BELL SYSTEM PRACTICES
Teletypewriter Stations

SECTION P65.908
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T. P. T. & T. Co.
All Areas

AUTOMATIC TRANSMITTER START UNIT ARRANGED FOR SINGLE OPERATION (DRAWING P92.911.01)

CONTENTS Page

1. PURPOSE OF CIRCUIT

1.01 The Automatic Transmitter Start Unit provides a means of automatic traffic dispatching on a single operation teletype circuit by a search of the various stations. Selective calling with teletype characters is employed.

2. WORKING LIMITS

2.01 A maximum of twenty different station call letters may be used. Excluded are T, O, M, V, H, S. If weather code is ever sent on a circuit, "Figures S" is used for motor stop replacing "Figures H", and eliminating the BELL function on all machines.

2.02 Stations may be searched in any predetermined order, and any station may be searched as many times as desired, provided only that a maximum of twenty search calls may be sent out during a search pattern.

2.03 Broadcast call letters must not be used on a search.

2.04 Equipment may be used only on single operation circuits using speeds of 60 or 75 WPM.

2.05 Equipment must be associated with a 19 type station on a circuit. Only one unit is required on a circuit.

3. FUNCTIONS

3.01 Searches all stations on the circuit for traffic, automatically starting the transmitters of 19 type machines:

(a) 2 or 15 seconds after traffic has been handled on the circuit.
(b) At regular intervals of 3 or 6 minutes if desired (Key Controlled).
(c) 15 Seconds after receipt of a line open and closure.

3.02 Will not search or send signals when the circuit is busy.

3.03 Transmits a 2 second open to the line followed by a closure and in approximately 1 second, "Figures" prior to the start of any searching operation.

3.04 Transmits one teletype code letter for each station searched.

3.05 Waits for each searched station to transmit traffic. (2 seconds for 19 type machines, 15 seconds for 15 machines.)

3.06 After all stations have been searched and no traffic is handled, transmits upper case "H" to the line turning off all stations and stops searching.

4. ASSOCIATED CIRCUITS

4.01 P92.901.02 Teletypewriter Station Equipment arranged for Teletypewriter Code Selection with or without automatic start features.

DESCRIPTION OF OPERATION

5. BASIC SEARCH

5.01 The L relay has just operated to mark, releasing the L1 relay. While the L1 relay was operated, condenser TA was charged to about 60 volts thru resistor RO. The L1 relay in releasing starts charging condenser TA in the opposite polarity thru resistors RA and RP. When the voltage across condenser TA reaches about 65 volts, tube T fires. This requires about 3 seconds. Ionization of tube T causes current flow to the main anode operating relay T. Current flow to the starting anode is limited by resistor RB.

5.02 T relay operates (locking to its own contacts thru T1 contacts)	Line is opened, (T RLY 1-2T) T tube is extinguished Condenser T1A starts charging thru resistances RG and RJ L relay operates to spacing, operating the L1 relay
5.03 L1 relay operates	Prevents firing of Tube T Releases RT2 relay if operated Charges Condenser TA to 60 volts negative
5.04 After condenser T1A charges for 2 seconds, tube T1 fires	T1 relay operates
5.05 T1 relay operating locks operated to its own contacts thru T and L relay contacts	Closes Line L relay operates to mark T1 tube extinguished Releases RT relay if operated Operates tape withhold magnet T relay released Operates SM relay slowly
5.06 T relay releasing	Keeps line circuit closed
5.07 L relay on mark	Releases L1 relay

5.08 SM relay operates thru thermistor SM. As current flows thru the thermistors they heat and their resistance decreases allowing more current to flow. The effect is to make relay SM slow to operate. The motors of the teletype machines on the line are coming up to speed during the operate time of SM.

5.09 Operated SM relay	Operates transmitter stop magnet in local teletype machine, and brush arm starts to rotate. Provides lock path for T1 relay
5.10 Brush arm rotates	Auxiliary contacts in transmitter close as brushes move on to start segment
5.11 Auxiliary contacts closing	Operate TR relay Operate A relay to 1st step Operate FG relay

5.12 The A relay is a 2 step type (U-680). The characteristics of this relay are such that it will partially operate closing contacts 5-6T and 5-6B on a low current and fully operate on a higher value.

5.13 TR relay operating locks to its own contacts thru T1 contacts	Transfers teletype distributor segments to FG relay which is coded for "Figures" by its operation in 5.11
5.14 Transmitter Brush Arm rotates	Sends "Figures" on line
5.15 Brush arm reaches stop segment	Auxiliary Contacts open
5.16 Aux. Contacts opening	Fully operates A relay Releases FG relay

5.17 During transmission of "Figures" the L relay operated to space and mark, and operated the L1 relay.

5.18 Transmitter brush arm continues rotating to start segment	Aux. Contacts close

5.19 Closing of Aux. Contacts	Operates C relay and C1 relay
5.20 C relay operating	Connects distributor segments to selector wipers B to F Releases transmitter stop magnet (Arm will rotate until "stop" segment is reached)
5.21 C1 relay operating (locks to L mark contact or to operated A contacts)	Prevents tube T from firing Starts charging condenser T1A

5.22 Transmitter Brush Arm rotates sending station code letter in accordance with the strapping of the selector banks B-F.

5.23 Brush arm reaches stop segment	Auxiliary contacts open Brush arm stops rotating
5.24 Auxiliary contacts opening	Operate C2 relay in series with C relay
5.25 C2 relay operating	Releases T1 relay Operates Rotary Magnet Discharges T1A condenser
5.26 T1 relay releasing	Releases A relay Releases SM relay (slow release) Allows condenser TA to start charging positive Releases TR relay
5.27 SM relay releasing	Releases tape withhold magnet Releases rotary magnet (Selector steps once) Releases C and C2 relay

5.28 The C2 relay releasing operates the RT relay which releases the C1 relay if the searched station is a 15 machine.

5.29 The "Wait for Traffic" period now takes place.

5.30 If the searched station is a 19 machine with tape in the transmitter, the transmitter will start sending, the L operates to space on the first space signal sent on the line releasing the C1 relay. The C1 relay prevents tube T1 from firing. Tube T will fire and operate relay T 3 seconds from the completion of transmission. The sequence is then repeated from 5.02.

5.31 If the searched station is a 15 machine and traffic is or is not sent, the RT relay remains operated from 5.28. Operation of the RT relay prevents tube T1 from operating and adds resistance RE to the charging circuit of condenser TA. Tube T will fire operating relay T 15 seconds from the last space signal received from the line, or if no traffic is handled, 15 seconds from the release of the T1 relay in 5.26. While traffic is being sent, space signals operate the L relay to spacing which operates the L1 relay to prevent tube T from firing.

5.32 If the searched station is a 19 machine and no traffic is handled, the sequence described in Par. 6 follows.

5.33 Par. 7, miscellaneous operations, covers additional operations which may occur after the "Wait for Traffic" period.

6. ABBREVIATED SEARCH (Subsequent to search of type 19 station with no traffic)

6.01 The C1 relay will have remained operated. (See 5.28, 5.30.)

6.02	Continuing from 5.27 The C2 relay releases (Slow to release)	Condensers TA & T1A start charging in positive direction
6.03	In 2 seconds T1 tube fires	T1 relay operates
6.04	T1 relay operating	Extinguishes T1 tube Prevents T tube from firing Operates tape withhold magnet Relay SM operates after thermistors SM warm up
6.05	SM Relay operates	Transmitter stop magnet operates, brush arm starts rotating.
6.06	Movement of Brush Arm to start segment	Closes Aux. Contacts in Trans.
6.07	Auxiliary Contacts closing	Operate TR relay Operate A relay to first step Operate C relay

6.08 Operation of TR and C relays transfers the distributor segments to the B-F selector bank connections, which are strapped for the code letter of the searched station.

6.09 The distributor arm in rotating sends the call letter of the searched station.

6.10 Brush arm reaches stop segment and opens the auxiliary contacts.

6.11	Opens Aux. Contacts	Operate A relay (2nd Step) Operate C2 relay
6.12	C2 relay operating	Releases the T1 relay Operates the Rotary Magnet

6.13 T1 relay in releasing	Releases the A relay Releases the TR relay Releases the slow to release SM relay Allows condenser TA to start charging positive
6.14 SM relay releasing	Releases tape withhold magnet Releases C and de-energizes C2 relay Releases Rotary Magnet and selector steps once

6.15 If the station searched is a 15 machine, the C2 relay releasing will cause relay RT to operate and relay C1 to release.

6.16 The "Wait for Traffic" period now takes place. If the searched transmitter has tape, it will start sending. At the conclusion of sending, there will be a timing period followed by a new search.

6.17 The functioning on the next search is determined by the position of the selector and the strapping of the selector bank, and by the conditions of relays C1 and RT1. See 5.30, 5.31, 5.32 and 7.

7. MISCELLANEOUS OPERATIONS

7.01 The following miscellaneous operations can be performed in accordance with the strapping of the selector bank and the condition of relays C1, RT, RT1 and RT2.

7.02 These operations all take place after the completion of the "Wait for Traffic" period at the end of the basic and abbreviated search operation sequence.

7.03 A search sequence occurs at the end of normal searching during which "H" is transmitted to the line to stop all machines. This action takes place if the RT1 relay has been held operated during the last complete search of all stations. This action is automatically initiated on selector Pos. 21 and may occur on other selector positions if appropriately strapped.

7.04 A Rest condition occurs when relay RT2 operates as the selector steps to position 22, and possibly on other selector positions if so strapped. RT2 relay in operating changes the value of the R-C timing circuit associated with tube T so that tube T fires in 3 or 6 minutes or not at all in accordance with the position of the Time Control Key.

7.05 If the RT1 relay is not operated when the selector reaches position 21 or other positions as strapped, a search is sent on both positions 21 and 22 in which "BLANK" is transmitted to the line. The selector then steps to position 1 or the next assigned position and a complete new search of all stations is made.

7.06 If the selector stops on an unassigned position, a search occurs during which "BLANK" is transmitted and the selector steps once.

7.07 If a second unassigned position follows, the selector will be strapped for automatic stepping until an assigned position, or 21 is reached. The S relay is operated from arc A, operating the S1 relay which operates the Rotary Magnet and releases the S relay. The S relay releasing, releases the S1 relay which releases the Rotary Magnet and the selector steps to the next position. This action continues in accordance with arc A strapping.

8. POWER SUPPLY

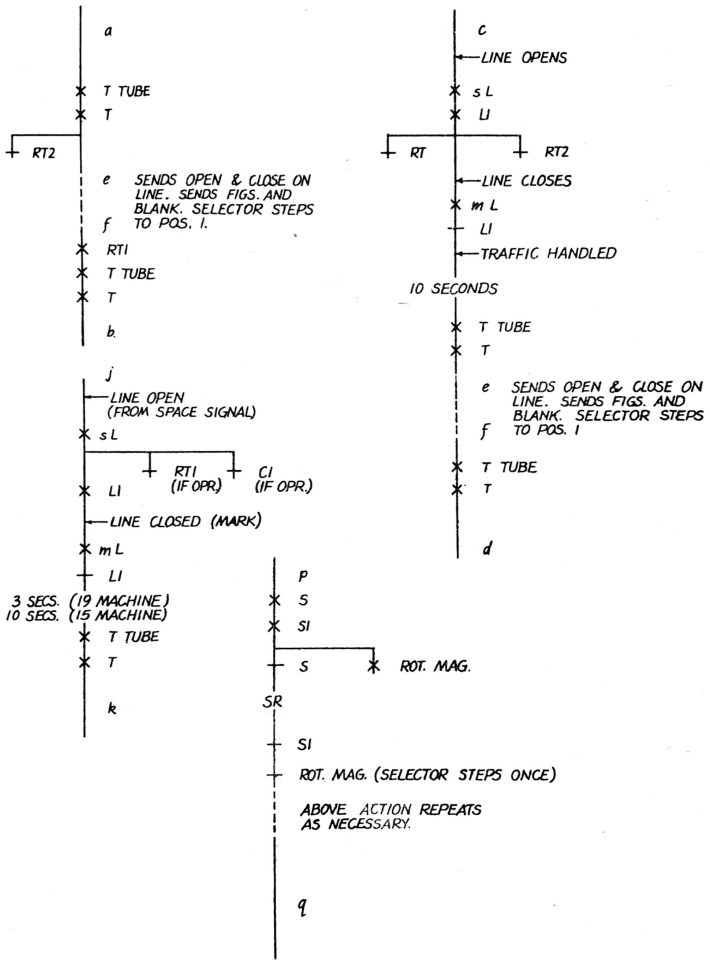
8.01 Battery supply is furnished by two half wave rectifier supplies, supply P1 furnishes power to the selector rotary magnet RM. Supply P furnishes power for all other relay operations. Each rectifier is separately fused with a one half ampere slow blow fuse, AC and AC1. 5 Ohm current limiting resistor P1 is used to reduce the peak current in the selenium stack P1. Power is filtered with one condenser on each supply P and P1. Transformer T acts as an autotransformer to reduce the voltage of the P supply.

8.02 A.C. power is obtained thru a three wire power cord in which the green wire is a water pipe ground, white is the power system ground, and black is the hot power lead. The power ground and the water pipe ground are not wired together in the equipment, and must not be connected.

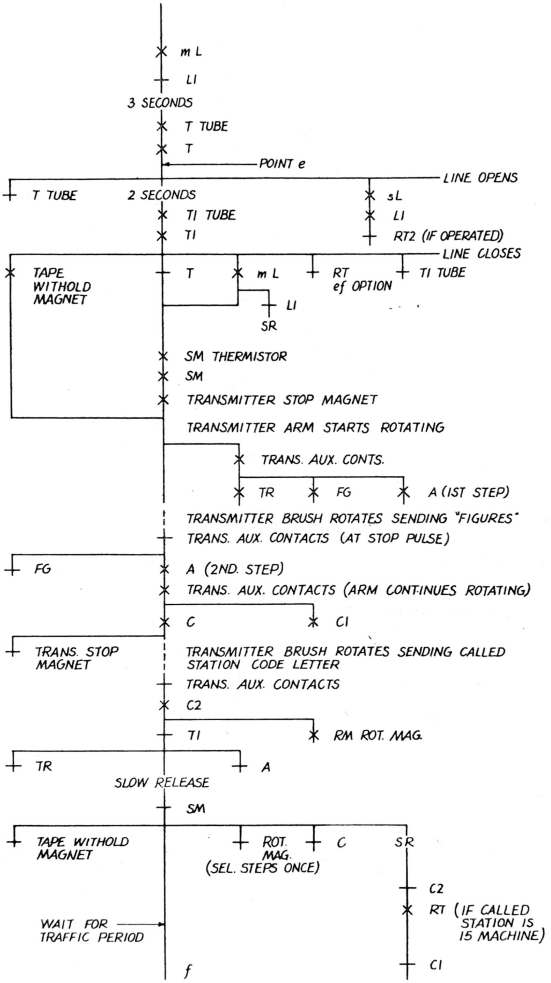
8.03 Nominal A.C. power line voltage is 117. Nominal D.C. supply voltage is 155 for supply P1 and 125 for supply P.

9. SEQUENCE CHARTS

9.01 Miscellaneous Relay Operations. See 9.04 For Overall Operation.

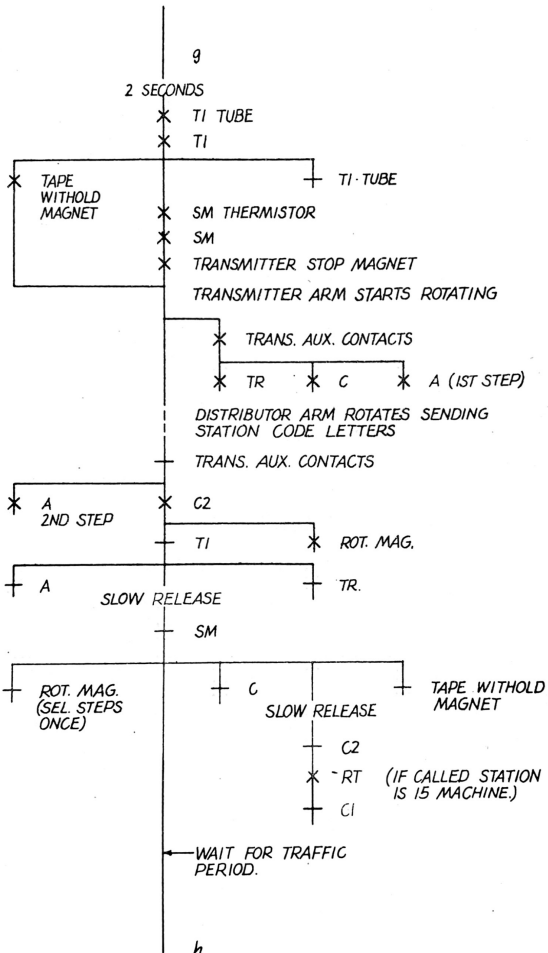


9.02 Basic Search Operation.

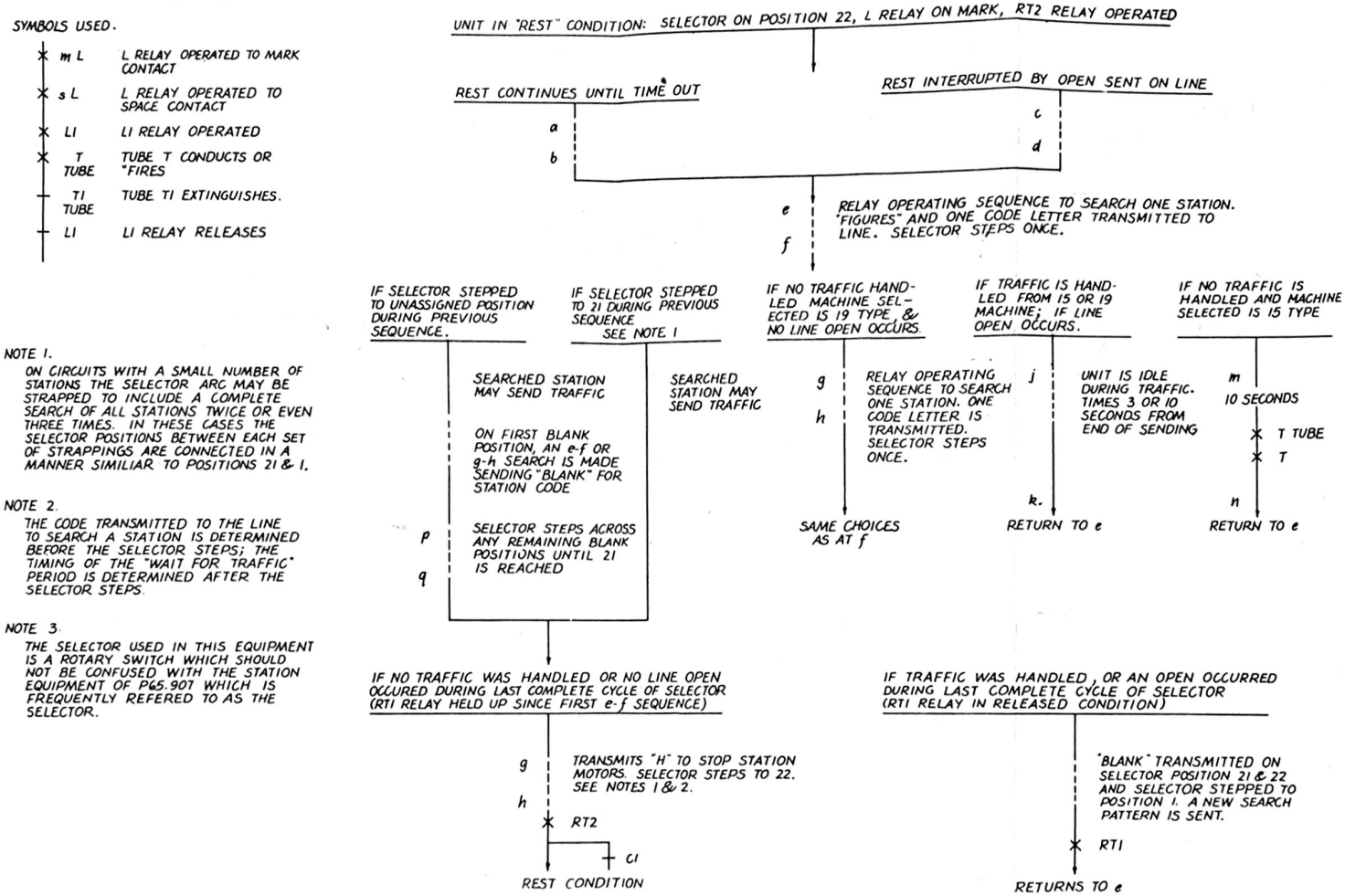


AUTOMATIC TRANSMITTER START UNIT ARRANGED FOR SINGLE OPERATION (DRAWING P92.911.01)

9.03 Abbreviated Search Operation.



9.04 Overall Functional Sequence Chart. The detailed relay sequences appear on 9.01, 9.02 & 9.03.



NOTE 1.

ON CIRCUITS WITH A SMALL NUMBER OF STATIONS THE SELECTOR ARC MAY BE STRAPPED TO INCLUDE A COMPLETE SEARCH OF ALL STATIONS TWICE OR EVEN THREE TIMES. IN THESE CASES THE SELECTOR POSITIONS BETWEEN EACH SET OF STRAPPINGS ARE CONNECTED IN A MANNER SIMILIAR TO POSITIONS 21 & 1.

NOTE 2.

THE CODE TRANSMITTED TO THE LINE TO SEARCH A STATION IS DETERMINED BEFORE THE SELECTOR STEPS; THE TIMING OF THE "WAIT FOR TRAFFIC" PERIOD IS DETERMINED AFTER THE SELECTOR STEPS.

NOTE 3.

THE SELECTOR USED IN THIS EQUIPMENT IS A ROTARY SWITCH WHICH SHOULD NOT BE CONFUSED WITH THE STATION EQUIPMENT OF P65.907 WHICH IS FREQUENTLY REFERED TO AS THE SELECTOR.

10. TIMING CIRCUITS

Cold Cathode Tubes

10.01 The 376B (T1 Tube) is a three element inert gas filled cold cathode tube that is normally non-conducting. The tube will start to conduct or "fire" when the voltage between the cold cathode (Pin 2) and the starter (Pin 7) reaches about 65 volts. If the voltage between the cathode and the anode (Pin 5) is 75 volts or higher when the tube fires, the tube will conduct heavily across the main gap, that is from cathode to anode. The starter is in effect a trigger, and is not itself designed to carry more than a few milliamperes of current. Resistance must be provided in both the starter lead and the main anode circuit to limit the current to safe values for the tube.

10.02 Figure 1 is a simplified drawing of the two second timing circuit. The timing action is described as follows:

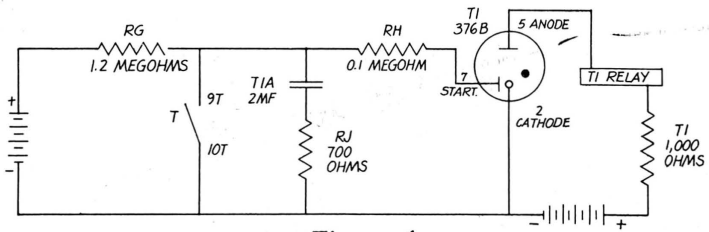


Figure 1

10.03 Timing starts when contacts 9T-10T of the T relay open. Current then flows in the RG and RJ resistors to charge condenser T1A. Condenser T1A does not reach full charge immediately but takes a number of seconds to do so because the current flow is limited by the high resistance of RG.

10.04 The voltage across condenser T1A is essentially the same voltage appearing between the cathode and starter of the tube.

10.05 Two seconds after condenser T1A started charging, the voltage reaches about 65 volts and causes the tube to fire. Current flow in the starting gap is limited to less than one milliampere by resistor RH.

10.06 Tube T1 in firing, conducts heavily in the main gap causing relay T1 to operate. Current flow is limited by the resistance of the T1 relay winding and the T1 resistor. The operation of T1 ends the timing interval.

10.07 Resistor RJ is provided to reduce sparking when contacts 9T-10T of the T relay close, discharging condenser TE.

10.08 The amount of time delay provided by the circuit is determined by the capacity of condenser T1A and the resistance of RG. The values were chosen to provide two second timing in the circuit discussed.

10.09 The T and T1 relays lock operated to their own contacts and open the anode of the respective tubes, thus extinguishing the tube almost immediately after operation. This action helps to prolong the life of gas tubes.

10.10 The timing circuit used with the T tube operates in a somewhat different manner than the previously discussed T1 tube circuit. Figure 2 is a redrawn and simplified version of the T tube circuit. When the L1 relay contacts are closed, the condenser charges to about 60 volts with negative on the top plate and positive on the bottom plate.

To start the timing action, the L1 relay contacts open, and the condenser discharges and then recharges to positive on the top plate from positive battery thru the megohm resistors. Figure 3 shows the voltage across the condenser during the timing interval. When the voltage reaches about 65 volts positive on the starter, the tube fires and operates the T relay completing the timing action.

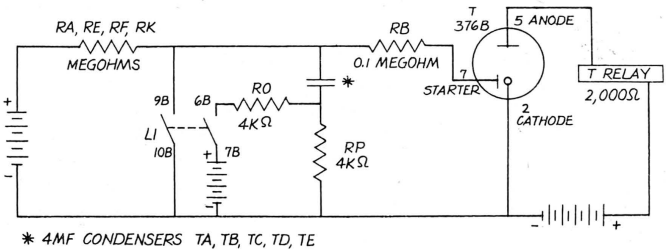


Figure 2

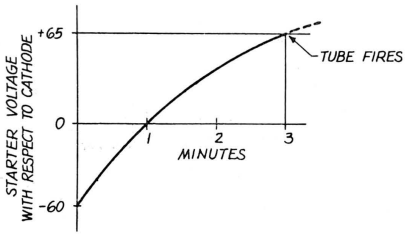


Figure 3

10.11 The megohm resistances and the condensers are used in various combinations to provide four timing intervals, i.e. 3 seconds, 15 seconds, 3 minutes and 6 minutes.

Thermistors

10.12 The SM Thermistors used in this equipment are known as "1D Thermistors". They are made of semi-conducting metallic oxides which have a large negative temperature coefficient. A temperature increase of about 20 degrees F. will cause this thermistor to decrease its resistance to half of the original value. Physically, this thermistor takes the form of a tiny bead of semi-conducting material not much larger than a pin-head. The bead is enclosed in a glass tube to in-

crease its thermal capacity thus slowing down the temperature changes. The glass tube is then installed in a fiber tube. The 1D Thermistor is capable of changing its resistance from 100,000 ohms down to 275 ohms when passing 20 milliamperes of current (maximum rating).

10.13 The SM relay has two 1D Thermistors in its operating path. When the T1 relay contacts 6T-7T close, the thermistors have a high resistance, and therefore only a small current flows thru the SM relay. However, this current is sufficient to heat the thermistors slowly, causing the thermistors to decrease their resistance, and consequently, the current to increase. This process continues until the resistances of the thermistors are low enough to permit operation of the SM relay about one second after the closing of the T1 relay contacts. As the thermistors are no longer needed after the SM relay operates, they are shorted out by its operation.

Varistors

10.14 The 400 E Varistors used in this equipment are point contact germanium crystal rectifiers with a maximum current handling capacity of 30 milliamperes, and a maximum reverse direction voltage rating of 140 volts.

10.15 As used in P92.911.01, two varistors are connected in parallel across the L1 relay winding, and are connected with the polarity arranged so that current does not flow when the relay is energized. However, when the battery is removed, the energy stored in the magnetic field of the relay induces a voltage in the relay winding that has the opposite polarity to the former battery voltage, and this voltage appearing across the varistors will cause the varistors to conduct, and thus establish a current flow thru the relay winding. The effect of this current flow thru the relay winding is to hold the relay operated for a longer time, and thus make the relay slow to release. This effect only lasts for a fraction of a second, but is effective in slowing the release of the relay.

11. INSTALLATION

11.01 This equipment must be installed in conjunction with a 19 type teletypewriter which is equipped with a selector in accordance with P92.901.02 and P65.907.

11.02 All necessary installation information is contained in P92.911.01. The rotary selector must have its banks individually strapped in accordance with the circuit order for the particular system.

11.03 The control unit must be located within about eight feet of the teletypewriter due to length of the interconnecting cords.

11.04 The unit may be mounted on a wall back of a machine or on a floor stand.

12. INSTALLATION AND TROUBLE TESTS

NOTE: The tests in this section require that the loop be terminated in the Telegraph Central Office in a spare TLT supplying normal line current.

12.01 After all cabling and installation work is completed but before power is connected to the Control Unit, the teletypewriter and it's selector are tested in accordance with the provisions of P65.907, Installation Tests. The Jones Plug is connected to the LINE position for these tests. After the machine and the selector operate properly, proceed with the following tests of the control unit.

12.02 In the control unit the power system ground is also the circuit ground. The equipment rack is connected to a water pipe ground. It is important to check that no turnover exists in the power wiring which would cause the hot power lead to appear on the circuit ground. With the Control Unit power cord plugged in a hot outlet and the Control Unit Power Switch OFF, make the following measurement with a KS-14510 meter on the 300 VAC range. Measure from the framework ground to the white power cord wire on the back of the power switch. A reading of full AC line

voltage indicates a reversal in the AC power connections. A reading of less than about 10 volts may exist due to differences in ground potential, and is not a trouble condition.

12.03 Remove the T tube and operate the Control Unit power switch to ON. Check the DC battery supply voltages as follows, using a KS-14510 or similar meter:

P Pwr TS 1-2	125 Volts ±5 Volts
P1 Pwr TS 4-5	155 Volts ±15 Volts

If these limits can not be met, or voltage regulation of the AC Power is poor, the use of a constant voltage regulating transformer for the AC Power is suggested.

Circuit Function Tests

12.04 Preparation	Test
Block T1 relay NO and Block L1 relay O and note that all other relays are released. If RT relay is operated, step rotary selector until RT releases. Replace T tube.	Remove Block from L1 Relay, In about 3 seconds, the T relay should operate. Remove block from T1 relay, and turn off Control Unit power.
12.05 Block L1 relay O and Block SM relay NO	Turn Control Unit power on. Manually operate T relay. In about 2 seconds, the T1 relay operates and releases the T relay.
12.06 Turn Control Unit power off. Block L1 relay O and Unblock SM relay.	Turn Control Unit power on. Manually operate T1 relay. After a noticeable delay, the SM relay operates and the transmitter distributor arm rotates twice.

CAUTION: The L relay case is connected to the hot side of the battery supply.

12.07 Preparation: Turn Control Unit power off. Block L1 and T1 relays operated, and the L relay marking (Left). Manually operate the rotary switch until the switch stands on the position corresponding to the master station. Slide the transmitter-distributor forward until the slip connectors disengage and the motor stops. Turn Control Unit Power on. Operate the start magnet manually.

Preparation	Test
Rotate the motor by hand until the brush contacts the start segment.	The TR & FG relays operate and the A relay operates to 1st step.
Continue turning motor by hand until brush contacts stop segment.	The FG relay releases, and the A relay fully operates.
Manually operate the start magnet and continue rotating the motor until the brush contacts the start segment.	The C and C1 relays should operate.
Continue turning motor by hand until the stop segment is reached.	The C2 relay operates.
Block the SM relay operated and Remove block from T1 relay.	The T1, TR and A relays release.
Block T1 relay released and Remove block from SM relay.	The C and C2 relays release (See Note). The rotary switch steps once.
Unblock the L relay.	L relay operates to space (Right) C1 relay releases.

NOTE: The above is correct when a 19 machine is searched. When a 15 machine is searched, the RT relay operates upon release of the SM and the stepping of the rotary switch. The RT in operating releases the C1 relay.

12.08 Preparation:	Test
Block L relay marking (Left) and Block T relay NO and Block T1 relay NO and Block S relay NO and release all other relays Transmitter is still disengaged.	Operate & release the S1 relay stepping the rotary switch. The RT relay locks up on 15 station positions.
	The RT1 relay operates on the first switch position and on the first station of a repeated search pattern. Step the switch one position past where RT1 operated.
Remove block from L relay.	L relay operates to space and RT1 relay releases.
Block L relay to Mark (left).	
Step switch with S1 relay until RT1 operates again, and continue one full search until RT2 operates.	RT1 releases.
Block L1 relay NO and Release L relay.	L relay operates to space.
Remove block from L1 relay.	L1 operates and RT2 releases.
Block L relay marking (left)	L1 relay releases.

12.09 Selector stepping check. Place a temporary connection between TSC-16 (Ground) and TS B-23 (S relay). The rotary selector should step continuously. Remove the temporary connection.

Remove all blocks from relays. Slide Transmitter into normal position.

12.10 The unit should now be allowed to send a normal search pattern starting with the wiper arms of the rotary switch in a vertical position.

12.11 Check the printer copy to see that all station calls are printed in upper case in the correct order as specified in the service order. Check operation thru at least a 360° rotation of the rotary selector switch.

12.12 With the search key in the "Short" position, and no tape in the transmitter, the unit should rest between search patterns two to three minutes. In the "Long" position, the rest should take about six minutes. In the "Rest" position, it should not start a search indefinitely. After a check for about 10 minutes, place a tape in the transmitter with Figures H near the end. Operate the control key up until the Busy Lamp lights, down until the transmitter starts and release the key. After the tape is transmitted, the machine shuts off. In about 15 seconds, the control unit should initiate a new complete search.

12.13 The Master Station should now be suitable for operation on its regular circuit.

12.14 The preceding tests have all been of an out of service type. In case of trouble conditions in the Control Unit that must be fixed while the Master Station remains on the circuit, the following procedure may be used:

> Move the 21 contact Jones Plug on the rear of the Master Station table from the lower (line) position to the upper (test) position.

12.15 The Control Unit may now be worked on without disturbing the circuit, and the Master Station may function on a manual basis.

13. ROUTINE TESTS AND ADJUSTMENTS

13.01 Adjustment of the relays in the control unit is accomplished in accordance with the Circuit Requirements Table in P92.911.01. Adjusting procedure for the relays is found in the following references:

U	Relays	A461.011	B461.011
Y	Relays	A461.010	B461.010
280	Relay	A460.059	B460.059
209	Rotary Selector	A468.002	B468.002

13.02 The lubrication requirements for the 209 selector shall be carefully followed and checked at least as often as specified in the above BSP.

13.03 A special testing circuit has been built into this equipment for checking the action of the rotary selector. A push button located next to the selector applies low voltage operating conditions to the selector magnet to step the switch once.

13.04 Operate the test button so as to step the selector thru one complete revolution of the switch while carefully observing for binding, snagging of the wipers and other defective conditions. If the selector operates properly in this test, it may be assumed to be in satisfactory operating condition.

13.05 No routine tests are specified.

13.06 The 376B tubes may be tested on a J94731A Cold Cathode Tube Test Set in accordance with A493.151. If this set is not available, substitution of a new tube is suggested when the operating tube is suspected.

13.07 The selenium rectifiers used in this equipment normally have a long trouble free life. However, a unit may occasionally become defective. Im-

pending failure may be detected by the temperature of the stacks, after first turning off the power to prevent a shock. The stacks normally feel neither warm nor cold to the touch. As a selenium stack begins to deteriorate, it passes more reverse direction current, which may be measured as follows. Use a KS-14510 meter on the 300 V AC range with a two or four microfarad condenser in series with one test lead. Connect to battery supply and ground. After an initial swing of the meter up scale, turn the range switch until a reading is obtained. A normal value of ripple voltage is 3 volts AC. A value appreciably above 3 volts would indicate that replacement of the selenium stack is required.

13.08 A 400E varistor may be tested in the following manner. Disconnect one lead from the circuit under test. If possible, use a long nose pliers to hold the lead wire as heat from the soldering iron can injure the varistor. Connect leads from a KS-14510 volt-ohm-milliameter to the varistor, with the positive lead to the #1 end, and set the selector to Ohms X10,000. The resistance measured would be at least 500,000 Ohms and may be as high as 1,500,000. The fingers must not touch both leads while marking this measurement. Reverse the connections so that the positive meter lead is connected to the #2 end of the varistor, and turn the selector to Ohms X10. The measured resistance should be between 150 and 250 Ohms. Caution: The Ohms X1 range should not be used as it passes sufficient current thru the varistor to cause damage.

13.09 The T timing circuit may be tested as follows. Connect negative lead from KS-14510 volt-ohm-milliameter to Battery. Put meter on 60 volts DC Scale. Connect positive lead to Pin 3 of T tube. Reading should be 0.

Remove Control Unit from line by a temporary jumper from 4 to 5 on the A terminal strip. L relay operates to space (right). Release all relays except L1 which will be operated. If RT tends to operate,

block it non-operated. With a pick operate and hold the L relay to its left (mark) contact. The L1 relay will release. The voltmeter operates backwards. In about one second, the meter moves upscale. The T tube should fire, and the T relay operate about 3 seconds after the release of the L1 relay.

The firing of the tube is only momentarily visible. To see the tube fire, look directly at the top of the tube. If there is a question as to whether the tube fires, block the T relay non-operated and repeat the above test. In about three seconds the tube should glow continuously. The glow may be very difficult to see in tubes with a date number smaller than 439. Pull the block and the T relay should operate and the T tube extinguish.