between the subscribers and the exchange operators. Each sub­scriber was given the exclusive use of a circuit as in other systems, and shared a call-wire with a number of other sub­scribers. Each telephone set was equipped with a special key or switch by means of which the telephone could be transferred from an exclusive line to the call-wire at will. A subscriber desiring a connexion pressed the key and communicated his own number and that of the wanted subscriber to the operator in attendance on the call-wire. Then, when the connexion was made, the originating subscriber rang up the other. At the close of a conversation the originating subscriber again entered the call-wire and requested the operator to take down the connexion. The call-wires were usually equipped with drops in order that the exchange might be called at night when the operators were not listening continuously.

One of the greatest advances made in the development of the art of telephony was the introduction of the “ common battery relay system.” This advance did not merely remove the primary batteries from the subscribers’ stations; it removed also the magneto-generator, and at the same time it modified consider­ably the conditions governing the exchange operating. The calling­drop of the magneto system was displaced by a relay and a small electric incandescent lamp, and whereas in the older system the calling-drop and the answering jack with which it was associated were some distance apart, the calling-lamp and the answering jack of the newer system were placed in juxtaposition. This alteration improved the operating conditions in three ways. In the first place it increased the visibility of the signalling instrument; in the second place it brought that instrument into the position in which it could most readily catch the operator’s eye; and finally it eliminated the effort involved in associating one piece of appa­ratus with another and in finding that other. Moreover the clear­ing-out drop of the cord circuit was replaced by an arrangement which included the provision of one signal to be controlled through the agency of a relay by the calling subscriber, and another to be controlled by the person wanted. These supervisory signals took the form of lamps and were placed on the keyboard in positions immediately adjacent to the associated cords. With the adoption of relays the signalling between the subscribers and the exchange became automatic, and, with the introduction *of* the principle of double and automatic supervision on the cord circuits, it became possible for the operators to tell at any instant the state of a con­nexion. As a result the time occupied by an operator per call was reduced from 50∙77 seconds to 16·63 seconds.

Threefundamental common battery transmission systems have been devised and are shown in figs. 8, 9 and 10. In the Hayes system (fig. 8) a repeating coil is placed in the cord circuit, and when two sub­scribers are connected together the winding connected to the line of the subscriber who is talking for the time being acts as primary, and the other, which is in the line of the listening subscriber, as secondary.

The Stone system (fig. 9) is characterized by the use of imped­ance coils between the battery and the line wires. When one of two subscribers connected together by this arrangement talks, the variation in resistance of the transmitter spoken into causes a variation of the pressure at the line terminals of the impedance coils, and since those terminals are common to the two circuits the variable E.M.F. operates in the line of the listening subscriber, causing the reproduction of the speech in the latter's receiver. The Stone system, compared with that of Hayes, possesses the disadvantage that one of the conditions affecting the supply of current to any particular subscriber’s circuit is the resistance of the other circuit to which it is connected for the time being. An improvement in this respect has been effected by the insertion of condensers in the cord circuits, coupled with the use of two sets of impedance coils, one set on each side of the condensers.

Dean’s method (fig. 10) embodies the idea of supplying current to the transmitters over the line wires in parallel instead of round the loop circuit, as in the other systems referred to. An earth return is used. The transmitter is placed in multiple with the primary winding of an induction coil whose secondary operates in the loop circuit, and con­sequently when the transmitter is spoken into, a variable E.M.F. is impressed upon the circuit through the medium of the induction coil. The impedance coils shown connected between the battery and the lines and between the latter and the transmitters are joined up non-inductively as regards the transmitter circuits, but inductively as regards the secondary circuits. Figs, 11 and 12 indicate typical subscriber’s and con­necting-cord circuits as equipped by the Western Electric Company. At the subscriber’s station when the receiver is on the hook switch the circuit is through the call-bell and a condenser. The conditions permit of the circulation of the alternating currents of low periodicity, which are used for operating the bells, but in respect of the battery the circuit is open until the subscriber lifts the receiver, when the hook switch, thus released, joins the transmitter with one winding of an induc­tion coil in series across the circuit. A current then flows and in passing round the circuit operates the line relay, with the result that the calling-lamp is lighted. The operator, whose attention is thus attracted, inserts a peg in the jack, then throws over the speaking key of the cord circuit, and having ascertained particulars of the requirement places the other peg of the pair in the nearest multiple jack of the wanted subscriber, whom she proceeds to ring up. In the meantime the calling­lamp has darkened ; and each subscriber’s line being equipped with a cut-off relay whose function it is to disconnect the calling apparatus while the circuit is in use, the insertion of a peg is im­mediately followed by the disappearance of the calling signal. The supervisory lamp associated with the peg in the wanted sub­scriber's jack glows from the time that the peg is inserted until