CHAPTER II

AUTOMATIC ELECTRIC COMPANY'S APPARATUS

The systems of the Automatic Electric Company are divided into the two general classes—"three-wire" and "two-wire." The term "three-wire" is commonly applied to systems which require, in addition to the regular metallic circuit from a telephone to its central office, a connection from each telephone to ground. This term is used to distinguish these systems from what are called "two-wire systems" and which require no ground connection at a subscriber's station.

While there are in operation a large number of three-wire systems of the Automatic Electric Company's manufacture, which are either of the earlier local battery type (using a cell of battery at each telephone for supplying current for talking purposes) or else of the later common battery type and which are giving excellent and economical service, they are thought to be of especial interest only to those connected with the companies operating them and they will, therefore, not be described in this chapter. It may be said, however, that the practice, mechanisms and principles employed in these systems are not greatly different from those used in the two-wire common battery systems herein described.

The Telephone Instrument.—The discussion of the apparatus will open with a description of the telephone instrument, with special reference to the automatic calling or impulse sending device used.

FIG. 28.—Calling push-buttons.

Prior to the year 1896, an automatic telephone subscriber called any number which he might desire by pressing push-buttons on his telephone. There were generally three push-buttons arranged and labeled as shown in Fig. 28. If the subscriber wished to call No. 143, for example, he would first push the "hundreds" button once, then the "tens" button four times, and finally the "units" button three times. While this arrangement gave passable service, the subscribers made many mistakes in counting the pushes and sometimes did not press a button in far enough, or hold it long enough. Consequently, in 1896 a contact-making machine or a "calling device," as it is commonly named, was substituted for the push-buttons. A wall telephone equipped with a modern calling device is shown in Fig. 29, and a desk telephone in Fig. 30.

As shown in these figures the visible portion of the calling device consists

of a dial pivoted at its center, so that it may be turned in a clockwise direction. For convenience in turning the dial it has finger holes, ten in number,

FIG. 29.—Wall telephone instrument.

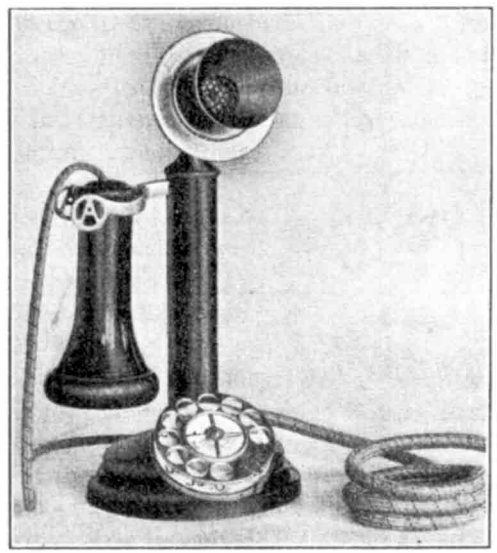

FIG. 30.—Desk telephone instrument.

around its outer edge. Through each finger hole a number is seen; these numbers are consecutive from "1" to "9" and through the tenth finger hole,

"0" appears. In the Automatic Electric Company's practice "0" always represents "10."

To call "143," for example, a subscriber will first remove his receiver from its switch hook, then put his finger into the hole through which "1" is seen and pull the dial around until his finger strikes the stop. He will then take out his finger, allowing the dial to return to normal, and place it in the hole through which "4" is seen, and again pull the dial round until his finger strikes the stop. Finally, he places his finger in the hole showing "3," and turns the dial until his finger again strikes the stop. He then places the receiver to his ear and awaits the answer of the party called. Each turn of the dial requires approximately one second. By the time he has placed the receiver to his ear, the automatic machines at the central office will have completed the connection to the desired line and will have commenced to ring intermittently the bell of the desired telephone. If the number called by a subscriber is busy, his receiver will give forth an intermittent buzzing sound, the same as that used for a busy signal in large manual systems. When through talking he hangs the receiver on the switch hook and the circuit changes thus made cause the central office apparatus to return to normal condition.

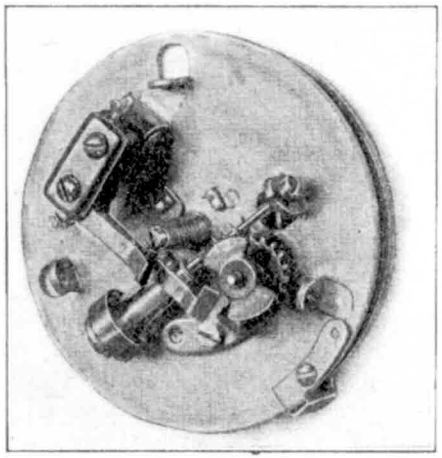

FIG. 31.—Automatic telephone calling device.

There is contained within the calling device, but not seen, a revolving cam, arranged to make and break the contact between a pair of springs. A small governor, which is geared to the cam shaft, controls the speed at which it revolves. The power is furnished by a piano wire spring which is rewound each time the subscriber turns the dial. The cam does its work after the subscriber's finger strikes the stop and as the dial returns to normal position.

A photograph of the calling device mechanism which is ordinarily hidden within the telephone instrument is shown in Fig. 31, and a drawing showing the functions of some of the parts more clearly is given in Fig. 32.

As the dial is turned, the ratchet spring snaps from tooth to tooth of the ratchet wheel and at the same time the spring coiled around the dial shaft (projecting from the rear of the calling device) is wound up. When the dial is released the ratchet spring at once engages a tooth of the ratchet wheel and under the influence of the shaft spring the dial returns to its normal position, carrying the ratchet wheel with it. The governor and impulse cam are

geared to the ratchet wheel and are therefore operated as the dial rotates back to its normal position. Each time the cam revolves, it breaks the contact between the impulse springs twice.

The principles involved in the operation of the dial are carefully worked out and are essential to rapid and accurate calling. Every turn of the dial

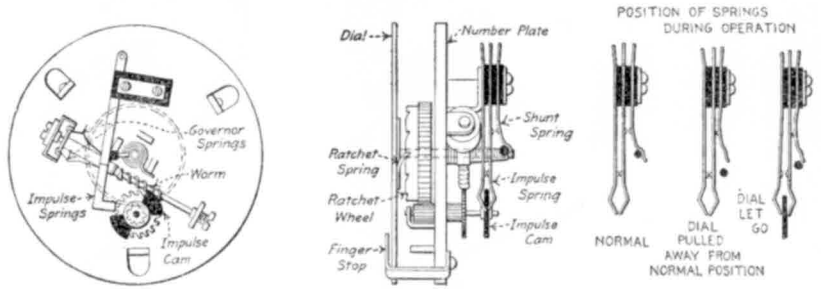

FIG. 32.—Details of calling device.

is positive and correct, regardless of the speed at which it is made. Anyone who has experienced the slow and painstaking care required to manipulate the dial of an ordinary office safe to bring each successive number opposite the stopping point without first passing it, will readily appreciate that any calling device which would require the subscriber to stop each number opposite a pointer or, vice versa, to stop a pointer opposite each number, would be very slow and inaccurate in comparison with a calling device like that shown in the illustrations.

The only feature of the telephone which is peculiar to automatic systems is the calling device. The signaling, receiving and transmitting circuits and apparatus may be the same as those used in any common battery manual telephone. It is essential, however, that the circuits just mentioned be connected through the calling device in such a way that they will be automatically disconnected or shunted out while the calling device is being operated.

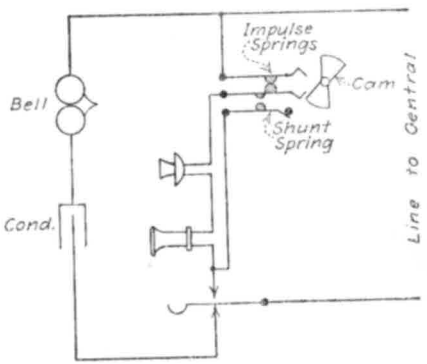

FIG. 33.—Automatic telephone circuit.

Telephone Circuit Diagram.—A diagram of a typical circuit is shown in Fig. 33. When the receiver is removed and the switch hook rises, the bell is switched out of circuit and the transmitter, receiver and impulse springs are connected across the line.

Each time the impulse cam breaks the contact between the impulse

springs, it opens the line for an instant, thus causing one "impulse" to be sent. During the time of sending impulses the receiver and transmitter are both shunted out of the circuit by the action of the shunt springs, between which contact is closed whenever the dial is turned away from its normal position. This contact is opened, when the dial returns to normal, by the bushing at the end of the arm carried by the dial shaft.

The object of shunting out the transmitter and receiver during impulse transmission is to keep the resistance of the subscriber's loop constant. Very

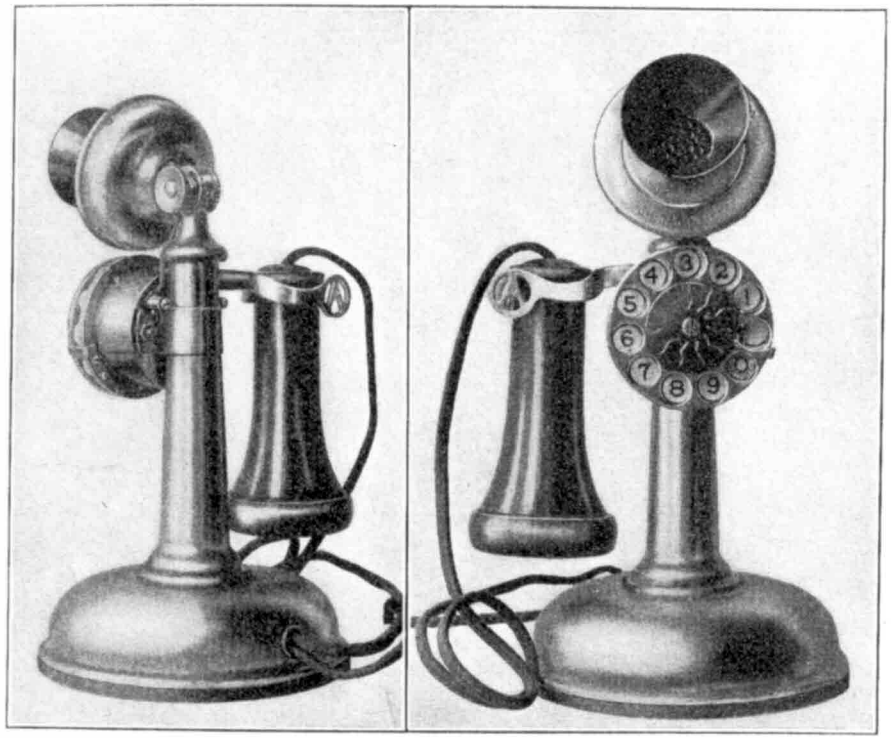

FIG. 34.—Manual telephone instrument converted into an automatic instrument.

often it would not remain constant, especially on a desk telephone, if the transmitter were in circuit, because it is not uncommon for a subscriber to pick up a telephone and hold it at various angles so that the carbon in the transmitter shifts about, causing wide variations of the transmitter resistance during the time the dial is being used. Although in most cases the operation would be satisfactory, even with the handicap of this varied resistance, it is safer and requires less careful adjustment of the mechanism to use the shunt springs. Fully to comprehend the diagram it should be understood that the receiver used with this circuit is what is called a direct-current or series re-

ceiver, i.e., it has no permanent magnet, but uses an electromagnet and is connected in series with the line and the transmitter during conversation.

The direct-current type of receiver is not essential to the operation of the two-wire system, but was perfected and put on the market by the Automatic Electric Company at about the time their two-wire system was. Since it is especially applicable to that system but is not applicable to three-wire systems, it has become identified with the two-wire systems. Several of the first two-wire plants installed, however, use induction coils and receivers with permanent magnets at the subscribers' stations.

In Fig. 34 is shown an ordinary common battery manual desk telephone which has been converted into an automatic instrument by mounting a calling device upon it in a suitable cup clamped to the handle tube of the instrument. This indicates one of the attractive features of this system, which is that almost any common battery telephone may be readily converted into one suitable for use on an automatic system by mounting a calling device on it and connecting the calling device in series with the transmitter of the instrument.

Switchboard Apparatus.—The automatic switchboards used in systems of the Automatic Electric Company employ the following principal pieces of apparatus:

1. Line switches (primary and secondary) with their master switches.
2. Selector switches (first, second and third).
3. Connector switches.
4. Repeaters.

Whether or not all of these pieces of apparatus are used in any system depends upon the size of the system and the number of offices in it.

Many of our readers are more familiar with manual switchboard apparatus than with the principles of automatic switchboards. Therefore, this explanation of automatic switchboard apparatus will begin with a description of the two pieces of equipment whose functions are most nearly analogous to the subscribers' line equipment and to the cord circuits manipulated by an operator in a common battery manual office.

The subscribers' line equipment of the manual is resembled by the line switch associated with each line of the automatic switchboard; and the cord circuit manipulated by the operator is resembled by the connector switch of the automatic switchboard. By means of these two pieces of apparatus, only, a system of not more than 100 lines capacity may be built up. After such a system has been discussed, the equipment used for enlarging it into a system of almost unlimited capacity, as explained in the chapter on "Trunking," will be described.

A switchboard for 100 lines consists of 100 line switches with their master switch and other associated apparatus and about ten connector switches for making interconnections between the lines.