

PENNSYLVANIA RAILROAD THE INFORMATION

for the Public and Employees

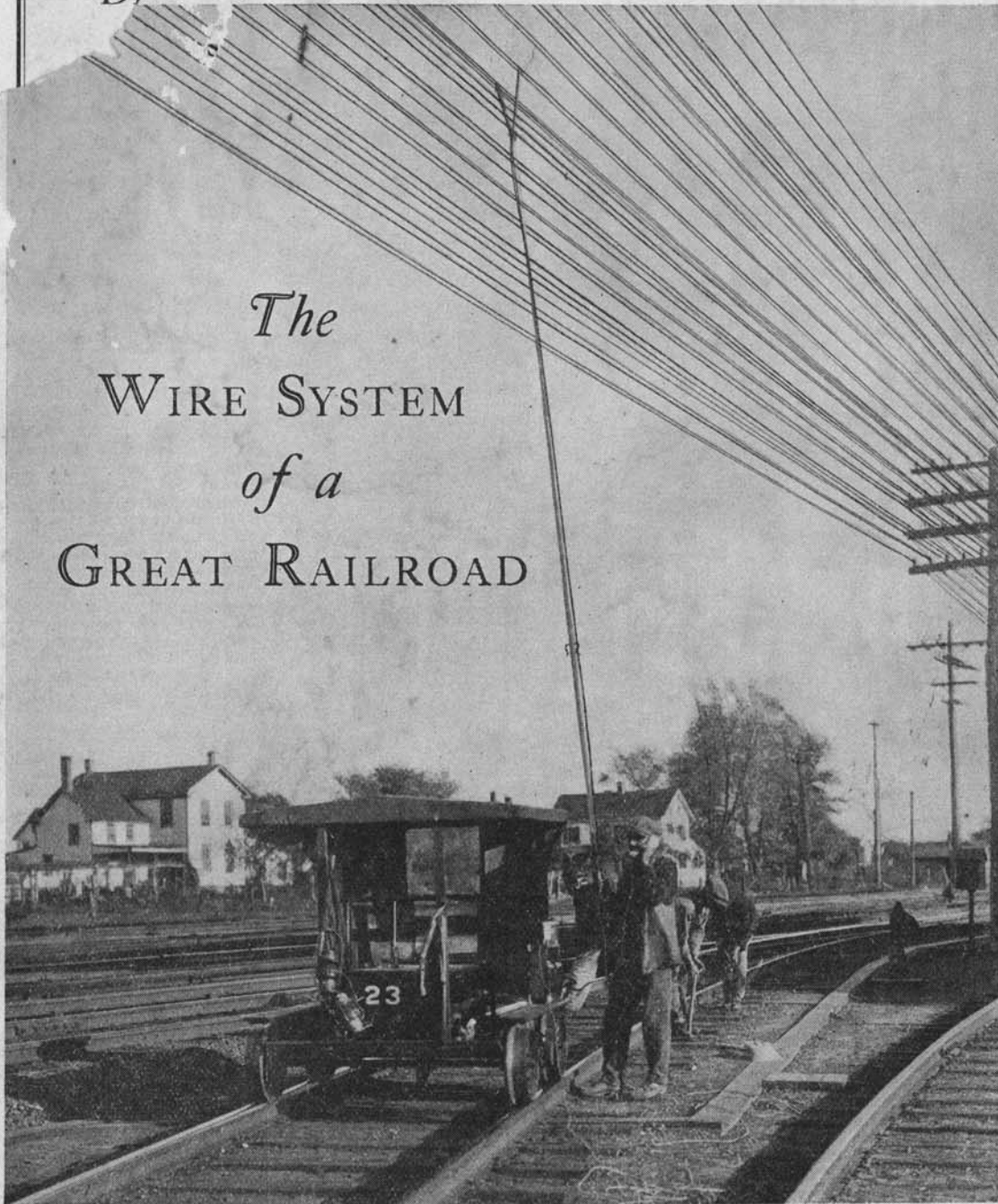
Issued from the General Offices, Broad Street Station, Philadelphia



1925

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The WIRE SYSTEM *of a* GREAT RAILROAD

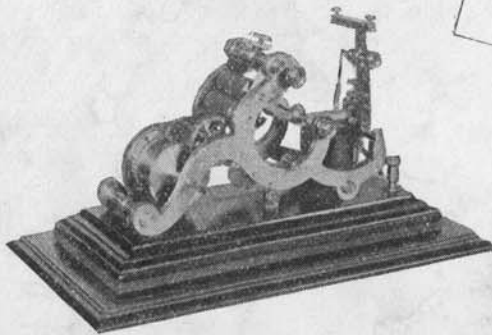


TELEPHONING DIRECTLY FROM THE TRACK

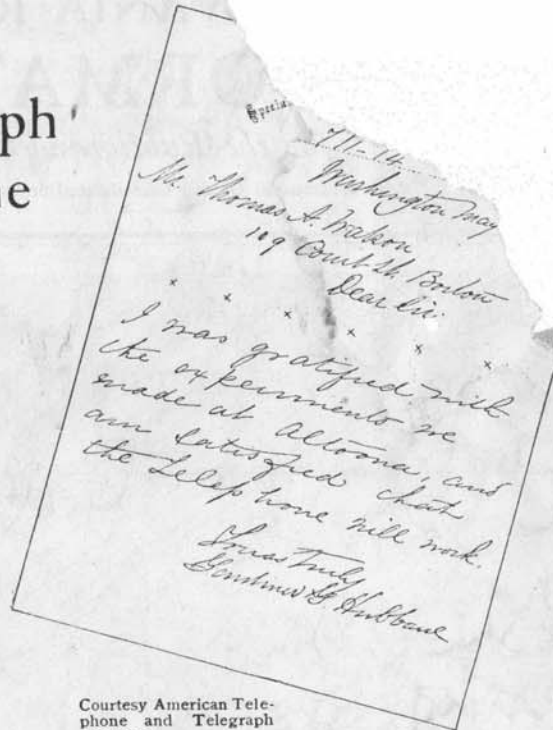
Each of the modern gasoline motor cars now used extensively in track repair work on the Pennsylvania Railroad carries a portable track telephone outfit. Through the medium of a pole extension hung to the overhead wires, this telephone equipment enables the track foreman to keep himself constantly informed, through direct contact with headquarters, of train movements and other matters affecting his work.

When Telegraph and Telephone Were New

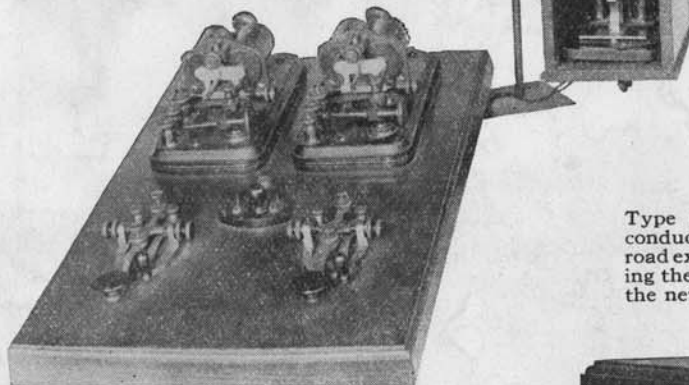
One of the earlier types of telegraph registers. In this instrument the Morse Code was recorded by dot and dash impressions on paper tape instead of by sound alone as is the case in modern telegraph receivers.



Courtesy American Telephone and Telegraph Company.



Portion of a letter written by G. G. Hubbard, who conducted the first railroad tests of the telephone in the Pennsylvania Railroad shops at Altoona, to his mechanical associate, T. A. Watson, which clearly indicates how early in the life of the telephone these Pennsylvania Railroad experiments were made.



Type of early telephone used in conducting the Pennsylvania Railroad experiments at Altoona, marking the first use by any railroad of the new means of communication.

Original telegraph set installed in the office of President Frank Thompson. This board was equipped with two circuits to "PO" telegraph office in Broad Street Station, through which immediate contact was had with road offices.



Courtesy American Telephone and Telegraph Company.

THE WIRE SYSTEM OF A GREAT RAILROAD

Did you know that the Pennsylvania Railroad owns and operates the largest private telephone and telegraph plant in the world?

THE use of telegraphy in railroad operation, particularly in the dispatching of trains, dates almost from the inception of the railroads themselves. The telegraphic art has developed side by side with the art of railroading and it is a generally acknowledged fact that the telegraph has played a most vital part in the miraculously swift growth and expansion of America's railway transportation system.

Before the invention of telegraphy, the few steam railroads then in operation ran their trains on what was known as "the time interval system." Under this arrangement, trains were designated as "superior" and "inferior" according to their class and the direction in which they moved. "Inferior" trains were required to wait one hour at designated passing points for late "superior" trains. If, at the expiration of the 60 minutes, the "superior" train had not arrived, the "inferior" train would start a flagman on foot to the next station, the train following slowly 10 minutes later. This procedure was continued until the

trains met. When this happened between stations, the train nearest a siding or the train of lesser importance would back up. All railroad lines were at this time, of course, single tracked.

About the year 1844 Professor Morse introduced practical telegraphy in the United States by throwing open a complete telegraph circuit between Baltimore and Washington. It was seven years later, in the early autumn of 1851, when telegraphy was first used to dispatch a train on an American railroad. When it is remembered that the Pennsylvania Railroad Company was chartered on April 15th, 1846, it will be readily seen that the advent of American railroading and the inception of telegraphy were closely associated events.

The Pennsylvania Railroad was one of the earliest pioneers in the use of the new means of communication. Experiments in transmitting train orders by telegraph were made on the old Belvidere Delaware Railroad, now a part of the Trenton division, and a method

FACTS ABOUT THE PENNSYLVANIA RAILROAD'S TELEPHONE AND TELEGRAPH PLANT:

Handles 98,492,000 local and 17,514,000 long distance telephone messages a year, together with over 32,000,000 telegraphic messages, not including the use of the telephone and telegraph in train dispatching work, etc.

Has 180 private branch telephone exchanges and 30,500 telephone instruments.

Utilizes 10,260 miles of pole line, 410,520 poles, 126,921 miles of wire, 232 miles of underground conduit, and 928 miles of lead sheathed telephone and telegraph cable.



The General Office Private Branch Telephone Exchange at Broad Street Station, Philadelphia. This is the largest railroad private branch telephone exchange in the world. It handles the telephone business of the Company's headquarters through 1089 circuits and 23 operating positions.

of handling this work was developed entirely independently of the researches of other railroads in this direction.

The rules covering the transmission of train orders by telegraph and the movement of trains by these orders, which were formulated as a result of these early experiments, were in force for many years and formed the basis of the original set of rules for the handling of this business adopted by the Pennsylvania Railroad. With certain modifications to meet modern conditions, the rudiments of these rules are still in effect.

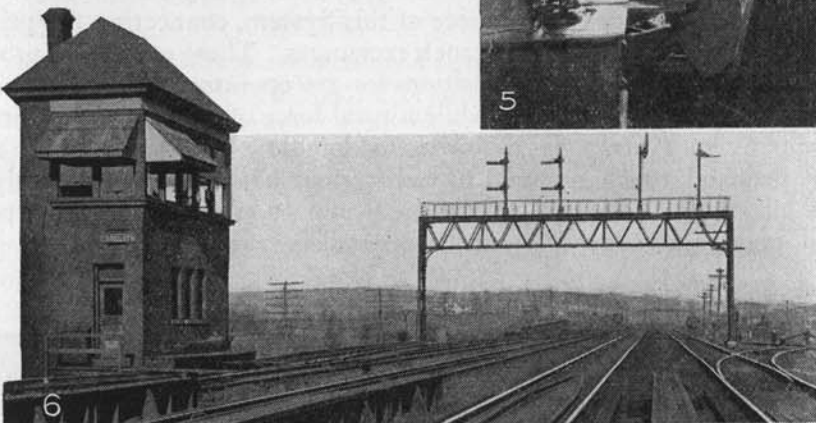
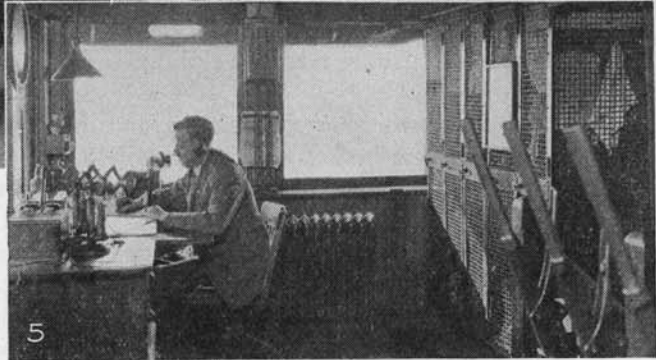
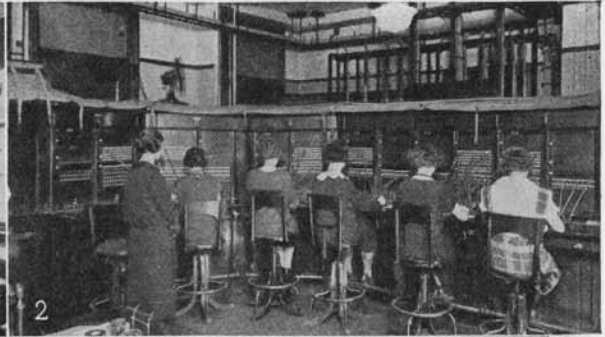
After the telegraph had been proved a satisfactory means of communication in dispatching trains, many improvements were made upon it. The old paper tape instruments were relegated to the scrap heap and the audible system of telegraphy was adopted. The Pennsylvania Railroad was quick to take advantage of all innovations and improvements in telegraphic methods and these, when proved reliable, were added without delay to the Company's telegraph system.

Then, in the early part of 1875, there came whisperings of a man, Alexander Graham Bell, who claimed that his invention, the telephone, would project the human voice over a wire between two given points. The Pennsylvania Railroad, always anxious to investigate and try fairly a device which might possibly improve its service, began to question

the telephone makers. At that time the telephone had hardly been born; only a few of the then rather crude instruments had been made and their service was limited to single line or grounded circuits with an instrument at either end. The exchange system of operation had hardly been thought of, much less put into material form.

It was during this early period in the life of the telephone, only about two years after its official birthday—to be exact on May 21, 1877—that Alexander Graham Bell sent his associate, Gardiner D. Hubbard, with his mechanical expert, Thomas A. Watson, to Altoona to give the telephone a trial in the Pennsylvania Railroad shops in that city. Tests were conducted for a short period, resulting in the permanent installation of a telephone line in the Altoona shops.

These tests and resultant installations marked the first trial and use by any railroad of the new invention, the telephone. Not only was the Pennsylvania Railroad the first railroad in the world to use the telephone but it was numbered among the very first customers of the telephone inventors. The experiments at Altoona, followed by permanent installation, occurred but a year and two months after Bell's transmission of the first sentence by telephone on overhead wires between Boston and Cambridgeport, a distance of two miles.



The story of a typical railroad operating division's telephone and telegraph plant told pictorially. These pictures illustrate the facilities on the Maryland Division at Wilmington, Delaware.



1. The Telegraph Office
2. The Private Branch Telephone Exchange.
3. The chief train dispatcher and his assistants.
4. A train dispatcher at his desk.
5. A tower operator with his battery of ready telephones.
6. "Landlith" a typical block tower.
7. Sending messages over the telephone message wires.



Within a short time additional orders for telephones were placed by the Pennsylvania and it was not long before these instruments were in active service in many of the Railroad's terminals, stations and shops. With the constant increase in the Company's business and the continual improvement in telephonic means of communication, the Pennsylvania Railroad down through the years has kept abreast of the very latest innovations and improvements in telephone service until today it operates on its System the largest, and one of the finest, private telephone plants in the world.

Generally speaking there are three major types of telephone systems in operation on the Pennsylvania Railroad. The largest and best known is the great network of long distance lines and local private branch exchanges with their manifold extensions which spread like a great spider web over the entire Railroad System. Through this telephone plant the executive officers of the Company in Philadelphia are able to keep in personal touch with the entire Railroad at all times. The officers and employees at all points have a

ready means of communication for the handling of general railroad business, while contact is afforded with the public through direct connections with the commercial telephone companies' exchanges.

The most modern appliances are utilized by the Company to increase the range of transmission and the efficiency of its circuits. By means of telephone repeaters and loading coils leased from the American Telephone and Telegraph Company, it is possible for Railroad officers and employees to talk from New York and Philadelphia to Chicago over their own wires, as well as to such intermediate points as Fort Wayne, Grand Rapids, Cleveland, Detroit, Pittsburgh, Columbus and Buffalo.

A total of 22,545 miles of trunk circuits are in the service of this System, connecting 180 private branch exchanges. These exchanges provide positions for 376 operators to work at one time, while a total force of over 750 operators is required to handle the traffic over a period of twenty-four hours. Approximately 98,492,000 local and 17,514,000 long distance messages are handled yearly.

System and Regional officers in charge of telegraph and telephone work on the Pennsylvania Railroad System.



W. M. Post, Supt. Telegraph and Signals, Central Region, Pittsburgh, Pa.



J. C. Johnson, General Supt. Telegraph, Pennsylvania Railroad System, Phila., Pa.



J. D. Jones, Supt. Telegraph and Signals, Eastern Region, Philadelphia, Pa.



C. W. Hixson, Supt. Telegraph and Signals, Northwestern Region, Chicago, Ill.



E. B. Pry, Supt. Telegraph and Signals, Southwestern Region, St. Louis, Mo.



A patron of the "Broadway Limited" using the telephone facilities in the observation car before departure of the train.



Special telephone exchange at Philadelphia devoted entirely to the handling of telephonic requests from patrons for train information.

In the more important centers of railroad activity the Company's private branch telephone exchanges assume very large proportions. The Exchange at Broad Street Station, Philadelphia, for instance, is the largest private branch telephone exchange operated by any railroad in the United States or in the world. This Exchange, which handles the telephone business of the General Offices and Headquarters of the Company, controls 890 circuits to telephones in the General Offices, through a total of 17 operating positions. Six additional long distance or toll positions are in service, controlling 99 circuits to other exchanges. Through the lines radiating directly from the General Offices Exchange and the exchanges connected with it, it is possible to communicate with every station on the Railroad between New York, Atlantic City and Washington on the east and Chicago, Grand Rapids, Detroit, Cleveland and Indianapolis on the west. Contact with the public is provided by 100 additional trunk lines to the Spruce Exchange of the Bell Telephone Company in Philadelphia. In 1924 the Broad Street Station Exchange handled 7,142,116 calls, including over 1,000,000 long distance connections. Forty operators are required to handle its traffic.

In the entire Philadelphia district a total of twenty-four railroad private branch exchanges are operated. These exchanges reach 1952 telephones and require 125 operators to handle their traffic. A total of 254 direct lines to city commercial exchanges are provided through these facilities.

At Altoona, Pa., the Railroad's exchange provides service to 2,548 telephones through 14 operating positions. An important part of this exchange's activity is the calling of train crews for their runs. The centering of the Middle, Pittsburgh and Cresson Divisions at Altoona renders the crew calling work quite heavy at this point. A total of 1,667 telephone connections in the Altoona Exchange are set aside exclusively for use in calling the train men for their runs. These instruments are installed in homes scattered throughout Altoona, Hollidaysburg and Juniata.

Three large private branch telephone exchanges are operated in Pittsburgh, Pa. The largest of these, "GO" exchange, handles the traffic of the Central Region General Offices, while "OD" takes care of the Pittsburgh Division and "AC" the Conemaugh Division. These exchanges reach a total of 1,236 telephones in the Pittsburgh District having, in addition, 109 direct connections with the City commercial exchanges. Twenty-six operators can sit at the three Pittsburgh exchanges at one time while a total of fifty-five operators are required during a 24-hour period.

Other large telephone exchanges are operated by the Company at New York, Harrisburg, Chicago, Jersey City and St. Louis.

One of the most important functions of these private branch exchanges is the facilitating of communication between the Company's patrons, the general public, and its officers and employees. In the 180 private



"PO" telegraph office, at System Headquarters in Broad Street Station, Philadelphia. A total of 8,000 messages and reports are transmitted and received daily through this office, which is the largest telegraph office on the System.

branch exchanges operated on the Pennsylvania Railroad, a total of 1,339 circuits are provided directly to the central exchanges of the commercial telephone companies, through which ready contact with the public is established.

In several important centers, such as New York, Philadelphia, and Pittsburgh, special telephone exchanges, entirely separate and distinct from the regular private branch exchanges, have been provided to handle telephone requests from the public for passenger train information. At Pennsylvania Station, New York, 12 operators are kept busy answering travelers' questions. More than 1,300,000 telephone calls for train information are handled at this exchange yearly. In Philadelphia, a special "train information" exchange includes 10 operating positions with 35 direct lines to the commercial telephone company's central exchange. The Philadelphia "Information" exchange handles an average of 3,000 calls a day, while during the peak summer period as many as 5,000 calls a day have been received. It is not unusual during the heavy season for this exchange to receive between six and seven hundred calls an hour during the busier periods of the day.



A veteran of the key. Fred Reese of "PO" Office.

Another important feature of the private branch exchange work is the providing of telephone service on limited trains before their departure from the originating terminal. Passengers boarding the "Broadway Limited" at New York City and Chicago have available, until the train leaves, public telephone service to all parts of the United States through the Pennsylvania Railroad's local exchange. If a traveler, after boarding the train, suddenly remembers some important detail which has been overlooked and which should be taken care of without delay, the convenience of the train telephone is readily appreciated. "The St. Louisan," "The New Yorker," "Washington-Broadway Limited," and "The American," the new train between New York and St. Louis, are also provided with this service.

For the convenience of railroad patrons whose private telephones do not happen to

be in a locality affording direct connection with a railroad private branch exchange, the Company has leased and installed in practically every station agency on the System one or more telephones directly connected to the commercial telephone company's local exchange. In this way the local public is able to establish immediate contact with the Railroad's representative in the community.

As an additional public service, the Railroad, through an arrangement with the telephone companies, has installed commercial telephones in public booths in practically all of its local stations.

In the larger terminals such as New York, Philadelphia, Chicago, Pittsburgh, etc., special public exchanges with convenient booth facilities provide a twenty-four hour telephone service to patrons. In Pennsylvania Station, New York, and Broad Street Station, Philadelphia, alone, 322 telephone instruments are installed for public use. A total of 1355 telephones of this kind are provided on the entire Pennsylvania Railroad System.

The second system of telephone communication in operation on the Pennsylvania Railroad is that used by the train dispatchers, tower operators and other operating employes, to control the movement of trains. This is entirely independent of, and distinct from, the private branch exchange and long distance trunk system and is devoted exclusively to the handling of communications relative to train movements. The most careful safeguards are thrown around these circuits so



A view of the special commercial telephone exchange and booth facilities provided by the Railroad for public use in Broad Street Station, Philadelphia.

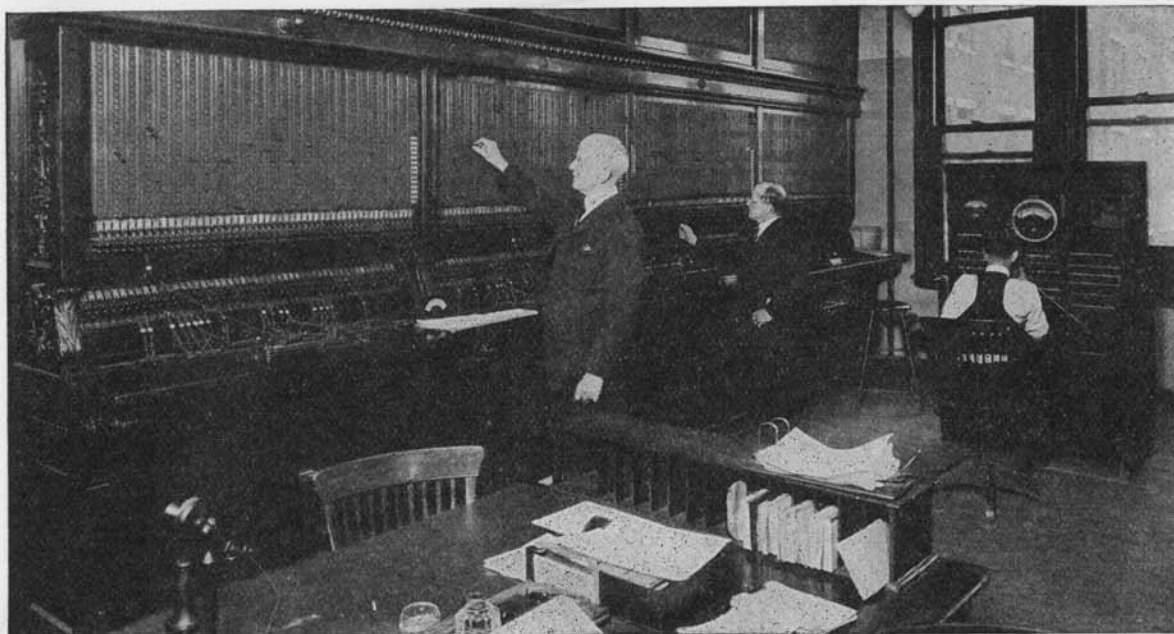
that nothing will interfere with the proper transmission of messages relating to train operations.

Trains were first dispatched by telephone on the Pennsylvania Railroad on the South Fork Branch of the Pittsburgh Division in December 1897. On the first circuit seven telephones were installed and used by the train director to direct the movement of traffic and obtain information regarding the distribution of cars on this branch.

Practically all the train dispatching done on the Pennsylvania Railroad today is handled by the telephone. This instrument has been very successfully adapted to train operating work and has almost entirely superseded the



A stretch of standard four-track roadbed on the New York division showing the double line of poles carrying railroad telegraph and telephone wires. The Railroad believes in the old adage, "Do not put all your eggs in one basket." In the event of storm or emergency, immediate connections may be made between wires on these two lines, providing a reserve wire service sufficient to meet practically every demand made upon it.



Test boards in "PO" telegraph office, Philadelphia. Through the large board on the left the circuits are checked constantly from a telegraphic standpoint. The board on the right is provided to test the wires telephonically, for in the dual use of circuits the wires and associated equipment must be functioning properly from both standpoints if efficient service is to be had.

older telegraphic method. Its use has not only made possible the handling of a greatly increased volume of traffic, but this traffic is handled much more efficiently and expeditiously than by telegraph.

The system of telephonic train dispatching on the Pennsylvania Railroad can best be described by telling of the methods in use and the apparatus and equipment in service on a typical operating division; for dispatching is done on a divisional basis and practices are, generally speaking, uniform on all the divisions of the System.

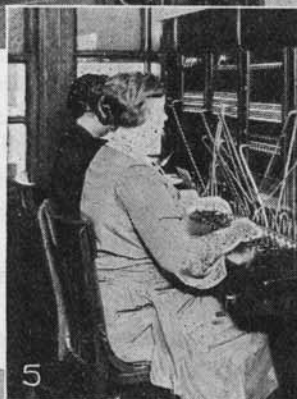
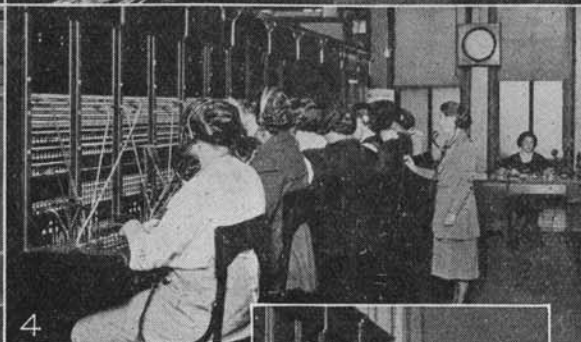
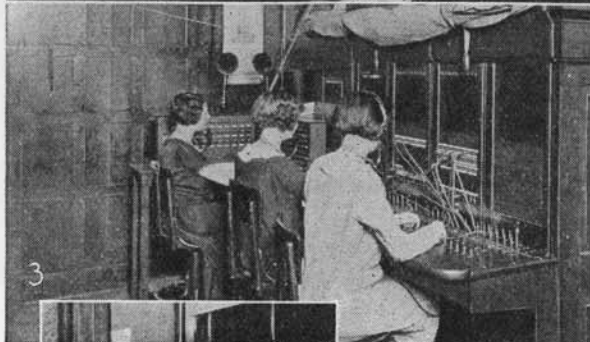
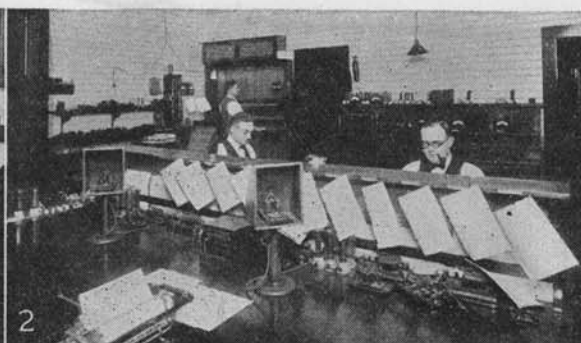
The Maryland Division, along the route of the famous "Congressional Limited," will be taken as an example. This division operates the line from Philadelphia to Baltimore, including the Octoraro Branch, the Columbia and Port Deposit Branch, and several other smaller branches. It has one of the finest telephone train dispatching systems on the Railroad and is a standard four-track railroad along practically the entire course of its 95 miles of main line.

The heart of each operating division on the Pennsylvania Railroad beats in that division's train dispatcher's office. It is a quiet, very precise and methodical heart, however, for these men, although they are in entire control of the movement of hundreds of trains, are so expert and exact, as a result of thorough study

and long experience, that their work is carried forward with an almost uncanny calm and quiet and with absolute accuracy and dispatch.

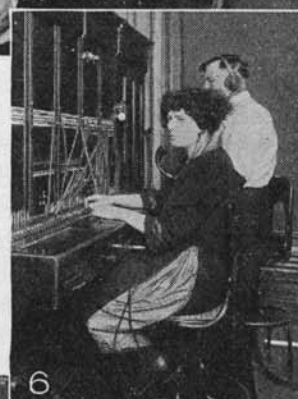
A Chief Train Dispatcher with four assistants on duty, simultaneously, operate the Maryland Division.

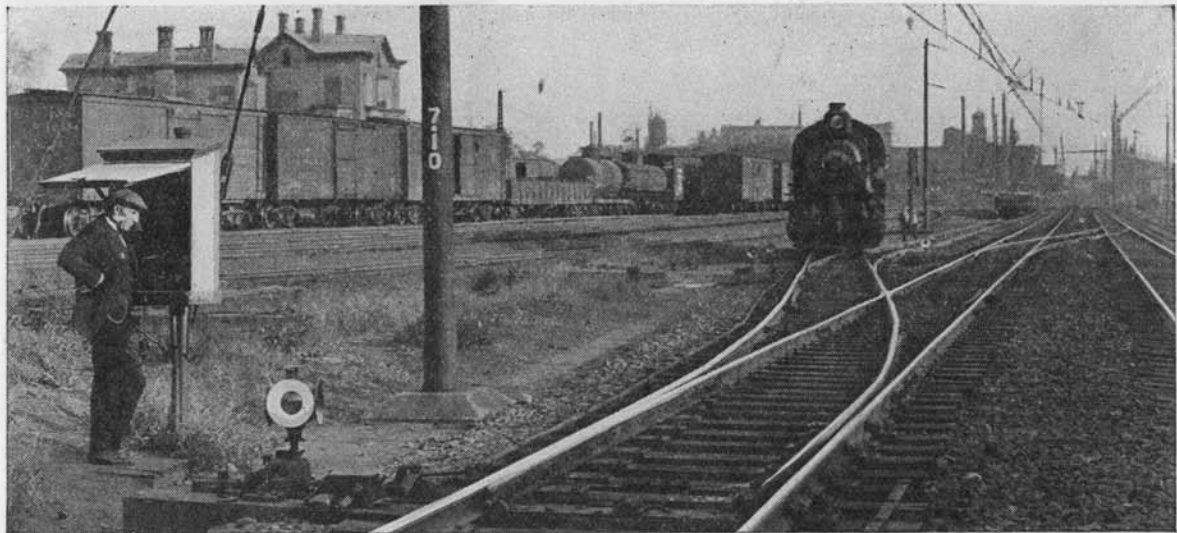
Each of the four dispatchers is in charge of a certain section of track under the supervision of the Chief. These men sit at individual tables with a train sheet spread before them on which they mark in ink the progress of each train over their respective sections of railroad. A large panel in front of them has on its face many small levers, each labeled with the name of the block tower which it represents. The train dispatcher, by turning one of these levers, is placed in immediate touch, through the telephone transmitting apparatus in front of him, with the tower represented by that particular lever. The receiving apparatus in the shape of ear-phones is at his ears during his entire tour of duty. On some divisions, by choice, loud speaking telephone receivers, instead of head telephones, are used in this work. The dispatcher is in constant communication with his block operators by telephone, giving orders for the switching of this train to that track, or the holding of that train at this particular point and all the multitude of details which go into



**A GLIMPSE OF THE SYSTEM'S
WESTERN WIRE PLANT**

1. "NY" telegraph office, Indianapolis, Ind.
2. "NY" telegraph office, Fort Wayne, Ind.
3. Private Br. Telephone Ex., Indianapolis, Ind.
4. Private Br. Telephone Ex., Chicago, Ill.
5. Private Br. Telephone Ex., St. Louis, Mo.
6. Private Br. Telephone Ex., Fort Wayne, Ind.
7. Train dispatcher's office, Fort Wayne, Ind.
8. "GN" telegraph office, St. Louis, Mo.
9. "GF" telegraph office, Chicago, Ill.
10. Dispatcher's office, Grand Rapids, Mich.





Before a train not regularly scheduled can pass from a branch line track to a main line track permission must be obtained from the train dispatcher. Here the conductor of a freight shifter is using the conveniently located track telephone to reach the dispatcher and get the required permission, before throwing the switch and entering the main track. This is only one of the myriad uses of the handy track telephone.

the intricate operation of trains on a stretch of modern railroad.

Reports are also constantly passing from the block operators to the dispatchers, giving the time each train passes each particular tower. These reports are entered on the train sheets. In this way each dispatcher is kept informed down to the quarter and half minute as to where his trains are moving, and is ready at all times to take immediate action when occasion arises.

The telephone is used exclusively in carrying on this important dispatching work. The circuit used is called the dispatcher's line and it is indeed sacred to the dispatcher's use. One of the Company's strictest rules is that this circuit shall not be used by any other than the dispatcher, and that it shall be used only for dispatching trains.

The utmost safeguards are thrown around this circuit at all times and extreme care is exercised to see that it is not interfered with in any way and is always ready to provide the dispatcher with an instant means of communication with his block operators. The dispatcher's telephone circuit reaches only the dispatcher at divisional headquarters and his block operators along the line.

A second exclusively train operating circuit is in use between each block tower and the next tower on either side. Every block operator has, through this circuit, a special telephone connection to the tower next to him

each way. This circuit is used to convey from tower to tower exact information as to the time of passing trains. In this way, the block operators are enabled to prepare the switches and signals for on-coming trains, and at the same time restore switches and signals to normal after a train has passed out of their territory.

Three reports must be made by a block operator on every train. When it passes his tower, he uses the block circuit to tell the tower ahead that a train is coming. He uses the dispatcher's circuit to inform the dispatcher of its passing, and he uses the block circuit in the reverse direction to inform that block operator that the train has passed out of his territory.

Another telephone circuit is operated from division headquarters into all the block towers and many of the important freight and passenger stations along the line. This is called the "message circuit" and is used exclusively to transmit and receive messages having to do with general railroad operating matters, not, however, dealing with the actual movement of trains and requiring not quite so much dispatch in their transmission. On the Maryland Division, three operators are constantly engaged in transmitting messages by telephone from the divisional headquarters at Wilmington to various stations, block towers, etc., on the division, including messages on a through line to Philadelphia. These employes use

special telephone transmitting apparatus, just like the dispatchers, and are an entirely separate and distinct force from operators, handling general railroad business in the division's private branch telephone exchange. The message circuit is not available for ordinary telephone conversations, but is restricted entirely to the handling of written message work.

Still another telephone circuit is in use from division headquarters to the more important towers, freight and passenger stations, enginehouses, yards, etc., on the division. This circuit is called the general talking circuit and is connected with the division's general telephone exchange. This circuit is really a part of the long distance and local exchange system and is mentioned here merely to show its use on a typical operating division. While this circuit is used for handling all general railroad business and is not necessarily connected in any way with direct train operation, yet it is entirely at the disposal of the train dispatcher and is used by him many times in the handling of certain phases of his work. It is, of course, always available in an emergency for the train dispatcher's use.

At points where a block tower is in the neighborhood of a large yard or enginehouse, in many special cases a direct circuit is provided from that particular tower to the yard or enginehouse. This circuit has no other outlets and is used exclusively to facilitate the handling of business having to do with the movement of car and locomotive equipment to and from the yard or enginehouse and the main line tracks. Through the use of this circuit, the operator is kept constantly informed as to these movements and is able to keep the train dispatcher promptly advised.

One of the most interesting telephone services on the Pennsylvania Railroad is that provided by the track telephone. At certain intervals, usually less than a mile apart, along the Company's entire 10,464 miles of main track, these telephones are placed beside the track in a specially designed box or booth. Through the medium of these telephones, the conductor of a train, or the foreman of a track gang, is enabled to get in immediate communication with the adjacent block operators through the block circuit. If their business is such as to demand connection with the dispatcher, the block operator connects the block circuit with the dispatcher and the

conversation is begun.

A train may stop almost anywhere on the Pennsylvania Railroad and if it should not happen to be near a block tower or station, the conductor may rest assured that he will not have to walk over half a mile until he comes to a track telephone, where instant communication may be established with headquarters. In the same way, the foreman of a track gang may get in immediate touch with the dispatcher and ask permission to take up certain lines of rail, or place his car on the tracks for a short run.

These track telephones are also placed at all points where branch lines form a junction with the main line tracks. Before freight or passenger trains other than those regularly scheduled can move from the branch line tracks to the main line tracks, the conductor must first obtain permission from the dispatcher at headquarters through the track telephone.

Another interesting phase of track telephone work is that provided in the portable telephone equipment carried on the new gasoline motor cars used by the track maintenance forces, as illustrated on the first page.

The gasoline motor car is gradually replacing the old familiar handcar as a means of getting the track gangs over the line. Each of these motor cars is equipped with portable telephone apparatus which, when occasion arises, is connected with the wires paralleling the track through the medium of an extension pole about 25 feet long. Through the use of this telephone equipment, the track foremen are able to keep constantly in touch with headquarters concerning the movement of trains and other matters affecting their work. About 1,000 motor cars equipped with this apparatus are now in service on the Pennsylvania Railroad.

On every operating division of the Pennsylvania Railroad System, a wire chief is assigned to keep a constant check on the functioning of all divisional circuits. In every block tower on each division, the dispatcher's circuit, the block circuit, the message circuit and the other operating circuits are run through a test board terminating in a miniature switchboard directly before the block operator.

On orders from the wire chief, the block operator is enabled, through the medium of this test board, to use all the above named



"GO" Private Branch Telephone Exchange, Pittsburgh, Pa. A total of 5,128,148 calls are handled yearly through its 16 operating positions. This exchange handles the telephone business of the Central Region General Offices, and is the largest and most important telephone exchange in the Pittsburgh District.

circuits interchangeably and in cases of emergency to merge or connect them to suit the need of the moment. If a certain circuit is in trouble, say between block stations "A" and "B," the operator may detour this circuit over any other circuit which is functioning properly between the same points. This is called "patching." The wire chief's first concern is, of course, the dispatcher's circuit. With all these resources at his command, it will be readily appreciated that it is next to impossible for the wire chief to fail to provide the dispatcher with a means of communication with his block operators.

Another protective feature is the placing of railroad pole lines on both sides of the track so that if one line fails, the other may be resorted to through the medium of these emergency connections. The railroad has faith in the old adage, "Do not put all your eggs in one basket."

A total of 3,358 miles of wire and 324 miles of telephone pole lines are required to handle the telephone and telegraph business on the Maryland Division. Over 900 telephone instruments are in service on this division. The telephone train dispatching circuits in operation over the entire Railroad include 17,112 miles of wire and involve approximately 8,556 miles of main track, or about 82% of the System. The total number of telephones used

in dispatching and work incident thereto is 15,352.

There is still another general type of telephone system in use on the Pennsylvania Railroad System. This is the small intra-divisional, intra-yard or shop exchange, which is used exclusively for telephone communication within a limited area and to serve a special operating requirement. These exchanges are usually found in large freight yards and in the larger terminal divisions where the facilities are so extensive as to make necessary special, independent telephone service.

An excellent illustration of this type of exchange is to be found on the Philadelphia Terminal Division. There has been in service on this division since 1917 an automatic dial telephone system said to be the busiest of its kind in the world. This system includes an instrument in practically every important operating office on the division, supplementing in each case the standard uniform telephone facilities. The 160 stations on the Philadelphia Terminal Division special automatic exchange are able, through the use of this special apparatus, to handle the tremendous amount of additional operating detail which falls to the lot of a divisional organization operating a great passenger and freight terminal.

Through this system special wires are avail-



"GO" telegraph office at Pittsburgh. A total of 2,161,272 messages are handled yearly through this plant, which is the telegraphic center and general relay station of the Central Region. A force of 51 employees is required to operate "GO" office.

able at all times for rush business which might be delayed if it were necessary to await the use of wires already burdened with other important traffic.

The utility of this exchange is clearly illustrated by the following typical situation: Passengers from New York have just gotten off a train at West Philadelphia Station. They desire to continue through to the West on a convenient train. The train dispatcher's representative, on being informed of the situation, telephones immediately over the automatic instrument to the Station Master at West Philadelphia Station, ordering him to hold Main Line Express, train No. 1, which has just arrived in the Station, until the passengers from the New York train have had an opportunity to board it. The order is carried out and an usher guides the passengers to the waiting western train. Fortunate circumstances, as well as the quick use of the dial telephone, have made possible a very desirable connection. Although this service is not advertised, the Company's operating employees always having the patron's interest foremost in mind will, when opportunity arises, make such transfers if no undue delay to trains will occur.

The dial telephone is, of course, completely automatic, no operators being required to handle its traffic. The efficiency of this telephone system has been demonstrated on more

than one occasion. During the Broad Street Station fire in June of 1923, 11,000 calls were handled by the automatic exchange during a 24-hour period, with 13 of its lines out of service. Recently during a very heavy snow-storm, the exchange handled a total of 12,980 calls in a 24-hour period. A record of 960 calls handled in one hour is held by this exchange.

There are 12 of these small independent exchanges in service on the entire System, of which 7 are automatically operated. A total of 791 telephones are connected with these exchanges.

It is interesting to note that over 10,260 miles of pole line, carrying 126,921 miles of wire, are used in the Pennsylvania Railroad's telephone and telegraph service. In addition to the above, 232 miles of under-ground conduits are operated, containing from 1 to 12 separate ducts, carrying telephone and telegraph cables. The cables held by these ducts, if merged into a single line, would reach a distance of 928 miles.

The Pennsylvania Railroad telegraph and telephone wires would furnish 8 complete circuits from Portland, Me., to Jacksonville, Fla., thence to Los Angeles, Cal., Seattle, Wash., and back to Portland, Me., with enough wire left over to form two complete circuits between New York and San Francisco.

"Hold No. 1 for Passengers off No. 221."

A typical illustration of the utility of the automatic telephone. The train dispatcher at West Philadelphia is using the instrument to order the Station Master at West Philadelphia Station to hold a western express for passengers just arriving on a train from New York. In situations of this kind demanding quick thought and action, the automatic telephone proves its ready usefulness. Although not advertised, when opportunity arises to accommodate patrons by such transfers the arrangement is usually made if no undue delay to trains will result.



A total of 410,520 poles are needed to support these wires, while 4,270,520 insulators are required to hold them. If the poles were laid end to end, they would measure over 2,700 miles, the equivalent of the distance from Philadelphia to Los Angeles, Cal. If these poles were still in their natural state as trees, they would make a forest covering approximately 2,052 acres. The insulators would fill a total of approximately 23,831 barrels, requiring a train of 300 box cars to handle them. In the entire telephone plant of the Pennsylvania Railroad, there are over 30,000 telephones in use, a number equivalent to all the commercial instruments installed in the combined cities of Trenton, N. J., and Harrisburg, Pa.

In the intricate operating mechanism of a modern railroad it is very hard to consider and deal either with the telephone or the telegraph plant as a separate and distinct entity. In the evolution of railroad telephone and telegraph communication the two have become

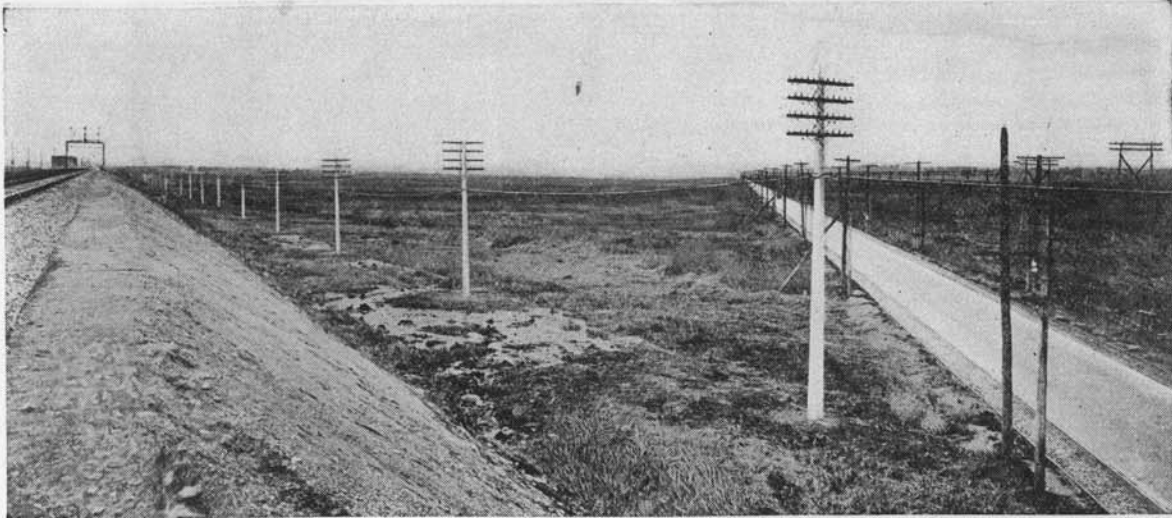
almost inseparably associated. In modern railroad operation, however, there has been a steady trend toward the telephone, and telephonic means of communication have superseded the telegraphic methods where close personal contact is desirable.

Most of the wires in Pennsylvania Railroad service are available for joint telegraph and telephone use. In the early days one wire was put up on which a telegraph circuit was operated. Later an additional wire was placed beside this original telegraph wire, and from these two wires by transposition and through the use of specially designed coils one telephone circuit and two telegraph circuits were secured.

It might be said that today railroad telegraph circuits are really by-products of telephone circuits. As an example of the utility of wires on the Pennsylvania Railroad it might be mentioned that on four of the Company's wires between Philadelphia and Pittsburgh, through the use of the special apparatus mentioned above, three telephone circuits and four telegraph circuits are obtained.

It is interesting to note here that practically 75 per cent of the wires on the Pennsylvania Railroad are available for simultaneous telegraph and telephone use.

In spite of the widespread use of the telephone there still remains, however, considerable work for the telegraph instruments to do. Voluminous reports of freight and passenger operations must be prepared and transmitted from Divisional and General Divisional Headquarters to Regional Headquarters and then to System Headquarters at Philadelphia. The telegraph is peculiarly adapted to this



Concrete pole line along the New York Division between Manhattan Transfer and the Bergen Hill portal of the Hudson River tubes. Due to the marshy condition of these "meadows" it became practically impossible to properly maintain a line of wooden poles. The installation of concrete poles completely solved the problem. Although the initial cost was more, the permanency of the concrete rendered it a very economical investment.

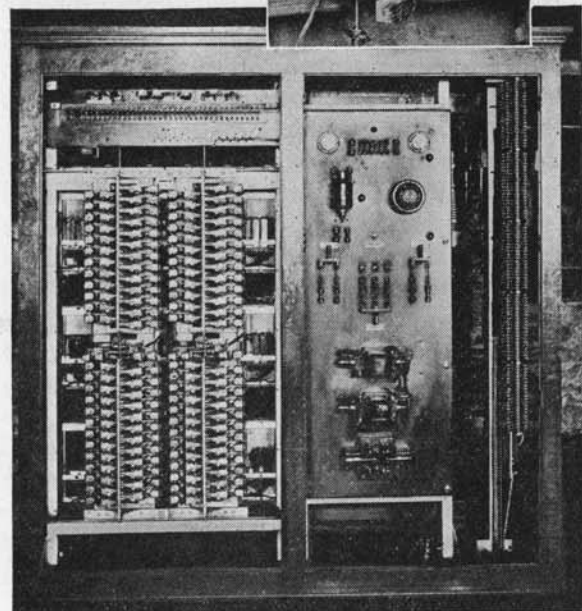
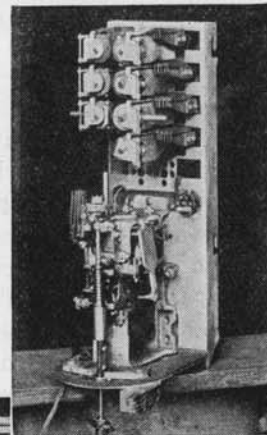
kind of work and serves to relieve the telephone lines of the heavy bulk traffic. In addition thousands of miscellaneous messages are handled daily over the telegraph wires between System, Regional, General Divisional and Divisional Headquarters.

On most divisions where the telephone is used exclusively in train dispatching, telegraph instruments are still available in an emergency for the dispatcher's use in moving trains. There is a total of 2,420 block stations and relay offices on the Pennsylvania Railroad where telegraph, telephone or both services are available for handling train movements or communications incident thereto. Of these, 88 are terminal and relay offices and 2,332 are block, inter-locking and other message offices. The first classification includes the offices at System, Regional, General Divisional and Divisional Headquarters together with some of the larger yard and terminal operations. The second group includes the block and inter-locking towers and the smaller yard and terminal operations.

The largest telegraph office on the System is "PO," located at the General Offices in Philadelphia. This office handles the telegraph business between the Executive and General offices in Philadelphia and Regional Headquarters at Pittsburgh, St. Louis and Chicago. In addition it has direct connections to all Divisional Headquarters in the Eastern Region and performs the function of a general

One of the small automatic operators used in the Philadelphia Terminal Division's automatic telephone exchange.

A full view of the switchboard of the Philadelphia Terminal Division's Automatic Telephone Exchange. This is the busiest exchange of its kind in the world. It holds a record of 960 calls handled in one hour.





Battery of duplex telegraph printing machines in operation at "PO" Telegraph Office. Complete messages in plain English are transmitted over the sending apparatus of these instruments and are run off at points of reception almost instantaneously and in complete readable form. No knowledge of telegraphy is required to operate these machines.

relay office in the East. In the capacity of relay office, "PO" acts as a central point for the relaying of messages between small outlying points which are not directly connected by wire.

A total of 48 through telegraph circuits are in constant use between "PO" and its connecting offices. Most of these wires are used for simultaneous telephone and telegraph service through "PO" and the General Office private branch telephone exchange.

An interesting feature of the "PO" operation is a battery of four duplex telegraphic printing machines which operate 15 hours daily on direct circuits, two between Philadelphia and Pittsburgh and one between Philadelphia and Harrisburg. The fourth set is for emergency use. No knowledge of telegraphy is required to operate these instruments. The sending apparatus is in the form of a keyboard very similar to that of a typewriter and anyone who can operate the latter machine can operate the telegraph printer. As the keys of the sending apparatus make electrical impressions in Philadelphia similar impressions are made almost instantly on the receiving apparatus which types them mechanically at Harrisburg and Pittsburgh. Approximately 1800 messages and reports are handled daily

on these printers. Similar telegraph printers are in operation at Cleveland, Columbus, Indianapolis and Chicago. These instruments provide a direct means of communication between Pittsburgh and Chicago; Pittsburgh and Cleveland, Pittsburgh and Columbus, and Pittsburgh and Indianapolis.

The work of testing and tuning the network of wires in "PO" office is no small task. For this purpose an enormous telegraphic switchboard with a capacity of 200 wires has been placed in the office and an assistant chief operator checks the circuits constantly from a telegraphic standpoint. A telephone test board is also provided in "PO" to test the wires telephonically, for in the dual use of circuits, wires and associated equipment must be functioning properly from both standpoints if efficient service is to be had.

Approximately 8000 messages and reports are transmitted and received daily over the "PO" telegraph office circuits. These include messages handled over two telephone circuits to local Philadelphia commercial telegraph offices and one telephone message circuit to division headquarters at Wilmington, Delaware.

The furnishing of exact time, a very important factor in railroad operation, is another

of the functions of "PO" Telegraph Office. Twice a day, at 12 o'clock noon and 12 o'clock midnight, "PO" transmits by wire over the entire Eastern Region the official time signals from the Government's Naval Observatory, Washington, D. C. Similar signals are transmitted over the other Regions from their respective telegraph offices.

The telegraph offices at regional headquarters in Pittsburgh, Chicago and St. Louis are exact counterparts of the "PO" office at Philadelphia, except that they are, of course, somewhat smaller. This is also true with respect to the still smaller general division and division telegraph offices.

During an average month, the 88 relay and terminal telegraph offices on the System handle a total of 2,533,322 Morse messages, 145,714 messages by telegraph printer, and 524,276 by telephone. The telegraph messages alone total about 32,000,000 a year. This business is carried over a total of 674 circuits which if taken as one wire would reach a distance of 37,417 miles.

As an added feature of service to the public the Company provides at practically every station on the System facilities for the receiving and transmission of commercial telegrams. At points where the commercial telegraph companies do not have their own representatives, the Railroad's employees act as agents for the telegraph companies in handling the general public's business.

On Pennsylvania Railroad limited trains the railroad stenographer is always ready to handle a patron's telegrams. These are turned over promptly to the commercial telegraph company for transmission. For the further convenience of the traveling public uniformed messengers of the commercial telegraph companies are permitted to pass quietly through trains at terminals to facilitate the sending of messages.

At several of the larger passenger terminals on the System there is still another means of wire communication available. This facility, known as the telautograph, is an electrically operated mechanism, transmitting messages through the medium of automatic writing. It is particularly valuable in affording an accurate and speedy means of communication between terminal towers, passenger stations and offices directly concerned with the movement of trains.

In transmitting a message telautographic-



The sending keyboard of the duplex telegraph printer is almost exactly like that of a typewriter and the operation of transmission is closely akin to typing on an ordinary writing machine.

ally, the sender takes up a metal tipped pencil and writes in the usual way on a metal sheet in front of him. The movements of the pencil are recorded by a system of electro-magnets, and the electrical impulses set up are carried over wire circuits to the receiving stations. Here a pen-like arrangement attached to two movable arms, and controlled by electro-magnets, automatically reproduces the writing on paper in exactly the same manner as the sender wrote it at the transmitting station.

An excellent example of telautograph service is found on the Philadelphia Terminal Division. Here five transmitting and 15 receiving instruments are installed covering the train operating offices in Broad Street Station, at West Philadelphia, the terminal towers and the train announcer's platform in the concourse at Broad Street Station. At this terminal the telautograph's most important use is the recording of train movements for the information of the general operating and terminal division offices. In addition the train announcer at Broad Street Station receives from the outlying tower operators advance information by telautograph as to the time

each train will arrive and the station track it will use. This information is passed along to the public immediately.

A total of 13 transmitting and 84 receiving telautograph stations are in service on the System. They are located at Philadelphia, New York, Harrisburg, Wilmington, Baltimore, Altoona and Pittsburgh.

Although at the present time all communications having to do with train dispatching and general railroad operation are handled either by telephone or telegraph, the company's Management is fully alive to the forward strides in radio, and is watching its de-

The train director at "A" tower, just outside of Broad Street Station, Philadelphia, sending a message by telautograph to the train announcer in the Station Concourse informing him of the track on which an incoming train will arrive.



Train announcer in the Concourse at Broad Street Station receiving the telautograph message from "A" tower. He will immediately make a megaphone announcement to the waiting people of the incoming train and the track on which it will arrive.

velopment carefully, with a view to its possible future utilization in railroad work.

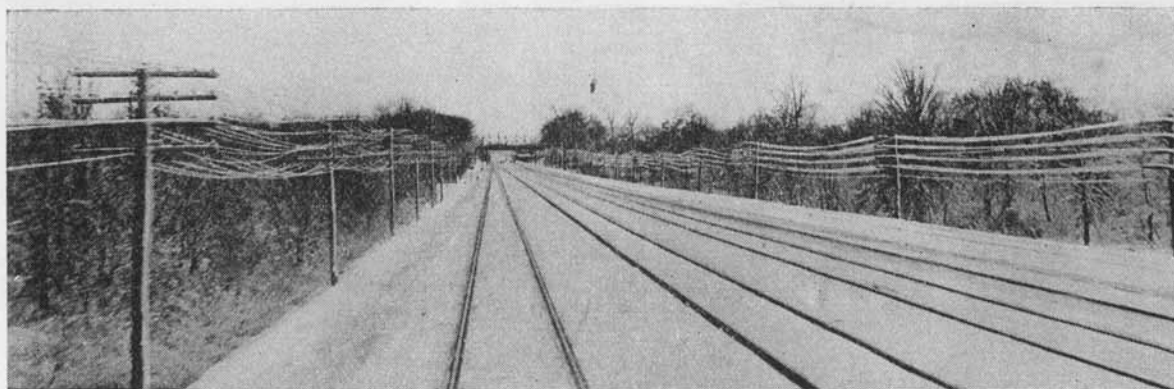
Practical tests and experiments with the radio are being made from time to time, in order that the railroad may keep abreast of the situation and fully informed as to the latest advances and improvements in this field. When, in the evolution of radio, a point is reached where it can be adapted practically and satisfactorily to the needs and conditions of railroad operation, the Pennsylvania Management will be adequately prepared to take advantage of all that it has to offer.

It will be readily seen that a telegraph and telephone plant the size of that in service on the Pennsylvania Railroad requires in its op-

eration and maintenance the services of a large group of carefully trained and efficient workers, including highly skilled directing executives and technicians.

In general charge of these activities on the Pennsylvania Railroad is a System Officer known as the General Superintendent of Telegraph. It is he who establishes general policies, negotiates contracts with commercial telegraph and telephone companies, and prepares specifications for new construction and maintenance. In addition, he also prepares standards for the guidance of those buying telegraph and telephone material for the Pennsylvania Railroad.

On each region there is a Superintendent of



The icy hand of winter tests the efficiency of the Railroad's telegraph and telephone organization. It is during a period of storm and very low temperature, such as pictured above, that the mettle of the wire forces is tried. All efforts are then redoubled to provide satisfactory and uninterrupted service.

Telegraph and Signals, who has general supervision of regional operation, construction and maintenance, in addition to being in direct charge of all regional telegraph and telephone offices. The Regional Superintendents of Telegraph and Signals are also responsible for carrying out System policies and standards formulated by the General Superintendent of Telegraph.

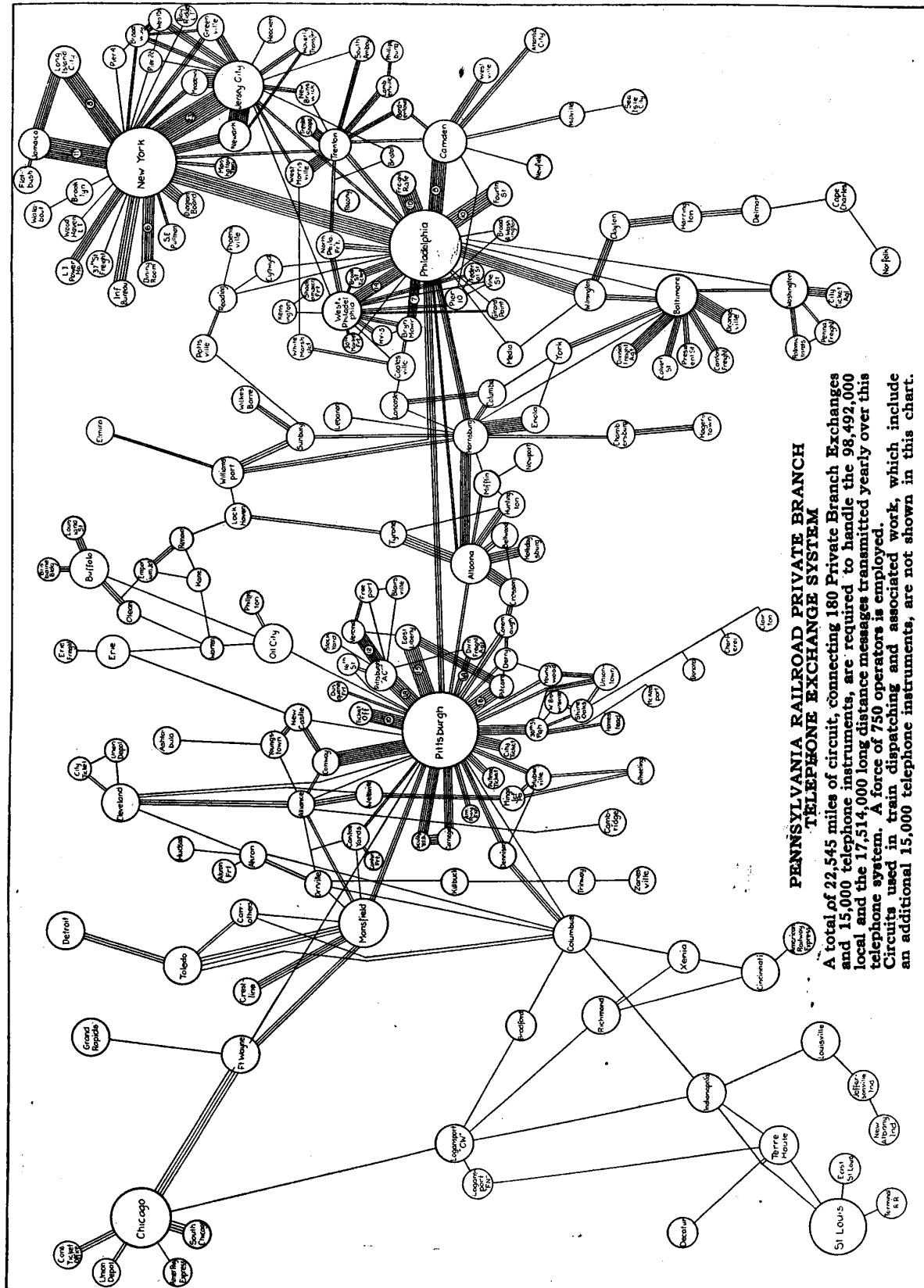
On each Division, the forces operating the telegraph and telephone systems report to a Division Operator on the staff of the Superintendent. The employees engaged in telephone and telegraph construction and maintenance work report to the Supervisor of Telegraph and Signals on the staff of the Division Engineer. For maintenance and minor repairs, each Division is divided into several sections with a maintainer in charge of each section. In addition, each Division also has one or more special gangs devoting their entire time to new construction and extensive repair work.

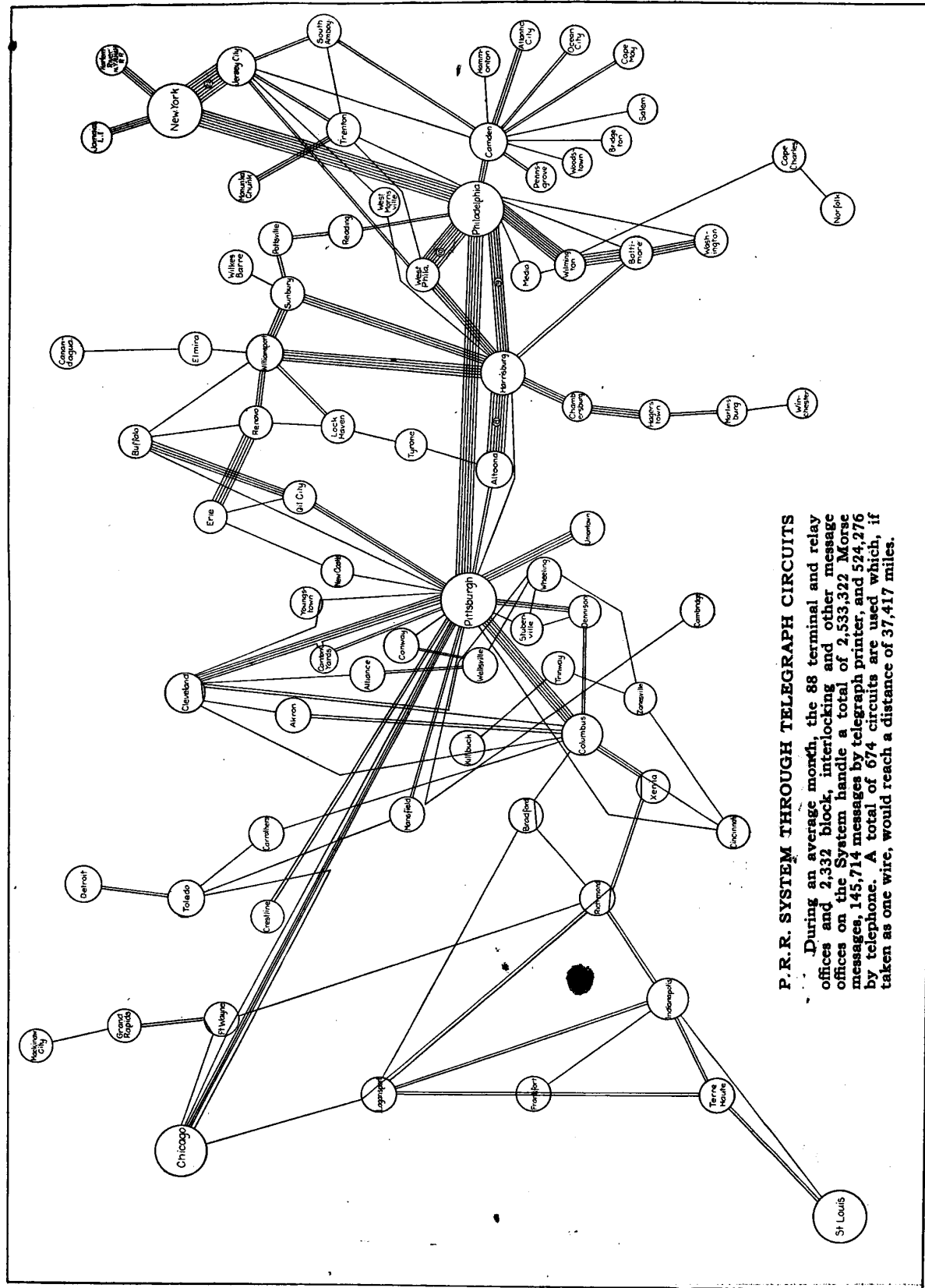
The watchword of the telegraph and telephone organization, from the General Superintendent of Telegraph to the maintainer on the line, is "Uninterrupted Service." In the

endeavor to uphold this standard of achievement, the telegraph and telephone men are constantly checking the thousands of wires, circuits and associated apparatus which make up the Pennsylvania Railroad's plant, seeking to discover the slightest defect or flaw which would cause an interruption in service. In times of greatest stress, such as during a very heavy storm or a period of very low temperatures, these efforts are redoubled, and the utmost precautions are taken to see that the wires are always available for instant use.

On the Pennsylvania, to the best that is obtainable in telephone and telegraph equipment and in mechanical safeguards, is added the loyal devotion to duty of the working forces and their bull-dog tenacity in the face of difficulty—an unbeatable combination. The fruit of this union of constructive effort and unrelenting vigilance on the part of the telegraph and telephone forces with one of the finest physical telephone and telegraph plants in the world, is a service as nearly perfect as human ingenuity can make it—a service which is indeed no small factor in producing the ultimate and supreme service—the Pennsylvania Railroad System.

Three interesting charts showing the intricacies and scope of the telegraph and telephone systems of the Pennsylvania Railroad are reproduced on the following pages. These diagrams will help to give a vivid mental picture of the wire plant of a great railroad, and how it works.





P. R. R. SYSTEM THROUGH TELEGRAPH CIRCUITS

During an average month, the 88 terminal and relay offices and 2,332 block, interlocking and other message offices on the System handle a total of 2,533,322 Morse messages, 145,714 messages by telegraph printer, and 524,276 by telephone. A total of 674 circuits are used which, if taken as one wire, would reach a distance of 37,417 miles.

