COMPOSITE AND SIMPLEX SIGNALING ARRANGEMENTS

DESCRIPTION

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1. INTRODUCTION

1.01 This section describes the various Type B composite (CX) and simplex (SX) signaling circuits which are now available. The purpose and capabilities of each of the arrangements are discussed with their relationship to other equipment, the use of dc and ac earth potential compensation, etc. The principles of operation of composite and simplex signaling are covered in Section 179-701-101 and the composite sets and repeating coils used in deriving the dc paths are discussed in the section covering composite sets and associated line or hybrid transformers.

1.02 The Type B CX signaling circuits employ identically connected arrangements at both ends of the line section whereas the Type A, which is no longer used, required battery at one end of the earth potential compensating winding and ground at the other. This winding functioned in the dual capacity of an earth potential compensating and an auxiliary biasing winding.

1.03 In connection with the installation of new composite signaling equipment which is to be used with trunks connected to similar existing

circuits in another office, a check should be made to ascertain that the same optional wiring connection is employed between the T and R conductors of the CX set and the composite signaling equipment. The standard optional wiring, which has been designated variously on the different circuit drawings and, in certain cases, on different issues of the same drawing, permits any spare composite signaling equipment which ordinarily would be employed with side circuit 2 at one terminal of the signaling channel to be used with equipment ordinarily associated with side circuit 1 at the other terminal or vice versa.

1.04 Certain of the connecting leads shown on the signaling circuit drawings, such as those designated (F) and (N), may not always be required and should therefore be disregarded whenever they are not shown on the connecting trunk circuit, auxiliary pulse link circuit, signal converter, or patching jack circuit.

1.05 Where composite signaling is provided it is to be noted that ground should be connected to the midpoint of the phantom repeating coil, or if the facilities are nonphantomed, to the mid-point of the physcial circuit repeating coil. This is to prevent cross-fire between signaling channels in the same phantom group or pair. Where this grounding practice leads to excessive noise, reduction may be obtained as discussed in the section covering composite sets and asssociated line or hybrid transformers.

1.06 Except where specifically limited to "signaling only" it may be assumed that the circuits described herein will transmit dial pulses as well as supervisory signals.

1.07 The term "short haul signaling circuit" refers to one which is arranged for signaling over a line section having a conductor loop of 5000 ohms or less. Generally, because of their length, such circuits will involve no intervening voice repeater. The term "long haul signaling circuit" refers to one which is arranged for signaling over a line section with a conductor loop from 5000 to 12,000 ohms. Such circuits include one intervening voice repeater around which the signals are bypassed. Short haul and long haul circuits may be connected in tandem in any combination by means of auxiliary pulse links, thus providing signaling channels of any desired length. However, it is generally undesirable on 2-way circuits to use CX or SX signaling for total lengths of more than 300 miles, both from the standpoints of cost and the delay introduced in the transmission of signals. Excessive delay results in an undesirably long unguarded interval during which the toll circuit may be picked up by operators at both ends. On one-way only circuits, the range is, in general, limited by economic and maintenance considerations.

1.08 The attached Table I summarizes the features and operating characteristics of the various arrangements covered below. Greater detail as to range and special features may be obtained from the drawings. Table II lists the equipment drawings and J specifications which apply and summarizes the equipment arrangements.

2. COMPOSITE SIGNALING ARRANGEMENTS

A. For Intertoll Trunks

2.01 The two following types of CX signaling units, which are the most generally used arrangements, may be used separately or connected in tandem through auxiliary pulse links to provide CX signaling channels for most intertoll trunks.

(1) SD-95048-01 for ***short haul*** use on ***cable*** or ***open wire.***

(2) SD-55415-01 for ***long haul*** use on ***cable.***

2.02 Although SD-95048-01 generally is used for a line section which does not include an intermediate voice repeater it may also be used in the rather uncommon case where a 19-ga. line section 50 miles or less in length includes an intermediate repeater equipped with a Type E composite set. It is arranged for use on phantom or nonphantom facilities. A typical composite signaling arrangement employing this circuit is shown on Sketch A, attached.

2.03 SD-55415-01 may be used for a line section which includes an intermediate voice frequency repeater around which the signals are bypassed. Its maximum range is about 110 miles of 19 ga. if Type E CX sets are used, or about 130 miles of 19 ga. if Type C CX sets are used. With 16 ga. the maximum range is about 130 miles in all cases. When the line section consists of 110 miles or more of 16-ga. cable or 90 miles or more of 19-ga. cable (loop resistance of 8000 ohms), retardation coils are connected across the operating

and balancing windings for the purpose of improving the wave shape of the received pulses. The transformer effect of these coils is utilized to reduce first pulse distortion by introducting a portion of the signaling current into the circuit of the balancing winding in a direction opposing the normal bias at the beginning of the pulse and aiding it at the end of the pulse. By affording a low impedance path around the relay to low frequencies and high impedance to high frequencies, the inductive reactance of these coils serves to compensate for the loss, due to the capacity of the cable, of the high frequency components of the pulses. A retardation coil also is added in the earth potential channel to balance the corresponding coil in the operating channel.

2.04 Composite signaling circuit SD-554515-01 when used on 4-wire circuits should be connected through a Type C composite set to the output of the voice repeater in order to avoid introducing noise in the talking circuit and interference into the signaling circuit. Another restriction is that the phantom group repeating coil associated with this signaling circuit should not be employed for battery supply purposes because of reaction upon the signaling circuits due to surges resulting from switchhook and relay operation. This circuit, in common with other signaling circuits, cannot be used with Type E CX sets at terminals having 93-type repeating coils associated with the 22-type repeater.

2.05 In addition to the two commonly used CX signaling units discussed above, the following types have been made available for special applications on intertoll trunks:

(1) SD-95029-01 is a ***short haul*** arrangement for ***open wire*** which is somewhat cheaper than SD-95048-01 described above.

(2) SD-95067-01 is an arrangement for use in the rather uncommon case where an intermediate repeater is included in a line section of 19-ga. cable or open wire 50 miles or less in length where the intermediate repeater is bypassed by means of Type C CX sets. SD-95048-01 may be used for this case where Type E CX sets are used at the intermediate point as discussed in Paragraph 2.02.

(3) SD-95028-03 is a ***short haul*** arrangement for ***open wire*** or ***cable*** for the special cases where the CX set is located in one office and the signaling circuit in another office.

(4) SD-95028-02 is a ***short haul*** arrangement for ***open wire*** or ***cable*** for use between a manual office having a 38-volt battery and a dial office having the usual 48-volt battery. Dialing is of course only from the manual end, but signaling and supervision is transmitted both ways.

(5) SD-95084-01 is a ***long haul*** arrangement for two-way ***signaling only*** (no dialing) on ***cable*** circuits. One intermediate repeater may be bypassed.

B. For Tributary and Toll Connecting Trunks

2.06 The above discussed arrangements for intertoll trunks also may be used or tributary and toll connecting trunks. However, cheaper arrangements employing the Type D composite set are applicable in many cases. Sketches B1, B2, and B3, attached, show the use of certain of the circuits in community dial offices.

Combined Repeating Coil, CX Set and Signaling Unit

2.07 SD-95032-01 is the most common of those arrangements designed specifically for tributary and toll connecting trunks. The attached Sketch B3 shows typical community dial office trunks using this circuit. This circuit employs Type D composite sets and is intended for use where a comparatively inexpensive composite signaling arrangement is required, and where refinements to facilitate maintenance are not justified because of its use in small circuit groups in offices generaly having no other composite signaling trunks. To isolate the composite signaling relay for maintenance purposes it is necessary to remove straps on the unit terminal strip.

2.08 SD-95032-01 is limited to use on community dial office trunks, switching trunks, and tributary trunks because

(1) The Type D composite set which is not satisfactory with terminal repeaters since it cannot be balanced in the repeater balancing network,

(2) The absence of test jacks,

(3) It is arranged for 120-type repeating coils. (See the section covering composite sets and associated line or hybrid transformers for further discussion on CX sets and repeating coils.)

Arrangements are included to provide a dialing channel for use with an H1 carrier system. Network arrangemens are provided to permit the use of this circuit with the arrangement of Drawings SD-95029-01 or SD-95048-01 at the other end of the trunk.

2.09 The equipment arrangements include repeating coils, composite sets and composite signaling circuits which are furnished on a single circuit unit and also on a phantom group basis. The single circuit unit is intended primarily for use with the phantom group unit to obtain a fourth signaling circuit on an open wire phantom group or on a cable quad, but it may also be used as a single circuit with the Type B composite set.

Signaling Over Composited Phantom

2.10 SD-95058-01 is used for signaling over a ***composited phantom*** on ***cable*** or ***open wire*** where no voice repeaters are involved. However, the noncomposited side circuit may have repeaters. Where dc earth potential compensation is not required, two dial channels may be obtained from a composited phantom and used with one of the side circuits and the phantom, the other side circuit being operated on a ringdown basis.

2.11 SD-95058-01 also makes provision for extending the composite signaling channel derived from the phantom over a simplexed physical circuit to an office situated within a distance of approximately 2 miles, terminating in signaling equipment located at the remote office. In this case, the composite leg is connected to the midpoint of the repeating coil on the physical circuit.

2.12 Like Drawing SD-95032-01 certain maintenance requirements have been omitted for economy reasons from SD-95058-01. Therefore, to isolate the composite signaling relay for maintenance purposes, it is necessary to remove straps on the unit terminal strip.

Signaling Only (No Dialing)

2.13 SD-95016-01 is a ***short haul*** arrangement for two-way ***signaling only*** (no dialing) on ***cable.*** It is an inexpensive arrangement employing a B type composite relay instead of the more expensive polarized relay. It may be used with 38-volt or 48-volt batteries and with either Type C or E composite sets. However the capacity of the composite set condensers to ground should be 2 mf instead of 4 mf, and the signaling circuit balancing network should be arranged correspondingly.

Signaling Associated with G1 Carrier

2.14 SD-95019-01 may be used for signaling and dialing in cases where one of the speech channels is derived by means of a G1 carrier system superimposed upon an open wire nonphantomed pair.

2.15 If the extra talking channel is obtained by superimposing a G1 carrier system on the side circuit of an open wire phantom group which is already equipped for composite dialing per circuit Drawing SD-95029-01, it may be desirable from a unifomity standpoint to obtain the extra dialing channel by using SD-95029-01. Since all four composite legs are used as signaling channels, dc earth potential compensation cannot be provided on such a phantom group. The composite sets shown on Drawing SD-95004-01 should be used. The signaling circuit at one end may be in accordance with Drawing SD-95029-01 and the other end in accordance with Drawing SD-95019-01 if desired.

3. SIMPLEX SIGNALING

3.01 Two different simplex signaling arrangements are available for use with or without intermediate or terminal voice repeaters. One arrangement provides earth potential compensation and the other does not. In cases where earth potential compensation is required it may be desirable to provide a group of composite signaling circuits in combination with the simplex signaling group of trunks, in order to obtain the necessary earth potential compensating paths. Thus, for example, if a group of eight dialing trunks are to be obtained from eight physical pairs, two pairs might be equipped with ***composite signaling*** to obtain three signaling channels and an associated earth potential compensating channel and five pairs might be arranged for ***simplex signaling***, leaving the simplex

on one pair to be used for earth potential compensation for the five simplex signaling circuits. Thus eight dialing paths would be obtained with full provision for earth potential compensations.

3.02 SD-95051-01 is a signaling circuit for tributary and toll connecting trunks where conditions permit the omission of earth potential compensation. The range for various earth potential voltages is given on the drawing. It is also arranged to permit bypassing an intermediate voice frequency repeater.

3.03 SD-95053-01 is a ***long haul simplex*** signaling circuit which may be used on intertoll or toll connecting trunks and permits signals to be bypassed around one intermediate repeater. It is arranged for earth potential compensation on the basis of a maximum of five signaling circuits compensated by one ground compensating leg.

4. AUXILIARY PULSE LINKS AND CONVERTER CIRCUITS

A. General

4.01 Where the long haul signaling circuits are used, the signals may be bypassed around one intermediate repeater. In the case of Type C composite sets, bypass is provided by connecting together the CX legs in the two directions. (On 4-wire circuits, the CX legs from the set connected to the output of the one amplifier are connected to the CX legs from the set associated with the output of the oppositely directed voice amplifier; similarly input sets are connected together.) Type E bypass arrangements also are available. All of these bypass arrangements are discussed in the section covering composite sets and associated line or hybrid transformers.

4.02 Where signals are to be repeated from one signaling unit into the next, a pulse link is used for connecting the signaling circuits together. In addition there are converter circuits used for converting from CX or SX signaling to loop or ringdown signaling. These are summarized in the attached Table III and are discussed briefly in the following paragraphs.

B. Relay Type Pulse Link

4.03 The relay type auxiliary pulse link shown on Drawing SD-95095-01 is used for repeating pulses around intermediate voice frequency repeater equipment between two long haul or between one long and one short haul composite or simplex signaling circuits. The relay pulse link is required to avoid pulse distortion which would otherwise result when connecting two signal circuits of this type. This distortion results from the longer operating time of the signaling relay in long haul circuits due to the pulsing current being attenuated more on the long circuits than on the short ones.

C. Nonrelay Type Pulse Link

4.04 For connecting together short haul composite or simplex signaling circuits using 239, 206, or B type relays, the nonrelay type auxiliary pulse link circuit SD-95043-01 should be used. Provision is made for the use of 48-volt battery or, in the 9C type offices, the use of 38-volt battery.

4.05 In connection with the operating tests of this equipment, the 1000-ohm resistance in the F lead of the nonrelay pulse link should be short-circuited by grounding the F lead while zero adjustment of the meter of the pulse repeating test set is being obtained at points equipped with nonrelay type pulse links and during pulsing tests made at such intermediate points from another point on the line. This resistance should not be shorted however during through pulsing test from one terminal to the other.

D. Telegraph Type Pulse Link

4.06 SD-95311-01 covers the telegraph type auxiliary pulse link for use as a connecting link between a composite signaling circuit and telegraph loop terminal equipment. For either one-way or two-way dial operation both the receiving and sending parts of the telegraph pulse link circuit are required at both ends of the telegraph channel.

4.07 When used at an intermediate point as the link between a telegraph circuit and a composite signaling circuit, the auxiliary pulse link shown on SD-95095-01 should also be employed in conjunction with SD-95311-01.

E. Converting Loop to CX or SX

4.08 Two-way trunk circuits for use at intermediate offices for connecting loop signaling or reverse battery supervision trunks to composite or simplex signaling trunks are shown on Drawings SD-95060-01

and SD-95061-01. The former provides one-way dialing from the loop signaling end toward the composite or simplex end and one-way automatic signaling from the composite signaling end toward the loop end, whereas the latter provides one-way dialing from the composite signaling end and one-way automatic signaling from the loop end. These circuits are suitable for use at nonrepeatered points or at points equipped with 22-type repeaters. If they are required at V1 repeater points the latest information should be obtained.

F. Converting CX or SX to Ringdown

4.09 A signal converter circuit is used to enable the test board attendant to patch between ringdown and dial circuits, to terminate a dial trunk on a ringdown drop, or to restore a full period ringdown talking circuit on a regular or emergency basis over a dial trunk. The dial feature of the trunk is of course surrendered and it is necessary to operate the circuit established over the dial facilities on a ringdown basis.

4.10 One of these converter circuits is SD-64697-01 which is for use in connecting a composite or simplex signaling circuit to a 20-cycle ringdown circuit, or to a No. 1 toll switchboard having No. 5 toll test board secondary positions. This circuit is arranged for 48-volt operation and two-way signaling.

4.11 Another converter circuit is SD-64698-01 which is for use in connecting a composite or simplex signaling circuit to the SG lead at No. 3 or No. 11 toll switchboards with No. 8 test and control or similar type test boards or a DC/20-cycle, DC/135-cycle or DC/1000-cycle signal receiving circuit. Two-way signaling is provided with 48-volt operation toward the CX or SX signaling circuit and 24-volt operation on the SG lead.

5. EARTH POTENTIAL COMPENSATION

A. General

5.01 CX and SX signaling circuits operate on a ground return basis and are therefore affected by earth potential differences existing between the offices.

5.02 For measuring the dc earth potential differences between two offices, a recording voltmeter is preferred. However, a high impedance voltmeter such as is used on toll test boards may be used. The recording 5-0-5 scale milliammeter of the No. 171A telegraph transmission stability test set can be converted into a recording voltmeter by use of a 5000-ohm series resistance for voltages up to 25 volts and 10,000 ohms or 20,000 ohms for maximum voltages of 50 or 100 respectively. To convert the reading into volts, the value of a series resistance plus the resistance of the line over which the readings are made, should be multiplied by the readings of the milliammeter and the result divided by 1000. It is desirable that the readings be taken for a period of one representative week. If this is impracticable a 24-hour period of a representative busy day should be covered.

5.03 The effects of 25-cycle and 60-cycle induction on ground return signaling circuits are discussed elsewhere.

B. DC Earth Potentials

5.04 Where CX signaling is used under conditions involving dc or ac earth potentials or the probability of severe magnetic storm disturbances, the effect of earth potential difference may be compensated for within certain limits by employing one of the two signaling legs of a composited pair or one of the four signaling paths of a composited quad or phantom group for energizing a winding of the composite signaling relays at both ends of the circuit as described in Section 179-701-101.

5.05 A similar arrangement is employed for SX signaling circuits. However, in this case provision is made for compensation of a maximum of five SX signaling circuits by use of one SX path for this purpose; that is, six SX paths give five signaling channels and a compensating path.

5.06 Earth potential compensation should be used in all cases on CX or SX signaling circuits employed for intertoll dialing. It should also be used for tributary and toll connecting trunks wherever practicable except in the latter case the extra channel may be used for telegraph or other important dc services if the dc earth potential conditions permit.

5.07 In most cases a dc earth potential value of $\pm$50 volts is permitted where earth potential compensation is provided. Without this compensation the earth potential may be limited to a value as

low as 1.5 volts. These limitations are covered in detail on the signaling circuit drawings.

C. AC Earth Potentials

5.08 For use in eliminating the effect of 60-cycle earth potentials on composite signaling circuits, two general types of filters are available as listed in the attached Table IV. The less expensive type, shown in Fig. 1 of SD-95073-01, employs a resonant circuit for draining the longitudinal current to ground, and is suitable for use either with or without the dc earth potential compensating leg where a moderate 60-cycle earth potential is encountered. One filter is used with each CX signaling circuit arranged for dc earth potential compensation. For similar conditions, two filters are required for each CX signaling circuit not arranged for earth potential compensation, one in the line and one in the network. Usually filters at one end of a trunk are sufficient, but in some cases these arrangements may be required at both ends of the trunk. The permissible ac earth potentials for this type of filter (called the bridge type) are given for various conditions on SD-95073-01. The principles of operation of these filters and methods of associating them with the signaling circuit are discussed in Section 179-701-101.

5.09 Due to a more simple type of balancing network the SX circuits employ a 60-cycle filter differing in certain details from that required for CX. An arrangement consisting of a combination of a transformer and a resonant circuit, suitable for use with SX circuits not arranged for dc earth potential compensation, is shown on SD-95073-01, Fig. 3, and is for use with the SX circuit shown on Drawing SD-95051-01.

5.10 A similar arrangement is available for draining the 60-cycle currents to ground on the SX circuit having dc earth potential compensation (SD-95053-01) and is covered by Fig. 2 of Drawing SD-95073-01. This filter is required in cases where the 60-cycle earth potential voltage exceeds the limits specified for the particular condition listed under Table A and Charts A and C of Drawing SD-95053-01.

5.11 These filters are somewhat less expensive for CX signaling than the longitudinal retardation coil described below, but are unsuitable for use where 25-cycle earth potential exists since they are designed to resonate at 60 cycles and thereby afford a low impedance path to ground at this frequency only. They also have maximum 60-cycle voltage limitations.

5.12 Where 25-cycle earth potentials are involved or where the 60-cycle potentials exceed the capabilities of the simple type of filter described above (see Charts on SD-95073-01), another type of filter is used. This is a longitudinal type filter employing a 4-winding retardation coil or transformer with one winding connected in series with each signaling lead and one series with the earth potential compensating leg. The function of these windings is to block the equal induced or longitudinal currents that flow in the four legs of the phantom group or quad and at the same time provide a path of negligible impedance to signaling currents. This coil must be associated with both ends of the particular line section upon which the earth potentials are encountered. A schematic drawing of this filter and a discussion of its operation is given in Section 179-101-101.

5.13 The circuit arrangement of this filter shown on Fig. 4 of Drawing SD-95073-01 is suitable for use with Type C or E composite sets. It is connected in series with the composite legs as shown on Drawings SD-95004-01 or SD-64903-01, SD-64903-03 and SD-59002-01 for the V1 repeater and Drawings SD-60136-02 and SD-60136-03 for the 22-type repeater.

5.14 For circuits with simultaneous ac and dc earth potentials, the sum of the dc earth potential measured for the particular case divided by the maximum ac earth potential allowable, as shown on the circuit drawing, and the measured ac earth potential divided by the maximum allowable ac earth potential should not exceed 1. Thus, if the measured dc earth potential voltage on a particular line is 30 and the maximum allowable for the circuit is 50 volts dc and 25 volts ac, the permissible ac voltage would be obtained as follows:

$$\frac{\text{30v. measured dc earth potential}}{\text{50v. max. allowable dc earth potential}} + \frac{\text{Measured ac earth potential}}{\text{25v. max. allowable ac earth potential}} = 1$$

Hence the permissible ac earth potential would be 10 volts.

6. RANGES

A. Minimum Insulation Resistance

6.01 The signaling circuits have been designed on the basis of total minimum insulation requirements, including that of the conductor to ground and that between the conductors, of 160,000 ohms per mile per conductor for open wire circuits less than 25 miles and 200,000 ohms per mile per conductor for circuits above 25 miles long. These values also apply to circuits operating over combinations of cable and open wire. For cable circuits, the total minimum insulation resistance requirement per conductor is generally 60,000 ohms for any length of cable. In some cases, however, it has been necessary to specifiy a total minimum insulation resistance of 200,000 ohms to ground in order to obtain extreme dialing ranges.

B. Signaling Range

6.02 The ranges of the CX and SX signaling circuits vary with the earth potential condition, the minimum insulation resistance per conductor, the voltage of the battery at both terminations of the circuit, percent break of the dial contacts, and whether or not one leg is used for earth potential compensation. On combined cable and open wire circuits the permissible cable resistance is determined by the resistance of the open wire line in the circuit. Conversely, the maximum resistance value of the open wire line depends upon the resistance value of the cable in the circuit. Generally, within certain limits an increase in one may be expected when the other is decreased. These values are indicated for the various conditions involved in the form of chart on the circuit drawing. The permissible overall resistance of a trunk is the sum of the resistance values shown on the curve of the particular circuit. Thus, for example, referring to curve 3 of Chart A, on sheet -014 of Drawing SD-95032-01 an open wire resistance of 410 ohms will permit 800 ohms of cable, or an overall trunk conductor loop of 1210 ohms. The permissible conductor resistance of trunks used for simplex operation is, of course, twice that of composited trunks, since the former uses two conductors in parallel.

7. TESTING AND MAINTENANCE FACILITIES

7.01 The methods of testing and taking circuits out of service differ somewhat from the practices employed with ringdown trunks. The testing methods for use on composite dialing trunks are covered in Sections 333-122-603—"Overall Pulsing from Toll Test Boards of Intertoll Dialing Trunks," 333-122-605—"Overall Pulsing from Intertoll Dialing Two-Way Trunk Selector Multiple," 333-122-607—Overall Test of Type B Composite Signaling Circuits," 040-011-711—"Pulsing Requirements for Intertoll Dialing Pulse Repeating Relays." Similar arrangements, but not necessarily using the same testing equipment, would be required for testing the composite relays on trunks for other uses. Various test board facilities are listed in Table V attached.

7.02 Jack appearances of the ringdown and the dial intertoll trunks are provided at primary toll test boards for maintaining the outside plant, and at secondary boards for making overall tests. Patching arrangements for making good any faulty equipment, are also provided when specified at the secondary appearance patch board.

A. Primary Toll Test Board

7.03 At the primary toll test board, line and drop jack appearances are furnished for the tip and ring conductors of the toll trunks. Line and equipment jacks for CX legs are also provided in this testboard and are arranged on a quad basis in order to retain the neutralizing ground leg which is associated with the quad when patching is done. The tip and ring jacks serve as convenient points for making voltmeter and Wheatstone bridge tests and in addition, for substituting new facilities for faulty ones.

B. Secondary Appearance

7.04 Each of the one-way outgoing intertoll straightforward or dial trunks and the outgoing end of two-way trunks will have a test appearance which is a multiple of the switchboard appearance at the toll test board, together with an out-of-service jack for making the circuit busy to outgoing traffic. The test jack will be used for making overall tests.

C. Patching Facilities

7.05 In addition to the primary line jacks and CX leg jacks, patching jacks on the drop side of the signaling units as shown on Drawings SD-55337-01, SD-62741-01, and SD-64724-01 may be provided when specifically ordered by the customer. Sketches D, E, F, and G, attached, cover the location and arrangement of these patching jacks for the various toll offices. Since the dial paths have been entirely segregated from the transmission paths, the patching arrangements for dial, composite, or simplex signaling facilities differ from those provided for ringdown circuits.

7.06 The signal converters shown on Drawings SD-64697-01 and SD-64698-01 are for use in patching between ringdown and dial circuits or for terminating a dial link on a ringdown drop, as discussed in Part 4(E). The information Sketches D, E, F, and G show arrangements for patching between auxiliary converter and pulse link circuits and toll trunk circuits.

D. Toll Test Board Testing Units

7.07 The voltmeter test circuits of the No. 4 and No. 5 secondary test boards cannot be used directly with intertoll dial trunks. A dial and supervisory circuit is required as shown on SD-64595-01, SD-64881-01, and SD-55202-01 which permits using the positional dial with the intertoll dial trunks. A pulsing jack is provided for adding the pulse repeating test set to a dial trunk for testing. The application of this equipment is shown schematically in Fig. 1 of Sketch G, attached. The holding jack and recall circuit shown on Drawings SD-64595-01, SD-64881-01 and SD-55202-01 may be used with the composite signaling straightforward trunks. No additional maintenance features will be provided in the test board for the lamp in the multiple supervision type of straightforward trunks since these will be small groups and can be maintained from the switchboard. A pulsing jack is provided for adding the pulse repeating test set to a dial trunk for testing. The application of this equipment is shown schematically in Fig. 1 of the attached Sketch G.

7.08 The No. 8 test and control board position circuit is modified for intertoll dialing as shown on Drawings SD-62066-01, SD-62961-01, SD-64159-01, and SD-64581-01, and is used without an applique. However, whenever pulsing tests are made, the cord is connected to the intertoll dial trunk through a pulsing test patching circuit per SD-64893-01. The application of this equipment is shown schematically in Fig. 2 of Sketch G. The No. 17B and 18B toll test boards are arranged for maintaining intertoll dial trunks directly as shown in Fig. 3 of Sketch G. The No. 16 toll test board is arranged for maintaining intertoll dial trunks as shown on Drawings SD-55112-01.

7.09 The No.8 test and control board and the No. 16, 17B, and 18B toll test boards are arranged for maintaining intertoll composite signaling straightforward trunks directly.

8. POWER

A. General

8.01 The composite and simplex signaling circuits described above function with the usual regulated and nonregulated 48-volt battery supply with the exception of SD-95028-02 on which provision has been made for termination of one end of the circuit in a 38-volt battery supply office of the manual type.

8.02 Where 48-volt power is not available at terminal points, consideration may be given to use of a KS-5386 copper oxide rectifier (0.4 amps. output to 30-75 volts dc) and a KS-5361, list 100 battery (4 amp. hr. capacity) equipped with 23 or 24 cells.

B. Current Drains

8.03 The following current drain information will be included on Issue 20 of the signaling key sheet, SD-62405-01. These values are for 48-volt signaling battery except where otherwise indicated.

	CURRENT DRAIN — AMP. HOURS PER BUSY HOUR	
	BAT.	GRD.
COMPOSITE SIGNALING CIRCUITS		
SD-95016-01 per trunk	negligible	.023
SD-95019-01 per Fig. 2	.022	.080
SD-95028-02 per trunk (38 or 48 volts)	.030	.080
SD-95028-03 " "	.030	.080
SD-95029-01 " "	.030	.080
SD-95032-01 " "	.030	.055
SD-95048-01 " "	.030	.080
SD-95058-01 " "	.030	.055
SD-95067-01 " "	.030	.080
SD-95084-01 " "	.030	.080
SD-55415-01 per phantom group	.100	.220
" Non-Ph, per trunk	.060	.100
SIMPLEX SIGNALING CIRCUITS		
SD-95051-01 per trunk	.024	.075
SD-95053-01 " "	.030	.080
COMPOSITE OR SIMPLEX SIGNALING TO LOOP SIGNALING CKT.		
SD-95060-01 per trunk	.128	.073
LOOP TO COMPOSITE OR SIMPLEX SIGNALING CKT.		
SD-95061-01 per trunk (Talking Bat.)	.053	.038
AUX. PULSE LINK CIRCUITS		
SD-95043-01 per trunk	.100	.070
SD-95095-01 " "	.165	.086
SD-95311-01 " "	.050	.100
CONVERTER CIRCUITS		
SD-64697-01	negligible	
SD-64698-01	negligible	

9. DRAWINGS AND TABLES ATTACHED

A. Drawings

SKETCH DESIGNATED	DRAWING NUMBER	ABBREVIATED TITLE
A	ES-536782	Typical CX Sig. Arrangement and Explanation of Operating Features
B1) B2) B3)	ES-536401	Typical Signaling Arrangements for CDO
C	ES-536783	Compositing the Phantom
PATCHING FACILITIES		
D	ES-536630	For No. 3 Toll Offices
E	ES-536631	For No. 1 Toll Offices
F	ES-536632	For Early No. 3 Toll Offices
G	ES-536687	Maintenance Facilities

B. Tables

NUMBER	TITLE
I	Characteristics of Composite and Simplex Signaling Circuits
II	Equipment Arrangements of Composite and Simplex Signaling Circuits
III	Characteristics of Pulse Link and Signal Converter Circuits
IV	Characteristics of AC Earth Potential Filters
V	Test Board Facilities

BELL TELEPHONE LABORATORIES, INC.

ES-536782
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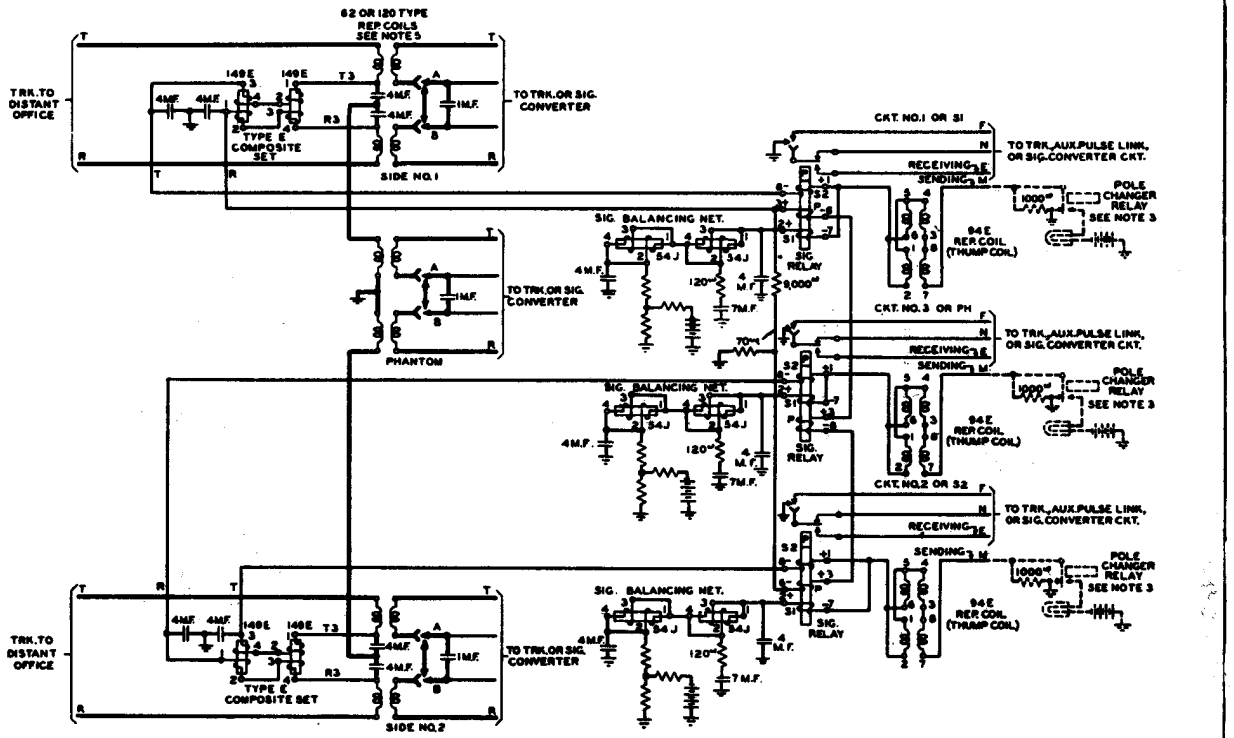
NOTES:

1. LEADS "N", "F" (AND OTHER LEADS, WHEN SHOWN ON CIRCUIT DRAWING) ARE OMITTED WHEN NOT REQUIRED BY CONNECTING CIRCUIT. THIS LAYOUT IS BASED ON 30-96306-01 AND 30-95048-01
2. THE 94E RER COILS IN THE "N" LEADS FUNCTION TO DECREASE SIGNALING DISTURBANCES.
3. WIRING AND APPARATUS CONNECTING TO "M" LEAD AND SHOWN DOTTED IS LOCATED ON ASSOCIATED TRUNK CIRCUIT.
4. THE SIGNALING CIRCUITS MAY ALSO BE USED WITH TYPES "C" OR "D" CX. SETS, BUT REQUIRE DIFFERENT SIG. BAL. NETS.
5. IF A NO. 22 TYPE TELEPHONE REPEATER IS USED, THE 120 TYPE COIL IS NOT USED BUT NO. 82 TYPE OR SIMILAR OLDER TYPE COIL MAY BE EMPLOYED.
6. A DIFFERENT SIG. BAL. NET. IS REQUIRED IF INTERMEDIATE VOICE REPEATERS ARE EMPLOYED ON THE TOLL LINE.

OPERATION OF TYPE "B" COMPOSITE SIGNALING CIRCUIT

1. THE CIRCUIT ARRANGEMENT IS IDENTICAL AT THE TWO TERMINATIONS OF THE TRUNK.
2. DUE TO CURRENT THRU S1 WINDINGS AT BOTH ENDS OF THE TRK., THE COMPOSITE RELAYS AT THESE OPPOSITE TERMINATIONS ARE NORMALLY BIASED IN THE RELEASE CONDITION.
3. D-C EARTH POTENTIAL THRU P WINDINGS AT OPPOSITE TERMINATIONS BALANCES SIMILAR CURRENT THRU THE S2 WINDINGS.
4. DURING SIGNALING, BATTERY ON "M" LEAD REVERSES THE CURRENT THRU S1 AT THAT END. HOWEVER, THE FLUX THUS PRODUCED IS OPPOSED BY THAT DUE TO CURRENT THRU S2, AND THE CX. RELAY DOES NOT OPERATE.
5. THE CURRENT FLOWING OVER THE TRUNK CONDUCTOR INTO THE RECEIVING S2 WINDING CAUSES THAT RELAY TO OPERATE.
6. WHEN BATTERY IS APPLIED SIMULTANEOUSLY AT BOTH ENDS, LITTLE OR NO CURRENT FLOWS THRU THE S2 WINDINGS, BUT THE REVERSED CURRENT THRU THE S1 WINDINGS AT BOTH ENDS CAUSES OPERATION OF THE COMPOSITE RELAYS AT BOTH TERMINALS.

COMMON SYSTEMS
COMPOSITE SIGNALING
WITH EARTH POTENTIAL COMPENSATION
SHOWN WITH TYPE E TERMINAL CX. SET
FOR TWO WIRE CABLE CIRCUITS



SKETCH A

BELL TELEPHONE LABORATORIES, INC.

NOTES: SD-95029-01 IS A SHORT HAUL CX. SIG. CKT.
SD-95043-01 IS THE NON-RELAY AUXILIARY PULSE LINK CKT.

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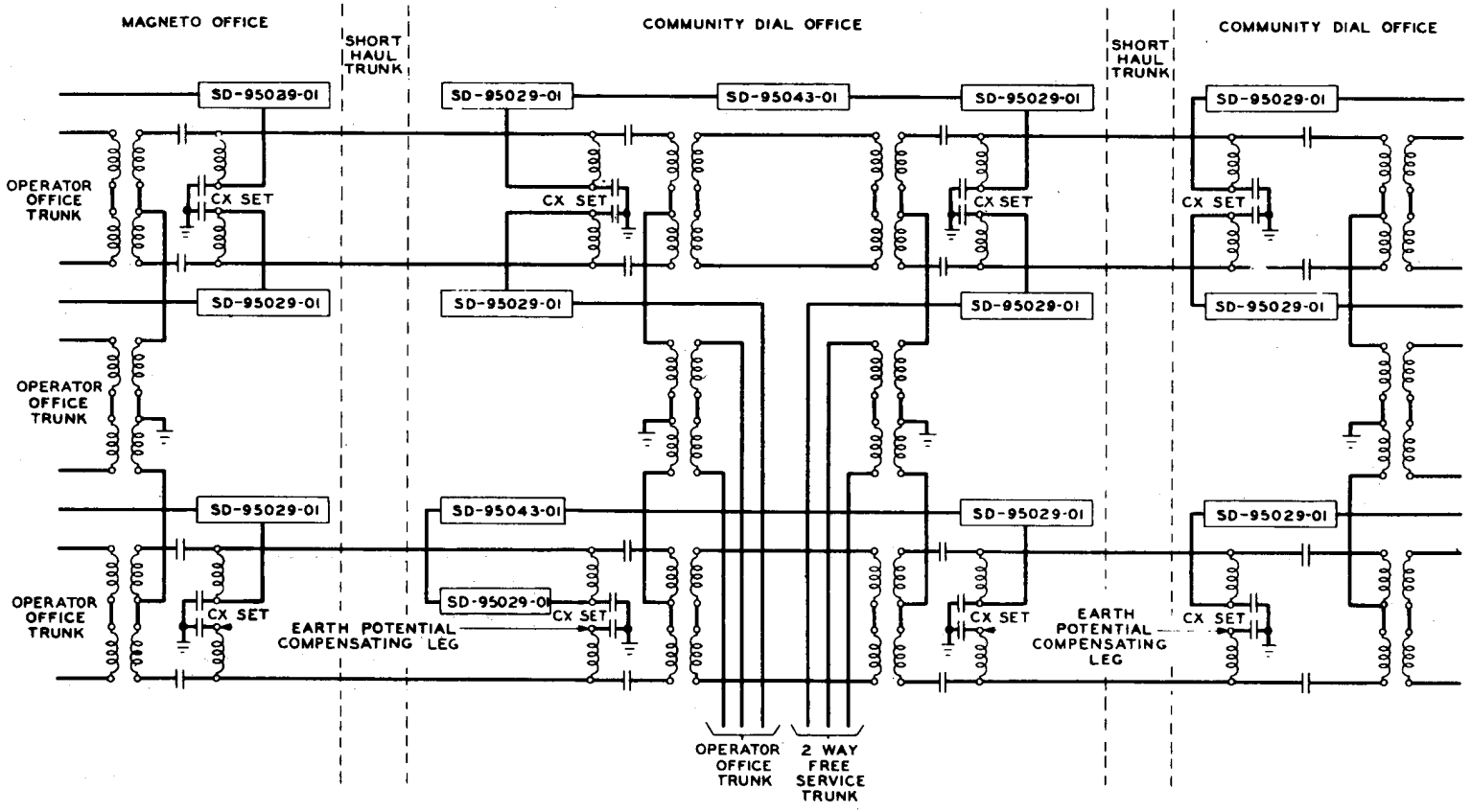
COMMON SYSTEMS
COMPOSITE SIGNALING
TYPICAL SCHEMATIC
FOR COMMUNITY DIAL OFFICE TRUNKS
OPEN WIRE CIRCUITS



ES-536401

SKETCH B1

BELL TELEPHONE LABORATORIES, INC.

NOTES: SD-95028-02 IS THE SHORT HAUL CX. SIG. CKT. FOR 38 VOLT OFFICES.
SD-95032-01 IS A SHORT HAUL CX. SIG. CKT.
SD-95043-01 IS THE NON-RELAY AUXILIARY PULSE LINK CKT.

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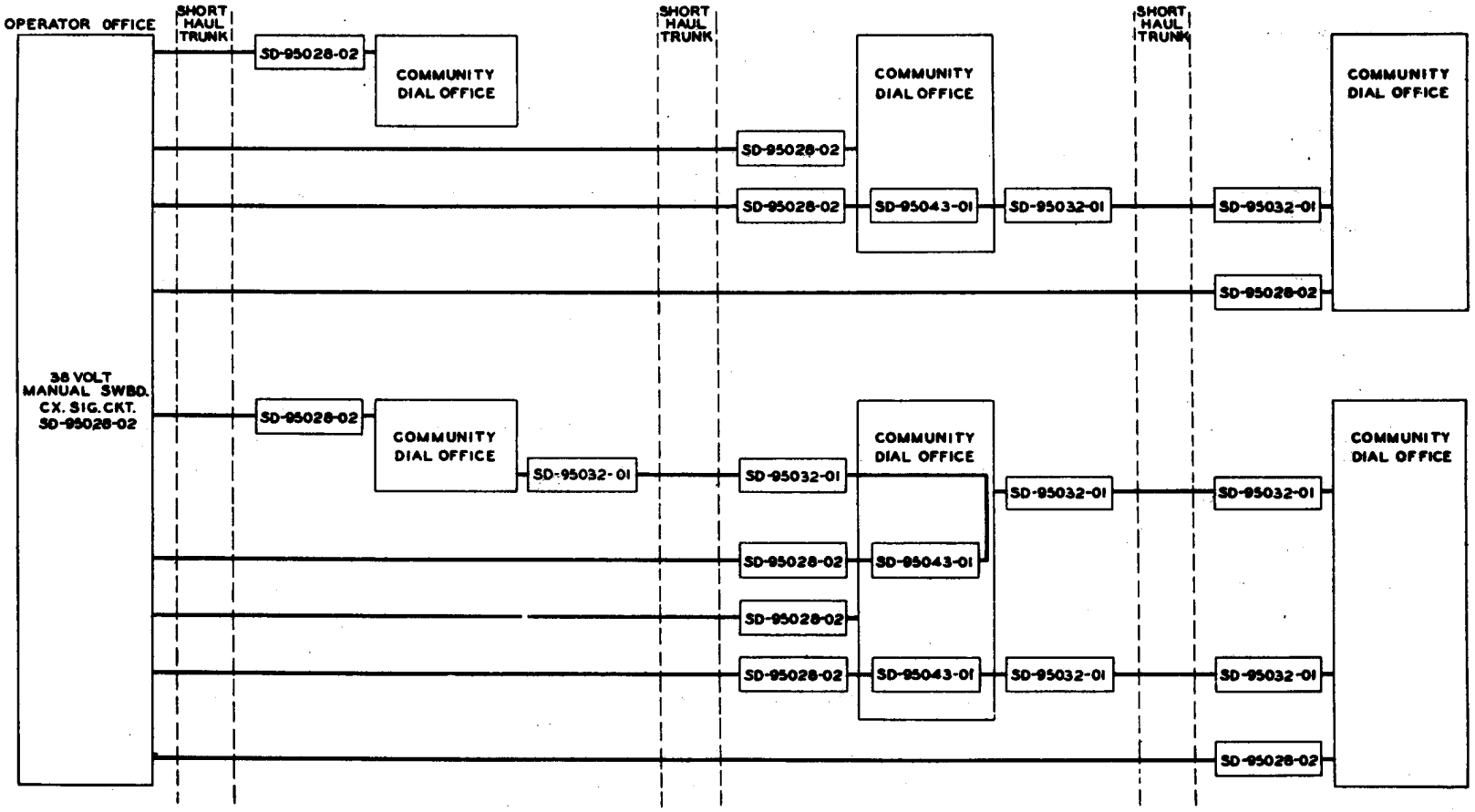
COMMON SYSTEMS
COMPOSITE SIGNALING
TYPICAL SCHEMATIC
FOR COMMUNITY DIAL OFFICE TRUNKS
TWO WIRE CABLE CIRCUITS



ES-536401

SKETCH B2

BELL TELEPHONE LABORATORIES, INC.

NOTES SD-95051-01 IS A SHORT HAUL SX. SIG. CKT.
SD-95032-01 IS A SHORT HAUL CX. SIG. CKT.
SD-95058-01 IS A CX. SIG. CKT. FOR COMPOSITING A PHANTOM.
SD-95043-01 IS THE NON-RELAY AUXILIARY PULSE LINK CKT.

3 SHEETS, SHEET 3 **ES-536401**
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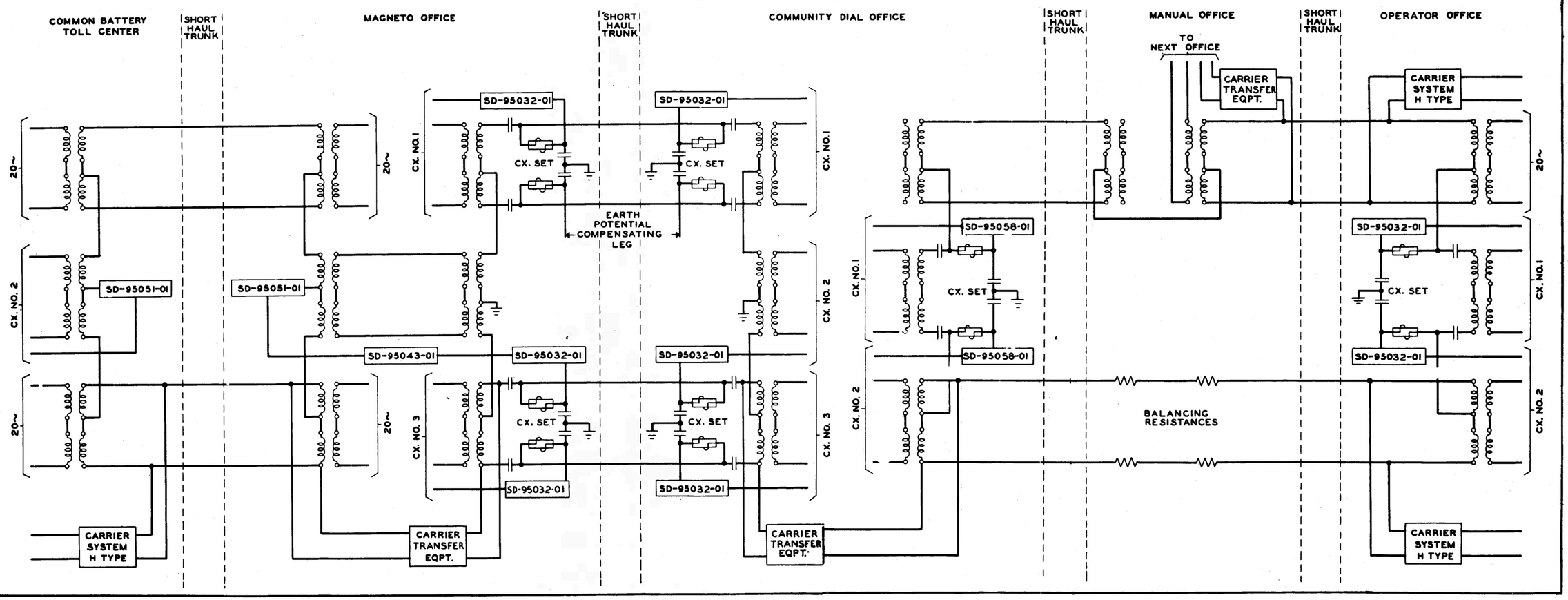
COMMON SYSTEMS
COMPOSITE SIGNALING
TYPICAL SCHEMATIC
FOR COMMUNITY DIAL OFFICE TRUNKS
TWO WIRE CABLE CIRCUITS



BELL TELEPHONE LABORATORIES, INC.

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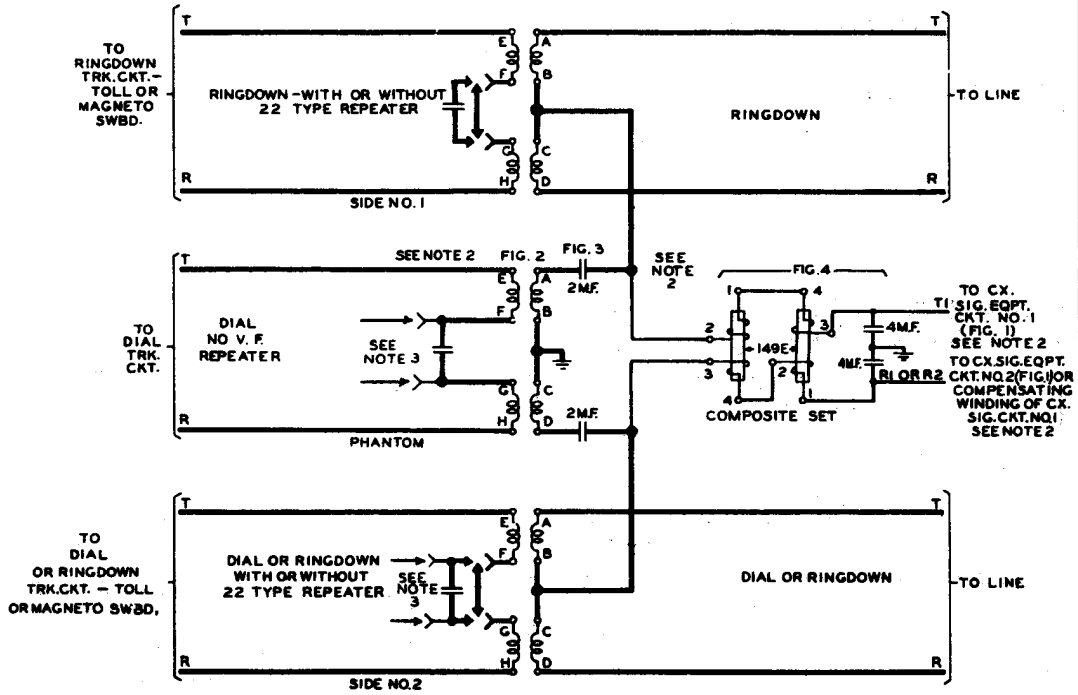
NOTES:
1. WHERE THE TWO SIDE CIRCUITS ARE RINGDOWN, ONE COMPOSITE SIGNALING CHANNEL MAY BE EMPLOYED FOR EARTH POTENTIAL COMPENSATION, OR FOR TELEGRAPH OR OTHER D-C SIGNALING PURPOSES.
2. FIGURE NUMBERS REFER TO FIGURES ON DRAWING SD-95058-01
3. FOR ARRANGEMENTS SEE NOTE 105 ON SD-95058-01

COMMON SYSTEMS
COMPOSITE SIGNALING
COMPOSITING THE PHANTOM
FOR USE IN OFFICES HAVING 22 TYPE REPEATERS WITHOUT VOICE REPEATERS ON PHANTOM TYPE D CX. SET
FOR OPEN WIRE OR TWO WIRE CABLE CIRCUITS



SKETCH C

BELL TELEPHONE LABORATORIES, INC.

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PATCHING FACILITIES FOR INTERTOLL CX SIGNALING STRAIGHTFORWARD, DIALING AND RINGDOWN TRUNKS IN NO. 3 TYPE TOLL OFFICES

AT TOLL TEST BOARDS NOS. 16, 17B & 18B AND TEST & CONTROL BOARD NO. 8

TYPICAL PATCHING FACILITIES

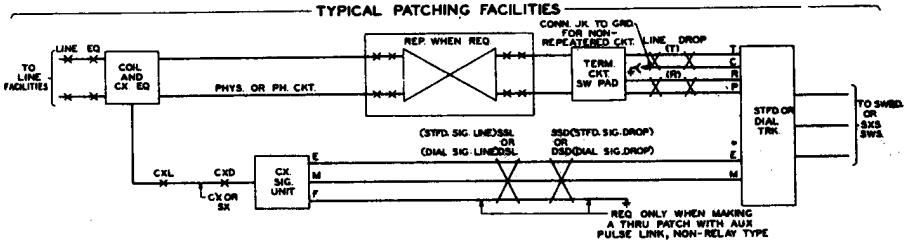

FIG. 1 INTERTOLL STRAIGHTFORWARD OR DIAL TRUNK-TERMINATING CIRCUIT

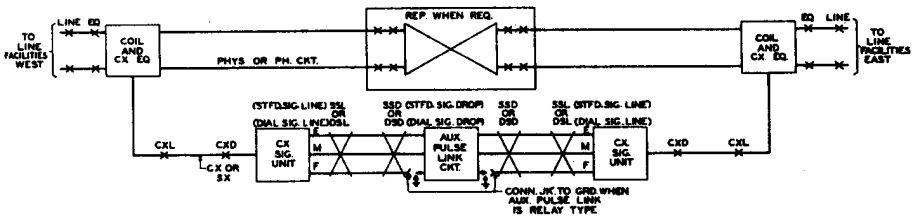

FIG. 2 INTERTOLL STRAIGHTFORWARD OR DIAL TRUNK-THRU CIRCUIT

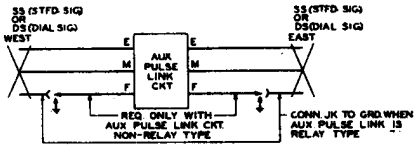

FIG. 3 SPARE AUXILIARY PULSE LINK CKT.

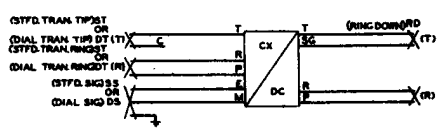

FIG. 4 SPARE SIGNAL CONVERTER CKT

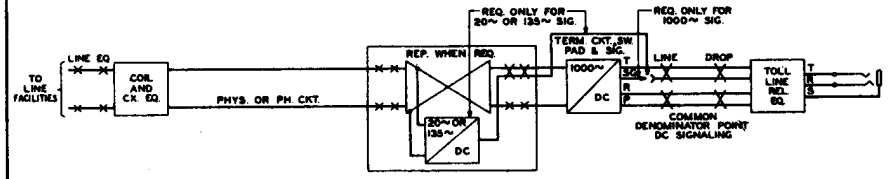

FIG 5 INTERTOLL RINGDOWN TRUNK-TERMINATING CIRCUIT

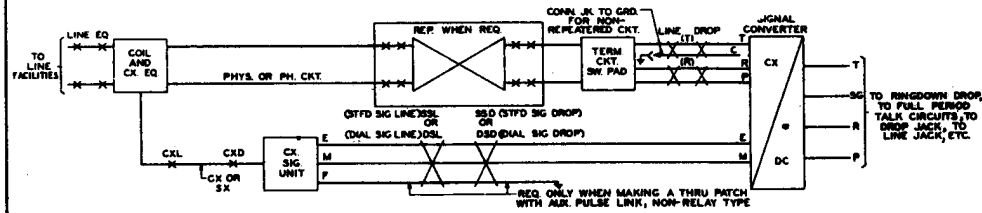

FIG 6 INTERTOLL STRAIGHTFORWARD OR DIAL TRUNK USED AS FULL PERIOD TALK OR RINGDOWN CKT ON A WIRED BASIS

TYPICAL PATCHES

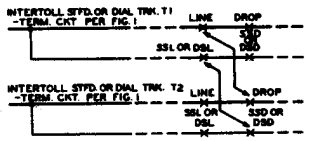

FIG A - PATCHED UP IT. STFD. OR DIAL TERM. TRK. = LINE EQ. OF STFD. OR DIAL TRK. T1 + DROP EQ. OF STFD. OR DIAL TRK. T2

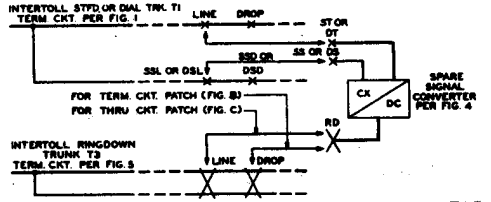

FIG. B - PATCHED UP IT. RD. TERM. TRK. = LINE EQ. OF STFD. OR DIAL TRK. T1 + CONVERTER + DROP EQ. OF RD. TRK. T3

FIG. C - PATCHED UP IT. RD. THRU TRK. = LINE EQ. OF STFD. OR DIAL TRK. T1 + CONVERTER + LINE EQ. OF RD. TRK. T3

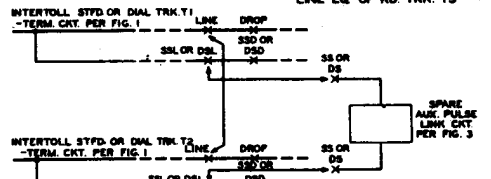

FIG D - PATCHED UP IT. STFD. OR DIAL THRU TRK. = LINE EQ. OF STFD. OR DIAL TRK. T1 + AUX. PULSE LINK CKT. + LINE EQ. OF STFD. OR DIAL TRK. T2

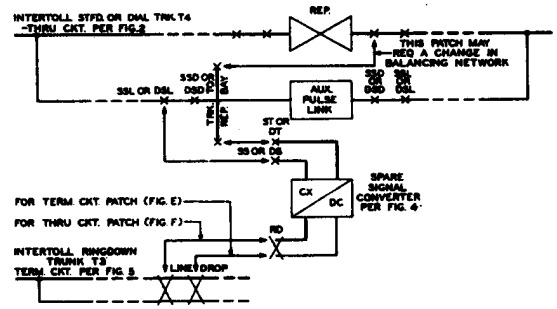

FIG. E - PATCHED UP IT. RD. TERM. TRK. = LINE EQ. OF STFD. OR DIAL TRK. T4 + CONVERTER + DROP EQ. OF RD. TRK. T3

FIG. F - PATCHED UP IT. RD. THRU TRK. = LINE EQ. OF STFD. OR DIAL TRK. T4 + CONVERTER + LINE EQ. OF RD. TRK. T3

LEGEND.
- TRANSMISSION PATH
- SIGNAL PATH
- X JACK OR JACKS
- PATCHING CORD

SKETCH D

BELL TELEPHONE LABORATORIES, INC.

PATCHING FACILITIES FOR INTERTOLL CX SIGNALING STRAIGHTFORWARD, DIALING, AND RINGDOWN TRUNKS IN NO. 1 TYPE TOLL OFFICES

AT TOLL TEST BOARDS NOS. 4 & 5

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TYPICAL PATCHING FACILITIES

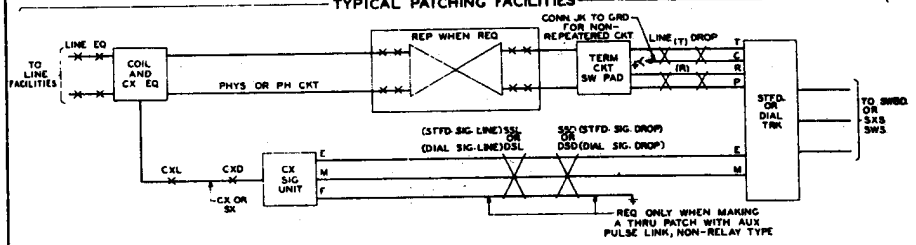

FIG 1 INTERTOLL STRAIGHTFORWARD OR DIAL TRUNK-TERMINATING CIRCUIT

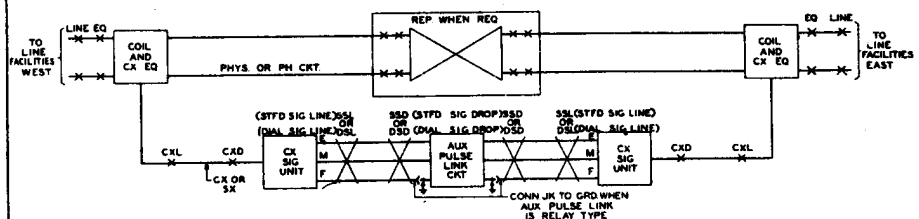

FIG 2 INTERTOLL STRAIGHTFORWARD OR DIAL TRUNK-THRU CIRCUIT

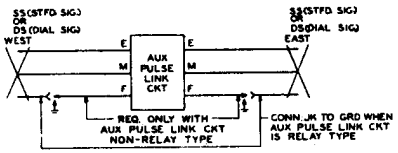

FIG. 3 SPARE AUXILIARY PULSE LINK CKT

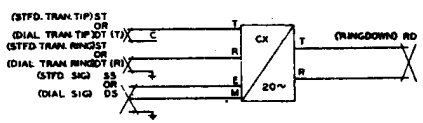

FIG 4 SPARE SIGNAL CONVERTER CKT.

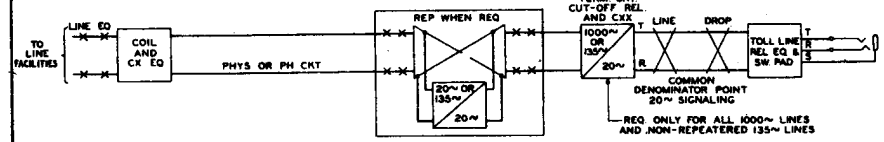

FIG 5 INTERTOLL RINGDOWN TRUNK-TERMINATING CIRCUIT

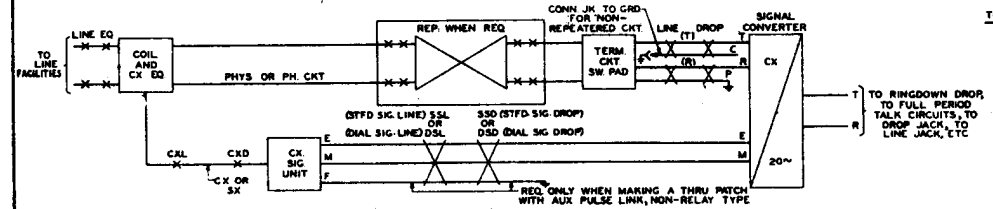

FIG 6 INTERTOLL STRAIGHTFORWARD OR DIAL TRUNK USED AS FULL PERIOD OR RINGDOWN CKT ON A WIRED BASIS.

TYPICAL PATCHES

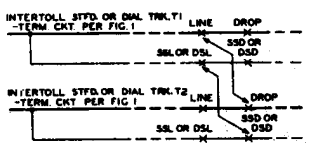

FIG A-PATCHED UP IT STFD OR DIAL TERM. TRK = LINE EQ OF STFD OR DIAL TRK T1 + DROP EQ OF STFD OR DIAL TRK. T2

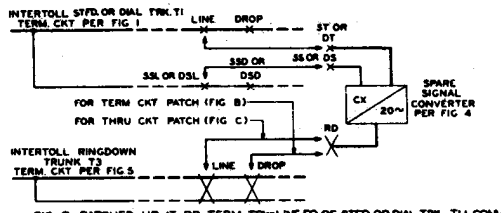

FIG B-PATCHED UP IT RD. TERM TRK = LINE EQ OF STFD OR DIAL TRK. T1 + CONVERTER + DROP EQ OF RD TRK T3

FIG. C-PATCHED UP IT RD. THRU TRK = LINE EQ OF STFD. OR DIAL TRK. T1 + CONVERTER + LINE EQ OF RD TRK T3

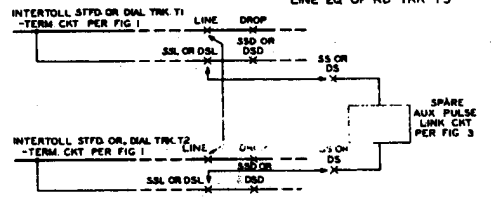

FIG D-PATCHED UP IT. STFD OR DIAL THRU TRK = LINE EQ OF STFD. OR DIAL TRK T1 + AUX. PULSE LINK CKT + LINE EQ. OF STFD. OR DIAL TRK. T2

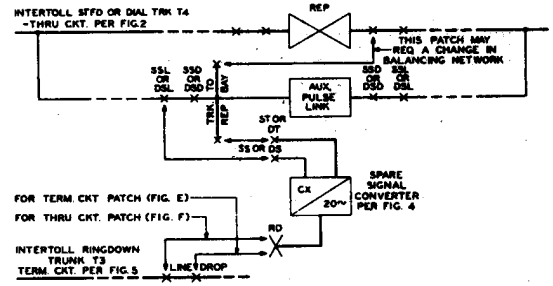

FIG E-PATCHED UP IT RD. TERM TRK = LINE EQ. OF STFD. OR DIAL TRK + CONVERTER + DROP EQ. OF RD. TRK. T3

FIG F-PATCHED UP IT. RD. THRU TRK. = LINE EQ. OF STFD. OR DIAL TRK + CONVERTER + LINE EQ OF RD TRK. T3

LEGEND
- TRANSMISSION PATH
- SIGNAL PATH
- X JACK OR JACKS
- PATCHING CORD

SKETCH E

BELL TELEPHONE LABORATORIES, INC.

PATCHING FACILITIES FOR INTERTOLL CX SIGNALING STRAIGHTFORWARD, DIALING AND RINGDOWN TRUNKS IN EARLY NO. 3 TYPE TOLL OFFICES

AT TOLL TEST BOARDS NOS. 4 & 5

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TYPICAL PATCHING FACILITIES

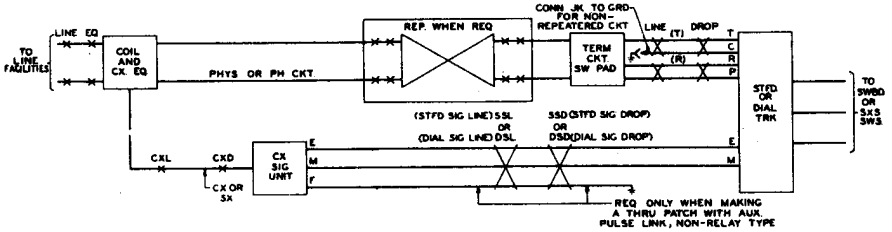

FIG 1 INTERTOLL STAIGHTFORWARD OR DIAL TRUNK-TERMINATING CIRCUIT

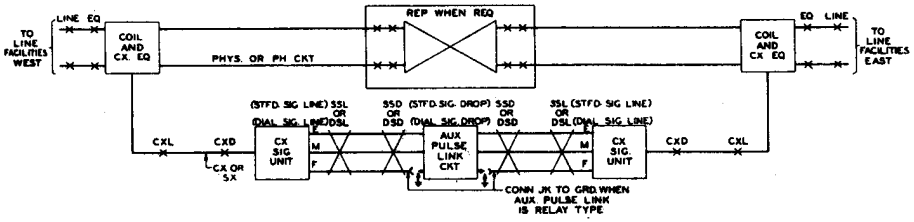

FIG 2 INTERTOLL STRAIGHTFORWARD OR DIAL TRUNK-THRU CIRCUIT

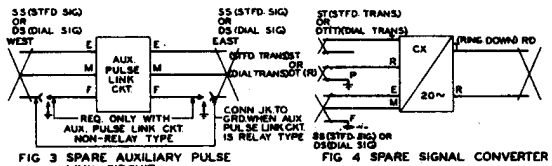

FIG 3 SPARE AUXILIARY PULSE LINK CIRCUIT

FIG 4 SPARE SIGNAL CONVERTER CKT

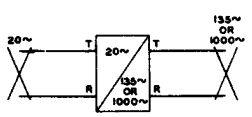

FIG. 5 SPARE RINGER CIRCUIT

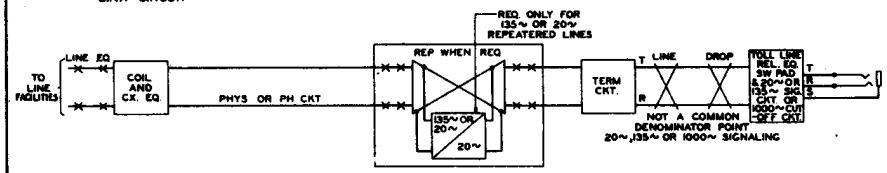

FIG 6 INTERTOLL RINGDOWN TRUNK-TERMINATING CIRCUIT

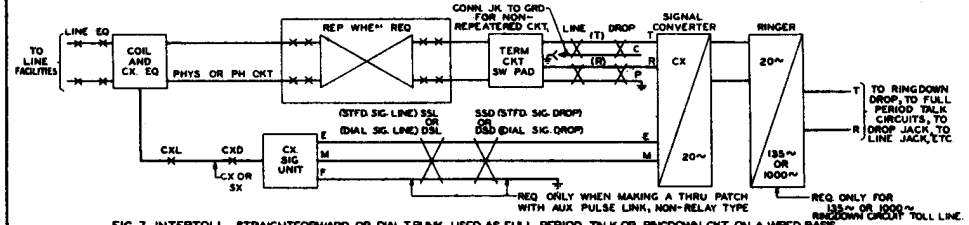

FIG. 7 INTERTOLL STRAIGHTFORWARD OR DIAL TRUNK USED AS FULL PERIOD TALK OR RINGDOWN CKT. ON A WIRED BASIS.

TYPICAL PATCHES

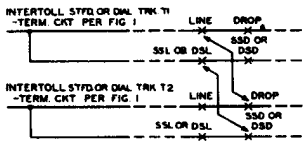

FIG A-PATCHED UP IT. STFD OR DIAL TERM. TRK. = LINE EQ. OF STFD. OR DIAL TRK. T1 + DROP EQ OF STFD. OR DIAL TRK T2

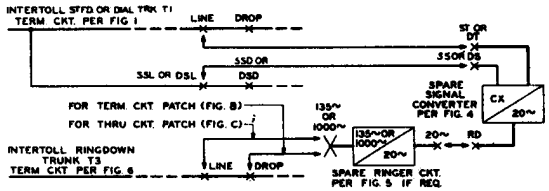

FIG B-PATCHED UP IT RD TERM TRK = LINE EQ OF STFD. OR DIAL TRK. T1 + CONVERTER + SPARE RINGER IF REQ. + DROP EQ OF RD TRK. T3

FIG C-PATCHED UP IT RD. THRU TRK. = LINE EQ OF STFD OR DIAL TRK. T1 + CONVERTER + SPARE RINGER IF REQ. + LINE EQ. OF RD. TRK T3

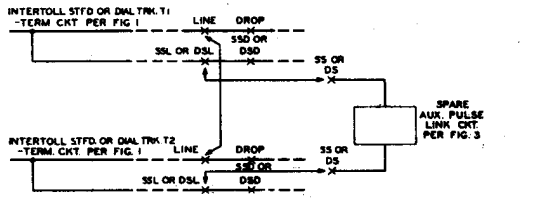

FIG D-PATCHED UP IT STFD. OR DIAL THRU TRK - LINE EQ OF STFD. OR DIAL TRK. T1 + AUX. PULSE LINK CKT. + LINE EQ. OF STFD. OR DIAL TRK T2

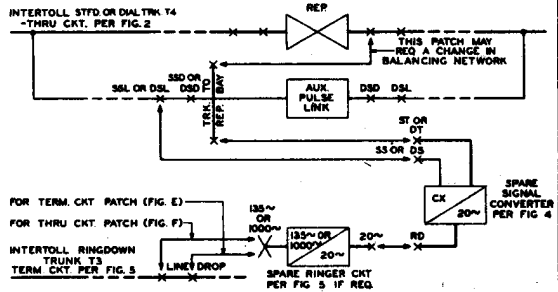

FIG. E-PATCHED UP IT. RD. TERM TRK. = LINE EQ OF STFD OR DIAL TRK. T4 + CONVERTER + SPARE RINGER IF REQ. + DROP EQ. OF RD. TRK T3

FIG. F-PATCHED UP IT. RD. THRU TRK = LINE EQ OF STFD OR DIAL TRK. T4 + CONVERTER + SPARE RINGER IF REQ. + LINE EQ OF RD. TRK. T3

LEGEND
- TRANSMISSION PATH
- SIGNAL PATH
- JACK OR JACKS
- PATCHING CORD

SKETCH F

MAINTENANCE FACILITIES AT TOLL TEST BOARDS FOR INTERTOLL COMPOSITE SIGNALING STRAIGHTFORWARD OR DIAL TRUNKS

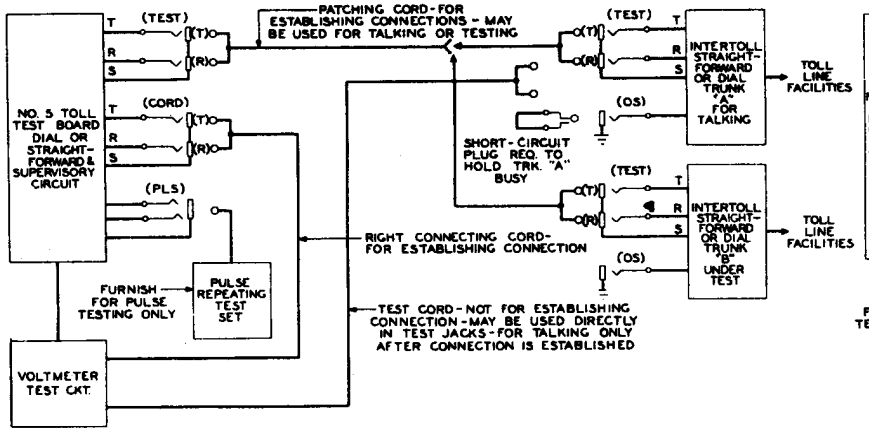

FIG. 1 ARRANGEMENT FOR SIGNALING, DIALING OR TESTING AT NO. 5 TOLL TEST BOARD

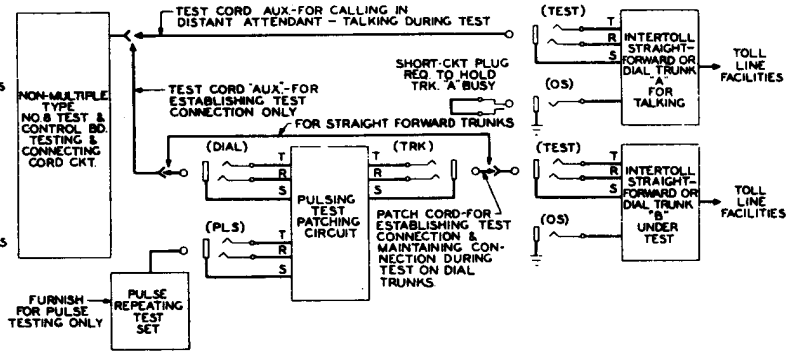

FIG. 3 ARRANGEMENT FOR SIGNALING, DIALING OR TESTING AT NON-MULTIPLE TYPE NO. 8 TEST & CONTROL BOARD

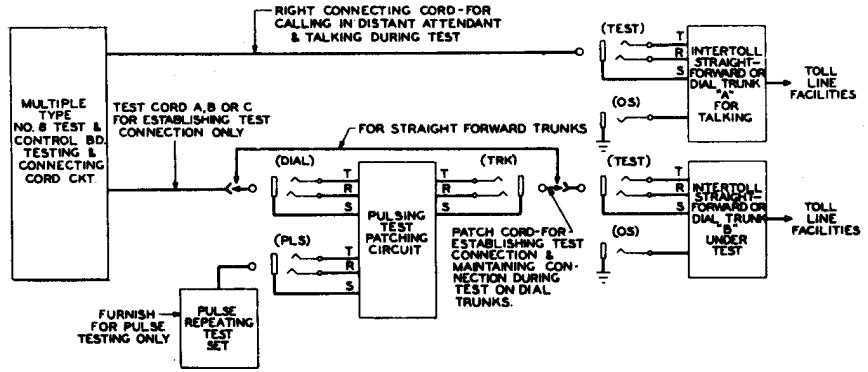

FIG. 2 ARRANGEMENT FOR SIGNALING, DIALING OR TESTING AT MULTIPLE TYPE NO. 8 TEST & CONTROL BOARD

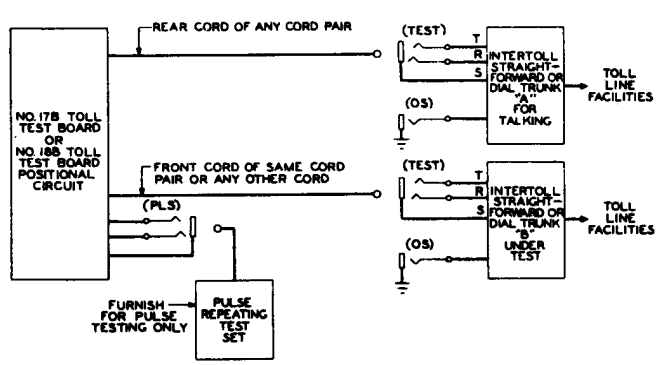

FIG. 4 ARRANGEMENT FOR SIGNALING, DIALING OR TESTING AT NO. 17B TOLL TEST BOARD OR NO. 18B TOLL TEST BOARD

TABLE I

CHARACTERISTICS OF COMPOSITE AND SIMPLEX SIGNALING CIRCUITS

DRAWING NUMBER	TYPE OF SIG. CKT.	LINE SECTION: TYPE OF FACILITY	LINE SECTION: VOICE REPEATER PERMITTED: AT TERMINAL POINT	LINE SECTION: VOICE REPEATER PERMITTED: AT INTERMEDIATE POINT	TYPE OF CX SET	DC EARTH POTENTIAL COMPENSATION	MAX. DC EARTH POT. VOLTS	LIMITS OF SIG. CKT. BAT. VOLTAGE (SEE NOTE)	TYPE OF CX RELAY	APPROX. SIGNALING RANGE MILES OR OHMS OF LOOP RESIST. (SEE NOTE): 16-GA.	19-GA.	22-GA.	O.W.	REMARKS
For Intertoll Trunks														
SD-95048-01	Short Haul CX	OW or Ca.	Yes	No	C	Yes	±50	40-56	239	75 mi	4800	—	100 mi	Generally used where no intermediate repeater is involved, but may be used with intermediate V1 repeater when a Type E bypass is provided at the intermediate point and type E CX sets are provided at the terminals. See SD-95067-01 for intermediate arrangement for use with Type C bypass.
		Cable	Yes	Yes	E	Yes	±50	40-56	239	—	4400	—	—	
SD-55415-01	Long Haul CX	Cable	Yes	Yes	C	Yes	±50	45-50	209	130 mi	12,000	—	—	For 12,000 ohm range, either Type C or E CX sets may be used at the bypass point but Type C must be used at terminals of line section; for 10,000 ohm range, Type E may be used at all points. For ranges over 8000 ohms, added first pulse distortion eqpt. is used. Type E cannot be used at terminals with 93-type repeating coils and 22-type repeaters. This is also true of all other CX sig. ckts.
										130 mi	10,000	—	—	
SD-95029-01	Short Haul CX	OW	Yes	No	C	Yes	±50	40-56	239	—	—	—	100 mi	Somewhat cheaper than SD-95048-01 (Type A CX sets may also be used, but it is generally recommended that they be changed to Type C).
SD-95067-01	Short Haul CX	OW or Ca.	Yes	Yes	C	Yes	±50	40-56	239	—	4400	—	70 mi	Differs from SD-95048-01 in that provision is made for use at intermediate point, with Type C bypass set at the intermediate point and Type C CX sets at the terminals.
SD-95028-03	Short Haul CX	OW or Ca.	Yes	No	C	Yes	±50	40-56	239	—	2100	—	20 mi	For use where the CX set and the sig. ckt. are located in different offices. Total conductor loop for cable limited to 750-2100 ohms, including 0-1320 ohms of cable between the CX set and the sig. ckt. Open wire may include 0-1320 ohms of cable in addition to 20 mi. OW.
SD-95028-02	Short Haul CX 1-way dial	OW or Ca.	Yes	No	C	Yes	±50	31-43) man.) 44-52) dial)	239	75 mi	3900	—	50 mi	For use between manual and dial office.
SD-95084-01	Long Haul CX Sig. only	Cable	Yes	Yes	C or E	Yes	±50	40-56	206	3520	11,000	—	—	Either Type C or E bypass may be used at an intermediate point with any combination of Type C or E CX sets at the terminals. This circuit provides for rering.
SD-95053-01	Long Haul SX	Cable	Yes	Yes	None	Yes	±50	40-56	239	5000	7920	8800	—	Simplex signaling circuit in which five circuits are compensated over one earth potential compensation path.
For Tributary and Toll Connecting Trunks All of the above plus the following are suitable.														
SD-95032-01	Short Haul CX	OW or Ca.	No	No	D	Yes	±50	40-56	239	70 mi	4800	—	90 mi	Equipment unit includes signaling circuit, Type D. composite set and repeating coils. Limited flexibility and maintenance facilities.
SD-95058-01	Short Haul CX	OW or Ca. Ph. Ckt.	No	No	D	Yes	±50	40-56	239	3000	6000	—	105 mi	For composited phantom circuits. Range for open wire assumes insulation resistance of 400,000 ohms per conductor mile for circuits over 25 miles long; 320,000 ohms under 25 miles.
SD-95019-01	Short Haul CX	G Carrier	No	No	D	No	±5	40-56	239	—	—	—	65 mi	Assumes min. insulation resistance of 6660 ohms. Range may be as much as 100 miles with certain CDO's and min. insulation resistance of 2850 ohms.
SD-95051-01	Long Haul SX	OW or Ca.	Yes	Yes	None	No	±2	40-56	239	100 mi	80 mi	40 mi	90 mi	Simplex signaling circuit.
SD-95016-01	Short Haul CX Sig. only	Cable	Yes	No	C or E	Yes	±62	45-50	B	8200	8200	8200	—	Inexpensive. Signaling only, but unsuitable for toll because rering feature is not provided.
							±37	31-43	B	3000	3000	3000	—	

Note: Although the circuit may function with battery having wider voltage limits, the approximate maximum ranges indicated above are generally based on office battery potentials of 45-50 volts, with dc earth potential of ±50 volts, no ac earth potentials, with min. insulation resistance of 60,000 ohms per conductor for cable, and 160,000 ohms per conductor per mile for 25 miles or less of open wire, or 200,000 ohms per conductor per mile for open wire longer than 25 miles. For specific range information, reference should be made to the charts on the circuit drawings. Signaling circuits may be operated without compensation on tributory and toll connecting trunks if earth potential conditions permit.

TABLE II

EQUIPMENT ARRANGEMENTS OF COMPOSITE AND SIMPLEX SIGNALING CIRCUITS

ABBREVIATED TITLE	DRAWINGS		SPEC.	CKTS. OR PH. GROUPS PER UNIT	SPACE OCCUPIED PER UNIT (NO. OF 1-3/4" MTG. PLATES)
	CIRCUIT	EQUIPMENT			
COMPOSITE SIGNALING					
Open Wire Facilities					
Two-Way Signaling, Two-Way Dialing, Short Haul Open Wire With or Without Terminal Voice Repeaters, Without Intermediate Voice Repeaters. Type C CX Set.	SD-95029-01	ED-95029-01	J98602J	1 Ph. group	4 — 19"
Combined Cable or Open Wire Facilities					
Two-Way Signaling, One-Way Dialing. G1 Carrier Without Intermediate Voice Repeaters. Type D CX Set.	SD-95019-01	ED-95019-01	J68737C	2 Ckts.	2 — 19"
Cable Facilities					
Two-Way Signaling Only. Not Arranged for Dialing. With One-Pulse Rering Feature. For use in 48 volt Offices. Long Haul Cable with or without an Intermediate or Terminal Voice Repeater. Type C or E CX Set.	SD-95084-01	ED-91680-01	J98606E	1 Ph. group	3 — 19"
Two-Way Signaling Only. Not Arranged for Dialing. For use with 38 or 48 volt offices. Short Haul Cable with or without Terminal Voice Repeater. Type C or E CX Set.	SD-95016-01	ED-95016-01	J98602C	1 Ph. group	2 — 19"
Two-Way Signaling, Two-Way Dialing. Short Haul Cable or Open Wire Without Intermediate or Terminal Voice Repeater. Combined Repeating Coil, Composite Set and Composite Signaling Unit. Type D CX Set.	SD-95032-01	(ED-95032-01 (ED-91541-01	J98604Aø J98604Bø J98606C*	1 Ph. group 1 Ph. group 1 Ckt.	7 — 19" 8 — 19" 1 — 19"
Two-Way Signaling, Two-Way Dialing. Short Haul Cable or Open Wire. Compositing the Phantom. Without Intermediate or Terminal Voice Repeater. Combined Repeating Coil, Composite Set and Signaling Unit. Type D CX Set.	SD-95058-01	ED-95058-01	J98606A	1 Ckt.	1 — 19"
Two-Way Signaling, Two-Way Dialing Short Haul Cable or Open Wire With or Without One Intermediate Voice Repeater. Type C or E CX Set.	SD95048-01	ED-91738-01	J98606G† J98606H†	1 Ph. group	2 — 19" 1 — 19"
Two-Way Signaling, Two-Way Dialing. Short Haul Open Wire or Cable. With or Without an Intermediate or Terminal Voice Repeater. Type C CX Set.	SD-95067-01	ED-95067-01	J98606B	1 Ph. group	6 — 19"
Two-Way Signaling, Two-Way Dialing. Composite Set in Distant Office. Short Haul Cable or Open Wire. With or Without Terminal Voice Repeater. Without Intermediate Voice Repeater. Type C CX Set.	SD-95028-03	ED-95028-01	J98602H	1 Ph. group	4 — 19"
Two-Way Signaling, One-Way Dialing. For Use with 38 Volt Manual and 48 Volt Dial Offices. Short Haul Cable or Open Wire Without Intermediate or Terminal Voice Repeater. Type C CX Set.	SD-95028-02	ED-95028-01	J98602H	1 Ph. group	4 — 19"
Cable Facilities					
Two-Way Signaling, Two-Way Dialing, Long Haul Cable With or Without an Intermediate or Terminal Voice Repeater. Type C or E CX Set.	SD-55415-01	ED-55415-01	J98606J† J98606K†	1 Ph. group	8 or 9 — 19"
SIMPLEX SIGNALING					
Two-Way Signaling, Two-Way Dialing. Short Haul Physical Cable With or Without Intermediate or Terminal Voice Repeater. With or Without Earth Potential Compensation.	SD-95053-01	ED-95053-01	J98603C	5 Ckts.	5 — 19"
Two-Way Signaling, Two-Way Dialing. Short Haul Cable or Open Wire. With or Without Intermediate or Terminal Voice Repeater. Without DC Earth Potential Compensation.	SD-95051-01	ED-95051-01	J98603D	2 Ckts.	3 — 19"

* Limited demand. Similar to the unit of ED-95058-01 for composited phantom but is used primarily for obtaining a fourth signaling ckt. in a phantom group per SD-95032-01 in cases where earth potential is not required.
† Sig. Ckt. and sig. network are on separate units.
ø J98604A provide 500 volt condensers to ground in CX Set; J98604B provides 1000 volt condensers.

TABLE III

CHARACTERISTICS OF PULSE LINK AND SIGNAL CONVERTER CIRCUITS

DRAWING NUMBER	TYPE OF CIRCUIT	USE	EQUIPMENT DRAWING	SPECIFICATION	CIRCUITS PER UNIT	NO. OF 1-3/4" MTG. PLATES PER UNIT	REMARKS
SD-95095-01	Relay Type Pulse Link	Between two long haul or long and short haul CX or SX signaling circuits	ED-95095-01	J98605D	3	4 — 19"	
SD-95043-01	Nonrelay Type Pulse Link	Between two short haul CX or SX signaling circuits	ED-95043-01	J98602K	3	1 — 19"	
SD-95311-01	Telegraph Type Pulse Link	Between either DC or VF telegraph channel and CX or SX sig. ckt.	ED-91765-01	J98605B	3	4 — 19"	
SD-95060-01	Loop to CX or SX Converter	For connecting loop sig. to CX or SX — dialing from loop end	ED-95060-01	J98605A	1	2 — 19"	Provides 1-way signaling from CX or SX end and 1-way dialing from loop end. Loop signaling range 1200 ohms. The range of the CX or SX end of this trunk is determined by the associated signaling ckt.
SD-95061-01	Loop to CX or SX Converter	Same as above but dialing from CX or SX end	ED-95061-01	J98605	2	1 — 19"	Provides 1-way dialing from the CX or SX and 1-way signaling from loop end. Loop signaling range 2400 ohms. The range of the CX or SX end of this trunk is determined by the associated signaling ckt.
SD-64697-01	CX or SX to 20 cycle	For converting CX or SX sig. trunk to ringdown operation	ED-64697-01	J98602M	2	2 — 19"	Provides 2-way connection between CX or SX sig. and ringdown trunks such as those to No. 1 switchboard.
SD-64698-01	CX or SX to DC sig.	For converting CX or SX sig. trunks to ringdown operation	ED-64698-01	J98602N	3	1 — 19"	Provides 2-way connection between CX or SX sig. and a dc signal receiving circuit or a switchboard such as a No. 3 or 4

TABLE IV

CHARACTERISTICS OF AC EARTH POTENTIAL FILTERS

DRAWING NUMBER	TYPE OF CIRCUIT	USE	EQUIPMENT DRAWING	SPECIFICATION	CKTS. PER UNIT	NO. OF 1-3/4" MTS. PLATES PER UNIT	REMARKS
SD-95073-01 Fig. 1	60 cycle filter	On CX sig. ckts. with or without dc earth potential compensation.	ED-91726-01	J98605E	3	1 — 19"	One filter is required per CX sig. channel with dc earth potential compensation, and 2 filters are required per channel without dc earth potential compensation.
SD-95073-01 Fig. 2	60 cycle filter	On SX sig. ckts. with dc earth potential compensation (SD-95053-01)	ED-91726-01	J98605E	3	1 — 19"	Three filters are required for the first SX sig. ckt. and two are required for each SX sig. ckt. 2, 3, 4, and 5 (total of 11 filters per group of 5 SX sig. ckts.).
SD-95073-01 Fig. 3	60 cycle filter	On SX sig. ckts. without dc earth potential compensation (SD-95051-01)	ED-91726-01	J98605E	2	1 — 19"	One filter is required per SX channel.
SD-95073-01 Fig. 4	Longitudinal retard coil for 60 cycle or 25 cycle	On CX sig. ckts. with dc earth potential compensation	ED-91726-01	J98605 Note 4.02	2	4 — 19"	One coil is required per quad or separate pair.

TABLE V

TEST BOARD FACILITIES

ABBREVIATED TITLE	DRAWINGS		SPEC.
	CIRCUIT	EQUIPMENT	
Dial Ckt.— Repeated Dialing	SD-55112-01	ED-55112-01	J63513R
Dialing & Supv. Ckt. Repeated Dialg. Sec. Posns. in Ofcs. with No. 3 Toll Swbd. For Assoc. T.T. Bd. No. 4 or 5. Pos. Dial with I.T. Dial Trk. or CDO Trk.	SD-55202-01	ED-55202-01	J63513S
Key Set No. 3 Toll. T&C Bd. No. 8	SD-62066-01	ED-60501-01 ED-61623-01	J63504
Dial Ckt T&C Bd. No. 8 Mult. or Non-Mult.	SD-64581-01	ED-61630-01 ED-61631-01	J63504
Dialing and Supv. Ckts. Loop Dial. Sec. Posns. in Ofcs. with No. 1 Toll Swbds. For Associating Posn. Dial of T.T. Bd. No. 4 or 5 with I.T. Dial Trks. or CDO Trk.	SD-64595-01	ED-64595-01	J63513L
Dialing and Supv. Ckt. Repeated Dial Sec. Posns. in Ofcs. with No. 1 Toll Swbd. For Associating Posn. Dial of T.T. Bd. No. 4 or 5 with I.T. Dial Trks. or CDO Trk.	SD-64881-01	ED-64881-01	J63513P
Pulse Test, Patching Ckt., T&C Bd. No. 8	SD-64893-01	—	—
Patching, Mon. and Test Jacks	SD-64724-01	(ED-61548-01 (ED-61706-01 (ED-61962-01	—
Patching Jack T&C Bd. No. 8 T.T. Bd. No. 16	SD-62741-01	ED-60440-02	—
Patching Mon. T.T. Bd. No. 4 or 5	SD-55337-01	ED-62013-01	—
Cord Mod. for KP or Dial or Both, T&C Bd. No. 8 Non-Mult.	SD-62961-01	ED-60501-01 ED-61623-01	J63504
Cord Mod. for KP or Dial or Both, T&C Bd. No. 8	SD-64159-01	ED-60501-01 ED-61623-01	J63504