No. 5 crossbar AMA translator

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In the No. 5 crossbar system, the subscriber lines terminate on verticals of crossbar switches on the line link frames. They are identified for switching purposes by the number of the frame on which they appear and their position on that frame. This position on the frame is defined by specifying the horizontal group, and the vertical group and file in which the vertical is found. The scope of the divisions of the frame is shown in Figure 1. There are ten horizontal groups and from six to twelve vertical groups on each line link frame. Each vertical group consists of five vertical files.

The series of numbers specifying the line link frame, vertical group, horizontal group, and vertical file, is known as the equipment number, but there is no fixed relation between this equipment number and the directory number. The reasons for this lack of relationship have to do mostly with keeping an even distribution of traffic through the frames and with providing flexibility for changes in assignment of directory numbers.

Since the marker obtains the equipment number in the process of handling an originating call, it is readily available to the AMA equipment. However, directory numbers rather than equipment numbers are required by the AMA equipment in billing the charges for a call. A translator is therefore required to convert the equipment number to a directory number. This translator is an electrical directory with the equipment numbers appearing in an orderly array each with its associated directory number.

After a subscriber picks up his handset to place a call, the marker seizes the calling

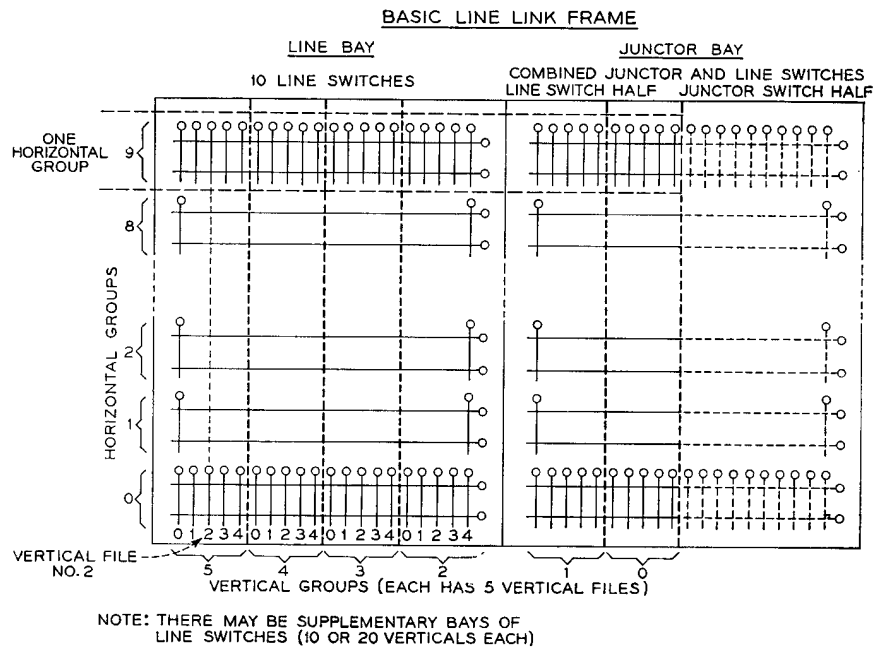

Fig. 1 — Division of lines on a line link frame into vertical groups, horizontal groups, and vertical files.

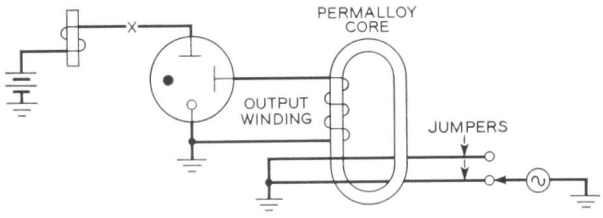

Fig. 3—Simplified diagram indicating method of using the coil shown in Figure 2 for translating.

line link frame, finds the calling line, connects it to an originating register, and tells the register the equipment number. The register records this number and, if the call is from a two-party line, determines whether the tip or ring party is calling. After the subscriber has dialed, the register obtains a marker and gives it the calling equipment number, including tip or ring party identification, and the called directory number. The marker in turn passes this information to the outgoing sender, which records it. After the marker completes this job, the sender controls the selection of the called number and at the same time obtains a transverter, which is part of the AMA equipment, and gives it the information. The transverter uses this information to obtain a translator to which it passes the equipment number. From this information the translator determines the directory number and returns it to the transverter, which causes it to be placed on the AMA tape in the form of five digits: one to indicate the office, and one each to indicate the thousands, hundreds, tens, and units digits of the subscriber's directory number.

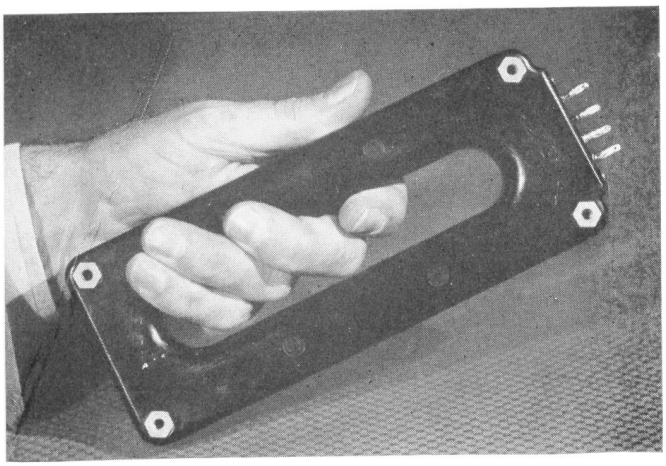

Fig. 2—The coil used with AMA; one of the essential elements of the "Dimond" ring translator.

The new element of the translator is the coil shown in Figure 2 and is shown schematically as applied to a circuit in Figure 3. The winding of the coil is connected to the control anode of a gas filled tube. If a surge of oscillating current is sent through one of the jumpers, an oscillating voltage is induced in the winding. This voltage ionizes the tube, thus allowing it to pass current between the cathode and the main anode, and operate the associated relay.

The method of using these coils in the AMA translator is shown in Figure 4. At the top of this figure is the surge circuit which generates the jumper current. Below is a relay tree that selects one of the terminals in the equipment number terminal bank. There is one terminal in this bank for each equipment number.

From each terminal, a jumper is threaded through one coil in each of the five rows of coils and terminated in ground. The coil used in the top row indicates the number of the office in which the calling line is located. The coils used in the other four rows are chosen in accordance with the thousands, hundreds, tens, and units digits of the associated directory number.

When the transverter is connected to the translator, it operates relays in the relay tree which select one of the thousand equipment number terminals and connect it to the surge circuit. When this connection is made, a path is closed from ground through the jumper, the relay tree, and the back contact of relay SST. This ground suddenly changes the potential of point A from minus 48 volts to ground. This voltage change is carried through a coupling condenser to the control anode of the SST tube which is caused to pass current, thus operating relay SST. Relay SST now closes a discharge path for the oscillatory discharge of capacitor C through inductance L to ground. The discharge circuit is closed by the mercury contact relay SST rather than by the contacts of the tree circuit because the high current (about 3 amperes peak) in the surge might damage ordinary relay contacts, especially if there is

any contact chatter. Any chatter which occurs in the relay tree contacts subsides during the operating time of relay SST.

The surge current in the selected jumper induces a voltage in the output windings of the coils through which the jumper passes. The associated gas-filled tubes fire from this voltage, and cause relays in the transverter corresponding to the directory number to operate. The translator connector then releases, disconnecting the transverter from the translator.

The relay tree is shown schematically in Figure 5. By using the line link frame number and the vertical group number, the transverter grounds one of the twenty G leads to operate the proper G relay. Tip parties and ring parties are assigned to separate translators. The transverter also operates one of the VF relays corresponding to the vertical file number of the calling line, and operates horizontal group relay in accordance with the horizontal group number.

The G relay uses fifty contacts to select from the thousand equipment number terminals the particular fifty of the vertical group of the calling line. The VF relay selects ten of the fifty terminals selected by the G relay, and the horizontal group relays select one of the ten terminals selected by the VF relay. Thus, by this process, one terminal out of 1000 is connected to the surge circuit, whereupon the operation proceeds as above.

Since the jumpers are changed rather frequently and since the terminals in the equipment number terminal bank are fairly closely spaced, it is felt to be worthwhile to design the translator so that inadvertent shorts between adjacent terminals will not cause severe reaction. With all the jumpers connected to a common ground bus as indicated at the bottom of Figure 4, such a short might result in the failure to translate the equipment numbers for a large number of lines, and the fault might be difficult to find. Suppose, for example, there were a short between the equipment number terminals for jumpers A and B. An attempt to translate the equipment numbers associated with either of these terminals would, of course, give the translation of both because of the short. This in itself is not too serious since only two lines are involved and the trouble could soon be located. The serious feature of such a short is that the short forms a closed loop consisting of the two jumpers. As a result, a surge in any jumper passing through one or more of the coils threaded by either of the shorted jumpers will induce a surge in the closed loop and thus besides operating the proper tubes for the translation will also operate those associated with the jumpers of the closed loop. With the short between jumpers A and B, for example, when jumper D is energized, a surge voltage is induced in jumper A because it threads tens-coil No. 6 in common with the D jumper. A current is therefore induced in the A and B jumpers, which energizes several coils besides the desired ones. This does not cause charging irregularities, however, because the transverter recognizes the operation of more than the correct number of tubes as a trouble condition. It would not accept the translation but would call in a trouble recorder. The fault would be difficult to locate, however, because the equipment number of the line that caused the trouble recorder to be called in may not be anywhere near the equipment numbers whose terminals are shorted in the bank.

To avoid such a situation, the formation of closed loops by shorts must be prevented. To this end, ground is provided through a bank of 1000 terminals physically arranged just as are those of the equipment-number terminal bank. Jumpers are run between corresponding terminals of the two banks. The method of supplying ground to the terminals of the ground bank is indicated in Figure 6. The ESW relay is operated by the horizontal group relays of the relay tree whenever the equipment number being translated is in an even horizontal group. Similarly the OSW relay is operated if the horizontal group is odd. The VF relays are the same relays as the VF relays shown in the relay tree. When a translation is to be made, the ESW or OSW and VF relays together supply ground to only a certain fifty of the thousand ground-supply terminals, and no two of these fifty are adjacent. ESW and VFO, for example, ground the even terminals in the bottom row of Figure 6.

With this arrangement there can be no

closed loops due to shorts between adjacent terminals in the equipment number terminal bank. If the shorted terminals are horizontally adjacent, then one must be in an odd horizontal group and the other in an even and, therefore, only one of the jumpers can be supplied with ground because of the ESW and OSW relays. If they are vertically adjacent then only one can be supplied with ground because only one VF relay is operated, and each horizontal row of terminals is supplied from a different VF relay. With no closed loops there can be no tubes falsely operated, and therefore the circuit will translate satisfactorily in spite of the short.

Not only does this scheme prevent false operation, but it causes a trouble record to be made indicating that a short exists. If jumpers A and B are crossed either in the equipment-number or ground-supply terminal banks, then when the A jumper or any other jumper on the same ground sup-

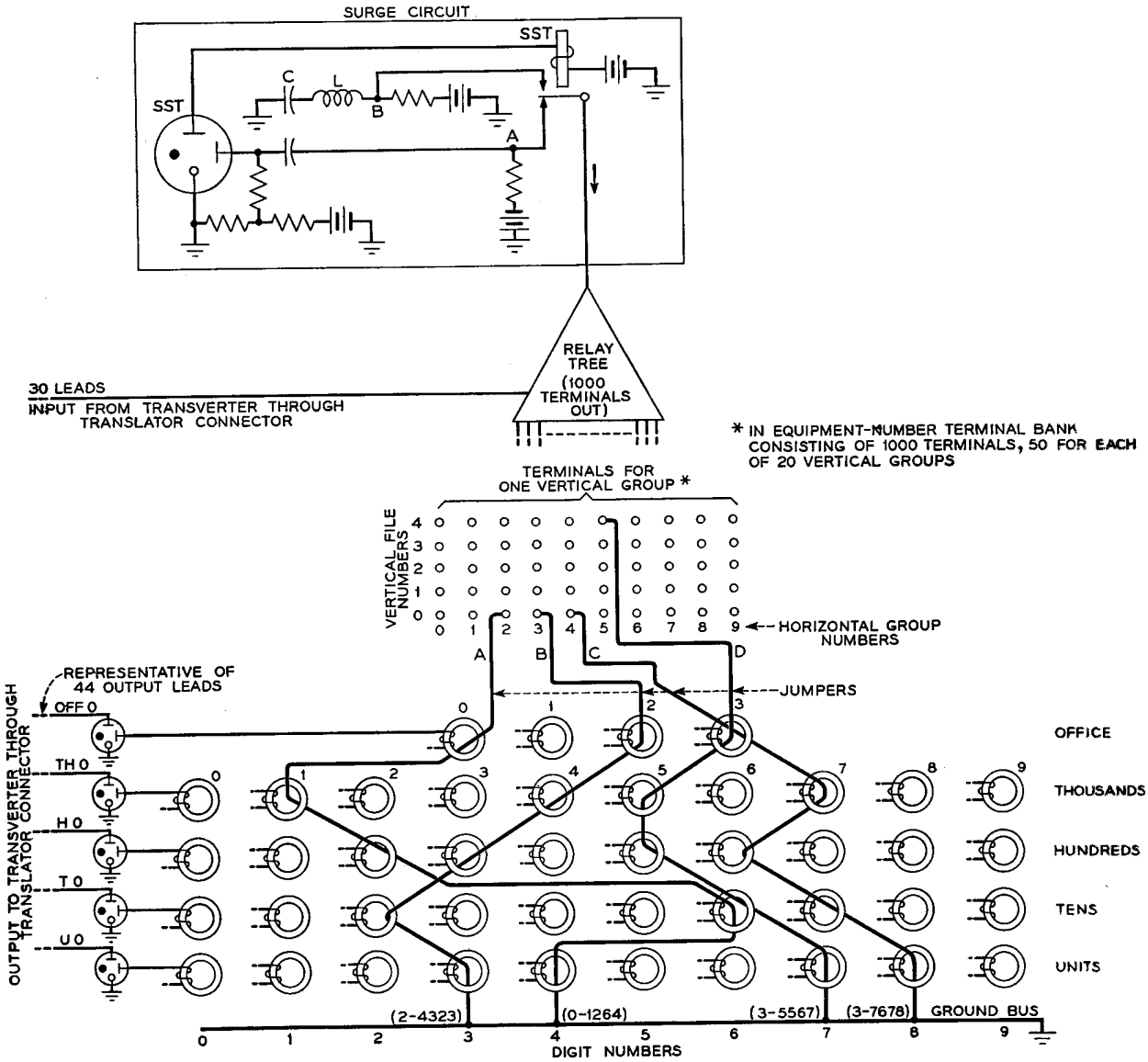

Fig. 4—Simplified circuit schematic of the AMA translator. This schematic shows jumpers set up to identify terminals of directory numbers 2-4323, 0-1264, etc.

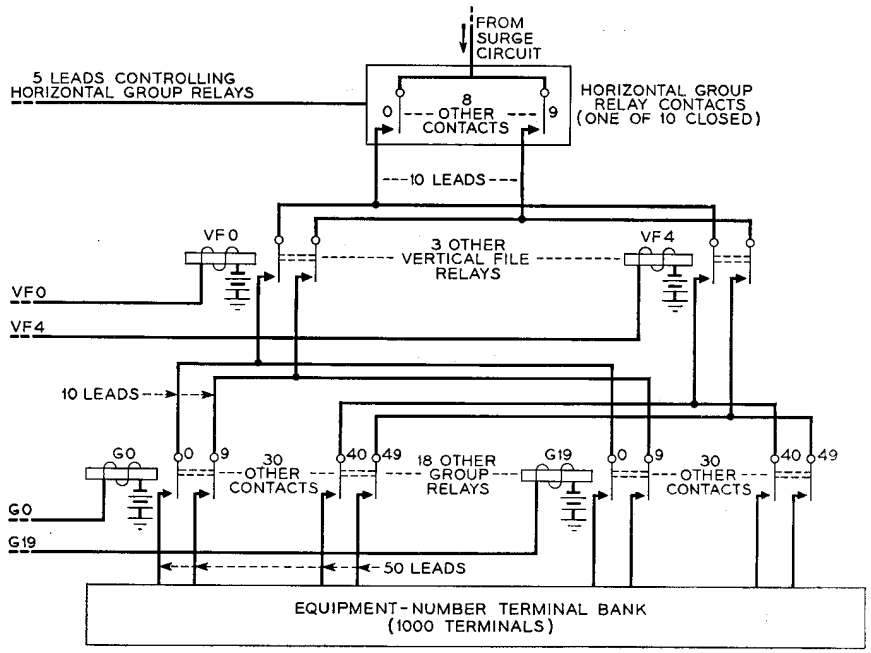

Fig. 5 – The relay tree of the translator, which distributes the surge to the terminal for the equipment number that is to be translated.

ply lead is selected, the ground furnished by the VFO and ESW relays will close a circuit through the short and through the back contact of relay OSW to operate the cross-detecting relay in the transverter. This causes a trouble record to be made but does not interfere with the translation.

It may be wondered why it is necessary to indicate when a short exists since it does not interfere with the translation. The answer is that a single short cannot cause a closed loop but two shorts may. For this reason it is desirable to indicate a short as soon as it occurs so that it can be cleared

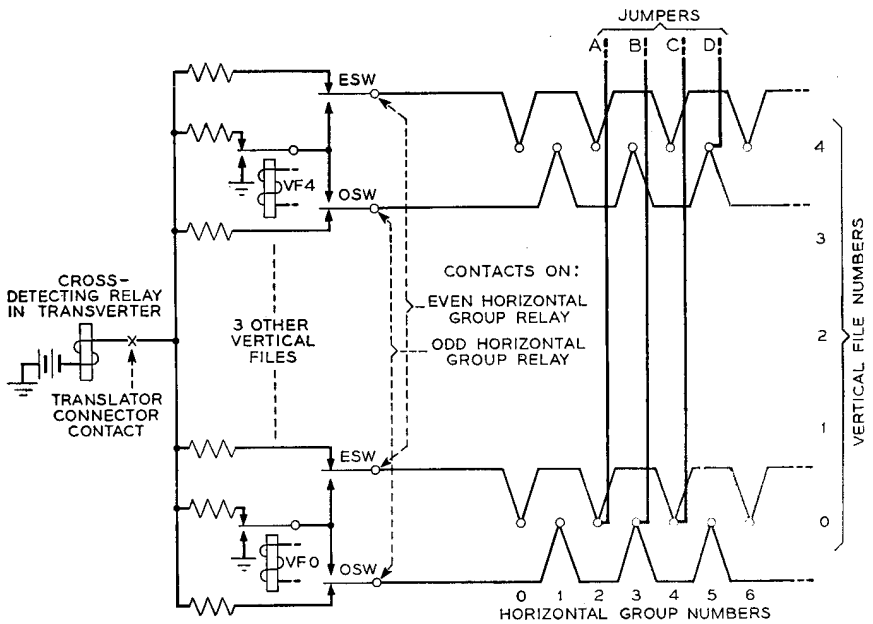

Fig. 6—Simplified sketch indicating the method of distributing ground to the terminals of the ground bank.

before another occurs which, in combination with the first, might cause translation failures on a large number of telephone lines.

A translator frame is shown in Figure 7. At the top, not shown in the photograph, is the translator connector, which has a capacity for five transverters. In the middle of the frame are the relays making up the relay tree. The bulk of these are the multicontact G relays. Below the relays are the terminal strips making up the equipment-number terminal bank. The coils are mounted next. The tubes are mounted immediately behind the coils. Near the bottom is the ground supply terminal bank. The whole assembly of coils and terminals is within easy reach of a maintenance man standing on the floor.

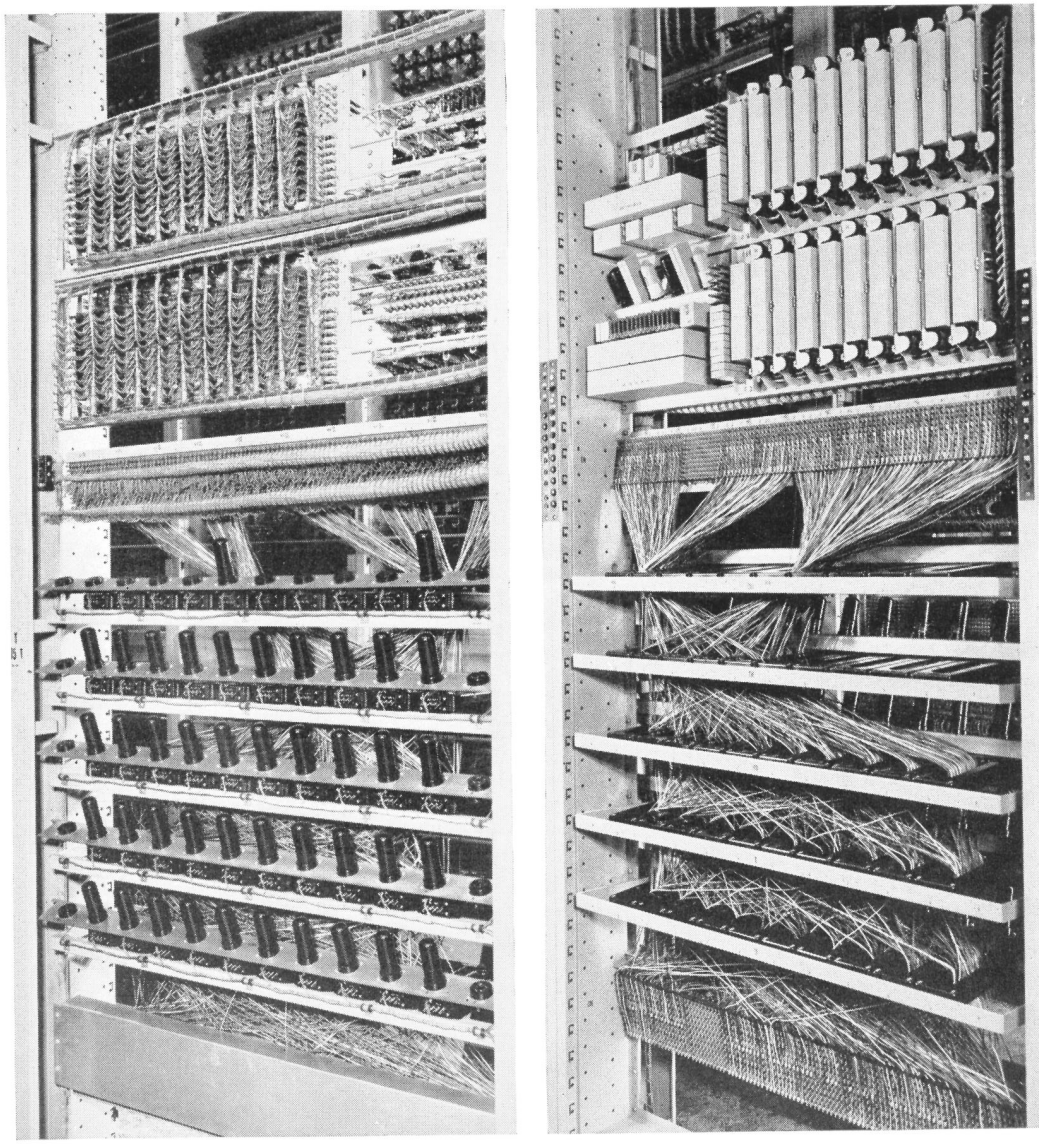

Fig. 7—Lower part of a translator frame; tube side at left, and coil side at right.

One of the difficult equipment and apparatus problems was the design of the coil structures and the general layout in such manner that the jumper could be readily removed. With the arrangement finally devised, the jumper can be removed by loos-

ening both ends and pulling. One reason for terminating the jumpers in the same relative locations in both terminal banks is to make this possible without tracing the jumper through the coils to find its ends. The coils, one of which is shown in Figure 2, are enclosed in bakelite cases with smooth rounded jumper windows to reduce friction. It was found that an oblong window accommodates more jumpers than a round window of the same area. The maximum that can be placed in the coil is 600.

As a further aid in changing jumpers, the terminals in the equipment number and ground supply banks are of a new solderless type. These are shown in Figure 8. Each consists of a slit punching into which the stripped end of a jumper is slipped. A complete turn of the jumper is then made around the terminal so that any movement of the jumper will not disturb the electrical connection. The pressure between the jumper and terminal is very high, insuring a good, low resistance contact. Tests show that this terminal allows a reduction in connection and disconnection time.

The basic type of translator employing the kind of coil described above is known in the Bell System as a ring translator because of the shape of the coil. Its main advantage over more conventional types of translators is that it reduces the number of jumpers and connections. This saving in jumpers represents appreciable savings to the Telephone Companies because on the average each jumper is removed and re-run once each three years.

The same translator circuit as described above is used in the No. 1 crossbar system, although the equipment details are slightly different. The basic ring translator scheme has also been applied to computers.

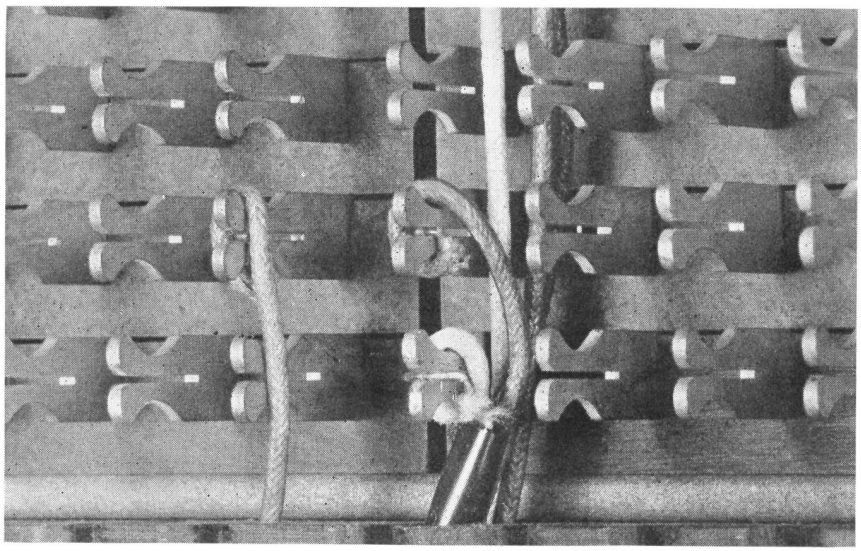

Fig. 8—A close-up of one of the terminal banks of the translator showing the new type of terminal employed.