CROSSBAR SYSTEMS
NO. 1
RECORDER CIRCUIT
FOR USE IN OFFICES ARRANGED FOR AUTOMATIC MESSAGE ACCOUNTING

2. WORKING LIMITS

2.1 None.

3. FUNCTIONS

3.01 To perforate the paper tape as directed by the transverter district identifier or master timer.

3.02 To advance the paper after each line is punched.

3.03 To provide time intervals sufficient for the operation and release of the perforator and paper advance magnets.

3.04 To check that the proper number of perforator magnet leads are grounded for each line; one or three out of three for the first group of three, and two out of five for each of the other groups.

3.05 To notify the transverter or the master timer when each line is perforated and when the paper advance magnet lead has been closed and opened.

3.06 To insure that the relays are released from one call before the recorder can be reseized or that relays falsely held will cause an alarm.

3.07 On a line identification call to remove ground from the associated district junctors to prevent them from using the district identifier on answers and disconnects.

3.08 To release the district identifier at the end of a call and if it is off-normal when the recorder is seized by a transverter or master timer.

3.09 On a call from the transverter, to make possible the operation of two district identifier "tens" or two "units" relays in case of trouble grounds or crosses so that these troubles can be detected by the transverter.

3.10 To partially prepare paths so that the transverter can test for two district identifier "tens" or "units" relays operated and for continuity of the DC lead.

3.11 To transfer the DR from the DP to the DR1 lead so that the district identifier can signal the transverter that district number entries can be recorded.

3.12 To receive a signal from the district junctor when the district times out on disconnect and to perforate holes in the AA, AB, and AC position as an entry number.

3.13 To operate and check the operation of the talking charge relay in the district junctor.

3.14 To check the locking circuit of the "units" relays in the district identifier.

3.15 To operate and check the functioning of relays in the district junctor which open the start lead on answers and disconnects.

3.16 To record the time in minutes on the tape on entries originated by the district identifier.

3.17 To signal the master timer thru the make busy circuit when a splice is encountered in the paper tape or when an end of the paper passes under the SP spring. The master timer causes the splice to pass thru the machine by causing the recorder to make end of tape and splice-traction entries.

3.18 To bring in an alarm when the paper is torn and when the paper supply is exhausted.

3.19 To keep a record of minutes and tenths of minutes under control of the master timer.

3.20 To aid the master timer in checking the synchronism of the timing selectors.

3.21 To provide paths for synchornizing the selectors with the master timer.

3.22 To prevent the advance of the selectors when an entry involving the time record is being perforated on the tape.

3.23 To prevent a time entry from being recorded while the selectors are advancing.

3.24 To print an hour record every hour on the hour, using information received from the master timer.

3.25 To check that the hour record is recorded at the beginning of each hour and to give an alarm on failure.

3.26 To cause one line at a time to be perforated to aid in feeding new paper into the machine when the ET key is operated with the recorder out of service.

3.27 To start timing when the recorder is seized by the district identifier or when the recorder originates a call. If the call is not completed before the end of the time period to call in the trouble indicator.

3.28 To record the district number on calls originated by the district identifier or by the transverter.

3.29 To record the district frame number when so signalled by the master timer.

3.30 To time for the district identifier circuit while the recorder is being seized for an answer or disconnect call.

3.31 To check the OT lead for false grounds or battery and for continuity.

3.32 To check for false grounds on the RC and TCO leads.

3.33 To open the TL1 lead if the TL lead is open longer than the release time of the TL relay.

3.34 To perforate a trouble entry 385400 if the TC lead is falsely grounded.

3.35 Operates a check relay if two out of five check through perforator series check relays is O.K. or a trouble relay if check is not O.K.

3.36 On trouble relay operation times for trouble indicator record and proceeds to perforate trouble record on the tape.

3.37 On failure to perforate an answer or disconnect record properly, a trouble record 387210 is perforated on the next line.

3.38 On failure to perforate an hour record properly, a trouble record 381899 is perforated on the next line.

3.39 On transverter calls a failure to properly perforate any line causes a trouble indication to be given to the transverter which after taking a trouble indicator record will proceed

to perforate a trouble record on the next line and cancel other lines of perforation for that call.

3.40 Locks the series check relay and associated perforator magnet in order to detect transient or false operation.

4. CONNECTING CIRCUITS

4.1 SD-25631-01 Recorder Connector, Transfer and Make Busy Circuit.

4.2 SD-25633-01 Master Timing Circuit.

4.3 SD-25606-01 To Transverter Trouble Indicator Circuit.

4.4 SD-96188-01 Visual and Audible Alarm Circuit.

4.5 SD-25640-01 Floor Alarm Frame, Fuse and Time Alarm Circuit.

5. RECORDS PERFORATED

5.1 There are 28 positions on the tape at which holes may be punched. They are divided into six digits designated A to F. The A digit is nearest the front of the perforator and has three hole positions. Each of the other digits has 5 hole positions. On one line of record one or all three holes are perforated in the A digit and two and only two in each of the other digits. The hole positions in each digit are designated A to C for the A digit and A to E for each of the other digits. The 28 positions appear on two lines on the tape in a zig-zag arrangement. The first, third, fifth, etc. positions are on the second line and the second, fourth, sixth, etc. positions are on the first line. In digits B to F the different combinations of two holes punched represent the numerals 0 to 9 as follows:

Digit	Holes Punched
0	A and B
1	A and D
2	B and D
3	D and E
4	B and E
5	C and D
6	A and C
7	B and C
8	C and E
9	A and E

5.2 The type of records perforated on the tape under direct control of the recorder are as follows: For the sake of simplicity the perforating positions for a single line of entry are shown on a horizontal row. Actually each line of entry occupies part of two lines, the even perforating positions being the first line and the odd positions being on the second line.

TYPE OF RECORD

	DIGIT A	B	C	D	E	F
ANSWER OR DISCONNECT	Entry +2	Time in minutes: Tens	Units	Tenths	District No.: Tens	Units
	o o o	o o o o o	o o o o o	o o o o o	o o o o o	o o o o o

+In case the district junctor times out on disconnect all three holes are perforated on the A digit.

HOUR	Entry: 3	8	1	1	Hour: Tens	Units
	o o o	o o o o o	o o o o o	o o o o o	o o o o o	o o o o o
DISTRICT FRAME NO.	Entry: 3	8	0	0	Dist. Fr. No.: Tens	Units
	o o o	o o o o o	o o o o o	o o o o o	o o o o o	o o o o o
TALKING CHARGE TROUBLE	Entry: 3	8	5	4	0	0
	o o o	o o o o o	o o o o o	o o o o o	o o o o o	o o o o o
ANSWER OR DISCONNECT TROUBLE	Entry: 3	8	7	2	1	0
	o o o	o o o o o	o o o o o	o o o o o	o o o o o	o o o o o
HOUR PERFORATION TROUBLE	Entry: 3	8	1	8	9	9
	o o o	o o o o o	o o o o o	o o o o o	o o o o o	o o o o o

6. LINE IDENTIFICATION RECORD

6.1 Seizure by Transverter

When a recorder connector functions to connect a transverter to the recorder it (1) energizes both windings of the PTO relay over the TB1 lead, but does not operate the relay and (2) operates the TV and CO relays. The TV relay operates the ON relay and connects battery to the BU lead so that more than one "Units" relay in the district identifier may operate in case of trouble. The ON relay operates the ON1 relay and grounds the B lead to the transverter. The ON relay connects ground thru the M resistance to the OTK relay. The OTK relay operates if the OT lead is crossed with battery. The OTO operates if this lead is crossed with ground. The operation of either relay prevents progress of the circuit and causes the transverter to time out and call in the trouble indicator.

6.2 District Identification

6.21 When the CO relay operates (1) it opens the CHO-9 leads so that district junctors cannot originate answer or disconnect entries. (2) operates the RD relay which locks over the RDL lead to any operated "tens" or "units" relay in the district identifier. The RD relay in operating removes ground from the TL1 lead and battery from the BT lead releasing any operated relays in the district identifier. This is to prevent any interference from a call which might have been started by the district identifier. When the district identifier relays are normal the CO1 relay operates over the CO1 lead and locks under control of the CO relay. The CO1 relay (1) removes ground from the XT lead so that the transverter can make a test for two "tens" relays operated. (2) connects the DR lead to the DR1 lead so the district identifier may notify the transverter when it has completed identification and (3) connects the DCK and TK leads together to signal the transverter to make a check of the DC lead thru the sender, sender link, district junctor and district identifier. When this check is complete, the RD relay releases (1) allowing the district junctor involved on the call to be identified by the district identifier and (2) connects battery thru the T resistance to the TK lead so that more than one of the district identifier "tens" relays may operate in case of trouble grounds or crosses.

6.22 When the district junctor involved on the call has been identified the transverter grounds the DK lead operating the DK relay over the TCO lead in series with the Talking Charge relay in the district junctor. The DK relay operates the DK1 relay which locks to a make contact of the ON relay. The talking charge relay does not operate due to the high resistance in the circuit. Ground from the break contact of the talking charge relay operates the RCK relay as a continuity check of the RC lead.

6.3 Recording on the Tape

6.31 While the operations listed in paragraphs 6.21 and 6.22 are proceeding, the transverter operates its perforator magnet cut-in relay for the first line of perforations.

6.32 The perforator magnet cut-in relay (1) operates the PTR relay over the PT lead, (2) operates the required perforator magnets and check relays AA to FE over the AA to FE leads. The check relays lock to normally closed contacts on relays PR1, PR2 and PR3. Relay PTR closes the TB1 lead to operate the paper advance magnet PAM and relay PA, and removes ground from the P lead to the transverter. The operation of the PTR relay removes the short circuit from the A condenser allowing it to charge in series with the secondary winding of the PTO relay. When the condenser is charged, current flow ceases thru the secondary winding and the PTO operates on its primary winding. This allows sufficient time for the perforator magnets to operate. When one relay in the A group (AA to AC) and exactly two in each of the other groups (BA to BE; CA to CE; DA to DE; EA to EE; FA to FE) are operated, a ground is connected to operate relay CK. When relays PTO, PTR, CK and PA are operated a circuit is closed to operate relays PR1, PR2 and PR3 in parallel. This closes ground to the P1 lead and provides a second break in the P lead to the transverter so that ground will not be re-applied when the PTR relay releases, until the PR1 relay also releases. The operation of the PR1, PR2 and PR3 relays opens the locking leads to the series relays AA to FE while ground on the P1 lead is the signal for the release of the perforator magnet cut-in relay in the transverter. Relay CK is locked to a multiple contact of the series relays to check their release. This indicates that the circuit has functioned correctly to perforate the tape and causes the release of the perforator magnets.

6.33 When the perforator magnet cut-in relay releases, the ground is removed from the PT lead. When all the series relays have released the CK relay is unlocked and releases thus unlocking relay PTR which releases. The release

of the PTR relay releases the PA relay and the PAM magnet. The release of the PAM magnet advances the paper. The release of the PTR relay releases PTO which releases the PR1-2-3 relays. This grounds the P lead to indicate that the perforator is ready for the next line.

6.34 When the recorder signals that the perforator is normal and that it is ready for the next line, the next perforator magnet cut-in relay is operated. The operation and release of the cut-in relays and the punching of lines on the tape continues as long as there is information to be recorded.

6.35 The last line cannot be perforated until the district identifier has signaled the transverter over the DR and DR1 leads that the district junctor involved on the call has been identified and the continuity check of the talking charge relay in the district has been completed. (DK1 relay operated. See par. 6.22.) When the transverter is ready to have the last line perforated it operates its perforator magnet cut-in relay and at the same time grounds lead DN operating the DN relay if relays OTK and OTO are normal. The cut-in relay in the transverter grounds the PT1 lead and the proper combination of leads for the A, B, C and D digits. The DN relay (1) connects the district number leads (UA to UE and TA to TE) to the check relays and perforator magnets for the E and F digits and (2) connects the ground on the PT1 lead to the PTR relay, operating it. The recording on the tape is as described in paragraphs 6.32 and 6.33.

6.36 When the transverter has been signaled that the last line is perforated it grounds the A1 lead operating the A1 relay if the RCK relay is operated (paragraph 6.22). The A1 relay connects a direct ground to the 4 ohm winding of the DK relay. The talking charge relay in the district now operates and releases the RCK and DK relays. When both of these relays release the RD relay operates and releases the district identifier by opening the BT, TL1 and GU leads.

6.4 Release

6.41 When the last line is perforated on the tape and the district identifier released, the transverter releases the recorder connector. This releases the A1, CO and TV relays. The RD, CO1, ON and DK1 relays now release. When all of these relays are released, the ON1 relay releases, restoring the circuit to normal.

7. ANSWER OR DISCONNECT RECORD

7.1 When the recorder is seized by the district identifier both windings of the PTO relay are energized over the TB1 lead insuring that the relay is on its back contact. The DPA relay also operates and operates the ON relay. The DK2 lead connects ground thru the M resistance to the OTK relay. On answer entries and on disconnect entries in which the district has not timed-out, the OTK relay operates to check the continuity of the OT lead. The ON relay connects the UL relay in the locking circuit of the district identifier "units" relays also provides a locking circuit for relay DK1. The UL relay operates if its circuit is continuous. The DK relay operates as a continuity check of the RC lead. The DK, DPA and OTK relays operated close a circuit to operate the DK1 relay. With the DK1 and UL relays operated perforator magnet cut-in relays DN and M operate. The DN relay connects the district number tens and units leads (UA to UE and TA to TE) from the recorder connector to the check relays and perforator magnets, operating those associated with grounded leads. The M relay operates the AB relay and (AB) perforator magnet and closes the minutes time leads thru the timing selectors to the B, C and D groups of check relays and perforator magnets operating those associated with grounded leads.

7.2 On a disconnect entry on which the district has timed-out, the OTK does not operate. The OTO relay operates to ground on the OT lead. Otherwise the operation is the same as described in paragraph 7.1 except that the OTO relay connects ground to contacts of the M relay which when it operates, connects ground to all three check relays and perforator magnets of the A digit. The OTO relay also changes the A digit checking circuit so that it now checks for all three A digit check relays operated.

7.3 After the paper is perforated and checked and the CK and PTO relays have operated as described in paragraph 6.32 the A relay operates and locks. The A relay releases the DN and M relays and connects ground to the low resistance winding of the DK relay to shunt down a relay in the district junctor which opens the start lead to the district identifier. This relay in releasing opens the RC lead thus releasing the DK relay.

7.4 When the perforator magnets are released and the paper advanced as described in paragraph 6.33 the A1 relay operates. The operation of the A1 relay and the release of the DK

relay operates the RD relay. The RD relay releases the district identifier which releases the recorder connector. The DPA, A, ON, DK1, A1, RD and ON1 relays release restoring the circuit to normal.

8. OPERATION WITH THE MASTER TIMER

8.1 The master timer causes the end of tape information entries to be perforated on the tape once a day, whenever a splice is encountered in the paper and whenever a recorder is removed from or restored to service. When the recorder is seized on this type of call, this information is perforated in the manner described in paragraph 8.2. The master timer also causes a multiplicity of splice-traction entries to be perforated. The control of the perforator for these lines is in the master timer. The PT, PT1 and P1 leads are not used, the PTR and PTO relays do not operate and the perforator magnet check relays have no functions on these entries. The P lead is used to start the operation and the PA lead is used to advance the paper for each line of the space pattern.

8.2 After the master timer is connected to the recorder the recorder functions as described in paragraph 6.1. The control of perforation and the release of the cut-in relay is described in paragraphs 6.32 to 6.34. Each group of the end of tape entries includes the district frame number. For this line the master timer operates its own perforator magnet cut-in relay and the DF relay. The cut-in relay in the master timer grounds the PA and PT1 leads and the proper combination of leads for the A, B, C and D digits. The DF relay grounds two perforator magnets in the E and two in the F digit to perforate the district frame number. The grounds are connected directly to the DF relay of a regular recorder but are connected to the DF relay of the emergency recorder by the operation of the transfer circuit. The DF relay also connects the PT1 lead to the PTR relay operating it.

8.3 When the last line is perforated the master timer releases the recorder connector. This releases the TV, A1 and CO relays. The CO1, ON, DK1, RD and ON1 relays release restoring the circuit to normal.

9. SPLICE IN PAPER AND NO PAPER

9.1 When a splice in the paper tape comes under spring SP on the perforator a hole in the paper at the splice allows spring SP to make contact. This operates relay SP which grounds leads SP, MB and EXT and causes the make busy circuit to function. The master timer then causes the recorder to make end of tape and splice-traction entries.

9.2 Before completing these entries under control of the master timer the movement of the paper pulls the hole in the paper away from spring SP and it opens contact. With spring SP open the SP relay will release.

9.3 If the SP spring had closed contact because the paper was torn or because the paper supply was exhausted, the SP relay will not release when the master timer completes the splice pattern. Under this condition the NPA relay will be operated by the master timer and will lock to the AR lead. The NPA relay will light the NP lamp and ground lead MTR and leads to the alarm circuit.

10. MINUTE TIMING CIRCUIT

10.1 This circuit keeps time in minutes and tenths of minutes under control of the master timer. The time is recorded on three 206 type selectors, one for the minutes tens, one for the minutes units and one for tenths of minutes.

10.2 Control of Selectors

10.21 Every six seconds the master timer grounds the C lead operating relay C which operates relay UH, which in turn operates relay C1. The C1 relay is slow in releasing and prevents the time from being recorded on an entry which comes in after the C relay releases at the end of a pulse until the selectors have had time to advance. The C relay operates the UH relay. Other functions of the C relay will be described later. The UH relay operates the U selector magnet. When the C relay releases, which occurs at the end of the time pulse if the DPA relay is normal, the UH relay and the U selector magnet release, advancing the selector to the next position. It will remain in this position for six seconds unless it is in position 21. In position 21, the UH relay operates thru the back contact of the selector magnet. This operates the U selector magnet which releases the U magnet to step the selector to position 22. The cycle of events described for position 21 is repeated for position 22 thus causing the selector to advance to position 1.

10.22 At the end of each minute period, the U selector is in position 10 or 20. When the C relay operates the TH relay is operated, closing the circuit for operating

the T selector magnet. When the C relay releases the TH relay and T selector magnet also release. This advances the T selector to the next position. If this position is 21 the selector will be advanced to position 1 in a manner similar to that described for the U selector.

10.23 At the end of a ten minute period the T selector will be in position 10 or 20. When the C relay operates, the HH relay is operated closing the circuit for operating the H selector magnet. When the C relay releases the HH relay and H selector magnet also release. This advances the H selector to the next position. If this position is 7, 14 or 21 the selector will be advanced in a manner similar to that described for the U selector.

10.3 Check for Synchronism

10.31 The terminals of the No. 6 arcs of the selectors are connected to corresponding arcs of the master timer. When the master timer checks for synchronism it grounds the SYC lead, operating the SYC relay. If all selectors are in synchronism with those of the master timer ground thru the arcs of the master timer and recorder selectors will operate the H, T and U relays. This will indicate to the master timer, by opening the AL lead, that the selectors are in synchronism.

10.32 If one of the selectors is not in synchronism one of the H, T or U relays will not operate and the AL lead will not be opened. This will signal the master timer to bring in an alarm and light the SSF lamp. The RE lead is grounded when the time selectors are in synchronism and the SE when out of synchronism. These indications are used by the master timer to determine the entry number to be recorded when a recorder is taken out of service.

10.4 Synchronizing the Selector

10.41 In order to identify the recorder out of synchronism the CHL key is operated to light the CH lamp. Before synchronizing the selectors, the recorder must be placed out of service either by making it busy or transferring its functions to the emergency recorder. Either of these conditions operates the NS relay which operates the SYC relay. If one of the relays H, T or U is not operated the SE lead is grounded indicating to the master timer that one of the selectors is not synchronized with the master timer. If all of these relays are operated the RE lead will be grounded indicating that all selectors are synchronized.

10.42 To synchronize the selectors the S key is operated causing the master timer to send ground pulses over the H, T and U leads. This operates the HH, TH or UH relay associated with the unsynchronized selector, operating the associated selector magnet. This releases the relay which in turn releases the magnet and steps the switch. The pulses continue until the selectors are in synchronism, whereupon the associated T, H and U relay operates and opens the LS leads to the master timer causing the pulses to stop.

11. HOUR RECORD

11.1 When the C relay operates on the hour, the selectors are on time 599. Selector H is in position 6, 13, or 20, selector T in position 10 or 20 and selector U in position 10 or 20. Under this condition the HS relay operates and locks. If the recorder is idle or when it becomes idle, the battery which the HS relay connects to the HP lead causes the recorder connector to operate the HP preference relay. The HPA relay operates and in turn operates the perforator magnet cut-in relays, HR1 and HR2. The HR1 and HR2 relays operate the HR3 relay and connect the time leads from the master timer to the perforator magnets causing the hour record and the entry number 381 to be recorded.

11.2 After the paper is perforated and checked as described in paragraphs 6.22 and 6.23 and the CK, PTO and PR2 relays are operated, the A relay operates. This releases the HR1 and HR2 relays. After the perforator magnets are released and the paper is advanced, the A1 relay operates which operates relay RD and releases the HS relay. This causes the recorder connector to release and release the recorder relays A, ON, A1, and RD. The HPA relay releases when the C relay releases at the end of the time pulse. This releases relay ON1 to make the circuit normal.

11.3 If the HR3 relay is not operated by time 001, that is, by 0.1 minute after the hour, the HRA relay will operate thru the selector arcs causing an alarm to be brought in. At time 002, the HR3 relay, if operated, will be shunted down. If the HR3 is still operated at time 003, the HRA will be operated causing an alarm to be brought in.

11.4 When the recorder is out of service the hour record is not made since the operating circuit of the HS relay is opened when the NS relay is operated.

12. NEW PAPER FED INTO PERFORATOR

12.1 Means are provided for perforating "180303" on the tape to aid in feeding a new piece of paper into the perforator. The recorder must be made busy by inserting a plug in the make busy jack. This will operate relay NS. When the ET key is operated with the NS relay operated, the ETS relay operates. The ETS relay locks to a normally made contact of the RD relay and connects ground from a back contact of relay A to operate the ET relay. Relay ET closes ground to operate relay PTR directly since no preference relay is operated. The paper is perforated and advanced as previously described. When the ET key is restored the ETS relay releases and the recorder is normal. The paper will be advanced one line of perforation for each operation of the ET key.

13. TROUBLE TIMING

13.1 The trouble timing in the recorder is effective only on an entry originated by the district identifier or by the recorder itself. The object of the trouble timing is to provide for a trouble indicator record on all entries which for any reason are not completed within a time interval slightly greater than the maximum time for a normal entry. Three timing intervals are provided; the first to cover the normal time of an entry after which the trouble indicator is called in, and a second time interval to cover the normal time for taking a trouble indicator record. Following the second interval the RC lead is grounded to release the identifier while a third timing interval is introduced before operating the RD relay directly. The first two intervals are produced by the condenser timed relay TM and the third interval by the release time of slow release relay TF.

13.2 The trouble timing start lead is closed to ground over the AG lead on an answer or disconnect entry and by the operation of relay ON on all entries originated by the recorder. This ground through a back contact of relay TV operates and locks relay TA. Battery is closed to relay TM through a preliminary make contact of relay TA to insure that it is on its back contact before closing the front contact to the winding of relay TC. Relay TA also removes a ground short circuit from the timing condenser. The windings of relay TM are differential so as long as current is flowing through the secondary winding to charge the condenser the relay will remain on its back contact. After a minimum time of .5 second the condenser will become sufficiently charged thereby reducing the charging current through the secondary winding so it will operate to its front contact by the current through the primary winding. This operates relay TC to call in a trouble indicator. Relay TC closes ground to the junction of the primary and secondary windings of relay TM thus shunting the charging battery and effectively locking up relay TM by the discharge of the timing condenser through the secondary winding and reverses the current through the primary winding. After a minimum time of .65 second the condenser discharge current decreases to a value where the primary winding predominates and operates relay TM to its back contact. This operates relay TE, if it is not already operated by the operation of relay TT1B at the completion of the trouble indicator record.

13.3 The operation of relay TE closes ground to the RC lead to release the identifier also removes battery from the TM relay and releases relay TA. Relay TA in releasing shorts the timing condenser through a low resistance to complete its discharge before another timing function is required by the recorder. The operation of relay ON closes ground to operate slow release relay TF through a contact of relay TE. The operation of relay TE therefore opens the operating circuit for TF which will release in .075 to .150 second and will close a circuit to operate relay RD. Relay RD releases the identifier which in turn releases the recorder. The timing relays TC and TE release when relay ON releases and are checked down by a locking circuit to the RD relay which in turn releases to release relay ON1 after lead AG is opened.

14. TROUBLE RECORDS ON TAPE

14.1 Whenever a failure occurs in the two out of five check through the series relays in the perforator magnet circuit it indicates a probable failure in the proper perforation of the tape. Whenever such trouble occurs it is desirable not only to time out and take a trouble indicator record of the trouble for central office use but also to advance the paper to the next line and perforate a specific trouble record on the tape for use in the accounting center.

14.2 On an answer or disconnect entry if the check relay CK fails to operate on the two out of five circuit through all of the series relays while the PTO relay is timing for the perforator operate, then relay TBL will operate. The circuit for operating the trouble relay is from ground on the make contact of relay PTO, make contact PTR, break contact PR1, break contact CK and break contact ETS to the winding

of TBL. Relay TBL locks to the same ground by shunting the last two contacts in the above traced circuit. Relay TBL opens the circuit for operating the A relay so progress of the call is blocked forcing the timing circuit to function as described in paragraphs 13.2 and 13.3. Relay DTS is operated and locked to a back contact of relay A1. When relay TE operates following the taking of the trouble indicator record it operates relay RD which releases relay DPA. A circuit is then closed through a make contact of the trouble relay to operate relay XPC which locks to a contact of relay DTS. The operation of relay XPC is the signal for the recorder to advance to the next line of perforation. Relay CK is operated which operates relays PR1, PR2 and PR3 to remove the local locking grounds from the series relays AA to FE. Relay TBL releases. The release of relay DPA releases the perforator magnet cut-in relays DN and M thus opening the perforator magnet circuits. When all series relays have released relay CK releases which releases PTR. This causes the release of relay PA and the advance of the paper. Relays PTO, PR1, PR2, PR3, ON, TA, TC, TE, RD and ON1 release. Relay DTS however remains locked up and maintains resistance battery closed to the preference relay so the recorder is held busy to other calls. Relay XPC closes ground to the EXT lead to extend the timing on any transverter which may be waiting for this recorder. The release of relay TE closes a circuit to operate relay TC2.

14.3 The recorder is now in condition to perforate the trouble record which for an answer or disconnect call is 387210. Since the preference relay is operated the release of relays RD and ON1 reclose circuits to operate and lock relay DPA. Relays ON and ON1 reoperate. Relay ON in releasing and reoperating recycles the timing circuit to provide for an attempt at a trouble indicator record if failure occurs in perforating the trouble record. Normally such a condition would change the alarm associated with the trouble indicator from a minor to a major alarm. Relay ON closes ground to operator perforator magnet cut-in relay TCP which operates the perforator magnets for the desired trouble entry. If the trouble record is made properly the CK relay is operated in the usual manner and after the PTO timing the PR1, PR2 and PR3 relays will be operated. This closes a circuit to operate relay A which releases the cut-in relay TCP causing the release of the series relays AA to FE. Relay CK releases followed by relay PTR which operates relay A1. This opens the locking circuit for relay DTS which releases followed by the release of relay XPC and the preference relay in the connector circuit. Relay PTR releasing causes the paper to advance and releases relay PA. Relay A1 operated, operates relay RD which releases relays DPA, ON, A and A1. Relay ON releasing releases relays TC2 and RD whereupon relay ON1 releases making the recorder at normal.

14.4 If trouble is encountered in perforating the trouble record then relay CK will not operate on the two out of five check through the series relays and the trouble relay TBL will reoperate. As previously indicated this results in a time out with an attempt to call in the trouble indicator resulting in changing from a minor to a major alarm. Following time out under this condition relay TE opens the locking circuit for relay DTS since relays A and A1 will not operate. This releases relay XPC as before while relay TC2 remains locked up thus preventing a second trouble record on the same failure.

14.5 If a failure to properly perforate occurs on a transverter type call or initial entry, during any line of perforation the circuit functions to cancel further perforation and to advance to perforate a specific trouble record on the tape. On this type of call the transverter controls the perforations also the timing. The two out of five check is made in the usual manner to operate relay CK. If this fails to operate then relay TBL will be operated when PTO operates after its timing interval. This prevents closure of the P1 lead which compels the transverter to time out and call in the trouble indicator. At the same time a ground is closed to lead TBL through a contact of relay CO1 as an indication to the transverter of a failure to perforate and a signal to perforate the appropriate trouble record. At the completion of the trouble indicator record the transverter will close ground to lead CK to operate the CK relay. This operates relays PR1, PR2 and PR3 to open the local locking circuit for the series relays AA to FE and at the same time closes the P1 lead as a signal to release the perforator magnet cut-in relay in the transverter. The recorder then advances the paper and recloses the P lead as on any line of perforation of an initial entry. The transverter then closes the perforator magnet leads to perforate the trouble record after which the recorder is released in the usual manner.

14.6 A failure to properly perforate the hour record calls for a recorder time out, taking a trouble indicator record and perforating a specific trouble record. Since this entry originates in the recorder it

functions more nearly like the trouble entry for an answer or disconnect call. Relay HS operates for the hour record (par. 11) and this operates the preference relay HP to make the recorder busy to all other classes of calls. On a failure to check two out of five on the perforation of the hour record the TBL relay will be operated in place of the CK. The operation of relay TE and release of TF after time out operates relay RD which releases relay HPA. This closes a circuit to operate relay XPC. Relays HR1 and HR2 release and relay CK is operated to release the perforator magnets. The recorder advances the paper and releases as described in paragraph 14.2 except that relay HS is locked up in place of DTS. Relay HS keeps the hour preference relay energized and locks relay XPC during the transitional period when all other relays of the recorder are released. The release of relays PTO, PA, PR1, PTR and TE with relay XPC operated provides a circuit to operate relay TC2. Relay HPA reoperates operating relay ON and closes a circuit to operate relay HCP. Relay HCP energizes perforator magnets to perforate the trouble code 381899 on the tape. The timing is recycled for the trouble recording and the further operation of the recorder is the same as described in paragraph 14.3.

14.7 Provision is made for perforating the same trouble records 381899, on the tape when an hour alarm is brought in after an hour record. In this case the hour record itself may not be mutilated but the hour alarm is brought in due to other circuit causes as described in paragraph 11.3. The hour alarm relay HRA in operating closes ground to operate relay TC1 which locks to a contact of relay RD. This closes resistance battery to operate the preference relay DP in the connector circuit. This operates relay DPA which operates relay ON. These relays provide a circuit to operate relay TC2 directly without operating relay XPC since only one line is to be perforated. Relay XCO is operated by TC2 and locks to HRA.

Relay TBL does not operate and no trouble indicator record is taken since a major alarm is already given by the operation of relay HRA. Relay HCP is operated to perforate the trouble record. Relay CK operates on the two out of five check. Relay PTO times for the perforator magnet operation and operates relays PR1, PR2 and PR3. Relay A operates releasing relay HCP and the series relays after which relay CK releases releasing relays PTR and PA and advancing the paper. The three PR relays release. Relay A1 is operated which operates relay RD to unlock relay TC1 which releases and brings about the release of all other relays of the recorder except HRA and XCO. These relays may remain operated for a short period until the alarm condition is corrected or the alarm release key is operated. However, the recorder is normal to handle other calls.

14.8 Another condition requiring a trouble record to be perforated is a ground on the XCO or XTC1 leads due to trouble in the district identifier. Ground on either lead will operate relay XTC which operates relay TC1 to lock in XTC. On a transverter type call if the XTC or XTC1 leads are grounded the XTC relay will be operated and locked in a similar manner. In this condition relay TC1 will not operate relay TC2 immediately if a call is in progress with relay DK1 operated and locked to relay ON. However, relay XTC removes ground for operating relay RD thus blocking the progress and requiring a trouble indicator record to be taken. When the trouble indicator record is completed by the transverter or the recorder the recorder advances the paper and restores to normal except that relays XTC and TC1 remain operated. XTC maintains the preference relay DP operated which causes the reoperation of relay DPA. Relay DPA operates relay ON to start timing for the trouble record and also closes the circuit to operate relay TC2 which operates relay TCT to perforate the trouble record 385400 on the tape. Relay XCO is operated by TC2 and the former locks directly to relay XTC while relay TC1 is locked to a back contact of relay RD. This prevents relay TC1 from reoperating on the same trouble condition which operated relay XTC. The perforation of the trouble entry and release of the recorder is accomplished as described in paragraph 14.7. As indicated above relays XTC and XCO may remain operated for a short interval of time but the recorder is free for other entries.

14.9 With the normal locking provision on the perforator series relays AA to FE it is possible to perforate a trouble record if any one of these relays operates even momentarily while the recorder is standing idle. The trouble record 387210 is perforated indicating improper perforation. If

any series relay operates while relays PTR and ON are normal, relay DTS will be operated and locked to ground through a normal contact of relay A1. Relay DTS operates preference relay DP which makes the recorder busy to other calls and operates relay DPA followed by relay ON. The circuit will time out for the trouble indicator record which will indicate the perforator magnet, or magnets, operated. At the end of timing, relay RD is operated which releases relay DPA which in turn operates relays XPC, CK, PR1, PR2 and PR3. If the ground on the perforator magnet lead is permanent the circuit will block until the trouble is removed. If the trouble is a transient ground then relay CK will release when the ground is open and cause the circuit to advance to perforate the trouble record 387210 as described in paragraphs 14.2 and 14.3. Relay DTS holds the recorder during the transition from the multilated perforation to the line for the trouble record as has been described.

15. TL RELAYS

15.1 The TL relay is held normally operated by the district identifier. In case a "units" relay fails to operate following the operation of a "tens" relay, the TL relay will release and remove ground from the TL lead to the district identifier.

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