

THE MODERN TELEPHONE EXCHANGE.

by

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George Wolf.

The Modern Telephone Exchange.

To thoroughly appreciate the convenience of the modern telephone practice, it is essential to take a brief review of the apparatus which has formerly been used in the telephone exchange office.

While there is, without a doubt, plenty of room for improvement in almost any part of the telephone system, yet it is reasonable to expect more change in the central office apparatus than in the receiver, transmitter, bells, magneto, etc., of the subscribers stations, since with but slight modifications, these instruments have remained the same as those used in the first successful and practical systems. However, on the other hand, one would hardly recognize the modern telephone switch-board, as being such, as compared with those of the earlier days in telephone engineering.

Since the telephone is no more than a device for the saving of time and labor, it is and will be imperfect until the time and labor of operating together with the cost, are reduced to a minimum.

As the subscriber's instruments are made at present so that they are ready for use as soon as the receiver is placed to the ear, it is self-evident that all delay is in making connections at central and calling the desired party to the phone. The latter fault can be corrected only by having a telephone clerk at each subscriber's station, whose business it is to answer the "phone" exclusively. From the standpoint of the central station manager this point is of but very little interest as his responsibility ceases as soon as connections are made and the calling current sent. But the convenience and rapidity of making connections is of vital importance to him, and very little experience is required to show him that with the most

modern, and convenient apparatus he is enabled to not only operate a larger system with fewer "central girls", but at the same time better service is rendered to his patrons. Very many attempts ~~were~~, and in fact all, ~~attempts~~ to improve the telephone practice are properly aimed at the central office, and indeed surprisingly rapid strides have been made in the few years' life of the telephone.

The great desire for good service is shown by the many installations of automatic central stations, though they cost from two to five times as much as cord systems, yet they are being installed because the calling party can call any party he desires by pressing from one to four buttons and taking down the receiver, and when he gets the busy signal he knows that the 'phone he desires is in use and not simply a busy central.

Leaving any further discussion of the automatic central out of this discussion, let us return and note some of the changes in the switch-board from the beginning.

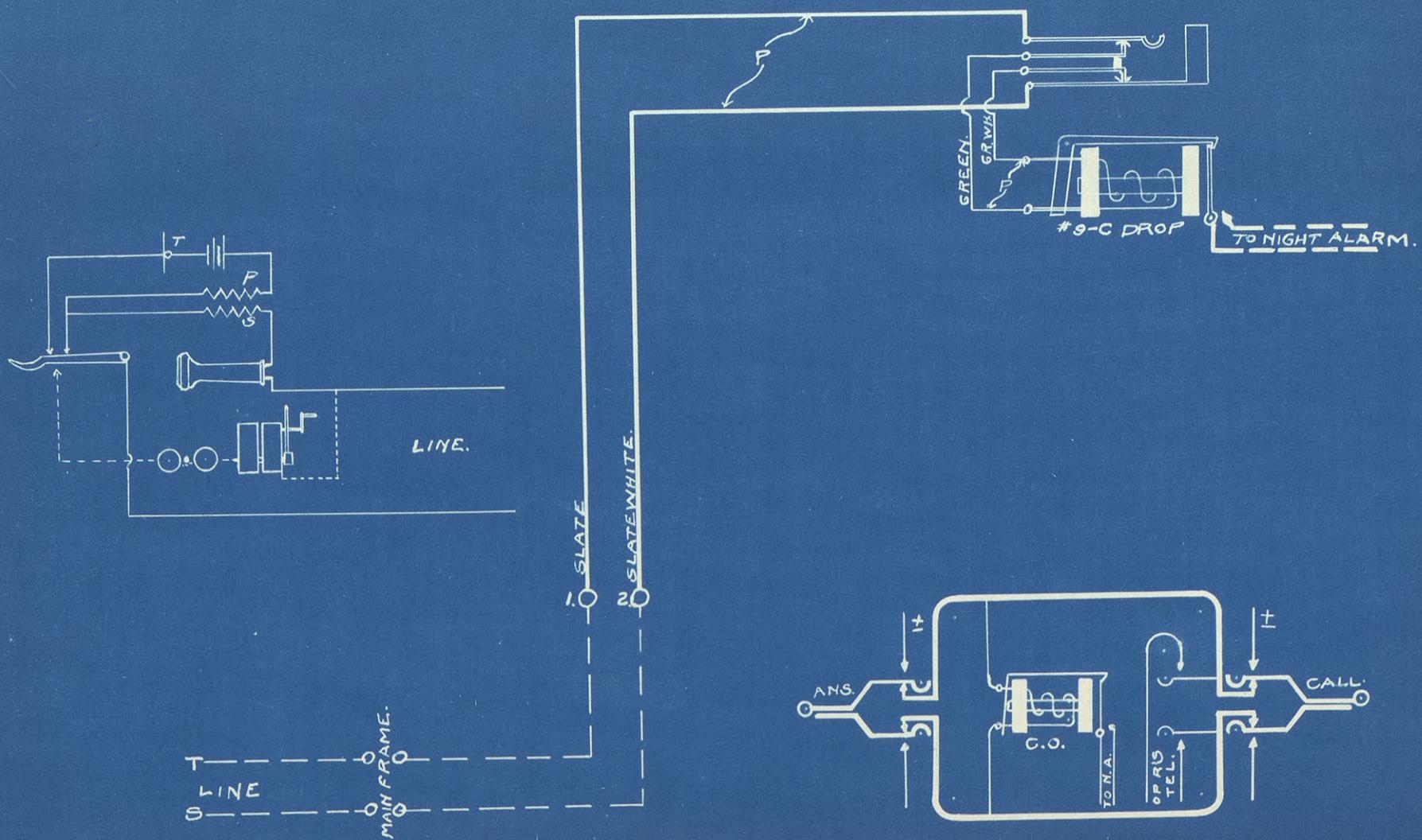
The early ideas of telephone central practice were along three distinct lines. This might naturally be expected from the origin of the telephone men. One class coming from the experts in telegraphic work tried to introduce the pin system for connecting subscribers, while those who were familiar with the "Burglar Alarm" work and "Stock Quotation, Printing, etc." clung to their system of connecting with cords, with metal tips to fit receptacles upon the board. The third class who were the real telephone men and who had grown up with the telephone business were ignorant as to the trades of the other two classes, but being used to stringing wires from one point to another for connectors, and realizing that the cord and plugs were very convenient, unconsciously adopted this system. Further they realized the needs of the central station and sought to divide

the work into several distinct operations, such as receiving calls, making connections, calling the desired parties, etc., and the cord systems to-day are based upon these principles though these different operations are so brought together in the simple little combination key that now it seems a very simple arrangement.

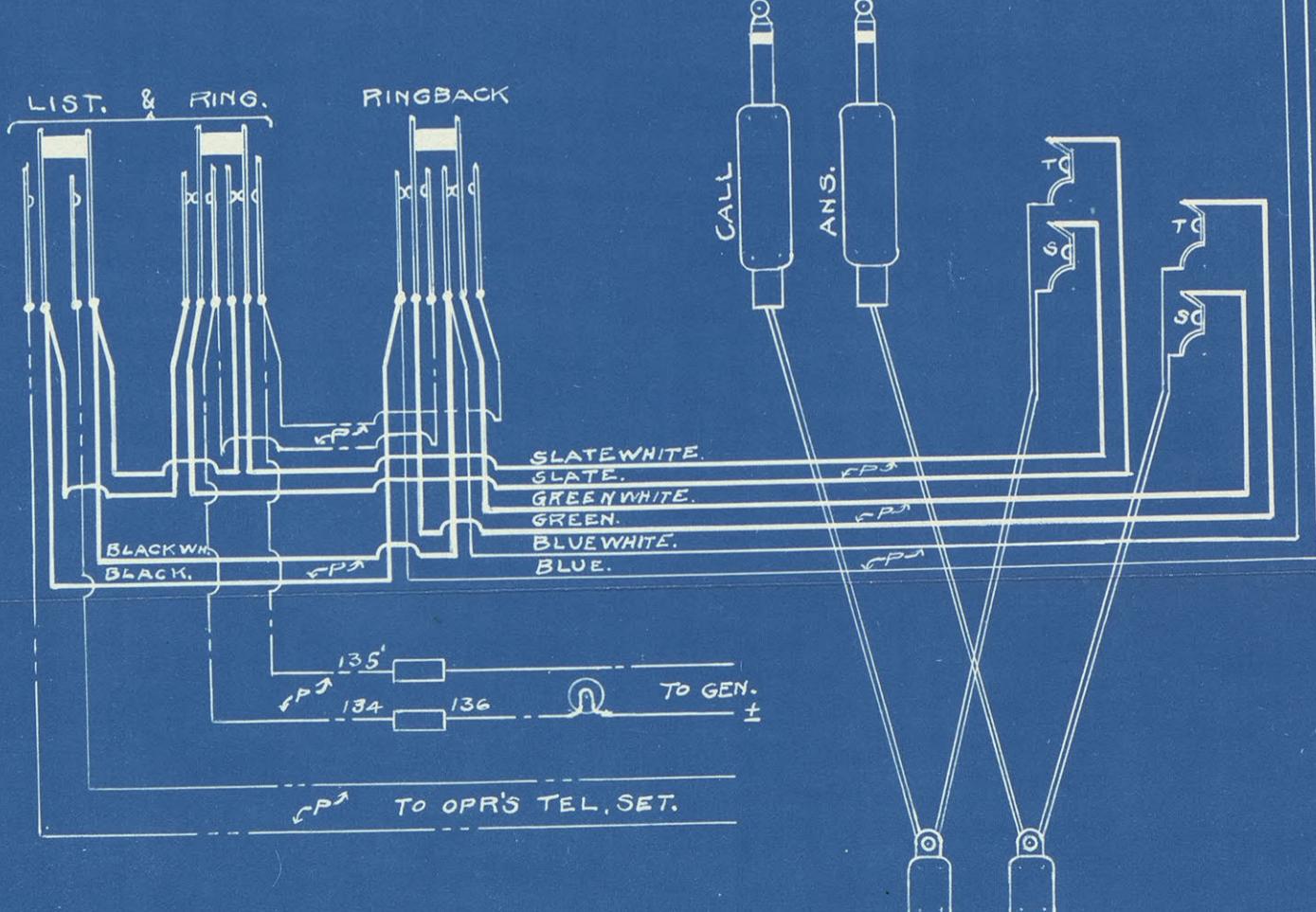
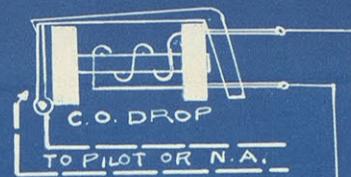
In the equipment of the board is where the greatest change has been made. The earliest boards were equipped with rows of bells with jacks beneath, one connected to each line and operated with batteries. There were several objectionable features here, first it was hard to find which bell was ringing, and then annunciators were introduced. Now the weakest point was the distance over which one could ring with batteries and to overcome this defect the alternating current-magneto was adopted. This instrument, up to the time of central energy and common battery systems has been as important, for lines longer than a thousand feet, as the receiver or transmitter. Here, however, it is interesting to note that the battery which was discarded long ago as an expensive, awkward and troublesome part of the office equipment, has been reinstated as a time and money saver and an indispensable part of the modern systems.

After the introduction of the magneto generator it was necessary to use an alternating bell and annunciator, hence the appearance of the double action bell, described in Part I for subscribers' phones and the visible drop for the switchboard. As the drop occupied a space of about one by one and one-half inches it was possible to connect a great many more subscribers to one panel of the switchboard, so the drop has held its place above anything else until the last few years when lamp signaling has come into use. The lamps occupy still less space than the drops and as they need no restoring

TOLL LINE CIRCUIT
STANDARD NON-MULTIPLE



**TOLL OP'R'S. CORD CIRCUIT.
TOLL TO TOLL
WITH RINGBACK & WITHOUT REP. COIL.**



SILK & COTTON TWISTED PAIRS. ————— TALKING CIRCUIT NOT COMMON.
SILK & COTTON ————— SIGNAL " " "
 *IB SPECIAL SILK & COTTON. ————— COMMON SIGNAL CIRCUIT.
 SPECIAL SILK & COTTON. ————— LISTENING "
 SPECIAL SILK & COTTON. ————— RINGING "
 "P" DENOTES A TWISTED PAIR.

to their place, as in case of drops, one operator is enabled to take care of two or three times as many subscribers. The drop is still held in preference for "toll line" work and long lines.

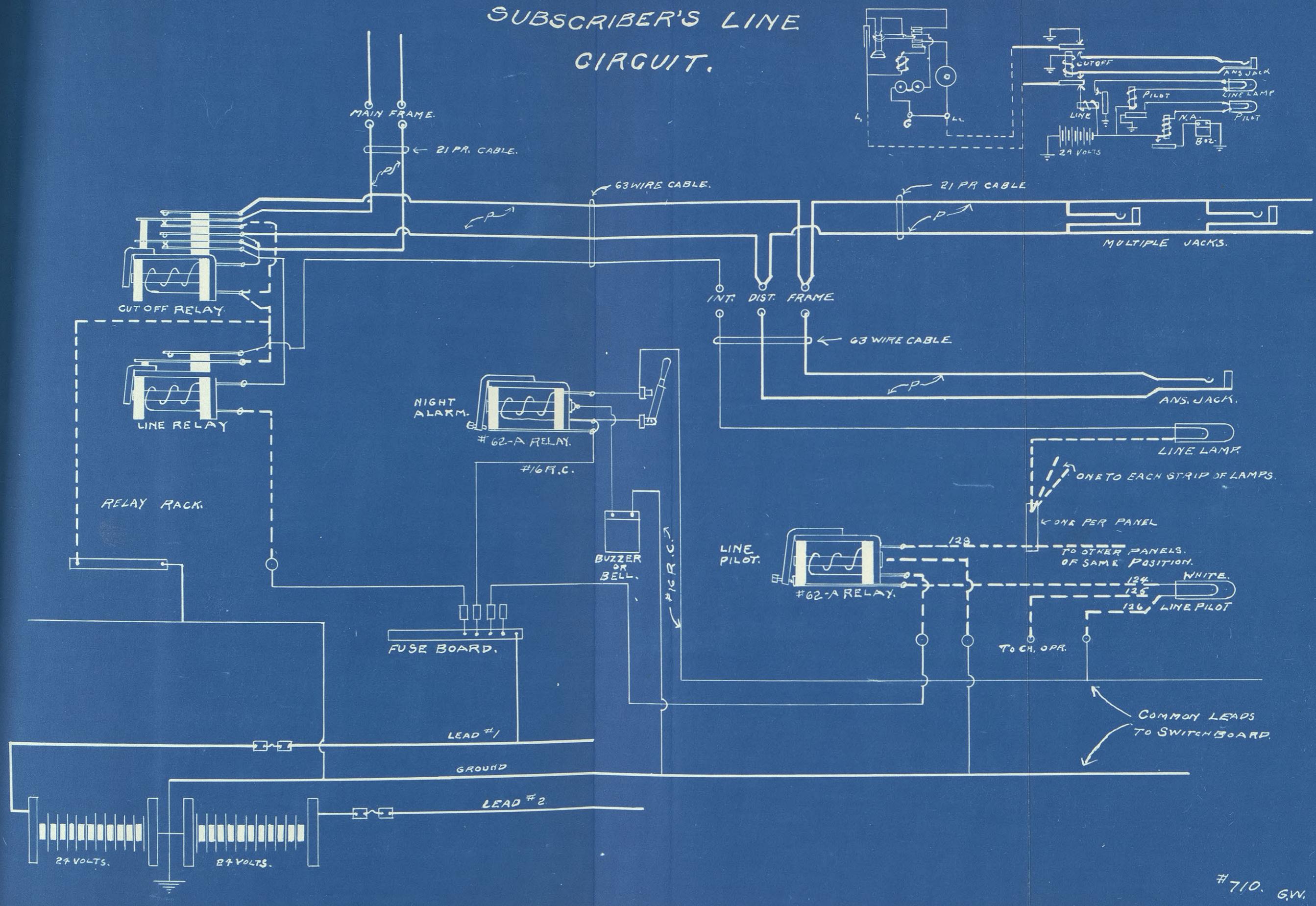
The principal type of board for pin connecting was to have vertical insulated bars of copper running down in front of the rows of jacks, with holes for pins in connecting to the jacks? On top of these and insulated from them were horizontal bars bored with holes for pins to connect to the vertical strips. The method of answering a call was as follows: When the annunciator gave the signal, the operator plugged into the corresponding holes with a pair of plugs permanently connected to her telephone set, and after ascertaining the number desired, removes those plugs and replaces them with another pair having a ring off annunciator connected between them, then she inserts two plugs into the numbers desired and to these plugs is permanently connected the generator. After ringing up the party she replaces the ringing plugs with pins to connect them to the vertical strips. Then with two more pairs of pins the two vertical strips may be connected to the same horizontal one and the connection is complete. The next system to be discussed is the drop signaling, cord system which is now very extensively used and thought it is giving way to central energy systems for large city systems, it is still installed for long distance lines and for small exchanges where the common battery system would not make enough difference in expense and service to warrant its being put in. Connections and detail drawings for the drop signaling system may be found on Plate II 591 and 588. First is shown the connections in the telephone of one of the subscriber's stations.

The line wires S and T are connected to one side of the

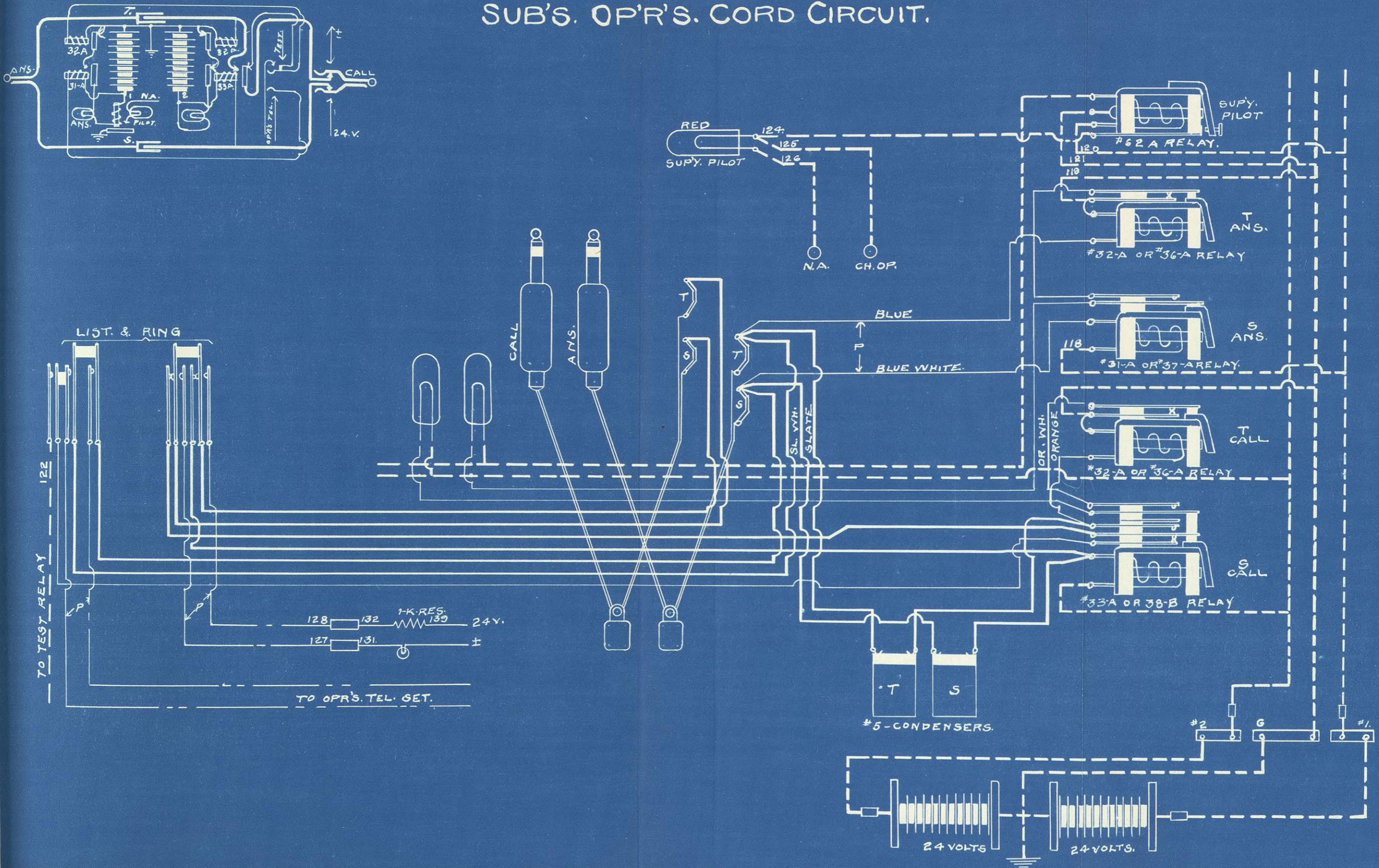
the "main frame" or cross connecting board, while the other side is connected to the jacks on the switchboard. From one side of the main frame to the other twisted pairs are threaded through, connecting any line to any drop. The line wires run to the sleeve and spring of the jack. Bridged between the spring and the sleeve is the ringing drop, which is a coil of wire wound on an iron core which controls a soft iron armature, which in turn raises the hook and releases the drop. It is so connected that when the drop falls upon a bar corresponding to the arrow that the drop completes a local circuit through a battery and bell which is used for night alarm.

Below is shown the cord circuit for this system both in detail and sketch of connections. When the "ringing in" drop falls the answer plug is inserted into the jack. This spreads the spring from the connections which lead to the drop, cutting out this shunt. Then placing front key in listening position the telephone operators set is cut in and communication established. The call plug is then inserted in the jack belonging to the number desired and the front key placed in position of ring. This cuts out the operator's set and also the calling party and prevents ringing in their ears. Then with both keys in talking position the telephones are connected directly together with a high resistance "ring off" drop bridged over the circuit. When the parties are through talking and either party rings off the "clearing out" drop tells the operator they are through. The ring off drop is also connected to the night alarm. Without the ring back key this would be a regular exchange system, but as it always takes from ten minutes to two or three hours to get a party on toll line it is always necessary to call back to the calling party when his party has been obtained. The ringback key is for this purpose, and

SUBSCRIBER'S LINE
CIRCUIT.



SUB'S. OPR'S. CORD CIRCUIT.



2672.

G.W.

it also cuts out and the party at the other end while ringing back. The "ring in" drops are of lower resistance than the clearing out drop and must be cut out to make the resistance of the total shunt high enough not to lower the efficiency of the instruments. As can be seen in this system it is necessary for the operator to put up three drops for every connection that is made. This takes time that might profitably be spent in answering other subscribers. It is also necessary to have battery, magneto and induction coil in each telephone which is very expensive and troublesome. With these points in view other systems were put forth until the modern central energy system came out, which abolished all of the before mentioned devices.

Plate #, 710 shows the connection and details of the line circuit, while Plate #, 2672 shows the same of the cord circuit for a central energy system. The central energy telephone with receiver hook down has bridged over the line the alternating bell in series with a condenser. The condenser is used as a cut out for a direct current but allows alternating currents to pass through the bells. On removing the receiver the bell is cut out and the receiver cut in its place, also the transmitter is bridged across the line. As will be noticed the telephone contains neither a magnet nor a battery. The operation is as follows: Before the receiver is taken from the hook the line is open circuited by the condenser but when the receiver hook is released it cuts the transmitter across the line and allows current to flow from the battery through the line relay, over one side of the line, through the transmitter, back on other line to the battery. This current exciting the line relay draws its keeper which being one terminal of the battery connects to the line lamp and allows current to flow from the same battery through the

line lamp and Pilot relay in series. This current in turn excites the pilot relay and connects for current through the pilot lamp and if desired excites night alarm. The lighted line lamp is the ring up signal and the operator answers by plugging into the answering jack with the answer plug. Since the sleeve of the answer plug is connected to the ungrounded side of battery No. 1, it makes connection for exciting the cut off relay, when inserted into the jack, and thus cuts off everything but the wires to the jack. After getting the call, by means of the listening key, the operator inserts the call plug into the jack desired. The sleeve of this plug is connected to the ungrounded side of battery No. 2, so when in the jack it makes connection for current to excite the cut off relay of the party to be called, thus cutting off everything but the line. Then with the ringing key alternating current is sent out over the line and since it is alternating, it passes through the condenser and rings the bell. The direct current from the station now supplies the transmitters over the line wires and the varying impulsations are sent over the same line wires. When the parties are through talking and one or both hang up their receivers, the direct current can no longer pass over the line and both T relays are released, thus making connection through the clearing out lamps and telling the operator that those cords are not in use, and when the plugs are removed all relays are released breaking all connections.

This system for central stations has brought to the telephone user the best service yet attained, but still there is a great problem to be solved in large telephone exchanges, and that is the problem of connecting telephone subscribers on different panels of the board

and too far from each other to be connected with the cord.

Two systems in use now are the best so far invented but on large boards they are very cumbersome. They are the "multiple jack" system and the "transfer" system.

In the multiple jack system a panel is placed in reach of each operator which contains a jack connected to each subscriber on the system. Such jacks are shown on Plate # 710. With this system it is necessary to arrange a test system to tell the operator if any one of the jacks, belonging to the same phone, is in use, and besides it demands an enormous outlay in jacks, which outlay rapidly increases with the size of the system.

The transfer system is arranged by having a row of plugs which are used only for transferring and being connected, so many between each two panels of the board. When a transfer is to be made from, say #3 panel to #8 panel, #3 operator lifts one of the group of transfer plugs which are connected to #8 panel and places it in the calling jack. Immediately a lamp signal lights at #8 panel and the operator thereby pressing a button, may ask for the number. Then raising the transfer plug and inserting in the jack the transfer lights are extinguished. The drawbacks to this system are its great complication and also it requires so many transfer plugs to supply each panel with as many transfer plugs as it should have in order to always insure several connections between the same two panels.