BELL LABORATORIES RECORD

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MARCH 1928 VOL. 6 NO. 1

Bell Laboratories Record

A Monthly Magazine of Information for Members of
BELL TELEPHONE LABORATORIES, INCORPORATED

Edited by the Bureau of Publication:
PAUL B. FINDLEY *Managing Editor*

Printed, not published, *by*
BELL TELEPHONE LABORATORIES, INCORPORATED
463 West Street, New York, N. Y.

Printed in U. S. A.

Bell Laboratories Record

Volume Six | March, 1928 | Number One

A New Loud-Speaking Receiver

By A. L. THURAS
Research Department

THERE has been developed in Bell Telephone Laboratories a loud-speaking receiver which differs in many respects from previous devices. In commercial form known as the Western Electric 555-W Receiver, the device has already found application to talking motion-pictures.

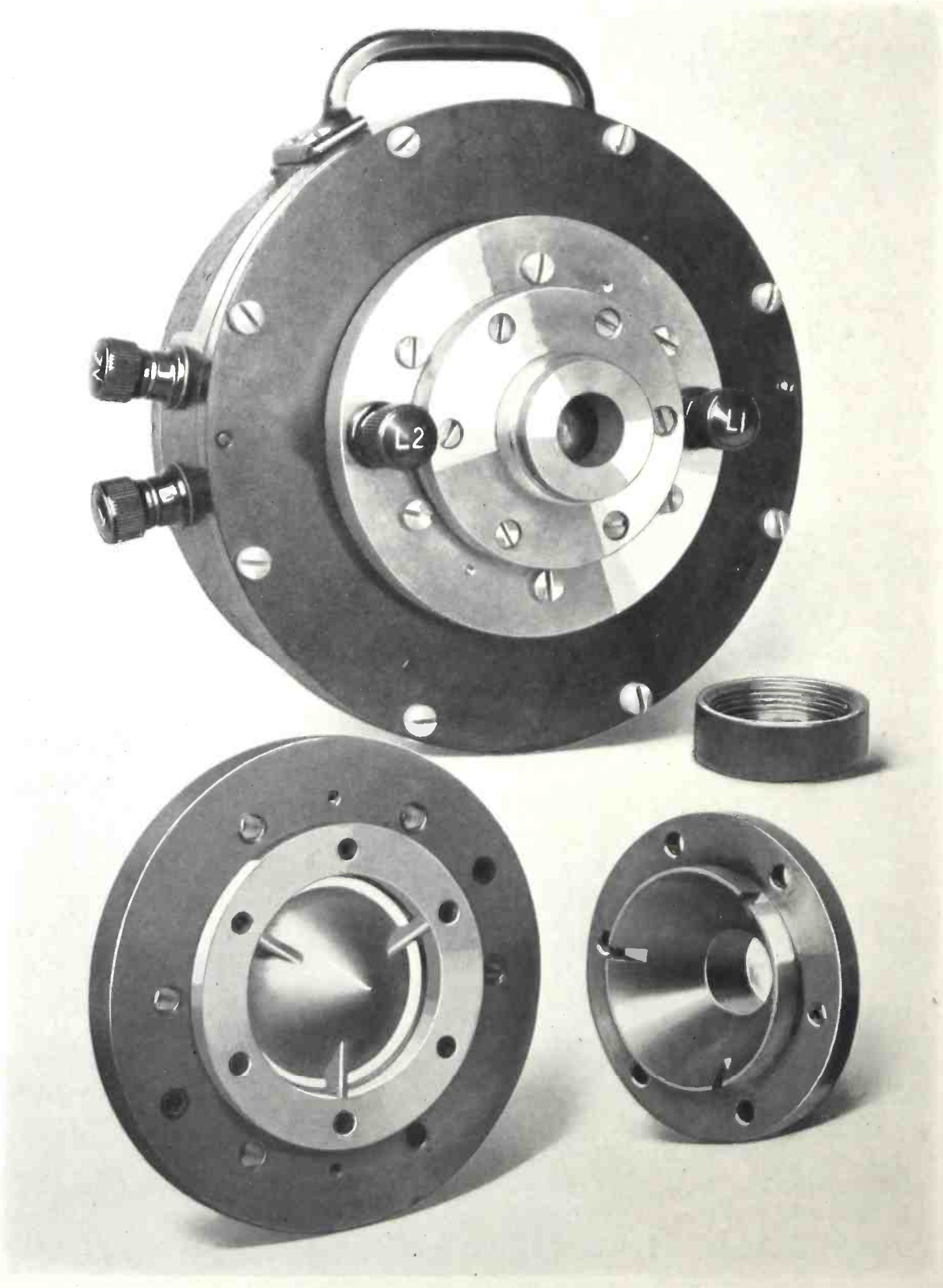
Briefly, the new receiver consists of a duralumin diaphragm to which is attached a coil of flat aluminum wire. Audio currents circulating in this coil interact with a steady magnetic field, forcing the diaphragm in and out of an air-chamber of novel form. Air-waves thus set up are radiated through a horn.

One of the things which may limit the sound-radiating efficiency of the horn type of loud speaker is interference between air waves as they pass through the chamber between the diaphragm and the throat of the horn. In many forms of loud speaker, the dimensions of this chamber are comparable with wave-lengths of sound within the audible range. To avoid this effect, and the resultant irregularities in the frequency-response curve, the air chamber in this receiver is so constructed that no serious phase-differences can occur within the useful range of wave-lengths.

Another factor which has come out of development studies on receivers is the desirability of having the diaphragm vibrate to and fro as nearly like a rigid plunger as possible. An ordinary flat piece of metal clamped around a circular edge assumes a domed shape when vibrating at low frequencies. The diaphragm can be made to vibrate with its central portion essentially unflexed by adopting a shape which makes it less rigid near the edge and more rigid toward the center and then applying the force uniformly around the outside of the central portion.

These things are accomplished by the shape of diaphragm illustrated in Figure 1. It is made of a single piece of sheet aluminum alloy 0.002 inch thick. To this is fastened a driving

EDITOR'S NOTE: *The definitive technical presentation of this development appears in an article by E. C. Wente and A. L. Thuras in Bell System Technical Journal for January, 1928.*



Above, the Western Electric No. 555-W Receiver ready to be attached to a horn; below, the horn-coupling opened to show the novel form of the air chamber

coil of circular form, indicated by (B) in Figure 1. This coil, which is itself of a novel type, is mounted rigidly on the diaphgram. In the assembled receiver it moves up and down in the annular space between the ring-shaped pole pieces of an electromagnet. Between the coil and the clamped edge, the diaphragm is corrugated tangentially to prevent resonance. This idea was developed in the Laboratories by H. C. Harrison and is incorporated in the soundbox now used by the Victor Talking Machine Company.

The driving coil (B) is a single layer of aluminum ribbon 0.015 inch wide and 0.002 inch thick wound *on edge*. The turns are held together by a thin film of insulating lacquer about 0.0002 inch thick which is thoroughly baked after the winding is completed. Thus the coil becomes mechanically self-supporting, and rigid, and is very light. Ninety per cent of its volume is occupied by metal, and since the metal is continuous between the outer and inner surfaces, heat is conducted outward quite readily so that larger power input can be used without danger of warping through overheating. There is but a single layer, and so the distributed capacity of the coil is very small. Partly for this reason, the impedance of the coil is a resistance nearly constant with frequency — a factor in the flatness of the frequency-response curve. Aluminum was selected instead of copper because its much smaller weight yielded less mass-reactance at high frequencies. The resulting gain in efficiency at the upper end of the spectrum more than counterbalanced

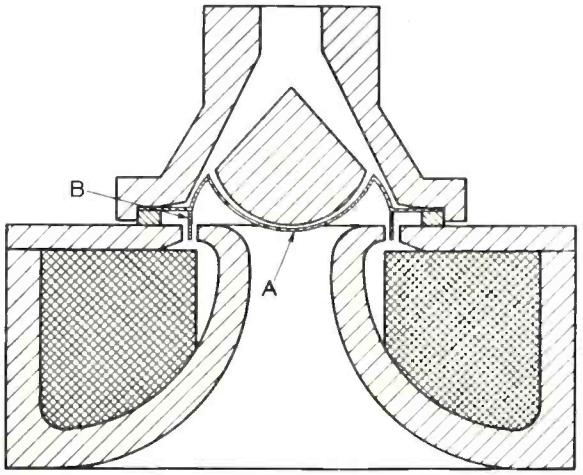


Fig. 1. — A sectional view of the loud speaker: A, the diaphragm; B, the driving coil

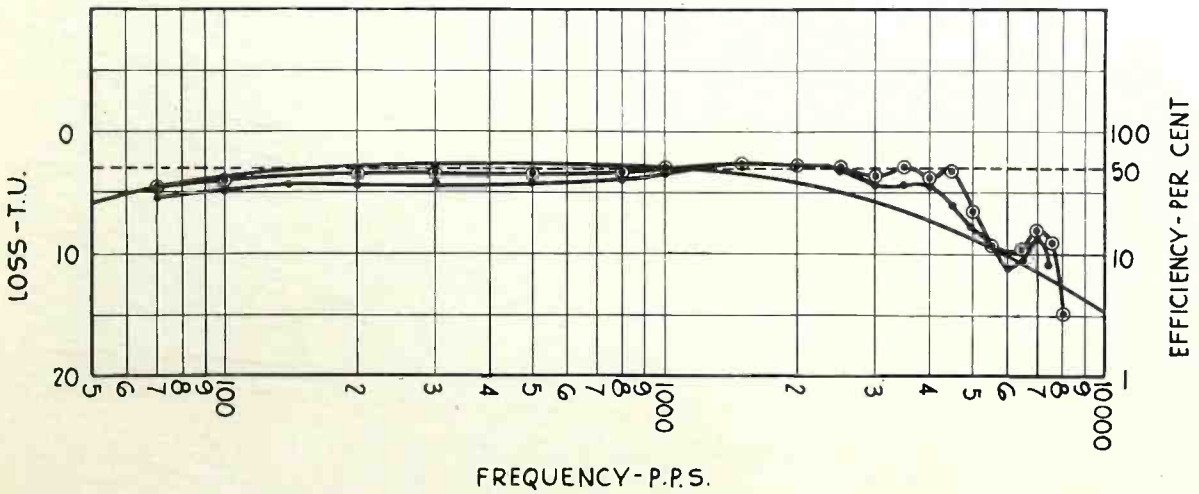
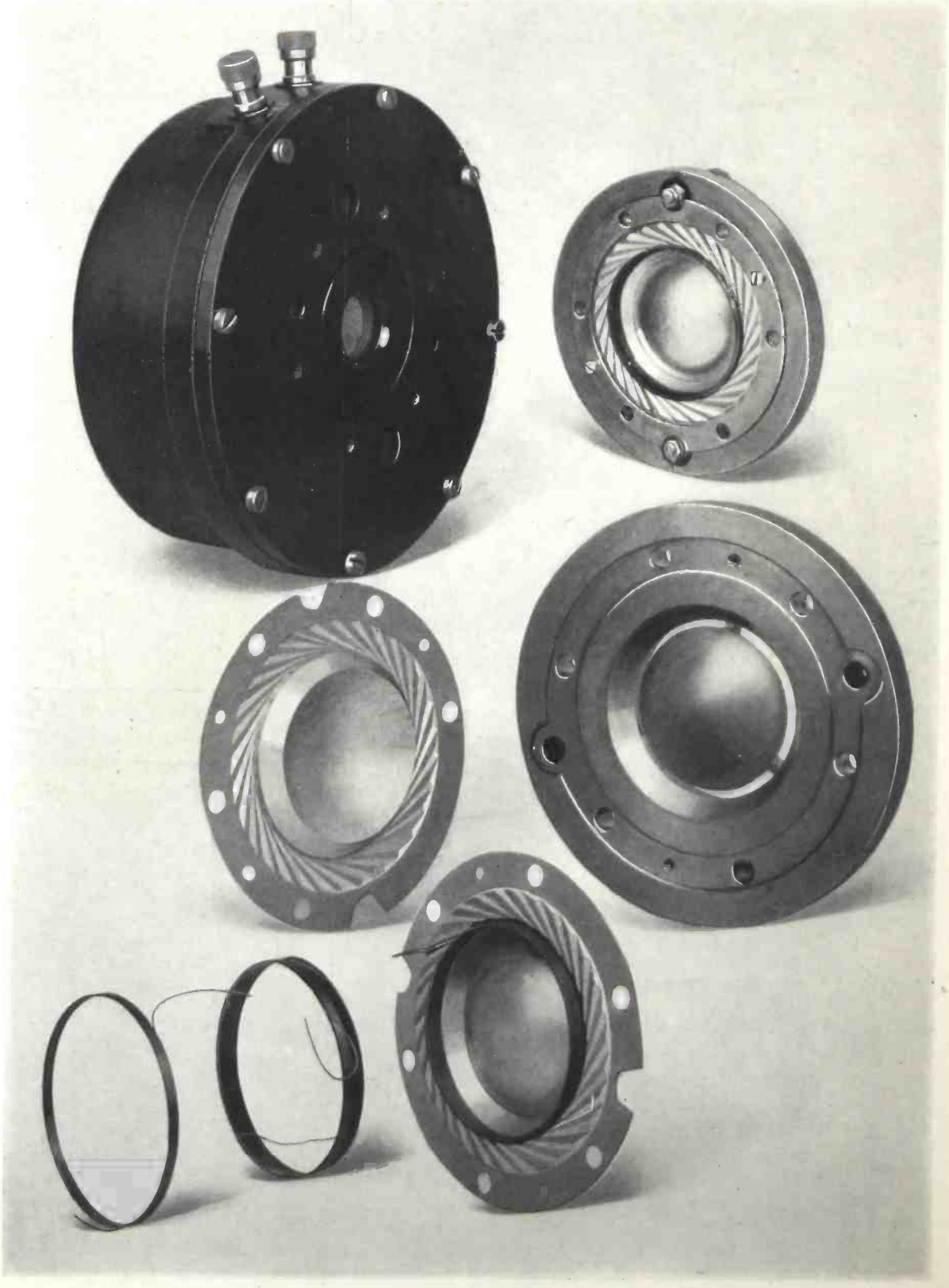


Fig. 2 — Performance of the 555-W Receiver. The solid curve was calculated; the other curves represent actual measurements



Details of the 555-W Receiver. At top, the receiver separated at the air-gap. The driving coil is seen attached to the diaphragm. Below, the diaphragm and its mounting-plate separated as the leaves of an opened book. At bottom, the progressive assembly of the coil on the diaphragm

the somewhat increased electrical loss.

The manufacture of the coils is a story in itself which is to be told in a later issue of the RECORD. It has been shown that it is feasible to make the coils in quantities within narrow tolerances so that very small clearance between the coil and the electromagnet can be obtained. Small clearance facilitates the dissipation of heat and makes more effective use of the steady field so that a smaller magnetizing force can be used. Studies were made of both permanent and electromagnets as the source of the steady field; the electromagnet was adopted for the commercial receiver.

An outstanding feature of the receiver is the high efficiency with which it converts power from that of electricity to that of sound. For the experimental model, efficiencies as high as fifty per cent are realized. When it is recalled that the resulting sound intensities are only three transmission units lower than those to be obtained at one hundred per cent efficiency, it will be understood that little is to be gained from any further increase in efficiency, except in so far as reduction in the percentage of loss enables greater power to be handled without exceeding a safe operating temperature. When coupled to a suitable horn, fifteen watts of sound power can be radiated.

Variation of efficiency with frequency was measured by two methods. The results are given in Figure 2 where the efficiency is expressed both in percentages and as TU below the ideal maximum of 100 per cent. The smooth curve in this figure is calculated theoretically from the mechanical and electrical constants of the system. The tests are seen to agree well with theory except for some irregularities at the high-frequency side. As the actual efficiencies are above the theoretical the receiver unit

The 555-W Receiver is tested by connecting it to a long tube and measuring its input to this acoustic "line" by the condenser transmitter shown on top of the tube. Theodore Osmer had a large part in the development work

may be said to have exceeded expectations for these frequencies.

At high frequencies the power output is limited solely by the current-carrying capacity of the coil. A temperature rise of one hundred degrees centigrade in the coil is allowable, corresponding to a continuous power input of thirty watts. This means fifteen watts of sound power at fifty per cent efficiency.

Step-By-Step Cordless "B" Board

By W. J. LACERTE
Systems Development Department

IN the course of converting the telephone equipment of a community to a dial basis, it is necessary during the transition to handle calls in both directions between the older manual and the newer mechanical offices. And even when complete conversion to machine-switching takes place, it will still be necessary to transfer many toll calls, incoming and outgoing, between the two types of equipment. For traffic originating at machine-switching offices the electrical signals are translated into numbers displayed before an operator at the distant manual office or at an intervening manual tandem center. In the other direction, calls to panel offices have long been translated into the machine's language by depression of keys provided at an incoming trunk board* in the machine-switching office. Until recently, however, step-by-step offices have received their incoming calls from manual offices by dialed signals from those offices, the arrangement being known as the "out-dialing trunk" system.

From operating and traffic standpoints this procedure is quite satisfactory, but under certain conditions recently encountered it does not bring about the most efficient use of equipment. In addition to modification of trunks to the step-by-step offices, it necessitates provision of dials at all subscribers' and tandem switchboard positions and dialing equipment on all the cords. That arrangement is the most economical in a small community, but for a step-by-step office near a large metropolitan area it involves a large investment in dialing equipment at the manual offices, used in most cases on a comparatively small part of the outgoing calls.

For such situations a cordless incoming-trunk board is now available, which concentrates the facilities for conversion of the calls at the step-by-step office, where the incoming calls converge. The first installation is in service at McKeesport, Pennsylvania, a manufacturing city in the Pittsburgh district served by a step-by-step office. With its use no modification of manual switchboards or trunks is needed to permit completion of calls from subscribers in Pittsburgh or its trunking area. The originating operator's work is the same as with a straightforward call to a manual subscriber. The call is transferred to machine-switching equipment at the terminating office, and at that office all the necessary equipment is located.

For the calling subscriber there is no indication that his call is receiving special handling. His operator asks him for the number wanted; after she acknowledges it, he hears the order signal, the same "zip-zip" tone used in manual practice. Thereupon the "A" operator states the number

** For the same purpose, equivalent key equipment may be installed instead at each A-board position.*

wanted, and thus finishes her work until the conversation is finished; after a short interval the calling subscriber hears the ringing signal which indicates to him that connection has been completed as far as the line of the person wanted. But he has had no intimation that the connection has taken place through step-by-step switches, or been guided by controlling circuits of machine-switching equipment.

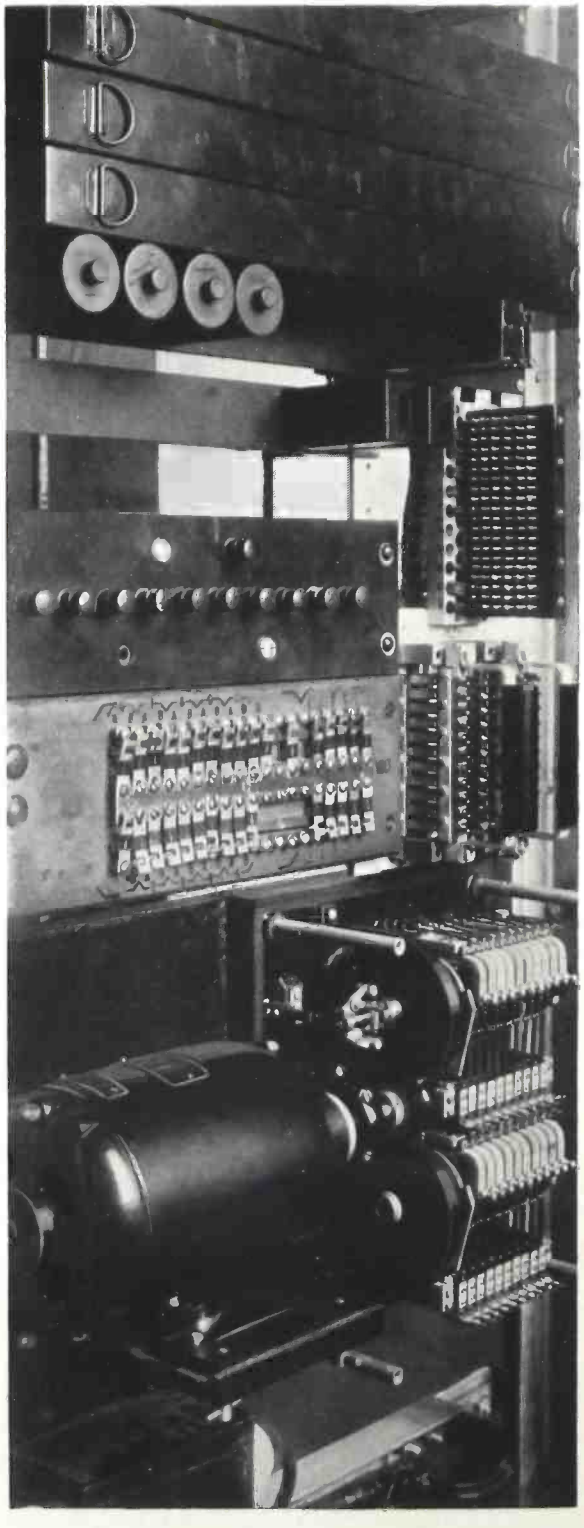
At the terminating office is a "completing" operator who receives and acknowledges the order just as a manual "B" operator would. Through a group of ten numerical keys she communicates the number to the completing switches, pressing in turn the keys corresponding to the successive digits. Her headset is connected and disconnected automatically by the circuit equipment; hence she has no allotting keys, and hence likewise she exercises no supervision over the call. At her position are two switchboard lamps, showing progress of the call, and three additional keys. One key, if pressed before the last digit has been recorded, stops the call and resets the recording equipment so that she can rectify an error if it is noticed in time; another, for use when her position is not disconnected automatically at the completion of the pulsing, releases it and makes it available for the next call; the remaining key is used to summon the supervisor when she is wanted. Removal of the operator's plug directs calls to the occupied positions.

The complete cordless equipment aside from the operator's position is made up of six principal parts, shown on the accompanying chart, whose functions are indicated by their names.

Two operators' positions. At the left is a section in which the cable comes up from the floor

One branch of each incoming trunk, through which conversation takes place, is permanently attached to a first selector; the other branch runs to the cordless "B" equipment, whereby movements of the step-by-step switches are governed. These controlling branches terminate on trunk-finder switches by which the necessary switch-controlling mechanism is connected during completion of each call, and then freed for use on other trunks; the trunk finders are standard step-by-step type switches, but with six hundred terminals and a vertical commutator. A circuit of six conductors is required; hence the terminal capacity of each trunk finder is one hundred trunks, and for each hun-

dred incoming trunks a group of finder switches is provided, depending in size on busy-hour traffic. There are ten levels to the trunk-finder bank, with ten trunks on each. To minimize hunting time and to prevent discrimination between subscribers the trunks are terminated on different levels of the several finder switches, allowing each trunk to appear on the first level at least once; the circuit which starts the switches will choose that one on which the incoming call appears at the first level, if it is not busy.



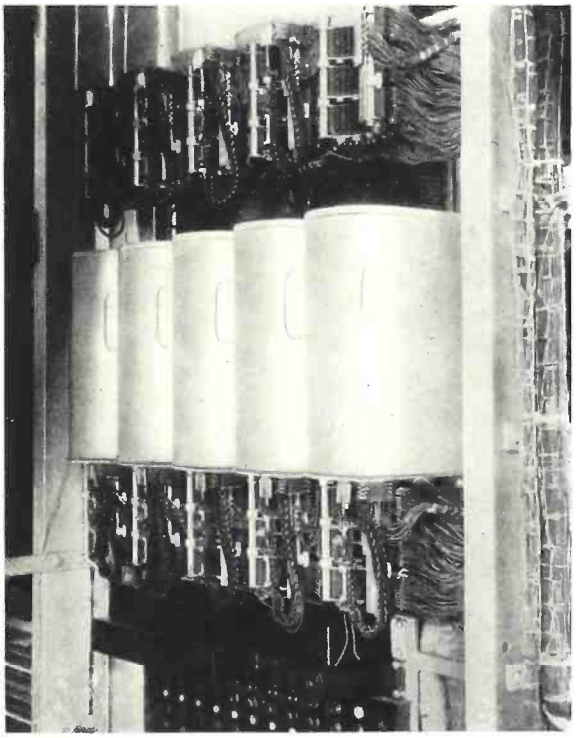
Lower section of sender frame, showing the motor and the interrupter with cover removed

Each trunk finder is a permanent part of a link circuit, the heart of the system. The other two parts of each link are two 200-type selectors; on one of these are terminated lines to the operator's positions and on the other lines to the senders. Governing both, and governing the trunk finder as well, are control circuits to start these hunting switches at the proper moment. This link circuit ties the incoming trunk, through the trunk finder, to the completing operator and the sender, and thereby allows the call to advance from an order passed by the "A" operator to a setting of relays in the sender, which in turn controls the mechanical completion of the call.

The sender, an innovation in step-by-step practice, increases the operator's load to her working capacity, freeing her from limitation by the speed of the completing selectors and connector. Its function, like that of the senders in panel equipment, is to receive and record the number set up, and to send out a series of pulses guiding the operation of the step-by-step completing switches as each in turn is called upon to function. The sender is suited alike for four- and five-digit numbers; it contains five groups of register relays, of which each group records one digit. Pulses are sent out by two sets of interrupter contacts

controlled by these register relays, to communicate the recorded number to the selector and connector switches. Of these contacts, one set functions the same as the pulsing contacts of a dial, and the other controls counting mechanism to terminate each group of pulses when the proper number have been sent. Connection of the sender to the link circuit through a searching switch, rather than by a permanent contact, provides equipment economy to a marked degree. The McKeesport installation requires eighteen link circuits, but on account of reduced sender holding time secured by the use of sender selectors and the higher efficiency of group operation, it requires no more than ten senders.

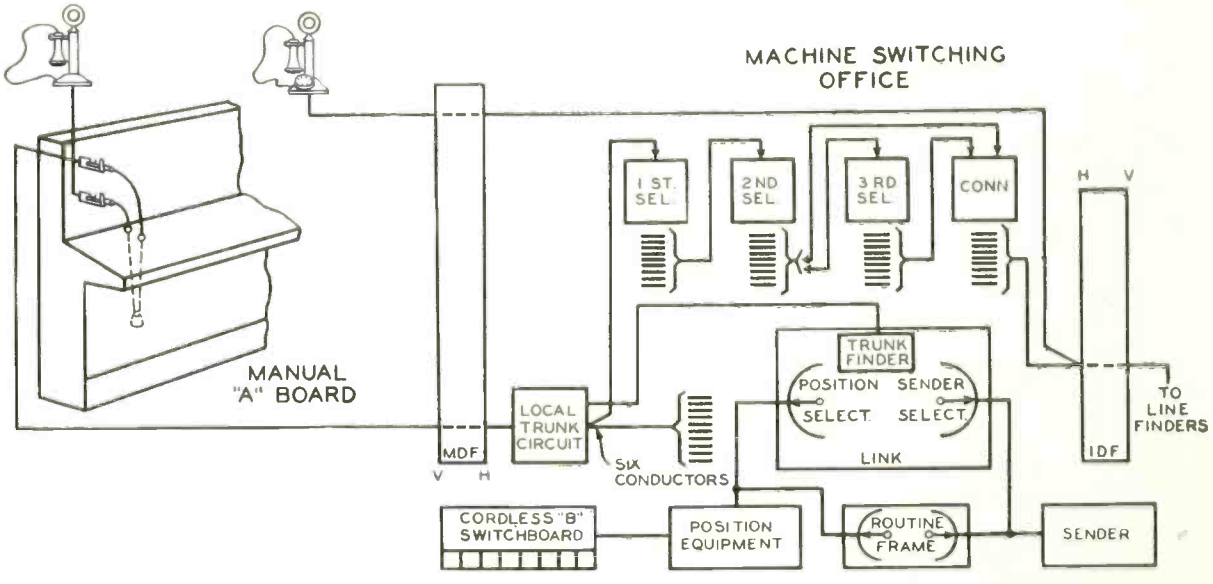
Possibly the best explanation of the system would be to trace a call from a distant subscribers' or "A" board to completion. The "A" operator, receiving a call for a machine-switching office, chooses an idle trunk as in straightforward practice and plugs into the jack. Immediately at the completing end the trunk finder of one of the link circuits starts hunting for the trunk on which the call is waiting; almost simultaneously the position selector of the link begins searching for an idle operator's position, which it finds at about the time the trunk is located. Thereupon both "A" and "B" operators receive the order tone; the "B" operator is further notified that a call is coming by the lighting of her two switchboard lamps. As soon as the "B" operator's position has been connected, the link's controlling equipment disconnects from the position selector and guides the sender selector in choosing an idle sender. About the time the order has been passed and acknowledged, the idle sender has been found, whereupon one lamp is extinguished to indicate that everything is in readiness to record the number and to pass it on to the step-by-step equipment. The cordless "B" operator then registers the digits on



Trunk-finder switches

her numerical keys, pressing them successively and thereby recording on consecutive register relays of the sender the code to secure completion of the call; her position then is disconnected automatically. The first group of register relays controls pulses sent to the first selector and the second group those sent to the second selector, and so forth, until the brushes of the connector are stopped at the terminals of the called station. Then, the connection completed except for lifting of the receiver by the called subscriber, the work of the link circuit and its associated equipment is done. At once the trunk finder and sender selector re-

lease their contacts, freeing for other calls the circuit-controlling equipment. But the connection to the called station from the incoming trunk through its permanently joined sending and to disconnect within a few seconds after the operator's position has been released, and by other operating and equipment difficulties. Attention of maintenance men is



Schematic diagram of the cordless "B" switchboard

first selector remains, ready for conversation.

On account of the large number of operations taking place in a few seconds — action of approximately two hundred relays and in addition a few manual and several switch operations — reliable means for prompt detection of trouble is most important. There are therefore audible alarms for trouble of various sorts — alarms operated by a melted fuse, by failure of the trunk finder to function within a predetermined maximum time, by an excessive link-holding time, by failure of the sender to finish its pulse-

thereby called immediately to points needing attention, and service delay is prevented.

Although it includes previously known elements, the step-by-step cordless "B" board marks a distinct advance in conversion of calls from manual offices, particularly in certain communities adjoining large cities. Conversion of calls to panel and step-by-step dial offices is placed on a closely comparable basis. Most important, wherever suited to the operating needs of a community the board provides greater over-all economy of facilities than was formerly attainable.

New Devices in Television

MEMBERS of the American Physical Society and the American Optical Society meeting in our auditorium on Saturday, February 25, witnessed a demonstration of television during which were shown important new developments which remove some of the many conspicuous obstacles now separating the television art from any important commercial applications.

Heretofore syncronization between the sending and receiving apparatus has been accomplished by a signal transmitted from one device to the other. Electric oscillators controlled by vibrating quartz crystals have now been developed which permit two stations to be held in synchronization without being connected to a common control, and which also permit of making the preliminary adjustment known as framing in an extremely simple way. These crystal control oscillators are the development of J. W. Horton and W. A. Marrison and are capable of holding to a constant frequency within one part in ten million.

Such oscillators were originally developed for other purposes in the communication art, as for instance the precision measurement of frequency. They have just been applied to television for the first time and provide simple and effective synchronization. When controlled by these crystals, the driving motor of the receiver would require one week to get out of step with the motor at the sender by as much as one revolution. In an hour the television image will, at most, wander only one-third of the distance across the field of view. The maintenance of a television image "in frame" therefore requires only occasional attention from those viewing it.

The new system also simplifies the original centering of the image within the viewing aperture. By the operation of two push buttons, the image can be caused to travel slowly across the field of view in either direction, and when it arrives at the desired position within the frame, release of the buttons automatically locks it in place.

The system not only involves crystal-controlled oscillators, but frequency-reducing circuits, recently developed by Mr. Marrison, which will generate from any vacuum tube oscillator a current whose frequency is a simple fraction of it such as a quarter, a fifth or a sixth. There is as well a device for introducing into the synchronous motor an additional positive or negative cycle at a very slow rate, to change the speed of the motor gradually and thus to effect the desired framing operation under perfect control of the operator.

Radio Installations in South America

By D. H. NEWMAN
Apparatus Development Department

WITH perhaps a greater appreciation of music and the fine arts than we have, our Latin American neighbors have not yet contracted that avid zeal for advertising and publicity which is the real incentive to the great multiplication of broadcasting stations existing in this country. Basking in the radiations from the six hundred and fifty and more stations of the United States, we sometimes fail to realize that on the entire continent to the south of us there are probably less than two score broadcasting stations. This is typical of the many differences that exist between the North and South American continents. Climatically they are radically different. Excepting the southern part of Mexico, no part of North America is in the tropics while South America is about two-thirds tropical. The peoples and customs of the southern continent also are distinctly different from those of the United States and Canada. Industrialism and high-powered salesmanship while beginning to invade the southern republics are still far from vitally affecting the lives of the bulk of the population.

These differences have been brought closer to the Laboratories within the last two years because of the installation of standard Western Electric broadcasting stations in five cities of the republics to the south of us. The work was supervised by members of the Laboratories' technical staff acting for the International Standard Electric Corporation. The first to be installed was in Caracas, the capital of Venezuela. This subtropical republic at the northern end of South America includes the rich Orinoco Valley and while largely mountainous contains much valuable grazing land. As is the case all over Latin America there is a big contrast in Venezuela between life in the cities and that in the country districts. This is well illustrated by the two accompanying photographs, one showing a quiet street in the capital and the other a thatched hut in the interior. In the cities, although the architecture is different from ours and life is less complex and moves more slowly, the modern spirit is evident, but in the smaller towns and agricultural areas life is more or less uncontaminated by twentieth century inventions, and the implements of industry are still primitive.

Until recently no radio apparatus has been allowed to enter Venezuela but a short time ago the government granted a monopoly to the Empresa Venezolana Radio Telefonica. This Company is now importing receiving sets and has installed a one-kilowatt broadcasting station to transmit programs of local and national interest which, it is hoped, will develop a demand for their sets. The station is housed in a three-room building beside the principal bull-ring. The studios, about a block away in a

private dwelling, are connected to the station by suitable cable circuits. One of the features to be broadcast is music by the Presidential Band, which plays in the Plaza Bolivar in the center of the city.

Following the installation at Caracas another was made in the republic of Haiti in the West Indies. In this country a traveler from the north sees much of a primitive character to marvel at. The photographs of the horse-driven sugar mill, built with Biblical simplicity in its setting of tropical shrubbery, and of the hand-power lathes, with their large driving-wheels lined up along a modern concrete road for contrast, show to what a great extent modern progress has passed Haiti by. The natives of African descent still cling to many of their Voodoo practices. Evidence of this is the rectangular niches in the sides of the tombs shown in the accompanying photograph. Into these recesses is placed food for the departed spirit as a form of propitiatory offering. Curiously enough it is the custom to mix poison or powdered glass with the food so that if the ghost should partake of it, a second death would send it back to the tomb for the time at least.

Map of South America and the West Indies showing the location of the recent installations of Western Electric sets

The station is located in Port-au-Prince, capital of the country, and is owned by the Government. It is operated by the Department of Public Works which purposes to broadcast lectures on hygiene, sanitation, and methods of planting, cultivating, and harvesting the national agricultural products which are very largely coffee and sugar. In the principal towns and villages radio receivers operating into public-address systems are set up in the markets where the

A native thatched hut in the mountains of Venezuela

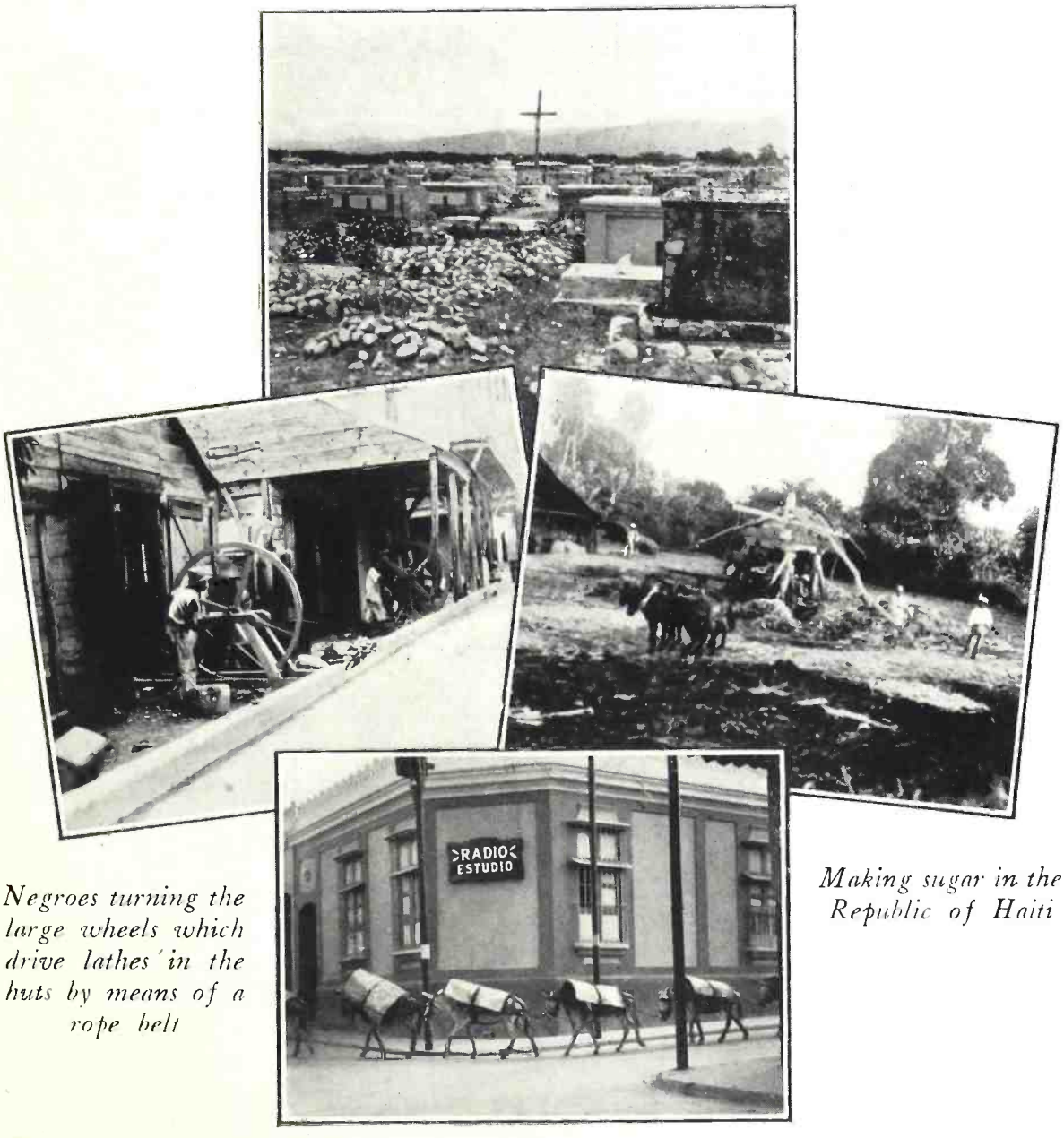
A noon day meal in Montevideo. Note the shovel serving as a frying-pan

A quiet street in the Venezuelan city of Caracas

citizens congregate. In this way the government hopes to reach the greater part of the people who, because very few of them can read or write, could not well be reached in any other manner. Radio will thus serve Haiti as a very effective educating force.

While the author was installing these stations in Caracas and Port-au-Prince, a similar set was being installed, also under direction from the Laboratories, in São Paulo, the center of the coffee trade of Brazil and capital of the State of São Paulo. The Brazilian St. Paul is the richest city in the country and one of the most modern and progressive of all South America. The station is privately owned, being operated by a large group of amateurs known as the Sociedade Radio Educatora Paulista.

Brazil, the largest country in South America and almost equalling in size the United States and Alaska combined, is unique among all the South and Central American Republics in having Portuguese instead of Spanish as the national language. Two years after Columbus' first voyage a treaty



Negroes turning the large wheels which drive lathes in the huts by means of a rope belt

Making sugar in the Republic of Haiti

Top, a Haitian cemetery; below, radio station at Caracas

was signed by Spain and Portugal which established an imaginary line running north and south about eighteen degrees west of the Cape Verde Islands. All new land discovered west of this line was to belong to Spain and all east to Portugal. While there were some minor infractions of the treaty, nevertheless it has been for the most part observed. Under it Brazil was the only South American land falling to the lot of Portugal.

On the way south the tropics are left at São Paulo, for through the northern part of this city runs the Tropic of Capricorn. Uruguay, just south of Brazil, is wholly in the South Temperate Zone. It is semi-tropical, however, and like Los Angeles and southern California or Florida has palm trees, rainy seasons, and other evidences of equatorial climate. Montevideo, its capital city, stands on the north side of La Plata, the

great estuary of the Parana and Uruguay Rivers, which separates it from the Argentine Republic. The new station, which is government-owned, is located in this city on property belonging to the Escuela Militar, the West Point of Uruguay. The programs will be largely educational, probably including lectures from the national university. Although there are many who take pride in their pure Spanish ancestry the larger portion of the people of Uruguay, as of most of the South American republics, are a mixture of Spanish or Portuguese with the native Indians and former negro slaves. For the most part the working classes take life easily and make the most of what they have, as may be seen from the acompanying photograph where a shovel, used during the forenoon for digging the foundation of the new broadcasting station, is being utilized during the breakfast hour for frying beef steak. No faintest echo of the modern cry for cleanliness has yet reached their ears and should it finally do so would perhaps have little attention paid to it. The gasolene can beside them probably contains water for making maté, the native substitute for tea so commonly used in Uruguay, Brazil, and other parts of South America.

The last of the series of five southern stations is at Buenos Aires, capital of the Argentine Republic. This is the largest station of the group, being rated at five kilowatts. It is owned and operated by the municipality and will broadcast music from the famous Colon Opera House during the season. Out of the opera season various concerts will be broadcast and possibly also the proceedings of the City Council. The station is located on low lands which are often flooded by the waters of La Plata and due to this, construction work was considerably hampered. For each tower it was necessary to build a concrete platform nine hundred square feet in area.

Buenos Aires, or B. A. as it is popularly called, is probably the most modern and is the largest city in the entire continent. It is one of the few in South America that have had broadcasting stations for some time, so it is gratifying to know that its newest and largest is a "Western Electric."

Water Cooling for Radio

By J. O. GARGAN
Apparatus Development Department

TO dispose of the heat generated in vacuum tubes of a high-power broadcasting station is a problem none the less real for all that it is seldom appreciated by radio listeners. Heat is continuously generated not only by filaments consuming as much as twelve hundred watts each but by the bombardment of the plates by electrons moving at high velocity.

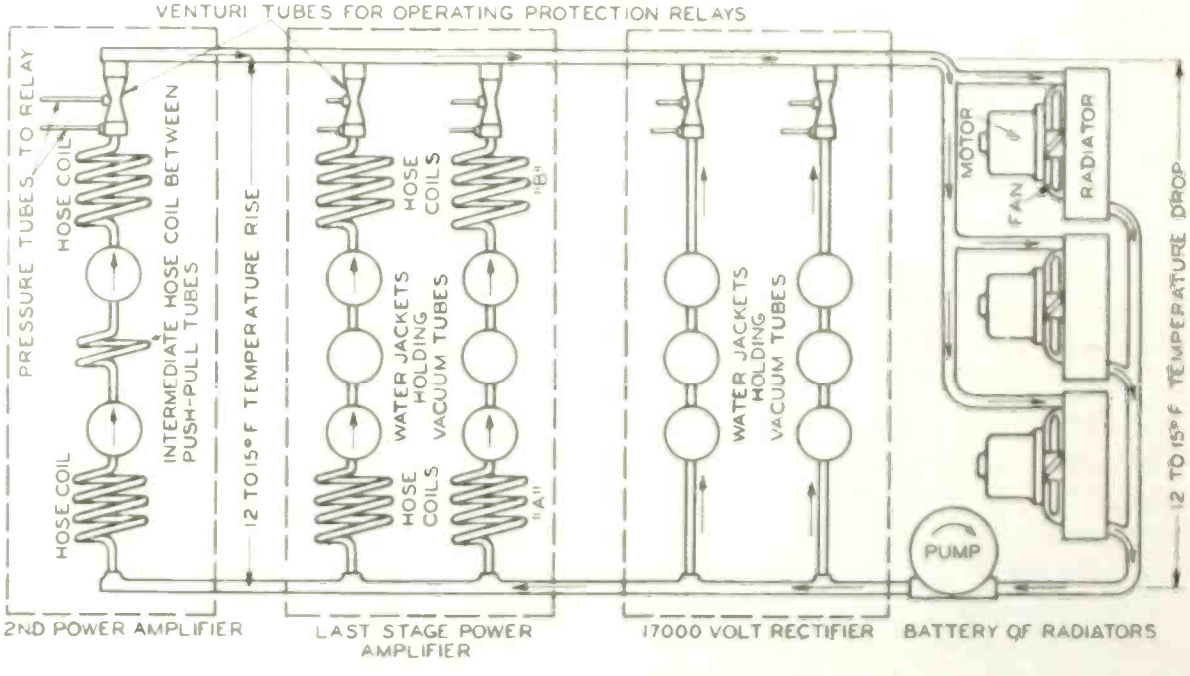
In smaller tubes the heat is radiated from the plate and taken from the glass enclosure by the surrounding air fast enough to keep the temperature down to a suitable value. As filament and plate currents and plate voltages are increased, however, heat is produced at such a rate that air cooling is no longer adequate. The limitation thus imposed on the power capacity of tubes was removed by the development and introduction of water-cooled tubes, and this in turn made the high-power radio transmitter commercially feasible.

The water-cooled tube differs from the more familiar air-cooled tube in the construction and location of the plate or anode element. This is of copper, cylindrical in form and closed at one end; at the other end it is welded to the glass wall of which it forms an extension so that the tube shell or envelope consists partly of the anode itself. Within it are suspended the grid and the filament, for which leads are brought in through the glass-enclosed end of the tube. In use, the tubular anode is inserted and clamped in a suitable metal water jacket through which the cooling water circulates in direct contact with the anode. Through its water jacket the anode is also connected electrically to the plate circuit.

Much of the fundamental design work in connection with water cooling was put into commercial application several years ago when the first Western Electric five-kilowatt sets were installed. The cooling system employed in the fifty-kilowatt set at Whippany is the result of further study based on electric, hydraulic, and thermal considerations.

In this transmitter a total of twenty-five tubes are employed, of which fourteen are water-cooled. Six of the latter are rectifiers for providing plate current to the other eight which are used for the last stages of amplification. The total heat generated in fourteen tubes due to filament heating and electronic impact is equivalent to 185 kilowatts or about 250 horsepower. This amount of heat must be transferred to the cooling water from anode surfaces which total only four square feet for the fourteen tubes. In a steam boiler the heating surface transferring an equivalent amount of heat would generally be over two hundred square feet. In the tubes at Whippany, which have the same anode surfaces as do the tubes

of the five-kilowatt transmitter, four times as much energy must be transferred. To meet this condition satisfactorily has required the design and adoption of a new type of water jacket in which a thin cylindrical sheet of water passes over the anode surface at very high velocity. Thus a larger part of the heat is transferred as well. To maintain the necessary rate of flow without requiring excessive power for pumping and without endangering the comparatively thin copper anode by crushing from excessive water pressure, it is necessary to compromise and to use hose of length and diameter moderately satisfactory from both the electrical



Schematic diagram of the cooling system

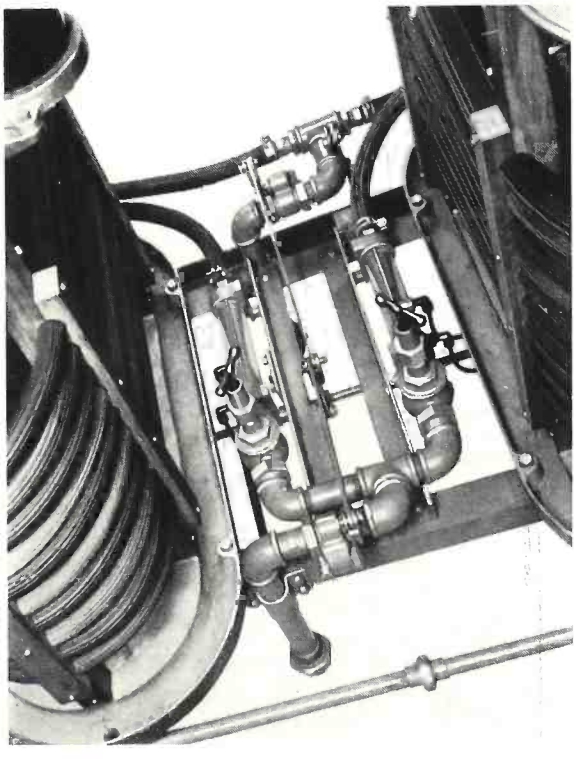
to the water by direct contact with the surface of the anode and much less of the transfer is dependent on convection within the jacket.

Anodes and water jackets of the amplifier tubes are maintained at a potential of 17,000 volts above ground. To restrict leakage of current from the jackets to the grounded pipes of the system, connection is made through lengths of coiled hose so that there are interposed columns of water long enough to make the electrical resistance to ground a matter of hundreds of thousands of ohms. Unfortunately, conditions making for high electrical resistance make for large hydraulic resistance and hydraulic standpoints rather than ideal from either consideration. In the second power amplifier, which employs two tubes, a total of seventy feet of ¾" hose is used and in the six-tube power stage, there are one hundred and thirty feet of 1" hose. The effective resistance of the two parallel paths of distilled water in the small amplifier unit is approximately 2,000,000 ohms and in the larger amplifier where there are four parallel paths for leakage, the resistance is about 300,000 ohms. The direct current losses through these are about 150 watts and 1000 watts respectively.

The water jackets and anodes of

the rectifier tubes are at ground potential so that water connections to the supply pipe can be made directly.

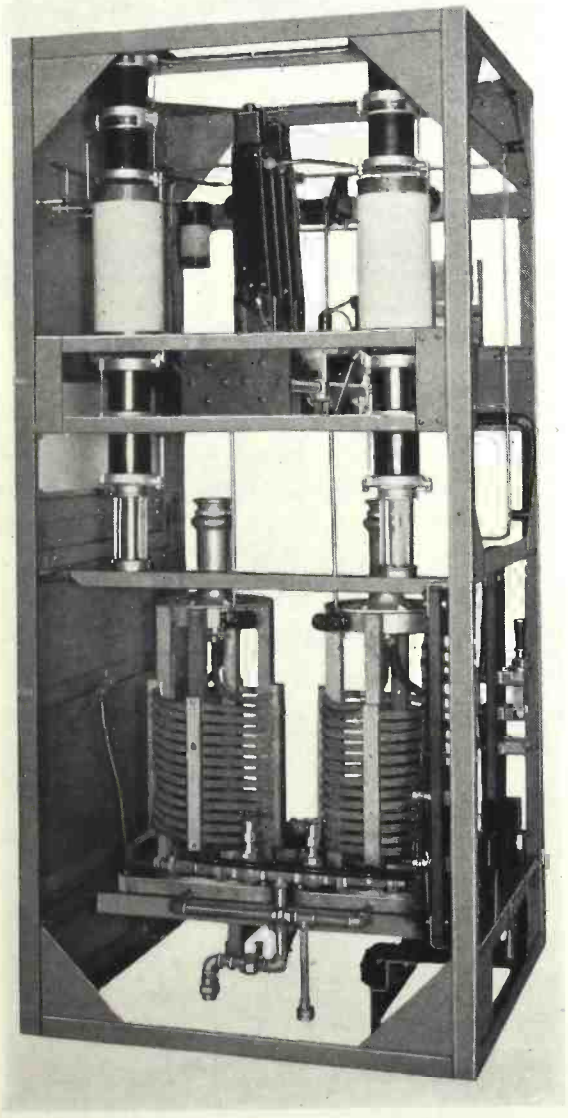
To avoid formations like boiler scale on the anode surface, and also to obtain high electrical resistance, distilled water is used for cooling. Obviously, for economic reasons the same water must be used indefinitely. It is therefore cooled in three large tubular radiators through which each minute 25,000 cubic feet of air are forced by motor-driven fans. The water-circulating pump and the fans are stopped and started automatically with the transmitter from the power panel. In its passage the air is heated about 25° F. At a station operating regularly, the air could be distributed



Venturi tubes at the ends of two hose coils

through ducts to various parts of the building and used for heating, but at Whippany irregular operation makes this plan impracticable. The heated air is therefore blown out of the building through louvers.

Because the amount of dissipated energy differs in each of the various groups of vacuum tubes, for the same temperature rise each group must receive only its proportional amount of water flow. The hydraulic resistance of each of the paths through which the water can flow from the pump to the radiator is therefore designed to give the flow wanted, just as the impedance in an electrical network can be designed to govern the current through it. In the present system the rate of flow is about one hundred gallons per minute.



Frame of one of the panels, containing water jackets for two tubes

In case of interruption or reduction of the flow the tubes must be instantly and reliably protected at each anode from the dangerous heating effects of the large amount of energy liberated. Such protection requires automatic disconnection of the power supply. Each branch of the hydraulic network therefore contains a Venturi tube whose inlet and throat orifices are connected to a device containing two opposed metallic bellows. These are operated by the difference in pressure established between the two orifices by the flowing water and when the flow is normal close an electrical contactor to the power service. If the flow is interrupted or if it falls to seventy per cent of normal in any branch, the bellows at once open the contactor and disconnect the power.*

To a visitor in the transmitter room at Whippany, there is little to indicate that there is such an extensive cooling system. Three dials on one of the panels are the only measuring devices to be seen. Two are thermometers indicating respectively the temperatures of the water as it enters and leaves the jackets. From readings of these and of small pressure gauges attached to the inlets and throats of the Venturi tubes, the rate at which energy is being dissipated at any time can be computed. On these thermometers are electric contacts which give an alarm if the water heats to an undesirable point; then, if the rise in temperature continues, shut the set down completely. The third dial on the panel is a pressure gauge to indicate whether the pump is operating properly. The water jackets can be seen through the panel windows, but to the casual observer they appear to be parts of the tubes themselves. The hose coils and their accessories are at the back of the panels and the expansion tank with valves and fittings is in a corner of the room. The pump and radiators are at a dis-

The radiators and pump

** The bellows and the protective relay which they operate were described by the writer in the "Record" for February, 1926.*

tance in another wing of the building.

After distilled water is used for a considerable period of time, it may absorb enough impurities from the metallic surfaces it touches to lower its resistance considerably. For that reason a milliammeter is provided in one of the panels which indicates to the operator, whenever the equipment is in operation, the magnitude of the current leaking through one of the hose coils and thereby warns him when it is advisable to change the water. Special precautions have been taken in the plumbing to avoid entrapping air when filling the system since air bubbles clinging to the anode surfaces hinder satisfactory cooling. In addition, valves have been provided for removing occluded air which has been liberated from the water during heating.

FORMS OF LIFE INSURANCE

I. Ordinary Life

The person who carries an ordinary or "straight life" policy pays for it during his entire life, and at his death the policy becomes payable to the beneficiary. However, the insurance company credits the policy-holder annually with a share in its profits, and if these dividends are left with the company, in about twenty-one years the policy becomes fully paid. Dividends continue to be paid but there are no further premiums. After the first year the policy has a value which the company will pay in cash if the policy is canceled, or it will lend this sum at interest, the policy remaining in force. The cash value increases from year to year.

Life insurance takes so many forms adapting itself to many individual needs that its consideration becomes a matter where expert advice is necessary and desirable. The Laboratories have, therefore, arranged to have a specialist in life insurance, Mr. L. H. Bunting, stationed at West Street who may be freely consulted by any employee. Mr. Bunting is to be found in Room 144 and may be reached on Telephone 264.

Report on Employees' Benefit Fund

BELL TELEPHONE LABORATORIES, INCORPORATED

January 1 — December 31, 1927

IN common with other companies of the Bell System, the Laboratories has maintained a Plan for Employees' Pensions, Disability Benefits and Death Benefits. By action of the Board of Directors, a change effective as of January 1, 1927, has been made in the method of providing funds for the payment of service pensions to employees retired from active service under the terms of the Plan. This change does not, in any way, affect the amount of the pensions or other benefits payable under the Plan, but is of real importance as a progressive and forward looking development of the pension system, to meet adequately the future demands upon it.

Although the number of retired employees of the Laboratories is still small, the increase in this group which lies ahead has been foreseen and a method has been developed for making financial provision for the increasing pension payments which will accompany this growth, so as to place added security behind the terms of the Employees' Benefit Plan relating to service pensions. Under the arrangements which have now been made, a Pension Fund, segregated from the assets of the Laboratories, will be built up by systematic charges to operating expenses which will be made each year. These charges will be so computed that when employees become eligible to retire on pension at their own requests [that is, under paragraph 1 (a) of Section 5 of the Plan] there will be available in the Pension Fund a sum which, with the interest it will earn, will be sufficient to provide a life pension of the amount stated in the Plan.

The Pension Fund will be held by a trustee solely to meet service pension obligations of the Laboratories for employees who are retired. Pensions which became effective prior to January 1, 1927, will be charged to the Employees' Benefit Fund Reserve and the amount of the Reserve will be reduced as such charges are made. Service pensions which became effective on or after January 1, 1927, will be charged to the newly established Pension Fund. Checks for pension payments will continue to come direct from the Laboratories, as heretofore.

The arrangements which have been made, as described above, are an added surety for the integrity of the pension plan.

By reason of the foregoing it is no longer necessary to increase the Benefit Fund by monthly accruals of 1% of the payroll. Accordingly, pursuant to further action by the Board of Directors, the sixth paragraph of Section 11 of the Plan for Employees' Pensions, Disability Benefits and Death Benefits was amended, effective

January 1, 1927, omitting the provision for setting aside in the Benefit Fund at the end of each month 1% of the payroll, and providing for the reimbursement of the Fund at the end of the fiscal year with such amount as will restore the Fund to its amount at the beginning of the year less service pension payments made during the year in respect to service pensions to employees who retired prior to January 1, 1927.

In accordance with the foregoing and as prescribed in paragraph 4 of Section 3 of the Plan for Employees' Pensions, Disability Benefits and Death Benefits, following is the record of receipts and disbursements for the year affecting the Benefit Fund:

Balance in Fund as of January 1, 1927	$186,688.11
Additions to Fund during Calendar Year 1927:	
Interest at 4%	5,794.88
Amount Added to restore Fund to its amount as of January 1, 1927, less Service Pensions to employees who retired prior to January 1, 1927	79,576.09
Total Credits	$272,059.08
Disbursements from Fund during Calendar Year 1927:	
Service Pensions to employees who retired prior to January 1, 1927	$ 1,274.88
Disability Pensions	1,668.41
Accident:	
Disability Benefits	5,567.60
Disability Expenses	519.05
Death Benefits	9,551.50
Sickness Disability Benefits	68,064.41
Total Disbursements	$ 86,645.85
Balance in Fund December 31, 1927	$185,413.23

J. E. MORAVEC,
General Auditor.

The above statement of Receipts and Disbursements audited and found correct.

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

News Notes

At the Midwinter Convention of the American Institute of Electrical Engineers, technical and scientific advances of the Bell System were recognized by presentation of the John Fritz Medal to John J. Carty, Vice-President of the American Telephone and Telegraph Company and Chairman of the Board of Bell Telephone Laboratories. The award was made "for pioneer achievement in telephone engineering and in the development of scientific research in the telephone art."

By use of the transatlantic telephone circuit, a joint meeting of the Institute was held with the Institution of Electrical Engineers in London. After papers by O. B. Blackwell and K. W. Waterson had described technical and traffic features, the circuit was set up so that each audience could hear speeches and applause in the other's auditorium. H. P. Charlesworth greeted Col. A. G. Lee, an engineer of the British Post Office, and introduced Bancroft Gherardi, President of the American Institute. Mr. Gherardi, after greeting Archibald Page, President of the British body, asked him to preside over both meetings. Mr. Page in turn called upon Dr. Jewett and Col. T. E. Purves, Engineer-in-Chief of the British Post Office. General Carty, in New York offered a resolution, which was seconded by Sir Oliver Lodge in London.

Called on for an address, Sir Oliver said:

"All those who in any degree have contributed to this result from Maxwell and Hertz downward, including all past members of the old British Society of Telegraph Engineers, will rejoice at this further development of the power of long-distance communication. Many causes have contributed to make it possible; that speech is transmissible at all is due to the invention of the telephone. That speech can be transmitted by ether waves is due to the invention of the valve and the harnessing of electrons for that purpose. That ether waves are constrained by the atmosphere to follow the curvature of the earth's surface is an unexpected bonus on the part of Providence, such as is sometimes vouchsafed in furtherance of human effort.

The actual achievement of today at which we rejoice and which posterity will utilize, must be credited to the enthusiastic cooperation owing to the scientific and engineering skill of many workers in the background whose names are not familiar to the public as well as to those who are well known.

The union and permanent friendliness of all branches of the English speaking race, now let us hope more firmly established than ever, is an asset of incalculable value to the whole of humanity. Let no words of hostility be ever spoken."

The joint meeting then adjourned.

In the afternoon, about 350 members and guests of the Institute visited our Auditorium as one of the inspection trips incident to the Convention. Here Donald MacKenzie described the various forms of talking motion-pictures, and H. E. Ives described and demonstrated the television system. The speakers were presented by John Mills following an introductory talk in which his voice was reproduced from a film record.

Two methods of sound recording were shown: one, now employed in the Movietone, uses a photographic film and a neon lamp glowing in synchronism with the sound. The other, that employed in Vitaphone, is a development of our Laboratories in which the sound is recorded on a wax disc.

At one of the technical sessions of the Convention a paper, "Manufacture and Magnetic Properties of Compressed Powdered Permalloy" was presented by W. J. Shackelton of the Laboratories and I. G. Barber of the Western Electric Company.

* * *

MR. JEWETT spoke at a luncheon of the New York Building Congress held on February 15 at the Hotel Commodore on "The Value of Research in Industry."

* * *

MR. CRAFT has returned from a tour of the Pacific Coast during which he addressed twenty-nine representative gatherings. Among them were dinners given in his honor by local telephone officials, sections of the A. I. E. E., and electrical engineering departments of Oregon State College, the Universities of Washington and of California, Stanford University, and California Institute of Technology. At Stanford Mr. Craft was the guest of Harris J. Ryan and visited his high-tension laboratory. President R. A. Millikan was his host at California Tech. Mr. Craft's war-time interest in naval communications was recalled in conversations with the officers in charge of the San Diego Naval Base. Executives of the Pacific Telephone and Telegraph Company planned the details of the trip.

ON THE EVENING of February 14, 125 members of the New York Section of the American Society for Steel Treating visited the Laboratories and were greeted by F. F. Lucas and R. W. King. After a short talk by Mr. King on the work of the Laboratories, the guests were given a demonstration of Vitaphone and Movietone in the Auditorium, under the supervision of L. W. Davee, R. E. Kuebler, T. J. Engel and H. Jones, and then were taken to the Microscopic Laboratory where Mr. Lucas, H. A. Anderson, Anna K. Marshall and R. M. Sample demonstrated the equipment.

* * *

AT THE COLLOQUIUM MEETING February 6, A. W. Horton, Jr. spoke on Measurement of the Velocity of Light, and D. MacKenzie on Significance of Professor Miller's Ether Drift Measurements. J. M. Eglin spoke February 20, on The Physical Theory of Diffusion.

* * *

DURING A MONTH'S VISIT to the Pacific Coast, J. C. Hunsaker made a number of contacts with air transport companies, and discussed the requirements for communication which would grow out of their plans for expansion.

GENERAL STAFF

S. P. GRACE addressed the Minnesota Telephone Association on recent developments of the Laboratories and demonstrated speech inversion, at a meeting in Minneapolis on January 25. On January 27 he spoke before the Business Men's Association and the Rotary Club of the same city. Mr. Grace lectured on the same subject before the Wisconsin State Telephone Association in Milwaukee on February 8, and at the University of

Wisconsin on February 10. On February 24 he spoke before the City Club Forum of Washington, D. C.

Apparatus Development

K. O. Thorp and J. D. Sarros returned to New York, having spent the past three months assisting in the installation of power line carrier telephone apparatus for the Pacific Gas and Electric Company between Oakland and Pitt River. R. D. Gibson and C. N. Nebel remain on the Pacific Coast, to continue installation.

W. Fondiller spent the week of January 29 at Hawthorne in discussions of various new developments, particularly loading coils, magnetic materials and enamelled wire. On the trip he was the official host of Professor Michael Pupin, who went to Chicago to make several addresses and to receive the Washington award of the Western Society of Engineers. At Hawthorne Professor Pupin was received by C. L. Rice, Works Manager, and J. R. Shea, Superintendent of Development, and was shown noteworthy developments of recent years.

F. J. Given spent the week of January 23 at Hawthorne in connection with a new design of coil for use in filters of Type C carrier telephone systems, and improvements as to crosstalk of new permalloy dust core loading coils.

H. B. Arnold recently made a study of the Union Gas and Electric Company's power line carrier telephone system in Cincinnati, Ohio.

H. M. Stoller visited the Fort Wayne plant of the General Electric Company for the purpose of testing and approving two new types of motors to be used in production of talking moving pictures.

L. B. Cooke spent several days in Keysport, Tennessee, assisting the American Gas and Electric Company in the installation of a new power line carrier telephone terminal.

W. A. Evans inspected transfer switches of pulse machines at the Baring Exchange of the Bell Telephone Company of Pennsylvania.

P. Neill was in Hawthorne the week beginning January 29 for meetings of the Inspection Survey Committee in connection with the inspection of plugs and jacks.

H. S. Price supervised the installation of a new oscillator unit in the five-kilowatt broadcasting transmitter belonging to the U. S. Playing Card Company at Mason, Ohio.

W. L. Tierney supervised the installation of a five-kilowatt broadcasting transmitter for the Moody Bible Institute of Chicago. This is the second Western Electric Installation for this organization. Due to the excellent cooperation by the contractor and the customer, the new station was put in operation on the eighth day after Mr. Tierney's arrival — a new record for a job of this sort.

O. F. Forsberg visited in January the factory of the Northern Electric Company, Montreal, Canada, at the invitation of Mr. Adams, Chief Engineer. While in Montreal, he attended a conference of officials of the Bell Telephone Company of Canada and the Northern Electric Company for a discussion of dials.

W. C. Ellis, W. Fondiller, C. H. Greenall, J. E. Harris, W. S. Hayford, C. H. Mathewson, E. E. Schumacher, J. R. Townsend and H. N. VanDeusen represented the Laboratories at a conference of the joint Bell System — American Brass Company committee which is working out specifications for non-ferrous

sheet materials, such as bronze, nickel silver and brass. The meetings were held at the Laboratories February 16 and 17.

H. A. ANDERSON spent February 16 to 18 in Montreal in attendance at the Winter Meeting of the American Society for Steel Treating. He also visited the Northern Electric Company and discussed copper wire problems with them. During the month of January, Mr. Anderson and J. B. Mudge of Hawthorne visited the Rathbone Company of Palmer, Massachusetts, and the American Steel and Wire Company of Worcester to discuss the production of pinion wire for parts for operators' calling dials.

H. A. ANDERSON is Chairman, and J. R. Townsend and F. F. Farnsworth are members, of the A.S.T.M. Committee on Die Cast Metals and Alloys, which met February 24 in New York to plan an extensive series of tests of die cast specimens with bases of aluminum and zinc.

J. R. TOWNSEND, F. A. HOYT AND C. L. HIPPENSTEEL visited the Gray Telephone Pay Station Company in Hartford to confer on changes in coin box stations.

D. T. MAY has been appointed a member of the A. I. E. E. Sub-committee on Communication Circuit Protection.

SYSTEMS DEVELOPMENT

R. S. WILBUR, J. W. WOODARD AND D. C. MEYER represented the Laboratories at a conference in Chicago the second week in January, discussing the conversion of the Chicago toll board to the C. L. R. method of operation.

W. L. FILER, F. J. SCUDDER, J. F. TOOMEY, H. W. HEIMBACH AND R. H. MILLER attended the cutover of the new step-by-step dial office and No. 3 toll board at New London, Connecticut, on the evening of January 7.

J. H. BELL, E. P. BANCROFT, E. J. JOHNSON AND J. A. MAHONEY attended a conference held in Montreal January 17 to 21 to discuss plans for the introduction of carrier telegraph equipment on the lines of the Canadian Pacific Railway System.

G. A. HURST made several visits to Boston, to inspect a trial installation of new message registers.

J. G. WALSH has been in Chicago for six weeks beginning January 25 conducting tests on the new No. 701 semi-mechanical P. B. X.

W. C. BEACH has been at McKeesport, Pennsylvania, since January 31 testing cordless "B" dial equipment.

J. A. MAHONEY was in Hawthorne working on lightning suppressor equipment for telegraph systems.

F. VAN VOORHIS visited Pittsburgh, Mount Vernon, Indiana, and Pineville, Kentucky, for studies of noise conditions in central office power plants.

S. F. BUTLER spent several days at Hawthorne discussing the introduction of the new decoder type sender on panel dial equipment.

A. D. KNOWLTON visited Washington, D. C. the beginning of February for an investigation of present equipment preliminary to the proposed installation of dial telephones.

C. E. WHITE has been in Chicago, conducting tests on constant frequency equipment used with the picture transmission apparatus there.

RESEARCH

E. BRUCE sailed on February 11 via the Leviathan for England, where he is going to work in conjunction

with A. G. Jensen on transatlantic radio.

C. H. G. Gray attended a conference on transmitter testing machines held at Hawthorne by the Committee for the Survey of Apparatus Inspection Methods and Quality, January 23 to 27.

H. A. Frederick and H. A. Larlee attended a meeting of the American Telephone and Telegraph Repair Committee at Hawthorne February 6 to 11.

Herbert E. Ives has donated to the Optical Society of America the premium of one thousand dollars, which accompanied the John Scott Medal recently awarded to him for his work in the development of electrical telephotography and television. The money will endow a medal in honor of his father, Frederic Eugene Ives, a pioneer in the application of optical science to color photography and photoengraving.

Dr. Ives lectured on "Television" before the Franklin Institute in Philadelphia on February 15, J. G. Knapp assisting him with the apparatus.

R. R. Williams, J. E. Harris, E. E. Schumacher and C. H. Mathewson left for Hawthorne on January 29, where they attended various conferences, particularly on lead covered cable and permalloy dust. On February 2 they visited the smelter and mine of the National Lead Company at St. Louis. From there Mr. Harris and Mr. Mathewson went to Alton to inspect the smelter of the American Smelter and Refining Company, and Mr. Williams and Mr. Schumacher went to Keokuk to visit the plant of the National Lead Company. Mr. Harris, Mr. Schumacher and Mr. Mathewson returned on February 5, while Mr. Williams extended his trip to Gulfport, Mississippi, where he met S. C. Miller, and A. L. Fox of the American Telephone and Telegraph Company. They inspected creosoting plants there and at Texarkana, and discussed a number of problems related to creosoting.

F. F. Farnsworth, J. M. Finch and H. Boving, and E. B. Wheeler and H. H. Glenn of the Apparatus Development Department, attended a conference on enameled wire held at Hawthorne from February 7 to 14. Mr. Wheeler and Mr. Glenn also discussed questions relating to development of switchboard lamps and to manufacture and testing of toll office cable.

W. G. Knox and L. H. Campbell visited the Corona typewriter factory at Groton, New York, inspecting the new Duco finish on Corona typewriters.

R. E. Waterman attended the annual meeting of the American Wood Preservation Association held at Montreal January 23 to 26.

A. R. Kemp and C. L. Hippensteel visited the Henry L. Scott Company at Providence on January 13 for a discussion of operational details of the rubber compression testing machine which is being built there for the Laboratories. In the same connection, Mr. Hippensteel visited the Scott Company February 14.

On January 19, Harvey Fletcher visited the new laboratory of Johns Hopkins Hospital in Baltimore, which has recently been established under the direction of Dr. S. R. Guild to study the anatomy of normal and pathological ears. Mr. Fletcher was also in Washington January 20 and 21, where he gave a lecture on "Instru-

mental Problems of the Deaf" before a sectional meeting of the National Research Council, on Problems of the Deaf.

Inspection Engineering

G. D. Edwards, R. J. Nossaman and D. S. Bender represented the Laboratories at a conference on field engineering work in the territory of the New England Telephone and Telegraph Company, which was held in Boston on January 25.

The Cleveland Field Territory has been divided into two parts. I. W. Whiteside, formerly Local Engineer at Cleveland, has been appointed Field Engineer in the territories of the Michigan Bell Telephone Company and the Indiana Bell Telephone Company, with headquarters at Detroit. G. Garbacz, who had been assisting Mr. Whiteside, is now Field Engineer in the territories of the Ohio Bell Telephone Company and The Cincinnati and Suburban Telephone Company. Mr. Garbacz' headquarters will be in Cleveland.

D. S. Bender, Local Engineer in the territory of The Southern New England Telephone Company, has also been appointed Field Engineer in the territory of the New England Telephone and Telegraph Company, replacing R. J. Nossaman. Mr. Bender's headquarters will be in New York.

C. E. Hooker visited Radio Station WHAM in Rochester on February 7.

W. A. Shewhart visited the Forest Products Laboratory at Madison, Wisconsin, during the week of January 30, to discuss general methods of analyzing engineering data.

W. A. Boyd, H. G. Eddy, R. M. Moody, P. S. Olmstead and E. R. Leroy attended regular Survey Conferences at Hawthorne. W. C. Miller, H. F. Gortheuer and T. Mellors attended similar Conferences at Kearny.

H. W. Newlund, Local Engineer at St. Louis, visited Kansas City and several cities in Texas and Oklahoma during the first part of February, in connection with regular field work in his territory.

P. B. Almquist, Local Engineer at San Francisco, was in Seattle and Portland during January.

Outside Plant Development

B. A. Merrick visited the plant of the P. Wall Manufacturing and Supply Company in Pittsburgh on February 1.

S. C. Miller was in Gulfport, Mississippi, Texarkana, Texas, and St. Louis during February conducting timber preservation studies.

I. C. Shafer was in Boston on February 10 in connection with development problems involving drop wire attachments.

C. S. Gordon visited the plant of the Indiana Steel and Wire Company, Muncie, Indiana, during the early part of February.

On January 23 C. H. Amadon was in Philadelphia attending a meeting of a committee engaged in revising the national safety code for ladders.

Patent

I. MacDonald was in Washington from January 10 to February 8 in connection with the prosecution of application for patent.

Club Notes

THE Spring Dance of the Club will be held in the Grand Ballroom of the Waldorf Astoria on Friday evening, April 27. There will also be provided an hour's entertainment by well-known Broadway stars. Tickets will be one dollar and sixty-five cents and box seats will be two dollars and twenty cents each. Since the demand for box seats at our dances always exceeds the number available, the Committee suggests that those planning box parties order the seats at once. Forty-two boxes will be available.

Bowling

A "free lance" bowling team from Room 910 met the Test Engineers' team of the Western Electric Installation Department Monday night, January 30. The Laboratories team, consisting of T. V. Curley, A. M. Elliott, F. S. Entz, E. D. Johnson and C. White, were in their best form, and won all three games with a high score of 906. High individual average, 200, was made by Elliott. The team wants to arrange games with other capable bowlers in the Bell System.

Golf

Seventy golfers reported to starter L. P. Bartheld at the Vander-Built-In Golf Course on Wednesday evening, January 25, for the second indoor tournament of the season.

Thirty-six holes of medal play were required to determine who would qualify for the final match play. T. C. Rice carried off the prize for low medal score in Group 1 and F. D. Smith won a similar prize in Group 2. Each prize was a half-dozen golf balls donated by Alex. Taylor & Company.

The gallery had an opportunity to see some fine golf in the finals. One match that provided suspense till the finish was that in Class A, Group 1, in which T. C. Rice defeated J. G. Roberts only after the eighteenth hole had been played. H. Wood gained a three and one victory over W. Burger in Class A, Group 2. In Group 1 of Class B, G. H. Heydt won from A. A. Reading, and in Group 2 of the same class, J. Hillier defeated F. S. Entz. In the first group of Class C, E. G. Paterson was defeated by W. F. Johnson, while in the second group J. V. Moran defeated G. Kellogg. In Class D, W. Smith was the victor over O. D. M. Guthe in the first group, and in Group 2, H. K. Farrar won from D. M. Terry.

The next indoor tournament will be held Tuesday evening, March 27.

Glee Club

The Glee Club for Men and Women was reorganized on January 19 and held its first rehearsal in the Auditorium on Monday evening, January 23. This group is being trained by Mr. L. K. Le Jeune, a paid director who has been engaged to coach the Glee Club for a period

Club basketball team. Standing: Christ (Systems), Waldron (Apparatus), Hanson (Shop), Hiscock (Commercial); seated: Hasior (Systems), Maurer (Research), Gittenberger (Systems), Steinmetz (Commercial), O'Neill (Systems)

of fifteen weeks. Each Monday evening at 5:10 Mr. Le Jeune will be more than pleased to give newcomers a welcome and an opportunity to sing.

WOMEN'S ACTIVITIES

Dancing

The members of our dancing class are still reporting at Louis Vecchio's studio on Monday evenings, their versatile talents ranging from the leisurely tango and stately waltz to the intricacies of soft-shoe and tap dancing.

Swimming

Swimming is largely a matter of form, as Miss K. Spranger's pupils are fast finding out. Miss Spranger is substituting for Miss Steil, who was recently the victim of an unfortunate accident. The swimmers are rapidly learning the six- and eight-beat crawl, and several of the more intrepid are now performing creditable jack-knife and swan dives. The class meets at the Carroll Club, each Monday at 7:00 and Wednesday at 5:30.

Basketball

The outside games of the Women's Basketball Team are still progressing. During January and February seven games were played. With two more to be played in March, the schedule will be complete, and a final report will be ready. The season's records indicate that if such able players as Natalie Skinner, Lillian Kaempffe and Mandy Reinbold continue their high scoring, we shall have an undefeated season. The last two games, which should prove the best, are: Thursday, March 1, at five-thirty, with the Federal Reserve Bank, at 44 Maiden Lane; and Friday, March 16, at eight o'clock with the Hempstead Varsity Alumnae

Women's basketball team. Seated: Mary Zwarick, Harriet Newman, Ann Barioni, Alice Pease, Lillian Kaempffe; standing: Marion Grimm, Margaret Brisbane, Natalie Skinner, C. Gittenberger—coach, Marie Boman—captain, Jean Hassett, Mandy Reinbold

team, which two years ago played the champion team from Ohio and won the National High School Championship.

Bowling

There is a new activity for women in the Club—bowling. This new interest gives indications of creating the same enthusiasm among the women as it has done for the past few years among the men. The management of this activity will be patterned on the Men's Bowling League, so that by fall the Women's Bowling League will be fully organized. All girls interested in bowling and who have not already sent in their names are urged to communicate with Miss A. E. Hamilton at once.

Women's Bridge Tournament

A source of satisfaction to the women bridge players was the evening of Tuesday, February 7, when twenty players from the Laboratories played an equal number from the General Headquarters of the Western Electric Company. After three hours of intense playing, and astute bidding, our team won by a total score of plus 4,326. Our players were:

Catherine Maull	Eleanor Barton
Katherine Munn	Gertrude Beidel
Mildred Theubel	May Murtagh
Thelma Taylor	May Lynch
Elizabeth Priztkow	Virginia Crim
Marion Stein	Ellen Kerney
Marguerite Johnston	Evelyn Brisbane
Helen Wilson	Margaret Packer
Allegra Hamilton	Hazel Mayhew
Marion Cater	Martha Kopf

Club Calendar for March

THURSDAY, 1: Basketball, Women, Federal Reserve Bank vs. Bell Laboratories Club, 44 Maiden Lane, 5.30
Handball Tournament, Men, Labor Temple, 5:30
FRIDAY, 2: Bowling League, Dwyer's Manhattan Alleys, 5:45
SATURDAY, 3: Commercial Chess League Tournament. Bell Laboratories Club vs. Chase National Bank, Room 164, 2:00
MONDAY, 5: Men's Bridge Club, Room 275, 6:00
Glee Club, Auditorium, 5:10
Women's Swimming Class, Carroll Club, 7:00
Athletic Dancing Class for Women, Louis Vecchio Studio, 5:30
TUESDAY, 6: Symphony Orchestra Rehearsal, Auditorium, 5:35
Women's Bridge, Rest Room, 5:15
Handball Tournament, Men, Labor Temple, 5:30
WEDNESDAY, 7: Women's Swimming Class, Carroll Club, 5:30
THURSDAY, 8: Handball Tournament, Men, Labor Temple, 5:30
FRIDAY, 9: Bowling League, Dwyer's Manhattan Alleys, 5:45
MONDAY, 12: Men's Bridge Club, Room 275, 6:00
Glee Club, Auditorium, 5:10
Women's Swimming Class, Carroll Club, 7:00
Athletic Dancing Class for Women, Louis Vecchio Studio, 5:30
TUESDAY, 13: Symphony Orchestra Rehearsal, Auditorium, 5:35
Women's Bridge, Rest Room, 5:15
Handball Tournament, Men, Labor Temple, 5:30
WEDNESDAY, 14: Women's Swimming Class, Carroll Club, 5:30
THURSDAY, 15: Handball Tournament, Men, Labor Temple, 5:30
FRIDAY, 16: Bowling League, Dwyer's Manhattan Alleys, 5:45
Basketball, Women, Hempstead High School, Alumnae, Hempstead, Long Island, 8:00
SATURDAY, 17: Commercial Chess League Tournament. Bell Laboratories Club vs. Brooklyn Edison Company, Room 164, 2:00
MONDAY, 19: Men's Bridge Club, Room 275, 6:00
Glee Club, Auditorium, 5:10
Women's Swimming Class, Carroll Club, 7:00
Athletic Dancing Class for Women, Louis Vecchio Studio, 5:30
TUESDAY, 20: Symphony Orchestra, Rehearsal, Auditorium, 5:35
Women's Bridge, Rest Room, 5:15
Handball Tournament, Men, Labor Temple, 5:30
WEDNESDAY, 21: Women's Swimming Class, Carroll Club, 7:00
THURSDAY, 22: Handball Tournament, Men, Labor Temple, 5:30
FRIDAY, 23: Bowling League, Dwyer's Manhattan Alleys, 5:45
MONDAY, 26: Men's Bridge Club, Room 275, 6:00
Glee Club, Auditorium, 5:10
Athletic Dancing Class for Women, Louis Vecchio Studio, 5:30
TUESDAY, 27: Symphony Orchestra, Rehearsal, Auditorium, 5:35
Women's Bridge, Rest Room, 5:15
Handball Tournament, Men, Labor Temple, 5:30
Indoor Golf Tournament, Vander-Built-In Golf Course, 5:15
THURSDAY, 29: Handball Tournament, Men, Labor Temple, 5:30
FRIDAY, 30: Bowling League, Dwyer's Manhattan Alleys, 5:45
SATURDAY, 31: Annual Telegraphic Chess Match with Hawthorne Club, 3 C, 1:30