BULL'S SELECTIVE SYSTEM OF WIRELESS TELEGRAPHY.

BY A. FREDERICK COLLINS.

Since the recent successful tests in cableless telegraphy have proven beyond the peradventure of a doubt the feasibility of long-distance transmission, greater effort than at any time heretofore has been made to solve the difficult problem of syntonization.

In nearly every system except the one under consideration, syntonic or selective wireless telegraphy has been based on the principles of electrical resonance, in which the resonator is made to respond sympathetically to the emitted waves of the oscillator in virtue of the similarity of their electrical dimensions.

It is easy to show theoretically the action of a syntonic system based upon the parity of the coefficients of the oscillator and of the resonator as exemplified by a given receiver responding to a given transmitter, and it may likewise be shown by actual experiment that the deductions upon which the theory of resonance was evolved are correct.

But in applying these principles practically it has been found that there are other factors which must be reckoned with, and as these are not constant a serious obstacle is at once brought prominently into evidence. As an illustration of the foregoing statement, in a practical system of wireless telegraphy one side of the oscillator and one side of the resonator are connected with the earth; now the earth acts as a capacity, and as such it varies constantly and so changes the whole system connected with it.

To avoid these difficulties Mr. Andres Bull has designed a system which operates mechanically and in which the dimensions of the sending and receiving circuits are not factors controlling the matter of selection, but instead a fixed number rate of wave impulses actuate different receiving instruments in accordance with prearranged time intervals.

The instruments employed in the Bull system of selective wireless telegraphy are shown in the photographs, Figs. 1 and 2. The "disperser" and "collector," as Bull terms the transmitter and receiver, are combined in the apparatus illustrated in Fig. 1, *A*. This mechanism is connected by means of gearing to an electric motor, *B*, the speed of which is controlled by a Siemens & Halske brake regulator, *C*. The device represented by *D* consists of an electro-magnet connected with and automatically controlling the disk referred to. Fig. 2 shows a number of Morse registers connected with the collector or receiving apparatus.

In transmitting a wireless message an ordinary Morse key is employed. When the key is closed the current from the battery, 1, Fig. 3, flows through and energizes the electro-magnet 2. This attracts an armature, to which is attached a clutch, the side elevation being shown in Fig. 4. Attraction of the armature serves to draw the clutch out of engagement with a pin, 4, on the disk, 3, and this permits the disk to rotate by frictional contact with the shaft, 5, at a speed of about five revolutions per second. In the course of each turn of the disk the pin, 3, closes the circuit, of which the battery, 7, and the electro-magnet, 8, form a portion, through the medium of the contact springs, 6.

If it is desired to send a dot the key is made to close the circuit for a period of less than one-fifth of a second, so that the clutch will engage the pin and bring the disk to a stop as soon as it has made one complete revolution. Thus the current flows through the circuit, which includes the magnet, 8, in the form

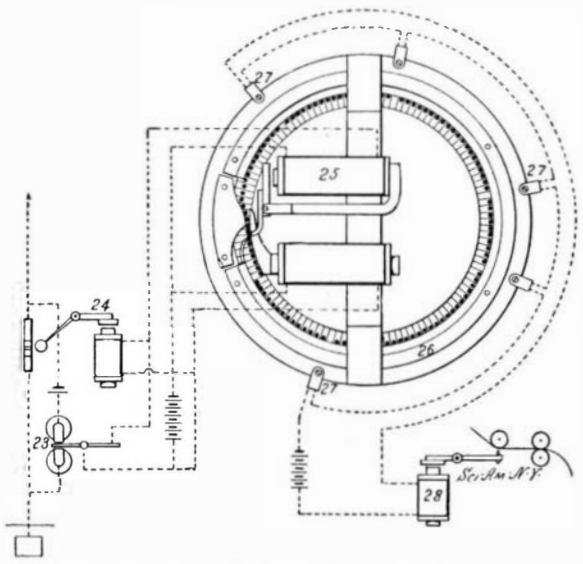

Fig. 5.—The Receiver, Showing Connections Between Coherer Relay, Morse Register and Collector.

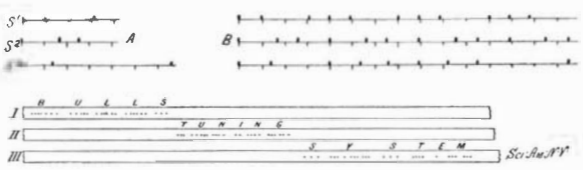

Fig. 6.—Diagram Showing Impulses of Series and Specimens of Tape.

of a single impulse. When it is desired to send a dash the key is held into contact for a sufficient period to permit the disk to revolve several times, when successive current impulses flow through the circuit at intervals of one-fifth of a second. This actuates the transmitter or disperser, consisting of a disk to which are attached four hundred steel springs, 9, positioned vertically near the periphery. The free ends of these springs pass through radial slots (as shown in Fig. 3) in an upper and oppositely disposed disk, 10. These slots permit movement of the springs relative to the disk in a radial line only. The disks are mounted on the same shaft or spindle, which in turn is mounted vertically in the frame of the disperser. The shaft is rotated at the rate of one revolution per second. A brass ring, 11, is secured to the frame and serves as a guide for the spring points, 9, so that when the disk revolves they slide either within a U-shaped groove, 12, formed by the ring or within the ring itself.

Referring again to Fig. 3, a bronze arc, 13, whose ends conform to the angle described by the dotted lines, *a*, is inserted in place of the brass ring at that section. The bronze piece, 13, has a projection extending toward the concentrically arranged springs, and causes these springs in traversing this section to bend toward the polar projection of the magnet, 14, which then attracts them, being constantly energized by a current from the battery, 7. Thus attracted, the springs slide along the projection until the edge, 15, is reached, when they are released and instantly spring back into their normal position. As the disks continue to revolve, the steel springs simply slide within the ring, 11. This is the normal process which takes place when the magnet, 8, is not energized; but if the electro-magnet, 8, is excited the armature to which the finger, 16, is attached will be swung forward so that it projects slightly in front of the polar projection of the magnet, 14. When this occurs the springs in clearing the finger, 16, are forced from the pole of the magnet, 14, when they will again assume their vertical position in virtue of their elasticity and will pass into the U-shaped groove at 17, remaining there until the disk has completed its cycle.

The purpose of this device is to establish contact at certain prescribed intervals with the induction coil, 20, and the oscillator which emits the electric waves. This is done by means of a number of contact points, 18, fitted to the circumference of the frame supporting the disperser; these consist of two contact springs insulated from each other; when the steel springs, 9, move within the ring, 11, they just clear the contact springs, but when passing in the U-shaped groove, 12,

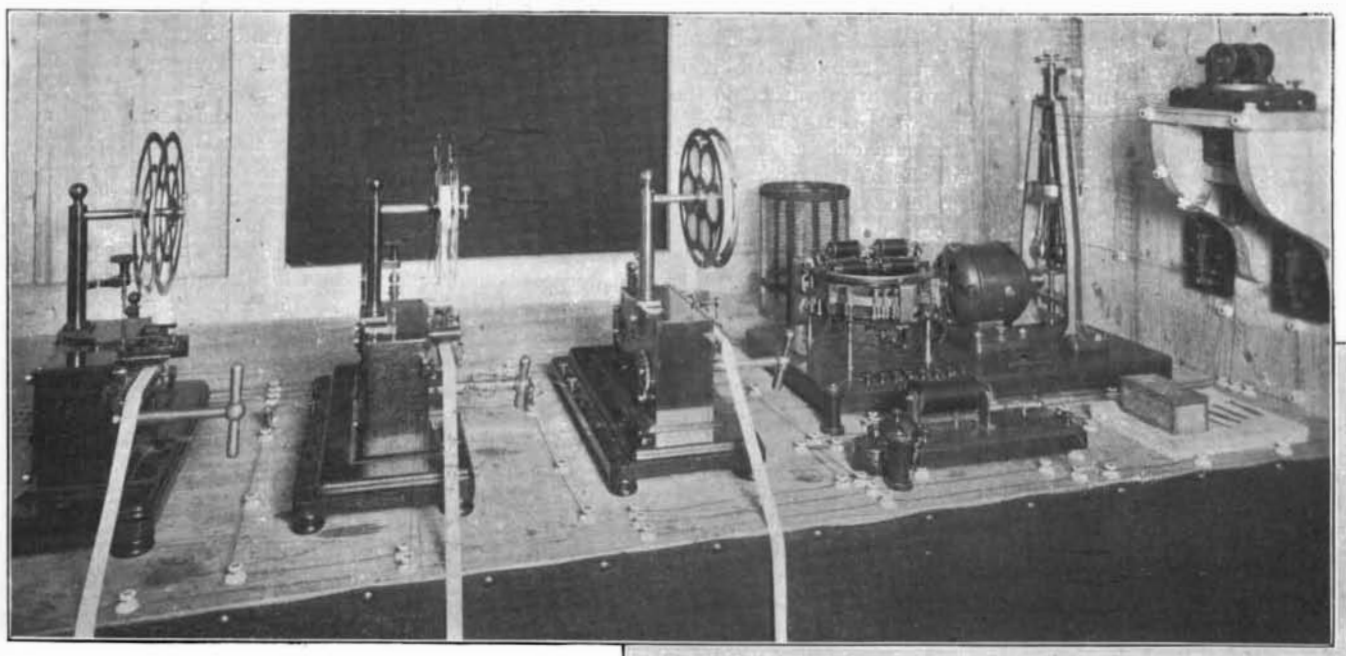

Fig. 2.—The Receiving Station.

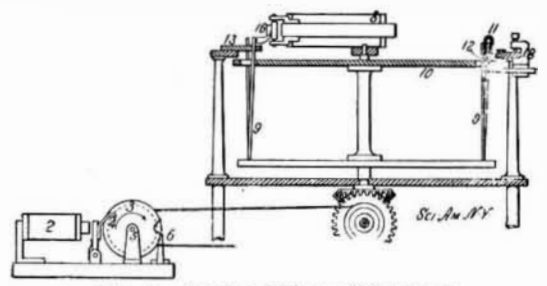

Fig. 4.—Sectional View of Disperser.

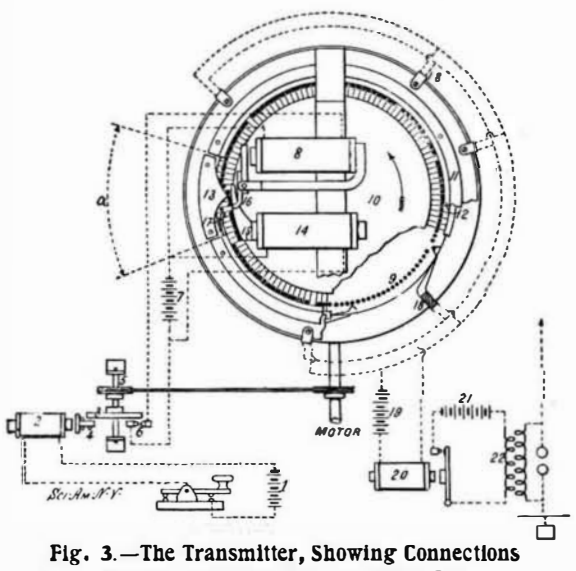

Fig. 3.—The Transmitter, Showing Connections Between Disperser and Induction Coil.

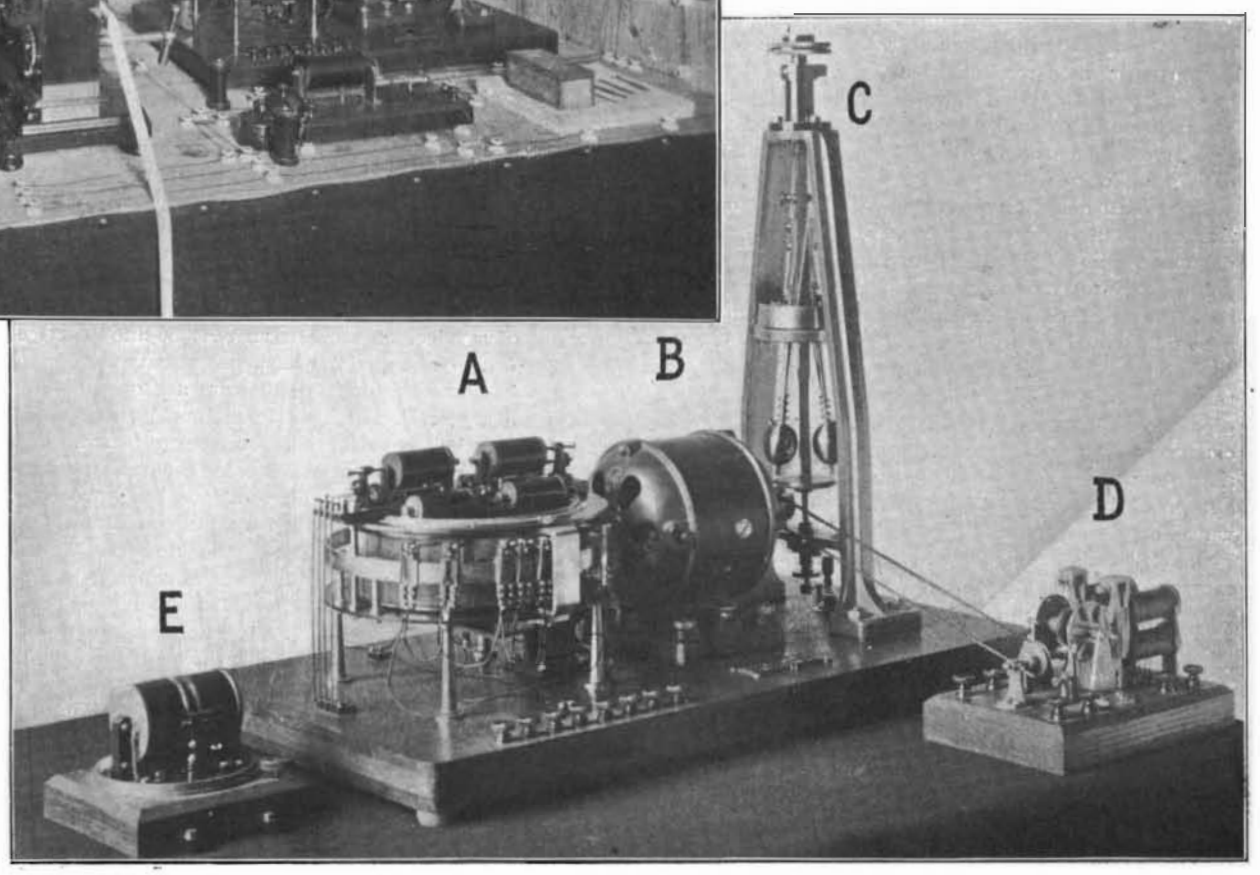

Fig. 1.—Main Apparatus of the Bull System of Selective Wireless Telegraphy.

THE BULL SELECTIVE SYSTEM OF WIRELESS TELEGRAPHY.

they project sufficiently to make contact and therefore close the circuit operating the induction coil.

If the magnet, 8, is not excited and the disk is revolved the steel springs will slide within the ring and all the contact points will be open; if on the other hand the key is closed and a current impulse is sent through the magnet, the steel springs sliding through the groove make connection with each of the contact points in passing them. The electrical connections between the steel springs and the contact points and the induction coil and oscillator system is clearly shown by the dotted lines and it is evident that upon contact being established between a steel spring and the points the circuit will be closed and the current from the battery, 19, will operate the magnetic circuit closer, 20, thus causing the current from the battery, 21, to flow through the primary of the induction coil, 22, when a disruptive discharge takes place through the spark gap and electric waves are emitted. Now for every current impulse that flows through the disperser magnet, 8, by means of the key, 1, a series of electric waves are radiated, which equal the number of contact points, 18, and since the disks revolve at approximately constant speed the time intervals between a series of impulses will be proportional to the angular distances between the contact points, and thus by varying the distance between these points and by arranging these at different positions around the frame of the disperser the series of impulses or waves may be varied at will and within wide limits. When the electric waves thus emitted impinge upon the receiving antenna (Fig 5) the normally high resistance of the coherer is instantly lowered and the local current flowing through the coherer and relay magnets, 23, actuates its armature, closing an auxiliary circuit in which is included the decoherer, 24, for tapping the filings back to their normal resistivity, and the collector magnet, 25, which is in shunt with the tapper. The collector, as the receiving mechanism is termed, is constructed on the same principles as the disperser, Fig. 3, in fact they may be substituted one for the other by means of proper cut-outs. It will therefore be clear that for each series of impinging waves a steel spring is brought into the groove of the ring, 26. The disk of the collector, to which the steel springs are attached, revolves at a speed isochronous, practically, with that of the disk of the disperser; hence the angular distances between the springs brought into the groove will be proportional to the time constant between the series of electric waves received by the antenna; e. g., if five electric wave series are transmitted, five springs will be brought into the groove of the collector at angular intervals representing the intervals of time between the series of waves. The points, 27, making contact in the collector are arranged in the same relative positions as they are in the disperser, the springs moving in the groove forming the controlling contacts; these are connected in series with the Morse register, 28, and consequently contact is made by all the points simultaneously. Now when the mutual angular value is the same for the points and the springs a prearranged series of electric waves will bring the latter into the groove, and as the disk revolves the series of steel springs, corresponding to the series of waves, will make contact simultaneously at all points; the battery current operating the Morse register then flows through the circuit and prints a dot on the tape. A succession of wave series will produce a dash, or a row of dots reading as a dash. Wave series of any other combination than those to which the collector is adjusted will not operate the Morse register, for simultaneous contact is not possible and the circuit is left open.

In the experiments conducted by Mr. Bull only one transmitter and one receiver were employed, but the disperser was provided with three sets of contact points, 27, and was so arranged that any set desired could be operated by the induction coil, by means of a switch, and thus any one of three series of waves could be emitted and received at will. Uniformly with the diperser the collector was equipped with three sets of similarly arranged contact points, each set being connected with a Morse register, enabling the operators to use any one of three combinations to the exclusion of all others. Three series or combinations of waves only were required, as shown diagrammatically by S^1, S^2, and S^3, Fig. 6 *A*. The element of time is represented by the horizontal line and the wave series or combinations by the vertical heavy strokes; the equi-distant spaces marked by the vertical lines designate 0.05 of a second. At *B*, Fig. 6, is illustrated how the wave series are registered rhythmically when the key is kept closed. By this arrangement selective wireless messages were sent and received with accuracy and dispatch and were printed in Morse characters on the tape of that register only for which it was intended, the other two machines remaining inoperative. Specimens of the tape from the three registers are shown at I., II., III., Fig. 6, each of the three series, S^1, S^2, and S^3, being employed successively. The speed attained approximated fifty letters per minute.

This is the first time in the history of wireless telegraphy that three messages have been transmitted and received simultaneously and selectively and it is also the first time in the history of the art that mechanical methods have been successfully employed in obtaining selectivity. The sending and receiving instruments may be set up at different points and at varying distances, which is a decided advantage over those systems based on pure electrical resonance.

THE PNEUMATIC TUBE SYSTEM OF A MODERN DEPARTMENT STORE.

BY DAY ALLEN WILLEY.

The use of pneumatic tubes in transmitting money, papers, and parcels of various kinds has become so extensive that the service is considered a necessity in the equipment of the modern mercantile establishment. The plan is not a new one. Improvements, however, which have been made in the system in the last two or three years have greatly increased its practical value. In the dry goods or department store, for example, it is valuable as a labor saver, dispensing, as it does, with the many cash boys, in some instances cash girls, that have been employed, and performing their work much more quickly, besides avoiding many mistakes which formerly occurred. There is no delay in "making change," as the amount due the customer is usually handed him by the salesman within a minute, sometimes less than a minute, after his money has been taken over the counter. The system also assists in checking or auditing the sales, for the charge or cash slip which represents the amount of the transaction is sent to the cashier or bookkeeper, where it is examined and verified before being returned.

In the ordinary store the pneumatic tubes extend from the cashier's and bookkeeper's departments to the principal sales departments, varying, of course, in number according to the extent of the establishment. Each tube is termed a "line" and is usually 2¼ inches in diameter. The tubes are generally extended along the ceiling or under the floors for the purpose of economizing space, and the terminals where the carriers are received and sent are of various shapes adjusted to suit the conditions. The system is so laid out that when a sale is made the clerk prepares his purchase check, gets the money from the purchaser, and places it in a small brass cylinder which can be unscrewed at the end merely by a twist of the fingers. To start the carrier, it is necessary only to insert it in the receiving end. The air forces it through the line to what is called the main station. This is usually in the cashier's office, for so many articles in the retail store are sold for cash that no entry is required. The carrier drops into the open receiver at the end of the tube, from which it is taken by the "change maker," who, as already stated, glances over the figures on the slip and verifies the total. If an error has been made, the slip and money are returned to the department from which they were sent. If correct, the slip is returned with the amount due the customer. If the sale is to be charged, the slip of course contains the name of the customer in addition to a description of the article and the amount due. As soon as it has been examined, the clerk in the cashier's office again places it in the carrier and inserts it in the tube or line connected with the bookkeeper's department. Here the memorandum is taken out, entered on the books, and either the original slip or a duplicate is returned to the salesman.

These operations are usually performed in less time than it takes to read the description; for the carrier travels at a rate varying from 1,000 to 2,500 feet per minute, according to the air current. The length of a line is seldom over 600 feet. The current is produced by the blower system, and the mechanical plant installed provides for a force representing from one-fourth to one-half horse power to each line, depending upon the number of bends or curves and the amount of service. A store having a "50-line" service therefore requires an engine of about twenty-five horse power. In some systems the blowers are operated by steam power direct, but electric motors, either direct connected or bolted to the blowers, are preferred.

The air current is maintained in the tube system in the following manner: The various lines are connected with what may be called a main conduit, which leads to the engine room and to the blowers. These blowers draw the air from the various sending terminals of the line, expelling it through a conduit of suitable size, which may open in the engine room or be connected with the street. While the velocity of the current varies according to the speed of the blower fans, the minimum is rarely less than 2,500 feet per minute, the pressure in the tubes ranging from 6 to 12 ounces per square inch, the latter pressure being secured with a service of one-half horse power. The principle is simply the exhaustion of the air in the tubes to produce a partial vacuum. The effect is so powerful that, although the carriers and their contents weigh a half pound, they are transported without difficulty. The suction is not apparent twelve inches from the end of the receiver. Consequently, the end of the receiver can be placed over a desk or table on which light material, such as paper or currency, is spread. Incidentally the system is of considerable value from a hygienic standpoint, as it assists in the ventilation by continually changing the air in the apartment where the terminals are installed.

The carriers are merely cylinders of sheet brass covered at each end with felt to protect the metal from abrasion in passing around the elbows of the tube. They range from four to six inches in length for the ordinary store service, but do not fit closely against the side of the tube. Enough space is provided to allow the carrier to be borne along by the air current with little or no friction except at the turns, thereby permitting of a much greater speed than if the carrier acted as a piston and was continually in contact with the tubing. The receiving terminals are of two kinds, although both work automatically. The ones used in the cashier's and bookkeeper's department are merely open tubes, which are usually suspended over a receiving table or desk. An air valve is placed in the receiver at a point three or four feet from its end. This is so adjusted that merely the pressure of the carrier against it opens the valve. The carrier then drops by gravity to the end of the receiver, and is taken out by the cashier's clerk or bookkeeper. As soon as the carrier passes, the valve is shut by a spring, and thus the current is confined. The air is then diverted into a parallel tube connected with the sending terminal, the operation of which has already been described. The return tube to the sales department also terminates in the valve, which is located directly at its mouth. When the carrier is sent back, its impact is sufficient to open this valve, and it drops upon the salesman's table, the valve closing automatically and confining the air current as in the other instances. The system in the cashier's and bookkeeper's department requires some one to take the carriers out, in order that they may be examined as they are received, thus preventing unnecessary delay in making change. As the extent of the service is limited only by the power of the blower plant, some of the pneumatic systems which have been installed in department stores recently constructed are very extensive. Perhaps the largest in the United States is located in Philadelphia. It consists of over 250 stations, each connected with a line varying from 400 to 500 feet in length. A plant of 150 horse power is utilized, and in all nearly 20 miles of tubes are used. The power is sufficient to force the carriers through every line as rapidly as they can be inserted in the tubes.

Carriers of three and four inches in diameter are employed for transmitting papers and small packages in factories and warehouses, where bulkier material is required to be transferred from one portion to the other. The arrangement of the tubes is the same, and the carriers are received and dispatched according to the same plan, the power plant being of course, correspondingly larger to meet the requirements.

Not only the blower, but the compressed air system is utilized in the long-distance tube service which is employed by the government in New York and other large cities in connection with the Post Office Department. Thus far the plants for transmitting mail have been principally used in conveying it between New York and Brooklyn by way of the present Brooklyn Bridge and between the main post office in New York and the Grand Central Station. Here carriers which are 10 inches in diameter and about 3 feet in length are employed. The most extensive installation of this kind, however, is in operation in Boston, extending from the retail shopping district on Harrison Avenue to Back Bay, South End, Roxbury, Dorchester, and other sub-stations. This system conveys carriers which are 10 inches in diameter. The tube is laid underground, and consists of ordinary cast-iron water pipe finished at the joints in order to make a close fit. It is laid like a water conduit, with lead and iron joints, the curves being of 12 feet radius to the center line. The bends were cast in sections, the standard of 90 degrees comprising three 30-degree sections bolted together. The carriers which, as might be imagined, were manufactured especially for the purpose, consist of sheet metal riveted together, but move through the tube on wheels, five of which are placed at each head. The carrier is opened at the side by a hinged door. On account of size and weight, the terminals are of special design. The receiving terminal consists of an air cushion closed at one end by a revolving valve, opened and closed by a cylinder and piston operated by the air from the tube. Ordinarily this valve is closed, but when a carrier enters the receiver, it compresses the air in front of it. This pressure affects a small auxiliary valve. When the carrier is brought nearly to rest, the auxiliary overbalances and moves the controlling valve of the main cylinder. This opens the revolving valve, and allows the carrier to roll out. Just at the end of the receiver two vanes are mounted, so that the pressure of the air behind the carrier tends to move them. This motion is made

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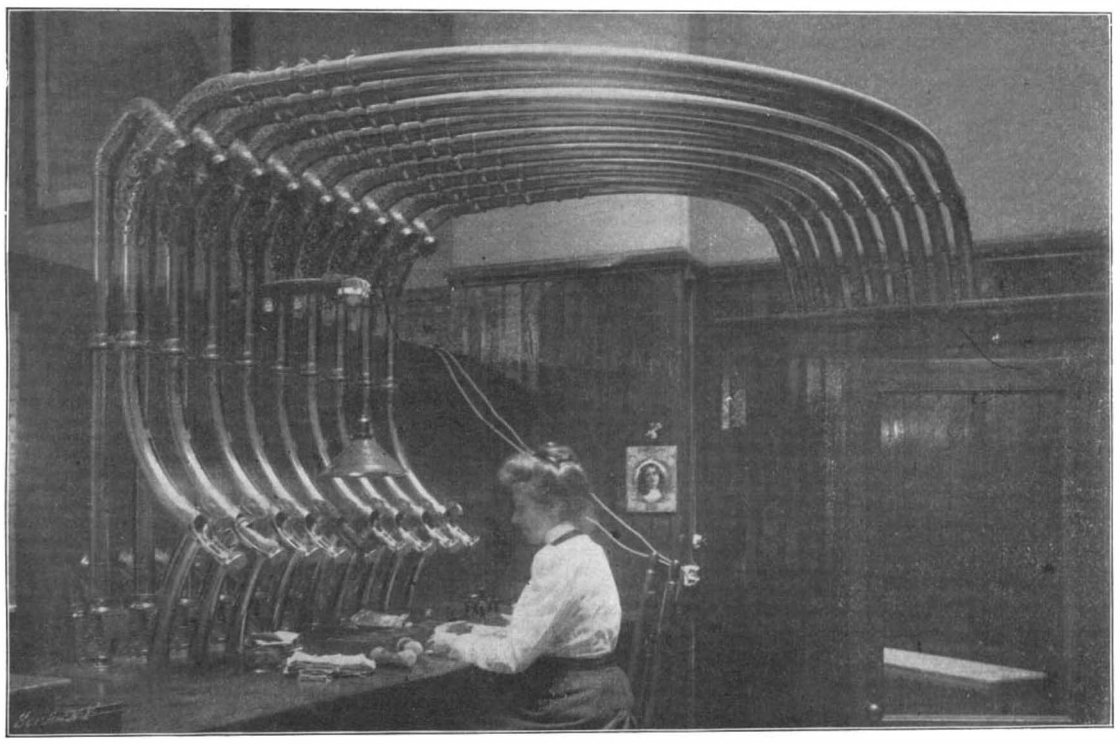
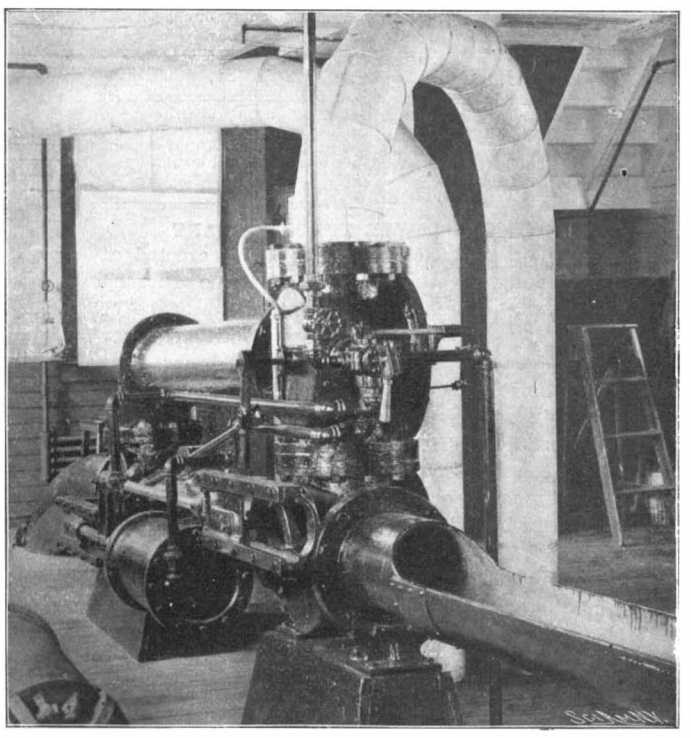
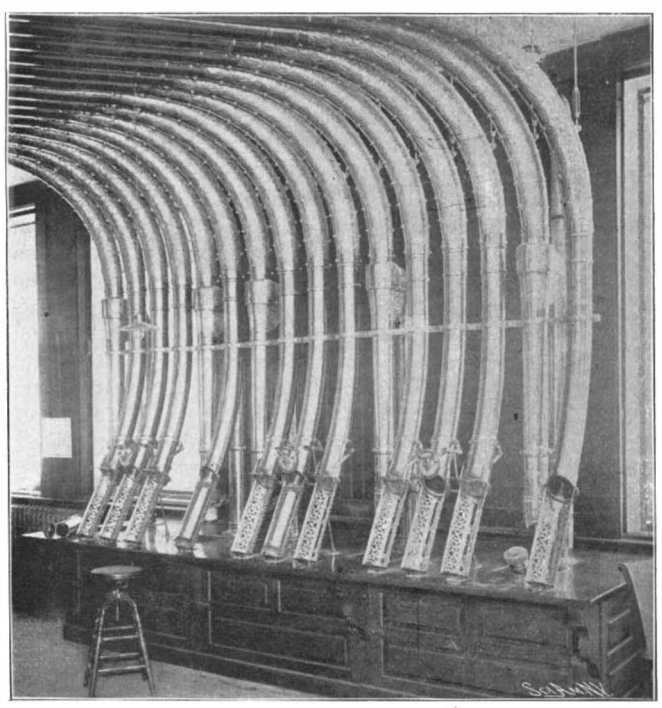


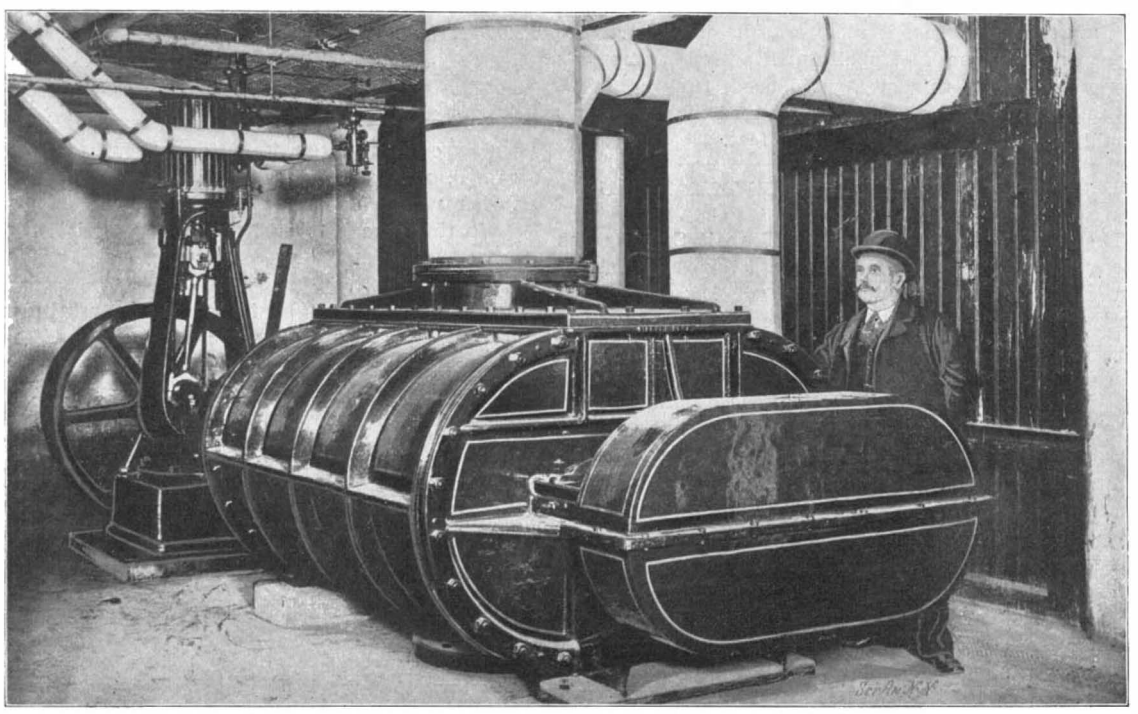
Pneumatic Tubes Controlled by One Operator



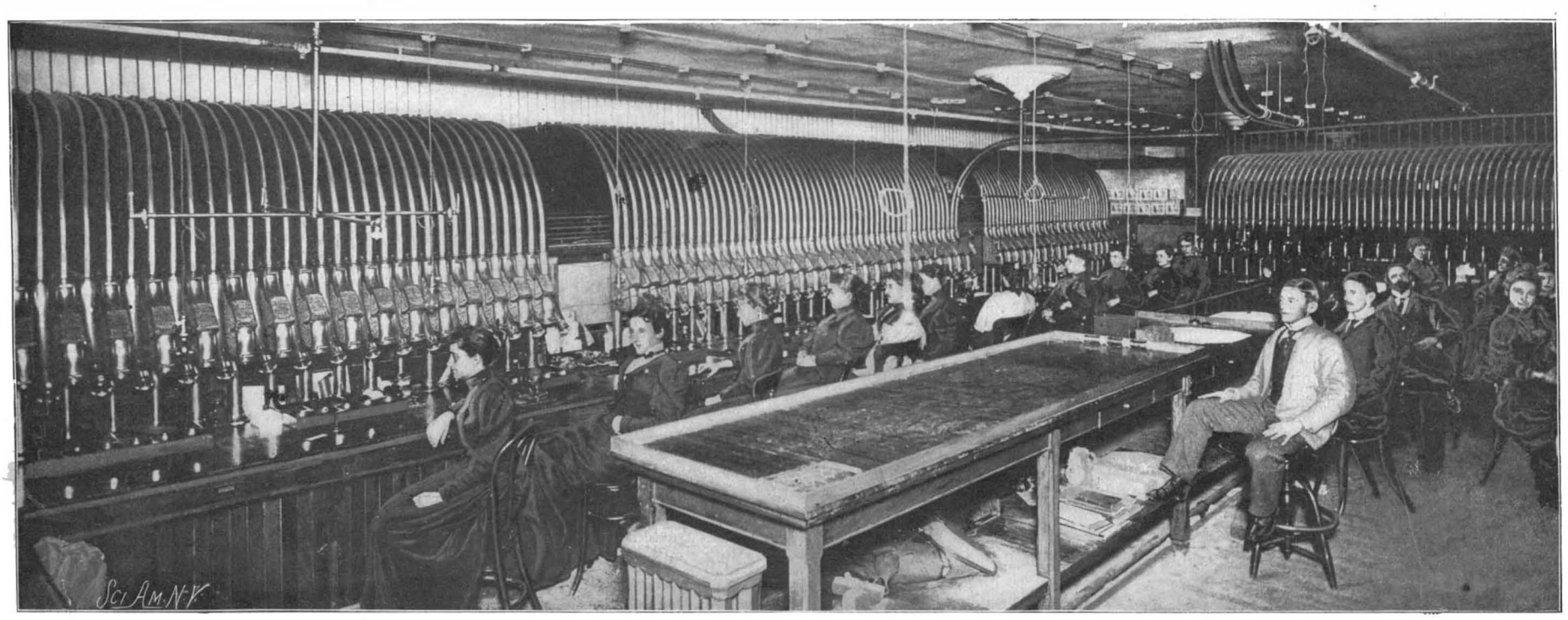
Engine and Section of Conduit of the Boston Pneumatic Package Service.



Sending Tubes Connecting With Sales Department. Terminals in Cashier's Office.



Power Plant Showing Engine, Blowers and Main Conduits.



Cashier's Office in a Large Department Store Showing Pneumatic Receivers

THE PNEUMATIC TUBE SYSTEM OF A MODERN DEPARTMENT STORE.—[See page 206].