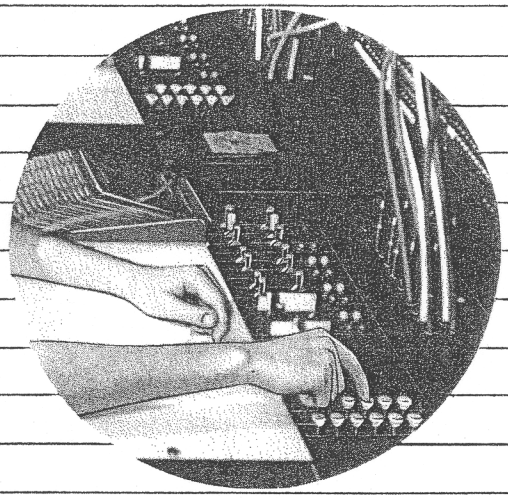
AUTOMATIC ELECTRIC TRAINING SERIES | Bulletin **816**

The TOLL SWITCH TRAIN

STROWGER AUTOMATIC TELEPHONE SYSTEMS



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May we send you others
pertaining to equipment in your exchange?

THE TOLL SWITCH TRAIN

1. GENERAL.

The toll switch train is composed of a series of selector and connector switches available with all services only to the toll operators; combination toll and local connectors are, however, available to subscribers for local calls when other equipment is busy. Special features, intended for operators alone, are not available to subscribers who seize such equipment. The subscribers, of course, do not realize that they have seized combination switches, because, on local calls, such switches operate just as any regular switch.

A toll train is recommended in a telephone exchange to increase the efficiency in handling toll calls from a toll board or from inter-toll dialing trunks. The advantages in a toll train that are not normally present in a local switch train include the following: flash busy signals, ring-start control and re-ring for the delayed-toll service operator, re-ring to P-B-X's, changing cords without releasing the switch train, reduction in line noise by the use of a repeating coil in transmission circuit, coin control by the operator for pre-paystation service, and a reduction in interference from local traffic with incoming toll traffic. Furthermore, the latest toll train includes means for an intercept operator to identify a toll call and permits her to flash back the toll operator, thus expediting the call.

In principle, the toll switch train is similar to the regular train of switches through which regular subscribers make their calls except that a separate control lead is provided over which the ringing is controlled and that transmission battery is fed from the first switch in the train instead of from the connector. This latter feature permits by-passing the transmission circuit when it is necessary for the operator to have a direct path to the subscriber's line. The toll switch train, however, is used only by the toll operators in making calls in one direction -- from the toll board to the subscriber. This train of switches gives the toll operator the special control and supervisory facilities which assist in the rapid completion of incoming toll calls.

1.1 Delayed Ring. -- Toll connectors, unlike regular local connectors, do not start the ringing until the operator initiates it by operating the ringing key. Once this key is operated momentarily, the connector rings the called station repeatedly until the call is answered or abandoned. This feature is particularly advantageous where an operator wishes to hold a subscriber's line until she completes the outward toll connections. Then she immediately operates the ringing key, signaling the calling party to tell him that his toll call (outward) is ready. (By optional wiring, ringing may be started automatically on calls from inward positions. There is, of course, no reason to delay ringing on toll calls coming into the exchange. Thus, the operators, handling incoming toll calls, do not have to operate ringing key in order to start ringing.)

1.2 Flash Busy. -- A busy condition may be indicated to the toll operator either by the audible busy tone or by a flashing of the supervisory lamp. The latter condition is referred to as "flash-busy". It is essential with automatic toll boards and all other boards where a keyset instead of a dial is used by the toll operator (she would otherwise not get the full benefit of the greater efficiency of the keyset); it is also required in the W. E. Co. #3 toll boards due to their circuits. Various flashing signals are used for different conditions - such as 60 interruptions (flashes) per minute for line-busy, 120 I.P.M. for all-trunks-busy.

1.3 Transmission Circuit. -- The toll train supplies talking battery to the called station by a special transmission circuit which includes a repeating coil bridge. The repeating coil provides a better balance and reduces the effect of unbalanced line conditions.

1.4 Changing Cords. -- The toll train switches can be held operated either by the called party or by the operator alone. If a subscriber complains about a noisy connection and the operator wishes to change the cord circuit, this feature enables her to remove the cord from the completing trunk and to reinsert a new cord without losing the connection. This cannot be done with local connectors.

1.5 Re-ring. -- When the called party disconnects prematurely and until the operator removes the plug connecting the toll board to the switch train, the operator can re-ring the line by operating the ringing key. This releases the ring cut-off relay in the connector, starting the ringing again. "Re-ring" is the same as delayed ring with the additional feature that it not only permits re-ringing a subscriber who has replaced his handset but will also resignal a P-B-X or paystation operator; that is, where an answering bridge is across a called line such as at a P-B-X with blocked supervision, the operator may not release the

ring cut-off relay to restore automatic ringing but instead connects regular straight line ringing current direct to the called line. This will resignal the P-B-X operator.

1.6 Coin Box Service. -- In automatic exchanges serving pre-pay multi-coin boxes, the toll train permits collect and refund service on inward or delayed toll calls from such stations. A special "coin type" toll train is required.

1.7 Intercepted Calls. -- Some toll calls, failing to reach the called parties, end up at the intercepting operator. Frequently the toll operator does not stay with a given connection but proceeds with other calls until she receives a visible supervisory signal. But local intercepting circuits do not ordinarily provide such supervision; hence special provisions must be made. First the intercepting operator must receive a special tone on toll calls as a warning that she must flash the toll operator, and secondly, the intercepting operator must be provided the means for flashing the toll operator. The supervisory signals of the toll train, however, operate over the intercepting trunks as well as over the subscriber's lines. Thus the intercepting operator can get the inward toll operator's attention by causing her supervisory lamp to flash.

NOTE: The toll switch train described in this bulletin does not include "coin box service" nor "intercepted call service."

1.8 Toll Dialing. -- Increasing use is being made of dialing over toll circuits to complete toll calls directly from the originating toll exchange. Calls of this type may be completed in the terminating exchange either through the local switch train or through a toll train. The latter method has the advantage of giving a flash busy.

On short-haul toll traffic, called A-B toll, the A-B toll train is exactly like the toll train described except that the start of ringing is automatic. In a suburban area or a small toll network, the operator puts the call through directly, and if the connection cannot be completed, the call is abandoned, the operator making no attempt at holding a line for recall; hence, there is no need for delayed ringing.

2. DESCRIPTION OF SWITCHES.

The typical toll train, described in this bulletin, consists of a toll transmission selector, a toll intermediate selector, and a combination toll and local connector. See figure 1. Very often the toll transmission relays are mounted in a group separate from the first toll selector. Such a group of relays are called the "toll transmission relay group."

The toll transmission selector unit consists of the usual selector relays and switch mechanism, and, in addition, a repeating coil, transmission condensers, and resistance coils. To provide for the extra equipment, the base of the switch is approximately twice as long as that of an ordinary selector, and requires two selector shelves, spaced at the standard distance, for mounting. The toll transmission selector functions in the same manner as a local selector when hunting a trunk leading to a toll intermediate selector. It differs from a local selector in that after the selector operation is completed, it has additional duties, namely: to repeat the impulses to the toll intermediate selector and to the toll connector, to supply talking current to the called subscriber, and to provide for all necessary supervision. Another difference is that the toll transmission selector has a 400-point bank. The fourth wire, termed the "extra control" lead, is necessary to control the start of ringing by the combination connector. The circuit of a typical toll transmission selector is shown in A of figure 2.

The toll intermediate selector is similar to a regular selector except for its 400-point bank. The fourth contact is necessary, as in the transmission selector, to carry the E.C. lead through to the toll connector. As direct trunks from the toll board to each office are generally employed, only one intermediate selector would be required in a toll switch train in what is ordinarily a 5-digit system (100,000 lines). The circuit of a typical toll intermediate selector is shown in B of figure 2.

Combination toll and local connectors are usually employed, which are connected to the last contacts on the local selector bank levels and to the first contacts on the toll selector bank levels. Thus, the combination connectors are not used for local calls except when all the regular connectors are in use. Only the combination connectors are available to the toll intermediate selectors. On calls from a local selector the combination connectors operate in the regular fashion, but, on toll calls, the operation is special to provide for supervision, special talking battery, and manually controlled ringing. The circuit of a typical combination toll and local connector is shown in C of figure 2. The combination connector may be of the trunk-hunting, ten-party frequency selecting, or of any other special type. However, connectors exclusively for toll service are also employed.

3. TOLL CALL PROCEDURE.

The toll board and switch train may be equipped for either an audible busy signal (the conventional busy tone) or a visual busy signal (a flashing lamp).

To complete a call from the toll board to an automatic subscriber, the operator plugs the calling cord into a trunk leading to a toll transmission selector in the dial office; operates the "dial" and "talk" keys, and dials the desired number. When the operator is ready to ring the called party, the operation of a ringing key will cause the operation of an a-c relay in the toll transmission selector, which results in the start of automatic ringing by the toll connector. The supervisory lamp is extinguished when the called party answers. At the time the conversation is completed and the called party replaces the receiver, the

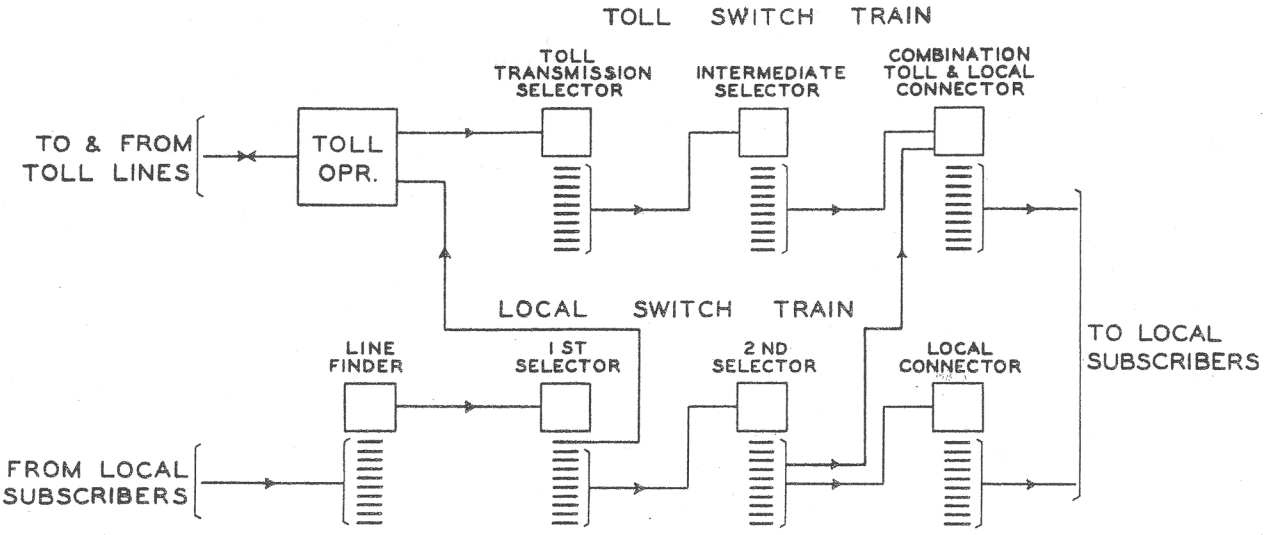

FIG. 1 Toll Switch Train and Local Switch Train.

supervisory lamp again lights, giving the operator disconnect supervision.

If an all-trunks-busy condition is encountered at the toll transmission selector, or at an intermediate selector, the supervisory lamp flashes at a certain frequency (or busy tone is received). If the dialed line is busy, the lamp flashes at a different frequency (or busy tone is received). When a busy condition is encountered, the toll operator must release the connection and dial over again, the same as a regular subscriber.

4. CIRCUIT EXPLANATION OF TOLL TRAIN.

The circuit operation of the component parts of the Toll Train are discussed in the following subsections.

4.1 Selector Action of Toll Transmission Selector (A of figure 2).

When the toll operator connects to the toll transmission selector trunk, the line relay A is operated through its lower winding as follows: from "+" battery at a break contact of S, a "Z" resistance, one winding of the repeating coil, the "+" toll trunk, through the toll board circuits, the "-" toll trunk, a winding of the repeating coil, a "Z" resistance, break contact of relay S, break contact of relay H, lower winding of A, a break contact on the release magnet, to "-" battery.

Relay A operates B, which grounds the control trunk. This places busy protection on the trunk by means of a lamp, or other signal, at the toll board (or holds a selector operated when it is used). Relay A follows the impulses from the dial and operates C and the vertical magnet. Relay C, in addition to its regular functions, short-circuits the winding of the repeating coil in the "-" trunk. The effect of the short-circuited winding is to reduce the impedance in the impulsing circuit by two methods: (1) the repeating coil in the "-" trunk is removed from the impulse path, and (2) the impedance of the remaining coil, which is in the "+" side of the impulsing loop, is very much reduced.

The operation of the off-normal springs causes the operation of the rotary interrupter relay E. When C falls back, the rotary magnet is energized, steps the wipers to the first contact, and breaks the circuit to E. If the first trunk is busy, ground is conducted over the C wiper to E, which re-energizes the rotary magnet. The switch will rotate under the action of E and the rotary magnet until an idle trunk is found; whereupon the "switching through" relay R, heretofore shunted by "+" battery on the control trunk and the C wiper, will operate in series with E. Relay E does not operate.

When relay R operates, the circuit to the line relay A is still maintained. The operation of R closes the circuit of the line relay A-1 of the toll intermediate selector by a loop through the 125-ohm winding of relay S as follows: "-" battery, upper winding of A-1, break contact of F-1, "-" wiper, make contacts of A and R, break contact of F, a winding of the repeating coil, break contact of S, 125-ohm winding of S, another winding of the repeating coil, break contact of F, make contact of R, "+" wiper, contact of F-1, lower winding of A-1 to "+" battery.

Relay S does not operate except to close its "X" contacts because of the opposing effect of the circuit closed by R through the 1300-ohm winding at the same time the circuit through the 125-ohm winding is established. This circuit is "+" battery, make contacts of A and R, cam springs, break contact of S, 1300-ohm winding to "-" battery.

The closing of the "X" contact forms a locking circuit from "+" battery at the off-normal springs to the 1300-ohm winding.

4.2 Impulsing to the Toll Intermediate Selector (B of figure 2).

The impulses to the toll intermediate selector are repeated by contacts of the A relay to the A-1 relay. The slug on S prevents the complete operation of S, by the 1300-ohm winding, when the circuit through the 125-ohm winding is momentarily broken during impulses.

The vertical and trunk hunting motions of the selector are standard. When the switching-through relay F-1 operates, the loop through the 125-ohm winding of S completes a circuit to the line relay A-2 of the combination connector; F-1 remains operated from multiple grounds on the control trunk, furnished by B and B-2; A-1 releases as customary. Ground from B, over the control trunk, makes the combination connector busy to both local and toll selectors from the instant of seizure.

4.3 Impulsing to the Combination Connector (C of figure 2).

Impulses to the A-2 relay are repeated by A. The impulse path, at the connector, is from "+" battery at a break contact of K-2 break contacts of A-2, make contacts of B-2, the vertical off-normal springs, relay coil C-2, and the vertical magnet.

In addition to its usual duty, the series relay C-2 energizes the 1300-ohm winding of the ring-cut-off relay F-2 from "generator ground" at the toll transmission selector, the E.C. lead, a make contact of C-2, the 1300-ohm winding of F-2 to "-" battery. F-2 locks itself up through its "X" contact and the 125-ohm winding of K-2, the "supervisory control relay," to the same ground on E.C. The 125-ohm winding of K-2 is short circuited through the "X" contact of F-2.

After the last impulse of the series, relay C-2 restores, opens the operating circuit to F-2, removes the shunt on K-2, allowing the 125-ohm winding to be energized in series with F-2, and transfers the impulsing circuit to the rotary magnet. K-2 operates only its "X" contact, connecting, but not energizing, its 1300-ohm winding in parallel with the 1300-ohm winding of J-2.

A-2 follows the impulses of the last digit and, through its back contact, closes the circuit to E-2 and the rotary magnet. E-2 connects the busy relay H-2 through to the control wiper, opens a part of the incomplete busy tone (or busy flash) circuit so that no signal is sent back to the toll operator when passing over busy lines, and short circuits the back contact of H-2 through which the impulsing circuit is taken. The rotary magnet rotates the shaft, moving the wipers to the dialed line.

4.4 Switching Through to a Free Line.

When E-2 restores, the 125-ohm winding of J-2 is energized over the control wiper in series with the B.C.O. relay of the dialed line equipment. J-2 operates and locks itself up through its "X" contact to ground at B-2.

Relay K-2 operates from "-" battery, 1300-ohm winding, its own "X" contact, contact of H-2, the J-2 "X" contact to ground at B-2. The operation of K-2 transfers the locking circuits of J-2 and K-2 to "+" battery on the control trunk, grounds the local control trunk, separates the local and toll control trunks, and breaks the circuits to A-2 and B-2. The holding circuit of J-2 is from "-" battery, 1300-ohm winding, contact of H-2, "X" contact of K-2, another make contact of K-2 to ground on the toll control trunk.

When K-2 breaks the circuit through A-2, it opens the loop through the 125-ohm winding of relay S of the toll transmission selector. S now operates fully, by the action of its 1300-ohm winding, and reverses battery from A back to the toll board, as well as connecting "battery-feed" relay G to the called line. The reversal of battery operates a polarized relay at the toll board. This relay operates a lamp, which gives the operator "seizure supervision." (This feature is not always provided. If not, cord supervisory lamp is lighted as soon as operator seizes trunk to the toll transmission selector.) The circuit to relay A now includes both windings as follows: "+" battery, upper winding of A, break contacts of F and H, a "Y" resistance, make contact S, a "Z" resistance, one winding of the repeating coil, the "-" toll trunk, through the toll board, the "+" toll trunk, a winding of the repeating coil, a "Z" resistance, a make contact of S, a "Y" resistance, a break contact of H, the lower winding of A to "-" battery.

4.5 Ringing.

The toll operator can now start the ringing, as soon as she is ready, by momentarily throwing her "Ring" key. This operation connects alternating current to the toll trunk, operating the 700-ohm a-c relay D. Relay D operates relay F, which removes generator ground from the E.C. lead, thus permitting relay F-2 of the connector to restore to normal and start the automatic ringing to the called line. A ring back tone is furnished to the toll operator from the connector. Ground, placed on the "+" trunk at the toll board, holds A operated during the ringing.

When the called party answers, relay F-2 operates and again locks up to generator ground on the E.C. lead. Relay G is now operated by the direct current loop through the called telephone and operates relay H. Relay H breaks the direct electrical connection between the toll board and the toll train. This extinguishes the lamp at the toll board and gives the operator "answer supervision." Relay A is held operated by a loop through a 1000-ohm resistance at the toll transmission selector.

During the talking period, relays S, G, H, A, B, R, F-1, K-2, F-2, and J-2 are operated.

The resistance of relay G has been made less than that of a regular back-bridge relay partly because of the resistance of the repeating coils in series with relay G. The repeating coil resistance is generally quite small. The principal reason for the low resistance of G is to permit the flow of more talking current on toll calls than on local calls. This improves the transmission over long distance by increasing the intensity of voice currents.

The repeating coil method of furnishing talking current to the called station is used on the toll transmission selector. The low impedance of the battery-feed relay G prevents the effective use of the condenser-impedance coupling method, such as used in the regular connector. For this reason and others, the repeating coil method furnishes superior transmission. which is highly desirable because of the strict requirements of toll service.

4.6 Re-Ringing.

The toll operator can re-ring a P-B-X, or a subscriber whose receiver is off the hook, by means of generator furnished at the toll transmission selector. The operator throws the same ringing key as before, operating the a-c relay D, which in turn operates F. This connects generator through the make contacts of H and F to the "-" line and generator ground to the "+" line. Relay A remains operated through the same 1000-ohm resistance as before, but through different relay contacts, during the re-ringing. Relay F-2 remains locked up from ground on the E.C. lead at a make contact of H. Relay G remains operated by only one winding as follows: "-" battery, upper winding of G, make contact of S, one winding of the repeating coil, a make contact of F, a 500-ohm resistance, and a make contact of H to ground.

A person who has replaced the receiver of his telephone is re-rung, from the connector, in the same fashion as the initial ringing.

4.7 Release.

When the called person hangs up, G and H release. This reconnects "+" battery from A to the "-" toll trunk and "-" battery through the lower winding of A to the "+" toll lead. This lights the lamp at the toll board and gives the operator release supervision.

When the toll operator releases the trunk, relay A restores followed by B. Relay B releases R, and the two remove "+" battery from the C and E.C. leads, releasing F-1, K-2, F-2 and J-2.

The release of A, B and R completes the toll transmission selector release magnet circuit. The release magnet springs remove "-" battery, during release, from the winding of A, to avoid disturbance due to condenser-inductance discharges. When the off-normal springs restore to normal, the locking circuit of S is opened, permitting S to restore. The release of F-1 by B completed the toll intermediate selector release magnet circuit. The release of K-2 by B completed the combination connector release magnet circuit.

4.8 "Y" and "Z" Resistance.

The "Y" resistance values depend on the current flow limits of the connecting toll board. The "Z" resistances are used to adjust the trunk circuit resistance to a standard value.

5. BUSY CONDITIONS.

The circuit operation necessitated by certain busy conditions is discussed in the following subsections.

5.1 Toll Transmission Selector -- All Trunks Busy (A of figure 2).

When a tone busy is used, the operation is as follows: The removal of "+" battery from the control wiper, as it comes off the bank on the eleventh rotary step, permits R to operate. At the same time, the cam springs operate and connect busy tone through a make contact of R and a break contact of F, one winding of the repeating coil, the condensers, another winding of the repeating coil, contacts of F, the cam springs and through a 1000-ohm resistance to ground. The tone is induced in the toll board side of the repeating coil and carried over the toll trunk to the toll operator.

The operation, when a flash busy is used, is quite different. The flash busy lead is connected to a source of interrupted "+" battery. R operates as before and, after the cam springs close on the eleventh rotary step, the first ground impulse is conducted through a wire strap on the cam springs, a cam spring contact, a break contact of relay S, and the 1300-ohm winding to "-" battery. Relay S closes its "X" contact, operates completely, and locks up to ground at the off-normal springs. The operation of S causes the reversal of battery to the toll board and illuminates the supervisory lamp.

Succeeding ground impulses take a path through the cam springs, a make contact of R, break contact of F, one winding of the repeating coil, a make contact of S, through the upper winding of G to "-" battery. These impulses cause G to pull up and release 60 times a minute. The operation of G causes H to pull up and release in the same fashion, thus alternately breaking the connection from A to the toll board and thus causing the supervisory lamp to flash at 60 interruptions per minute.

5.2 Toll Intermediate Selector -- All Trunks Busy (B of figure 2).

If a busy tone is used, the operation of the cam springs, on the eleventh rotary step, opens the circuit to F-1, preventing it from operating. At the same time, busy tone is connected through the cam springs, a make contact of B-1, a break contact of F-1, the cam

springs, through a condenser, to the "-" trunk, over the trunk, through two windings of the repeating coil, back over the "+" trunk, and the winding of A-1 to ground. The busy tone is carried to the toll board by induction through the repeating coil.

If a flash busy is used, the operation varies from that just given. After the cam springs operate on the eleventh step, the first ground impulse, over the 60 I.P.M. lead, takes a path through the cam springs, a make contact of B-1, a break contact of F-1, the winding of F-1, the rotary interrupter contacts, the off-normal springs, and the winding of relay E-1 to negative battery. Relay E-1 does not operate, but relay F-1 closes its "X" contact, operates, and locks itself to ground on the control trunk from the toll transmission selector. The operation of F-1 breaks the circuit to A-1, opening the loop through the 125-ohm winding of S, and thus permitting the 1300-ohm winding to completely operate S. Succeeding ground pulses take a path through a jumper on the cam springs, the cam spring contacts, a make contact of F-1, and over the "-" trunk, ending at "-" battery through the winding of G. This results in the supervisory lamp at the toll board flashing at the rate of 60 I.P.M., as explained for the toll transmission selector.

5.3 Called Line Busy (C of figure 2).

The combination connector also operates differently according to whether a tone busy or flash busy is used. When a tone busy is used, the restoring of E-2 locks up the busy relay H-2 and completes a circuit from the busy tone lead, through a make contact of F-2, break contact of E-2, make contact of H-2, through the condenser in the "-" trunk lead, through the "-" trunk, the repeating coil, back over the "+" trunk, break contacts of K-2 and D-2, and through the lower winding of A-2 to ground. The busy tone is carried to the toll operator by induction through the repeating coil as before.

When a flash busy is used, E-2 falls back, locks up H-2 and completes a circuit from ground on the flash busy lead, through contacts of F-2, E-2, H-2 and K-2 through one winding of D-2 to "-" battery. D-2 operates and connects ground from a make contact through an "X" contact of K-2, and the K-2 1300-ohm winding to "-" battery, K-2 operates, locks itself up from ground on the control lead, and breaks the circuit to A-2. This permits S, of the toll transmission selector, to operate. Succeeding ground pulses are diverted from D-2 and take a path through contacts of F-2, E-2, H-2 and K-2, the "-" toll trunk, and ending at "-" battery through one winding of G. Battery is reversed and interrupted back to the toll board by the same method as explained under "Toll Transmission Selector, All Trunks Busy." The supervisory lamp flashes at the rate of 120 I.P.M., instead of 60 I.P.M. as before, permitting the operator to discriminate easily between "all-trunks-busy" and "busy-line" conditions.

Reprinted March 1959

Printed in U.S.A. by John S. Swift Co., Inc. 3-59

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