
CIRCUIT DESCRIPTION


## D. Description of Changes

# D. 1 Note 110 revised to show AE option as 

 Standard at Issue 36D and Note $11 l$ and Fig. l and N corrected to remove AP option reference at various contact protect networks in order to bring circuit schematic into agreement with manufacturing drawings.BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT 5143-ABVL
NECk DEPT 367-FAM-JBK-GW

# CROSSBAR SYSTEMS 

NO. 1
FULL SELECTOR
TERMINATING SENDER CIRCUIT

## CHANGES

## B. Changes in Apparatus

## B. 1 Removed Replaced By

Relay EF, Ul57, Relay EF, U157, Fig. Q Fig. N and P Relay EF, U258, Fig. R

## D. Description of Changes

D. 1 Relay EF has been removed from Fig. N and $P$ and it is now shown as a separate figure, Fig. Q, rated "Mfr Disc*", and Fig. Q is replaced by Fig. R.
D. 2 In Fig. 1 a multiple connection note is added to NSO and NSI leads.
D. 3 Circuit Note 110 is changed and Circuit Note 118 is added to reflect the changes noted in D.I.
D. 4 CAD Fig. IK has been revised and CAD Fig. IR is added to reflect the changes noted in D.2.

BELU TELEPHONE LABORATORIES, INCORPORATED

## CHANGES

## A. Changed and Added Functions

A.l Office brush and office group selections
can be used to generate five DID number series for direct-in-dialing type operation to PBX stations using LLP.
A. 2 Dedicated trunk group indications
$O A$ and $O B$ or $F O O$ and $F 10$ and number series indications NSI can be used to generate two DID number series for direct-in-dialing type operation to PBX*stations using LLP.

## B. Changes in Apparatus

B. 1 Added Apparatus

OBA Relay J729, Fig. 1, "AU" Option
SC3 Relay U699, NSO Relay U1318,
NSI Relay U694, Fig. 1, "AV", "AW" Options
B. 2 Superseded Superseded By

324C Crossbar 324AR Crossbar Switch - Fig. $1 \quad$ Switch - Fig. 1
D. Description of Circuit Changes
D. 1 In Fig. I the six vertical crossbar switch "AR" option is rated "Mfr Disc." and superseded by an eight vertical crossbar switch, "AX" option, which is needed for DID operation when office brush and office group selections are used to generate DID number series.
D. 2 In Fig. 1, "AY" option is specified
and rated "Mfr Disc." and superseded
by "AZ" option in order to provide the proper contact protection networks for the DID circuit sections.
D. 21 Circuit Note 117 is added to show the correct method of applying options
"AZ" and "AY".
D. 3 In Fig. 1, "AT" option is designated to show the present wiring and its alternate option "AU" is designated to show the wiring required to generate DID number series from office brush and office group selections.
D. 4 In Fig. I, "AV" option is designated
to show wiring necessary to generate $D I D$ number series from $O A$ and $O B$ indications and its alternate "AW" option is designated to show wiring necessary to generate DID number series from FOO and F'lO indications.
D. 41 Circuit Note 116 is added to explain
the correct use of "AV" and "AW" options.
D. 5 Cross-connection Note 400 is added to show DID cross-connections for options "AV", "AW", and "AU".
D. 6 New leads "NSO", "NSI", "NS2", and
"NS4" from Fig. l, to the terminating marker connector are added.
D. 7 New leads "NSO" and "NSI" from Fig. l to the terminating sender link are added.
D. 8 CAD Fig. 51, 53, 54, 62, 63, and 64 are modified to include the above changes.
D. 9 Option "AP" designations are added to four option "AE" locations to bring the $S D$ and the $T$ drawings into agreement.

## F. Changes in CD Sections

F. 1 Add the following paragraphs to SECTION III:
3.31 To provide for direct-in-dial type operation to PBX stations using LLP.
3.311 To provide means to receive office brush and office group selections and to translate them to a DID number series which is then transferred to the terminating marker connector on a two-out-of-four leads grounded basis.
3.312 To provide means to translate $O A$ and OB indications or FOO and FlO indications to a DID number series which is transmitted to the terminating marker connector on a two-out-of-four leads grounded basis.
3.313 To operate the TT relay if an improper $O B$ and $O G$ selection is made.
F. 2 Change the second sentence of 5.4 to read:

About 38 wires are involved in this connection....
F. 3 Change the first sentence of 7.41 to read:
1.41 This registers the 5 or 7 selections sent by the originating sender, office
brush and office group for DID type operation and incoming brush, incoming group, final brush, final tens and final units for DID and atandard type operation.

Change the fourth sentence to read:
The swit.ch has eight verticals designated $F$ for the frame, and $O B, O G, I B, I G, F B, F T$, and FU for the selections.
F. 4 Add 7.55:
7.55 The $O A$ and $O B$ or $F O O$ and FlO indications along with a number series indication from the terminating sender link can be used to generate two DID number series. The "NSI" lead from the TSL must be grounded to indicate a DID type call and NSO must be grounded for a non-DID call. If neither or both leads are grounded the TT relay will operate when the IG hold magnet operates. If the "NSI" lead from the TSL is grounded and an OA, OB, FOO, or FlO indication is cross--connected to represent a DID number series, leads "NSO", "NSI", "NS2", and "NS4" are grounded in a two-out-of-four code to transfer the information to the terminating marker connector.

## F. 5 Change the first sentence of 11.1 to read:

1.1. 1 The five or seven selections reg.istered...
F. 6 Change the first sentence of 11.61 to read:
11.61 Five or seven selections are registered on each call, office brush and office group for DID type operation only and incoming brush, incoming group, final brush, final tens and final units, in that order, for all calls.
F. 7 Change paragraph number 11.62 to 11.621.
F. 8 Add 11.622.
11.622 When $O B$ and OG selections are used to generate DID number series, the sender must be able to receive both 7 selection DID and 5 selection regular calls. The first selection is always registered on the $O B$ crosspoints and the following action depends on the level of the first selection. If it is a $0-4$ th level selection the call is a 5-selection call, the OG selection is skipped and the same level crosspoints on the IB vertical are closed when the OBA relay operates. A 7 -selection call is indicated if the first selection is a $5-9$ th level selection. When a level from 5-9 is cross-connected for DID operation the selection is stored on the $O B$ vertical only and the call proceeds to the office group selections. If the OG selection is a 4 th level selection the call proceeds to the remaining 5 selections. If the first selection is a 5 th to 9 th level selection indicating a 7 -selection call but it is cross-connected as a non-DID call the OG selection is skipped and it is registered on the IB vertical where it is handled as an improper IB selection. If the 5 th to 9 th level is properly chosen for the first selection and the IB selection is not a 4 the TT relay is operated.
F. 9 Add the following sentence to 13.31:

Leads "NSO", "NSI", "NS2", and "NS4" are grounded in a two-out-of-four code to give the number series selection used for DID type operation.
F. 10 Add 13.37:
13.37 The OB and OG registers ground the leads "NSO", "NSI", "NS2", and "NS4"

| Number Series | Office Brush Cross-conn. | Office Group | Leads Grounded |
| :---: | :---: | :---: | :---: |
| 2 |  | 4 | "NSO,NS2" |
| 3 | one of 5 | 4 | "NS1,NS2" |
| 4 | through 9 | 4 | "NSO,NS4" |
| 5 | per number | 4 | "NS1,NS4" |
| 6 | series | 4 | "MS2,NS4" |

## F. 11 Add 13.38:

13.38 The OA and OB or FOO and F1O indications when combined with relay NSl
operated can be cross-connected to indicate number series 2-6 and ground leads "NSO", "NS1", "NS2", and "NS4" as shown below:

| Number <br> Ser1es | Leads to TMC <br> Grounded |
| :--- | :--- |
| 2 |  |
| 3 | "NSO,NS2" |
| 4 | "NSI,NS2" |
| 5 | "NSO,NS4" |
| 6 | "NSI,NS4" |
|  |  |

BELL TELEPHONE LABORATORIES, INCORPORATED

## CROSSBAR SYSTEMS

NO. 1
FUTL SELECTOR
TERMINATING SENDER CIRCUIT

## CHAFGES

## B. Changes In Apparatus <br> B. 1 Added <br> Rl Resistor, 18DJ, R2 Resistor, 18DJFig. P. <br> D. Description Of Circuit Changes <br> D. 1 Resistors $R 1$ and $R 2$ are added to $F 1 g$. $P$ in serien with relay $L$ and resistance lamp $L$ to enable the $L$ relay to hold over pulsing thus avoiding the registration of faice numbers.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT 5615-RFB-TNL-AA

CROSSBAR SYSTEMS
NO. 1
FULL SELEC'TOR
TERMIN'ATING SENDER CIRCUIT

## CHANGES

## A. CHANGED AND ADDED FUNCTIONS

A. 1 Provision is made to indicate to the traffic usage recorder circuit service busy, test busy and maintenance busy conditions.
C. CHANGES IN CIRCUIT REQUIRENENTS OTHER THAN THOSE APPLYING TO ADDED OR RENIOVED APPARATUS

## C. 1 Sheet -015

C.ll On page 3 of the circuit requirements table under relay (L) of Fig. $P$ the N.O. test requirement formerly read 0.6.
C. 2 Sheet 016
C. 21 On page 8 of the circuit requirements table under relay (SS) of Fig. $P$ the
N.O. test requirement formerly read 22.6 .
C. 22 On page 9 of the circuit requirements table under relay (STP) of Fig. P the
N.O. test requirement formerly read 0.6.
C. 23 On page 12 of the circuit requirements table test note 1 formerly
read:

1. Connect sender (T) jack as described in BSP. Block (ON2), (Ll) operated. Block (TM) non-operated. Block (GR) operated to set current fiow, unblock (GR) for int. test.
D. DESCRIPTION OF CIRCUIT CHANGES
D. 1 Sheet 011
D. 11 In circuit note 104 a break interval of the TS interrupter formerly shown incorrectly as 2.8 seconds is changed to 28 seconds.
D. 12 In the contact protection table, circuit note lll, the following
changes and additions are made:
The location of contact protection $C$ was formerly shown as Fig. 1.

The information concerning protected contacts for contact protections Ll, Ll relay, $J$ and $S$ was formerly shown as 1T-2T(L).

## The connect terminal C or D column for contact protection RVI, option AB, formerly showed 8T (RV1).

Information for Fig. P contact protection (RV2) relay is added. The location of contact protection RV4 was formerly shown as Fig. 1.
D. 13 Option "AS" is added to the Options Used table.
D. 2 Sheet 012
D. 21 Leads SB and SBM, option "AS", are added to Fig. 1 and shown connecting Fig. l to the traffic usage recorder circuit.
D. 22 The lead connecting 6T(FU), 8B(L2) to Figs. G or H, L or M, and N or $P$ was
formerly shown as a heavy dashed line.
D. 23 Leads grounded by 9-10T (ON1), 3-4T
(ON2) and 8-9BB. (ON2) were formerly
shown as solid lines.

## D. 3 Sheet -013

D. 31 In Fig. $N$ the lead grounded by operated contacts $3-4 T$ (GR) relay was formerly shown as a dashed line.
D. 32 In Fig. $N$ the lead which connects 4 T (IFi) relay to Fig. C or $D$ and the
lead which connects $2 T$ ( 1 Fl ) relay to
Figs. C or D, Figs. J or K and Fig. 1 were
formerly shown as solid lines.
D. 33 Leads 24 and 25 of Fig. D were formerly shown as solid lines.
D. 4 Sheet 014
D. 41 Lead 3 of Figs. L and M was formerly shown as a dashed line.
D. 42 Option AI in Figs. H and G was formerly incorrectly shown connecting B ground to Fig. 1.
D. 43 The wiring at $2 T-1 T$ (RV2) relay was formerly shown reversed.
D. 44 The wiring at 5B-4B (RV4) relay was formerly shown reversed.
D. 45 Capacitor C was formerly incorrectly shown in series with the winding of relay (GR) in Fig. P.
All other headings under Changes, no change.

INDEX

1. PURPOSE UF CIRCUI'T
2. WurkING 'LIMI'l's
3. FUNC'IILONS
4. CunNeCTING CIRCUITS
5. TRaNSIENT CUNNECTIONS TO OTHER CIRCUITS
6. GENERAL METHOD OF OPERATION
7. PRINCIPAL PARTS OF SENDER AND OPTIONAL FEATURES
7.2 General Control Circuit
7.3 Pulsing Circuit
7.4 Frame and Selection Register.
?.5 Multi-Office Operation
8. SEIZURE, HOLDING aND RELEASE OF SENDER
8.2 Sender Seized and Held for a Service Connection
8.3 Sender Seized and Held for Test
8.4 Sender Released After Service or Test
8.5 Sender Made Busy for Maintenance
9. INCOMING FRANE AND DEMAND FCR SPECIAL MARKER REGISTERED IN SENDER
10. REGISTRATION OF OFFICE DESIGNATION
11. PULSING AND REGISTRATION OF SELECTIONS
11.2 Preparation of Originating Sender for Each Selection
11.3 Preparation of Incoming Trunk for First Selection
11.4 Preparation of Terminating Sender for Each Selection
11.5 Pulse Counting
11.6 Selections Registered
11.7 Selections Synchronized
11.8 Incoming Advance
11.9 Test Circuit at Incoming Advance
12. TRUNK CLOSURE
13. TERMINATING MARKER ENGAGEMENT
13.1 General
13.2 Marker Seized
13.3 Information from Sender to Marker
13.4 Connection Established and Marker Released
14. IRREGULARITIES AND TROUBLE CONDITIONS
14.1 Defective Frame Indication from Link Control Circuit
14.2 Trouble Release by Link Control Circuit
14.3 Trouble Release by Marker Connector
14.4 Premature Disconnect
14.5 Telltale
14.6 Stuck Sender Timeout
14.7 Cross Between D \& ST Leads in Incoming Trunk
14.8 Bridged (STP) Contacts
14.9 Terninating Sender Overload Control
15. PROVISIONS FOR SPECIAL TESTS
16. PIGURES AND OPTIONS
17. INTERDIGITAL TIMEOUT
18. TAKING EQUIPMENT OUT OF SERVICE
19. ALARM INFORMATION
20. PURPOSE OF CIRCUIT
1.1 The purpose of this circuit is to provide means for satisfying any originating sender circuit which may have to complete a call to a crossbar office on a revertive pulse basis. This circuit receives information from the originating sender and transmits this information with necessary translations to a terminating marker circuit.

## 2. WORKING LIMITS

### 2.1 External Circuit Loop

2.11 The maximum external circuit loop is 3115 ohms, including not more than 32 miles of cable.
2.12 The minimum external circuit loop is 900 ohms, exclusive of the relays in the originating sender.
2.2 Insulation Resistance
2.21 The minimum trunk insulation resistance is 30,000 ohms.
2.3 Voltage
2.31 45-50 volts.
2.4 Panel Multiple Bank Capacity
2.41 The equivalent of 50 frames in multiple at the originating office (on the basis of . 006 mf . mutual capacity per appearance).

## 3. FUNCTIONS

3.01 To recognize the selection of the sender by the link circuits, and to register the number of the associated incoming trunk frame.
3.02 To provide a circuit path to enable the link circuit to check for continuity of the lead over which the holding ground for the hold magnets is furnished.
3.03 To recognize that the associated link circuit has closed the cross-points

Page 2
CD-25013-01 - ISSUE ll-D
between the incoming trunk circuit and the sender circuit.
3.04 To furnish ground to the sender busy relay in the link circuit.
3.05 To recognize that the sender busy relay in the link circuit has operated.
3.06 To open the frame indication leads as soon as the frame registration is
completed.
3.07 To furnish ground for holding the hold magnets of the primary and secondary switches of the link circuit.
3.08 To furnish ground to the link circuit as a signal that the sender is ready for the link to release, but not to do so in case the link has grounded too few or too many frame indication leads.
3.09 To supply a ground for operating a cut-off relay in the incoming trunk circuit.
3.10 To prevent a false pulse from being recorded by the origi nating sender
circuit at the time that the line and stepping relays are connected to the trunk.
3.11 To provide pulses with which to satisfy the originating sender circuit.
3.12 To record the incoming brush, incoming group, final brush, final tens and
final units seḷection.
3.13 To supply a reverse battery condition to the originating sender circuit after selections have been recorded, first testing with direct battery for the closure of the fundamental in the originating sender.
3.131 To send reverse battery signal on telltale and to prevent premature termination of the reverse battery signal maintaining this signal until the fundamental circuit has been closed for a sufficient period.
3.14 To inform the incoming trunk circuit that the reverse battery condition has been terminated.
3.15 To release the cut-off relay in the incoming trunk circuit and to prevent its reoperation under certain conditions.
3.16 To recognize that the trunk has been closed through to the incoming trunk circuit.
3.17 To furnish battery for starting the associated marker connector circuit.
3.18 To establish connection with a marker through the marker connector after registrations have been completed.
3.19 To transmit to the marker the information recorded on the sender register switch. This information is transmitted by grounding a selection of leads, and this is done in such a way as to check all of the leads for absence of opens or grounds, any trouble encountered preventing the marker from returning information to the sender.
3.20 To release under control of the link circuit in case the link encounters
certain trouble conditions.
3.21 To release under control of an automatic priming feature in case of trouble after the sender off-normal relay has operated.
3.22 To release under control of the marker circuit on a normal call.
3.2.) To differentiate between a "regular" incoming and a "special" incoming.
3.24 To prevent the circuit from restoring to normal when held for maintenance.
3.25 To prevent the circuit from restoring to normal if ground fails to be re-
moved from the sleeve lead.
3.26 To send current through the contact of the stepping relay in one direction when connected to an incoming trunk mounted on an odd-numbered frame, and to reverse the current when connected to an incoming trunk on an even-numbered frame،

### 3.27 To indicate the engaged or made busy condition of the sender to an auto-

 matic test circuit attempting to seize it.3.28 When the test circuit is making a non-operate test of the (L) relay to time for reversed battery and at the end of a specific time it furnishes reversed battery.
3.29 To provide for multioffice operation.
3.291 To receive a signal from the sender link and control circuit over leads $O A$ and $O B$.
3.292 To receive a signal from the originating sender, recognized by incoming group selection under or over 5.
3.293 To signal the terminating marker for selection of number series, normally over the OAB lead, but in some cases over the FlO lead.
3.294 To signal the terminating marker over the OAB lead when the sender is used to discriminate between physical trunk groups and theoretical trunk groups.
3.295 To timecut in 3 to 6 seconds if the Terminat: ng Sender Timing Control Circuit indicates a probable sender overload.
3.296 To recognize an all terminating sender busy condition, as indicated by the Terminating Sender Timing Circuit, and then to send reverse battery to the originating sender, after incoming brush selection, as an indication of the terminating sender overload condition.
3.30 To provide over two leads plugged busy, test busy and service busy information for the use of the traffic usage recorder circuit.

## 4. CONNECTING CIRCUITS

This circuit will function with the following crossbar system circuits:

| 4.01 | Terminating Sender Link and Controller - SD-25459-01. |
| :---: | :---: |
| 4.02 | $\begin{aligned} & \text { Terminating Marker Connector - } \\ & \text { SD-25036-01. } \end{aligned}$ |
| 4.03 | Terminating Trouble Indicator Frame -SD-25064-01. |
| 4.04 | Interrupter Frame - SD-25062-01. |
| 4.05 | ```Terminating Sender Frame - SD-25053-01.``` |
| 4.06 | ```Terminating Sender Test - SD-25159-01.``` |
| 4.07 | $\begin{aligned} & \text { Terminating Sender Timing Control - } \\ & \text { SD-25471-01. } \end{aligned}$ |
| 4.08 | Terminating Sender and B Sender Selection - SD-25437-01. |
| 4.09 | Holding Time Recorder - SD-90246-01. |
| 4.10 | Traffic Usage Recorder - SD-95738-01. |
| DESCR | IPTION OF OPERATION |

## 5. TRANSIENT CONNECTION TO OTHER CIRCUITS

5.1 The senders mounted on 2 frames constitute a group of 10 senders, and
all the senders in a number of such groups are used in common as a large group to function with a number of incoming trunks and associated terminating sender links. The total number of senders which can be used in one large group is limited by the fact that they are arranged to function with a maximum of 20 incoming frames. Only one such large group can be used with one group of terminating markers. The 10 senders in a small group may consist partly of these terminating senders, and party of "B" position senders.
5.2 Each group of 10 senders is connected to the sender link and control circuit by 19 wires, which are connected into any one individual sender for a short time when it is first seized for service. These are
the "GS", "SL", "RL" and "TR" leads which assist the link control circuit in its functions; 12 numbered "F" leads for registering in the sender the number of the incoming frame, and the "EF" lead which indicates when the frame number is even, and the "OA" and "OB" leads which indicate which office is required on multi-office operation.
5.3 Each sender is individually connected to the sender link and control circuit by 9 leads, "T", "R", "CO", "D", "FC", "S", "SC", "SB" and "BS".
5.31 Leads "T" and "R" are connected straight through the link switch contacts to the incoming trunk, and serve to transmit revertive pulses over the trunk line to the originating sender.
5.32 Leads "CO", "D" and "FC" are also connected straight through the link switch contacts to the incoming trunk, and serve for mutual control while the sender is engaged.

### 5.33 Lead "S" is connected through the link switch contacts to hold the switches operated while the sender is engaged.

### 5.34. Lead "SC" operates relays in the sender while the link control cir-

 cuit is engaged in seizing the sender, principally for the purpose of connecting the common leads into the sender.5.35 While the sender is either engaged or plugged busy, it operates a relay individual to itself in the link control circuit over lead "SB", and that relay returns an indication of its own operation to the sender over lead "BS".

### 5.4 The sender is connected through the

 terminating marker connector to a terminating marker for a fraction of a second on each call. About 34 wires are involved in this connection, but mutual control and for transmitting information from the sender to the marker.6. GENERAL NETHOD OF OPERATION
6.1 When a sender is seized by a sender link and control circuit to serve on a call, it immediately registers the number of the incoming frame involved, and whether that number is odd or even, by indication from the link control circuit over one of the numbered "F" leads and the "EF" lead. If the kind of incoming trunk requires the services of a special marker, that fact is registered by indication from the trunk over the "FC" lead.

[^0]originating sender; and proceeds to send such pulses under the control of the originating sender, for the five incoming and final selections, counting the pulses of each selection and registering the selection. It then sends a pulse in the reverse direction. In sending directing pulse for the five selections, and then a reverse or incoming advance pulse, the terminating sender acts toward the originating sender just as would an incoming and a final selector of the panel type.

### 6.3 The sender then restores the incoming

 trunk circuit to a condition where it is in control of supervision over the trunk, and awaits trunk closure at the originating end. When the incoming trunk notes this trunk closure, it sends a signal to the sender.6.4 Notified of trunk closure, the sender connects to a marker and sends it the number of the incoming frame and the called number, which the sender translates from the incoming and final selections it has registered. The marker then connects the incoming trunk to the called line, obtaining connection with the particular incoming trunk by way of the sender. The marker then causes the sender to release its connection with both marker and incoming trunk, and to return to normal.
6.5 In case of abandoned call, partial dialing, or trouble condition, the condition either becomes apparent at once or else the sender is stuck and times out by its timing circuit. It generally sends a reverse pulse to the originating sender to establish an overflow indication, and is released. If so desired, a jack may be plugged up which will cause the sender in case of trouble to be released from its external connections, but held busy with operated relays locked up until it can be examined.
7. PRINCIPAL PARTS OF SENDER AND OPTIONAL FEATURES
7.1 The elements of this sender may be divided, in respect to their functions, into three principal parts. Each of the following subsections is a brief general statement of the function of one of these principal parts and a list of the relays comprising it, and also describes any of its features which may be optional.

### 7.2 General Control Circuit

7.21 This controls the connections between the sender and the sender link and control circuits and the incoming trunk on the one hand, and the connections between the sender and the marker connector and marker, on the other hand. It consists of the following relays when fully equipped: Sender control (SC1) and (SC2), off-normal
(ON1) and (ON2), make busy (MB), trunk closure (TC1), (TC2) and (TC3) special marker (SPL), release (RL), trouble release (I'RL), timing (TMI), (TM2)'and (TM3).

### 7.22 Relay ( HIB ) is required only when a terminating sender test circuit is

 provided.
### 7.3 Pulsing Circuit

7.31 This generates and counts the pulses which are sent for each selection to satisfy the counting relays in the originating sender, and generates a reverse pulse to advance the originating sender when the selections have been completed. It consists of the following relays: Line (L), (Ll), (L2), (L3), (L4) and (L5); stepper (STP); grounding (GR); pulse (Pl), (P2), (P3), (P4), (P5) and (P6); telltale' (TT), and reversing (RV1), (RV2), (RV3), (RV4) and (RV5). When Fig. $P$ is equipped an additional relay (SS) is required.

### 7.4 Frame and Selection Register

### 7.41 This registers the five selections

 sent by the originating sender, incoming brush, incoming group, final brush, final tens and final units. It also registers the number of the incoming frame involved and whether it is odd or even. Besides a crossbar switch which registers the selections and the units digits of the incoming frame number, there are relays to register the tens digit of the frame number and whether it is odd or even, and relays to control the action of the switch. The switch has six verticals designated (F) for the frame, and (IB), (IG), (FB), (FT) and (FU) for the selections. The full complement of relays is as follows: Incoming frame (FOO), (F1O) and (EF), select magnet (SM), crossed select magnet (XSM) , hold magnet ( $H M_{1}$ ) and register advance (RAl) and (RA2).7.42 The (FOO) and (F1O) relays are shown as A apparatus, associated with A wiring. This equipment is provided according to circuit note 107.

### 7.5 Multi-Office Operation

7.51 Number Series Indication

The $O A$ and $O B$ relays are designated "X" apparatus and are required when the sender receives information from the sender link and controller circuit over leads OA and OB. These leads, together with incoming group register, are used to signal the terminating marker over the OAB lead to distinguish between two 10000 number series.

When it is desired to use the OAB lead to discriminate between physical trunk groups and theoretical trunk groups, the
number series identification is passed over the FlO lead.
7.52 "Y" wiring is used in connection with the signal via incoming group selection to distinguish between two number series, or between physical and theoretical offices.

### 7.53 "Z" wiring is used where the OAB lead

 is used for signaling in combination with $X$ or $Y$ wiring, but the $O A$ and $O B$ relays are not required.7.51 "W" wiring is used for operation of the (ON2) relay when the (OA) and (OB) relays or "Z" wiring are omitted.

## 8. SEIZURE, HOLDING AND RELEaSE OF SENDER

8.1 The sender may be seized by a sender link for service, or by a sender test circuit for test. It is held busy when in service or under test, and is made busy when in trouble.

### 8.2 Sender Seized and Held for a Service Connection

8.21 The ten senders on two frames are associated together in a group and are connected to the associated sender link and control circuit by two sets of leads, one set individual to each sender, and one set common to all ten senders.
8.22 When an incoming trunk calls for a sender, the sender link control circuit chooses an idle sender and grounds its indi vidual "SC" Jead. Relay (SCI) operates from ground on the (SC) lead to baitt ery through the resistance lamp, this being of great importance at a later stage in the connection. When operated, (SCl) connects common leads "SL", "GS", "RL" and "TR" into this sender.
8.23 After grounding the "SC" lead, the link control circuit proceeds to operate the link switches which close six individual leads to the sender. Five of these leads, "T", "R", "FC", "CO" and "D" are connected straight through from sender to incoming trunk. The sixth lead "S" is connected to the hold magnets of the link switches.

### 8.24 The operating ground for the link switch hold magnets gets a circuit

 into the sender over the individual "S" lead and back to the link control circuit over the common "SL" lead. Satisfied by this that the sender is ready for the next step and that the "S" lead is good, and first making a test to guard against a double connection, the link circuit then grounds common lead "GS" and sc operates relay (ON1) after (RV5) has operated as described in a later paragraph.8.25 (ONz) operated grounds the individual lead "SB", and that causes the link control circuit to ground individual lead "BS" and so operate relay (ON2) after (RAl) has operated as described in paragraph 9.4.
8.26 (ON2) operated connects ground to the individual "S" lead to hold the link switch hold magnets after the link control circuit has released, and it also grounds the common "RL" lead to release the link control circuit.

### 8.27 The release of the link control cir-

 cuit breaks ground from the "SC"lead, and relay (SCl) releases to break the connection of the common leads into the sender, but the sender remains connected to the incoming trunk by the individual leads through the link switches until it has completed its work. Relays (ON1) and (ON2) lock each other up, ground off-normal ground leads to hold other relays and the cross bar register hold magnets in the sender, hold the link switches by grounding the "S" lead, and guard against the intrusion of other links and the test circuit by grounding the "SB" lead.
8.28 (RV3) operates over the "FOO" or the cuit after (SCl) and either (FOO) or (F10) operates, and is held by an off-normal ground after (ONl) operates, until it is released after the completion of selections. The operation of (RV3) causes the operation of (RV4) and (RV5) in turn which operates (ONl) previously described.

### 8.3 Sender Seized and Held for Test

8.31 All the individual and common leads from the sender and the group of ten senders which run to the sender link and control circuit run also to the sender t.est circuit, except the individual leads "SB", "BS" and "SC".
8.32 The test circuit seizes a sender for test in the same way that the sender link and control circuit seizes it for service, except that it demands connection with a particular sender instead of choosing an idle sender more or less at random. Before it can seize the desired sender, the latter must be idle, and to determine this condition it makes a test on the "S" lead, which is not made in the case of a service connection.
8.33 If the sender is engaged on a call the "S" lead is grounded by the (ON2) relay. If the sender is made busy, the "S" lead is connected to resistance battery.
8.34 The test circuit first tests the "S" lead for battery and then for ground. Finding neither, it connects to the sender;
otherwise it:waits until the battery or ground disappears.

### 8.35 When the test circuit seizes the sender, the relays operate as on a service call.

### 8.4 Sender Released After Service or Test

### 8.41 When a connection has been established

 or a test completed, or when the attempt has definitely failed, either relay (RL) or (TRL) is operated and locked to an off-normal ground.8.42 (RL) operating breaks battery from the "ST" lead to release the marker connector. (RL) also breaks the local ground connection which locks (ONI) and holds the link switches over lead "S", but these do not release at once because they are also held by ground over lead "HLD" from the marker connector. When that releases (ON1) and the link switches also release, and the sender is freed from its external connections. The reasons for holding over the "HLD" lead is to prevent the breaking of current on the crosspoint of the register When (ONl) releases, it is followed by (ON2). The register and all locked up relays release, and the sender is normal and ready for reuse.

### 8.43 (TRL) operating breaks battery from the "ST" lead to release the marker

 connector and breaks the local ground connection which locks (ONI) and holds the link switches over lead "S", but they are held over the "HLD" lead to' the marker connector. The marker connector is released, and in doing so breaks its ground from the "HLD" lead, so there is no longer any ground on the "S" lead or the primary winding of (ONl). The link switches release and the sender is freed from its external connections. If there is no plug in the (HLD) jack ( ONL ) also releases and the sender restores to normal just as if (RL) had operated instead of (TRL). But if there is a make-busy plug in the (HLD) jack, (ONI) will hold on its secondary winding, the register and all locked up relays will hold, and the sender will test busy with ground on the "SB" lead, until it is restored by withdrawing the plug. The (HLD) jack is plugged up when it is desired to hold the sender for examination after any timeout.8.44 While it is operated (RL) grounds the "SB" lead. The purpose of this is in connection with a special test which the sender test circuit makes over the common "TR" lead from the link control circuit. Grounding the "TR" lead, it checks for ground on the "SB" lead to make sure that (RL) operates.

### 8.5 Sender Miake Busy for Maintenirace

8.51 The sender is made busy when it is in trouble or for ether purposes of
maintenance by inserting a make busy plug in the make busy jack. This operates relay (MB) if that is provided, otherwise it simply grounds the "SB" lead to indicate that the sender is busy, just as relay (ON1) would do. The (MB) relay if provided grounds the "SB" lead and also connects resistance battery to the "S" lead to serve as a busy signal to the sender test circuit.
8.52 If a marker connector serving five senders times out for trouble, each of the five senders is made busy by grounding the "MB" lead from the marker connector. This has the same effect on each sender as plugging up the make busy jack:.
8.53 The grounding of the "SB" lead when the sender is made busy not only prevents link circuits from seizing it, but it also causes the "BS" lead to be grounded in the link control circuit.

### 8.54 The "BS" lead is carried thru a make

 contact of the (ONl) relay. This is to prevent the (ON2) relay from operating and putting a ground on the "S" lead. This would interfere with the link false ground test if the sender should be made busy just after being seized by a link.
### 8.55 In case there is a false ground on the "S" lead, holding the link

 switches engaged after relay (RL) has operated to release the sender from a connection, this ground will hold (ON1) from releasing, and that in turn will hold (ON2). The register and all operated relays will hold, and the timing circuit will time out and eventually give an alarm.
## 9. INCOMING FRAIME AND DEMAND FOR SPECIAL MARKER REGISTER IN SENDER

9.1 The frame information comes from the sender link and control circuit in the form of grounds on two or three of the thirteen leads common to ten senders and designated "EF", "FOO", "FlO" and "FO" to "F9" and is registered on relays (EF) and (FOO) or (F1O) and on the "F" vertical of the crossbar register. The special marker indication ca:aes from the incoming trunk over the individual lead "FC" through the link, and is registered on relay (SPL). When the sender is under test, the test circuit sends to the sender a frame indication, and if desired a special marker indication, by means of keys set up in the test circuit.
9.2 When the sender is seized for service by the link control circuit, the first act is to operate relay (SCl) as previously described. This connect.s the common leads "FOO" and FlO" to the windings of relays ( $F O O$ ) and (FIO), and one of them operates from a grolind in the link control circuit, according to whether the number of the incoming frame is under or over 10. The relay operated will lock to an off-normal ground $w^{i}$ en relay (ON:) operates.
9.3 When relay ,(SC1) has operated, (SC2) also operates to the "SC" lead, and it connects the common leads "EF" and "FO" to "F9" to the windings of relay (EF) and of the crossbar register select magnets. Relay (EF) operates from a ground in the link control circuit and locks to an'offnormal ground when (ONo) operates. The (EF) relay is used to extend the life of the (STP) relay contacts, and is operated on approximately one half of the calls which engage the sender. One of the select magnets operates from a ground in the link control circuit, according to the units digit of the incoming frame number, and it passes the operating ground on to operate relay (SM).
9.4 (SM) closes a circuit to operate (RAD) and to shunt the (RA2) so that it cannot operate. (RAD) locks up. The ground which operates and locks (RAD) is furnished from the link control circuit over lead "FOO" or "FlO" at first, and later through the front contact of (ON) which locks "FOO" or "FlO".
9.5 (RAD) operated connects the winding of the (F) hold magnet to both windings of relay ( HM ) . These windings are differentially connected and so proportioned that the relay will not operate or hold with the same current in both windings, before a hold magnet is connected to them, nor will it operate with the combined current through the hold magnet and the secondary winding passing through the primary winding. The hold magnet operates under the latter condition as soon as the (ON2) operates to ground the primary winding of (HM) .
9.6 The hold magnet closes the contacts of the crosspoints at the level of the operated select magnet. The locking contact of the hold magnet not only locks up the hold magnet, but also causes relay ( HM ) to operate with full current through its secondary winding and none through its primary.
9.7 When (ON2) operated, which it had to do prior to the operation of the hold magnet, it released (SC2), and that broke the operating path to the select magnet. But the select magnet and relay (SM) remain locked up through parallel front contacts of (SM) until (HM) operates, and further, until the closure of the "T" and "R" leads through the stepper relay of the originaling sender causes (L), (L1) and (L2) to operate.

### 9.8 When (SM) releases, after the (LR)

has operated, the shunt is removed
from the (RA2) which operates and holds along with (RAD), disconnecting the winding of the (F) hold magnet from the winding of (HM), (HM) thereupon releases.
9.9 An incoming trunk which requires the service of a special marker connects ground to the "FC" lead while in its normal condition. When such a trunk is first connetted to the sender through the link switches, and (ON1) operates, relay (SPL) operates to this ground. The front contact of (ON1) is to make the final circuit plosure and so prevent wear on the link switch contacts. When (ON2) operates (SPL) locks to an off-normal ground. Later on, when lead "FC" is required for its principal function as a path between incoming trunk and marker, it is disconnected from ground by a relay in the incoming trunk, and from the winding of (SPL) by the operation of relay (RVI).

## 10. REGISTERING DESIGNATION FOR NUMBER SERIES

10.1 Fig. B and the (OA) and (OB) relays arranged to complete calls over common trunks to two 10,000 number series. While the (SCI) relay is operated as described above, the (OA) or (OB) relay will be overate from ground in the associated link circuit. These relays lock to off-normal ground and they close the circuit for overting the (ON2) relay. The arrangement provided is such that one of these relays must be operated and the other one normal in order to close the path for operating the (ON2) relay and this arrangement is to make sure that one of these relays is overlated but not both of them. If the (OB) relay is operated, it also connects ground to the "OAB" lead to the terminating marker. The (OA) relay however connects the "OAB" lead to the incoming group vertical of the register switch.
10.2 Originating senders which are arranged to complete calls over common trunk groups to two number series are arranged to send over or under five incoming group pulses, that is, transmit the normally require number of pulses for incoming group when one of the number series is wanted while for the other, they will transmit five additional pulses to the normally require number of pulses for incoming group selection. If the originating sender transmits the normal number of pulses and the (OA) relay is operated, the "OAB" lead will be connected to the "C K3" lead which will cause the terminating marker to set up the connection up to one of the number series. If the originating sender transmitted five additional pulses for incoming group selection, the "OAB" lead will have ground connected to it and the terminating marker will accordingly set the connection up to the other number series. Originating senders that are not arranged to complete calls over common trunk groups will always transmit the normal number of incoming group pulses and therefore the "OAB" lead
will be connected to the "CK3" lead with the (OA) relay operated.
10.3 The (FOO) and (F1O) relays and "FlO" lead may also be used to transmit to the marker the number series designation. In this case these relays cannot also be used for incoming frame number transmission.

## 11. PULSING AND REGISTRATION OF SELECTIONS

11.1 The five selections registered in the originating sender are transferred to the terminating sender by battery pulses generated in the latter and transmitted over the trunk conductors. They are registered on the crossbar register of the terminating sender. The latter sends a reverse battery pulse to notify the originating sender that all selections have been received. The actions of the originating and terminating senders are synchronized and the pulsing kept in step with the registration.

### 11.2 Preparation of Originating Sender for Each Selection

11. 21 The originating sender is ready for selections or for the receipt of the reverse battery pulse, when its stepping relay and its polarized overflow relay are connected in series across the tip and ring of the trunk.
11.22 The originating sender is ready for the first selection before the terminating sender is seized. It causes the incoming trunk to notify the link control circuit to seize a terminating sender and attach it to the trunk.
11.23 As soon as the originating sender receives the correct number of pulses, on Each selection, it opens the fundamental circuit, which is held open for a measured interval and then recloses for the next selection.

### 11.3 Preparation of Incoming Trunk for First Selection

11.31 At the time the terminating sender is seized and attached to the incoming trunk, the latter is holding ground on the ring conductor, and battery through the winding of its trunk relay on the tip. The trunk relay and the distant stepping relay are operated. This ground and battery must be disconnected before pulsing begins, but before they are disconnected another ground and battery in the terminating sender must be connected to the same conductors otherwise, the distant stepping relay would release and record a false pulse.
11.32 Relays (RV3), (RV4) and (RV5) operate over the "FOO" or "FlO" lead when the terminating sender is first seized, and hold up throughaut pulsing. When the link
control releases (SCl), a ground through its back contact, a front contact of ( RV 4 ), back contact (TC2), Fig. D, and a front contact of (ON1), is applied to the "CO" lead. By this time it is certain that the link control circuit has made all its checks and definitely decided to use this particular sender, that the link switches have had time to close through the "T" and "R" leads to the sender, and that (ONI) has operated to close through the "T" and "R" leads to the windings of relays (L) and (STP), which are respectively connected to battery and to ground in Fig. $N$, and are connected through windings of relays (STP) and (L) in series with lamp (L) to battery and ground in Fig. P. Grounding the "CO" lead operates a relay in the incoming trunk which disconnects the battery and ground connections existing there from the tip and ring conductors throughout pulsing.

### 11.4 Preparation of Terminating Sender for Each Selection

11.41 Unbalanced Revertive Pulsing - Fig. N
11.411 The terminating sender is ready for a selection when the operating winding of relay (L) is connected to the "T" lead, without being shunted by its noninductive winding, and the winding of relay (STP) is connected to the "R" lead, without being shunted by ground through back contacts of (L1) or (L2). Although ready when in that condition, it will not begin pulsing on the first selection IB until the incoming trunk has removed ground from the ring conductor, because this shunts the (STP), or on any subsequent selection until the originating sender is ready with the circuit closed through its stepping and overflow relays.

### 11.412 Teget ready for the first selection leads thealgh to the (L) and (STP) relays.

 The reason for this is to insure against interference with another terminating sender in case of a double connection at the sender links.! (ONl) will not operate until the link control circuit has satisfied itself that a double connection does not exist. |11.413 Because of the variable resistance of the trunk loop the (L) may or may not operate on the first selection as soon as it is cut through to the trunk, or it may wait until the incoming is ready with its trunk relay cut off. On later selections (L) operates as soon as the originating sender is ready. It operates with its noninductive winding shunting its active winding. This is unimportant on the first selection, but on later selections the noninductive winding smooths out the descending side of a cable capacity surge which has a tendency to cause the distant stepper to momentarily release, and then reoperate which would generate a false pulse. When
(Ll) operates it cuts off the noninductive winding in order to speed the subsequent operations of the distant stepper.

The (L) is permanently shunted by 4250 ohm resistance (J) and 0.5 mf condenser (B) in series with 2000 ohm resistance (F) to insure that the (L) will hold on all lengths of cable at the end of each ground pulse.
11.414 (L) operates (Ll) through a back contact of (L2) and a front contact of (SM), and then (Ll) locks directly to the contact of (L). (Ll) operates (L2) and then (L2) locks to a front contact of (SM). The purpose of these connections is to prevent a selection from starting before the ereceding one has progressed far enough in its registration to avoid possible interference, and yet to allow the two selections to overlap one another as much as possible and so save time. This is explained in detail under SELECTIONS SYNCHRONIZED.
11.415 When (L1) and (L2) have both operated the terminating sender is ready for selection, a back contact on (Ll) disconetted the noninductive winding of (L) from the "T" lead, and a back contact on each relay disconnected separate ground connections which shorted relay (STP) on the "R" lead. The reason for having parallel ground connections through back contacts of (Ll) and (L2) is as follows: On their operation, ground must be finally removed by (L2), because if it were removed by (Ll) at the same time (Ll) breaks off the noninductive winding of (L), the stepping relay of the originoting sender might make a false release from having too much inductance thrown into its circuit at one time. On the other hand, on the release of the relays (L2) may be delayed some time, and it is necessary to short out (STP) at once when (L) and (Ll) release, to prevent a chance of starting the next selection prematurely.

### 11.42 Pulses Generated - Fig. N

11.421 When all three circuits, trunk, originoting and terminating sender, are ready to start a selection, relay (L) and the stepping relay of the originating sender will be operated in series, (Ll) and (L2) will operate following (L) then (STP).
11.422 When (STP) operates, it causes (GR) Li
to operate. (GR) grounds the "T"
lead, thus short-circuiting and releasing Sift
(STP) and the distant stepping relay, while $G R$ still holding (L) operated and therefore (L1) and (L2). This operation and release of the stepping relays constitute the first pulse. When (STP) releases so does (GR) removing the ground from the "T" lead and allowing (STP) and the distant stepper to reoperate. (GR) then reoperates and again grounds the "T" lead, releasing (STP) and the distant stepping relay. This pulsing, or alternate operation and release of the
two stepping relays, continues as long as the circuit is kept closed in the originating sender, or until 11 pulses have been counted.

In order to extend the life of the contact of (STP), the direction of current flow through the contact is reversed on the approximately half of the calls, (EF) being operated by alternate incoming frames.

### 11.43 Balanced Revertive Pulsing - Fig. P

11.431 As explained previously, the L relay may operate when the (RV3) connects the two primary windings of the (L) to the tip and ring leads to the trunk, or it may wait until the line relay of the trunk is disconnected from the tip by the operation of the (T) relay. The (SS) operates when the (GR) operated closing auxiliary shunt paths on the stepper line windings.
11.432 The (L) relay consists of three windings, two primary windings in series, and a biased secondary winding. (L) overates over the tip and ring leads on its two primary windings in series. The biased secondary winding is energized when (ON1) operates. It is used for providing a nonoperate requirement for the (L) to prevent its false operation on cable surges and to prevent its non-operate on certain trunk test circuit conditions. Since the (L) relay has no biasing spring the armature may make contact with either front or back contact or may float between them when the circuit is normal and no. current is flowing in any of the windings. For this reason the ground is connected to the armature spring only after (ONI) operates.

## 11. 433 With both (L) and (ON2) operated,

 (Ll) operates through a back contact of (L2) and a front contact of (SM) which operates during registration of the trunk link frame number. (Ll) locks directly to the front contact of (L). (Ll) also overates (L2) which opens one locking path of (SM) and the operated select magnet. The (SM) relay and the select magnet release when an additional locking path is removed by operation of the (HM) relay following closure of the ( $F$ ) hold magnet and when their operating circuit is removed by release of relays in the link when the (ONO) relay operates. The (SM) relay released, permits operation of the (RA2) relay which releases the (HM) relay. The circuit is now ready for registration of incoming brush selection although pulsing may start before completion of all of the foregoing operations without any adverse circuit reaction. The purpose of the remaining contats of the (L) , (LI), (L2) and (SM) relays is to control registration and to prevent a selection from starting before the preceding one has progressed far enough in its registration to avoid possible interference, and yet to allow the two selections to overlap one another as much as possible so as to save time.Page ${ }^{10}$ STP/GR = COMmutator BRUSHES - SEGMENTS

#  <br> CD-250J3-01 - ISSUE 11-D 

11.434 When (L2) has operated indicating that the loop is closed satisfactorily, (SS) releases. When (Ll) and (SS) have removed their shunts from the (STP) relay, STP operates over the loop. (STP like the (L) relay has three windings two primary and a secondary. (STP) operates on its two primary windings in series. The secondary is used as a bias winding to prevent its false operation on cable surges and to insure its release on lead currents. This winding is energized when (ONl) operates. The (C) capacitor is connected between the junction of the bias resistor and the secondary winding and the winding of the (GR) relay. This (C) capacitor provides a pulse help action to insure that once (STP) operates, it remains operated for a minimum interval and once it releases, remains unoperated for a minimum interval.

### 11.44 Pulses Generated - Fig. P

11.441 When the (STP) relay operates, it operates the (GR) relay through contacts of relay (EF). In order to extend the life of the (STP) contacts, the direction of current flow through the contacts is reversed on approximately half the calls by reversing the connections to the (STP) contacts depending on whether the incoming frame number registered is odd or even.
11.442 (GR) in operating, shorts the tip
and ring leads between the (L) and (STP) relays. This short across the tip and ring holds (L) operated and therefore (L1) and (L2). (GR) also operates (SS) which shunts and releases the (STP) and the distant stepping relay. This operation and release of the stepping relays constitutes the first pulse. When (STP) releases so does (GR) removing the short from the tip and ring leads allowing (STP) and the distant stepper to reoperate. (GR) then reoperates and again operates (SS) which shunts and release (STP) and the distant stepping relay. This pulsing, or alternate operation and release of the two stepping relays, continues as long as the circuit is kept closed in the originating sender or until eleven pulses have been counted to initiate a telltale condition.

### 11.443 (SS) is under control of GR when

 pulsing and when operated applies shunts to both line windings of the STP relay. This action disables the line windings of (STP) momentarily after each release of (GR) and prevents a false operation of (STP) to the cable capacity at the end of a train of pulses when the loop is opened by the sender at the distant end.
## ll. 5 Pulse Counting - Fig. N or P

11.51 The originating sender counts the pulses on its counting relays and breaks the circuit, stopping the generation of pulses when a predetermined number from

1 to 10 has been generated and counted. In case of an abandoned call or a trouble condition the originating sender may fail to count the pulses and to break the circuit after the predetermined number has been generated. In that case, the terminating sender will generate eleven pulses before stopping of itself.
11.52 The terminating sender counts the pulses on relays (Pl) to (P6), actuating them by relays (L3), (L4) and (L5). The periodical operation and release of (GR) causes (L3), (L4) and (L5) to operate and release in a recurrent cycle of half the frequency, as follows: The operation of (GR) on the first or any odd-numbered pulse operates (L3); its release permits (L5) to operate in series with (L3); the operation of (GR) on the second or any even numbered pulse operates (L4) in series with the secondary winding of (L5), whereupon (L3) releases but (L5) holds; (GR)'s release causes (L4) and (L5) to release. Thus (L5) operates at the end of each odd pulse, and releases at the end of each even pulse. The ground connection for holding (L3) and (L5) in series and (L4) is furnished by front contacts of (Ll) and (L2) in parallel, The reason for having parallel ground connections through front contacts of both (Ll) and (L2) is as follows: On their operation (Ll) operates first, and by having it supply a locking ground there is better assurance that it will be ready in time than if reliance were placed on a possibly vibrating contact of (L2) alone. On the other hand, on the release of the relays (L2) may be delayed some time and it is necessary to hold the locking ground until it releases, or else an addition (P) relay might be operated from the back contact of (L5) when it releases.
11.53 The operation of (L5) on the first pulse causes (Pl) to operate and
lock. The release of (L5) on the second pulse causes (P2) to operate, lock, and unlock (PI), which releases. Similarly the operation or release of (L5) on subsequent pulses operates other ( $P$ ) relays, and on the llth pulse operates relay (TT). The relays left locked up after each pulse, any one of which may be the last pulse of a selection are as follows:

| Pulse | Relays | Pulse | Relays |
| :---: | :---: | :---: | :---: |
| 1 | Pl | 6 | P5-P6 |
| 2 | P2 | 7 | P1-P6 |
| 3 | P3 | 8 | P2-P6 |
| 4 | $\mathrm{P}_{4}$ | 9 | P3-P6 |
| 5 | P5 | 10 | P4-P6 |

11.54 The operating ground for the (P) relays is controlled through a front contact of (L2) to allow sufficient time to operate the last ( $P$ ) relay on the last pulse of a selection. For this reason (L2)
is made slow rélease. (Ll) must be fast release, however, because it must get down before (L) reoperates on the next selection.
11.55 The locking ground for the (P) relays is supplied through a front contact of (L2) and back contact of (SM) in parallel. The contact of (SM) holds the locking circuit until the select magnet is operated and locked. The contact of (L2) holds the locking circuit through the interval during which (SM) has not yet released from the previous selection, and (L2) is held operated until (SM) shall release.
11.56 If (TT) is operated by an eleventh pulse, it locks to off-normal ground, and represents telltale.

### 11.6 Selections Registered

ll.6l Five selections are registered on each call, incoming brush, incoming group,
final brush, final tens and final units, registered in that order. Each selection is registered by operating one of the ten. select magnets and then operating the hold magnet appropriate to that selection, after which the select magnet is released and the hold magnet is held. This closes the crosspoints which are at the level of the operated select magnet.
11.62 When the originating sender has counted the proper number of pulses it breaks the fundamental circuit. Relays (L), (Ll) and (L2) release, and (L2) closes a circuit from back contacts of (SM), (TT) and (RVI) in series through a front or back contact of (P6) and one of the front contacts of one of the other (P) relays to operate a select magnet, that one whose number is one less than the number of pulses which had been counted. The front contact of that select magnet passes the operating ground on to operate relay (SM), which locks itself and the select magnet. The operating circuit from a front or back contact of (P6) for the select magnets is taken through two different back contacts of (L2) instead of a single back contact, so that if (L2) operates to start the next selection while a select magnet and relay (SM) are still locked up, and two adjacent (P) relays are for a moment both operated, the locking ground for the operated select magnet cannot find a path to operate another select magnet. The operating circuit for the select magnets is taken through a back contact of (SM) so that if (P6) releases faster than the other operated (P) relay, momentarily closing an operating path to another select magnet, there will be no ground on that path. The operating circuit for the select magnet is taken through a back contact of (TT) so that when eleven pulses are counted for a telltale condition, no select magnet will operate.
11.63 When (SM) operated the first time to register the incoming frame number,
it operated (RAl), and when it released (RA2) operated. When (SM) operates the second time to register the first (incoming brush) selection, it shunts down (RAI), and then when (SM) releases, (RA2) releases. That completes one cycle of relays (RAl) and (RA2), and on the four subsequent selections they go through the same cycle twice more.
11.64 Each time (SM) operates, it either operates (RA1) and leaves (RA2) normal, or it releases (RA1) and leaves (RA2) operated. In either case, the effect is to connect the windings of ( HN ) to the winding of the first nonoperated hold magnet, causing the same to operate. The hold magnet closes the contacts of the crosspoint at the level of the operated select magnet, locks up to a front contact of (ON1), and by connecting the locking ground to the windings of ( HM ), causes that to operate. When (HM) has operated on one selection and (L2) on the next selection, (SM) and the operated select magnet release.

## 1l. 65 Each time (SM) releases it either

 operates (RA2) and leaves (RAl) operated, or it releases (RA2) and leaves (RAl) normal. In either case the effect is to disconnect the windings of (HM) from any hold magnet, and (HM) releases.
### 11.7 Selections Synchronized

11.71 The control of the selections is primarily in the originating sender. It holds the fundamental circuit closed until it has counted the correct number of pulses, then it holds it open while preparing for the next selection, then recloses it. But in order to prevent selections from succeeding one another too rapidly to be registered properly in the terminating sender, the latter must exercise some check on the operations.
11.72 The operations necessary to transmit and record each selection consists of two parts. The first part is the pulsing, which consumes widely varying times depending upon the number of pulses and the speed of pulsing, which in turn depends upon the length of trunk. The second part is the registration of the crossbar register, which consumes a fairly constant time.
11.73 There are two requirements to be met. The first is that selections shall not follow each other too rapidly to be properly registered. The second is to keep down the average total time needed to transmit and record all five selections.

### 11.74 If control were left solely in the

 originating sender, with no check by the terminating sender, the second requirement would be met to the greatest possible extent. If all selections were of maximum length, this might work satisfactorily onthe assumption that pulsing would take more time than registration. Then each selection would be registered while the succeeding one was being pulsed, and the total time required would be the sum of the times required for pulsing, plus the times taken out between selections by the originating sender. But a series of successive selections of minimum length would run through too rapidly for registration on the crossbar register and in such case, the first requirement would be violated.

### 11.75 In order to meet the first requirement

 the terminating sender could be arranged so as not to permit any selection to start pulsing until the preceding selection had been completely registered. With a fair proportion of long selections this would make the total time required longer than if pulsing and registration were allowed to proceed simultaneously. This circuit is arranged to allow a certain amount of overlapping, but with sufficient control by the terminating sender to prevent the loss of any registration.11.76 In case of a series of short selections, the originating sender counts the first set of pulses, breaks the circuit, then closes it again for the second set of pulses. The pulses were also counted on the (P) relays, and when the circuit is broken (L), (LI) and (L2) release, a select magnet and (SM) operate, (RAl) either operates or releases, a hold magnet and (HM) operate. Before this can occur the circuit is closed again and (L) operates. The next set of pulses must not start until the (P) relays are released, and they must not release before the select magnet and (SM) are safely operated. Therefore the release of the (P) relays and the operation of (Ll) are both delayed until (SM) operates, by locking the (P) relays through a back contact of (SM), and operating (Ll) through a front contact of (SM).

## 11. 77 When (SM) operates for the first se-

 lection, (Ll) and (L2) operate and pulsing starts for the second selection. The originating sender counts the pulses, breaks the circuit, then closes it again for the third set of pulses. The pulses were also counted on the ( $P$ ) relays, and when the circuit is broken (L) and (LI) release. The second registration cannot be permitted to proceed to the point of operating a select magnet until a hold magnet has been operated on the first registration. Therefore, the release of (L2) is delayed until (SM) releases, by locking it to a front contact of (SM); and the release of (SM) is delayed until (HM) operates, by locking it to a back contact of (HM).11.78 (Ll) can operate only when (SM) is operated. When a selection is completely registered before the originating sender closes the circuit for the next selection, (HM) will have operated and broken its
circuit for locking (SM), but if (SM)
should be permitted to release at that time, there would be no circuit to operate (Ll) later when (L) operates for the next selection. To prevent that, (SM) is also locked through a back contact of (L2), so that (SM) cannot release from one selection before (L), (Ll) and (L2) have operated for the next.
11.79 (L2) can release only when (SM) is normal. This might lead to a situation where the originating sender breaks the circuit and releases (L) and (Ll), but (L2) cannot immediately release because (SM) is operated. Before this situation changes, the originating sender closes the circuit and operates (L) and (Ll), without (L2) having had any opportunity to release and start a registration. One registration would then be lost. To prevent this possibility, the operating path for (Ll) is taken through a back contact of (L2).

### 11.8 Incoming Advance

11.81, Unbalanced Pulsing Circuit - Fig. N
11. 811 When the last selection (final units) has been transferred from the originating sender to the terminating sender, the fornier closes the circuit again through its stepping and overflow relays and awaits the reverse battery pulse.

### 11.812 (L), (L1) and (L2) release prepara-

 tory to registering final units selection, and operate again when the originating sender closes the circuit to receive a reverse battery pulse. (RVI) then operates, through front contacts of the (FU) hold magnet and (L2), and locks. The (RV1) operated removes the operating ground for the select magnets AI option.11.813 Before (RV1) operated, (RV2) being normal, with (RV3), (RV4) and (RV5) operated, the winding of (L) was connected "to the "T" lead, and the "R" lead was grounded through a front contact of the (FU) hold magnet. This furnished a direct battery which operated the distant stepper, but with no other action in the originating sender. When (RVI) has operated, the winding of (L) is transferred to the "R" lead, and the "T" lead is grounded at the (RV3) operated, now both "T" and "R" leads are grounded. During the short space of time while these connections are maintained the cable is discharged, the distant stepper loses its energy and relay (L) is held in local circuit through (RV2) normal and (FU) hold magnet operated.
11.814 Slow operate relay (RV2) operates from a front contact of (RVI) and breaks ground from the "R" lead, which was also connected to the winding of (L). Reverse current which starts with a surge due to the previous soak of the (L), is applied toward the originating sender to operate
the distant stepper and overflow relay. The purpose of the procedure described in this and the preceding paragraph is to compensate for a tendency under certain conditions for the overflow relay to operate faster than its associated stepper.
11.815 Slow release relay (RV3) starts to deenergize when its circuit is broken by back contacts of both (RV2) and (L)
(Fig. D). The release of (RV3) relay breaks the connections to the "T" and "R" leads, terminating the reverse battery pulse and allowing the distant stepper to release.
11.82 Balanced Pulsing Circuit - Fig. P
11.821 When the (L), (L1) and (L2) relays release upon completion of pulsing
of the final units selection, registration of this selection is completed by operation of the (FU) hold magnet. (FU) operated, operates the stepper shunt relay (SS) which puts a shunt on both line winding of the (STP) preventing any further operation. (FU) also closes ground to operate the (RVI) relay through a front contact of (L2), (L), (Ll) and (L2) operate when the originating sender closes the loop to receive a reverse battery pulse. The (L2) also causes release of (SM), (RA2), (HM) and the operated select magnet.
11.822 (RV1) locks to a front contact of (ON2), and shorts out the tip and ring leads between the (L) and STP) relays. (RVI) also closes ground to operate the slow operate (RV2) relay. (RVI) opens the operating ground of the select magnets to prevent a false operation of the zero magnet during incoming advance with option AI.
11.823 During the operate time of (RV2) the tip and ring leads are shorted, releasing the distant stepper and discharging the cable. When (RV2) operates, it reverses the connection of the tip and ring leads to the (L) relay. Thus reverse current is applied toward the originating sender to operate the distant stepper and overflow relay. (RV2) also opens the operating path of the slow release relay (RV3) and that relay releases if its locking path through a back contact of (L) is also open. (RV3) is locked through an (L) back contact to insure that reverse battery will continue until the originating sender, by operating the (L) relay, has indicated that it has received it. This locking path provides for cases where the terminating sender registers a telltale condition operating the (TT) and (RVI) relays and at the same time the originating sender is satisfied either by the final pulse or the ground pulse supplied by the (RVI). Under this condition the originating sender would be between selections and thus unable to receive the reverse battery pulse. The (RV3) locking path is wired through the (IBI) crosspoints so that it is effective only after the incoming brush selection has been registered. If the originating sender
receives reverse battery during incoming brush selection it will open the fundamental during the reverse battery period without waiting for termination of the reverse battery. An (RV3) locking path during this selection might stick the terminating sender.

## ll.9 Test Circuit at Incoming Advance

11.91 When the test circuit checks for nonoperate of the (L) relays the (L) relay remains normal and consequently the (RV1) and (RV2) do not operate to send reversed battery to the test circuit and the test is blocked. When (FU) hold magnet operated, ground through the B contact of the interrupter (IF) operates (IF) relay and when the ( $F$ ) contact makes one second later (IFI) operates, which operates (RVI) relay starting reversed battery functioning, On a regular call the operation of the (RVI) opens the operating path of the (IFI) relay.

## 12. TRUNK CLOSURE

12.1 This section describes how the terminating sender, after registering all selections and sending a reverse battery incoming advance pulse to the originating sender, returns supervision to the incoming trunk, and receives notice from the incoming trunk that trunk closure has been effected at the originating end.
12.2 When (RV3) releases to break the "T" and "R" leads and thereby terminate the reverse battery pulse, it starts (RV4) to releasing, and the release time of (RV4), which is slow release, affords a short open period to allow the originating sender to function and open the trunk at that end.

### 12.3 When (RV4) has released, it connects

 the "T" lead to battery through a resistance lamp, and the "R" lead to the resistance battery feed to (RV5). This dischargesthe cable from the preceding reverse battery pulse and recharges the tip side of the trunk to a negative polarity, which reduces the trunk capacity surge on the trunk relay when its battery winding is connected prior to trunk closure, thereby preventing its false operation.
## 12.4 (RV4) releasing also breaks ground

 from the "CO" lead through the link to the incoming trunk. This releases the relay in the incoming trunk which previously cut off the incoming trunk relay, which is reconnected to the trunk for supervisory purposes, but with its winding connected to the "R" lead shorted out by direct ground in the trunk. This ground also shunts down and releases relay (RV5).
## 12.5 (RV5) releasing breaks its own wind-

 ing from the "R" lead, and the lamp battery from the "T" lead, leaving both those leads open in the sender. (RV5) releasing also connects the lamp battery tothe "CO" lead, to prevent the reoperation of the incoming relay, connected to that lead, by a possible local condition in the trunk.
12.6 (RV5) releasing also connects a low (TCI), which was already connected to a resistance battery. This causes a relay in the trunk, connected to the "D" lead, to operate in series with the winding of (TCl) through the (D) low resistance ground.
(TCl) does not operate because it is polarized and operates only to current in the other direction.
12.7 The trunk relay operates when it is connected back on to the trunk, or as soon thereafter as the trunk is closed at the originating end. The trunk relay operating grounds the "D" lead, causing current to flow in the opposite direction through the winding of (TCl), which operates, and in turn operates the (TC2) relay, which removes the low resistance ground from the "D" lead.

## 13. TERMINATING MARKER ENGAGEMENT

13.1 The sender seizes a regular or a special terminating marker, sends a record of the incoming frame number and of the called number as translated from the five selections, provides a path between marker and incoming trunk for control in setting up a connection to the called line, and receives a release signal from the marker.

### 13.2 Marker Seized

13.21 When relay (TCl) operates on trunk closure it operates (TC2), which locks and connects battery to the "ST" lead to the terminating marker connector circuit. The latter connects the sender to an idle marker. If relay (SPL) happens to be operated, it grounds the."SPL" lead to the connector and a special marker is chosen. Otherwise, either a regular or a special marker may be chosen.

### 13.3 Information from Sender to Marker

13.31 The sender transfers to the marker the number of the incoming frame involved and the called number as translated from the five selections, by grounding a selection of leads "F1", "F2", "F4", "F5", "F10", "TH1", "TH2", "THُ4", "TH8", "H1" "H2", "H4", "H5", "T1", "T2" " "T4", "T5", "U1", "U2"', "U4"' and "U5". Those leads which are not grounded are connected to lead "CKl" or "СК2" or "СКЗ" of "СК4". Lead "RO", which is used by "B" switchboard senders connecting with the same markers, is permanently connected in this sender to lead "CK3". Lead OAB is also in the register scheme.
13.32 The (F) register grounds leads "Fl" "F2", "F4" and "F5" according to the incoming frame as follows:

| Frame |  | Leads | Frame. |
| :--- | :--- | :--- | :--- | Leads

If the frame number is 0 to 9 relay (FOO) connects lead "FlO" to lead "CK4", or if it is 10 to 19 relay (FlO) grounds lead "FlO", with "A" option.
13.33 The (IB) and (IG) registers ground leads "TH1", "TH2", "TH4" and "TH8" according to the thousands digit of the called number as translated from the incoming brush and group selections, as follows:

| Thousands | IB | IG |  |
| :---: | :--- | :--- | :--- |
| 0 | 0 | 0 or 1 | Leads |
| 0 | 0 | 2 or 3 | None |
| 1 | 1 | 0 or 1 | TH2 |
| 2 | 2 | or 3 | TH1-TH2 |
| 3 | 1 | 0 or 1 | TH4 |
| 4 | 2 | 2 or 3 | TH1-TH4 |
| 5 | 2 | or |  |
| 6 | 3 | 0 or 1 | TH2-TH |
| 7 | 3 | 2 or 3 | TH1-TH2-TH4 |
| 8 | 4 | 0 or 1 | TH8 |
| 9 | 4 | 2 or 3 | TH1-TH8 |

13.34 The (IG) and (FB) registers ground leads "H1", "H2", "H4", and "H5" according to the hundreds digit of the called number as translated from the incoming group and final brush selections, as follows:
Hundreds IG FB Leads

| 0 | 0 or 2 | 0 | None |
| :---: | :---: | :---: | :---: |
| 1 | 0 or 2 | 1 | Hl |
| 2 | 0 or 2 | 2 | H2 |
| 3 | 0 or 2 | 3 | H1-H2 |
| 4 | 0 or 2 | 4 | H4 |
| 5 | 1 or 3 | 0 | H5 |
| 6 | 1 or 3 | 1 | H1-H5 |
| 7 | 1 or 3 | 2 | H2-H5 |
| 8 | 1 or 3 | 3 | $\mathrm{Hl}-\mathrm{H} 2-\mathrm{H} 5$ |
| 9 | 1 or 3 | 4 | H4-H5 |

13.35 The (FT) register grounds leads "T1", "T2", "T4" and "T5", and the (FU) register grounds leads' "Ul", "U2", "U4" and "U5", according to the tens and units digits, respectively, of the called number, which are the same as the final tens and final units selection, as follows:

| Tens or Units | FT | Leads | FU | Leads |
| :---: | :--- | :--- | :--- | :--- |
| 0 | 0 | None | 0 | None |
| 1 | 1 | T1 | 1 | U1 |
| 2 | 2 | T2 | 2 | U2 |
| 3 | 3 | T1-T2 | 3 | Ul-U2 |
| 4 | 4 | T4 | 4 | U4 |
| 5 | 5 | T5 | 5 | U5 |
| 6 | 6 | T1-T5 | 6 | U1-U5 |
| 7 | 7 | T2-T5 | 7 | U2-U5 |
| 8 | 8 | T1-T2-T5 | 8 | Ul-U2-U5 |
| 9 | 9 | $T 4-T 5$ | 9 | U4-U5 |

13.36 When the sender and marker are first connected together, leads "CKl", "CK2", "СК3" and "CK4" are grounded in the marker, so the marker relays connected to all the "F", "TH", "H", "T", "U", "OAB" and "RO" leads operate. That closes chain circuits in the marker, with the effect of breaking ground from leads "CKl", "CK2", "CK3" and "CK4". This releases all the marker relays except those which are operated by ground originating in the sender. The reason for first operating all the relays in the marker and then releasing such as are not wanted, is to check all the connecting leads for continuity and for freedom from grounds and crosses.

### 13.4 Connection Established and Marker Released

13.41 When the marker has received information from the sender, it establishes a connection between the incoming trunk and the called line, or if the latter is busy it puts the incoming trunk in position to send a busy back signal. In performing these functions the marker has direct connection with the particular incoming trunk involved over lead "FC", through the connector to the sender and thence through the link to the incoming trunk.
13.42 Its work completed, the marker grounds lead "RL" to operate relay (RL). (RL) breaks battery from the "ST" lead, dropping the marker connector and marker, and it also causes the complete release of the sender.
14. IRREGULARITIES AND TROUBLE CONDITIONS
14.1 Defective Frame Indication From Link Control Circuits
14.11 If the link control fails to ground either lead "FOO" or lead "FlO",
(RV3) cannot operatie, therefore (ON1)'cannot operate to ground the "SB" lead, so ground will not return over the "BS" lead to operate (ON2).
14.12 If the link control fails to ground one of leads "FO" to "F9" to operate a select magnet, (SM) will not operate nor (RAl), so no circuit will be closed from the "BS" lead to operate (ON2).
14.13 If the link control operates both ( FOO ) and (FlO), or both (OA) and (OB), when furnished, they will break the connection from the "BS" lead to operate (ON2).
14.14 If the link control operates two or more select magnets, marginal relay (XSM) will operate and break the connection from the "BS" lead to operate (ON2).
14.15 In any of the above cases (ON2) will fail to operate, the "RL" lead to the link control will not be grounded, the link control will time out and release all connection with the sender. The sender will at once restore to normal without having grounded the "CO" lead to disturb the incoming trunk.
14.16 If some trouble condition should cause the closure of one of the unused crosspoints on the register switch for Incoming Brush, Incoming Group or Final Brush, ground thru the crosspoint will operate the (TT) relay. This will cause reverse current to be sent to the originating sender and set up an overflow condition.
(TT) and (L2) operated, the (RV1) operates. See Telltale section for operation following (RVI).

### 14.2 Trouble Reiease by Link Control Circuit

14.21 If the link control circuit, while in the act of connecting the sender to an incoming trunk, detects a trouble such as a double connection or a failure to receive a release signal from the sender, it grounds the "TR" lead and so operates relay (RL). If (ON1) and (ON2) have operated to hold the link switches and relays in the sender, (RL) will lock to a front contact of (ON2), but will break the ground for lockin̄̈ the link switches and (ONl). When the link control circuit disconnecting releases (SCl), the sender will completely release.

### 14.3 Trouble Release by Marker Connector

14.31 If two markers called in by the marker connector both fail to complete the call, the connector grounds lead "TRL". Relay (TRL) operates and causes the release of the sender.

### 14.4 Premature Disconnect

14.4ll If a call is abandoned after trunk closure but before the marker has given a release signal, the sender must be disconnected at once from the trunk, which is liable to be seized for another call.
14.412 The abandoning of the call breaks the trunk closure, with the result of
removing ground from the "D" lead, and leaving attached to it in the trunk only a relay with battery on its winding. This causes (TCl) to release and closes a circuit through front contact of (TC2) to operate (TC3). (TC3) is slow operate to prevent its operating on a momentary accidental break in the trunk closure.
14.413 (TC3) operating operates (RL), and causes the release of the sender.
14.42 If a call is abandoned after the fundamental circuit has been closed long enough to operate the (L), (Ll) and (L2) relays and release the (SM) but before one or more pulses have been sent, the opening of the fundamental at the originating end will release the (L), (Ll) and (L2) relays. Since no pulse has been sent the reclosure of the fundamental upon reselection of the trunk causes the (L) to reoperate on trunk test rather than the trunk relay in the incoming. The (Ll) cannot operate since the (SM) is released. The operation of the (L) with the (SM) released will operate the (IF) when the (IF) interrupter closes its "B" contact. When the "F" contact closes, l second later, the (IFI) operates and operates (RVI) to send reverse battery to the originating. sender.

### 14.5 Telltale

14.51 If a call is abandoned while pulsing is in progress or if a trouble condition in the originating sender prevents its breaking the circuit when ten pulses have been generated in any selection, or if a trunk with crossed conductors seizes the sender without having been called into service at its originating end, a telltale condition ensues. This condition is one where the pulses of a selection are allowed to run to il, and is so called because a similar condition when a panel incoming or final selector is involved, drives the selector elevator to the telltale position.
14.52 The first effect is for the eleventh pulse to operate relay (TT). (TT) locks up and grounds the $R$ lead of the trunk through the back contact of (RV2), which in a completed call, is grounded by the operation of the (FU) hold magnet. This shunts the (STP) and stops pulsing. (RVI) is operated and the succeeding operations are the same as in incoming advance and trunk closure on a completed call, except that the sender is released without calling in a marker.
14.53 The operation of (RV1) and (RV2) switches the "T" to the "R" lead, thus connecting reverse battery to the trunk. The release of (RV3) terminates the reverse battery pulse (RV4) and (RV5) then release in the usual manner.
14.54 (RV4) and (RV5) releasing substitute battery for ground on the "CO" lead, restoring the incoming trunk relay to its normal connection with the trunk, and (RV5) releasing grounds the "D" lead through the winding of (TCl). Shortly after the termination of the reverse battery pulse, or immediately in case of a crossed trunk, the incoming trunk receives trunk closure and grounds the "D" lead, operating (TCl), and (TC1) operates (TC2).
14.55 The operation of (TC2) cannot call in a marker as it does after completed selections, because a back contact of (TT) breaks the "ST" lead. But the operation of (TC2) closes a circuit from ground (TM2) normal through a front contact of (TT) to operate (RL), and that causes the complete release of the sender.

### 14.6 Stuck Sender Timed Out

14. 61 Various conditions may cause the sender to stick and time out, among them the following: The sender is seized by a trunk having the tip or both conductors grounded; the calling subscriber does not finish dialing or else is so slow that he is still dialing after the sender times out; a trouble in the originating sender prevents the closure of the fundamental for one of the selections; a trouble in the terminating sender prevents its sending pulses.

### 14.62 The timing interrupter (TS) is always

 in operation on a 30 second cycle, both contacts open 28 seconds, then the back contact closes one second, then the front contact closes one second, and repeats. If the front contact closes while the sender is engaged, with relay (ON2) grounding the "A" lead, relay (TMI) operates over the "F" lead and locks. If the sender still remains engaged on the same connection when the back contact next closes, relay (TM2) operates over the "B" lead and locks. It thus required from 28 . to 58 seconds to time out and operate (TM2). If the sender still remains engated on the same connection \& when the front contact again closes, one second after the operation of (TM2), relay (TRL) operates over the "F" lead and locks, causing the complete or partial release of the sender.14.621 If (TT) was not previously operated, the operation of (TM2) will operate it, and then if the reverse battery has not been sent, (TT) will operate (RVI) which in turn operates (RV2) to connect reverse battery to the trunk. (RV3), (RV4) and (RV5) then release, terminating the reverse battery, substituting battery for ground on the "CO" lead, and grounding the "D" lead through the winding of (TCl), causing the complete or partial release of the sender.
14.622 If the (RV3) is locked up to the back contact of (L) through the crosspoints IB Fig. D the reverse battery is not removed. One second later the (TRL) operates to release the circuit.
14.63 If the nature of the trouble is such that the sender cannot be released as described above, or if a plug in the (HLD) jack prevents the operation of (TRL) from causing a complete release, it will remain stuck, testing busy to links and test circuits, and with (TM2) locked up. (TM2) grounds lead "TL" to.light an individual lamp at the trouble indicator frame, and it grounds lead "AL" to a timing circuit which is common to a number of senders. The timing circuit will give an audible alarm.
14.7 Cross Between D and ST Leads Incoming Trunk

An added back contact on the TC2 relay Fig. D opens the CO lead to prevent reaction in case of a cross at the "transmission cut through relay" in the incoming trunk on trunk closure. This cross would ground the ST lead as well as the $D$ lead and cause a 2 d link and sender to be attached to this same trunk. The TCl and TC2 relays of the 2 d sender would also operate in multiple with the lst sender trunk closure, but the operated 2d sender TC2 relay prevents the operation of the "trunk reversing relay" by opening the CO lead and thereby prevents a possible false charge.

### 14.8 Bridged (STP) Contacts

If the (STP) contacts become bridged during pulsing the (GR) will remain operated and no more pulses will be sent to the originating sender. The terminating sender will time out and the (TT) Fig. H operates which will transfer the revertive pulse ground, supplied by the operated (GR), from the winding of the (L) to the "S" winding of the (ONI) and will in effect be the same as if the hold plug was in the (HLD) jack, but only for as long as the bridge remains on the (STP) contacts.

### 14.9 Terminating Sender Overload Control.

When Fig. $K$ is used, and when an all term. sender busy condition is recognized by the term. sender timing circuit, the "G" and "Gl" leads and the "G2" and "G3" leads to the term. senders are closed. If the sender is in the process of handling a call, this closure will be ineffective. However on the next call, when the sender is seized and on the operation of the sender relays (SC1) and (ON2), relay (OF) operates and locks. When the fundamental circuit is closed for incoming brush selection, the sender (L) and (LI) relays operate as before, and the (Ll) relay operates relay (IF) which locks. When the (L) relay releases at the
completion of inc. bru'h selection, relay (IFI) operates, locks and operates relay (RVI) which reverses the tip and ring. When the originating sender recloses the fundamental for incoming group selection, it recognizes the reversal as an overfiow signal. Circuit action from this point is similar as described for incoming advance. This feature is intended to relieve originating sender delay caused by an overload in the terminating office.

## 15. PROVISIONS FOR SPECIAL TESTS

15.1 The (T) jack provides ready connection for a special test set to test the characteristics of the pulses generated.
15.2 Terminal "SB" is provided for connection to a holding time recorder.
15.3 Two leads are grounded to the traffic usage recorder circuit under the
following conditions:

Sender Busy
(SB)

Sender Busy Maintenance SBM

Grounded whenever the sender is busy for any reason.

Grounded whenever the sender is plugged busy.
16. FIGURES AND OPTIONS
16.01 Fig. A shows the (SCI) relay where "OA" and "OB" leads are not required.
16.02 Fig. B shows the (SCI) relay having contacts $f$ or the "OA" and "OB" leads.
16.03 Fig. C shows the circuit arrangement prior to the change per Fig. D.
16.040 Fig. D
16.041 Shows the (TC2) with a break contact in the "CO" lead to prevent reaction in the case of a cross of the "D" and "ST" leads at the "transmission cut through relay" in the incoming trunk circuit, on trunk closure.
16.042 Another break contact on the (TC2) relay removes ground from the "TH2" lead used to operate the (TT) relay at IB crosspoints which likewise are rearranged in Fig. D to facilitate the next item.
16.043 Changes the locking path of the (RV3) to prevent terminating the reverse battery closure before the originating sender has the fundamental circuit closed.
16.044 Changes the (IFI) relay locking circuit to prevent a stuck sender in case of a short single pulse received after the sender is off normal.

> 16.045 Show connections to timing control circuit for Interdigital Timeout.
16.05 Fig. F replaces Fig. E to provide a (RV3) relay which is faster in release time to. accommodate the automatic test circuit.
16.06 Fig. H replaces Fig. G to arrange a trap for bridged (STP) contacts and removes direct ground from the winding of the (STP) relay to facilitate its readjustment.
16.07 "A" or "G" wiring and apparatus provides for frame indicators above 10
or for two 10,000 number series.
16.08 "B" wịring less than 10 frames.
16.09 "E" wiring and apparatus provides for terminating sender test circuit.
16.10 "F" wiring when terminating sender test circuit is not furnished.
16.11 "H" wiring and apparatus provides Interdigital Timeout.
16.12 "J" wiring when Interdigital Timeout is not provided.
16.13 "N" wiring produces Telitale on certain incoming group selection oversteps.
16.14 "W" wiring provides a path for the the (OA) and (OB) relays are omitted.
16.15 "X" wiring and apparatus provides for a signal from the sender link for selection of number series when two 10000 number series are used, or may also be used to distinguish between physical and theoretical offices.
16.16 "Y" wiring permits the use of incoming group selection above five as a means of distinguishing between number series or between physical and theoretical offices, and is used in combination with "X" or "Z". "Y" and "N" wiring are never used together.

> 16.17 " Z " wiring is provided to permit omission of the (OA) and (OB) relays in those cases where no signal from the sender link is required.
16.18 "AI" wiring and apparatus supersedes "AH" and introduces a break contact in the select magnets operate path at the (RVI) relay to prevent a possible false operation of the 0 select magnet at the end of a call following "Incoming Advance".

## 17. INTERDIGITAL TIMEOUT

17.1 "H" option and Fig. D provides an interdigital timeout of 3 to 6 seconds
under control of the Terminating Sender Timing Control Circuit which functions when all terminating senders are busy for a measured interval. The purpose of this feature is to reduce sender holding time in an emergency when all senders are busy and partial dials are encountered.

### 17.2 The (L) and (LI) will not operate if the originating sender holds the

 fundamental open awaiting the subscriber to dial.17.21 The (LI) failing to operate whenever the "G" and "Gl" leads are closed in the timing control circuit for a measured interval of 3 to 6 second, any time after the sender is seized, and before the (TC2) operates for trunk closure the (IDT) interrupter B contact will operate the (TM3) and the $F$ contact operates the (TRL) to effect a release.
17.22 The operation of the (Ll) relay shunts the (TM3) and will cause its release if operated or prevents its operation, and accordingly starts a new cycle count between each digit.

### 17.3 Subsequent closure of the fundamental

at the originating end may cause the reseizure of another terminating sender which will again time out in the same manner if the Timing Control Circuit is still effective. In spite of this possibility, however, the holding time is less than that which would be required, if the (TS) interrupter and relays (TM1) and (TNI2) were controlling.

## 18. TAKING EQUIPNENT OUT OF SERVICE

18.1 This circuit is taken out of service by the insertion of a 322A make busy plug into the associated MB jack at the terminating trouble indicator frame.

## 19. ALARM INFORMATION

### 19.1 Alarms and Indications

19.11 If this sender is delayed in the progress of a call for an interval greater than 30 to 60 seconds, the sender trouble release feature will function and the individual sender TL (trouble) lamp at the terminating trouble indicator frame will light momentarily.
19.12 Should the trouble release feature fail to restore the sender to normal, or if a make busy plug in the HLD (hold) jack prevents the operation of the sender trouble release relay from causing a complete release, the sender will remain stuck, testing busy to links and test circuits. Under this condition the TL and $\dot{A L}$ leads are grounded and the individual sender TL lamp at the terminating trouble indicator frame lights and after 5 to 12 seconds the minor alarm operates.
19.13 If a TL lamp on the trouble indicator frame is observed to flash occasionally without bringing in an audible alarm it may be an indication that the sender is requiring too long a time to handle the call, in which case a make busy plug should be inserted into the HLD jack of the sender in order to hold the trouble. If the lamps appear generally over a large number of senders it may be desirable to insert make busy plugs in the HLD jacks associated with those senders.
19.2 Responding To Alarms
19.21 If, in response to the intermittent audible alarm, a lighted sender T'L lamp on the terminating trouble indicator frame is found, the lamp indicates the particular frame and sender which is being held.
19.22 The audible alarm may be retired by operating the ACO key before leaving the trouble indicator frame.

Note: This key should be operated as short a time as possible. The ACO key when operated cuts off the minor audible alarm for the terminating trouble indicater frame. This cancels the minor audible alarm for any trouble which may occur in the sender, marker or trouble indicator circuits.
19.23 If a full selector terminating sender is causing the alarm, determine from
its setting in what portion of the sender or what general direction the trouble may be located. The following examples give an indication of the location of trouble outside of the sender.
(a) If the sender is seized and no selections recorded this may be an indicadion of trouble in the sender link or incoming trunk circuit.
(b) If the sender had partially completed selections this may indicate a failuse in the originating sender.
(c). If the sender reverse battery condilion has not been satisfied, this may indicate a failure in the terminating sender itself.
(d) If the trunk closure feature in the sender is not satisfied this may indicate a failure in either the incoming trunk or originating circuits.
(e) If it is found in the sender that trunk closure had been completed it may indicate a failure in either the associated marker connector or marker.
19.24 If trouble is located in the sender and cannot be cleared immediately make the sender busy in accordance with par. 18.1 and manually restore the sender to normal and restore the ACO key.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT. 2314-WTS-CGM-WA


[^0]:    6.2 The sender then prepares the incoming trunk circuit not to interfere with the transmission of revertive pulses to the

