Type-7 Crossbar Selector

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THE TYPE-7 crossbar selector is a mechanism for selecting one of several trunk groups in a dial telephone switching system. Each of these trunk groups may lead to a subsequent rank of group selectors, to connectors (final selectors), to outgoing trunks, or to one of several special services. Switching in this case is based on a system of decimal numbering; consequently the selector, in response to a single pull or digit of a telephone dial-calling device, provides a choice of one trunk group out of 10. The selector consists of a group of relays, a magnetic impulse counter to register the digit, and certain permanently associated portions of several crossbar switches. Generally, each selector has access to 100 outlets, which are arranged in 10 groups of 10 paths each.

In modern telephone practice, it is widely recognized that to provide trunking flexibility, group selectors are desirable, and often a necessity, even in small initial installations, such as a community dial office. The ease of equipment growth thus gained is self-evident. With the advent of nation-wide toll dialing and customer toll dialing, the area and exchange numbering plans frequently demand the use of so-called 2–5 numbering in the exchange, that is, 2 letters followed by 5 numerals. It is generally more practical and economical to accomplish this by the use of group selectors at the outset, at the same time providing for an orderly growth beyond an initial equipment of, say, 60 or 80 line terminals.

The fundamental operation of the type-7 selector and the division of available outlets into groups of 10 are based on well-known practices. However, the use of crossbar switches for establishing the selected path on a direct-access basis involves several details of operation that differ somewhat from those generally used in decimal systems. The following descriptions and illustrations are presented for the engineer and technician who are interested in the circuits, apparatus, and equipment arrangements employed.

Elements of the Selector Equipment

The type-7 selector uses the 4000-type relay, which consists of a spring bank assembly, heel iron, relay coil, and armature assembly as shown in Fig. 1. The spring bank assembly consists of contact springs, insulators, lifting cards (or ladders), and clamping plates. The contact springs have conventional terminals for soldered wire connections. The complete spring bank for a relay is clamped between two metal plates and held by three screws. The spring bank is fastened to the heel iron by two assembly screws.

The winding of the relay coil is made up of layers of enameled magnet wire with a sheet of cellulose acetate between adjacent layers. When the winding operation is completed, the protruding ends of the interleaved cellulose-acetate sheets are coalesced to seal the coil against entry of moisture.

The relay coil and spring bank are assembled to a conventional L-shaped heel iron, to which the armature assembly is also attached.

People in the communications field have long understood the possibility of completing an electric path by connecting two crossbars where they intersect. For example, the peg-type telegraph switchboard, which is shown in Fig. 2, has been in use for more than 50 years. It should be noted that, with a considerable number of lines, it is possible to connect any two of them together by connecting both to a commonly accessible link. For example, as shown in Fig. 2, L-3 is connected to L-12.

The crossbar switch differs somewhat from other types of telephone switches, in so far as direct electric paths are established through precious-metal contacts with only two rapid relaylike operations. Associated apparatus that assists in making the connection is subsequently released for further calls. The crossbar switch, Fig. 3, is composed of a formed metal frame on which is mounted a multiple bank comprising a number of horizontal and vertical paths, the cross-point selecting and establishing mechanisms, and magnets.

Located at the ends of the switch are

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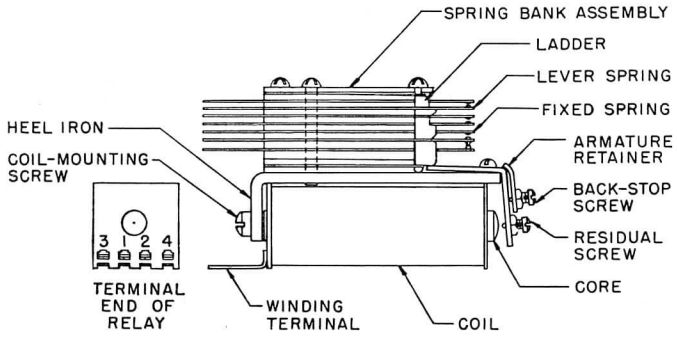

Fig. 1 (left). A 4000-type relay

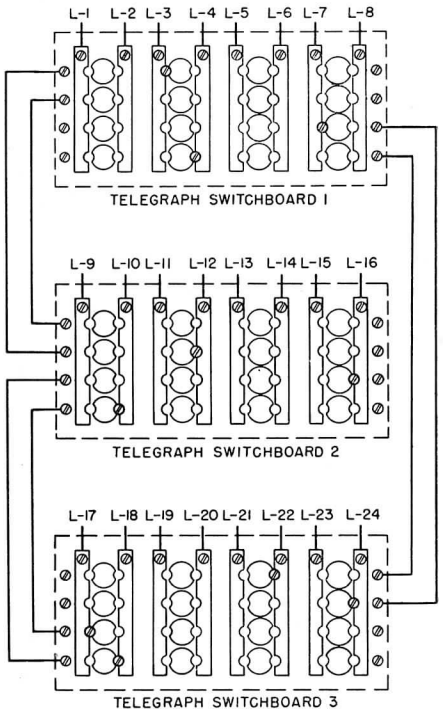

Fig. 2. Peg-type telegraph switchboard

The lines are connected to vertical conducting strips and the circular conducting islands are connected in horizontal rows. Metallic pegs make contact between the cross bars

five or six pairs of select magnets, each pair controlling the rotation of a select rod. The select rods span the distance between the switch-frame ends on the underside and carry a number of finger springs corresponding to the number of vertical-path elements the switch contains. Fig. 4 shows how these finger springs actuate select levers, which are mounted on the armature assembly of each vertical element. When the switch is in an unoperated condition, each select lever rests between two adjacent ladders. When a select magnet is energized, the select rod rotates a few degrees causing the finger springs to move each of the select levers under one of its adjacent ladders. The direction in which the select lever moves depends on which of its two controlling magnets is energized. When the select-rod action has taken place, Fig. 4, the hold magnet of the appropriate vertical path is energized, operating its armature and causing the select lever to lift the ladder, closing the contacts of the selected vertical and horizontal paths. The select magnet is then released, restoring the select rod and all other finger springs to their normal positions. The switch is then available for another selection. The hold-magnet armature remains operated until the subscriber releases the circuit.

The magnetic impulse counter pictured in Fig. 5 is fundamentally a 2-step relay. However, instead of the usual single armature it has 10 armatures. The armatures operate in sequence, each one responding to its respective pulse of current in the driving coil. Once operated, the armatures are held by the residual magnetism in the core. The counter is shown schematically in Fig. 6.

The counter-coil has in addition to its driving or pulsing winding, a second winding that is used to bring about the release of any operated armatures. Release is effected by passing direct current through the release winding in the proper direction to induce into the core a magnetic flux of opposite polarity to that induced by the operating pulses. The release flux is of sufficient intensity to neutralize the residual flux left by the operating pulses, and the tension of the spring stacks is then sufficient to cause the armatures to restore to their normal positions.

Each armature acts on its own set, or stack, of contact springs. The springs are similar to the type used in many conventional relays. The counter used in the type-7 group selector is equipped with one pair of normally closed contacts and one pair of normally open contacts in each of its 10 spring stacks.

Equipment Arrangement

The equipment used in the group-selecting stage of a type-7 office, shown diagrammatically in Fig. 7, consists of the selector relay units, crossbar switches and the common test circuits. Each selector relay unit has a group of relays and a magnetic impulse counter that perform the usual functions of digit registration, holding, etc. Also, each selector relay unit is permanently wired to a horizontal path of one or more crossbar switches, depending on the number of outlets required.

A test relay circuit is provided to serve each 12 selector relay units. It is capable of testing all paths in the selected group of outlets simultaneously, choosing the idle path of the lowest number, and directing the crossbar switch to establish a connection to the chosen outlet. Such operation permits the trunks individually accessible to selectors of a group to be taken into use whenever available, reserving those commonly accessible to a greater number of selector groups for use when the individuals are all engaged.

Operation of the Selector

Operation of the typical type-7 selector circuit is illustrated by Fig. 8. The calling party lifting the telephone handset causes a selector to become associated with his line by way of a line finder. The selector relay unit returns dial tone to the calling party, indicating that it is prepared to receive signals from the telephone dial. The calling party dials the first digit of the number, and the cut-through action of the selector is accomplished in the following manner.

The series relay, which operates on the first pulse, will release after the last pulse of the digit is received, extending ground

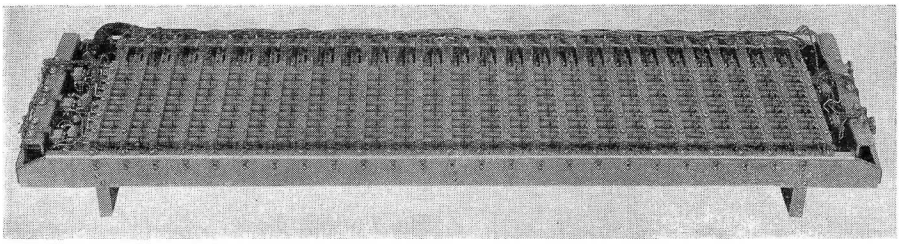

Fig. 3. Crossbar switch

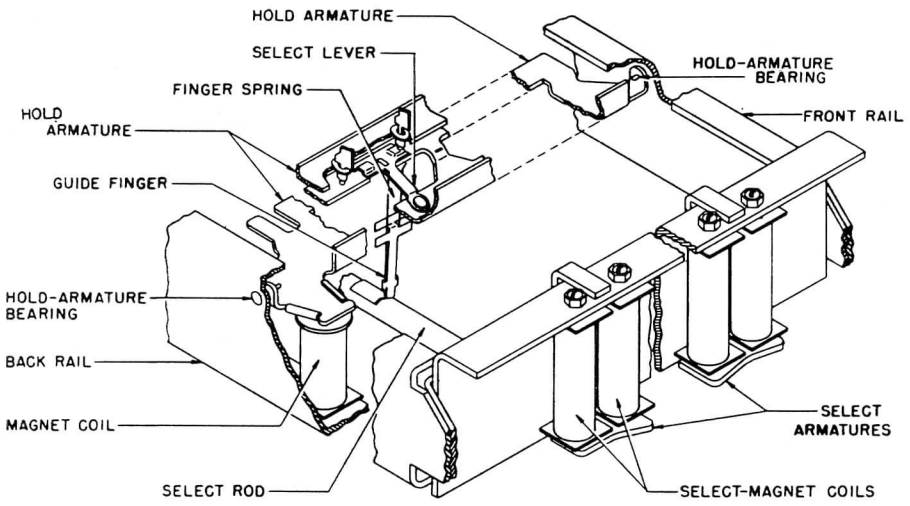

Fig. 4. Select-and-hold magnet mechanism

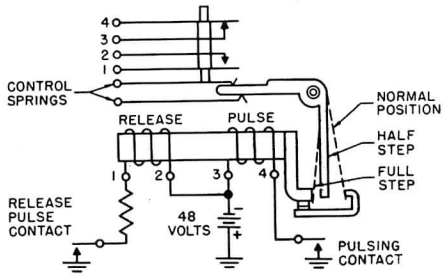

Fig. 6. Operation of magnetic counter

through the off-normal contacts of the magnetic impulse counter to operate the chain relay of the selector. The chain relays (one in each selector) are interconnected so that only one can be operated at a given time. The operation of the chain relay connects ground through the selected path of the magnetic impulse counter to operate the call-in relays of the trunk group, corresponding to the digit dialed. These relays connect the sleeve leads of the selected trunk group to the common test relays, and prepare the select-magnet and hold-magnet operate paths to the associated crossbar switch. The chain relay also closes ground through contacts of the select magnet operate relay to energize a select magnet of the crossbar switch. Since the selector relay circuit involved in the call being considered is permanently associated with a specific horizontal path in the crossbar switch, it is necessarily associated with a particular select magnet of the switch.

The trunk sleeve conductors, which have been "called in," are connected to the test relay circuit. There usually are 10 test relays, so arranged that only one of them can be fully operated at a time. They are adjusted so that they will operate in series with 250 ohms to negative battery (indicating an idle-path condition); however, two relays testing the same sleeve wire cannot operate because of the current-limiting effect of the 250-ohm resistor. This prevents double selection of trunks on simultaneous testing by two selector groups. Operation of any common test relay chooses the path to the next stage. The select magnet operating closes off normal ground through contacts of the operated test relay to energize the corresponding hold magnet of the crossbar switch.

Operation of the hold magnet of the crossbar switch closes the selected crosspoint, and in turn grounds the sleeve to operate the cut-off relay in the selector relay unit. The cut-off relay releases the chain relay, which in turn releases the common test relay circuit. The hold magnet locks to ground on the sleeve and the loop of the calling line is extended through the operated crosspoints of the crossbar switch to the selected circuit in the next stage. Operation of the selector cut-off relay releases the line and hold relays of the selector, but the next-stage circuit returns ground on the sleeve conductor to maintain the established path. The magnetic impulse counter remains operated until the selector cut-off relay restores on release of the connection.

While at a given instant, only one call in a group of 12 selector circuits may be in the process of actual switching, the operation is so rapid that a single test circuit is well able to perform the tasks for the group. Only after the selecting digit has been recorded on its counter, is the selector permitted to demand the test circuit. The test circuit acts in a fraction of a second and, having completed the switching operation for that call, becomes available for the next demand which may come from any other selector circuit in the same group.

If the common test relay circuit finds that all trunks are busy, the busy relay of the selector relay unit will be operated. Associated common equipment will be released, and busy tone returned to the calling party.

It should be pointed out that the selector just described is the basic one, and that there are variations to meet special requirements. One of these variations is the digit-absorbing selector. The necessity for such a switching device frequently arises because of the technical requirements of nation-wide operator toll dialing, and nation-wide customer toll dialing. Normally, the directory numbers in an exchange include only the digits necessary for the local switching and selecting functions. However, the introduction of long-distance dialing, with the nation-wide numbering plan, necessitates in

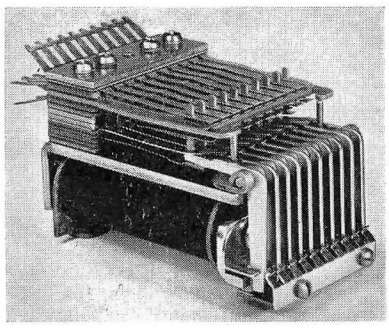

Fig. 5. Magnetic impulse counter

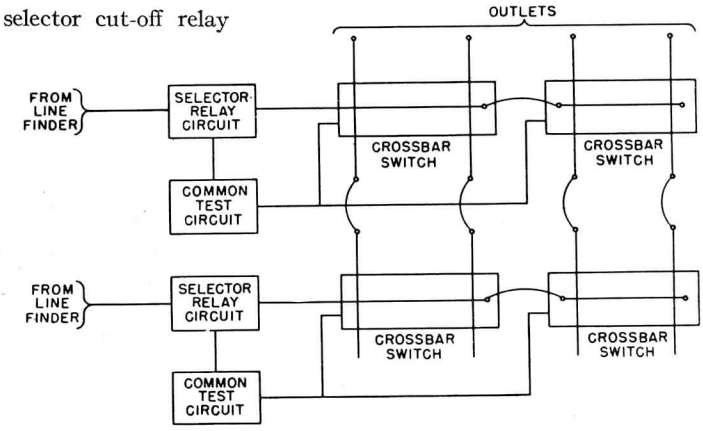

Fig. 7 (right). Block diagram of type-7 selector

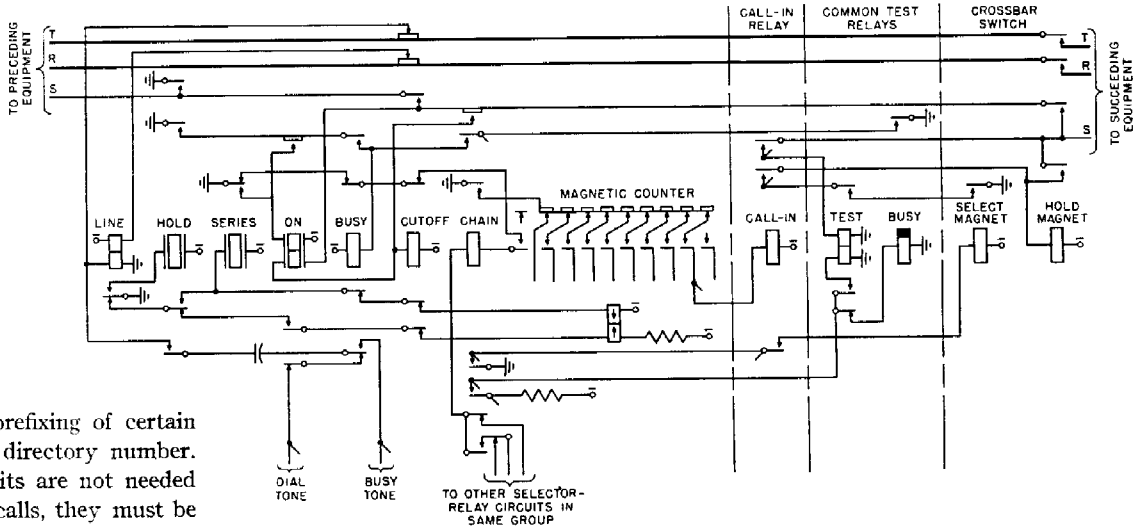

Fig. 8. Schematic diagram of type-7 selector

some exchanges the prefixing of certain digits to the normal directory number. Since these prefix digits are not needed for locally originated calls, they must be absorbed.

The absorption of unneeded prefix digits is accomplished in the type-7 selector by registering them on the magnetic counter in the usual manner and, if the digit is to be absorbed, the counter is released so it will be prepared to receive the next digit. On receipt of a significant digit, the selector action proceeds as in the basic selector already described.

It should be mentioned that the connector (or final selector) of the type-7 crossbar system utilizes the same type of crossbar switches, relays, and magnetic counters used in the group selector. However, the connector normally permits selection of a particular line terminal in a group of 100, rather than choosing an idle path in a selected group of trunks.

Conclusion

While a crossbar switch associated with a selector group may have several of its transmission paths closed at a given time, only one path may be in the process of closing at a given instant. To minimize the time required in testing available paths and in closing the desired cross-points, the type-7 selector has been arranged to test all available outlets of the selected group simultaneously rather than in sequence. By this method, the testing and connecting time is no greater for the last-choice path than for the first-choice path. These factors made possible the design of a direct-access decimal-type crossbar group selector that readily cooperates with decimal systems of other types.

No Discussion