously presented by them in their out-of-hour courses.

Irving B. Crandall

At the invitation of the Electrical Engineering Department of Massachusetts Institute of Technology a course of forty-five hours is now being given, the first half by Mr. Crandall and the second by Mr. Wegel. While this course is nominally for

* *H. J. van der Bijl, a member of the Research Department, 1913-1920; now Director of the Department of Mines and Industries, Union of South Africa.*

the benefit of students taking the communication option in electrical engineering it is drawing its attendance in part from graduate students and the younger members of the instructing staff. The first twenty-five hours given by Mr. Crandall follow quite closely the subject matter of the course on sound which he gave in the out-of-hour courses last year. The text material for this course has been revised by him and brought up-to-date and is now on the press for early publication. The last twenty hours of the M. I. T. course will be conducted by Mr. Wegel and will consist very largely of material similar to that of the course which he is giving this year in our Laboratories.

With the completion of this joint course our part in the solution of the present educational problem will have been accomplished, so far as concerns the subject matter of this course. Our scientists will have turned over to the educators of the next generation of scientists certain new material and methods which should prove of real value.

A Peculiar Error

IT is the exception, according to the old proverb, which proves the rule. Much of the present interest and popular recognition which is being given to science and its workers must be credited to the newspapers of our country. As a rule the news-gathering agencies follow quite closely any written notes or picture captions with which they are supplied by the company or the individual scientist whose work they are reporting. Such obscurity as arises is frequently the result of the necessity of shortening statements, because the general reading public demands tabloid presentations, and in this process there may be eliminated material which, from a scientific point of view, is necessary. Less rarely does obscurity arise from the expansion of the original material. But one such case of highly imaginative expansion, which has come to the attention of the Record, is a humorous exception.

Early in January popular attention was directed again to our audiometer because of its use by the Science Editor of *The Forum* to measure street noises at various points in New York City. Pictures of audiometers were immediately in demand by newspapers, and were supplied to various news agencies. The pictures were accompanied by brief and scientifically correct captions, which stated that the audiometer shown in the picture was a development of Bell Telephone Laboratories for measuring the sensitivity of the human ear to sounds of various pitches within the range of speech and music. One picture showed an audiometer with Harvey Fletcher and two young ladies posed as under the ordinary conditions for its use in making a record of a patient's acuity of hearing. This is the amazing caption which that picture received at the hands of a news agency:

NEW EARS MADE FOR THE DEAF

New York . . . Photo shows Dr. Harry Fletcher, of the Bell Telephone Laboratories, and the designer of the audiometer, as he appeared in the laboratory experimenting with his invention, the audiometer, upon a deaf woman.

The audiometer is an instrument, composed of a tiny telephone receiver, weighing but half an ounce, and fitting into the outer ear, and an artificial larynx. This instrument permits a deaf person to hear. Sound enters the microphone, from there the artificial larynx admits these sounds to enter the throat and mouth, thus enabling the afflicted person to hear plainly.

Considerable ingenuity must have been required to construct this caption, which is a scrambling of several stories relating to different phases of the work on speech and hearing which has been carried out in the Laboratories. One naturally wonders where the caption writer obtained the information which enabled him to expand the caption with which he was originally supplied. The explanation appears in the fact that on the same day there appeared in the New York papers an Associated Press dispatch from Chicago which read as follows:

Chicago, Jan. 14 (By A. P.).—A tiny telephone receiver, weighing only a half-ounce and fitting into the outer ear, an artificial larynx and an audiometer for measuring hearing were described today by Paul B. Findley, of the Bell Telephone Laboratories of New York, to members of the Electric Club here.

For severe cases of deafness, the speaker explained, a two-stage vacuum tube amplifier is provided. A microphone picks up the speech. The artificial larynx, he said, was a device that would artificially produce and feed into the throat and mouth sounds which were molded into syllables and words.

That the exception proves the rule and that as a rule our news-gathering

This is the picture which received an astonishing caption

agencies must be credited with a very remarkable performance in the correctness of their accounts of scientific accomplishments is evidenced also by this Associated Press dispatch. Each sentence is technically correct. In the short space of two paragraphs, however, there are summarized the important ideas of an hour's talk. Any obscurity which might arise in the mind of a reader is due to the compactness of the statement rather than to any technical inaccuracy.

An incident in this connection gives proof of the widespread public interest in hearing aids. The Associated Press dispatch quoted above was widely published throughout the country. As a result the Laboratories received over two hundred letters from persons of reduced hearing, or their friends, asking for further information.

How the Laboratories Will Observe March Tenth

FIFTY years ago on March tenth the personnel of Bell's telephone laboratories consisted of Mr. Bell and Mr. Watson. Today Bell Telephone Laboratories, Incorporated, includes over 3600 men and women.

Fifty years ago Mr. Bell addressed his fellow worker over the first telephone system. Since those early days, because of the larger personnel involved, it has never been practicable, even when it might have been possible, for the leader of the laboratory work to address practically all of his associates at once over the telephone.

On March 10, 1926, however, at ten o'clock, Frank B. Jewett, Vice-President of the American Telephone and Telegraph Company and President of the Bell Telephone Laboratories, Incorporated, will speak over the telephone to the members of the Laboratories who are at West Street and in the Tube Shop at Hudson Street.

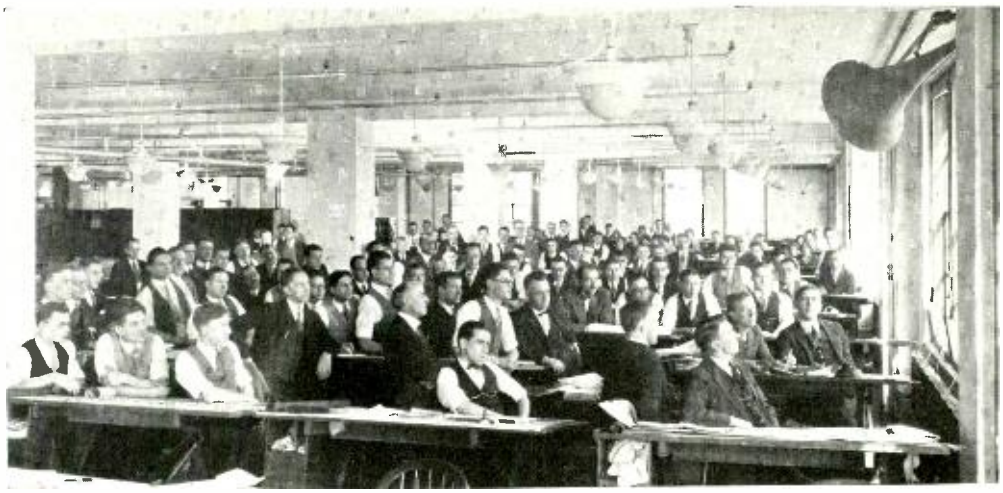
For fifteen minutes all work in the laboratories will be stopped; the elevators will cease running; and only incoming calls will be answered at the P. B. X. board. For these fifteen minutes we shall pause to consider the mighty scientific development of which we are a part and to commemorate its fiftieth anniversary.

Arrangements for this event in the history of the Laboratories are being made by members of Omer M. Glunt's department, who are responsible for the transmission features, and by the Building and Personnel Departments. The technical accomplishment is in charge of Howard B Santee, from whom the RECORD quotes certain details as to loud-speaker and amplifier equipment.

A standard high-quality transmitter, of the type common to both broadcasting and public-address installations, will be used by President Jewett in the office of Executive Vice-President Craft. This transmitter will be connected by wire circuits from Mr. Craft's office on the twelfth floor to a standard 1-A Public Address System located in one of the laboratories on the eighth floor. From this point will radiate throughout the building a network of circuits, to which at various points will be connected sound projectors. Thus we shall have an ordinary public-address system, with its voice pick-up, its amplifier, and sound projectors applied to an out-of-the-ordinary use. Special wires will extend to 395 Hudson Street, where special amplifying equipment installed at their terminals by engineers of Mr. Santee's group will enable the members of the Tube Shop to hear Dr. Jewett's address.

The public-address system to be used is our most powerful equipment of this type, and is suitable for large outdoor installations or situations where many sound projectors are to be connected to its output. Normally it will cover an area represented by a circle whose radius is about one thousand feet, an area which can accommodate thousands of people.

Throughout the building it is



How the loud-speakers will be used, as illustrated by a test in the Telephone Systems drafting room

planned to use twenty-six of the 549-W receivers equipped with 6-A horns, and eight 540-AW loud-speaking telephones. The horn which is to be used is the three-foot straight horn common to public address work. The receiver element, however, is the latest type in which improvments in efficiency and quality have been brought about. The 540-AW is the familiar cone-type loud-speaker.

The horn-type loud-speaker is being used in many cases, where a directional effect is desirable. For example, in large open sections of the building or in hallways, because the distances to be covered are relatively great, the horn is used and advantage taken of the fact that the sound is thrown in one direction. In the smaller areas, however, where a wide distribution is more desirable the cone-type will be used because of its practically non-directional action.

Nearly all of the large sections in which are located many desks are being equipped for this occasion. In sections of the building where there are large numbers of smaller offices it was not thought advisable to supply each office; and accordingly central assembly points have been chosen, as to which announcement will be made in sufficient time, where the occupants of these offices may listen to the talks.

At the output of the amplifier there is a distributing panel to which are connected the various circuits running throughout the building. This volume-control panel permits an adjustment of the volume of the projectors connected to each individual circuit; and thus the variation in size of the different areas to be covered will be compensated for so that only sufficient volume of sound will be supplied to cover comfortably each space. Areas of the same size will have their loud-speakers connected to a common circuit in which the volume will be properly adjusted at the amplifier position before the ceremonies begin.

The aim of the General Staff Department is, and must be, to perform with efficiency and economy those corporate and general services which will facilitate the Research and Development work of the Laboratories.

Services performed under the grouping of activities in the General Staff Department of the Laboratories are of value only to the extent that they further the performance of the Laboratories' primary function as a business institution organized for the purpose of carrying on Research and Development work.

E. P. CLIFFORD, *Vice-President.*

The General Staff Department

By J. S. Hartnett

In our daily life in the Laboratories, with its primary purpose of research and development in electrical communication, we are naturally prone to give that purpose our fullest thoughts. The business or commercial aspects of the organization we are thus likely to feel in general result rather than see as continuously abetting elements in the day's work. We know, of course, that the Laboratories has a corporate status in New York State, and an associate status in the Bell System. As a corporation, we understand generally that we must observe the legal requirements of the state and federal governments. We realize that as an Associated Company, our engineering function must be made to fit into the composite commercial purpose of our System in serving the public. And as an organization within ourselves our operations must run the gamut from the employment of personnel to the providing of adequate housing, materials to work with, medical attention, and the wherewithal to fill our pay envelopes. Where does the responsibility for these matters rest? How is it organized?

Recounting a little of the history of our earlier organization as the Engineering Department of the Western Electric Company, let us begin in the days when the executive offices of that Company and its New York house were also located at West Street. The Engineering Department was concerned then only in engineering. Financial, commercial and service functions were managed from the executive offices. But in 1917 we were left in exclusive possession of the building and shortly it became apparent that these functions—which were seen to group themselves generally into personnel, commercial and office service, accounting and finance—were a vital conjunct of the engineering function and would best be handled if established as a separate department of the engineering organization. With the entry of our country in the same year into the World War, the Bell System placed all its resources at the service of the government. Both the Army and the Navy called upon our engineers for assistance and actual development of wire and radio communication devices. In some cases, as for instance vacuum tubes, large scale manufacture was carried on.

It was such sudden increases in commercial relationships which led to the determination to add to the staff of Dr. Jewett, then Chief Engineer, the services of a man of broad experience in the general business affairs of the Western Electric Company. It thus came about that on July 1, 1918, Edward Preston Clifford, then in charge of Western Electric branch houses in the Eastern District, was appointed Office Manager at West Street. In April, 1919, he was appointed Commercial Manager and with the incorporation of the Lab-

oratories was elected Vice-President with supervision over its General Staff Department. At the same time there were added to his staff the Secretary and General Attorney, the Treasurer and the Director of Publication.

Mr. Clifford entered the Western Electric in November, 1892, and advanced during the next six years to be cashier of the New York office. After being Chief Clerk at

James E. Moravec, Commercial Manager and General Auditor

Chicago, Philadelphia and New York, he became Assistant Manager of the New York House, and in 1911 its Manager, with supervision of the Boston, Philadelphia and Pittsburgh Houses. In 1917, he was appointed Eastern District Manager. With these twenty-five years of experience, Mr Clifford brought to West Street a recognized ability as an organizer, and with his natural interest in developing men, was able to apply a broad understanding of job and man requirements to his new work. Of significance in his present office is his sympathetic appreciation of research and development and the importance of such work in its application to the general field of communication.

The same surge of war-time activity brought J. E. Moravec in February, 1918, from the Hawthorne Works, where he had been in charge of costs and expense accounting for the Manufacturing Department. Mr. Moravec was graduated from Loyola University in 1900, and two years later entered the Western Electric Company. Starting at West Street as Chief Accountant, his responsibility grew not only with the organization, but by the addition of new functions. In October, 1919, he was made an Assistant Commercial Manager with statistics, payrolls, accounts and finance as activities of his department. In 1922, commercial service and in 1923, general service were added. With the formation of our present corporation, Mr. Moravec became Commercial Manager and General Auditor.

Commercial relations with the American Telephone & Telegraph Company and the Western Electric Company as those customers whom we serve, and with suppliers are under the direction of C. W. Lowe, Commercial Service Manager, a member of Mr. Moravec's staff. This activity may be divided generally into purchasing, merchandising and commercial customer relations. Through the Purchasing Department are secured the multitudinous things re-

quired in the operation of the Laboratories—raw materials, stationery, plant equipment, books, restaurant supplies, items for personal purchase by employees—from a bank pin to an electric photostat-dryer. The merchandise activity comprises the maintenance of stocks for such of these materials as are regularly used, the receiving of materials, the handling and ultimate disposal of by-products, or junk and the shipping of completed merchandise.

The output of the Laboratories is so largely one of ideas that few realize the substantial amount of merchandise produced. In addition to vacuum tubes made at Hudson Street, a considerable amount of equipment which is still in the course of development is made in our Engineering Shop. Likewise, certain installations of telephone, radio broadcasting, public address and other systems are made or supervised by our engineers. These activities have aspects at once commercial and technical since there is involved the preparation of estimates and costs of the work as ordered by our customers and the eventual disposition of the expense incurred. For purposes of expediting the commercial phases, each order as carried out is assigned to a specialist who devotes his attention to particular apparatus or systems.

This group of specialists, or contact men, is under the supervision of Bayard B. Webb, reporting to Mr. Lowe, with the responsibility of seeing that all details are attended to at the proper time; that is, the specialist confers with the engineer in the preparation of cost estimates; he has an engineering case authorized to cover the work; he arranges for the purchase or manufacture of material specified by the engineers; he takes care of the eventual shipment of the material and when the job is completed aids in analyzing the expense involved with regard to its disposition.

General service in the Laboratories is furnished by the General Service Department in charge of Kenneth B. Doherty, another member of Mr. Moravec's staff. To us "general service" means the library; the correspondence files, office service such as mail, messenger, telegraph, photostat, photographic and blueprint facilities; and the transcription service. The Library, familiar to us all, contains some 8,000 books, and 3,000 pamphlets, and is concerned with the circulating and filing of about 300 technical magazines and the preparation of bibliographies and abstracts for our technical staff. The Transcription Department furnishes central typing and stenographic service and affords training in these lines —many of our secretaries have there had their initial experience.

Mr. Moravec is himself in direct charge of General Accounting. The Cost and Accounts Department, in charge of E. J. Santry, is concerned with the recording of money invested in our physical plant — the building and its equipment—and the cost of operating and maintaining it; the compiling of engineering case costs; the making up of payrolls; the handling of vouchers in payment of bills; and the maintenance of the general books of the corporation.

Functions more of the investigative than operating character are assigned to the Statistical Department in charge of A. O. Jehle and the Methods and Audits Department in charge of J. S. Hartnett. The interpretation

of data accumulated from sources both within and without the Company, relating to the broader questions of accounting as applied to the work of the Laboratories; the preparation of standards or budgets for use as guides in operating results; the construction of graphic charts; and the furnishing of data on special subjects are functions of the Statistical Department. Data is accumulated and studied, and conclusions presented in suitable form to executives for action or information. The preparation of our annual budget and the comparison of actual results month by month is one of the activities. Mr. Jehle briefly discussed budget preparation in a recent issue of the RECORD.

Warren B. Sanford, Plant and Shops Manager

The Methods and Audits Department is charged with the broad consideration of methods of operation in accounting and in the performance of commercial and other services, the preparation and issuance of general executive instructions and bulletins, and the standardization of office equipment and stationery. It makes comparisons of methods and formulates and recommends new ones or revises those current, with a view to eliminating or minimizing waste, effecting better coordination between departments and supplying the routine necessary for the proper handling of activities in connection with accounting and commercial work. In addition it is responsible for auditing the accounts of the Company.

In 1901, W. B. Sanford, a Cornell graduate in engineering, came to West Street, reporting to the Electrical Engineer of the factory. Except for two years' absence, Mr. Sanford was connected with this manufacturing work, of which he was made head in 1912. With the transfer of all manufacturing to Hawthorne at the close of 1913, he remained as Superintendent of the West Street building and its shops. In May, 1916, he became Purchase Engineer and was located at 195 Broadway for a year and a half. Late in 1917, on account of the increasing demands on the Engineering Department for war material, he returned to West Street, resuming substantially his former responsibilities. Mr. Sanford is now Plant and Shops Manager, reporting to Mr. Clifford.

Operations of the Engineering Shop are under the superintendence of J. W. Upton. The functions of the Shop, as previously described in the RECORD, are to make up apparatus for experimental work and models

for trial, and also to make devices and equipment, during the process of development, for customers' accounts. Operation and upkeep of the building are supervised by S. H. Willard, Assistant Plant Manager, who with his staff is responsible for the handling of engineering matters relative to plant and repairs thereto; the maintenance of our building restaurant; the operation of power, telephone, elevator services; and the cleaning and guarding of the building. J. G. Motley, also an Assistant Plant Manager, has recently been concerned with the plans and work on the new section of our building.

In earlier days personnel work had been handled informally by department heads and supervisors, with some assistance in routine matters from a central group. With the growth of our organization it required intensive development along broader lines. The need was seen to be one of procuring suitable men and women, giving them elementary training in our work and opportunities for subsequent study, placing them where they could be most useful, and furnishing medical and other assistance as might be necessary. To meet this, the Personnel Department was set up in 1918. George B. Thomas was transferred from development work on submarine detection and put in charge of technical training. Mr. Thomas had entered the Laboratories the previous year after an extensive experience as an educator. He was graduated from Ohio State University in 1907, where he was prominent in athletics among other activities. He later taught at Massachusetts Institute and at Colorado College, where he was head of the Department of Physics and Electrical Engineering. Under his supervision many forms of training have been arranged. These include an extensive group of out-of-hour courses given by members of the technical staff; a course for high school graduates by which they may reduce their major handicap as compared with college-trained men in doing development work; an apprentice course for instrument makers; and facilities for part-time post graduate work. In 1925 Mr. Thomas was appointed Personnel Director.

George B. Thomas, Personnel Director

On Mr. Thomas' staff, Dr. John S. Waterman is Medical Director. Under his supervision is the medical service rendered to our organization. Maurice B. Long is Educational Director. He is in charge of the selection and placement of members of

the technical staff and the training courses outlined above. To his work Mr. Long brings past experience in our research and engineering inves-

James W. Farrell, Secretary and General Attorney

tigations. Among the functions of A. F. Weber, who is also Secretary of our Benefit Fund Committee, are employment, personnel studies, and general employee relations. This latter activity is under the supervision of Clyde Drake, who is also Assistant Secretary of the Benefit Fund Committee.

The general legal affairs of the Laboratories are in the hands of J. W. Farrell, who entered the employ of Western Electric Company as a law clerk in 1911. Four years later he was made Assistant Secretary, and in 1919 was assigned the additional duties of Assistant Attorney. He was placed in charge of the work of the Secretary's Department in 1923, and later in the same year was made Secretary of the Employees' Benefit Fund Committee. Upon the incorporation of the Laboratories, he was elected its Secretary and was placed in charge of the General Legal Department. As Secretary he is responsible for the corporate records and documents of the company; has charge of issues and transfers of capital stock and keeps records of all meetings of the stockholders and directors. As General Attorney he is responsible for the legal form of con-

William B. Wallace, Treasurer

tracts, leases, bonds and other documents of the company, tax and other reports, statements and affidavits as are required by law. He is respon-

sible for advising the various departments of current legislation and decisions of courts and commissions affecting the company's business, and for the rendering of opinions on legal questions affecting the company's business and relations.

W. B. Wallace, our Treasurer, was elected in January, 1925, coming from an assistant treasurership in the Western Electric Company. He entered the financial department of that company in 1890, and from 1911 until 1924 was Credit Manager of the Atlanta House. In his present office he is responsible for receiving, safeguarding and disbursing money and securities of the corporation and for insurance matters. He passes upon the credit standing of suppliers, and on request advises with members of the organization as to their individual financial problems. R. F. Newcomb is Assistant Treasurer.

W. L. Richards* is also a member of Mr. Clifford's staff as Consulting Historian. His extensive knowledge of the telephone business from long service in the Bell System makes available to those who carry on the Museum work, to which he contributed so much, and to the organization as a whole historical facts concerning the art of communication.

Research work and authorship are the two principal elements in the experience of John Mills, Director of Publication. Starting in physics at the University of Chicago, he became interested in the practice and teaching of engineering. He was attracted to the Bell System at the time of the formation of our Research Department and entered the Engineering Department of A. T. & T. in April, 1911. He was intimately connected with transcontinental wire telephony and transatlantic radio telephony in their early days. Some twenty-two patents and ten pending applications record some of his contributions to the art; among these might be mentioned the echo suppressor of four-

John Mills, Director of Publication

wire telephony. After further experience in our Research Department, to which he was transferred in 1915, he became Educational Director and later Personnel Director. During these more recent years he wrote several books dealing with radio and electronic physics, and developed an interest in publication, to which work he was transferred soon after the incorporation of the Laboratories. Reporting to Mr. Mills are L. S. O'Roark, Information Manager, and Paul B. Findley, Editor.

Mr. Richards' portrait appeared on page 137 of the RECORD *for December, 1925.*

Radio Engineers Visit the Laboratories

By George F. Fowler

During the annual convention of the Institute of Radio Engineers in New York, January 18 and 19, 1926, inspection trips were arranged for its members. On the committee responsible for these arrangements were William E. Harkness, Assistant Vice-President, American Telephone and Telegraph Company; and Kenneth B. Doherty, representing the Laboratories. The radio engineers visited the studio of WEAF on the morning of January 19 and spent about two hours in our Laboratories in the afternoon.

The first impression and, indeed, the last impression that guests visiting the Laboratories under such conditions obtain is from their reception by the watchmen and elevator men. It is interesting to note that where such large groups are entertained there are always some who comment favorably to their guides upon the efficient and courteous manner in which they have been introduced to the building.

The next step in the reception of

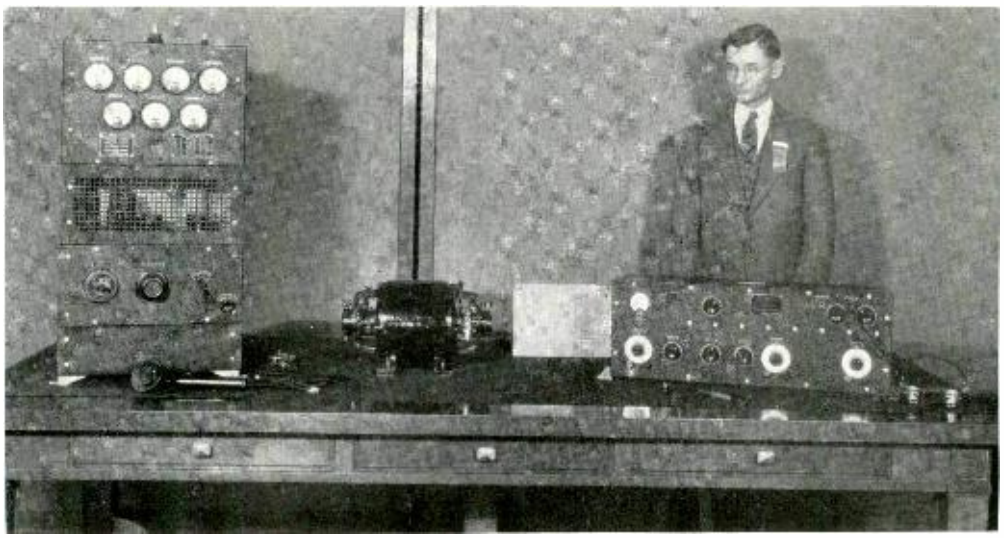
H. S. Price explained the 6204-D Radio Receiver designed for use with broadcasting stations

guests is to assemble them in one of the class rooms of the Personnel Department, where they may check their coats and hats and then be divided into groups and introduced and assigned to guides. In accordance with previously arranged schedules the guides conduct their parties through the building to various laboratories where work may be seen in process or particularly interesting pieces of apparatus demonstrated and explained.

The guides are usually chosen with reference to the visitors who are being conducted through the Laboratories. For example, in a recent visit of equipment engineers who had been attending a conference called by the American Telephone and Telegraph Company the guides were supervisors from the Telephone Systems Department. In each Laboratory which is scheduled for a visit there is an engineer who is responsible for the apparatus and for explaining to the successive parties its operation and significance in the communication art.

In the case of the recent visit of radio engineers, because of the special interests of the party some commercial pieces of apparatus developed by the Laboratories were displayed on the eleventh floor. These exhibits were arranged by the group in the Apparatus Development Department which is concerned with the design of radio equipment and public address systems. The equipment of Station 2XB, which, is also on the eleventh floor, was exhibited together with some of the commercial broadcasting equipment which has been designed by the Laboratories.

The shortness of time at the disposal of the guests prevented their seeing many places of interest in the building; but to give them an idea of the fundamental side of our work, which has to do with wire communication, they were shown some of the latest developments in step-by-step and panel types of machine switching equipment. Some but not all the groups into which the guests



P. H. Betts described a 50 watt radio transmitting and receiving outfit

The men who introduce our guests to the building; Standing, James Cusack, John Hughes, Thomas Creaven; Seated, Dennis Cronin, Martin White, William Carroll

were divided had an opportunity to see the developments which led to application in the new acoustic talking-machine; and other groups had a chance to listen to heart beats through the electrical stethoscope and to see them as shown by the cathode-ray oscillograph. The equipment, set up for this purpose in the Museum, was that used by Mr. Snook before the A.A.A.S. at Kansas City and before the New York Electrical Society on February third.

In addition to the exhibits which have already been mentioned or are shown in the accompanying pictures our guests saw the use of liquid air; the 6204-D radio receiver for broadcasting stations; the combination of 6004-D receiver, 6025-B amplifier and 540-AW cone-type loud speaker; the electromagnetic phonograph-reproducer operating with a 32-A amplifier and a 36-inch cone; 50 watt and 1000 watt radio transmitters for broadcasting; and also equipment for photo-telephony.

Why the Time-Clock Knobs Are Black

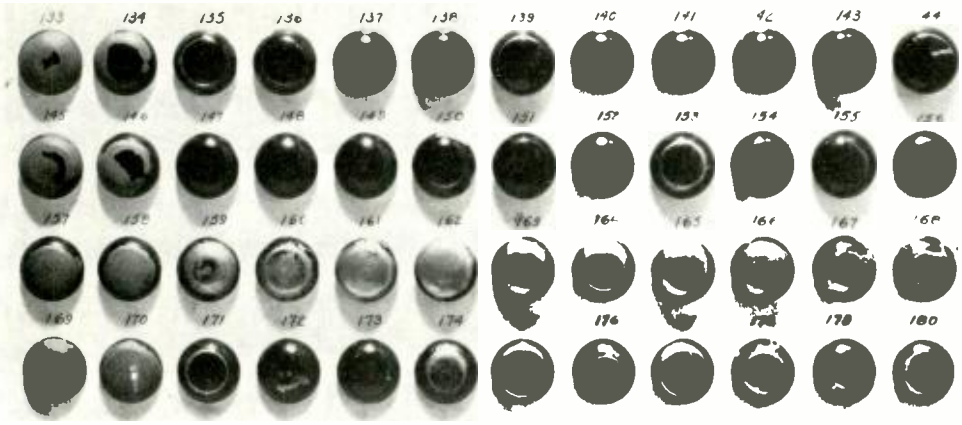
By Edward M. Honan

THE starting of a series of tests in our laboratories ordinarily does not cause particular excitement nor arouse any general curiosity. But one summer's day almost three years ago, when a life-test study was begun on the black baking japan that is used to make the telephone black, there was not a little wondering and questioning. On that day, as many of us recall, the bright nickel knob on the handle of the time clock was replaced by a black one. And for what reason? Nobody seemed to know why, except possibly Mr. Carr, the clock man, whose picture appeared in a recent issue of the Record. Mr. Carr did know, and so did several people in the Building Department, together with the members of the Chemical Research Department who were actually conducting the test. The life-test study on japans is still going on and the clock knobs are still black.

A japan, by the way, is a variety of metal finish, partly paint in nature, and partly varnish. The peculiar thing about it is that, as a rule, the finish is baked in an oven instead of being allowed to dry of its own accord, as paint does. The usual procedure is either to dip the article to be finished into the liquid japan or to spray the liquid japan onto the article by an atomizer. The article is then placed in an oven and heated until the coating is sufficiently dry and hard. Although the process appears very simple, much time and study have been spent in determining the most desirable temperature of baking, as well as the most satisfactory time. When one remembers that this baking operation, which requires approximately two hours, dries the finish as thoroughly as if the article were exposed to the ordinary sunlight for several days, it is easily seen that a great many difficulties may be encountered in the baking. The first thing that happens in the oven is the removal by evaporation of the "thinner" which was used to render the japan sufficiently liquid for application. After the solvent has been evaporated, the temperature is raised to bring about the actual drying or hardening of the finish. If this temperature is raised too quickly and the drying becomes too rapid, an unsatisfactory finish is produced; conversely if the temperature is too low the finish is under-baked, and does not give suitable service.

There are many other interesting stories which could be told about japans: how the name originated from covering-materials used for centuries by the Japanese; how water-soluble japans are applied; the story of crystalline japan finishes. But we started to tell why it is that the knobs of the time clock are black.

The telephone desk stand is the point of most intimate contact between the Bell System and the subscriber. It is particularly desirable



Time-clock knobs used in testing japan finishes

that the finish on this article remain neat and serviceable. Black baking japan has been used for many years, but sometimes this finish becomes soft and presents a bad appearance. The telephone engineers have spent much effort to find the cause of the trouble and to remedy it.

Remedies seemed easy until one thought about it for a while. Then a multitude of questions assailed the thinker on all sides and angles. Was an inferior grade of liquid japan being used? Did the shop clean the metal properly? Was the baking correctly done? Was the failure due to the wear alone, or due to perspiration on the hands of the subscriber? Was a japan the proper kind of a finish to use in this service? These questions and others of similar nature could not be answered until there was available a standardized and sensitive test to prove the correctness of the various ideas.

When trial lots of desk stands were put in ordinary service the results only added to the confusion. It was apparent that the trial stands received a wide variety of treatment. Some were used much; others little. A few were sadly banged about and the rest treated with due consideration. Some were used exclusively by a single individual who might or might not be fair, fat and forty, and who might or might not perspire freely. Other stands were handled by many individuals whose hands were clean, dirty, or oily, according to their several occupations and habits. Various test pieces were suggested; door knobs, typewriter or comptometer keys or bars, brass railings, bell buttons, or special test devices with which boys in the laboratory might entertain themselves by handling all day long. None of these suggestions compared with the happy thought of using time-clock knobs. Each knob receives a recorded number of contacts with the hands of a number of individuals who may be expected to represent a fair average of the public at large.

The results obtained have been gratifyingly consistent and instructive. W. R. Erickson, W. H. Strain, and R. E. Waterman, who with the author were responsible for the

work, have had to commiserate each other on only one defect: some people's curiosity apparently overcomes them and knobs are occasionally found showing the effects of attacks by nail files. Also apparently a belief is current that scratching the knobs will serve to tell paste diamonds from the genuine. In the interest of truth and science it should be said that this is not the case.

It was not the intention to use time-clock knobs indefinitely for testing japans, since chemical tests might be devised which would be more rapid and convenient, and applicable directly to a variety of parts of the desk stand and subscriber's set. The time-clock knobs were used to indicate the possible chemical tests and to verify the truthfulness of the chosen test. An excellent test is one carried out with a solution of phenol (carbolic acid), a sort of varnish remover which will evaluate japans in a few hours almost as well as the time-clock service can do in months. Either the chemical test or the time-clock test will tell whether the metal is properly cleaned and whether the japan is well chosen and suitably baked—in short, whether the finish will endure in service.

The accompanying photograph shows a set of knobs which have been removed from the time clocks after a seven-months' test. The japan on the two upper rows was baked under conditions which, it was expected, would produce a very satisfactory finish. The finish on the two lower rows of knobs was baked under conditions which, it was expected, would give a finish that would not last in service. The two left-hand knobs in each row were subjected to the phenol test. It will be noted that the finish of each of these knobs has been removed by the action of the testing solution. However, the time required to remove the finish from knobs numbered 133, 134, 145 and 146 was two and one-half times as long as the time required to remove the japan from knobs 157, 158, 169 and 170. These results of the phenol test, therefore, checked quite well with the service test as represented by the entire group of knobs. The conditions under which the next-to-the-bottom row of knobs was baked were considered to be least desirable of the four. It can readily be seen that in practically every case the finish on this group of knobs was entirely removed in seven months' service, whereas the finish on the knobs in the two upper rows was practically perfect after that same period of test. Also, the time required to remove the finish from knobs 157 and 158 in the phenol solution was just one-fifth of that required to remove the finish from knobs 145 and 146. The finish on each of these knobs was two coats of japan, and each coat was baked for the same time and temperature.

Events have proved that most of the ideas regarding the causes of failure were partly right, and that there are a number of factors affecting the life of the japan finishes. However, none is more important than the degree of baking. During last year the Development Branch at Hawthorne has greatly improved the control and manufacturing methods. To a great extent this has been due to the testing methods described.

News Notes

During the month of February a number of groups and individuals made inspection trips through the Laboratories. February tenth brought the annual inspection trip of the American Institute of Electrical Engineers, whose mid-Winter Convention was in session in New York during that week. Among the other visitors of the month were Professor W. S. Ayars with a group of Columbia students in industrial engineering, and about twenty members of the Transmission School of the Bell Telephone Company of Pennsylvania.

The third annual exhibition of Printing for Commerce was recently opened by the American Institute of Graphic Arts at the Art Center, 65 East 56th Street, New York. This showing of one hundred pieces of commercial printing produced by various firms throughout the United States, has as its object the improvement of typography particularly in the fields of advertising and publicity as distinguished from bookmaking. While the Institute makes no pretence that the work shown is the best of its kind done during the year, it is considered fairly representative of the higher type of printing devoted to the promotion of commerce; and it will be a source of satisfaction to members of the Laboratories to know that the first number of Bell Laboratories Record is among the exhibits.

The winter term of our out-of-hour courses started on Monday evening, January 25th, with an enrollment of 472 in eighteen courses. The courses being conducted and the instructors are as follows:

Elementary Differential Equations, L. A. MacColl; Patent Law, J. W. Schmied; Theory of Probability, T. C. Fry.

Theory of Telephone Quality, R. L. Wegel; Theory of Telephone Transmission, A. W. Horton; Theory and Practice of Transmission Networks, T. E. Shea; Advanced Transmission and Circuit Theory, C. R. Englund.

Manual Telephone Systems, R. H. Miller; Panel-Type Machine Switching, G. Thompson; Toll Systems, C. W. Greene; Step-by-Step Systems, E. D. Butz; Telephone Systems Engineering, S. B. Williams.

Physical Chemistry, A. C. Walker.

Speed Dictation, Miss H. B. Mayhew; English Grammar, Miss G. L. Prouty; Typing, Miss C. Ritter.

Drafting, J. E. Clark; Shop Reading, C. W. Maurer.

The second term in the course in Theory of Probability shows a considerable increase in enrollment over the first term, as a number of those who took the first term's work when it was given a year ago enrolled to continue in the course. Interest in the course in Theory of Telephone Transmission continues to be so strong that two sections are being given this term as well as last term.

At the annual dinner given by the Polytechnic Institute of Brooklyn, Sergius P. Grace described and demonstrated some of the apparatus

developed in Bell Telephone Laboratories as a result of our fundamental studies in acoustics and transmission. Among the exhibits shown by Mr. Grace were the artificial larynx, electrical stethoscope, audiometer, electrically cut records, and electrical filters.

At the Midwinter Convention of the American Institute of Electrical Engineers held in New York during the second week of February, three papers were presented by Bell System engineers. A review of the art of loading telephone circuits was given by William Fondiller and Thomas Shaw; a printing-telegraph-cipher system developed during the war was described by G. S. Vernam; and methods and apparatus for high-quality phonograph recording and reproducing were outlined by Joseph P. Maxfield and Henry C. Harrison.

"Electrically Amplified Heart Beats" was the subject of an address and demonstration by H. Clyde Snook before the New York Electrical Society.

On February First W. J. Ripkey, of the Inspection Department's Field Engineering Force, became Local Engineer for the Chicago District, with headquarters at 111 West Washington Street, Chicago. Mr. Ripkey's district embraces the territory covered by the Illinois Bell Telephone Company.

R. C. Kamphausen has been appointed Local Engineer for the St. Louis District, with headquarters at 655 Planters Building, St. Louis. Mr. Kamphausen's district embraces the territory of the Southwestern Bell Telephone Company.

The headquarters of the Inspection Department's Field Engineering Force for the Mid-West territory have been moved from Chicago to Hawthorne. This transfer affects H. J. Knowlton, J. M. Schaefer, and A. I. Rivenes, Miss A. DeMuth and Miss L. Barry. In addition to supervision of the Inspection Department's activities in the territories of the Southwestern Bell Telephone Company and the Illinois Bell Telephone Company, the Mid-West headquarters office will cover directly from Hawthorne the territories of the Northwestern Bell Telephone Company, the Wisconsin Telephone Company, and the Indiana Bell Telephone Company. Effective February first, Mr. Knowlton was appointed Hawthorne representative of the Inspection Department in addition to his duties as supervisor of the Field Engineering Force in the Mid-West territory.

E. B. Hinrichsen, who has been Hawthorne representative of the Inspection Department during the past two years, was transferred to New York in February to assume responsibility for certain phases of engineering complaint work.

R. J. Nossaman, recently stationed in St. Louis as Local Engineer for the Inspection Department, has been transferred to New York in connection with the general activities of the Field Engineering Force.

Maurice B. Long, Educational Director, has been on a six weeks' trip through the territories of the Pacific, Mountain States, and Southwestern Bell Telephone Companies, where he spoke to a number of groups of engineering students, and to several engineering societies, describing the work of Bell Telephone Laboratories. In a few cases he devoted particular attention to the development of picture transmission by telephone.

FOR the last six years basketball has been one of West Street's major sports, sharing with bowling the honor of being one of our two oldest and most successful activities. A great measure of its success has been due to the skillful managership of John A. Waldron, who from 1920 to 1925 was in charge of basketball.

The game was started at West Street in 1920 when we entered a team for the first time in the Telephone Society League. This league was composed of eight teams, representing various associated companies and their branches in the Metropolitan district. The success of this first year prompted us to enter a team each succeeding year until the league was disbanded after the 1923 season.

In 1922 our team, which had won the league championship, was sent to Philadelphia to meet the representatives of the Philadelphia Installation Department, champions of that district. Our boys lost this game, but won out in their return match played later in the season in New York.

John A. Waldron, Basketball Manager from 1920 to 1925

An interdepartment league of eight teams was organized for the first time in 1921. After a hard season's fight, the championship was won by the representatives of the Commercial Department.

No interdepartmental games were played in 1922 and 1923, but in October, 1924, the Western Electric Engineering Club organized another league of eight teams representing various branches of the Engineering Department. All games were played in the Telephone Society Clubhouse on 17th Street; Equipment won the championship without the loss of a game.

Mr. Waldron retired from the managership of basketball after the season of 1925. During the present season, which started on December 8th, the manager is Charles Gittenberger, of the Equipment Drafting Room, who is also a member of the Equipment team. With the first half of the season just completed the Commercial team is leading without the loss of a game. Equipment, winners of last season's championship, are second, having won six games and lost one. The second half of the season started on Tuesday, February 9th. Games are being held every Tuesday and Friday evening at 5:30 in the Labor Temple, 14th Street and

Second Avenue. All members of the Laboratories, both men and women,

Basket Ball: *E. O. Prichard of Toll Circuit blocking C. Hiscock of Junior Assistants*

are invited to attend the games and root for their favorites.

BELL SYSTEM BASEBALL LEAGUE

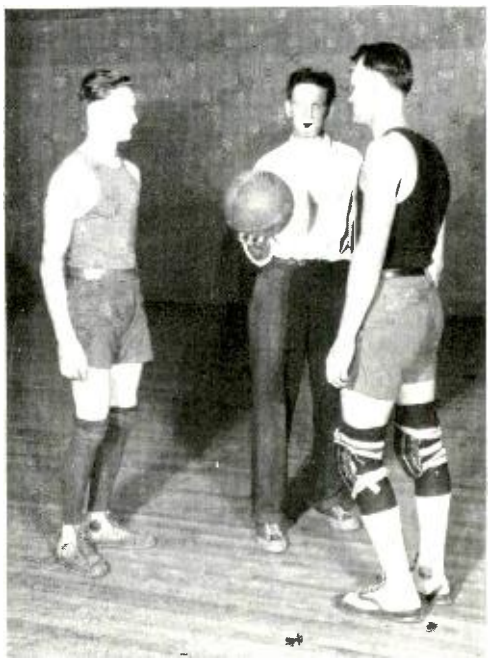
At a meeting held on January 7th, athletic representatives of the various branches of the Bell System in New York City discussed the advisability of forming a Bell System baseball league. Committees were appointed to formulate rules, look after finances, and secure suitable grounds. Another meeting of the athletic representatives was held on January 21st; after reports of the committees had been read and approved the organization of the league was completed and the athletic representatives became an executive committee in charge of the league's activities.

Games will start during the early part of May, and will be played in the evening at Erasmus Hall High School field, Gravesend Avenue, Brooklyn. Each team will play once a week and will meet each of the other seven teams in the league.

The companies who have formed this league are as follows:

A. T. and T. Company.
Western Electric, 195 Broadway.
Western Electric Installation.
Western Electric, Hudson Street.
New York Telephone, L. I.
New York Telephone, Manhattan.
Holmes Electric Company.
Bell Telephone Laboratories.

With the league organized, the



Starting a Basket Ball Game: *C. E. Cerveny of Apparatus Development, Thomas Driscoll, and C. Bisenius of Commercial*

next move is for the Bell Laboratories Club to organize a team which will represent us, a problem which should not be difficult, as we have always had a baseball team of which we could be justly proud. This year's competition is going to be very keen,

as we may expect to meet teams in this league which will compare favorably with some of the Class "A" semi-professionals around the Metropolitan District. Try-outs will be held during April; all that Manager Bartheld needs to assure our team a successful season is to have all of West Street's ball players turn out for try-outs and practice.

Interdepartment Baseball League

As in previous seasons, the Club again this year will have its own league, composed of teams representing the major departments of the Laboratories. All games will be played at Erasmus Field on Saturday afternoons, and it is hoped that the teams will be encouraged by the support of the fellow members of their departments. Full details will be published in the April issue of the Record.

Basketball for Women

The Women's Basketball Committee, at a meeting on February 11, organized a team to represent the Club in outside competition and accepted the challenge of the Western Union team for a game to be played on Friday, March 12, at 6 P.M., in the gymnasium of the Stuyvesant High School, 1st Avenue and 15th Street, New York City.

A professional coach has been engaged by the Club to train and direct the players at practice games which will be played once a week at Friends Seminary, Stuyvesant Square.

This is the second year that the Club has had basketball for women. Modified women's rules are used. The departmental games have been greatly enjoyed by players and spectators, and the first game with an outside team is being eagerly awaited. The Stuyvesant High School Gymnasium provides excellent facilities for watching the game.

Information about the series of practice games and other games that will be played later on, may be obtained from Miss Janet Johnson, team manager, or from Miss Helen Cruger, chairman of the committee in charge of women's interests.

The Commercial team, league leaders at the end of the first half of the season. Standing, W. Steinmetz, C. Maurer, C. Bisenius, J. Smith; kneeling, G. Wolff, T. Ryer, A. T. Hansen

L. R. Harrison of Patent Inspection tries for a goal from foul

Poster Contest

A poster is needed to advertise our Spring Dance at the Pennsylvania. All artists in the Laboratories are invited to submit designs, the winning design to be used as a bulletin board notice and to win a cash prize offered by the Club. Competitors are asked to consult with D. D. Haggerty before designing their posters. The posters must be done in ink and must be submitted to Room 108 not later than March 15, 1926.

Dressmaking Classes

The success of the dressmaking classes held during the spring and fall of 1925 has encouraged the Club to promote another series of classes this spring. Miss Bowman, teacher of dressmaking at Pratt Institute, Brooklyn, will supervise the course, which will cover eight weeks of work, meeting every Tuesday evening during February and March. The charge for eight lessons is four dollars.

If any of the women at West Street who are interested in planning their own Easter outfits have not yet joined the class, the committee in charge will be glad to arrange for them to attend the four classes held during March, at the regular fee of fifty cents a lesson. Miss Hence has charge of this activity.

Report On Employees' Benefit Fund

Bell Telephone Laboratories, Incorporated

January 1—December 31, 1925

In accordance with Section 11 of the Plan for Employees' Pensions, Disability Benefits and Death Benefits effective January 1, 1925, the Company is required to establish a Fund by setting aside therein "at the end of each month an amount equal to 1% of the Company's total payroll for that month, plus an amount equal to all payments charged to the Fund during the month, such procedure to be continued until further action by the Board of Directors."

To meet this requirement the stipulated percentage of total payroll has been set aside as a reserve for the accumulation of the Fund. For all benefit payments made under the provisions of the Plan, the Fund has been reimbursed monthly by including in operating expense an amount equal to such payments. In addition, interest at 4% has been credited to the Fund as of June 30th and December 31, 1925.

Accordingly the record of transactions for the year is as follows:

Fund at beginning of period	$ None	
Cumulative Fund at 1% of payroll for period	87,321.47	
Interest at 4% on average balance of Fund	1,606.96	
Reimbursement for payments made during period	77,553.99	$166,482.42
Payments during period		
Pensions	$ None*	
Accident Disability Benefits	3,501.94	
Sickness Disability Benefits	66,404.15	
Death Benefits	7,180.40	
Disability Expense	467.50	77,553.99
Fund at end of period		$88,928.43

*No employees pensioned during 1925; pensions granted prior to January 1, 1925, being paid by Western Electric Company, Incorporated.

J. E. Moravec,
General Auditor.

Audited and found correct,
William R. Reid,
Traveling Auditor for American Telephone & Telegraph Company, January 30, 1926.