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Systematized Research

By H. D. ARNOLD
Director of Research

ONE of the most characteristic features of research is its demand for individual initiative and resource; and its most valuable results often come from plans of procedure and methods of experiment originated during the actual progress of work.

To attempt to order in advance the detailed conduct of a problem would be undesirable and futile and would indeed violate the very spirit of research, which is one of self-reliant adventure along uncharted paths. Any proposal to limit too closely the initiative of the experimenter is bad; and its adoption would be certain to impose upon results the fallacies inherent in prejudgment. Nevertheless, a broad and careful consideration must be given to each research at its inception, for the course of experimentation is long and costly and not to be lightly attempted.

It is to the consideration preliminary to undertaking a research that I wish to direct attention under the general caption of "systematized research." The words imply a plan and method actively impressed upon the research from without. The advantages of such an external control and the limitations within which it must operate have been subjects of growing interest during the past few years; and I have no doubt that those of you who continue actively in research during the next decade will find them demanding increasing consideration. Scientists are trained in the constant effort to display the reign of order in the realms of nature; and this schooling predisposes them to a lively interest in attempts to impose orderliness upon their own diversified efforts. In the last few years, moreover, an added incentive has arisen through the growth and success of systematized research in industry.

It is interesting to recall the situation that developed fifteen or twenty years ago, when research in industrial laboratories first came into prominence as a matter of broad concern. Its place was not then clearly

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apparent and its growth was the cause of some distrust among those who worked within university precincts and were financed from university funds. An attempt to set a gulf between the two fields was a natural enough gesture for the protection of research in universities against possible encroachments of research in industries. Industries differ from universities in their objectives, their organizations, and their methods of finance; it is quite understandable that they should differ also in their attitude toward the conduct of research. It was conceivable that industries might promote in their work a spirit and a method which, if commonly accepted, would react disastrously upon the fundamental progress of science. The passage of time has shown, however, that the two fields are not antagonistic, nor even competitive, but are complementary.

A little reflection shows that there is not much difference in the underlying motives of workers in the two fields. Their training is identical; and once they have set foot upon a promising trail both are enthralled in the interest of the chase, and neither needs bow to the other in the integrity and thoroughness of his pursuit.

It is in the method of choosing problems, rather than in the mental or mechanical attack upon them, in which there is, and should be, the greatest difference. In an industry, fortunately, the systematizing of research is comparatively simple. The evolution of any industry will have marked off its general field of interests; its operations will have accumulated evidence of needs or deficiencies which can be weighed and interpreted by minds accustomed to research methods; its facilities will provide immediate avenues of attack; and its commercial requirements will serve in evaluating results which it may seem possible to achieve. Its research must follow a plan, however flexible, in which there is a conscious and never-flagging effort to secure for the industry the maximum ultimate financial return from the money expended. The plan will be determined by such considerations as the timeliness and relative urgency of the various problems, the probability of success, the value of the possible results, and the adequacy of available funds, man power, and technique. Within this plan the individual scientist accepts a problem and conducts his work, knowing that his value will be appraised upon his performance. Because he has accepted direction in his choice, and in the measure that his work is part of a systematized attack, he is relieved of some of the hazard of ill success should his problem prove insolvable, or should its solution find no application.

Not quite so simple is the situation determining the choice of problems in a university, for there we find two concurrent objectives. The research funds of the institution are intended both to promote additions to knowledge, and to provide for the training of new minds in research. The success of a department is measured by the number and quality of the men who complete their training as well as by the apparent importance of the department's publications. Students must choose, or have suggested to them, problems which can be completed in a rather short specified time, problems which are of sufficient importance to stand by themselves as contributions to knowledge, which are so timely as to attract some attention, and which, nevertheless, will not run so closely along the line of work of another as to involve too great a possibility of being forestalled in publication. The scientific repute of the department as a whole rests, however, upon persistent and monumental contributions in a particular subject. Heads of departments find themselves too frequently perplexed in the conflicting efforts toward sufficient diversification to meet the needs of their students and toward sufficient concentration to permit consistent and cumulative work in the field where they see most promise of success from their personal efforts.

In the universities the need to systematize research becomes more apparent and pressing as the field broadens and the number of workers multiplies. The student is rightly and wisely encouraged to seek a problem for himself. He finds himself, however, partly by choice and partly by chance, in a laboratory best equipped for a certain line of work, and associated with a teacher whose interests incline for the moment toward a special subject. He makes a choice under these circumstances as best he may. If he follows the line of his professor he may find himself making an essentially minor contribution, but one which nevertheless acquires some degree of prominence because it is a part of a systematized whole. In this respect he accepts certain conditions and avoids certain hazards as does his fellow worker in systematized industrial research. If he chooses a course outside the established line he may reap a spectacular reward, but all too frequently his work goes promptly to the limbo of dusty shelves, because although thoroughly good it is untimely or, inadequate in itself, it rests without fruition or extension. The professor, for his part, finds himself torn between the urge to use his students in forwarding lines of work with which he is thoroughly familiar and which he believes are valuable, and the fear lest by so doing he may unduly narrow the student's attention and thus hinder his view of other parts of the field which may become the scenes of greatest activity in the immediate future. Under these circumstances it is natural that questions rise as to how university research may profit by a more directly systematized effort, and as to the pitfalls which are to be feared if such a course is pursued.

The call to systematize research has found its most immediate answer, outside the industries, in the establishment of national and international bodies for the consideration of problems, the rendering of financial aid and the interchange of information. These organizations must find their way carefully and have already proved of great value, especially in furnishing material and financial aid to a large number of research men who already had definite problems in mind. In choosing among these men and problems the ones to assist, it is obvious that they exercise a conscious direction of the trend of advanced research. Meantime, the vast opportunities of science now open present many more points of attack than there are workers. Since this is so it seems most unfortunate to find, as we sometimes do, students in two institutions vying as to which shall be first to complete the same problem. And it seems almost as unfortunate that the weight of student effort should at times be massed in one part of a field while another of comparable importance is left relatively uncultivated. An obvious method of coping with this would be to systematize student research through some central organization. But while a degree of centralized control might be acceptable it would necessarily intrude upon the autonomy of separate institutions and if carried too far would give rise to violent reactions. This indeed presents a most efficient safeguard against too great centralization, and we need never fear that we shall drift unwarned into a condition in which personal initiative is too much restrained.

Attending any effort to systematize research there are definite dangers, but these are all, I believe, of a transient nature and tend to generate their own safeguards within a reasonable time. Chief among them, in the industrial field, is the chance of killing the research spirit of the individual worker by limiting his initiative through an unwise effort to hold to procedures determined in advance of, and therefore in ignorance of, the facts. This becomes of real magnitude when the control of research is exercised by those too far removed from or too little acquainted with its actual performance. It is easy and sometimes seems far more economical of time and money to plan a detailed method of attack, through a central organization, as well as to choose the subject of a research, but a broader view quickly shows such a policy to be short-sighted when for the sake of immediate economy it puts in jeopardy the future creative power of the individual.

In systematizing industrial research another danger lies in the temptation to limit the choice of problems too closely to the immediate needs of the industry and to be a little intolerant of a desire to follow leads into new fields. It is not particularly difficult to secure support for researches that have a high probability of immediate profit, but it is quite a different matter when the proposal is to sacrifice immediate returns in order to concentrate on more forward-looking investigations of less certain outcome. The principal loss which comes from restricting problems too narrowly to matters of current interest is, of course, the ultimate financial one to the industry, but carried too far such a policy may seriously react upon the research worker himself for it tends to dull his vision of possible new avenues of research which may appear during the progress of his work and which, if passed unregarded, may not come to the light again for years.

Corresponding dangers are present in any attempt to systematize research in the universities. The pressing need for immediate results may be very apparent to those who are advising on the general plan; and with their greater experience they may find it hard to refrain from too particularized directions when the man on the job seems to be slow and uncertain in his attack. The obvious risks of yielding to this impulse are that the student will tend to become a highly trained laboratory assistant rather than an independently minded investigator and that the work will proceed too much according to past traditions with an accompanying lack of new discoveries in methods of experimentation.

Furthermore, there is very real danger in attempting even to suggest subjects for university research in accordance with a comprehensive plan.

Combined experience may justify an opinion as to the portions of the front where the attack is lagging, but who can tell where an avenue of progress is about to open or the value of that which lies just ahead? Nevertheless a greater degree of orderliness in the choice of subjects seems desirable and little to be feared, for, fortunately, the very conduct of research fosters the growth of mental independence and although for a time science might suffer from an attempt to hold subjects within too narrow bounds, no limits of such a nature would long be respected.

I have not attempted to argue the case for or against any particular plan or scope of systematized research. This is a matter where little is to be gained by haste toward organization, and the situations differ among the various sciences. I have simply tried to turn your thoughts for a few moments from the compelling and clear-cut interests of your individual problems to the broader but more hazy picture of research management. The greatest fascination of research lies in the uncertainty as to what is just ahead, and no one knows better than the research worker the futility of too careful thought for the future. To be mentally self-reliant, to be persistent and alert and to keep one's judgment unbiased by preconceived notions are among the essentials for success in the conduct of any research problem. How far these may be consistent with more consciously systematized plans of attack along the front of each individual science is the future "management problem" of both industrial and academic research.

Site Purchased for New Radio Station

To provide a site for an additional receiving station for transatlantic radio-telephony, the American Telephone and Telegraph Company has assembled by purchase and lease a tract of 450 acres near Flanders, New Jersey. By association with a transmitting station at Deal Beach, and appropriate installations overseas, a new short-wave channel to Europe will be established. These additional facilities are required to care for the rapidly increasing load, which has already reached nearly sixty calls a day.

New Standards in Emergency Power-Supply Units

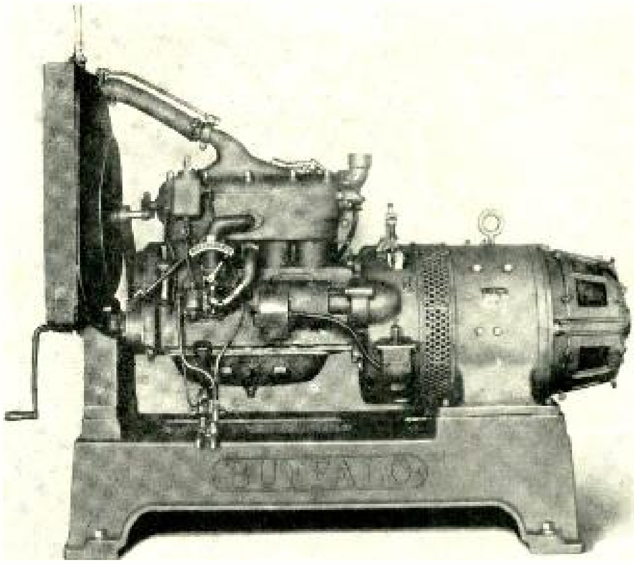
By V. T. CALLAHAN
Systems Development Department

POWER for telephone central offices is normally obtained from the local electric power lines. The supply is, in general, reliable; rarely is the current off or the voltage or frequency unsatisfactory for more than a few moments at a time. When such interruptions occur, power is drawn from a local battery which is of ample size to supply all needs for several hours. Telephone service, however, above everything must be available at all times and regardless of all emergencies. On rare occasions, floods or other catastrophies entirely beyond the control of the electric utilities may cut off the power supply for an extended period. To insure the continuance of telephone operation in such cases, it is the usual practice to provide an emergency power supply which is independent of outside power lines in cases where only a single source of power is available.

To furnish this emergency supply, generators driven by internal-combustion engines are used. A large range of capacities from one and one-half kilowatt direct-current farm lighting units to sets of one hundred kilowatt alternating-current rating are required and have been available in a relatively large number of sizes and types of sets. The increase in reliability of the commercial power supplies, the adoption of gasoline as fuel for emergency engines, and the tendency toward the use of two or more small emergency sets rather than one large set have resulted in an effort to decrease the number of standards and to effect the economies resulting from an increased demand for fewer types. The various types and requirements have therefore been reviewed; and, in collaboration with the Buffalo Gasolene Motor Company, the Laboratories have now developed a group of emergency power-supply units consisting of three sizes of Buffalo engines with three sizes of Western Electric and two sizes of Star Electric low-voltage direct-current generators and two sizes of Western Electric alternators which will cover the range from twelve to fifty kilowatts. Requirements below twelve kilowatts are filled by the Westinghouse 1.5 kw sets singly or in multiple, and requirements above 50 kw will be taken care of by the use of a larger type of Buffalo engine now being developed. The three sizes of the two new types of engines with various generators used singly or in multiple will replace eight sizes of two types of engines now standard and four older types used occasionally, as well as three types of engines used extensively on a trial basis.

For the lower part of the range covered by the newly-developed line, the twelve-kilowatt four-cylinder Buffalo Type BA gasolene engine has been adopted, direct-connected to and mounted on a common sub-base with a Star Electric generator. To reduce the cost to a minimum, all but absolutely essential accessories have been eliminated. No engine governor or generator field rheostat is used, the output of the generator being regulated entirely by means of the engine hand throttle.

The subbase of the new set is equipped with four coil springs for support. These springs with the flexible sections in the piping system prevent the transmission of the engine vibration to the building and so permit the set to be mounted directly on a floor of ordinary construction. This spring mounting, not evident in the photographs, is a simple and effective arrangement which may be understood by reference to Figure 1. The set, which comes as a unit, is placed in position and the plugs over the springs are then screwed down till the under surface of the subbase just clears the floor. The entire load is then carried on the springs. This eliminates the expensive concrete foundation which is to be seen in such a large number of installations of this nature in the industrial field.



Buffalo Type BA Engine Generator Set showing radiator for cooling the circulating water

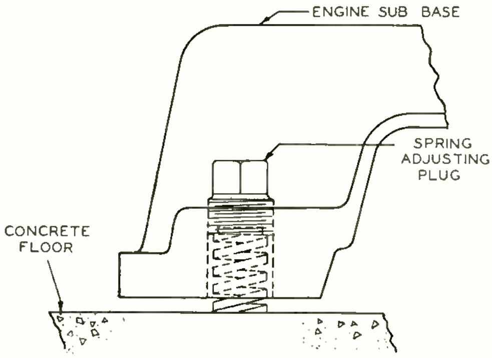
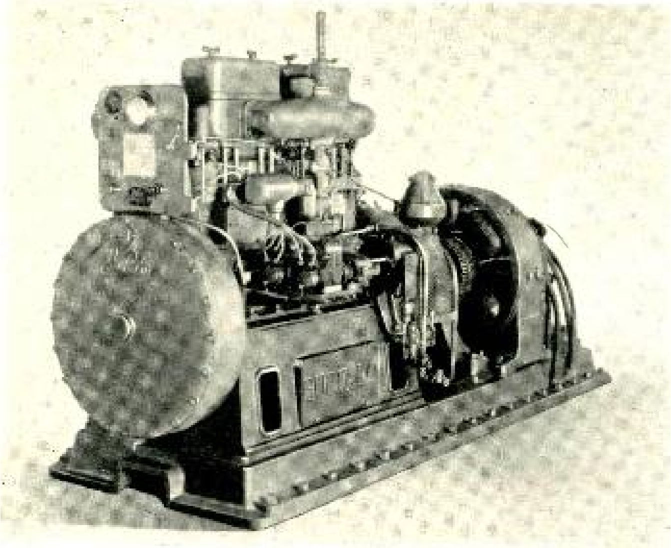


Fig. 1—Detail of spring-mounting for engine bases

A high-tension magneto is furnished for ignition and an overspeed trip for grounding the ignition to stop the engine in case of excessive speed. The engine is arranged for both electric and hand starting. Cooling is normally by means of city water but where there is only a local water supply, inadequate sewers, or where other reasons make it desirable, a radiator may be used, as shown in the photograph. A fuel pump mounted on and driven by the engine pumps gasoline from a tank buried beneath the basement floor or located in some other safe and convenient place, to a small auxiliary fuel cup fastened to the engine frame. Lubrication of the internal working parts is accomplished by a splash feed system while main bearings and gears are fed by means of a low-pressure oil pump and piping. The generator control equipment is mounted on a panel located beside the generator.

Two capacities of commercial-type low-voltage direct-current generators are direct-connected to this type BA engine. One has an output of two hundred amperes within the range from twenty-two to sixty volts which permits floating of batteries having from eleven to twenty-five cells. The other has an output of four hundred amperes from twenty-two to twenty-eight volts for floating eleven- and twelve-cell batteries. The new sets of this type cost approximately one-half as much as the former types of the same rating which they replace.

For the upper part of the range covered by the newly-developed line the recently-designed type "R" engine was adopted. A four-cylinder engine is used for the smaller sizes of low-voltage direct current generators or the small alternator and a six-cylinder for the larger generator or the large alternator. This engine is of the valve-in-head type and has a governor to maintain closer speed regulation. Direct current generator voltage control is accomplished by means of a field rheostat. The generator or alternator control equipment is mounted on a separate power board.



Buffalo Type R Engine driven set which also uses the spring mounted base

These engines are arranged with duplicate high tension magnetos for ignition, forced feed lubrication, and for cooling by city water. The overspeed trip, starting motor, and fuel pump are in general of the same construction as employed with the type BA engine. A spring-type mounting is used also so that the set may be mounted directly on a floor of ordinary construction. The springs and the flexible connections in all piping prevent the transmission of engine vibration to the building.

The four-cylinder type R engine will be arranged to drive a five-hundred-ampere, 53-volt, or a one-thousand-ampere, 28-volt, direct-current generator or a 50-kilovolt-ampere alternator. The thousand-ampere generator is used for floating eleven- or twelve-cell batteries and the five-hundred-ampere generator will float twenty-four-cell batteries.

The six-cylinder engine is arranged to drive either an eight-hundred-ampere, 53-volt direct-current generator or a 75-kilovolt-ampere alternator.

In addition to the reduction in the number of different sets used, material savings in floor space will accrue, as it has been found possible to eliminate all the older belt-driven sets employing single-cylinder horizontal engines. Economies are also expected due to freedom from special building requirements, easier installation, and improved maintenance and operating results. Using these unit engine sizes makes it economical to furnish units nearer the requirements of the initial power plant, supplying an additional set or sets as the power plant grows. With these sets, the use of compact units, which has proved so successful and beneficial in a great many other parts of the telephone plant, will be extended to our emergency power-supply problems.

New Standard Units

Engine Type	*Generator Ratings*
BA—4-cylinder	200 amp., 22-60 volt d.-c. generator
	400 amp., 22-28 volt d.-c. generator
R—4-cylinder	500 amp., 44-53 volt d.-c. generator
	1000 amp., 22-28 volt d.-c. generator
	50 kva alternator
R—6-cylinder	800 amp., 44-53 volt d.-c. generator
	75 kva alternator

Offer of Additional Shares of A. T. & T. Stock

Stockholders of the American Telephone and Telegraph Company of record June 1, 1928, *are privileged to subscribe at par for one additional share for every six held. Subscriptions are payable as follows:* $20.00 *per share on August* 1, 1928, $40.00 *on December* 1, 1928, *and* $40.00 *on April* 1, 1929. *Interest at five per cent will be allowed, making the final payment* $38.65. *Those who wish may pay in full on August* 1, *or complete their payments on December* 1.

Warrants evidencing subscription rights will be mailed to stockholders on June 11. *Fractional warrants, entitling the holder to subscribe for less than a share of stock, must be combined. Purchase and sale of warrants may be handled through the Financial Department of the Laboratories.*

Sound-proof Rooms

By J. G. MOTLEY
Assistant Plant Manager

FOR research on sound reproduction and for development of transmitters and sound-reproducing apparatus, it is important to have working space as nearly sound-proof as is practicable. Rooms deadened with hair felt and other absorbing materials have been provided for a number of years, but newer methods of sound measurement and improved transmitting and receiving apparatus have made it necessary that sound be excluded more completely than is possible in rooms of that type. Meanwhile theories of sound absorption developed in recent years by the Research Department have brought to light important considerations governing the design of sound-proof rooms. Fortunately there became available a new building material, boards of matted vegetable fibre commonly used for heat insulation and known by trade-mark names such as Celotex, which provided a ready means of meeting the new requirements.

Despite the general impression that sound absorbers are the main factors in rendering a room sound-proof, our rooms are started with brick walls four inches thick, laid with cement mortar and covered on both sides with hard cement plaster. This base, as solid and massive as the building structure permits, provides a system having a low fundamental period, with a minimum tendency to resonate and a maximum tendency to reflect sound. On the same basis, the doors are built of two thicknesses of ¼″ steel plate, separated by an air space and braced to prevent drumming action; they are fastened by clamps similar to those used on water-tight bulkhead doors.

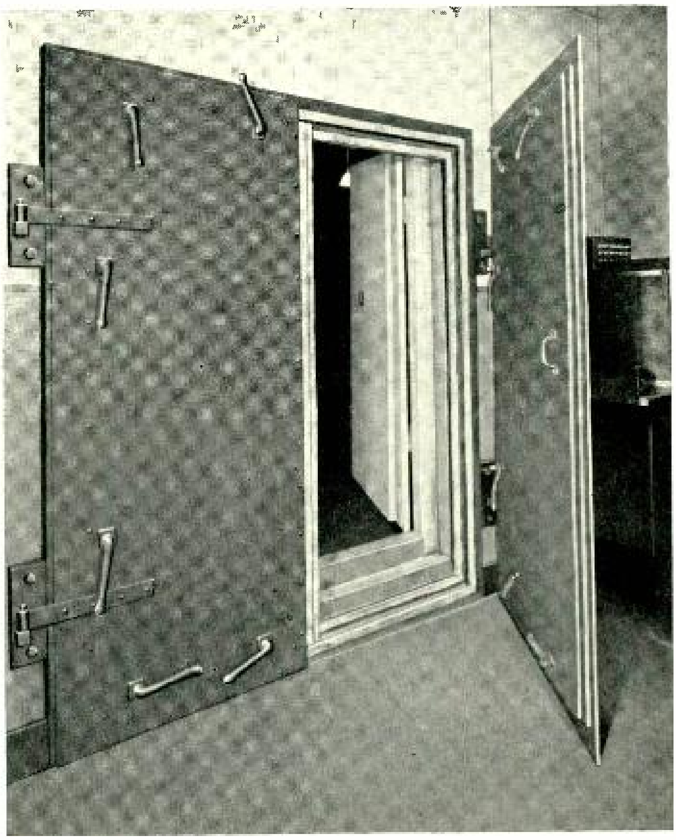
Inside the masonry wall, and separated from it by a continuous air space to reduce the transmission of building vibrations, is an inner room consisting of laminated walls built on a light framework of wood. Outermost in walls and ceiling is a layer of Celotex to damp any sounds conducted by the masonry; next is a sheet of metal 1/16″ thick, which reflects sounds back into the absorbing fibre; within are four successive layers of Celotex. The last of these serves the dual purpose of absorbing incoming sound and of preventing the reflection of sound produced inside the room. The floor of the inner room is of two-inch boards, with a layer of 1/16″ sheet metal above and with Celotex both above and below; the wearing surface is a quarter-inch layer of linoleum. Supporting the floor, and thereby the walls and ceilings, are blocks of wood resting on a layer of Celotex with which the concrete floor of the building is covered.

The layer of metal was adopted primarily to increase the mass of the inner room and to provide a hard, sound-reflecting surface. It is continuous on walls, floor and ceilings, and at the jambs of the door it overlaps with the metal on the door itself.

In certain of the rooms the metal sheets are of copper to provide an electrical shield, but in the majority galvanized iron is used, since it is quite as effective as a sound reflector, is much less expensive, and has a certain amount of shielding value in addition.

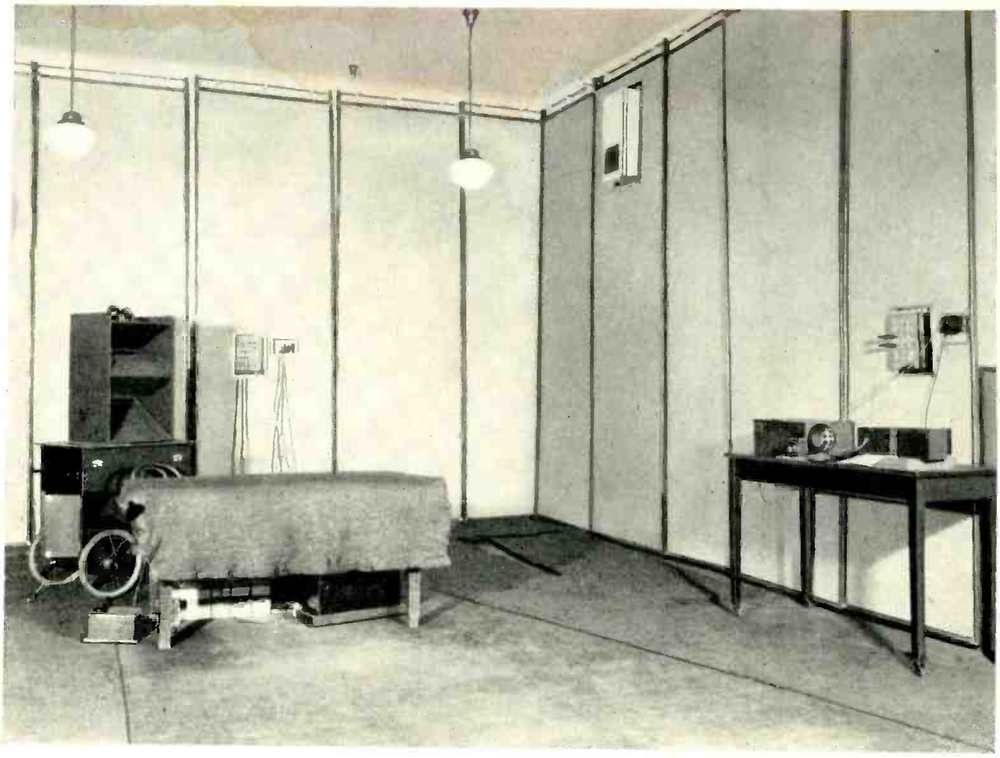
That its full sound-proofing value may be obtained, each inner room is supported on as few wooden blocks as possible. As a further means of reducing physical connection of the inner room to the masonry of the building structure, studding of the inner wall frame rests on the Celotex covering the wood fibre of the inner room. Care has been taken likewise to restrict to a minimum the solid material passing through the inner layers of Celotex. On that account flexible electric connections are used, and the last three layers of the fibre are fastened into place with glue rather than with nails. During construction it became apparent that the smallest opening permitted entrance of sound. Outer and inner doors are arranged therefore to be clamped against cushions of rubber foam.

The precautions for preventing leakage of sound make the room airproof as well. For the necessary ventilation, a labyrinth-like duct runs to and from each of the rooms. The outer walls of the duct are of cement plaster, applied directly to a base of Celotex. They are lined with Acoustic Celotex, and then with a layer of hair felt. The air passages are wide and the velocity slow, so that sounds are quite effectively absorbed by the time the air has gotten to the room.



Doorway of the largest sound-proof room, showing strips of rubber foam to assure tight fitting

Thirteen rooms have been built according to the construction described, ranging in floor area from approximately 900 square feet to 50 square feet. They are sound-proof and sound-absorbent on the inside so far as the higher frequencies are concerned, but the lower frequencies do transmit through the entire structure. It is interesting to note that, as the room becomes more nearly sound-



Room 1072, *whose acoustic properties are varied by means of Celotex panels along the walls and by strips of hair felt*

proof, listeners become more sensitive to small volumes of sound from the outside. A theoretically sound-proof room seems therefore to be impracticable with our present knowledge.

A large room of somewhat different construction, 600 square feet in floor area, has been provided as well, for aid in the study of the effect of room acoustics on the action of transmitters and receivers. It is built with the same solid masonry walls as the other rooms, finished with hard plaster, and with the same metal doors. Within are hangers along the walls at the top, from which there are suspended removable panels of sound-absorbing material so that in any location the thickness of the absorbing material can be varied, and the acoustic properties of the room changed correspondingly.

The Light of a Television Eye

By FRANK GRAY
Research Department

"IN the act of seeing, light comes out of a person's eyes and explores the object at which he is looking." So believed certain Greek philosophers, who considered light as an intangible tentacle, proceeding from and directed by the eyes of an observer. What a comfort it might be to proponents of this long-discarded theory if they could know that our television system apparently sees by shooting a beam of light from what looks like its eye! Appearances deceive; the lens at the center of the television transmitter merely functions with other apparatus to direct a beam of light, and the seeing is done by three photoelectric cells which are grouped around the face of the instrument.

Still the difficulty persists. Long familiarity with cameras leads one to expect that the television transmitter will look through a lens at a broadly-lighted object, and then in some way convert the image of that object into electrical signals which can pass over a line. Most television schemes have proposed to use this plan. Figure 1 is typical; it shows the apparatus looking through its lens-eye at a box flooded with light by two intense lamps at the side. By means of the lens an image of the box is formed on the rotating disc, and as one of the apertures moves across the image, light passes through onto the photoelectric cell behind. Current from the cell is therefore a continuous record of brightness of the parts of the image passed over by the successive apertures. Meanwhile the lamps are sending out rays in all directions, and that small area of the box, whose image just fits the aperture at any instantaneous position of the disc, is itself scattering in all directions the light which it receives. It is of course only the rays directed through the aperture that produce a current. The light reaching the photoelectric cell at any instant is therefore very small even when the object is brightly illuminated, for of course only a tiny fraction of the light from the lamps falls upon the particular area "seen" at any instant.

Of the light falling upon the area under consideration, part only is so reflected that it reaches the lens; the remainder is lost to the television apparatus. Quite evidently the portion of the light collected depends on the area of the lens. Physical difficulties prevent increasing the diameter of the lens, with respect to its focal length, beyond a certain ratio. When this ratio is reached a further increase in lens area means a larger image, and therefore a larger rotating disc to scan it. Mechaical limitations of the size of the disc therefore impose a limit on the size of the television eye.

These two restriction are particularly serious on account of the small currents to be secured from light-sensitive cells. A photoelectric cell of the usual type, with an opening an inch in diameter, will give a current of a millionth of an ampere when a twenty-five watt lamp is burning about four feet away. But television must operate with far less light than that; roughly, it has available only the feeble light reflected from an area approximately the size of a finger tip.

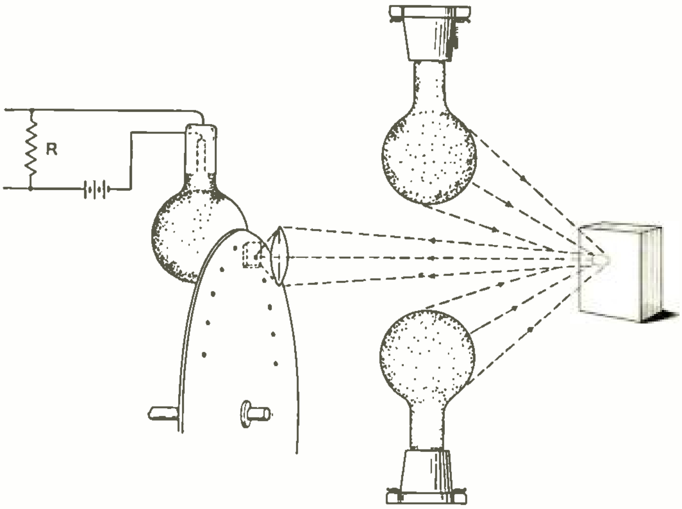


Figure 1—A television system in which the object is broadly illuminated

Then there is the "ghost" of television, which haunts the system with its phantom snowstorm. The reason is that the current from the cell must pass through a resistance to produce the voltage drop by which the first amplifier tube is operated. In this resistance, as in any piece of metal, the electrons are constantly in a state of swift, random motion, giving minute but rapidly changing differences in voltage between the ends*. The amplified current fluctuates correspondingly and, if it has been magnified sufficiently to make the fluctuations large, gives the effect of a snowstorm on the screen at the receiving end. If, however, the object can be lighted brightly enough, the output of the cell will be great enough to override the random fluctuations from the resistance, much as a powerful broadcasting transmitter overrides static.

In order to secure the effect of an intense illumination without inconvenience to a subject, our apparatus resorts to sight by a method in accordance with ancient philosophy, and thereby makes rather startling gains in effectiveness. The entire optical system is reversed, with the light starting from what has previously been visualized as its destination. The rays from an arc lamp are condensed so that they converge on a small area on the back of the rotating disc. As one of the apertures passes across the illuminated area, a pencil of light passes through and is focussed on the box by a lens. The box is thus traced over by the moving image of successive apertures of the disc: in effect, by a spot of light moving in a series of adjoining parallel stripes. After striking the box the light is reflected in all directions and some of it enters large photoelectric cells placed where the flood lights had been imagined to be in the previous arrangement. The result in television operation is the same as if the whole object were continuously illuminated. The moving beam coming from successive apertures of the scanning disc illuminates at any time the only area whose light can be used. At the same time there is no inconvenience to the subject; al-

* *These random voltage variations were discovered by J. B. Johnson.*

though the intensity of the spot is high, the average intensity over the field is low.

A second gain comes from liberation of the apparatus from its former limitation: the size of lens available. The light reflected from the subject is collected directly by giant photoelectric cells developed for that special purpose and used in a system permitting several to be operated in parallel. The three cells of an actual television apparatus present an area of 360 square inches to collect light, instead of a possible seven square inches of lens that could be used to form an image on the fifteen-inch disc.

By these gains in efficiency, the photoelectric current is increased to an average value of a ten-billionth of an ampere—a current extremely small, but well beyond the range of interference from random fluctuations which which may occur in the resistance.

In the two methods of operation mentioned, the light passes in opposite directions over identical paths. A natural question is whether the increased sensitivity of the system has been at the expense of perspective or truthful reproduction. That happily is not the case to even the slightest degree. It appears to be a general law of optics that when light striking a surface has a particular fraction of its energy reflected in any direction, then light passing back over the reflected path has the same fraction of its energy turned back to the original direction. The flow of energy for any position of the scanning disc is therefore of exactly the same character in one direction as in the other.

Utilizing this principle, we can secure lighting effects by placing the photoelectric cells symmetrically around the object as if they were lamps. The light, coming from the front, is of course scattered in all directions but it can be caught only where cells are available. If these are on one side only, light reflected from the opposite side of the object would be lost, and the effect on the received image would be to leave that side in darkness. In addition each cell catches a considerably larger part of the light coming from the nearer part of the object than from the farther part, just as a lamp illuminates bodies close to it more strongly than those further away. The apparatus therefore "sees" the object as if it were illuminated by the photoelectric cells.

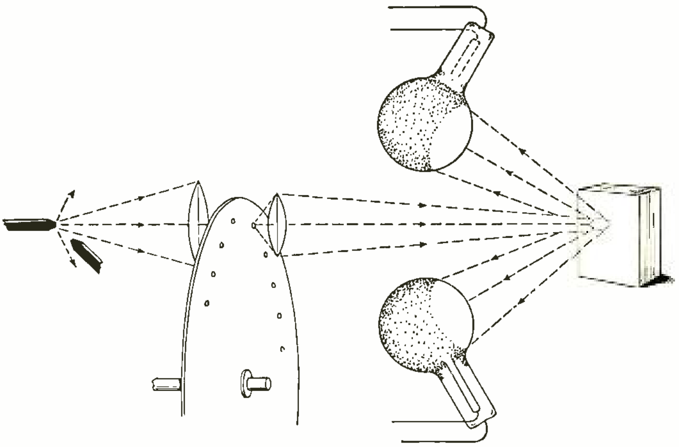


Figure 2—In this system the object is scanned by an intense beam of light

To be consistent in operation and to assure truthful reproduction as well, the apparatus should be blind to all illumination not coming from its own eye. This might be secured by having no other illumination in the transmitting room, but actually it comes about as a result of the electrical circuits used in transmission. These necessarily amplify and transmit the fluctuations of the photoelectric current, but not the steady value about which the fluctuations occur. Uniform increase in brightness over the entire field results in an increase in the steady current from the cells and in a shifting of the fluctuations, practically unchanged, up to a higher current range. The fluctuations will be amplified and transmitted, and the direct current rejected, as before; the received image will consequently be the same whether transmission takes place from a darkened room, or from one well lighted.

Having intimated that the over-all brightness of the transmitted scene has no effect on the received image, a natural question is, "What is the relation between the two and how is it controlled?" Experience with ordinary photography answers the first question: there is none. A twilight scene when photographed may yield a picture as brilliant as if the sun had been shining. Actual practice is to adjust the brightness of the arc lamp to secure optimum conditions at the transmitter and independently to adjust the circuits at the receiving end.

An interesting case is that met when the subject is smoking. Those who have not seen this demonstrated frequently ask, "What does the glowing end of a cigar look like at the receiving end?" The answer, curiously enough, is, "Black", as long as the light from the red-hot carbon acts continuously on the cells, adding its own steady component to the output. As the amplifier is not responsive to direct current, this illumination does not register at the receiving end. When the scanning point of light passes over the glowing carbon, it is reflected just as it would be from a dead coal—that is, the cigar tip looks black to the photoelectric cell, and therefore it looks black to the observers at the receiver.

Amplifier for Condenser Transmitter

H. C. CURL
Apparatus Development Department

CONDENSER transmitters have two principal advantages over the older carbon button type, which have made them invaluable not only as laboratory precision instruments but for the electrical recording of phonograph records and the talking motion pictures. Their electrical output follows much more faithfully the sound input over a very wide frequency range than does that of the carbon tranmitter, besides being free from carbon noise and difficulties due to packing of the carbon granules. Their use has been limited, however, by the two disadvantages of a high impedance and small output. These shortcomings make the use of a special amplifier necessary and for this purpose primarily the 47-A has been designed. Its circuit, shown in Figure 1, includes a vacuum tube coupled by resistance coupling to the transmitter, and an output transformer with permalloy core.

The condenser transmitter is essentially a condenser whose capacity follows very closely the pressure variations in the sound waves. When connected to the amplifier it is charged to a potent al of about two hundred volts through the resistance R_1. Under these conditions it acts somewhat as an alternating-current generator having an internal impedance equal to that of the transmitter, which is about eighteen million ohms at thirty cycles per second and about five hundred thousand ohms at one thousand cycles. The condenser C_1 prevents the high positive potential from being applied to the grid of the tube. The proper grid bias, applied through the resistance R_2, is obtained from the voltage drop of the filament current flowing in R_3. The transmitter charging battery is used also to supply a plate potential of about fifty-five volts through the drop in resistances R_4 and R_5.

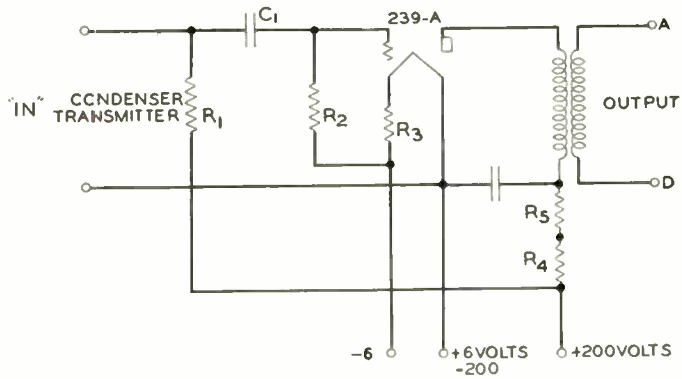


Fig. 1—Schematic diagram of the 47-A Amplifier

The grid circuit which required the most careful consideration from the design standpoint, consists of the usual resistance coupling employed in many amplifiers where high quality is required, but differs from the usual circuits in the extremely high values of resistances employed. As the voltage developed is very small, it is desirable to impress as great a proportion of it as possible on the grid of the vacuum tube. To attain this result it is necessary that the impedance into which the transmitter is operated be high in comparison with the impedance of the transmitter at all frequencies. It was shown by sealed into the ends of the small glass tube that contains it. These resistances were chosen on the basis of their small size, stability, and quietness.

With a high resistance in the grid circuit of the vacuum tube certain factors ordinarily neglected must be

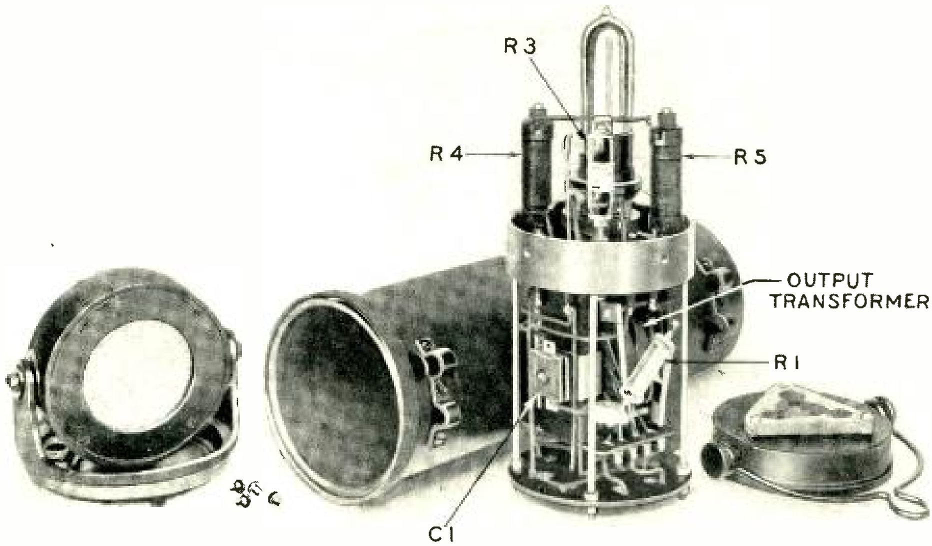


Fig. 2—The 47-A Amplifier assembly with the containing shell and the condenser type transmitter

computations, checked experimentally later, that R_1 and R_2 would each have to be about fifty million ohms to give an overall characteristic which would have but two T.U. less gain at 30 cycles than at 1000 cycles.

The necessity for resistances of such high values introduces difficulties both in obtaining reliable resistances and in the operation of the circuit. The resistances employed in the 47-A amplifier consist of a liquid known as xylol which is a mixture of xylene and alcohol. Contact with the liquid is made by platinum wires considered. Referring to the circuit of the amplifier, it will be seen that a current may flow from the positive of the two hundred volt battery supply through resistance R_1, the insulation resistance of condenser C_1, and back through R_2 to the negative of the battery supply. Another leakage path is from the plate of the vacuum tube through the vacuum tube base and socket and through R_2 back to the negative of the battery.

The effect of these leakage currents is to cause a voltage drop in R_2 which subtracts from the applied grid bias. Five hundredths of a micro-ampere is sufficient to cause a change in the grid voltage of two and a half volts which would cause a very noticeable distortion. A leakage current of this value would be obtained with an insulation resistance of four thousand megohms across condenser C_1 which is considerably higher than the usual requirement placed on condensers. Condenser C_1 therefore must have unusually high insulation resistance which for the condenser employed is approximately fifty thousand megohms. The insulation resistance between the grid and plate of the vacuum-tube base and socket is made correspondingly high.

The maximum voltage cannot be obtained from the transmitter merely by making the grid resistance high, since there remains the input capacity of the tube which also limits it. For this reason it is advisable to employ a tube with an input capacity small compared to that of the transmitter. Capacity between the leads from the transmitter to the amplifier and between the wires in the amplifier also has the effect of reducing the voltage reaching the grid so that this capacity must also be reduced to a minimum by placing the transmitter as close to the amplifier as possible. This arrangement eliminates also the interference which long transmitter leads would pick up.

Fig. 3—Decorative floor-stand models designed by G. R. Lum

The requirement of high resistances and low capacity in the grid circuit necessitates extreme care in the design of all parts of the amplifier and of the mechanical arrangement of the apparatus, to eliminate low insulation leakage paths and losses due to shunt capacity. The vacuum tube employed is the 239-A. It consists of elements similar to those of the 215-A tube but mounted in a larger structure to increase the insulation resistance between the tube elements. These tubes, in addition to the usual tests, are subjected to a special ionization and insulation-resistance test, and to other tests to insure that they are non-microphonic.

The 47-A amplifier is shown disassembled in Figure 2. The amplifier unit fits into the metal shell shown, which measures about three and three-quarters inches in diameter by eleven inches long. The transmitter housing is fastened to one end of the shell by a clamping ring which engages with the threads on the base of the housing. By releasing the clamping ring the transmitter housing may be turned approximately 360° or removed altogether to make connections to the terminal plate of the amplifier. The transmitter itself is held in a cradle pivoted as shown, which permits rotation of about 90°. These two adjustable rotations allow the transmitter to be turned to face the source of sound regardless of the position of the amplifier.

This type of amplifier is designed to be suspended in the air, either by the two lugs shown on the side of the shell, or from the handle at one end. The small diameter of the amplifier, which is but little greater than that of the transmitter itself, provides a unit which is not objectionably large when placed in a conspicuous place, such as is often necessary in picking up material for broadcasting or recording. This small size of the unit is especially advantageous in the recording of talking moving pictures, because it permits easy concealment from the lens of the camera.

The main supporting element of the amplifier assembly is a circular brass casting. On one side of this casting the vacuum-tube socket and three resistances are mounted and on the other side the output transformer, the grid circuit resistances and condenser, and the terminal plate. After the apparatus is wired this assembly is dipped and impregnated under a vacuum with an insulating varnish to protect the apparatus from the effects of high humidity. This assembly may be mounted in floor types of stands such as shown in Figure 3 for use where this type of mounting is preferred.

A Large P. B. X. Installation

An unusually large private branch exchange has recently been put into service for the Consolidated Gas Company of New York. It has forty-two positions, with a present installation for 2300 extension lines and 520 trunk and tie lines. About six million calls a year are now being handled. The board is of the No. 1 Type, but equipped with circuits of the 604-C Switchboard arranged for operation with the dial system. The power plant includes two motor-generator sets and a 210-ampere storage battery.

Terminal Strips

By E. S. SAVAGE
Apparatus Development Department

Of the evolution of terminal strips into their present form comparatively little is known. It is certain, however, that the strips have undergone less change during the past thirty-five years than almost any other apparatus in the telephone plant. A study of Patent Department records and old photographs of central offices shows that terminal strips of practically the same general design as those still in service were used at least as early as 1892.

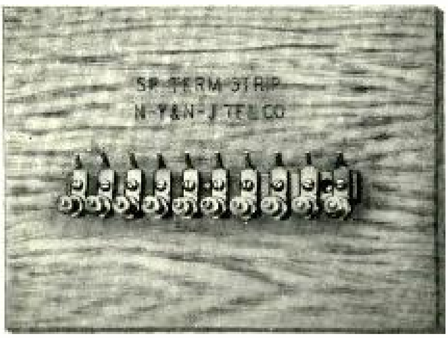


Fig. 1—An early terminal strip, drawn from an old photograph. This was probably used at a switchboard

Terminal strips became important when the main distributing frame was patented by Angus S. Hibbard in 1891. Previously, as is set forth in the patent, lines entering a central office had been distributed without order, by means of connecting wires running in the shortest paths from the ends of the cables to the switchboard terminals. This older method involved such extensive crossing of the wires that they became inextricably interlaced, and moving or withdrawing any of them for testing, redistribution, or any other purpose could be accomplished only with the greatest difficulty.

It is probable that some sort of terminal strip was in use at the switchboards even during this earlier period to permit permanent wiring of the jacks, so that there would be no need for entering the switchboard to make changes in wiring. There is in the files an undated picture of an old terminal strip, used at one time by the New York and New Jersey Telephone Company, which looks as if that were its purpose. Its terminals are fitted with screw binding posts at one end and soldering lugs at the other. A still earlier type, with screw binding posts at both ends of the terminals, is shown in a patent filed in 1890.

As at present designed, the great majority of terminal strips are of the general type shown in Figures 2 and 3. Figure 2 is a fifty-circuit terminal strip for terminating trunk and miscellaneous cross connections on the horizontal side of the main distributing frame. Figure 3 represents the more usual twenty-circuit terminal strip of the type used in switchboard sections and desks. Terminal strips of this general type are used on horizontal and vertical sides of the intermediate distributing frame, on the various frames for dial equipment and on relay racks. There are some eighty-odd coded varieties of terminal

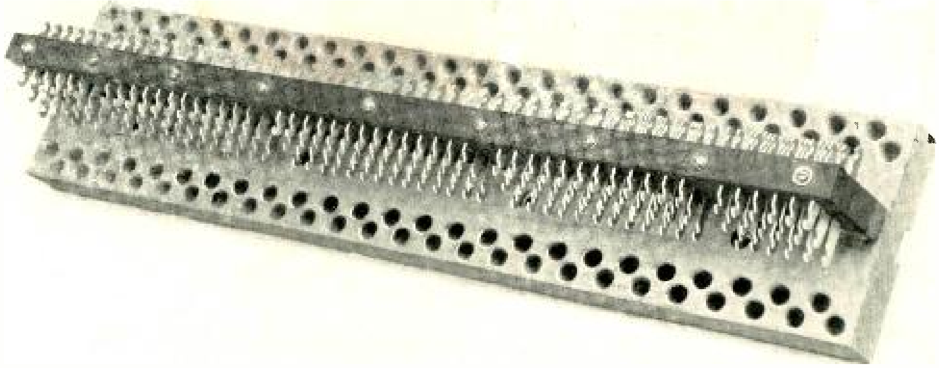


Fig. 2—No. 183 *terminal strip*

strips of this general type providing for various combinations of from ten to fifty circuits and three to eleven terminals per circuit. Each of these terminal strips is made with a base of hard maple, perforated with holes through which the wires are drawn. In practically all cases a hole is provided on each side of the base for each vertical row of terminals. By passing the wires through these fanning holes, as they are called, an orderly distribution of the wires to the various terminals is accomplished, and in case of trouble the tracing of the wires is made much easier. On top of each base is a wood strip called the bottom strip, and above this there are a number of mounting strips of hard rubber, usually three or more, slotted to carry the terminal punchings. Above is a top strip of hard rubber, and in some cases this is surmounted by a wooden designation strip. The entire pile-up is clamped together with long machine screws, fastened into threaded holes in a narrow steel strip lying in a groove on the lower side of the base. The terminal punchings themselves are stamped from sheet brass and coated with tin, and are of several lengths. They are held in parallel rows in the slots of the mounting strips, with the longest on the bottom in order to facilitate soldering.

Another type of strip, used for terminating subscribers' lines on main distributing frames, is No. 65. The base is irregular in cross section, with an upper edge overhanging the terminals to protect them from crosses which might be caused by solder or other material falling from above. Only one mounting strip is used, fitted with three-armed punchings having three soldering terminals; of these, one comes above the mounting strip,

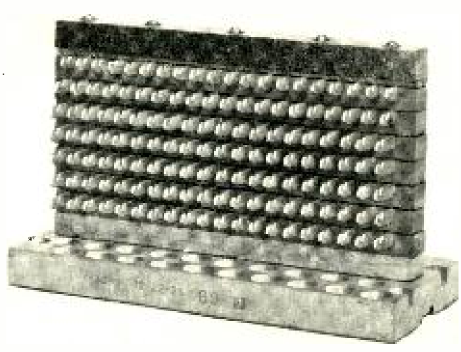


Fig. 3*—Strips of this type have as many as eleven rows of terminals* which is horizontal, and the other two below. In general, according to current practice, the cable pairs from the outside terminate on the vertical side of the main distributing frame. From there they are connected by jumper wires to the upper terminals of the No. 65 strips, which are on the horizontal side of the frame, and from the lower terminals, switch-board cables run to the intermediate distributing frame. Should a subscriber move to another location within the same central office area, or should a new cable be installed, it would be desirable to change his line from one cable pair to another without changing his telephone number. In such a case the usual procedure is to move the connection of the jumper wires from the upper lugs to the middle lugs of the same punchings, and then to connect jumpers from the new cable pair to the vacated upper lugs. Thus the subscriber has a connection to both cable pairs involved. When he moves or when the new cable is put into service, the old jumpers are cut off at the terminals and pulled out.

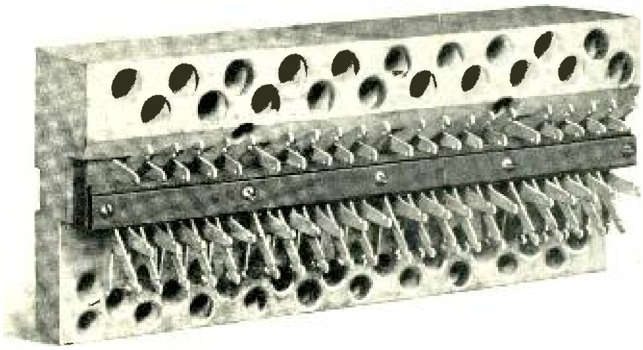


Fig. 5—No. 65 terminal strip. Staggering of the punchings permits closer spacing

Quite recently terminal strips of this design have been produced with the punchings mounted closer together than in the No. 65 type, so that fifty cable pairs can be terminated in the space formerly occupied by forty. Since new and old strips can be mounted interchangeably, the result is a twenty per cent increase in capacity of the horizontal side of a main distributing frame of any particular size.

In addition to these terminal strips of regular type, which differ from each other principally in the length

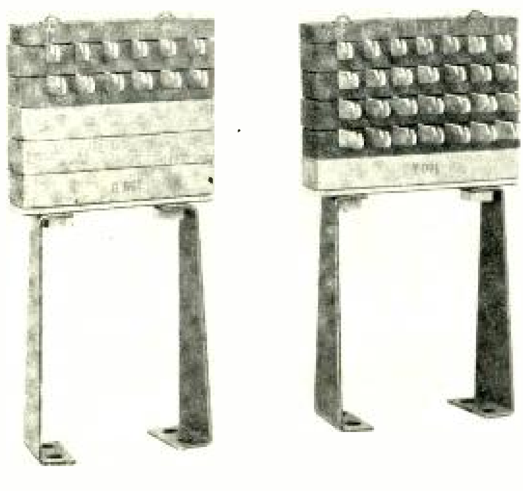


Fig. 4—Two strips fitted with metal brackets for mounting on panels

of the base, number of punchings per row, height of the pile-up, and other details, there are many modifications of the standard designs. Among these are strips with only half the usual base, others without any base, strips with the pile-up mounted on small *metal* brackets, and still others quite unlike terminal strips in appearance; in one of these, used for terminating the wires to translators, the lugs are of such lengths that their ends form a concave arc. These special designs constitute in all less than a twentieth of the strips made each year.

In the number of piece parts required annually, terminal strips are probably near the head of the list of telephone apparatus. More than four hundred thousand strips of all sorts are manufactured each year, and these require no less than forty-eight million punchings. Each punching in turn uses at least two soldered connections for installation of the original wiring, or a total of about a hundred million for a year's output. Other millions—possibly dozens of millions—of soldered connections are made each year by Associated Company men on account of moving by subscribers and rearrangement of facilities. It is therefore evident that the design of such pieces of apparatus is most important from the standpoint of installation and maintenance.

"To Have and To Hold"

SINCE 1920, the market value of A. T. & T. stock has climbed steadily from about $100 per share to twice this value. To those who during this period purchased stock under the Employees' Plan and who have held it after it was paid for, this increase in market value brings a pleasant reward. To those who failed to take advantage of the plan or who disposed of their holdings, it is likely to be the subject of equally keen regret.

There are many different ways of stating in figures just how advantageous the stock purchase plan is. The following form of statement does not pretend to be unique but it does emphasize certain important features which may not be generally realized.

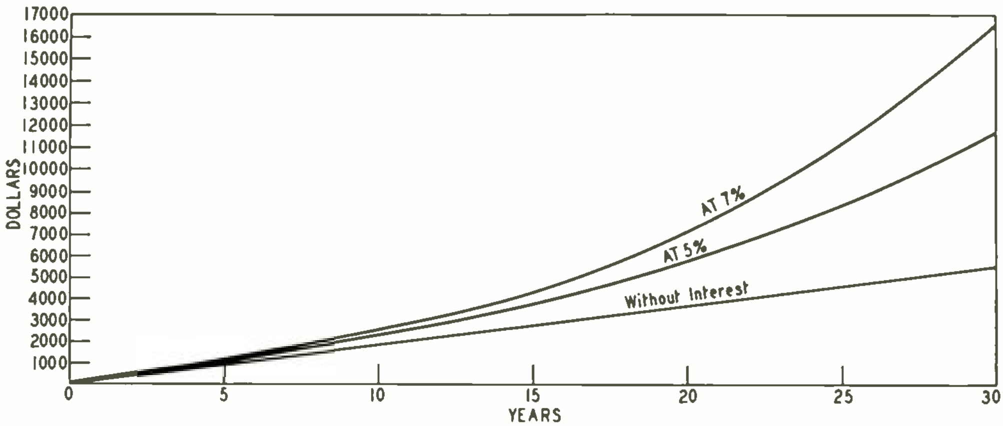
The ultimate aim of every savings plan is to provide a competence for later years. It is generally recognized that any such plan should be systematic and of course should effect the growth of principal as rapidly as possible. These conditions are met by setting aside a certain sum of money at regular intervals to draw interest and by reinvesting the interest so that it will be compounded. The higher the rate of interest at which one is able to invest his funds, the more rapidly does the principal grow.

The present plan under which we may purchase stock is dated May 1921. Let us, therefore, calculate the savings of a member of the Laboratories who decided at that time to invest $15 monthly toward the purchase of stock, and commenced payment July first. His first five shares of stock would have cost him $100 per share and would have been paid up in January, 1924. Resubscribing for five more at $118 per share, he would have had these fully paid for in January, 1927. His next subscription would have been for five more shares at $130. Although the total of his monthly installments amounts to $1237, the value of these plus interest and dividends amounts to $1605. However, if the present market value of his ten shares which are paid for is taken into account, the value of his savings is actually about $2590. Restating this last figure in terms of a single rate of compound interest, holding throughout the period from July 1921 to the present date, we arrive at a startling result: had this same individual begun in 1921 to lay aside $15 a month, he would have had to obtain the extraordinary return of 24% compound interest in order to have today what the Employees' Stock Plan has provided him.

Another interesting comparison can be made. Payments of $15 per month deposited in a savings bank at 4% annual interest compounded quarterly would come to $1,453 at the end of 7 years; the present value of the savings under the stock plan exceeds that sum by $1230. This surplus has accrued to the employee in question over a period of 7 years, and therefore represents an average annual gain of $175. If we assume that he subscribed to his full quota of stock, his annual salary must have been between $1200 and $1500. In other words, by subscribing he has been able, just for the asking, to increase his yearly income by an amount equal to about 12% of his salary.

It is by no means the present intention to imply that benefits to the participant under the stock purchase plan will over a long period of years show such striking opportunities. Nevertheless the plan will certainly continue well worth subscribing to.

Now that the market value of the stock has reached a new high for all time, many holders are beginning to wonder whether or not they should sell and thus "realize" their profit. In the case of our hypothetical employee who now has ten shares of stock fully paid for, this means the exchange of these ten shares for about $2000 in cash. Immediately, the problem of reinvesting the $2000 has to be found. Safety of investment is the first consideration and satis-



Accumulation of $15 saved each month, with and without compound interest factory yield second. The combination of these two features in a single investment is now notoriously hard to find. Many good bonds yield little better than 4% and some of the best common stocks even less than this. Let us contrast this situation with the other alternative of holding the ten shares of A. T. & T. stock. Each share is paying $9 per year dividend and during the period beginning in 1924, when the first shares were fully paid up, each share has been granted rights whose value averaged over six years has amounted to $4.05. Every share has, therefore, actually returned to its owner $13.05 a year which on the *present market value* of the stock represents a yield of 6.5%.

Again a definite statement as to the future is impossible, but we all know that the growth of the American Telephone and Telegraph Company is destined to be very rapid and that it is the stated policy of the management to raise much of the new money required to finance growth by issuing rights for the sale of new stock to stockholders. The advisability of selling our A. T. & T. stock, even at the present prices, therefore seems doubtful.

SUBSCRIPTION TO A. T. & T. STOCK

Payments July 1, 1921-June 30, 1928 on five shares of stock

First group of shares at $100	$500.00	
Less interest credited on payments	47.70	
Net payments		$452.30
Second group of shares at $118	$590.00	
Less interest credited on payments	60.30	
Net payments		$529.70
Current group, 17 months at $15 per month		255.00
Total payments		$1,237.00

Approximate value of holdings July 1, 1928

First group	5 shares at $188*	$940.00
Second group	5 shares at $188*	940.00
Third group	Payments unfinished. Equity $53.59 per share	267.95
Dividends received:		
17 dividends on first group of 5 shares . . .		$191.25
5 " " second " " " " . . .		56.25
Average market value of rights received:**		
5 rights May, 1924, at $3.68		18.40
5 " May, 1926, " 6.12		30.60
10 " May, 1928, " 14.50		145.00
Value of stock and returns		$2,589.45

* *Value, ex rights, at market close May 31, 1928.*

** *These figures show the account as it would have stood had the rights been sold. Had the employee exercised his rights using accumulated dividends, and perhaps, arranging a loan at his bank which future dividends would liquidate, the profit he would have derived from his rights would, of course, be considerly greater than the market values shown.*

News Notes

AMONG guests at a banquet tendered by All America Cables, Inc., to celebrate its fiftieth anniversary, were Edgar S. Bloom, Bancroft Gherardi and W. F. Hosford, Directors of the Laboratories; E. B. Craft, Executive Vice-President and E. P. Clifford, Vice-President.

MR. JEWETT addressed the engineering faculty and students of Princeton University on May 1 on the subject of "Cooperative Research." On April 26 Mr. Jewett spoke on "The Development and Use of Radio Telephony as a Means of Communication" before the Harvard Graduate School of Business Administration.

MR. CRAFT and his staff entertained the Division of Engineering and Industrial Research of the National Research Council at a luncheon meeting on May 4, Mr. Elmer Sperry, President of the Sperry Gyroscope Company, presiding. Afterwards the visitors viewed a demonstration of television and the talking movies.

MR. CRAFT spoke on "Research and Its Relation to Industry" before the Connecticut Chamber of Commerce at Hartford on May 17.

THE ELLIOTT CRESSON MEDAL was presented to Gustav W. Elmen by the Franklin Institute on May 16. Award was for "extended researches in the magnetic characteristics of nickel-iron alloys resulting in Permalloy."

Among other workers in the communication field to whom the Elliott Cresson medal has been awarded are Dr. Alexander Graham Bell, for the electrical transmission of speech; Dr. Michael I. Pupin, for loading of telephone lines, the American Telephone and Telegraph Company for contributions to the telephone art, and Dr. Lee De Forest, for the three-element vacuum tube.

AT THE COLLOQUIUM meeting on April 30 Professor J. Franck of Göttingen, spoke on "Collisions of the Second Kind". On May 15 E. U. Condon of Columbia University brought out a number of applications of the utility and power of wave mechanics in dealing with certain current problems of physics.

APPARATUS DEVELOPMENT

F. A. KUNTZ visited the New England Telephone and Telegraph Company in Boston to investigate operation of No. 392 type loud ringing bells.

H. T. MARTIN AND O. A. SHANN visited the Gray Telephone Pay Station Company at Hartford, Connecticut, to discuss upper steel housings and locks for coin collectors.

E. L. NELSON addressed the Philadelphia Section of the Institute of Radio Engineers on April 27 on "Recent Improvements in Radio Broadcasting Apparatus."

D. H. NEWMAN supervised the installation of a one-kilowatt broadcasting equipment for the Universal Broadcasting Company in Philadelphia.

E. L. NELSON AND H. S. PRICE

made a survey for the installation of a fifty-kilowatt broadcasting equipment for the Crosley Radio Corporation in Cincinnati, Ohio.

W. L. TIERNEY has been in California where he made a survey for a one-kilowatt broadcasting installation for Nichols and Warinner at Long Beach. He also inspected the stations of Warner Brothers at Hollywood, Pasadena *Star News* at Pasadena, and Tenth Avenue Baptist Church at Oakland.

D. H. GLEASON visited New London, Connecticut on April 24 to observe the operation of step-by-step switches installed there.

H. B. ARNOLD attended the Regional Meeting of the A.I.E.E. at Baltimore on April 19 and 20.

C. F. BOECK has been engaged since April 12 in testing the power line carrier equipment which is now being installed on the Pacific Gas and Electric Company's lines between Claremont, Vaca-Dixon and Pitt River by R. D. Gibson and C. N. Nebel.

G. C. PORTER visited Philadelphia on May 3 to inspect alternating current motors to be used with talking motion pictures.

F. F. LUCAS has been elected Chairman of New York Chapter of the American Society for Testing Materials for the coming year.

H. O. SIEGMUND presented a paper on electrolytic condensers before the meeting of the American Electrochemical Society in Bridgeport, Connecticut, on April 27. J. H. Bower and J. C. Wright were also present.

E. B. WHEELER visited the Bureau of Standards in Washington on April 26 to consult with Dr. Vinal regarding dry cell work.

J. R. TOWNSEND has been appointed Chairman of a special committee on hardness testing of the American Society for Testing Materials.

J. R. TOWNSEND AND H. A. ANDERSON attended the meeting of the Committee on methods of testing of the A.S.T.M. at Philadelphia on April 27.

J. M. WILSON AND J. D. CUMMINGS visited the Siemen Rubber Company, Bridgeport, Connecticut, on May 4.

H. A. ANDERSON was in Southington, Connecticut and Phillipsburg, New Jersey in connection with the manufacture of linemen's climbers.

INSPECTION ENGINEERING

R. L. JONES, D. A. QUARLES, H. F. DODGE, W. A. SHEWHART, O. S. MARKUSON AND P. S. OLMSTEAD represented the Laboratories at a series of conferences held at Hawthorne during the week of April 16. They discussed application of statistical methods to product, and inspection problems on lead covered cable and telephone instruments.

D. A. QUARLES AND S. H. ANDERSON were at the General Electric Company's factory in Lynn, Massachusetts, the week of April 23 for a survey conference on "P" type ringing and coin control generators.

S. H. ANDERSON visited the Buffalo Gasoline Motor Company at Buffalo on April 18 to discuss standardization problems of type "ATT" emergency gasoline engines.

E. G. D. PATERSON AND C. D. HOCKER visited the R. H. Buhrke Company at Chicago on April 13 and 14 to examine processes in manufacturing body belts and safety straps.

E. G. D. PATERSON was in Boston on May 10 and 11 discussing problems involving extension ladders with engineers of the New England Telephone and Telegraph Company.

O. S. Markuson visited the Chemung Telephone Company at Sayre, Pennsylvania on May 9 to observe a cable installation.

H. G. Eddy and R. M. Moody attended regular Survey Conferences at Hawthorne during the latter part of April and the first part of May. H. F. Kortheuer and T. Mellors were in Kearny and W. C. Miller was in Philadelphia during the same period attending similar conferences.

A. G. Dalton, formerly of the General Installation Engineering Department of the Western Electric Company, has been transferred to the Inspection Engineering Department. Mr. Dalton will have charge of the Field Activities Groups of the Systems Inspection Department.

W. E. Whitworth has been appointed Field Engineer in the territories of the Northwestern Bell Telephone Company and The Mountain States Telephone and Telegraph Company, replacing J. M. Schaefer. Mr. Schaefer is returning to New York for a special assignment in field engineering work. Mr. Whitworth's headquarters will be in Omaha.

R. J. Nossaman visited Chicago, Omaha and Denver during May in connection with work of the field engineering group.

J. A. St. Clair, Local Engineer at Atlanta, visited Macon, Georgia and several cities in Florida during April in connection with regular field work in his territory.

Outside Plant Development

R. L. Jones, S. C. Miller and J. A. Carr made studies of outdoor testing facilities for development work in Phoenixville, Pennsylvania on May 1.

L. W. Kelsay visited Bridgeport, Connecticut on May 9 in connection with development studies on molded insulating materials.

C. D. Hocker visited Pittsburgh, Altoona and State College, Pennsylvania and Sandy Hook, New Jersey between April 30 and May 3 to examine zinc coated sheet products being tested by the American Society for Testing Materials.

F. F. Farnsworth attended the Spring meeting of the American Electrochemical Society in Bridgeport, Connecticut on April 27 and 28.

W. T. Hervey visited Providence during the early part of May in connection with development studies on insulators.

Systems Development

L. Earl spent several days at Monticello and Catskill, New York, making noise tests on the power plants prior to the cutover of new No. 11 switchboards.

H. M. Pruden spent the last of April in Chicago testing 1000 cycle signalling equipment in the Long Lines Offices of the Illinois Bell Telephone Company.

G. E. Sohnle and J. E. Cassidy arranged for the installation of an automatic carrier pilot channel system between Washington, D. C. and West Palm Beach, Florida. G. H. Huber, D. M. Terry and W. F. Kennenberg are conducting tests at various stations along the line.

H. J. Fisher has returned from London, England, where he has been making tests on transatlantic radio equipment.

W. M. STUART was in Boston April 9 to 11 investigating subscribers' ringing conditions.

G. R. VERNON visited the new step-by-step office at New London, Connecticut on April 23 and 24.

J. IRISH spent the last week of April at Hawthorne to promote closer relations between drafting practices of the Laboratories and the Hawthorne Works.

C. A. SMITH AND L. P. BARTHELD visited the new Cleveland Toll Office in connection with tests and studies on toll equipment.

A. E. PETRIE AND V. T. CALLAHAN were in Buffalo April 17 and 18 testing a new 6 cylinder Buffalo gasoline engine.

J. L. LAREW AND H. KEPPICUS visited the toll offices at Utica and Syracuse to make noise tests in the repeater equipment.

RESEARCH

H. H. LOWRY made two visits to the coal fields in the neighborhood of Wilkes Barre from April 18 to 20 and from April 24 to 26.

B. L. CLARKE AND K. K. DARROW attended the Spring meeting of the American Chemical Society held at St. Louis, April 15 to 20.

R. M. BURNS, C. L. HIPPENSTEEL, C. A. KOTTERMAN, L. E. KROHN, A. G. RUSSELL AND J. V. VOORHEES attended the Spring meeting of the American Electro-Chemical Society held in Bridgeport, Connecticut, from April 26 to 28.

W. C. ELLIS was at Hawthorne from March 31 to April 23 in connection with metallurgical work which is being carried on out there.

C. H. G. GRAY sailed May 12 on the Majestic for a three months stay in Paris where he is to supervise the installation of the European Master Telephone Transmission Reference System which is a replica of the American System adopted a year and a half ago. The European Reference System is to be installed in the Conservatoire Des Arts and Metiers under the jurisdiction of the Comite Consultatif International Des Communications Telephoniques a Grande Distance.

J. B. KELLY AND R. L. WEGEL attended a meeting of the American Otological Society in Washington on April 30 and May 1.

R. M. BURNS, with F. F. Farnsworth of Outside Plant Development, discussed the corrosion of cable sheath in concrete conduits before a regional meeting of the A. I. E. E. at Baltimore on April 18.

J. A. BECKER was elected a Fellow of the American Physical Society on February 28 and a Fellow of the American Association for the Advancement of Science on April 22.

R. W. WATERMAN was in Gulfport, Mississippi, from April 8 to 26 in connection with the study of wood preservation now being made in conjunction with the Gulfport Creosoting Company.

H. FLETCHER visited the Southern Bell Telephone Company in Atlanta in connection with his work on audiometric problems.

A LARGE DELEGATION from the Laboratories attended the two recent scientific meetings held at Washington: the annual meeting of the American Section of the International Union of Scientific Radio Telegraphy held on April 19 and the Washington Meeting of the American Physical Society held from April 20 to 21. At the former meeting J. W. Horton and W. A. Marrison presented a paper on "Thermostat Design of Frequency Standards" and H. T. Friis gave the general report of the Chairman of the Committee on Atmospherics. At the meeting of the American Physical Society, there were papers by R. R. Riesz on "Differential Intensity Sensitivity of the Ear", C. J. Davisson and L. H. Germer on "The Refraction of Electrons by a Crystal of Nickel", J. M. Eglin on "Thermionic Activity, Evaporation, and Diffusion of Barium in Tungsten", T. C. Fry and H. E. Ives on "The Voltage Current Relation in Central Cathode Photo-Electric Cells", and H. E. Ives, A. L. Johnsrud and A. R. Olpin on "The Distribution in Direction of Photo-Electrons from Alkali Metal Surfaces". H. E. Ives also gave an after-dinner talk on "Back Stage in Television" before the American Physical Society.

R. M. Burns opened the round table discussion of "The Corrosion of Lead Cable Sheath" at a meeting of the New York Section of the American Electrochemical Society on May 18.

L. H. Germer addressed the New York Microscopical Society on "The Diffraction of Electrons" on May 4.

General Staff

S. P. Grace spoke on inverted speech and recent discoveries and inventions of the Laboratories before the Dayton Engineers' Club at Dayton, Ohio, on May 8, the Western Society of Engineers in Chicago on May 14, the Pennsylvania State Telephone and Traffic Association at Harrisburg, on May 16, and the Up-State Telephone Association of New York at Rochester, on May 24.

G. F. Fowler gave a talk on liquid air and a demonstration before a group at Pioneer Lodge, 70, F. & A. M., Hackensack, on Friday evening, May 1.

R. A. Deller spoke before the Students' Training Class of the New York Telephone Company on April 28, on the subject of television.

R. W. King addressed the Engineers' Society of Milwaukee on May 16, and the Electrical League of Milwaukee on May 17, on television.

"The Magic of Communication" by John Mills is one of the selections in a volume of literature for junior high schools, published by Bobbs-Merrill.

Vail Medal Awards

ONE gold and five silver medals have been awarded by the National Vail Medal Committee to men and women selected from the fifty-four to whom bronze medals were awarded during 1927 by Associated Companies of the Bell System.

To be selected for National Vail Medal recognition an act must have for its objective the accomplishment of something of real value in the public interest through the medium of Bell System facilities, organization, training or experience, and must reveal to a high degree many, if not all, of the positive qualities of intelligence, initiative and resourcefulness, and usually courage, endurance and fortitude.

Outstanding service rendered during the Mississippi flood was essentially the result of group organization and effort and accordingly does not offer the opportunity for individual awards as did the New England flood where, although the group performance was equally noteworthy and outstanding, the suddenness of the onset made emergency individual action vital before group action could be organized.

Awards and Citations

A gold medal, with a cash award of $500 to Fred F. Brown, Foreman, The Connecticut Valley Telephone Company, Bradford, Vermont.

For courage, initiative and resourcefulness in restoring vital telephone service in a serious emergency, in face of grave personal danger.

When the unprecedented rains in Northern Vermont in early November 1927 had turned the rivers into torrents of destruction which paralyzed activities in that section of the state, Foreman Brown and two fellow-employees set out on November 5 to clear at least one toll line into Montpelier, the capital city, which had been isolated.

After driving twenty miles over back roads and high ground, they found that the lines were crossed where the Wells River had washed out a pole and left the tie wires tangled in the toll circuits. The cross could not be shaken out and, although the river was a rushing torrent filled with logs, trees and other debris and a fall would have meant almost certain death, Brown hooked his safety strap over the four wires and rode out on what was then a two hundred and sixty foot span, untangled the ties which caused the cross and, when one wire broke as he started back, rode the remaining three back to the pole in safety.

The circuit which he restored was immediately put into service for official use of the state authorities and was of vital importance in the organization of the relief work and in giving accurate news to the outside world.

A silver medal, with a cash award of $250, to William Foster Owens, Manager, Rock Springs Telephone Company, Rock Springs, Texas.

For initiative, courage and resourcefulness in restoring vital telephone service at a time of disaster.

In the evening of April 12, 1927, a tornado struck the town of Rock Springs, killing sixty-five people and seriously injuring many more, destroying many homes and utterly isolating the little town.

Mr. Owens saw his own house demolished and members of his family seriously injured. Leaving his family in the care of others, he proceeded to the edge of the devastated district where the toll wires were still intact. Removing the telephone from a house nearby, he climbed a pole and connected to the toll line and called Kerrville, sixty miles away, notifying them of the disaster and asking for medical aid and supplies. Through the night this telephone afforded invaluable aid in organizing and speeding the relief program.

A silver medal, with a cash award of $250, *to Mrs. Clara B. Pitkin, Agent, White River Valley Telephone Company, West Hartford, Vt.*

For fortitude and devotion to public service in the face of grave personal danger.

During the evening of November 3, 1927 when unprecedented rains had caused severe floods in Northern Vermont and the White River was a raging torrent, Mrs. Pitkin was on duty at the switchboard in her home on the bank of the river. She began to receive ever more urgent calls for help and, although she saw her neighbors' houses washed away by the flood and knew that her own home was in serious danger, she remained at the board, doing her best with failing lines to give all possible warning and to send help where needed. She warned all subscribers in the valley whose lines were still working and all except one family escaped.

Although she was repeatedly urged to leave, she remained until all her lines had failed and only then made her way across the road to higher ground ten minutes before the highway was flooded with rushing water. A few hours later the house was washed away by the flood.

A silver medal, with a cash award of $250, *to Patrick B. McCormick, Agent, New England Telephone and Telegraph Company, Becket, Mass.*

For fortitude, initiative and devotion to public service despite grave personal danger.

Unprecedented rains in Western Massachusetts early in November, 1927 had swelled the rivers and streams to torrents and it was feared that the dams in the vicinity of Becket would go out and cause great destruction. About four o'clock in the morning of November 4, when McCormick was notified that the nearest dam a mile above the town would doubtless fail, he notified every subscriber in the valley, warned them to leave, and asked them to notify those who had no telephones. He sent his own family to safety in the hills and, realizing that some of the residents would remain despite his earlier warning, stayed at the switchboard in his home, in constant telephone communication with people at the dam, to receive and transmit the final warning.

The dam went out at six o'clock and after notifying all who had remained he started warning all the towns in the path of the danger. This task completed, his escape was cut off and he was forced to remain, while houses and trees were torn up and carried past and his own home was flooded and the switchboard put out of order.

As soon the the water began to recede he climbed a pole, cut in on the toll line with his test set, and gave to the outside world the first call for relief.

A silver medal, with a cash award of $250, *to Mrs. Mary Elizabeth Algor, Agent, New Jersey Bell Telephone Company, Holmdel, N. J.*

For initiative, resourcefulness, persistence and devotion to public service.

While on duty in the evening of April 4, 1927, she was notified by the Central Complaint Desk in New York City that a woman whose address was Wickatunk, N. J., had purchased a prescription for eye drops in a drug store in the city but by mistake had taken away a bottle of acid. Mrs. Algor learned by inquiries that the woman was the sister of a local resident and, receiving no answer on his telephone, she called her relief operator to take her place so that she might drive to his home three miles distant. Meanwhile, however, she saved priceless minutes by calling various subscribers in the vicinity and reaching one who went to the house and reported the brother was away for the night.

Recalling that earlier in the day this brother had called another brother in New York, she located the New York brother's residence through a New York City directory, called him quickly and found that the sister was there and just about to use the acid which she supposed was the prescription for her eyes.

Mrs. Algor's resourcefulness and persistence, and her intelligent use of the telephone facilities were directly responsible for the saving of the woman's eyesight.

A silver medal, with a cash award of $250, *to Horace E. Roby, Superintendent of Traffic, New England Telephone and Telegraph Company, Montpelier, Vermont.*

For conspicuous initiative, resourcefulness and accomplishment in the service of the public at a time of disaster.

When on the evening of November 3, 1927 Montpelier was cut off from all communication by a devastating flood, he assisted city, state and other authorities in the initiation of measures for rescue and relief through the greatest possible emergency use of almost totally crippled telephone facilities and made unique emergency utilization of the first toll circuit to be restored in transmitting messages from the flood victims to their anxious friends and relatives.

Club Notes

The Spring Golf Tournament will be held on two Saturdays in June at the Salisbury Country Club, Salisbury Plains, Long Island, in two rounds, each consisting of eighteen holes of handicap medal play. On June 2, twenty-eight golfers will be qualified for the finals which will be played on June 9. These will be divided into two classes based on scores of the qualifying round. The fourteen low gross scores will gain entry to class A and the remaining fourteen best net scores will make up class B. The players in each class will be divided into flights of seven each. The prizes for the qualifying round will be two medals: one for low gross score and one for low net score. In the finals a first and second prize will be given in each of the four flights. The value of these prizes will be the same for each flight. In addition to the prizes mentioned, two Elgin wrist watches will be given for the low gross score in both A and B classes on June 9.

Baseball

To date the Laboratories' team in the Bell System League has been successful in all of the games played. On Tuesday evening, May 1, they defeated the team representing the Western Electric Company, 195 Broadway, by a score of ten to one, and on Friday evening, May 11, they defeated the Western Electric Company, Telephone Department, by a score of seven to four.

Admission is free to all league games and bus service will be provided if enough requests are received by the Club Secretary.

In the Interdepartmental League which opened on Saturday, May 5, with a double header, Telephone Systems Department defeated the Tube Shop and the Ringers' team composed of men from the Commercial, Research and Apparatus Development Departments defeated the Plant and Shops team.

Bell System Athletic League

At a meeting held on Wednesday, May 9, the Bell System Athletic League of New York was organized for the purpose of promoting inter-company athletics among the employees of the Bell System in the Metropolitan district. The officers elected to serve until June 30, 1929 are:

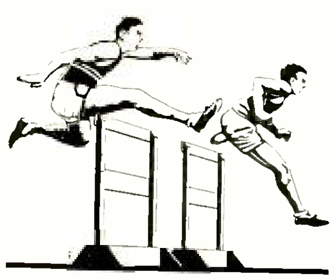
President—D. D. Haggerty, Bell Laboratories.
Vice-President—R. S. Kirkwood, N. Y. Tel. (Manhattan).
Secretary—E. H. Straus, N. Y. Tel. (Long Island).
Executive Committee—
C. Stoll—W. E. Co.—Telephone.
J. B. Stevens—W. E. Co.—Gen. Headqrs.
S. A. Henszey—W. E. Co.—Installation.
E. R. Schoen—A. T. & T. Co.

In 1926 the first Bell System Baseball League was organized and was followed in that year by the organization of a chess league and a handball league. So successful were these activities that they were continued in 1927 and in September 1927 a basketball league of eight teams was organized.

With the start of 1928 baseball season when fourteen teams applied for admission into the league, and with the same number of them likely to apply for admission into the basketball league, steps were taken to bring all the intercompany activities under the supervision of one organization. After a careful study the athletic league was organized, whose plan it is to promote intercompany competition in baseball, basketball, chess, track, handball and bowling.

Track and Field Meet

The Bell System Athletic League will hold an Intercompany Track and Field Meet at Erasmus Hall Athletic Field, Brooklyn, on Saturday afternoon, June 16, 1928.



The program will include:

For Men

100 Yard Dash	Broad Jump
220 Yard Dash	High Jump
440 Yard Dash	Novelty Race
880 Yard Run	Mile Relay Race
Shot Put	Tug of War

For Women

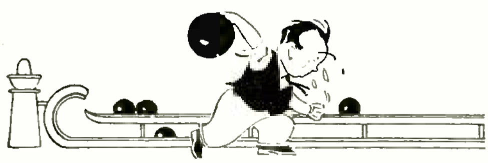
60 Yard Dash	1/4 Mile Relay Race
Basketball Throw	

Fourteen branches of the Bell System in the metropolitan district will compete in this set of games, each limited to three entries in all events but the tug of war and relay race, in which the competing organizations will enter one team apiece.

General admission will be fifty cents. Games will start promptly at 2:00 P.M. Tickets may be purchased from your Departmental Representative or in Room 164.

Bowling

The Bell Laboratories Bowling League officially closed its seventh season on April 16, with the customary bowling party which was held



this year at the Hotel Manger, and the Winter Garden. Following the dinner, for which the entire main dining room of the hotel had been reserved, Mr. Craft distributed the bowling prizes. Individual gold medals were awarded to A. Muller, J. L. Sherry, W. H. Berthold and A. G. Kobylarz.

The attendance of two hundred people at the party and the fact that all those wishing to attend could not be accommodated, indicates that interest in bowling continues to increase. Chairman Gilson in reporting on his stewardship of the bowling league affairs stated that out of one hundred and forty men, each bowling twenty-eight nights, there had been only five absentees. He also stated that the Women's Group inaugurated during the past season was proving a popular innovation and inferred that next season might see additions to the League which would make it the largest in the Metropolitan District.

The trial season of the Women's Group, during which four teams bowled each Friday for six weeks, ended April 13. In the distribution of the season's prizes, seven individuals were rewarded: for three highest averages — Catherine Wales, Anna Wells, Florence Baker; for three highest scores — Natalie Skinner, Margaret Horne, Elsie Hacker. A prize for the greatest improvement in average was awarded to Mandy Reinbold. The team prize was won by the Pencils whose record was upheld by Anna Wells, Mandy Reinbold, Natalie Skinner, Margaret Horne and Josephine Pagano.

Glee Club

The Bell Laboratories Glee Club closed its official season on May 7, 1928, after fifteen successful weeks under the guidance of Mr. L. K. LeJeune, its professional director.

The Glee Club has planned an informal post-season program, the members meeting on Mondays at 5:10 in Room 198. Regular activities will be resumed in the fall. A cordial welcome to participate is extended to those interested in singing.

Brighton Beach Tickets

During the last three swimming seasons the Club has obtained for its members tickets for the Brighton Beach Baths at one-half the regular rate. This privilege will be available during the 1928 season to all members and their friends who wish to effect a decided saving by purchasing these tickets through the Club. Tickets for Saturdays may be had for fifty cents instead of one dollar and tickets for Sundays and holidays may be obtained for one dollar instead of two. Your Departmental Representative can supply you with as many tickets as you want.

WOMEN'S CLUB NOTES

Indoor Golf Tournament

The Women's Indoor Golf Tournament held April 10 was contested by eighteen members, a number of whom experienced their first attempt at the game. The qualifying round of eighteen holes of medal play was won by Marjorie Joseph with a score of 44. In the final round of thirty-six holes, she entered as scratch player and each of the other entrants was allowed a handicap of three quarters of the difference between her own and the scratch score. Five prizes were awarded for the best scores to Marion Mason, Natalie Skinner, Mary Crawford, Marie Boman and Marianne Grimm.

Bridge Tournament

The Women's Bridge Tournament which afforded much enjoyable competition to its participants concluded the meetings of the Bridge Club until the fall. At the close of the Tournament, on April 24, May Murtagh was pronounced winner and Edna Haunfelder second highest. The average attendance on individual nights was four tables.