Bell Laboratories Record

Volume Four | March, 1927 | Number One

The String Oscillograph in War and Peace

By A. M. CURTIS

THE World War had not been in progress very long before its combatants learned that they must live in holes in the ground or entirely give up the idea of living. Direct visual observation of artillery fire was almost impossible and airplane or balloon observation was often interfered with by the enemy. Still it was necessary to know where his guns were located. For this purpose the art of sound ranging was developed and used by the French and British armies prior to our going into the war. As the report of a gun travels through the air at a definitely known rate of speed its position can be determined by triangulation if the time of arrival of the report at at least two points can be accurately measured. The only practical way of doing this is to locate several microphones at known points along the front and wire them into some instrument which will record the sound arriving at each microphone in such a way that the time intervals can be measured.

In 1897 a French submarine cable engineer, M. Ader, invented a cable recorder which consisted of a strong magnet having a very fine wire stretched between its poles. The signal current passing through the wire caused it to be deflected and the apparatus was arranged so that the shadow of the wire fell on a moving strip of sensitized paper. After the latter was developed the signal appeared as a white line on a black background.

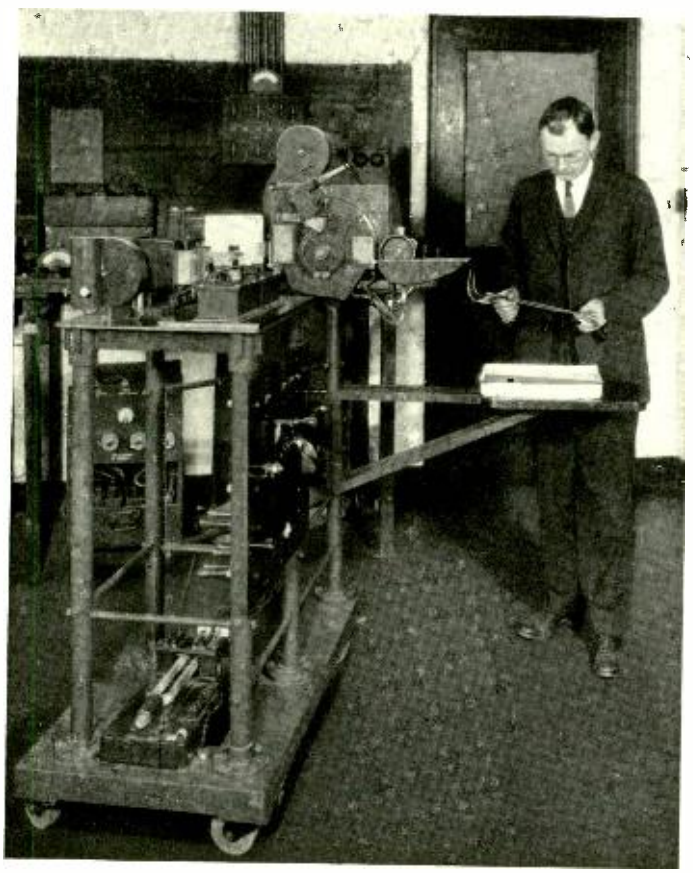
Four years later the Dutch physicist Einthoven utilized this principle in developing his extremely sensitive but equally delicate string galvanometer. When the war came the cable recorder of 1897 was developed into an oscillograph which permitted the measurement of the time intervals between the arrivals of the report of a gun at the different microphones; it was the key to the problem of sound ranging.

Shortly after our country entered the war a group of scientific men were recruited by the Army and organized as the Sound Ranging Group of the Air Service under the direction of Major Augustus Trowbridge, who in civilian life was a professor at

Princeton. He called on the Western Electric Company to design and make some of the principal parts of the sound ranging equipment, including the string oscillograph and the timing mechanism. P. M. Rainey had charge of this work in the laboratories with M. B. Kerr to assist him. A number of completed instruments were made and sent to France, where they served their purpose in the Great War. This sound ranging apparatus permitted German batteries to be located with such accuracy that they could be destroyed by a few rounds fired from heavy naval guns.

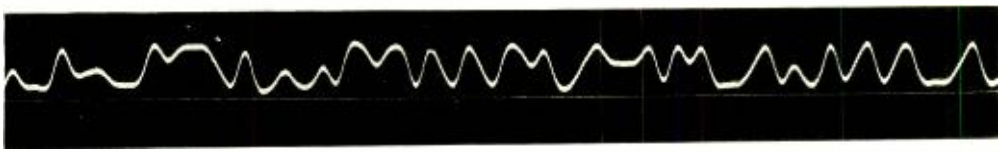
When the Armistice closed the hostilities of the World War, sound ranging devices as well as shrapnel and guns were no longer in demand. Orders were cancelled; and a wholesale process of salvaging war materials was started. From the lot of string galvanometers which Western Electric was making, Mr. Rainey saved two complete equipments, anticipating that some day they might be useful in laboratory work.

Shortly after this the development of loaded submarine cables and appropriate terminal apparatus was commenced. A first consideration of the problem by O. E. Buckley showed that if a loaded cable were built it would be so much faster than the old cables that none of the ordinary receiving apparatus would be fast enough to record the signals. In this juncture, the two string oscillographs were recalled into service, where they proved to be almost ideal. In the first two years the two original machines were entirely worn out; instead of building others like them both the oscillograph unit and the camera were redesigned by A. A. Clokey, A. M. Curtis and H. H. Hall. The speed of the camera was doubled and the sensitivity of the oscillograph was increased about 20 times.



Mr. Curtis inspects an oscillogram as it comes from the instrument

The present string oscillograph is an instrument which will

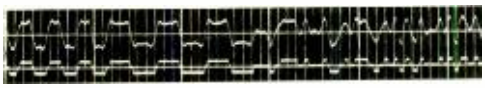


Part of the first high-speed code message transmitted over a permalloy cable—1900 letters per minute

record satisfactorily the wave form of the current sent through either of its two strings up to frequencies of about 200 cycles. When shunted for critical damping its resistance is about five ohms and it will give a workable oscillogram with a current as low as one milliampere. It will turn out a developed and fixed oscillogram in an average time of two seconds. Provision is made to mark off time-intervals of 0.01 second on the paper.

Four oscillographs are at present in service at the terminals of various permalloy-loaded cables; it is a fact that testing of the cables and installation and maintenance of the high-speed apparatus could hardly have been accomplished without them. Before the cables were laid they were used to measure interference to be expected at the cable terminals. Next they were used to measure the inductance of the completely laid cables by measuring the time it takes a pulse to traverse the cable; and they were used in adjustments of the cable amplifier and its circuits for the purpose of compensating the attenuation and distortion of the cables. After the high-speed multiplex apparatus was installed it was found impossible to keep the relays and other parts in proper adjustment without having a string oscillograph instantly available at every station.

Suppose, for example, that we wish to know what is going on in a particular relay in the cable multiplex apparatus. We connect one string in the winding circuit and the other string in the contact circuit, adjust two shunts until the indication on the screen is seen to be of convenient size,



Above, signal as received at Rockaway after reshaping by amplifier and network
Below, signal as repeated to New York by high-speed relay

and raise a lever. In a couple of seconds we depress the same lever, then remove the oscillogram from the hypo tank and examine it. Almost any low-frequency signalling apparatus can be studied in this way. Dur-

Above, signal as it came from diaphragm of pneumatic transmitter
Below, perfected signal as impressed on permalloy-loaded cable at Bay Roberts

ing the cable development work, at least 50,000 of these oscillograms have been made and in the last year alone more than twenty miles of oscillograph paper have been used. In the laboratory the string oscillograph often permits the solution in a few hours of problems which would take weeks to work out by any other method.

Formal opening of the third and northern route for transcontinental telephony, January 17, 1927: At the New York end. Seated: E. H. Colpitts, F. B. Jewett, N. T. Guernsey, J. S. McCulloh, L. N. Stoskopf, F. A. Stevenson, E. S. Wilson, President Gifford, T. G. Miller, A. W. Page, B. Gherardi, C. P. Cooper. Standing: E. K. Hall, J. J. Pilliod, J. L. R. Van Meter

A New Amplifier for Train Dispatching

By R. A. MILLER

IN the practical operation of Western Electric train dispatching sytems* occasion often arises where certain operators should be able to hear all that passes over the circuit without the necessity of wearing head-receivers. Among these operators are tower-men at terminals, who need to be in touch with all that is going on in order to prepare for coming trains, and the dispatcher himself, who must be "on the line" continuously. For this purpose the 12-A Loud Speaking Telephone outfit was developed in our Laboratories; and is now in satisfactory service on many railroad systems. It includes a single-stage vacuum-tube amplifier, a loud-speaker, and a foot-switch to disconnect the loud-speaker in order to prevent "howling" when the local transmitter is in use.

While the 12-A outfit was satisfactory from a transmission standpoint, its use of batteries for filament and plate supply introduced an element of expense and of uncertainty. As radio listeners know, both dry and storage cells require attention; and they have a disconcerting habit of "going dead." When this happens to a radio set, a sudden failure causes only annoyance; if any element of a train-dispatching set fails, consequences are likely to be serious.

How the problem of battery elimination could be solved was suggested by a device popular for radio use—the 25-B amplifier.* This amplifier system requires no batteries for the supply of filament, plate and grid potentials. It draws all its power from the 60-cycle commercial lighting circuit, with which most offices and towers are equipped.

In adapting the circuit of the 25-B amplifier for its new use in the 33-A amplifier, consideration has been given to the fact that the train-dispatching line must transmit efficiently the alternating-current pulses of very low frequency used to operate the selectors. A condenser has therefore been placed in series with that winding of the input transformer which is to be bridged across the telephone line; this minimizes the losses of low-frequency impulses. Since no gain-control is provided, some means is desirable to reduce possible overloading on short-distance transmission. For this purpose a half-megohm resistance has been placed in series with the grid of the vacuum tube. If, due to excessive amplitude of the input-waves, the grid should become positive to the filament, current will tend to flow through the grid circuit. The fall of potential through this resistance then acts in effect as an additional negative grid-bias, and so limits distortion.

The 33-A amplifier, which externally is similar to its prototype, the 25-B amplifier, is installed in any convenient out-of-the-way place and its input is connected directly to the tele-

Described in BELL LABORATORIES RECORD, *December*, 1926, *page* 108.

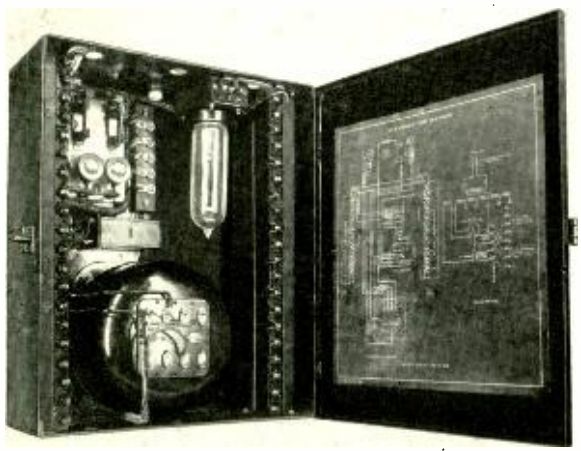
See the RECORD *for June*, 1926, *page* 151.

phone line. When it is to serve a dispatcher, its output is connected to a 543-W loud speaker mounted on an adjustable bracket. If a larger volume of sound is wanted, as for a towerman who must operate levers, a 518-W receiver is used. The amplifier and its loud speaker thus add flexibility to our train-dispatching system's last link—that which carries to the railroad operator the never-ending story of train-movement.

A Rectifier for Train Dispatching

By J. C. FIELD

SYSTEMS for train dispatching by telephone* are substantially heavily loaded party lines. Connected across the line at each station is an electromagnetic device—the selector—which closes the bell circuit upon reception of the proper combination of current impulses. To operate the selector each impulse must have a current value close to five milliamperes. Since each impulse advances the wheels of all selectors, the total current needed is a multiple of the number of stations. A sixty-station line, for instance, takes about 300 milliamperes. Fairly high potentials are also essential; as high as 400 volts being necessary for sixty stations.



The Western Electric 60-A rectifier

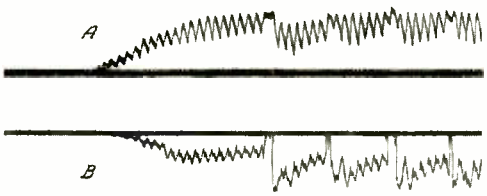
An ideal means of supplying these needs is a vacuum tube rectifier** which converts the usually available alternating current into direct current. Such a system has been developed by our Laboratories for the Western Electric Company and is being generally installed by the railroads under the name "60-A Rectifier".

In this, the 110-volt, 60-cycle supply line is connected to the primary of a transformer. The secondary of this is so tapped that 60 to 540 volts in steps of sixty volts may be supplied to the plate circuit of the rectifying tube. It is by varying this voltage that differently sized installations may be accommodated. A third winding on the coil supplies ten volts for lighting the filament of the tube. A

* *Described on page* 108 *of the* RECORD *for December,* 1926.

** *A general picture of rectifiers and their problems was presented on page* 191 *of the* RECORD *for February,* 1927.

relay closes this circuit only when a calling key is operated by the dispatcher. Lowered power drain and lengthened tube life result. The power saving can be appreciated



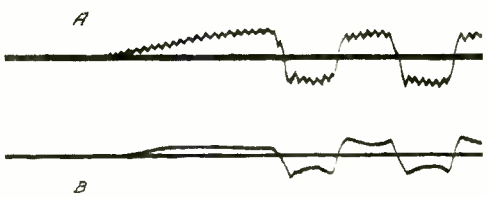
Voltage (A) and current (B) of rectifier output. Note how the voltage builds up as the filament heats. Current falls to zero as interrupter contacts open between each impulse

when one considers the difference between the non-rectifying drain of eight watts, and the average calling drain of ninety. The maximum output of the rectifier is approximately 300 milliamperes at 400 volts.

For the rectifier to function smoothly in the already-established dispatching systems it had to deliver maximum output within the three-quarters of a second intervening between closing of the filament circuit and operation of the impulse-sending relay. Since rectifying tubes with oxide-coated parts require more time than this to reach the high temperature necessary for conduction, a new tube was developed. This is a fifty-watt tube with a thoriated tungsten filament and a plate of clean molybdenum. Also, to have the plate resistance very low, the plate is mounted as close to the filament as manufacturing limitations permit.

As this system rectifies half-waves only, condensers with a total capacity of twenty microfarads are bridged across the output to maintain the voltage during the time when no current is passing through the rectifying circuit. This condenser also acts as a low-pass filter which practically silences the 60-cycle tone from the rectifier. The slight hum which remains is taken care of by the filter in the sending equipment, and by the telephone sets, which are designed to be inefficient at low frequencies.

When telephone train dispatching was initiated vacuum-tube rectifiers had little chance of being developed with vacuum tubes still in their infancy. Meanwhile some kind of power had to be supplied and recourse was had first to the dry cell, and then to storage batteries and motor generators. Each of these sources has conspicuous faults. The charging



Voltafe (A) and current (B) after passing reversing relay and filter of sending equipment

and replacement needs of batteries are well known, and their proclivity to failure at critical moments is a further point against them. Generators require a deal of maintenance work and are costly to operate.

With the development of the 60-A rectifier these difficulties were eliminated. At a low cost and with little maintenance this rectifier adequately and unfailingly supplies the direct current needed. Thus another link is forged, welding together more strongly the communication units which form the nerve system of the railroads of today.

Report on Employees' Benefit Fund

JANUARY 1 TO DECEMBER 31, 1926

The following is a record of the transactions during the year 1926:

Balance in Fund as of January 1, 1926.		$ 88,928.43
Additions to Fund during year 1926:		
1% of Payroll	$ 92,484.33	
Interest at 4% on average balance	5,275.35	
Reimbursements for payments made during period	102,345.63	200,105.31
Total Credits		$289,033.74
Disbursements from Fund during year 1926:		
Pensions	$ 914.08	
Accident:		
Disability Benefits	4,355.22	
Disability Expense	556.69	
Death Benefits	11,778.92	
Sickness Disability Benefits	84,740.72	102,345.63
Balance in Fund at December 31, 1926		$186,688.11

J. E. MORAVEC,
General Auditor.

Audited and found correct,

WILLIAM R. REID,
Traveling Auditor for American Telephone and Telegraph Company, February 14, 1927.

The Printed Form

By W. G. SAWYER

CONSIDER the Egyptian ruler who idled in anxiety seven hours, as seven scrolls of papyrus were unwound, ere he learned the result of an inventory of the royal granaries. The plentiful showing had in all probability to be discounted by the time the ceremonial was consummated, in the face of a more convincing cry of want in the land.

The modern executive, in a similar predicament, presses a button and a moment later is handed a small card form giving a perpetual inventory and complete status of a particular stock. And this may have been accomplished either by means of a punched tabulating-card form, manipulated automatically through the media of mechanics, and electricity, or by the operation of an ingenious visible-record system. Thus printed forms become the lubricant of the modern business machine—the film of oil on the bearings of the daily grind. Without them and the methods they represent, we should retrogress to the encumbrances of an earlier era.

The term applied to the scientific designing and use of a business form is standardization. In our Laboratories, forms are but one of the various classes of office equipment which are standardized. Furniture, accounting machinery, blue-print and process papers, drawing materials, filing equipment, safes, et cetera, are all considered from the standpoint of adaptability to a standard type. The nature of the printed form, however, is such that it has particularly permitted of facile and effective treatment in this respect.

The importance of well-designed printed forms is a matter which has been given much attention in recent years by management and industrial experts. Apart from the order and system effected by their proper design, forms are the basis for controlling routines, communications, the tabulation of data, and virtually any representation requiring embodiment on paper. Providing thus the free flow of activity, as well as its record, the consumption of forms may often be taken as an accurate barometer of activity.

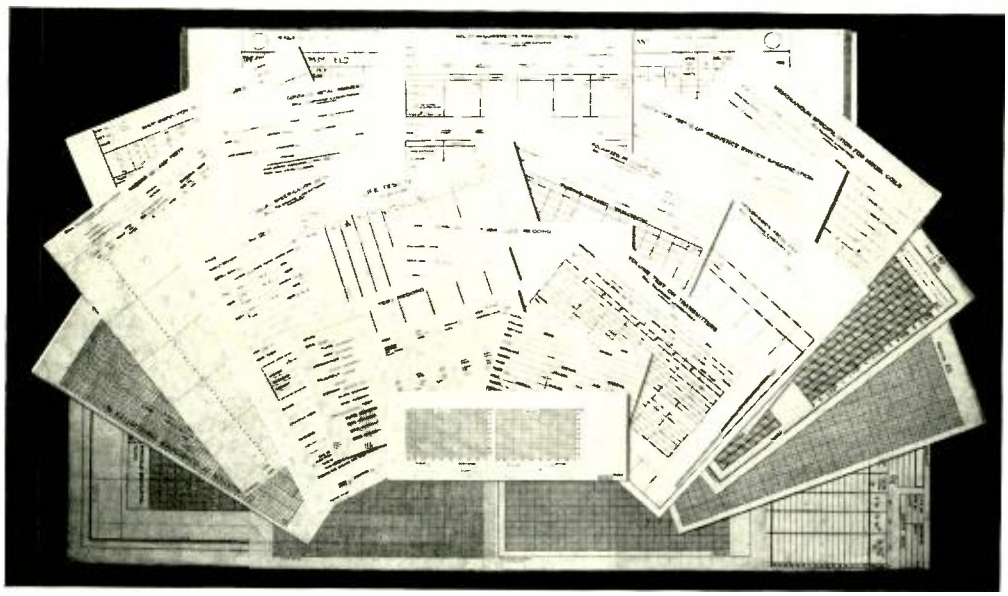
The purpose of the form is to effect conformity, whether it be a legal document or a sales ticket. There is no conformity about a series of unrelated writings. When, however, similar work is performed under similar conditions, or repeatedly, there is a certain uniformity of data collected and here the form is introduced. It standardizes procedure, demands attention, asks questions, directs thought, and insures thoroughness and completion.

There are in active use in the Laboratories over 550 forms variegated in materials, from 8-pound tissues to 225-pound boards, and in size from that of a postage stamp to the proportions of a desk top. In spite of this range, however, each is carefully designed, with due consideration for

economy and utility. The majority of printed forms are standardized to a basic size, providing convenient proportions for handling, filing, a symmetrical and pleasing appearance, and a commonly economical cut from master-size sheets.

In addition to size, well-designed forms are conformed to fundamental regulations as to type sizes and faces, grades of stock, punching, binding, ruling, purpose of use, longevity, conditions of filing, and methods of manufacture. First principles in regard to a form are, that the size should be economically cut, that the subject matter is in logical arrangement, that the stock is adapted to its ultimate use, that the purpose of the form is fully served, and that the form bears an identifying number, name, and company of origin. Other details contributing toward the permanency of a form, enhancement of its appearance, its more effective and diverse use, its lower cost, are incorporated in a code of standards and are fully applied.

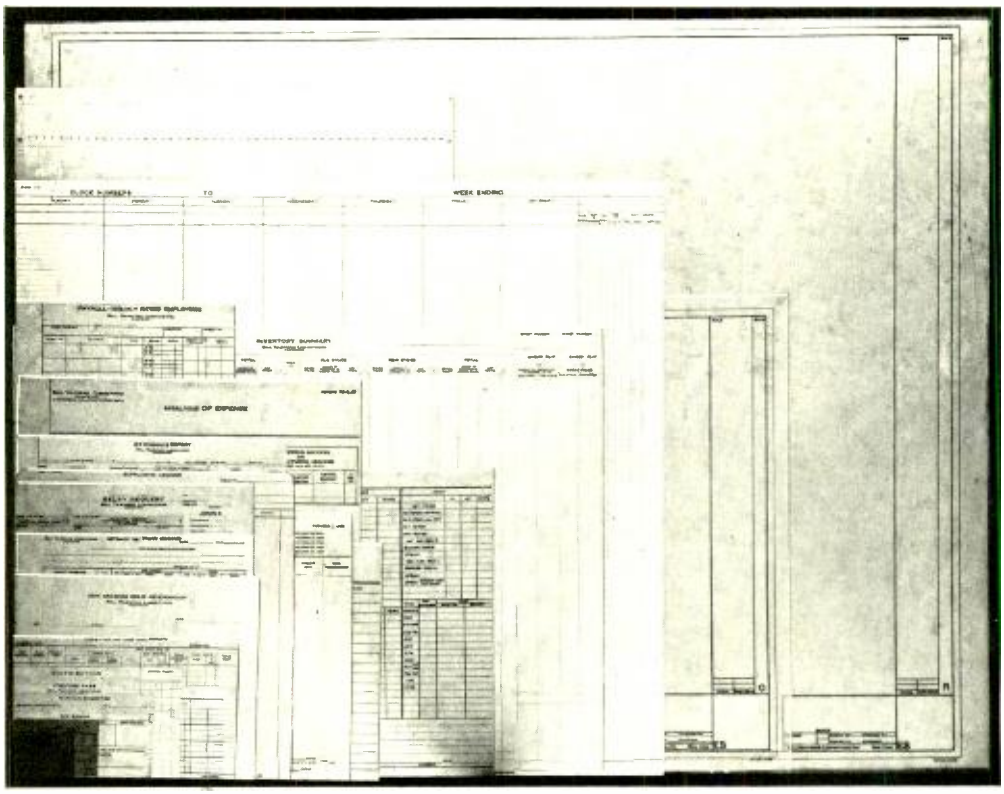
Many are the crafts which may be employed in the devising of a form. Through the use of alternative methods many economies are put into effect. For example, by imprinting a standard sketch form with a photographic zinc plate made from a hand-drafted original a considerable saving was effected on a small lot of cross-section forms used in radio-transmission work. The conventional method would have been a lengthy, expensive, regular printing job. In radio-signal testing work in the field, a large record book of several pages was satisfactorily printed by the photo-offset process at a considerable saving over the regular printing-from-type or plate process. In a small lot of a large statistical form, photo-offset printing from an original made by a guided, hand-lettering system result-



A few examples of technical data forms

ed in a relatively large saving as compared with the cost of regular printing from composition of type.

The development of the printed form involves a knowledge of the sign of such forms that skillful planning is required. In addition, a constant vigil against errors is maintained from the inception of the form to its eventual placement in use. It



How some of the forms range in size

structure, strength factors, supply and utility of paper, of typography, of printing and reproductive processes, of files and filing systems, binders, and general conditions of use, since forms may resolve into such items as folders, tracings, cross sections, loose leaf records, index cards, drawings, tags, labels and even parts of mechanical equipment. A case of the latter is a specially constructed recording card used in a rubber-testing machine.

So many factors enter into the de- was a common occurrence that, a form being required, the nearest-at-hand sheet of paper was requisitioned for the purpose, regardless of kind or size; a rough outline was drafted; and the form ordered, unrevised and without specifications. This, obviously, frequently would result in a wasteful cut, poor arrangement of subject matter, errors, delays, misunderstandings, a form imperfectly suited to the use, duplications, early revisions, waste, and a stock unadapted to the use, such as a temporary stock where

permanency was needed, or opaque paper instead of transparent, or possibly special equipment to suit the form. In this latter respect, there is brought to mind the case of a questionnaire which required specially constructed cabinets because of an inadvertent variation in the size of the form. Another case is recalled of the thoughtless use of a brilliant red paper in a form designed to attract the eye but which so offended it as to render the form unreadable. The result of such lack of planning is usually a heterogeneous collection of forms, dissimilar in most respects yet without the virtue of individual merit.

An interesting method is followed in securing to the Laboratories a continuous, dependable, uniform and economical supply of printed paper and card forms, and printed envelopes. These items are now furnished under contract. Under this arrangement all forms applicable are specified in detail, insuring uniform high quality, and are priced on the aggregate volume of a year's consumption, providing low cost. The consumer contracts to accept a definite amount of forms in any event and the supplier agrees to maintain a specific amount of certain forms in stock ready for shipment. This method accrues to the mutual advantage of the parties in agreement, insuring to the consumer, among other advantages, preferred service, and to the supplier a steady, known, not inflexible volume of work.

A Textbook of Personal Finance

Out of his experience as personal financial adviser to members of the Western Electric Company, William A. Schnedler has drawn the material for his book "How to Get Ahead Financially", recently published by Harper and Brothers. Much of the data included has appeared previously in a series of articles written by Mr. Schnedler for the Western Electric News, and in pamphlets circulated among members of the Bell System; it has been somewhat added to, and recast to form a unified text.

Mr. Schnedler's handling of his subject is sympathetically reasonable; his suggestions fall well within the bounds of what normal, extravagant human nature may accomplish without undue discomfort. Although the book begins with certain inspirational matter—this is necessary, in the nature of the subject—the author has wisely devoted most of his space to information rather than exhortation. There are particularly valuable chapters on life insurance, investment, installment buying, and various phases of home ownership.

Electro-Mechanical Oscillators

By C. R. MOORE

As soon as the telephone became an established reality, alternating current at frequencies within the voice range was needed for testing purposes. At about the time interest in this was first displayed, those who were experimenting with subscribers' station networks observed that when a receiver was held in front of its associated transmitter a "howl" was emitted. This suggested the possibility of obtaining small currents inexpensively from the sustained electro-mechanical oscillations produced by a transmitter and receiver properly coupled both electrically and mechanically. The electrical system must include also a source of power which by movements of the transmitter diaphragm is released as electrical vibrations.

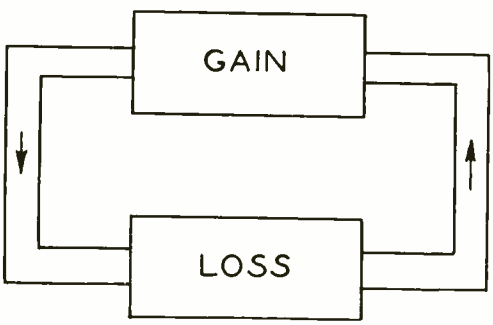
To yield sustained oscillations at a particular frequency, certain requirements must be met. The mass, stiffness, and resistance of the moving parts must be properly proportioned. Also the impedances of the various units of the system must be matched to assure maximum output. And finally, the elements must be interconnected so that an increasing current in the magnet windings shall act through the moving system to cause an increase in the microphone resistance. If on the contrary an increasing current causes a decrease in resistance, the current will still further increase until it reaches a limit, set by the constants of the electro-mechanical network. At this point the system will come to rest: that is, vibration cannot be set up. This is a steady state which precludes oscillation.

Studies of the system using air as the mechanical coupler did not lead to a "howler" which could be used as a source of current. They did, however, engender several useful principles as well as a practical testing device. These experiments showed that in such a system a steady oscillating state will be maintained if the gain in the transmitter due to its amplifying action is just equal to the losses in the mechanical and electrical circuits. This principle applies to all types of electro-mechanical systems, and in a generalized form to all types of energy feed-back circuits. The practical device which evolved from this study was the "howler" test set used extensively in the rapid shop-testing of transmitters and receivers. This set uses the test instruments as part of the "howling" circuit and measures their efficiency by the voltage generated across their terminals. Since the set does not generate currents for external use, it cannot be considered a solution of the original problem.

Since mechanical oscillations are the basis of operation of the hypothetical system, a pure mechanical element can be substituted for the acoustical arrangement of the howler. It was along these lines that development work then was directed. In essence,

these newer devices eliminated the air column and combined the receiver and transmitter diaphragms into a single magnetic element, usually a bar. This bar most often was of the type known as "clamped-free", taking its name from the fact that one end is held fast while the other is free to vibrate. The mechanical oscillations of the free end are converted into electrical ones by an arrangement of microphones at that end. These devices are known under various names, the more common of which are interrupters, buzzers, and mechanical oscillators.

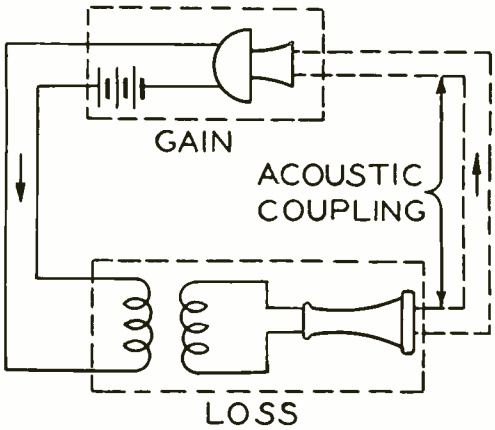
Although quite satisfactory from the expense standpoint, all of these systems possess a common fault—inability to maintain over extended periods the frequencies for which they were designed. Information available at the time indicated that improvement lay in the direction of bettering the carbon microphone. As knowledge of the peculiarities of carbon buttons broadened, their resist-



Basic oscillating circuit. When gain equals loss a steady oscillatory state is maintained

ance, breathing, and modulation characteristics were improved. But even with the newer and better microphones incorporated in the old apparatus no worthwhile improvement was noticed.

With the microphone given a clean bill of health, the investigation centered on the vibratory system, the only other possible weak link. And it was here that the weakness proved to be. The "howler" coupling—an air column with a diaphragm at either end—was found to be very unstable.



Elementary "howler" circuit showing how it resolves into the basic oscillator

Atmospheric conditions, position of neighboring objects and even of the person using the set—all may affect the frequency and energy of "howling". In the systems using a bar which is clamped at one end any change in the tightness of clamping will vary its natural period. Also, any vibrations set up in the base, or any variation in the manner of fastening the clamping device to the base, will find a too ready response in the bar. Thus in addition to trouble in operation, there is always the possibility of bars, accurately milled to dimensions, being set up improperly, or forced out of adjustment by slight jars.

In view of the weaknesses of this simple vibratory system, a search for a stable device was inaugurated. Of those systems which could be readily

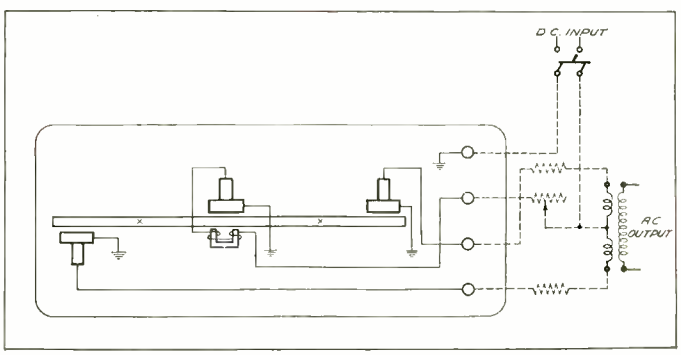
adapted to the oscillator, only one offered any possibilities. This was a first cousin to the "clamped-free" bar, commonly known as a "free-free" bar. From the name its construction can be surmised. Both ends of this rectangular bar are free to vibrate, the supports being placed at its nodal points. Since these are points at which vibration produces no motion, there is practically zero reaction on the supports. The natural period and amplitude are thus independent ofthe holding devices, and almost complete stability may be expected. In this bar it is always possible to find two points which move in opposite directions; thus the driving mechanism and the device for converting the mechanical oscillations into electrical ones can be applied in various ways.

In the simplest form, this system has two nodal points and, therefore, two sets of mounting pivots. Each set has two metallic points which seat in small conical depressions in the upper and lower surfaces of the bar. Provided the same number of nodal points are used, the frequency which is generated increases as the bar is widened, and decreases as it is lengthened.

At the center of the two-node bar developed in the Laboratories is the driving mechanism. The microphone and magnet placed on opposite sides of the bar are connected in series with a battery. This part of the system is nothing more than that solution of the problem of electro-mechanical oscillators which was suggested by the acoustic coupling of the original "howling" telephone.

To convert the mechanical vibrations of the bar into electrical vibrations, microphones for the output circuit are placed near the ends on opposite sides of the bar. These microphones, as well as the driving one, are of the barrier type and the insulated surface of the bar is directly in contact with the carbon, which it agitates. By this construction the microphones add only minute masses.

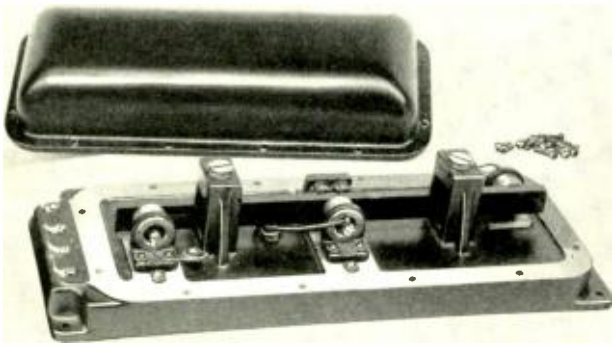
When the drive circuit is closed the center of the bar is pulled toward the magnet. Since this causes the resistance of the center microphone to increase, the magnetizing current decreases and the bar moves back toward the button. This periodic movement is maintained as long as voltage is applied to the motor elements. As the center moves, the ends of the bar move also in a direction always opposite to that of the center. Thus the bar acts as a diaphragm which operates the end buttons "push-pull". The direct current flowing through these microphones is thereby converted into pulsating current of a frequency mainly dependent on the dimensions of the bar. The alternating current output passes through the



Circuit of the electro-mechanical oscillator in its present stage of development

primary of a repeating coil to whose secondary are attached the circuits in which the oscillator is to be used. A very nearly pure wave form is obtained from this arrangement, and its output is more constant than that of any other microphone generator.

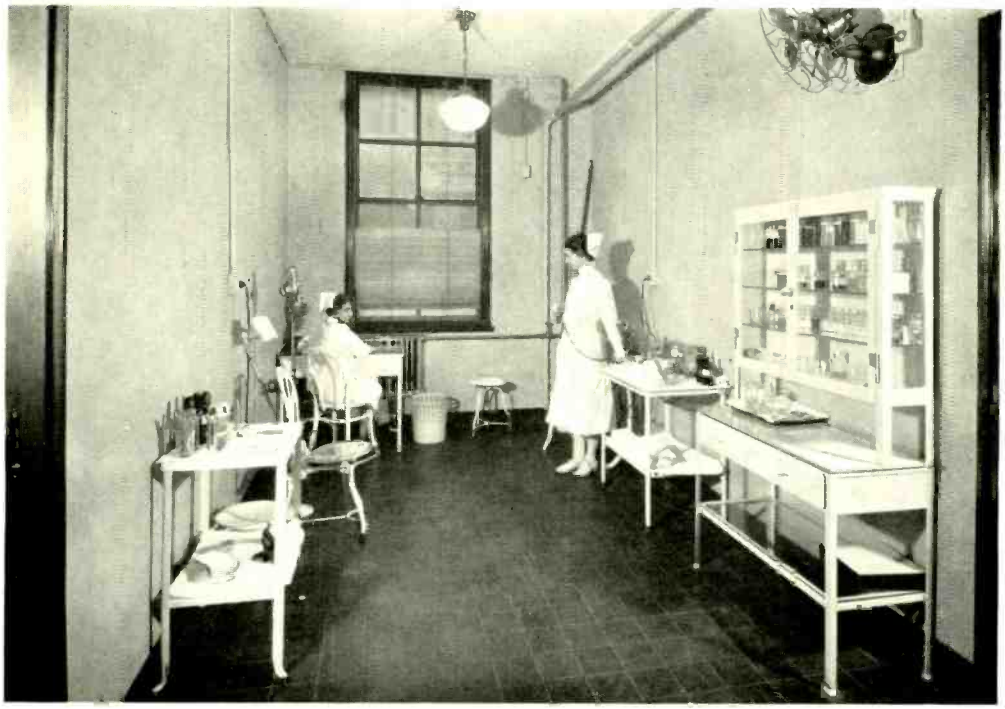
Howling, as a condition occurring during a telephone conversation, is eminently undesirable. But those who first observed the "howl" were alert to see in it more than something to be remedied and forgotten. The research initiated by their interest, and continued intermittently through the years, has culminated in several laboratory models which are being subjected to rigorous tests in various field conditions. Several difficulties have arisen, which must be thoroughly investigated; but in general the results are encouraging, and give us reason to hope that there is in the making a stable electro-mechanical oscillator, inexpensive to manufacture and maintain, which will ultimately be useful.



How the electro-mechanical oscillator appears with its cover removed

Two John Scott Medalists whose researches have been of distinguished service to trans-oceanic communication by cable and by air: Gustaf W. Elmen, discoverer of permalloy, and William G. Housekeeper, inventor of the copper-glass seal

Reception room of the Laboratories Medical Department



Ella Good and Janet Ackerman, in the first-aid room

The Ounce of Prevention

By GEORGE B. THOMAS

THE ounce of prevention is worth more than the pound of cure in any case where reliability is essential. The telephone can be counted upon for its many services because, from its design to its maintenance, adequate operation has been insured as completely as human ingenuity permits. But this principle, applicable to mechanisms, can be applied to more complicated organisms —to human beings whose physical disability entails expense and suffering. Hence the Medical Department of Bell Telephone Laboratories.

Half the ounce, more or less, is expended for the protection of the organization as a whole and the other half for each member as an individual. Through the physical examination, required of all otherwise successful applicants for employment, the department prevents the introduction of members who would be physically unfit, and protects the individual from being given work for which he or she would be physically unadapted. Our company being functionalized into such closely related and dependent groups, limps in its progress if any considerable number of its force is unable to meet its daily nine-to-five engagements by reason of poor health. The farther one progresses in responsibility, the more important it becomes to the company that he or she shall be physically able to carry the work without interruption. For this reason also, there is insistence on a promising condition of health at the time of entrance into the organization.

But more than a promise that a man will be healthy in future years is necessary and many grains of prevention are required to promote health. Taking care of one's body is like maintaining any other machine. Minor repairs must be made promptly before the whole mechanism is endangered. Periodic inspection must disclose the real condition of the machine so that careless operation may not result in over-straining some part and in a complete break-down.

Dr. John S. Waterman, Medical Director

In this diagnosis of one's condition—a periodic check-up of health—

or in the information as to the cause and possibilities of one's minor ailments, the Medical Director and his staff of doctors are at the service of the other members of the organization. He invites each and every member of the Laboratories to accept his

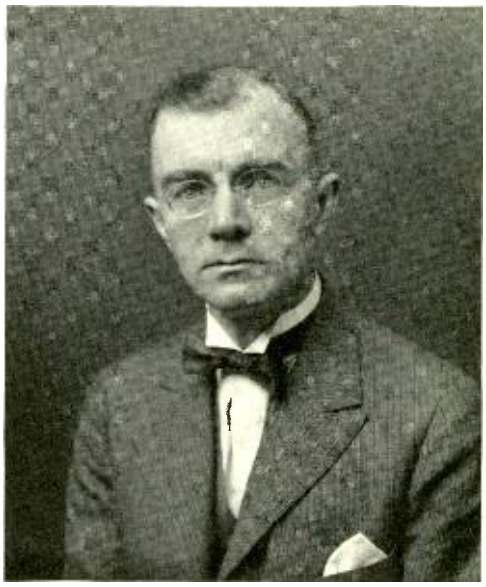
Dr. Charles A. O'Malley

department's services in a periodic physical examination, that is, to come in at about yearly intervals for a confidential inspection report. Since this service is freely given, and there is no compulsion on the part of the company that it shall be accepted by any employee, it is arranged in individual appointments which are scheduled by the office nurse in response to telephone requests.

On the basis of such confidential reports many have undertaken medical treatment with their own or family physicians and cleared up conditions formerly unsuspected but threatening seriously their future health. Others have been encouraged by the assurance that heart, lungs, and other vital organs were healthily performing their proper functions and gave no signs of trouble.

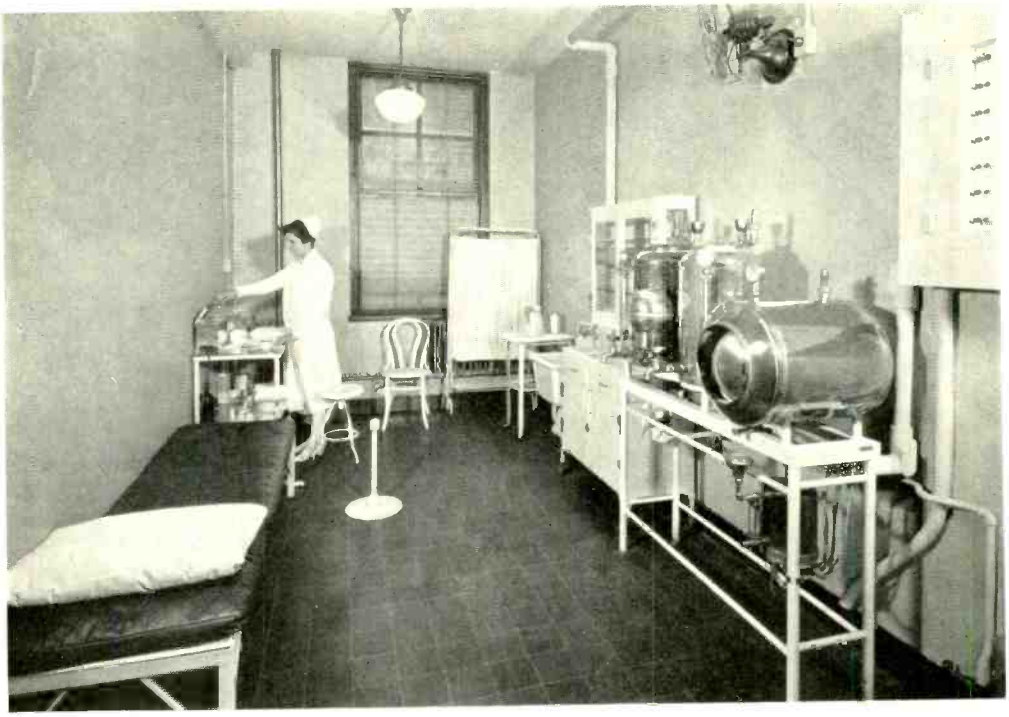
Medical information, not treatment, is the method of the department in this growing service of health promotion. What action each employee takes on the basis of the information is his own concern and on his own initiative.

An element of compulsion, however, justly enters into the advice of the Medical Department in the case of employees who develop illnesses or have accidents. Just as the department determines at the time of their employment whether or not they are fitted to undertake the work for

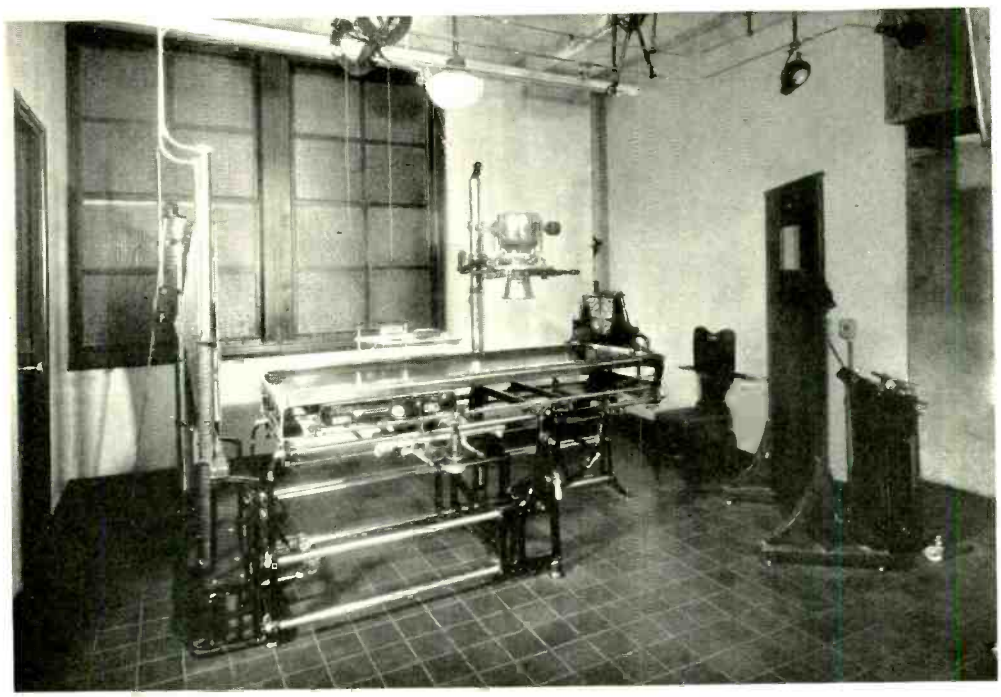


Dr. John A. Wilson

which employment is proposed, so it determines whether or not the individual who has been absent for physical reasons is qualified to return to work or should take a longer time to recuperate. In this it protects the individual and the group; and its advice is a basis for action on the part



Statira Crawford, Executive Nurse, in the treatment room



The X-ray room

of the Benefit Fund Committee, which under the Benefit Plan assures a specified amount of financial protection during physical disability. Its advice is also final, for the same reasons, as to whether an employe who is apparently entering upon an illness shall continue his work or promptly leave for home and the care of his physician.

More obvious but equally definite is the responsibility of the Medical Department in those relatively rare but always-to-be-anticipated instances of accident during employment. Here apply the Benefit Fund provisions and also various state laws as to industrial accidents. The department must be equipped to render the most efficient first-aid and to insure that adequate medical care or surgical attention is given to the unfortunate employee. As its contribution to the prevention of such accidents it must cooperate and advise with the other departments, and particularly those of Plant and Shops, to insure that there is no introduction at any time of conditions conducive to accident or illness for an industrial cause. Whenever an accident occurs it must be able to present complete medical information to the individual, to the Company, and to the State under whose laws it operates. Every accident, no matter how minor—a drawer falling against a girl who is filing letters, a fall on the stairs, a splinter or scratch from a wire by a man in the laboratories—must be properly treated. Surgical rooms, dressing-rooms, X-ray equipment, and rest rooms, are the facilities which the doctors and nurses have at their disposal for all emergencies from minor to major.

Equipped with the best, provided with adequate space, attractive waiting room, and suitable auxiliary rooms, the Medical Department pursues quietly but efficiently its service duties to the organization and its members. In any instance of sickness or accident, however, it should be immediately sought and its assistance obtained. Where no such occasion exists for a visit to the department its invitation is extended to initiate a series of annual physical examinations as the ounce of prevention which will out-weigh in health, happiness and in economic returns the pound of cure.

Standing: Ethel de Ronde and Kathryn Poellman; seated: Statira Crawford, Marie Sweeney and Ella Good

In the Month's News

ON THE EVENING OF FEBRUARY 15 in our auditorium, Mr. Craft addressed the Metropolitan New York Section, N. E. L. A., on the subject "Some Electrical and Mechanical Problms in the Development of the Vitaphone." The Tannhauser Overture, and selections by Martinelli and Elman were then reproduced by the Vitaphone. Also the Vitaphone film* was shown, in which Mr. Craft describes the process. Details of the entertainment were in charge of George F. Fowler.

R. M. BURNS AND W. A. HYDE were in Washington January 20 to 23 to view some soil-corrosion specimens at the Bureau of Standards.

R. E. WATERMAN attended a meeting at Nashville of the American Wood Preservation Association, and also inspected the wood preservation of telephone poles in Mississippi.

R. R. WILLIAMS AND H. H. LOWRY visited the Chemical Warfare Research branch of the Englewood Arsenal on February 9.

R. M. BURNS AND H. T. BYCK recently returned from a four months' trip to the Pacific Coast where they made corrosion tests on cable sheathing. Among the cities visited were Seattle, Portland, San Francisco and Los Angeles.

C. L. HIPPENSTEEL visited the Henry L. Scott Co. at Providence on January 21 and inspected a rubber compression-testing machine which was recently purchased by the Laboratories.

A. W. HAYES recently returned from Hawthorne, where he dealt with some details of transmitter testing.

PHONOGRAPH DEVELOPMENT STUDIES occasioned a trip on January 23 to the Victor Talking Machine Company at Camden, by H. A. Frederick, D. G. Blattner, W. C. Jones, and L. W. Giles.

M. B. LONG spoke to the Ithaca section, A. I. E. E., on Friday, February 18. The talk included discussions of speech, music and hearing.

W. WILSON and J. W. HORTON visited the Bureau of Standards in Washington, D. C., in January to discuss some standardization work in which the Laboratories is interested.

AT THE FEBRUARY 7 MEETING of the National Heart Association in Philadelphia, H. F. Hopkins demonstrated a 1-A Stethoscope in conjunction with a loud speaker. He also demonstrated phonograph records of the different types of heart action and murmurs. Both of these demonstrations were repeated at the School of Medicine, University of Pennsylvania.

A BIRD'S-EYE VIEW of our telephone industry, through the eyes of an associate editor of *Atlantic Monthly* is presented by Arthur Pound in his book "The Telephone Idea."* To many it will recall achievements in which Bell Labora-

* *This was described on page 126 of the* RECORD *for December, 1926.*

* *Now available through Personal Purchase channels.*

tories men participated; it should remind us all of the social importance attached to the service we help to render.

RUMORS that the Western Electric Company contemplates placing a radio receiving set on the market have been met with an official statement that at present no such move is anticipated. The Company continues, however, to manufacture a radio receiving set designed specifically for use with its public-address systems and radio-telephone broadcasting equipments.

Another report which has been circulated from time to time was that Western Electric loud speakers were to be withdrawn from sale to the public. It is stated now that there is no basis whatever for this report. While this line of manufacture has never been widely exploited by sales efforts, the production of speakers has never been stopped and they will continue to be available to the public.

AMONG RECENT PUBLICATIONS by members of the Laboratories were:

"Crystal Structure of Magnesium Platino-cyanide heptahydrate" by Richard M. Bozorth and F. E. Haworth, and "Photoelectric Emission as a Function of Composition in Sodium Potassium Alloys" by Herbert E. Ives and G. R. Stilwell, *Physical Review*, February, 1927.

"A Shielded Bridge for Inductive Impedance Measurements" by W. J. Shackelton, *Journal of the American Institute of Electrical Engineers*, February, 1927.

In the past few months, fifty-eight abstracts of papers by members of the Laboratories have appeared in various journals both in the United States and in foreign countries.

ON THE MORNING of February 10, members of the A. I. E. E., which was then holding its mid-winter convention, were entertained in our Auditorium. After Vitaphone presented the Tannhauser Overture, John Mills welcomed the guests. "The Magic of Communication," an animated portrayal of the telephone repeater, was shown. Harvey Fletcher then spoke on various phases of research in speech and music. The Vitaphone film, in which Mr. Craft describes the Vitaphone process, concluded the program. Details of the visit were handled by George F. Fowler.

FRANCIS F. LUCAS presented a paper on "The Application of Microtome Methods to the reparation of Soft Metals for Microscopic Examination" at a recent meeting of the American Institute of Mining and Metallurgical Engineers.

DURING JANUARY, R. M. Moody and H. F. Kortheuer were in Hawthorne in connection with regular Survey Conference work.

A CONFERENCE on the general situation with respect to Engineering Complaints and Questions from the territory of the Southern New England Telephone Company was held in New Haven on January 5. In addition to Southern New England Telephone Company engineers and Western Electric Distributing House people, G. D. Edwards and R. J. Nossaman were present from the Laboratories.

A NEW DEPARTMENT in the Laboratories, that of Outside Plant Development, has been organized under R. L. Jones, Inspection Engineer. This department, which is to be responsible for the application to the design of outside-plant apparatus, of advances in knowledge of materials, in methods of manufacture, and of

changes affecting the supply of materials, will from its engineering studies propose subjects for research investigation and for specific development and design. It will also be responsible for outside-plant apparatus and materials, and for their adequate specification.

Three groups compose the new department. Work on timber and on miscellaneous materials will be handled by S. C. Miller, formerly of Inspection Engineering. Hardware, ceramics and moulded materials come under C. D. Hocker, formerly of the Research Department. C. S. Gordon who has recently transferred from the Development and Research Department (A. T. and T. Co.) has charge of wire and tools.

Incident to the formation of this department, several engineers have been transferred from A. T. and T. In addition to Mr. Gordon, they are R. C. Eggleston, L. M. Lindemuth, L. V. Lodge, J. A. Carr, F. D. Powers, J. A. Rapelje, and E. St. John.

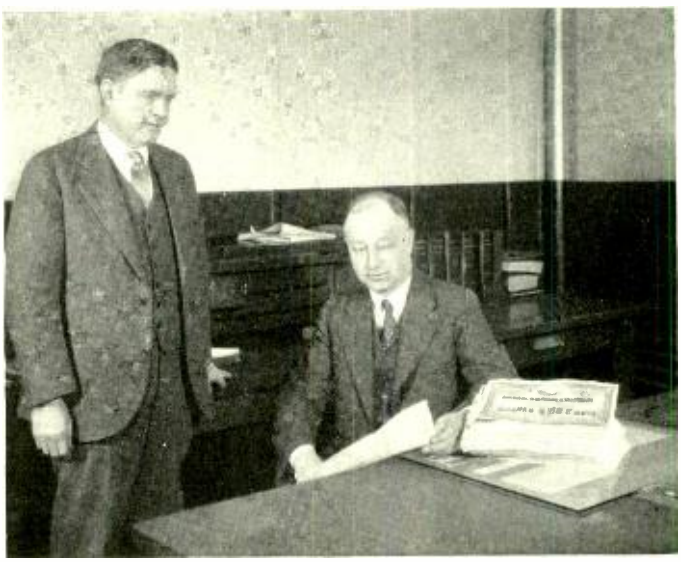
THE TWO GENTLEMEN in the picture on this page are W. B. Wallace, treasurer, and R. F. Newcomb, assistant treasurer, of the Laboratories. Mr. Wallace is about to hand Mr. Newcomb a pile of certificates, representing 4432 shares of A.T.&T. stock, for delivery to members of the Laboratories. Of the total, 3089 shares were delivered to 411 people on the monthly payroll, and 1343 to 334 on the weekly and hourly payrolls; 450 of the certificates were for lots of five shares or less. At the market price of February 19, this pile of stock was worth about $700,000.

J. J. KUHN, of the Laboratories, R. M. Hatfield, of the Electrical Products Research Company, Incorporated, and E. M. Hall, of the Western Electric Company, visited the Victor Company at Camden to discuss details regarding the new types of horns for loud speaking telephones.

H. C. RUBLY was in Philadelphia on matters concerning the inspection and operation of 3-A Capacity Unbalance Sets in the field. Upon his return he inspected the Public Address Systems in the Short Hills Grammar School and the Milburn High School.

O. A. SHANN AND F. A. HOYT recently visited the Gray Telephone Pay Station Company at Hartford in connection with coin collectors.

A. F. GILSON has returned from



R. F. Newcomb, W. B. Wallace, and an imposing pile of A. T. & T. stock certificates

Hawthorne, where he dealt with several matters concerning substation apparatus and reviewed the electromagnetic reproducer situation.

THE EMPLOYEES' STOCK PLAN has been modified as it applies to those cases where an employee's service is terminated by death before his stock is fully paid for. Heretofore his estate has had no alternative but to receive the net amount accumulated on his subscriptions as a result of deductions from wages plus interest at 7 percent compounded quarterly. In the future, however, the estate will have the further option of receiving a certificate for as many full shares of stock as the amount standing to the employee's credit will purchase at the price at which he subscribed. Any remaining balance will be paid to the estate in cash.

P. A. ANDERSON has completed the installation of a one kilowatt broadcasting equipment in the Hotel Majestic for the International Broadcasting Corporation.

THE WOODMEN OF THE WORLD have replaced the five hundred watt broadcasting equipment at their home office in Omaha with a one kilowatt set under the supervision of W. L. Tierney. On his return trip, Mr. Tierney made a survey for the installation of a similar set purchased by the Jenny Wren Company of Lawrence, Kansas.

H. S. PRICE visited Chicago and Oil City to discuss the installation of a five kilowatt broadcasting equipment under consideration by the Chicago Federation of Labor, and of a one kilowatt outfit purchased by the Petroleum Telephone Company. During the same period he completed a one kilowatt installation for the Acme Mills, Hopkinsville, Kentucky.

THE STROMBERG-CARLSON Telephone Manufacturing Company have taken over Station WHAM, now located at the Eastman School of Music, Rochester, and will replace the one hundred watt transmitter there with a one kilowatt transmitter to be installed in their factory. F. W. Cunningham made the survey.

D. G. BLATTNER and C. W. Lowe, at the request of the William S. Murell Drug Company, visited their laboratories in Cincinnati on January 3, and made a number of observations, having in mind a change in the present inadequate methods of standardization of potent drugs, principally digitalis and pituitrin.

H. A. FREDERICK attended a meeting of the American Telephone and Telegraph Repair Committee held at Hawthorne on January 27.

J. T. L. BROWN was in Hawthorne January 13 to 23 in connection with the testing of loud-speaking receivers.

THE BALTIMORE SECTION of the A. I. E. E. was addressed on January 21 by Paul B. Findley on the general topic of the difference in point of view between power and telephone engineers.

DURING THE PAST YEAR, 780,000 subscribers' stations were added to the Bell System. This brings the total number to 12,815,000. Also in this period, forty-two new machine-switching offices were placed in service. With the half million stations affected by this change approximately two million stations are now being operated on the machine-switching basis.

DURING THE YEAR 1926, more than three thousand visitors were shown points of interest in our building. This is twice as many as visited the Laboratories in 1925.

AN EDITORIAL, "Why Women are Misunderstood," in the New York *Herald-Tribune* for January 17, ac-

knowledges as the source of its information the article "Understanding Women," contributed by J. C. Steinberg to the January issue of the RECORD.

DURING THE MONTHS November to January, ninety-seven U. S. Patents were issued to the following:

H. A. Anderson
C. C. Barber
E. L. Baulch
W. M. Beaumont
D. G. Blattner
L. J. Bowne
J. T. L. Brown
O. E. Buckley
J. T. Butterfield
W. W. Carpenter
W. L. Casper
E. B. Craft
J. F. Dahl
K. M. Fetzer (2)
F. E. Field
J. C. Field
H. A. Flammer
H. Fletcher
C. B. Fowler
J. S. Garvin (2)
E. W. Gent
H. H. Glenn
H. W. Goff (2)
W. S. Gorton
T. R. Griffith
C. W. Green
L. R. Guilbaud (2)
H. C. Harrison
R. V. L. Hartley (4)
R. A. Heising (3)
E. E. Hinrichsen (2)
E. M. Honan
J. W. Horton (2)
H. Hovland (2)
H. E. Ives (2)
K. S. Johnson (4)
L. Keller
W. A. Knoop
O. H. Kopp
G. A. Locke
M. B. Long (2)
G. R. Lum
H. W. MacDougall
R. C. Mathes (3)
W. H. Matthies
John Mills
F. Mohr
L. A. Mortimer
P. B. Murphy
E. L. Nelson
H. W. O'Neill (6)
E. B. Payne (2)
G. A. Persons
L. F. Porter
H. M. Prudens
V. L. Ronci (2)
W. H. Scharringhausen
P. Schwerin
E. O. Scriven
W. J. Shackelton
G. H. Stevenson (3)
R. L. Stokely (2)
H. M. Stoller
J. R. Townsend
R. L. Wegel
R. S. Wilbur
R. R. Williams
S. B. Williams

TO GUSTAF W. ELMEN was presented the John Scott Medal for his invention of permalloy. The presentation took place at the February eleventh session, mid-winter convention of the A. I. E. E.

A REVIEW OF K. K. DARROW'S "An Introduction to Contemporary Physics" appears in the February *Physical Review*. Mentioning some of the features of the book, the reviewer says of the Prolegomena, "In this, the relation of theories to experimental data is discussed with a clarity and perspective giving invaluable guidance to the student venturing for the first time into serious exploration beyond the settled ground of classical physics."

THORNTON C. FRY presented a paper on "Light Waves in Metals" at the February twenty-fifth meeting of the Optical Society of America.

AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY, on the afternoon of February 18, Mr. Craft delivered the Aldred lecture on "The Romance of Research in Industry." Speaking of the importance of industrial research Mr. Craft said, "It is at last sinking into the consciousness of the American public that our national wealth depends to a large extent upon our advances in the technique of applying science and engineering to the solution of our industrial problems."

D & R News Notes

Contributed through H. S. SHEPPARD, *Executive Assistant*

A PAPER under the title "Measurement of Telegraph Transmission" was presented at the Winter Convention of the American Institute of Electrical Engineers by Messrs. H. Nyquist, R. B. Shanck and S. I. Corey.

Others having an active part in this Convention were A. H. Inglis, Chairman of the Inspection Trip Committee and H. B. Coxhead, who was Chairman of the Smoker Committee.

During the month of December, 1926, ten patents were issued to the following members of the Department of Development and Research:

M. L. Almquist, R. S. Bailey, F. C. Bisbee, I. W. Green, W. H. T. Holden, H. Nyquist, R. B. Shanck, P. M. Snavely.

W. T. Breckenridge spent a week in Ft. Wayne, Indiana, in connection with acceptance tests on a new commercial line of charging generators.

A. Weaver is in St. Louis, assisting in preparation for the opening of a commercial telephotograph station February 15th.

R. L. Young visited Toledo, Ft. Wayne, Cleveland and Buffalo during January in connection with improvements in gas engines, charging generators and storage batteries.

B. P. Hamilton was in Chicago recently in connection with carrier telegraph matters.

Messrs. Gill and Mumford, of the British General Post Office, are guests of the Development and Research Department. During their stay in America, they are making a study of the receiving problems on this side of the Atlantic in connection with the transatlantic telephone service.

At the meeting of the Midwinter Convention of the American Institute of Electrical Engineers on February 10th, Mr. A. H. Schirmer presented a discussion of the papers relative to tests involving the use of the surge voltage indicator. Mr. Schirmer reviewed the tests carried on during last summer at Mt. Kisco, when the klydonograph was used to investigate the effects of lightning discharges on telephone lines.

Club Notes

Our first indoor golf tournament was held at the Vander-Built-In Golf Course, on Wednesday evening, February 9, 1927, and it proved to be one of the most successful and interesting parties promoted by the Club.

Ninety men teed off in the qualifying round, which consisted of thirty-six holes of medal play; the players being divided into two groups of forty-five each. Thirty-two men qualified in each group and made up eight flights for the elimination match play.

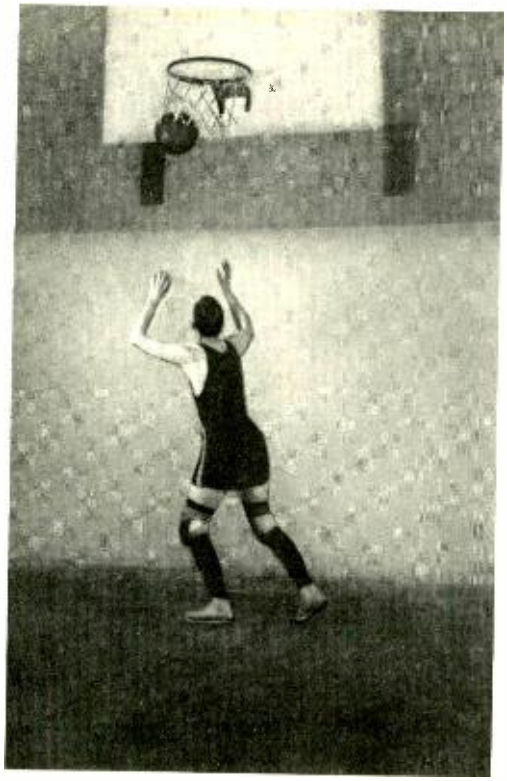
Low medal score in each group received a prize and was eliminated from further competition in the finals.

The winner in each of the eight flights in the finals also received a prize.

Each week we read in the daily papers about some upset in the sport world and our tournament was no exception, J. G. Roberts being the only player among our first class golfers to finish. Low handicap men like G. T. Lewis, G. E. Kellogg, J. Hillier, E. H. Clark and others dropped by the wayside as the tournament progressed, and the class B men came into their own.

The winners were as follows: Flight 1 qualifying round J. Dusheck, Flight 2 qualifying round C. D. Walker. Finals, Flight 1-A J. G. Roberts, Flight 2-A W. F. Robb, Flight 1-B E. J. Johnson, Flight 2-B G. Heydt, Flight 1-C W. Harvey, Flight 2-C L. Hoyt, Flight 1-D P. C.

Team representing Equipment; winners of B. L. C. inter-departmental basketball championship



C. Maurer scoring a field goal

Smith, and Flight 2-D H. L. Walter.

Among the prizes were a golf bag and steel shafted driver which were donated by the management of the course and one dozen golf balls donated by Alex. Taylor & Co., athletic outfitters for the Bell Laboratories Club.

If there is sufficient demand another tournament will be held during the month of March.

Basketball

The women are out to play basketball and to play it well. The group playing on Monday nights promises well for a good team in the near future. They played Houston House on February first and Dumont High School on February twenty-eighth. Plans are being made for two regular teams—one practicing girls' rules; the other boys'. A group of the new players will act as substitutes, and will be trained to take part in either game. By this arrangement, all who have been practicing will get into the game. Miss Boman is planning more outside games this month.

Bridge

Bridge is going strong as usual. The players, after six weeks' instruction, began their Spring Tournament on February 9 and will continue for ten weeks. There are seven tables in the rest room each Wednesday night beginning at 5:05. Suitable prizes will be awarded for the entire period and also for each evening's play. From present indications we expect games between the men and women in the near future.

Entertainment and Dance

On Friday evening, April 22, the Club will hold its Spring Dance and Entertainment in the Grand Ballroom

J. A. Waldron ready to start game between Tube Shop and Equipment

of the Pennsylvania Hotel. The committee is planning for the personal appearance of a number of well known popular radio artists. Club members and their friends should take advantage of the opportunity to see some of the stars who are heard each week from WEAF.

Dancing

The dancing and gymnastics class has moved to Broadway this season. Louis Vecchio's Studio will be the scene of activities for the ten weeks beginning February 11. Exercises will be varied. Both mat and bar stretching will be practiced, and the dances will range from, as Mr. Vecchio puts it, "Jazzical to Classical."

Swimming

Spring is in the offing, and with its approach comes the usual interest in outdoor sports. The ever-popular swimming class was filled to overflowing this winter. A new class starts on March 9 at the Carroll Club with Miss Steel again in charge. The size of the pool necessitates limiting the number admitted, and a few applications had to be refused. However, if a sufficient number of requests are received the Committee will make a special effort to secure the pool for an additional period. If you are interested, let Miss E. D. Bolan know.

Blocking a try for a field goal

Hiking

The outdoor clan gathers once more. It invites all to join in its hikes. Although this group have not been dormant this Winter, their real interest in hiking is now awakening. Their first hike is scheduled for March 19, and will probably be along the Bronx River Parkway from Wakefield to White Plains. Come and join them.

Plans are also being made for campfire-supper hikes on Saturdays throughout the summer. In addition, one supper hike a month

C. Hiscock ready to make a try from foul

will probably be dated on a week-day.

HANDBALL TOURNAMENT

The Bell Laboratories Club will hold an indoor handball tournament during the month of March. The courts are located in Labor Temple, 14th Street and 2nd Avenue, New York City.

The tournament will extend over a period of four weeks and will consist of elimination singles matches.

Time—Tuesday and Thursday evenings 5:30 to 7:30 P. M.

An entrance fee of twenty-five cents will be charged. Prizes will be given to the four men in the semi-finals in accordance with their ranking after the finals are completed.

After all applications are received the entrants will be advised of the date, time, and the opponents with whom they are to be matched. Matches must be played on nights scheduled.

For Vacation

About a month or six weeks from now that cheery harbinger of spring, the Vacation Schedule, will be passed around; it will be greeted pleasantly, for nothing is more delightful than a vacation in prospect. There is only one slightly unpleasant drag on the Two Weeks Off: paying the bills. Even the happy and prosperous bachelor sometimes feels the need of money in larger quantities, or at an earlier date, than is provided by vacation pay.

It is respectfully suggested that a convenient way to meet this financial stringency is to make use of the Employees' Savings Plan. The Payroll Department, if requested, will deduct from salary any desired amount each week (or month) and deposit it in a savings bank; it may then be withdrawn, at the vacationer's convenience, to purchase railroad tickets, fishing tackle, or what not.