

effected by suitable relays cutting off current from the energizing-magnet and closing circuit for a stopping-magnet, from which current is at once cut off when the cord-finder has stopped. The press-buttons of the operators' keys are all connected to earth, and stand free from everything until pressed. When pressed they bring earth into contact with springs, into which they insert, and this sets up a train of relay movements, which thereby transfer the numbers set up, by means of impulses, to the registers. When the registers take up the necessary positions the operator's keys are released for use again, although the registers may not have completed transferring the numbers to the first, second, third selectors and final connector. If, however, a call comes quickly for a second connection the keys are released so quickly that they are practically always ready for use by the time an operator can take up another cord and insert it in the calling-jack to get the number. The operator then strikes the keys. If she has them all struck before the train of movements formerly set up has been completed, and in connection with which the A set of registers and sender is required, then by relays the connections are so disposed that the numbers of the second connection she is making are transferred to a second set of relays which govern the second or B set of registers and sender, so that there may be no delay.

When a jack is plugged into, a green supervisory lamp on the plug-shelf lights and remains alight until the subscriber answers. This light blinks once as soon as the train of connection through the automatic apparatus up to the bell beginning to ring has been completed. It is thus, if timed, a guide as to the time occupied by the apparatus in doing its movements from the answering of the subscriber to the bell ringing, and then of the time the called subscriber takes to answer. Several calls were timed. It was found that the operator plugged in under three seconds, and that the time from the depressing of the keys to the commencement of the ringing was seven seconds in the case of the highest numbers.

When a line called for is "busy" the white supervisory lamp lights and flashes. This signal is understood by the operator, and she informs the subscriber accordingly, and takes notes so as to complete the "busy" call later. When the line is not "busy" the white supervisory lamp glows as soon as the ringing starts, and darkens when the called subscriber takes up his receiver. Lamps remain dark during conversation. On both glowing the cord is removed which disassembles the mechanism.

The answering-jacks may be multiplied on the manual board to aid team working. This may speed up the service a little.

Cords are not absolutely necessary. It is as easy to arrange for a distributor to mechanically seek an idle operator as it is now arranged to find a cord made "busy" by being plugged into a subscriber's jack. The subscriber never hangs up until conversation is finished. Howlers take care of cases where receivers are left off the hook. The American Telephone and Telegraph Company, for whose purposes this system has primarily been designed, considers it is desirable under the circumstances that prevail in the large cities in which they operate that the subscriber should have access to the operator under all conditions.

Metering is the same as on ordinary manual boards. Party lines, private branch exchanges, and coin service are also provided for. The system is flexible, and practically anything can be done. The system has been specially designed so as to be capable of being connected to full automatic at any time.

All movements of switches are forward, all are rotary; there are no vertical movements—no falling of shaft or jarring. The whole apparatus is power-driven—2 horse-power is sufficient for 10,000 lines. The power-driven apparatus can be either partially or wholly shut down at night or during slack periods. Arrangements can be made for part of the mechanism to take care of calls or for any part to be started up when a call comes in. The apparatus is all well made and finished, and does not call for much mechanical attention.

On an average about 9,000 calls a day are put through the exchange. The calling-rate is high—about twenty per subscriber per day. The errors fluctuate from 1.5 per cent. to 0.5 per cent., and on some days are as low as 0.3 per cent. An error means anything that requires an operator to make out a trouble ticket. The best results got on manual exchanges are 2 per cent. of error, and this is not often attained, the more frequent results varying from 5 per cent. to 10 per cent.

The relays are placed on the top of the last frame. There are two sets—one for A and one for B registers and senders. Some of the relays are for district, office, stepping, trunk, &c., purposes. Other relays are for rotating. There are twenty of these. The first ten are for the even 100 and the next for the second 100, as the banks of tags are 200. It may be said that the grouping on this system is not in tens or hundreds, as in the Strowger, but any number of trunks may be used.

The cord-finder is arranged with three wiper sets 120 degrees apart to move round the levels, and always goes forward. It remains where stopped until required to move to find a cord. It may move one space only or several, according to the cord used. The bank is the standard size. Banks of this kind and for other purposes with the brush wipers have been subjected to a time test, and have been found to have a life of seventy-five years and still be good for service. The wipers are moved by a magnetic clutch. A wheel is continually in motion, and associated with it is a magnet winding. When a jack is plugged the sleeve connection completes a circuit which causes a cord-finder to hunt for a busy cord. The cord-finder switch is clutched and revolved. When the cord is found the magnet is demagnetized and another relay—the stopping relay—is operated, which stops the switch and immediately itself ceases to be energized. To the right-hand side of this switch is a set of springs arranged vertically; further to the right is a shaft carrying a set of separated insulation-pieces. These pieces are cammed or cut on their circumference so that a middle spring against which the cams may bear makes contacts in different ways. The cams are eighteen in number, and are differently cut so that the contacts occur in a certain order according to circuit requirements. The registers have camshafts, contacts, friction clutches, wipers, and banks not unlike the cord-finders. Coming to the selectors, we find the first selector has on the left-hand side a shaft with fingers mounted spirally about it. They also have spring contacts, cam-shaft, and magnetic clutch on the right-hand side similar to the others.