COMMON SYSTEMS
LINE CONCENTRATOR IDENTIFIER CIRCUIT
APPLIED TO TELEPHONE SECRETARIAL SERVICE
ORIGINATING END

CHANGES

A. CHANGED AND ADDED FUNCTIONS

A.1 Provision has been added in this circuit for a Traffic Register and All Trunk Busy control circuit (Fig. B). This circuit will provide the following (a) peg count register lead, (b) all trunk busy register lead and (c) resistance battery to the terminating unit for operation of a ATB relay when all trunks are busy.

B. CHANGES IN APPARATUS

B.1 Added

In Figure B
4 - U779 Relays
(TBR1-TBR4)

In Figure B
KS-8512 - L3A Resistor 1000 ohms
(TB)

C. CHANGES IN CIRCUIT REQUIREMENTS OTHER THAN THOSE APPLYING TO ADDED OR REMOVED APPARATUS

C.1 Change relay designation TAA-VT to TAA-UT on Page 9.

C.2 Add to reference Note 7 for the MC relay, Page 3 the following "Waive BSP requirement, "shall not make" requirement for 1 and 2B".

D. DESCRIPTION OF CIRCUIT CHANGES

D.01 Fig. B is added to provide a Traffic Register and All Trunk Busy control circuit.

D.02 ZS wiring added to Fig. 20 to provide for connection to Fig. B.

D.03 Wiring formerly shown as part of Fig. 2 is shown as Fig. A; rated Mfr. Disc. and superseded by Fig. B.

D.04 Circuit Note 103 changed to reflect drawing Issue 20-D.

D.05 Note 114 added and reads as follows - When less than 4 trunks are provided block operated the "TB-" and "TBR-" relays associated with the unequipped trunks.

D.06 Note 107 rated Mfr. Disc.

D.07 In circuit Note 101, the asterisk and note associated with fuse "J" is removed.

D.08 In Figure 28 the code of the "MC" resistance is in error and is changed to read KS-8512,L3A.

D.09 In Figure 15, the connecting information for lead "F" is rated Mfr. Disc. and new information is added.

D.10 In Figures 16, 17, 18 and 19, reference to cross-conn. Figure 64 is added.

D.11 In Figure 52, the lead designated 48V or MJ connecting to the FA relay is rated Mfr. Disc.

D.12 Figures 58 and 59 are rated Mfr. Disc.

D.13 Figures 64 and 65 are added.

D.14 Equipment Note 202 is added.

All other headings under Changes, no change.

1. PURPOSE OF CIRCUIT

This circuit is used to connect any one of 100 called subscriber lines to a telephone answering service bureau over any one of 4 trunks, and signal the identity of each called line to the terminating equipment.

2. WORKING LIMITS

2.1 S and ST1 relays - 2000 ohm maximum external circuit.

2.2 Earth potential ± 20 volts (between originating and terminating equipment).

Ringup Circuits (Fig. 31)

Office Where Originating Equipment is Located		High Impedance Ringing Bridges on Called Sub's Line	Max. Conductor Loop Res. - Ohms			
Ringing A-C	Voltage D-C		Min. Insulation Res.	0V. Earth Potential	5V. Earth Potential	10V. Earth Potential
72-88	30-34	1	50,000	1100	600	100
		2	"	700	200	None
		3	"	100	None	None
		4	"	None	None	None
		1	10,000	700	200	None
		2	"	100	None	None
		3	"	None	None	None
		4	"	None	None	None
72-80	42-46	1	50,000	2200	1750	1250
		2	"	1850	1350	850
		3	"	1300	800	300
		4	"	900	400	None
		1	10,000	1850	1350	850
		2	"	1300	800	300
		3	"	900	400	None
		4	"	400	None	None
72-88	46-52	1	50,000	2600	2100	1650
		2	"	2250	1750	1250
		3	"	1700	1200	700
		4	"	1350	800	300
		1	10,000	2250	1750	1250
		2	"	1700	1200	700
		3	"	1350	800	300
		4	"	850	300	None
80-88	30-34	1	50,000	1900	1500	1050
		2	"	1400	950	500
		3	"	1000	500	100
		4	"	500	100	None
		1	10,000	1400	950	500
		2	"	1000	500	100
		3	"	500	100	None
		4	"	100	None	None
80-88	46-52	1	50,000	2800	2800	2400
		2	"	2750	2300	1900
		3	"	2350	1850	1500
		4	"	2000	1500	1050
		1	10,000	2750	2300	1900
		2	"	2350	1850	1500
		3	"	2000	1500	1050
		4	"	1500	1050	600
84-88	37-40	1	50,000	2800	2600	2200
		2	"	2550	2100	1700
		3	"	2050	1650	1200
		4	"	1600	1200	750
		1	10,000	2550	2100	1700
		2	"	2050	1650	1200
		3	"	1600	1200	750
		4	"	1250	800	400
84-88	46-52	1	50,000	2800	2800	2800
		2	"	2800	2800	2450
		3	"	2800	2400	1950
		4	"	2400	1950	1550
		1	10,000	2800	2800	2450
		2	"	2800	2400	1950
		3	"	2400	1950	1550
		4	"	2050	1600	1150
95-103	16-19	1	50,000	1800	1400	1000
		2	"	1400	1000	600
		3	"	900	500	100
		4	"	500	100	None
		1	10,000	1400	1000	600
		2	"	900	500	100
		3	"	500	100	None
		4	"	100	None	None

3. FUNCTIONS

3.01 Recognizes ringing current on a subscriber's line.

3.02 Recognizes and registers the equipment number of the called subscriber line.

3.03 Selects a trunk and pulses out the called subscriber equipment number to the terminating circuit.

3.04 Upon receiving an answering signal from the terminating circuit, it trips the ringing in the central office equipment.

3.05 Closes a talking path between the calling subscriber line equipment and the trunk to the terminating equipment.

3.06 Provides two controllers which are used alternately on successive calls.

3.07 Provides a timed interval between calls to transfer controllers, restores the circuit to normal and transmits a disconnect signal to the terminating circuit.

3.08 Guards against overlapping calls by delaying the start of a second call if the first call is still in the process of being served.

3.09 Provides for operation of a peg count register when a trunk is seized by the terminating end.

3.10 Provides for the operation of an all trunk busy register when all trunks are busy.

3.11 Provides for the operation of an all trunk busy relay at the terminating end when all trunks are busy.

3.12 Provides the following keys, lamps and jacks having functions as indicated.

Keys

TB1 makes trunk No. 1 busy
TB2 makes trunk No. 2 busy
TB3 makes trunk No. 3 busy
TB4 makes trunk No. 4 busy
CA makes controller A busy
CB makes controller B busy
EA makes controller B busy (Mfr. Disc.)
EB makes controller A busy (Mfr. Disc.)
AA makes the regular trunk allotter busy and exercises the alternate allotter
AR releases locked in alarm
RST isolates controller
ACO cuts off audible alarm
LOA places entire circuit on timed lockout circuit A
LOB places entire circuit on timed lockout circuit B

Lamps

AL timeout
UIO-UI9 progress lamp units selection made
TIO-TI9 progress lamp tens selection made
CA progress lamp controller A selected
CB progress lamp controller B selected
T1 to T4 trunk selected
AA alternate allotter serving calls
ACO audible alarm cut-off

Jacks

P adjust P relay
PG adjust PG relay
LC test Line Current

4. CONNECTING CIRCUITS

When this circuit is listed on a key-sheet, the connecting information thereon is to be followed.

4.01 Subscriber Line Circuit.

4.02 Line Concentrator - Identifier Circuit Terminating End - SD-95748-01.

4.03 Aisle Pilot Circuit (Crossbar No. 1) - SD-25087-01.

4.04 Floor Alarm Frame Fuse and Time Alarm Circuit (Crossbar No. 1) - SD-25046-01.

4.05 Floor Alarm Board Fuse and Time Alarm Circuit (Panel) - SD-21201-01.

4.06 Audible and Visual Alarm Circuit (Step-by-Step) - SD-96188-01.

4.07 Office Alarm Circuit (Crossbar No. 5) - SD-25671-01.

4.08 Alarm Sending Circuit - SD-95417-01*.

4.09 Frame Line Circuit - SD-96379-01*.

4.10 Annunciation Circuit - SD-15443-01*.

4.11 Peg Count Circuit (Manual #1) - SD-10517-01*.

4.12 Traffic Register Circuit (Step-by-Step) - SD-30896-01*.

4.13 Traffic Register Circuit (Crossbar No. 5) - SD-25892-01*.

*Typical Circuit

DESCRIPTION OF OPERATION

5. GENERAL

5.1 Originating End Equipment

This concentrator-identifier system consists of two units interconnected

by 2 to 4 trunks as shown in attached Figure 9.

The originating equipment, located in the central office consists of a 11' 6" frame mounting about 225 relays and 2 crossbar switches (used as multicontact relay) which concentrates 100 lines (MAX.) over 4 trunks (MAX.) to the terminating equipment.

Each line to be served by the system is cross-connected to the originating equipment by a pair of wires at the "Main" frame. For identification purposes, each line connected is assigned an arbitrary 2-digit code from 00-99. The originating equipment components are as follows:

(1) Auxiliary line circuits (100 Max.) consisting principally of a cold cathode tube and a ring up relay per line.

(2) One units identifier, consisting of ten relays corresponding to the units digit (0-9) operated by the auxiliary line circuit to indicate to the system the units digit of the called line.

(3) One tens identifier connector consisting essentially of two crossbar verticals, receives information from the auxiliary line circuit and the units identifier and passes this to the tens identifier.

(4) One tens identifier consisting of ten relays corresponding to the tens digit (0-9) which indicate to the system the tens digit of the called line.

(5) One controller connector provides a means of transferring from one controller to the other on successive calls.

(6) Two controllers that operate on alternate calls to pulse the line code number forward.

(7) Two trunk allotters are provided to seize an idle trunk. One allotter has access to all talking trunks the alternate used in case of emergency, connects to only the first trunk.

(8) Four trunk connectors consisting of four crossbar verticals per trunk. Each is provided to complete the transmission path from the subscribers line thru to the allotted trunk.

(9) One start circuit (not shown in the attached Figure 7) is provided to coordinate the functions of the various concentrating and identifying circuits.

(10) Two to four trunks each consisting of a transmission path and two composite signal paths.

(11) One Traffic Register and All Trunk Busy control circuit to (a) indicate to the terminating end an all trunk busy condition and (b) provide register leads.

5.2 Terminating End Equipment

The terminating equipment located at the answering bureau is a floor supported cabinet 7' high mounting about 100 relays, 3 crossbar switches (used as multicontact relays) and a 24 volt storage battery supply. It is connected to the associated switchboard that contain the required answering jacks and line lamps. The terminating equipment components are as follows:

(1) Two to four trunks each consisting of a transmission path and two composite signal paths.

(2) One controller connector provides means of transferring from one controller to the other on successive calls.

(3) Two controllers "A" and "B" that operate alternately to receive the digits pulsed by the originating end and to energize the indicating equipment at the terminating end.

(4) Two indicator allotters "A" and "B" are provided which seize an idle indicator for each call and determine the length of time the switchboard lamp is lighted.

(5) Four indicators are provided which lights the proper switchboard lamp through the indicator connector.

(6) One indicator connector is furnished consisting of 8 verticals of 2 crossbar switches which closes the crosspoints to light the selected switchboard lamps.

(7) One trunk connector is furnished consisting of 16 verticals of 3 crossbar switches which closes the crosspoints to complete the transmission path from a trunk to the switchboard jack.

(8) 3 unit selectors which are part of the three crossbar switches determine the level at which the crosspoints are to be closed by both the trunk connector and the indicator connector.

5.3 General Operation

On an incoming call, ringing in the called line thru the cross-connection at the main frame causes the auxiliary line circuit to operate. This action energizes a "Start" circuit which calls in a units and tens identifier circuit in order to identify the two digit number of the line being called. This circuit then connects to a common "Controller" circuit which first

checks the pulsing path for continuity and then pulses the identified line number forward over the ring side of the 1st trunk to the terminating equipment. Receipt of this information is verified over the ring conductor of the second trunk circuit.

The originating equipment pulses the identified line forward by means of two digits. Each digit consists of three pulses, CC+ (+115 volts DC) CC- (-115 volts DC) or an open as shown below:

Units or Tens Pulse	First Pulse	Second Pulse	Third Pulse
0	CC-		
1	CC-	CC-	CC+
2	CC-	CC-	CC-
3	CC-	CC+	CC-
4	CC-	CC+	CC+
5	CC+		
6	CC+	CC-	CC+
7	CC+	CC-	CC-
8	CC+	CC+	CC-
9	CC+	CC+	CC+

Simultaneously, the Controller Circuit in the originating end causes a Trunk Allotter circuit to hunt an idle trunk talking path. If available the path is closed through on crossbar switches at each end of the trunk for a period of about 1/2 second.

In the meantime the terminating equipment has received the units and tens pulses, selected and utilized an indicator circuit to light the proper line lamp on the associated switchboard and has connected the trunk determined by the originating equipment thru to the switchboard jack.

If the attendant has an answering cord connected to the jack associated with this lamp during the 1/2 second period when the trunk path is closed through the switches, she will be connected with the calling party. Otherwise at the expiration of the 1/2 second the trunk talking path will be released but will usually be reinstated on the next identification of the calling line. Should the attendant plug in this jack when the line lamp is dark, the talking connection will not be completed until the next identification and a second trunk closure occurs.

Called line "scanning" is independent of trunk talking path availability so that when all talking paths are busy the equipment continues to flash line lamps associated with other incoming calls.

A maximum of four talking paths are provided. However, the number of lamps that can be lighted is independent of this number of talking paths. Four indicator circuits are provided at the terminating end so that a maximum of four lamps can be lighted simultaneous. However, as many as six different lamps can be lighted successively during six seconds which is the length of each cycle of machine ringing. While more than six unanswered calls exist, each call is indicated once by its lighted lamp before any call is indicated a second time. Thus, each call will be indicated once every six seconds while six or less unanswered calls are waiting; and while more than six calls are waiting, the interval between successive indications of the same call will be more than six seconds, the amount more being determined by the total number of unanswered calls.

5.4 Identification and Supervisory Signaling

Signaling between the originating and terminating end is accomplished over the composite legs derived from the trunk conductors. Four types of signals are used:

(1) Identification

The identity of the called line requesting service is pulsed to the terminating end over the composite leg of the ring conductor of trunk #1 during normal operation. Verification of pulses received at the terminating end is made over the composite leg of the ring conductor of trunk #2.

During trouble conditions the pulsing and verification signaling is transferred to the composite legs of the ring conductors of trunks 3 and 4 respectively or to the tip and ring conductors of an auxiliary pair which is provided if trunks 3 and 4 are not equipped.

(2) Trunk Supervisory Signaling

The composite legs of the trunk tip conductors are used for the following purposes: (1) trunk seizure of the terminating end corresponding with that selected at the originating end and (2) attendant seizure and disconnection of the trunk circuit controlled by the terminating end.

(3) Trouble Supervisory Signals

The composite leg of the tip conductor of trunk #1 is used as an alarm timeout path to transfer the terminating equipment controller connector from A to B or B to A depending upon the circuit in use at the time. The composite leg of the tip conductor of trunk #2 is used as an alarm timeout release path which releases the trouble relays at the terminating equipment. Both functions are independent of trunk supervisory signals.

(4) All Trunk Busy Signaling (Fig. 34)

During normal operation the composite leg of trunk #3 ring conductor supplies a 48 volt battery which operates an ATB relay at the terminating end to indicate an all trunk busy condition. This feature is canceled during an alarm time-out period.

The following table indicates the functions that take place over the various trunk conductors:

Originating End	Trunk Conductor	Terminating End
Sends - 48 volts as signal of call to be served	R1	Ground as signal to start pulsing
Sends units pulses	R1	Receives units pulses
Sends - 48 volts to select terminating end of allotted trunk	Tip of allotted trunk	Selects trunk
Sends - 48 volts as signal units pulsing completed	R2	Shunts relay winding as signal of digits pulses registered and to pulse tens digit
Sends tens pulses	R1	Receives tens pulses
Removes - 48 volts from ring of trunk No. 2	R2	Registers tens pulses
Receives signal to trip ringing	Tip of allotted trunk	Attendant answers, sends signal to trip ringing
Receives signal to release trunk	Tip of allotted	Attendant disconnects, sends signal to release trunk
Sends CC+ signal as an alarm (timeout)	T1	Receives alarm signal
Sends CC+ signal to release alarm	T2	Receives alarm release signal
Alternate for R1	R3	Alternate for R1
Alternate for R2	R4	Alternate for R2
Sends - 48 volts to the terminating end to indicate all trunks busy	R3	Operates an All Trunk Busy Relay-lights an ATB lamp.

5.5 Certain common equipment has been duplicated and will be used on alternate calls to minimize the chance of service failure. Other features have been provided to facilitate the location of troubles in the equipment.

5.6 Functional Designation of Relays

AA	- alternate allotter (trunk)
AA1	- Auxiliary to AA
ACO	- alarm cut-off
AL	- alarm
AR	- alarm release
AT	- alternate trunk
ATC	- alternate trunk connector
C	- starts timing
CO, C1	- subscriber connector
CA, CB	- controller indicators
CT	- control timing
DC	- digit check (operates on registering unit) (digit)
DC1	- auxiliary to DC3
DC2	- auxiliary to DC1
DC3	- auxiliary to DC
DR	- trunk delay release
DSA	- delay pulsing start (cont. A)
DSB	- delay pulsing start (cont. B)
FA	- fuse alarm
H	- hold magnet check
HA	- auxiliary to H
LOO to LO9	- lockout
MA, MB, MC	- timed lockout
P	- pulsing
PG	- pulse generator
PT1	- pulse tens
PU	- pulse units
PU1	- pulse units auxiliary
RUOO to RU99	- ring up

S	- supervisory
S1	- auxiliary to S
SS	- switch supervisory path
ST	- start
ST1	- sleeve test
ST2	- auxiliary to ST1
STA	- start controller A
STA1	- auxiliary to STA
STB	- start controller B
STB1	- auxiliary to STB
T	- trunk allotter seized
T0 to T9	- tens identification
TA0 to TA4	- trunk allotting
TAA	- time alarm
TAB to TAF	- auxiliary to TAA
TB1 to TB4	- trunk busy
TBR1 to TBR4	- trunk busy register
TC	- trunk check
TI0 to TI9	- tens indication
TK1 to TK4	- trunk indication
TS	- trunk seized
U0 to U9	- units identification
UI0 to UI9	- units identification
W, X, Y & Z	- counting relays

6. SEIZURE (See attached Figs. 2,3,5 and 8)

6.1 One gas tube (GT fig. 10) and one ring up relay (RU fig. 6) or one figure 31 is provided for each connected line (Max. 100). When the subscribers bell is rung, ringing current over the ring side of the bridging pair is connected to the GT tube (fig. 10) or thru figs. 32 and 7 to tube GT (fig. 31).

6.2 With "W" option (figs. 6, 10, 31 and 32), the ring side (negative polarity) is connected to the cathode (element 6). The control and main anodes (elements 1 & 5) are connected to "E" ground thru the winding of relay RU-. The ground on the winding of relay RU- changes in polarity with respect to the alternations of ringing current.

6.3 With "X" option (figs. 6 and 10) the ring side is connected to the main and control anodes (elements 1 & 5). The cathode (element 6) is connected thru contacts of relay LO- (fig. 7), contacts and winding of relay RU- to battery or with fig. 31 the ring side is connected thru contacts of relay LO-, winding and contacts of relay RU- to the main and control anodes (elements 1 & 5). The cathode (element 6) is grounded. The ring side changes in polarity with respect to the alternations of ringing current.

6.4 The action of tube GT starts with the breakdown potential applied across the cathode and control anode to ionize the gas content of the tube. The tube will only conduct when negative potential is connected to the cathode and a positive potential is connected to the main and control anodes. After the gas has become ionized to the point where the potential across the cathode and main anode reaches the striking voltage the tube passes current to operate relay RU-. (Only one half of the AC cycle of the ringing current is used to activate the tube.)

Note: Assume relay RU63 is operated for the purpose of describing circuit operation.

0.5 Two varistors designated "RU" and "RUA" are in parallel with the winding of relay RU63 so that current will flow through its winding in only one direction although the operating voltages is alternating. The varistors offer a low resistance to one half of each AC cycle and bypass the RU63 relay winding while on the other half of each cycle the varistors offer a high resistance and permit current to flow thru the winding of relay RU63.

The current thru the winding of relay RU63 may be greater than the current required to operate the ringing tripping relay in the central office; however, this current thru relay RU63 has a very short duration but is is interrupted when relay RU63 operates. Pretripping does not occur because relay RU63 is faster than the tripping relay in the central office.

6.6 Relay RU63 operated (1) locks operated until served by a controller, (2) opens its own operating path so as not to trip the ring, (3) de-ionizes tube GT, (4) operates "Start timing" relay C (fig. 8) thru contacts of relay TAC, and (5) operates units relay U3 (fig. 7) thru contacts of relay LO3, winding of relay U3 to battery "H" (fig. 9) with a parallel path thru the contacts of relay TAB or TAC (fig. 8) depending upon the units group in which the operated RU- relay is located.

6.7 Relay C (which is connected to all 100 RU- relays will remain operated as long as there is an RU- relay operated) operated (1) connects cc+ battery thru the winding of relay TAA to the control and main anodes of the tubes that control the units and tens timing (UT and TT), (2) locks through its own contacts under control of relays HA or DC1 and (3) removes the short circuiting "D" ground from the UT condenser allowing it to start charging. (This charging time delays the voltage build-up on the control anode of tube UT for approximately 2.2 seconds which is the maximum time allowed for completion of units pulsing before a "time-out" alarm is signaled. Normally the units pulsing is completed in a fraction of the time allowed for timeout.

7. UNITS IDENTIFICATION

7.1 A U- relay (units group) represents those lines in a horizontal group of the crossbar switch (e.g. lines 00, 10, 20 etc. comprise horizontal group zero).

10 U- relays are provided each controlled by the operation of one or more of 10 RU- relays in the same units group (e.g. RU relays 00, 10, 20 etc.). These relays are wired in a double transfer chain circuit for preference seizure selection. The operating path functions from the highest to the lowest U- relay. The operation of a U- relay will open the operating chain and prevent any lowered U- relay from operating. However, any higher numbered U- relays can operate at any time. It is possible to have simultaneous operation of the U- relays when two or more unit groups request service.

Preference to the controller circuit access is given to the lowest U- relay operated and proceeds to the next locked up U- relay in sequential operation until all U- relays have been served.

Unit relay U3 operated (1) transfers lead D from the higher numbered U- relays to lead 3 (these leads are a part of the circuit for pulsing units digit), (2) locks operated under control of relay RU63, (3) removed the battery required to operate any lower numbered U- relay, (4) opens the operating path for any higher numbered LC- relays and operates relay LC3 (lead F thru contacts of relays TAB and TAC to ground fig. 8), (5) transfers the operating path from the select magnet SM- corresponding with the higher numbered U- relays to operate select magnets SM3 (fig. 23) in both crossbar switches (lead E and contacts of relays H and TAC fig. 8), lead B and contacts of relay ST (fig. 20), lead B, contacts of relay DC2, and to ground thru contacts of relay Y or DC1 (fig. 3) and (6) operates units indicator relay UI3 from battery thru lamp UI3 (fig. 20) to ground on lead TL thru contacts of relays CT, TAF and TAD (fig. 8).

7.2 Lamp UI3 lighted identifies the units digit of the line being served and the progress of the call. (The UI3 varistor in the operating path of relay UI3 is to prevent false operation of other UI- relays when locking ground is connected to lead LL.

7.3 Relay LO3 operated (1) opens the operating path for the associated RU- relays (03, 13, 23, etc.), (2) opens the operating path for relay U3, and (3) operates relay MA (fig. 28) thru the lock out key (fig. 29). Only one LO- relay can operate on any one call, being controlled by the preference chain thru the U- relays.

7.4 Ten select magnets SM0-SM9 (fig. 23) are each wired in the chain circuit of their corresponding U- relays so that the select magnet associated with the lowest operated U- relay can operate. Select magnets SM3 operated (1) positions the selecting fingers so that when the hold magnets operates two sets of crosspoints will be closed and (2) operates the tens identifier connector hold magnets 8 and 9 in parallel.

8. TENS IDENTIFICATION

8.1 Hold magnets 8 and 9 (fig. 9) operated (1) close the crosspoints on verticals 8 and 9 as determined by the select magnet SM3, (2) operates tens relay T6 (fig. 4) and (3) operates the hold magnet check relay H (fig. 8).

8.2 There are ten T- relays designated T0-T9. Each relay is connected to 10 RU- relays having a corresponding tens digit number. Each relay RU- that is operated at this time in the horizontal group as determined by the select magnet SM3 will operate its own corresponding T- relay to indicate those calls waiting to be served. Relay T6 operated (1) operates tens identification relay TI6 and lights lamp TI6 (fig. 21), (the lowest numbered TI- lamp lighted identifies the tens digit of the line being served and the progress of the call), (2) transfers leads B, C, and E from all higher numbered T- relays to leads B6, C6, and 6 (Leads C0, C3, C5 and C8 are not required, see table paragraph 13. Leads E and 6 form a part of the circuit for pulsing the tens digit) and (3) transfers a locking path (lead A) from the higher numbered T- relay to its own winding.

8.3 Relay H operated (1) locks operated to its operating path and a parallel path over lead B thru (fig. 20 & 3) to ground on relay Y and DC1, (2) operates relay HA, (3) connects a parallel ground to short circuit condenser CT which is normally short-circuited by relay HA released and (4) opens the operating path for select magnet SM3 over lead E. Relay HA operated (1) locks relay C operated, (2) connects CC+ from the winding of the control timing relay CT to the control and main anodes of control timing tube CT (relay CT does not operate because tube CT is not receiving its igniting voltage), (3) removes one of the short-circuit grounds from condenser CT, (4) locks operated to ground thru relays CT and TAA, (5) operates start controller A relay STA or start controller B relay STB, (6) opens the operating path for relay H and (7) locks relay ST operated on its primary winding if relay ST was left operated by the previous call.

9. SELECTION OF CONTROLLER

9.1 Assume that relay ST was left operated and that relay STA did operate to prepare controller A (fig. 3) to handle the call. If relay ST has been released, then relay STB would have operated and controller B would handle the call. Relay ST operated (1) connects lead B and D thru the controller

A and (2) provides an operating path for relay STA. Relay STA operated (1) connects short-circuiting ground (resistance D fig. 8) over leads C and A1 (fig. 3) to the tens timing condenser TT (fig. 8) to prevent the TT tube from conducting, (2) operates relay STA1, (3) operates trunk allotter relay T (fig. 2) thru relay AA1 (fig. 24), (4) partially completes a holding path for the primary winding under control of the auxiliary digit check relay DC1, (5) locks operated over the secondary winding thru the CB key to ground under control of relay STB, (6) opens the holding path for the secondary winding of relay ST and (7) connects -48 volts battery to lead BAT to start controller A. Relay STA1 operated (1) connects the pulsing path (lead R1) from controller A thru the switch supervisory path relay SS to the ring side of the 1st trunk, (2) connects leads 0-9 from the tens identifier (fig. 4) to controller A and (3) operates relay CA and lights lamp CA (fig. 21) as an indication that controller A is handling the call.

10. SELECTION OF TRUNK

10.1 The purpose of the trunk allotter is to allot the trunks in a regular sequence. Assume the trunk allotter circuit normal with the trunk allotter relay TA0 operated. This provides for the first trunk to be selected. Relay T operated (1) operates relay TA1 in series with one winding of relay TA0, (2) locks relay TA0 and (3) provides a locking path for holding any trunk busy relay TB- that may be operated. Relay TA1 operated (1) opens the operating path for relay TB1, (2) prepares its own locking circuit depending upon the release of relay T, (3) prepares an operating path for relay TA2 in series with one of its own windings, (4) operates trunk seized relay TS, (5) opens the operating path for alternate allotter relay AA (fig. 24) and (6) prepares a path to operate relay S1. Relay TS operated (1) operates trunk indicator relay TK1 and lights lamp TK1 as an indication of the trunk seized (fig. 22), (2) operates the trunk delay release relay DR, (3) closes the "C" leads for operating the subscribers connector relays C0 and C1 which may or may not operate, (4) closes the "B" leads for the operation of a trunk hold magnet (fig. 5), (6) closes lead S to provide a holding path for the trunk hold magnet and (7) prevents relay AA (fig. 24) from operating. Relay DR provides a holding path for relay S1. (If the traffic is heavy, it is possible for relay S1 to still be operated to the tip side of the trunk from a previous call. This happens because the trunk allotter circuit does not have time to release itself. The operation of relay TS in this case will release relay S1 which removes ground from lead S releasing the trunk hold magnets and relays C0 and C1 if either or both were operated.

11. PULSE GENERATOR

11.1 The pulse generator consists of relays P and PG in conjunction with condenser PG. Relays P and PG are polarized relays without biasing springs and their armatures are moved and held on their contacts entirely by the current through their windings.

11.2 When relay STA connected -48 volts of battery to lead BAT (paragraph 9.1), a voltage divider circuit was established for pulsing. This circuit consists of resistances A, B, BA, C and CA together with the windings of relays P and PG. Ground from relay ST2 normal has the secondary winding of relay PG in series with condenser PG short-circuited. This same ground is connected to the negative (-) side of the primary winding of relay PG and in series with winding of relay P on its positive (+) side, thru the GA and C resistance, to battery on lead BAT. The other branch of the voltage divider circuit is connected to the negative (-) side of relay P thru resistances BA and B to ground. The current flowing at this time thru relays PG and P is from ground on relay ST2 to battery on relay STA. The polarity of relay PG is in the release direction and the polarity of relay P is in the operate direction.

11.3 After the ST2 relay operates the PG relay will be operated and released three times, each operate and each release taking place on a condenser timed basis. The P relay in turn will release and operate at the start of each condenser timed period. Each time the P relay releases a pulse closure can take place if required and each time the P relay operates a pulse is opened. The PG closes its front contact when energized in one direction by its primary winding and closes its back contact when energized in the other direction by its primary winding. It remains on either contact or between contacts when not energized. When the current is first closed thru the primary winding in either direction, its force is more than neutralized by an opposing current in its secondary winding, the source of which is the charging or discharging of the PG condenser. When the condenser has been charged or discharged, current ceases to flow in the secondary, and the primary causes the armature to move from one contact to the other.

12. PULSING UNITS

12.1 Relay ST1 operates from battery at relay DC1 over lead R1, composite side of trunk 1, thru the terminating relays PP and PN in series to ground. Relays PP and PN at the terminating end do not operate but the presence of ground to operate relay STL is a signal to start pulsing units. Relay ST1 operates causes relay DSA to operate

which in turn operates relay ST2 over lead RS2 to ground at relay TAC (fig. 8). Relay ST2 operated (1) completes a portion of the operating path for digit check relay DC, (2) locks its own operating path, (3) releases relay ST1 which in turn releases relay DSA, (4) provides a locking ground for relay PU in parallel with lead RS1, (5) removes the short-circuit from condenser PG which starts charging and (6) operates relay W. Relay W operated (1) grounds the R1 lead thru 300 ohms if relay P is operated to prevent false pulses due to energy stored in the composite circuit and (2) completes the operating path for relay X (relay X does not operate due to its winding being short-circuited to ground.

12.2 First Pulse-Units

When relay ST2 operated, it removed ground from the primary and secondary windings of relay PG changing the voltage divider circuit thereby reversing the voltage polarity on the windings of relays P and PG causing relay P to release (battery on lead BAT thru resistance A, primary winding of relays PG and P, resistances BA and B to ground). Another path is provided thru the secondary winding of relay PG to charge the condenser PG which prevents relay PG from operating until the potential across condenser PG is equal to the source. As indicated in the pulse chart the first pulse will always have a closure of CC- for digits 0 to 4 and CC+ for digits 5 to 9. These pulses are controlled by the operated U-relay and the X and Y relays released. The pulsing circuit is from either the CC- or CC+ leads thru resistance ZU or ZV, contacts of relays X, Z, STA1 or STB1, U3, and ST or STB, lead D, contacts of relay DC1 and P, jack LC, resistances KA and K, lead R1, contacts of relays STA1 or STB1 and SS to the trunk. Relay P released connects CC- (units digit 3) to the trunk causing the terminating end equipment polarized relay PN to operate which causes a registration of a pulse and starts the terminating equipment. Relay PG operates (condenser timed) which (1) removes ground from one side of the winding of relay X which operates and (2) operates relay P. Relay P operated (1) removes the CC- pulse from the trunk and (2) discharges the trunk condensers. Relay X operated (1) completes the operating path for relay Y when relay PG releases, (2) opens leads 0 and 5 for the 2nd and 3rd pulses and (3) shifts the CC+ or CC- on other leads for the 2nd pulse.

12.3 Second Pulse-Units

Relay PG releases (condenser timed) to (1) operate relay Y and (2) release relay P. Relay Y operated (1) removes one of the parallel locking grounds for relay H and (2) completes the operating path for relay Z (relay Z does not operate due to short-circuit ground on its winding.) Relay P released removes the 300 ohm ground from the trunk and connects CC+ to the trunk for the second pulse (an open pulse is required for the second pulse of digits 0 to 5). Relay PG operates (condenser timed) to (1) operate relay Z and (2) operates relay P. Relay P operated (1) disconnects the CC+ from the trunk and (2) discharges the trunk condenser. Relay Z operated (1) partially completes a holding path for relay ST2 over its own secondary winding, (2) partially completes the operating path for relay PU over its secondary winding and (3) shifts the CC+ or CC- on certain leads for the 3rd pulse.

12.4 Third Pulse-Units

Relay PG releases (condenser timed) to (1) release relay P, (2) provide a holding path for relay ST2 and (3) operates relay PU. Relay P released (1) removes the 300 ohm ground from the trunk and (2) connects CC- to the trunk for the third pulse (open pulse required for digits 0 and 5). Relay PU operated (1) opens the operating path for relay ST2, (2) partially completes the operating path for relay ST2 (for tens pulsing), (3) partially completes the operating path for digit check relay DC, (4) locks operated over its primary winding to ground at relay TAC (fig. 8), and ST2 released, (5) provides a locking ground for relays DC1 and PT1 and (6) operates relay PU1. Relay PG operates (condenser timed) to (1) operate relay P and (2) release relay ST2. Relay P operated (1) removes CC- from trunk and (2) discharges the trunk condenser. Relay ST2 released (1) connects relay DC to the ring side of the second trunk to await completion of the registration of the units digit at the terminating end (at this time ther is a high resistance ground (24,000 + 160 ohms) on the ring side of the trunk which prevents relay DC from operating. When the terminating end completes the units registration it reduces the resistance to 160 ohms which allows relay DC to operate as a signal to pulse the tens digit), (2) short-circuits condenser PG to stop the pulsing, (3) releases relay PG, (4) holds relay P operated and (5) releases relays W, X, Y, and Z. Relay PU1 operated (1) operates relay CO or C1 (fig. 1), (2) operates a hold magnet (fig. 5), (3) operates relay TC (fig. 2) in series with relay S1, (fig. 1), releases relay RU63 (fig. 31), (4) provides an additional ground to hold relay H, hold magnets 8 and 9 and select magnet SM3, and (5) provides an additional ground to hold relay TS (fig. 1), (see par. 13 and 14.)

13. SELECTING T AND R CROSSPOINTS

13.1 There are four trunk connector circuits (fig. 5) each consisting of four verticals of a crossbar switch. The first

crossbar switch is divided as follows: verticals 0, 2, 4 and 6 for the first trunk connector, verticals 1, 3, 5 and 7 for the second trunk connector, verticals 8 and 9 for the tens identifier and the select magnets for the units selector. The second crossbar switch is similarly divided for the third and fourth trunk connectors.

13.2 At this point there are two functions that take place simultaneously. The horizontal crosspoint closure is made in a particular trunk vertical and the T and R crosspoint is selected. The required hold magnet when operated will close the crosspoint for either a group of 3 lines or a group of 2 lines. The central office tip and ring of the line calling will be selected and closed by the trunk.

13.3 Relays CO or C1 are operated by relay PU1 (paragraph 12.4). The operation of the CO or C1 relay is controlled by the operated preferred T-relay. More than one T-relay can be operated in a horizontal group of 10 lines when the tens identifier crosspoints are closed, but only the lowest operated T-relay (preferred) is closed thru to the CO or C1 relay when required. The "C" leads are grouped at relay TS and only those T-relays indicating a line associated with the 0 and 1 crosspoint of the vertical (T and R leads) will not operate the CO or C1 relay. The T-relays associated with the 2 and 3 crosspoint (T1 and R1 leads) will operate the C1 relay and the T-relays associated with the 4 and 5 crosspoint (T2 and R2 leads) will operate the CO relay. The C leads numbered C0, C3, C5 and C8 are not connected to relay TS because the CO and C1 relays are not required to be operated. (This case the C1 relay will operate). The following table indicates the operation of the various relays:

T-relay operated	CO or C1 relay operated
T0,T3,T5,T8	NONE
T1,T4,T6,T9	C1
T2,T7	CO

When either the CO or C1 relay is operated they lock up over lead S in parallel with the operated hold magnet or under control of relay S1.

14. OPERATION OF TRUNK HOLD MAGNET

14.1 Each trunk has access to the total of 100 subscribers thru the 4 verticals of the switch. The horizontal crosspoints associated with the 4 verticals are connected to the tip and ring leads of the 100 subscribers as follows:

Assigned Numbers	(0-29)	on Verticals	0	and	1
"	"	(30-49)	"	"	2	"	3
"	"	(50-79)	"	"	4	"	5
"	"	(80-99)	"	"	6	"	7

By the operation of the select magnet, the particular horizontal group of 10 lines having the same units digit are prepared for closure. When one of the hold magnets is operated 2 or 3 lines are extended to the trunk. Hold magnet 4 (fig. 5) operates over lead C, contacts of relay TS, lead B6, contacts of relay T61 lead B to ground at relay PU1 and locks over lead S to ground at relay S1. The hold magnets are controlled by the operated T-relay (preferred) and the following chart indicates the hold magnets operated by the various T-relays.

T-relay operated	Hold magnet operated 1st or 3rd TRUNK	2nd or 4th TRUNK
T0,T1,T2	0	1
T3,T4	2	3
T5,T6,T7	4	5
T8,T9	6	7

Relay TC operates in series with relay S1 when relay PU1 operated. Relay TC operated (1) locks to relay S1 and (2) extends ground from relay PU1 (lead 1) to the alternate allotter circuit to operate relay AA (fig. 24) if for any reason the trunk allotter fails to allot a trunk due to a trouble condition. Relay S1 operated (1) provides an additional ground to hold the hold magnet 4 and relay CO or C1 if previously operated, (2) closes the talking path thru the repeating coil, (3) provides its own locking path under control of relays DR and TC and (4) connects the operating path for relay S to the tip side of the trunk. (Battery thru the winding of relay S is connected to the tip of the trunk and in series with relay TC at the terminating end which has ground on its winding). Relay TC at the terminating end operates but due to the high resistance of its windings (24,000 +160 ohms) relay S does not operate. Relay TC is operated at the terminating end for the purpose of indicating the trunk selected for the call.

14.2 Relay RU63 is shunted down and relay T6 is locked operated by relay PU1. Other RU- relays of the same horizontal group may be locked up at this time waiting to be served. The self contained lock-up circuit on each RU- relay means that a controller has to serve the call before the shunting process is available. Relay RU63 released causes relay U3 to release provided that there are no other RU- relays operated in the same horizontal group of lines. Relay U3 released (1) causes relay UI3 to release and (2) extinguishes lamp UI3.

15. PULSING TENS DIGIT

15.1 When the pulsing of the units digit has been completed and relay ST2 of the Controller circuit has released, the DC relay is connected to the ring side of the second trunk to wait for a signal from the

terminating equipment that the units digit has been registered satisfactorily. When the signal is sent the resistance in the ringside of the second trunk is changed from 24,000 + 160 ohms to 160 ohms by shunting the winding of a relay to operate relay DC. Relay DC operated causes relay DC3 to operate which in turn operates relay DC1. Relay DC1 operated (1) transfers part of the pulsing path from the U3 relay (lead D) to the tens relay T6 (lead E), (2) provides an additional holding ground for relay C (fig. 8), (3) removes the short-circuit ground from condenser TT (fig. 8) allowing it to start timing the tens pulsing, (4) short-circuits condenser UT (fig. 8) to stop the units pulsing timing, (5) locks itself operated under control of relays PU and PT1, (6) removes one of the locking grounds for lead B, (7) provides a locking path for relay STA, (8) transfers the operating battery for relay ST1 and the locking battery for relay ST2 from control of relay PU to relay PT1, (9) opens the operating path for relay PU, (10) closes the operating path for relay PT1 under control of relay Z and (11) partially completes a holding path for relay DC.

15.2 First and Second Pulse - Tens Digit

After the registration of the units digit is completed by the terminating equipment, if all pulse register relays are released satisfactorily, the terminating equipment relay DC operates and reconnects ground thru the relays PP and PN to the ring of the first trunk to operate relay ST1 as a signal to pulse tens digit. Relay ST1 operated in turn operates relay DSA which in turn operates relay ST2. Relay DC holds to ground on the ring side of the second trunk thru contacts on relay ST2. When relay ST2 operated the pulse generator circuit is started and the first two pulses are pulsed as described for units pulsing except that the T6 relay operated in combination with relays W, X, Y, and Z determine whether the pulses are CC+ or CC-.

15.3 Third Pulse - Tens Digit

When the condenser timed period is completed for the release of relay PG at the end of the second pulse relay Z operates causing relay PT1 to operate which (1) opens one of the operating paths for relay DC, (2) provides a locking path for relay DC1 under control of relay TAC (fig. 8), (3) opens one of the locking paths for relay PU, (4) locks itself operated to relay PU, (5) opens the locking path for relay ST2, and (6) operates relay DC2. Relay DC2 operated (1) removes two parallel locking grounds on lead B, (2) locks itself operated to battery on lead BAT and (3) opens the operating path for relay ST1. Relay P releases and connects the third pulse to the ring side of the first trunk. Relay PG operated (condenser timed) (1) operates relay P which disconnects the pulse from the ring side of the first trunk and connect 300 ohms ground to discharge the trunk condensers and (2) releases relay ST2. Relay DC releases due to being disconnected from the ring of the second trunk by the release of relay ST2. The disconnection of relay DC causes relay DC in the terminating equipment to release which closes the crosspoints in the crossbar switch of the first trunk and connects the trunk thru to the answering jack at the switchboard for line identifications.

16. RELEASE OF CONTROLLER

16.1 Relay ST2 released (1) releases relay PG (secondary winding of relay PG and condenser PG short-circuited to ground) (2) stops the pulse generator and (3) releases relays W, X, Y, Z, and PU. Relay PU released releases relays PT1, PU1, and DC1. Relay DC1 released short-circuits condenser TT to stop the tens timing cycle. Relay PU1 released releases (1) units select magnet SM3, (2) tens identifier hold magnet 8 and 9, (3) relay H, (4) relay T6 and (5) relay TS. Relay H released removes the short-circuit from the control timing condenser CT which allows it to charge for a timing cycle. Relay T6 released (1) releases relay TI6, (2) extinguishes lamp TI6 (3) releases relay TK1 and (4) extinguishes lamp TK1. Relay TS released (1) causes relay S1 to lock up during the release time of relay DR and (2) releases relay DR if not held by relay S.

17. TIMING FOR HOLD MAGNET RELEASE

17.1 Relay H released removes a short-circuit ground from control timing condenser CT to start a new timing cycle. This timing period is to delay the selection of controller B if a call is waiting to allow time for select magnet SM3 and hold magnets 8 and 9 to release. Condenser CT completes its charging and ignites tube CT to operate relay CT. Relay CT operated (1) releases relay HA, (2) releases relay CA and (3) extinguishes lamp CA. Relay HA released (1) short-circuits condenser CT, and (2) releases relays CT, C, ST and STA. Relay ST released (1) removes battery from lead BAT to relay P which is a nonbiased polar relay and remains in its operated position (2) releases relays DC2, STA1 and T. (Relay C releases provided no other RU- relays are operated at this time).

Relay T released (1) releases relay TC, (2) locks relay TA1 operated until relay T is operated on the next call and (3) releases relay TA0.

Relay S1 releases provided that relay T and DR have released. For relay DR to release relays S will have to be released (end of call or no answer at the switchboard).

Relay S1 released (1) disconnects relay S from the tip side of the first trunk causing relay TC in the terminating end and to release which releases the terminating equipment and (2) releases either relay CO or C1 if operated and the trunk hold magnet.

18. ATTENDANT ANSWERS CALL AT SWITCHBOARD

18.1 The time between the release of relay DR and the lighting of the switchboard lamp is so short that the attendant may not be able to pick up the call during the first lamp indication. The answering cord must be in the line jack during the time the call is being served in order for the attendant to be connected to the trunk.

18.2 After the tens digit has been pulsed, the terminating equipment connects the trunk to the tip and ring of the answering jack and lights the associated switchboard lamp.

18.3 When the terminating trunk hold magnet has operated and closed the crosspoints, relay S1 in the originating end is still held operated in series with relay T. Relay TS released removes the operating ground for relay DR which is slow to release. Relay S is still connected to the tip side of the trunk holding terminating end relay TC operated. A plug in the answering jack will cause relay TCA at the terminating end to operate which shunts down the resistance of relay TC from 24,000 + 160 ohms to 1660 ohms causing the originating end trunk relay S to operate. Relay S operated (1) connects resistance T across the midpoint of the repeating coil to trip the ringing, (2) connects a holding circuit for relay DR, (3) operates relay TB1 if relay TA1 has released when Fig. A is provided and (4) operates relay TBR1 if Fig. B is provided. Relay TBR1 operated (1) operates relay TB1 if relay TA1 has released and (2) grounds the PC lead to stroke the peg count register when provided. Relay DR operated holds relay S1.

> Note: Relay S must operate in time to prevent the release of relay DR if the selected trunk is to be locked in at the terminating end. The trunk busy relay TB1 cannot operate because relay TA1 remains operated until the next trunk is selected at which time relay TA1 will release and relay TB1 will operate provided the first trunk is still busy.

19. ATTENDANT DISCONNECTS

19.1 When the attendant disconnects by removing the plug from the answering jack, relay TCA releases in the terminating end. The resistance in the tip side of the trunk increases from 1660 ohm to 24,160 ohms to release relay S. Relay S released (1) removes the tripping resistance from the midpoint of the repeating coil (2) releases relay DR and (3) releases relay TB1. Relay DR (slow releasing) releases relay S1 which (1) removes relay S from the tip side of the trunk, (2) opens the talking path at the midpoint of the repeating coil and (3) release the trunk hold magnet and relay CO or C1 if they were operated. (The trunk is now restored to normal and may be allotted in the regular sequence).

20. SECOND CALL SERVED DURING ONE RINGING INTERVAL

20.1 If the RU- relay is operated for the second time during one ringing interval, it will be allotted to the next trunk in sequence. The terminating indicator connector used the first time may or may not be used the second time. (It will depend upon the number of calls served and how far the terminating indicator allotter has advanced during the interval). If the indicator connector is still up for the first call, a second indicator connector may be set up for the same call and this overlap will extend the time that the switchboard lamp is lighted (with this arrangement the attendant has a chance to answer the call on the first ring). If a second call of a lower numbered units digit is waiting to be served, it will operate its U- relay and be served before the RU- relay of the first call can be reoperated.

20.2 When two calls each in a different horizontal group are rung up simultaneous, they will be served in order as determined by the preference chain of the operated U- relay.

20.3 Where there are a number of simultaneous calls and two or more calls are in the same horizontal group associated with the lowest numbered U- relay that is operated, these calls will be served first as the U- relay will be held until the associated operated RU- relays are shunted down. The calls within the horizontal group will be served in preference as determined by the lowest operated tens relay. When the last RU- relay in the same horizontal group is shunted down by the operation of relay PU1, the preference will be passed to the next higher numbered U- relay that is operated.

21. CALL NOT ANSWERED BY THE ATTENDANT

21.1 If a call is established on a trunk and then is not answered by the attendant, after approximately 3 seconds the equipment operated to light the switchboard lamp at the terminating end will be retired. The retirement of this equipment is the responsibility of the terminating indicator allotter. The terminating equipment operated in the trunk to close the crosspoints to

the trunk is under control of the originating equipment.

At the originating end, under this condition trunk relay S will not operate. The trunk will not be made busy in the trunk allotter. If this is the only call in progress, then on the release of relay TC, the trunk allotter will advance to release relay S1, thereby releasing the hold magnets at both ends. Should heavy traffic be in progress, then the release is performed by the operation of relay TS when the trunk is next selected. Relay S does not operate. Relay DR is slow to release after relay TS releases. Relay S1 is held operated during release of relay DR. Relay S1 released (1) releases relays C0 or C1 if operated, (2) removes relay S from the tip of the trunk and (3) releases hold magnets. (The trunk cannot be seized until again allotted).

22. ALL TRUNKS BUSY

22.1 When all trunks are allotted and are busy, the associated S relay of each trunk will be operated which operates the associated TB- relays in the trunk allotter (fig. 2) when Fig. A is provided or operates the associated TBR- relays in the Traffic Register and all Trunk Busy control circuit when Fig. B is provided. With Fig. B the operated TBR- relays (1) operates the associated TB- relays in the trunk allotter Fig. 2 (2) closes a 100Ω battery through series contacts 7/8B of the TBR- relays, through the 5/6B of relay SS over lead R3 to the terminating end to operate an all trunk busy relay and (3) grounds the all trunk busy lead PB to the traffic register control circuit when provided.

22.2 When the last trunk has been allotted, the controllers continue to serve calls, except that when relay T operates it will not cause any movement in the trunk allotter circuit. Relay T operated locks relays TB1 - TB4 so that no trunk can be allotted while a call is in progress should a trunk become idle. The succeeding calls are pulsed to the terminating controller as fast as it accepts them. These calls will be displayed by lighting the switchboard lamps. The terminating equipment is able to display a maximum of 6 calls in 6 seconds lighting only 4 lamps at any one time. Each call will be displayed for approximately 3 seconds and then wiped out. This "nonlocked-in" method of indicating incoming calls permits the attendant a choice of specific line answering.

23. TRUNKS MAKE BUSY

23.1 In the trunk allotter circuit there is a TB- (trunk busy) key for each trunk. These keys are of the push button type and are located above the crossbar switches. There is no provision for making the trunk busy at the terminating end.

23.2 When a TB- relay is operated and Fig. A provided the associated TB- relay in the trunk allotter Fig. 2 operates when the TA- relay releases if operated. With Fig. B the operated TB- key operates the associated TBR- relay in the traffic register and all trunk busy control circuit Fig. 34.. The TBR- relay provides a ground from the 7/8T contacts to operate the associated TB- relay in the trunk allotter circuit through the normal contacts of the TA- relay.

23.3 During regular trunk allotter operation ground from the 2/3T of the operated T relay holds any operated TB- relay. This locking circuit prevents the release of an operated TB- relay during the time a trunk is allotted.

24. TRUNK PEG COUNT AND ALL TRUNK BUSY REGISTER (FIG. B AND OPTION ZS)

24.1 When the attendant seizes the trunk the S relay operates as explained in Section 18.3. The operation of relay TBR- provides a ground over lead PC or removes ground on lead PC if another TBR- relay is operated. The grounded PC lead operates the peg count register; the removal of ground releases the register. The sequential closure and open to ground of the PC lead will stroke a peg count register.

24.2 When all trunks are busy as explained in Section 22.1 the operated TBR- relays (1) provides a ground over lead PB to the traffic register control circuit and (2) provides a 1000ω battery to the terminating end to operate a ATB relay.

25. TIMED LOCKOUT

25.1 The purpose of the timed lock-out circuit is to extend the time that the LU- relays are held operated beyond the time when all of the associated RU- relays have been released. This extension of time amounts to about one second (.6-1.2 seconds). The purpose of this extension is to prevent the operation of an RU- relay a second time on a single call until the release of the trunk circuit that used when the call was first served. If the time extension were not made, it might be possible to connect two trunks on a single call.

Two timed lock-out circuits are provided. One serving units group 0 to 4 and the other serving units group 5 to 9. The operation of key LOA places all units group on time-out circuit A, or if key LOB is operated all units groups are placed on time-out circuit B.

Relay MA operated (paragraph 7.3) operates relay MB. Relay MB operated connects

ground on the inner winding terminal of relay MC which does not operate because of ground on both ends of its winding.

When the U3 relay which operated the LO3 relay releases, ground is removed, and relay MC operates in series with relay LO3. Relay LO3 holds in series with relay MC. Relay MC operated releases relay MA which in turn releases relay MB. Relay MB released, releases relays MC and LO3. Relay LO3 released connects relay RU63 back on the line. Relay MA and MB are slow release and their combined release time determines the length of time the relays are locked out. (Option "ZR" was added to prevent relay MC from buzzing).

26. OPERATION AND RECYCLE OF THE TRUNK ALLOTTER

26.1 When the first trunk (paragraph 10) was allotted, relay TA1 was left operated and all other relays released. Relay T again operates to allot the second trunk causing relay TA2 to operate in series with one winding of relay TA1 which holds operated. After the second trunk has been allotted, relay T releases which (1) releases relay TA1 in turn operating relay TB1 if the first trunk is busy, and (2) locks relay TA2 operated thru contacts of relay TB3 released or TB1 operated. Relay T operates to allot the third trunk which (1) holds relay TB1 operated during the allotting time and (2) operates relay TA3 in series with relay TA2 which holds operated. Relay T releases after the third trunk is allotted and (1) removes holding of relay TB1, (2) releases relay TA2 and (3) locks relay TA3 operated. Relay TA2 released causes relay TB2 to operate if the trunk is busy. Relay T operates to allot the fourth trunk to (1) operate relay TA4 in series with one winding of relay TA3 which holds operated and (2) holds relay TB1 and TB2 operated if these trunks are busy. Relay T released (after the fourth trunk has been allotted) releases relay TA3 and opens the holding path for relays TB1 and TB2 if the trunks are not busy. Relay TA3 released (1) operates relay TB3 if the third trunk is busy and (2) releases relay TA4. Relay TA4 released (1) operates relay TB4 if the fourth trunk is busy and (2) operates relay TA0. The trunk allotter is now recycled and will again allot the trunks in a regular sequence passing any trunk which is busy as indicated by operated TB- relay. In the sequence of allotting trunks the higher numbered trunks are busy (for example trunk 3 and 4 are busy and trunk 2 is being allotted), then relay T released will release relay TA2 which will operate relay TB2 and TA0 and the allotter is again recycled. Any time relay T is operated it holds any operated TB- relay so that any trunk being released from a busy condition will not become available until the end of an allocation.

27. ALTERNATE ALLOTTER

27.1 If a call is originated and a trunk allotter, due to a trouble condition, cannot allot an available idle trunk, relay T will be operated and relays TA0 to TA4 will be released, causing relay AA to operate. If all trunks are not busy and no TS relay (in the trunk ckt.) operates, relay AA will operate when the TC relay operates. Without "G" option, relay AA operated, (1) operates relays TAD and AA1, (2) lights lamp AA, and (3) locks under control of relay TAD. With "G" option relay AA operated (1) locks to the AR key, (2) light lamp AA, (3) operate relay AA1 and (4) operates relay TAD. Relay AA1 operated, takes the regular trunk allotter out of service and replaces it with an alternate trunk allotter by transferring control leads 2, 3 and 5 from Fig. 2, to Fig. 24. Relay AT and ATC Fig. 24, perform the same functions as relays T and TC Fig. 2, and all calls are served by trunk No. 1. Without "G" option the operation of the AR key releases relay TAD which in turn releases relay AA. With "G" option the operation of the AR key releases TAD and AA relays. Relay AA released extinguishes lamp AA and releases relay AA1 which in turn transfers control leads 2, 3 and 5 back to Fig. 2. Subsequent calls will then be served by trunk allotter Fig. 2 and any idle trunk No. 1 to 4.

The operation of the AA key will light lamp AA and operate relay AA1, thus forcing calls to use the alternate allotter. The circuit will then function as described above so that maintenance can be performed on the regular allotter.

28. TROUBLE TIMING (See Attached Fig. 7)

The trouble timing circuit provides for a timing period of 2.2 seconds for the call to be served and the second timing period of 2.2 seconds for the call to be completed.

The first timing cycle (units timing) starts when relay C operates (paragraph 6.7) and completes when relay DC1 operates (paragraph 15.1). The second timing cycle (tens timing) starts with the operation of relay DC1 and ends when relay DC1 releases (paragraph 16.1).

27.1 Units timing - Relay C is operated by the operation of any RU- relay at the start of a call. Relay C operated (1) connects CC+ from the winding of relay TAA to the control and main anodes of tube UT and condenser UT and (2) disconnects the short-circuiting ground (resistance D) from condenser UT which begins to charge. Relay DC1 is released and has condenser TT short-circuited to ground to prevent condenser TT from charging.

Any trouble which delays the operation of relay DC1 for more than 2.2 seconds will allow condenser UT to charge and ionize tube UT. Relay TAA operated (tube UT) (1) removes locking ground for relay HA, (2) operates relay TAE, (3) with "K" option operates relay AL, (4) with "B" option operates relay SS and (5) operates relay TAD. Relay AL operated (1) connects CC+ from resistance P to the tip side of the first trunk which causes a polarized relay RC to operate in the terminating equipment which effects the release of the digit register relays, (2) lights the timeout lamp TO, transfers the terminating pulsing circuit from the ring of the first trunk to either the ring of the third trunk or the tip of the auxiliary pair (3) locks the trunk equipment operated if the first trunk is busy, (4) locks relay S if operated and (5) removes the -48 volts from the tip side of the first trunk if it is busy (removal of this battery will cause relay TC to release at the terminating end but the trunk equipment was held operated by the operation of relay RC). Relay SS operated (1) transfers the originating pulsing lead from the ring of the first trunk to the ring of the third trunk or to the tip side of the auxiliary pair and (2) opens the AB lead from Fig. 34 to the R3 lead when ZS option is provided. Relay TAD operated (1) with "T" option locks to the alarm transfer circuit (2) with "V" option locks under control of key AR, (3) with "Z" option ground from figs. 16, 17 or 19 is connected to alarm leads DL, DG, G, R, W, MG, MW and MJ and with fig. 18 battery is connected to lead 48V or if "Y" option is provided the contacts of relay ACO are added in the leads, (4) locks relay SS operated (5) with "ZD" option lights lamp AL, (6) transfers the operating paths to locking paths for any operated relays UI-, TI-, TK-, CA or CB to show the progress of the call to the point of timeout (operation of any trouble indicator relays on subsequent calls is prevented) and (7) with "ZC" option operates relay TAF which in turn (1) lights lamp AL and (2) prepares a path to operate relay AR upon release of relay TAD. Relay TAE operated (1) locks the operated LO- relay to allow other units relay to have preference if the trouble was caused by the horizontal group of lines just served, (2) connects a holding circuit to relay MA, (3) connects an additional short-circuiting ground to relay MC, and (4) operates relay TAB. Relay TAB operated (1) releases relays U5 to U9 if operated, (2) opens the operating path for relay LO-, (3) operates relay TAC and (4) connects an additional holding ground for relay AL. Relay TAC operated (1) releases relays UO-U4 if operated, (2) removes the operating ground for relays LO- (3) releases start relay C, (4) releases relay ST2 if operated, (5) releases relay PU if operated which in turn releases relay PU1 if operated and (6) releases relay H if operated which in turn releases relay HA, hold magnet 8 and 9, and select magnet SM- if operated. Relay HA released causes relay ST (controller A) or relay STB (controller B) to release if either were operated (relay ST released allows controller B to serve the next call or relay STB released allows controller A to serve the next call. This change transfers controllers in case the trouble was in the controller). Relay C releases (TAC released) causing relay TAA to release which releases relay TAE. Relay TAE released (1) releases relay TAB and (2) removes ground from timed lock-out circuit (fig. 28). Relay MA holds operated and relay MC operates due to the short-circuit ground being removed from its winding and releases relay MA which releases relay MB in turn releasing relay MC (the timed lock-out circuit requires about one second for its operation and is a separate function from the normal time-out release). Relay MB released causes relay LO- to release. Relay TAB released (1) releases relay TAC and (2) releases relay AL. Relay AL released (1) removes CC+ from the tip of the first trunk to release relay RC in the terminating end (the terminating end relay TO remains locked operated to the AR relay which is normal), (2) connects -48volts to the tip side of the first trunk if the trunk was used on a call (battery on the tip of the first trunk causes relay TC at the terminating end to reoperate locking the trunk hold magnet and relay TC1 which are being held by relay RCA) and (3) opens the locking path for relay S.

28.2 Alarm Release "V" Option - To release the alarm the alarm release key AR must be operated. Key AR operated (1) releases relay TAD and (2) operates relay AR. Relay TAD released (1) with "ZD" option extinguishes lamp AL, (2) removes ground and battery from the leads to the misc. alarm circuit to retire the alarm, (3) releases the indicator relay and associated lamps (UI-, TI-, TK- and CA or CB (4) releases relay SS and (5) releases relay TAF when "ZC" option is furnished. Relay AR operated (1) removes -48 volts from the tip of the second trunk (if trunk is in use) to release relay TC at the terminating end, (2) locks relay S operated if the second trunk is in use and (3) connects CC+ to the tip side of the second trunk to operate relay AR in terminating end which holds the second trunk hold magnet and relay TC1 if operated, extinguishes lamp TO and shifts the pulsing path to the first trunk. Relay SS released (1) shifts the pulsing path back to the first trunk and (2) closes lead AB from Fig. 34 to the R3 lead when ZS option is provided. When the AR key is released relay AR releases to (1) removes the locking circuit for relay S in the second trunk, (2) removes the CC+ from the tip of the second trunk to release terminating relay AR and (3) connects -48 volts from the winding of relay S to the tip of

the second trunk if it was in use to reoperate relay TC at the terminating end.

28.3 Tens Timing - When relay DC1 operated, the units timing was stopped by short-circuiting condenser UT and tens timing started removing the short-circuit from condenser TT. If due to a trouble, relay DC1 fails to release before condenser TT is charged then tube TT conducts to operate relay TAA. The same functions take place when relay TAA operates as for units timing.

28.4 When the originating equipment is in an unattended office and relay TAD has locked operated thru the AR key with "T" option to lead LK or AR, the alarm may be released from the master office by removing the locking grounds. In this case relay TAD will release relay TAF if "ZC" option is provided. Relay TAF being slow to release will cause relay AR to operate the same as if the AR key had been operated to retire the alarm as described under paragraph 27.1.

29. ALARM CUTOFF

29.1 (Option "ZC") When it is desired to cut off the misc. alarm circuit and not release the alarm on the system, the alarm cutoff key ACO is operated which (1) operates relay ACO and (2) light lamp ACO. Relay ACO operated (1) locks thru contacts of relay TAA to ground at key AR and (2) opens the leads to the alarm circuit if "Y" option is provided. To extinguish the ACO lamp and reconnect the misc. alarm leads it is necessary to operate release alarm key AR. If another timeout should occur after the alarm cutoff key ACO was operated and before the Alarm Release Key AR is operated, relay TAA will operate to (1) release relay ACO and (2) extinguish lamp ACO. Relay ACO released connects the alarm leads to give the alarm for this timeout.

29.2 (Option ZF Mfr. Disc.) Key ACO operated (1) operates relay ACO and (2) lights lamp ACO. Relay ACO operated opens the leads to the alarm circuit.

30. ALTERNATE USE OF CONTROLLERS ON SUCCESSIVE CALLS

30.1 The ST relay operating steers a call to controller A and ST relay released steers the call to controller B. When the STA relay operates, as described under the paragraph "Tens Identification", it opens the secondary winding of the ST relay which, however, does not release at this time since it is locked on its primary winding. After the tens digit has been pulsed and gas tube CT has fired, relay HA releases and in turn releases relay ST. Relay STA will remain locked on its secondary winding to ground on relay STB. When the next call is originated, it will be served by controller B since it will find relay ST normal. The operation of relay HA operates relay STB which in turn releases relay STA. When the HA releases at the end of the second call, it releases relay STB which in turn operates relay ST. This completes the cycle of events and a third call will then be served by controller A.

31. LINE CURRENT TEST JACK

31.1 To read the value of line current that flows during a pulse from controller A, operate key EA or CB. Insert the plug of a cord connected to an ammeter into the line current test jack for controller A. The current that flows is from CC+ thru resistance ZV, the sleeve of the jack, thru the ammeter to the tip of the jack, thru resistances KA and K, thru controller connector relays of controller A, to lead R1 and over the ring side of the first trunk to the terminating equipment. As long as the ammeter is plugged into this jack the system will be unoperative and an incoming call attempting to use this controller will cause a timeout alarm and for this reason the plug should remain in the LC jack only a short interval just long enough to read the current.

The current should be between 25 and 35 milliamperes. If it is outside these limits the KA and K resistances should be adjusted so that their resistance plus that of the outside conductor of the R1 lead is equal to 2000 ohms or other troubles such as a faulty line should be corrected.

31.2 To read the line current for controller B, key EB or CA should be operated and the ammeter plugged into the LC test jack for controller B.

32. ALARM ROUTINE

32.1 As this circuit performs its function, the following lamp signals will indicate the progress of a call.

The UIO to UI9 lamps indicate the particular units selection made. The lowest numbered lamp lighted indicates the call being served.

The TIO to TI9 lamps indicate the particular test selection made. The lowest numbered lamp lighted indicates the call being served.

The CA or CB lamps indicate which controller (A or B) has been selected for use in the call.

The T1 to T4 lamps indicate which trunk (1, 2, 3 or 4) has been selected for use in the call.

The AL lamp indicates that a trouble either in this circuit or in the terminating circuit caused this circuit to time out.

Any of the above progress lamps which are lighted together with the AL lamp will indicate the progress of the call up to the time of the timeout. A momentary operation of the AR key will release the alarm.

33. TAKING EQUIPMENT OUT OF SERVICE

33.1 Any trunk (1 to 4) can be taken out of service by operating the corresponding trunk make busy key TB1, TB2, TB3 or TB4. When it is necessary to do any work on the apparatus of the trunk circuit Fig. 1 or the TA1 to TA4 or TB1 to TB4 relays of the trunk allotter circuit Fig. 2 operate the TB1, TB2, TB3 or TB4 key associated with the apparatus involved.

(Fig. B & ZS Option) When it is necessary to do any work on the TBR1 to TBR4 relays of this register and all trunk busy control circuit block operated the corresponding TB1 to TB4 relay in the trunk allotter circuit Fig. 2.

The trunk allotter Fig. 2 can be taken out of service by the operation of the AA key. It should be noted that when the AA key is operated, all calls will be served by trunk No. 1, and trunks Nos. 2, 3 and 4 will automatically be taken out of service even though the TB2, TB3 and TB4 keys are normal.

Controller A or B can be taken out of service by the operation of keys CB or CA. When it is necessary to do any work on the apparatus in controller A or B or STA, STA1, or STB, STB1 relays in the controller connector circuit (Fig. 20) operate the CB key to make controller B busy and the CA key to make controller A busy.

The operation of the LOA key removes timed lockout circuit B from service and the operation of the LOB key removes timed lockout circuit A from service.

Any maintenance on the following relays should be performed with caution during periods of light traffic since it is possible to deny service to a number of subscribers, as indicated below. In the event a call attempts to gain access to the terminating equipment through the apparatus under test, the test equipment should be disconnected and the call should be given an opportunity to be served.

Apparatus Under Test	No. of Circuits Denied Service
Relays	
RU0 to RU99	1
L00 to L09	10
U0 to U9	10
T0 to T9	10
T, TC	100
Any app. in start circuit	100
Select Magnet	
SM0 to SM9	10
Hold Magnets	
0, 4	30
1, 6	20
8, 9	50

The number of subscribers denied service is based on the assumption that this circuit is fully equipped with 100 subscriber lines and uses 4 trunks.

When it is necessary to change any of the relays listed below, the precautions indicated should be observed to prevent blocking the system.

Any relay in trunk circuit Fig. 1

(1) Make the associated trunk busy by operating the TB1, TB2, TB3 or TB4 key.

L00 to L09 relays Fig. 7

(1) Loop connections to all normally made contacts.

U0 to U9 relays Fig. 7

(1) Loop connections to all normally made contacts.

Any relay in controller A and B Fig. 3

(1) Make the controller busy by operating the CB or CA key for controller B or A.

MA, MB or MC relays Fig. 28

(1) For relays associated with circuit A, operate LOB key.

(2) For relays associated with circuit B, operate LOA key.

PU1 relay Fig. 3

(1) Loop connections at 3B (PU1) and 2B (PU1) relay.

ST relay Fig. 20

(1) Operate the CA key.

(2) Loop connections at 6T and 7T (ST) relay.

(3) Loop connections at 1T and 3T (ST) relay.

STA or STA1 relay Fig. 20

(1) Operate the CA key.

STB relay Fig. 20

(1) Operate the CB key.

(2) Connect direct ground to 3B, (STB) relay.

STB1 relay Fig. 20

(1) Operate the CB key.

TAB, TAC or TAD relays Fig. 8

(1) Loop connections at normally made contacts.

TBR1 to TBR4 relays Fig. B

(1) Block operated the corresponding TB1 to TB4 relays in trunk allotter Fig. 2.

34. RELAY OPERATIONAL CHARTS

34.1 Fig. 8 (attached) is an operation chart of the complete circuit operation.

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Att. Figs. 1-9

FUSE AND TERMINAL BLOCKS	
TIMED LOCKOUT	
ALARM	
TRUNK NO. 3	TRUNK NO. 4
TRUNK NO. 1	TRUNK NO. 2
TRUNK ALLOTTER	
CONTROLLER B	
CONTROLLER A	
CONTROLLER CONNECTOR	
START CIRCUIT	
UNITS IDENTIFICATION	
TENS IDENTIFICATION	
TRUNK CONNECTOR AND IDENTIFIER CONNECTOR (XBAR SWITCH)	
TRUNK CONNECTOR (XBAR SWITCH)	
TROUBLE INDICATOR	
JACK AND LAMP FIELD	
RING-UP CIRCUITS	

FIG. 1 FRAME LAYOUT

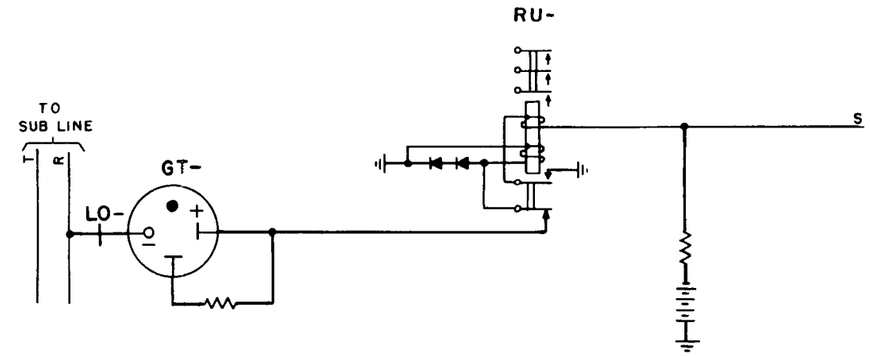

FIG. 2 RING-UP CIRCUIT
NEGATIVE SUPERIMPOSED LINE

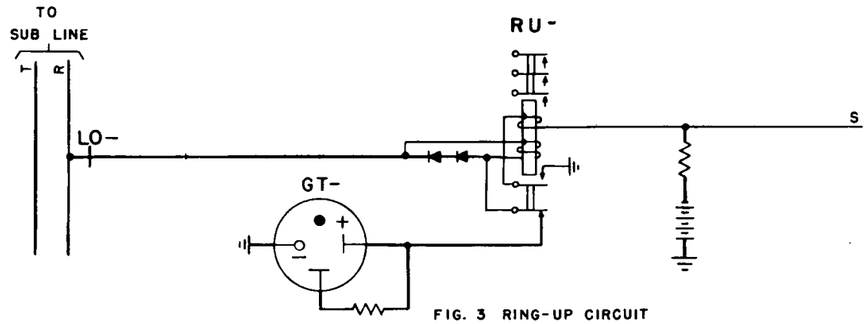

FIG. 3 RING-UP CIRCUIT
POSITIVE SUPERIMPOSED LINE

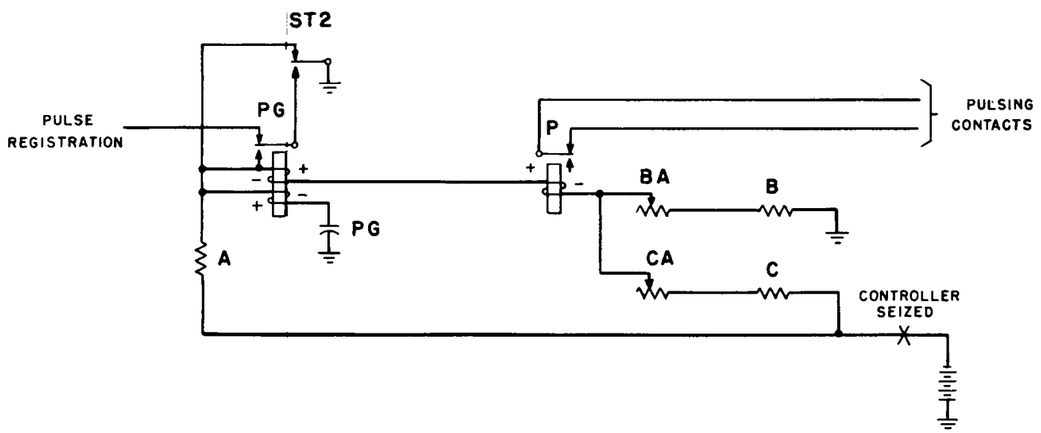

FIG. 4 PULSE GENERATOR

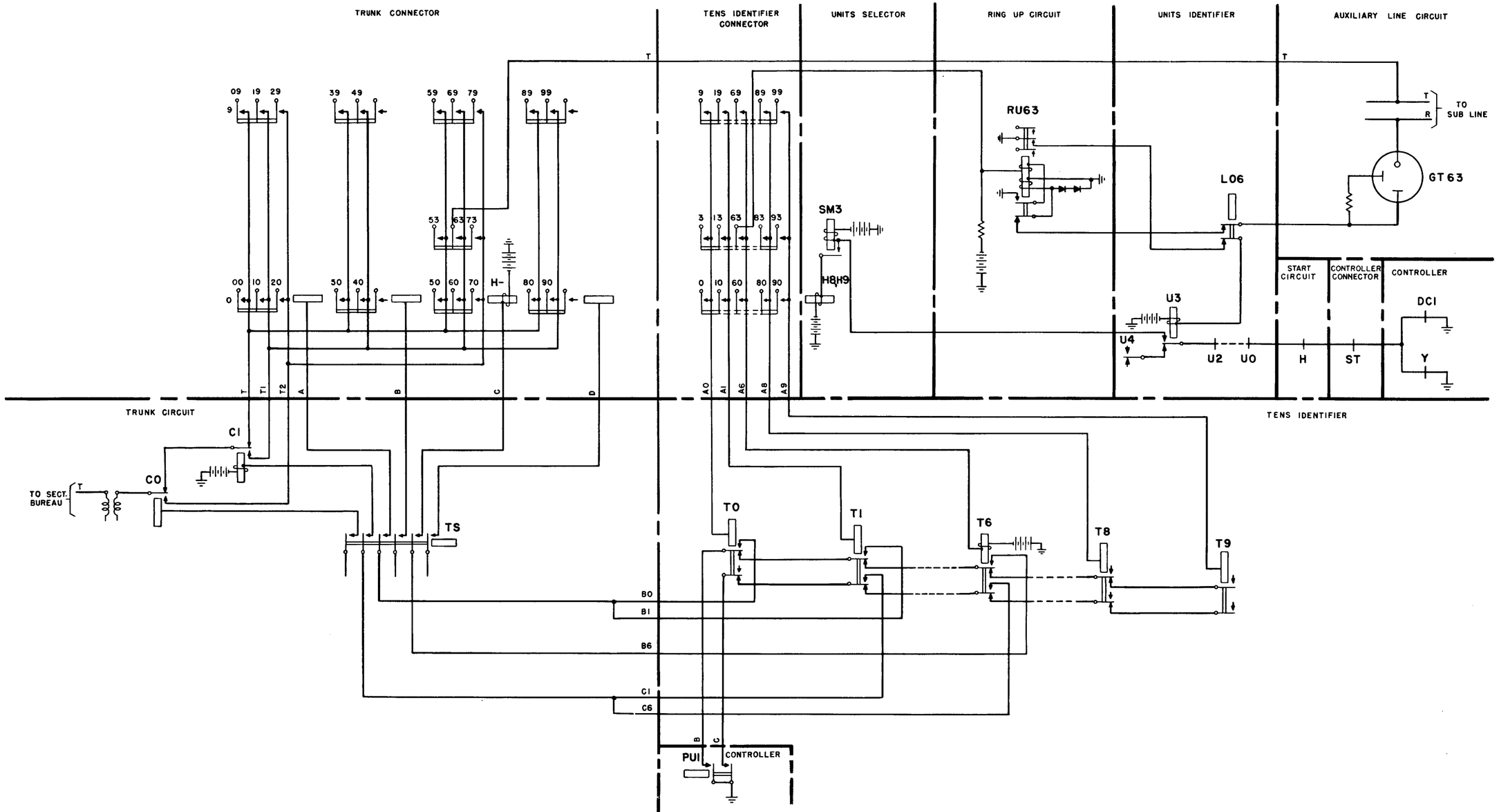

FIG. 5 SUBSCRIBER IDENTIFICATION

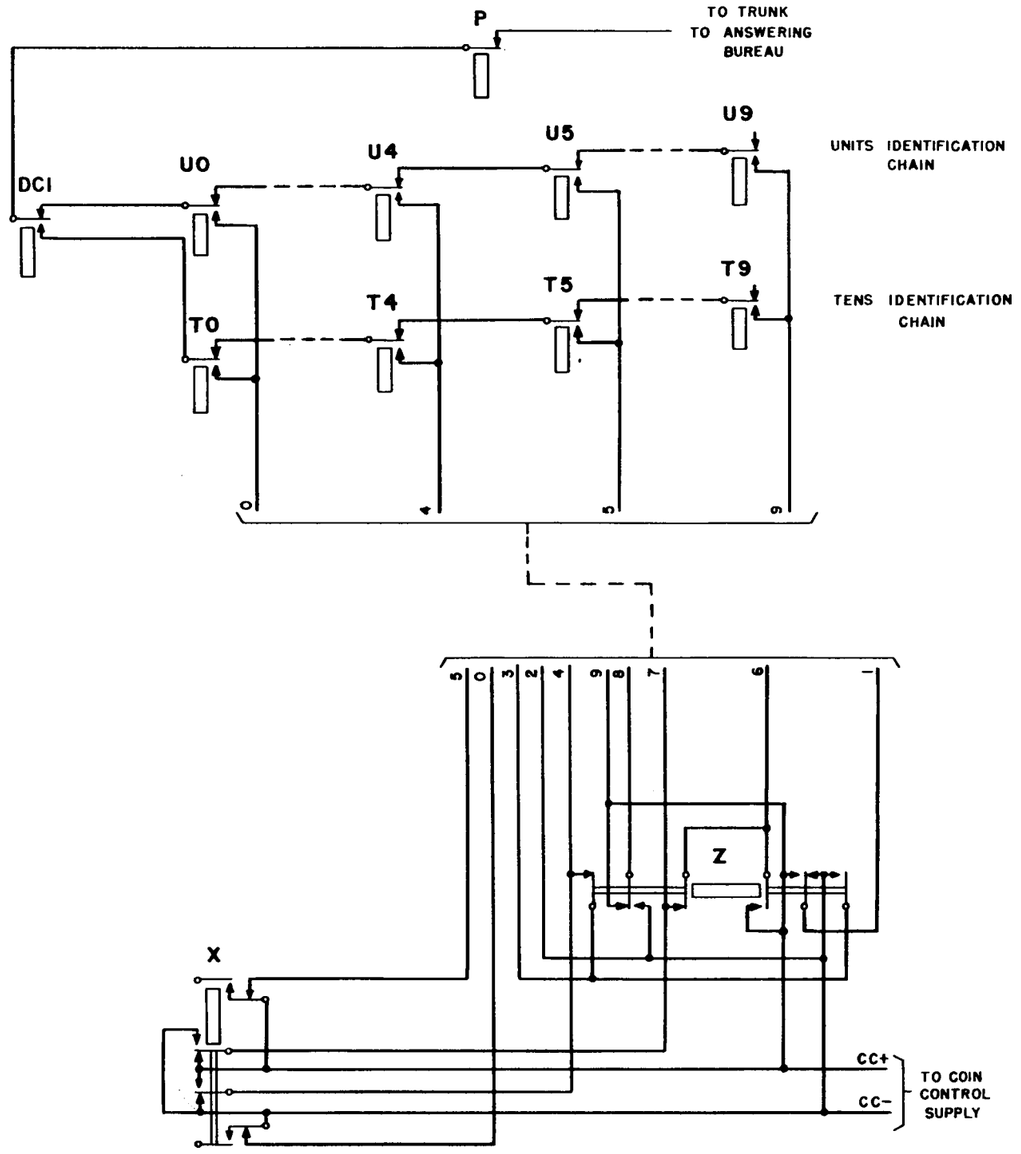

FIG.6 DIGIT CODING

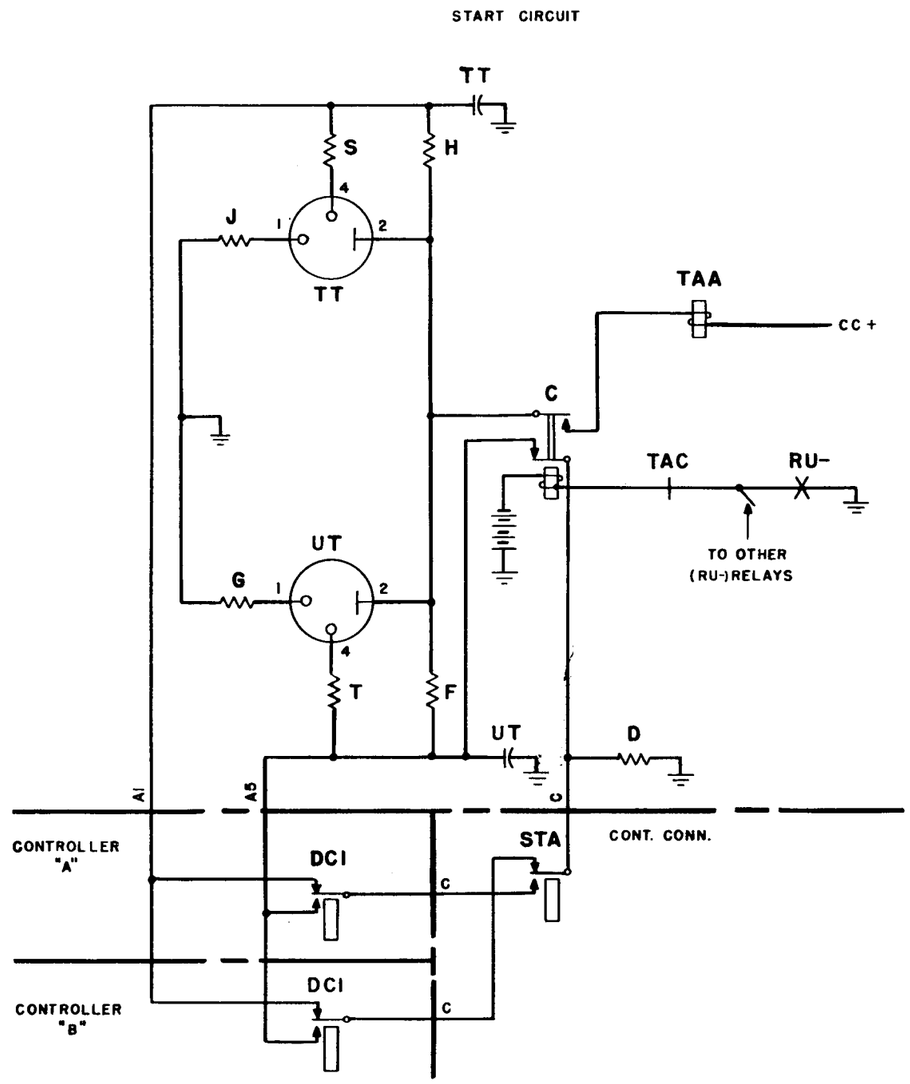

FIG. 7 TIME ARRANGEMENT

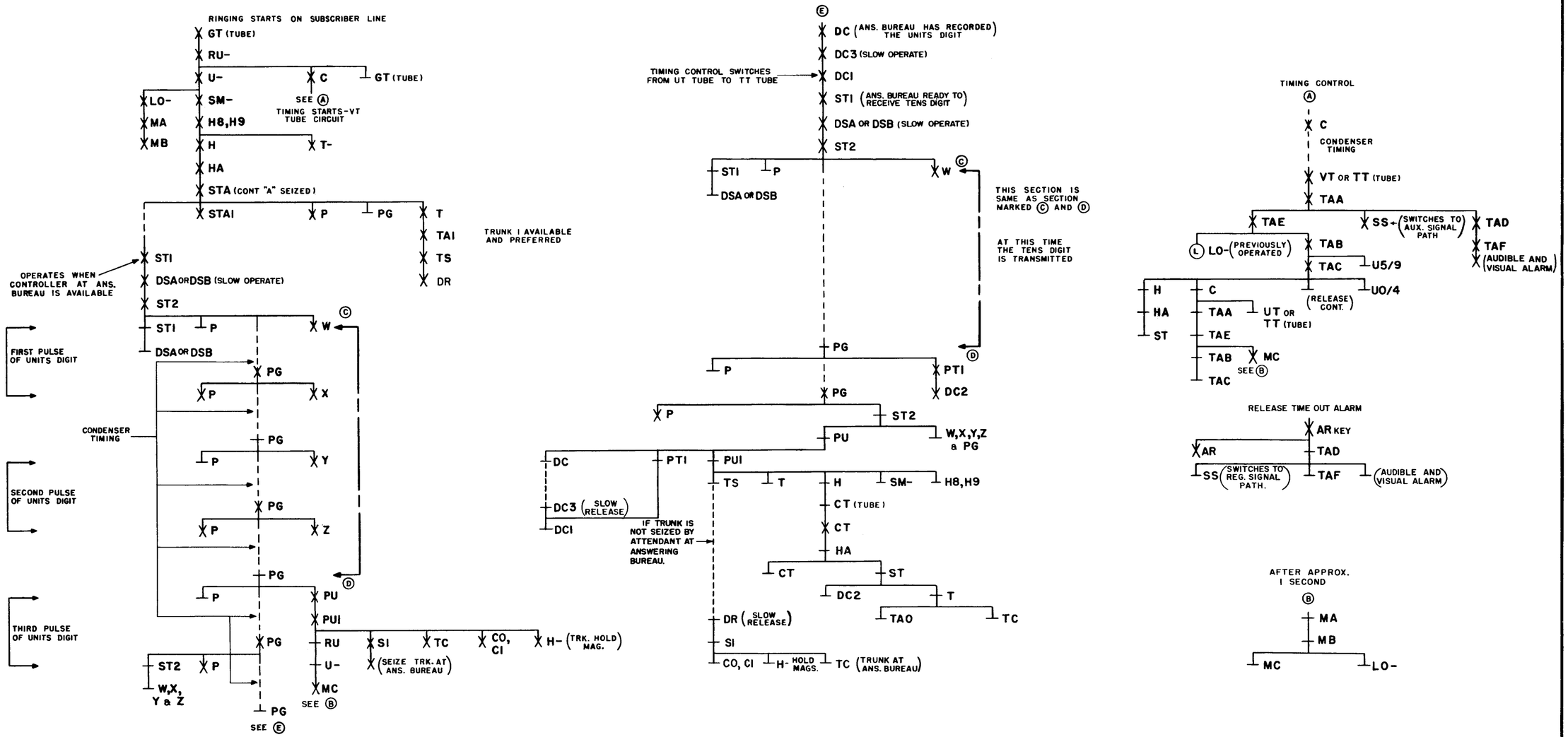

FIG. 8 OPERATIONAL CHART

FIG 8