TWO-POINT FOREIGN EXCHANGE SERVICE TOLL FACILITY ARRANGEMENTS WITH E & M LEAD SIGNALING

CONTENTS PAGE

1. GENERAL

1.01 Included in this practice is a general description of foreign exchange services that use toll facilities and a more detailed description of the operation of foreign exchange circuits that use dial long line equipment per Drawings SD-96251-01 and SD-96252-01.

1.02 Foreign Exchange Service (FX) is that of providing the requisite facilities, including channels and station equipment, by which the customer may obtain local exchange service in an exchange foreign to the exchange district in which he is located.

1.03 One end of each circuit terminates in either a station handset or PBX. Future references will refer to this as the "subscriber end" of the circuit. The other end of each circuit terminates at a local exchange central office in a Telephone Company switchboard (A or DSA board) and/or dial switching equipment. This end of the circuit is referred to as the "central office end" of the circuit.

1.04 The arrangements described in this practice can also be used to provide service to an off-premises PBX station.

1.05 Detailed description of the operation of the individual equipment units used in providing foreign exchange service is not included in this practice. Instead, the descriptive information included herein is based on over-all circuit operation and conditions, i.e., the information is presented in a manner so as to aid testboardmen in accurate analyzation of circuit conditions so that troubles and potential troubles can be quickly located and cleared. The detailed description of specific equipment units can be found in the associated SD Drawings and CD Sheets.

2. CIRCUIT OPERATION — GENERAL

2.01 To facilitate the presentation of information in this practice a series of drawings has been prepared. In each case the two terminal toll offices and the local office at the central office end are designated in a uniform manner as shown in Fig. 1. The letter designations shown in Fig. 1 are also used in text when describing circuit operations.

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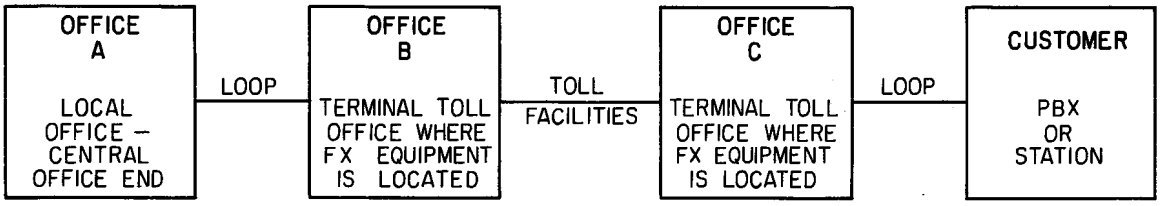

Fig. 1

2.02 The term "loop" as used in this practice refers to all of the facilities between offices A and B and between office C and the subscriber. These loops in many cases will include exchange trunks (facilities between two local central offices) and toll connecting trunks (facilities between a toll office and a local office).

2.03 Throughout this section the terms "on-hook" and "off-hook" are used in describing the circuit operation at the subscriber end of the circuit. When the subscriber's telephone is removed from its cradle or switchhook or when the PBX operator has a plug inserted in the circuit PBX trunk circuit jack, the circuit condition at the subscriber end is said to be "off-hook." When the subscriber's telephone is "hung-up" or when no plug is in the PBX jack, the circuit is said to be "on-hook" at the subscriber's end.

2.04 At office A, foreign exchange circuits terminate in standard subscriber line circuits; the exact type being determined by the type of local exchange equipment at office A.

2.05 At the subscriber's end, standard central office trunk terminations or long trunk circuits are used for PBX terminations and standard telephone sets, such as those used for local telephone service, are furnished for station terminations. In each case a dc path is closed across the loop at the subscriber's station or PBX when an off-hook condition exists. The dc path is opened in the on-hook condition.

2.06 A local telephone number is assigned to the foreign exchange circuit at the local exchange office (office A). On inward calls to the subscriber the calling party is connected by dial switching equipment at office A or by a Telephone Company operator at office A to the foreign exchange circuit for communication with the subscriber. On outward calls from the subscriber, the off-hook condition at the subscriber end automatically signals the A or DSA operator at office A who completes the call; or in the case of dial foreign exchange service, the off-hook condition at the subscriber end causes the foreign exchange circuit at office A to be connected to the local dial equipment so that the subscriber can dial his call.

2.07 If office A is a manual office:

(a) Office A termination is a Telephone Company "A" board jack.

(b) The subscriber's end of the foreign exchange circuit terminates in a manual PBX or manual switchboard associated with a dial PBX or in a station set.

(c) Inward calls to the subscriber are completed by the "A" board operator on a ringdown basis.

(d) Calls from the subscriber are automatic without dialing. An off-hook condition at the subscriber's end automatically signals the "A" board operator who completes the call.

2.08 If office A is a dial office and dialing from the subscriber is not desired or is not possible because of equipment not being available or because the subscriber's PBX is not equipped for dialing:

(a) Office A termination is a Telephone Company "DSA" switchboard.

(b) Subscriber's end of the circuit can terminate in a manual or dial PBX or in a station set.

(c) In most cases, inward calls to the subscriber are completed by the dial equipment at office A without assistance of the DSA operator. Signaling is on a ringdown basis towards the subscriber.

(d) Calls from the subscriber are automatic without dialing. An off-hook condition at the subscriber's end automatically signals the DSA board operator who completes the call.

2.09 If office A is a dial office and dialing from the subscriber is provided:

(a) Office A termination is a subscriber's line circuit terminated in the dial switching equipment.

(b) Subscriber's end of circuit can terminate in a dial PBX or in a dial station set.

(c) Inward calls to the subscriber are completed by the dial switching equipment at office A.

(d) Outward calls from the subscriber are dialed; the dial pulses being transmitted to office A for operation of the switching equipment without the assistance of an operator at office A.

2.10 Completely different signaling requirements exist in the two directions of transmission. On inward calls to the subscriber, a ring at office A, usually 20 cycles, must be transmitted to the subscriber's end of the circuit. Part 3 of this section describes one of the methods of converting the ring at office B to a signal that can be transmitted over the toll facilities and then reconverting the signal at office C to a 20-cycle ring towards the subscriber.

2.11 The requirement for signaling from the subscriber is: the equipment at office A must "know" at all times whether an on-hook or an off-hook condition exists at the subscriber's end. In local exchange service the presence of a dc path (off-hook) or absence of a dc path (on-hook) at the subscriber's end is transmitted over the cable pair to control the operation of relays and other equipment at the local exchange central office. In the case of dial service, operation of the dial at the subscriber end also opens and closes a dc path at the subscriber end of the circuit. The dial pulses are similar to alternate on-hook and off-hook conditions except that they are at a much faster rate. When foreign exchange service is provided over toll facilities, the presence or absence of a dc path across the loop at the subscriber end causes foreign exchange equipment at office C to function and transmit signals over the toll facilities to office B. The foreign exchange equipment at office B responds to these signals so that a dc path is opened and closed at office B towards office A in step with the on-hook and off-hook conditions and dial pulses at the subscriber end. The dc path that is opened and closed at office B is usually referred to as a supervisory bridge. The supervisory bridge across the loop usually consists of an inductor and resistor in series and has very little effect on voice transmission. For dial foreign exchange service, the equipment that is used to transmit the dial pulses between offices C and B must be such that the correct length of pulses (correct per cent make and break) are transmitted to office A. Part 3 of this section describes one of the arrangements used for transmitting switchhook signals and dial pulses over toll facilities.

2.12 Two-wire loops are normally used between office A and office B and between office C and the subscriber.

3. DIAL FOREIGN EXCHANGE SERVICE USING DIAL LONG LINE EQUIPMENT PER DRAWINGS SD-96251-01 AND SD-96252-01

3.01 In order to permit the subscriber to dial outward calls through office A, dial long line equipment (DLL) is furnished at offices B and C. Drawing SD-96251-01 covers the equipment at office B (central office end), and SD-96252-01 covers the equipment at office C (subscriber end).

3.02 The dial long line equipment converts the opens and closures of the loop at the subscriber end (on-hook and off-hook signals and dial pulses) to E and M lead signaling. The 20-cycle signaling current from office A is also converted to E and M lead signaling. Standard single frequency (SF), type B composite, or built-in N and O carrier signaling systems are employed to transmit the signals between offices B and C. Description of these signaling systems can be found in other standard practices. In order to assist test rooms in the servicing of foreign exchange circuits, some frequently used arrangements employing SF signaling, O carrier signaling, and combination of SF and N carrier signaling are described in this section even though those arrangements are not specifically covered by the standard drawings at the present time.

3.03 Operation of a typical foreign exchange circuit employing SF signaling is described in Paragraph 3.07-3.17. Circuits employing other signaling systems (N, O, or CX) are

described in less detail since their operation is similar in most respects to the operation using SF signaling.

(A) Signaling Arrangements — Central Office End Toward Subscriber

3.04 Two different arrangements are used for transmitting 20-cycle ringing current from office A to the subscriber. Fig. 2 of this section shows signaling arrangements using Option J of SD-96251-01 at office B and Fig. E of SD-96252-01 at office C. Fig. 3 of this section shows signaling arrangements using Option K of SD-96251-01 and Fig. F of SD-96252-01. The use of these options and figures is dependent on the type of signaling system employed. Fig. E of SD-96252-01 must always be used with Option J of SD-96251-01 and in a like manner Fig. F must always be used with Option K.

3.05 In Fig. 2 with the circuit in the idle or talking condition, battery is connected to the M lead at office B and the E lead at office C is grounded. The E relay is operated and the R relay is released. When a 20-cycle ring is connected at office A, the R relay operates at office B which in turn operates the R1 relay. Operation of the R1 relay changes the M lead condition from battery to ground. The E lead condition at office C changes from ground to open and the E relay releases. With the E relay released, the R relay at office C operates and connects 20-cycle ringing current toward the subscriber.

3.06 In Fig. 3 the E and M lead conditions are reversed. With the circuit in the idle or talking condition, the M lead has ground connected to it. The E lead at office C is open and the R relay is released. When 20-cycle ringing current is connected at office A, the R and R1 relays operate at office B. Operation of the R1 relay changes the M lead condition from ground to battery. The E lead condition at office C changes from open to ground, thus operating the R relay. The R relay in the operated condition connects 20-cycle ringing current towards the subscriber.

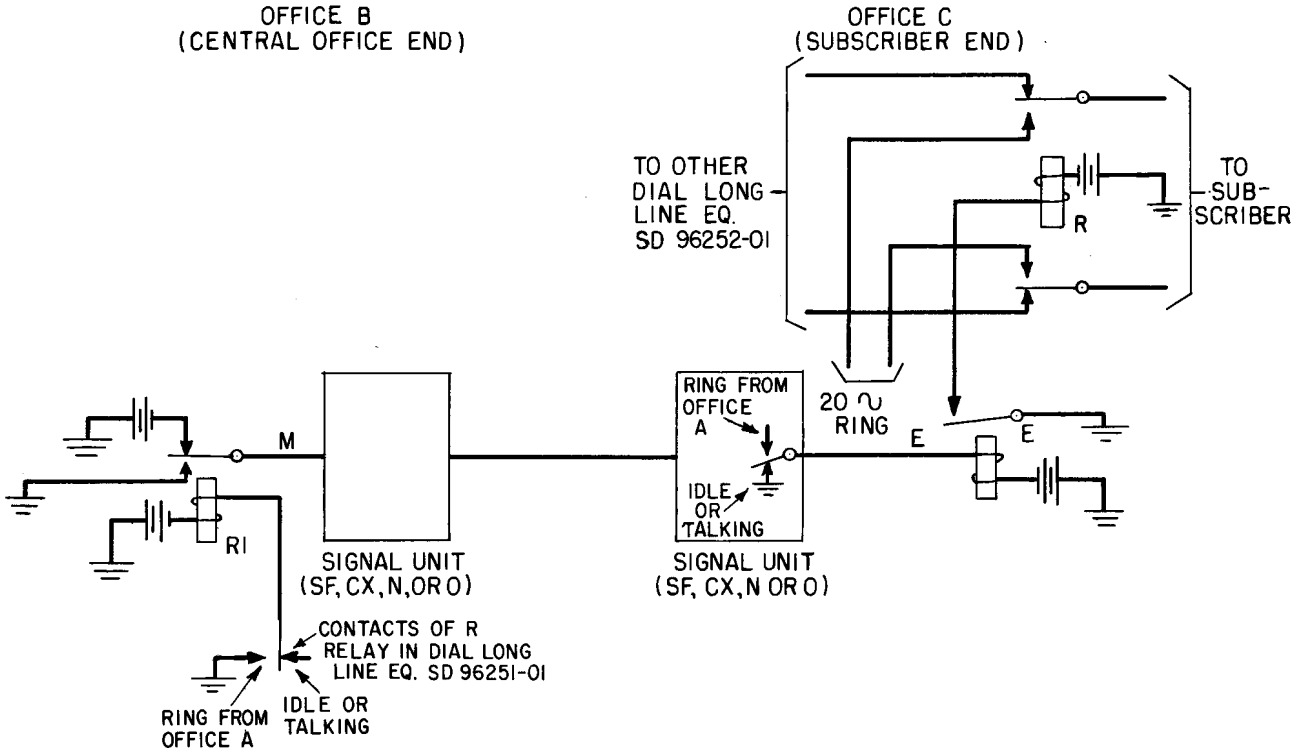

Fig. 2 — Foreign Exchange Circuit Signaling — Inward Signaling to Subscriber Using Option J of SD-96251-01 and Fig. E of SD-96252-01

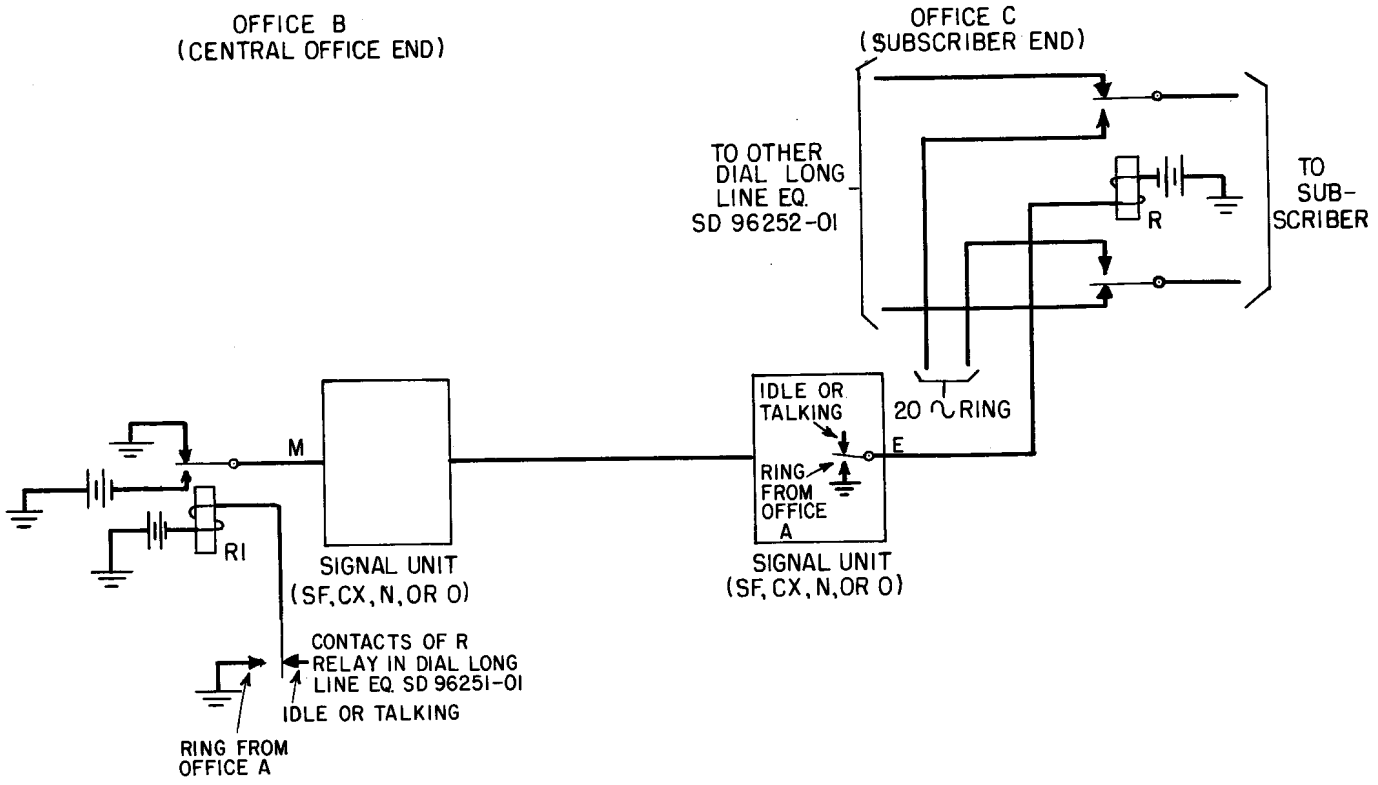

Fig. 3 — Foreign Exchange Circuit Signaling — Inward Signaling to Subscriber Using Option K of SD-96251-01 and Fig. F of SD-96252-01.

(B) Operation Using Single Frequency Signaling Units

3.07 The conditions described in Paragraphs 3.08-3.17 that follow are applicable when signaling from office B to office C (inward signaling toward the subscriber) is per Fig. 3 of this section.

Idle Condition (Fig. 4)

3.08 At office B the R relay of the dial long line equipment is connected across the tip and ring of the loop ready to operate on ringing current from office A. The loop between offices A and B is opened with an idle circuit termination connected toward the 4-wire terminating set or other hybrid arrangement. The idle circuit termination is a simple resistance termination that can be strapped for 615 ohms, 1000 ohms, or 1600 ohms. The value is determined by the impedance of the loop between offices A and B which the idle circuit termination replaces in the idle circuit condition. The condition of the M lead is controlled by the R relay. In the idle condition, R relay released, ground is connected to the M lead by the dial long line equipment. Ground on the M lead to the SF unit connects SF tone on the line towards office C. SF tone coming in at office B causes the E lead to be open from the SF unit.

3.09 At office C, the P relay operating circuit in series with the A relay operating circuit is open during on-hook conditions at the subscriber's end. The P relay in the nonoperated condition connects ground to the M lead and thus SF tone is transmitted from office C to office B. The A relay in the nonoperated condition causes an idle circuit termination to be connected at office C. One type of idle circuit termination, shown in Fig. 4, consists of a short circuit across the tip and ring of the receiving 4-wire path. Another arrangement that is used to provide a good idle circuit termination consists of short circuits across the tips of the 2-wire line and net and across the rings of the 2-wire line and net. Both arrangements effectively open return current paths through hybrid arrangements. With SF tone being received at office C from office B, the E lead at office C is open.

Inward Call to Subscriber (Fig. 5)

3.10 When a party dials the telephone number assigned to the foreign exchange circuit termination at office A, he is connected to the foreign exchange circuit and machine ringing is connected toward office B. During the two-second intervals that ringing current is connected, the R relay at office B will operate causing the M lead condition to change from ground to battery. Battery on the M lead removes the SF tone towards office C. During the four-second intervals between rings, the circuit is returned to the condition shown in Fig. 4.

3.11 The absence of SF tone at office C causes the SF unit to function and connect ground to the E lead. Ground on the E lead operates the R relay which connects 20-cycle ringing current toward the subscriber. The 20-cycle ring at the subscriber's location operates an audible bell or a relay for signaling the subscriber.

Subscriber Answers Inward Call (Fig. 6)

3.12 When the subscriber answers the call, the off-hook condition closes the A and P relay operating circuits allowing them to operate. Operation of the A relay removes the idle circuit termination. Operation of the P relay connects battery to the M lead and thus the SF tone is removed at office C towards office B. The P relay battery is used for talk battery at the subscriber's end.

3.13 Removal of the SF tone causes the SF unit at office B to operate and ground the E lead. The ground on the E lead operates various relays in the dial long line equipment at office B. The operation of these relays removes the idle circuit termination, cuts the loop through at office B, disconnects the R relay and connects the supervisory bridge across the tip and ring of the loop. Connection of the bridge trips the machine ringing and cuts the transmission path through office A to the calling party.

Outward Call from Subscriber (Fig. 6)

3.14 When the subscriber removes the phone from the cradle or inserts a plug in the PBX jack, the equipment functions at offices B and C as was described in Paragraphs 3.11 and 3.13. That is, at office C the idle circuit termination is removed, battery is connected to the M lead, and the SF tone towards office B is removed. At office B the idle circuit termination is lifted, the transmission path is cut through to office A, the R relay is disconnected, and the supervisory bridge is connected across the tip and ring. The connection of the supervisory bridge at office B causes the equipment at office A to function and connect the foreign exchange circuit to the local dial switching equipment. Dial tone at office A is transmitted over the foreign exchange circuit signifying to the subscriber that the circuit is ready for dialing.

3.15 The subscriber then dials the number he desires. As the dial is released for each digit, the dc path is alternately opened and closed a number of times corresponding to the digit dialed. The first open of each digit dialed causes the P and A relays to release thus reconnecting the idle circuit termination at office C. The relay circuits are so arranged that the idle circuit termination at office C remains connected while the pulses of each digit are transmitted. Alternate battery and ground is connected to the M lead at office C in step with the dial pulses.

3.16 At office B, pulsing SF tone is converted to alternate opens and closes of the supervisory bridge circuit towards office A. The relay circuits at office B are arranged so that the idle circuit termination remains disconnected during dialing.

Flashing and Disconnect Signals

3.17 Flashing is accomplished the same as dialing but at a somewhat slower rate. Disconnect signals are of such duration that the supervisory bridge at office B is disconnected and the idle circuit termination is restored.

Operating Notes for SF Signaling

3.18 While the SF signaling arrangements that employ "tone on" towards office C during the idle and talking conditions (Paragraphs 3.08-3.16) are frequently used, there are some minor deficiencies in this type of operation. The SF tone that is applied towards office C in the talking condition is not heard by the subscriber as it is removed by a filter in the receiving SF circuit that is automatically inserted when SF tone is received. However, the filter in the talking path

results in slightly degraded transmission towards the subscriber. The design of SF units is such that SF tone is applied by bridging it onto the main transmission path in the SF unit. Because of this, the SF tone in addition to being transmitted toward office C where it is filtered out will also feed back to the 2-wire side at office B. The level of the SF tone at this point is approximately 45 db below circuit level and is not normally heard at office A or by a party connected to the foreign exchange circuit at office A. An amplifier is sometimes used between the transmitting side of the terminating set and the transmitting side of the SF unit at office B to prevent the SF tone from being fed back to the 2-wire side. Another deficiency in the signaling arrangements that employs "tone on" during the idle and talking conditions is the danger of false rings toward the subscriber. Since ringing signals are transmitted from office A to the subscriber by removal of SF tone, any open or excessive loss in the transmission path from office B to office C will cause ringing current to be connected toward the subscriber. The false rings can occur either while the circuit is idle or while it is in use by the subscriber.

3.19 The difficulties discussed in Paragraph 3.18 are sometimes overcome by using the arrangements shown in Fig. 2 for signaling toward the subscriber. When this arrangement is used, SF tone is transmitted toward office C only when ringing current is applied at office A. However, when signaling arrangements per Fig. 2 are used it is necessary to strap contacts 1T and 2T of the M relay in the SF unit at office B. This modification disables that portion of the receiving SF guard circuit that is under control of the M lead and is necessary to prevent dialing errors that would be caused by the guard circuit.

3.20 When the arrangements described in the preceding paragraph are used, the problems of SF tone interference, false rings, and slightly degraded transmission are eliminated. However, the nonstandard strapping of the M relay in the SF unit is not always desirable, especially at offices that have a large number of SF units to maintain. The danger of "talk-off" is increased due to strapping out part of the guard circuit in the SF unit at office B. There is no change in circuit operation for transmission of switchhook signals and dial pulses from the subscriber to office A.

(C) Operation Using N and/or O Carrier Facilities

3.21 Foreign exchange circuits composed entirely of N and/or O carrier channels normally use the associated built-in signaling system for the transmission of signals between offices B and C. Arrangements for signaling from office A to the subscriber are those shown in Fig. 2. The circuit operation for transmitting switchhook supervision and dial pulses from the subscriber to office A is similar to that described for circuits employing SF signaling.

3.22 N or O carrier channels can be operated 2-wire using the terminating set associated with the channel unit, or they can be operated 4-wire using an external 4-wire terminating set. Since operation of an N or O carrier channel 2-wire does not provide an office frame appearance for the balancing network, it is necessary to operate the channel 4-wire using an external terminating set at any terminals where a precision type balancing network is required.

3.23 Shown in Fig. 7 is the idle condition of a foreign exchange circuit employing N or O carrier channels operated 2-wire. The idle circuit termination at office C in Fig. 7 is the type that is used when N or O carrier channels are operated 2-wire. If the channel is operated 4-wire, the idle circuit terminating arrangements at office C are the same as those described for SF signaling.

(D) Operation Using Type B Composite Signaling

3.24 The arrangements for providing foreign exchange service employing type B composite signaling are practically the same as the arrangements described for SF signaling. The only difference is CX signaling units are substituted for the SF signaling units and the signals are transmitted between office B and C over dc channels. CX signaling systems are described in other standard practices. Fig. 8 shows the idle condition of a foreign exchange circuit arranged for CX signaling. Either the transmit or receive cable pairs can be composited to obtain the necessary dc channels. The arrangements shown in Fig. 3 are used for signaling from office A to the subscriber.

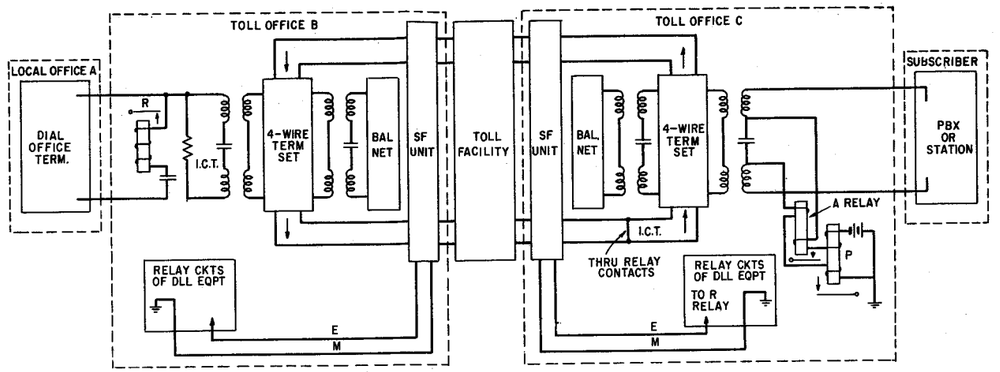

Fig. 4 — Dial Foreign Exchange Service — Dial Long Line Equipment — SF Signaling — Idle Circuit Condition

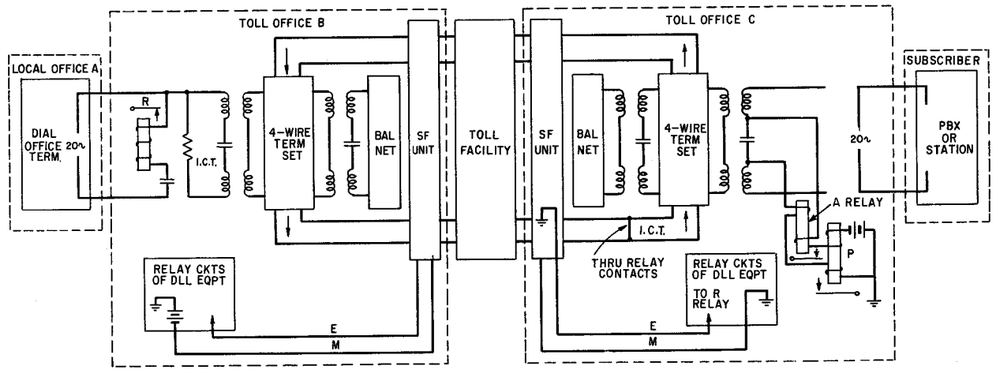

Fig. 5 — Dial Foreign Exchange Service — Dial Long Line Equipment — SF Signaling — Inward Call to Subscriber

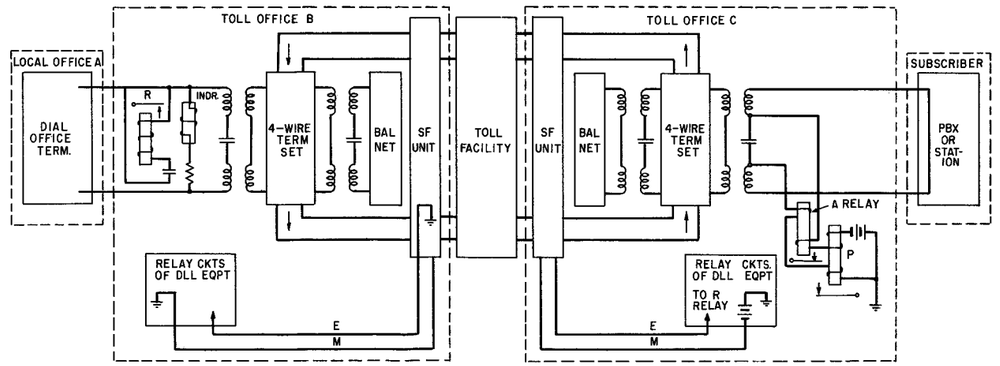

Fig. 6 — Dial Foreign Exchange Service — Dial Long Line Equipment — SF Signaling — Off-hook Condition at Subscriber End

Figs. 4, 5 & 6

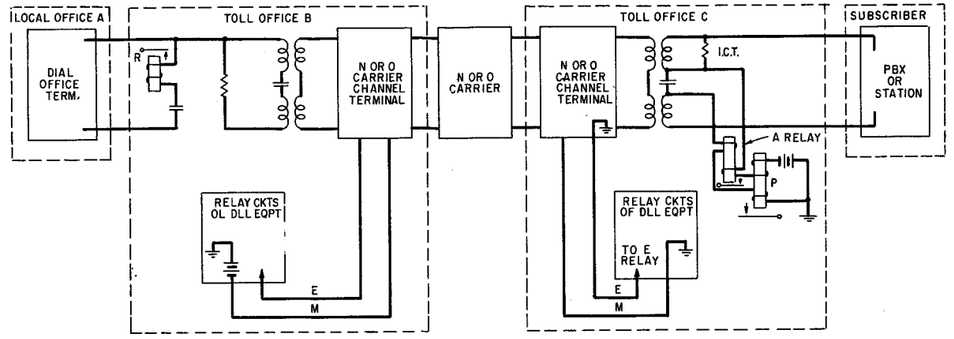

Fig. 7 — Dial Foreign Exchange Service — Dial Long Line Equipment — N or O Carrier Signaling — Idle Condition

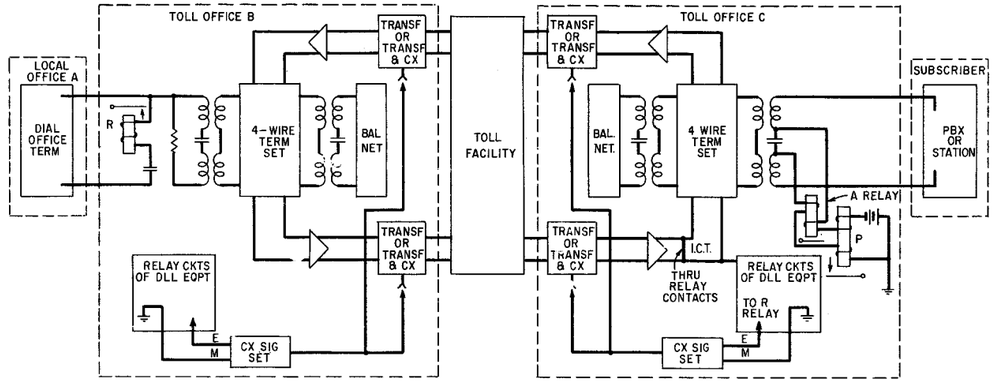

Fig. 8 — Dial Foreign Exchange Service — Dial Long Line Equipment — CX Signaling — Idle Condition

Figs. 7 & 8

(E) Operation of N or O Carrier Channels in Tandem with Other Facilities

3.25 Frequently it is necessary to operate N or O carrier channels in tandem with other facilities when providing foreign exchange service. Built-in N or O carrier signaling is normally used in the N or O carrier section and SF signaling is used in the other section. Pulse link repeaters are used at the junction office for interconnecting the E and M leads of the two signaling systems.

3.26 Signaling from office A to the subscriber can be arranged either according to Fig. 2 or Fig. 3 of this section. The information included in this section for SF signaling (Paragraphs 3.07-3.20) is also applicable when SF signaling is operated in tandem with N or O carrier signaling using pulse link repeaters.

3.27 Occasionally N or O carrier channels are operated in tandem with other facilities and SF signaling is used between offices B and C and the built-in N or O carrier signaling is disabled. If this arrangement is used and dialing transients are not suppressed, dialing errors are likely to occur due to compressor action in the N or O carrier terminals.

(F) E and M Lead and Other Circuit Conditions

3.28 If jacks are connected in the E and M leads at offices B and C, a 1A signaling test set can be used to observe the circuit operation. Tables I and II summarize circuit conditions and indications for foreign exchange circuits employing dial long line equipment per SD-96251-01 and SD-96252-01. Table I is applicable for circuits employing signaling arrangements per Fig. 2 of this section and Table II is applicable for circuits employing signaling arrangements per Fig. 3 of this section.

3.29 Condition (1) in the tables is the idle circuit condition. On an inward call to the subscriber, 20-cycle ringing current is applied at office A and is shown as condition (2). When the subscriber answers, condition (3) should be observed.

3.30 On outward calls from the subscriber, the off-hook condition at the subscriber's location will cause the circuit to change from condition(1) to condition(3). After dial tone is connected at office A, the subscriber dials the desired number. While the subscriber is dialing, condition (4) should be observed. When the dialing is completed, the circuit should return to condition (3).

(G) Operation on Manual Foreign Exchange Circuits

3.31 Dial long line equipment per SD-96251-01 and SD-96252-01 can also be used for terminating manual foreign exchange circuits. When the subscriber transmits an off-hook signal, the connection of the supervisory bridge at office B signals the A or DSA operator who completes the call. As can be seen by Fig. 6, rering by the A or DSA operator is not possible since the R relay is disconnected in the talking condition.

TABLE I

FOREIGN EXCHANGE CIRCUIT CONDITIONS

Dial Long Line Equipment per SD-96251-01, Option J and SD-96252-01, Fig. E

	CIRCUIT CONDITION		SUBSCRIBER'S LOOP	CENTRAL OFFICE END OFFICE B					SUBSCRIBER END OFFICE C				SF TONE*	
	Office A	Subscriber		1A Set		E	M	Supvr	1A Set		E	M	Toward	
				Line	Drop	Lead	Lead	Bdg	Line	Drop	Lead	Lead	Ofc B	Ofc C
(1)	Idle	On-hook	Open	On	Off	O	B	Disc	Off	On	G	G	On	Off
(2)	20-Cycle Ring Conn.	On-hook	Open	On	On	O	G	Disc	On	On	O	G	On	On
(3)	Idle or Busy	Off-hook	Closed	Off	Off	G	B	Conn	Off	Off	G	B	Off	Off
(4)	Dial Eqpt Conn.	Dialing	Alternate Open & Close	On Off	Off	O G	B	Disc Conn	Off	On Off	G	G B	On Off	Off

B — Battery C — Closed G — Ground O — Open Conn — Connected Disc — Disconnected
* Applicable only when SF signaling is employed.

TABLE II

FOREIGN EXCHANGE CIRCUIT CONDITIONS

Dial Long Line Equipment per SD-96251-01, Option K and SD-96252-01, Fig. F

	CIRCUIT CONDITION		SUBSCRIBER'S LOOP	CENTRAL OFFICE END OFFICE B					SUBSCRIBER END OFFICE C				SF TONE*	
	Office A	Subscriber		1A Set		E	M	Supvr	1A Set		E	M	Toward	
				Line	Drop	Lead	Lead	Bdg	Line	Drop	Lead	Lead	Ofc B	Ofc C
(1)	Idle	On-hook	Open	On	On	O	G	Disc	On	On	O	G	On	On
(2)	20-Cycle Ring Conn.	On-hook	Open	On	Off	O	B	Disc	Off	On	G	G	On	Off
(3)	Idle or Busy	Off-hook	Closed	Off	On	G	G	Conn	On	Off	O	B	Off	On
(4)	Dial Eqpt Conn.	Dialing	Alternate Open & Close	On Off	On	O G	G	Disc Conn	On	On Off	O	G B	On Off	On

B — Battery C — Closed G — Ground O — Open Conn — Connected Disc — Disconnected
* Applicable only when SF signaling is employed.

(H) Operating Limits

3.32 The maximum resistance of the loop between offices A and B depends on the ringing supply voltage at office A. For 60-volt ringing supply 1900 ohms resistance is the maximum, and for 72-volt ringing supply 3200 ohms is the maximum.

3.33 The maximum loop resistance from office C to the subscriber is 3000 ohms for proper operation of the dial long line equipment. However, a lower resistance is usually required in order to provide sufficient current through the subscriber's transmitter.

3.34 The dial long line equipment described is designed to operate at dial speeds of 8 to 11 pps. In many cases present PBX's are equipped with 20 pps dials. These dials must be replaced with 10 pps dials when dial foreign exchange circuits are terminated in the PBX.

(I) Required Tests

3.35 The dial long line unit at office B is equipped with test jacks so that pulses can be transmitted on the E lead and the percentage of make and break measured on the loop to office A. These tests should be made prior to initial over-all tests on the foreign exchange circuits and thereafter as required. The requirements for these tests and methods of adjusting the per cent break are covered on the SD Drawing and CD Sheet.

3.36 Pulsing tests should be made on the over-all circuit signaling system prior to placing it in service. These tests are made by pulsing on the M lead at one terminal office and measuring the per cent break on the E lead at the other terminal office. The limits for these tests and the methods of making them are covered in the practices for the various types of signaling systems. It should be noted that the pulsing tests mentioned do not include the dial long line equipment.

(J) Transmission Considerations
Circuit Net Loss

3.37 Foreign exchange circuits are engineered for a specific net loss between the terminals of the circuit, i.e. the local central office (office A as referred to in this section) and the subscriber's PBX jack or the line terminals of the induction coil associated with the subscriber's telephone. The transmitting level at each end is assigned an arbitrary value of O dbm although the actual volume level is likely to be quite different, especially the transmitting level at office A since it is dependent on the level received from the connected trunk. In any case a net loss is assigned to the foreign exchange service so that the subscriber will have as good service or better service than the other subscrib-

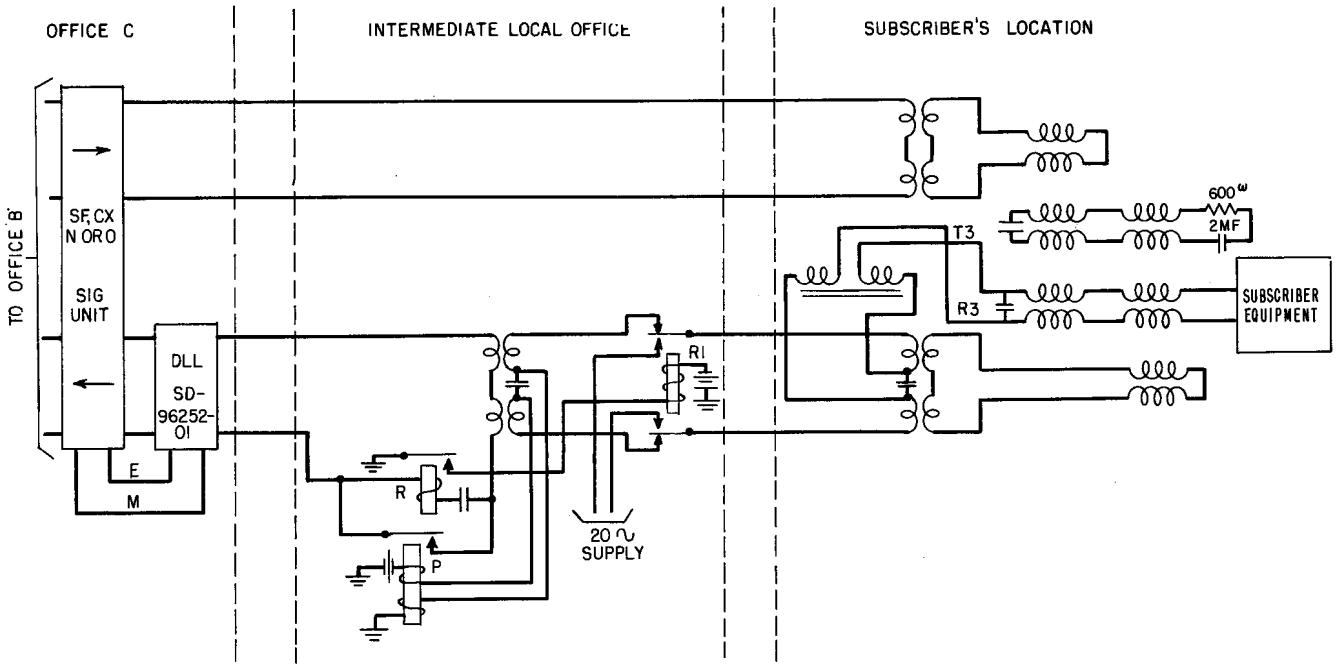

Fig. 9 — Foreign Exchange Circuit Arrangements — Operation Over Long Loops Between the Terminal Toll Office and the Subscriber

ers served by the local central office A. Two of the factors that are considered when the net losses are engineered are the type of instrument in use at the subscriber's end and the transmitter current at the subscriber's telephone.

Operation Over Long Subscriber Loops

3.38 For loops between office C and the subscriber of over 800 ohms loop resistance, a long line circuit at an intermediate office on the loop is usually required in order to provide sufficient transmitter current at the subscriber's location. A typical long line circuit for use in furnishing talk battery from an intermediate office for the purpose of increasing transmitter current is shown at the intermediate office in Fig. 9.

3.39 On extremely long loops it is usually necessary to provide some means to compensate for the loop loss as well as for increasing the current through the subscriber's transmitter. The loss of the loop can be compensated for by increasing the gains at office C or by using E-type repeaters at an intermediate office on the loop. However, the degree of balance that can be obtained using 2-wire loops often limits the amount of gain that can be applied at either office C or an intermediate office. Shown in Fig. 9 is one typical arrangement that is frequently used on long loops. The long line circuit at the intermediate office should be located not farther than 800 ohms (loop resistance) away from the subscriber in order to provide sufficient transmitter current. The use of 4-wire loops together with a terminating set arrangement at the subscriber's location permits the use of higher gains at office C or the use of E-type repeaters at an intermediate office while maintaining a good circuit balance. The terminating set at the subscriber's location is arranged to bypass the battery feed, inward ringing current, switchhook supervision, and dial pulses around the hybrid. Leads T3 and R3 in Fig. 9 are used for this purpose.

3.40 The long line circuit shown at the intermediate office in Fig. 9 can also be used on a 2-wire loop to increase the current through the subscriber's transmitter. However, its use often makes the balancing of the loop more difficult. This problem is partially overcome if the long line circuit is located as close as possible to the subscriber.

3.41 The 4-wire terminating set arrangement at the subscriber's location can be used to increase transmitter current without using a long line circuit at an intermediate office. By

connecting the T3 and R3 leads of Fig. 9 to the simplexes of the transmit and receive loops, the transmitter current can be effectively doubled. The maximum loop resistance for a 2-wire loop is approximately 800 ohms if a long line circuit is not used at an intermediate office, but by using a 4-wire loop with simplexes for battery feed, the maximum loop resistance is increased to approximately 1600 ohms for each of the transmit and receive loops. When arranged in this manner, the simplexes of the loops at office C are connected to the dial long line unit.

Balancing Networks

3.42 The type of balancing network to use at office B is determined by the impedance presented by the loop with a call completed at office A. In many cases the loop from office A to office B will be a short nonloaded cable loop, in which case its impedance is mainly determined by the impedance of the connected trunk and telephone at office A. In this case a compromise type of network composed of 600 ohms in series with approximately 2 mf will probably provide the most satisfactory balance. In case the loop between offices A and B is composed of loaded cable of fairly long length, a precision balancing network may be required.

3.43 The type of balancing network to use at office C is determined by the make-up of the loop between office C and the subscriber.

3.44 To check the drop balance across the hybrid at office B, the foreign exchange circuit should be in the talking condition at offices A and B. The following procedure can be used to condition the circuit at offices A and B for making balance tests.

(a) At office C, open the loop toward the subscriber. This is done to prevent the possible connection of ringing current toward the subscriber.

(b) At office B, place a call from a local telephone to the foreign exchange circuit at office A. This is accomplished by dialing the telephone number assigned to the foreign exchange circuit termination. The telephone at office B should be left in the "off-hook" condition while the balance tests are made.

(c) At office B, ground the E lead toward the dial long line unit. This will simulate an off-hook signal from the subscriber and will thus lift the idle circuit termination and connect the supervisory bridge at office B. Connection of the supervisory bridge will trip the machine ringing at office A.

(d) The balance can then be checked from the 4-wire office appearance of the carrier channel or repeater.

Note: On circuits with SF signaling that use "tone on" toward office C during talking conditions, connect battery to the M lead toward the SF unit. This will remove the SF tone while balance tests are being made.

3.45 The balance across the hybrid at office C should be checked with an off-hook condition at the subscriber's location. The following procedure can be used to check the balance.

(a) If the foreign exchange circuit employs SF signaling, the loop at office B should be opened toward office A in order to prevent the seizure of the dial equipment at office A.

(b) If the foreign exchange circuit terminates in a handset at the subscriber's location, the handset should be off-hook. If the circuit terminates in a PBX, the PBX operator should be requested to connect it to a PBX extension. The extension telephone should be off-hook.

(c) The balance can be checked from the 4-wire office appearance of the carrier channel or repeater.

4. TESTING AND OPERATING CONSIDERATIONS

4.01 The number of different arrangements available for providing foreign exchange service makes it very important that certain steps be taken prior to placing a foreign exchange circuit in service. Some of the more important are:

(a) Check the SD Drawings and CD Sheets to ascertain that the proper options and figures are used.

(b) Visually check the equipment to ascertain that the correct equipment and options are actually connected.

(c) The tester should familiarize himself with the various operating conditions of the circuit to be tested. A few brief notes pertaining to the operation of a specific foreign exchange circuit will quite often prove helpful in testing and servicing the circuit. These notes should be attached to the circuit layout card or sketch.

4.02 Circuit order tests should be made in accordance with the sections covering the type of facility assigned to foreign exchange service. Additional tests per Part 3 of this section should be made on circuits using dial long line equipment per SD-96251-01 and SD-96252-01.

4.03 The following procedure should be followed when removing a foreign exchange circuit from service.

(a) Notify the subscriber that the circuit is out of service and when they can expect it to be OK.

(b) Notify the local testboard at office A that the telephone number is out of service so that they can take action according to local practices.

(c) Open, do not terminate, the loops at the terminal toll offices. The idle circuit terminations should prevent the circuit from singing.

4.04 Certain precautions should be observed when monitoring foreign exchange circuits. A foreign exchange circuit can be monitored at standard monitoring jack appearances of carrier channels and repeaters without affecting circuit operation or balance conditions. Monitoring across the 2-wire loops requires use of a high impedance monitoring arrangement that does not bridge a direct current path across the loop. The test cords and the left-hand correcting cords at a No. 5 testboard meet these requirements as long as the talk key is closed.

4.05 In testing the signaling and supervisory functions of a new foreign exchange circuit, the toll testboardman at office B should place a call from a local telephone to the foreign exchange subscriber. This is done by dialing the number assigned to the foreign exchange circuit or by having the operator make the connection. The subscriber should then be requested to place a call to a telephone at office B. During both calls all supervisory functions provided with the circuit such as reringing, flashing, etc., should be checked. Quality of transmission should also be checked during these calls.