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VOLUME X, 1931

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A Medium of Suggestion and a Record of Progress

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What the Electrical Communication Industries Expect of the Technical Schools

Address by Bancroft Gherardi, Vice President and Chief Engineer of the American Telephone and Telegraph Company, at Lehigh University, October 16, 1930.

As a part of the ceremonies of the dedication of the James Ward Packard Laboratory of Electrical and Mechanical Engineering, I have been asked to speak on "What the Electrical Communication Industries Expect of the Technical Schools." At the outset, I must admit that I cannot undertake to speak for the whole electrical communication industry of these United States; I can only speak for that considerable part of it known as the Bell Telephone System. Even in this narrower capacity, I cannot say that there would not be some who might differ from me in their ideas on this question. It is a question in which I am greatly interested and to which I have given much thought. What I say is based upon over thirty-five years of experience and observation in the Bell System, and I feel confident that my views do not differ in any essential respect from those of the great majority of my associates.

The Bell System has in round figures 400,000 employees. The administration of this number of people engaged in a business which extends throughout the whole of this country, which is growing rapidly, and which is based upon a complex and rapidly developing art, necessarily requires much administrative ability, a large and skilled administrative personnel, and many departments whose work demands a knowledge of scientific and technical questions not only by the supervisors but by practically every member of the department.

A recent survey of the Bell Telephone System showed that on the first day of this year there were over 14,000 college graduates in the System. College graduates constitute a most important part of the supervisory personnel, and about one-third of all the supervisory positions in the Bell System are filled by men who have had a college education. We were among the earliest of the business organizations to recognize the value and the opportunities of the college man in industry. Almost from the invention of the telephone, it has been a definite part of our program to hire a number of college men each year.

Of the college graduates in the Bell System, about 55 per cent are graduates of scientific or technical courses; about 35 per cent of courses in arts and science; and about 10 per cent come from business courses. Enough facts have been given to show the dependence which the Bell System has placed, in the building up of its supervisory and technical forces, upon the graduates of our colleges and universities, and especially upon the graduates of our scientific and technical schools.

We have been employing, on the average, during the last few years about 1,500 college graduates each year, and there is every reason to believe that this is a fair measure of our future requirements. In making our studies of our needs for college men, we are careful not to make our estimates so large that we will be unable to give to each man opportunities for advancement commensurate with his abilities. We also make full allowance for the developing of men from our non-college forces, and many able men in the supervisory and technical forces of the Bell System have come from this source. For the rest, we must look to the colleges. In addition we must go to the colleges for a large part of the personnel of such departments as those dealing with engineering and research.

Perhaps no industrial organization has a greater diversity in the scope of its work than the Bell System. The Western Electric Company, the manufacturing department of the Bell System, employs over 70,000 people, and at the present time has about 2,700 college graduates. The Bell Telephone Laboratories, the largest industrial laboratory in the world, employs over 1,200 college graduates; the remainder of our college graduates, over 10,000 in number, are engaged chiefly in the supervision of operations and the carrying on of engineering and technical work pertaining to the telephone business. In order that in this paper I shall not try to talk about too many things at the same time, my remarks from now on will be confined to a consideration of the requirements of positions in the engineering and operating departments of the System, although many of my comments might apply equally well to our laboratories and manufacturing department.

Perhaps it would not be out of place at this point for me to make some reference to the kind of men that we would like to get from the colleges and technical schools, for the output of the colleges is a product of at least two factors—the characteristics of the men themselves, and the influence which their education has had upon their knowledge, judgment and character. As the technical schools are in general responsible not only for the courses of training which they give to their students but for the selection of the students themselves, it would perhaps not be amiss for me to outline briefly what seem to us to be the principal characteristics of a good man of the type which we are now considering. Perhaps such an analysis might be of some help in the selection of the men who are to receive technical training, and perhaps it might have some influence upon the kind of training to be given to them.

What we want are men who can recognize the problems with which they are confronted; study the problems; determine the appropriate action; and then take such action in the right way. For men in administrative and general engineering departments, these seem to me to be the essential requirements, and to perform them adequately there are a limited number of characteristics necessary. There are others which are desirable, but those which I shall enumerate here seem to me to be essential.

Understanding of the problem needs perception. Questions do not ordinarily come to those in responsible positions in concrete form; such persons live in the midst of events and have to see accurately what the situation is. There can be but little perception without broad knowledge of the business, as things must be seen in proper relation to each other and to the business as a whole. There must be imagination, intelligence, judgment, intellectual honesty, and high aims.

The study of the problem and the determination of the action to be taken after perceiving that some action is required or is desirable, requires, in addition to the characteristics already named, courage or the will to do; requires an active type of courage—the willingness, even the eagerness, to face difficulties, both difficulties of a physical nature and opposition from others. The determination of action, which often involves personnel questions, requires a sense of justice.

The effective carrying out of action when decided upon involves an additional characteristic—skill in persuading and in meeting difficulties, for there is often met inertia and opposition in the processes of execution. These must be overcome and the many subordinate questions which arise in a large undertaking must be disposed of satisfactorily.

To the above, I would add only a few additional characteristics: good health; a sympathetic understanding of people and of the world at large; and an ability to carry on several projects simultaneously without becoming overwhelmed or confused by varied activities.

Some may be surprised that I have made no specific mention of tact. It is admittedly helpful in getting things done and in making life pleasant for all concerned; it is a desirable characteristic for men in administrative work; it is perhaps, at least in some of its aspects, included in "Skill in Persuading and in Meeting Difficulties." Probably men wholly lacking in tact will not be completely successful. However, I think we all know enough successful men who are not markedly tactful to suggest the possibility of overrating tact as an essential characteristic. I believe that co-operation and good morale may be maintained by other means, such as enthusiasm, sincerity of purpose, and by just and fair dealing. An over-emphasis on tact may result in the selection of colorless individuals and those lacking force.

I have not specifically mentioned skill in the judgment of people. This is essential, but in general I believe it goes with the other characteristics outlined, for good all-round men instinctively recognize one another. To be able to select good men, train them and give them opportunities for advancement, are of course essentials.

In speaking of the educational course itself, I shall confine myself to discussion with reference to preparing the student, not for his general responsibilities to society, but with reference to the special qualifications needed in his professional work. This is not because I underrate the importance of having a man prepared to play his part in the general social structure, but to undertake to consider that aspect of education would carry me far beyond the scope of the subject on which I have been asked to speak. Even the aspect of the subject to which I have limited myself is so broad that it is impossible for me to treat of it here comprehensively. I shall only undertake to bring out a few ideas which my experience has indicated as worthy of consideration.

Telephone engineering is one of the specialties into which engineering has been differentiated, and while ordinarily considered a subdivision of electrical engineering, in fact it invades many of the other fields of engineering, notably mechanical engineering. I do not feel that the school training of a man for communication engineering should be essentially different from that given to electrical and mechanical engineers in general. The communication engineer is, after all, confronted by problems which are underlain by the common basis of these branches of engineering; he deals with the same materials and the same physical laws; and his problem, as in other branches of mechanical and electrical engineering, is to accomplish the most satisfactory results in the most economical manner, and so that the product of his work will meet not only the conditions of today but those of the future.

In the relatively short time available for the professional training of the student, it is not possible to teach everything in science and engineering which might be useful in his profession. It seems therefore that the important thing is that the engineering student should have discipline in the methods of solving engineering problems and a general foundation in mathematics, physics and materials which will enable him to solve the special problems that come before him by getting the facts in that case and then interpreting these facts and reasoning from them correctly. Train the student on the necessity of getting his facts and teach him the best methods of getting engineering facts, and train him on interpreting engineering data and in reasoning therefrom. I am not suggesting that his education should teach him the facts beyond the fundamental ones.

All important communication systems today, except those which are essentially transportation problems, are basically electrical. Therefore, in electricity, the student's work should be carried further than in other branches of physics, and he should have a thorough working knowledge of both direct and alternating currents. In addition to giving this knowledge in abstract form, it should be taught in some of its principal applications. Laboratory experimental work is valuable but should, it seems to me, be carried on primarily as illustrating fundamental laws and so as to give the student the manual dexterity needed in handling electrical instruments. The time devoted to this work may be divided between the different branches of electrical engineering, and certain fundamental problems with reference to the telephone and telegraph should not be excluded.

One of my strongest convictions is that unusual effort may well be made to teach every engineering student to speak and to write a report or letter in clear convincing English, setting forth the facts and arguments and conclusions pertaining to the question before him. It is of the greatest importance to an engineer that he shall be able to state in correct and logical form the problem before him, and to enforce his conclusions with arguments which shall be convincing. Such training as this is not merely one in literature, composition or rhetoric, for to present such a report the problem must have been mastered, and clear thinking must precede clear speaking or writing. It has always seemed to me that a knowledge of at least one foreign language is desirable, perhaps more so than ever now that the export business and foreign activities of this country have become so great.

I do not know how much it is possible within the scope of technical education to emphasize the importance of arriving at the most economical solution of a given problem. Correct engineering is the determination of the most economical way of arriving at a desired result. It is not sufficient to find a way to accomplish a result; it should be the most desirable way. I can appreciate the difficulties of emphasizing this point of view in a college education, but whatever can be done along these lines will be helpful.

I do not think that it is possible to over-emphasize the importance of accuracy. I have sometimes noticed that beginners in engineering seem to feel that arithmetical errors are of trivial importance as compared with the use of incorrect mental processes. Without wishing to condone the use of incorrect mental processes, I should like to point out that, as far as practical results are concerned, errors due to carelessness are as serious as those due to incorrect mental processes; in fact, they are often even more troublesome to deal with, because errors of logic can be detected by a competent chief engineer in a comparatively brief examination of the subject, whereas errors of computation and similar errors can be found only by a complete re-check of the work.

In presenting my ideas to you on this matter, I have tried not to be dogmatic. I recognize that it is for the educators to determine how results in education shall be accomplished, while, on the other hand, it is the duty as well as the privilege of those in industry to outline what they need. In some ways the problem is analogous to the relation between the operating departments of the Bell System and its manufacturing company. The operating departments undertake to tell the manufacturing company and the laboratories what they want, but not how it shall be manufactured; it is the function of the manufacturing department to determine how a given device or mechanism shall be manufactured in order to produce the desired result. Education is in many ways a more complex operation, because manufacturers use uniform standardized materials, while the educational process is not applied to uniform materials but to human beings of infinitely varying characteristics. While this greatly complicates the problem of the educator as compared with that of the manufacturer, it does not in my opinion greatly change the relationship which should exist between the educators and the employers who subsequently will hire those who have been educated.

In accepting the pleasant task of speaking to you as a representative of the communication industries and in trying to outline what we " expect " of the colleges, I would not wish you to think that I feel that in the past our colleges and technical schools have not met the needs of the Bell System. We are deeply appreciative of the contributions which the graduates of Lehigh University and of the many other colleges represented in our organization have made to our success. They will be important contributors to further progress in the years to come. Nothing that I have said should be interpreted as criticism of these men or of the institutions in which they acquired their academic training. On the contrary, I am ready to maintain at any time that these men have been essential to the Bell System and that the training which they received during their years of academic study was essential to the contributions which they have made. If what I have said is helpful to the educator in arriving at a more definite understanding of what the communication industries expect of the technical schools, I am grateful to have had the opportunity to present this paper today.

The Training of Telephone Operators

THE important part played by the operator in furnishing telephone service is a matter of common knowledge. As the industry has grown, her work has evolved from a simple occupation to one of such scope as to require careful training; and the Bell System has attempted to meet this training requirement. This has involved the development of an extensive educational system within the telephone business, adapting the science of vocational training to the needs of one of the largest and most essential classes of women workers.

The extent of this training problem was pointed out by Mr. K. W. Waterson in his article, "Change from Manual to Dial Operation," which appeared in a recent issue of the BELL TELEPHONE QUARTERLY. In this article it was shown that in 1920, at the time conversion to the dial system started, there were 128,000 operators in the Bell System and that in July, 1930 with the System 28 per cent on a dial basis, there were 160,000 operators. It was stated, moreover, that by 1940, when all proposed dial conversions will have been completed, there will be 180,000 operators.

It is necessary to employ many thousands of new operators each year to meet the demands of this increasing force, and the Bell companies exercise great care in conducting the examination of applicants for these positions. In large cities, at least two out of three applicants for operators' work are rejected because they fail to meet the essential qualifications.

Each applicant for operators' work is interviewed by an employment representative of the telephone company, and if this interview is satisfactory, she also is examined by a physician. This interview and physical examination, which reveal whether the applicant possesses the essential qualifications, are conducted with the objects of protecting and furthering the interests of sustained, dependable telephone service, the interests of the applicants themselves, and those of the other employees with whom accepted applicants will work and be associated. Among the more important items considered are intelligence, health, sight, hearing, voice, size, temperament, character, appearance, and previous record.

An applicant accepted for employment is assigned to a training department which has the function of training her in the work for which she was engaged, and she becomes a paid employee on the day on which her training starts. Long ago, telephone operating apprentices, as well as those in other occupations, were trained by being placed on the actual job, and acquired skill as best they could through observation, contact with skilled workers and the performing of such tasks as came within the scope of their ability. This plan had the serious disadvantage that training became interwoven with productive operation to an extent which was detrimental to both. The recognition of this disadvantage led to the establishment of organized vocational training in trade schools and also within important industries. In this matter of providing exclusive training facilities for its operating employees, the Bell System can take pride in a record which extends back twenty-five years. During that time well organized operators' training departments have been established and operated in all of the large cities served by the Bell System.

The training department provides for the student a training course which prepares her to start handling the ordinary work of a regular operator in a central office in a dependable manner. This training is given by instructors who, first of all, are experts in the operating work in which training is to be given and who also have the ability and training to teach others to perform this work.

In the training department the student operator is instructed in classrooms in the methods of performing her work and also receives practice in the actual handling of this work. This practice operating is considered the most important part of the training and is given on special switchboards by means of simulated calls under the full control of the instructors. These calls are varied according to the requirements of the individual students, but in every case a student handles many hundreds of practice calls before she ever handles a regular service call in a central office.

Intensive drills are given to the students in certain features of their work, such as locating lines on the switchboard, the use of phrases, and the understanding of speech as heard over the telephone by an operator. The drills in the use of phrases and in understanding are fundamental to an operator's work, affecting, as they do, the transmitting and receiving of the orders, requests, and acknowledgments which determine and control the service rendered by her. Particular care is taken to impart such training as will result in clear enunciation and accurate hearing; and an ingenious arrangement has recently been produced for developing the hearing of students. By means of this device, the transmission on practice calls is gradually reduced during the training course, until, at the end of the course, the students are receiving orders which are more difficult to hear than any they will ordinarily receive when handling actual calls.

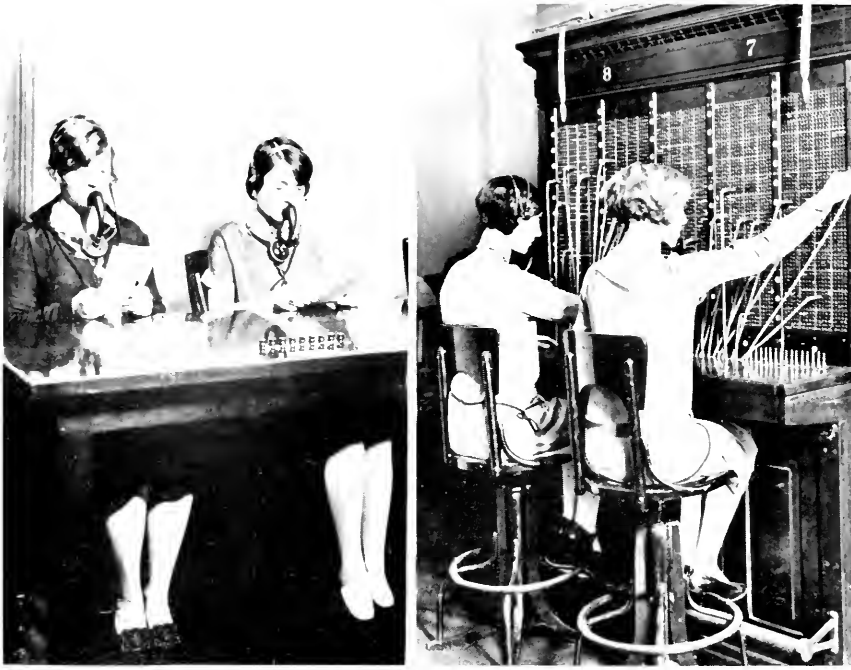
Of all the training activities, the one which the students like best is operating on the practice switchboard. This is quite natural, since this activity is essentially the same as the job for which they applied to the telephone company. The instructors realize the advantage of satisfying this interest on the part of the students, and an attempt is made to give them as much of this practice operating as the general progress of their training will permit. At the very beginning of the training course, one of the first things the student does is to go to a practice switchboard and establish a few connections under the direction of an instructor. This lays a foundation of interest and satisfaction for the training which is to follow.

In order to adjust the training of students accurately to the work they will perform, periodical analyses of the work of operators are made in the central offices in each city. This adjustment of the training to the job—a basic requirement of

Student operators are shown a feature of telephone operation with a demonstration switchboard.

Student operators listen in on numbers received at a working switchboard and write them down.

STEPS IN THE TRAINING OF TELEPHONE OPERATORS.



The girls at the left pass numbers to the student operators at the right who are finding the lines on a practice switchboard.

Student operators under instructors at a practice switchboard handle calls made by the girls at the right.

STEPS IN THE TRAINING OF TELEPHONE OPERATORS.

effective vocational training—results in concentrating the training in each city on those operations which actually make up an operator's ordinary job in that city. Only a relatively small proportion of the wide range of operations embraced by any important class of operating occur frequently enough to be included in the ordinary work of an operator, and these conditions vary as between cities. Hence the advantage of this analysis is apparent.

Another interesting training analysis is one which is made, at intervals, of the work of students immediately after they start to operate in the central office. This reveals those features of the work with which the students are encountering the most difficulty and thus forms the basis for readjustments in the training. Important advances in training have resulted from this sampling process.

When the student is capable of handling a moderate quantity of the ordinary work of an operator in a dependable manner, she is sent to a central office. There she receives such additional instructions as she needs to prepare her to take up her work. These additional instructions have to do with arrangements peculiar to that particular central office or conditions which are of such infrequent occurrence that they are not included in the training department course. She is given all the assistance and instructions she needs, but she is also given real work to do, since the latter is an essential requirement at that stage of her development as an operator. Soon she is performing a regular operator's work, although, of course, in limited quantity. Her remaining progress is largely a matter of acquiring experience under the direction of expert supervisors.

The progress of the student through her training course and then on through the central office to become an operator is gradual and uniform. Every training step has two objectives, namely, training in the feature involved, and also preparing the student to take up the steps which follow. This is important to the student because it renders easier her task of acquiring skill in her new work, and it is of advantage to the telephone user because the student has acquired reasonable proficiency before she handles his calls.

Throughout the training course and after the beginner goes to the central office, careful attention is given to making the training and the work as pleasant and interesting to her as possible. The training itself is planned and administered with this in mind, and the associations of the student with the supervising and instructing employees and with her associates are kept on a cordial and friendly basis. An attempt is made, in particular, to let the student know of the interest which the Company takes in her welfare and progress, and also to give her the opportunity to observe the progress she is making.

Sustained attention is devoted to keeping operators' training abreast of approved vocational training development and to producing such distinctive new arrangements as the conditions of telephone operation require. Training studies and experiments are continually being made with these ends in view.

The training imparted to the student operator not only serves to prepare her to perform skillfully the important work of telephone operating, but also forms a sound basis for advancement to higher positions. This is attested by an imposing group of women employees, who started by taking this same student training course and who, today, are occupying positions of importance and responsibility.

The task of administering this training is full of live, human interest and appeals to the imagination. The training organization, in performing its work, has the satisfaction of knowing that it is not only contributing to the furnishing of an essential service, but that it is helping thousands of girls to learn something useful and profitable.

The training described in this article is local operators' training, which differs in some respects from toll operators' training.

H. C. LaChance.

Moving the Indianapolis Telephone Building

CONSIDERED from the viewpoint of popular interest, the moving of the Indiana Bell Telephone Company's main building in Indianapolis, housing the administration and downtown business offices and toll equipment, was perhaps one of the outstanding engineering projects of the year. This 11,000-ton building of steel-frame and brick construction, eight stories high, covering an area of 100 feet x 135 feet was moved and turned from its original position at the front corner of the lot facing Meridian Street to a new location at the rear of the property fronting on New York Street, as indicated in Figure 1.

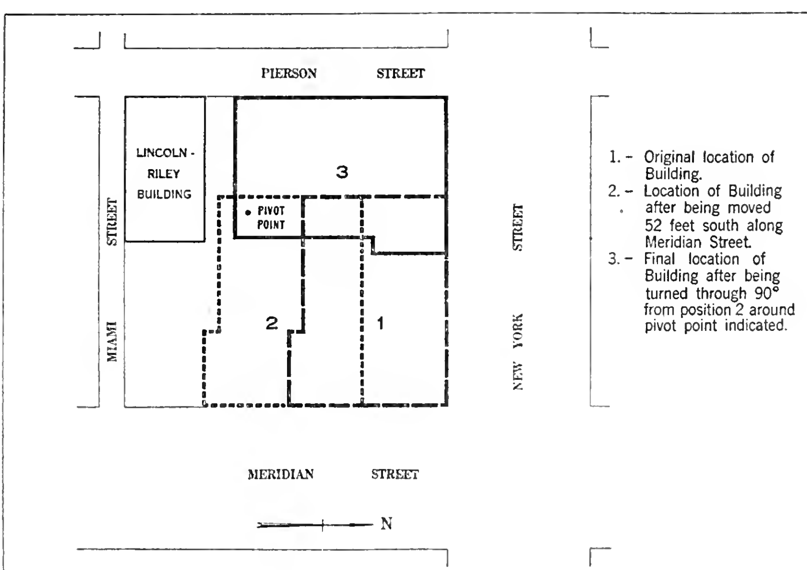


FIGURE 1. Plot Plan.

It was determined after a study of several possible schemes that by first moving the structure in a straight line 52 feet south it would then be practicable in the space available to rotate it through an angle of 90° into its final location. In effect, the general plan of carrying out this operation was, after excavating the site, to strip the building down to the steel skeleton below grade, cut it loose at the foundations and load it onto rollers, the building then being pushed and pulled in the required directions using for a road-bed a system of tracks laid generally railroad fashion on a concrete mat.

The structure, except for the basement, continued to be fully occupied and business was conducted with the public and employees coming and going as usual and with the normal operation of all house services and telephone equipment. For example, gas, water, sewer and steam heat services were continuously maintained through flexible hose connections at the basement ceiling level and the electric service through temporary overhead leads from a pole, all as shown in Figure 2. Elevator service, which normally included travel to the basement, was continued by stopping the cars at the first floor with proper safety apparatus installed on the steel framework under the shaft. To avoid any interruption to the service, the telephone wires where they left the building were lengthened by splicing in place temporarily seven large armored submarine-type cables —five for toll circuits and two for trunks to local offices—with 200 feet of slack. As a point of interest, through these cables a telephone conversation between a young man in Australia and his father who was ill in an Indianapolis hospital took place while the building move was under way.

The objective in moving the structure, erected in 1906, was to clear the front portion of the lot to provide space for the erection of a new administration and equipment building required to keep pace with the continuing telephone growth in Indianapolis. Meridian Street, along which the new structure is to be erected, is one of the principal thoroughfares of

FIGURE 2. Eighteen men with jacks push 8-story, 11,000 ton building. This picture shows the start of the straight move south.

Figure 3. A close-up view of jack operation, I-beam construction, rollers and rails.

the city and by relocating the old building it was possible to realize fully the inherent value of the property, to allow development of the new building along the most desirable lines and to secure the full service life from the existing buildings and telephone equipment representing in all an investment of close to $4,000,000.

Preliminary Work

To prepare for the move, a considerable amount of preliminary work was necessary in the form of wrecking relatively small buildings on the property, driving steel sheet piling to hold up the embankments along the streets and underpinning the adjacent Lincoln-Riley building in which is located local telephone equipment. Also, to maintain connection between the main entrance and the sidewalk, a movable steel and concrete bridge, shown in Figures 4 to 10, had to be constructed. One end rested on the floor of the building vestibule entrance and the other was supported on rollers near the sidewalk. Arrangements were provided also for continuing in service the fire escape at the rear.

Temporary provision was made on the first floor for the mechanical and electrical house service equipment. The heating boilers which were used as a reserve for outside central heating service and which were located in a sub-basement occupying a small area at one corner of the building were removed and the lower level was built up solidly to the elevation of the rest of the basement. Provision for these boilers did not have to be made in the new location as this reserve will be cared for in the new building. Following this the floor and the walls, as well as the fireproofing on the columns in the basement, were removed. With this space cleared out, except for piping on the ceiling, the entire area over which the building was to move was excavated to a depth of about 21 inches below the level of the basement, and foundation footings were placed in the new locations.

Trackage and Bracing for Building

The next step was to provide for the system of trackage. For this a reinforced concrete mat, generally six inches thick, was placed over the entire ground area upon which the building would travel and laid level with the top of the footings. While the underlying gravel provided very firm bearing conditions, the mat furnished a rigid flat base for distributing the concentrated loads during the moving operation and insured a level surface for laying the tracks and rolling the building. On top of the concrete mat 6-inch x 8-inch timbers were laid similar to railroad ties to act as a cushion and to help distribute the weight. They permitted any slight unevenness in the thickness of the mat or in the height of the rails to be taken up as the building loads rolled along. Across the timbers railroad rails, used ones obtained for the occasion, were laid close together generally without spiking, as there was no tendency for the rails to move under the heavy loading and slow steady movement. Both the timber and the track arrangements can be seen in Figure 15.

As means for lifting and supporting the weight of the building, brackets formed of I-beams were riveted to the 59 columns and under these brackets were placed two layers of heavy steel beams extending in two directions. Some of this bracing can be seen in Figures 2 and 3. All of these steel members were rigidly fastened and tied together to resist any possible twisting strains. The use of wood for structural bracing was avoided for fire protection and other practical reasons.

With the mat and trackage in place and the steel supports and bracing fastened to the columns, the building was ready to be lifted the ¼ inch required to permit of sliding the rollers and steel bearing plates or shoes under the supporting beams, all of which are illustrated in Figure 3. The longer columns which had extended to lower levels because of the sub-basement boiler room previously referred to, were burned off at a point

FIGURE 4. As the building appeared on October 14 ready for the move to start.

FIGURE 5. On October 18 the structure had reached the end of the straight move.

FIGURE 6. October 25 showing curved walk in place. The building turn has been started.

FIGURE 7. By October 28 the turn of the building was becoming quite apparent.

FIGURE 8. Two days later on October 30 shows one-third of the turn completed.

FIGURE 9. On November 1 the structure had moved around to the half-way point.

THE FIRST STAGES OF THE MOVING OPERATIONS.

FIGURE 10. November 4. The front face of the building has now disappeared from view.

FIGURE 11. By November 6 only one-quarter of the right-angle turn was left.

FIGURE 12. November 8. The rear of the building begins to show in this picture.

FIGURE 13. November 11. Next to last day and only a few feet to go.

FIGURE 14. On the afternoon of November 12 the building move had been completed.

FIGURE 15. Pulling cables, trackage and arrangements for public to view operations.

THE SECOND HALF OF THE TURNING MOVEMENT.

above the tracks. The rollers were 3-inch solid steel shafting 30 inches long. The bearing shoes were made up of four short lengths of railroad track laid between two ¾ inch steel plates about 2 feet x 4 feet in size, the bottom plate being bent upward at the ends to facilitate feeding in the rollers.

The building was raised by 100-ton ratchet screw jacks placed under the upper layer of beams. It was not practicable to lift all of the columns in one operation and they were accordingly handled in groups of four to six at a time. The rolling equipment was placed under the lower layer of beams and the cast iron bases supporting the bottom of the columns were slid out from under them. The jacks were then released transferring the loads to the rollers. This operation was repeated until the entire building had been freed and placed on rollers.

It might be interesting to note here how the column loads, which amounted for the largest ones to 250 tons and which were supported on four sets of shoes and rollers, were distributed over the tracks. Each of these sets carried one-quarter of this total load or about 64 tons. This was spread over eight rollers, each of which rested on an average of four rails resulting in a pressure on a rail of about two tons under each roller.

Moving Operations

In pushing the building on the first straight move eighteen jacks, each handled by one man, were used as shown in Figures 2 and 3. The jacks, although rated at 100-tons capacity, were operated to exert a force of only about 10 tons each or a total of approximately 180 tons. This was equal to a little over 1½ percent of the total weight of the structure. The relatively large number of jacks was adopted with the view of distributing the forces evenly along the length of the building and of balancing the pressure with respect to the steel bracing on either side of the columns.

The jacks were braced against timbers clamped to the tracks and projecting over to the steel sheet piling and retaining wall at the street as indicated in Figure 2. Reblocking was necessary for every twelve inches the building moved, this being the limit of travel of the jack screw. As an idea of the speed of operation, at the sound of a whistle the jack handles were moved back and forth six times through an arc of 90°, this taking about half a minute. The men rested about another half minute and then the whole operation was repeated. For these six strokes the jack screws and the building moved 3/8 inch. By counting the number of strokes and by judging the amount of resistance offered in operating the jacks, the men were able to determine with a fair degree of accuracy the amount of pressure being applied and were able to maintain a very even distribution of the pushing forces. As a safety factor the bracing between the columns provided insurance against any possible twisting effect from unbalanced forces, and also frequent check-ups were carefully made on the alignment of the structure and supports as an additional precaution. The distance of 52 feet for the first straight move was covered in four days, October 14 to 18, this being illustrated in Figures 4 and 5.

At this stage of the operation, a steel and concrete curved temporary walk shown in Figures 6 to 14 was constructed to maintain sidewalk connection with the bridge entrance during the turning operation.

As soon as the building had been rolled to its farthest point south, the work of raising it again to change the position of the shoes and rollers was started. This step, which was similar to the first one of placing this equipment, was completed in four days and then the building was ready for the turn into its final position. The procedure was to rotate the structure around a pivot point near the rear inside corner of the building which is indicated in Figure 1. The engineering features involving the layout of the tracks and ties as well as the guiding lines, and establishment of the pivot point formed a very important part of the project. The pivot point had to be so located that the building might be rotated about it exactly into its final position. Lines radiating from this point were painted on the rails as an aid in setting the shoes and rollers which were required to be parallel with them. Some of these lines can be seen in Figure 15. Other marks were placed on the rails to indicate at all times the direction in which the structure was to travel. With the radiating lines determining the position of the rollers and with the requirement of having the rollers pass over the rails at an angle of not less than 45°, it was possible by anticipating these conditions to arrange the track layout in advance so that it would be unnecessary to change any of the rails after they were once laid.

The horizontal force for the principal part of the turning movement was provided by ten jacks pushing on the south side of the building and two sets of tackle blocks pulling on the north side using stranded steel cables operated from separate drums on a stationary steam engine. The pulling arrangements are shown in Figure 15. The strain required on each single line to keep it taut, with the jacks also pushing, was not over three tons. This six-ton pull for the two lines was multiplied through the six-sheave tackle blocks to about 72 tons total force. The ten jacks pushing on the opposite side of the building developed in the order of twice this force, making a total of something over 200 tons. These force agencies easily moved the building with margin to spare and permitted a more satisfactory rate of speed during the turning than could have been obtained by the use of jacks alone. By using both jacks and cables it was possible to obtain a movement which measured on the arc traveled by the farthest front corner of the building amounted to 10 to 17 feet per day. The total distance at this point traveled on the turn was 224 feet, and this was covered between October 23 and November 12, or seventeen working days. The building turn is illustrated in Figures 6 to 14.

As a result of the careful preparations in the track layout and guiding lines, the building in moving never varied more than about one inch from the predetermined path. This variation when it occurred was immediately corrected by changing the angle of the rollers slightly either in setting them as they were fed under the shoes or by tapping them with a hammer while they were under the shoes. During the last few feet of travel, the building was steered over the guiding lines with extreme accuracy to the exact position desired.

The smoothly applied forces and the slow, easy motion of the building could not be felt by the occupants and was imperceptible to the eye. The only way it could be detected was to line up some object and check the relative change in position from time to time during the day. Even with the rollers, the movement was so gradual that it could be realized only after a close-up inspection of them.

No damage to the building, even of a minor nature, resulted from the move and the structure was in the same sound condition at the end as it was before the move started. A few small cracks in interior partitions appeared as the columns were lifted in groups during jacking operations, but these as a general thing closed up as the whole building was brought back to an even bearing. During the rolling operation there was no apparent change in the condition of these cracks.

Unloading of Building from Rollers

With the building in its final position on the lot, the reverse of the original procedure of jacking up groups of columns was followed progressively until the building had been lowered to its permanent foundations. This last operation, involving the preparation of the new column bases and the lowering of the structure, required about a month to complete.

Certain columns which will be adjacent to the new structure are now being underpinned to the new building subgrade, and this work, together with the restoration of the walls and house service equipment in the basement, is expected to be entirely completed in February.

Engineering and Contracting Personnel

The work was planned under the direction of the Engineering Department of the Indiana Bell Telephone Company in co-operation with the Operation and Engineering Department of the American Telephone and Telegraph Company. Vonnegut, Bohn and Mueller, Indianapolis, were the architects. The consultants were Voorhees, Gmelin and Walker, Architects; Moran and Proctor, Consulting Engineers, for foundations; H. G. Balcom, Consulting Engineer, for the structural steel design, all of New York, and Bevington-Williams, Inc., Indianapolis, Consulting Engineers, for the mechanical and electrical services.

The general contractor was Leslie Colvin of Indianapolis. The contractor for moving was John Eichleay, Jr., Company of Pittsburgh.

Because of the weight and size of the structure and due to the restricted area available for turning, together with the necessity of continuing normal operations within the building—including the regular business office activities with the public and uninterrupted maintenance of telephone service—this project introduced many problems new to the building moving art.

The wholly successful result—accomplished without even a minor mishap—is clear evidence of the ingenuity and precision with which the plans were conceived and made and of the skill and orderliness with which all the operations were carried out.

Vance Oathout
W. H. Harrison

The Methods of Industrial and Business Forecasting

Extract from Paper Presented at Dedication of the James Ward Packard Laboratory of Electrical and Mechanical Engineering, Lehigh University, October 17, 1930.

ONE approach to the matter of business forecasting methodology is through a consideration of the source from which the universal need for such forecasting arises. Why is it that business forecasting is so unavoidable? The answer to this question is, happily, a simple one. Forecasting is necessary because the modern economic system with its related social order is highly dynamic in character. What we usually call the economic machine is, in effect, a living organism which has much in common with the characteristics of living organisms in the animal and vegetable kingdoms. Conditions in the sphere of economic life are constantly in a state of flux. Change is ever in progress in markets, in sources of supply, in prices, in business organization, in methods of production and distribution, in habits of consumption—to name only a few of the elements of economic existence which every business man recognizes. And behind the outward and visible change in such elements as these, a process of modification is continually taking place in economic relationships, in ethical standards, in political beliefs, in social customs, morals, and ideals, and in all those fundamental and frequently intangible forces which wield an influence over the destinies of the human race and all its institutions. Moreover, these changes do not occur in a steady uniform flow. On the contrary, they come and go, they vary in intensity and in radius; they may be continuous, discontinuous, or periodic. In the case of any business institution, the objective of forecasting is to discern these prospective changes, to appraise their probable importance, and to translate them into estimates, plans and policies relating to the future operations of the particular enterprise.

The Nature of Forecasting

Many persons seem to regard business forecasting as a species of black magic. As a matter of fact, of course, the processes of business forecasting are in no way mysterious. But it is true that these processes cannot be reduced to any rigid formula or series of formulas which can be expounded in fairly concrete terms. Unfortunately, forecasting in the business world may still be more of an art than a science. Moreover, the forecasting needs of some enterprises are radically different from those of others. In the case of many merchandising establishments, for example, the prime need is for short term forecasts covering the period required for a single turn-over of their stocks, whereas in other lines of business the emphasis naturally falls upon forecasts covering far longer periods. Accordingly, forecasting methods which may be appropriate and adequate for some enterprises may be wholly unsuitable for others. These methods tend to vary from industry to industry and from concern to concern, depending upon the character of the industry and the position of the individual concern within the industry. The methods actually employed must be closely adapted to the particular needs of particular organizations. In short, while the need for business forecasting is universal, the methods involved in such forecasting are almost infinitely varied and should never be purely mechanistic.

Under this set of conditions, the present discussion must be confined to methods applicable to the forecasting work of the larger industrial and business organizations; and it can do no more than suggest the general character of these methods. These suggestions, however, will be derived from the actual experience of an organization which does not have merely a hypothetical existence. This organization is the American

Telephone and Telegraph Company and its associated companies which together comprise the Bell System. Moreover, the nature of the telephone business is such that its experience in the field of forecasting has necessarily been exceptionally wide and, perhaps, exceptionally significant. As a business whose assets consist almost wholly of fixed and immobile property which does not "turn over" in the ordinary commercial sense of the term, long term forecasts are vital to the determination of the quantity, type and location of plant and equipment required to anticipate future demands for service in the most economical manner. As a business which touches the economic processes of the nation at every point, forecasts of the probable fluctuations in economic activity over short periods in advance are helpful aids to the preparation of short term budgets and operating programs. Finally, as an institution devoted to public service and intimately associated with the social life of the people, the Bell System must anticipate in its policies social as well as economic changes, both temporary and permanent.

As we see it, there are two classes of business forecasting: long term and short term. The line of demarcation between the two classes may not be especially well defined; and of course the differentiation between them will tend to vary among different types of business enterprises. But we are disposed to establish the distinction because the specific objectives of each class, and the methods required to meet these objectives, are essentially different from those of the other. In general, long term forecasting may be described as comprising those processes of intelligent prevision which are necessary, first, for reaching sound conclusions in respect of such matters as the fundamental rational status of the industry in economic society and the average level, or rate of growth, of business volume which is consistent with that status; and, second, for the development of progressive business policies which are in tune with prospective economic and social trends. Short term forecasting, on the other hand, comprises those processes which are necessary for the determination and measurement of the prospective changes in economic and social behavior which are likely to be ephemeral in character, and for the formulation of those temporary plans and practices best adapted to adjusting the particular business to these transitory conditions. Even more briefly, long term forecasting is concerned primarily with the persistent trends of economic and social progress and with the associated long term planning of business concerns; while short term forecasting is concerned primarily with seasonal fluctuations and with the more or less periodic and rhythmic, semi-rhythmic or quasi-rhythmic deviations of economic and social phenomena around their lines of seculiar trend. These observations, I realize, are far from profound. I have ventured to present them, however, because it is apparent that great confusion exists in the public mind as to both the scope and the nature of those excursions into the realm of the unknown to which the term "business forecasting" has recently been applied.

Long Term Forecasting

In discussions of forecasting, its objectives and its methods, the emphasis is usually laid upon the class of short term predictions and estimates, almost to the exclusion of consideration of long term forecasts. I intend to violate this tradition by stressing the value of the longer look ahead. In my judgment, the accurate forecasting of basic economic and social trends is of vital importance to sustained progress on the part of business organizations; for constant vigilance must be exercised in order that fundamental business policies may be progressively modified to accord with the spirit motivating those trends which are persistently, though perhaps unobtrusively, tending to refashion the structure and the character of contemporary civilization. Business men generally should recognize that the present economic regime, even though it has produced the greatest advance in material welfare in the history of the world, is still far short of perfection; indeed, it may not permanently survive unless business leaders are sensitive to basic trends in the economic concepts and in the social aspirations of our people. The tides of human behavior are just as important as the waves of passing fancy; and the two should not be confused.

There are two methods of approach to the problem of long term forecasting. Purely for purposes of present convenience, one of these methods may be called the quantitative, or statistical, method; the other, the qualitative, or philosophical, method. The two are not independent or alternative methods, however; on the contrary, they are distinctly complementary —so much so that it may safely be said that united they stand, divided they fall. In fact, while investigations along the two lines of approach have long been carried on simultaneously, it has only been since there has been collaboration between the mathematical statistician and the realistic economist that rapid progress has been made in the development of an adequate foundation for forecasting procedure.

The essence of the quantitative or statistical method is the collection of significant periodic, usually annual, data descriptive of various pertinent elements of economic life over a reasonably long term of years in the past; and the application to these data of statistical methods of analysis which will yield a quantitative measure of their characteristic behavior as to growth or decline. In other words, after ascertaining those series of economic and social statistics which are most significant and useful for the purposes of the particular forecast, the secular trends of these series are determined. These trends, it is clear, will reflect the net effect upon the series of the interplay of economic and social forces up to the current date. Under this method a forecast of the probable future trend of any series may be made merely by a simple projection of its current trend line. Through the application of the same statistical processes, the trends of elements within any particular business concern (such as volume of sales) may be statistically described and measured, the degree of correspondence with the trends of external economic factors may be discovered, and current trends may be projected with due recognition of any pertinent relationships which have existed between internal and external data.

The question of the extent to which this method can profitably be employed by any particular business organization in the analysis of the trends of economic factors and of internal operations for forecasting purposes is, of course, one which can be decided only in the light of the type and character of the organization. The general question, however, is competently discussed in the bountiful crop of statistical textbooks which have matured in recent years; and these texts also explain the details of the statistical processes which this method embodies. It is not my purpose to compete with these excellent texts. But it may be appropriate to call attention, parenthetically, to the fact that practical experience shows a reasonable knowledge of statistical technique to be an essential part of the equipment of the potential forecaster in any line of business.

It is obvious that any objective extension into the future of current trends, no matter how carefully these trends may have been measured, will be fully significant only if the forces which have affected them remain unchanged in number and in relative intensity. The statistical approach might be adequate in itself under static conditions. But in a dynamic society the forces of development and progress do not remain unchanged. This provides the cue for the entrance of the philosophical method as a means of interpreting the statistical measurements and of furnishing qualitative descriptions of the changing currents in the economic stream.

This method presupposes in the forecaster a reasonable degree of understanding of the complex structure of the current economic and social order, and an insatiable curiosity to discover logical explanations for the action and interaction of the many forces and groups of forces constantly at work to produce change. It assumes an innate flair for the detection of those undercurrents in economic behavior which are not visible on the statistical surface of the stream, and a keen sensing of the advent and the potentialities of new forces as yet in embryonic stage. Under the method, economic processes are continually under quasi-microscopic observation; and the observer must be alive to the silent but relentless evolution in popular tastes, habits, ideals and objectives which is characteristic of a progressive people and an advancing civilization. Cultural values, as well as economic values, must be appraised. In a word, the philosophical method provides the means whereby the projection of statistically-determined trends may be tempered and modified to allow for the probable influence of factors and forces which cannot be statistically described or measured. The fact that the probable effects of such forces are not expressible in quantitative form in no way lessens the need for their consideration. Indeed, a proper recognition of the existence of these intangibles and semi-intangibles is essential in the formulation of policies and in the provision of sufficient flexibility in the long term plans of business organizations.

The importance in business forecasting of an informed appreciation of the character of economic processes and a high degree of sensitivity to the significance of economic movements is not, in my opinion, adequately emphasized in the ordinary textbook which gives reluctant attention to the subject. Consequently, it is perhaps not surprising to find the existence of a fairly widespread belief that forecasting methods can be expressed in mathematical terms. I am firmly convinced that one cannot learn all about the future merely by turning the crank of a computing machine. There is no mathematical substitute for sound economic judgment based upon economic knowledge and economic intelligence. It is through the exercise of powers of philosophical reasoning, rather than through the concoction of ingenious mathematical equations, that American business management must adjust its fundamental policies, whenever necessary, to keep pace with the progress of a developing civilization reflecting the popular conception of economic, as well as political, democracy.

To my mind, a knowledge of those economic and social movements which have led up to our present economic structure and a thorough *understanding* of the significance of these movements, are exceedingly helpful in providing a background against which the significance and the potentialities of contemporaneous movements may better be assessed. I am not one of those who adhere to the belief that history is meaningless. On the contrary, I have no hesitation in entering upon the record a few words of modest praise of the study of the economic and social history of older communities and of the more modern business annals from the time, in the 15th and 16th centuries in western Europe, when business began to assume a position of dominance in the direction of the course of civilization,—a position which has grown stronger as the centuries have rolled by. In those days business men still constituted only a small minority of a population which was overwhelmingly agricultural; but by the time the first settlers came to America, the upward surge of the commercial revolution had already delineated the fundamental elements of a complex "money economy" or "business economy" in which the economic motives of the community are dominated by the making and spending of money. The succeeding development of this economic system is not only a fascinating study, but one which is useful to the business forecaster. History still deserves an honored place in educational curricula.

Short Term Forecasting

The problem of short term forecasting has received more public attention than has the problem of long term forecasting. This situation is primarily due, I suspect, to the fact that the short term outlook is usually a matter of immediate and often of pressing importance, whereas speculation as to the long term trend of business can always be deferred until tomorrow and may not be needed at all in certain types of mercantile enterprises. If month after month and year after year, business invariably advanced steadily and uniformly along a measurable line of secular trend, a forecast of this trend would serve all purposes. But unfortunately for the forecaster among others, business progress is characterized by recurrent periods of accelerated and retarded growth. These alternating periods constitute that sector of economic dynamics which has come to be known as the "business cycle." In certain circles controversies may rage over the suitability of this term. But the business man is wholly indifferent to the niceties of nomenclature. He merely knows that no matter how stable his business may be, it will undoubtedly experience some degree of quasi-rhythmic fluctuations; and he wants reasonable advance notice of these movements—even though he may not act upon this notice when he receives it. I assume that we, likewise, are not interested in questions of terminology on this occasion. What we want to consider is the major question of how these cyclical fluctuations can be forecasted and anticipated.

Again I must be the bearer of bad tidings. There is no adequate mechanistic, rule-of-thumb, or lazy man's method of short term forecasting, if the subject is to be approached on anything like a scientific basis. As in the case of long term forecasting, there is need for statistical analysis and measurement on the one hand and economic interpretation and judgment on the other; but here the union between statistical processes and economic reasoning is so close and so indissoluble that they must be considered jointly in any discussion of the fundamental principles of methodology.

In these days of interdependent relationships in the business world, it may properly be assumed that any business organization, in appraising the near-term prospect for its own affairs, is first interested in forecasting the corresponding prospect for business enterprises as a whole. To be most useful, this forecast should be expressed in quantitative terms, just as future long term trends must be expressed statistically. For practical purposes, it is usually not sufficient to know that the outlook is "good," "fair" or "poor," since such linguistic symbols as these are overly vague and each of them is broad enough to cover a fairly wide range of possibilities. One of the unfortunate characteristics of many forecasts is the fact that they are couched in language which is reminiscent of the utterances of the Delphic Oracle. What the business man wants is as definite a picture as possible of the "balance of probabilities." Qualifications may be necessary, but they should be presented so as to clarify rather than obscure the main theme.

As one prerequisite to short term forecasting, the forecaster must have at his command a quantitative and up-to-date statistical index appropriately representative of the relative monthly fluctuations of general business activity over a fairly long period in the past. The type of index I have in mind is so well-known that I believe no specific description is warranted. There are a number of such indexes available to the business man, such as those prepared by the Federal Reserve Board and by a number of independent statistical agencies. Some business organizations like our own, however, prefer to construct an index themselves, since they thereby have full knowledge of its ingredients, its character and its idiosyncracies. The statistical processes involved in the construction of such an index are fully explained in recent textbooks. Through the application of these processes, we obtain an index reflecting the relative monthly deviations of business activity around its secular trend, deviations due to purely seasonal causes having first been eliminated. That is, the index reflects those movements of business which are primarily cyclical in character; thus it gives the clearest possible picture of past cyclical movements and of the stage in the latest cyclical movement which has been reached by business as a whole at the time the forecaster must go to work. It likewise aids in the interpretation of the results of statistical analyses of the cyclical movements of those economic factors which must be considered individually rather than *en masse*.

Such an index also assists greatly in the study of the phenomenon of the business cycle and of the forces which generate it. The more the forecaster knows about these forces—their character, their relative importance and significance, their sequence, and so on—the better is he equipped to understand and to interpret the current business situation from a cyclical point of view. And I believe that we are making substantial progress in our knowledge of cyclical behavior. This progress, moreover, is not due to the fact that the cycle is a product of modern industrial organization. The cycle is not a new phenomenon in the economic world. Persistent students have uncovered a cyclical trail back into the 18th century; and economic archaeologists have discovered unmistakable traces of the beast as early as the 16th century. Indeed, the further back one follows the history of economic activity, the more precarious does existence seem to have been. Rather has our progress in cyclical knowledge been due to the fact that only comparatively recently has sufficient statistical material become available to make it possible to vivisect the phenomenon. While theories of causation are still numerous and diverse, nevertheless we are no longer ignorant of most of the vital facts as to the results of the motivating forces, whatever these forces may be. This certainly not only represents substantial progress, but gives hope of continued progress in the future.

Study of the past oscillations of business activity above and below its normal trend of growth shows beyond peradventure of doubt that these cyclical fluctuations, while definitely wavelike in their contours, do not exhibit a high degree of periodicity in the mechanistic sense of the term. Nor are they uniform in character. Business cycles are clearly governed by economic laws, not by the laws of mathematics. They occur as a result of economic forces which themselves vary in intensity. Consequently, in forecasting cyclical movements of business it is absolutely essential to undertake a careful analysis of the relative importance of the particular forces in operation at the particular time. Knowledge of the current cyclical position, as determined by statistical measurements, is of immense assistance in this analysis. But a forecast of the future short term movement of any statistical index of business can be made only by the application of sound economic judgment based upon thorough analysis of all available pertinent facts bearing upon the probable influence of the various economic forces which are currently in operation. Here again, it may be remarked, the statistical procedure is indispensable as an aid to the analysis of individual economic factors and the study of their interrelationships.

The same general procedure is followed in making short term forecasts of elements within a particular business organization. First, the pertinent monthly data are statistically analyzed so as to isolate the movements therein which are cyclical in character. In order to determine the extent to which these movements are influenced by external factors, the cycles of the internal data are then compared with the cycles either in indexes reflecting business activity as a whole or in indexes reflecting certain lines of activity to which the particular business is especially sensitive. In view of the interdependence of business operations throughout the economic world, usually a degree of correspondence between internal and external cycles will be found which will permit a forecast of the prospective cyclical movement of the external index to be translated back into terms of the probable movement of the internal index. By applying this estimate of the cyclical movement to a projection of the trend and seasonal characteristics as previously determined in the statistical analysis, a forecast of the element in question is secured. This forecast may then be tempered, if necessary, by application of special knowledge relating to the plans or the characteristics of the particular business.

Conclusion

I want to associate myself with those who believe that a scientific approach to problems of business forecasting will contribute its full quota to the achievement of that greater steadiness in economic progress which is so devoutly to be wished. Forward-looking industrial leaders are recognizing that opportunistic action on the part of business institutions merely for the sake of temporary competitive gain must more and more give way to systematic planning of reasoned programs. The business statesman must supplant the business politician, if order is to be maintained in a world in which the economic machinery is becoming more intricate and the economic processes more interdependent as time goes on. One of the most important qualities of the business statesman, perhaps the most important single quality, is intelligent foresight; and, after all, business forecasting is merely a process of rationalizing this foresight. Taking business as a whole, it is probably true, as some critics assert, that the effect of business forecasting upon overall economic stability has not yet reached substantial proportions, though some beneficial effects are already clearly visible. But it is also true that the science of business forecasting is still in its infancy. It is an upstart among the older sciences. By careful and sympathetic nurturing, can we not confidently expect that it will develop and expand in usefulness as have other sciences? I can see no sound reason for doubt on this point.

S. L. Andrew.

Toll Conduit Construction on Private Property

Preface

THE toll conduit between Albany and Catskill, New York, recently completed, was installed largely on private property. Prior to the construction of this project the use of underground conduit had been confined generally to highways and city streets. Because construction across private property introduces problems in design, construction and maintenance not met in work along highways, it is felt that a description of the experiences on this project will be of value in planning and building underground systems of a similar nature.

This account of the various steps in design and construction includes much data already available since existing standard designs and methods were adopted wherever practicable. The new features are described in more detail. Pictures of various pieces of equipment and operations on different parts of the work are included.

Subway Study

At the beginning of the year 1929, two aerial cables, the "A" and "B" cables, were in service between New York and Albany. A third, the "C" cable, was constructed aerially as far north as Catskill in 1929. Growth studies made in conjunction with the Long Lines Department indicated that the "C" cable would be required between Albany and Catskill in 1930, and that subsequent cables would be required at approximately two-year intervals. After comparing available types of construction, it was decided to construct underground conduit to provide for the "C" and subsequent cables from Catskill to Albany. The decision as to the type of construction was based on the expected reduction of maintenance costs, the prospect of fewer service interruptions, and the right-of-way situation in this region. It was anticipated that if aerial construction were adopted, right-of-way would be difficult to acquire and would become increasingly so as each succeeding line was required. This situation was a very important factor in favor of underground construction.

Preliminary Route Survey

The general route follows the west side of the Hudson River valley through gently rolling country consisting largely of cultivated land and orchards with occasional small villages and hamlets. The soil is generally clay loam and clay, although the southern part of the project passes through considerable sedimentary rock which required blasting. At several points the line crosses swamps consisting of fine sand overlaid with muck.

Factors Affecting Selection

Preliminary trips over the proposed general route indicated that construction over private property rather than along existing highways was desirable. At the present time the only improved road along the route is rather circuitous and, in general, only 18 feet wide. The curves are frequently quite sharp. The Highway Department is planning to improve a route on the west side of the Hudson River similar to the high-speed highway recently completed on the east side, and major changes of line and grade were anticipated. At many places along the road rock is close to the surface, and substantial blasting operations would be required in connection with highway improvement work. It would be practically impossible to maintain a subway while highway construction operations were under way. Because of the present narrow road, construction of a subway in the shoulder would seriously interfere with traffic. Subsequent highway widening and realignment would undoubtedly throw some of the manholes under the driving surface, which would create a dangerous situation when the manholes were open for any new construction or repairs.

Aside from the construction difficulties which would attend the selection of a highway route, there were other factors tending to throw the balance in favor of construction on private right-of-way. Construction along the highway would have subjected the cable to exposure to a 66 KV transmission line which parallels the road for about 16 miles, whereas it was possible to select a route on private right-of-way that reduced this exposure considerably. Also, this permitted the construction of the conduit in practically a direct line for its entire length, thus shortening the line by approximately three miles as compared to the shortest highway route. This, of course, represents a substantial saving in present worth for the plant contemplated during the period of study. Furthermore, this reduction in length was of added importance, inasmuch as it might otherwise have been necessary ultimately to build an additional repeater station.

Preliminary office studies of the route were made on a composite map of United States Geological Survey sheets showing the area through which the line would pass. A tentative line was laid out for study in the field and trips were made to check the desirability of this line, keeping in mind at all times that all points along the route had to be accessible to motor vehicle equipment.

Detailed Survey

Aerial Photographs

Aerial photographs were also used in the preliminary studies of the route and in the right-of-way negotiations. These photographs presented physical conditions in more detail than the U. S. G. S. maps and also indicated improvements which had been made since the maps were last revised. They showed the objects which were to be avoided, fence and property lines, and the character of the land through which the proposed line was projected. At one point the photographs disclosed an abandoned railroad grade close to the proposed line. Investigation in the field showed that about five miles of this right-of-way was adapted to the requirements of the proposed line, and the tentative route was located to include this section.

The photographs, with the proposed line drawn upon them, proved of considerable value in later discussion. With their aid, property owners were shown how the line would cross their properties, and the important features of the route were pointed out to the surveyors. They also proved useful in condemnation proceedings.

Factors Affecting Location

The line was laid out with as few deviations from a straight line between the termini as was consistent with economical construction. However, various factors, physical and electrical, influenced the decision as to the best location. Exposure to potential electrical troubles caused the most important deviations. On the southern end of the project, the direct line route would have carried the subway parallel to a transmission line with very little separation between the two lines. Five miles of the tentative line was relocated to reduce this exposure. At other points along the line minor deviations were caused by the estimated inductive effects of proposed power lines and the possible electrification of a paralleling railroad.

There were many physical features which caused minor bends in the line. Some of these were natural, such as streams, swamps, rock and steep banks, and some were man-made, such as railroads, highways, and buildings. Crossings under railroad tracks were made approximately at right angles to the tracks. Streams and ravines were crossed on existing bridges or at sites where it was economical to build new structures. Swamps and rock were avoided wherever it was possible to do so with a slight relocation of the line. Steep banks, were crossed at points suitable for building and maintaining the duct line.

Ultimate Line of Subway

The final line consisted of about 8 miles of construction in city streets and along highways and 24 miles of construction on private property. The total length of the conduit line is approximately two and one quarter miles more than the airline distance between the cable vault at the central office in Albany and the cable house at Catskill, the termini of the project.

Right-of-Way Negotiations

Permits

Construction on private property required extensive right-of-way negotiations. Beside the actual right-of-way it was necessary to obtain various easements, permits for surveying, rental of storage space for materials, rights of entry to the conduit line through the various parcels, and permits for construction in state, town, city and village roads and streets, and for crossing railroads and attaching to existing bridges.

Right-of-Way

The right-of-way acquired consisted in a permanent easement to construct and maintain the various features necessary for the telephone project, the company being restricted to the uses mentioned. All other uses, not inconsistent with the rights granted to the company, were reserved to the owner. Rights were acquired for construction along highways where the fee to the center of the road was retained by the abutting property owner.

On private property the conduit line was laid along the center of a 20 foot right-of-way, the space on the sides being used for construction operations and to provide for future reinforcement. This width was sufficient when construction equipment could be driven over adjoining land but was too restricted when the use of equipment was confined to the area between the right-of-way lines, as it was in all cases where the property was condemned. A strip 25 or even 30 feet wide probably could have been secured for the same price as the 20 foot strip, as the major factor in determining the value of the strip was the effect of the presence of the easement on the salability of the property.

Rights of Entry

Rights of entry were secured along an existing traveled way or along a route suitable for trucking designated by the property owner. They generally cost about half as much per lineal foot as the right-of-way parcel which they served.

Condemnation

The preparation of petitions in condemnation required that title searches and surveys be made for every parcel involved. The searches were necessary to determine the parties having interest in the property, so that they could be included in the suit. The survey was required so that a plan could be prepared showing the crossing of the proposed line and the proposed route of entry. Detailed plans of the various construction features had to be included in the petition also. The preparation of the engineering features of each case required about three days work by two men. Progress reports were kept, showing the right-of-way acquired, on the basis of lineal feet of right-of-way, and the method of acquisition.

Duct Construction

Start of Work

Work in the city of Albany was started on July 29. Construction work on the rest of the project was started shortly thereafter. Working conditions on the rural sections were such that mechanical equipment could be used on about three fourths of the excavating and backfilling. In all, five trenching machines, five mechanical backfillers, and three types of excavators were used.

Duct Work

With the exception of two cases of special bridge attachments and one case of steel pipe placed on a steep bank, all described in detail later, vitrified clay conduit was used throughout the project. The tile was hauled by truck to practically every point on the line, the loads being reduced when the hauling was too hard. Only standard lengths were hauled and stocked in the rural sections, the short and special pieces being secured when required. The other materials used in the duct work were standard, with the exception of the forms and covers used in making the joints.

Protection

Wherever soil conditions were favorable no top or bottom concrete protection was placed where a 2 foot cover was secured as it was felt that the danger from excavation was too slight to warrant the placing of protective concrete and a satisfactory bed could be secured without the use of a concrete base. However, concrete top and bottom protection was used through cities and villages and wherever the conduit line was within 100 feet of a highway. The concrete used was of 1:2½:5 mix and was kept rather dry (about 1 inch slump). At all points where less than 2 foot cover was secured, concrete top protection was used.

Special Construction

Swamp Crossings—Fills

Through swamps and across ravines, the conduit was generally placed upon fills made of suitable local material. The decision as to whether the conduit would be placed underground or on a fill was affected by various considerations. The accessibility of the duct line and the assurance of positive drainage were the principal factors supporting construction on fills in most cases. Construction on fills was expensive because not only was the fill material required, but also forms had to be set and concrete protection poured around the conduit. Generally, some sort of drainage structure had to be built also, to carry the natural surface drainage through the fill. Where underground construction would have been as satisfactory, comparisons of costs of the different methods were made. At some points cost considerations were not a factor, as underground construction would not have been satisfactory because of the impossibility of draining the ducts.

The fills were made 10 feet wide across the top, with 1½:1 side slopes. Fills greater than 3 feet high required a wider right-of-way or a reduction of the top width. Both methods were used with satisfactory results. The fills were placed in thin layers and thoroughly compacted, as time was not available to allow them to settle. In two cases suitable local material was not available so screenings were secured from nearby quarries and used in the fills. This material is apparently satisfactory, but few of the fills have been subjected to erosion as yet, so no definite experience can be cited. The possibility of using trestle construction, consisting of a concrete slab resting on concrete piers was studied but it was found that this method would have been economical only where the height of fill exceeded four feet. This type of construction could have been adapted to crossing ravines but suitable footings might have been difficult to build in swamps.

Culverts

Vitrified clay pipe and concrete culverts were used to provide drainage through the fills, the type depending on the relative

FIGURE 1. Fill placed where route traverses swampy land.
FIGURE 2. Sewer pipe culvert under conduit on fill.
FIGURE 3. Concrete culvert under conduit on fill.
FIGURE 4. Manhole partially above ground (exterior view).
FIGURE 5. Manhole partially above ground (interior view).
FIGURE 6. Piers for conduit bridge.
FIGURE 7. Steelwork for conduit bridge.

FIGURE 8. Forms for concrete encasement of conduit bridge.
FIGURE 9. Conduit bridge completed.
FIGURE 10. Forms and reinforcing for encasement of conduit structure placed above ground.
FIGURE 11. Conduit structure on fill.
FIGURE 12. Conduit structure on fill, showing drainage culvert
FIGURE 13. Manhole marker on private property.
FIGURE 14. Manhole marker at side of highway.

costs and the requirements of the site. No head walls were used on the pipe culverts as the height of the fill was generally low and it was cheaper to extend the pipe to the points where the slopes of the fill met the normal ground. Concrete culverts proved more economical than the larger sizes of pipe. The former were used for sites where a waterway greater than that afforded by a 24 inch pipe was required to carry a stream through a fill. Span lengths of 6, 8 and 10 feet were used depending on the location and waterway requirements. The design consisted of a reinforced concrete slab resting on two concrete abutments. The abutments were designed with wings to retain the fill. The conduit was laid on the slab with a mortar bed and encased in concrete. Footings were carried to a depth sufficient to avoid erosion and frost heave. Where the duct line drained to the culvert, weep holes were left in the slab to carry off the water. These functioned satisfactorily at normal temperatures, but during prolonged cold weather ice formed in the weep holes. This resulted in the water backing up in the ducts and subsequently freezing. To remedy this condition intercepting drains were installed in the banks on either side of the low spot. These drains consist of a stone pocket under an open joint in the tile. Where practicable, an 8 inch vitrified pipe is installed to drain from the pocket to an outlet.

Where manholes were required in sections where the conduit was laid on a fill, the design was modified to provide for pulling-in through the end of the manhole by constructing a pressed steel coal window in the ends above the ducts. Recesses were constructed in the end walls of the manholes. The manhole walls were carried through the fill to bearing on a substantial footing built in the original ground.

Conduit Bridges

At six points along the line where small streams had to be crossed, studies were made to determine the most satisfactory method of crossing. The costs of wrought iron pipe, steel pipe encased in concrete and a concrete and steel trestle structure were studied and the concrete and steel structure seemed most economical and assured drainage of the duct line. Special conduit bridges were designed to carry the line across these streams. These structures were constructed of steel channels and angles encased in concrete for protection. Beside the dead load, the designs provided for a live load consisting of one cubic foot of ice per foot of span. The structures were so designed that the entire weight was supported by the steel, the only function of the concrete encasement being that of protection to the steelwork and duct, and affording also a somewhat more sightly structure. The bond between the spans and the piers and abutments was broken so that only vertical stresses could be transmitted to the supports. The normal section of tile conduit was carried through in each case. Span lengths varied from 10 to 40 feet.

Comparisons of costs were made for these and longer spans. On one structure, during the time between the design and the construction, the water level rose so that the span length required to keep the piers on dry land was increased from 42 to 55 feet. The possibility of building a longer span and keeping the piers on dry land was investigated but it was felt that constructing the shorter span with the piers in shallow water would be more economical. The designs of the long span structures required material which was not available locally. They were revised so that material from local shops could be used because steel deliveries in Albany were uncertain. These revisions consisted in riveting heavier angles on the channel beams and riveting plates on the vertical leg where angles were used for the beams. Longer spans would have required the use of built-up members involving special erecting equipment.

No particular trouble was encountered in building the special conduit bridges across the various streams. The structures were constructed eccentric on the right-of-way, the center line of the structure generally being parallel to and five feet away from the center line of the right-of-way strip. The duct line was brought back to the center line on a long radius curve. The object of moving the structure away from the center line was to allow sufficient space for the construction of a temporary bridge beside the structure. (On a wider right-of-way this, of course, would not have been necessary.) Piers and abutments were constructed to the proper designs and elevations at each location. Where the heavier steel members were required, a gin pole was used in their erection. The steel members were trucked as close as possible to the bridge site and then dragged to the site by tractor. Forms for encasing the steel work and conduit with concrete were generally suspended from the steel beams. Encasement concrete was of 1:2:4 mix using one-half-inch stone to reduce the tendency for honeycombing to form. Care was required in tamping the concrete into the recesses under the channel flanges but the remainder of the concrete was easy to place. All exposed surfaces were floated with a wooden float immediately after stripping the forms, in order to remove form marks and rough places.

Drainage Provision

Drainage of the duct lines was provided for in laying the grade lines on the profiles. Subsequent changes in the manhole locations threw two low points in the duct line. A pumping sump consisting of a concrete box with 6 inch walls, floor and roof, was constructed at one of these points. The inside dimensions were 4 feet x 4 feet and it was carried to a depth of 1 foot below the bottom duct. It was equipped with a type "B" 27 inch manhole frame and cover, so that a man can get in and clean out any silt which might wash through the tile and be deposited in the hole. At another point, a stone drain and outlet pipe was placed at the low point in the duct line. Such conduit drains were used only where a positive outlet could be secured as it was felt that without positive drainage a rise in the water table would cause water to flow from the drain into the duct line.

Complete Encasement

Where there was less than 1 foot cover, or where the conduit was exposed, it was completely encased in concrete. This encasement consisted of a 4 inch concrete base and 3 inch sides and top. Where the conduit was in a trench, no forms were used for the encasement. When the conduit was even with the ground or on a fill a trench was dug for the concrete base and side forms were used. One-half inch reinforcing bars were placed in the base to prevent any local settlement of the fill from affecting the duct line. Wire mesh 6 inch x 6 inch x 14 gauge was also placed in the base and around the tile to help hold the encasement in position. A 1 inch chamfer strip along the top of the form was used to furnish a guide for smoothing off the top. This chamfer also decreased the possibility of spalling along the top edges. Concrete for the encasement was of 1:2:4 mix using ½ inch stone. The use of larger stone was tried but it was found too difficult to avoid honeycombing. The exposed surfaces were floated immediately after stripping the forms and defective places were patched.

Provision for expansion was made in most of the concrete encasement on conduit built above the ground. Two types of expansion joints, poured and premolded, were constructed and some short sections of encasement were constructed without joints. Cracks about 30 feet apart have appeared in the latter sections but, as the cracks are small, no serious trouble is anticipated. In both cases where joints were provided they were made only in the concrete encasement, it being felt that, if sufficient stress develops, the bond between the concrete and the section of tile spanning the joint will be broken and the expansion joint will function. Three-quarter-inch premolded expansion material was used for one set of joints. This material was placed to form a transverse joint through the concrete every 30 feet. In the case of the poured joints, wooden bulkheads 1 inch thick were placed in the concrete 30 feet apart. These were pulled after the concrete had set, leaving a break in the encasement. These spaces were then filled with bituminous mastic joint filler.

MANHOLES

Designs

Manholes on the toll run are so designed that no cable will have to be moved after splicing. This feature seemed so desirable that a study of the possibility of splaying the ducts entering the manholes was made soon after the work was begun. The results indicated that because of the special features involved in the construction of this project the costs of splaying would be abnormally high and that the operations would progress much more slowly. In view of this, no splaying was used. The racks are set out from the wall to permit the splicer to make the splice without moving the cable out from the wall. Also, the cables are to be racked on 12 inch centers.

Loading Manhole Excavation

Loading manhole excavation was done by machine. In most cases the holes were carried to a depth of about 15 feet. Sheeting was used on all of them. A three-fourth-yard excavator, equipped as a clam shell, was used on the northern end of the job. The machine dug the center of the hole and hoisted the material removed from the sides. In the city of Albany it was emptied directly into trucks so that double handling was avoided. Material around the sides of the hole had to be removed by hand, and shovelled to a position where the bucket could reach it. A three-eighths-yard crane was used on one contract and a small shovel equipped as a trench hoe on another. These machines were better adapted to the work than the clam shell because of their smaller size and greater ease of handling.

Line Manhole Excavation

Line manhold excavation was done by hand throughout the job as the holes were not big enough to allow a machine to operate. The trenching machine was used to dig a few manholes, but because of the demand for it in opening trenches, it was available for manhole work only a small part of the time. Sheeting was not, in general, required on these manholes but shoring was used on about one-half of them.

Pouring

Two systems of pouring manholes were used. On the two northern contracts mixers were set up at central points and the mixed concrete was hauled to the manhole sites. On the two southern contracts mixers were set up at each manhole site. The use of the central mixing plant was very convenient in the city work as it reduced the amount of street space necessary for the construction operations. The setup in the city was used for all the work on this contract and about three miles on the northern end of the next contract. One other setup was used to complete the remainder of the second section. The maximum haul was about six miles, most of this being over improved roads. The concrete and mortar were generally hauled in special trucks consisting of hopper bodies mounted on Ford chassis. Mortar was not seriously affected by the haul but segregation appeared in the concrete, especially in the wetter mixes. This was corrected to some extent by dumping the trucks into a receiving hopper and shoveling from the hopper into the forms. The concrete was remixed by hand where the segregation was too great. Some type of agitation would have been preferable for use on the extreme hauls over rough roads. Extreme segregation occurred in only a few cases but remixing by hand gave fairly satisfactory results.

Marking

One concrete marker was set along the side of the manhole opposite the manhole cover at all manholes on private property. This marker was set with one face parallel to the side of the manhole and with about three feet exposed. The manholes were numbered consecutively from Albany to Catskill with an additional serial number for each loading manhole, the pulling-in of the cable being started at the Albany end with cable reels numbered in the order in which they would be placed. The manhole numbers were stenciled on the concrete markers with standard black stencil paint using 2½ inch stencils. Where the conduit was laid under the shoulder of a highway, one marker was set on the right-of-way line of the highway opposite the head. Numbers for manholes in these locations were stenciled on this marker. On the manholes under streets the number was stenciled on the side of the roof opening under the cast iron frame.

Equipping

Manhole frames were drilled and two anchor bolts, set in the roof of the manholes, were used to hold the frames in place during pulling-in. The anchor bolts were omitted in manholes in the city where covers would be secured by sidewalks or pavements. Where manhole heads were located in highway shoulders close to the pavement a concrete ramp was constructed to prevent erosion of the surrounding soil from leaving the head extending above the surface. These ramps consisted of a 5 inch concrete slab with one edge level with the edge of the highway and the other edges curved down beneath the surface of the shoulder. A mason and helper, following the gang stripping forms, laid the collars and set and bolted the frames in place. The racks, loading manhole decks and manhole markers were set in connection with rodding the ducts, to reduce the number of times the manholes had to be pumped out.

Winter Construction

Construction work on the project continued until the end of January and cold weather proved a serious drawback to the work. The frozen ground was much easier to haul over than the mud but this advantage was not appreciable as most of the trucking had been done earlier in the season. The tile froze to the ground, both in the storage yard and along the job. When pried loose, clots of frozen mud stuck to the sides and had to be chipped off. Motor equipment was hard to start on cold mornings and many small delays were caused by the inability to start the trenching machine or trucks. With 15 inches to 18 inches of frost in the ground the trencher would not handle the excavation. Unslaked lime was spread along the trench about 2 inches thick and covered with straw. In slaking, the lime developed enough heat to draw the frost from the ground for 6 inches to 8 inches and the trencher was able to handle the rest of the frozen ground. Heavy sod and the cinder ballast on the railroad grade prevented the frost from penetrating as deeply as it did in open fields. A compressor or steam jet probably would have been required had the ground been frozen to a depth of as much as two feet.

Concreting operations were made more difficult by the cold weather and greater care was required to secure a good job. The aggregates were heated by fires built in cans in the stock piles. These were not very efficient in heating the aggregates but prevented lumps of frozen sand from getting into the mixer. Mixing water was heated in all cases and admixtures either of salt or calcium chloride were used where the use of such admixtures was consistent with the purpose for which the concrete was used. Where the central mixing plant was used it was practically impossible to keep the concrete from freezing in the trucks on the haul to the job. Because of this, concreting operations were delayed until favorable weather. Less difficulty was encountered in keeping the mortar warm as the sand was easier to heat than the stone for the concrete. The steel joint forms were heated and the joints were covered as soon as possible after pouring. Back-filling was done the same day that the trenching was done because the spoil banks froze so solidly over night that the back-filler would not handle the material without its being broken up with picks. Several small fills had to be made when the ground was frozen. As it was planned to lay the duct immediately after the fill was completed unfrozen earth was used so it could be compacted. The frozen crust was stripped from a borrow pit and the material beneath was placed in the fill as quickly as possible. The tractor treads collected mud which froze and rubbed on the guards and body of the tractor and had to be chipped off several times each day.

The labor cost of winter construction was about one-third greater than that of work done in the summer and, even with this additional cost, the job was not as satisfactory as fills could not be compacted satisfactorily and concreting operations had to await warmer weather. In this part of the country, therefore, such a job should be scheduled for completion not later than early December, if possible.

Conclusions

Construction on this project is now completed and the first cable, of 2⅝ inch diameter, was installed and placed in service on May 1. Having reached this point, those intimately in contact with the progress of the work on the entire project are quite in accord in the opinion that in localities where the available highway routes are unfavorable from various standpoints, a private right-of-way route will frequently afford an attractive alternative. Elimination of interference from traffic, particularly where high speed through highways would offer the only alternative route, is, of course, a feature worthy of consideration. Also, it was possible to take advantage of the flexibility the selected route afforded in avoiding the natural and man-made obstacles which would have presented themselves had the conduit followed a highway.

It is true that the selection of the route followed introduced some new problems, but they were of minor importance in comparison with those which were avoided. Furthermore, the experience gained on this project will be invaluable in anticipating and providing for these new features when they are encountered on future projects. In view of the above, when new conduit routes through similar territory are contemplated, careful consideration will be given to the possible use of a route over private right-of-way as against construction on an existing highway.

G. P. Dunn
J. C. Nash

Overseas Telephone Extensions During the Past Year

IN a letter written in 1878, the early dawn of telephone development, Dr. Alexander Graham Bell foresaw that "A man in one part of the country may communicate by word of mouth with another in a distant place." Few prophecies, so daring for their time, have been so completely fulfilled, both in the letter and in the spirit.

On January 1, 1931, 91 per cent, or 32,200,000, of the 35,300,000 telephones in the world were within conversational distance of any Bell System instrument. Additional arrangements for international telephone connections during the year 1930 were responsible for 2,200,000 of these telephones, distributed among fifteen nations, seven of which previously had been without telephone contact with this country. These 2,200,000 telephones were distributed also among four continents, two of which, namely, South America and Australia, had been without such contact. The countries and districts served by these newly connected telephones have an estimated population of 92,000,000, which, together with the population served by the Bell System and its previously established connections, makes a total of some 450,000,000 people, or 23 per cent of the world's population, to whom Bell System service is now available.

The expansion of international telephony during 1930 is briefly summarized as follows:

During 1930 radio-telephone service was established between the United States and two continents in the Southern Hemisphere. The telephones of Argentina, Chile and Uruguay in South America were linked with this country by means of a radio station at Buenos Aires, and the eastern portion of Australia, including the city of Adelaide, has been connected via London. In addition to the slightly more than one-third of Mexican telephones previously reached, the remaining two-thirds have been connected. In Europe, telephone service with the United States was established for the first time with Finland, eight cities in Poland, and two cities in Lithuania. The international service which had been established previously was extended from Paris and certain other points in France to include all of France; from Copenhagen to include all of Denmark; from Budapest to include all of Hungary; from Oslo to include all of Norway; from Luxemburg City to include all of the Duchy of Luxemburg; from three Swedish cities to include all of Sweden; from three Italian cities to include all of Northern Italy, Rome and Vatican City, or approximately 75 per cent of the Italian telephones.

In the realm of mobile radio-telephony, five ocean liners are in contact with the Bell System telephones. In addition to the service instituted with the *Leviathan* on December 8, 1929, radio-telephone service was established during 1930 with three other transatlantic liners, namely, the *Majestic, Olympic* and *Homeric,* and with the steamship *Belgenland* now on a round-the-world cruise.

There are very few of the larger countries of the world not now connected with the United States telephonically. For instance, of the countries not now accessible by telephone from the United States, only five, namely, Japan, Brazil, New Zealand, Russia, and China have more telephones than the city of Baltimore, Md.

With the establishment of the radio telephone station now under construction on the Pacific Coast, service will be given between the United States and Hawaii, and this station will be capable of providing telephone service across the Pacific to Japan and other Far Eastern countries. The establishment of service to such countries will necessarily await the construction of radio telephone stations there. The present indications are that if economic conditions and demand develop normally, service to countries such as Japan is not far in the future.

Those radio telephone facilities in the United States now serving three countries in South America will undoubtedly be expanded to provide service to additional South American countries in the near future. It is probable, therefore, that within a relatively short span of time the only larger nations of the world not connected with the United States will be China and Russia. The vast size of these countries is disproportionate to their telephone development and it may be some time before the economic conditions there will justify the establishment of telephone service with the United States.

When a goal is reached a new one must be visualized. The Bell System has more than fulfilled Dr. Bell's early prophecy. In the next few years we may expect connection with a majority of the remaining nine per cent of the world's telephones with which Bell System service is not yet available. After that international telephone extension must be interdependent with the world's advances in civilization, economic development, and more complete understanding. That is to say, that while there is no necessity for telephone contact with undeveloped regions, existing and possible international telephone circuits may well become a powerful factor in extending the boundaries of civilization.

Notes on Recent Occurrences

SCOPE OF OVERSEAS AND SHIP-TO-SHORE TELEPHONE SERVICE FURTHER EXTENDED

Australia

REGULAR commercial telephone service was inaugurated by the American Telephone and Telegraph Company between North America and Australia on Monday, October 27.

The circuit employed in this service is by far the longest ever established for regular commercial telephony. It consists principally of two radio links, one across the Atlantic and the other between England and Australia. With the wire lines involved in the connection, the circuit between New York and Sydney, Australia, is more than 14,000 miles long.

The service covers the States of Queensland, New South Wales, and Victoria and the City of Adelaide. This adds nearly half a million telephones, serving a population of some five and a half million, to the network within the reach of Bell System stations.

The Australian service was arranged by the American Telephone and Telegraph Company in co-operation with the British and Australian Post Offices and the Amalgamated Wireless Company of Australia. The circuits across the Atlantic are the same as those employed in the telephone service connecting North America with England and the Continent. The England-Australia link is operated by stations near London and Sydney, which established commercial service between the two countries last April.

The cost of a call between New York and any Australian point is $45 for the first three minutes, and $15 for each additional minute. For calls involving more distant points in

North America, an additional charge is made, corresponding to the present zone charge for the transatlantic service.

Among conversations passing between the United States and Australia on the day after the service was opened was the longest commercial call on record. It covered a total distance estimated at 21,000 miles terminating at Los Angeles, Calif. and Sydney, Australia.

Due to the eighteen-hour time difference between the two points, the speaker in Australia talked at about one o'clock, Wednesday morning, while his words reached the listener in Los Angeles, approximately a fraction of a second later, at 7:00 a.m. Tuesday. Following the usual route of conversations over the new speech channel, the call went from a Sydney telephone to the local radio station. There it was amplified and sent to London where it was received, switched to one of the regular transatlantic circuits and forwarded to New York to the American Telephone and Telegraph Company's receiving station at Houlton, Me. It then passed over the regular long distance land lines to Los Angeles.

The novel feature of this call is the unusual path it followed. As a result of extended tests at the Australian and British radio stations it has been found that transmission in daylight is much better than at night. To take full advantage of this, the radio stations in England and Australia have, therefore, been set up to transmit either directly at each other or around the other side of the world,—for example, from London southwestward across South America and the Pacific to Sydney. This adds about 4,000 miles to the total distance.

South America

All points in Argentina, Chile and Uruguay having telephone connection with Buenos Aires are now within reach of Bell System telephones. This is in consequence of an extension, effective January 1, 1931, of the telephone service from the United States to these three countries, operating through the New

Jersey radio stations of the American Telephone and Telegraph Company, and the Argentine stations of the International Telephone and Telegraph Corporation. Previously the service was limited to Argentina, nine cities of Chile and the city of Montevideo, Uruguay.

Canada and Mexico

A similar extension became effective on that date in the Canadian and Mexican territory connected by telephone with Europe and South America. Practically all telephones in Canada and Mexico now come within the scope of the service. Formerly the overseas talking range was confined to the Eastern part of Canada, a few cities in Western Canada and a dozen cities in Mexico. Transatlantic telephone service to Canada and Mexico is handled over the four radio-telephone channels linking the A. T. and T. Company's stations with those of the British Post Office in England and Scotland.

Europe

Within the past few months, transatlantic telephone service abroad has been extended generally to practically all parts of Western and Middle European countries in which the service was previously available to only one or two cities.

Service Planned to Bermuda

Application has been made by the American Telephone and Telegraph Company to the Federal Radio Commission for a construction permit to erect stations for a short wave radio telephone service between the United States and the Bermuda Islands. The Company contemplates a service that will provide voice communication between the Bermudas and all the United States. In Bermuda the service will be handled by the Imperial & International Communications, Ltd., working in conjunction with the Bermuda Telephone Company.

The plans call for the construction of a transmitting station at Lawrenceville, N. J., adjacent to the short wave transmitters now used in the telephone service to Europe and South America.

The receiving station will be located at Netcong, N. J., the site of the short wave receivers for the European and South American telephone systems.

The Bermuda Islands are approximately 800 miles from New York. While the population is small, since the entire group lies within a 22-mile circle, the islands are visited annually by thousands of Americans on vacation, and the number is increasing each year. The proposed direct voice channel will enable these visitors to keep in close touch with affairs at home.

The transmitting and receiving stations of the Imperial & International Communications, Ltd., will be located in the vicinity of St. George's and Hamilton, respectively, where connection to the island telephone system will be made.

Ship-to-Shore Service

When the steamship *Belgenland* of the Red Star Line left Antwerp for New York on December 2 to begin her round-the-world cruise, she was equipped with a radio telephone system similar to that which has been in service on several other large vessels. Regular ship-to-shore telephone service through the American Telephone and Telegraph Company's New Jersey radio telephone stations linked the liner with this country while she was in the North Atlantic, and will be in service on the rest of her voyage around the globe as long as effective talking is found possible. Similar telephone connections will be maintained with Europe through short wave radio telephone stations in England, and with South America through the Argentine stations of the International Telephone and Telegraph Corporation. This service will be largely experimental to determine the extent to which ship-to-shore telephone service may be extended to areas outside of the North Atlantic. Ship-to-shore telephone equipment on the *Belgenland* is owned and operated by the International Marine Radio Company, a subsidiary of the International Telephone and Telegraph Corporation. This globe-circling voyage will be the first of such extensive voyages during which telephone service has been attempted.

Permission to erect a radio station to be used for radio-telephone communication between water craft operating in New York Harbor and vicinity and the land telephones of the Bell System is sought in an application which has been filed with the Federal Radio Commission, through the Supervisor of Radio of the United States Department of Commerce in New York, by the New York Telephone Company. The New York Telephone Company contemplates the introduction of this new type of ship-to-shore service within the next year.

The Pacific Telephone and Telegraph Company and the Southern California Telephone Company recently filed applications for construction permits for similar harbor telephone stations to be located in the vicinity of Seattle, San Francisco and Los Angeles.

HALE HOLDEN MADE A. T. & T. DIRECTOR

AT the meeting of the Directors of the American Telephone and Telegraph Company on December 17, Hale Holden, Chairman of the Executive Committee of the Southern Pacific Company, was elected a Director.

VICE-PRES. GHERARDI OF A. T. & T. CO. ELECTED PRESIDENT OF THE AMERICAN STANDARDS ASSOCIATION

BANCROFT GHERARDI, Vice-President and Chief Engineer of the American Telephone and Telegraph Company, was elected President of the American Standards Association at the annual meeting of the Association in New York on December 11.

Mr. Gherardi has been a member of the Association's Board of Directors for some time. As President he will assume direction of the standardization activities, national and international, in which more than 2,000 representatives of approximately 500 national trade, technical and governmental groups are engaged under the auspices of the American Standards Association.

THE RUSSELL PORTRAIT OF ALEXANDER GRAHAM BELL. See page 124.

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Some Commercial Aspects of Radio Network Service

RECENT surveys of the number of radio sets in this country and of the daily activity per set indicate the arrival at the top of a new monarch in the American entertainment realm. Though relatively young in years and still growing, the moving picture has been outdistanced at least in quantity output by the baby of the family—radio.

Yet it is hardly just to class radio any longer as an infant, for wide public acceptance has already conferred maturity upon it. No longer do people marvel at the achievement of picking up music and speech "out of the air." The miracle of yesterday has become the commonplace of today.

The rapid development of a more exacting public demand has been of particular interest to the Bell System which has been charged with the important task of conveying radio programs from the microphone to the radio broadcasting station, sometimes individually, sometimes duplicated a hundred fold across the continent.

A few short years ago each request to serve a broadcasting station was a special undertaking, custom-tailored out of experimental materials, as has been previously described in these pages.[1] Today it is a regular telephone company service available from coast to coast over permanent facilities representing the latest developments in the art of sound transmission. Paralleling the major talk highways of the nation between its chief cities are entertainment ribbons of copper, dedicated to public education and pleasure sixteen hours of every day.

Mr. H. A. Bellows, former Federal Radio Commissioner and

[1] "Telephoning Radio Programs to the Nation," by L. N. Stoskopf, Bell Telephone Quarterly, January, 1928.

now vice president of the Columbia Broadcasting System, has written recently: [2]

"It is to the telephone, not to radio, that we owe the development of the equipment whereby speech and music are made available for broadcasting.

"More than this, it is the telephone wire, not radio, which carries programs the length and breadth of the country. John Smith, in San Francisco, listens of a Sunday afternoon to the New York Philharmonic Orchestra playing in Carnegie Hall. For 3200 miles the telephone wire carries the program so faithfully that scarcely an overtone is lost; for perhaps fifteen miles it travels by radio to enter John Smith's house. And then he marvels at the wonders of radio!

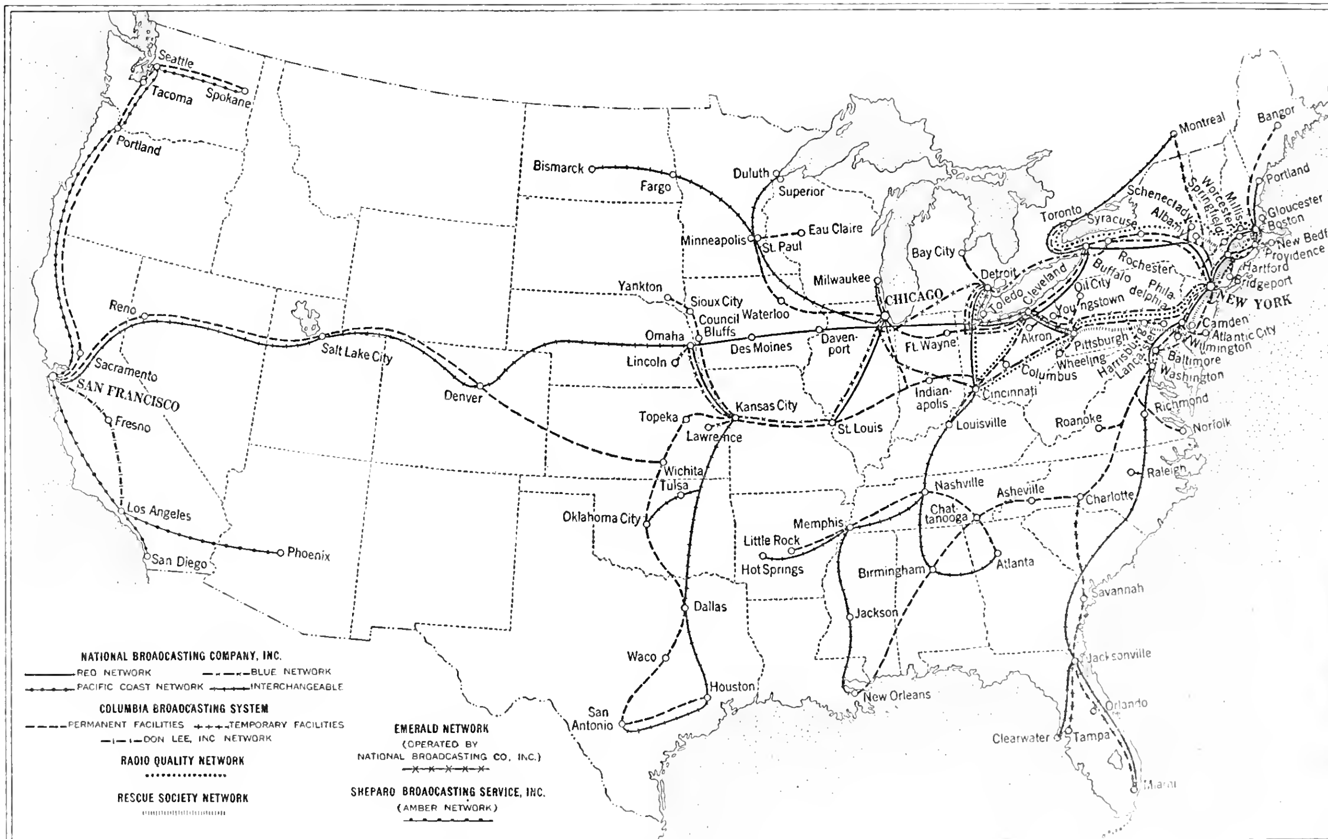
"But what of programs from overseas? Here, indeed, wireless telephony steps in, but not broadcasting in the ordinary sense. The program from London is telephoned across the Atlantic by radio, but on frequencies entirely outside of the broadcast band. . . .

"Broadcasting, then, is the child of the telephone; in America it is certainly the child of the American Telephone and Telegraph Company. The whole structure of commercial chain broadcasting as we know it today has grown out of the pioneer work done prior to 1926. Telephony has largely created the mechanism of broadcasting."

High-pressure research and construction have at times had to be crowded into months in order to keep pace with the public demand for expansion and improvement as reflected by the broadcaster customers to the telephone company. The very shift of program service from the unusual and the experimental basis to that of a regular service has brought about economies in operation resulting in either improved facilities or reduced charges. The broadcasting companies have become regular customers of the telephone company, participating like the smallest residence telephone subscriber in the benefits of research and development skillfully applied to achieve the best possible service at the least possible cost.

The growth of this network service has been one of the most rapid and interesting developments in the past decade. Starting back in 1923, there was only experimental service. At the beginning of 1931 upward of 200 broadcasting stations received

[2] "Broadcasting: A New Industry," *Harvard Alumni Bulletin*, December 18, 1930.



PROGRAM TRANSMISSION NETWORKS PROVIDED BY THE BELL SYSTEM, AS OF MARCH 15, 1931.

network service regularly over the 40,000 circuit miles of telephone wire devoted exclusively to program transmission. Out of a total of 630 broadcasting stations now operating in the United States under licenses of the Federal Radio Commission, only 320 are rated at 500 watts power or more. Of approximately 200 stations receiving regular network service at the beginning of 1931, about 175 were stations of 500 watts or over.

The development of such a volume of business carries with it of necessity developments along other lines. They may be of a commercial nature, such as improved servicing practices, or they may be along engineering or plant lines, involving new types of repeaters to provide amplification, new types of circuits, improved apparatus at terminal cities, switching arrangements, or better procedures for "lining up" and testing circuits.

It must be remembered that the telephone company's first function was the satisfactory handling of telephone messages, meaning the transportation by wire of the human voice between two individuals. The range of the human voice is relatively limited, as compared to that of even the simplest musical program. Telephone equipment and lines in the past have been designed and built for the purpose of doing a satisfactory job in transmitting speech.

The sudden popularity of radio broadcasting, with its consequent demand upon the telephone business for a system of networks to transmit programs to all parts of the country, brought a tremendous problem in the enlarged frequency range that was necessary for satisfactory transmission. The increase in range was due to the fact that music must be handled as well as speech, and the upper and lower frequency limits of normal telephone circuits were no longer sufficient. At the present time, program circuits are designed with such characteristics as to permit the successful transmission of speech, symphony, band and orchestral music.

The design of the amplifying devices known as repeaters had to be changed to keep pace with the circuits, and research developed the necessity of a repeater of a type entirely foreign to that previously used for telephone messages. The Bell System investment in recent construction of plant has been far in excess of former normal service requirements, for the reason that the type of circuit necessary for the best service to broadcasters is superior to anything which is required to handle ordinary telephone conversations. At the present time the Bell System facilities devoted to broadcasting purposes represent an investment amounting to more than $13,000,000.

There has been a constantly increasing demand on the part of our broadcasting customers for a continually improved type of service to meet changing conditions in the field of transmitters and to keep pace with development of new commercial radio receiving apparatus.

Receiving sets now handle faithfully a much wider frequency band. The public prides itself on the fact that it is able definitely to judge the quality of transmission as well as the quality of program material. Accordingly, the broadcasters have found that they must improve the quality of the output from their broadcasting stations if they are to continue to hold their listening public.

As a result the telephone companies have been kept busy developing new types of facilities and improving the equipment already in use, to keep pace with the increasingly critical demands of the public as passed along by the broadcasters. As the radio art progresses, new and improved means of transmitting the programs over the networks will have to be devised. All this points to an increasing plant investment in the network field.

The Columbia Broadcasting System, Inc., and the National Broadcasting Company, Inc., are the major network users of the country. There are numerous others using regional services. To name a few: the Shepard group in New England with key station WNAC; the Radio Quality Group, the key station of which is WLW in Cincinnati; the Chinese Rescue Society at New York, keyed by WMCA; Station WTAM at Cleveland;

Don Lee of Packard fame on the Pacific Coast, key station KHJ, Los Angeles; and others.

More and more, the broadcasting of political speeches is becoming popular and each Fall shows an increase in the wire requirements for this purpose. Coming along at the same time, and adding to the Fall peak, are the football games which create probably more interest than any other sport from the point of view of the radio listener. Much is being done to stimulate interest in other branches of sports, and a great deal of success is being met with as far as boxing, baseball, hockey, and more recently, track and field events, are concerned. The sailing races for the America's Challenge Cup were delivered to the networks from a marine pickup located on board a yacht which followed the course of the race. In this way, the public at large was enabled for the first time to keep track of the progress of one of these races.

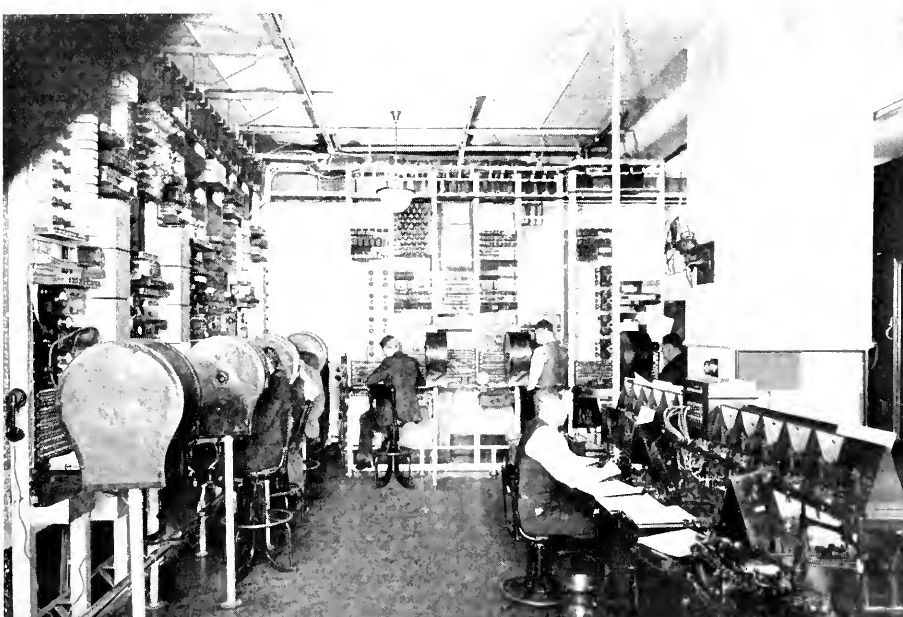
Some other outstanding broadcasts of the past three years are listed below as a matter of interest.

The broadcasting, by both the National Broadcasting Company and the Columbia Broadcasting System, of all activities in connection with the nomination and election of the President of the United States. During the nominating conventions of the Democratic Party at Houston, Tex., and the Republican Party at Kansas City, Mo., portions of both the day and evening sessions were transmitted to and broadcast by leading stations throughout the United States.

After the nomination of the presidential candidate, the radio networks were used as a means of presenting the platforms of both parties throughout the entire period of the campaign. For the first time in the history of a presidential election, radio network service was used as a means of keeping the people throughout the country advised as to the election returns.

The broadcast of the ceremonies in connection with the inauguration of President Hoover, at Washington, was one of the most extensive programs that was ever undertaken. The networks on which the broadcast was handled were composed of 118 stations receiving service from 14 different pickup locations within the city of Washington and composed the largest group of stations ever to receive a single program up to that time.

New York Program Transmission Control Room.



Chicago Program Transmission Control Room.

The broadcast of the ceremonies in connection with the Golden Jubilee of the Electric Light, from Dearborn, Mich., was a fete of international interest and involved the picking up of proceedings from Dearborn and from Berlin, Germany.

The broadcast by both major networks of the opening ceremony of the Naval Arms Conference from a pickup at London, England, on January 21, 1930, as well as periodical résumés of the activities of the Naval Arms Conference during such time as it was in session.

Ceremonies marking the inauguration of commercial telephone service between North and South America were broadcast by both major network patrons from a pickup in the temporary Presidential offices in the State, War and Navy Building, Washington, D. C., on April 3, 1930.

The growth of international broadcasts has proved an interesting development, and the overseas telephone channels from Europe and South America are being used frequently for this purpose. Transoceanic broadcasts began when a program featuring Maurice Chevalier in Paris was picked up, September 28, 1929, for one of the networks. On December 8, 1930, music was handled on the transatlantic link for the first time when John McCormack sang from London for another network. Since then, the use has been practically weekly, and programs originating in England, France, Germany, Italy, Switzerland, and Argentina have been successfully handled.

Late in 1930, a program was transmitted for network use from the S. S. *Leviathan* which was making a special trip to New York after an overhauling in Boston. Later on, the *Belgenland,* while on a world cruise, originated a program which was picked up and put on the National Broadcasting Company network when the ship was in the vicinity of the Panama Canal.

On February 12, at the request of the Columbia Broadcasting System assistance was given them in putting on their network the first world-wide broadcast of Pope Pius XI from Vatican City.

In order to transmit high quality programs employing a wide frequency band, special one-way circuits are utilized. One of the more interesting developments in chain broadcasting, whereby the broadcasting company obtains a considerable amount of flexibility in its network, is by the use of the so-called " Round Robin " layout. Under this arrangement, two one-way program circuits are provided between two main sources of programs, one transmitting in each direction so that programs can be transmitted from and to each point simultaneously. By routing each circuit through cities which are potential sources of programs, the patron at a very small additional expense can pick up worthwhile programs at such intermediate points and bring them into either or both of the main offices.

In order to illustrate this more clearly, it may be of interest to consider a specific example of such an arrangement. Let us assume a Round Robin with one circuit transmitting from New York to Chicago routed via Pittsburgh-Columbus-Cincinnati-Indianapolis and the other circuit transmitting from Chicago to New York via Detroit-Cleveland-Buffalo-Albany. Here is a typical day's service showing exactly what use can be made of the facilities:

8:00 A.M.—A New York program is sent out making the complete round-trip, thus including all stations.

8:30 A.M.—The Pittsburgh station puts on a program which is sent to Columbus, Cincinnati, Indianapolis, and Chicago.

At the same time a program originating in Chicago is sent out over the circuit to New York and all points en route.

9:00 A.M.—The circuit returns to regular routine and a New York program goes to all stations.

2:00 P.M.—Description of a Princeton-Chicago football game at Chicago is picked up and sent to New York to be furnished to stations in the East.

At the same time, a description of the Wisconsin-Cornell game being played in New York, which is of particular interest to Midwestern points, is sent out over the New York-Chicago circuit for distribution to radio stations northwest of Chicago.

9:00 P.M.—A symphony orchestra program in Buffalo is transmitted to

New York and thence over the other side of the Round Robin to Chicago and back to Cleveland, so that the Buffalo program reaches Cleveland by way of New York and Chicago.

There are other possibilities of use for the Round Robin arrangement, but the above will give some idea of the program flexibility which such an arrangement provides.

While radio network service is the major development, of course, in the program transmission service field, other complementary forms of service have been natural outgrowths of the public's enthusiastic acceptance of the radio entertainment field.

In the Middle West, in the South, and in the Rocky Mountain States, where the large cities are separated widely, the problem of clear channels for broadcasting is not yet as pronounced as it is in the East where many cities practically merge into each other. It was a condition of this latter kind that made necessary the Federal Radio Commission's control of the allocation of wave lengths, time assignment, and amount of power. All of these are definite limitations to broadcasting and it was necessary for the art to find ways and means to overcome the limitations. Experimental work developed the possibilities of synchronization. Co-ordination by wire proved an effective answer and the Bell System has developed the ways and means for performing the task satisfactorily.

This is called the Standard Frequency Service, by means of which the Bell System furnishes a chain broadcaster with a frequency service to his radio stations, enabling him to operate them on the same wave length without interference. Practical synchronization is feasible only as a result of such a standard frequency service. Synchronization introduced commercially only in the last few months bids fair to solve a serious problem of the broadcasting companies; it overcomes to a large extent the limitation of the number of channels available in any given area.

Public Address Service is another item becoming more popular each day. By means of it, a speaker in one city may address large gatherings at some distant point. This service may be used separately or in conjunction with program transmission to broadcasting stations. The value to modern business of a cheaper form of service of this general character caused the introduction of a minor edition of this master method in the form of Private Address Service. This latter service is finding ready acceptance in the normal commercial business field, and conferences and small groups are easily covered in this way at a surprisingly low cost to the patrons, inasmuch as the service does not require program circuits with their wide frequency band but simply the best grade of regular telephone circuits. Two-way discussions are successful over systems of this kind, indicating the probability of universal acceptance for purposes of this character.

While these services belong to the same general family that network service does, they are somewhat apart from the present discussion. To return to program transmission service: As has been shown it has had a beanstalk growth. In seven years it has developed into one of the most intricate branches of a highly specialized art.

Back of the facilities devoted to network service is a small army of highly trained specialists who engineer, operate and maintain the networks. In control room, test room, repeater station, in city office building and on patrol along country roads, this efficient force is serving day and night. Few if any of the multitude of broadcast listeners so much as suspect their existence. They themselves, however, are keenly aware that any slight relaxation of vigilance on their part might mean instant and serious interruption to the broadcast program and disappointment to hundreds of thousands of listeners.

A typical instance of this devotion to service on the part of the network guardians occurred on the bitterest day-before-Christmas in years, while the nation prepared for the Radio to lead it in carol singing. A shanty burst into flames by a New Jersey roadside in Livingston, and an all-important telephone cable was burnt through, severing the wires which form a vital link to many of the broadcasting stations of the land. Their own holiday preparations were forgotten by the telephone line crew which responded to the call to face the stormy blast.

The cable splicers' fingers moved faster than the eye could follow. Ten minutes' work—ten minutes' thawing of fingers, while other fingers took up the task. . . . 400 flying fingers, stinging in the sub-zero cold. And the carols went on the air "as scheduled!"

H. H. Carter

Milestones, Guideposts and Footprints

A REVIEW OF THE DEVELOPMENTS OF THE PAST FIVE YEARS IN THE FIELD OF TELEPHONE COMMUNICATION

THE past five years have been crowded with developments in the field of communication, and particularly in the field of telephone communication. Out of the scientific laboratory have come achievements that have arrested the attention of a world grown accustomed to miracles; accomplishments so charged with drama and romance that they have made blasé humanity pause amid the high-speed business of life in sheer amazement. Never, since man first began wig-wagging his thoughts to his fellows and the art of communication began, has a greater measure of accomplishment in this art been achieved in so brief a length of time.

Outstanding among the telephone achievements of this period have been the opening of commercial radio telephone service between the United States and Europe, South America and Australia and of telephone service by wire between the United States and Mexico; the completion of a third transcontinental telephone line; the inauguration of ship-to-shore radio telephone service; the adaptation of radio telephone communication to the requirements of aviation; the development of talking motion pictures and noteworthy accomplishments in the field of television.

One might review the past five years of telephone history by describing these outstanding events, as a traveler pauses along his road and counts the milestones he has passed. Or one might search along the path of telephone development for some guidepost which indicates the direction in which progress has been made or which defines the objective toward which telephone development has been aimed. Or, finally, one might examine in some detail the footprints, as it were, that form this pathway of progress—the innumerable accomplishments that, taken together, have brought telephone development nearer to its objective.

To enumerate the notable events of telephone history during the past five years, however, is to describe them. They speak for themselves. So widespread has been the interest they have created that it is merely necessary to list them, without discussing them in detail. In the present article, therefore, we shall seek, as it were, for guideposts and footprints; shall look for some clear indication of the direction of telephone progress and then examine some of the evidence that progress has been made in this direction.

The Objective of Telephone Progress

Of the guideposts which have indicated the direction of telephone progress during the past five years, one deserves particular emphasis. It affords the explanation and *raison d'être* not only of the spectacular achievements of telephone scientists and engineers during this period, but of the general progress in the development of the telephone art and the improvement of telephone service.

This was the address delivered by Walter S. Gifford, President of the American Telephone and Telegraph Company, before the National Association of Railroad and Utility Commissioners, at Dallas, Tex., in October, 1927. The time is an important consideration, for it provides the background against which must be viewed the picture presented by this representative of thousands of telephone employees and thousands more of telephone investors. Mr. Gifford's address was a statement of policy—the fundamental policy of the Bell System. He was speaking at a time when the nation's prosperity was climbing to its peak. Individuals and organizations alike were quite generally bending all efforts toward taking the quickest possible advantage of favorable business conditions; when "melon-cutting" was more or less common practice and was looked upon by the rank and file of the public as an evidence of astute business management. He was speaking in an era which, as a whole, had as its keynote the taking of profits.

And because he spoke with such a set of circumstances as a background, what he said was all the more noteworthy. He outlined the responsibilities of the management of his company to its investors and to the telephone using public and summarized them both in two striking sentences:

> "Obviously, the only sound policy that will meet these obligations is to continue to furnish the best possible telephone service at the lowest cost consistent with financial safety. This policy is bound to succeed in the long run and there is no justification for acting otherwise than for the long run."

Going somewhat more into details regarding those phases of the company's policy that were of particular interest to his audience, Mr. Gifford continued:

> "Earnings must be sufficient to assure the best possible telephone service at all times and to assure the continued financial integrity of the business. Earnings that are less than adequate must result in telephone service that is something less than the best possible. Earnings in excess of these requirements must either be spent for the enlargement and improvement of the service furnished or the rates charged for service must be reduced. This is fundamental in the policy of the management."

More closely allied with the events of the five-year period which we are about to review was Mr. Gifford's statement that "Progress is assured by having a large group of scientists and experts devoted exclusively to seeking ways and means of making service better and cheaper."

Translating a Policy into Action

The policy which Mr. Gifford thus outlined was not precisely a new policy but, as never before in telephone history, it was stated so definitely and concretely that every man and woman in the telephone organization could understand it. Nothing could be less vague or abstract than the ideal of "making telephone service better and cheaper." Here was something tangible; something that was capable of being translated into terms of the day's job—a clean-cut proposal of increased individual and group effort toward attaining an objective so simply stated that about it there could be not the slightest misconception.

Here was a definite challenge calling for progress—in the direction of better and cheaper service. To this challenge the Bell System's response was prompt, widespread and wholehearted. All along the line, in executive and engineering office, in laboratory, in factory, at the switchboard and out where the long distance lines make their way across country, men and women began thinking, as never before, in terms of the ideal and aim thus newly stated—and translating their thought into more intensified action.

The True Measures of Advances

The footprints of these thousands of men and women—their individual and group achievements in the direction of making telephone service better and cheaper—are the true measures of advances in the development of the telephone art and of telephone service during the past five years.

One of the measures of progress is growth, for it is obvious that telephone service must grow to meet the ever-increasing needs of a growing nation. Statistics are notoriously prosaic, yet at times they afford almost dramatic evidence of growth. How well the Bell System has met its obligation to grow may be appreciated from a study of statistics for the end of 1925 as contrasted with those at the end of 1930. Some of the important items of growth are shown in the following table.

	Dec. 31, 1925	Dec. 31, 1930
Number of telephones		
Bell Companies:		
Manual Service	10,538,935	10,705,118
Dial Service	1,496,289	4,976,941
Connecting Companies and Lines	4,685,000	4,416,242
Total	16,720,224	20,098,301
Number of Central Offices	6,017	7,163
Miles of Pole Lines	386,064	422,489
Miles of Exchange Wire:		
Underground Cable	28,425,392	44,455,852
Aerial Cable	9,462,213	16,209,279
Open Wire	1,953,235	2,201,556
Total Exchange Wire	39,840,840	62,866,687
Miles of Toll Wire:		
Underground Cable	2,057,196	5,769,125
Aerial Cable	1,209,332	4,576,627
Open Wire	2,366,172	3,035,826
Total Toll Wire	5,632,700	13,381,578
Total Miles of Wire	45,473,540	76,248,265
Average Daily Telephone Conversations *		
Exchange	46,702,307	62,365,069
Toll	2,098,163	2,933,026
Total Conversations	48,800,470	65,298,095
Number of Employees	293,095	324,343‡
Number of A. T. & T. Co. Stockholders	362,179	567,694

* For the year ending December 31.

‡ The employees of the Western Electric Company, Inc., and the Bell Telephone Laboratories, Inc., numbering approximately 70,000 on December 31, 1930, are not included.

Now, what does this growth mean in terms of increased value to the individual telephone subscriber? It means a definite advance toward making his telephone more useful to him, for its value to him increases as its reach is extended. Reference to the above table will show that the number of telephones capable of being interconnected by wires of the Bell System has been increased by nearly four million during the past five years.

At the beginning of this five-year period, the only foreign telephones that could be reached by Bell System subscribers were about 1,000,000 in Canada and about 62,000 in Cuba. The opening of transoceanic radio telephone service and of wire communication with Mexico has placed within his reach about

32,200,000 telephones on five continents—more than 91 per cent of all the telephones in the world. In other words, the total number of telephones capable of being connected with Bell System telephones has practically doubled within the past five years.

This increase in value, due to increased reach, is, however, an increase in potential rather than in present value, so far as the average telephone user is concerned. Of greater and more direct importance to him are the increases in the value of his own telephone to him as he utilizes it in his daily life. How much better is telephone service than it was five years ago?

Some Service Improvements

Improvement in the quality of a public service cannot, of course, be measured by statistics alone. In so intimate a service as that provided by the telephone organization, quality is evaluated not only in terms of efficiency and accuracy, but in terms of the personal attitude of those who provide the service. Much progress has been made during the past five years in this direction. The personalization of service has been the aim not only of the operators who handle telephone calls, but of all telephone employees who have contacts with the public. Their aim has been to impress the public with a sense of their desire to serve it to the full.

During this period marked progress has been made in introducing the dial system of operation. At the end of 1925, about 12.5 per cent of Bell telephones were dial instruments; at the end of 1930, about 30 per cent were of this type.

The extension of dial service has been an important contribution to improved telephone service due to its greater accuracy and reliability, particularly during hours of light use, such as nights, Sundays, and holidays. Dial service is also more adaptable to improvements and developments required to keep pace with the rapidly increasing telephone business, and is preferred by the great majority of those who use it, to the manual system.

During 1930 a small dial intercommunicating system for residences and smaller business establishments was made available for Bell System subscribers.

Many improvements in methods and in operation and supervision have raised the standard of efficiency to a higher level. This uniformity is reflected not only in the quality of local service, but also in that of toll service. On calls of the latter type, two or more sets of operators, often in widely separated territories, are involved in making the necessary connections, and if there were not a uniform standard of accuracy and efficiency, the best efforts of one group might be seriously offset by poor traffic results on the part of the other.

There has been a marked improvement in toll service during the five-year period under consideration. This improvement has included not only an increase in the percentage of toll calls completed, but an even more significant increase in speed of completion.

During 1925, the present practice of having the customer remain at his telephone while a toll connection is being completed was not generally in use and there is no record for that year of calls so handled. During 1930, toll calls completed while the calling party remained at his telephone constituted 82 per cent of the total calls.

Facilities for long distance and toll service have been greatly increased, an outstanding illustration being progress in extending the Bell System's toll cable network. Since the beginning of 1926 approximately 15,000 miles of toll cable, providing more than forty-two billion conductor feet of wire, have been constructed and put in service throughout the system. Seventy-five per cent of the cities of 50,000 or more inhabitants are now connected with the network of toll cables that are practically storm proof.

Long Distance Rate Reductions

There began in the latter part of 1926 a series of reductions in long distance rates which, taken in connection with the improvements in this type of service above outlined, as well as others, strikingly illustrate the progress made toward more efficient and more extensive telephone service at a lower cost to the telephone user. The first of these reductions, made late in 1926, effected an estimated total annual saving to users of the service of about $3,000,000. In December, 1927, a further reduction was made, for a total annual saving estimated at $1,500,000. On February 1, 1929, another reduction became effective, for an annual estimated saving to the telephone users of $5,000,000. On January 1, 1930, long distance rates were further reduced, for an estimated saving of more than $5,000,000 a year. These four reductions represent, at the present time, a saving to the public of about $20,000,000 a year.

In the Bell System, about 20 per cent of all the telephones are connected with private branch exchanges. In the larger cities, such as New York and Chicago, the percentage is very much greater. The operation of these switchboards is an important factor in determining the quality of telephone service in general. During the past five years particular efforts have been made by the telephone companies to improve the service rendered through private branch exchanges by supplying them with trained attendants and through close contact with those already employed. Bell System companies have maintained schools for the instruction of private branch exchange attendants, to assist them in using the best methods of giving telephone service.

Solving Installation Problems

An important aspect of the provision of telephone facilities for the use of a subscriber is not merely to provide them, but to provide them when he wants them. During the past five years there have been important advances in speeding up installation of equipment on subscribers' premises in order that this requirement of adequate service might be met. To accomplish this, it has been necessary not only to provide adequate facilities and equipment, but to improve methods of handling applications for service.

One of the important factors in speeding up installation has been the adoption of the Appointment Plan. Under this arrangement the subscriber, at the time of filing his application for service, sets a definite date upon which he desires to have the installation made. This system was not in general use throughout the Bell System until 1928, in which year 38 per cent of all installations were handled by appointment. During 1930, 83.9 per cent of all installations throughout the system were made under the Appointment Plan, and in 96.6 per cent of these, the appointment dates were met.

During the past three years the hand telephone has been made generally available throughout the system, thus adding to the comfort and convenience of subscribers who use this type of instrument. The number of instruments of this type in use has grown from some 60,000 at the end of 1927 to about 1,750,000 in 1930.

Business offices have been improved in appearance and comfort for the customer and new methods have been introduced that have made the transaction of his business with the telephone company more convenient for the subscriber. Improved systems of billing have made for greater accuracy and promptness.

Selling by Telephone

The use of telephone service, and particularly of toll service, by business concerns has undergone a marked increase during the period under consideration. An important phase of this development has been the steady growth of the use of the telephone in selling. During 1926 the Keytown Selling Plan was worked out by telephone engineers and the following year it was made generally available throughout the Bell System. In connection with this plan, there has been prepared a map on which the United States is divided into areas, each with a centrally located "key town." From these central points sales representatives may place calls to prospects or customers in the surrounding towns. This is usually done by filing sequence call lists with the telephone company. During this period there has also been developed the Credit Identification Card plan, by which sales representatives may have telephone toll calls billed to their home office. These developments have proved important factors in increasing the value of telephone service as an aid in establishing sales contacts conveniently and cheaply.

Directory Service

One of the vitally essential phases of providing adequate telephone service is the publication and distribution of directories. It is interesting to note that in this respect the telephone business is unlike all other industries. The Bell System is the nation's only business concern which finds it necessary to compile, and to distribute for public use, a complete list of its customers and to do this, in a majority of cases, not only once a year but twice a year. It is obvious that this activity necessarily involves compiling the directory lists with the highest possible degree of accuracy, getting them printed in the shortest possible time, and distributing the printed edition without delay.

This problem has increased in complexity and difficulty as the number of telephone subscribers has increased. In 1925, for example, the total number of copies of telephone directories published by the Bell System was about 27,000,000, with listings totaling about 14,000,000 separate names. The corresponding figures for 1930 were 36,000,000 copies and 18,500,000 listings.

That it has been possible to increase the accuracy of the directories and to speed up their production and delivery, in the face of these increases in the size of the total issue and in the number of listings, is a striking evidence of progress in the improvement of the service as a whole during the past half-decade.

Meanwhile, steps have been taken generally to improve the appearance of telephone directories by removing advertising matter from the covers and to improve arrangement, typography and quality of paper so as to make the use of directories more convenient for the telephone user.

This effort to improve the appearance of directories is only one manifestation of a trend that has become general throughout the Bell System. The idea that beauty may be expressed in that which is primarily utilitarian in purpose is becoming increasingly a part of the Bell System's business and service philosophy.

An important innovation in the directories has been the inauguration of "Where to Buy It" service. Under this plan, trade marks of nationally advertised products or services are reproduced in the directories, followed by the names, addresses and telephone numbers of dealers, agents, service stations or other representatives from whom the product or service may be obtained.

Proofs of a Pledge Fulfilled

These are some, but only some, of the "footprints" that have marked the path of telephone development during the past five years. There have been others—almost numberless steps, most of them unspectacular, many of them seemingly unimportant when considered by themselves, but all pointed in the same direction.

It is a far cry from so romantic an achievement as the opening of radio telephone service between continent and continent, across thousands of miles of ocean, and so prosaic an accomplishment as, let us say, the rearrangement of the type on a telephone directory page. Yet, properly evaluated, both of these are simply parts of the same general progress toward more extensive, more efficient and more economical telephone service. Milestones and footprints alike indicate advances toward the Bell System's objective as indicated by the guidepost of Mr. Gifford's statement of its fundamental policy. They are evidence of the fact that this statement of policy was more than a statement—that it was a pledge of performance. They are proof that this pledge is being fulfilled.

R. T. Barrett

Teletypewriter Service and Its Present Day Uses

MIRACLES of modern science are available and in use today in the conduct of normal business. The teletypewriter is an outstanding example. The magic carpet of fiction would today be considered inconvenient and uncomfortable and probably slow, certainly slow when compared with the speed of transmission of the teletypewriter. In addition to its speed, the teletypewriter is convenient and after all takes up no more room than the carpet would have taken if folded up and placed beside it.

Teletypewriter Service is the answer to today's exacting demand from business concerns for a communication service that is almost human and less prone to error than a human being. Briefly described, it is typewriting by wire. The distance, whether a few feet or the width of the continent, is of no consequence. The results are the same—accurate, fast, and reliable.

Its uses are infinite; it serves the rapid, continuous, high-pressure demand of the Press, the extraordinarily complex demands of financial organizations for a flexible and fool-proof service to handle transactions affecting the world or involving millions; it fits into the methodical, ceaseless grind of the industrial world when handling its manufacturing problems, shipping instructions, orders, price changes, or the many burdensome problems requiring prompt administrative opinion and advice. Then, too, we find it on the great national airways, at the landing fields, in the weather bureau offices, the radio stations of the Department of Commerce, and even in automobile clubs whose members may be interested in weather information which is so essential to the successful conduct of air navigation, our fastest modern means of transportation, yet which after all is slow compared to the functioning of the teletypewriter in transmitting messages, ideas, thoughts, in fact all but the physical being, from one location to another. Finally, as if to demonstrate conclusively its practically limitless application for making easier business burdens, the teletypewriter holds an enviable place among the important tools of the police departments of the United States in handling information designed to assist in the capture of criminals, in the tracing of missing persons, as well as in the normal, and more or less routine, operation of these many and scattered police departments with their numerous branches, precincts, headquarters, and remote stations.

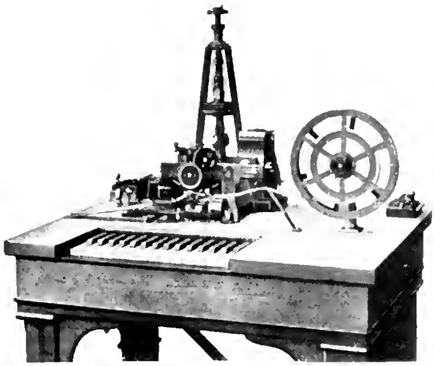
Anything that does all of these things must be interesting—its history must be interesting. Teletypewriter Service and its history are interesting.

It has been many years since telegraph signals were first transmitted; 1837 in fact. To facilitate handling the telegraph code, the "tape recorder" was developed. This used a strip of paper tape on which the dots and dashes of the telegraph code were indicated as they came over the line. This then was decoded visually.

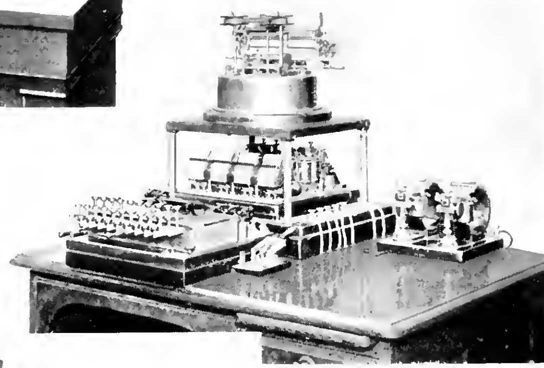
Back in about 1848 the idea of the teletypewriter was reduced to crude machine form and known as "House's" machine. It had a piano type keyboard and used compressed air to operate the mechanism. It printed typed characters on a tape. Then other systems came along—David Hughes, Humaston, Dr. Werner Siemans, Creed, Gell, Baudot, Donald Murray, Delany, Rowland, Potts, Cardwell, Wright, Morkrum, Kleinschmidt, and the Western Electric—all put apparatus on the market.

Gray & Barton, which later grew into the Western Electric Company, became interested in 1870 in printing telegraph equipment, as it was then called; and while much development work went on from time to time in this field, it was not until 1915 that the service was finally, after many tests, tried and proved successful. The latter part of that year, the Bell System furnished the United Press Associations a service consisting of one transmitting station in the United Press Bureau Office, six receiving stations located in newspaper offices in New York City, and three others located in Jersey City, Hoboken, and Newark. In 1916, the first commercial service was in operation between New York and Chicago and between New York and Kansas City. In 1917, a New York-Boston service, with several intermediate points, was started for The Associated Press. From then on, its field of usefulness continually increased and Press Associations, newspapers, and all lines of commercial business enterprise accepted the teletypewriter as an established fact. The United States Army Signal Corps and the United States Navy used it during the World War. In the years succeeding 1918, its growth has been steady; and at the present time the Bell System has about 10,000 stations in operation furnishing service to 800 concerns in practically all lines of industry.

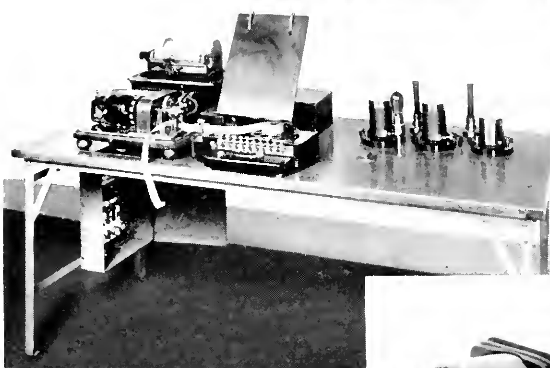
While it is true that from time to time many concerns have been engaged in the manufacture of teletypewriter apparatus, it finally boiled down to the point where there were only five main manufacturing concerns and two of these were foreign corporations: Siemans Halske in Germany; Creed in England; Morkrum, Kleinschmidt, and the Western Electric in the United States. Then Morkrum-Kleinschmidt companies combined under that name; and later, for purposes of manufacturing economy, the Western Electric contracted with them to manufacture the teletypewriter apparatus for the Bell System and discontinued production itself. This left one organization in the American field. Soon afterwards, Morkrum-Kleinschmidt became the Teletype Corporation, which the Western Electric recently purchased. The Bell System is, therefore, in the very satisfactory position of having an efficient teletypewriter manufacturing organization whose policy and procedures



(Left) Tape Printer Piano Keyboard—1855.
(Reproduced by permission of the Scientific American.)



(Right) Page Printer—about 1900.



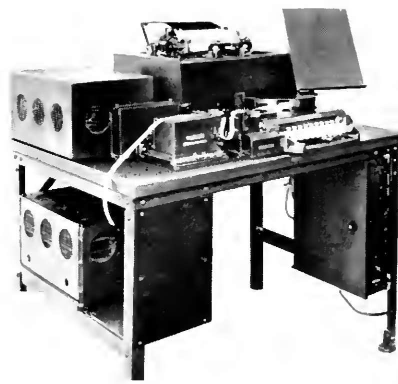
(Left) Page Printer—about 1912.

(Right) Potts Page Printer—about 1916.

THE EVOLUTION OF THE TELETYPEWRITER.

(Left) Type Wheel Tape Printer—about 1921.

(Right) Western Electric Page Printer Type Bar 10-A—1920



(Left) The Bell System's Latest Tape Machine.

(Right) The Bell System's Latest Page Machine.

THE EVOLUTION OF THE TELETYPEWRITER.

are shaped to the purpose of developing the art to the fullest extent and at the lowest possible cost.

Teletypewriter Service plays an important part in keeping the reading public acquainted with the happenings in the world. It is the outstanding method of communication used by the Press for collecting and disseminating news. It is said that news travels fast; it has to. Any important development in the political or economical situation, a disaster, a new record, anything, in fact, of interest to the general public, is flashed, within a few moments from its happening, into the newspaper plants of North America.

To accomplish this, the Press, in addition to utilizing other facilities of the Bell System, operates 250 long-haul teletypewriter circuits involving a total operating mileage of 300,000. Page type equipment, being particularly adaptable for handling straight news, takes the copy of the news report to 1,250 newspapers.

Tape type equipment, installed in the offices of 210 newspapers, enables them to obtain still faster special news features like the stock and bond market reports.

The greatest number of circuits is required between New York and Kansas City. Some of the newspapers in this group take the complete report of two or three news agencies, and at the peak hours of the day, 10:00 A.M.–4:00 P.M., are receiving from 15,000 to 20,000 words per hour. This does not take into consideration special sporting news; such as racing charts, baseball results, and other items that make up the sporting page. It is estimated that the over-all news report delivered by teletypewriter machines to the larger newspapers approximates 150,000 words; although when the edition is put out for our edification, it numbers only 25,000 words.

The use of teletypewriters in the financial field has increased steadily since the first service was established in April, 1925. This operated between New York, Philadelphia, and Cleveland, and was followed shortly after by one between New York and Chicago.

Stock brokerage houses are the largest users of this type of service. Daily they set teletypewriters operating between all principal cities in the United States and radiating to many smaller municipalities, so that 160 cities are so connected.

NEW YORK FEB 18 1931
ANDERSON
CHICAGO
STOCKS SOLD FOR TAX PURPOSES CANNOT BE REPURCHASED
FOR 30 DAYS BUT IT IS FREQUENTLY POSSIBLE TO SELL
DOUBTFUL STOCKS AND PUT THE CAPITAL INTO STOCKS WHICH
MIGHT HOLD BETTER DURING PERIODS OF MARKET WEAKNESS AND
RECOVER MORE QUICKLY WHEN CONDITIONS IMPROVE. WE WOULD
BE GLAD TO CONFER WITH CUSTOMERS REGARDING SALES OF
STOCKS OR BONDS IN CONNECTION WITH THE ABOVE.
MATHEWS 340 PM

Typical Message. Tape Service.

Tape service is particularly adapted to brokerage use because of its flexibility of operation. With several offices on a line it is necessary for each office to be able to break in at will and send an order even though a message is being transmitted. To do this without making it necessary to retransmit the whole message after the order is completed, tape service is used.

Previous to the opening of the Stock Market each day, the services are kept busy with the transmission of market letters, news items pertaining to financial markets abroad, and general messages between members of the firms. Upon the opening of the market, the service is cleared for the transmission of orders that are to be executed on the Stock Exchange. During market hours, orders have preference over everything else. Reports of orders executed on the Exchange are next in importance.

Flashes are also transmitted which may relate to the condition of the market, some item of interest pertaining to a particular

12 NY SELL 200 AGE $19\frac{3}{4}$ 200-$19\frac{3}{4}$

BROKERAGE. SELL ORDER. TAPE SERVICE.

stock, or news which might have an effect on the market in general. A customer in a distant office often requests the latest quotation on a particular stock before entering an order. In the course of an average business day as many as two hundred requests for "quotes" may be received over a single service.

After the close of the market, all orders which were executed during the day are confirmed by the originating office. Accounting discrepancies, which necessitate numerous messages before the differences are corrected, frequently exist.

10 NY BOT 300 EL $81\frac{1}{2}$ 300-$81\frac{1}{2}$

BROKERAGE. CONFIRMATION. TAPE SERVICE.

Cases of quick executions and reports on orders over teletypewriter circuits have been called to our attention; an outstanding example happened recently when an order was placed in a San Francisco office, teletyped to New York, executed, and the execution report handed to the customer in San Francisco less than two minutes later.

In the banking business, messages relating to the transfer of stocks or funds, those containing credit information, Foreign Exchange rates, or messages of acceptance, are transmitted. The Federal Reserve Board transmits hundreds of messages each day relating to the transfer of millions of dollars between its members.

Bond and security houses are very large users of Teletypewriter Service. One particular house, dealing exclusively in bonds and securities, has a network of circuits extending from Maine to Georgia, and from New York to all the principal cities in the Middle West and on the Pacific Coast. The teletypewriters in the offices of this concern are installed in the same room with the traders so that speedy execution of orders can be reported. Cases have been known where an order for the purchase of certain securities was placed on the Pacific Coast for execution in Boston, and the report made to the customer four minutes after the order was placed. Execution of orders between offices of shorter distances are often made in less than one minute, when these offices are on the same circuit.

The use of Teletypewriter Service in the industrial field has proven an important factor; for it brings together with speed, efficiency, and economy branch offices, plants, mills, and warehouses. In effect, it enables them to function as though under one roof. In fact, it has provided a means of stimulating sales, manufacture, and shipments. It is particularly adaptable by reason of the written record which greatly reduces the possibility of error.

This service has enabled credit concerns to link their branch offices in distant cities with the headquarters office, thereby centralizing the collection and dissemination of credit information. Replies to inquiries are furnished in fifteen to thirty minutes, and on rush jobs in two to five minutes; whereas under the old method of handling by mail and public telegraph, it took from one to several days.

Textile companies' sales offices are easily connected with mills in distant cities, facilitating the handling of orders, inquiries regarding manufacture, billing, and shipping. Transmission of orders on forms with carbon copies arranged for billing and other purposes can be readily handled. Formerly, it was necessary to send this type of communication by mail.

Many concerns in the metal industry use Teletypewriter Service for communication between main and branch offices and plants. By its use they are able to keep in touch with the progress of their manufacturing job, check specifications, and to handle labor and mill problems, replace stocks, rush a ship-

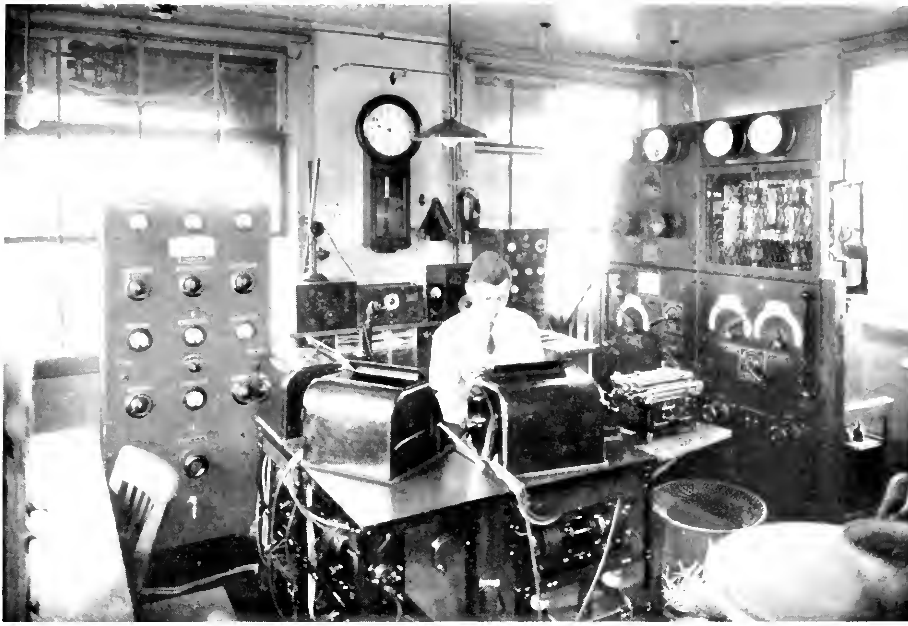


FIGURE 1. DEPARTMENT OF COMMERCE RADIO STATION, HADLEY FIELD, STELTON, N. J.

FIGURE 2. AMERICAN CAN COMPANY, CHICAGO OFFICE.

FIGURE 3. E. A. PIERCE AND COMPANY, NEW YORK OFFICE.

FIGURE 4. INTERNATIONAL NEWS SERVICE, BUREAU OFFICE, WORLD BUILDING, NEW YORK.

FIGURE 5. INSTALLATION IN STATE POLICE HEADQUARTERS AT HARRISBURG, PA.

ment on a broken part, or handle any one of the hundred or more things that arise and call for action. It is also used for administrative purposes and for the carrying of communications of more importance than ordinary routine matters.

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95 NY 1/10/31
R E WILLIAMS
          CHICAGO
SHIP TO JONES & BROWN ST. LOUIS 24 GROSS LOT 15 BLEACHED ORDER NUMBER
FOUR EIGHT SEVEN SIX BILL THEIR ATLANTA OFFICE ALSO WIRE CONFIRMATION
ON CREDIT TO SEVENTY SIX ON AMOUNT ELEVEN SEVENTY SEVEN EIGHTY FIVE
       CALDWELL 3:10 PM
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A Typical Page Service Message.

A hosiery mill has recently given us an interesting comment on the service by saying, "The instant and continuous contact between all units guarantees smooth production. This is particularly important to us where factories are dependent upon each other, one making yarn, another hosiery, and another labels for boxes. Teletypewriter Service provides the vital contact which brings the separated units closely together. Billing and purchasing are centralized; duplicate records are eliminated; traffic matters are handled quickly and accurately. Our officials in different cities communicate directly with each other in the space of minutes to ask and answer questions, make decisions, or give instructions, and, further, have their 'conversations' in typewritten form, a record insuring against misunderstanding. The teletypewriter gives customers exceptional service. A store may be out of a certain style of hosiery on Friday and need a supply for Saturday business. A message is teletyped directly to the factory, and the order is on its way to the store almost immediately."

To list some of the advantages of the service, we quote haphazard from expressions of customers: "Brings together general office, mills, and export offices"; "Handles sales quotations, market information, costs, accounting data, and operating directions"; "Speeds orders, shipping advice, matters relating to production; customers get faster service; secures quotations, dates of shipment"; "Tends greatly to increase the speed of sales in a highly competitive market."

Leaving normal everyday business procedure and departing into realms that contain much more readily seen "service romance," we find that there, as well, Teletypewriter Service plays its part. The airways of the United States, which as recently as ten or twelve years ago were totally unprotected and generally even uncharted, are now provided with the most efficient guides and safeguards science has been able to develop. From a single air route operating from Washington to New York at that time, we now find about 30,000 miles of regularly operated airway. Half of it is lighted for night flying; and all the principal routes are protected by the best land line communication system available, the teletypewriter. The Airways Division of the Department of Commerce of the United States Government has put its stamp of approval on this communication medium; and, as a result, large airway operating units like Transcontinental & Western Air, Inc., "The Ludington Line," Eastern Air Transport, Inc., and others, have seen fit to specify this service as a protection to their passenger traffic. No other means of communication offers the degree of reliability found here, which, of course, is essential in handling necessary information to keep the airway pilots informed as to the conditions on their operating section.

The service furnished the Airways Division of the Department of Commerce between Newark and Cleveland exemplifies how teletypewriters help maintain schedules despite adverse weather conditions. The Weather Observer at Newark types out the local meteorological conditions at short intervals. All the way to Cleveland, the information rolls out on the tape services at the various intermediate fields. As Newark finishes its message, the observer at Northampton, Pa., the next field westward, types out the meteorological data collected at his station. So in a few minutes, every station along the airway has accurate and detailed information on conditions at every other landing field along the way.

WEATHER REPORT NEWARK TO WASHINGTON
340 PM NK THIN OVC LIGHT HAZE CEILING EST 12 THSD 5 NE
25 42 22 2958 TA THIN OVC HAZE UNL 6 NE 16 39 2951
DUSTY SUN VISIBLE THROUGH OVC PA OVC EST 5000 8 NE
19 40 2954 AB OVC EST 5000 5 N 16 41 23 2953 BO OVC EST
4000 6 N 15 39 2956 WN OVC EST 7000 7 N 21 39 24 2964

Department of Commerce, Airway Division, Weather Report. Tape Service.

The police usage offers an interesting example of up-to-date methods to offset the advantages otherwise accruing to criminals in flight. These advantages are speed, as evidenced by automobiles, crack trains, speed boats, and planes. They are the most rapid means of transportation available, and the criminal makes the most of them. However, before he has barely begun his journey, the teletypewriter networks of the police have flashed their messages and usually block his way. Data on stolen cars, missing persons, fires, riots, disasters, as well as the ordinary routine procedure which goes to make up the normal police work must be handled rapidly and accurately; therefore, headquarters, precincts, stations, booths, and departments no matter how widely separated, are tied together by the teletyepwriter and are only a key length apart.

The need for still more extensive police networks is evidenced clearly in an editorial appearing in The Saturday Evening Post, November 22, 1930, which discussed networks of the New Jersey State Police, the Pennsylvania State Police, and the New York City Police, and said in part, " We see no reason why co-operation of this type stimulated by science should not go very much farther. The police force of the whole country should be a highly interrelated system; separately they can never compete with the criminal."

If this is the development that has taken place in Teletypewriter Service and it is used as extensively as we have said, perhaps in your mind will rise the thought that we have found nearly all the use for it that exists. Hardly. Teletypewriters are now numbered in the thousands. Their future lies in the millions. They are as inevitable as the telephone and will, before many years have passed, rank with it as an absolutely essential office appliance. Where there are now thousands in use in business, in a few years there will be infinitely more thousands located in homes where they will be considered to be as desirable as a radio with the added value that the running story of the event can be received on tape whether you are there or not, so that when you come in from the theatre or a bridge game you can consult the teletypewriter for the latest news of the world, political, economical, sporting, or whatever it is that holds your interest.

W. L. DUSENBERRY

The Growing American Taste for Beauty and What the Bell System is Doing to Satisfy It

ONE of the most encouraging tendencies in our modern American life is the increasing appreciation of beauty which is manifest everywhere. Until within the last few decades the American people poured nearly all their energies into the material tasks of settling a continent and building a nation. There was little time for the cultivation of a taste for the beautiful. But today the modern spirit finds opportunity to explore the satisfactions of increased attention to beauty; and the expression of that spirit is rapidly transforming the American scene. Ugly things, drab furnishings, uninspiring buildings are gradually giving way to new creations which satisfy the modern taste for the beautiful and which are expressive of the modern mind.

The beauties of landscape, too, are much more widely appreciated than once they were. Our National Parks bear eloquent witness to that. For additional evidence we need look no further than the Palisades on the Hudson, which the Victorian era started to use as trap-rock quarries, but which are now preserved as a public park. The movement against unsightly bill-boards, especially along scenic highways, is another manifestation of the same trend.

For this increasing appreciation of natural scenery, the automobile is largely responsible. With the good roads which it has brought forth, the beauties of hill and dale, moor and mountain, seashore and lake have become accessible to millions whose horizon would otherwise be bounded by city streets or by the unlovely environs of a provincial town.

The cars that took the lead in thus broadening the horizon of the modern American family were unquestionably the old models dedicated uncompromisingly to utility and economy without noticeable regard for beauty. It is a far cry indeed from the old black pre-war automobiles, tall and angular, to the swift and silent cars of the present day, brilliant of color, long, low and luxurious—graceful embodiments of the modern spirit of speed and comfort.

Despite their undeniable utility and economy the old cars had to give place to the new, in which the popular demand for beauty is fully recognized and met. Color, stream-lines, chromium plate—you can make an efficient motor-car without any of these, but it will not meet the present day demand for beauty. And those whose prosperity depends on satisfying the public realize that they must cater to that demand, they must keep in line with the modern trend.

We see the results all about us, in a myriad forms, affecting the appearance of countless articles of everyday use. This is an industrial age and it is the products of industry that primarily reflect the spirit of the time. "I salute the workers in physical research as the poets of today . . ." says Owen D. Young. "They appeal to the imagination of us all. They contribute the warming glow of inspiration to industry, and when industry pulls their ideas down from the heavens to the earth and harnesses them for practical service, it too feels that it is an important actor, not only in the making of things, but on the larger stage of the human spirit. There may be enough poetry in the whir of our machines so that our machine age will become immortal."

It is the workers in physical research, of whom Mr. Young speaks, that have brought from the fields of industrial chemistry a rich selection of new materials, combinations, alloys, colors and the like. In the hands of skilled designers these new mediums of expression have been turned to countless uses in beautifying otherwise prosaic products and affording scope for the exercise of creative artistic imagination. A few examples that come to mind are chromium plating, monel metal, the new quick-drying lacquers, improvements in color printing, neon gas glow lamps, bakelite, fabrikoid, imitation tortoise-shell, cellophane, rayon, improved linoleum, indirect lighting, colored flood lighting of buildings and the like. The list could be extended indefinitely.

Beauty is achieved, however, not only through the use of new processes and new products but also through the application of old techniques in a new spirit. The development of new and more artistic typefaces is one example. The notable recent progress in interior decoration is another. The tasteful assembly of furniture and furnishings, rugs, draperies, pictures, mirrors and lighting fixtures that are not only beautiful in themselves but that harmonize and blend to form an attractive interior, has achieved a great vogue in recent years. The services of professional decorators are in demand not only for residential but also for business interiors. Contrast the modern specialty shop—or even the modern grocery-store—with its prototype of twenty years ago and you cannot fail to appreciate what progress has been made toward meeting the popular demand for beauty in the field of retail shopping.

The contents of the shops, too, have in many cases been carefully beautified. There has always been some striving after beauty in women's clothes, but today beauty and style have completely superseded durability in this field. Where are the black cotton stockings of a former day? Even the serviceable black leather shoes that went with them have wellnigh disappeared. The women's shoe business has become like the millinery trade, a kaleidoscope of rapidly changing styles, varied materials and designs, and pleasing colors.

Much attention has been given, also, to presenting merchandise in attractive packages. The huge growth in the demand for perfumes and cosmetics in recent years reflects the all-pervading attention to beauty. It has, however, been substantially stimulated by the attractive array of decorative jars, bottles and boxes in which such articles are sold. Even food products are displayed in tempting guise, and the rapid turnover of package foods is encouraged by the attractiveness as well as the convenience of the handy containers.

A volume could be written on the increasing use of color in the general beautification of the adjuncts of life. Its application to automobiles, women's shoes and stockings, neon lights and floodlighting, has already been mentioned. From the garage it overflowed into the kitchen, and the granite-wear utensils of yesteryear were displaced by pots and pans gay with red or blue or yellow enamel. Here and there a gas-stove, a refrigerator or a set of wash-tubs blossomed out in vivid hues. The bath-room was the next to feel the influence and tiles, fixtures and accessories were inundated with a flood of color. No longer did it resemble the sanitary but chilly dairy-lunch or hospital operating-room,—white porcelain and tiles gave way to variegated brilliance suggesting sometimes the rather barbaric splendor of an oriental palace.

Time would be lacking to tell of all the varied manifestations of this modern urge for beauty—of colored fountain pens and cameras and gasoline-pumps, of camouflaged gas-tanks and colored electric signs, of the enthusiasm for esthetic dancing and rhythm, of the fad for dieting, of regional planning, of artistic design applied to coins and stamps, of village improvement societies and the magazines devoted to beautiful homes and gardens, of the improvement in moving picture artistry and in magazine illustration and poster art, in the design of motor-boats and in architecture, both residential and business. All of these and many more are instances of this same urge for beauty which makes itself felt in many ways till it seems in a sense to form the unifying influence that co-ordinates many of the diverse activities of our time. As Myron C. Taylor has put it: "Love of beauty, an inquiring mind as to higher spiritual things, is evidenced as a growing force in the community. . . ."

What, then, is the Bell System doing to co-operate with this trend? Operating, as it does, a nation-wide service of personal communication, having more contacts with the public than any other business enterprise, it is fitting that the Bell System should be responsive to such trends of popular thought as make for a fuller and more satisfying life. In some respects, the Bell System is in a position to advance signally the movement for beautification of the American scene. Of course, the beautification of all the Bell System's far-flung instrumentalities of service is not the work of a day. It is a gradual process, carefully planned and long-continued, a step here, a step there, as economic considerations warrant. In newly developed communities, in new telephone buildings, in new installations generally, considerations as to appearances can be given great weight. Much has already been done and more will be accomplished in the future toward beautifying the innumerable instrumentalities through which the telephone service is carried on. In all of these, utility must of course remain the primary consideration, but beauty is a factor of increasing importance.

The telephone instrument—which to so many users epitomizes the whole telephone service—is a case in point. For all practical purposes the standard Bell System desk telephone is satisfactory. But it is not distinguished for beauty and there is no question that the telephone hand-set fits in better with modern decorations and gives an up-to-date touch to the home or office of today.

In the design of this instrument it was first necessary to overcome the technical difficulties of securing satisfactory service with the transmitter and receiver combined. The essential specifications as to the size of these and other parts were worked out by Bell System engineers after careful tests. The distance between transmitter and receiver, for example, was determined by the average distance between the human ear and mouth. The size of the "cradle" had to leave room for springs and for a dial of certain dimensions. These matters having been decided, various designs were worked out and commercial artists, of the same calibre as those who design new automobile bodies and the like, were retained to pass on the designs and suggest improvements from the standpoint of artistic appearance. The result has been the hand-set as we see it today—low, simple and giving the streamline effect which appeals to discriminating modern taste.

Special designs have been worked out, too, for particular uses, such as subsets for outdoor use at taxistands and elsewhere, and intercommunicating sets for large residences and small offices. In these last the design of the buttons in the base of the hand-set, by which connections are established, was given special attention to make sure that they should be simple and easy to work. Suggestions from the consulting artist cover such matters as whether the corners of the wall mountings should be bevelled or rounded, and the provision of chromium-plated face plates, molded phenol plastic housings and other slight changes to improve the appearance of the small push-button type keys used in connection with wiring plans.

The placing of the instruments when they come into use has also received careful attention. Bell System engineers have co-operated with the manufacturers of steel and wooden desks, telephone tables and cabinets in working out designs for convenient and attractive receptacles for the telephone and for the telephone directories.

Telephone installers have been instructed and trained to make the interior wiring necessary for connecting up the telephone as inconspicuous as possible. Much can be done by the installer, but in order to attain the best results along this line the Bell System has been active in encouraging architects and builders to provide wire runways in the walls and floors of new buildings with outlets at convenient points, so that whatever the arrangement of the furniture, the telephone wires can be kept out of sight. This suggestion has been stressed in Bell

System advertisements in building and architectural journals and in booklets distributed among architects and builders.

Where telephone booths are to be installed the Bell System has encouraged the provision of built-in booths specially designed to harmonize architecturally with the interiors in which they are placed. Improvements have also been made in the appearance of the standard booths and 25,000 of the better looking type have been placed in service.

Systematic attention has also been given to improving the appearance of telephone plant outside as well as inside the subscribers' premises. Great progress has been made in placing telephone cables underground and in the congested sections of our large cities the telephone plant is practically all out of sight. In many smaller cities and in suburban residential areas, too, the telephone network has been put underground, including both the main cables and those connecting them with the subscribers' premises. At present practically two-thirds of the entire mileage of Bell System wire is in underground cable.

In localities where economic conditions do not warrant the considerable additional expense of placing telephone cables underground it has often been possible to utilize aerial cable (which now makes up more than 27 per cent of the total Bell System wire mileage). Such cable, suspended from short, sturdy poles, is less conspicuous than a like number of circuits in the form of open wire. In many residential neighborhoods the telephone cables are run along alleys or on the rear line of properties, avoiding the necessity of pole lines along the streets, and thus enhancing the attractiveness of the community. Similarly, toll and long distance lines are frequently constructed on private rights of way, rather than along main highways.

Much attention is also paid to keeping up the appearance of Bell System pole-lines. The use of shapely poles, the elimination of broken attachments, and the erection of cable in uniform spans, help to keep the telephone pole-lines inconspicuous. It is not practical to paint the poles because they would soon be scratched and marred by the climbing-irons of the linemen. Vines cannot be trained about them, either, for they would interfere with the work of the linemen and would cause leakage of current from the wires. But the end desired is attained in other ways.

Where connections are made between overhead and underground cable, the somewhat bulky cable terminal boxes are much reduced in numbers and are located at inconspicuous points away from the front of residences or other buildings where they might be objectionable on esthetic grounds. Guy wires, too, are placed in such a way as to render them relatively inconspicuous.

In the matter of tree-trimming along aerial telephone lines, the Bell System is giving practical proof of its interest in the movement for landscape beautification. Pruning specifications have been issued establishing an orderly routine for tree-trimming and instructing telephone linemen how to prune trees without permanently marring their beauty. These specifications have met with the approval of Shade Tree Commissions in several States. Some of the Bell Telephone Companies have employed outside firms of tree experts to do their trimming for them, thus assuring property-owners of having the work done by experienced specialists. The attention paid to the protection of trees from damage due to pruning was recently cited by Earnest Elmo Calkins as an "encouraging phase of the telephone policy" of giving thought to improving the appearance of Bell System plant.

Then there are the telephone motor vehicles, approximately 20,000 of them operating all over the country. Much care is being given to securing a pleasing appearance so that they may be a credit to the Bell System and to the communities in which they operate. The Associated Companies of the Bell System and the American Telephone and Telegraph Company undertook, some years ago, extensive experiments with various colors for the purpose of working out a standard color scheme for trucks that should be both practical and attractive. Panels showing seven or eight colors for truck assemblies were prepared and the Bell Telephone Laboratories engaged in research for the purpose of improving the lacquers and finish and the method of application. As a result, uniform color schemes for Bell System trucks were worked out, providing for either a sagebrush green or a blue-gray color, centering on the former. The lettering and figures and the familiar Bell seal are being given systematic attention and attractive designs have been developed which are put on by transfer. The introduction of these improvements is necessarily gradual, owing to economic considerations, but progress is being made in the right direction.

At the same time much attention has been given to designing the lines of the truck bodies for beauty as well as utility. In the case of certain makes, de luxe bodies, which resemble passenger automobiles rather than trucks, have been standardized. The design of the truck cabs has been modified to resemble a coupé, and facilities for carrying tools and materials have been so arranged as to make them orderly and inconspicuous. In addition, every effort has been made during the last few years to make the trailers, pole-setting and earth boring equipment, etc., conform with the general design of the vehicles.

The zeal for good appearances has even in a few cities been carried experimentally to the extent of having a uniformed force make deliveries of telephone directories to subscribers. The appearance of the directories themselves has been made much better during recent years by the gradual elimination of advertising from the covers and by the adoption of more pleasing cover-stock. The inside of the directories has also been greatly improved by new and more attractive type-faces (especially developed for use in telephone directories), by rearrangement of the page make-up—particularly in the classified sections—and by the standardization, as to size and shape, of the advertisements printed in the directories. The introduction of Trade Mark Listings (showing the names, addresses and telephone numbers of authorized dealers listed under the names, trade-marks and brief descriptions of advertised products) also enhances the appearance as well as adding to the usefulness of the classified telephone directories.

But, when all is said and done, it is in its buildings that the Bell System most strikingly exemplifies the careful attention given to the beautification of its facilities for service.

In their design and construction, these buildings, large and small, reflect the policies of the Bell System. They are planned to provide at reasonable cost for present service needs and for the continuing growth of telephone use. Modern in conception, they also reflect in their substantial character and careful planning something of the System's stability and its regard for the comfort and convenience of its customers and its employees. These buildings contribute toward the achievement of the ideals of the communities in which they are located and exemplify the progressive spirit which has made possible modern telephone communication as it is today and as it will be in the years to come.

Several of them contain decorative features of outstanding beauty. Notable among these are the impressive mural paintings in the new Headquarters Building of the Mountain States Telephone and Telegraph Company at Denver. These include allegorical representations of The Crucible of Science and The Wings of Thought, besides more mundane subjects such as The Lineman and The Cable Reel Crew. Historical themes appropriate to the locality inspired paintings of the Indians' Smoke Signal and of the Pony Express. The Spirit of Service is represented in symbolic pictures of an operator and of a repairman. "They are all," said Allen True, the Colorado artist who painted them, "intended to beautify the place where the company meets its patrons and are but another expression of its actuating principle which is service to the public."

Many other Bell System buildings contain artistic decorations which testify to the attention paid to matters of beauty.

Among these may be mentioned the group of statuary representing the Spirit of Service in the Telephone and Telegraph Building at 195 Broadway, New York, and the great colonnaded marble lobby in which it stands. The restrainedly modernistic decorations in the Newark Headquarters Building of the New Jersey Bell Telephone Company, the ornamental hanging lamps in the New York Telephone Company's Headquarters, and the rich ceiling on the ground floor of the Pacific Telephone and Telegraph Company's Headquarters at San Francisco, are other examples of the careful attention paid to decoration.

In this connection it may be mentioned that a few years ago the American Telephone and Telegraph Company presented to the Smithsonian Institution at Washington a bust of Alexander Graham Bell, who was formerly one of the Regents of the Institution. The bust was the work of the well-known sculptor, Victor Salvatore, of New York.

The counterless business offices which have come into general use during the last few years are another earnest of the Bell System's interest in improving the appearance of its facilities. The provision of individual desks, at which the company's representatives transact business with its customers, is primarily in the interest of giving more personal and more satisfactory service than is generally attained in dealings across a counter. But it also undoubtedly enhances the attractive appearance of the telephone company's business offices.

The Bell System is thus not unmindful of the modern trend toward putting added emphasis on beauty. It conforms to that trend while at the same time giving every attention to the efficiency and economy which must always be the foremost considerations in the rendition of its indispensable communication service. Evidence of the interest and attention given to matters of beauty may be found, as has been pointed out, in the design, installation and maintenance of Bell System instruments and other plant, both on the subscribers' premises and in the open; in the neat and attractive appearance of telephone trucks; and of telephone directories; and last but not least in the buildings which house the telephone equipment and the telephone workers and which are designed to be a credit to the Bell System and a source of pride to the communities in which they stand.

RICHARD STORRS COE

Population Changes in Small Communities and in Rural Areas

IN spite of the increase of 17,000,000 in the population of the United States between 1920 and 1930, recorded by the latest Federal Census, more than a third of the counties and about 40 per cent of the incorporated places actually lost inhabitants during the decade. Declines or slow growth were particularly characteristic of rural areas and of small communities, although there were a few very exceptional gains in such places. Since territory of this type has always presented some especially difficult problems from the standpoint of the telephone industry, some analysis of the census returns to determine what is occurring in these areas and what future changes are indicated by present trends may be important.

There are 14,842 telephone exchanges in the United States with under 500 telephones each, of which number 8,762 have less than 200 telephones. Generally, each of these exchanges covers one or more small communities and considerable contiguous rural territory. It has always been difficult to furnish such areas with telephone service comparable with that given to large communities, and often the operation of the small exchanges, considered by themselves, has not been financially profitable. Automobiles, good roads, and other factors in our economic life are tending to reduce the population in the rural sections of these exchanges and sometimes to wipe out entirely the central community.

Changes in Rural Counties

More than 600 counties, out of a total of 3,073, now have a smaller population than they had in 1890, although in the meantime the United States has doubled the number of its inhabitants. Indeed, over 2.5 per cent of all the counties had fewer people at the time of the 1930 census than they had in 1850 when the population of the country was only one-fifth of its present size. In many instances the losses have been steady decade after decade, but in other cases the decline during the last ten years wiped out the large gains of preceding intercensal periods.

The number of counties losing population between 1920 and 1930 exceeded 1,100, while as a result of outward migration an additional 1,000 counties lost at least part of their natural increase. Moreover, there were declines in the rural portions of one-third of the counties which gained in total population; and such gains as were recorded in rural counties were generally slight (with some notable exceptions) and frequently occurred in small communities arbitrarily classed by the census as rural rather than in scattered territory of purely rural character.

The population changes in rural counties are naturally associated with the radical developments which have been taking place in agriculture. Modern farming methods and the use of power machinery have permitted a greatly increased output per worker, with a consequent decrease in the amount of labor required. Consolidation of farm holdings and the abandonment of marginal crop lands have caused a reduction of 150,466, or 2.3 per cent, in the number of farms in the United States since 1920. The 1,805 counties with fewer farms in 1930 than in 1920 may be compared with the approximately 1,800 which either lost in total population or suffered rural losses.

While the losses in both farms and rural population were distributed very similarly by counties throughout all 48 states, a detailed comparison shows in a few instances partial inconsistencies in the correlation. The explanation of some of these lies in the changes which have taken place in coal mining during the last decade. For example, the increased efficiency in mining methods has made possible a material reduction in the number of wage earners and has contributed towards heavier population losses in some areas than would have been caused by the decline in agriculture alone. On the other hand, the shift of coal mining from one location to another has brought about rural gains in some counties which lost farms. Factors contributing to rural gains in the face of agricultural and mining losses have been the rapid growth of essentially industrial communities, such as the unincorporated textile mill villages in certain southern states, the increases in suburban areas whose population cannot be separated from the census "rural" (based on an arbitrary definition), and the development of resort sections where catering to tourists has proved more profitable than farming.

While the rural counties generally lost population and their declines can be explained by the shrinkage in the labor demands of the extractive industries, some rural counties had tremendous gains. Particularly in the semi-arid high plains extending from southwestern Texas to western Nebraska, the substitution of field crops for grazing has brought about a rapid growth. Large-scale wheat production has been undertaken in the northern portion of the area, while in the remainder (as yet free from the boll weevil infestation of much of the South) the profit to be derived from a mechanized cotton production during an era of high prices has led to a great expansion of that industry. Since the census was taken cotton prices have dropped drastically, which lessens the possibility of further development in this area.

In fact, it is questionable whether the gains of the past decade may be considered permanent if lower cotton prices are accompanied by years of subnormal rainfall such as recur in this section of the country. The amount of moisture is often the deciding factor between success and failure in farming. For example, there may be a period of years in which the average rainfall is exceeded and a series of good crops are realized. This temporary success encourages many new settlers to undertake farming in the region. Then will follow several years of subnormal precipitation when crops fail completely and the recent migrants abandon their farms and move elsewhere.

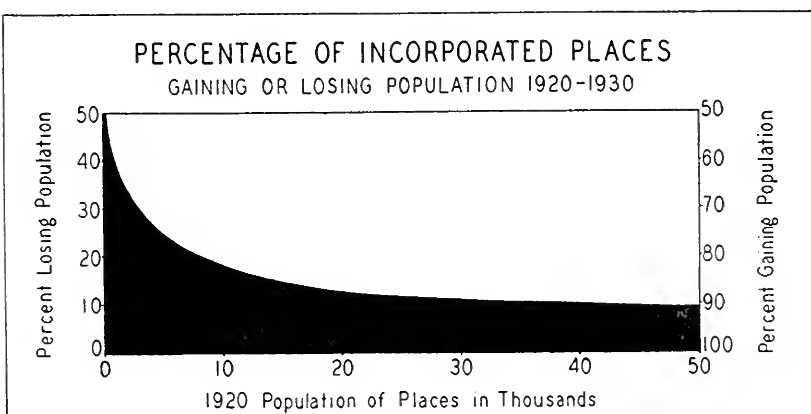
Considerable rural gains occurred in other areas perhaps better suited for continued crop cultivation. The most notable increases were in Florida, California and southeastern Texas. It is possible, however, that the future growth of these areas will repeat the history of other sections of the country just beyond the frontier stage of development, where first gains have proved to be excessive and periods of declining population and readjustment have soon followed. For example, it is possible to trace the progressive movement of population by successive decades through broad though rather well-defined territorial belts. Between 1890 and 1900 many counties in the strip extending from southern Minnesota through Iowa, Missouri and Arkansas grew rapidly but lost population in the next decade. Likewise from 1900 to 1910, numerous rural counties in the band of states including South Dakota, Nebraska, Kansas, and Oklahoma gained heavily, only to lose during the following ten-year period. As migration proceeded further west, various counties in North Dakota, Montana, Wyoming, Colorado and New Mexico experienced substantial increases between 1910 and 1920 and then lost considerable numbers in the past decade.

Perhaps Montana is the most outstanding example of recent rural population losses. The State as a whole (almost entirely rural) gained 172,836 or 46 per cent from 1910 to 1920, but lost 11,283 between 1920 and 1930. Here much land was brought under cultivation during the war period under the stimulus of high prices for wheat. After the reserve of accumulated moisture was exhausted, however, many producers were forced to abandon their holdings as reduced yields and low prices combined to render their operations unprofitable.

Changes in Small Communities

About 6,200 incorporated places, in which number every State in the Union had a share, lost population between 1920 and 1930. These losses occurred in communities of widely different sizes, ranging from such small places as Arundel-on-the-Bay, Maryland, which declined from 12 persons in 1920 to 1 in 1930, and Douglas, Arkansas, which lost 146 of its 151 population in 1920, to such cities as Lowell, which lost 12,525 during the decade, and New Bedford, whose size in 1930 was only 93 per cent of its 121,217 population in 1920.

The census returns for incorporated places showed a wide variation in the proportion of the different sized groups losing population. The principal declines occurred in the small communities whereas in general the larger cities grew, many of them very rapidly. This change might be aptly characterized by paraphrasing an old Biblical passage to read—To the city that hath shall be given, and from the community that hath little even that which it hath shall be taken away. The distribution of losses and gains, by size of place, among incorporated places of less than 50,000 inhabitants is shown in the accompanying chart.



The geographical distribution of the population losses in incorporated places is significant. The general tendency was for the proportion of losing communities having under 2,000 inhabitants in 1920 to increase from east to west. For example, in the group of places of 500 or less, the percentages ranged in the northern half of the country from 29.4 in the New England and Middle Atlantic States through 51.2 in the East North Central region and 55.3 in the West North Central to 57.8 in the Pacific Northwest; in the southern area the corresponding percentages were South Atlantic 35.8, East South Central 40.4, West South Central 50.6 and the Pacific Southwest 44.6. This last figure, reflecting the only exception to the general trend, may be accounted for by the heavy growth in resort and retired population in California, while the explanation for the other geographical differentials lies mainly in the fact that in the East many of the places are at least partly industrial in character and consequently less subject to population declines than are the trading towns further west, which are largely dependent on the prosperity and buying habits of the surrounding rural territory.

Moreover, the evidence available indicates that the unincorporated places as well as the small incorporated communities declined both in size and in number during the past decade, many having practically if not actually disappeared. According to the 1921 edition of a standard atlas, about 129,000 places were in existence in 1920. Nearly 16,000 of these communities were incorporated and a few thousand more were located within the boundaries of large cities or in suburban territory. Thus there were about 110,000 unincorporated places in the United States in 1920, with an average population of less than 100. Comparative figures from the 1931 atlas indicate a net loss of about 8,000 places during the past decade. That this decline of 6.2 per cent is some measure of the number of places which have passed out of existence is corroborated by the reduction of 6.8 per cent in the number of post offices during the same period. Since there has been little change in the number of incorporated places, it may be judged that the decline has been chiefly in unincorporated communities.

The losses in the small communities during the past decade must be interpreted in the light of the economic conditions prevailing at the dates of the two most recent censuses. In 1920 industrial activity was at a high level and had drawn many workers from small places into the large cities; in 1930, on the other hand, a considerable number of urban workers under the stress of unemployment had perhaps returned home to rural areas for a time. Consequently, it is possible that the actual declines of the small communities exceed substantially the losses recorded by the census.

In the widespread tendency for small places to suffer rather heavy losses during the past decade, one type of community fared decidedly better than the group as a whole. This favored class included the county seats all over the country, which benefited appreciably by reason of the concentration of judicial, political, and associated business activities within their confines, and from the added advantages of a central location and good roads. Thus, most of the county seats in the rural areas gained population, usually at the expense of other places in the surrounding territory. This growth, however, may not continue much longer, as accessibility to larger centers becomes more general and as proposals looking toward consolidation of counties, or at least of administrative headquarters, tend to bring about reduced per capita governmental costs in declining territory where taxes might become excessively burdensome.

Percentage of Places Losing Population, 1920–1930

Size	All Incorporated Communities	County Seats
Under 500	48.5	20.0
500–1,000	47.2	26.1
1,000–1,500	41.2	30.0
1,500–2,000	33.0	29.5
2,000–2,500	31.4	25.9
2,500–5,000	23.3	19.3
Over 5,000	16.4	14.4
Total	41.0	21.8

Effect of the Automobile on Population Distribution

The fact that many small places lost population and at the same time the county seats of similar size were doing relatively better suggests the possibility that the influence of the automobile and good roads in facilitating travel may be responsible for increasing the distances between growing communities. It has frequently been said in connection with rural transportation that the range of travel for ordinary purposes was formerly necessarily limited to the distance which could be conveniently covered by horse-drawn vehicles, perforce only a few miles in most rural areas. This is one reason why the average distance between places in the United States is approximately five to six miles. The assumption that factors contributing to easier and faster transportation are tending to place growing towns farther apart is supported by the fact that, while all incorporated communities are separated by an average distance of 15 to 16 miles, those which gained population between 1920 and 1930 are located 20 to 21 miles apart. Moreover, the towns along major highways, especially those carrying through traffic, appear to be doing better than other places of comparable size.

PER CENT GAIN IN POPULATION IN SMALL INCORPORATED PLACES IN COUNTIES TRAVERSED BY REPRESENTATIVE HIGHWAYS

State	Places with Less Than 1,000 Inhabitants in 1920		Places with 1,000–2,500 Inhabitants in 1920	
	On Highways	Off Highways	On Highways	Off Highways
Virginia	22.2	13.8	19.6	5.3
Tennessee	14.5	0.5	20.6	−1.8
Illinois	−2.8	−10.3	3.7	−9.5
Nebraska	9.5	4.5	19.4	−6.7
North Dakota	4.7	−0.9	−2.7	0.9
Oregon	−3.1	−2.3	22.1	−0.7
Total Group	5.5	−2.0	12.0	−3.8

The influence of the automobile as a contributing factor to the decline in rural population has perhaps only just begun to register its potential possibilities, for it was not until the middle of the past decade that car ownership became quite general and construction of improved roads reached large proportions. And in large sections of the country the development of all-weather roads is still to come. Thus, the effects of the continued expansion of paved roads and the accompanying increase in automobile ownership during the present decade should be much more pronounced than anything in the past.

Effect of Rural Losses on Small Telephone Exchanges

In view of the type of places either losing population or remaining stationary, it may be interesting to see to what extent the telephone industry is affected. All parts of the country, of course, have many exchanges of relatively small size, the number of places with exchanges of less than 200 telephones totaling 8,762, as previously mentioned. About 4,800 of these are in unincorporated places essentially no different from the many rural areas declining in size. Of the remaining 4,000 exchanges (located in incorporated communities), approximately one-half were in communities which lost population between 1920 and 1930.

In general, these small exchanges have been of the type which often experience plant and commercial difficulties by reason of their small scale operations in a rural market of marginal characteristics. The significance of population losses in small places may be more apparent when it is noted that over 500 Bell exchanges having less than 200 subscribers each in 1930 suffered a net decline in telephones during the last five years, which was a period of rapid increase in overall telephone development. The continued building of good roads and the wider use of automobiles, together with a further decline in rural industries, may tend to accentuate the so-called rural problem, which has always been a serious one for the telephone industry.

R. L. Tomblen

The Russell Portrait of Alexander Graham Bell

THE British Institution of Electrical Engineers has paid its tribute to Alexander Graham Bell as one of the great geniuses of the electrical science and art by placing a portrait of him on the walls of its auditorum in London. Recognizing him not simply as the inventor of the Telephone, but as an outstanding figure in the whole field of the knowledge and use of electricity, Dr. Bell is represented not as the young man of twenty-nine, but as the white-haired and bearded man of years at the height of his career. The portrait was presented to the Institution by Sir Hugo Hirst, Bart., and unveiled at the regular meeting on January 8, 1931. It was received by the many eminent engineers present with the heartiest appreciation and applause.

The desire of the Institution to honor Dr. Bell in this way was first communicated more than two years ago by Colonel Sir Thomas F. Purves, Engineer-in-Chief of the General Post Office of England, in a letter to Bancroft Gherardi, Vice President of the American Telephone and Telegraph Company. From the standpoint of painting the problem was not a simple one, for only one portrait of Dr. Bell, as it happened, had ever been painted, and that did not represent him in the period or character that was appropriate for the present purpose. Nor of course would any mere color copying of a single photograph answer. The painter would have to construct his portrait from a number of photographs and gain his understanding of Dr. Bell's character and temperament and manner from biographical material. Every assistance possible was gladly given not only by those in the Company to whom the matter was referred, but by Dr. Gilbert Grosvenor, and Mrs. Grosvenor, Dr. Bell's daughter, and others of the family. Those actively interested in the matter in England expressed their sincere appreciation of this American co-operation, and the result is evidenced by the fine achievement of the painter. Some idea of the portrait may be gathered from the reproduction used as the frontispiece of this number, if it be remembered that black and white reproduction can never give the full effect of anything that is done in color and that is intended to be seen in color and not merely in drawing and tone.

One question that presented peculiar difficulty will be of interest to everyone. Of what color were Dr. Bell's eyes? The first round of inquiry sent to those who, it seemed, would be able to answer authoritatively brought a confusion of testimony. Some said brown; some said hazel; some actually said black, though nothing is really black. It may be remembered that when the Salvatore bust of Dr. Bell was presented to the Smithsonian Institution by Mr. Walter S. Gifford, as President of the American Telephone and Telegraph Company, Chief Justice William H. Taft, receiving it as Chancellor of the Board of Regents, and praising the bust as a remarkable likeness, spoke of the unique character of Dr. Bell's eyes, which no one could forget and which nothing could reproduce. So now in this inquiry, however widely they disagreed as to the color, all agreed that his eyes glowed. It came down eventually to the conclusion that Dr. Bell's eyes in color were medium dark brown, as was said by his early associate, Thomas A. Watson, and by Theodore Spicer-Simson, an artist who had frequently studied his face, but that at times of intense interest or emotion, which were not seldom, the pupils of his eyes dilated to an unusual degree and gave his eyes the glowing effect of actually being black. This quality it will be seen the painter has secured.

For the painting of this portrait the British committee decided to give the commission to Walter Westley Russell, R.A. Mr. Russell is noted in England for the subtle yet firm understanding of character in his portrait work, an understanding which is aided withal by a strong but well subordinated sense of humor. He is also noted as a teacher; it is sufficient to say in this respect that Sir William Orpen and Augustus John were his pupils. Genre scenes of almost rowdy humor, and landscapes in oil and in watercolor of exquisite delicacy and mastery of color indicate the range of his ability. His paintings are treasured in many of the most important galleries of England and of the British Empire. Since 1927 Mr. Russell has had charge with the title of Keeper of the Royal Academy of the art collections of that famous body of painters and sculptors.

Sir Hugo Hirst, who presented the portrait of Dr. Bell to the British Institution of Electrical Engineers, is one of the leading industrialists of England. He is Chairman and Managing Director of the General Electric Company, Limited, but his interests are by no means circumscribed by his duties in that capacity. The working conditions of employees, their sports and education, coal mining, the industrial situation in Australia, football and the turf, breeding and scientific agriculture, all come within his amply diversified range. And now for the second time he has been elected Master of the Glaziers Company, one of the oldest of the City Guilds of London, and with historical enthusiasm is undertaking to rebuild the hall of that Company, which was destroyed in the Great Fire of 1666. It will be recognized as quite natural that a man of such wide and generous interests should take a special interest in a man of such intense, such human and diverse interests as Alexander Graham Bell and should take the lead in placing a notable portrait of him on the walls of the British Institution of Electrical Engineers.

William Chauncy Langdon

Notes on Recent Occurrences

NEW SHIP-TO-SHORE TRANSMITTING STATION OPENED AT OCEANGATE, NEW JERSEY

NEW transmitting facilities for contact between the Bell System and ships at sea were made available on January 15 when the radio telephone transmitting station of the American Telephone and Telegraph Company at Oceangate, N. J., went into service. The station was in communication during the day with the *Leviathan* of the United States Lines and the *Majestic* and *Homeric* of the White Star Line. The *Majestic* was three-quarters of the way across to Europe while the *Homeric* was a few hundred miles off the coast of Ireland. The *Leviathan* was a few hundred miles off the American coast bound for England.

The Oceangate station was also used in endeavoring to keep in communication with the *Belgenland* of the Red Star Line, while far out on the Pacific bound for the Orient on a round-the-world cruise. In this endeavor, Bell System engineers set up a special antenna array at Oceangate with marked directional characteristics and capable of rotation so as to point in different directions.

The Oceangate transmitter operates on short waves in the range of from 17 and 63 meters. The power delivered to any one of four antenna arrays is about 15 kilowatts. These arrays are of the "curtain" type and have directional properties, the energy emitted being confined to directions covering the principal steamship lanes to Europe.

During the construction of the Oceangate station the transmitting end of ship-to-shore telephone service on the American side was handled by the experimental radio station of the Bell Telephone Laboratories at Deal Beach, N. J. It was this station that inaugurated ship-to-shore service in December, 1929, with the *Leviathan,* handling a record volume of holiday traffic while that vessel was approaching New York just before Christmas. Through it service was also opened with the *Majestic,* the *Homeric* and the *Olympic,* and several conversations were handled to and from the *Belgenland,* including a broadcast by Albert Einstein when the *Belgenland* was off the coast of Central America in the Pacific.

The receiving station for ship-to-shore service on the American side is at Forked River, N. J., a few miles from Oceangate. This station's antenna arrays also have directional characteristics.

Oceangate and Forked River are connected to Bell System telephones through the long distance center of the American Telephone and Telegraph Company at New York. By means of this link the four transatlantic liners are in touch, throughout the greater part of a voyage, with all telephones in the United States, Canada, Cuba and Mexico.

ANOTHER TELEPHONE CABLE TO CUBA GOES INTO SERVICE

A TELEPHONE call from New York City to Havana on January 22 marked the opening of commercial service over the first circuit in the new undersea telephone cable between Key West, Florida, and Havana. At Key West the cable connects with the Bell System, while at Havana it meets the lines of the Cuban Telephone Company.

With the three older telephone cables, the new cable is owned and operated by the Cuban American Telephone Company which is jointly owned by the American Telephone and Telegraph Company and the International Telephone and Telegraph Corporation. It is 125 land miles long, and at places lies a mile below the surface of the Florida Straits. Developed by the Bell Telephone Laboratories, it represents electrically the latest improvements in telephone cable design. By the application of carrier methods using high frequencies it provides as many telephone circuits as do the three older Key West-Havana cables combined.

The new cable was laid by the company which manufactured it—The Norddeutsche Seekablewerke of Nordenham, Germany. The course was buoyed beginning December 14. Following that, the various sections were laid, spliced and tested, after which a series of acceptance tests and overall tests of cable and apparatus was conducted.

ANNOUNCEMENT IS MADE OF A NEW NUMERICAL CENTER OF TELEPHONES

ANNOUNCEMENT was recently made by the Chief Statistician's Division of the American Telephone and Telegraph Company that the "median point" of telephone development in the United States, sometimes referred to as the "numerical center of telephones," was located at the beginning of 1930 in Van Wert County, Ohio, at a distance of about twenty-four miles almost due west of the city of Lima, Ohio, and approximately ninety-five miles east of Logansport, Indiana.

The median point is the junction of the line dividing the number of telephones equally north and south with the line dividing them equally east and west and was determined as the intersection of the 40°44′ north parallel of latitude and the 84°34′ west meridian of longitude.

The median point of population was located in 1920 about six miles southwest of Union City, Ind., whereas the corresponding telephone point was situated at that time about ninety miles air line distance northwest of that city near Logansport, Ind. From 1920 to 1924 the median point of telephones moved about one mile in a northerly direction and approximately thirty-nine miles in an easterly direction. During the five years from 1924 to 1929 this point moved about one mile in a southerly direction and approximately fifty-six miles farther to the east.

Information is not yet available from the 1930 Census in regard to the movement of the median point of population during the decade from 1920 to 1930.

THE ANNUAL MEETING

THE annual meeting of stockholders of the American Telephone and Telegraph Company was held on March 31, 1931. It was voted to make the term of the corporate existence of the Company perpetual and to increase the authorized capital stock from $2,000,000,000 to $2,500,000,000. The Directors were re-elected, Arthur W. Page being elected a director to fill the vacancy caused by the recent death of Henry S. Howe.

TELEPHONE SERVICE TO JAVA

REGULAR telephone service between North America and the Island of Java in the Dutch East Indies began on April 1. Voices from Bell System telephones make the first leg of the journey over the regular transatlantic telephone channels. At London they are switched to Amsterdam over a land line and submarine cable. There they go on the air through a Dutch short wave station, to be received at Rantjaekek, the receiving station in Java. The transmitter is at Soerabaja. The telephone network of the island, which embraces some 30,000 telephones, is connected to this radio circuit through the long distance center in Bandoeng.

During certain hours of the day connection is established through a German station near Berlin, instead of through the Dutch station. The overall length of the circuit from New York to Bandoeing via Amsterdam is about 10,400 miles, and via Berlin 10,900.

The service is available to all Bell and Bell-connected telephones in North America and to all telephones in Java. Calls are accepted at any hour of the day. The rate from New York and nearby states is $45 for the first three minutes and $15 for each additional minute.

There is a time difference of 12 hours and 20 minutes between New York and Java. When it is nine o'clock in the morning in New York, it is 9:20 in the evening in Java.

BELL TELEPHONE QUARTERLY

A Medium of Suggestion
and a Record of Progress

CONTENTS FOR JULY 1931

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International Radio Technical Conference at Copenhagen[1]

TOWARD the end of May, about 200 representatives from some 35 different countries met at Copenhagen, Denmark, to study the technical problems involved in the use of the common radio medium by the nations of the world. This gathering was the second meeting of the International Technical Consulting Committee on Radio Communication (C. C. I. R.) which was formed under the international treaty known as the Washington Radio Convention of 1927. This committee, as is indicated by its title, is advisory in character and deals with technical and engineering questions.

The questions studied are concerned largely with the reduction of interference between radio stations, including such factors as the degree to which radio stations may be expected to hold their frequencies constant and to confine their emissions to very narrow bands. While the technical advance represented by the findings of the meeting cannot be said to be as outstanding as that represented by the work of the previous meeting at The Hague in 1929, nevertheless the progress has been fully as great, particularly in respect to the consolidation of technical ideas concerning the problem of interference and the better *recognition* of the technical requirements which need to be observed.

Perhaps the most important single technical recommendation is that indicating the degree of constancy with which radio stations engaged in various services should be expected to hold their frequencies. The Copenhagen recommendation slightly relaxes the figures which the Hague Meeting had suggested for observance in the future, a result of a better appreciation of the practical difficulties involved. This very appreciation, coupled with the desire evidenced by all concerned to observe

[1] L. Espenschied, High Frequency Transmission Engineer, L. E. Whittemore, Special Radio Representative, both of the American Telephone and Telegraph Company, and W. Wilson, Assistant Director of Research of the Bell Telephone Laboratories, Inc., attended this conference as representatives of the Bell System in the United States delegation.—*Editor.*

the recommendations, represents real progress in the international co-ordination of radio channels.

Advice is given for the first time on several specific radiotelephone problems. The Conference has taken account of ship-to-shore radiotelephony and has drawn up a set of guiding principles for the establishment of systems engaged in this service, following the experience which has been obtained in the operation of the ship-to-shore telephone systems on the North Atlantic. The recommendation upon the subject includes information on the appropriate relations between the frequencies to be used for this service but does not go so far as to allocate frequencies.

The question of selectivity of receiving sets was discussed at the meeting but the study had not been carried far enough to permit of definite recommendations. It was left over for further study.

A related question which has now been raised for the first time before the C. C. I. R. is that of interference with radio reception from man-made sources, such as electrical contacts of various kinds. This refers especially to interference with broadcast reception in the home. Denmark has undertaken to act as a centralizing administration in collecting the information.

The problem, of how and for what purpose the various frequencies of the radio spectrum are to be used, is of course, a fundamental one in the whole radio situation. It involves other and even more important factors than the purely technical. The C. C. I. R. has no authority to deal with this question, and both the Hague and the Copenhagen Meetings have taken care to avoid it. However, it is distinctly in the background of the technical meetings, and the technical recommendations are carefully weighed in terms of their effect upon it. In fact it is because of this question of frequency allocation that the C. C. I. R. has considerably more governmental interest and is more formal in its conduct than are the corresponding telephone and telegraph technical committees which derive their authority under the International Wire Convention of St. Petersburg.

It is, therefore, of no small interest that the Copenhagen Conference has agreed that the C. C. I. R. would undertake a study of the physical side of this problem, i.e. of the uses to which the different frequencies are best adapted by virtue of their propagation characteristics. This study is to be co-ordinated by Great Britain, with a number of other nations collaborating, including the United States. It is planned that results from the study will be available in time for use at the next general radio conference which is to be held at Madrid in September, 1932.

The most immediate problem which has given rise to the need for this study is the desire on the part of the European broadcasting interests to make further use of the longer wave portion of the spectrum for European broadcasting. Such use would make inroads on the channels used for maritime services, and this in turn raises the question of the dependence which maritime communications may place upon the shorter waves. Naturally, any move in the direction of changing the uses to be made of certain wave bands is a disturbing factor and will raise the question whether the advantage is sufficiently outstanding to justify the undertaking of a readjustment, involving as it may serious economic, political and even juridical problems. Such questions as these can be dealt with only at major conferences such as that due to be held in Madrid in 1932. The agreement at Copenhagen to get in hand the physical facts of the case reflects a progressive and constructive attitude on the part of the conference members and may prove to be the most important outcome of the Copenhagen meeting.

No note on this conference would be complete without mention of the splendid facilities for it provided by the Danish Government. The great parliamentary building, Christiansborg Slot, was put at the disposal of the Meeting and the kindness and hospitality of the people of Denmark were evidenced on every occasion.

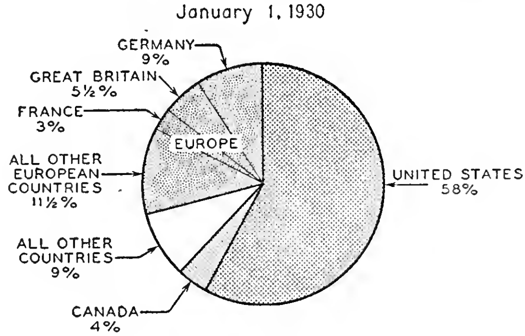
LLOYD ESPENSCHEID

World's Telephone Statistics

January 1, 1930

"I WAS 21 when I made the first telephone for Bell and I am still going strong." Thus spoke Dr. Thomas H. Watson before a gathering of telephone men in Indianapolis in the early part of May of this year. Watson constructed the first telephone in 1875. The latest world survey of telephone growth and development indicates that there were, on January 1, 1930, 34,526,629 telephones throughout the world. The rapidity of the growth of this means of communication, which has developed into a world-wide network of interconnected instruments during the lifetime of one man, can hardly be ap-

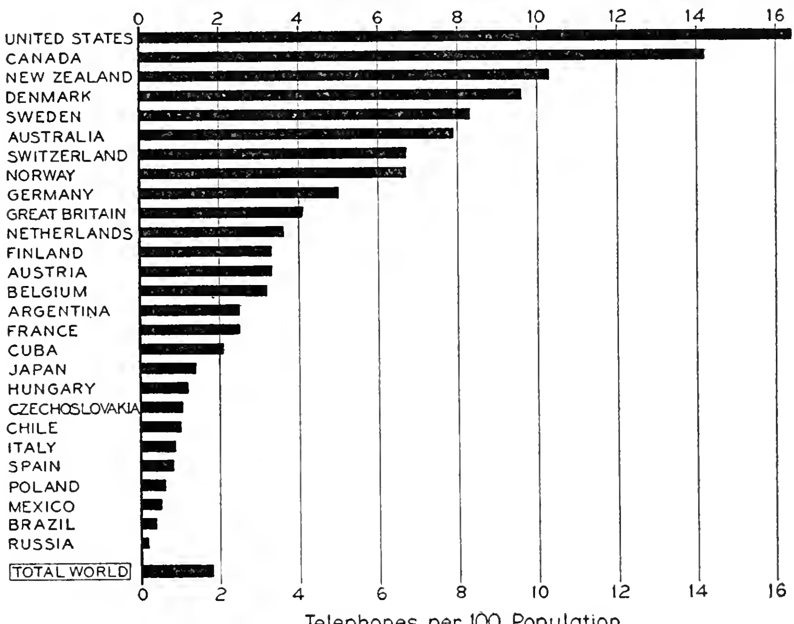
DISTRIBUTION OF THE WORLD'S TELEPHONES
January 1, 1930



preciated even by telephone people themselves. In fact, the telephone had reached its quasi-majority of twenty-one years of useful service before 80 per cent of the present Bell System workers were born.

This recent survey, conducted by the Chief Statistician's Division of the American Telephone and Telegraph Company, indicates that 1,962,409 instruments were added to the telephone networks throughout the world during the year 1929. This increase appears more significant when it is recalled that there were fewer than this number of telephones in the world at the beginning of the present century. Of the total number of telephones in the world on January 1, 1930, 20,068,023, or more than 58 per cent, were located in the United States; more than 99 per cent of these telephones were either owned by or connected to the Bell System. On the same date, Europe had 10,035,580 telephones, representing 29 per cent of the total in the world. The remaining 13 per cent of the world's tele-

TELEPHONES PER 100 POPULATION
January 1, 1930



phones were distributed among the countries of Asia, Africa, Oceania, South America and North America other than the United States.

The survey involved the gathering of authoritative information through correspondence with telephone officials in all foreign countries. As in former years, the data have been collated and printed in a pamphlet from which the accompanying tables and charts have been reproduced.

TELEPHONE DEVELOPMENT OF THE WORLD, BY COUNTRIES

January 1, 1930

	Number of Telephones					
	Government Systems	Private Companies	Total	Percent of Total World	Telephones per 100 Population	Increase in Number of Telephones During 1929
NORTH AMERICA:						
United States	......	20,068,023	20,068,023	58.12%	16.4	891,715
Canada	247,642	1,152,344	1,399,986	4.06%	14.2	65,452
Central America	11,892	12,739	24,631	.07%	0.4	974
Mexico	1,427	80,268	81,695	.24%	0.5	3,724
West Indies:						
Cuba	485	76,332	76,817	.22%	2.1	3,104
Porto Rico	404	11,856	12,260	.04%	0.8	—716
Other W. I. Places*	9,303	11,252	20,555	.06%	0.3	573
Other No. Am. Places*	100	11,309	11,409	.03%	3.2	1,214
Total	271,253	21,424,123	21,695,376	62.84%	13.0	966,040
EUROPE:						
Austria	222,236	......	222,236	.64%	3.3	12,766
Belgium	259,673	......	259,673	.75%	3.2	33,828
Bulgaria	18,505	......	18,505	.05%	0.3	1,414
Czechoslovakia	142,413	15,294	157,707	.46%	1.1	13,399
Denmark (March 31, 1930)	13,309	328,490	341,799	.99%	9.6	10,751
Finland	1,314	120,750	122,064	.35%	3.3	7,273
France	1,056,034	......	1,056,034	3.06%	2.5	90,515
Germany	3,182,305	......	3,182,305	9.22%	5.0	231,875
Great Britain and No. Ireland	1,886,726	......	1,886,726	5.47%	4.1	127,040
Greece*	13,000	......	13,000	.04%	0.2	3,000
Hungary	100,590	......	100,590	.29%	1.2	7,431
Irish Free State (March 31, 1930)	27,992	......	27,992	.08%	0.9	1,054
Italy (June 30, 1930)	......	381,992	381,992	1.11%	0.9	48,935
Jugo-Slavia	66,863	......	66,863	.19%	0.4	5,000*
Latvia (March 31, 1930)	42,189	......	42,189	.12%	2.2	7,742
Netherlands	284,433	......	284,433	.82%	3.6	28,944
Norway	111,238‡	77,000*	188,238	.55%	6.7	3,341
Poland	102,465	83,637	186,102	.54%	0.6	11,000*
Portugal	7,877	26,681	34,558	.10%	0.6	5,000*
Roumania	56,038	......	56,038	.16%	0.3	1,000*
Russia (October 1, 1929)‖	331,252	......	331,252	.96%	0.2	38,437
Spain	......	184,542	184,542	.54%	0.8	38,209
Sweden	507,325	1,736	509,061	1.47%	8.3	23,310
Switzerland	268,714	......	268,714	.78%	6.7	24,466
Other Places in Europe*	93,255	19,712	112,967	.33%	1.3	5,460
Total	8,795,746	1,239,834	10,035,580	29.07%	1.9	781,190

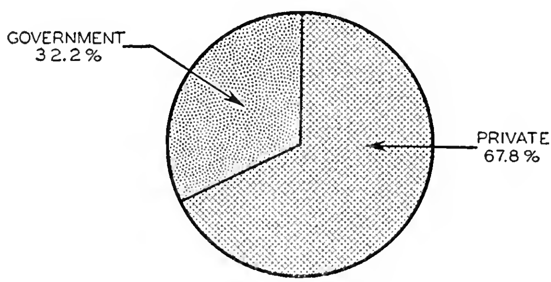
SOUTH AMERICA:						
Argentina	......	279,990	279,990	.81%	2.5	40,410
Bolivia	......	2,507	2,507	.01%	0.1	—176
Brazil	674§	159,283	159,957	.46%	0.4	30,128
Chile	......	45,239	45,239	.13%	1.0	3,123
Colombia	2,297	26,075	28,372	.08%	0.3	5,972
Ecuador	1,454§	2,693	4,147	.01%	0.2	—100*
Paraguay	185	1,785	1,970	.01%	0.3	907
Peru	......	13,299	13,299	.04%	0.2	—566
Uruguay	......	29,022	29,022	.08%	1.6	893
Venezuela	668§	19,182	19,850	.06%	0.6	5,217
Other So. Am. Places	2,768	......	2,768	.01%	0.5	49
Total	8,046	579,075	587,121	1.70%	0.7	85,857
ASIA:						
British India (March 31, 1930)	21,810	35,091	56,901	.16%	0.02	3,216
China*	90,000	66,000	156,000	.45%	0.04	1,000
Japan (March 31, 1930)	865,516	......	865,516	2.51%	1.4	54,197
Other Places in Asia*	105,795	16,796	122,591	.36%	0.1	9,151
Total	1,083,121	117,887	1,201,008	3.48%	0.1	67,564
AFRICA:						
Egypt	44,834	......	44,834	.13%	0.2	1,610
Union of South Africa†	108,937	......	108,937	.31%	1.4	6,629
Other Places in Africa*	81,023	1,314	82,337	.24%	0.1	8,507
Total	234,794	1,314	236,108	.68%	0.2	16,746
OCEANIA:						
Australia‡	505,554	......	505,554	1.46%	7.9	28,854
Dutch East Indies	48,571	4,800	53,371	.15%	0.1	4,170
Hawaii	......	24,366	24,366	.07%	6.6	1,700
New Zealand†	161,041	......	161,041	.47%	10.3	8,500
Philippine Islands	5,832	17,072	22,904	.07%	0.2	1,488
Other Places in Oceania*	3,500	700	4,200	.01%	0.3	300
Total	724,498	46,938	771,436	2.23%	1.0	45,012
TOTAL WORLD	11,117,458	23,409,171	34,526,629¶	100.00%	1.8	1,962,409

* Partly estimated.
† March 31, 1930.
‡ June 30, 1929.
§ January 1, 1929.
|| U.S.S.R., including Siberia and Associated Republics.
¶ Includes approximately 9,060,000 automatic or dial telephones, of which more than 50 percent are in the United States.

Comparative Telephone Development of Countries

No change occurred during 1929 in the relative standing of the principal countries as regards telephone development. The United States still headed the roll of nations with 16.4 telephones per 100 population. Canada with 14.2, New Zealand

OWNERSHIP OF THE WORLD'S TELEPHONES
January 1, 1930



with 10.3, and Denmark with 9.6 telephones per 100 population, were, respectively, second, third and fourth. Although Denmark ranked fourth in relative telephone development among the countries of the world, it was first in rank among the European countries. The next highest European country was Sweden with 8.3 telephones per hundred population, or about one-half the relative development in the United States. Norway and Switzerland each with 6.7 telephones per hundred population, ranked next. The chief European countries, Germany, Great Britain and France, were, however, distinctly below the leaders in telephone development, having 5.0, 4.1 and 2.5 telephones per 100 population, respectively. Of the South American countries, Argentina, with 2.5 telephones per 100 population, had by far the greatest telephone density. About 72 per cent of all the telephones in Asia were in Japan, although this Island Empire had no more than 1.4 telephones for each 100 inhabitants. The relative position of the principal countries of the world in point of telephone density is shown by the chart, "Telephones per 100 Population."

TELEPHONE DEVELOPMENT OF LARGE AND SMALL COMMUNITIES

January 1, 1930

Country	Service Operated by (See Note)	Number of Telephones: In Communities of 50,000 Population and Over	Number of Telephones: In Communities of less than 50,000 Population	Telephones per 100 Population: In Communities of 50,000 Population and Over	Telephones per 100 Population: In Communities of less than 50,000 Population
Australia (June 30, 1929)*	G.	289,961	215,593	9.1	6.8
Austria	G.	167,842	54,394	7.2	1.2
Belgium	G.	182,833	76,840	5.6	1.6
Canada	P. G.	713,000	686,986	23.3	10.1
Czechoslovakia	P. G.	64,424	93,283	4.6	0.7
Denmark	P. G.	152,267	189,532	16.4	7.2
France	G.	616,978	439,056	6.9	1.3
Germany	G.	1,948,317	1,233,988	9.2	2.9
Great Britain and No. Ireland†	G.	1,361,000	559,000	5.6	2.6
Japan (March 31, 1930)	G.	507,401	358,115	3.7	0.7
Netherlands	G.	182,106	102,327	6.2	2.1
New Zealand (March 31, 1930)	G.	61,095	99,946	12.0	9.5
Norway	P. G.	63,824	122,964	15.8	5.1
Poland	P. G.	98,957	87,145	2.7	0.3
Sweden	G.	202,899	306,162	21.0‡	5.9
Switzerland	G.	118,395	150,319	14.6	4.7
United States	P.	11,106,320	8,961,703	22.9	12.1

Note: P. indicates telephone service operated by private companies, G. by the Government, and P. G. by both private companies and the Government. See first table.

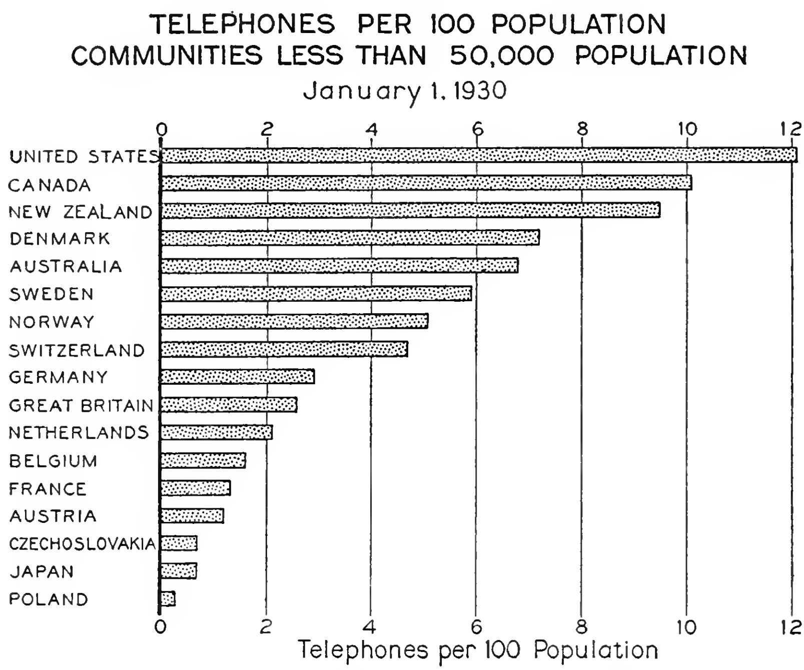
* Partly estimated.

† March 31, 1930.

‡ The majority of this development is due to Stockholm.

TELEPHONES IN LARGE AND SMALL COMMUNITIES

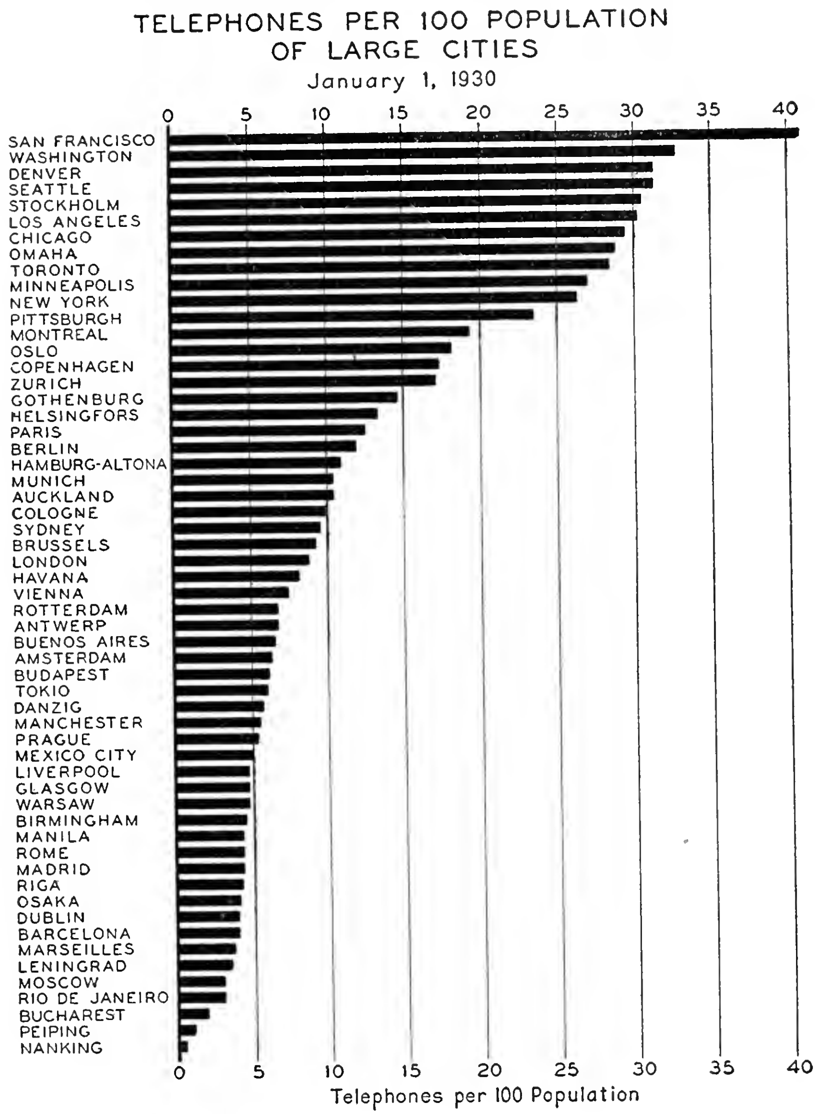
The table, "Telephone Development in Large and Small Communities," indicates the relative extent to which telephone service in the principal countries is made available in the smaller communities. That the less populated sections of the United



States are well provided with telephone facilities is evident from the fact that there are 12.1 telephones for each 100 inhabitants of communities of less than 50,000 population, a degree of development which exceeds the *total* development of any other country with the exception of Canada. Compared with conditions existing in the United States, rural telephone development may, in fact, be said to be practically non-existent in the principal European countries. Germany had a development of only 2.9 telephones per 100 inhabitants in communities of less than 50,000 population, Great Britain had 2.6, and France, 1.3.

TELEPHONES IN LARGE CITIES

The fact that the telephone service in foreign countries is



confined largely to the more densely populated regions is also reflected by the figures in the table, "Telephone Development

TELEPHONE DEVELOPMENT OF LARGE CITIES
January 1, 1930

Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones per 100 Population
ARGENTINA:			
Buenos Aires	2,300,000	149,968	6.5
AUSTRALIA:			
Adelaide	325,000	32,035	9.9
Brisbane	319,000	24,580	7.7
Melbourne	1,018,000	96,181	9.4
Sydney	1,239,000	118,269	9.5
AUSTRIA:			
Graz	164,000	8,719	5.3
Vienna	2,000,000	148,432	7.4
BELGIUM:			
Antwerp	519,000	34,813	6.7
Brussels	938,000	86,635	9.2
Liege	423,000	17,824	4.2
BRAZIL:			
Rio de Janeiro	1,500,000	44,144	2.9
CANADA:			
Montreal	975,000	187,985	19.3
Ottawa	183,000	37,750	20.6
Toronto	710,000	201,419	28.4
CHINA:			
Hong Kong	500,000	11,937	2.4
Nanking	500,000	2,749	0.5
Peiping	1,200,000	12,830	1.1
CUBA:			
Havana	650,000	52,659	8.1
CZECHOSLOVAKIA:			
Prague	732,000	38,869	5.3
DANZIG, FREE CITY OF	305,000	17,248	5.7
DENMARK:			
Copenhagen	790,000	136,528	17.3
FINLAND:			
Helsingfors	234,000	31,180	13.3
FRANCE:			
Bordeaux	264,000	16,207	6.1
Lille	208,000	14,301	6.9
Lyons	588,000	27,435	4.7
Marseilles	672,000	24,140	3.6
Paris	2,955,000	370,308	12.5
GERMANY:			
Berlin	4,330,000	515,175	11.9
Breslau	613,000	42,779	7.0
Cologne	725,000	68,967	9.5
Dresden	630,000	62,393	9.9
Dortmund	535,000	24,756	4.6
Düsseldorf	478,000	46,281	9.7
Essen	645,000	29,291	4.5
Frankfort-on-Main	623,000	65,606	10.5
Hamburg-Altona	1,590,000	173,828	10.9
Hannover	442,000	37,826	8.6
Leipzig	675,000	69,985	10.4
Munich	725,000	75,621	10.4
Nuremburg	494,000	36,924	7.5
Stuttgart	420,000	47,042	11.2
GREAT BRITAIN AND NORTHERN IRELAND (March 31, 1930):			
Belfast	420,000	15,138	3.6
Birmingham	1,115,000	49,805	4.5
Bradford	330,000	17,363	5.3
Bristol	410,000	17,933	4.4
Edinburgh	440,000	27,038	6.1
Glasgow	1,170,000	54,653	4.7
Hull	353,000	16,424	4.7
Leeds	505,000	20,952	4.1
Liverpool	1,165,000	55,091	4.7
London	7,740,000	675,783	8.7
Manchester	1,100,000	59,998	5.5
Newcastle	480,000	18,363	3.8
Nottingham	305,000	14,812	4.9
Portsmouth	290,000	6,993	2.4
Sheffield	515,000	18,049	3.5
Stoke-on-Trent	300,000	6,578	2.2

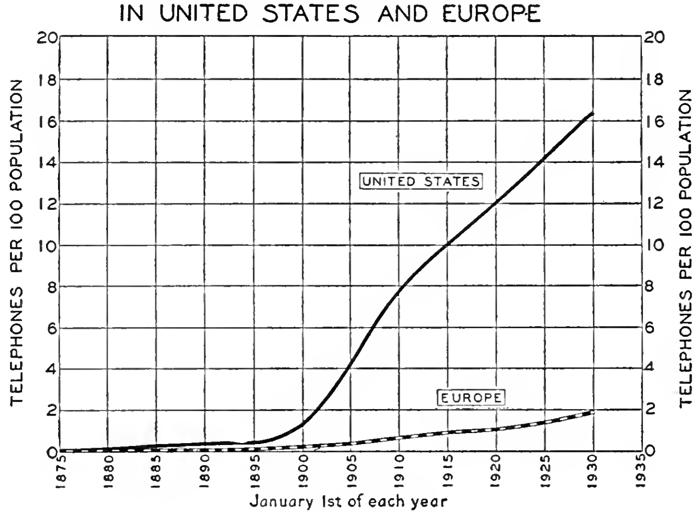
TELEPHONE DEVELOPMENT OF LARGE CITIES (Concluded)
January 1, 1930

Country and City (or Exchange Area)	Estimated Population (City or Exchange Area)	Number of Telephones	Telephones per 100 Population
HUNGARY:			
Budapest	990,000	60,539	6.1
Szeged	127,000	2,560	2.0
IRISH FREE STATE (March 31, 1930):			
Dublin	396,000	15,350	3.9
ITALY:			
Genoa	628,000	22,516	3.6
Milan*	965,000	65,000	6.7
Rome	950,000	40,393	4.3
JAPAN (March 31, 1930):			
Kobe	755,000	28,938	3.8
Kyoto	755,000	33,439	4.4
Nagoya	905,000	27,834	3.1
Osaka	2,409,000	96,044	4.0
Tokio	2,295,000	136,546	6.0
LATVIA (March 31, 1930):			
Riga	378,000	15,745	4.2
MEXICO:			
Mexico City	950,000	47,165	5.0
NETHERLANDS:			
Amsterdam	749,000	47,048	6.3
The Hague	466,000	39,846	8.6
Rotterdam	597,000	40,158	6.7
NEW ZEALAND (March 31, 1930):			
Auckland	198,000	20,558	10.4
NORWAY (June 30, 1929):			
Oslo	250,000	45,353	18.1
PHILIPPINE ISLANDS:			
Manila	370,000	16,000*	4.3
POLAND:			
Lodz	824,000	11,912	1.4
Warsaw	1,109,000	52,426	4.7
ROUMANIA:			
Bucharest	800,000	15,280	1.9
RUSSIA (October 1, 1929):			
Leningrad	1,840,000	63,104	3.4
Moscow	2,420,000	70,247	2.9
Odessa	435,000	4,886	1.1
SPAIN:			
Barcelona	845,000	32,848	3.9
Madrid	814,000	35,320	4.3
SWEDEN:			
Gothenburg	242,000	35,376	14.6
Malmö	120,000	17,454	14.5
Stockholm	415,000	126,529	30.5
SWITZERLAND:			
Basel	146,000	20,629	14.1
Berne	112,000	17,191	15.3
Geneva	131,000	20,132	15.4
Zurich	222,000	37,864	17.1
UNITED STATES:†			
New York	6,898,600	1,811,410	26.3
Chicago	3,360,000	987,891	29.4
Los Angeles	1,270,000	383,979	30.2
Total of the 8 cities with over 1,000,000 population	19,302,800	4,898,715	25.4
Pittsburgh	976,200	229,135	23.5
Milwaukee	708,100	155,209	21.9
San Francisco	642,300	262,019	40.8
Washington	500,000	163,343	32.7
Total of the 10 cities with 500,000 to 1,000,000 population	6,824,400	1,585,578	23.2
Minneapolis	487,700	131,907	27.0
Seattle	397,500	124,504	31.3
Denver	287,100	89,756	31.3
Omaha	226,200	65,150	28.8
Total of the 32 cities with 200,000 to 500,000 population	9,649,400	2,090,988	21.7
Total of the 50 cities with more than 200,000 population	35,776,600	8,575,281	24.0

* Partly estimated.
† There are shown, for purposes of comparison with cities in other countries, the total development of all cities in the United States in certain population groups and the development of certain representative cities within each of such groups.

in Large Cities." London, for example, had 675,783 telephones on March 31, 1930, constituting about 36 per cent of all the telephones in Great Britain. Paris, with 370,308 telephones, had 35 per cent of all the instruments in France. The four principal cities of Berlin, Hamburg-Altona, Leipzig and Munich had about one-fourth of all the telephones in Germany. On the other hand, New York, with 1,811,410 telephones, had about 9 per cent, and Chicago, with 987,891 telephones, had less than 5 per cent of all the telephones in the United States. Eleven American cities with populations of over 200,000 are

TELEPHONE DEVELOPMENT
IN UNITED STATES AND EUROPE



shown in the table, none of which had a development of less than 21.9 telephones per 100 population. All cities in the United States with a population of 200,000 or more had an average development of 24 telephones for each 100 inhabitants. This figure is all the more impressive when it is considered that, excluding Sweden and Canada, no foreign country has any large city in which the development is as high as 20 telephones per 100 population.

The comparatively high telephone development of the large American cities is further emphasized by the chart, "Telephones per 100 Population of Large Cities." In this chart San Francisco heads the list, with 40.8 telephones per 100 population, followed by Washington (32.7), Denver (31.3), and Seattle (31.3). Stockholm, by far the best developed of the larger European cities, had 30.5 telephones per 100 population, and ranks fifth. Paris is nineteenth, Berlin twentieth, and London twenty-seventh, with developments of 12.5, 11.9 and 8.7 telephones per 100 population, respectively. Of the first ten cities shown on the chart, eight are in the United States.

COUNTRIES REACHED BY TELEPHONE FROM THE UNITED STATES

The chart, "Countries Reached by Telephone from the United States," shows that on April 6, 1931, thirty-one countries could be reached by telephone from any Bell System instrument. In fact, on that date any Bell System telephone could be connected to any one of 12,600,000 telephones outside the United States. Adding these to the telephones connected to the Bell System in the United States, we have a total of 32,600,000 instruments available to Bell System subscribers, or 91.5 per cent of the estimated present total number of telephones in the world.

Some Auxiliary Services and Facilities of the Bell System

THE primary service of telephone communication rendered by the Bell System is so well known that its extent and efficiency are rather taken for granted by the American public. But there are ramifications of Bell System service that are not so familiar, and they include some highly interesting and useful auxiliary and by-product services of one kind or another. These fall naturally into two classes: first, those offered by Bell Operating Companies as refinements and adaptations of telephone service to meet the needs of particular situations and to increase the usefulness of the services; and, second, those facilities developed by the Bell Telephone Laboratories, Inc., and made available through the Western Electric Company and its subsidiary, Electrical Research Products, Inc., which afford services independent of and distinct from the telephone system proper.

The first class of auxiliary services has been developed by Bell System engineers to enable the operating companies to offer a flexible service adapted to individual personal or business needs. The objective is to develop new services and new adaptations of existing service and then show the public how these services can be advantageously utilized. For no matter how complete a service is offered by the telephone company and no matter how efficiently it is operated, the service, *from the telephone user's standpoint,* is not at its best unless his telephone arrangements meet his requirements as to comfort, convenience, and efficiency.

The hand-set telephone, which in addition to its attractive appearance can be manipulated with one hand, is an example of how telephone service may be made of maximum convenience to the user. In addition to the familiar form of this instrument, it is also available in a hang-up type which may be installed unobtrusively at the side of a desk or elsewhere. This is especially appreciated by architects, engineers, builders and others who like to keep the tops of their desks clear for spreading out large plans and drawings.

Residence Telephone Service

The simplest arrangement of telephone facilities, of course, either residence or business, consists of one line to the central office with one telephone on the subscriber's premises. In addition, one or more extension telephones may be provided, connected with the same line. This makes it possible to provide telephone comfort and convenience in the home by installing one telephone downstairs and another upstairs, or one in the living room, one in a bedroom and another in the kitchen, etc. A great many people in comfortable circumstances now provide themselves with every modern facility for comfort and convenience in the way of telephone equipment as well as other electrical appliances in their homes. The Bell System has for some years been actively calling attention to the possibilities of really adequate telephone service in the home, for saving time and effort, and fitting in with the modern way of life. This is directly in the interest of rendering a service that shall be thoroughly satisfactory to the user. The reduced rates for evening and night long distance calls, the arrangements for reversing the charges, etc., all help to make telephone service as useful as possible for personal as well as business messages.

In large residences, adequate telephone service may include the provision of two or more lines to the central office, one or two for the social uses of the household and the other primarily for the use of the servants. Of course, there is at least one telephone on each line and, in addition, extensions may be provided on either one or both of the lines as may be desired.

Such a lay-out is extremely flexible and can be so arranged as to meet practically any service need. Generally speaking, the telephone companies are in a position to provide any one of many different wiring plan arrangements for use in residences. Suppose, for example, that telephones are installed in the living-room, in the kitchen and in an upstairs bedroom. There are a good many different things that can be done with such a lay-out. If one of the family wishes to talk from the bedroom to the maid in the kitchen, the facilities can be arranged so that that can be done. Or if the subscriber is talking over the telephone in the living-room or bedroom, he can cut off the kitchen telephone. Different numbers may be assigned to the kitchen telephone and the living-room telephone, if the subscriber wishes, so as to separate incoming calls for the family from those for the servants. And even with such an arrangement, it can still be made possible for the maid to answer in the kitchen when someone is wanted on the living-room telephone. She can even hold the call on one line while she talks (over another line, but from the same instrument) to one of the family—who may be upstairs, for instance—and tells him he is wanted on the telephone. The person who has called up, of course, does not hear that conversation. And from any telephone one can call people to any other by bells, buzzers, or electric lamps, which the telephone company can install practically anywhere about the premises.

These arrangements are available irrespective of whether the subscriber is served by a dial or a manual central office. Then there is also apparatus for intercommunication of larger capacity which is still compact and unobtrusive. For instance, a set of buttons in the base of the telephone is all that the user needs to see of the apparatus that makes possible intercommunication among any number of telephones up to fifteen. The rest of the equipment is in a cabinet which may be relegated to some out-of-the-way corner. And those little push buttons in the base of a neat hand telephone have been designed with an eye to good appearance as well as convenience. Such an intercommunicating system is useful for lawyers, doctors and small business offices as well as for large residences and private estates. A system of this kind was described in detail in the Bell Telephone Quarterly for October, 1930.

Portable Telephones

In most homes there are certain rooms that are not continuously occupied. The guest-room, for one. The dining-room, for another. In some houses a sun-porch in summer or a billiard-room in winter represents additional space which is in use at certain times, but not continuously. Guests appreciate the extra touch of thoughtful hospitality implied in having a telephone in the guest-room. And it is convenient to be able to take a call on the sun-porch in summer. It is not necessary to keep a telephone in the guest-room or dining-room or sun-porch when they are unoccupied, however. "Jacks" or outlets can be installed in these locations and a portable telephone, equipped with a cord and plug, can be carried from room to room and plugged into a convenient jack for making or answering calls.

Some restaurants provide this jack and portable telephone equipment so that patrons can have a telephone brought to their table, if they wish. Certain progressive barber shops have found that customers appreciate being able to telephone direct from the barber's chair whenever they want to. There is a place for such equipment in "beauty shops," too, as women enjoy being able to chat with their friends by telephone, particularly while undergoing a permanent wave.

Head Receivers and Deaf Sets

Sometimes the telephone companies' customers have certain particular problems to be solved in connection with their telephone service, and the companies arrange to meet these individual needs. Occasionally a customer is hard of hearing and finds difficulty in using the telephone. For this situation there is available a telephone equipped with an amplifying unit. A key is provided to connect and disconnect the amplifier from the telephone circuit, and the volume of amplified speech can be made louder or softer at will.

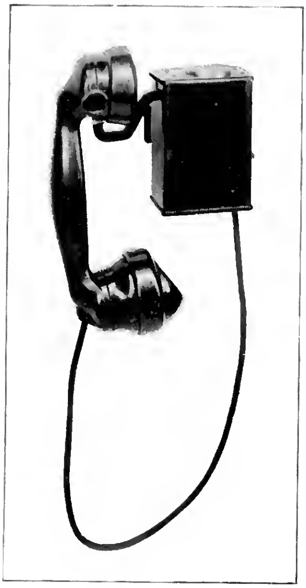
Private Branch Exchanges

The telephone services above described for residence purposes are also available for business use. Of course, large business establishments have more telephones than even the most elaborate residences and many business private branch exchanges are installed on a subscriber's premises by which one or more employees of the subscriber can switch incoming or outgoing calls among as well as interconnect the various telephones in the subscriber's establishment. These range all the way from the small key (cordless) switchboards to the large boards installed in hotels, banks, department stores, newspaper offices, etc. The little cordless boards usually provide for seven telephones and three trunk lines to the central offices. The larger manual boards may be either non-multiple, for use in locations where three or more trunks and seven or more telephones are required; or multiple, for use where more than two private branch exchange operators must have access to all lines.

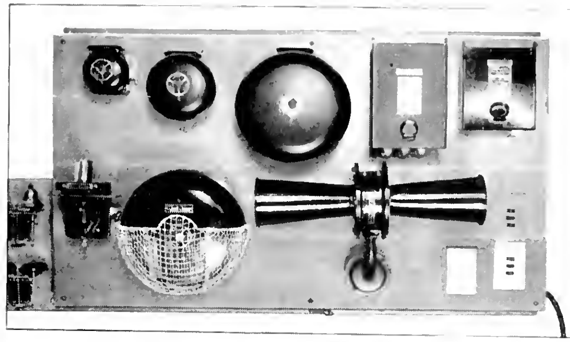
In addition, there are dial systems where the subscriber dials his intercommunicating and outgoing calls, attendant service being provided for incoming calls.

Order Receiving Equipment

There has been an extensive development of late years in shopping by telephone, and department stores have found that it pays them well to provide up-to-date equipment for the prompt handling of orders that are telephoned in. Newspapers have a similar problem in taking care of classified advertisements by telephone. To meet this need, equipment has been developed by the Bell System that is designed for the reception of orders with a maximum of convenience and speed, and permits of an efficient distribution of incoming calls among



Hand Telephone, Hang-up Type.

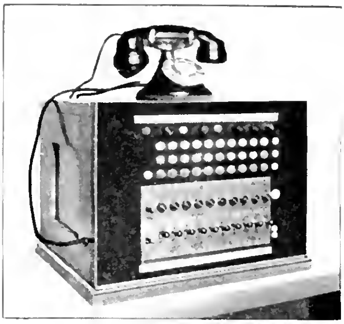


Gongs, Horns, etc., Code Calling Service.

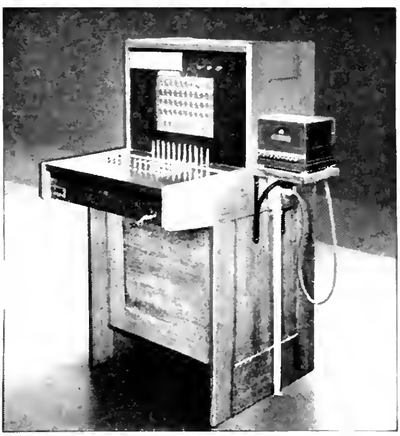
Intercommunicating System Handset.

Portable Telephone.

Telephone for the Hard of Hearing.



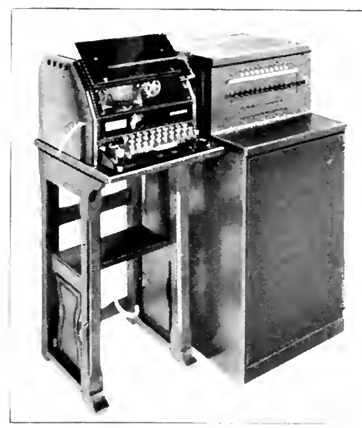
Dial Private Branch Exchange, Attendant's Turret.



Cord Private Branch Exchange, with Code Calling Equipment.

Teletypewriter.

Taking Orders by Telephone.



Teletypewriter and Control Board.

Public Address System.

a group of attendants equipped with head receivers. The equipment consists of a small cabinet or turret which is mounted on a suitable table, and as the calls come in they are answered by a group of attendants who sit at the table. These installations may be provided for any number of attendants, depending upon the amount of business to be handled. They may be non-multiple or multiple as desired. Equipment may be operated in connection with a private branch exchange, or may be connected directly to the central office, or, if desired, it may be connected directly to the central office with lines running also to the private branch exchange switchboard.

Code Calling Equipment

For other special needs there are other forms of specialized equipment available. For example, there is the case of the superintendent of a factory with one or several buildings covering acres of floor-space. He has an office on the premises, but he spends a large part of his time keeping in personal touch with operations here, there and everywhere throughout the factory. Important telephone calls come in when he is not in his office, but is known to be somewhere around the plant. To meet that situation there is available what is known as "code calling equipment." This is an arrangement of apparatus whereby bells or horns at various locations throughout the premises may be operated to sound code signals and thus summon persons who are not at their regular telephone stations to step to the nearest telephone and from there answer an incoming call. Each person is assigned his own particular code call. Occasionally, people having large residence establishments or estates ask the telephone company to install code calling equipment so that when the owner happens to be in the garage, or down at the boathouse, or out at the tennis court, he can be easily called when he is wanted on the telephone.

Outdoor Set

Still further convenience is afforded by special outdoor telephones in weatherproof boxes which can be put up at tennis courts or golf links, or in similar locations. That is rather an incidental use of this equipment, however. The outdoor telephone is chiefly used for police call boxes and for taxicab stands and other businesses at outdoor locations. Sometimes it is placed at railroad stations and like localities with an arrangement which enables a prospective customer to call a taxi and have the call charged to the taxi company.

Conference Equipment, Etc.

Another case calling for special telephone equipment is that of the business executive who wishes to be able to confer with a number of his associates quickly and easily, without taking them away from their desks. He can do this by means of what is called "conference equipment." This provides means by which telephone conferences may be held by several persons simultaneously, everything that is said by any of the conferees being audible to all.

Then there is the case of the business or professional man who wishes to have his secretary answer his telephone calls when he is out, but does not want to have it possible for her to listen in while he is talking. The telephone company can arrange his telephone equipment to meet those requirements precisely.

Private Line and Foreign Exchange Services

Some business concerns want a private telephone line between office and factory, for example, not connected to the general telephone system at all. The telephone company can supply that. Or, again, if they wish direct lines connecting two or more private branch exchanges, that equipment also can be furnished.

Another problem is that of a subscriber who desires to make it possible for people in another exchange area to call him up by telephone without having to pay a toll charge for the calls. There are two different ways in which this can be done. A store may have a special telephone number for its order department, and may arrange with the telephone company to have the charges reversed on calls to that number. Or a subscriber may have "foreign exchange service." This arrangement is exchange service furnished from a central office in an exchange area other than that in which the subscriber is located. For example, a subscriber in Boston may have a telephone number in New York. This has proved to be a very effective method for building up out-of-town business, especially when used in connection with advertising campaigns, in newspapers and direct mail, urging customers to place their orders by telephone, and pointing out that they can do so without payment of toll charges.

Practically all of these services and devices are adaptations of regular telephone service in one way or another. But suppose a company has an office in New York and a factory in Detroit, and wants to arrange for the use of the telephone all the time without paying for each call separately—or for the use of the telephone every day at a specified time—say from two to three o'clock, or any other period desired. Arrangements for such services can be made with the telephone company by contract.

Another form of service provides for manually operated telegraph service. The telephone company provides the line and the equipment, and the subscriber provides the operators on either end. This is a service extensively utilized by brokerage houses and newspapers.

Teletypewriter Service

In this connection the teletypewriter is coming into constantly greater use. This device may be described as two or more typewriters at separated points, whether in the same building or thousands of miles apart, connected by wires and electrical apparatus in such a way that anything typed at the sending machine will come out in typewritten copy at the receiving machines, either in page or tape form. The telephone company provides and maintains the necessary connecting channels and associated apparatus. The teletypewriter makes it possible to transmit simultaneous messages to any one or all of a number of receiving points from a single transmitting station. The teletypewriter is being widely used by brokerage houses and newspapers, and for communication between airports and the like. It is an invaluable means of quick communication between the police departments of neighboring communities, especially for sending out descriptions of "wanted" persons or stolen cars. For a detailed discussion of teletypewriter service and its present day uses, see the BELL TELEPHONE QUARTERLY for April, 1931.

PROGRAM TRANSMISSION SERVICE

The telephone companies also play a large and very essential part in radio broadcasting. They provide local or inter-city circuits for the purpose of transmitting programs from various sources to broadcasting stations. Chain broadcasting, in fact, is made possible by the utilization of thousands of miles of telephone circuits. On one occasion 106 broadcasting stations were linked up by 25,300 miles of telephone wire for the simultaneous broadcasting of a single speech. At another time 121 stations were joined by telephone wires for simultaneous broadcasting. An article on this service was published in the BELL TELEPHONE QUARTERLY for April, 1931.

TELEPHOTOGRAPH SERVICE

Another auxiliary service is the transmission of photographs by wire. Telephoto transmitting and receiving apparatus is maintained at eight cities, Boston, New York, Atlanta, Cleveland, Chicago, St. Louis, Los Angeles and San Francisco. News pictures are frequently sent in this way, and by distributing them by air mail from the cities reached by telephoto service, it is possible to send a photograph to newspapers all over the country within a very short time. The service is also useful for the transmission of thumb prints and Rogues' Gallery photographs for police identification of criminals, for the transmission of pictures of new styles as soon as they are received at New York, and for transmitting proofs of advertisements and the like. Advertisements, particularly those to be released simultaneously on the Atlantic and Pacific Coasts, can be transmitted in this way without risk of error, since the photograph received, of course, is an exact duplicate of the photograph transmitted.

Telephone Directories

Then there are the telephone directories. The telephone companies try to make them as useful as possible to telephone users. A telephone subscriber can get directories for other areas if he needs them, and in many localities there are available, at a reasonable charge, directories listing the names and telephone numbers of subscribers numerically by street address.

If a subscriber wishes he can arrange under certain conditions to have several names listed in the telephone directory in addition to the listing that goes with every telephone. Or a firm, say Smith & Jones, may have its firm name and the names of individuals in the firm listed separately with its business telephone number. In addition, a notice can be put in the directory telling what number to call if the regularly listed number does not answer. An adaptation of this is the night listing, which tells what number to call during certain hours or after certain hours. These two services are especially useful for doctors, but there are others, too, who find them of advantage.

Then there are the classified listings and display advertisements which enable business telephone subscribers to be represented in the classified telephone directories under the heading of the product or service they have to sell. A subscriber may purchase as many such listings or advertisements as he has products to advertise.

"Where to Buy It" Service

Within the last few years the Bell System has introduced Trade Mark Headings in the classified telephone directories. These consist of the name of a trade marked product or service, a few words descriptive of it, and the trade mark symbol, under which are placed the names of dealers in the product or service. If one is looking for a Ford Service Station, or a dealer in Sherwin-Williams Paints, or Whitman's candy, he can find them by turning to the Trade Mark Heading in the classified telephone directory. The Service is of great value to dealers also in steering to their stores people who have been "sold" by the advertising of the manufacturer of the trade marked product. In this way it links up national advertising with local distribution, to the mutual advantage of the manufacturer, dealer and purchaser. Further information on this subject may be found in the Bell Telephone Quarterly for July, 1930.

Services for Salesmen

The use of toll and long distance telephone service in selling by representatives of manufacturers and retailers has increased greatly in recent years. Like other uses of long distance service, it has no doubt been stimulated by the successive reductions in long distance telephone rates in 1926, 1927, 1929 and 1930 which represent a saving to the public of about $20,000,000 a year. To assist sales representatives in getting the utmost value out of their use of the telephone, the Bell System has worked out plans for "Key-town" selling, whereby the salesman visits the key-towns in his territory and canvasses the surrounding areas by telephone. Key-town maps, obtainable from the telephone companies, show the location of key-towns and the rates for calls to nearby points.

A further refinement of the Key-town plan is the "Skip-stop" plan,—the salesman visiting alternate towns on his route and covering intermediate towns by telephone. On the next trip he visits the towns he covered by telephone before and telephones to customers on whom he called personally on the previous trip.

At many points customers' rooms are provided at the telephone company business offices from which calls may be put through with great comfort. If the salesman's firm has provided him with a telephone identification card under the Bell System credit plan, his calls may be charged to the account of the home office of his firm. These plans for facilitating telephone selling by wholesalers and manufacturers were fully described in the BELL TELEPHONE QUARTERLY for January, 1929.

WESTERN ELECTRIC FACILITIES

Of the facilities outside of the telephone service developed by Bell System engineers and made available through the Western Electric Company and its subsidiary, Electrical Research Products, Inc., the most famous is the talking motion picture equipment which has revolutionized the movie industry. Another is the new service for measuring noise which is described elsewhere in this issue of the BELL TELEPHONE QUARTERLY.

The Public Address System enables speakers to address large audiences indoors or outside without straining their voices. It is used at race-tracks, stadiums, convention halls, overflow meetings, newspaper bulletin boards, etc., and for increasing the audibility of music at amusement parks and ball-rooms. There is also a Music Reproducer which magnifies the sound of phonograph records for use in restaurants and other places of amusement.

The Western Electric Hard-of-Hearing System is a device with headsets installed in movie houses, churches and other auditoriums to enable those with defective hearing to enjoy the talkies, church services, speeches, music, etc. The volume of sound delivered is controlled individually by each user.

There is also an Electrical Stethoscope which magnifies the sound of heart-beats, thereby facilitating diagnosis in cases of heart-disease.

More directly related to telephone communication are the two-way radio telephone systems which the Western Electric Company manufactures for use between ship and shore and between aircraft in flight and ground stations. The Marine Radio Telephone Equipment is particularly useful for harbor craft such as tug-boats, ferry-boats, lighters, municipal fire-boats and pilot-boats. It is also of value for fishing-craft.

The Aviation Communication Equipment is of two types: a low frequency system for receiving radio beacon signals and weather reports, and a two-way high frequency radio telephone system which permits the plane to keep in constant touch with other planes and with ground stations. It is an invaluable aid to safe flying, as landing instructions and weather reports can be received *en route*.

The Western Electric Company manufactures a wide range of radio telephone equipment and has provided a majority of the large broadcasting stations in the United States.

It has likewise applied its telephone developments in the field of electrical recording to the making of electrical transcriptions for radio use, and it supplies broadcasting stations with the equipment to put on these so-called "spot broadcasting" programs, which are used by advertisers who desire to reach the territory covered by an individual station or a group of such stations.

The Western Electric Company also manufactures for the use of railroads, oil companies, mines and others, switchboard and other telephone apparatus and communication equipment. In addition, it provides the high speed submarine telegraph cables used in trans-Atlantic and trans-Pacific wire communication.

A Unifying Objective

All these various services and devices that the Bell System has developed, whether they are directly a part of the telephone service or by-products of it, have been worked out by Bell engineers for the service of the public. They are the products of the large numbers of highly trained specialists who are constantly planning how to make the telephone service more useful, and how to develop new phases of service. Diverse as are the results of this research it has a unifying objective: to increase human knowledge of electrical communication and to turn the forces of nature to the service of mankind. Much has been achieved and more will certainly be accomplished in the future. Nothing has been said, for example, of Television because it is still in the experimental stage and Bell System engineers are unwilling to predict what its future sphere of service may be.

Richard Storrs Coe

The Development of the Microphone

(Presented at fifth meeting of the Acoustical Society of America, Camden, N. J., May 5th, 1931, as part of a symposium on microphones.)

THE invention of the telephone by Alexander Graham Bell accomplished a result which has revolutionized our means of communication. Like most similarly broad and fundamental inventions, it was based on a clear and thorough understanding of scientific work which had preceded it. Viewed after the lapse of 55 years it is clear that the development of human knowledge was very definitely leading up to this great invention for a period extending over several decades. It is of interest to note a few of the more outstanding steps. In 1837 in Salem, Mass., Dr. Page observed that sounds were emitted by a magnet if its magnetism was suddenly changed. He studied the effect and developed several different means of producing these sounds; for example, rapidly rotating a horseshoe magnet in a strong magnetic field. In this way he obtained musical tones and termed the effect "galvanic music." The results were published[1] and broadly known among scientific workers. In 1845, Sullivan observed that currents of electricity were generated by the vibration of a wire composed partly of one metal and partly of another.[2] Bourseuil[3] in 1854 described as a "telephone" a device "using a make and break" transmitter. In his written description he apparently considered the smooth or continuous modulation or variation of current unnecessary for the transmission of sounds. Satisfied with the written description he seems to have made no great effort to reduce his ideas to practical operation.

[1] Silliman's Journal, 1837, page 396.

[2] Phil. Mag., 1845, page 261.

[3] The Didaskalia, Frankfort/M, Sept. 28, 1854; Du Moncel, Applications de l'Electricité, 1854; U. S. Supreme Court Reports, Vol. 126 (1887).

Philip Reis,[4] a teacher of Physics in Garnier's Institute at Friedrichsdorf, Germany, in 1861 constructed models based on much the same fundamental ideas as those disclosed by Page and Bourseuil and produced what he called a "telephone." The receiver was operated on the magneto-striction principle and consisted of a knitting needle surrounded by a coil of wire. It was mounted on a sounding board. The transmitter was a platinum make-and-break contact operated by a membrane (Fig. 1). This transmitter was apparently quite sharply resonant and was operative only for rather continuous tones. Tones of different frequencies were transmitted, however, and it is reported that several tones were transmitted simultaneously. Reis never succeeded in transmitting articulate speech. With one of his transmitter models which was open on both sides of the diaphragm he used a baffle about 20 inches in diameter "to prevent interference between the front and back."

In 1863 Helmholtz published his classic work on acoustics.[5] This greatly extended the basic understanding on which subsequent developments proceeded.

In 1870 Varley discovered that sound may be emitted by a condenser.[6]

In 1874 Alexander Graham Bell, Professor of Vocal Physiology at Boston University, was busily engaged in the study of speech, hearing and telegraphy. He was interested in obtaining graphic records of sounds, and in discussing the problem with a friend, Dr. Clarence Blake, the suggestion was offered that a model consisting of an actual human ear might suffice. Dr. Blake prepared such a model which operated successfully and seems to have been of great aid to Dr. Bell. Telling of these experiments three years later he stated[7] "The stapes was removed and a stylus of hay about an inch in length was at-

[4] Prescott, The Electric Telephone p. 9 (Appleton & Co., 1879–'84–'90).

[5] Die Lehre von dem Tonempfindungen, 1st G. ed., 1863. Translation by Ellis, 1st English trans., 1875.

[6] Piérard, La Téléphonie, p. 20 (Desoer, Liége, 1894).

[7] Journal Society Telegraph Engineers, Oct. 1, 1877, p. 403.

tached to the end of the incus. Upon moistening the membrana tympani and the ossiculæ with a mixture of glycerine and water, the necessary mobility of the parts was obtained, and upon singing into the experimental artificial ear, the stylus of hay was thrown into vibration and tracings were obtained upon a surface of smoked glass passed rapidly underneath. While engaged in these experiments, I was struck with the remarkable disproportion in weight between the membrane and the bones that were vibrated by it. It occurred to me that if a membrane as thin as tissue paper could control the vibration of bones that were, compared to it, of immense size and weight, why should not a larger and thicker membrane be built to vibrate a piece of iron in front of an electromagnet." It seems certain that Professor Bell was possessed of a very clear understanding of his problem. There are numerous evidences of his broad and complete familiarity with the work of other scientific investigators and it appears that having developed new ideas on the characteristics of speech and what is needed to transmit and reproduce it electrically, he then proceeded with energy and enthusiasm to overcome the difficulties of reducing these ideas to practical operation. The conception of a "membrane speaking telephone" appears to have become complete in Bell's mind in substantially the form shown as figure 7 of his later patent,[8] in the summer of 1874 (Fig. 2).

On June 2, 1875, Bell heard a tuned reed receiver, with which he was experimenting in connection with his harmonic telegraph system, vibrate in response to the plucking of a somewhat similar tuned reed transmitter at the other end of the line (Fig. 3). The simple observation appears hardly more significant than similar observations of men who preceded Bell a number of years. Yet the phenomenon in his mind took on the greatest meaning. He immediately gave his assistant Watson instructions for the design of a structure which mounted a small drumhead of gold beater's skin over one of the vibrating reeds, joined

[8] Rhodes, Beginnings of Telephony (Harper & Bros., 1929).

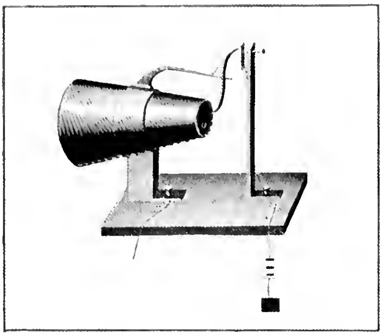


FIG. 1. Reis microphone. A make-and-break platinum contact microphone with which musical sounds but not speech were transmitted in 1861.

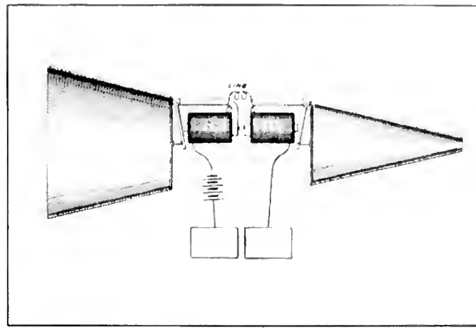


FIG. 2. Bell's conception of the telephone resulted in this sketch which was used in his first patent application of 1876.

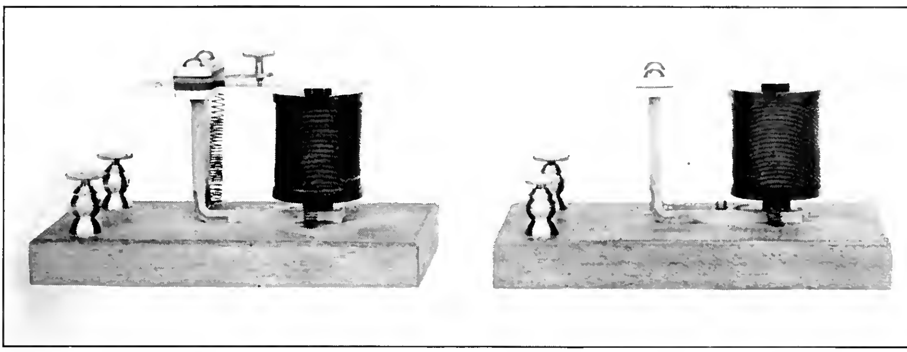


FIG. 3. Reed transmitter of June 2, 1875. With the device on the right Bell heard the sound of Watson plucking the reed of the device on the left with his finger.

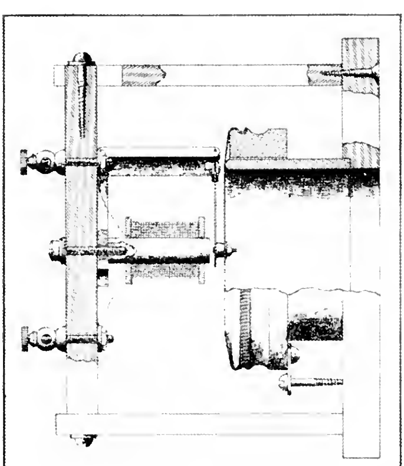


FIG. 4. "Gallows frame" transmitter. This is the instrument by which Bell transmitted the sound of his voice to Watson, June 3, 1875.

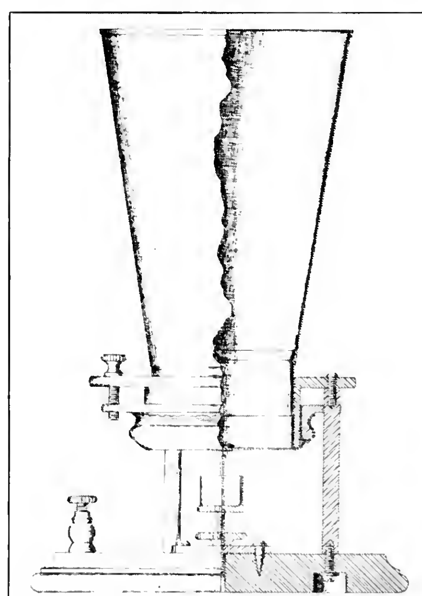


FIG. 5. Liquid transmitter. With this transmitter in March, 1877, Bell said "Mr. Watson come here, I want you."

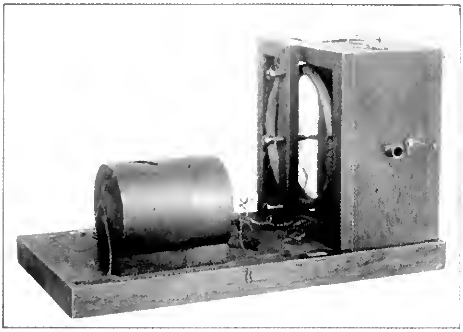


FIG. 6. Berliner invented this single contact microphone in 1877.

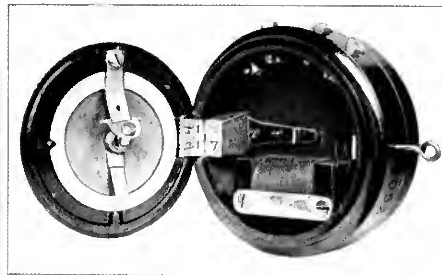


FIG. 7. This carbon to carbon single contact Berliner transmitter was brought out in 1879.

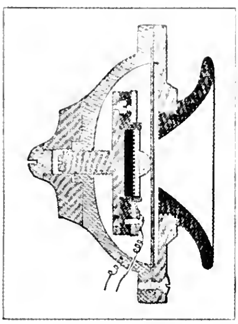


FIG. 8. The Edison transmitter used a solid disk of carbon as the variable resistance element.

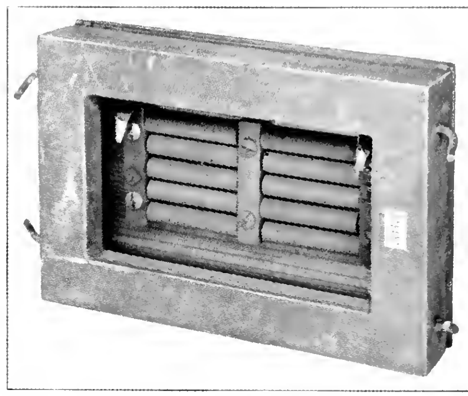


FIG. 11. This Ader transmitter used 10 carbon pencils connected 5 in parallel, 2 in series.

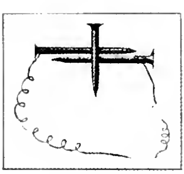


FIG. 9. Hughes nail microphone. Prof. Hughes in 1878 demonstrated the effects obtained with this simple but sensitive inertia type microphone.

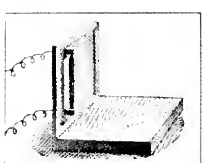


FIG. 10. Pencil Type microphone of carbon mounted on a sounding board. Demonstrated by Hughes in 1878.

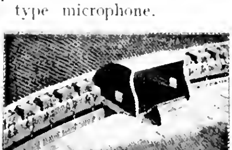


FIG. 12. Music from the Paris opera was picked up by a series of Ader multiple carbon pencil microphones mounted in front of the foot lights.

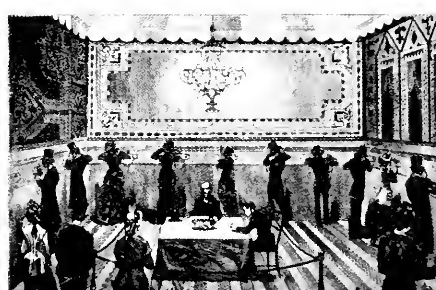


FIG. 13. Reception of music from the Paris opera by binaural system in 1881.

the center of the drumhead to the free end of the receiver spring or reed and arranged a mouthpiece over the drumhead to talk into. This model (Fig. 4) was prepared in record time by the enthusiastic Watson and was tested on the succeeding day, June 3. Watson reports distinctly hearing the tones of Bell's voice. He, however, reports with some sadness that his own voice was not as strong as Professor Bell's and therefore he could not make it heard. The principle, however, had been proven beyond doubt in Bell's mind and advance was sure. The difficulty was to devise more efficient or sensitive means.

Measurements have been made of the response of these early instruments. They show quite definitely that the first sounds transmitted must have been barely audible. Had the inventor not understood very clearly for what he was searching and what he expected to hear, these extremely faint sounds could hardly have attracted his attention.

Until recently the great demand has been for greater and greater transmitter output. Improvements in receiver efficiency raise the noise level with the level of speech whereas increased transmitter output means overriding the noise. As long as the transmitter merely converts the power of the voice itself, from acoustic to electrical form its output is, of course, necessarily very limited. The natural course has been to utilize in the design of a transmitter some principle or device in which the vibrations of the voice serve merely to control or modulate power supplied by some independent source, such as a battery; that is, the sound waves must be made to modulate a resistance through which a current is flowing in such a manner that the resultant current changes are a sufficiently accurate counterpart of the pressure changes in the air. Such a device should not and need not impose restrictions on the motion of the diaphragm used to pick up the motion from the air. It was to such a device that Bell turned in his next experiments. To a drum head of gold beater's skin in a horizontal position he attached a small platinum wire (Fig. 5). This barely made contact with the surface of a small quantity of acidulated water in a conducting cup. Vibration of the diaphragm varied the depth and area of contact between the wire and the surface of the water and therefore the resistance between them. Such a model was constructed and successfully tested March 10, 1876. This was the first transmitter to transmit successfully a complete sentence " Mr. Watson, come here—I want you."

Bell's patent application was filed February 14, 1876, and granted March 7, 1876. Later in the same day (February 14th) Elisha Gray filed a caveat, or statement of intention to later file patent application, claiming the art of transmitting speech electrically. The claims of Bell to inventorship of the telephone were widely contested in the courts, during the twenty years following, Reis, Dolbear, Blake, Gray, Drawbaugh and others having been claimed to be the inventors. The ensuing litigation was most extensive and continued until 1896. During this time Bell's claims were exhaustively investigated and were finally validated by the United States Supreme Court.[9]

Following his first successful transmission of a complete sentence in 1876, Bell promptly described his invention in numerous public lectures and demonstrations in both the United States and England; on May 10, 1876, before the American Academy of Arts and Sciences in Boston,[10] at the Centennial Exposition in Philadelphia,[11] June, 1876, before the Society of Telegraph Engineers in London,[7] October, 1877, etc. As a result, numerous inventors appreciating the fundamental importance of the new discovery promptly attacked the problem. During the five succeeding years almost every conceivable means of converting sound into electricity was tried. In fact, the situation was well described by Preece in 1882:[12] "There

[9] U. S. Supreme Court Reports, Vol. 126, Oct. term, 1887.

[10] Proc. Am. Acad. of Arts and Sciences, Vol. 12 (new series, No. 4), May, 1876–May, 1877, pp. 1–10.

[11] Casson, " History of the Telephone," p. 35 (McClurg & Co., 1913).

[7] Loc. cit.

[12] Prescott, loc. cit., p. 361 (1890).

is nothing more marvellous than the wonderful versatility of this power which electricity possesses of making everything produce speech. Now that we know what electricity can do, the difficulty appears to be not so much how to make the apparatus talk, but how to prevent it from speaking."

In 1877, Emile Berliner in Washington observed that the resistance of a loose contact varied with pressure, and constructed successful working models utilizing this principle.[13] The Berliner device was much like one used by Du Moncel in 1856.[14] The difference apparently was almost wholly one of understanding and resultant application and development. His first models used metallic contacts (Fig. 6) but these were later replaced by carbon (Fig. 7). Berliner's models were much more efficient than previous designs but their performance was extremely erratic, they could not be used in various positions, would carry but little direct current and would not maintain their adjustment. They were, nevertheless, developed to such a point that they were in considerable practical use.

In 1877, Edison[15] patented a transmitter of a variable resistance amplifying type in which the resistance element was a "button" of solid carbon or plumbago. This device (Fig. 8) gave quite good quality and was somewhat less erratic than previous designs. It was however relatively insensitive. He experimented with a wide variety of materials including "hyperoxide of lead, iodide of copper, black oxide of manganese, graphite, gas carbon, platinum black, finely divided metals including osmium, ruthenium, silicon, boron, iridium and platinum, in fact all the conducting oxides, sulphides, iodides, fibre coated with metals by chemical means and pressed into buttons, liquids in porous buttons of finely divided non-conducting material," but better than any of these he found was a button of lamp-black compressed into a solid disc by the application of

[13] Caveat filed in U. S. Patent Office, Apr. 14, 1877.

[14] Exposé des Applications de l'Electricité (1857).

[15] British Patent No. 2909, July 30, 1877; U. S. Patent No. 474,230, May 3, 1892 (Application filed Apr. 27, 1877).

several thousand pounds' pressure.[16] Due to the need of greater output and in order to transmit currents over greater distances, he devised and patented a combination of a telephone receiver and such a button, thus providing an amplifier or repeater. In some of Edison's transmitter models he interposed soft rubber between the diaphragm and the button in order, as he explained, "to damp the natural motion of the diaphragm. Interference with articulation which the prolonged vibration of the metal tends to produce in consequence of its elasticity is thus prevented and the sound comes out clear and distinct." This use of rubber undoubtedly added some damping. It probably also served to couple the diaphragm and its relatively low mechanical impedance and large amplitude to the high impedance, low amplitude or high pressure carbon button and very likely increased the efficiency and decreased the non-linear distortion by keeping the vibrations at the carbon within the narrow amplitude range within which its resistance change is substantially proportional to the displacement of the electrode. In other words, it served to couple an "amplitude" system to a "pressure" system. Edison later concluded that the carbon responded to changes in "pressure" only and not to "amplitude."

The Edison microphone was rugged, would operate in any position and gave rather better quality than its predecessors. It was however quite insensitive. The resistance was about 4 ohms, and it was operated from a low voltage source of approximately 1½ volts.

In May, 1878, Hughes in London published[17] an account of experiments with loose contacts between different materials. He described how a microphone may be made of three nails (Fig. 9), one resting on the other two, the loose contacts being highly sensitive to any vibrations either of their support or of the air. Following these ideas, models of sharpened pencils of

[16] Prescott, loc. cit., p. 124.
[17] Proc. Royal Soc., XXVII, 366; Phil. Mag., 5th series, Vol. VI, p. 44.

carbon mounted on a vibrating support were developed (Fig. 10). These inertia transmitters were extremely sensitive and were termed "microphones." The forces at the contacts were due to the mass reactance of the loose element.

The term "microphone" was revived by Hughes at this time. The term was apparently coined and first used by Wheatstone in 1827[18] for a purely acoustic device which he developed to amplify weak sounds. The term was for years used only to refer to sensitive loose contacts of the type used by Hughes and was not applied to telephone transmitters generally. More recently, the term "microphone" has been used, particularly in radio broadcast, public address and sound picture work, for any device which converts from sound to corresponding electric currents. In view of this usage the term microphone will be used here as synonymous with transmitter, particularly for applications other than those in the usual telephone system.

The Hughes microphone consisting of a carbon pencil sharpened at both ends and resting loosely in carbon supports received considerable development and commercial use in Europe, particularly in France where Ader and several contemporaries developed the multiple carbon pencil microphone (Fig. 11). This usually consisted of 6 to 12 such pencils connected electrically in series multiple. They were usually mounted on a rectangular sounding board of thin well-seasoned pine or spruce. These devices were quite successful and were to be found in commercial telephone systems until quite recently. The Hughes and later the Ader microphones were very sensitive but also quite erratic in their behavior. They were very sensitive to mechanical vibrations.

The Ader microphone was used at an early date for picking up musical programs. Considering recent developments in work of this type, it is of interest to quote an account published by Prescott in 1884:

"One of the most popular attractions at the Paris Electrical

[18] Wheatstone, "Scientific Papers," p. 32.

Exhibition of 1881 was the demonstration of the marvellous powers of the Bell telephone, by its transmission of the singing on the stage and the music in the orchestra of the Grand Opera. This demonstration was given nightly, . . . eighty telephones were constantly at work at the same time, the communication being shifted at short intervals to another set of eighty similar instruments in two other rooms."

"The transmitters were microphones of the Ader system, placed in front of the opera stage, close to the footlights and behind them." (Fig. 12.)

"A new acoustic effect was discovered by Mr. Ader, and applied for the first time in the telephonic transmission at the Electrical Exhibition. In listening with both ears at the two telephones, the sound took on a special character of relief and localization which a single receiver could not produce. It is a common experience that, in listening at a telephone, it is practically impossible to have even a vague idea of the distance at which the person at the other end of the line appears to be. In this case there was nothing of the kind. As soon as the experiment commenced the singers placed themselves, in the mind of the listener, at a fixed distance, some to the right and others to the left. It was easy to follow their movements, and to indicate exactly, each time that they changed their position, the imaginary distance at which they appeared to be."

Each person was provided with two telephone receivers (Fig. 13) which received their impressions from two distinct microphones placed a certain distance apart. Prescott explained the effect purely on a relative loudness basis not as being in any way related to phase differences.

In 1878, Francis Blake[19] in this country designed a telephone transmitter in which a block of hard carbon was supported on a rather stiff spring (Fig. 14). Between this and the vibrating diaphragm was interposed a small bead of platinum on a light

[19] U. S. Patents Nos. 250,126 to 250,129, Nov. 29, 1881; British Patent No. 229, Jan. 20, 1879.
Rhodes, loc. cit., p. 79.

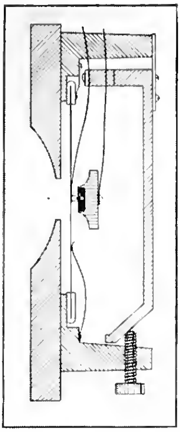


Fig. 14. This cross-section of an early Blake transmitter shows it to be of the inertia type.

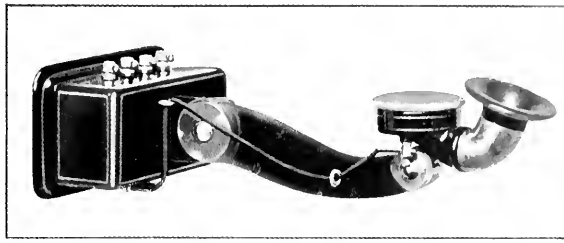


Fig. 15. The "long distance" transmitter of 1886, a development of Hunnings' transmitter, used Edison granular carbon in a horizontal cell.

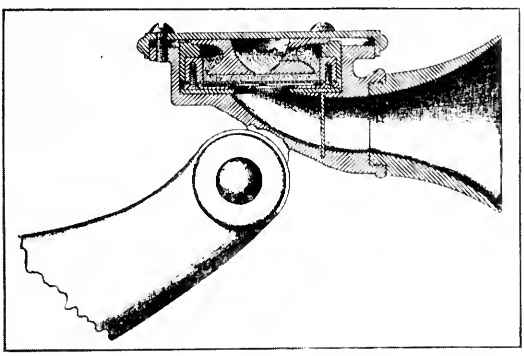


Fig. 16. Commercial models of the Hunnings transmitter were used in a horizontal position with the carbon resting on the diaphragm. The fixed electrode projected well into the granular mass.

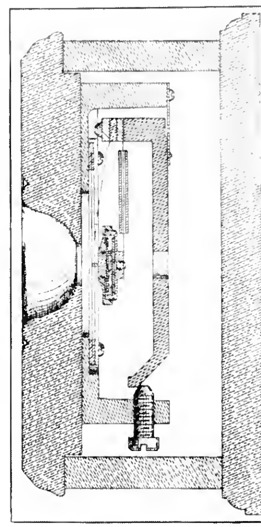


Fig. 17. The Blake type transmitter was later developed to this form using a button containing granular carbon.

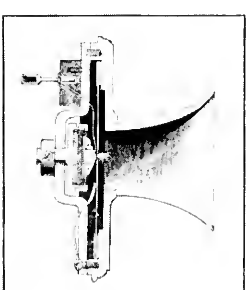


Fig. 18. The solid back transmitter invented by White in 1890 was of a general type of which millions have given good service.

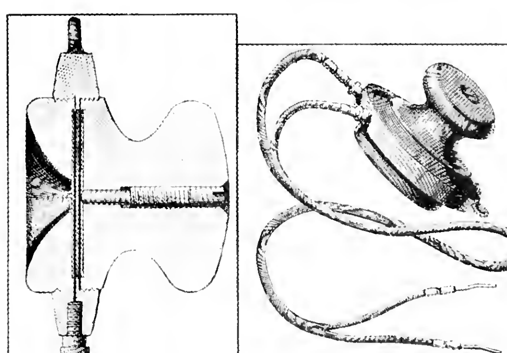


Fig. 19. One of the first condenser transmitters was devised by Prof. Dolbear of Tufts College.

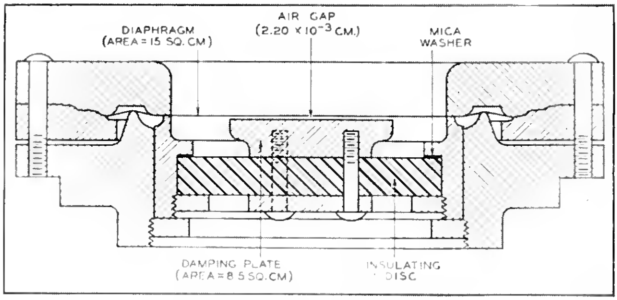


FIG 21. The Wente condenser microphone of 1917 gave faithful response over a very broad frequency range.

FIG. 20. Carbon granules average 0.011 inch in size. When magnified they look much like chunks of ordinary hard coal. They are hard, clean and free from dust.

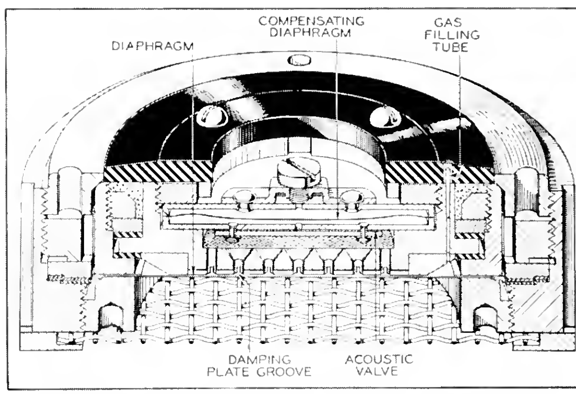


FIG. 22. The condenser microphone was modified by Crandall in 1918 to have a slotted damping plate. This increased the efficiency and also the damping, thus greatly increasing its practical usefulness.

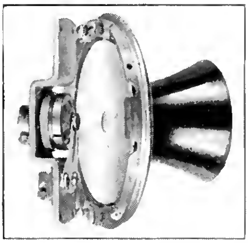


FIG. 23. The centrally damped solid back transmitter became standard in the Bell System in 1917.

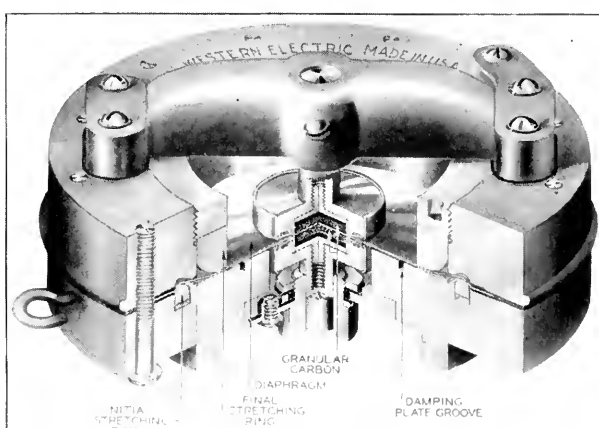


FIG. 24. Two carbon buttons are used in the Western Electric carbon microphone for broadcasting and public address systems.

spring. This instrument as developed for commercial use was more sensitive than the Edison and more rugged, reliable and permanent than the Berliner or Hughes. It rapidly replaced the Edison and Berliner types and was extensively used for many years by the Bell System. Its resistance was about five ohms, and the safe current was about ¼ ampere at 1½ volts.

On September 16, 1878, an English clergyman, Hunnings,[20] received a British patent on a telephone transmitter using a button partially filled with "pulverized engine coke," a light porous form of carbon. American rights to this invention were later purchased by the American Bell Telephone Company and the device was developed into a form suitable for commercial use (Fig. 15–Fig. 16). Like the Blake it was more sensitive than the Edison transmitter and more stable than the Hughes microphone. It could however carry larger currents than the Blake. One of its outstanding difficulties was that the carbon tended to pack into an insensitive condition. It was the type destined to be developed into the most broadly used commercial form.

On July 8, 1879, Gilliland[21] made application for a patent on a combination of a Bell receiver and Blake Transmitter with a common diaphragm. This again shows the early recognition of the need of an amplifier.

The mechanical features of the original Blake type single contact telephone transmitter were retained and the single contacts replaced by a carbon containing chamber much like that of present day deskstand transmitters. These granular carbon designs first went into use in 1885 and were somewhat modified in 1888. Several hundred thousand of them were used in the Bell System during the years following. Like the Hughes and the Blake single contact, these were inertia transmitters.

In 1886, Edison applied for a patent on a transmitter filled

[20] British Patent No. 3647, Sept. 16, 1878; U. S. Patent No. 246,512, Aug. 30, 1881.
[21] U. S. Patent No. 247,631, Sept. 27, 1881; Jl. Inst. Elec. Engs., XLI, p. 535.

with granules of carbonized hard coal.[22] Although great progress has been made in refining and controlling the methods of preparation, selected anthracite coal is still used as the raw material from which most microphone carbon is made.

In 1890 Anthony White invented the so-called solid back transmitter (Fig. 18).[23] In this design a solid bridge or button support much like that of the Edison design replaced the spring support of the Blake granular carbon type and the button was attached to the diaphragm. Other mechanical improvements added to the ruggedness and reliability of this design. It was so satisfactory commercially that the general principle is still used extensively. There are at present about twenty million telephone transmitters of this general type of construction in service.

Continental European telephone practice, particularly in Germany and France, has followed the use of the "insert" or "capsule" transmitter. This usually uses a thin carbon diaphragm and a few granules or pellets of carbon supported in a carbon or insulated metal chamber on the back of the diaphragm and provided with a rear carbon electrode. In some of these the carbon chamber has consisted of a felt annulus glued to the diaphragm. The rear carbon electrode was pressed or cemented on the back of the felt.

Having traced the important early steps in the development of the telephone transmitter it is seen that other types gave place to the variable resistance carbon amplifying type. Particularly in view of the fact that this is still the type most broadly used, it is of interest to note briefly the range of physical principles which broad general interest in the problem has utilized in the search for the best.

Microphones may operate on the principle of temperature change due to the sound waves. These are of two types. In one the motion of the air serves to fan and cool a fine wire

[22] U. S. Patent No. 406,567, July 19, 1889.
[23] U. S. Patent No. 485,311, Nov. 1, 1892.
Rhodes, loc. cit., p. 82.

carrying and heated by a direct current. Such a wire is usually mounted in the mouth of a resonator. Such a structure was used by Forbes[24] in 1887. A microphone of this type was used by Tucker during the war in the detection of large guns.[25] A similar device has substituted a series of fine themocouples for the fine resistance wire. In the second type a fine wire or thermocouple structure is placed close to a sound reflecting surface. In this case there is negligible motion of the air and the structure is alternately heated and cooled by the temperature changes associated with the sound.

The resistance of an electric arc has been caused to vary by the sound. Such a device was experimented with by Dolbear, Blyth, Simon, Hayes and many others.

The resistance of the glow discharge in open air has been caused to vary. A description and demonstration of such a device was given by Thomas before the A. I. E. E. in 1923.[26]

Liquid devices of many types have been devised since the first model by Bell. Elisha Gray devised one of the first liquid transmitters. Edison placed a small drop of liquid between contacts, the contact surface, cross-section and length of the liquid path being varied. Liquid jets have been used in various ways. The jet has been deflected on and off a conducting electrode. The electrode has been vibrated in and out of the jet, etc.

Pressure has been used to modify a flame, the conduction through the flame, the heat transmitted by the flame, etc., being used to control electrical effects.

Sound has been caused to deflect a beam of light on and off a photo-electric cell by means of a diaphragm and vibrating reflector.[27] The diffraction of light across a beam of sound has also been used to cause varying amounts of light to fall on a photo-electric cell.

[24] Proc. Royal Soc. Lond., Vol. 42, p. 141, Feb. 24, 1887; El. Wld., Vol. 9, p. 189, Apr. 16, 1887.

[25] U. S. Engr. School, Occasional Papers No. 63, Washington Govt. 1920.

[26] P. Thomas, Proc. A. I. E. E., Vol. 42, pp. 219–222.

[27] Photophone, Bell & Tainter, Prescott, loc. cit.

A magnet has been made to vibrate outside a vacuum tube and thus vary the flow of electrons. By a mechanical connection through the wall of a vacuum tube a grid has been made to vibrate, thus making the conversion from acoustic to electrical effects.

A bismuth resistance element has been vibrated in and out of a strong magnetic field. As the resistance of bismuth varies with the strength of the field, this provides a possible microphone.

Condenser type microphones were devised by DuMoncel, Dolbear (Fig. 19),[28] Varley and many others since. A recent novel manner of using a condenser microphone has involved the modulation of a high frequency oscillating current instead of the usual direct current in such a manner as to give a rather efficient device.[29]

Piezo electric crystals have been vibrated to generate corresponding electric currents.[30]

Of the magnetic microphones, devices have been made in which the sound mechanically strained a magnetic core of nickel and thus varied its permeability and generated a current. The best known magnetic type microphones are those in which the sound changes an air-gap, in a magnetic circuit, thus changing the number of magnetic interlinkages. The magnetic type in which a coil or conductor has been vibrated in a magnetic field is also well known and dates back within a year of Bell's first publication.[31]

The dimensions of solid conductors, both cross-section and length, have been varied by the sound to cause changes in resistance. The most effective device found has been of this type in which the dimensions of contact points of specially prepared carbon are changed. In fact, it would seem that

[28] A. E. Dolbear, A New System of Telephony, Sci. Amer., June 18, 1881, p. 388.

[29] A. H. Reeves, A Solution of the Problem of the Broadcasting Microphone, Electrical Communication, Vol. VII, p. 258.

[30] A. M. Nicolson, Proc. A. I. E. E., Nov., 1919, pp. 1315–1333.

[31] Siemens and Halske, German Pat. No. 2355, Dec. 14, 1877; British Pat. No. 4685, Feb. 1, 1878.

every known characteristic of matter by which temperature change, pressure change or motion may generate an electromotive force, has been used in the design of microphones.

Until recent years, and then only for special uses where amplifiers are available, other than carbon microphones have been of little more than academic interest. In view of this, it is worth while to consider some of the characteristics of the carbon instrument in greater detail.

Carbon microphones have presented a number of difficulties which for a time limited their usefulness. These have been investigated chiefly in connection with studies of the telephone transmitter. Most of these difficulties have been largely overcome in recent years. One of the earliest recognized is known as "packing." The instrument gradually becomes less and less sensitive. Its sensitivity may be revived by shaking or rapping. Packing is of two types, electrical and mechanical. Electrical packing or cohering occurs if the carbon element is subjected to a voltage such that more than approximately 1½ volts per contact is applied. After an application of such voltage, the transmitter sensitivity is apt to be reduced to the order of 1 per cent of normal sensitivity and very vigorous shaking may be required to revive the instrument. This effect is largely independent of the amount of power dissipated or the time for which the voltage is applied. For example, a carbon button or cell may ordinarily be packed almost as effectively by applying a voltage of 20 to 100 volts to 0.001 mf. and discharging it through the button as by a similar discharge from a very large condenser or by the application of the same voltage from a battery. In fact, if the amounts of power dissipated are large, subsequent heating effects may occur such as to free the carbon and decrease the effect.

Mechanical packing is due to a settling and compressing of the carbon mechanically. In this condition its resistance and sensitivity are low. It is often closely associated with "breathing." Many carbon microphones in certain circuits will, if left undisturbed, either increase or decrease, depending on design or circuit conditions, or may pass through cycles of resistance and sensitivity requiring anywhere from a few seconds to many minutes per cycle. These effects have been investigated and are known to be associated with mechanical expansions and contractions of the containing chamber plus those of the carbon itself. They are closely related to the type of circuit, the action often being quite different if supplied with constant voltage than if supplied with approximately constant current. The containing chambers may be so designed as to eliminate these effects almost completely, in which case the button will usually not pack. We might illustrate packing by an example: if, on passing a current through a carbon microphone in series with a considerably larger resistance, the resultant heat causes the carbon containing chamber to expand and the electrodes to move farther apart, the resistance will, at first, rise, due to this greater separation of the electrodes. This will increase the heat generated and cause further separation and resistance rise. This may continue, the sensitivity becoming very great, until the separation is such that the granular mass becomes mechanically unstable. The granular mass may then suddenly settle, particularly if jarred or spoken into at this moment. This lowers the resistance and hence the power dissipated in the button so that it then begins to cool, allowing the parts to draw together and compress the carbon into a highly insensitive state. In general, carbon microphones are more stable when supplied with direct current through a resistance as large or larger than the resistance of the button itself.

The resistance of a granular carbon button decreases with increased current. In certain systems this may be advantageous for transmission as, for instance, in a common battery telephone system where high transmitter resistance occurs on the long subscribers' loops where the series resistance is large. This increases the power dissipated in the button over what it would otherwise be, increasing the output. As the loop is shortened, the lowering in resistance tends to protect the button from excessive power and voltage and excessive heating.

Granular carbon microphones always deliver a certain amount of noise. In modern telephone transmitter designs, however, this noise may be negligibly small. It resembles in character the swishing of leaves. It has been termed "microphonic noise." It might perhaps well be called the inherent or minimum loose contact noise. In amount it is from 15 to 20 db below the output of a carbon broadcast microphone when speaking at normal loudness at a distance of three feet. This noise is undoubtedly due to heating effects at the points of contact between granules. It is not due to mechanical or temperature effects of the containing chamber. No type of carbon appears to be free from this effect and different types differ surprisingly little. It increases about in proportion to the power dissipated in the microphone until the direct current assumes fairly large values; i.e., 0.1 to 0.2 amps. for most telephone transmitter types. When the current is increased further, the noise begins to increase much more rapidly and to depart from its steady, smooth character and become erratic. Sounds like miniature explosions or sometimes continuous oscillations may occur. From its likeness to the sound of frying fat, it is sometimes called "frying." Most commonly, however, this noise has been called "burning." Viewed under a glass minute points of incandescence may be seen at the contacts. This noise limits the use of the carbon microphone in modern practice, where amplifiers are involved, to work where the sounds to be transmitted are sufficiently loud to mask this noise as in usual telephone use.

Carbon may show considerable aging from the condition when it is first prepared by roasting. It may age either as a result of mechanical agitation or burning. As it ages, its resistance increases, the increase often amounting to several hundred per cent.

Considerable work has been done in the investigation of the pressure-resistance characteristic of carbon cells. This approximates an hyperbola over quite a broad range of pressure and resistance although the exact characteristic departs from this curve and depends on a number of factors beyond the scope of this discussion.[32] Based on this characteristic, the character of the current resulting from a sinusoidal variation of pressure has been studied.[33] The effects are complicated. For many purposes, the distortion due to a failure of the current to vary in exactly the same manner as the resistance is not important, provided the resistance in the circuit external to the microphone approximates or exceeds that of the microphone itself. Such effects are often minimized by the use of two carefully matched buttons operated push-pull.

The mechanism of electrical conduction through a mass of granular carbon has been subjected to much study and many theories have been advanced to explain the phenomena observed. It has now been quite well established, however, that the current crosses the contacts through minute sub-microscopic irregularities in the surface in actual contact. As the pressure is increased, these protuberances are deformed so that the areas in contact and the number of contacts are increased and hence the electrical resistance is decreased. The gas which adheres to the surface of the carbon tends to restrict these points of contact and behaves like an elastic layer between grains.

Of the many substances which have been tried for use in a loose contact microphone, granular carbon appears to be much the best (Fig. 20). The combination of the strength, elasticity, the character of the surface as regards its roughness, the manner in which gas adheres to the surface, the heat conductivity, electrical conductivity, its infusibility, the fact that the oxides are gases, the value of the specific heat and the fact that, if properly prepared, the gases adhering to the surface are not

[32] Goucher, Science, Nov. 7, 1930, pp. 467–470.
[33] L. S. Grandy, A. I. E. E., Jour. (46), pp. 426–430, 1927.

given up except at high temperatures, make carbon much the most satisfactory microphonic material known. Microphone carbon is extremely hard, being nearly as hard as diamond. It remains hard at high temperatures. Its ratio of thermal to electrical conductivity is very high compared with other materials. This results practically in much less heating at the minute points of contact. Due to the combination of the characteristics mentioned, there is what might be loosely termed a critical voltage for most contacts. This is the voltage beyond which we cannot go without welding or cohering the contacts. For metals this is low. The fact that it is low was used in the iron-filing detector of early radio days. Such a detector was simply a cell of loose contact material which was very easily packed electrically or cohered. This "critical voltage" of most metals is of the order of 0.1 volt. For carbon it is about 1½ volts. While other materials have been found with higher values of "critical voltage," they are of such high resistance or have other characteristics which are so objectionable, that they are not at all adaptable for use in a microphone. In the light of present day knowledge, it appears probable that carbon will continue to be used as the loose contact material for microphone buttons wherever the conditions of use are such as to demand a microphone which is an amplifier. Due to the large amplification (about 30 db) obtainable with a carbon button, it seems unlikely that amplifying transmitters will be replaced in the near future for at least the great bulk of telephone work.

In most of the earlier carbon transmitters, the granular carbon was placed between two parallel disc electrodes separated from 0.05″ to 0.15″. One of these discs was vibrated by the diaphragm or composed the diaphragm itself so that the maximum agitation and hence aging occurred at this part of the electrical path, the agitation decreasing with increasing distance from the front electrode. Recently, this "direct action" type of carbon cell has in several designs been replaced by a button in which two ring electrodes are separated by an insulating barrier, the agitation being conducted to the granular mass by an electrically insulated element. In this type, known as the "barrier" button, the maximum agitation occurs at somewhere near the middle of the path through the granules. The aging effects are not localized at the electrodes. This type has shown low burning and long life. The earlier type buttons were usually filled only about two-thirds full. In certain recent types in which improvements in design have greatly reduced the slow expansions and contractions of the cell caused by heat, there is little or no breathing and the chamber is almost completely filled with granular carbon.

The carbon granules are of such size that there are about 50,000 granules per cubic centimeter. Buttons usually contain anywhere from 3,000 to 50,000 granules, depending on the particular design.

The telephone handset which has come into broad use by the Bell System during the last few years placed extremely severe requirements upon its transmitter. It must operate in any position and all of its performance characteristics must remain reasonably constant throughout all the various positions and with all the motion to which it is subjected. Moreover, it must maintain its good characteristics over a long life in spite of being subjected to very severe mechanical shock each time it is used. Only recently has it become possible to meet these requirements.

The Bell System handset transmitter uses a diaphragm which is very light, stiff and well damped. The electrical output is maintained partly by the use of a resilient method of supporting the diaphragm which is not clamped. The carbon chamber is practically non-breathing, is in front of the diaphragm and is filled practically full. It is of the barrier type.

The carbon microphone has presented great difficulties in experimental study and analysis as a vibrating structure. This is due to the variable character of the carbon cell, both mechanically and electrically. For this reason most progress has been made in both the theoretical and experimental studies of such structures by the use of receivers or electromagnetic microphones. Contributions to the theoretical and also the experimental technique have been made by Poincaré,[34] Kennelley,[35] Wegel,[36] Wente,[37] Crandall,[38] Gerlach,[39] Mallett and Dutton,[40] Kellogg,[41] Maxfield,[42] Harrison,[42] Moore,[43] Jones,[44] and many others.

About 1915, the vacuum tube amplifier became a potent influence on the development of microphones for certain applications, particularly where cost was not important. It did two things: it made it feasible to use, in these applications, a microphone of low sensitivity or efficiency and it created fields of usefulness for instruments of this type. It shifted the emphasis, at least in places where low cost was not a controlling element, from a magnitude of output basis to quality or faithfulness of reproduction, uniformity and reliability. In addition, it offered possibilities of exact measurements of acoustic effects if used with a suitable microphone. This influence was almost immediately reflected in the development of a very high quality condenser microphone by Wente (Fig. 21). This instrument was developed for use in such acoustic researches and its commercial applications were developed later. The faithfulness with which it reproduced sounds over a very broad range both of frequency and intensity represented a vast improvement over the previous microphones. It was later improved by Crandall (Fig. 22),[45] has received much commercial

[34] Écl. Électr. 50, pp. 221–234, Feb. 16; 257–262, Feb. 23; 329–338, Mar. 9; 365–372, Mar. 16, and pp. 401–404, Mar. 23, 1907.

[35] Electrical Vibration Instruments (MacMillan).

[36] A. I. E. E., Jour., Oct., 1921, pp. 791–802.

[37] Phys. Rev., May, 1922, pp. 498–503.

[38] Theory of Vibratory Systems and Sound (Van Nostrand).

[39] Phys. Zeit., Vol. 25 (1924), p. 672 and 675.

[40] I. E. E., Jour., May, 1925, pp. 502–516; I. E. E., Jour., Oct., 1923, pp. 1134–1138; Proc. Phys. Soc., Feb., 1921, pp. 139–141.

[41] A. I. E. E., Jour., Sept., 1925, pp. 1015–1020.

[42] Bell System Tech. Jour., 1926, pp. 146–147.

[43] Bell System Tech. Jour., 1927, pp. 230–247.

[44] Soc. Motion Picture Eng., Jan., 1931; Bell System Tech. Jour., pp. 46–62.

[45] Phys. Rev., June, 1918, pp. 449–460.

application and is used as the transmitter of the International Reference Standard with which the volume efficiencies of all commercial telephone transmitters are compared.[46]

Acoustic researches require as the most important tool for the use of the investigator a microphone whose calibration can be definitely determined and which will remain fixed. Carbon microphones do not meet this requirement satisfactorily. Such an instrument should operate over a broad range of frequencies and intensities. These requirements are very admirably met by the condenser microphone and its development has greatly stimulated and facilitated precise acoustic measurements. Such measurements would be further facilitated in the higher frequency ranges were the dimensions of the microphone such that its interposition in a sound field caused no distortion thereof. The character and extent of this field distortion has, however, been studied and methods and data developed by which such effects can either be controlled[47] or proper corrections be introduced.[48] The high mechanical impedance of its diaphragm adapts it well for investigations of sound in tubes or closed spaces.

If we wish to summarize the facts recounted above we see that during the period immediately following 1875 almost every conceivable type of microphone was tried. With the available technique, however, it was not possible to submit the different types to detailed quantitative study or analysis. They were used chiefly as telephone transmitters. The magnitude of the electrical output tended to exceed extreme faithfulness of reproduction in its practical importance. The granular carbon type rapidly outdistanced all competitors. Intensive work on this type of transmitter led to successive improvement in both these factors and also in the reliability of the instrument, the uniformity of commercial product and the uniformity of performance during its life (Fig. 23).

[46] Martin and Gray, Bell System Tech. Jour., 1929, pp. 536–559.
[47] Ballantine, Phys. Rev., Dec., 1928, pp. 988–992.
[48] Aldrich, P. O. E. E., Jour., Oct., 1928, pp. 223–225.

Since the publication in 1917 of Wente's work on the condenser microphone, there has been an increased demand for microphones which will reproduce sounds of widely varying character with extreme fidelity. Various lines have been followed in the development of different types. The condenser microphone has, as stated, been used quite broadly. The magnetic type with moving strip conductor actuated directly by the sound has been used abroad[49] and is coming into use in this country.[50] The stretched diaphragm air-damped carbon microphone (Fig. 24) has seen considerable use in this country, and

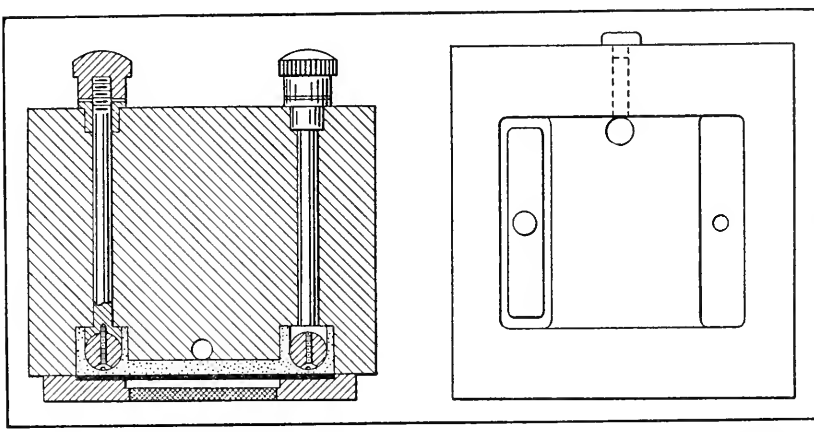


FIG. 25. The Reisz marble block carbon microphone has been used for European broadcasts during the last few years.

in Europe the Reisz,[51] transverse button microphone placed in a heavy marble block has seen considerable use (Fig. 25). The electrical output of such instruments is usually much lower than that of commercial telephone transmitters, the sacrifice being quite justifiable since, in their application, these microphones are usually associated with a suitable vacuum tube amplifier. Where the source of sound is somewhat remote from the microphone, so that the actual sound power available is very low, and

49 Gerlach and Schottky, Phys. Zeit., Vol. 25 (1924), p. 672 and p. 675.
50 Electronics, Feb., 1931, p. 492.
51 U. S. Pat. 1,634,210, June 28, 1927.

where quietness of operation is essential, loose contact noise bars the use of the carbon microphone, and the magnetic, or condenser instrument is to be preferred.

Microphones have been in demand in recent years for a wide and growing variety of uses. "Anti-noise" transmitters are demanded in airplanes and other noisy places. Although various principles have been suggested and used, it appears that most of the obtainable improvement in this direction can be realized merely by the use of a highly damped instrument. Beyond this, further improvement seems to rest chiefly on the exclusion of the noise. That this must be true and that the transmitter cannot be made to discriminate among the sounds reaching it seems obvious. An instrument cannot transmit efficiently all of the sounds of the voice over its broad frequency and intensity range and, at the same time, discriminate against sounds reaching it from other sources within these same ranges. If the voice is to be transmitted and other sounds excluded, it appears necessary to use a mouthpiece which carefully seals the transmitter to the face and, at the same time, provides an opportunity for the escape of the breath necessary in speech. This last requirement has been met by the use of a low-pass acoustic filter.

A frequency response curve has been taken using one of the earlier Blake single contact transmitters, of the type designed in 1878. This is shown in comparison with a similar curve for a Western Electric condenser microphone. Both curves are for constant sound pressure (Fig. 26 and Fig. 27). The contrast between these two curves needs no comment. It shows the great advance which has been made in fidelity of reproduction and it also shows at what sacrifice in magnitude of output.

If it were possible to state the requirements of future microphones in a single specification, it might be possible to make some predictions as to the type and range of future improvement. This, however, is not possible because designs will be needed for a wide variety of conditions of use. Some will be

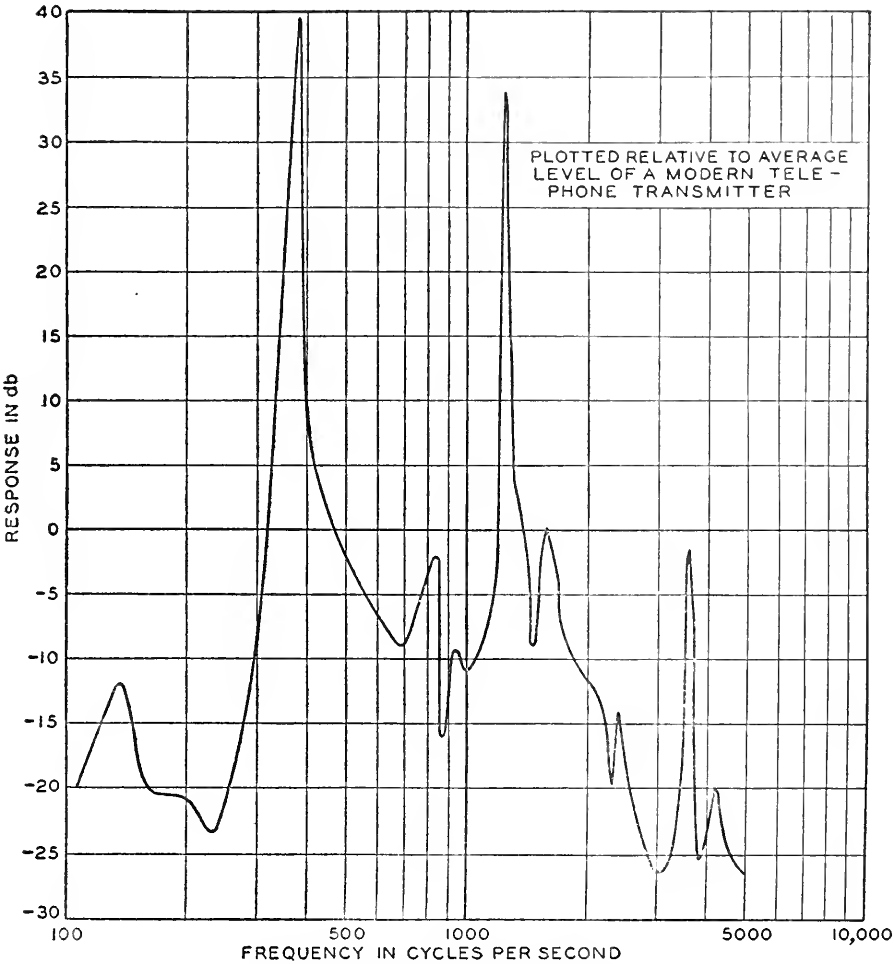


Fig. 26. Response frequency characteristic—Blake single contact transmitter of 1878.

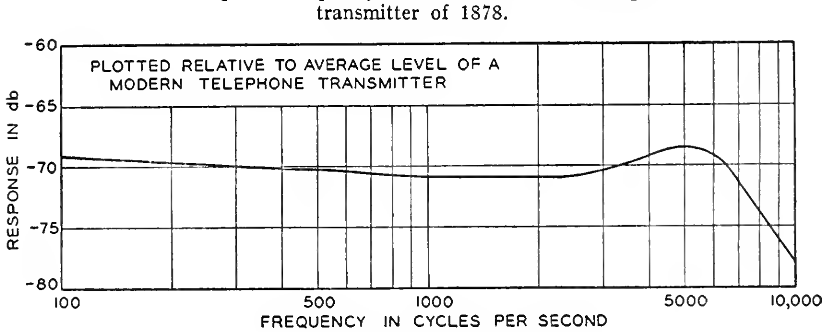


Fig. 27. Response frequency characteristic—condenser microphone.

used for comparatively close talking in which a moderately high level of output is needed and in which the battery supply is limited. Others will be needed for use in noisy locations, others for picking up mechanical vibrations such as detectors to be mounted on bank vaults, others for the picking up of sounds in water as in submarine detection and signalling, others for picking up weak sounds in the open air where sounds coming in all directions are of interest and still others for similar open air work where it is desirable that the instrument be highly directive. This list might be extended almost indefinitely. Obviously, many different types of microphones will be used in the future, and designs will be developed to meet an increasing variety of needs.

H. A. Frederick

The Measurement of Noise; a New Service of Electrical Research Products, Inc.

THE widespread use of machinery and the growth of congested municipalities have created noise problems which have become acute. Although noise has long been recognized as undesirable, it has only been comparatively recently that the full gravity of its harm was realized. Leading psychologists and physiologists have undertaken costly experiments to measure the effect of noise upon the human physical organism. Efficiency experts have endeavored to determine the economic waste caused by noise.

The findings from these various investigations have suggested many benefits that would result from successful efforts to abate noise and have resulted in a demand for such abatement. To achieve proper economic and satisfactory control of noise, a scientific analysis must be made and each contributing source independently studied. Only then can recommendations be prepared which will assure adequate isolation or elimination. Since the Bell Telephone Laboratories had already developed instruments and techniques capable of solving problems such as these, their aid was naturally enlisted.

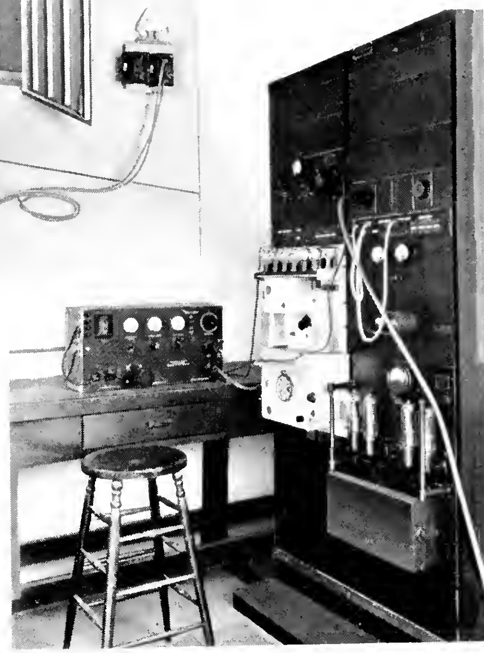
The need for similar engineering advice in the field of architectural acoustics has also become urgent. The necessity for satisfactory acoustics was recognized centuries ago with the construction of cathedrals, opera houses, and concert halls, but lack of a sufficient understanding of acoustic phenomena and of the characteristics of building materials made it impossible to effect desired conditions. An auditorium, proving acoustically acceptable, was hailed as a great achievement. What appeared to be an exact reproduction would often prove most unsatisfactory. Fortunately, the public was cognizant of the difficulties encountered and was tolerant. Until recent times, this toleration persisted, but with the ever increasing number of available auditoriums, the public has become selective.

With the introduction of sound amplifying and reproducing devices in theatres, satisfactory acoustic conditions became an important economic necessity. No matter how ingenious their conception, or how perfect their manufacture, these devices could hardly justify their inclusion where abominable "listening conditions" existed. A demand for engineering advice on acoustic conditions was thus created. The Bell Telephone Laboratories had long investigated acoustic phenomena, and through their own and other kindred researches, an exact science had been established. Here again, it was only natural that their aid should be sought.

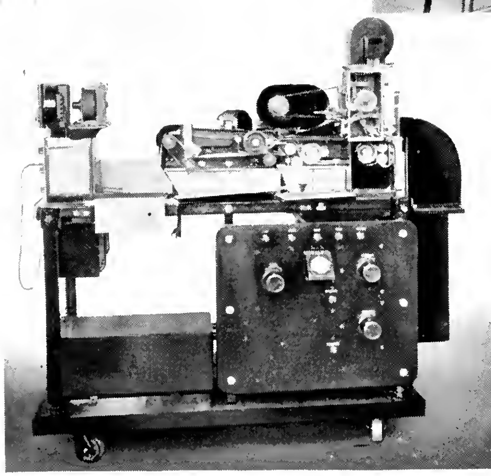
Some two years ago Electrical Research Products, Inc. established a department for disseminating acoustic information to their licensees in the talking motion picture field. Functioning as a noncommercial unit, this department acoustically analyzed over five thousand theatres and prepared recommendations for their correction. During these studies, considerable practical experience was gained, as nearly every type of architectural acoustic problem was encountered. Publicity, attendant upon each successful achievement, created a more general demand for this acoustic consultation and architects began seeking advice on other types of auditoriums. With the realization that a thorough study of auditorium acoustics necessitated knowledge of all catacoustic and diacoustic phenomena, a new demand became apparent, and aid was sought on all types of structures.

To meet the growing general demand for noise abatement and acoustic control, the services of the department were commercialized, thereby effecting a new application of telephone research. Instruments, experimental facilities, techniques, and practical experience were available. It was essential that this organization function purely as engineering consultants, with-

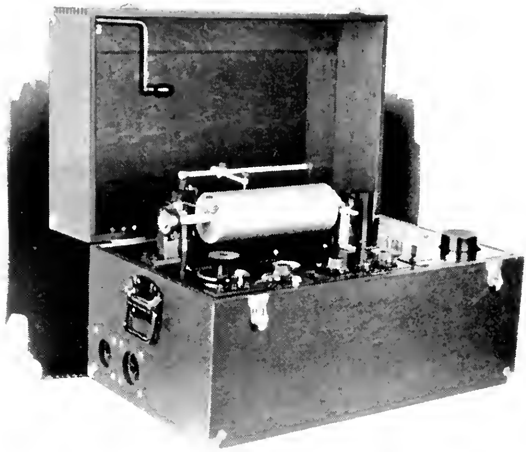
(Left) VIEW IN SOUND TRANSMISSION LABORATORY; samples of materials are tested here.



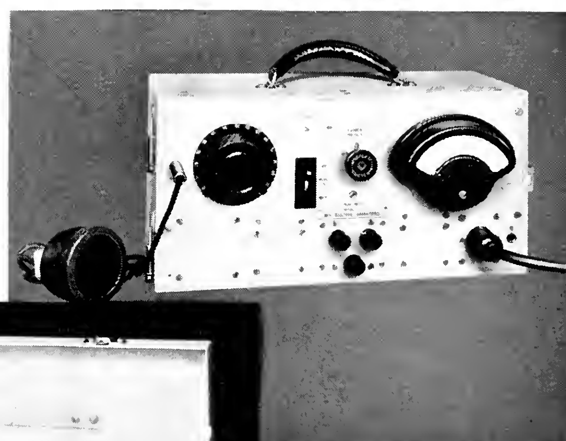
(Right) PART OF APPARATUS USED IN TESTING MATERIALS; the ear is replaced by electrical instruments.



(Left) THE RAPID RECORD OSCILLOGRAPH—AN EXTREMELY VALUABLE INSTRUMENT IN ACOUSTIC RESEARCH.



(Left) A Spark-Chronograph Type of Reverberation Meter Employed in Auditorium Measurements.



These Two Pictures Represent One Model of a Complete Portable Set for Measuring Noise. The battery box provides space for carrying the microphone and cords; it also houses a field calibrating device.

out interest in the manufacture, distribution or sale of any acoustic or noise isolating materials or devices. Only in this way could economical, practical and unbiased acoustic advice be disseminated.

Since the inauguration of this new Acoustic Consulting Service in January of this year, the scope of its activity has been extraordinarily wide, and valuable experience has been gained with the solution of each new problem. Acoustic analyses have been made, and specifications for correction prepared on all classes of architectural construction, from auditoriums seating over twenty thousand people to the private office of an executive, from recording and broadcasting studios to band shells, and from cafeterias to libraries. In fact, a practical solution of acoustic problems occurring throughout the architectural range has been effected. The instruments and theories developed in the Bell Telephone Laboratories have proven most adequate.

Noise analysis and the preparation of specifications for its control has offered a widely diversified field; and nearly every problem has necessitated a different application of engineering principles. Noises created in tunnels and subways, and by elevated railways, automobiles and airplanes, have been studied; and means of reducing or eliminating them have been recommended. Of equal importance, though not quite so formidable, have been investigations of noise emanating from office machinery, ventilating fans, and other extraneous sources. Instruments are used in this work, as it is only after a measurement of each contributing component that an individual noise may be thoroughly analyzed. By redesigning machine parts or introducing isolating materials or devices, a desired amount of reduction may be assured. Since effective solutions have been achieved for the above types of problems, new demand has become apparent. Inquiries have been received for the design of special acoustic instruments for mechanical inspection of noisy machine parts. Information also has been requested on the construction of acoustic signal devices which may be distinguished from surrounding noise. As each new noise problem is created, a new field for this service is established.

Although noise abatement and acoustic control predominate in the field, there is yet another branch of allied activity that is worthy of mention. The testing of materials, structures, or devices to determine their acoustic characteristics has become an important part of this new work. Laboratories have been established in New York and Los Angeles, equipped to measure accurately the absorbing, transmitting, and reflecting qualities of materials, and for conducting comparative noise tests. This latter function permits the design of quieting devices and the conduct of experiments on the effectiveness of acoustic signalling systems.

Certain specific commercial aspects of this new consulting service have been discussed above, but it must be borne in mind that other types of acoustic or noise problems may be solved with equal facility. Fundamentally all problems in sound and vibration are the same, so when particularly complex obstacles are encountered, their analysis may be achieved by recognizing basic similarities. From this point, special apparatus or new instruments may be developed which will adequately solve the problem. Through the establishment of this Acoustic Consulting Service, a highly specialized engineering field has been developed, and new commercial applications have been found for experimental discoveries made during telephone research. And, thus, another service has been rendered the public.

S. K. Wolf

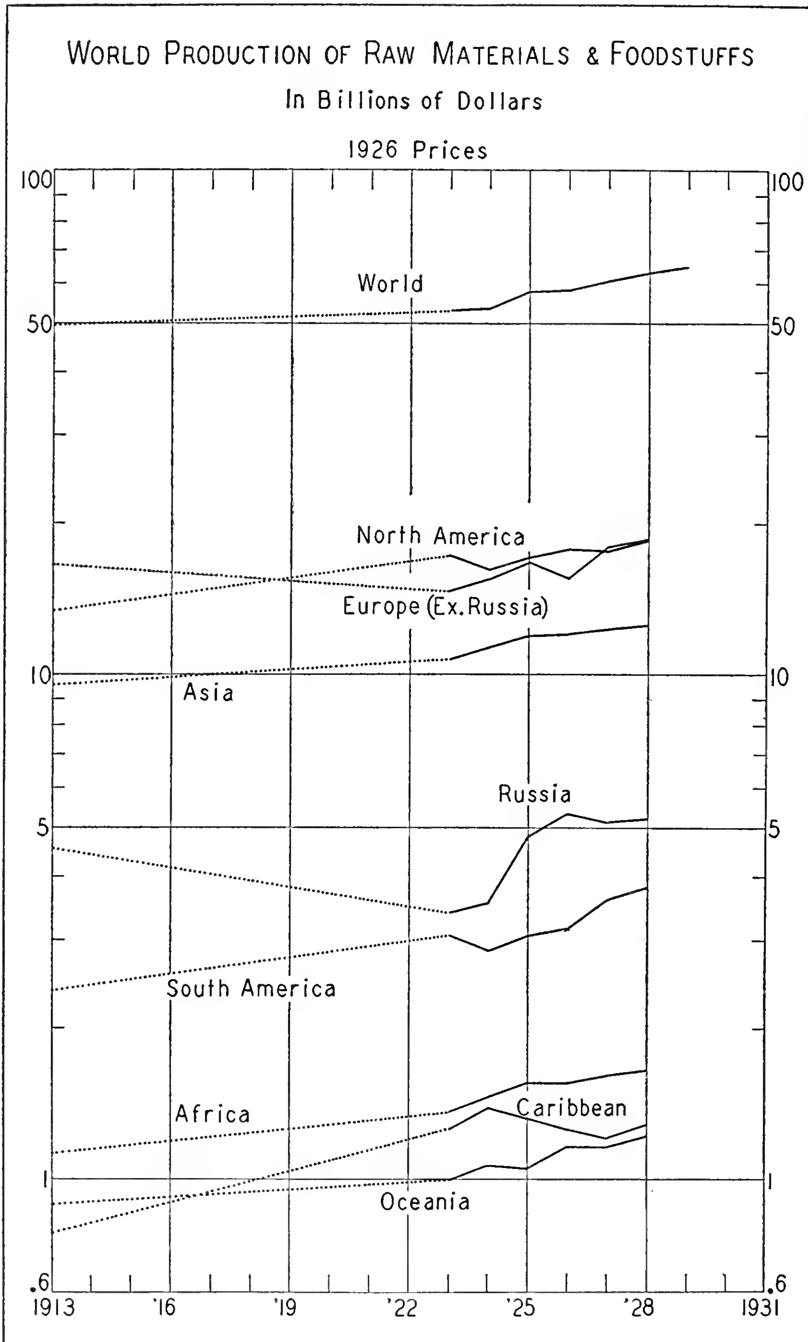
The Primary Production of the World

THE severe decline in prices on the stock market in October, 1929, marked the termination of a period of five years of practically uninterrupted prosperity in the United States. Never before in a period of equal length had American crops been so bountiful; never before had we extracted from the earth such large quantities of minerals and metallic ores. Concurrently, our forests were yielding a volume of timber products sufficient to support a tremendous building boom. In fact, so abundant was the production of basic raw materials and foodstuffs which accompanied our national prosperity that it has sometimes been claimed that this country was primarily responsible for the maladjustments and disequilibrium which have latterly disrupted the crude material markets of the world.

What are the facts? Is it true that during prosperity the United States increased its production more rapidly than did other nations? To answer this moot question it is necessary to know what the world in general has accomplished in the field of primary production. Fortunately there is available an index of the world's production of crude foodstuffs and raw materials, compiled by the Economic and Financial Section of the League of Nations.[1] (It is to be regretted that data on the output of manufacturing industries are not available, except in the case of a very few countries. Concern over the lack of such information, however, is tempered by the fact that the production of raw materials—primarily for purposes of fabrication—is a process only once removed from manufacture itself.)

The accompanying chart shows the League of Nations' index, both for the world and for continental groups. The chart is on a logarithmic vertical scale, equal vertical distances measured

[1] Memorandum on Production and Trade, 1923 to 1928/29. League of Nations, Geneva, June, 1930.



WORLD PRODUCTION OF RAW MATERIALS & FOODSTUFFS
In Billions of Dollars
1926 Prices
100
50
10
5
1
.6
World
North America
Europe (Ex. Russia)
Asia
Russia
South America
Africa
Caribbean
Oceania
1913
'16
'19
'22
'25
'28
1931

upward representing equal percentage increases, and equal vertical distances measured downward representing equal percentage declines. The North American group includes the United States, Canada, Labrador, Newfoundland and Alaska. The Caribbean group includes the West Indies, and the continental states from Mexico to Panama. Since the Union of Soviet Socialist Republics has abandoned the old distinction between European and Asiatic Russia, it is more convenient to show the U. S. S. R. as one continental group. Accordingly, the separate indexes for Asia and for Europe are exclusive of Russia. The world index and the separate component indexes are available for the year 1913 and for the years from 1923 to 1928 or 1929. In the chart the years from 1913 to 1923 are bridged by a straight dotted line.

It may be wondered why, if this chart measures physical production, the scale is "in billions of dollars." Obviously, to add together commodities so varied as wheat, pig iron, rubber, etc., it is necessary first to express them in terms of a common denominator. The common denominator used is value. A representative world price is chosen for each commodity and the physical quantity of the commodity produced in each year is multiplied by this price. The prices selected are averages for the year 1926, and are used as constant weights throughout the period of the index. The index itself is based upon data representing the production of 62 crude foodstuffs and raw materials, except that the production of foodstuffs in China is excluded since no data are available. The fact that the latest point on the world index is an estimate for 1929, while the latest points on the individual components are for 1928, is of no consequence for purposes of this discussion.

The chart indicates clearly, by comparison of 1923 with 1913, the losses in European and Russian production which occurred as a result of the war and the Russian Revolution. While 19 per cent below European output in 1913, North American production in 1923 exceeded that of Europe by an equal relative amount. Russian production declined twice as sharply as European production. Aside from European production, all of the other indexes on the chart rose in the decade 1913 to 1923. The extremely sharp rise in Caribbean output for the most part reflects the rapid development of the petroleum industry in Mexico. The accompanying table shows the changes from 1913 to 1923, both in dollar value aggregates and in percentages.

World Primary Production—1913 to 1923

Aggregates in Millions at 1926 Prices

	1913	1923	Net Change	
			Amount	%
Europe (excl. U. S. S. R.)	$16,647	$14,532	−$2,115	−13
U. S. S. R.	4,576	3,399	− 1,177	−26
North America	13,471	17,326	+ 3,855	+29
Caribbean	785	1,273	+ 488	+62
South America	2,385	3,070	+ 685	+29
Africa	1,115	1,372	+ 257	+23
Asia	9,692	10,698	+ 1,006	+10
Oceania	901	1,001	+ 100	+11
World	$49,572	$52,671	+$3,099	+6.3

First of all, therefore, the chart shows that by 1923 North America had become the leading producing area in the world. This leadership was, of course, associated with the considerable expansion which had taken place in American export trade accompanying the transition of the United States from the status of a debtor nation to that of a creditor nation.

But what has taken place during the period from 1923 to 1929 which was characterized by substantial economic recovery in Russia and in Europe and by widely diffused prosperity throughout most of the rest of the world? On this question the chart brings out the highly interesting and pertinent fact that North American output from 1923 to 1928 increased at a distinctly less rapid rate than output in any other continental group except the Caribbean. Just as the Caribbean area made the most rapid percentage gain between 1913 and 1923, due to the development of the petroleum industry in Mexico, so its negligible net increase from 1923 to 1928 largely reflected the declining relative importance of that industry. The table gives the story in numerical terms.

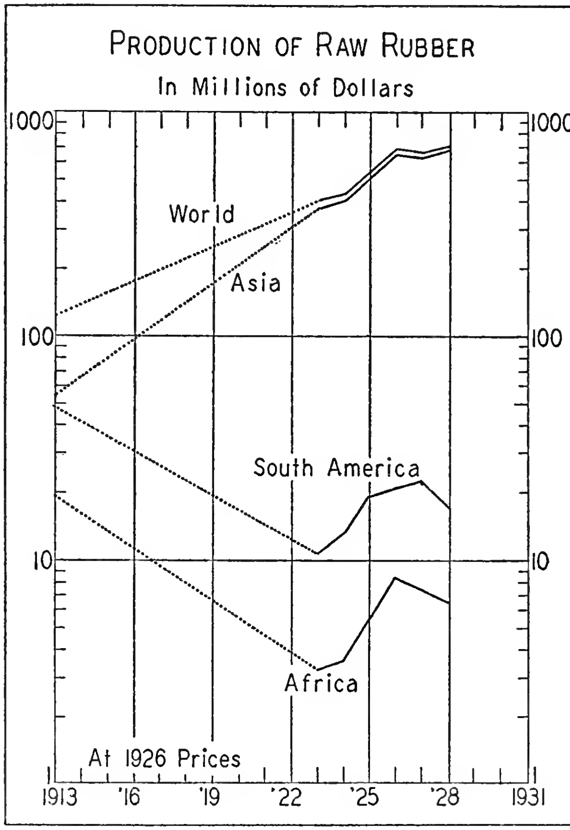
WORLD PRIMARY PRODUCTION—1923 TO 1928
Aggregates in Millions at 1926 Prices

	1923	1928	Net Change	
			Amount	%
Europe (excl. U. S. S. R.)	$14,532	$18,544	+ $4,012	+28
U. S. S. R.	3,399	5,195	+ 1,796	+53
North America	17,326	18,482	+ 1,156	+6.7
Caribbean	1,273	1,288	+ 15	+1.2
South America	3,070	3,814	+ 744	+24
Africa	1,372	1,670	+ 298	+22
Asia	10,698	12,565	+ 1,867	+17
Oceania	1,001	1,219	+ 218	+22
World	$52,671	$62,777	+$10,106	+19

From these figures it appears that the truth of the matter is that dominating the whole period was the rapid increase in European output, which absorbed no less than 40 per cent of the total world increase of 10 billion dollars between 1923 and 1928. North American output, which in 1923 was 19 per cent higher than that of Europe, had been outstripped by Europe in 1927, and in 1928 was a fraction of 1 per cent lower than European output. Russia, accounting for only 6 per cent of total world primary production in 1923, as compared with 33 per cent for North America, actually increased her production between 1923 and 1928 by a greater physical volume than the United States. In 1928, Russia accounted for 8 per cent of the world's output as compared to 29 per cent for North America.

If these figures are trustworthy, therefore, North America has been far from being the sole, or even the prime, contributor to the creation of those plentiful supplies of raw materials which have recently been a powerful factor in depressing the world's markets.

The data underlying these indexes reveal tendencies too numerous to mention in the direction of a geographical redistribution of the total production of basic commodities. For instance, the increase in per capita meat consumption in Europe, as opposed to a decline in this country, is reflected by a rapid



rise in European production and a slowing down in American output of the products involved. Another example is provided by the geographical changes in the production of crude rubber. As shown by the data on the accompanying chart, Asia produced only 45 per cent of the world's rubber in 1913. Of the remaining output, 39 per cent was produced in South America and 16 per cent in Africa. Fifteen years later, however, in

1928, 95 per cent of the rubber came from Asia, 4 per cent from South America, and only 1 per cent from Africa. Incidentally, the case of rubber brings out a weakness in any index of this sort. It was pointed out that the production series were combined on the basis of 1926 values. Between 1926 and 1928, the price of rubber declined about 54 per cent, while the prices of wholesale commodities in general declined only 2 per cent. Obviously, by continuing rubber in the index with 1926 prices there is a marked tendency to overstate its importance.

So far, this discussion of the League of Nations' index of the production of crude foodstuffs and raw materials has concerned itself with the matter of territorial distribution of output. Something might well be said, however, regarding the individual commodities included in the index, although the number of them—62 in all—makes impossible a detailed description of the changes which have taken place in their production. Taking production in 1913 as 100 for each of the 62 commodities, the 1928 points ranged from 71.0 in the case of rape-seed to 1,036 in the case of artificial silk. One method of examining these 1928 points for the individual commodities is to array them in order of magnitude and to find the points at which the list of commodities may be divided into four equal parts. Such points are called quartiles. The results of such a procedure are as follows:

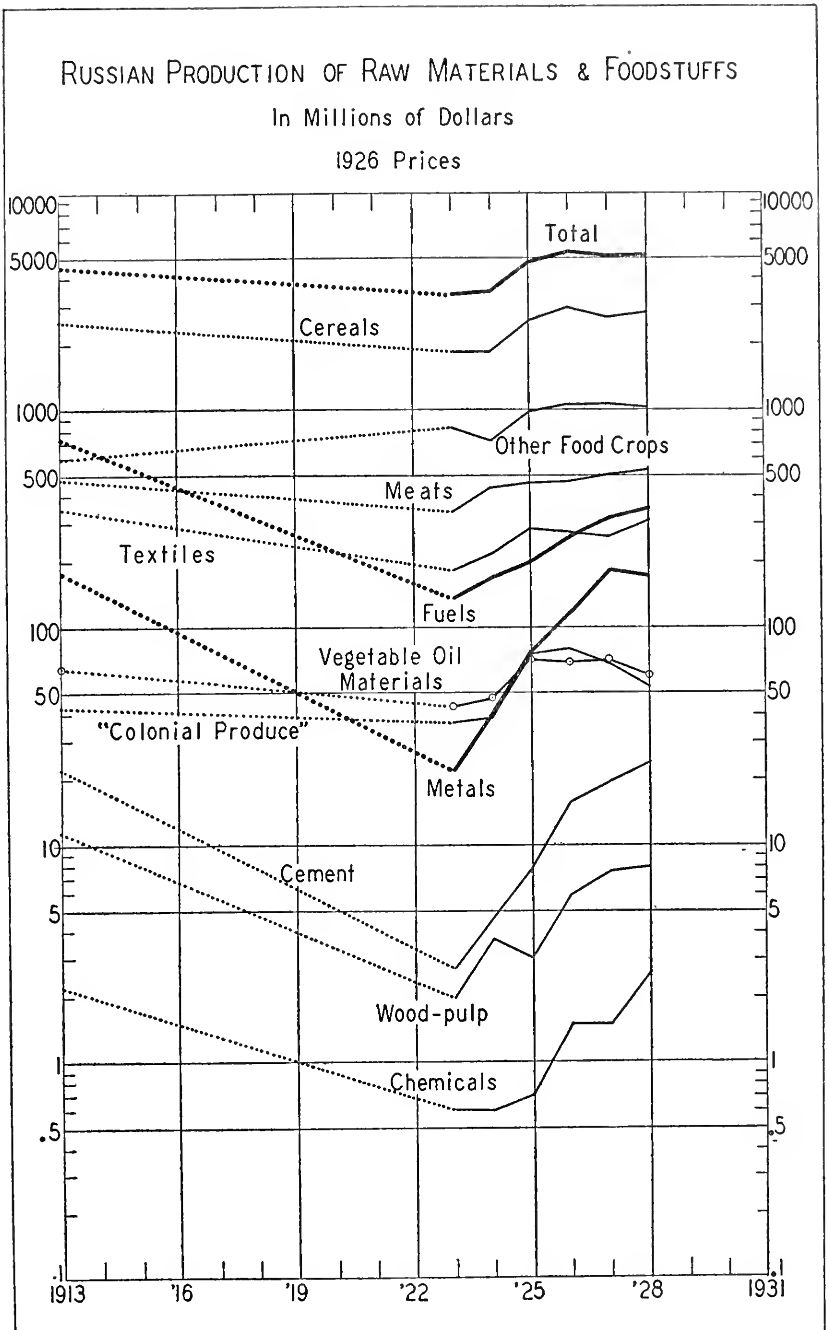
Highest point	1,036.0
Upper Quartile	190.5
Median	137.0
Lower Quartile	114.0
Lowest point	71.0

That is, during the period from 1913 to 1928 the output of half of the commodities increased between 14 per cent and 90.5 per cent, the other half showing changes outside these limits. The median shows the increase above and below which fall exactly half of the items; its value in this case is 137 per cent of the 1913 output. Interestingly enough, the composite world index itself in 1928, stands at 126.6 per cent of the 1913 level.

The reason for this difference between the median increase and the composite index lies in the fact that increases have been smaller in the case of foodstuffs than in the case of raw materials and the former class of products are more important in the index than the latter.

The increase in world population between 1913 and 1928, as estimated by the League of Nations, was 10 per cent, or less than half the increase in the world index of primary production. However, if we split the production index into two groups, crude foodstuffs and raw materials, we find an increase between 1913 and 1928 in foodstuffs output of only 17.5 per cent, as compared with one of 40.0 per cent in raw materials. That is, the production of crude foodstuffs was not greatly out of line with population growth, but the percentage increase in the production of raw materials was four times as great as that in population. This disparity is a natural development. The world in the past decade has been improving its standard of living. The demands made on production have not been so much for foodstuffs as for fabricated articles.

In view of the exceptionally high percentage gain in Russian output since 1923 and because of the general interest in the accomplishments of the Soviet Republics, the indexes compiled by the League of Nations on the production of important commodities entering into the overall index for U. S. S. R. shown in the first chart are presented graphically in the chart which follows. This chart shows the high degree to which primary production in Russia has thus far been confined to foodstuffs. It will be noted, indeed, that the composite index is a close replica of the index of cereal production; in 1928 cereal production constituted 52 per cent of all output reflected in the composite index. At the same time the largest percentage increases have been in those products which are characteristic of a growing industrial nation, such as fuels, metals, cement, etc. Such apprehension of the consequences of the increases in Russian production as exists, however, does not arise from the fact



Note: "Colonial Produce" in the League of Nations' index includes coffee, cocoa, tea, hops and tobacco.

that U. S. S. R. is becoming an increasing contributor to world production so much as from the fact that, under the political-economic organization of Russian industry, costs of production are fictitious or unknown and products are being offered on world markets at arbitrary prices bearing no relation to cost factors.

Consideration of the foregoing figures on primary production leads to a conclusion that the future rate of increase, besides its dependence on population growth, will be determined in part by changes in the standards of living throughout the world. The industrialization of Russia now under way and rising standards in other countries will be factors tending to maintain and even to increase the world's rate of output. However, political strife or non-economic measures of governments would inevitably curb this growth. On the whole, with the productive facilities at hand, the effective demand for products may be expected to advance appreciably and persistently. American achievements will continue, as in the recent past, to add vigor to the aspirations of other peoples.

WM. HODGKINSON, JR.

Notes on Recent Occurrences

NOW TALK TO ALL ITALY AND SICILY

ON April 6 the transatlantic telephone service was extended to include all of Italy and Sicily, instead of only Northern Italy, Rome and Vatican City.

TALK TO U. S. POINTS FROM CRUISE SHIPS IN DISTANT OCEANS

SEVERAL recent telephone calls from ships at sea to various points ashore have demonstrated afresh the practicability of this new service of communication.

During the past winter and spring, two liners equipped for regular ship-to-shore telephone service made cruises, taking them far out of their ordinary lanes of travel. While these ships, the *Homeric* and the *Belgenland,* were on cruise, ship-to-shore service was maintained whenever possible in an effort to determine the stability of the service when the vessels are far off the beaten track.

From the S. S. *Homeric,* off Alexandria, Egypt, a passenger talked directly with an acquaintance in New York. The call was transmitted by the wireless telephone equipment aboard ship, intercepted at the Forked River, N. J., receiving station and switched over land lines to New York. Traveling from New York by wire, the answering voice was launched into space through the Oceangate, N. J., transmitting station. The distance between the two speakers was about 5,100 miles.

The cruise of the Red Star liner *Belgenland,* which ended on April 28, marked the first occasion on which passengers on a ship circling the globe had been in touch by telephone with persons on shore. From points in the Pacific, off Bombay and in the Red Sea, passengers on the ship conversed by telephone with friends and relatives in various parts of North America. In the miles of wire and radio circuits involved, these calls broke all records in voice contact between shore telephones and ships at sea.

The service furnished the *Belgenland* was in the nature of an experiment. The American Telephone and Telegraph Company has for more than a year maintained regular service with several liners on the transatlantic run and the directional antenna arrays employed are designed primarily for such use. In view of this the frequency with which contact was established with the *Belgenland,* and the exceptional quality of transmission on several occasions over circuits thousands of miles long are considered gratifying results.

Contact with the ship was maintained through the American Telephone and Telegraph Company stations on the New Jersey coast. The equipment on the ship is owned and operated by the International Marine Radio Company, Ltd., a subsidiary of the International Telephone and Telegraph Corporation.

While the ship was in the Pacific off Central America Dr. Albert Einstein, a passenger, talked over the National Broadcasting network via the Bell System shore stations. With the ship a day's sail west of Hawaii, Douglas Fairbanks, also a passenger, telephoned his wife in New York, and a few minutes later talked over a wire and radio circuit some 9,000 miles long to a friend in San Francisco.

Off the coast of China a conversation was held with London through the British stations near that city. Off Bombay, India, the ship conversed with New York over a radio circuit about 8,000 miles long, the longest all radio ship-to-shore conversation as yet established. Off Ceylon, one of the passengers talked to his family and friends in Cleveland over a "line" consisting of a radio circuit to London, switched there to one of the regular transatlantic radio channels, thence over wires from New York to Cleveland.

When the ship was in the Red Sea one of the women passengers called her daughter in New York and later on, off Alexandria, another passenger talked to Piedmont, California. Other calls completed during the voyage went to cities in New York, Wisconsin, Florida, California, Oregon and several other states.

1931 OPERATING CONFERENCE

THE ninth Operating Conference of the Bell System was held at the Seaview Golf Club at Absecon, New Jersey, from April 30 to May 6. It was attended by the Operating Vice Presidents and General Managers of the Bell Companies, and representatives of the staff of the American Telephone and Telegraph Company, the Western Electric Company and the Bell Telephone Laboratories.

President Walter S. Gifford of the American Telephone and Telegraph Company spoke about the general business situation and some of the more important problems of the System. He also expressed appreciation of the results accomplished by the managements of the companies during the difficult situation which has been experienced during the past year. Vice President Gherardi discussed the general results of operations and referred to the need for a carefully considered construction program and the importance of maintaining reasonable construction and manufacturing programs under conditions like the present. He pointed out that future benefits might be expected from the opportunities for savings in expense which the present situation has brought to light. Emphasis was laid on the importance of maintaining service at a high grade and of still further improving public relations. Vice Presidents Cooper, Page, Carter and Wilson outlined important matters bearing on operations, relations with the public and with Connecting Companies and personnel work.

Reviews of the more important problems in departmental operations were presented by W. H. Harrison, Plant Engineer,

M. B. French, Traffic Engineer, R. H. Burcher, Plant Operation Engineer, and K. S. McHugh, Commercial Engineer, all of the American Telephone and Telegraph Company.

The activities and the problems of the Western Electric Company were outlined by President E. S. Bloom and Vice President C. G. Stoll, of that company.

Special sessions of the conference were devoted to sales and to employment conditions. Representatives of the various companies outlined the situation in their territories and their activities with respect to these matters. Other subjects discussed were budgets and estimating, special services and the development of administrative personnel.

BELL LABORATORIES MEN AWARDED HONORS FOR SCIENTIFIC WORK

ELLIOTT CRESSON MEDALS have been awarded by the Franklin Institute to Clinton Joseph Davisson and Lester Holbert Germer, both of the Bell Telephone Laboratories, "in consideration of pioneer work in the scattering and diffraction of electrons by crystals, and of its direct bearing on our theory of the constitution of matter." Among other holders of these medals are Henry Ford, Elmer A. Sperry, Dayton C. Miller, and Gustaf W. Elmen. The presentation of the medals was made on the occasion of the Institute's annual Medal Day exercises on May 20.

The Franklin Institute has also awarded the John Price Wetherill medal to Edward C. Wente, Acoustical Research Engineer of the Bell Telephone Laboratories, for his development of the condenser transmitter.

On June 9 the honorary degree of Doctor of Science was conferred by Lehigh University upon Francis Ferdinand Lucas in recognition of his contributions to the science of metallurgy and technical microscopy and of his inventions.

GENERAL COMMERCIAL MANAGERS' SALES CONFERENCE

A GENERAL Commercial Managers' Sales Conference, held at Shawnee-on-Delaware, Pennsylvania, from June 5 to 9, was attended by the General Commercial Managers and certain staff representatives of the Associated Companies and of the American Telephone and Telegraph Company. Keith S. McHugh, Commercial Engineer of the American Telephone and Telegraph Company, presided.

At the beginning of the conference, Vice President Gherardi of the American Telephone and Telegraph Company reviewed the results for 1930 and discussed the future prospects of the telephone business in relation to the general business situation.

The first three days of the conference were devoted principally to discussions of the experiences of the Associated Companies with various sales projects, led by J. W. Ord, Sales and Development Engineer, and H. H. Shearer, Directory Engineer, of the American Telephone and Telegraph Company, followed by papers prepared by Associated Company representatives from the standpoint of actual experience in their various territories.

During the latter part of the conference there was a discussion, led by Mr. Ord, of certain aspects of sales management, including: Personnel and Training, Organization, Sales Programming and Results, and Economics of Sales.

Interesting talks bearing on sales activities in the other departments and throughout the System were given by Vice Presidents Cooper, Page, and Carter, Assistant Vice Presidents Waterson and Bickelhaupt, Plant Engineer Harrison, Traffic Engineer French, Plant Operation Engineer Burcher, and Advertising Manager Cook, all of the American Telephone and Telegraph Company.

A Typical Private Branch Exchange Attendants' Training School. (*See page 231.*)

Bell Telephone Quarterly

A Medium of Suggestion and a Record of Progress

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An Important New Insulating Process for Cable Conductors

PULP insulation of wire conductors in telephone cables, to replace the familiar ribbon paper method that has been standard for 40 years, is one of the important recent accomplishments in the improvement of telephone apparatus and equipment. Its approval for Bell System use puts the pulp insulated wire process on a commercial production basis and marks the successful working out of the first phase of an interesting and rather spectacular development that has called for the closest co-operation between the various cable groups in the Bell System. Essentially, this development has brought the paper mill into the cable plant and combined it with the insulating process so as to eliminate some costly intermediate steps.

The pulp insulating machines are of a new type developed for the express purpose of applying pulp to wire and are something of a cross between wire handling and paper making equipment with numerous mechanisms especially designed for the job in question. Four of these machines are now in operation, two at the Hawthorne plant of the Western Electric Company and a like number at the Kearny plant with an output of approximately two hundred million conductor feet per week. The insulation itself consists of a continuous uniform sleeve of porous paper surrounding the wire but not adhering too tightly to it. The cables made from this material are of the new multiple unit type construction[1] the development of which came from the Laboratories at an opportune time to fit in with the pulp program and make its success more certain. They are of the same size as the older ribbon cables and possess similar though not identical physical and electrical characteristics.

[1] F. L. Rhodes, Bell Telephone Quarterly, January, 1929, pp. 25–29. J. R. Shea, *Bell System Technical Journal,* July, 1931, pp. 443–445.

The operating characteristics of the pulp wire cables, once they are in service, are for all practical purposes identical with those of the older type.

It is interesting to look backward something over a decade at the background of this development. The whole telephone cable industry had been built up through some thirty years of development around high grade manila paper as an insulating material. Even under normal conditions the old rope market was feeling the strain put on it by the increasing demands for cable paper. Then came the War and the consequent restrictions on imports and it was only by the closest co-operation with the suppliers that the quality of cables was kept up during this period. In the years of high production immediately following the War the situation did not improve noticeably and it appeared to be a foregone conclusion that paper made from the vast supply of domestic wood pulp would ultimately have to take an important place as an insulation in American telephone cable practice. Experiments with the strongest wood pulp papers available at that time indicated that while the insulation was satisfactory from the standpoint of cable characteristics it was not economical to apply this paper by means of the insulators which had been developed to handle the tough manila paper. The problem was still further complicated by the growing demand for more wires in a standard sized cable. This condition could only be obtained by decreasing the conductor size and thickness of the insulation. Attempts to use a thinner paper were at once reflected in insulating troubles and progress on this problem was practically at a standstill. This was the situation which confronted the cable engineers of the System at that period and whenever they got together in their frequent informal conferences there was sure to be some discussion as to ways out of the predicament. The need was probably first clearly stated by F. W. Willard at a Western Electric Engineering Manufacturing Conference held at Chicago in 1919 when he called attention to the fact that no fundamental advances in the cable making art had been made since the introduction of lead presses and paper insulation, but that all progress had been confined to improvements in materials and equipment, and suggested the need of work along new lines. Work in the direction of adding refinements to the equipment for applying paper ribbon to conductors was being pushed vigorously, but this offered little hope of giving the final answer since any improvement in this affected the runnability of manila and wood pulp paper similarly.

It was during this period of uncertainty that some experiments in the development laboratories of the Western Electric Company at Hawthorne indicated the possibilities of simply and cheaply applying a coating of any paper pulp directly to the wire by a modified paper making process. A crude single wire machine was improvised and some test cables made up from hand picked samples. The mechanical and electrical results obtained from these cables were so promising that the management without hesitation authorized proceeding with the development of the equipment and product as rapidly as possible. At the same time the broad decision was made in joint conference with the General Staff Engineers that the stakes were sufficiently high to justify basing the development on the use of a sulphate wood pulp. Thus, at one stroke, methods, product, and raw materials were cut loose from all previous experience and the task of working out a complete, new and revolutionary process was taken up in earnest.

The fundamentals of the process were apparent, but the combining of them into a single production unit of commercial size, capable of making a product with the required characteristics, offered difficulties that required time, money, and the combined talent of all the cable groups in the System for their solution. For the sake of brevity the curtain will be drawn over the following years with their disappointments and thrills and raised again in the latter part of 1929 when one machine of the present type was operating at Hawthorne on a 50 wire basis with the output going into 51 and 101 pair 24 gauge cables. The troubles were past, the idiosyncrasies that had threatened failure were ironed out and under control and the process was going smoothly twenty-four hours a day for six days a week. The outstanding developments which had made this possible were the electrolytic removal of residual drawing compound from the bare wire before it reached the pulp depositing mechanism so as to give a clean surface for contact with the pulp, the modification of the properties of the suspension of pulp in water by the addition of a small amount of soap to give a uniform sheet on the conductor, the ingenious mechanism for forming the sheet into a continuous somewhat loose sleeve around the conductor, which practically eliminated insulation breaks under normal conditions, and the drying of the insulation in a red hot furnace so rapidly as to minimize shrinkage and leave the insulation in a porous and concentric state as required for best results in cables.

During this development period the engineers of the Bell Telephone Laboratories and the American Telephone and Telegraph Company were struggling with the solution of their own particular problems in connection with the use of pulp insulation in cables, and it was not always smooth sailing for them, either, as is easily understood when it is remembered that the product with which they worked was something entirely new and still in process of development. However, the accomplishments of these years of struggle and uncertainty are best judged by a review of the advances shown in the art in 1929. At this time multiple unit type construction had become a fact in 26 gauge cable and almost a certainty for 24 gauge pulp cable, the proper sizes of insulated wire had been established, the capacitance was down to a reasonable figure, thanks to both cable design and improvement in the product, a good splicing technic had been worked out, certain pulp sources had been determined to be satisfactory for use in the product, the System was beginning to realize the advantages of the material and the program for extending its use to all sizes of finer gauge cables was well under way.

The extension program has been carried out as planned, and early this year the standardization of all 24 and 26 gauge cables for manufacture from pulp wire was completed. This new type cable is being regularly supplied to the Operating Companies in large quantities and it compares favorably in all respects with the older ribbon type. It is a new product, but it is behaving very satisfactorily, and it can be confidently predicted that, as a background of experience is built up, further improvement in quality will be reflected in its performance.

The making of pulp insulation is a new art and a valuable one. It is not a finished art and it is still too young for all of its possibilities to be appreciated, but it is now established as a definite part of telephone cable manufacture, fully paying its own way and holding out the promise of substantial economies. It is gradually supplanting the ribbon insulating process for fine wire cables and, as soon as practicable, its possibilities as to coarser wire cables will be investigated.

H. G. Walker

Preliminary Returns of the Distribution Census

BRIDGING the gulf between the farm and the factory on the one hand and the consumer on the other is the function of one of the largest divisions of American business, called Distribution. It comprises over a million and a half retail stores and about 170,000 wholesale establishments, requiring the services of more workers than any other single field of activity except agriculture and manufacturing, and representing an annual volume of business of over 100 billion dollars. It also includes the activities of over 17,000 hotels doing an annual business of well over a billion dollars.

In 1930, for the first time, the Bureau of the Census collected comprehensive reliable information regarding the volume, character and interrelationships of the vast network of distributive agencies engaged in the transfer of goods from producer to consumer. Although the preliminary returns contain certain imperfections, they provide a sufficiently accurate basis for the formation of some general conclusions regarding the quantitative aspects of distribution.

There has been much discussion in recent years regarding the increasing costs involved in the distributive processes. It is frequently claimed that the rising expense of distribution has largely offset the savings resulting from economies in production. The census figures have therefore been eagerly awaited not only by merchants, but also by manufacturers, bankers, economists and others interested in the problem of distribution, in the hope that a careful analysis of them will disclose methods of reducing the spread between the costs of primary production and the final selling prices of finished goods in retail markets. Not until now has it been possible to describe statistically the distributive machinery of the country with any degree of accuracy.

The telephone industry, too, has a direct interest in the census figures now becoming available; for these data may well prove exceedingly helpful in indicating ways whereby the movement of goods through the various distributive channels might be accomplished more economically and more efficiently by a more extensive utilization of existing communication facilities or even by the development of additional facilities or new types of service.

There are three fundamental steps in the movement of merchandise from producer to consumer: (1) manufacturer to wholesaler, (2) wholesaler to retailer, and (3) retailer to consumer. However, for present purposes, distribution may be divided into two main classifications—wholesale and retail, and these two divisions of trade will be discussed separately. The hotel business will be considered apart from the functions performed by wholesale and retail agencies.

The Wholesale Function

The annual volume of trade in the United States through all types of wholesale establishments approximates 70 billion dollars. This figure almost equals the gross value of manufactured products, is about six times the gross income from farm production, and exceeds the volume of retail business by nearly 20 billion dollars. The difference between the volume of wholesale trade and the volume of retail business is accounted for by the fact that the former includes exports made by wholesale establishments, and sales to industrial and dealer consumers, and also represents a certain amount of duplication due to the successive handling by several wholesale concerns of goods moved from producers to retailers and to industrial consumers through somewhat abnormal channels. Further inflation of the wholesale figures occurs where a wholesale transaction is later reflected in the cost of a manufactured product, as in the case of coal used for fuel in industry.

On the other hand, there are several channels of wholesale distribution which are not covered by the reported figures. While the volume of business shown in the above total includes sales by wholesalers to consumers at retail, it does not include the volume of wholesale business done by certain concerns which are primarily retailers. Neither does this total include the more than 11 billion dollars of sales made by manufacturers direct from their plants to retailers, such as to department stores, or the more than 16 billion dollars of sales made from manufacturing plants direct to industrial consumers, as when automobile parts are sold to an assembly plant. Furthermore, the wholesale figures omit direct transactions from producer to retailer, such as the farmer's deliveries of his products to the retail store.

The census figures show that the 170,000 wholesale establishments of all kinds in the United States have an average annual volume of business of over $400,000 per outlet. In addition to wholesale merchants of the usual type, these establishments include a secondary group performing wholesale functions and consisting of such types as brokers, commission merchants, manufacturers' agents and sale branches, importers and exporters, auction companies, bulk-tank stations, country buyers of farm products, and the like.

The extreme concentration of wholesale trade is convincingly shown by statistics for the group of 93 cities having over 100,000 population each. Although less than half the total number of wholesale establishments in the United States are located in these cities, which contain less than 30 per cent of the total population, these establishments account for over 70 per cent of the total wholesale business, or a volume practically equal to the entire retail sales in the whole country. The volume of wholesale business in these large cities is almost equally divided between regular wholesalers and all other channels of wholesale distribution, although the former group accounts for two-thirds both of the establishments and of the employees.

The importance of wholesale trade as a population-building force can be readily appreciated when it is noted that 35 per cent of the total number of persons employed in all the distributive activities in these large cities are engaged in wholesale functions. In some cities, the employees engaged in wholesale trade constitute a sizeable proportion of the total number of gainfully employed, reaching as much as 10 per cent or more in such cities as St. Louis, Kansas City, Omaha, and San Francisco.

The Retail Function

The retailing of merchandise falls into several subdivisions. Some manufacturers dispose of their entire output solely through house-to-house salesmen, and mail order business is a potent factor in merchandising, especially to rural communities. But the retail store still holds the dominating position among the agencies serving the ultimate consumer.

From the trading post and general store, storekeeping has developed in several directions. The country general store is still an important factor in many of the smaller trading centers of the country, there being about 90,000 now in existence. In the larger communities, the department and variety stores constitute the modern development of this elementary type and they have increased in number until virtually every good-sized city contains at least one representative of this type of institution. The growth of the chain store is a phenomenon belonging chiefly to the current century; in fact, the most rapid growth of chain organizations has been in the past ten years. The backbone of our distribution system is, however, the independent retail store; as a class such stores handle more than 60 per cent of the total retail business of the country. Even in this classification, however, there are "voluntary chains" resulting from the association of several independent stores for group buying and for common merchandising policies, although no census figures are yet available that might indicate the extent of this development.

The 7,000 retail chains in the United States account for only 156,000 stores, or 10 per cent of the total number. In the food group of stores, the chains operate about 62,000 units; but this is only one-eighth of the total number of food stores. The same proportion applies to the automotive group of stores and filling stations, of which the chains have 32,000 out of a total of 253,000. This ratio is exceeded only in the apparel group where the chains with nearly 18,000 units have 15.7 per cent of the total number, and in the general merchandise group where 18 per cent of the stores are chain units. It is probably true, however, that, considering the average sales per store, the chain units as a whole do a considerably greater individual volume of business than do the independent stores.

The 1930 Census of Population brings out clearly the increasing concentration of population in urban communities and in suburban areas adjacent thereto. In fact, more than 40 per cent of our population is accessible in less than 2 per cent of the area of the United States. The fundamental changes in the growth and distribution of population seem to necessitate some revision in former methods of serving the consumer market. Furthermore, the influence of the automobile and good roads in facilitating travel have aided greatly in making the city store more accessible to the rural population. These factors have led mail order houses to supplement their regular business with retail outlets located in strategic positions. Department stores, through the establishment of branch stores, are utilizing a similar method of adaptation to changing market conditions.

The total volume of trade through retail stores, amounting to slightly more than 50 billion dollars per year, does not include strictly service businesses such as laundries, cleaners, barber shops, and the like, the total transactions of which are estimated to be between one and a half and two billion dollars. It does not include the sale of meals in hotel dining rooms nor does it include a considerable volume of trade in supplies and equipment sold to business concerns for utilization rather than for resale, including such merchandise as hotel supplies, industrial and store supplies and equipment, and dentists' and physicians' supplies. In addition to sales through retail stores, there are direct sales at retail by planing mills, by milk producers, by bakeries, and by other manufacturers. There are also sales to ultimate consumers by wholesale establishments, offset in part by sales in wholesale quantities by one retailer to another retailer for resale. The aggregate volume of business transacted through all these non-retail channels might easily add 10 per cent to the total sales through retail stores. Furthermore, from the standpoint of total consumption of commodities, the retail figures do not give a complete picture since they do not cover cases in which the producer consumes his own product, as on the farm. However, the detailed figures for sales through retail stores are sufficiently inclusive to justify careful analysis.

The reported average retail sales per capita are $407.52, which would indicate retail purchases per family of from $1,600 to $1,700 annually. The annual per capita retail purchases in the several states vary greatly, ranging from as little as $172 in South Carolina to $575 in California and New York. The figures are generally low throughout the South and high in the Northeastern industrial belt (Illinois to New England) and the Pacific Coast states, with the farming region of the plains and Rocky Mountain states occupying an intermediate position.

The per capita sales through retail stores show an interesting relationship when compared with automobile registration, families with radios, and residence telephones per 100 population. It is not surprising to find that these ratios are usually high in regions where the per capita sales are greatest and correspondingly low in areas where the volume of individual trade is lowest.

The retail sales figures shown in the table on the next page

Region	Per Capita Sales	Passenger Cars per 100 Population	Families with Radios per 100 Population	Residence Telephones per 100 Population
New England	$463.31	17.9	12.2*	13.4
Middle Atlantic	500.01	16.1	†	11.5
East North Central	452.28	22.0	12.1*	13.6
West North Central	408.46	24.2	10.8	15.4
South Atlantic	268.60	13.8	4.2	5.2
East South Central	220.51	10.8	2.8	4.7
West South Central	307.92	17.0	3.4*	6.7
Mountain	424.72	22.4	7.7	8.6
Pacific	549.53	29.7	11.8*	14.4
United States	407.52	18.8	7.9	10.8

* Data unavailable for California, Illinois, Massachusetts and Texas.
† Data unavailable for entire region.

provide only a very rough measure of relative purchasing power, for the reported retail sales in a state cannot accurately reflect the economic status of the resident population when outside influences enter to affect the totals. Among the several factors operating to distort the comparisons presented by the sales statistics by states, a few of the more serious ones include the business done by mail order houses outside the state of location, migration of consumers across state lines to reach big department stores, purchases by transients in foreign states, and the consumption by farmers of their own produce.

For the United States as a whole, the average annual sales per retail store are $32,297, but again there is a great variation among the several states. South Carolina is low at $19,827 per store, while at the other extreme is Michigan with the highest sales per store of $39,715. The census report also shows that the average population per store for the whole country is 79, or about 19 families, with the extremes ranging from as many as 124 in Alabama to as few as 66 in California, Delaware, Florida, New York, and Oregon. Of these states, however, only California and New York also show high sales per store.

GEOGRAPHICAL DISTRIBUTION OF RETAIL STORES AND UNIT SALES

Region	Number of Stores	Sales per Store	Sales per Capita	Population per Store
New England	108,187	$34,972.25	$463.31	75
Middle Atlantic	386,642	33,960.60	500.01	68
East North Central	318,814	35,887.13	452.28	79
West North Central	172,725	31,444.66	408.46	77
South Atlantic	169,393	25,042.96	268.60	93
East South Central	89,528	24,352.12	220.51	110
West South Central	136,193	27,531.13	307.92	89
Mountain	44,812	35,084.58	424.72	83
Pacific	122,874	36,647.76	549.53	67
United States	1,549,168	32,297.24	407.52	79

From the above table, it would seem that the per capita sales vary inversely with the population per store, the indicated purchasing power being lowest where the number of persons per store is greatest, and vice versa. This might appear to be contrary to the impression gained from counts made in connection with telephone surveys that the poorer sections of a community have relatively more stores than the good sections. However, an explanation can probably be found in the fact that in the more prosperous sections a greater proportion of the purchases belong in the luxury class and to a considerable extent are made, not in the local neighborhood, but in the downtown section of the same city, or in other communities.

A corresponding table for cities grouped according to population brings out the contrast between the per capita sales, or amount of retail business, in the cities of the country in comparison with the smaller places and the rural districts. In cities, a large proportion of the consumers' purchases take place through retail stores, while in the country many supplies are often obtained direct from the producer in wholesale quantities. Moreover, in large cities the retail stores serve more than the resident population, especially for purchases other than food and similar low cost staple commodities, whereas the rural stores are chiefly patronized only for the day-to-day requirements, the people going to nearby sizeable cities for their luxury goods. Thus, it should be emphasized that the so-called per capita sales figure for a city constitutes a measure of the attraction of such city as a retail trading center rather than a measure of the buying power of its inhabitants.

RETAIL SALES DATA FOR CITIES BY POPULATION GROUPS

	Number of Stores	Sales per Capita	Sales pe Store
Cities of—			
Over 1,000,000	216,553	$628.95	$43,753
500,000 to 1,000,000	85,773	645.36	43,369
250,000 to 500,000	114,129	631.34	42,611
100,000 to 250,000	108,105	585.17	40,820
10,000 to 100,000	326.072	545.83	36 851
Balance of the United States	698,536	238.80	22,028
Total United States	1,549,168	$407.52	$32,297

It is interesting to compare retail expenditures by principal kinds of business and to see which group predominates in each division of the country. The table shown below indicates the relative importance of the principal retail groups for the country as a whole.

DISTRIBUTION OF RETAIL BUSINESS BY PRINCIPAL GROUPS

Group	Per Capita Sales	Per Cent of Total Sales	Per Cent of Total Stores
Food	$ 92.12	22.60	32.13
Automotive	77.76	19.08	16.35
General Merchandise	58.16	14.27	4.54
Apparel	35.15	8.62	7.29
Lumber and Building	29.62	7.27	5.15
Furniture and Household	18.62	4.57	2.87
Restaurants and Eating Places	17.08	4.19	8.76
Country General Stores	15 70	3.85	5 65
All Other Stores	63.31	15.55	17.26
Total All Groups	$407.52	100.00	100 00

The differential in per capita sales between the food and automotive groups is actually greater than appears from the above table. On the one hand, the figure for the food group is low, since it does not include the products belonging in this classification sold through other outlets such as hotels, restaurants and eating places, general merchandise and country general stores. On the other hand, the figure for per capita sales in the automotive group is high in so far as motor vehicles are concerned, because sales of new automobiles are probably reported at full list prices without deducting the trade-in values allowed for used cars. Consequently, a certain amount of duplication is introduced in the sales figures when the old cars are resold.

The per capita expenditure for food products varies considerably, being low in food crop states and high in industrial regions. In some areas, notably farming sections, a large part of the food consumed does not appear in the retail trade and this explains why food sales are relatively low in such regions. For example, the people of the New England states buy a larger proportion of their retail purchases through food stores than is the case in any other part of the country. On the other hand, the proportion of the retail dollar which they spend through the automotive group is lower than for any other division of the country, except the Middle Atlantic Division, which is influenced by the very low automotive sales in New York City. The Middle Atlantic Division shows the highest apparel sales, however, of any section of the country, due largely to the influence of New York City. A further examination of the table on the next page shows the prominence of the country general store in certain sections, notably in the South Atlantic and South Central states. It shows how the country general store, which is a combination food and general merchandise store, affects the figures of the food group and of the "all other" group, which includes principally coal, drug, feed, and farm implement stores.

Although the census returns showing the volume of sales through stores of different types of operation are not yet com-

GEOGRAPHICAL DISTRIBUTION OF RETAIL SALES BY PRINCIPAL BUSINESS GROUPS

(Expressed as a per cent of total sales)

Group	United States	New England	Middle Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Moun-tain	Pacific
Food	22.61	26.56	25.96	23.34	17.67	21.87	19.04	18.10	19.64	20.82
Automotive	19.08	17.23	14.82	19.48	21.93	18.98	19.32	23.71	23.60	23.14
General Merchandise	14.27	13.19	13.19	14.11	13.86	17.14	17.40	15.81	15.33	13.45
Apparel	8.62	9.34	10.95	8.96	7.61	7.27	5.98	5.54	5.11	7.89
Lumber and Building	7.27	6.64	6.84	8.07	8.91	5.74	5.70	7.78	7.27	6.78
Furniture and Household	4.57	4.46	5.34	4.40	3.71	4.36	4.36	4.38	3.90	4.59
Restaurants and Eating Places	4.19	4.13	4.85	4.21	3.47	3.10	2.94	3.47	3.88	5.49
Country General Stores	3.85	1.56	1.81	2.07	5.77	7.76	12.56	7.79	5.99	2.06
All Other Stores	15.54	16.89	16.24	15.36	17.07	13.78	12.70	13.42	15.28	15.78
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

plete for the entire country, sufficient data are available to indicate the relative importance of the principal channels of retail distribution. A summary of the 957 city reports, covering all cities in the United States with a population of 10,000 and over, shows that 62.5 per cent of the retail business of those cities is done by single store independents, 19.2 per cent by local multi-units,* 15.3 per cent by sectional and national chains, and the remaining 3.0 per cent by miscellaneous other forms of operation. In comparison with this typical city situation, the preliminary returns for the 22 states west of the Mississippi River show that 69.5 per cent of the retail business of those states is done by single store independents, 16.4 per cent by local multi-units, 11.2 per cent by sectional and national chains, and the remaining 2.9 per cent by miscellaneous other forms of operation. These figures may help to dispel some current illusions regarding chain store systems, which are popularly credited with a disproportionately large share of the retail business.

The Hotel Census

The distribution census also includes significant statistics regarding the hotels in the United States, their number, geographical distribution, plan of operation (American or European), type of occupancy (transient or permanent), number of guest rooms, seating capacity of dining rooms, receipts, employees, salaries and wages paid, etc.

This hotel information is confined to hotels having 25 or more guest rooms. The number of hotels which reported is 15,577, of which 13,328 are hotels normally operating the entire year, and 2,249 are hotels of the resort type, operating from two to eight months of the year. The census did not include apartment houses, boarding houses, clubs, Y. M. C. A.'s and Y. W. C. A.'s, nor did it include 1,734 hotels from which it was

* The composite classification called "local multi-units" is made up of the following types of operation: 2 and 3 store independents, local branch systems (merchandised from a parent store), and local chains.

impossible to secure reports. It should be noted that restaurants and eating places not associated with hotels are included under retail stores, which were discussed in the preceding section.

The principal items of interest for all reporting hotels are given in the following table:

	Hotels Normally Operating Entire Year	Resort Hotels Operating Part of the Year
Total Number Reporting	13,328	2,249
Plan of Operation.		
European	10,907	370
American	1,097	1,537
Mixed	1,324	342
*Type of Occupancy.**		
Transient	4,941	646
Permanent	1,702	324
Mixed	6,685	1,279
Number of Guest Rooms	1,134,957	158,939
Seating Capacity of Dining Rooms	610,762	274,571
Total Receipts	$962,801,000	$76,562,000
Full-Time Employees	291,259	—
Salaries and Wages	$257,034,000	$15,814,000

* In determining the classification of a hotel as transient or permanent, 75 per cent of its patronage one way or the other is controlling.

The largest ten states, containing slightly over half the total population of the country, have 51 per cent of the hotels operating the entire year and account for two-thirds of the total receipts. However, the geographical distribution of the hotel business does not hold any uniform relationship to population. The number of hotels per 100,000 persons ranges from less than four in Mississippi and South Carolina to 44 in Washington and 62 in Nevada. These ratios have little significance though, in view of the fact that the controlling factor affecting hotel development is the volume of travel requiring hotel accommodation, since the great bulk of the hotel patronage is transient. However, it is helpful to know something about the distribution of the hotel business, because the volume of general business in any city is affected somewhat by the incidental patronage of hotel guests.

In conclusion, it might be well to mention briefly certain other features of the distribution census which could not be included in the present summary because the returns are not yet available.

Later census reports will show the number of separate establishments which are operated by individuals, partnerships, corporations, or co-operative associations. They will indicate the length of time the establishments have been in business, as the rate of mortality among business concerns is a matter of real interest. Data have been collected regarding the number of employees, salaries and wages, expenses, amount of sales for cash and proportion of sales on credit, the relation of inventory to sales volume, the variety of stock carried, and many other items. Large retail stores have reported the amount of their returned goods and the part of their credit sales which is made on the installment plan. All important distributors were also asked to break down their total sales volume into the chief lines of goods sold.

Among the important data to be published when the tabulation of the census material is completed is information regarding the utilization of raw and semi-manufactured materials by the leading industries. Also, data on the sales channels through which specific types of manufacturers market their goods will later be available. Furthermore, this census will give comprehensive information for the first time about the distribution of so-called industrial goods, which are manufactured products the buyers of which are other manufacturers rather than ultimate consumers.

With the rise of nation-wide markets and with the increasing variety of consumer wants which has accompanied the improvement in the standards of living of the American people, distribution has become a highly important as well as highly complex element in our economic life. The organization and methods of our merchandising machinery are already being studied and are being revamped to meet the changed conditions resulting from recent developments in production, in transportation, in communication and in living habits. The appearance of the data accumulated through the census of distribution should be of real assistance in directing this process of evolution along sound and efficient lines; for the census information will enable the substitution of facts for conjecture in the consideration of many aspects of the subject.

R. L. Tomblen

Some Bell System Services Offered to Private Switchboard Users

THERE are approximately 120,000 private branch exchanges connected with the Bell System which are operated by about 135,000 attendants. From these switchboards are placed nearly one-fifth of the eighty million originating calls handled each day in the telephone company central offices. In addition about eight million intercommunicating calls a day are originated at these branch exchanges. The telephone companies continuously study the many and various service needs of their private branch exchange customers, paying particular attention to the provision of adequate equipment designed to meet individual requirements as to appearance, type and capacities. The equipment varies all the way from the small cordless switchboard with three central office lines and seven stations to the largest dial installations designed to serve 480 central office lines and 9,600 stations. Every possible effort is made to develop and continuously provide the most satisfactory service at these switchboards both from a maintenance and operating standpoint.

The activities followed by the traffic departments of the telephone companies will illustrate some of the forms of service given to this large group of telephone users. These departments have organized small groups of employees in each of the larger cities whose time is effectively devoted to assisting private branch exchange attendants and their managements in solving their individual telephone service problems applying particularly to the operation of the switchboards.

It is estimated that private branch exchange operation provides employment for about 135,000 young women as attendants as compared to the 140,000 central office operators in the

Bell System. Realizing the difficulties encountered by private switchboard customers in securing well trained competent attendants, the private branch exchange departments of the telephone companies undertake to supply, without charge to either the customers or attendants, people who have taken a training course in private branch exchange operating. (*See frontispiece.*) Customers are also encouraged to send their present attendants to the telephone company's private branch exchange school for retraining when needed. Such services are popular as is evidenced by the fact that in 1929 the telephone companies supplied more than 25,000 attendants and in 1930, when requirements were probably less due to the subnormal business conditions, more than 15,000 attendants were provided. In addition about 7,000 attendants were retrained each year.

Many unusual requests are made by private branch exchange managements for attendants and the telephone companies have been quite successful in providing people who have special training or abilities. For example, a large bank whose business is largely with Spain and the South American countries required an attendant who could speak and write Spanish and who would also be able to translate Spanish correspondence into English. While no girls with these qualifications had applied to the telephone company for positions, an operator in one of the central offices was found who fully met the customer's requirements. Many requests are made for attendants who are able to operate a typewriter or do other office work and little difficulty is experienced in meeting such requests.

The success of the telephone companies in retraining attendants now employed has encouraged many large telephone users to take advantage of this service to retrain their entire force of attendants. In such retraining, the telephone companies give careful consideration to the personal desires and peculiar needs of the individual customers, as well as the nature of the work to be done, in order to make sure that the operating practices fit their requirements. For example, the New York Police Department employ about 450 patrolmen and sergeants to operate their switchboards on a 24-hour basis. The Police Commissioner made arrangements with the telephone company for the training of their entire operating force and this work was completed during 1930. In the Police College which trains new patrolmen, a course in private branch exchange operating as suggested by the New York Telephone Company is now one of the important subjects.

Every effort is made by the telephone companies to keep subscribers, attendants and other employees well informed of the desirable feature of good telephone service in their establishments and of the large and important part this service performs in the conduct of their business. The attendants who handle incoming calls for their patrons speedily and helpfully register a first impression of the character of the business house which is of great value in placing the telephone caller in a pleasant frame of mind and avoids the antagonism which is often created through indifferent service. The station-users may further establish this impression of a well run business organization through promptly answering the telephone and subsequent courteous treatment of those who call them.

The private branch exchange organization in the traffic departments of the telephone companies is made up largely of two groups of instructors. One group devotes practically all of its time to the training of new attendants or the retraining of existing attendants on the telephone company premises. The second group consists of visiting representatives who spend most of their time on the continuous instruction of attendants on the customer's premises. These instructors, who are carefully selected from the central office supervisory forces, are given such special training in various phases of the telephone business as is adapted to qualify them to meet the private switchboard attendants and their employers. The visiting representatives of the telephone companies are often of assistance during times of emergency. For example, one of the visiting instructors in a large city was on her way to work one morning when she noticed an excited crowd pushing its way into a local bank. Her inquiries brought out that a run on the bank was in progress. Knowing what was probably involved she called upon the president of the bank and offered to help with the telephone service. All that day and the following morning she relieved the bank operators of the extra heavy load and dealt with an excited clientele tactfully and efficiently. She kept in touch with the bank for the next few days in case help should be needed again. Her good judgment and usefulness is an example of the high service ideals instilled in her by the telephone company.

The larger private switchboards often present equipment and operating problems which require considerable individual study to make sure that the telephone service given fully meets the needs of the establishments. To illustrate, the larger hotels have a number of operating problems in connection with the giving of satisfactory telephone service to their guests. As most of the patrons of these hotels are transients, up-to-date information records must be available to the attendants. Furthermore, prompt transmittal of local and toll charges must be made to the cashier so that they will appear on the guest's bill when he checks out. Calls are often handled by the attendants which require paging of guests, and this involves special handling due to the delays in completion. Hotel attendants, therefore, must be particularly well trained, and the telephone companies have given special assistance in this respect.

The larger department stores with their many departments, order-taking units and heavy traffic loads due to advertised sales, offer problems which the telephone companies are continually studying. These studies are designed to make sure that the volume of traffic passing through the department store switchboards is handled with dispatch and without delay due to either equipment or operating difficulties. Many of these stores have developed a big telephone order business, not only

A One-Position Cord Board Installation.

A Large Hotel Private Branch Exchange.

from patrons in the cities in which they are located, but also from suburban areas. It is often necessary to develop special toll practices and equipment arrangements to handle the large amount of traffic involved.

In a number of cases the telephone companies have taken over the continuous supervision of the work of attendants in order that special study may be given to the individual telephone service requirements of the establishments and to see that the attendants are properly trained in the operating methods found most practical. Gratifying operating improvements have been promptly made and the private branch exchange managements have shown appreciation for the improvement in service which has thus been brought about. A number of hotels, department stores, banks and other business establishments are now receiving this service.

While the problems encountered in connection with equipment arrangements and operating practices for the larger switchboards require special attention by the telephone companies, a large amount of time is also devoted to assisting customers who operate switchboards of one or two positions in meeting their telephone service needs. Over 95 per cent of all private boards are of one and two positions and necessarily most of the time of the telephone company private branch exchange organizations is devoted to the assistance of these telephone users in meeting their problems.

As a large proportion of all toll and long distance business originates or terminates in private branch exchanges, considerable study and aid has been given by the telephone companies to the development of methods to make this service the most useful to these telephone users. Extension users are encouraged to place their toll and long distance calls directly with the toll or long distance operator and to remain on the line until the called station answers or until a report is given by the operator. Where this is not feasible, it is generally suggested that the call be placed by the private switchboard attendant who requests the extension user to wait on the line until the called party answers or a definite report is received. With this arrangement, the service has proved to be much faster than when the extension user hangs up the receiver after giving the details of the call to the private switchboard attendant. Under the latter condition delays are often encountered in reaching the party who put in the call. He may have left the telephone or have made or received another call in the meantime. This results in annoyance to the called party, who is brought to his telephone several times unnecessarily, only to find that the person who placed the call is unable to talk. Delays are also avoided by encouraging the user or private switchboard attendant to give the called number and, in many cases, where the volume of long distance traffic warrants it, the telephone companies have found it desirable to supply lists of frequently called out-of-town numbers. If the amount of such business is exceptionally great, lines are provided in some cases directly from the private branch exchange to the long distance switchboard in order that calls may be routed to the long distance operator without passing through the local system.

There is no doubt that private branch exchange users are showing increasing appreciation of the important part good telephone service plays in the conduct of their business and are consequently giving full co-operation to the telephone company representatives in effecting improvements. The business man is generally alert to the fact that a good first impression of his establishment is of considerable value and that this first impression is often made by the private switchboard attendant who answers incoming telephone calls.

G. L. Whiteman

Buried Cable Distribution System

TAPE armored cable was first installed in the exchange plant of the Bell System in the latter part of 1929. The first installations were made on a very limited, experimental basis, but proved so satisfactory that the use of such cable has increased at a surprisingly rapid rate. During the year 1930 over two hundred thousand feet of cable of this type was installed, while judging from the experience to date, it seems likely that from three to four times that amount will go into plant during the current year.

Before describing this new cable system and the conditions under which its application to Bell System needs appears to warrant such rapidly increasing utilization, it will perhaps be helpful to review briefly the development of the situation that has brought this type of plant into being.

One of the very noticeable trends in community life in this country during recent years has been a growing sense of æsthetic values. This has been particularly in evidence in the case of residential developments where more and more attention has been given not only to building houses of distinctive and attractive appearance, but also to the landscaping of the surrounding grounds, the planting of shade trees along the highways, the installation of ornamental lighting systems, and to many other details designed to contribute to more pleasant living conditions.

This tendency is a natural accompaniment of our country's progress from the pioneer state where almost all man's energies were required to gain the bare necessities of life. The industrial era of today, however, brings a greater share of the leisure time that affords opportunity for appreciation of the beautiful and encourages our people to develop it. Perhaps, too, the urban conditions in which a constantly increasing proportion of our population finds itself have played their part in that urge toward pleasanter home surroundings which has found expression in the attractive suburban residential communities contiguous to practically all the larger cities.

It is peculiarly appropriate that modern industry, having contributed largely to promoting the desire for the æsthetic, has supplied in substantial measure the materials and facilities for its realization. The availability of telephone service has, of course, been an important factor in rendering suburban residence convenient and even possible. However, the provision of plant to furnish this service has in itself created a problem in that plant of the type that originally seemed economically most appropriate to such communities did not appear to harmonize with the general appearance of the surroundings.

Fortunately, fairly early in the period that marked the trend toward suburban residence, lead covered cable, for economic reasons, supplanted open wire for exchange distribution, except where only a very few lines were involved. Such cables, although carried on poles, presented a neater appearance than plant of the open wire type and, in addition, yielded certain maintenance advantages, not only in their greater freedom from sleet storm damage, but in avoiding the impaired insulation to which open wires were subject where they passed through the trees that were being planted in ever increasing numbers along the highways and residential streets.

The use of aerial cable in place of the open wire that had previously lined the streets was a distinct advance from the standpoint of appearance. But it was not felt to be completely satisfactory from this point of view, particularly in those localities where greater and greater emphasis was being placed upon the beauty of the surroundings. In some places the poles were painted green in order that they might harmonize with the foliage of the shade trees and thus be less conspicuous. As a further step, underground connections between poles and houses were made available to those subscribers who were willing to share the additional cost of this type of plant.

A very definite advance from the appearance standpoint was made through use of poles jointly with the electric light and power companies. This resulted in a reduction by one-half in the number of poles that had previously been required by the two utilities.

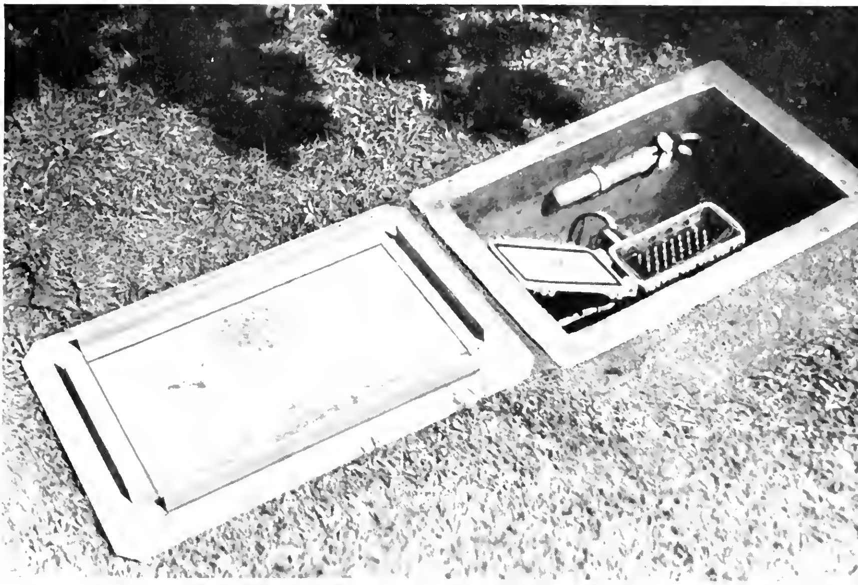
Despite the adoption of measures to improve the appearance of the aerial plant along highways, it was recognized that in communities where matters of civic beauty were being stressed, the presence of pole lines on the streets would frequently not continue to be appropriate and the interior block aerial cable system was accordingly devised. This consisted in transferring the pole line and its cable to a location along the rear property line throughout the block. The highways were thus relieved of unsightly plant, and for a time this seemed a reasonably satisfactory ultimate solution of the problem of reconciling the presence of telephone plant of an economical type with the appearance of the surroundings.

The demands of æstheticism had not been completely satisfied, however, and were expressed increasingly in the landscaping of the grounds surrounding these suburban residences, with the result that pole lines in the rear of the residences no longer seemed altogether appropriate. It became evident that there could be but one entirely satisfactory alternative, namely, to place the plant underground. This conception was, of course, by no means new, as underground plant had, in fact, been employed for residential distribution in a large number of instances, but the cost of such plant imposed severe limitations upon its use. The underground system available consisted of cables, conduit and manholes and, due to its very much greater cost than that of aerial plant, could be installed only where the subscribers directly benefited were willing to assume a substantial portion of its cost. It was apparent that if, as seemed desirable to conform to the popular trend, the use of underground distribution were to be extended, a less expensive type would have to be found.

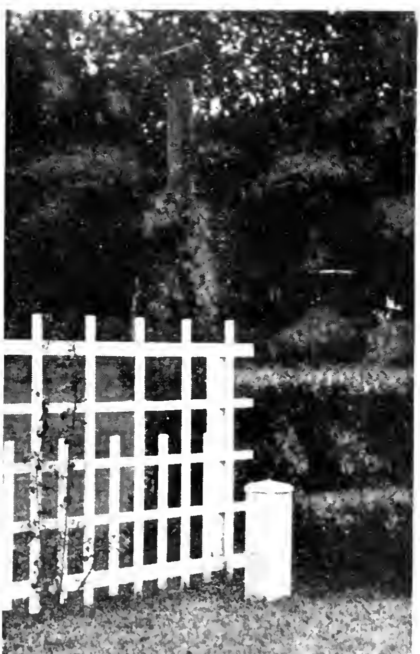
As in the case of the toll cable plant, the need of a lower cost underground system suggested the use of tape armored cable, buried in the ground without conduit. Such cables have been used satisfactorily for many years in various European cities, and while some of the conditions of service in this country are different, it was considered feasible to design a distribution system employing tape armored cable that would be adequate to our needs.

Normally, a tape armored cable is installed to care for the distribution within a single block, or a succession of blocks, this cable being fed by underground cable in conduit. To avoid the expense of a cable splicing operation each time a subscriber's connection is made, terminals are installed as in the case of aerial cable. The aerial cable terminal is, however, unsuited to use underground, and it was therefore necessary to devise a terminal for such use, a primary requisite being that the terminal be water-tight. This was accomplished by using a cast iron housing, the cover being equipped with a rubber gasket and clamped in place by means of wing nuts. Special fittings were needed to make water-tight the entrances of the small one and two pair cables employed to serve the individual residences. As the terminal must be accessible, it is usually installed in a small concrete box in which is also placed the splice between the terminal stub and the distribution cable. A removable steel cover is provided for the concrete box.

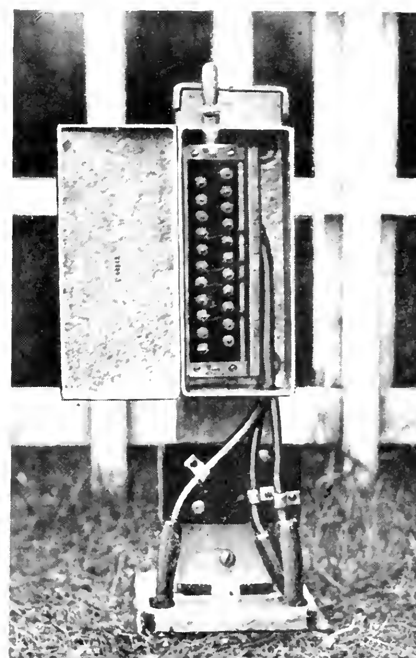
Terminals, in addition to providing the connection between the distribution and subscriber's cables, serve as testing points in locating cable failures. An underground terminal is not, therefore, sufficiently accessible in localities where snow and ice cover the ground throughout a substantial part of the winter months. To meet this condition, a terminal mounted on a pedestal has been designed. A metal housing serves to shelter the terminal and cables, and at the same time affords a sightly



Underground Terminal—Cover Open.



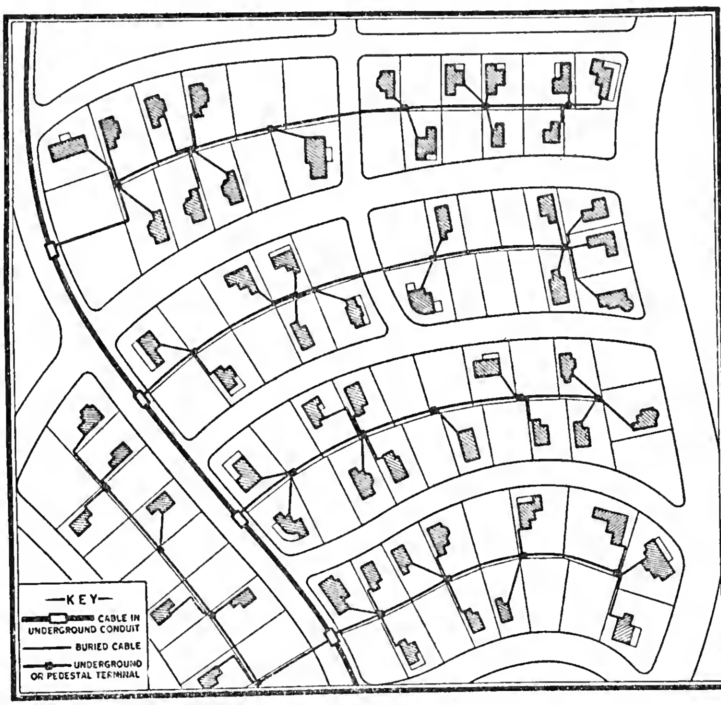
Pedestal Terminal on Rear Property Line—Housing in Place.



Pedestal Terminal—Door Open.

appearance. As the housing is only approximately seven inches square and about two feet high, it is reasonably inconspicuous.

Since the recovery of buried cable is of doubtful economy, it necessarily follows that such plant should be installed only where it will care for the requirements of the situation throughout a long period. Interior block cables can, as a rule, be de-



PLAN OF BURIED CABLE DISTRIBUTION.

signed to care adequately for long period service and, coupled with the ease of conducting installation activities under lawns, the location of the cable along rear property lines seems to offer the most attractive field for the use of buried cable in the exchange plant. There are, however, other applications of this new type of plant that have promising possibilities.

In towns where the telephone development is very slow and where the presence of a heavy growth of trees along highways would render the erection of aerial plant both expensive and undesirable, buried cables are being used for feeder purposes, such cables being installed either along the edge of the highway where they are unlikely to be covered by paving or through alleys, where the latter exist. In some instances the desirability of such construction may result from the necessity of avoiding conflicts with power lines or from considerations of economy.

Limited use will doubtless be made of buried cable for distribution purposes along streets, usually between the roadway and the sidewalk. This location is in general, however, less desirable than the rear property line, inasmuch as it is necessary either to place a cable along each side of the roadway, with the result that the cable footage is doubled, or to make frequent crossings of the roadway to reach houses on the side of the street opposite that on which the distribution cable is located. This latter alternative involves frequent openings across the roadway which are in themselves objectionable from the public's standpoint and also expensive, particularly where paving is encountered. In some instances, pipes have been pushed across the street under the paving, to avoid disturbing the road surface, but this is an inherently expensive operation. It thus appears that buried distribution cables can be employed economically along the streets only in those situations where right-of-way difficulties or frequent obstructions, such as garages, preclude placing the cable along the rear property line.

Compared to cable in conduit, tape armored cable is less expensive from the standpoints of both materials and installation. A factor in the latter consists in the possibility of making abrupt deviations in the line of the trench to avoid obstructions such as boulders and trees, whereas in laying conduit these irregularities in alignment must be limited in order that the cable can be pulled into the conduit.

Compared to aerial cable with overhead drop wires, the buried cable system is in general inherently more expensive.

There are, however, exceptions to this rule, particularly where the soil conditions are favorable to excavating operations. In some cases residential areas are laid out with winding, tortuous property lines that render the cost of pole line construction high, because of the many guys and anchors required. Under these conditions the cost of the buried distribution cable, in place, is likely to be less than that of an aerial cable and pole line.

Efforts are continuing in the direction of effecting further economies in the manufacture and installation of buried cable, and it is possible that in time costs can be reduced to a point where, under average conditions, buried distribution cable costs will be more closely in line with those of aerial cable and pole line. It seems questionable, however, whether the buried one or two pair cables used to make the connections between the distribution cable and the subscribers' houses, can be brought down to the cost level of overhead drop wires.

In conclusion it should perhaps be stated that the buried distribution plant has been adopted to meet new conditions for which aerial cable does not seem suitable and cable in conduit is too expensive. It does not contemplate the abandonment of pole line plant since the latter will, of course, continue to be appropriate under many of the conditions actually encountered. Rather, the effort is and should be directed to having available a plant system that, from the appearance standpoint, will be harmonious with the ideals of the community as evidenced by the erection of buildings of attractive design and the attention devoted to beautifying the environs. By effecting further economies in the buried cable system, it is the hope that the Bell System may constantly increase its contribution to the æsthetic achievement of the community, no matter how modestly the latter may be carried out, without sacrifice of sound economic procedure.

C. G. Sinclair, Jr.

The Beginnings of Long Distance

AT the Annual Meeting of the Stockholders of the American Telephone and Telegraph Company in March, 1931, it was voted that the corporate existence of the Company " be extended beyond the time specified in its certificate of incorporation, so that its duration shall be perpetual."

In the original certificate of incorporation, filed in 1885, the life of the Company was limited to fifty years. The stated object of the Company was to develop nation-wide and international telephony, and this was a very imaginative objective considering the state of the art at that time.

In sharp contrast with the telephone's usefulness today, which includes radio, telephotography, teletypewriter, and transoceanic service, are the conditions of those early days when it was necessary to experiment in order to ascertain the best methods and the right road to success. The formation of the American Company in 1885 was the beginning of a new era in communications, and there was little or nothing at hand to point the way. Vision and courage were necessary.

When the commercial work of the telephone began in May, 1877, the " subscriber " simply rented two instruments. He located them where he pleased and he connected them with an iron wire himself. But so much trouble resulted from improper installing that both parties welcomed the amendment when provision was made in the contracts that the line should be furnished by the Telephone Company. Local commercial development was initiated and superintended by agents licensed by the Bell Telephone Company in Boston. These agents raised the necessary money locally. This was the first, the Private Line period of telephone history. It drew to a close in 1878. A convenient date to mark the approach of the Exchange period is the opening of the first regular commercial exchange at New Haven, Connecticut, on January 28, 1878.

From these individual agents local telephone companies grew up. Soon telephone subscribers became numerous enough to be class conscious. The desire sprang up among them to talk to each other. This desire started experimenting. Each license agent worked out his own device for connecting his subscribers to each other. Gradually, through consultation with Thomas A. Watson of the Bell Telephone Company in Boston (the only one there was at first to consult); through conferences with each other; and improvements resulting from experience, the telephone switchboard and the central office developed and opened up new fields of practical use and of commercial value to the telephone. Soon it was forgotten there had ever been a time when telephone service had consisted entirely of private lines without any interconnection or exchange service. The inherent possibilities had led the way, and successful experiment had cleared the path. This was the second period of telephone development. It was made possible by Technical Engineering and may be called the Local Service or Exchange Period.

As the types of switchboard tended toward a standard, so too by natural extensions and mergings the numerous license agencies and local Telephone Companies first increased rapidly in number and then gathered together a smaller number of larger companies, pointing toward what are now the operating or Associated Companies of the Bell System. In exactly the same way that telephone subscribers developed inevitably a desire to talk with each other, different towns and cities (which at first usually meant different Telephone Companies), wished to be able to talk with each other. The steady improvement of telephone apparatus rendered this no vain wish, but promised that before long it would be technically possible.

But who should attempt it? Would telephone service over these longer distances pay? How should the lines and operation of this new intercity service be distinguished from the local telephone service? Or should the two be managed together in some way? In the case of Companies whose territory was adjacent it might be simple enough: let each Company contribute the construction and maintain the operation in its own territory. But when there was an intervening territory belonging to one or more other Companies, would it be feasible to expect these uninterested Companies to meet expense for the benefit of the distant Companies? Again, would they consent to having their territory invaded by outside Companies? On the other hand, would the outside Companies care to finance construction and operation in territory they did not control? The whole situation made up a complicated problem, but one that in the pressure of the march of events had to be met, had to be solved.

It was most fortunate that at the head of the telephone industry at that time stood a group of men of the right character to make the most of the situation and its possibilities. At their head was William H. Forbes, President of the National Bell Telephone Company from March, 1879, and of its successor, the American Bell Telephone Company, an executive of decisive influence, who knew men and was remarkable for getting results from and through them. The Board of Directors comprised men like Charles P. Bowditch, Alexander Cochrane, Francis Blake, George L. Bradley, and William G. Saltonstall, —men of standing and ability. Working hand in hand with Mr. Forbes was the General Manager, Theodore N. Vail, a man of initiative and of vision, and of rugged determination. Seen from the standpoint of the present, the problem was one of the original creation of a new Long Lines system. From the standpoint of the time, however, the problem appeared to be one of correlating the existing telephone exchanges, a problem of management. It naturally fell then primarily into the province of the General Manager, and Vail was a creative genius in business organization.

The third period of telephone development was thus introduced by Mr. Vail's decision to try to create what he called, with a use of the word common at that time, a *grand* system, or as we would now be more likely to express it, a universal system. It was a masterly piece of Commercial Engineering, as has been demonstrated increasingly ever since with the growth of the country.

So Vail with the support of Mr. Forbes and the Board of Directors put through the first long distance experiment, the Boston-New York Telephone Line. While the engineers were improving the apparatus so that it could be relied upon to give good transmission and justify commercial operation, he attacked the problem from the organic and financial side.

In a Boston-New York telephone line at least four, maybe five, distinct Companies would be concerned. There was first in Massachusetts the Telephone Despatch Company in Boston; and then the Southern Massachusetts Telephone Company, in process of consolidation with other local companies; in Rhode Island there was the Providence Telephone Company; in Connecticut there was the Connecticut Telephone Company; and at Greenwich the line would pass into the territory of the Metropolitan Telephone and Telegraph Company of New York.

Mr. Vail suggested that the long distance line be constructed by the parent company, the American Bell Telephone Company, separately from all local lines. The idea was approved on June 2, 1880. Almost immediately however it was decided to go more slowly, to feel the way, to start building the through line only from Boston to Providence. In case of failure the local companies could take over their own sections of the line. But Mr. Vail put through his point that the line should not be built by those local companies, but by a new, a separate company. Accordingly, on July 7, 1880, the Inter-State Telephone Company was incorporated in New York (the objective point he had in mind) for the purpose of building and operating this line, under a license from the American Bell Telephone Company. It built it. The line was opened for commercial operation on January 10, 1881.

The next section, extending westward from Providence, would carry the line into the Connecticut Telephone Company. The New Haven officials became enthusiastically interested. Most of the mileage of the line would be in their territory. So they urged a reorganization of the Inter-State. A second Inter-State Telephone Company was incorporated under the laws of the State of Connecticut on March 21, 1881, to carry the building of the line on to New York. Of the four chief officers, three were Connecticut men; the fourth represented Rhode Island. The President was Governor Marshall Jewell of Connecticut; the Vice President was Governor Henry Howard of Rhode Island; the Secretary-Treasurer was Morris F. Tyler of New Haven; and the General Manager was H. P. Frost of New Haven. Meantime consolidation was going on all along the line. In Massachusetts the Telephone Despatch Company was merged with other companies into the New England Telephone and Telegraph Company by November, 1883. In Connecticut, the Southern New England Telephone Company had taken the place of the Connecticut Telephone Company and on October 2, 1882, bought the Inter-State Company and gone on with its work. The changing interests were evident; this might have proved to be an unstable element if the building of the long distance lines had been apportioned out to the local companies.

The Boston-New York Line was completed in due course by 1884, and was formally opened on March 27, 1884. It worked sufficiently well for its real purpose, which was to test out the idea of a long distance telephone system, co-ordinated with but distinct from the local systems. In an official report Thomas B. Doolittle said, "The experimental wires between Boston and New York have fully demonstrated the practicability of telephonic communication to distant points, and that is all, and all that was expected of them."

Meantime the technical achievements of the engineers, such as Thomas B. Doolittle's hard drawn copper wire and young John J. Carty's metallic circuit, were opening up vistas of telephonic possibility. Envisioning the problem, finding the right man and urging him onward with stimulating support, Theodore N. Vail marshalled the whole work. From Boston to New York! After New York, what?—What not?

He recurred to his original idea, that the construction and operation of these long distance lines must be done by the parent company. It would require what was then considered an enormous amount of money. Application was made to the Massachusetts Legislature to permit an adequate increase of the capitalization of the American Bell for the purpose from $10,000,000 to $30,000,000. It was refused. Therefore there must be a special corporation to do this work under the American Bell. Mr. Vail again turned back to a previous suggestion. He had had the first Inter-State Telephone Company incorporated under the laws of the State of New York. Let the new Company be incorporated in New York.

Now for the right man. In Buffalo, New York, a young man by the name of Edward J. Hall, Jr., had done fine work. In 1884 he was only thirty-one. Mr. Vail himself was not yet forty, and was never dismayed by youth in his men if they had brains and initiative to make up for the lack of years. He sent for Mr. Hall, now living in Elizabeth, New Jersey, to come to Boston to see him. At the end of their talk, he pushed the papers on the table over toward him and said, "Well, there is the problem. Work it out." It was a great combination: Mr. Vail in command for general guidance; and Mr. Hall turned loose on the job as detail man. But they were large details. So Mr. Hall organized the American Telephone and Telegraph Company as a subsidiary of the American Bell Telephone Company to build, maintain and operate long distance telephone lines, i.e., lines extending between or across the territory of two or more operating telephone companies. Mr. Hall was the General Manager and Mr. Vail the first President.

So on February 28, 1885, the four incorporators, Edward J. Hall, Jr., of Elizabeth, New Jersey; Thomas B. Doolittle of Bridgeport, Connecticut; Joseph P. Davis of New York City; and Amzi S. Dodd of New York City, set their hands and seals to the Certificate of Incorporation of an association to be called the American Telephone and Telegraph Company, and they appeared before Jno. H. Cahill, Notary Public, No. 92, of New York County, and duly executed the same. And the certificate was filed and recorded in the Office of the Secretary of State of the State of New York, at Albany, on March 3, 1885, 9 hr. 40 m. in the morning, as attested by Anson S. Wood, Deputy Secretary of State.

The charter provided for a capitalization of $100,000 which was sufficient for the time being, for the period of organization. The capital was divided into 1,000 shares of the par value of $100 each, held in equal lots of 250 shares each by the four incorporators. In 1888, on May 5th, the first capital increase to $500,000 was voted.

Consider from the standpoint of 1884 and of that frankly experimental little telephone line from Boston to New York, the enormous range of this charter! How extraordinarily specific its geographical appropriations! After a tolerable success over 250 miles, it contemplated lines of 3,000 miles and more. It addressed itself at once to nation-wide telephony.

" The general route of the lines of telegraph * of said association will be from a point or points in the city of New York along all rail roads, bridges, highways and other practicable, suitable and convenient ways or courses,

* The word " telegraph " was until 1877 to all intents and purposes synonymous with " electrical communication," as the telegraph was the only means of electrical communication before the invention and development to a practical point of the telephone. By 1885 the word " telephone " was well established in its present discriminating sense, but in a legal document like this charter conservative judgment considered it advisable to hold to the old word " telegraph," which also closely identified the new telephone lines with the basic Bell patent, No. 174,465, March 7, 1876, in which the telephone is designated as an " improvement in telegraphy."

leading thence to the cities of Albany, Boston, and the intermediate cities, towns and places, also from a point or points in and through the city of New York, and thence through and across the Hudson and East rivers and the bay and harbor of New York, to Jersey City, Long Island City and Brooklyn, and along all rail roads, bridges, highways and other practicable, suitable and convenient ways and courses to the cities of Philadelphia, Baltimore, Washington, Richmond, Charleston, Mobile and New Orleans, and to all intermediate cities, towns and places; and in like manner to the cities of Buffalo, Pittsburgh, Cleveland, Cincinnati, Louisville, Memphis, Indianapolis, Chicago, Saint Louis, Kansas City, Keokuk, Des Moines, Detroit, Milwaukie, Saint Paul, Minneapolis, Omaha, Cheyenne, Denver, Salt Lake City, San Francisco and Portland, and to all intermediate cities, towns and places, and also along all railroads, bridges, highways and other practicable, suitable and convenient ways and courses as may be necessary or proper for the purpose of connecting with each other one or more points in said city of New York, and in each of the cities, towns and places hereinabove specifically or generally designated."

Dealing with large items indeed, it may still be noted that thus far the charter merely provided for work in the tangible future.

Continuing, the charter reached out to include with very specific thoroughness the whole world. At that time to the minds of most people this must have seemed decidedly visionary. Now it is seen to have been simply a matter of necessity, a matter of course.

"And it is further declared and certified that the general route of the lines of this association, in addition to those hereinbefore described or designated, will connect one or more points in each and every city, town or place in the State of New York with one or more points in each and every other city, town or place in said State, and in each and every other of the United States, and in Canada and Mexico, and each and every of said cities, towns and places is to be connected with each and every other city, town or place in said States and Counties, and also by cable and other appropriate means with the rest of the known world as may hereafter become necessary or desirable in conducting the business of this association."

But standing there with Hall, Doolittle, Davis and Dodd by his side, creating a powerful instrument for facilitating the will of the people and developing American civilization, Vail and his associates of the American Bell Company, did not forget his technical engineers, the successors of Alexander Graham Bell. Confidently depending upon what they would do, with a phrase which, though casual, impresses us with awe, the document sweeps us on to what was then unimaginable,—"also by cable and other appropriate means." Here was latitude for engineering ability! As long as seven years later, at the opening of the New York-Chicago open air line, the Company stated that "the use of cable which was exceedingly detrimental to telephone transmission" had been used as little as possible in that line. Yet here in 1885 this charter, anticipating and even guaranteeing steady advancement in the telephone art, specifies cable as a great means for doing the impossible. This it has become. The charter goes on with a magnificent inclusiveness:

> "Also by cable and other appropriate means with the rest of the known world as may hereafter become necessary or desirable."

Permalloy, radio telephony,—what else? Is there anything from which that new little Company with its $100,000 capitalization was excluded? The whole world was opened wide to it as its field. Surely this was a permanent organization, unlimited in any way.

But no. Like the first Boston-New York line, it must prove itself. A definite term is allotted to it. If it can make good on its possibilities, it will be evident within fifty years. So the clause is put in at the end:

> "And the period when it shall terminate shall be at the expiration of the term of fifty years from said day."

In effect, to the American Telephone and Telegraph Company with this charter of its creation, Theodore N. Vail said, as he said to E. J. Hall, Jr., "Well, there is the problem. Work it out." His successors have indeed worked it out. The great experiment has been a success. And now its charter has been made perpetual.

William Chauncy Langdon

Talking Pictures in Industry and Education

THE adaptation of the talking motion picture to the needs of industry and education is an activity that promises to bring to the public economic and cultural benefits of ever increasing value. Here is a comparatively new vehicle of communication, born in the Bell Telephone Laboratories and brought to maturity in the Western Electric Company, that records and transmits ideas, locale and personalities to this and future generations, with a fidelity to truth and simplicity of operation that have earned it a high place in the history of the art of communication. It is a medium that makes use of all of the well-known devices of the silent motion picture—microscopic, diagrammatic, time lapse, slow motion and realistic photography, and of the sound transmission principles of the telephone, the radio, and the phonograph, combining them all so skillfully into an harmonious whole that the illusion of reality is substantially maintained.

It was to be expected that leaders in industry would quickly recognize the merits of this new instrumentality and would welcome its inclusion in their spheres of activity. A few examples of the use made of talking pictures by industry show the wide range of business problems which it has successfully helped to solve. It has been used for employee training; for sales demonstration; for the introduction of new products to dealers and the public, and in advertising, publicity and public relations work. It has been employed to carry official messages of management to employees, to report conventions, to analyze service practices and in many other important business activities. For the past three years it has been thoroughly tested in hundreds of ways by industry and has fully justified the claims that were made for it.

The GOODYEAR TIRE AND RUBBER COMPANY for a number of years had followed the practice of bringing their dealers into Akron for meetings lasting several days. The expense involved in these meetings was very high, and this year it was decided to meet with the dealers in their own localities by using talking pictures. A sales training picture, running an hour and a half, entitled, "Every Third Wheel" was produced, taken to one hundred and sixty-nine cities and shown to more than twenty-one thousand dealers and their employees. The attendance at the meetings was almost double what GOODYEAR had anticipated, and it is the opinion of GOODYEAR officials that the use of talking movies increased their sales for 1931. As a result of the success of this picture, GOODYEAR is now planning the production of its second feature picture to be distributed in 1932.

A somewhat similar activity was carried on by CHEVROLET MOTOR CAR COMPANY, Detroit, Michigan. Three sound pictures were produced for dealer and employee training and were distributed and shown to dealers and employees in theatres throughout the country during the morning hours and in hotels equipped with Western Electric Sound Systems. One picture —"The Prospect Within Two Blocks"—which ran for forty minutes was particularly successful. It was shown in fifty-two cities and the results were so satisfactory that CHEVROLET will produce a fourth picture to be shown at their Fall meetings to dealers this year.

A similar use of the talking movie was made by THE PERFECT CIRCLE COMPANY, Hagerstown, Indiana. This concern produced a three-reel picture on the history of THE PERFECT CIRCLE COMPANY, including a complete explanation of the manufacturing processes involved in producing Perfect Circle Piston Rings. This picture was first shown at the annual convention of the National Spare Parts Association, held in Cleveland last November. Since that time it has been shown to dealers and jobbers throughout the country with gratifying results. In spite of the fact that the automotive industry has been hard hit by the present depression, the Vice President and Director of Sales of this organization reports that the sale of Perfect Circle Piston Rings has increased 52 per cent this year over any previous year. He gives full credit for this increase to the talking picture entitled "The Magic Circle" and, as a result, this organization is now preparing a new forty minute picture which will have its initial showing in November at the National Spare Parts Association Convention.

STUDEBAKER CORPORATION has been a consistent user of the talking movie for the past three years. Two of its recent pictures produced for theatrical distribution, entitled "A Trip to the Clouds" and "Wildflowers," in which the Studebaker musical organization, "The Champions," was presented to the public, have been particularly successful.

DODGE BROTHERS CORPORATION have made use of the talking picture principally at the automobile shows by means of shadow-box arrangements in hotel lobbies and have caused much widespread comment. So pleased were DODGE BROTHERS with the results of their talking picture campaign that they are now producing a ten reel feature subject in Hollywood, which will be shown for the first time at their dealer meetings to be held throughout the United States this Fall.

Another large user of the talking movie is STANDARD OIL COMPANY (OHIO). This company began with the production of a two reel training picture which was distributed throughout the State of Ohio under the Road Show Plan operated by Electrical Research Products, Inc. Forty-nine shows were given in six days' time. STANDARD OIL COMPANY (OHIO) was so well pleased with the results obtained that they immediately contracted for a series of twelve single reel training subjects, one to be released each month during 1931. Up to the present time seven of these pictures have been produced and shown throughout Ohio, and arrangements have been made for six new pictures for the first six months of 1932.

When the UNITED STATES RUBBER COMPANY wished to reach golf professionals with an intensive campaign, it turned to the talking movie and produced two sound pictures—one entitled "Pros, Players and Profits" and the other entitled—"The Inside Story of the Golf Ball." These pictures have already been shown in fifty cities to leading golf professionals, sporting goods dealers and gold enthusiasts.

An interesting use of the talking movie was made by Coca-Cola Company. This company produced several pictures, the most important of which was a four-reel subject, entitled "The Soda Fountain Service." This picture contained one of the largest sets ever used in the production of an industrial picture. A complete drug store was installed in the studio and placed in actual operation in all its details in order to give the picture a high degree of accuracy. The objective of the picture was the analysis of service and the presentation of methods for improvement.

Several other companies have been actively engaged in talking movie campaigns this year. Outstanding among these are the Puget Sound Light & Power Company with their excellent production picturing the State of Washington; Standard Brands, Inc. with an eight reel feature subject, entitled "Food For Thought"; Richfield Oil Company with their three reel subject featuring Lloyd Hamilton, entitled "Service Wins Again"; International Harvester Company with a feature length subject commemorating the one hundredth anniversary of the invention of the McCormick Reaper and Harvester; Armstrong Cork Company with a picture describing their new product "Temlock," which was taken out to lumber dealers throughout the country, and many others.

Another development that will be of economic importance in this time of depression, and which is well under way, is worthy of comment. Many of the largest corporations in the country are completing their plans for an intensive use of talking movies for the furtherance of better personnel relations, more economical training of employees and the improvement of public relations. An example of this work is the excellent start that has been made by the AMERICAN TELEPHONE AND TELEGRAPH COMPANY through the production of pictures for the training of directory advertising salesmen, the training of plant construction forces in the use of the new mortar bandage joints, and a picture showing the advantages of systematic training of P.B.X. operators.

The list of concerns using talking pictures is an imposing one for a year of depression and the results that industry has secured through these activities give a clear indication of the great value that the talking picture has in the commercial world.

Satisfactory as these results have been in the field of industry, perhaps even more striking have been the results secured by Electrical Research Products, Inc. in adapting the talking motion picture to education.

In the initial stages of this development, a small number of demonstration pictures were produced and shown at the principal educational conventions of the National Education Association, Progressive Education Association, Parent-Teacher Associations and many State Teacher Associations. Literally thousands of opinions and suggestions were sought for and secured from teachers and school administrators as to the value and proper use of talking movies in the schools, before the broad outlines of the educational plan were finally laid out.

In one of the early campaigns a twenty minute demonstration picture was shown at the summer training courses for teachers at eleven universities, including Chicago University, Columbia University, University of Southern California and other important institutions. Fifty-six demonstrations were given to nearly seven thousand students, faculty members and college officials, and by means of questionnaires some indication of the trend of educational thought was secured. The opinion was almost unanimous that the talking movie would be of tremendous value in educational work. These seven thousand educators listed their reasons for believing in the talking movie, and it is interesting to reproduce them here in the order of importance in which they were rated on the questionnaires. These educators thought:

1. The talking movie makes the subject more stimulating and interesting.
2. Gives information not available in the classroom.
3. Excels in revealing personalities.
4. Democratizes education.
5. Leaves a more lasting impression.

An Educational Advisory Committee was formed, consisting of several prominent educators, representing different activities in the educational field. For three years these advisers have been in constant consultation with the administrators of the educational plan. They have formulated educational standards to serve as guides in the production of talking movies for classroom use. As the plan evolves, they are determining from the standpoint of the teacher himself the subject to produce, with a careful scrutiny of their content, so that the greatest possible advantage may be taken of the talking movie as an agency for the enrichment of the school curriculum.

With the advice and assistance of this Educational Advisory Committee, three specialized groups were formed to carry out the broad plans of the Department of Educational Talking Pictures of Electrical Research Products, Inc. for the introduction of the talking movie as a teaching aid. These groups are the Research, Production and Promotion Divisions of the Educational Department.

The Research group, supervised by a former Superintendent of Schools, with graduate work at Chicago and Columbia Universities, was organized with several research associates, each one of whom is a specialist in the field of education. Each has had actual teaching experience and each holds the Ph.D. degree in educational research in his special field. This full time research staff has made a complete survey of the courses of instruction offered in American schools; has analyzed the sales possibilities and has determined in what way talking pictures can be employed to make the greatest possible contribution to American education. On the basis of these analyses, checked with educators throughout the country so that group judgment rather than personal judgment would prevail, a series of complete teaching courses, into which the talking movie has been incorporated, has been prepared. In each of these courses, units of instruction have been prepared. Teachers' Handbooks have been made available and suggested continuities have been written on the basis of which demonstration pictures have been made for release to the teaching profession.

The Production Division was organized with several experienced directors, scenario writers and technicians, each of whom has had several years training in the production of pictures for the non-theatrical market. Supplementing the work of this division and of great value in maintaining the quality of the pictures produced have been the services of the engineers, the technical experts on sound recording, sound reproduction, and acoustics, who are part of the headquarters staff of Electrical Research Products, Inc.

Using the material developed as a result of the research activities and with the advice and assistance of outside specialists in the educational field retained for consultation in the case of each production, the Educational Department produced some fifty educational talking movies for demonstration uses in the school field in the following departments of education: Teacher Training; Music Appreciation; Natural Science; Physical Education; Social Science.

Among the pictures produced are those featuring some of the most famous educators in the world, recognized leaders whose standing and reputation permit them to speak with authority on the subjects in which they have specialized. A few of these authorities are: Dr. William H. Kilpatrick, Columbia University; Dr. Guy T. Buswell, University of Chicago; Dr. Boyd H. Bode, Ohio State University; Dr. Arnold Gesell, Yale University; Dr. Charlotte Buehler, University of Vienna; Dr. Hughes Mearns, New York University; Dr. Richard D. Allen, Lecturer at Harvard University; Dr. Arthur I. Gates, Columbia University; Dr. Clyde Fisher, American Museum of Natural History, and others.

During the past year demonstration pictures produced under the educational plan have had a widespread showing throughout the country and a large number of interesting uses have been made of the material prepared and of the equipment provided for such use.

One activity which is of special interest is the Parent and Teacher Guidance course which was conducted weekly at the Mayflower Hotel, Washington, D. C., February 24 to April 15, 1931. This course, which was sponsored by Dr. William J. Cooper, Commissioner of Education, and by an imposing list of leaders in the educational world, used one of the teacher training pictures at each session as the basis for discussion. The course of instruction was taken by six hundred educators, teachers and parents. The discussions were spirited and prolonged and the results were approved as making a significant contribution to American education.

A similar course of instruction in visual education was given at the University of California, Los Angeles, during the month of July, in which a large number of educational pictures were used as the basis for the course. These two examples of the use of the talking movies in teacher training have been referred to generally in the press as "The Talking Movie University," and great good has been accomplished.

While these two courses show an interesting use of the talking movie, more important still has been the fact that, not only in teacher training courses, but also in actual classroom situations, the talking movie has been used during the past year to reach thousands of students as a regular part of their every day courses of instruction. With the opening of the present school term it is expected that a still wider use will be made of talking movies on the sound projectors that have been recently installed in several of the school systems throughout the country.

It may be well to note that schools may use the subjects prepared for them with the greatest assurance that a substantial contribution to the learning process will result. During the past year a staff of research workers, experienced in psychological testing and statistical analysis, has made a series of tests and measurements to determine the value of the talking movie in comparison with other teaching devices. The findings will shortly be published in monograph form for the professional field and will reveal for the first time well authenticated conclusions that the contribution of the talking motion picture to the learning process is definite and substantial.

Many related activities have been carried on in the non-theatrical use of talking movies, all of which are charged with interest, but do not fall within the scope of this present article. One of these is the production of medical pictures for clinical instruction, nurses' training and for use at medical societies throughout the country. Several remarkable pictures have been produced in this field and have been widely used with uniformly good results.

Demonstration pictures have also been produced for use in the religious field and several of the most important denominations are now carrying on research programs to determine in what way the talking motion picture can best be adapted to advance the work of the church. Sufficient results have already been secured in the training of Sunday School teachers, in the recording of outstanding messages and personalities, and in the production of religious music to indicate a widespread use of the medium for this purpose in the near future.

At many of the Veterans' Hospitals throughout the country, talkies shown on Western Electric equipment are bringing comfort and cheer to disabled soldiers and sailors. Ships at sea are showing regular programs. County and state institutions are bringing to their inmates a conception of the changing world outside. Teachers are gaining a new perspective and new enthusiasms for their calling. Doctors are studying the techniques of famous surgeons. School children are gaining their early concepts through carefully formulated talking movie lessons. Surely, here is a Bell System contribution to American civilization of growing importance, and one that is in harmony with the high ideals of service to the public that is the heritage of telephone men and women everywhere.

F. L. Devereux

Notes on Recent Occurrences

OVERSEAS TELEPHONE SERVICE EXTENDED

Radio telephone service was extended on August 15 from North America to the Canary Islands, off the west coast of Africa, slightly south of Morocco.

A call from New York to any point in the Canary Islands costs $40.50 for the first three minutes of conversation and $13.50 for each additional minute. After leaping the Atlantic by radio, calls cross England by land wire, pass under the English Channel and travel to Madrid by wire. Here they are transmitted by radio to their destination in the Canary Islands. This last operation is handled by the National Telephone Company of Spain while transmission from the United States is in the hands of the American Telephone and Telegraph Company.

600,000 A. T. & T. STOCKHOLDERS RECEIVED JULY 15 DIVIDEND

THE dividend of July 15 to American Telephone and Telegraph Company stockholders of record June 20 was paid to more than 600,000 owners of the stock. This is the largest number ever to receive a dividend payment from the Company.

From the beginning of the year to the record date the A. T. & T. stock list increased over 33,000. About 15,000 of the net gain was accounted for by employee stockholders while about 4,000 new accounts resulted from installment subscriptions completed last April under the 1930 stock offer.

As has been true in the past, small stockholders comprised the bulk of the gain, those holding 5 shares or less increasing 16,000 and those owning 25 shares or less about 30,000. From December 31, 1930 to June 20, 1931 the average number of shares per holder declined from 31.6 to 30.8.

Since the end of last year stockholders have increased in all geographical areas of the United States with the Central and Southwestern territories showing the largest percentage gains.

CONFERENCE OF BELL SYSTEM PRESIDENTS

A CONFERENCE of Presidents of Bell System Companies was held from September 29 to October 4, inclusive, at Yama Farms, Napanoch, New York.

BELL TELEPHONE QUARTERLY

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