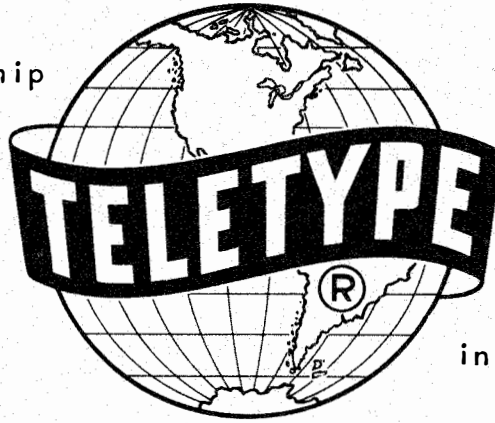


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BULLETIN 263B

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TRANSISTOR MULTIPLEX

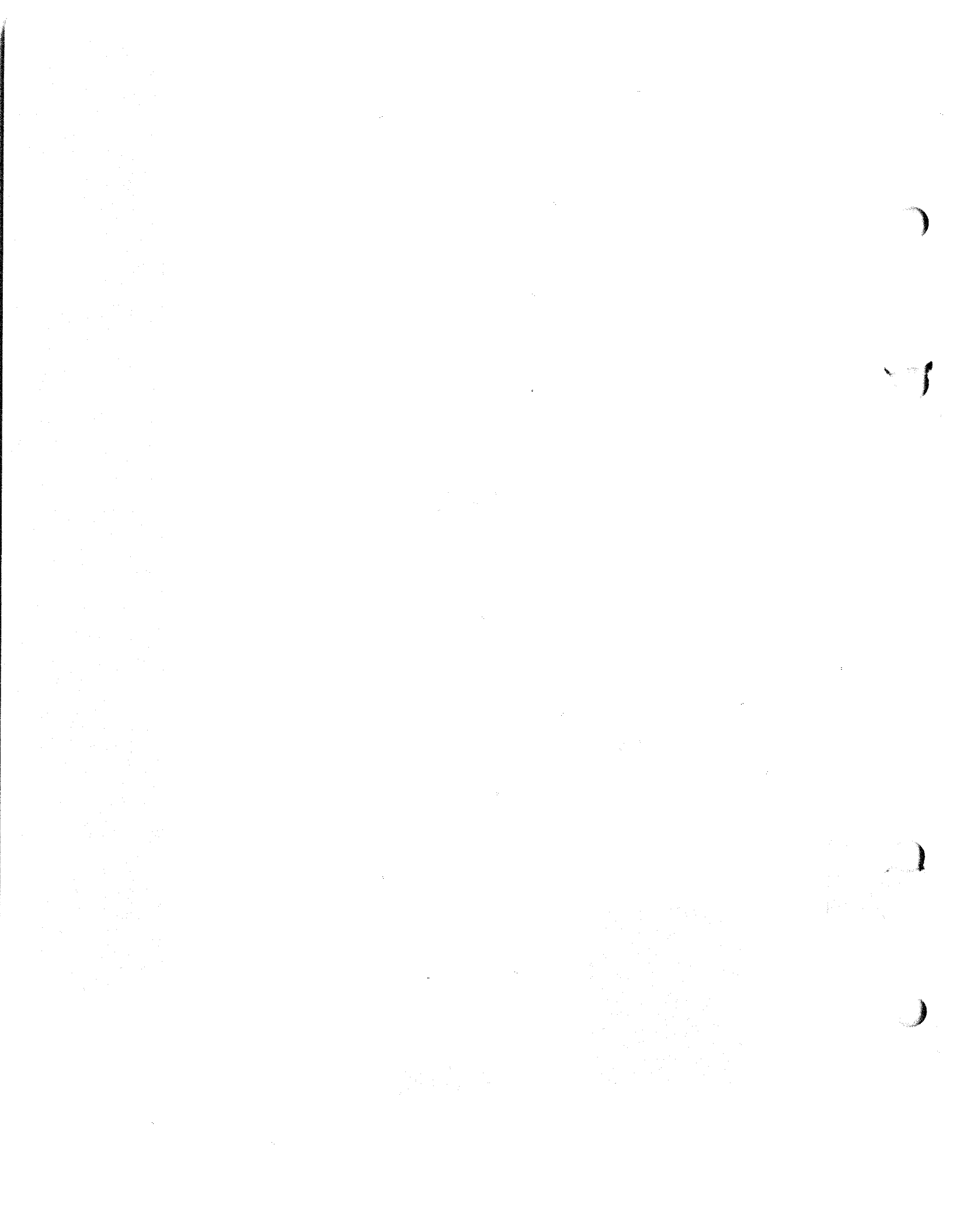
FOUR CHANNEL - TM 200

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BULLETIN 263B

TRANSISTOR MULTIPLEX

FOUR CHANNEL

TM 200

- SECTION 1. DESCRIPTION
- SECTION 2. INSTALLATION
- SECTION 3. OPERATION
- SECTION 4. PRINCIPLES OF OPERATION
- SECTION 5. TROUBLE SHOOTING
- SECTION 6. MAINTENANCE
- SECTION 7. PARTS

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LIST OF EFFECTIVE PAGES

SEPTEMBER, 1959

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2-1 to 2-19	Original
3-0 to 3-9	Original
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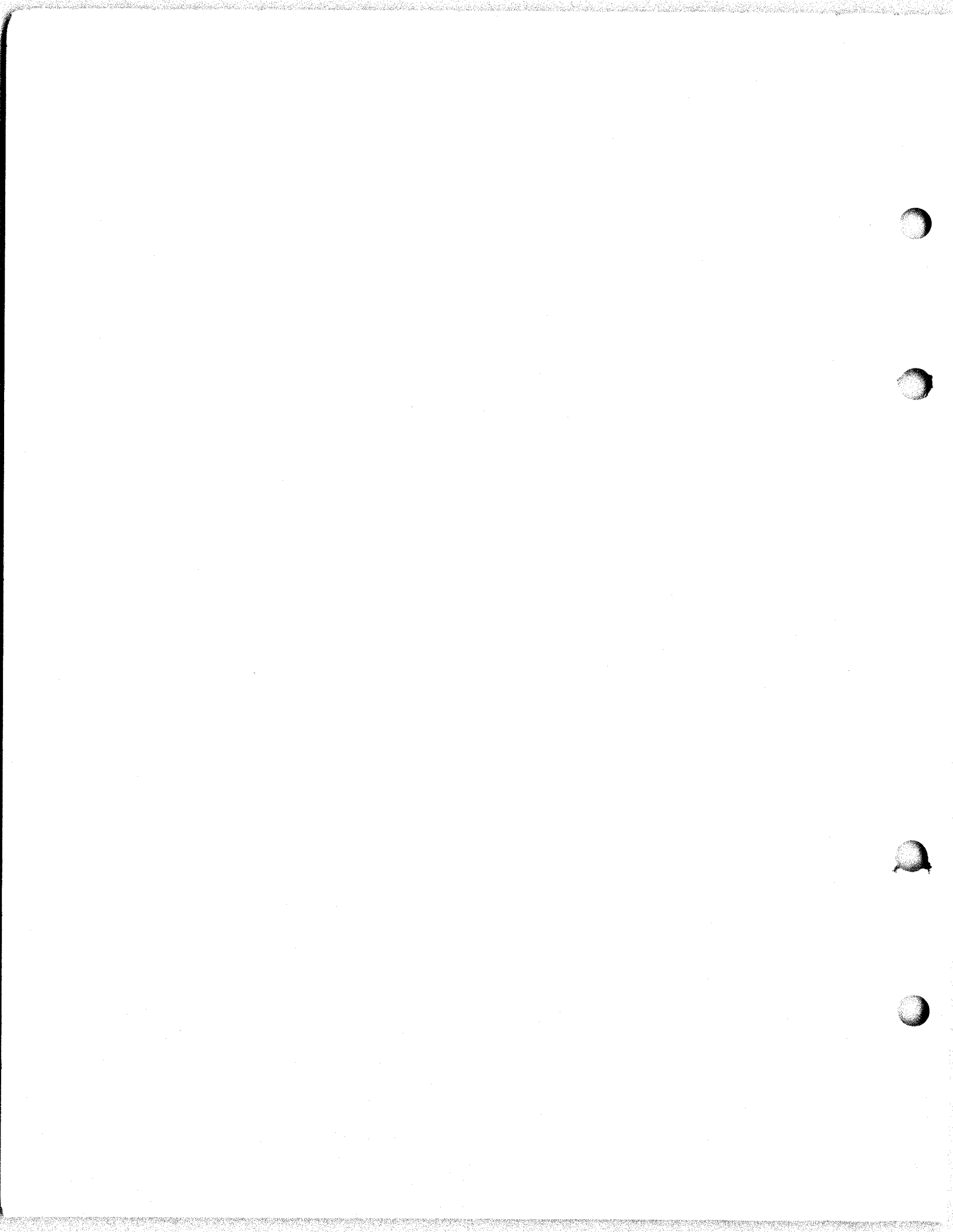


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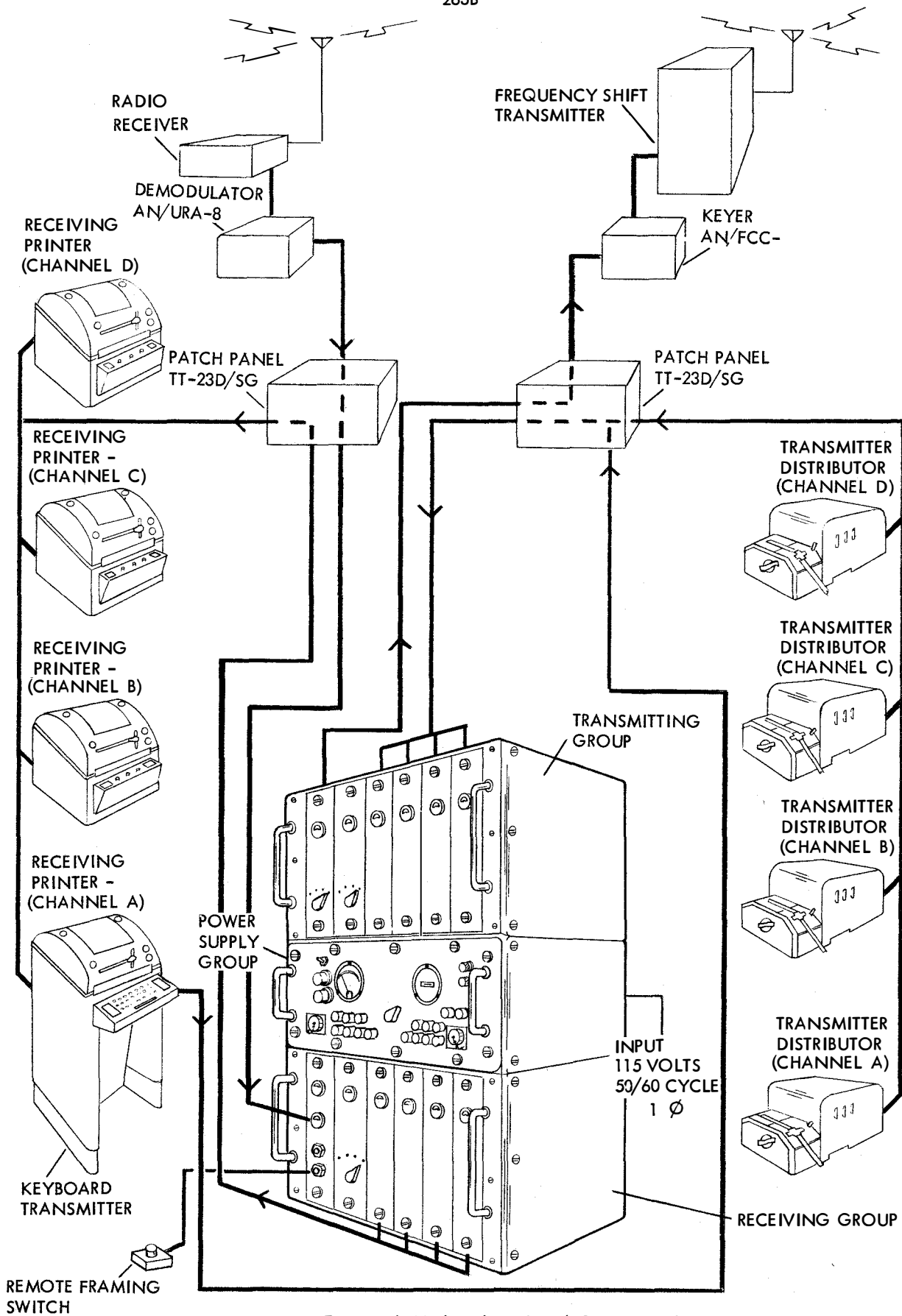


Figure 1-1. Typical Multiplex Send-Receive Station

SECTION 1

DESCRIPTION

1. INTRODUCTION

This bulletin covers description, installation, operator's instructions, principles of operation, trouble-shooting, maintenance and parts for the Teletype Transistor Multiplex Set (Telegraph Terminal Set AN/UGC-1). References in the text to left or right indicate the viewer's left or right as he faces the front of the equipment. In all illustrations, unless they are labeled otherwise, it is assumed that the equipment is being viewed from the front.

2. PURPOSE

The primary purpose of a multiplex system is to increase the message handling capacity of teletypewriter channels and the transmission equipment associated with them. This end is accomplished by the simultaneous transmission of several messages over a common channel. The transmitting equipment of a time-division multiplex system accepts start-stop signals from a number of circuits, converts them to multiplex signals (in effect, compresses them in time) and transmits them over a common channel. * Thereceiving equipment at a distant station accepts the multiplex signals, converts them to start-stop signals (in effect, expands them in time) and distributes them in the proper order to a corresponding number of circuits. The Transistor Multiplex Set provides terminal facilities for such a system. A schematic representation of a typical multiplex send-receive station is shown in Figure 1-1. The frequency-shift transmitter, the keyer, the radio receiver, the demodulator, the patch panels and the start-stop transmitting and receiving equipment are not furnished with the Set.

3. FUNCTIONAL DESCRIPTION

3.a. GENERAL

3.a.(1) The Set consists of a Transmitting Group, a Receiving Group and a Power Supply Group (Figure 1-2). The Transmitting Group accepts neutral, start-stop signals from two, three or four separate circuits and assembles

* Time division, start-stop signals and multiplex signals are explained in Section 4.

them in sequential order for multiplex transmission over a single circuit. The Receiving Group accepts multiplex signals from a distant source, converts them to start-stop form and distributes them to two, three or four separate circuits. The Power Supply Group provides the necessary voltages and a frequency standard for the Transmitting and Receiving Groups.

3.a.(2) The Set is made up of the following major units (Figure 1-2):

Transmitting Group (OA-1054/UGC-1)

- (1) Transmitting Cabinet - TMAC200
(/UGC-1)
- (4) Transmitting Code Converter -
TMCX201 (CV-408/UGC-1)
- (1) Multiplexer-Demultiplexer - TMD201
(TD-134/UGC-1)
- (1) Output Amplifier - TMXU201
(/UGC-1)
- (1) Neon Indicator - TMN200
(/UGC-1)

Receiving Group (OA-1053/UGC-1)

- (1) Receiving Cabinet - TMAC201
(CY-2686/UGC-1)
- (1) Synchronizer-Amplifier - TMS201
(/UGC-1)
- (1) Multiplexer-Demultiplexer - TMD201
(TD 134/UGC-1)
- (4) Receiving Code Converter - TMCR201
(CV-407/UGC-1)

Power Supply Group (/UGC-1)

- (1) Power Supply Cabinet - TMAC202
(/UGC-1)
- (1) Power-Oscillator - TMPU201
(0-647/UGC-1)

3.a.(3) Transistors and other solid-state devices are employed in the design of the Set to achieve minimum size, weight and power consumption. A primary a.c. power source of 115 volts + 10 percent, single-phase, 50/60 cycles per second is required. The Set will operate with start-stop equipment running at speeds of 60, 75 and 100 words per minute. Framing may be accomplished either semi-automatically or manually (see paragraph 2.a. of Section 4), and the Set may be operated on a local loop to effect

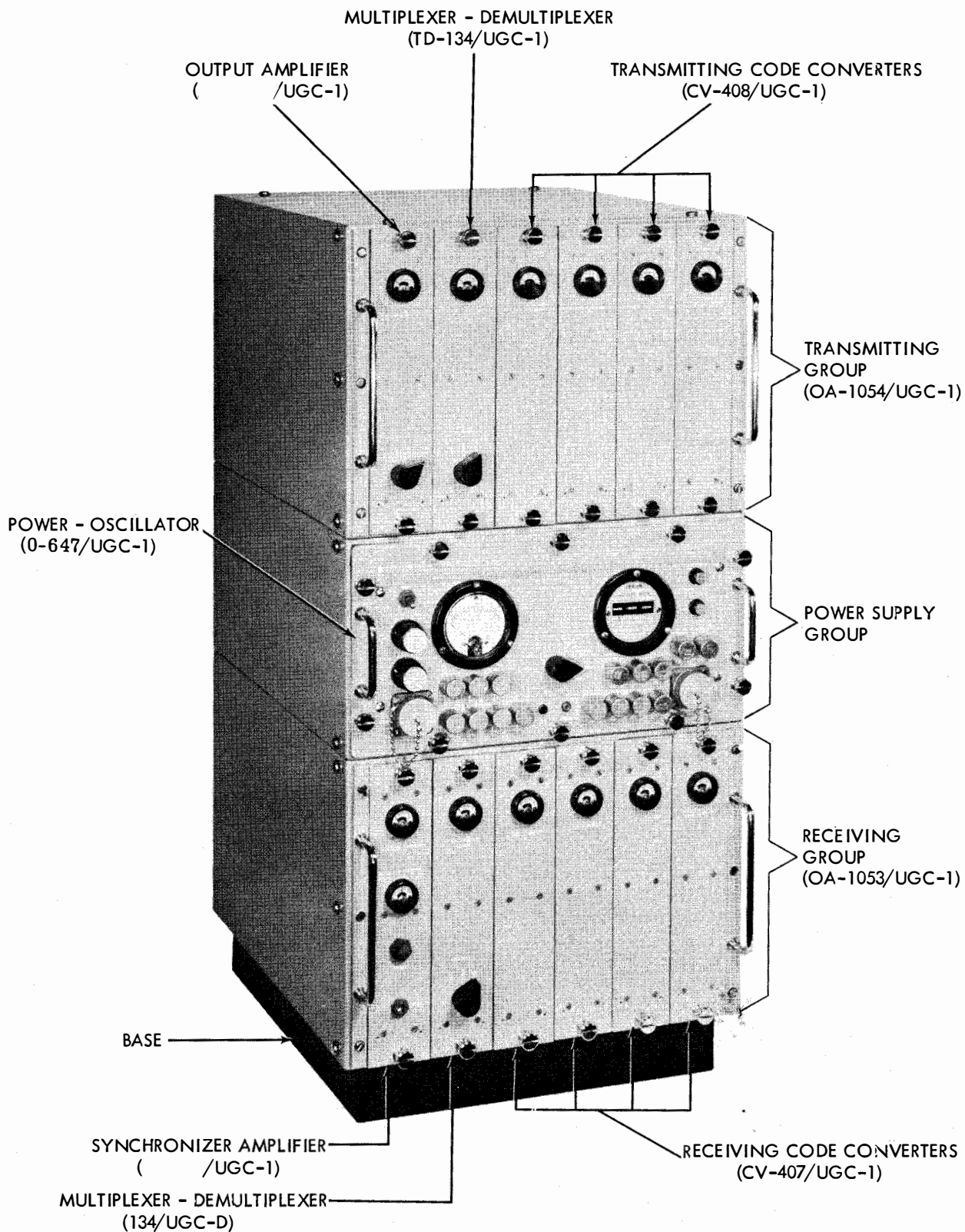


Figure 1-2. Transistor Multiplex Set (AN/UGC-1)

circuit line up. Various meters and a portable neon indicator are provided for test and adjustment purposes. Test jacks on the various major units provide for monitoring the circuit wave forms by an oscilloscope (not furnished). The equipment is drip-proof and will operate in an ambient temperature range of 0 to 50 degrees C. The multiplex signals of this Set are completely compatible with those of the Teletype Electronic Multiplex Set at 60 and 75 wpm.

3.b. HOUSING (Figures 1-1, 1-2 and 1-3)

3.b.(1) The Set is housed in three cabinets, one each for the Transmitting, Receiving and Power Supply Groups. Each cabinet may be rack or floor mounted, or they may be stacked one on top of the other in any desired order (Figure 1-2). A floor mounting base is provided.

3.b.(2) Basic mounting facilities for the components of each major unit of the Transmitting and Receiving Groups are provided by an aluminum frame and a front panel (Figure 1-4). Several etched circuit boards are mounted on a large etched wiring panel which is situated vertically in the frame. The boards are connected to the panel by wire straps and conventional soldered terminals. Thus the wiring panel serves as a chassis and local cable, and the boards may be replaced as complete components. The other components of the unit, such as switches, test points, variable resistors, capacitors, relays, etc., are located at the front and are connected to the wiring panel by straps and cabling. All circuits of the wiring panel lead into AN-type connectors at the rear of the frame. The twelve units, referred to as drawers, slide into vertical slots in their respective cabinets (Figure 1-2). The AN-type connectors are linked to connectors on the rear plate of the cabinet by flexible cables which permit the drawers to be withdrawn for servicing while the Set is in operation. All components are visible and readily accessible when the drawers are withdrawn.

3.b.(3) The power oscillator is housed in a separate cabinet (Figure 1-2) and can be withdrawn for servicing (see paragraph 3.e.).

3.b.(4) External connections to the group cabinets are made by AN-type connectors located on the rear plates (Figure 1-3). An input-output connector (without cable) on the Transmitting Group provides for the input start-stop signals and the output multiplex signals. A similar connector on the Receiving Group provides for the input multiplex signals and the output start-stop signals. If desired, the above connections can be made by terminal boards located under small covers on the rear plate. Connectors (drip proof) on the Transmitting and

Receiving Groups provide for interconnection with auxiliary equipment (not furnished). The Transmitting and Receiving Groups are linked to the Power Supply Group by interconnecting cables and connectors. A connector, cable and plug connect the power supply group with the primary a.c. power source. A coaxial cable connector (drip proof cap) is used when an external frequency standard is employed in place of the crystal oscillator.

3.c. TRANSMITTING GROUP (OA-1054/UGC-1)

3.c.(1) Transmitting Code Converter (CV408/UGC-1) (Figure 1-4) - Accepts conventional start-stop signals and converts them to multiwire signals. The incoming signals control a mercury relay which electrically isolates the converter circuits from the signal line. The outputs of the unit are six-wire parallel signals applied to the multiplexer-demultiplexer unit. The Transmitting Group may employ two, three or four converters depending on the number of start-stop channels that are being handled. The converter includes the following:

- (a) A range adjustment (variable resistor) for adjusting the unit in relation to the incoming start-stop signals.
- (b) A speed selector switch for selecting 60, 75, or 100 wpm operation.
- (c) A fine frequency adjustment (variable inductance adjusted by means of hex wrench).
- (d) An ammeter which indicates line current.
- (e) A line current adjustment (variable resistor).
- (f) Feed-back and clamp-time adjustments of start-stop oscillating circuits (variable resistors).
- (g) An input monitoring jack for connecting teletypewriter receiving equipment.
- (h) Octal receptacle for connecting neon indicator (see paragraph 3.c.(4) of this section).

3.c.(2) Multiplexer-Demultiplexer (TD134/UGC-1) (Figure 1-5) - Under the control of the crystal oscillator in the power-oscillator, this unit plays the dual role of a multiplexing device in the Transmitting Group and a demultiplexing device in the Receiving Group. In the Transmitting Group it accepts multiwire signals from the code converters and combines them into multiplex signals which it applies to the output amplifier. In addition, it supplies signals for control of auxiliary equipment. It includes the following:

- (a) A channel switch for selecting either two-, three- or four-channel operation.
- (b) A cycle meter for checking the operation of the distributor channel circuits.
- (c) An auxiliary-normal switch for regulating sampling signals.
- (d) An inverted-normal switch for selecting proper multiplex signals.
- (e) A speed selector switch for selecting 60, 75 or 100 wpm operation.

3.c.(3) Output Amplifier (/UGC-1) (Figure 1-6) - Accepts multiplex signals from the multiplexer-demultiplexer and amplifies them to the voltage levels suitable for use by local or remote signal circuits. The output signals are produced by an electronic relay which isolates the unit from the signal line. The amplifier will produce a steady mark, a steady space or a.c. reversals for test and alignment purposes. It will furnish signals at the proper voltage levels to auxiliary equipment, and it will accept signals from the auxiliary equipment. Space is provided for storing the neon indicator. The unit includes the following:

- (a) A test switch for selecting the signals used for test and alignment purposes.
- (b) An ammeter which indicates line current.
- (c) A line current adjustment (variable resistor).
- (d) A switch for selecting either local or remote output signal line.

3.c.(4) Neon Indicator (/UGC-1) (Figure 1-6) - Provides a visual indication of the operation of the transmitting and receiving code converters. Seven neon lamps are located on the front of the unit. Six of these, each of which is driven by one level at the multiwire signals of the code converter, indicates the condition of the storage circuits; the other lamp is an a.c. power indicator. The unit is self-contained and portable, and may be stored in the output amplifier drawer. It is connected to the converter to be tested by a flexible cable and octal-plug arrangement. A plug and cable are provided for connecting the unit to a conventional 115-volt, 50/60-cycle power supply.

3.d. RECEIVING GROUP (OA-1053/UGC-1)

3.d.(1) Synchronizer-Amplifier (/UGC-1) (Figure 1-7) - Accepts multiplex signals from a local or remote line, amplifies them and furnishes both inverted and normal versions to the multiplexer-demultiplexer. The input signals key an electronic line relay which isolates the unit from the signal line. In addition, the syn-

chronizer maintains the correct phase relationship between the incoming multiplex signals and the local frequency standard by adding to or subtracting from drive pulses derived from the oscillator. It also furnishes special signals used by auxiliary equipment. The unit includes:

- (a) A switch for selecting either a remote or local input signal line.
- (b) An ammeter which indicates the line current.
- (c) A line-current adjustment (variable resistor).
- (d) An adjustment of the slicing level of the line relay (variable resistor) (see paragraph 8.b. of Section 4).
- (e) A voltmeter which indicates the phase relationship between the incoming multiplex signal and the local crystal-oscillator binary.
- (f) Phase-relationship adjustments (two variable resistors).
- (g) Drive-pulse adjustments for controlling the adding or subtracting of drive pulses (two variable resistors).
- (h) An automatic-manual switch and a framing switch used in synchronizing the transmitting and receiving equipment (see paragraph 2.e. of Section 4).

3.d.(2) Multiplexer-Demultiplexer (TD134/UGC-1) (Figure 1-5) - Accepts synchronous multiplex signals from synchronizer amplifier and furnishes multiwire signals to the receiving converters. This unit is identical to the one used in the Transmitting Group (see paragraph 3.c.(2) of this section).

3.d.(3) Receiving Code Converter (CV407/UGC-1) (Figure 1-8) - Accepts multiwire signals from the multiplexer-demultiplexer and converts them to start-stop signals suitable for operation of start-stop receiving equipment. A circuit of the unit detects bona fide characters as opposed to multiplex idle signals. The output start-stop signals are produced by a mechanical relay which electrically isolates the signal line from the converter circuits. Battery for the output signals must be provided by an external source. Two, three or four converters may be used by the Receiving Group depending on how many start-stop channels are being handled. The unit includes the following:

- (a) A speed-selector switch for selecting 60, 75 or 100 wpm operation.
- (b) A fine frequency adjustment (variable inductance adjusted by means of a hex wrench).

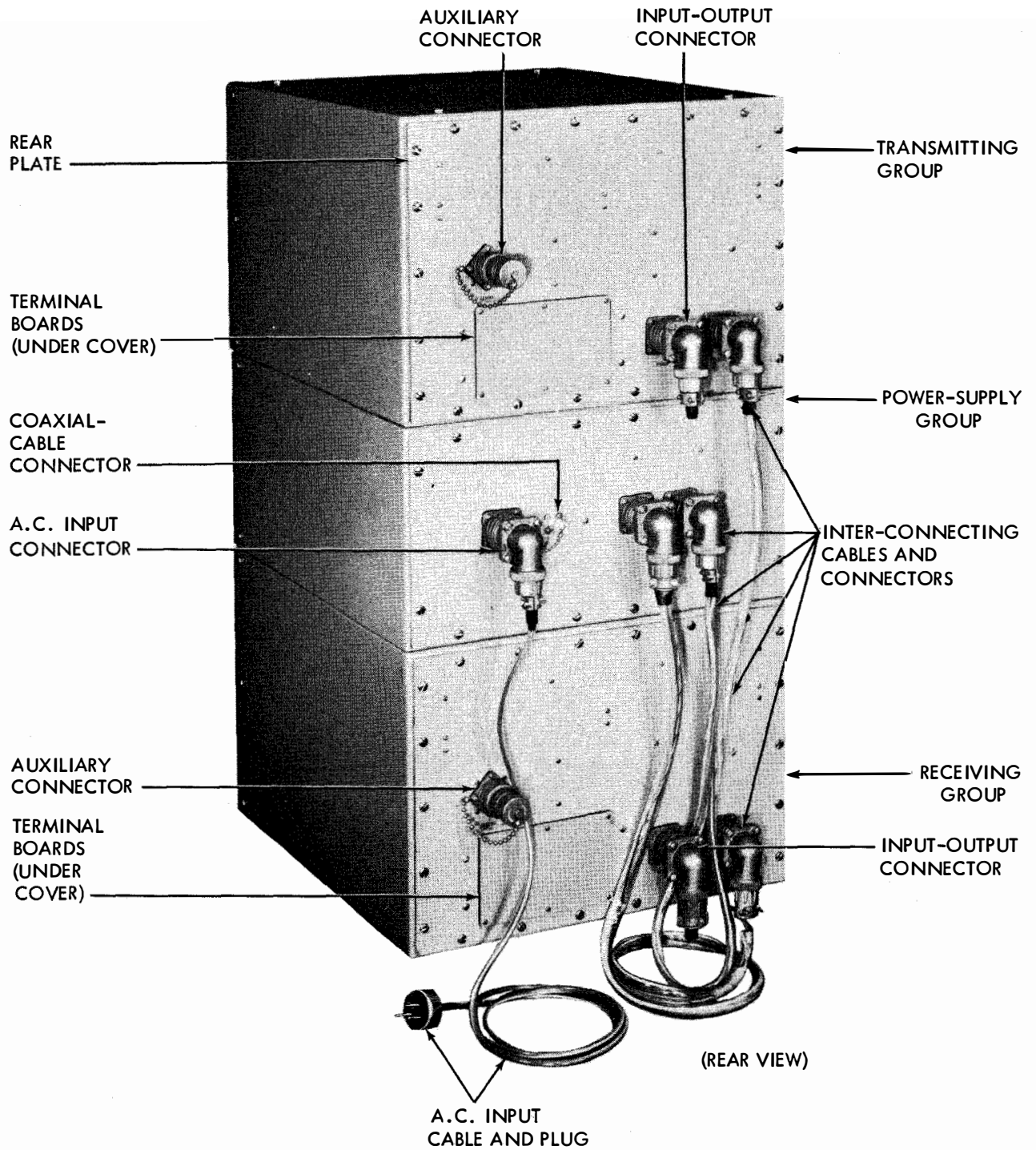


Figure 1-3. Transistor Multiplex Set (AN/UGC-1)

- (c) An ammeter which indicates the line current.
- (d) A line-current adjustment (variable resistor).
- (e) Clamp and feed-back adjustments (variable resistors).
- (f) An octal receptacle for connecting the neon indicator (see paragraph 3.c.(4) of this section).
- (g) Output monitoring jack for connecting teletypewriter receiving equipment.

3.e. POWER SUPPLY GROUP (UGC-1)

3.e.(1) Power-Oscillator (0-647 /UGC-1) (Figure 1-9) - Provides d.c. and a.c. voltages and accurately-timed frequency drive pulses for the Transmitting and Receiving Groups. The unit is housed in a separate cabinet and may be withdrawn while in operation for servicing. It operates from a single-phase, a.c. primary power source of 115 volts at a frequency of 50/60 cycles. Mounting facilities are provided by an aluminum chassis, a front panel and a control-mounting bracket. Filter reactors, capacitors, connectors, binary-counter circuit boards and a power transformer are located on the chassis. The d.c. potentials furnished by the unit may be monitored by means of a voltmeter and a selector switch. Variable resistors on the control-mounting bracket behind the front panel provide individual adjustments for certain of these d.c. voltages. An on-off switch and pilot light are furnished for the a.c. power input. The a.c. voltage applied to the input to the various rectifiers can be varied by means of a tap switch. The d.c. voltmeter (with its selector switch in the "Red Line" position) is used to select the tap that will provide the 12V. d.c. reference voltage. The tap switch can be used to check the operating margins of the complete set. The start-stop oscillators of the code converters may be calibrated by means of a vibrating-reed frequency meter. A jack for connecting the meter by means of a test lead to the respective code converter is provided. Fuses and convenience outlets with moisture seal caps are located on the front panel. Blown fuse indicators are furnished in each leg of the power line.

3.e.(2) A Crystal Oscillator provides accurately-timed drive pulses from which various clock pulses used in multiplexing are derived. A transistorized crystal controlled oscillator is packaged in a hermetically sealed oven which is maintained at a constant temperature by its heater and thermostat. The complete package is plugged into an octal socket on the chassis.

Two oscillators are furnished, one for 60 and 75 word-per-minute operation and one for 100 word-per-minute operation. The one not in use is plugged into a reserve socket. The frequency of the oscillator may be finely adjusted by a variable capacitor on the chassis. A lamp is provided to indicate when the oven is on. An external frequency standard, which may be used in place of the crystal oscillator, is applied to the Set through a coaxial connector located on the rear panel of the power supply cabinet (Figure 1-3).

4. REFERENCE DATA

4.a. PRIMARY POWER SOURCE - See Table 1.

4.b. TEMPERATURE

4.b.(1) Operating Range: 0° to 50° C.

4.b.(2) Storage Range: -40° to 65° C.

4.c. FREQUENCY CONTROL - By temperature-controlled crystal oscillators or external frequency standard. See paragraphs 4.e.(6) and (7) below.

4.d. SIGNALS

4.d.(1) Input Start-Stop Signals (Transmitting Group) - Neutral start-stop signals of 0.020 or 0.060 ampere d.c.; external battery required. For description of start-stop signals, see paragraph 3.a. of Section 4.

4.d.(2) Multiplex Output Signals (Transmitting Group) - Two outputs supplied, either or both of which may be used by external equipment independent of the other: (a) Current-keyed neutral d.c. signals of 0.020 or 0.060 ampere for remote transmission line; external battery of 130 volts (not exceeding 150 volts) required; fine current adjustment by variable resistor. (Signals for local line are also available --- see paragraph 4.e.(3)(b) below.) (b) Voltage-keyed d.c. signals with battery internally provided; voltage continuously variable up to +50 volts; negative terminal grounded. Signals compatible in all respects with signals of Teletype Electronic Multiplex Set at speeds of 60 and 75 wpm. For multiplex signalling speeds, see Table 2. For description of multiplex signals, see paragraph 3.b. of Section 4.

4.d.(3) Multiplex Input Signals (Receiving Group) - Keyed, neutral signals of 0.020 or 0.060 ampere d.c.; external battery required; means for isolating signal from chassis ground provided. For speeds and compatibility of signals, see paragraph 4.e.(4)(a) below.

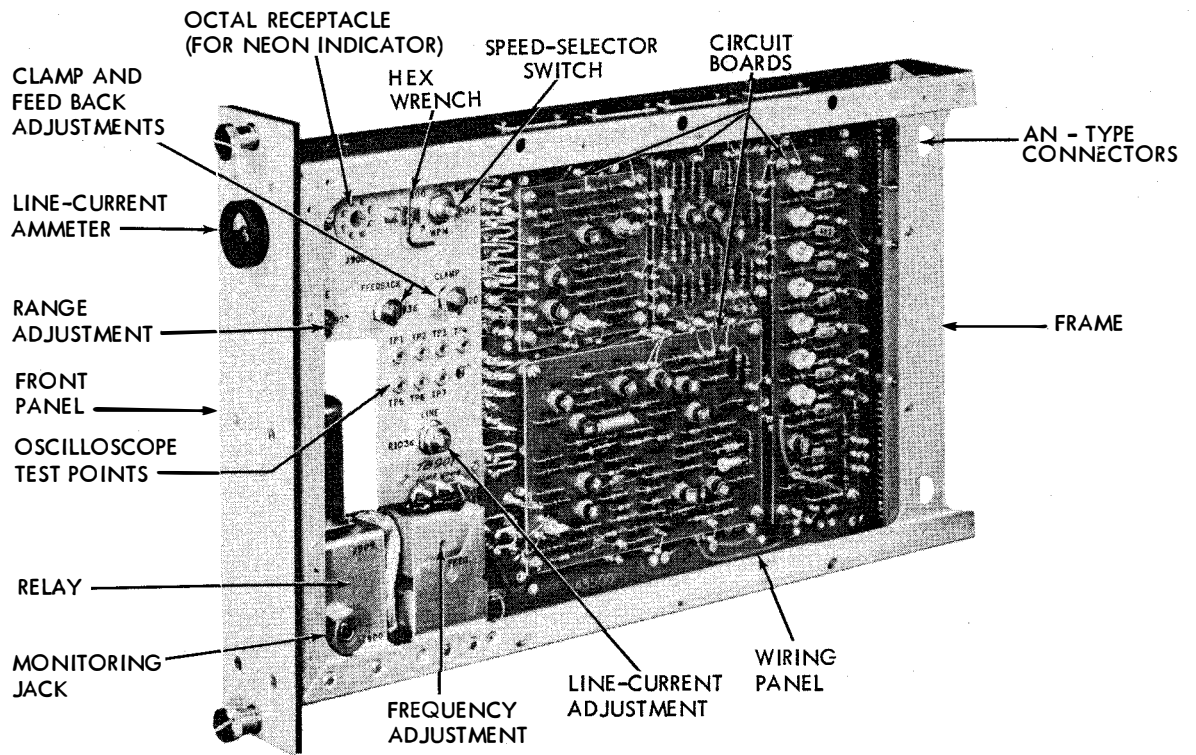


Figure 1-4. Transmitting Code Converter (CV-408/UGC-1)

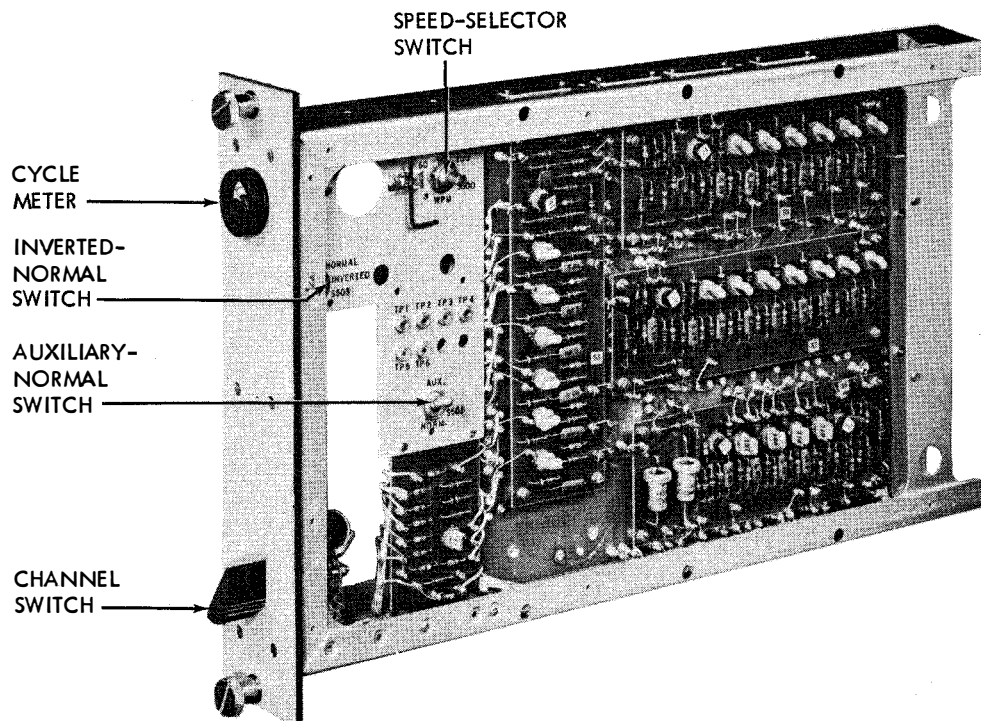


Figure 1-5. Multiplexer - Demultiplexer (TD-134/UGC-1)

4.d.(4) Output Start-Stop Signals (Receiving Group) - Keyed, neutral signals of 0.020 or 0.060 ampere d.c.; external battery required; quality suitable for use with standard Teletype start-stop equipment; less than 2% distortion of signals for all specified conditions of temperature and voltage.

4.d.(5) Transmitting Group Auxiliary Output Signals

4.d.(5)(a) Signal consisting of positive going pulses having amplitudes of 37 volts originating in an impedance of 10,000 ohms; time duration of each pulse not less than 150 microseconds; available at pin D of auxiliary connector (see Figure 1-3). Repetition rates: 60 wpm - 450 pulses per second; 75 wpm - 562.5 pulses per second; 100 wpm - 733.69 pulses per second.

4.d.(5)(b) Signal corresponding to normal multiplex signal but inverted: amplitudes of 0 volt for mark and +50 volts for space; developed across 220,000 ohms; available at pin E of auxiliary connector (Figure 1-3).

4.d.(5)(c) Signal consisting of negative-going pulse with amplitude of 24 volts across 1 megohm; time duration of each pulse greater than seven microseconds; repetition rate equal to baud of multiplex signal; pulses occur within 30 microseconds of start of each code element of signal specified in paragraph 4.d.(5)(b) above; available at pin A of auxiliary connector (Figure 1-3).

4.d.(5)(d) Signal consisting of positive pulse with amplitude of 37 volts originating in an impedance of less than 10,000 ohms; time duration of pulse greater than 150 microseconds; pulse occurs within 30 microseconds after start of first code element in channel B appearing in inverted multiplex output signal; available at pin B of auxiliary connector (Figure 1-3).

4.d.(6) Receiving Group Auxiliary Output Signals

4.d.(6)(a) Signal identical to one specified in paragraph 4.d.(5)(a) above: available at pin B of auxiliary connector (Figure 1-3).

4.d.(6)(b) Signal identical to one specified in paragraph 4.d.(5)(b) above: available at pin F of auxiliary connector (Figure 1-3).

4.d.(6)(c) Signal consisting of a positive pulse having an amplitude between +32.5 and +42 volts originating in an impedance not exceeding 10,000 ohms; time duration of pulse 150 microseconds or greater; rise time of pulse one millisecond or less; pulse occurs within first half of sixth code element of channel A

appearing in inverted multiplex input signal referred to in paragraph 4.d.(8) and occurs only when sixth code element of channel A in multiplex signal being received is marking; available at pin J of auxiliary connector (Figure 1-3).

4.d.(6)(d) Signal consisting of negative going pulses with amplitudes of not less than 15 volts originating in an impedance not greater than 10,000 ohms; time duration of each pulse less than 5% of width of multiplex code element; pulses occur coincidentally with nominal center of code elements of inverted multiplex output signal specified in paragraph 4.d.(4)(b); available at pin G of auxiliary connector (Figure 1-3).

4.d.(7) Transmitting Group Auxiliary Input Signals - Transmitting Group provides d.c. - coupled input circuit capable of accepting inverted multiplex signal from auxiliary equipment; signal shall have amplitudes of 0 (± 2) volts for mark and +55 (+20, -10) for space; input impedance of circuit is 50,000 ohms; signal accepted at pin F of auxiliary connector (Figure 1-3).

4.d.(8) Receiving Group Auxiliary Input Signals - Receiving Group provides d.c. - coupled circuit capable of accepting an inverted multiplex signal from auxiliary equipment; signal shall have amplitudes of 0 (± 2) volt for mark and +90 (+20, -10) volts for space, and shall be delayed 1/2 of a code element from signal specified in paragraph 4.d.(4)(b); input impedance of circuit is 50,000 ohms; signal accepted at pin E of auxiliary connector (Figure 1-3).

4.e. CAPABILITIES OF MAJOR UNITS

4.e.(1) Transmitting Code Converter (CV-408/UGC-1)

4.e.(1)(a) Input: Start-stop signals specified in paragraph 4.d.(1) above; current accommodations fixed for either 0.020 or 0.060 ampere, but wire strapping provides for changing from one to the other; fine adjustment of current by variable resistor; signal distortion up to 45% acceptable under all conditions of voltage and temperature.

4.e.(1)(b) Output: Multiwire signal pulses of 6 (0 to -6) volts d.c. supplied on a six-wire basis to multiplexer-demultiplexer; initiated and controlled by pulses originating in multiplexer-demultiplexer; obtainable from either "(1)" or "(0)" sections of storage flip-flops.

4.e.(2) Multiplexer-Demultiplexer (TD-134/UGC-1)

4.e.(2)(a) Multiplexer Operation - (1) Input: (a) Multiwire signal pulses of 6 (0 to -6)

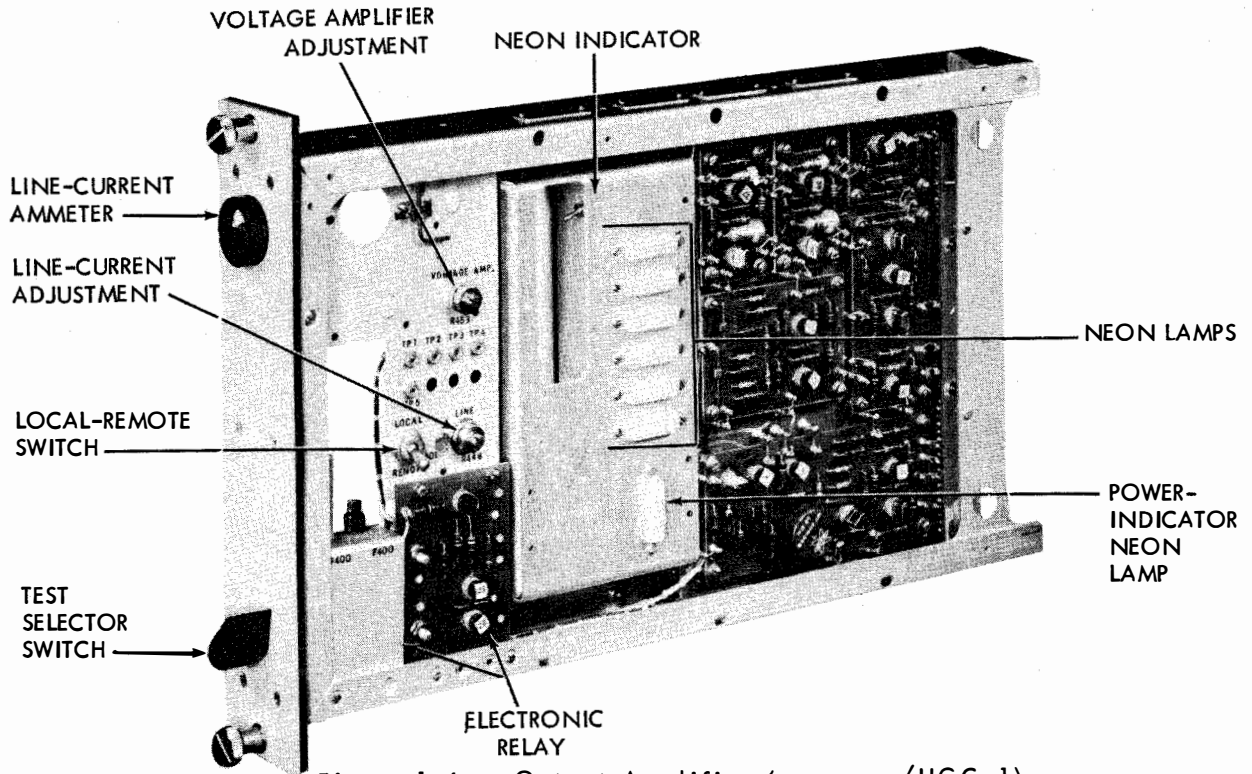


Figure 1-6. Output Amplifier (/UGC-1)

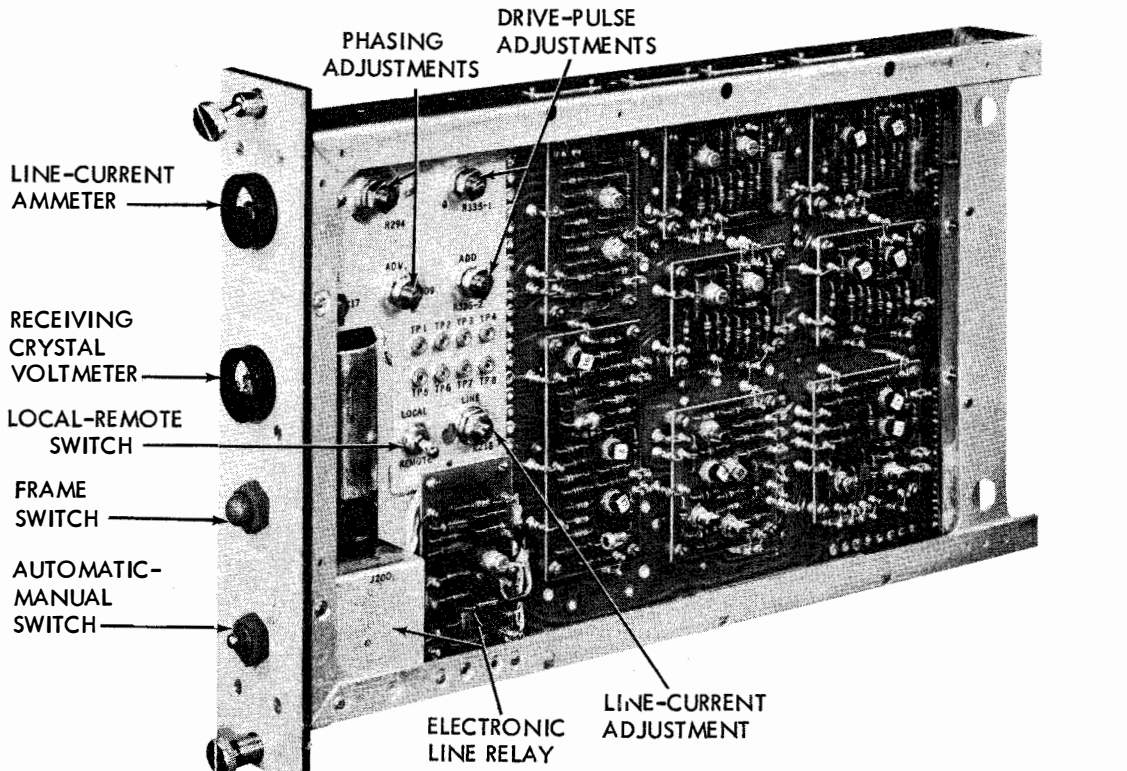


Figure 1-7. Synchronizer - Amplifier (/UGC-1)

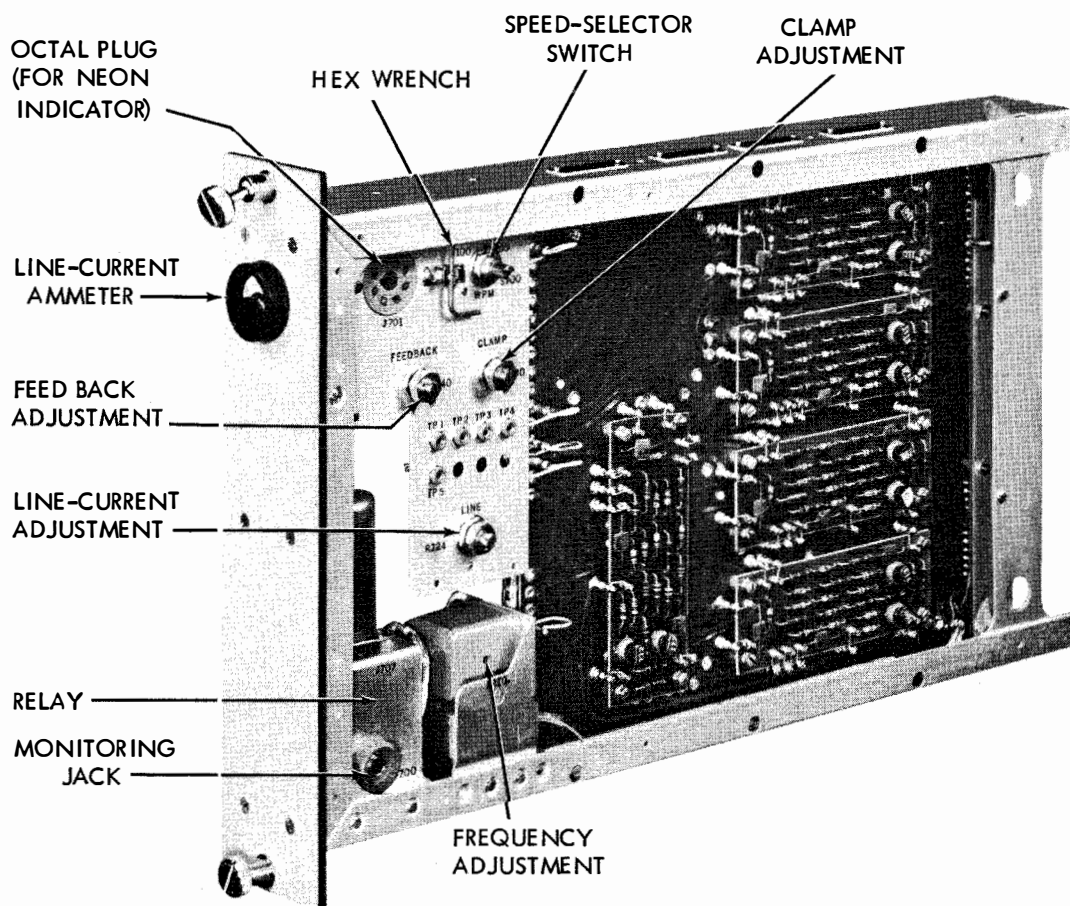


Figure 1-8. Receiving Code Converter (CV-407/UGC-1)

volts d.c. supplied on a six-wire basis by transmitting code converter. (b) Multiplex cycling rate controlled by -6-volt pulses from crystal oscillator; frequencies shown in paragraph 4.e.(6)(b) below. (2) Output: (a) Five volt (-1 to -6 volts) synchronous multiplex signals supplied to output amplifier. (b) Synchronous (clock) pulses at channel distribution rate supplied for each channel to transmitting code converters for control purposes. (c) Synchronous pulses at multiplex drive frequency rate supplied to output amplifier for a.c. test pattern.

4.e.(2)(b) Demultiplexer Operation - (1) Input: (a) Synchronous multiplex signals of 6 (0 to -6) volts d.c. from synchronizer-amplifier. (b) Provision included for stepping multiplex signal distributor in response to framing pulse from synchronizer-amplifier. (2) Output: (a) Multiwire signal pulses of 6 (0 to -6) volts d.c. supplied on a six-wire basis to each receiving code converter. (b) Sampling pulses with amplitudes of +6 volts supplied to synchronizer-amplifier to sample normal and inverted multiplex signal pulses respectively; occur in approximate center of each multiplex pulse and do not exceed by more than 5% time duration of multiplex pulse. (c) Synchronous (clock) pulses at channel distribution rate supplied for each channel to receiving code converters for control purposes.

4.e.(2)(c) Special Outputs - Certain outputs supplied for control purposes at sufficient voltage and power levels to operate auxiliary equipment: (1) Synchronous pulses at frequency dependent upon operating speed of code converters; 60 wpm - 450 cps, 75 wpm - 562.5 cps, 100 wpm - 733.69 cps. (2) Signal distributor (divider 5) drive frequency. (3) Channel B distributor element. (4) Output from channel A, number 6 element, matrix star.

4.e.(3) Output Amplifier (/UGC-1)

4.e.(3)(a) Input - (1) Five volt (-1 to -6 volts) d.c. synchronous multiplex signals from multiplexer-demultiplexer. (2) Will accept either an inverted multiplex signal from auxiliary equipment or, by proper strapping of Set, will accept inverted multiplex signal made available for use by auxiliary equipment. (3) Will accept positive pulses at multiplex signal baud rate.

4.e.(3)(b) Output - (1) Signals described in paragraph 4.d.(2) above. (2) Keyed, synchronous multiplex signals of 0.060 ampere for local transmission line; battery supplied internally; controlled by remote-local switch. (3) Steady marking, steady spacing or a.c. reversals which key local or remote transmission line.

4.e.(3)(c) Special Inputs and Outputs - (1) Accepts auxiliary clock pulses from multiplexer-demultiplexer varying in amplitude from +1 to -6 volts and having the following frequencies: 60 wpm - 450 cps, 75 wpm - 562.5 cps, 100 wpm - 733.69 cps; amplifies auxiliary clock pulses to approximately +37 volts and provides them for use by auxiliary equipment. (2) Accepts positive pulses at multiplex signal baud rate; amplifies, inverts and provides them for use by auxiliary equipment. (3) Accepts channel B clock pulses varying in amplitude from +1 to -6 volts from multiplexer-demultiplexer; amplifies, inverts and provides for use by auxiliary equipment.

4.e.(4) Synchronizer - Amplifier
UGC-1)

4.e.(4)(a) Input - Signals described in paragraph 4.d.(3) above; for remote operation, external battery of approximately 130 volts is required; for local operation, line battery is furnished by local output amplifier; operable when incoming current is down to 60% of normal value or when noise is up to 40% of line current; operable with signals biased up to 45% due to multipath or other phenomena.

4.e.(4)(b) Output - Normal or inverted multiplex signals of 6 (0 to -6) volts d.c. supplied to multiplexer-demultiplexer.

4.e.(4)(c) Special Inputs and Outputs - (1) Will furnish inverted multiplex signals to auxiliary equipment and will accept such a signal from auxiliary equipment; if auxiliary equipment is not used, by means of adapter plug, this signal is returned directly to amplifier. (2) Will accept auxiliary clock pulses from multiplexer-demultiplexer and amplify them for use by auxiliary equipment. (3) Will accept signal sampling pulses from multiplexer-demultiplexer and will shape, invert and furnish to auxiliary equipment. (4) Will accept output of sixth element for channel A in matrix of multiplexer-demultiplexer and amplify this signal for auxiliary equipment.

4.e.(5) Receiving Code Converter (CV-407/
UGC-1)

4.e.(5)(a) Input: Multiwire signals of 6 (0 to -6) volts supplied on a six-wire basis by multiplexer-demultiplexer.

4.e.(5)(b) Output: Signals described in paragraph 4.d.(4) above.

4.e.(6) Power Oscillator

4.e.(6)(a) Power Source - See Table 1. Two per cent taps on primary of input transformer compensate for variations in power source.

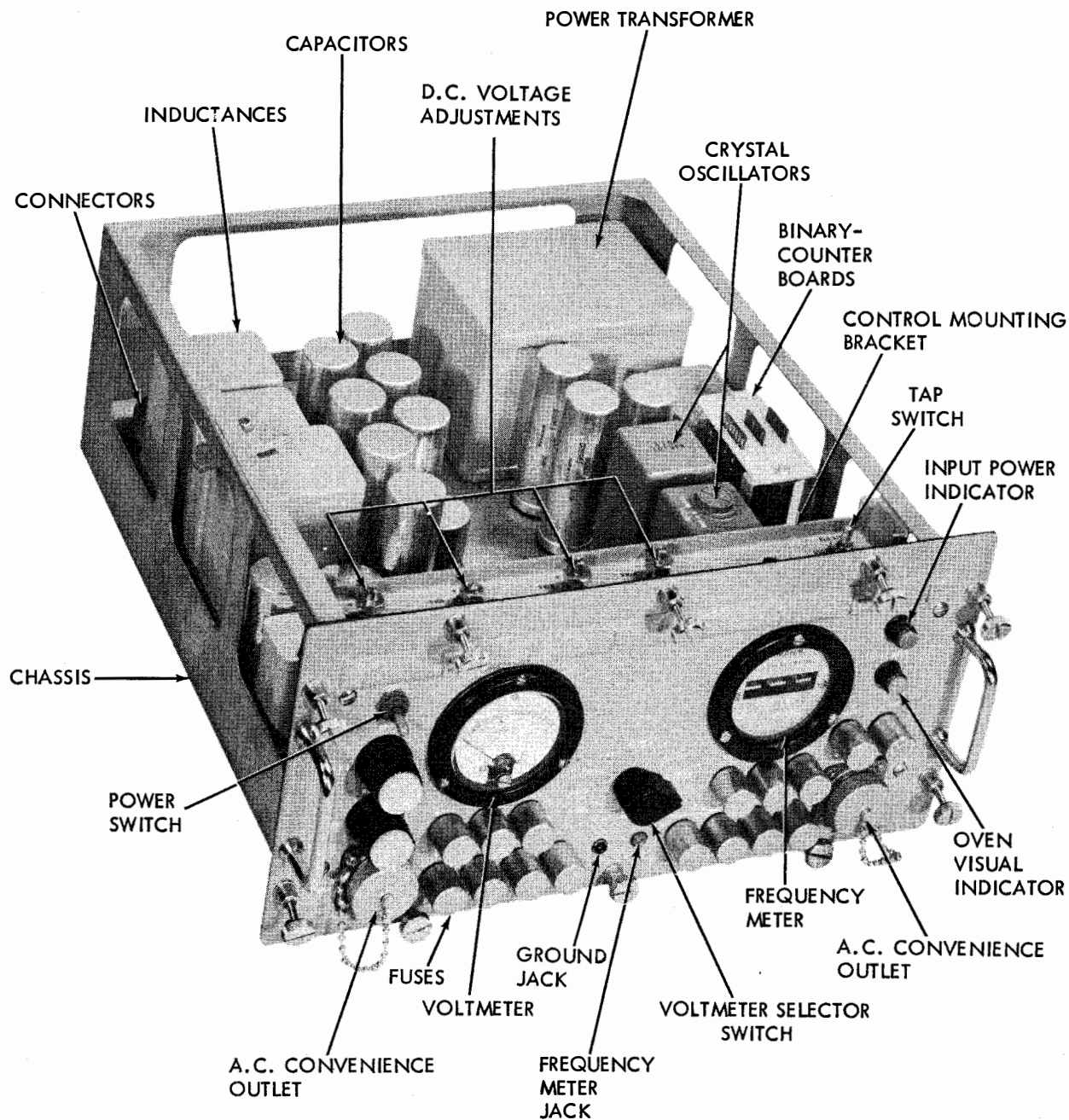


Figure 1-9. Power - Oscillator (ID-539/UGC-1)

4.e.(6)(b) Output - (1) Two drive frequency outputs (180° out of phase) of 6 (0 to -6) volts from first divider of crystal oscillator; supplied to multiplexer-demultiplexer and synchronizer amplifier; frequency -

60 - 75 wpm	15,750 cps
100 wpm	15,407.6 cps

For frequency division, see Table 4. (2) D.c. and a.c. voltages: See Table 3. (3) Two 115-volt, a.c. convenience outputs; connectors on front panel.

4.e.(7) Crystal Oscillator

4.e.(7)(a) Power Source: -12 volts ($\pm 10\%$) with respect to ground; maximum ripple of 2% r. m. s.

4.e.(7)(b) Oven Power Source: 12.6 volts ($\pm 10\%$) a.c.; current less than three amperes at 12.6 volts.

4.e.(7)(c) Output: frequency drive of 0.4-volt r. m. s., when operated from nominal -12 volts supply, with following frequency:

60 - 75 wpm	63 KC
100 wpm	61.63043 KC

4.e.(7)(d) Maximum frequency drift: five parts in 10^7 per day for specified ranges of temperature and voltage and variations in load from 300 to 10,000 ohms.

4.e.(7)(e) Oven Temperature: $70^\circ \pm 1^\circ$ C. for specified ranges of temperature and oven power-supply voltage.

4.e.(8) Neon Indicator (NE-263/UGC-1) - Operates from a power source of 115 volts ($\pm 10\%$) a.c. at 50/60 cps. Accepts six-wire signals of either 0 (± 1) volt or -6 (± 1) volts; 0 volt causes neon indicator to glow; -6 volts extinguishes indicator.

TABLE 1-1

PRIMARY POWER SUPPLY REQUIREMENTS

Voltage	115 Volts $\pm 10\%$ a.c.
Phase	Single
Cycles per Second	50/60 $\pm 5\%$
Current	1 ampere
Power Factor	0.75
Wattage	86
Heat Dissipation	86 watts

TABLE 1-2

MULTIPLEX OPERATING SPEEDS

Words/Min.	Operations Per Minute	Dot Cycles Per Sec.			Pulse Duration (Millisec.)		
		4 Chan.	3 Chan.	2 Chan.	4 Chan.	3 Chan.	2 Chan.
60	375	75	56.25	37.5	6.66	8.9	13.33
75	468	93.75	70.31	46.88	5.34	7.11	10.68
100	611.413	122.26	91.70	61.13	4.09	5.45	8.18

TABLE 1-3

D. C. AND A. C. OUTPUT RATINGS OF POWER-OSCILLATOR

Nominal Voltage (115 Volt Primary)	Load Current (amperes)	Percent Regulation	Ripple % R.M.S.	Power Watts	Voltage Adjustment	Bleeder Resistance Values (ohms) (Tentative)
+37 d.c.	0.005				Bleeder	
+50 $\pm 5\%$ d.c.	0.030	---	2	5.00	None	--
+12 d.c.	0.300	---	2	3.60	Rheostat	68
+6 d.c.	0.900	---	1	5.40	Rheostat	
+1.5 $\pm 10\%$ d.c.	1.300	---	2	2.00	None	
-6 d.c.	0.500	---	1	3.00	Rheostat	12
-12 d.c.	3.400	$\pm 2\%$	2	40.80	Tap on Primary ($\pm 2\%$ steps)	
6.3 a.c.	1.0 Max.	---		6.3 Max.	None	
12.6 a.c.	3.0			37.8 Max.	None	
12. d.c. Isolated	0.100	---	2	1.2		150

- +12, +6, -6, -12 volts shall be adjustable to achieve nominal over the complete range of primary a.c. voltage input.
- Load currents for all voltages, except -12 volt are constant at the values shown. Load will fluctuate between 3.400 and 3.200 amperes for a -12 volt supply.
- +37 volts derived from 750 ohm potentiometer across +50 volt. +37 volts bypassed to ground by minimum 500 mfd.
- 6.3 volts a.c. derived from tap on 12.6 volt a.c. supply.

TABLE 1-4

MULTIPLEXER-DEMULPLEXER FREQUENCY DIVISION CHART

Divider 2 WPM Ring

Input (cps)	Ratio	Output (cps)	Speed (WPM)
15,750	5/1	3150	60
15,750	4/1	3937.5	75
15,407.5	3/1	5135.833	100

Ring 7

Input (cps)	Ratio	Output (cps)	Speed (WPM)
3150	7/1	450	60
3937.5	7/1	562.5	75
5135.833	7/1	733.690	100

Divider 3 Channel Selection Ring

Input (cps)	Ratio	Output (cps)	Speed (WPM)	Channels
3150	3/1	1050	60	4
3150	4/1	787.5	60	3
3150	6/1	525	60	2
3937.5	3/1	1312.5	75	4
3937.5	4/1	984.375	75	3
3937.5	6/1	656.25	75	2
5135.833	3/1	1711.944	100	4
5135.833	4/1	1283.958	100	3
5135.833	6/1	855.972	100	2

Divider 4

Input (cps)	Ratio	Output (cps)	Speed (WPM)	Channels
1050	7/1	150	60	4
7875	7/1	112.5	60	3
525	7/1	75	60	2
1312.5	7/1	187.5	75	4
984.375	7/1	140.625	75	3
656.25	7/1	93.75	75	2
1711.944	7/1	244.563	100	4
1283.958	7/1	183.423	100	3
855.972	7/1	122.282	100	2

Mux Signaling Rate

60 WPM	375 OPM
75 WPM	468.75 OPM
100 WPM	611.19/46 OPM

TABLE 1-5

DIMENSIONS AND WEIGHTS

	Approx. Dimensions (Inches)			Approx. Volume (Cubic Inches)	Approx. Weights (Pounds)
	Height	Width	Depth		
Transmitting Group	12-1/4	17	25*	5206-1/4	71
Receiving Group	12-1/4	17	25*	5206-1/4	68
Power -Supply Group	8-3/4	17	25*	3718-3/4	58
Complete Set	33-1/4	17	25*	14131-1/4	197
Complete Set Packed for Shipping					300

* Includes connectors on rear and handles on front.

SECTION 2

INSTALLATION

1. UNPACKING AND HANDLING

1.a. The Transistor Multiplex Set - TM200 (Telegraph Terminal AN/UGC-1) is packed in a large wooden box. A smaller box contains maintenance spare parts, the instruction manuals, the mounting hardware and the accessories that are required for the installation. Inspect the location where the equipment is to be installed and make sure that ample room is provided at the rear of the cabinet -- see paragraph 2.c. below. Refer to Figure 2-2 for the outline dimensions of the equipment. Note the alternate location of the Power Supply Group in Figure 2-1.

1.b. The equipment is packaged with a moisture-vapor proof barrier. Individual items in the maintenance spare parts kit are also packed in moisture-vapor proof packages. The equipment may be removed from the wooden box for temporary storage; however, the vaporproof seal should not be broken until the unit is ready to be set up.

1.c. Remove the nails that secure the front panel and the top of the wooden box. This will expose the unit in its protective covering. Remove the corrugated detail at the top and lift the unit from the skid and lower detail. Remove the protective covering when the unit is to be installed immediately. If the unit is to be rack mounted, remove the ear brackets (144063 and 144056), rear brackets (144062 and 144064) and the bag of mounting hardware from the small box.

2. SITE SELECTION

2.a. The equipment may be installed in either a fixed or mobile station. Generally, the need for increased telegraph channels dictates whether multiplex equipment will be used at a particular location. The arrangement of the equipment is dependent upon the space available and the amount of traffic to be handled. Where space permits, it is recommended that the Multiplex Set be mounted at table-top height above the floor. The base (144200) is not required for this type of mounting. Where large amounts of traffic are to be handled within a limited floor area, two complete Multiplex Sets can be bolted together one above the other. This method of mounting results in a "package" approximately

6 feet high but narrower (17 inches) than conventional relay racks. If possible, a Transmitting Group, a Receiving Group and a common Power Supply Group should be installed together. This arrangement facilitates the overall testing of the equipment during routine maintenance checks.

2.b. The multiplex equipment should be installed in a shelter which is kept at temperature consistent with human habitation.

2.c. Where rear accessibility is limited to less than 18 inches, the Power Supply Group should be installed as the lower Group in the cabinet assembly -- see Figure 2-1. This procedure permits final bolting of the assembled cabinets to the mounting base from the front. CAUTION--The distance between the rear panels of the cabinet and a vertical wall surface should not be less than 5-1/2 inches. If this minimum distance is not maintained, the AN-type connectors on the rear panels cannot be removed.

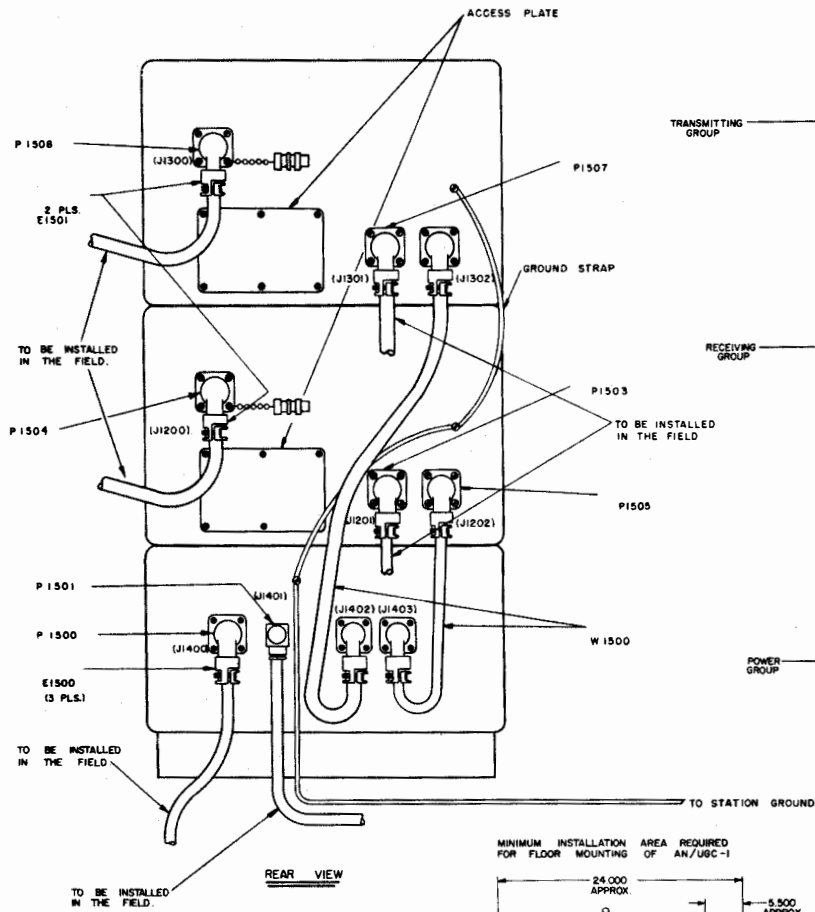
3. POWER REQUIREMENTS - During operation at normal room temperatures the Transistor Multiplex Set requires 86 watts of power from a 117 volt a.c. source. The unit has a power factor of 0.75. Refer to the power distribution information in Figure 2-3 and Table 2 of Section 1. Note that the power-oscillator will function on 50 to 60 cycle current; however, the associated motor driven readers and printers will require a frequency tolerance of ± 0.5 cycle unless governed motors are used.

4. INSTALLATION LAYOUT

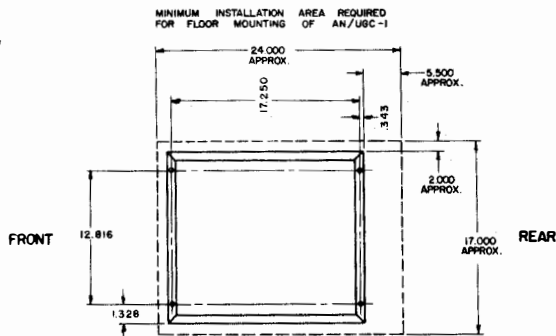
4.a. The Multiplex Set will operate for long periods of time with a minimum amount of attention. The remote framing switch feature enables the operator to bring the set into its framed condition while the operator is viewing the copy from the page printer. Therefore, the Multiplex Set may be located near the radio transmitting and receiving equipment, and the tape readers and page printers may be placed at a more distant location.

4.b. A typical shipboard installation in which the TT-23/SG patch panels are used is shown in Figure 1-1. A more detailed illustration of the actual wiring is shown in Figure 2-4.

Figure 2-1 Equipment Assembly

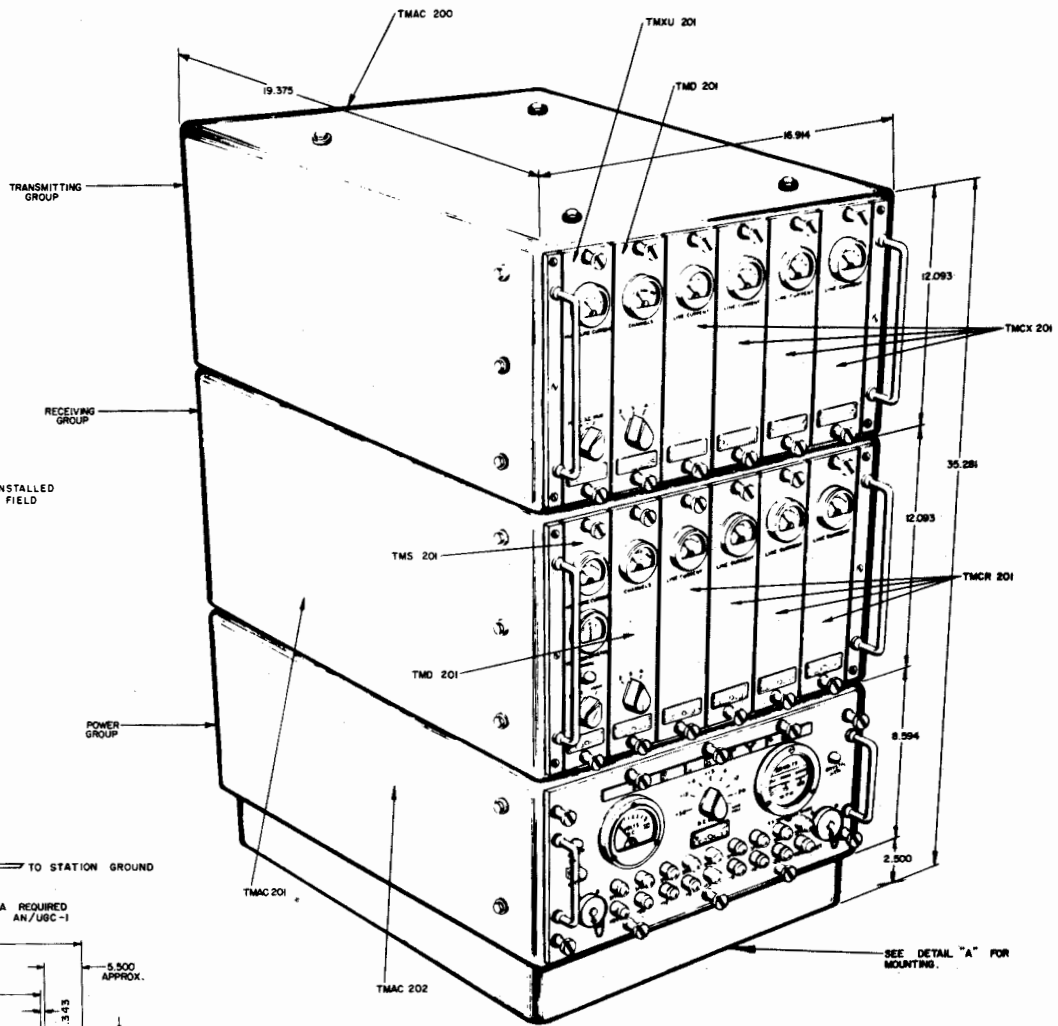


REAR VIEW



BASE MTG. INFO.
DRILL (4) .312 DIA. HOLES AS SHOWN
SCALE 1/8

DETAIL "A"



- NOTES:
1. TMAC 200, TMAC 201, & TMAC 202 CAN BE STACKED IN DIFFERENT ORDER PER CUSTOMER REQUIREMENTS.
 2. POWER INPUT 86 WATTS 115 V A.C. 50 - 60 CPS. P.F. .750
 3. WEIGHTS:

TRANS. GROUP	71 LBS.
REC. GROUP	68 LBS.
POWER GROUP	56 LBS.
TH 2000A (TOTAL)	213 LBS.

4.c. If possible, a send-receive teletypewriter should be located near the Multiplex Set for monitoring and order wire purposes. The order wire can be a separate circuit or one of the multiplex channels.

4.d. All incoming and outgoing signal leads should be shielded pairs. The shields should be grounded to the equipment at the ground terminations provided on the terminal blocks or in the AN-type connectors.

4.e. The cabinets, which are bonded by a ground strap, should be connected to station ground.

4.f. Mount base to floor or to table. Drill the mounting holes in accordance with the dimensions shown on Figure 2-4.

4.g. Fasten lower cabinet to the base using the 1/4 x 20-1/2 inch screws with the moisture seal. See Figure 2-2.

4.h. Connect the power cables from the power-oscillator to the Transmitting Group and the Receiving Group as shown in Figure 2-4. If the internal connections of each group are required, refer to Figures 2-6 and 2-7. Connect the patch panel (TT-23/SG) in accordance with Figure 2-4.

4.i. Connect an a.c. power cable (three wires) to the plug (P1500) that is furnished - See Figure 2-5. Connect the input and output circuits (shielded pairs) to the Transmitting and Receiving Groups. The latter connection may be made to terminal boards TB1200, TB1201, TB1300 and TB1301 when the access plates (144109) are removed. On installations where it is necessary to maintain a drip-proof seal, the signal connections should be made to the AN-type connectors. See Figure 2-4 or 2-1.

4.j. If auxiliary equipment is to be used in conjunction with the Multiplex Set, remove the dummy plugs (P1506 and P1509) from J1200 and J1300 respectively. Auxiliary equipment may be plugged directly into J1200 and J1300. Use plugs P1504 and P1508 for this purpose, and connect cables to plugs as shown in Figures 2-4 and 2-5.

4.k. Make sure that power switch S101 on the power-oscillator is in its OFF position. Connect the power cable plug (P1500) to J1400. The Multiplex Set is now ready for operation.

4.l. For further disassembly and reassembly information refer to Section 6.

5. ASSEMBLY OF MULTIPLEX SET IN A RELAY RACK (Navy Type CY597 A/G)

5.a. Attach the cabinet ear brackets (144056 and 144063) to the Transmitting Group Cabinet (TMAC202), Receiving Group Cabinet (TMAC201) and Power Supply Group Cabinet (TMAC200).

5.b. Install the right and left brackets (144062 and 144064) on the right and left vertical angles of the CY597 A/G cabinet. The angles are positioned approximately 15 inches to the rear of the front surface of the cabinet. The brackets should be mounted using the pre-tapped holes in the angles so that the rear of each cabinet rests on the brackets.

5.c. Fasten the cabinets in the rack using the mounting screws for the front ear brackets.

5.d. Connect the power, signal and auxiliary circuits as described previously.

6. INSTALLATION REQUIREMENTS

6.a. INSTALLATION POINTERS

6.a.(1) Ground all shielded leads to the cabinet ground.

6.a.(2) Exercise care when the signal input and output leads are connected to their terminals so that the polarities shown in Figure 2-4 are maintained.

6.b. OUTLINE DRAWINGS

6.b.(1) Refer to Figures 2-2 and 2-1 to obtain the dimensional requirements for the installation. Note that the Power Supply Group may be placed on the lower level when space limitations at the rear of the cabinet hinders a direct approach to the mounting screws.

6.b.(2) Refer to Figure 2-5 for a view of the cable assembly.

6.c. INTERCONNECTING DIAGRAMS (See Figures 2-8 and 2-9)

6.c.(1) The interconnection of the drawers of the Transmitting Group with the connector on its cabinet is shown in Figure 2-6. The interconnection of the drawers of the Receiving Group with the connectors of its cabinet is shown in Figure 2-7. The interconnection of the Power Supply Group is shown in Figure 2-5.

6.c.(2) If the Transmitting Groups and Receiving Groups are installed at different locations, it is recommended that the local multiplex circuits be used to connect them. The local multiplex signal is brought out to terminal no. 5 of TB1201 and TB1301 as well as pin "L" of J1201 and J1301. The groups are wired at the factory so that the local connection for the usual

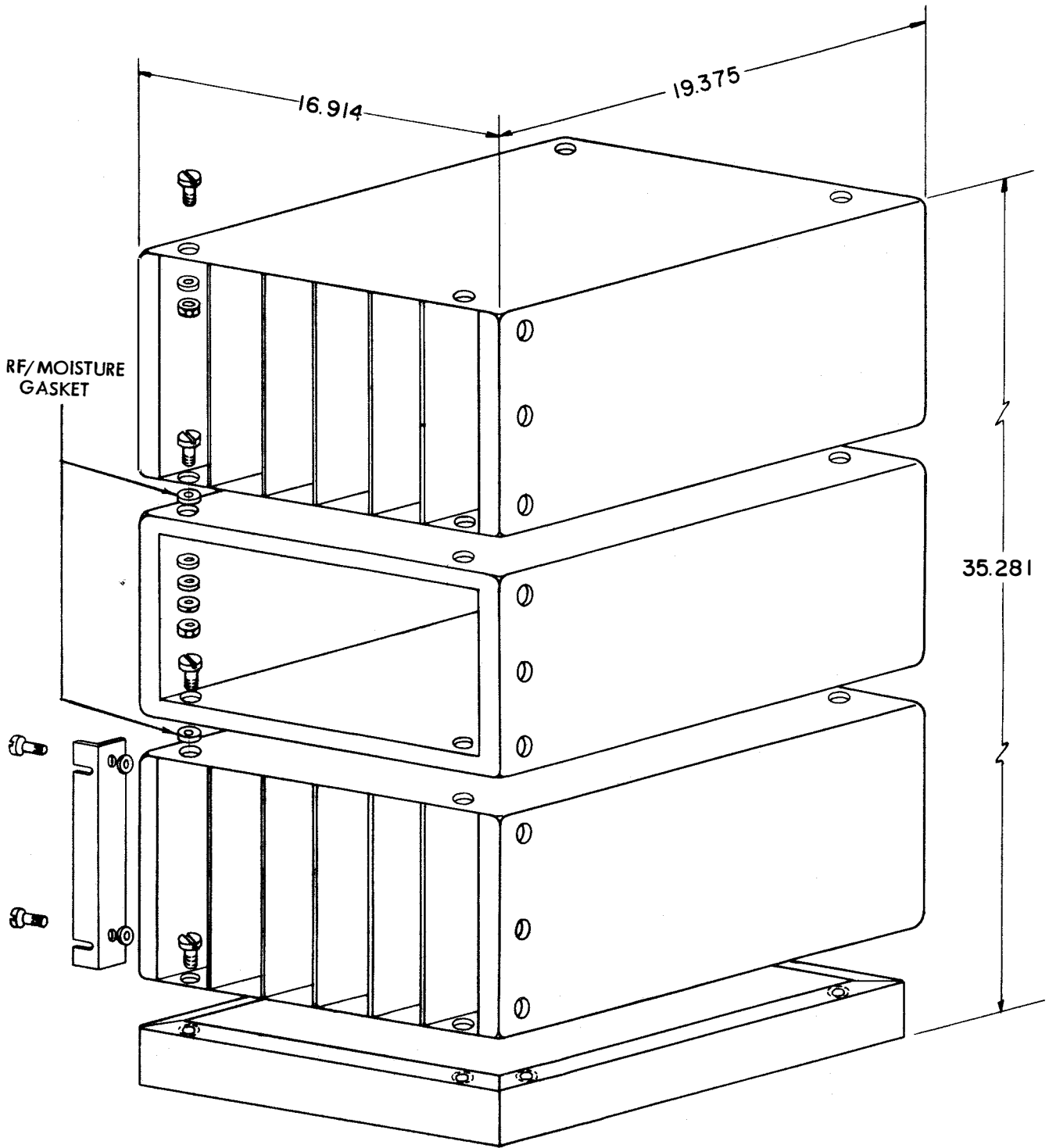


Figure 2-2 Cabinet Assembly

send-receive combination is made through the power-oscillator by means of J1202 and J1302 -- pin L. If the Transmitting and Receiving Groups are separated, it is necessary to remove the brass strap between the upper and lower screw of no. 5 terminal on TB1201 and TB1301. The interconnecting lead is then attached to the upper no. 5 terminal of TB1201 and the other end to upper no. 5 terminal of TB1301. Refer to Figures 2-10 and 2-11.

7. INSPECTION AND ADJUSTMENT

7.a. Make sure that all transistors in each drawer are seated firmly in their respective sockets. There should be no vacant transistor sockets.

7.b. The crystal oscillator for the desired speed of operation should be located in J113. The alternate oscillator should be in the reserve socket.

7.c. ENERGIZING THE EQUIPMENT

7.c.(1) With the power switch OFF, pull the power-oscillator out of its cabinet so that the tap-switch on the control mounting bracket is accessible. Set the voltmeter selector switch (on the front panel) to the "Red-Line" position (see Figure 1-9).

7.c.(2) Turn the power switch ON and adjust the tap switch until the voltmeter indication is closest to the red line.

7.c.(3) With power applied and the a.c. tap switch properly adjusted, the d.c. voltages furnished by the power supply should fall within $\pm 5\%$ of their nominal values. The rheostats on the control mounting bracket are factory-set and locked in position. They should not require adjustment at this time.

7.c.(4) The d.c. line currents are supplied by the external 130 volts supplies. Observe each code converter line current meter to see that it provides an indication. Set the local-remote switches in the output-amplifier and the synchronizer-amplifier units to LOCAL. Set the signal selector switch on the output-amplifier unit to MARK. Observe if the "Mux." line current meters have an indication. (If any of the signal lines were reversed during installation, the meters will not give the proper indication and steps will have to be taken to correct the signal polarity).

7.c.(5) Note that the distributor cycle meter on the multiplexer-demultiplexers functions for all settings of CHANNELS switch on the front panel.

7.c.(6) Set the CHANNELS switches to the same number of channels. The equipment is now ready for operation with actual signals.

NOTE---When power switch is turned ON, allow approximately one minute (1) for the oscillator to reach its operating temperature before the set is placed in service.

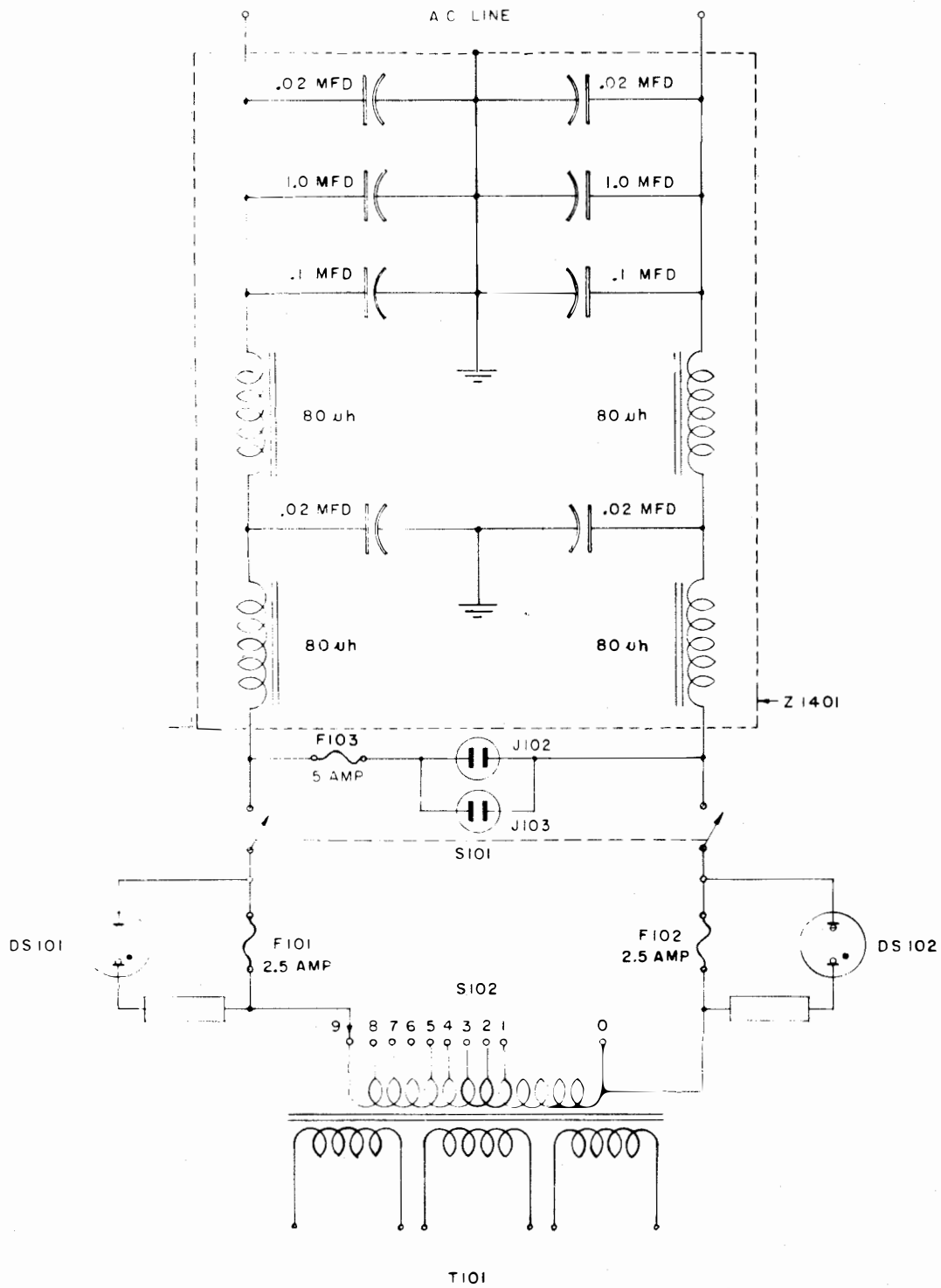
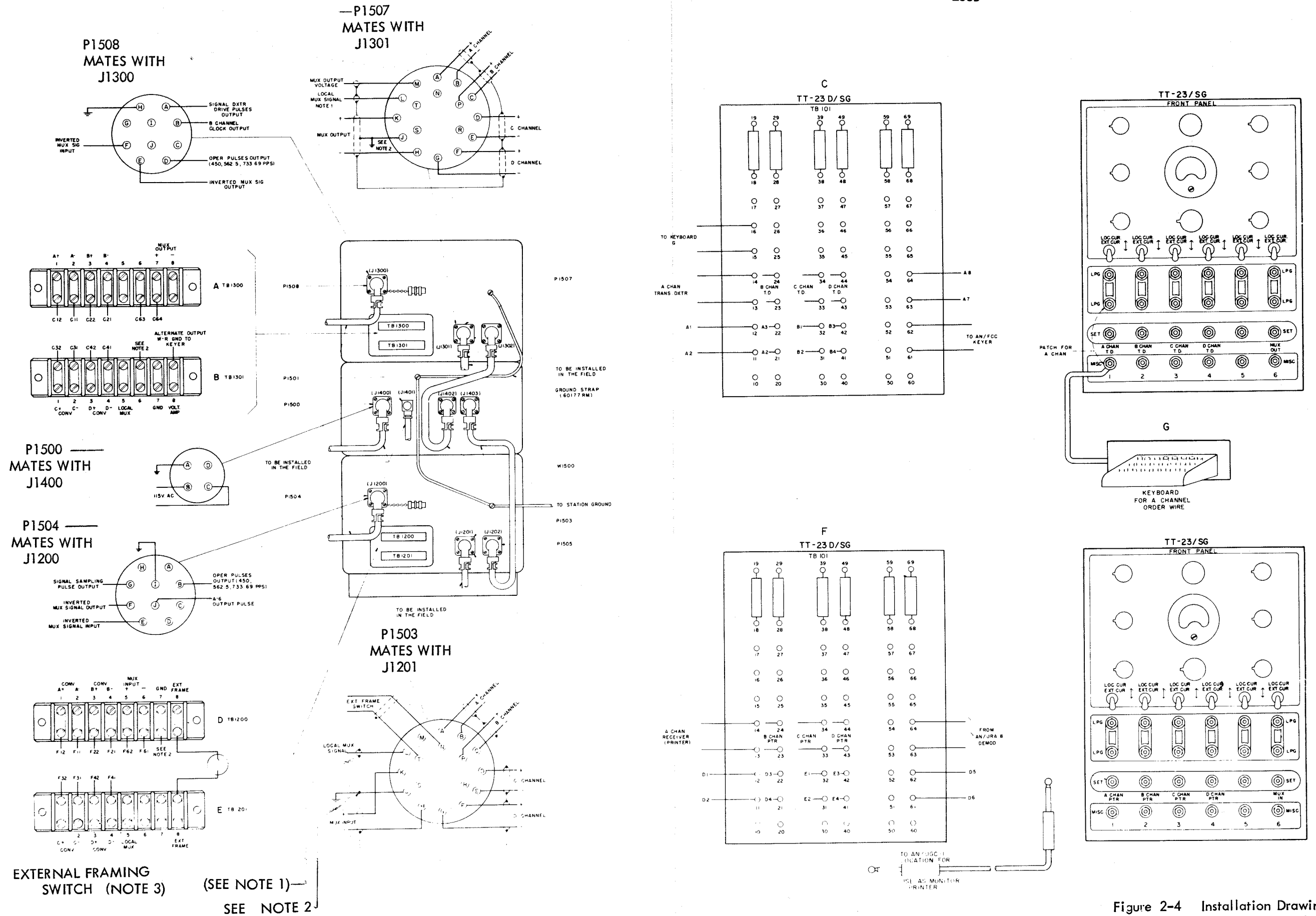


Figure 2-3. Power Distribution Diagram

NOTES ---

- (1) LOCAL MUX SIGNAL OUTPUT NEEDED ONLY WHEN TRANS. AND REC. GROUPS ARE SEPARATED AND BRASS LINKS ON TERM 5 OF TB 1301 AND TB1201 ARE REMOVED
- (2) USE SHIELDED PAIRS FOR ALL CABLE RUNS TO TT-230/SG JUNCTION BOXES GROUND SHIELDS AT GROUND TERMINAL 7 ON TB1301 AND TB1200, OR PIN J OF P1507 AND P1503.
- (3) EXTERNAL FRAMING SWITCH SHOULD BE LOCATED NEAR RECEIVING PRINTER AND LINE CURRENT METER MONITORING "A" CHANNEL



EXTERNAL FRAMING SWITCH (NOTE 3) (SEE NOTE 1) SEE NOTE 2

ORIGINAL

Figure 2-4 Installation Drawing With Patch Panels 2-7; 2-8

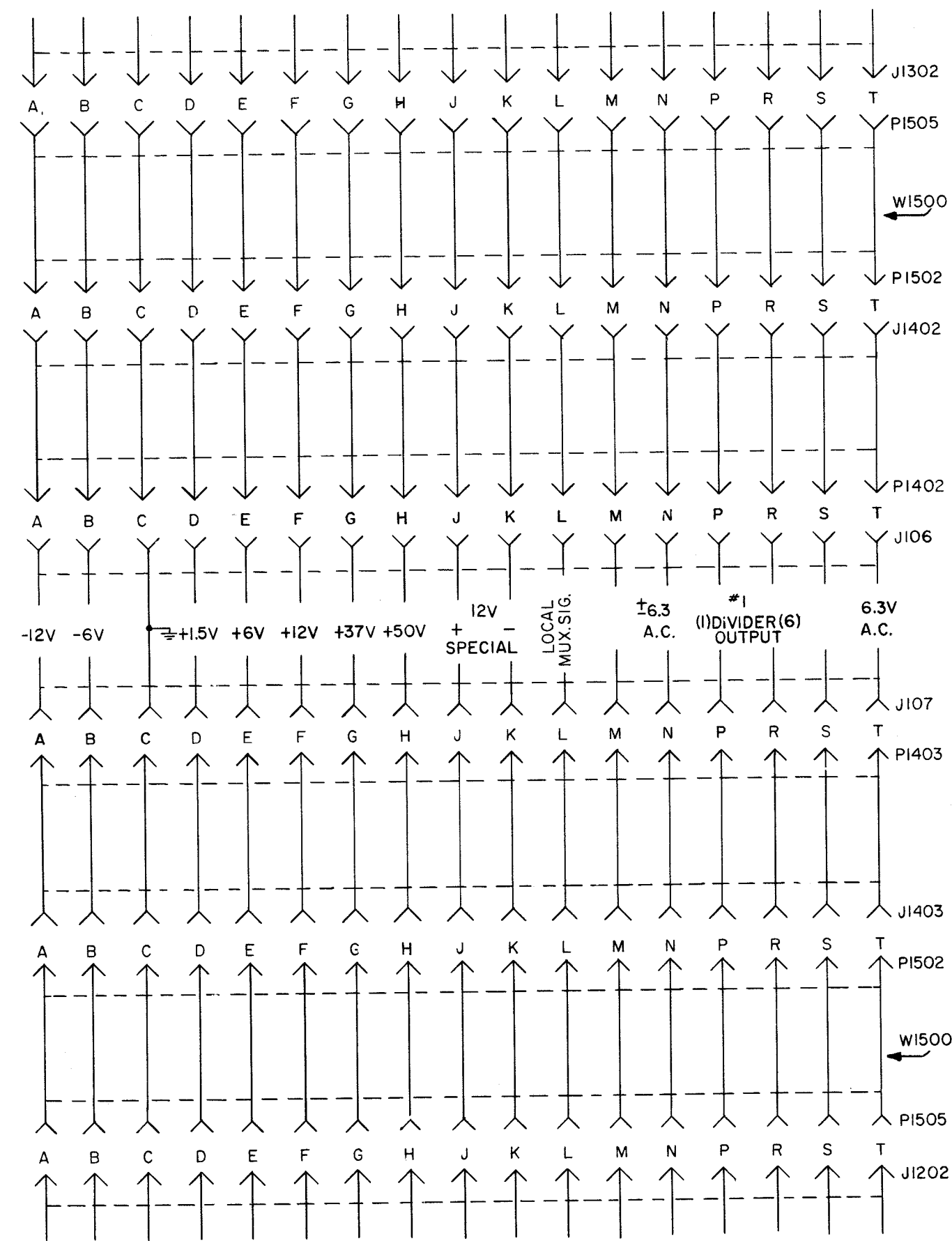
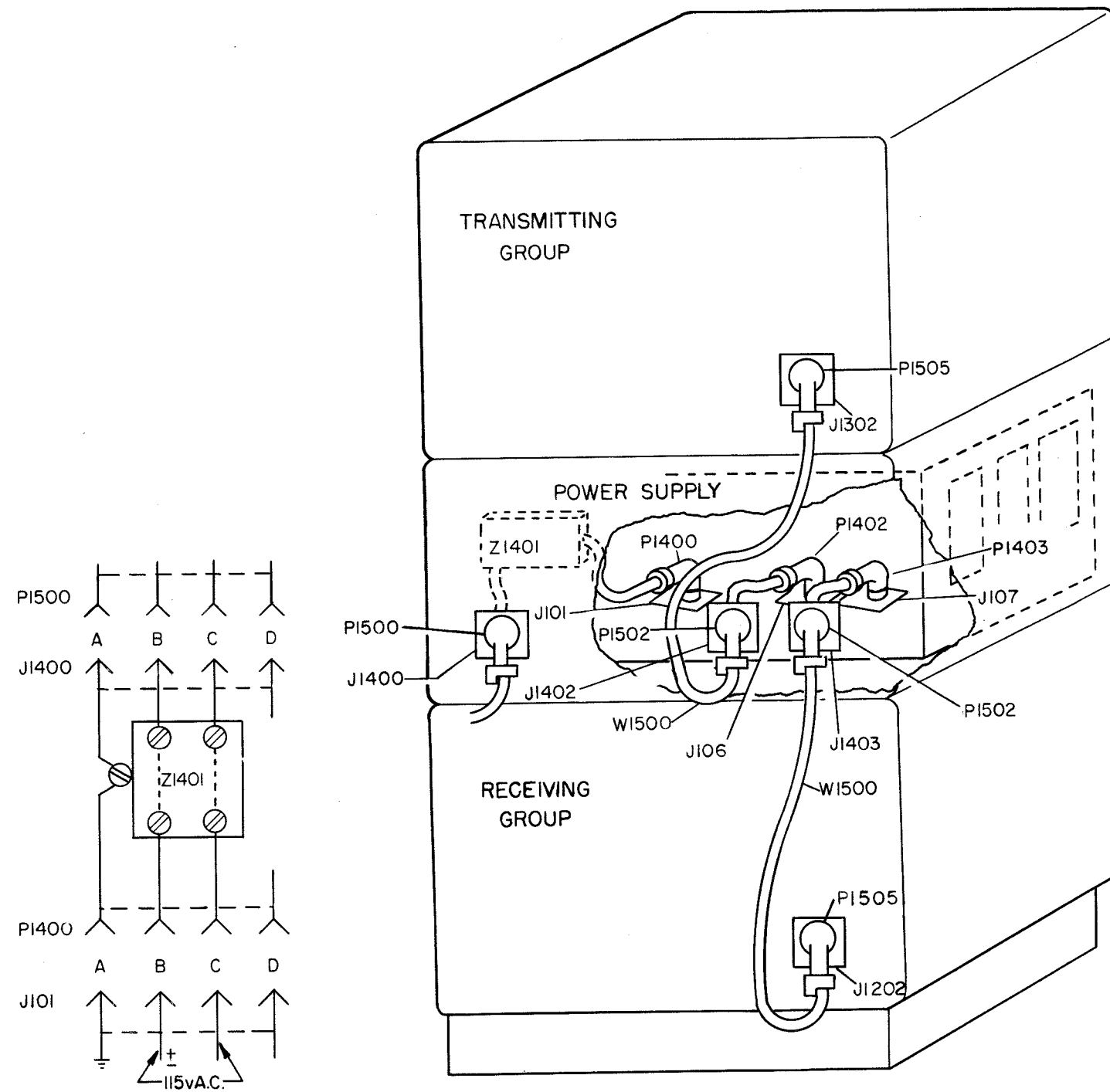


Figure 2- Power (Supply) Oscillator Connectors

NOTES																							
1	<p>WIRING LEGEND</p>																						
2	<p>TERMINAL DESIGNATIONS ENCLOSED IN PARENTHESIS ARE NOT MARKED ON COMPONENTS</p>																						
3	<p>COLOR CODE</p> <table border="0"> <tr><td>BK</td><td>BLACK</td></tr> <tr><td>BL</td><td>BLUE</td></tr> <tr><td>BR</td><td>BROWN</td></tr> <tr><td>G</td><td>GREEN</td></tr> <tr><td>O</td><td>ORANGE</td></tr> <tr><td>P</td><td>PURPLE</td></tr> <tr><td>R</td><td>RED</td></tr> <tr><td>S</td><td>SLATE</td></tr> <tr><td>Y</td><td>YELLOW</td></tr> <tr><td>W</td><td>WHITE</td></tr> <tr><td>V</td><td>VIOLET</td></tr> </table>	BK	BLACK	BL	BLUE	BR	BROWN	G	GREEN	O	ORANGE	P	PURPLE	R	RED	S	SLATE	Y	YELLOW	W	WHITE	V	VIOLET
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Y	YELLOW																						
W	WHITE																						
V	VIOLET																						
4	<p>ALL TERMINALS AS VIEWED FROM SOLDERED END EXCEPT IN AREA'S "C" AND "D"</p>																						
5	<p>GROUND STRAP CABLE TO BE CONNECTED TO BOTTOM SIDE OF CABINET.</p>																						

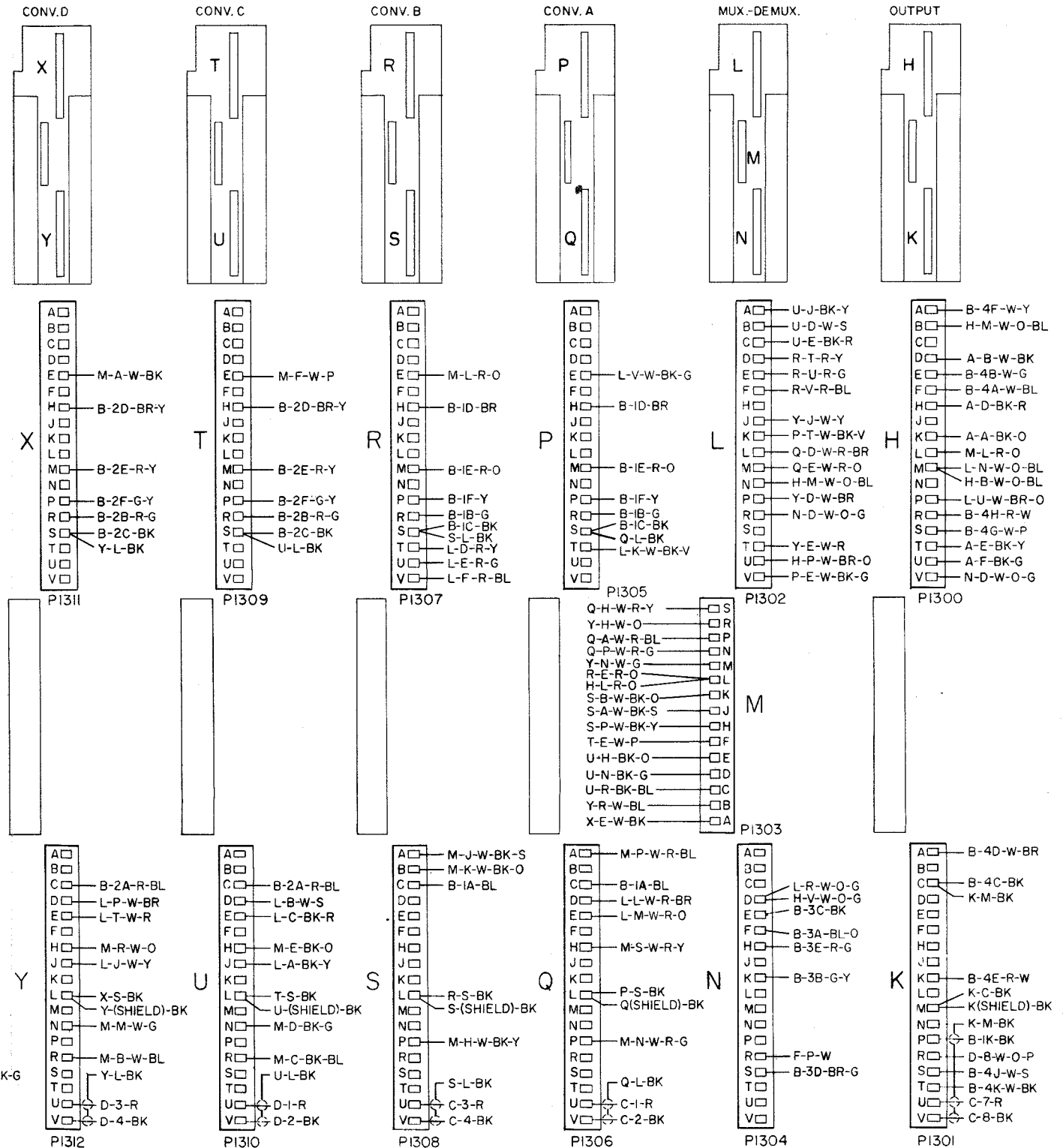
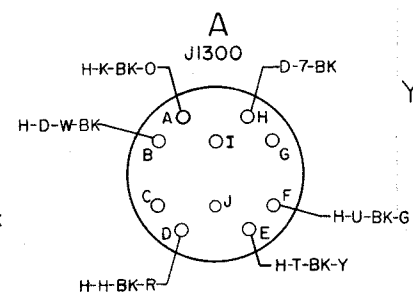
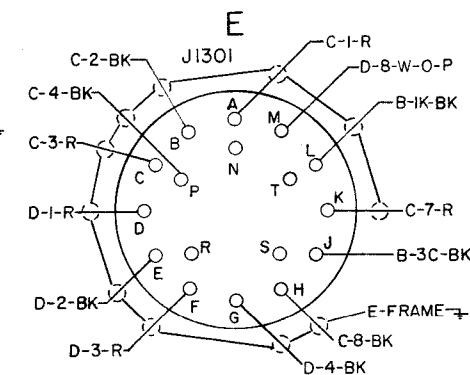
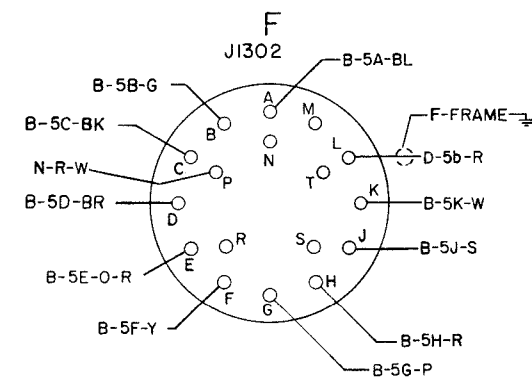
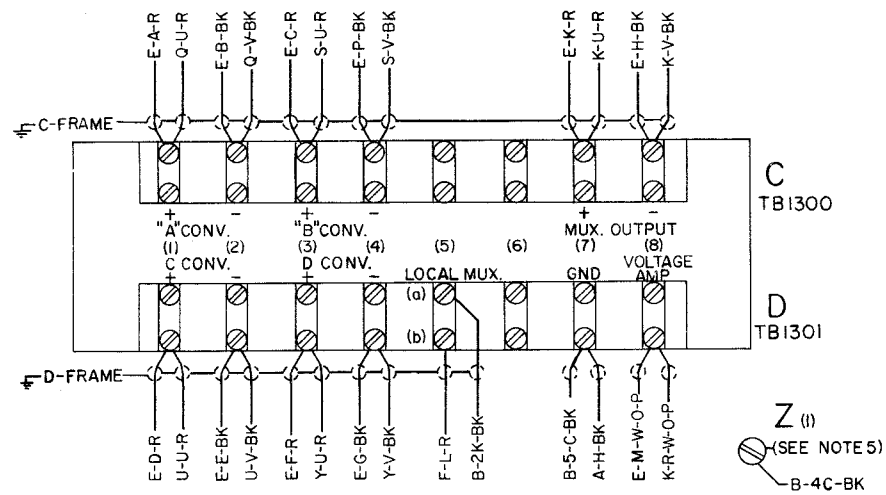
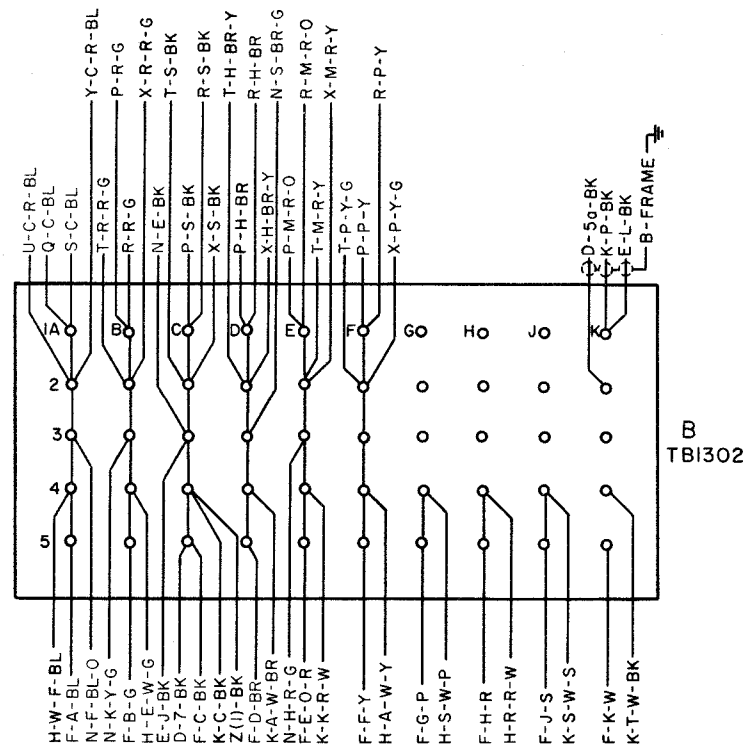


Figure 2-6 Transmitting Group Drawer Connections

NOTES																							
1	<p>WIRING LEGEND</p> <p> </p> <p> DISTANT TERMINATING AREA DISTANT TERMINAL DESIGNATION WIRE COLOR CODE </p>																						
2	<p>TERMINAL DESIGNATIONS ENCLOSED IN PARENTHESIS ARE NOT MARKED ON COMPONENTS.</p>																						
3	<p>COLOR CODE</p> <table border="0"> <tr><td>BK</td><td>BLACK</td></tr> <tr><td>BL</td><td>BLUE</td></tr> <tr><td>BR</td><td>BROWN</td></tr> <tr><td>G</td><td>GREEN</td></tr> <tr><td>O</td><td>ORANGE</td></tr> <tr><td>P</td><td>PURPLE</td></tr> <tr><td>R</td><td>RED</td></tr> <tr><td>S</td><td>SLATE</td></tr> <tr><td>Y</td><td>YELLOW</td></tr> <tr><td>W</td><td>WHITE</td></tr> <tr><td>V</td><td>VIOLET</td></tr> </table>	BK	BLACK	BL	BLUE	BR	BROWN	G	GREEN	O	ORANGE	P	PURPLE	R	RED	S	SLATE	Y	YELLOW	W	WHITE	V	VIOLET
BK	BLACK																						
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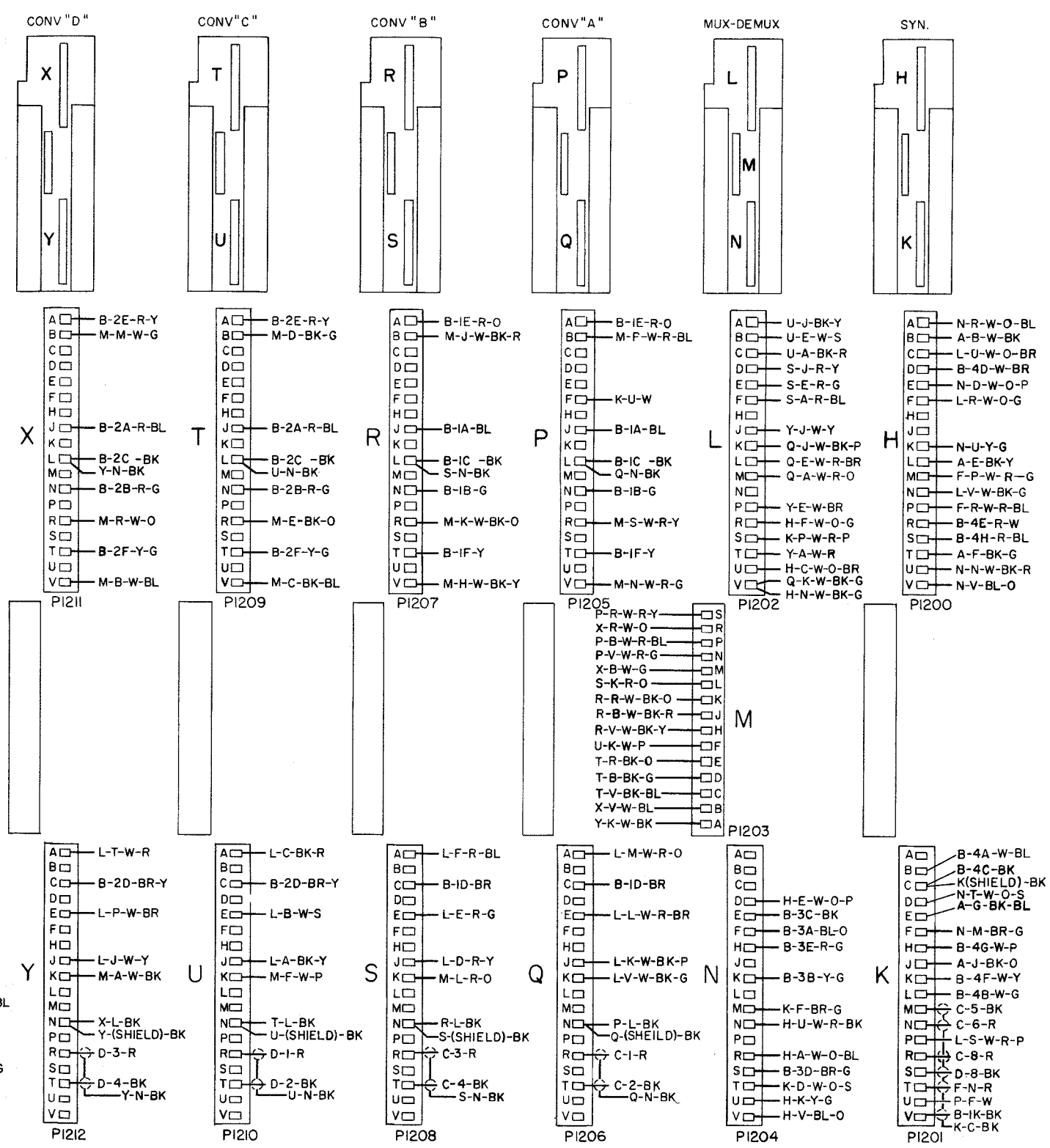
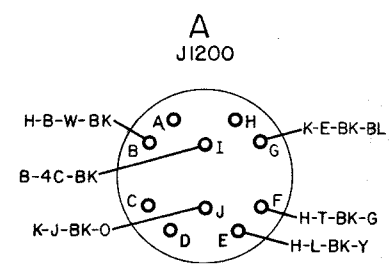
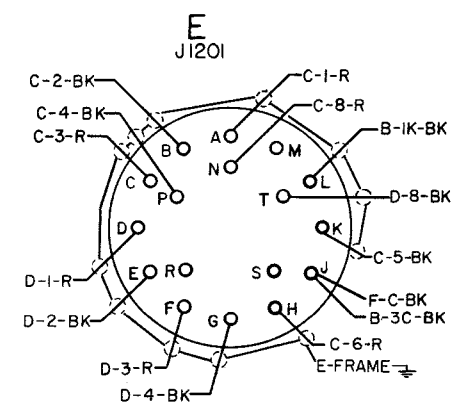
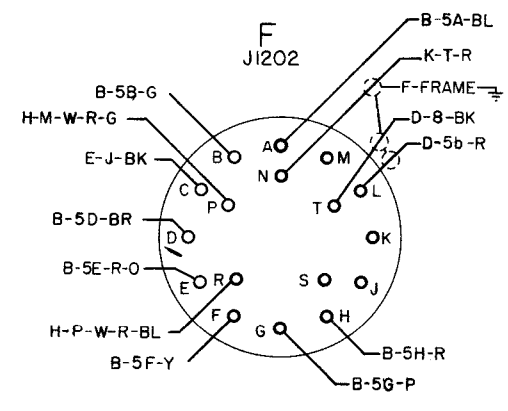
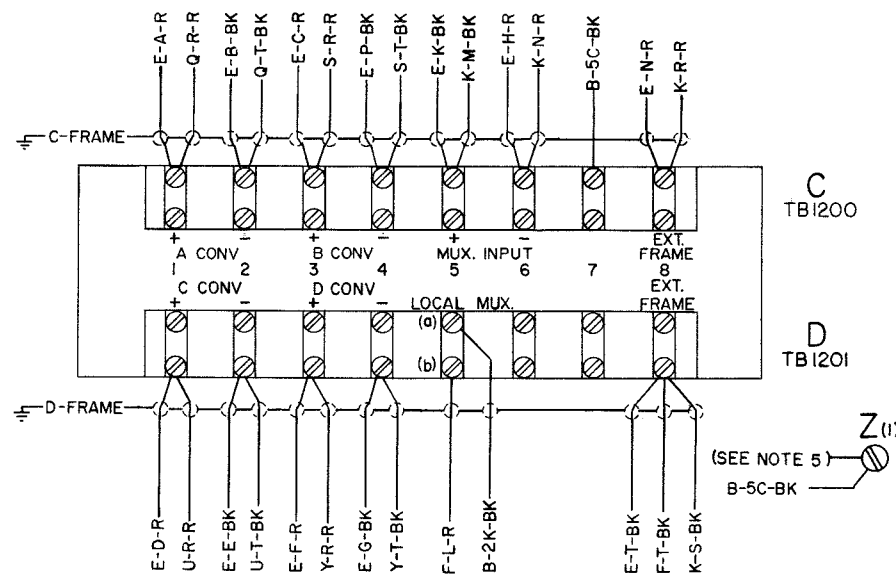
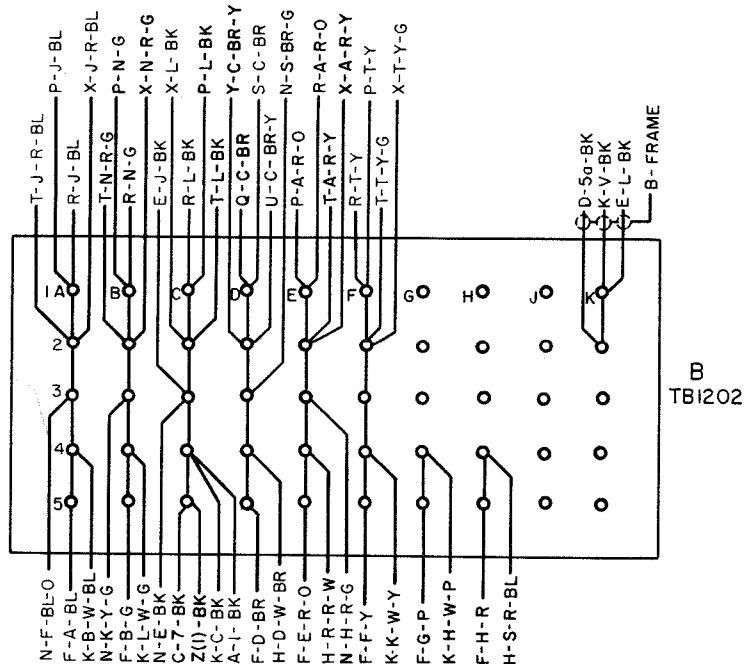


Figure 2-7 Receiving Group Drawer Connections

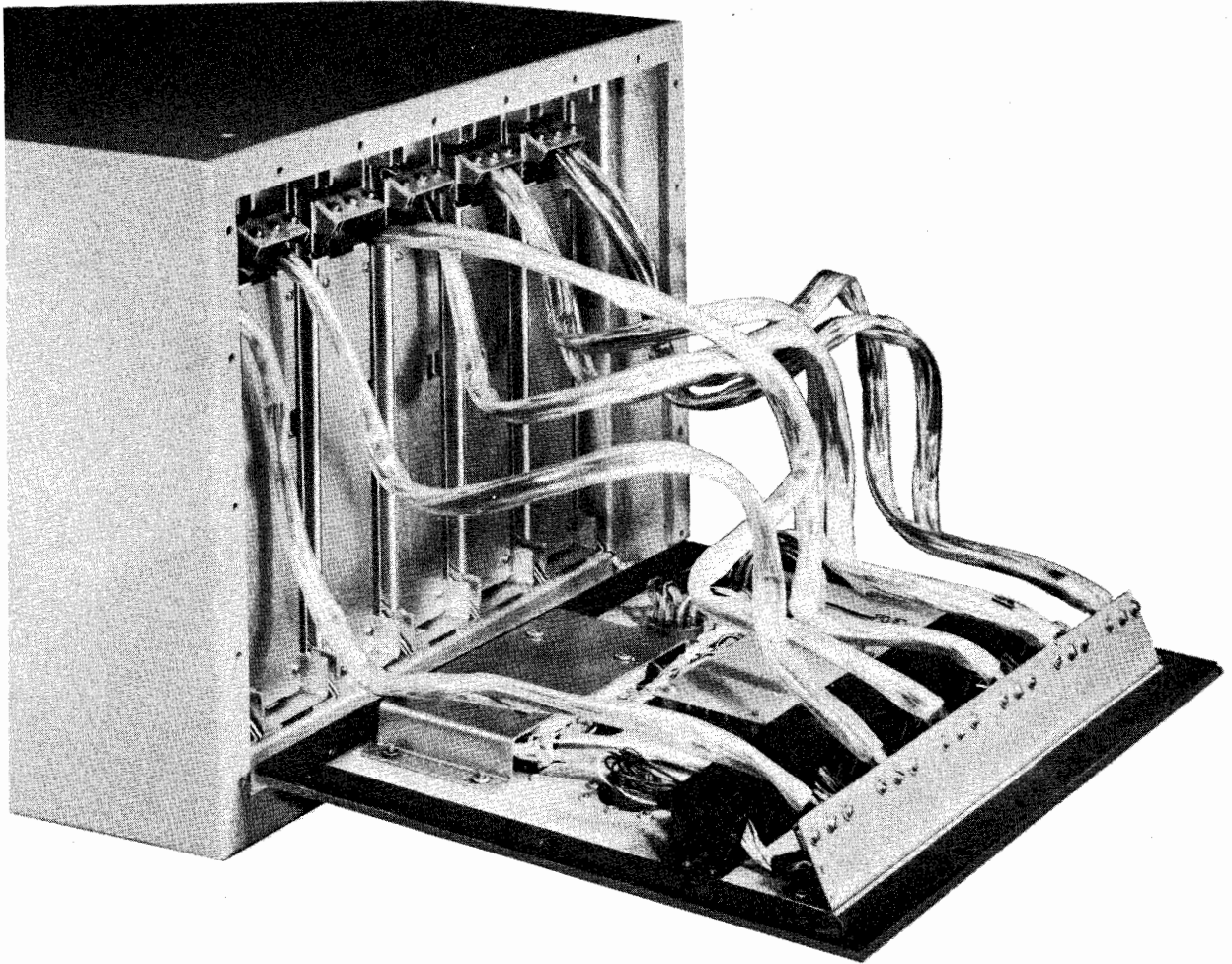


Figure 2-8. Drawer Connectors and Cable Assembly
(with Rear Plate removed).

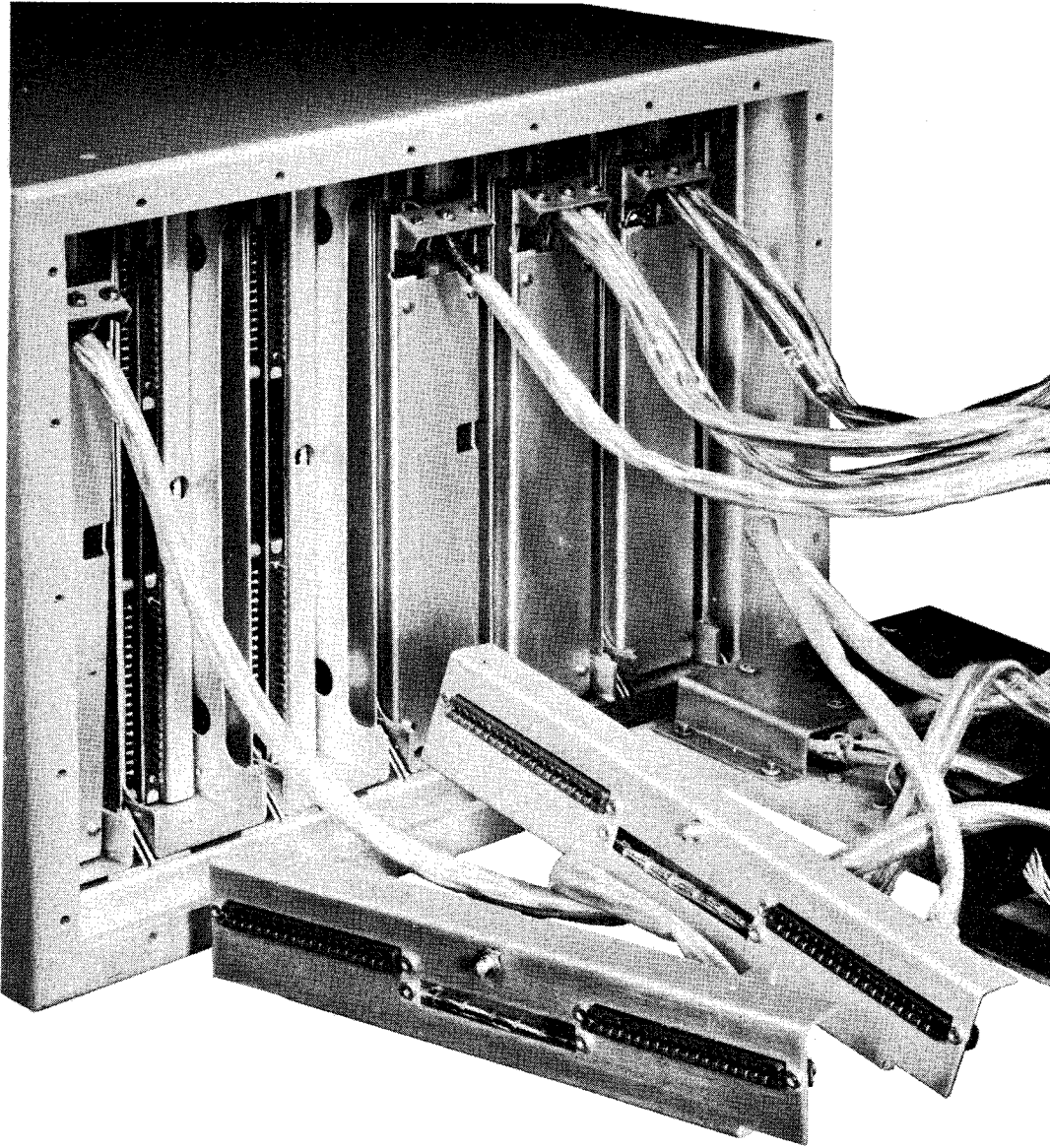


Figure 2-9. Drawer Connectors (2 Connectors Removed)

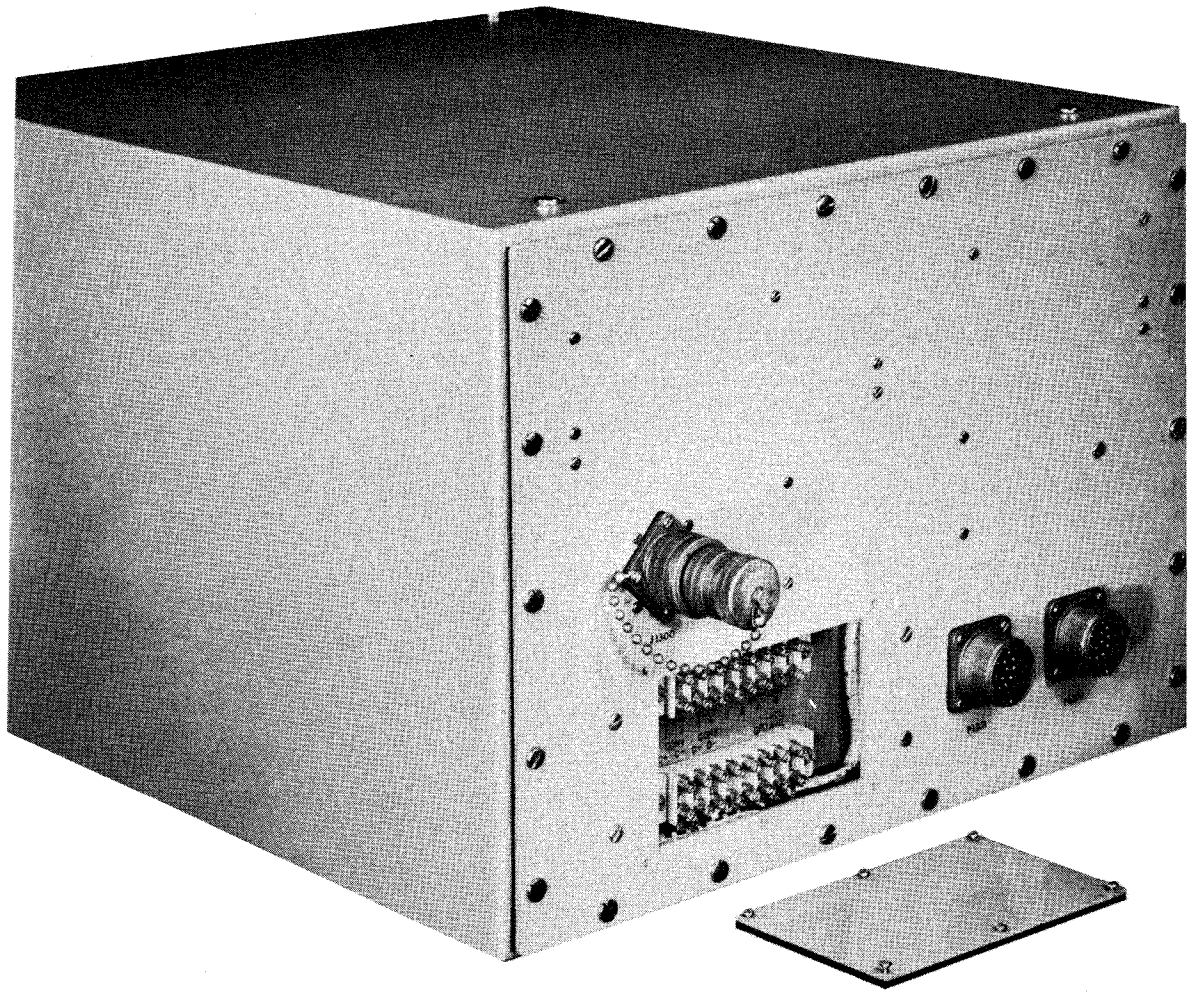


Figure 2-10. Transmitting Group - Rear View

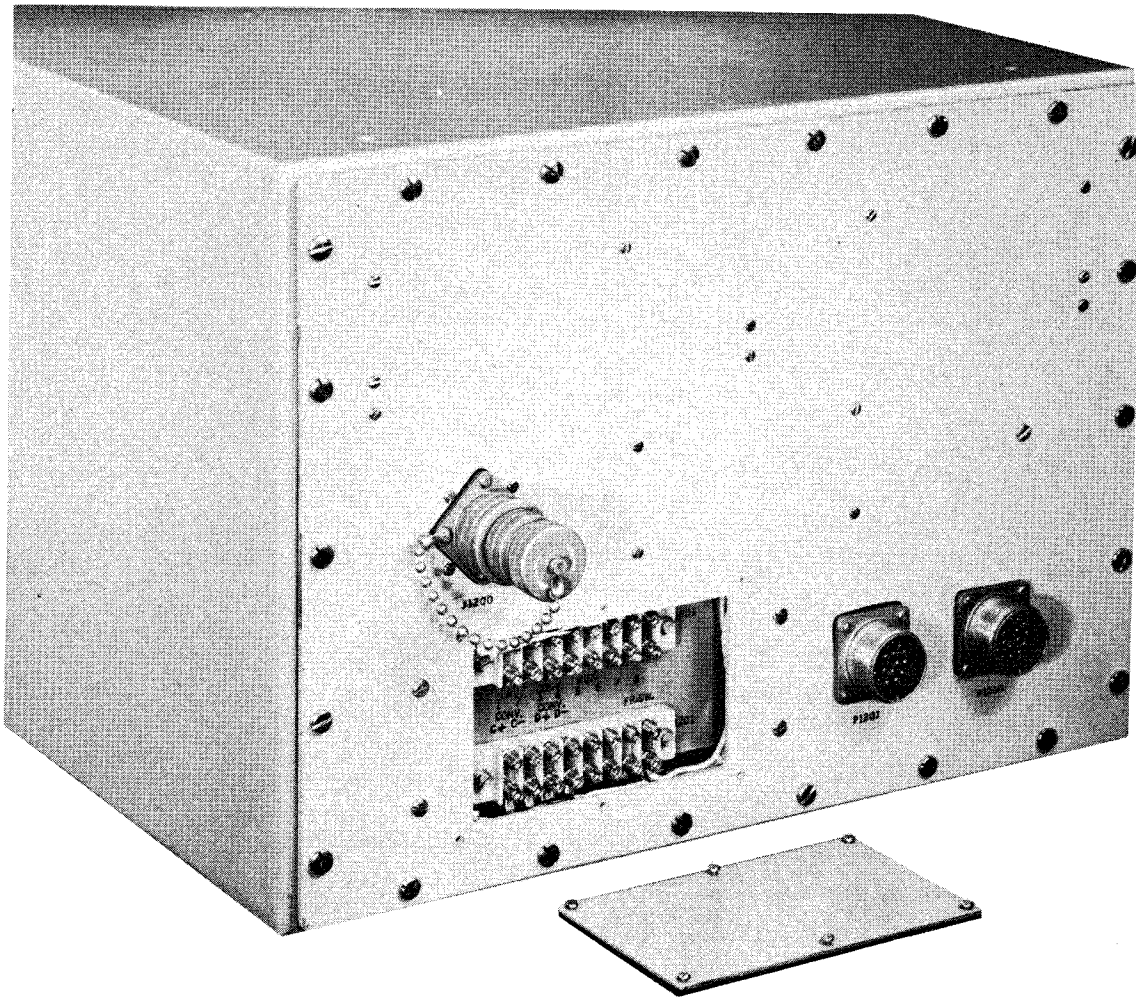


Figure 2-11 Receiving Group - Rear View

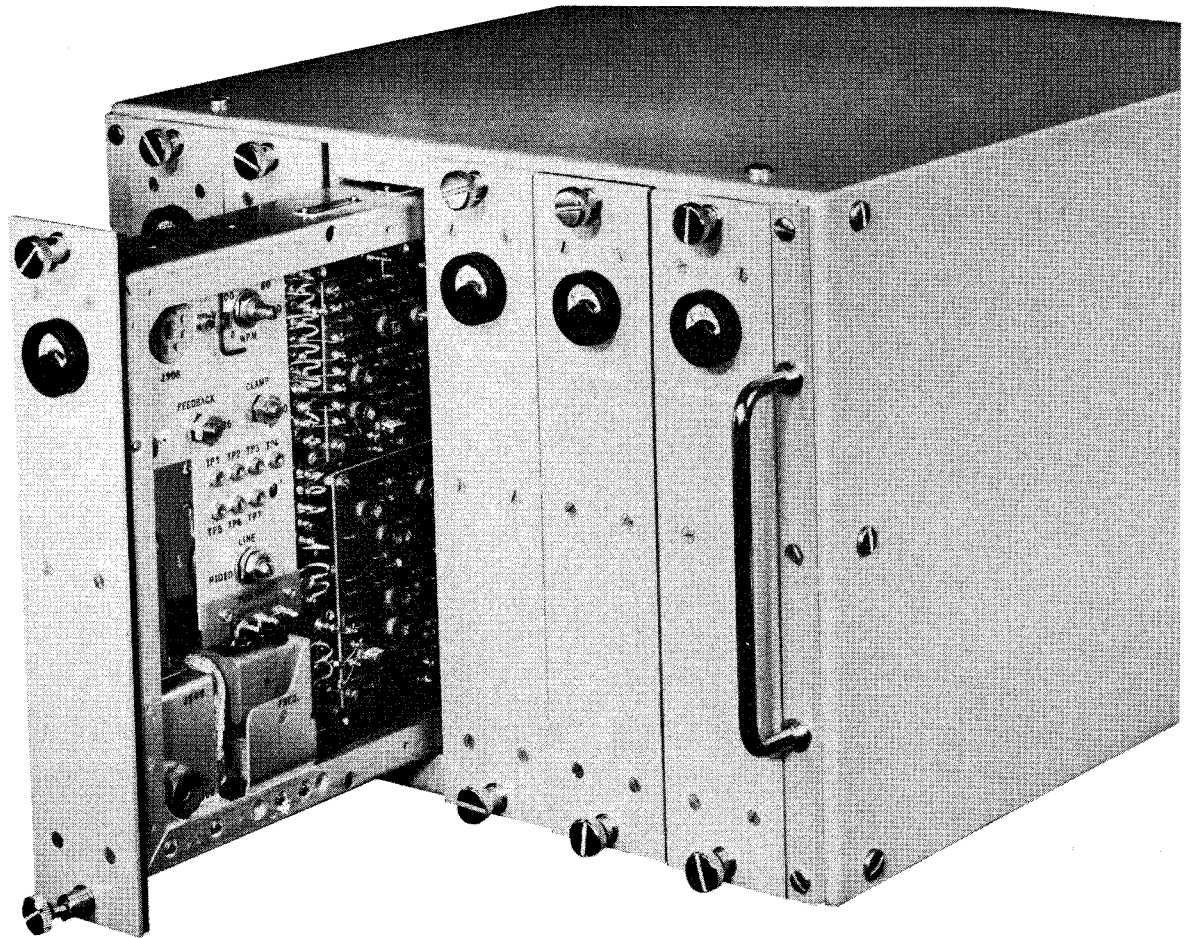


Figure 2-12 Drawer Assembly - Front View

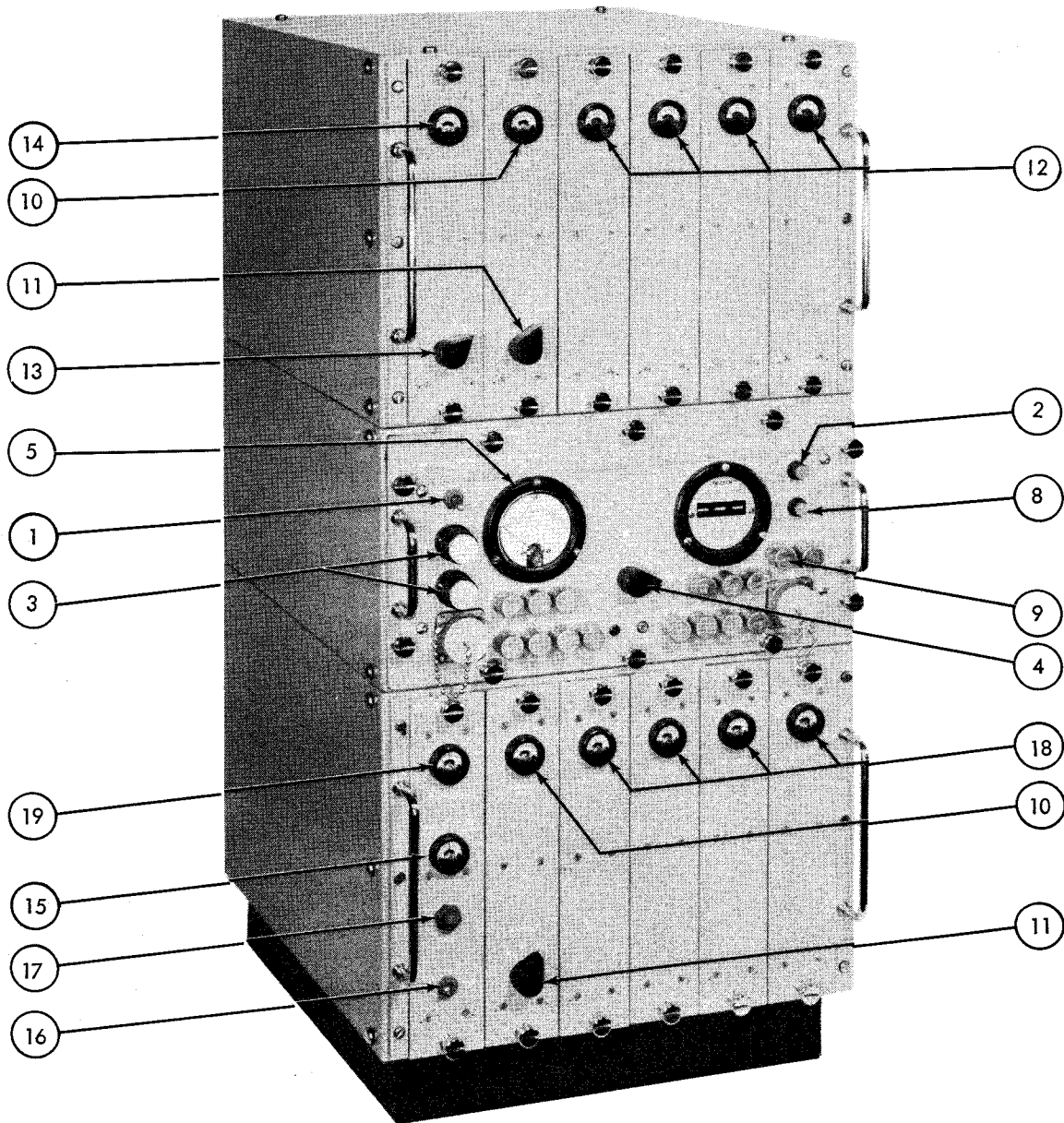


Figure 3-1 Multiplex Operating Controls

SECTION 3

OPERATION

1. FUNCTIONAL OPERATION

1.a. The Transistor Multiplex Set (Telegraph Terminal Set AN/UGC-1) provides facilities at a given station for combining two, three or four two-way START-STOP circuits into common long-haul telegraph circuits through the use of time division principles. At the distant end of the telegraph loop circuit, a duplicate equipment performs the complementary multiplexing functions. The START-STOP circuits of both terminals are made according to conventional practices, and may include any apparatus which utilizes the standard 7.42 unit START-STOP code at the speed chosen for the system operation.

1.b. The function of the Transmitting Group (OA-1054/UGC-1) is to accept START-STOP signals, detect and store the intelligence contained in the code combinations, and to assemble such information into sequential pattern, channel by channel, thereby forming the MULTIPLEX signal. This signal is then amplified and dispatched to the radio transmitting facilities of the telegraph circuit.

1.c. The function of the Receiving Group (OA-1053/UGC-1) is to accept the MULTIPLEX signal as delivered by the radio receiving facilities of the telegraph circuit. The Receiving Group in turn will detect and store the intelligence contained in the code combinations, and distribute such information in START-STOP form to the proper destinations.

1.d. The equipment transmits and receives a special type of telegraph signal (MULTIPLEX) which is intelligible only to a similar set or to an AN/FGC-5 Telegraph Terminal Set with which it is compatible. It should be noted that the latter unit operates at a speed of 60 or 75 wpm.

2. PREPARATION FOR USE

Since this equipment is a permanent installation, no preparation for use is required by the operator other than setting up a monitor in certain installations. For this discussion a typical installation consisting of the Transmitting Group, Receiving Group and common power-oscillator is considered. However, other applications may group two transmitters in a relay rack powered

by a common power-oscillator and two receivers and a power-oscillator located some distance from the transmitters. It may be necessary to provide some additional equipment to monitor the receivers.

3. OPERATING PROCEDURES

3.a. LOCATION OF CONTROLS - The more frequently used controls of the Transistor Multiplex Set are located on the front panels of the various major units in the Transmitting, Receiving and Power Supply Groups. These controls are marked (EXT) in Table 3-1 NORMAL OPERATING CONTROLS. Those located within the various drawers are marked (INT) in Table 3-1. The controls are numbered sequentially on associated illustrations to facilitate identification in the following text. Refer to DISASSEMBLY AND REASSEMBLY (Subdivision 3.) in Section 6 for procedure to open drawers.

3.b. SEQUENCES OF OPERATION

3.b.(1) Energizing the Equipment

3.b.(1)(a) Move power switch (1) located on the power supply to the ON position. Green power indicator lamp (2) should glow indicating primary power is available. Failure to glow may indicate a burned out (primary) fuse (3). Replace with spare. (Figures 3-1 and 3-3)

3.b.(1)(b) Place the voltage selection switch (4) in the red line position and observe the voltage on the d.c. meter (5). The needle should deflect to the red line position on the meter. Adjust by means of RED LINE ADJUST control (6) if red line indication is off by more than plus or minus 1 volt. (Figure 3-3)

3.b.(1)(c) By operating the voltage selection switch (4), observe (multivoltage) voltmeter (5) for the following voltages: +50, +37, +12, +6, +1.5, -6, -12 and the special 12 volt supply. No voltmeter reading (any switch position) may indicate a blown fuse. Replace the fuse with an appropriate size. Should any voltage deviate more than 5 per cent from normal, or be irregular, report the condition to a technician.

3.b.(1)(d) Observe illumination of the amber crystal oven light (8). It should remain on

TABLE 3-1. NORMAL POSITIONS OF OPERATING CONTROLS

UNIT	CONTROL	POSITION FOR NORMAL OPERATION	REMARKS
Power-Osc. TMPU201	Power Switch (EXT)	ON	
Output-Amplifier TMXU201	Signal Mode SW. (EXT) Local Remote SW. S401 (INT)	MUX Remote	Observe Output on Mux line Current Meter
Multiplexer - Demultiplexer TMD201	Channel Selection (EXT) WPM SW. S500 (INT) Aux-Normal S501 (INT)	Corresponds to Number of Channels Being Used As Applicable As Applicable	Observe DXTR operation on DXTR Cycle Meter Must agree with S900 and S700 located in transmitting and Receiving Converters When Multiplex is used in conjunction with auxiliary equip., S501 is in "AUX". Otherwise in NORMAL. When set is not used with auxiliary equipment, plugs P 1504 and P 1508 located on rear of cabinet must be in position.
Transmitting Code Converter	WPM SW. S900 (INT)	As Applicable	Must agree with S500 in Multiplexer-Demultiplexer and S700 in Receiving Converters
Synchronizer Amplifier TMS201	Auto Manual SW. (EXT)	As Required	Framing Switch should be in AUTO with an idle signal received on "A" channel
Synchronizer- Amplifier	Local Remote S200 (INT)	Remote	
Receiving Code Converter	WPM SW. S700 (INT)	As Applicable	Must agree with S500 in Multiplexer-Demultiplexer, and S900 in Transmitting Converters

for a period of 15 minutes or less following the first application of power, then cycle on and off at regular intervals. Failure of lamp to light may be caused by blown fuse (9). Replace with appropriate spare. If lamp still does not light, report the condition to a technician. Continuous burning of lamp should be reported to a technician.

3.b.(1)(e) Observe operation of the multiplexer-demultiplexer distributor cycle meter (10). The meter should be pulsing regularly at both transmitting and receiving terminals.

3.b.(2) Preparing for Circuit Operation - The following operations are to be performed when initially starting the equipment, and when preparing the equipment for application to telegraph circuits.

3.b.(2)(a) Turn the channel selector switch (11), located on each multiplexer-demultiplexer unit, to the number of channels to be used (2, 3 or 4). The distributor cycle meter should continue to pulse at a constant rate.

3.b.(2)(b) Observe line current on each of the transmitting terminal code converters (12). The four meters should read 60 to 65 milliamperes (unless operated on 20 milliamperes circuits, in which case the current should be 20-25 ma.). In order to observe the various line currents, the circuits should be in a steady mark condition. Should the meter be pinned to the left on any channel, the input line current is improperly polarized and must be reversed. This condition, as well as a low or high current reading on any channel, should be corrected by a technician.

3.b.(2)(c) Pull the output amplifier drawer out approximately 4 inches. Make sure that LOCAL-REMOTE switch (7) is in the REMOTE position (see Figure 3-2).

3.b.(2)(d) Pull the synchronizer-amplifier drawer out approximately 4 inches. Make sure that LOCAL-REMOTE switch (20) is in the REMOTE position. (See Figure 3-3.)

3.b.(2)(e) Place the operating mode switch (13) in the "M" (constant mark) position and observe the multiplex line current meter (14). The meter should read 60 to 65 Milliamperes as in Paragraph 3.b.(2)(b). Move the switch to "S" (constant space) position. The meter should now read zero. Move the switch to AC (alternating mark and space). The meter should read 30 to 32 ma. Place the switch finally in the MUX position. If the meter fails to deflect, check the external circuit.

3.b.(2)(f) The equipment should now be operated in conjunction with a distant terminal.

3.b.(3) Starting Multiplex Telegraph Circuit Operation.

3.b.(3)(a) For initial lineup purposes, it is desirable that voice or telegraph contact be made between distant terminals on separate facilities from those being used by the multiplex. However, this is not absolutely necessary.

3.b.(3)(b) Providing voice or telegraph contact has been made, the transmitting terminal should be requested to send a constant mark signal. The line current meter at the synchronizer-amplifier should then read 60-65 milliamperes as in paragraph 3.b.(2)(b). With the transmitting terminal sending an AC pattern, the meter should read 30-32.5 milliamperes. The transmitting terminal should finally be requested to transmit the multiplex signal, with no traffic on "A" channel. The line current meter (19) should now pulse irregularly.

3.b.(3)(c) Next, observe the receiver crystal meter (15). Initially the meter should deflect full scale to "fast" or "slow", followed by a series of needle "kicks". When the "kicks" cease, the equipment should be synchronized. "Kicks" should subsequently be observed on either the "fast" or "slow" side of the meter, but at a much reduced rate. Each "kick" indicates an addition or subtraction of a pulse to the crystal oscillator drive at the receive terminal.

3.b.(3)(d) Providing a multiplex signal is being generated at the transmitting terminal, and channel A is idle, AUTO MANUAL switch (16) should be moved to its AUTO position. The framing switch (17) should then be depressed until the equipment is in proper frame. By observing the channel A line current meter (18), it is possible to ascertain an "in-frame" condition. So long as an incorrect frame condition exists, the line current meter indicator will pulse. When the equipment is properly framed, the indicator will come to rest. If difficulty is experienced in framing the Receiving Group, operate the signal polarity switch (21) to the INVERTED position. If one is now able to frame the unit it indicates that inverted signals are being received. If difficulty in framing the unit is still experienced, check the position of the various controls as shown in Table 3-1.

3.b.(3)(e) The receiving converter output currents should be 60-65 milliamperes (or 20-25 ma) as recorded by the line current meters (18) and (19), as in paragraph 3.b.(2)(b).

3.b.(3)(f) It is not always practical to establish parallel voice or telegraph facilities, in

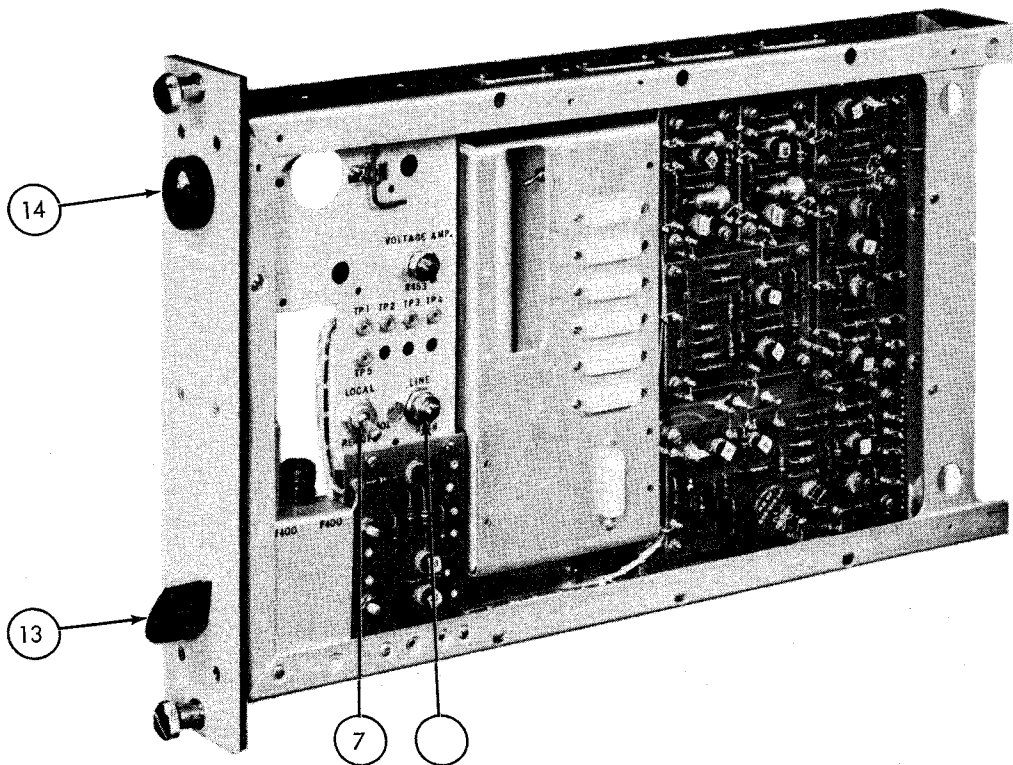
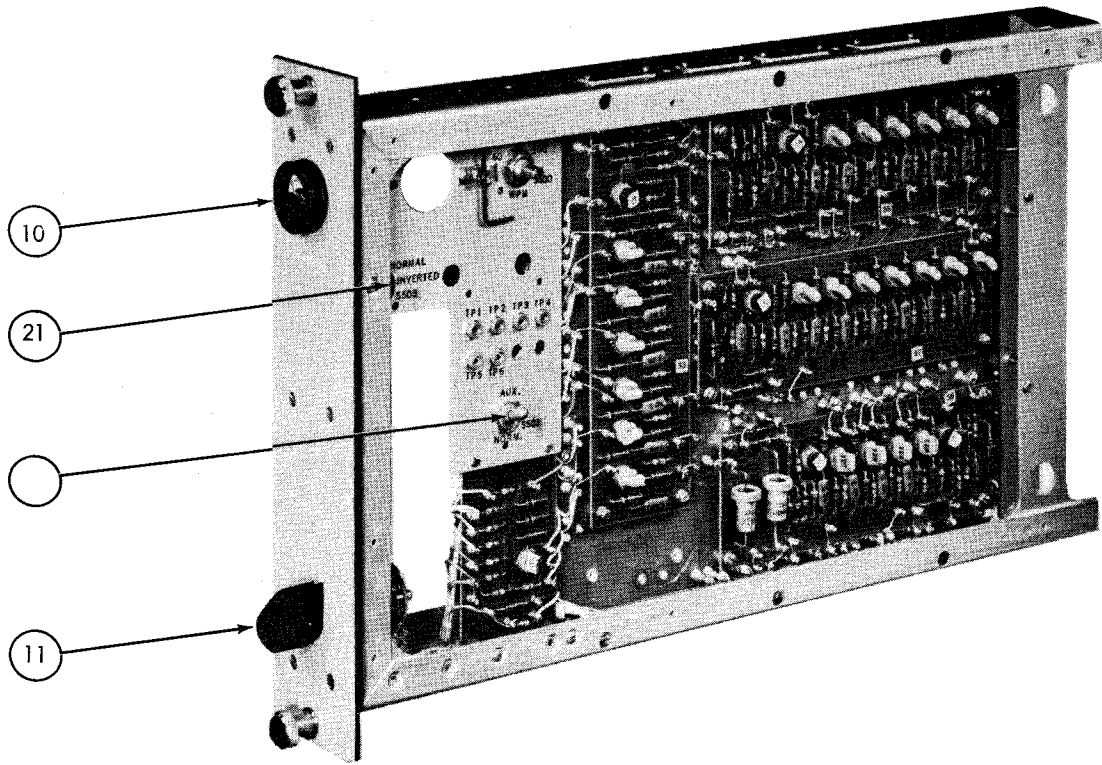


Figure 3-2 Output Amplifier and Multiplexer - Demultiplexer Controls

which case the receiving terminal must be framed when traffic may be present on channel A. If this proves to be the case, throw AUTO MANUAL switch (16) to MANUAL. Operate the frame switch (17) manually and observe copy on channel A monitor printer. When legible copy is received, the equipment is properly framed.

4. LOCAL TEST - Occasionally it becomes desirable, for circuit lineup or maintenance purposes, to connect the local Transmitting Group to the local Receiving Group. This mode of operation is usually originated by a serviceman or experienced operator.

4.a. The local Transmitting Group is connected directly to the local Receiving Group. Text messages transmitted by the local start-stop transmitters will be recorded by the local telegraph receiving equipments.

4.b. The local message center using the channels should be notified whenever a local test is being made. Bonafide traffic must not be lost by initiating a test when the circuits are in use. The following procedure should be followed:

4.b.(1) Turn the LOCAL REMOTE switch (7) of the output amplifier to LOCAL (Figure 2). Likewise, turn the LOCAL REMOTE switch (20) located at the synchronizer-amplifier to LOCAL (Figure 3). Turn the operating mode switch (13) to M (mark) (Figure 1) and observe multiplex line current. The line current should be approximately 53 milliamperes which is more than adequate for local test purposes.

4.b.(2) Frame the receiving group by operating the FRAME (17) and AUTO-MANUAL switch (16) as previously described in paragraph 3.b.(3)(d).

4.b.(3) Tests may now be run. Signals may be monitored at both the transmitting and receiving converters on each channel. Troubles within the equipment may therefore be isolated from those elsewhere in the system.

5. FUNCTIONS OF OPERATING CONTROLS - Table 3-2 lists functions of the operating controls for the units of the equipment. Refer to Figures 1, 2, 3 and 4.

6. ADJUSTMENTS

6.a. WORDS PER MINUTE - The equipment is set up initially to operate with associated 60, 75 or 100 word per minute terminal equipment. The need for a change in the speed of operation occurs infrequently. Note: A change in speed involves a gear change of all readers and printers associated with a Multiplex Set. Speeds of operation should be set up or changed using the following procedure.

6.a.(1) Select the proper crystal oscillator unit located in the power supply (Z103 for 60-75 wpm, Z104 for 100 wpm) and insert in the power supply. Place the oscillator unit not used in the RESERVE socket.

6.a.(2) Place the words per minute switch S500, located in the multiplexer-demultiplexer unit, in the proper position (Transmitting and Receiving Group).

6.a.(3) Position the words per minute switch S900, located in each transmitting code converter to the selected speed (60, 75 or 100 wpm).

6.a.(4) Position the words per minute switch S700 located in each receiving code converter to the selected speed (60, 75 or 100 wpm).

6.a.(5) Adjust the start-stop oscillator frequency in each of the eight converters as outlined in Section 6. This adjustment should be made by a technician.

7. LINE CURRENTS - Start-stop input, multiplex output, multiplex input, and start-stop output line currents must be adjusted prior to achieving operation. A 750 ohm rheostat is supplied in the Multiplex Set for fine adjustment of line current at each of the input and output circuits. Coarse adjustment must be made by adding or subtracting resistance externally. Each of the circuits is adjusted as follows:

7.a. INPUT START-STOP ADJUSTMENT - The line current requirements are dependent upon the associated monitoring equipment; strap the appropriate two terminals on TB907 (for either 20 or 60 milliamperere requirements). Then, while receiving a steady marking condition, adjust the line current on each of the four input lines by means of R1036, located in the transmitting code converters. Should the line current meter read in the reversed direction, the battery is improperly polarized and must be reversed. Fig

7.b. OUTPUT MULTIPLEX LINE CURRENT - The d.c. potential for the output multiplex signal is externally supplied and must be properly polarized. With the potential (battery) applied, and the signal mode switch turned to M (mark), adjust the Multiplex output line current by means of vernier rheostat R448 located in the output amplifier.

7.c. INPUT MULTIPLEX LINE CURRENT - The d.c. potential for the input multiplex signal at the receiving terminal must also be supplied externally. With a steady "mark" applied at the input, adjust the input multiplex line current by rotating vernier rheostat R218 located at the synchronizer-amplifier.

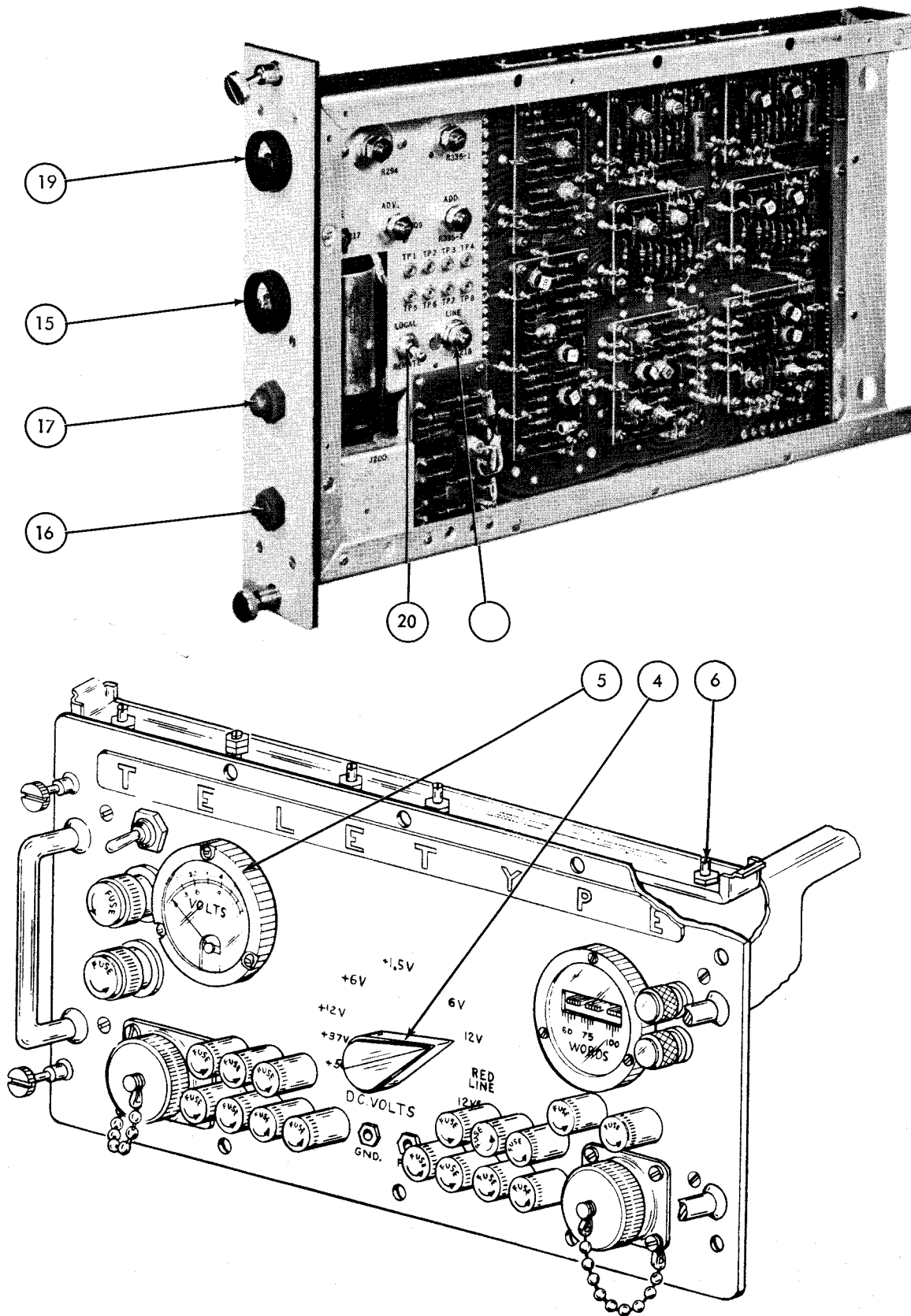


Figure 3-3 Power Supply and Synchronizer Controls

TABLE 3-2. FUNCTIONS OF OPERATING CONTROLS

UNIT	CONTROL	FUNCTION
Power Supply-Oscillator	Power switch Voltage Selection (DC VOLTS) RED LINE ADJ.	Switches AC power input ON or OFF. Selects voltage input to the voltage monitor meter. Matches tap on transformer primary to AC input voltage.
Output Amplifier	Operating Mode Switch (S400) REMOTE LOCAL switch	Provides 3 special multiplex outputs (for circuit test purposes) in addition to the regular multiplex signal: steady mark, steady space and alternating mark and space (M, S, AC, MUX) Routes the output signal to the remote or local circuits.
Multiplexer - Demultiplexer	Channel Selection Switch (S502) Signal Polarity Switch (S501)	Determines the number of output multiplex channels which are transmitted (2, 3, 4.) Reverses polarity of multiplex signal applied to the two matrix inputs at the receive terminal. Not used at the transmitting terminal. (NORMAL, INVERTED)
Synchronizer - Amplifier	Framing Switch (S202) Framing Mode (AUTO, MAN) REMOTE LOCAL switch	Passes framing pulses for achieving a proper phase relationship between transmitting and receiving terminals. (FRAME) Determines whether pulses are fed automatically to the phasing circuits (AUTO) or individually, one for each operation of the framing switch (MAN) Determines which input circuit (local or remote) will be applied to the receiving terminal.

7.d. **OUTPUT START-STOP LINE CURRENT**
- With d.c. potential (battery) applied externally, and a steady "mark" on the line, adjust the output start-stop line current to the correct value by rotating vernier rheostat R724 in the receiving code converters.

8. TEST PROCEDURES

8.a. The Multiplex Set includes a neon lamp indicator for use with the transmitting or receiving code converter. This feature permits visual checking of each level of operation. The indicator is operated as follows:

8.a.(1) Pull out the output amplifier drawer in which the neon indicator is stored. The indicator may be used without detaching it from the drawer, or it may be removed and placed at

a convenient eye level. For portable use, release the two quarter-turn fasteners on the output amplifier.

8.a.(2) The line cord should be removed from its storage space at the upper left hand section of the equipment and inserted in any convenient 117 volt a.c. outlet. Normally, the convenience outlets on the front of the power-oscillator are used. All seven neon lights should fire.

8.a.(3) Next remove the octal plug with its associated cable and insert the plug in the octal socket located behind the transmitting or receiving converter front panel. Operation of the storage elements of the converter may now be observed by the firing of the six top neon indicators. The seventh neon lamp indicates that the a.c. power is on.

TABLE 3-3
 POSITIONS OF OPERATING CONTROLS WHEN AN/UGC-1
 IS OPERATED WITH THE TSEC/KW-22 AUXILIARY EQPT.

UNIT	CONTROL	POSITION FOR OPERATION	REMARKS
TRANS.GROUP	P1508	REMOVE SHORTING PLUG - INSERT P1508 IN J1300	CONNECT P1508 CABLE TO TRANS PORTION OF/KW-22
REC.GROUP	P1504	REMOVE SHORTING PLUG - INSERT P1504 IN J1200	CONNECT P1504 CABLE TO REC. PORTION OF/KW-22
MULTIPLEXER -DEMULPLEXER TMD201	AUX-NORMAL S501(INT)	"AUX"	ALL OTHER CONTROLS SET AS SHOWN IN TABLE 3-1.

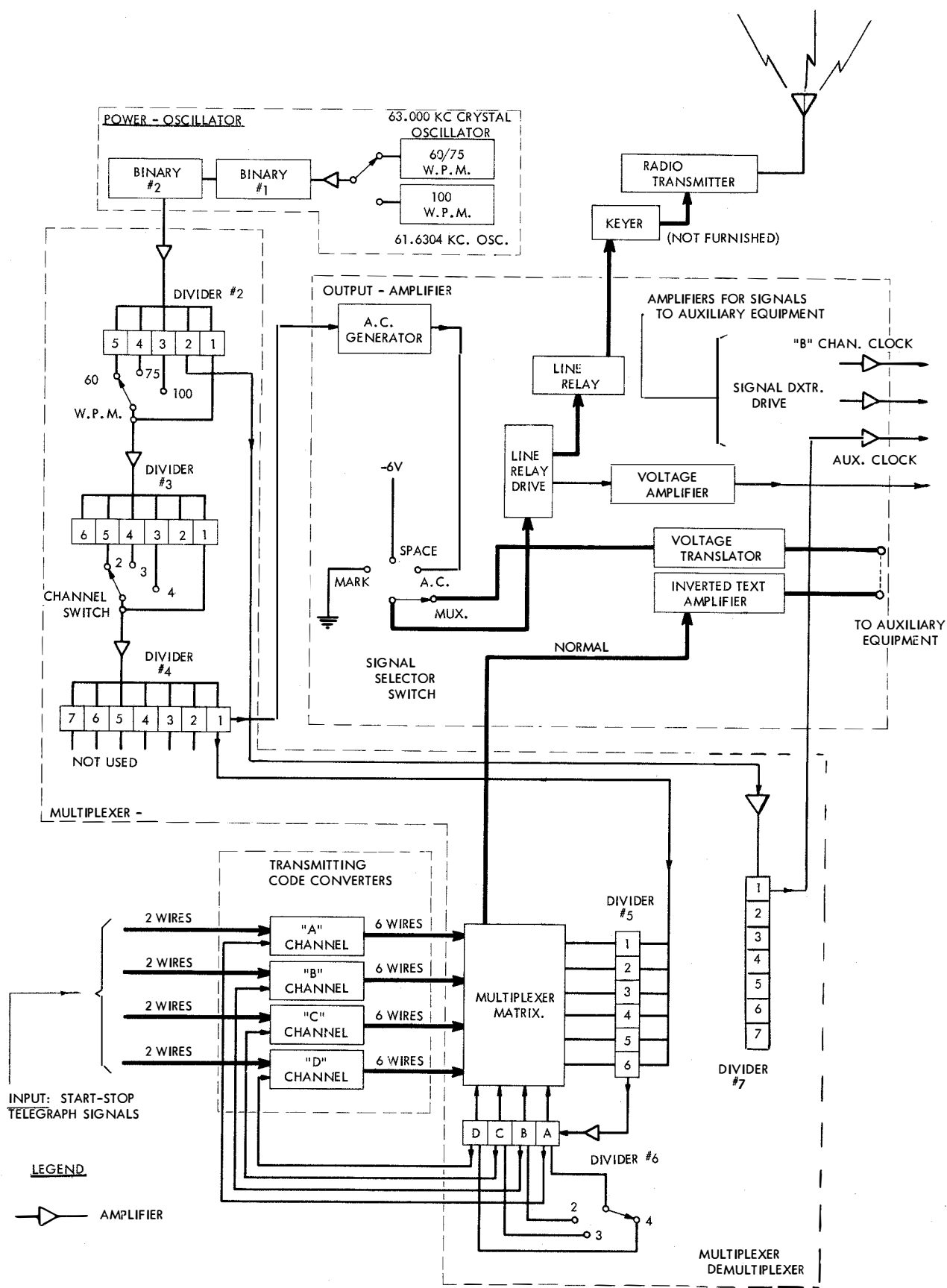


Figure 4-1 Detailed Block Diagram of Transmitting Station

SECTION 4

PRINCIPLES OF OPERATION

1. GENERAL

1.a. This section explains the operation of the Transistor Multiplex Set (Telegraph Terminal Set AN/UGC-1). The Set provides terminal facilities for a multiplex system which will simultaneously transmit two, three or four separate teletypewriter messages over a common channel (see Subdivision 2 of Section 1).

1.b. Multiplexing can be accomplished in several different ways. Frequency-division multiplexing, for example, employs a number of tone channels slightly displaced in frequency. Each tone channel carries the signals from a separate teletypewriter circuit and modulates a common frequency carrier. Time division multiplexing, on the other hand, divides the time duration of a standard start-stop signal into a number of equal intervals and allots each interval to a separate teletypewriter circuit. Thus the start-stop signals are, in effect, compressed in time for transmission. The Set covered in this bulletin is designed to operate in a time-division system.

2. OVERALL OPERATION (Figure 4-2)

2.a. Figure 4-2 is a simplified block diagram of a typical time-division multiplex system employing the Transistor Multiplex Set. Functional descriptions of the Set and its major units appear in Section 1. A.c. and d.c. voltages for the major units are provided by the power supply portion of the power oscillator (/UGC-1) which is not shown in figure 4-2.

2.b. At the transmitting station, four start-stop transmitters (not furnished with the Set) simultaneously send four messages in the form of start-stop signals to respective transmitting code converters (CV-408/UGC-1) in the Transmitting Group (OA-1054/UGC-1). The code converters translate these signals, which are in sequential form, into six-wire parallel form. The start and stop elements of the signals are discarded and a sixth element is added. The multiplexer-demultiplexer (TD-134/UGC-1) sweeps over the outputs of the code converters, channel by channel, and picks up, in turn, a complete signal (character) from each converter at the multiplex frequency rate. This rate is controlled by a crystal-oscillator circuit. Pulses generated by this circuit and various

dividing circuits step the multiplexer at the proper rate. By varying the pulse-division ratio, the equipment may be switched to operate with two, three or four start-stop circuits (referred to as channels A, B, C and D), or to accommodate start-stop speeds of 60, 75 or 100 words per minute. The multiplexer combines the multiwire signals received from the converters into multiplex signals and sends them to the output amplifier (/UGC-1). The latter amplifies the signals and furnishes them to transmitting equipment which is not furnished with the Set (see Figure 1-1). The outputs of the amplifiers may be either keyed voltage or 60 milliamperes d.c. multiplex signals. The transmitting equipment applies the multiplex signals to the radio channel which carries them to a distant station. As indicated in Figure 4-2, the multiplex signals contain certain inversions which are explained in paragraph 3.b. of this section.

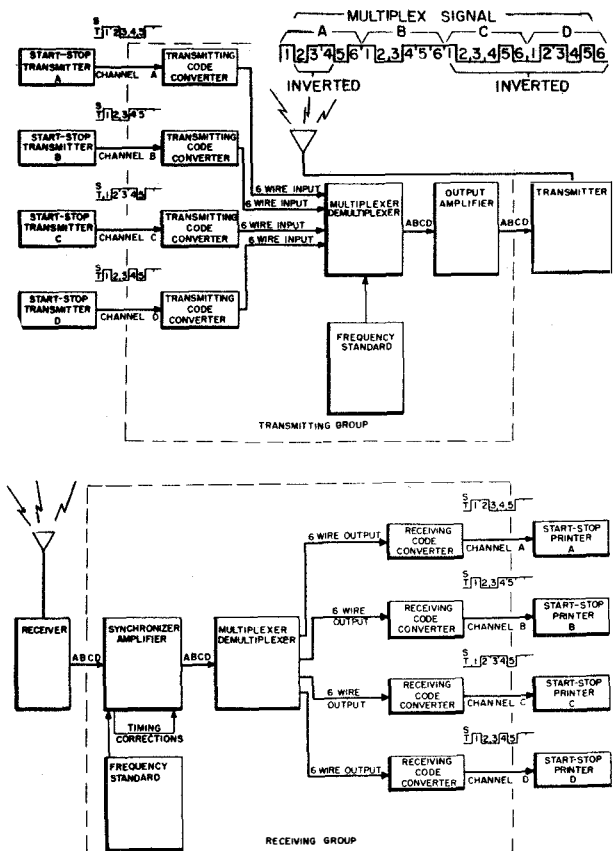


Figure 4-2. Simplified Block Diagram of Typical Time - Division Multiplex System

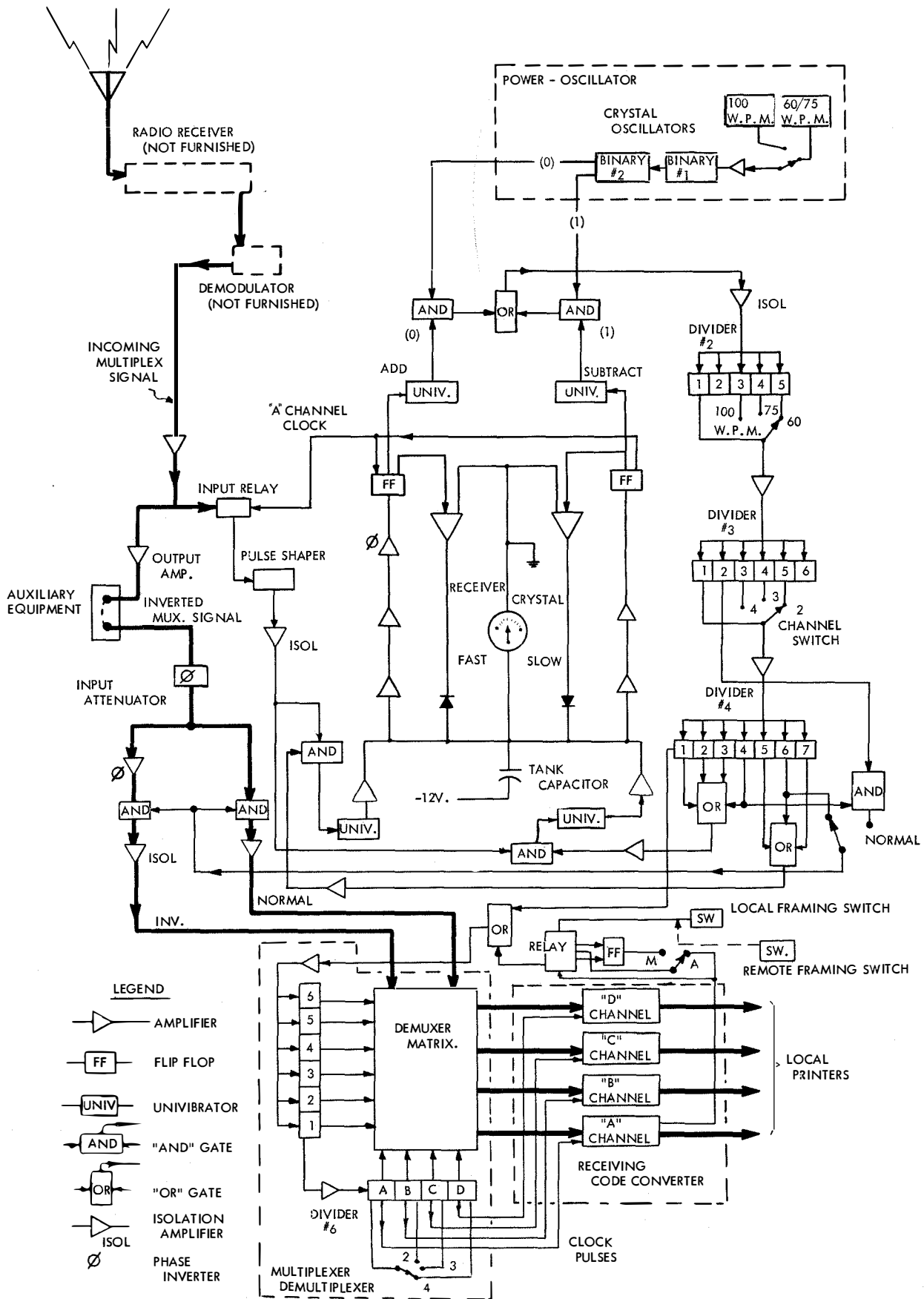


Figure 4-3. Detailed Block Diagram of Receiving Station

3.a.(2) The total number of permutations of a five-unit code is two to the fifth power, or 32. In order to transmit more than 32 characters and functions, a letters-figures shift operation is designed into the printing equipment. Thus each permutation, excluding those used to shift and unshift the apparatus, may represent two characters or functions.

3.a.(3) Only the intelligence elements of the code appear in perforated tape. The start and stop elements are added by the transmitting equipment. The marking pulses are represented by holes and the spacing pulses by the absence of holes. The various code combinations of a typical character arrangement as they appear in chadless tape form is shown in Figure 4-4c.

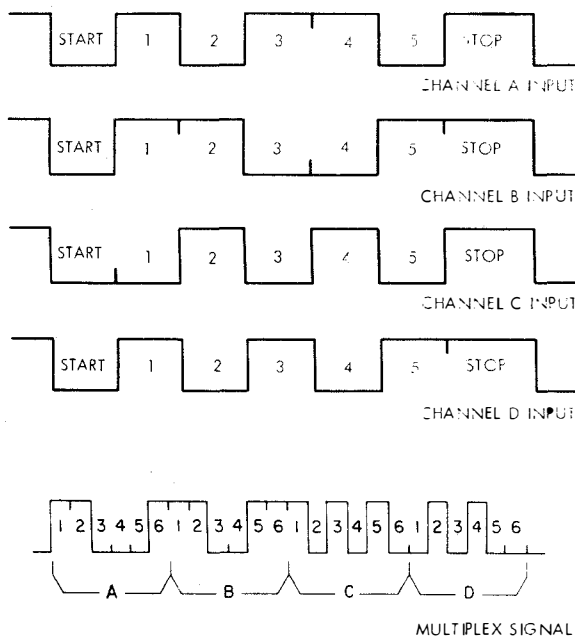
3.b. MULTIPLEX SIGNALS (Figures 4-5 & 4-28)

3.b.(1) Consideration of the concept of time-division multiplexing will reveal several important consequences:

- The original start-stop signal must be compressed (Figure 4-5).
- The outputs of the channels (referred to as A, B, C and D) must be transmitted in the proper sequence (in this case ABCDABCDAB--).
- Both transmitting and receiving equipment must be running in synchronism within very close limits.

3.b.(2) In conventional teletypewriter systems, the essential synchronization between the transmitting and receiving equipments is accomplished on a character-by-character basis with the start pulse synchronizing the start of all receiving equipments and the stop pulse providing an idle time interval so that all units can start together on the next start pulse. On the other hand, the time-division multiplex system covered here is a fully synchronous system. The receiving terminal is maintained in step with the transmitting terminal in both frequency and phase. Frequency is maintained by a very accurate standard which is derived from a temperature-controlled crystal oscillator. Phase relationships are maintained by special circuitry in the receiving equipment. There is no need to transmit a start pulse or a stop pulse as part of the multiplex signal. Consequently, only the five intelligence elements of the start-stop signal are used, and a sixth pulse, whose function will be described later, is added.

3.b.(3) In order to provide for speed and phase differences in start-stop systems, the receiving unit always runs slightly faster than



COMPOSITION OF MULTIPLEX SIGNAL: FOUR START-STOP SIGNALS ARE COMPRESSED WITH RESPECT TO TIME AND TRANSMITTED CHANNEL BY CHANNEL. PULSES 2, 3 AND 4 ON CHANNEL A AND ALL PULSES ON CHANNELS C AND D ARE INVERTED (MARK FOR SPACE AND SPACE FOR MARK).

Figure 4-5. Multiplex Signal

the transmitting unit. This speed difference is not cumulative because the stop pulse and the next start pulse permit synchronizing on every character. On the other hand, although the multiplex transmitting equipment operates faster than the start-stop input equipment, there is a constantly sliding, or varying, phase relationship between the start-stop and the multiplex signal with the multiplex signal continuously gaining on the start-stop signal. When the multiplex signal has moved so far ahead that the next start-stop signal cannot be transmitted, the system transmits an idle signal for that channel. The following multiplex signal will then carry the start-stop signal which could not be transmitted previously.

3.b.(4) The multiplex equipment must be capable of distinguishing between an all-spacing combination in the start-stop code (blank) and a multiplex idle signal. The start-stop blank is a true character which must be transmitted, while the multiplex idle signal signifies the absence of a start-stop signal. The multiplex equipment utilizes a sixth pulse to make this distinction. The sixth pulse is transmitted along with each character. When a bona fide blank is to be transmitted, the sixth pulse is the only pulse sent in that particular channel. During idle periods or the speed difference delay period, no sixth pulse is sent; consequently the receiving multiplex recognizes the idle condi-

tion and an idle signal (continuous marking for the period of the signal) is sent to the receiving teletypewriter.

3.b.(5) Since timing is a basic concept in understanding multiplex transmission, it is worthwhile to consider some actual examples of the periods involved. At 60 wpm, a start-stop character is nominally 163 milliseconds long. A multiplex signal is slightly shorter (thus faster), nominally 160 milliseconds. Thus a time difference of three milliseconds exists for every start-stop character coming in. After 53 characters the accumulated time difference is 159 milliseconds and the next multiplex signal to be transmitted will be the time differential blank. Thus, one time differential blank will be transmitted for every 53 (approximately) start-stop characters transmitted. Minute speed variations may affect this figure slightly.

3.b.(6) Since four characters (one from each of the four channels) are transmitted in sequence as a multiplex signal in 160 milliseconds, each character must be "compressed" to a 40 millisecond signal, and this 40 millisecond signal must include the five intelligence pulses plus the sixth pulse (Figure 4-5). Consequently each mark or space in the multiplex signal is one-sixth of 40 milliseconds or 6.66 milliseconds long.

3.b.(7) As mentioned above, the receiving equipment must remain in synchronism with the transmitting equipment within rather close limits. For example, at the time the number 1 pulse on Channel A is transmitted, the receiving equipment must be ready for Channel A, number 1 pulse, and not one of the other 23 pulses. The initial synchronizing, explained elsewhere in the text, is called "framing." Crystal control of timing gives a "coarse" control to maintain proper synchronism.

3.b.(8) Fine control is achieved by the continuous examination of the timing of space-to-mark transitions so that any timing differences between transmitting equipment and receiving equipment are continuously corrected and do not become cumulative. However, it is possible that all four-start stop circuits could be idle for varying periods of time. The absence of space-mark transitions could cause loss of synchronism when traffic resumes and result in garble and lost messages. This possibility is eliminated by certain signal inversions that are built into the multiplex signal. The transmitting equipment inverts the second, third and fourth pulse of Channel A and all pulses of Channels C and D (Figure 4-5). Without these inversions, an idle condition in the start-stop equipment would be transmitted as all-spacing groups. The inversions result in the following pattern:

A	B	C	D
1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
S M M M S S	S S S S S S	M M M M M M	M M M M M M

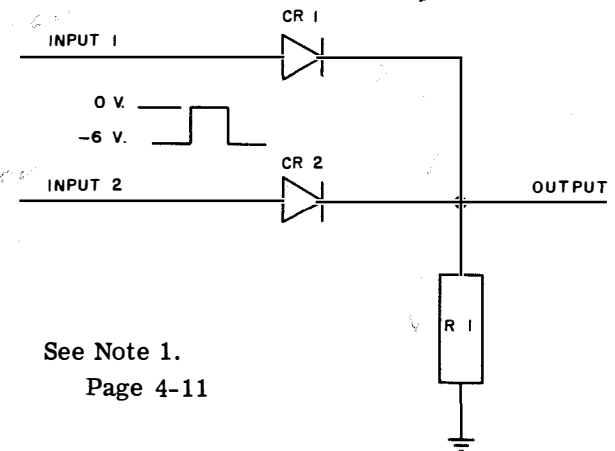
These inversions appear in all multiplex transmission; corresponding re-inversions in the receiving equipment result in the reproduction of the original intelligence. See Figure 4-28 which follows a number of typical signals through the system.

4. BASIC CIRCUITS AND NOMENCLATURE

4.a. A number of basic circuits are used repeatedly in multiplex equipment. An understanding of these circuits in simplified form will facilitate the understanding of the complete equipment. These "building-block" circuits will now be described:

4.b. Diode Logic - Circuits containing only diodes and resistors are used to perform two different switching functions. These are called "AND", and "OR" circuits, according to the logical functions they perform. Both types are often called "gate circuits". Figures 4-6, 4-7

4.b.(1) Logical AND Circuit - This circuit has several inputs and a single output. Its function is to deliver an output signal only when all of its inputs are marking.



See Note 1.

Page 4-11

Figure 4-6 Diode Logic AND Circuit

4.b.(1)(a) In this circuit, a zero voltage (ground) is used to indicate a marking signal. -6 volts is used for a spacing signal. Suppose that input 1 is spacing and input 2 is marking, current will flow from input 1, through Diode CR1, which is forward-biased, and through Resistor R1. The voltage drop across forward-biased CR1 is very small, so that the output terminal is held at -6 volts. The same thing happens if input 2 is spacing and input 1 is marking. The output will remain at -6 volts. There is then no voltage to cause current flow through R1.

4. b. (1)(a) The output line rises to ground potential. The operation of the circuit for all possible unit conditions is summarized in the following table.

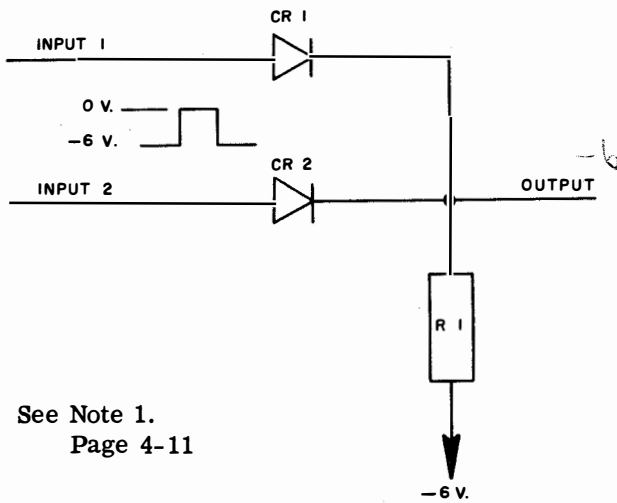
FUNCTION TABLE

Logical AND Circuit

Input 1	Input 2	Output
S	S	S
S	M	S
M	S	S
M	M	M

This table is called a function table for the logical AND circuit. The AND circuit may be built with more than two inputs without changing its method of operation. Regardless of the number to produce a marking output signal.

4. b. (2) Logical OR Circuit - Like the AND circuit, the OR circuit has several inputs and a single output. Unlike the AND circuit, the OR circuit produces a marking output signal when any of its inputs are marking.



See Note 1.
Page 4-11

Figure 4-7 Diode Logic OR Circuit

4. b. (2)(a) Here again a zero voltage indicates a mark and -6 volts a space. Suppose that both inputs are spacing. There is then nothing to cause current flow in R1. The output terminal remains at -6 volts. If input 1 is made marking, CR1 is forward biased. Current flows from -6 volts, through R1, through CR1, and out input 1. The voltage drop across CR1 is very small in this forward-biased condition. The output therefore rises to zero volt. No current flows through CR2, which is reverse biased. Input 2 therefore remains at -6 volts regardless of the potential of input 1. The function table for the OR circuit is:

Input 1	Input 2	Output
S	S	S
S	M	M
M	S	M
M	M	M

Like the AND circuit, the OR circuit may have any number of inputs. The output signal is marking whenever any one or more of the inputs are marking.

4. b. (2)(b) An additional form of diode logic circuit, in this case an AND circuit, is shown in the following figure.

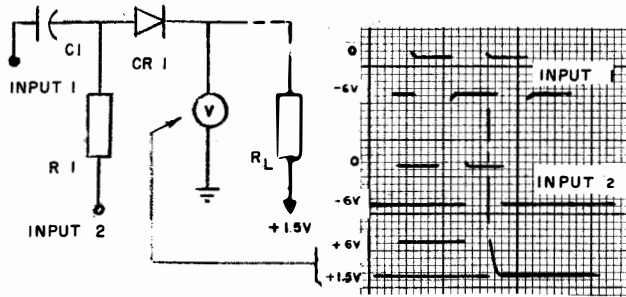


Figure 4-8 Diode Logic AND Circuit (One Diode)

This AND gate is useful when positive pulses are to be gated. C1 and R1 form a differentiating circuit which produces positive and negative pulses across R1 in response to the pulse transitions from input 1. When input 2 is returned to 0 volts, the positive pulses at R1 pass through CR1 as long as their amplitude is greater than +1.5 volts. With a 6 volt square wave applied at input 1 and input 2 held at 0 volts, the positive pulse output will be 4.5 volts peak. CR1 can be biased off for all pulses by making input 2 -6 volts. For this condition CR1 never becomes forward biased and no positive pulses appear across the load resistor.

4. b. (3) Clamp Circuits - A clamp circuit is a variation of the preceding diode logic circuits. One of the inputs is replaced by a fixed voltage source. Figure 4-9

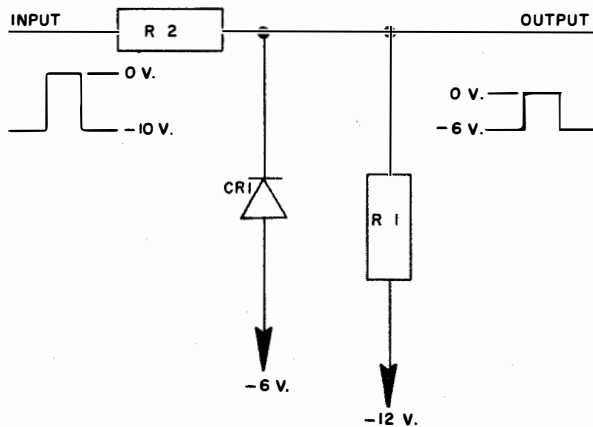


Figure 4-9 Diode Logic Clamp Circuit

In the circuit shown, the input level has somehow become non-standard; the spacing signal has become -10 volts. It is desired to restore this signal to standard levels of -6 to zero.

With no input applied, current flows from -12 volts, through R1, through forward-biased CR1, to -6 volts. Since the voltage drop across forward-biased CR1 is small, the potential of the output is -6 volts. When a -10 volt signal is applied to the input, current flows from the input, through R2, through CR1, and back to -6 volts. Thus the output remains at -6 volts whenever the input is any voltage more negative than -6. When the input voltage is somewhat more positive than -6, current from the input flows from -12, through R1 and R2, to the input. The input circuit effectively "steals" some of the current which originally flowed through CR1. When the input is sufficiently positive to prevent any current flow through CR1, the diode becomes reverse biased. The effective circuit is then a simple voltage divider composed of R1 and R2. For the voltage levels shown, it is assumed that R2 is small compared to R1, this allows the output to be very nearly 0 volts with a -1 volt input. The purpose of R1 is to provide a lead for the circuit load when CR1 is cutoff. When not required, it may be omitted.

4.b.(3)(a) The output is said to be clamped at -6 volts. The output follows input voltage variations only when the input voltage is more positive than the clamp voltage. If the diode polarity were reversed, and the diode and R1 were returned to positive voltages, the clamp circuit would allow the output voltage to be only more negative than the clamp voltage. Two clamp circuits might be combined, one clamping to a positive voltage and one clamping to a negative voltage. The output voltage would then be required to be somewhere between the clamping voltages. Such a double clamp circuit is called a clipper.

4. b. (3)(b) It should be remembered that the base-emitter junction of a transistor can act as a diode, and thus might become part of a gate or clamp circuit. When analyzing transistor circuits, always be aware of the hidden gates and clamps.

4. c. Binary Circuits - Binary circuits are a class of circuits having essentially "on" and "off" properties. In telegraph terminology the on and off states are called marking and spacing, respectively. A stable state of a circuit is a condition of specified current flow and voltage levels which the circuit can maintain indefinitely so long as power is applied. A quasi-stable state resembles a stable state, but cannot be maintained indefinitely. Quasi-stable circuit states are often used for timing purposes, since they can be made

to last for a definite period of time. Binary circuits are used in multiplex equipment for signal storage, for timing, and for frequency division. They occur in three forms: (1) Bistable binary (flip flop), having two stable states. (2) Monostable binary (univibrator), having one stable state and one quasi-stable state, (3) A stable binary (multivibrator), having two quasi-stable states.

4. c. (1) Triggering is a circuit action which causes a binary to switch from one state to the other. Triggering is usually accomplished by positive input pulses. Regeneration, or positive feed back, is present in all binaries. It causes the circuits to switch rapidly and completely when triggered.

4. c. (1)(a) Basic Binary Figure 4-10

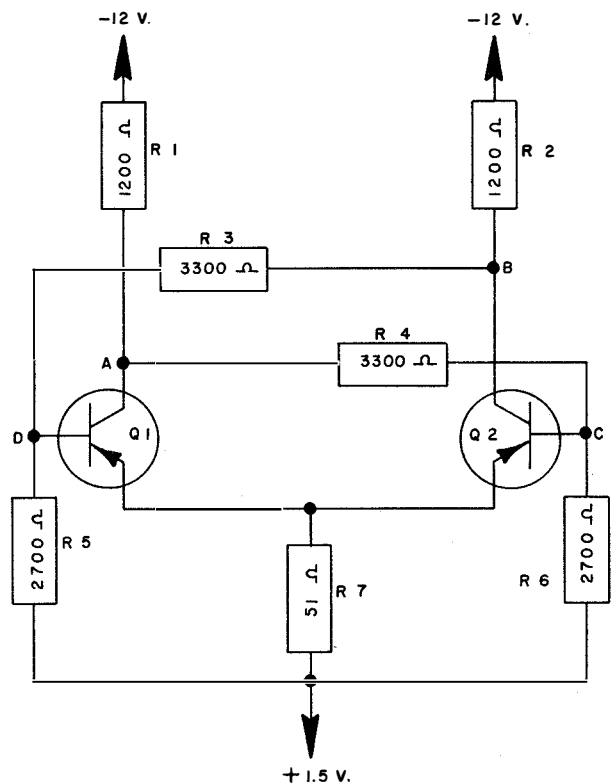


Figure 4-10 Basic Binary

The circuit shown is the basis of the family of binary circuits to be described. As will be shown, it is bistable. To understand the operation of this circuit, assume that Q1 is conducting into saturation. For circuit analysis purposes, a saturated transistor usually can be replaced with a short circuit between emitter and collector terminals. Point (a) in the circuit has a potential of approximately +1 volt. The potential at point (c) is approximately +1.25 volt. Q2 is therefore cutoff biased. Very little current can flow through Q2, so that the only current through R2 is about

2 ma. flowing through R3. The voltage at point (b) is therefore -9.6 volts. Current flowing through R2 and R3 into the base of Q1 biases Q1 into saturation. Thus the circuit is stable in this condition of current flow. The output terminals of the circuit are points (a) and (b). With Q1 saturated, point (a) has a voltage of +1 and point (b) has a voltage of -9.6.

4. c. (1)(b) It will be noted that this circuit is symmetrical; it may be divided into two identical halves. Assume that Q2 is conducting to saturation. Following the analysis of the preceding paragraph, it can be seen that Q1 is biased to cutoff. Point (a) is at a negative voltage and point (b) is slightly positive. This condition is just the reverse of that presented in the preceding paragraph, and serves to define the second stable state of operation.

4. c. (2) Switching - Referring to the above circuit, again assume that Q1 is saturated and Q2 is cutoff. It is desired to cause the circuit to change state. This is done by applying a positive voltage to point (d). This voltage has the effect of bringing Q1 out of saturation and reducing its collector current. This causes the voltage at point (a) to become more negative. A negative voltage at point (c) biases Q2 toward conduction. When Q2 begins to conduct its collector current increases, causing point (b) to become

more positive. The voltage at point (d) also becomes more positive.

4. c. (2)(a) This is a regenerative action -- a positive voltage applied to point (d) caused a positive voltage to be fed back to point (d). Even if the positive input is removed, the feedback action will cause point (d) to become more and more positive and point (c) to become more and more negative. This is the switching action in progress. When point (c) becomes sufficiently negative to saturate Q2 switching action will stop, since voltage changes at point (c) can have no more effect on the voltage at point (b). The circuit is then at equilibrium in its stable state rest again, but with Q2 saturated and Q1 cutoff. Note that once switching has been started (by the application of a positive voltage to point (d)), the regenerative action will cause switching to continue to completion even if the input is removed. This effect gives the binary circuit its characteristic "Toggle-Switch" action. When Q2 is saturated, operation analogous to the above with a positive input to point (c) will reset the circuit to its former state with Q1 saturated.

4. b. (2)(b) Switching action as described in the previous paragraph makes use of positive input signals to turn off the "on" transistor of a binary pair. Note that the same effect could be obtained with negative signals used to turn on the "off" transistor of a pair.

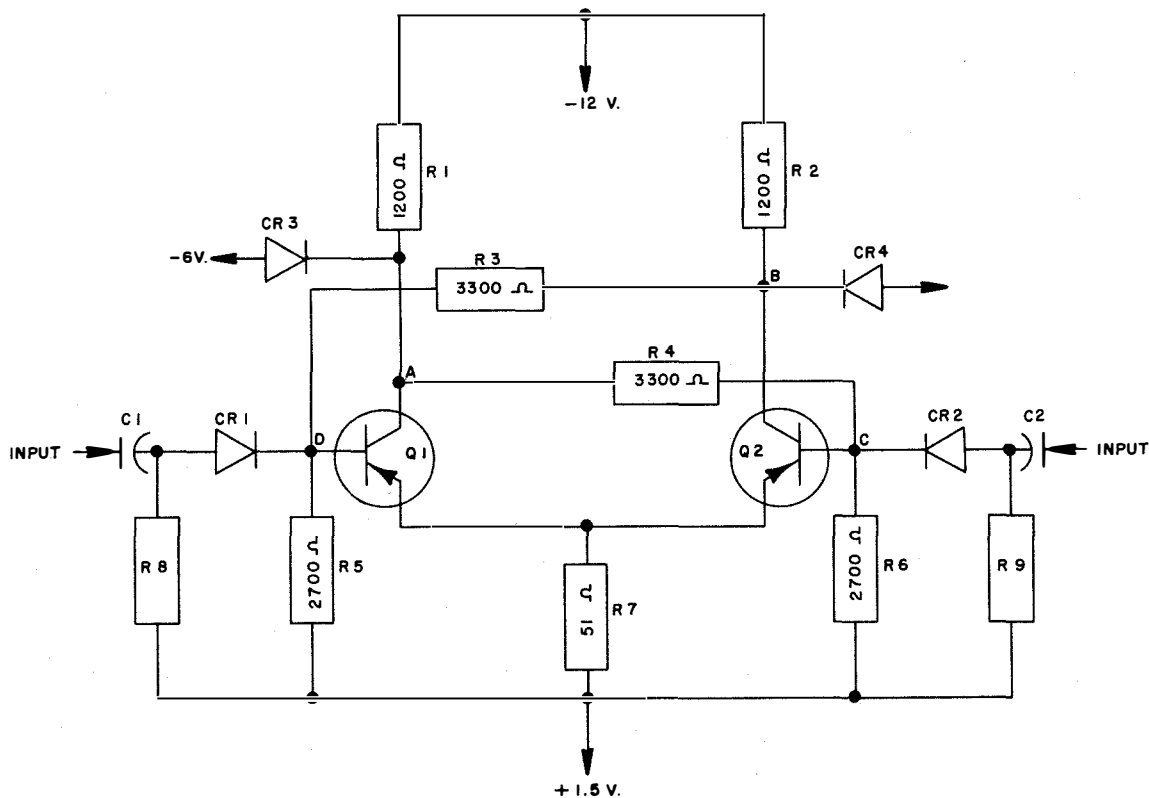


Figure 4-11 Dual Input Flip Flop with Clamps

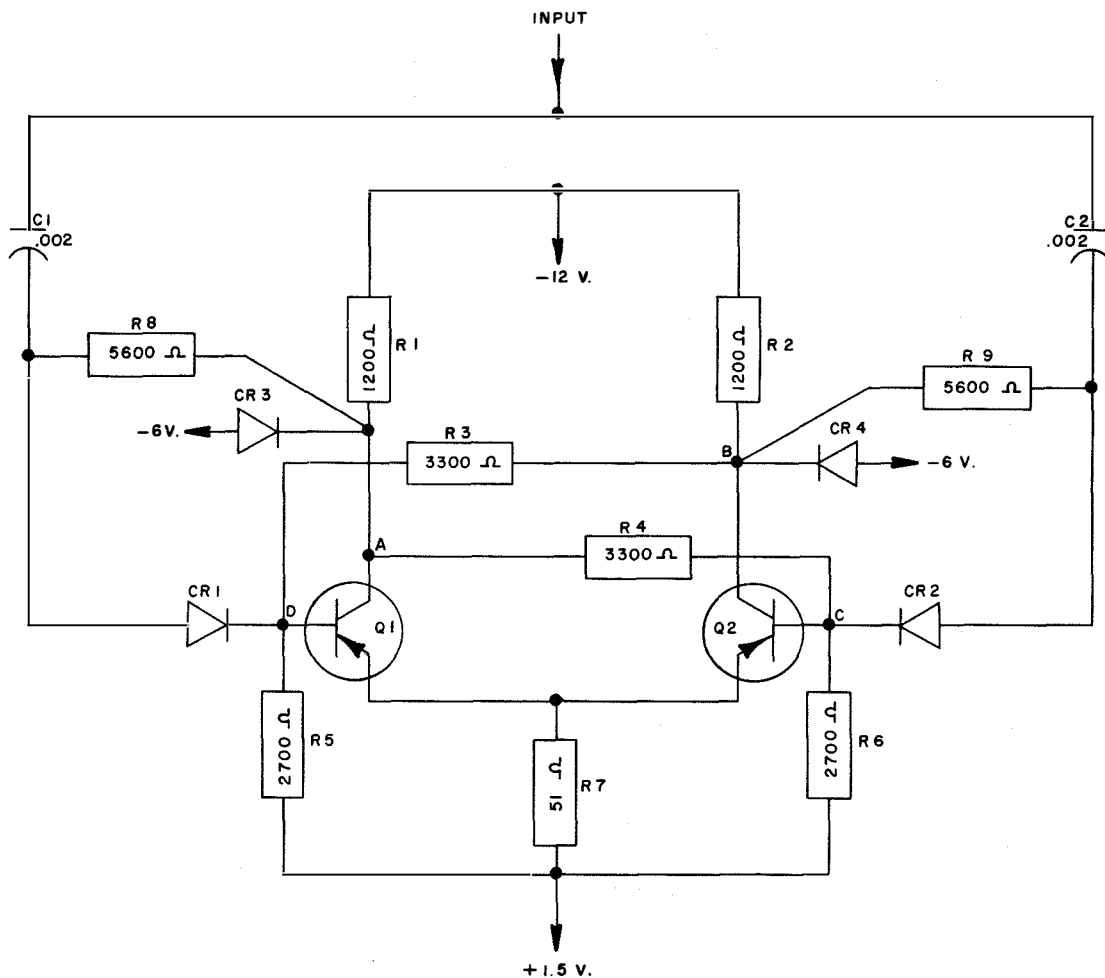


Figure 4-12 Single Input Flip Flop

4. c. (3) **Triggering** - Triggering operations with binary circuits consist of applying voltages to cause desired switching actions. For this purpose, the two states of binary operation are arbitrarily designated as mark (or one) and space (or zero). A set (or set 1) trigger causes a binary to switch to the marking state. A reset (or set 0) trigger causes the circuit to switch to the spacing condition. In the bistable binary (flip flop), both set and reset triggers are supplied from external sources. In the monostable binary (univibrator), the set trigger is obtained externally, while reset is automatic after a present time interval. Reset triggers may be applied, however, if it is desired to reset the circuit before automatic reset takes place. With a stable binary (multivibrator), both set and reset triggers are produced automatically. Multivibrators are not used in the unit and will not be discussed further.

4. c. (4) Binary with Separate Set and Reset Inputs Figure 4-11

It has been shown that once set and reset operations have begun, they will continue even if input signals are removed. In this circuit, the differentiating net works C1-R8 and C2-R9 cause

steady-state input signals to be changed into pulses. Diodes CR1 and CR2 block negative input pulses, which might cause the circuit to switch falsely. Diodes CR3 and CR4 clamp the outputs to -6 volts.

4. c. (5) Binary with Combined Set and Reset Input Figure 4-12 .

This circuit, unlike the previous circuit, changes state each time an input pulse is received on the input line. C1-R8 and C2-R9 are differentiating networks. CR1 and CR3 are called steering diodes. Their function is to direct a positive input pulse to the base of the transistor which is saturated when the pulse is received. When Q1 is saturated, CR1 is forward biased and CR2 is reverse biased. This is due to the connection of R8 and R9 to their respective collectors. A positive input pulse will accordingly appear at the base of Q1, causing a switching action to take place. The next positive input pulse will find CR2 reverse biased. Thus the circuit will change state at each input pulse. This circuit is useful for frequency division. Output signals can be differentiated to obtain pulses. A train of output pulses can be obtained from either output. One output pulse is produced for every two input pulses.

4.d. Ring Counters

4.d.(1) Description - Ring Counters are used for frequency division and signal distribution. As frequency dividers, they can perform division by any integer. Unlike synchronized multivibrators used for division, ring counters produce no output when no driving signal is present. As signal distributors, rings are combined with diode logic circuits to perform a function similar to that of a rotary switch.

4.d.(1)(a) A ring counter consists of a number of elements, all connected in parallel across a source of power. Each element is bistable; it can be either "off" or "on". A common connection to all elements makes it impossible for more than one element in a ring to be on at one time. The circuit counts by movement of the on state from one element to the next. One such movement takes place each time a drive pulse is applied.

4.d.(1)(b) Movement of the on state is facilitated by a process called priming. A ring element, if not connected in a ring, will turn on when power is applied. An element which has been primed will turn on faster than one which has not. Stepping of a ring is accomplished by momentarily interrupting power to all elements at the same time. When power is reapplied, any element which was primed a short time before will turn on well in advance of unprimed elements. Through the common connection mentioned above.

4.d.(1)(c) The primed element in turning on prevents any other elements from turning on. Rings are arranged so that any element which is on primes the element which is to turn on next.

4.d.(1)(d) All ring counters in the multiplex are closed rings. This means that the last element primes the first element. Thus in a 3 element ring, for example, the sequence of elements turned on is 1, 2, 3, 1, 2, 3, 1, 2, 3, . . . and so on for as long as drive pulses are supplied.

4.d.(2) The following figure shows the connections of a single ring element. Fig 4-13 This circuit makes use of a negative resistance characteristic found only in point contact transistors. The voltage current characteristic of the circuit is couple valued. This means that for some applied voltages the circuit may draw either of two different values of current. The higher value of current defines the "on" state, and the lower, the "off" state. Bias applied to the circuit can shift its operating point toward either the off or the on state.

4.d.(2)(a) In the circuit shown, S2 re-

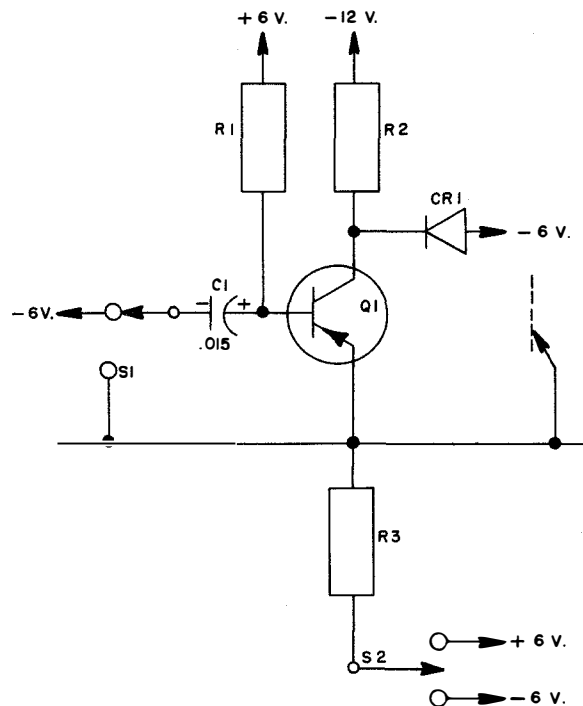


Figure 4-13 Single Ring Element

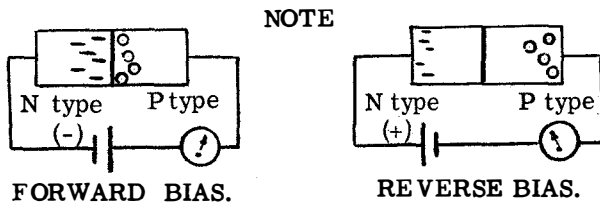
presents the action of the ring drive amplifier. During a drive pulse, R3 is returned to -6 volts. At all other times it is returned to +6 volts. S1 represents the action of the preceding ring element shown. C1 is returned to -6 volts if the preceding element is off. It is returned to the emitter circuit if the preceding element is on. The emitters of all transistors in a ring are connected together. Outputs are taken from the collectors of the elements, and are clamped to -6 volts.

4.d.(2)(b) When power is initially applied to a ring, the element having the highest combination of leakage current and gain will turn on. Current will flow to this element through R3, which is common to all elements. The voltage drop across R3 will be sufficient to hold all other elements off.

4.d.(2)(c) During a drive pulse, R3 is returned to -6 volts. This places the emitters and collectors of all transistors at the same voltage, so that no current flows. At this time all coupling capacitors corresponding to C1 are returned to -6 volts. If the preceding element had been off, C1 would be charged to 12 volts with the polarity shown. If the preceding element had been on, C1 would be practically discharged. C1 cannot charge immediately, and so retains practically its former state of charge or discharge at the end of the drive pulse.

4. d. (2)(d) If C1 was initially discharged (preceding element on), the base of Q1 will be held near -6 volts during and immediately after the drive pulse. This biases Q1 in the forward direction, and primes this element to turn on as soon as the emitter voltage rises above -6. C1 then charges through R1 and the collector resistor of the preceding element. For the priming of C1 to be effective, the drive pulse must end before C1 can charge appreciable. The drive pulse amplifier which is used with all ring circuits produces drive pulses which meet this requirement.

4. d. (2)(e) A detailed description of the operation of a complete ring counter is contained in the Principles of Operation. - 5. i.



4 e. BIAS. Each junction of a transistor can be visualized as a diode with polarity determined by the PN or NP material. If the applied voltages at the junction are of a polarity to cause current flow, the transistor is forward biased and will conduct (usually to saturation). If the polarity of the applied voltage is in the opposite direction, the transistor is said to be back-biased and will be non-conducting. Bias conditions are established by voltage divider networks connected to the power supplies. Input pulses change these bias conditions to switch or trigger the transistor circuit.

5. TRANSMITTING CODE CONVERTER. (CV-408/UGC-1) (Figures 4-14 thru 4-29 & 6-21)

5.a. GENERAL (Figure 4-29)

5.a.(1) The transmitting code converter accepts start-stop signals from a signal line and converts them to multiwire signals. The multiwire signals are sent on a parallel six-wire basis to the multiplexer-demultiplexer. See paragraph 3.c.(1) of Section 1. The general circuits of the unit are the line relay, range control, start-stop oscillator, start-stop distributor, selection gates, first-level storage, transfer gates, second-level storage, and transfer circuits.

5.a.(2) At the line-relay circuit (Figure 4-7), start-stop signals from the associated transmitting equipment are applied to the coils of a mechanical relay. Two outputs are obtained from the relay: normal and inverted. The output signal is applied in normal form to the start control gate and range control, and in inverted form to the signal selection gates.

5.a.(3) The range control circuit consists of a junction-transistor univibrator. The natural period of the univibrator is adjustable by means of the RANGE ADJ and is usually set to time out during a period equal to half of a signal element. The stop-start (mark to space) transition in the normal signal causes the univibrator to operate, and the output is applied to the control gate. The change in voltage that occurs upon relaxation of the range control gate unclamps the start-stop oscillator. The normal output of the line relay is connected to the control gate to insure that the start-stop oscillator is unclamped only by start elements which continue, at least, until the range circuit relaxes. Thus false starts due to hits of short duration on the input circuit are eliminated.

5.a.(4) When the start-stop oscillator is unclamped, it begins oscillating at a frequency whose period is equivalent to that of the telegraph input signal (22 milliseconds at 368 opm). The oscillator output, after being shaped by the squaring amplifier, is used to generate drive pulses for firing the elements of the start-stop distributor. The start-stop distributor consists of a ring of seven point-contact transistors, one each for the start element, five code elements and the stop element of the start-stop signal. The transistors conduct in sequence to perform a distributing cycle, the firing of each element being controlled by the timed drive pulses. Thus the start element of the distributor fires in response to the first drive pulse, and the first element fires in response to the second drive pulse. Each transistor conducts in turn until the seventh drive pulse fires the stop element of the start-stop distributor. An output from the stop element of the start-stop distributor is applied to the control gate. When the stop element fires, this voltage passes through the control gate and clamps the start-stop oscillator. As a result, no additional drive pulses are generated and the start-stop distributor comes to rest with the stop element conducting. The start-stop oscillator will remain clamped, and the stop element of the start-stop distributor will remain conducting until the next start pulse arrives at the line relay. The output of each code element of the start-stop distributor is applied to a corresponding storage selection gate. Outputs from the start and stop elements are applied to the transfer and transfer prime circuits.

5.a.(5) The inverted signal is applied to the five storage selection gates. Each gate also has a signal applied to it from the corresponding code element of the start-stop distributor. Timing is such that the leading edges of the distributor's code elements occur at a time determined by the delay introduced by the range control. This delay, as was mentioned, is normally one-

half of a code element. The leading edge therefore normally occurs at the nominal center of the incoming start-stop signal. This leading edge is employed to sample the incoming signal. Thus for each marking impulse in the start-stop input signal, an output pulse is directed from the distributor through a storage selection gate to the corresponding first level storage element.

5.a.(6) The first level storage consists of five junction-transistor flip-flop circuits, one for each of the five code elements of the start-stop signal. When an output pulse from a selection gate is received by a storage element, the storage element is triggered into an on condition. Thus as each start-stop distributor code element fires, an impulse is passed to a corresponding storage selection gate which will turn on the corresponding first level storage element if the storage selection gate has been primed by the presence of a marking impulse. Each marking selection is thus stored in the first level storage and is used to condition the storage transfer gates.

5.a.(7) The first level storage release circuit is operated whenever the start element of the start-stop distributor fires. This applies a pulse to all first level storage elements simultaneously and causes those elements which were in an on condition, as a result of the previous character, to be turned off and made ready for the reception of the next character.

5.a.(8) The storage transfer gates consist of five diode AND gates, one for each code element in the start-stop signal. Each gate will receive a marking signal applied to it if the corresponding first level storage element has been turned on. In addition, the output of the transfer circuit is applied simultaneously to the five transfer gates. Thus a particular transfer gate will produce an output whenever there is a coincidence between its corresponding first level storage being on and the transfer being on. Outputs from these gates are applied directly to the first five second level storage elements.

5.a.(9) The second level storage consists of six junction-transistor flip-flop circuits, one for each of the five code elements of the start-stop signal and one for blank indication. When an output pulse from a transfer gate is received by a storage element, the storage element is triggered into an on condition. Thus by means of the transfer gates, the first five elements of the second level storage are made to turn on in the same pattern that was set up in first level storage. The sixth second level storage element is controlled directly by the output of the transfer circuit and is turned on whenever the transfer fires. Both normal and inverted outputs from each element of the second level storage are applied simultaneously to the multiplexer matrix.

5.a.(10) Before the second level storage elements can respond to a new code pattern being impressed upon them by the first level storage, they must be relieved of the previous character. The second-level storage-release circuit is operated by a clock pulse which is received from the multiplexer unit and inverted by the clock inverter. The clock pulse arrives at a regular rate just after a stored code pattern has been utilized in the multiplexer unit. The storage release circuit applies a pulse to all the second-level storage elements simultaneously and causes those elements which were in an on condition to be turned off.

5.a.(11) The transfer circuit is a junction-transistor circuit capable of operation as either a flip-flop or a univibrator. During operation as a univibrator the transfer has a fixed relaxation period of approximately 0.5 milliseconds. The output of the transfer circuit is applied to the transfer gates and thereby controls the firing of the second level storage. The firing of the transfer circuit is controlled by the transfer firing gate which will produce an output pulse whenever there is coincidence between the output of the clock delay and the output of the transfer prime circuit. The clock delay circuit consists of a junction-transistor univibrator. The natural period of the univibrator is fixed to normally time out after a period of approximately 3.0 milliseconds. The clock delay is operated by the clock pulse which is received from the multiplexer unit. The purpose of the clock delay is to permit a short time to elapse between the release of the second-level storage elements and their subsequent reoperation. The transfer prime circuit consists of a junction-transistor flip-flop. The transfer prime is turned on by the firing of the start element of the start-stop distributor and is turned off when the transfer releases. The purpose of the transfer prime is to prevent the transfer from firing more than once per incoming character. The transfer normally is turned off by the firing of the stop element of the start-stop distributor. However, if the transfer should fire while the stop element of the start-stop distributor is conducting, the transfer will operate as a univibrator and turn itself off after producing an output pulse of approximately 0.5 milliseconds.

5.a.(12) Because the Multiplex Set is operating continuously and the start-stop signals are being received either randomly or automatically from a distributor operating at a slightly slower speed, the transfer circuits include a variable synchronizing feature that coordinates the two. The Multiplex Set operates faster by approximately two per cent (375 opm vs. 368 opm, 469 opm vs. 460 opm, or 611.413 opm vs. 600 opm) so that, for about every 50 start-stop characters handled on a continuous

basis, the Multiplex Set advances one complete character. The transfer circuit, accordingly, pauses at this time and permits a completely idle signal to be inserted. The second-level storage elements fire individually or collectively depending upon the instantaneous phase relationships between the clock pulse and the start-stop distributor. When the clock-delay transition occurs during the stop element interval of the start-stop distributor cycle, the second-level storage elements fire collectively. As each succeeding clock pulse arrives earlier and earlier in the start-stop distributor cycle, the number of second-level storage elements firing collectively will decrease and the number of storage elements firing individually will increase. This will continue until the clock pulse begins arriving during the start element interval of the start-stop distributor. At this time the second-level storage elements will fire individually as the elements are selected by the start-stop distributor. The first clock delay transition that occurs during the stop-element interval will find that the transfer prime has not yet been turned off. As a result, the transfer does not fire, and an idle blank is inserted in the multiplex signal. The next clock pulse which arrives will find the transfer prime off. It will operate the transfer and cause the second-level storage elements to fire simultaneously.

5.a.(13) The clock delay circuit, in addition to permitting a short time to elapse between the release and refiring of the second-level storage elements, also provides safe operating margins when the firing of the transfer occurs late in the stop element interval of the start-stop distributor. This condition exists for several characters following the insertion of the blank. The relaxation period of the clock delay univibrator is gradually increased from approximately 3.0 milliseconds to 6.0 milliseconds just prior to the insertion of the blank. Then, immediately following the insertion of the blank, the relaxation period of the clock delay is instantly restored to its normal 3.0 milliseconds delay. The short transfer pulse is advanced by approximately 3.0 milliseconds and prevents the possible loss of a character in the first-level storage. Otherwise, the character could be lost if a start-stop signal arrived earlier than usual and caused a premature release of the first-level storage.

5.a.(14) For the detailed treatment of the circuits and their operation that follows, refer to the complete schematic wiring diagram of Figure 6-21 and the timing diagram of Figure 4-30 in addition to the illustrations indicated in the text.

5.b. LINE RELAY - Neutral start-stop input signals are applied through terminals U and V

of connector J911 to the windings of line relay K900.

20 ma. operation: Two windings in series

60 ma. operation: One winding only (terminals 7 and 8)

This relay is a hermetically sealed relay with mercury wetted contacts. The armature is mechanically biased to the spacing side. In the marking condition, the windings are energized and the armature makes on the marking terminal and supplies -6 volts to R914. With a spacing signal (zero current) the armature returns to the spacing terminal and supplies -6 volts to this terminal. Thus the input start-stop signal is applied in normal form (-6 volts, space) to the start control gate and range control univibrator and in inverted form (-6 volts, mark) to the signal selection gates.

5.c. RANGE CONTROL (Figure 4-14)

5.c.(1) Transistors Q900, Q901 and Q902 comprise a univibrator circuit. Q901 is normally conducting and Q902 is cut off. Q900 is a buffer amplifier in the feedback circuit between Q902 and Q901. The univibrator receives its drive through C901 and R912 which are connected to the base of Q902 and CR906, CR907 and R917.

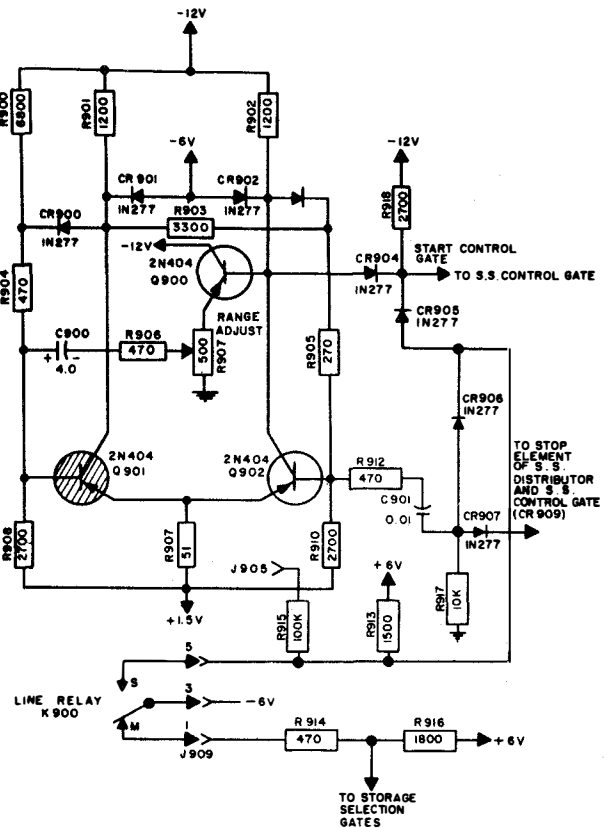


Figure 4-14 Range Control

5.c.(2) CR906, CR907 and R917 combine to form a gate, which is driven by the normal input signal, and the stop element of the start-stop distributor. With a steady mark on the input line and the stop element of the start-stop distributor fired, the potential applied to CR906 and CR907 is 0 voltage. The potential at their junction and R917 is therefore also 0 voltage. Receipt of a space causes -6 volts to be applied to CR906, driving the junction of CR906, CR907 and R917 to -6 volts. This negative going transition is passed through C901 and R912 to the base of Q902. The base, going negative with respect to the emitter, creates a forward bias and fires Q902.

5.c.(3) The collector of Q902 rises from -6 volts to 0 voltage. This signal is passed through Q900 (an emitter-follower), R907 (range control potentiometer), R906 and C900 to the base of Q901 and turns Q901 off. The range control univibrator now times out a signal determined by the charging time of C900. The charging time, and thus the period of the univibrator may be varied by the setting of range control potentiometer R907. The normal setting will cause the univibrator to time out at the middle of the start pulse.

5.c.(4) Firing of the range control univibrator initiates a start-stop cycle, the first pulse of which turns off the stop element and fires the start element of the start-stop distributor. A -6 volt potential is therefore applied to CR907 and holds the junction of CR907, CR906 and R917 to -6 volts for the remainder of the cycle. Consequently, mark-space transitions following the initial stop-start transition will not cycle the range control univibrator. Space-mark transitions are blocked by CR906. The output of the range control univibrator, a positive going signal, is applied to CR904 of the start-control gate.

5.d. START-CONTROL GATE (Figure 4-15)

5.d.(1) CR904, CR905 and R918 form an AND gate having as inputs the normal signal and the range control univibrator output. Normally with line current (marking), 0 voltage appears at CR905 due to the voltage-divider action of R913 and R918. A negative 6 volts appears at CR904 since it is connected to the collector of Q902. The diodes are polarized such that the potential at their junction will be that of the most positive input, or 0 voltage. This voltage is applied to CR908 which combines with CR909 and R922 to form a second AND gate.

5.d.(2) CR909 is connected to the stop element of the start-stop distributor, which is assumed to be conducting, and 0 voltage is applied to CR909. CR908 and CR909 are polarized such

that they will conduct when any signal is applied more negative than the voltage at their junction. Both diodes are therefore non-conductive. In this condition, current flows through R922 and R923 to the base of Q903, saturating that stage and holding the start-stop oscillator clamped.

5.d.(3) Receipt of a start pulse at the line relay drives Q902 into saturation and 0 voltage appears at its collector. A negative six volt signal also appears at CR905. The junction of CR904 and CR905 remains at 0 voltage. When the range control univibrator times out, however, inputs at both CR904 and CR905 will be -6 volts which permits the voltage at their junction to go to -6 volts. This voltage is applied to CR908, which conducts and draws the junction of CR908 and CR909 to -6 volts. Q903 is then driven into cutoff and the start-stop oscillator is unclamped to complete a cycle. Operation of the start-stop oscillator steps the start-stop distributor. The first drive pulse generated by the oscillator turns off the stop element, fires the start element of the distributor and causes a -6 volt potential to be applied to CR909. The oscillator therefore remains unclamped until the stop element of the start-stop distributor next fires.

5.e. START-STOP OSCILLATOR CONTROL AMPLIFIER AND CLAMP (Figure 4-15)

As mentioned above, when Q903 is saturated,

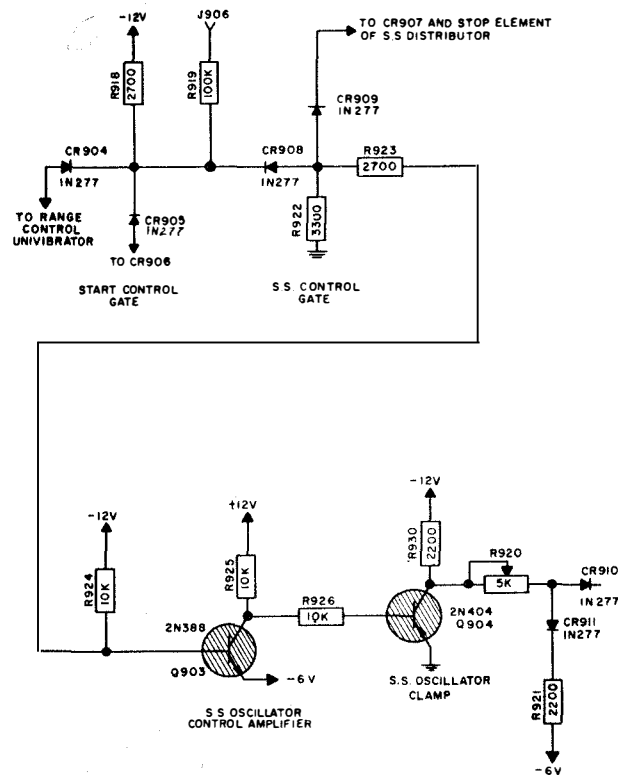


Figure 4-15 Start - Stop Control Gate

the start-stop oscillator is clamped and, when Q903 is cut off, the oscillator is unclamped. With Q903 saturated, -6 volts appears at the collector. This potential is applied through R926 to the base of Q904. Bias current flows and Q904 becomes saturated and 0 voltage appears at the collector. This voltage is applied through clamp-adjust potentiometer R920, to the junction of CR910 and CR911.

5.f. START-STOP OSCILLATOR (Figure 4-16)

5.f.(1) Q905 is a sine wave oscillator which is turned on or off by Q904. Q905 is connected as a Hartley oscillator with the output taken from its emitter. The switch permits changing the capacity of the tuned circuit to match different wpm operation. For example, at 60 wpm a single pulse (mark or space) is 22 milliseconds long. L900, C902A and C902B, connected in parallel, constitute a tuned circuit which is adjusted to produce a sine wave with a frequency of 45.45 cycles per second and a cycle duration of 22 milliseconds.

5.f.(2) With Q904 conducting, current flows through Q904 emitter, R920 collector, CR911 and R921 to the -6 volt supply. CR910 clamps the base of Q905 to the junction of R920 and CR911, preventing any variations in the base voltage of Q905, holding a charge on C902, and preventing any oscillations from occurring.

5.f.(3) R920 permits adjusting the base voltage of Q905 to any value between 0 and about -4 volts. This, in turn, determines the current through L900 in the idle condition. During the idle condition, the emitter of Q905 is at -6 volts so that no current is flowing in the feedback circuit consisting of the -6 volt supply, the lower section of L900, R937 and R939 (in parallel), R936, emitter to collector of Q905, and the -12 volt supply.

5.f.(4) As soon as Q904 is cut off, its collector goes to -12 volts, back biasing CR910 and unclamping the base of Q905. Current through L900 starts to decrease, the voltage across it decreases, C902 discharges, and the base begins to go more negative. This biases Q905 and increases conduction, and the emitter goes more negative. Current begins to flow through the feedback circuit, and through a circuit in parallel with the lower section of L900, namely, from the -6 volt supply, through C902, through section 1-3 of L900 and through the rest of the feedback circuit. This action continues until C902 discharges completely and becomes charged in the opposite direction to the same voltage as that across the lower section of L900. At this point, current in L900 is zero, and the emitter voltage of Q905 is about -10 volts (with proper setting of R936).

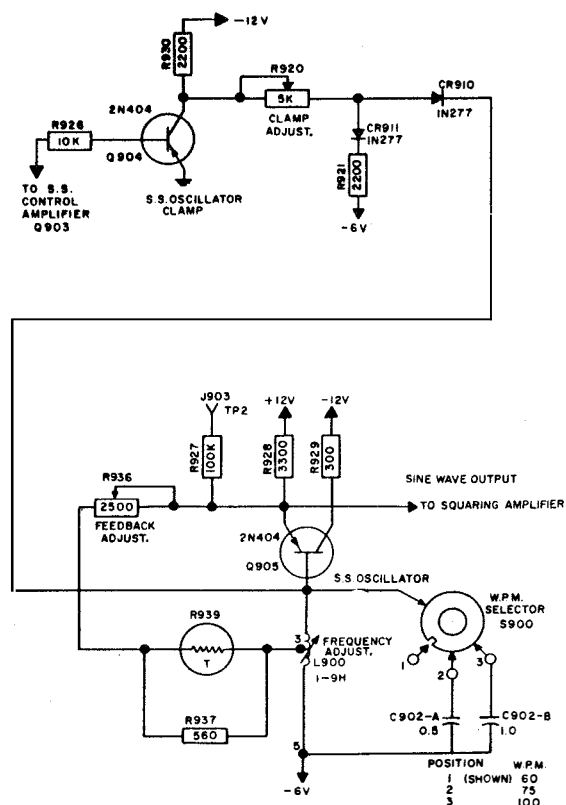


Figure 4-16. Start - Stop Oscillator

5.f.(5) C902 now begins to discharge, and the base begins to go less negative, decreasing conduction in Q905. The reverse of the previous action now takes place. Conduction through Q905 decreases and the emitter voltage increases. This results in a current through the feedback circuit in a direction opposite to the previous direction, and C902 is charged in the new direction. As a result of this continued action, a sine-wave oscillation occurs with frequency determined by L and C. When Q904 turns on again, base voltage of Q905 is clamped and the oscillation stops.

5.g. SQUARING AND DRIVE AMPLIFIERS (Figure 4-17)

5.g.(1) Transistors Q906 and Q907 comprise a squaring amplifier. With the start-stop oscillator clamped, -5 volts appears at its emitter. This potential is sufficient to drive Q906 into saturation, the emitter having been returned to -6 volts. With Q906 saturated, -6 volts appears at the collector and, when applied to the base of Q907, saturates that transistor.

5.g.(2) The first half-cycle generated by the start-stop oscillator is always negative-going and drives Q906 into cutoff. Then, one half cycle later, as the oscillator swings positive, Q906 conducts into saturation and draws Q907 into saturation. A feedback current through R935 aids in squaring the wave form at the col-

lector of Q906. The output of Q906 is applied to the base of Q908.

5.h. DISTRIBUTOR DRIVE (Figure 4-17)

5.h.(1) The output of the squaring amplifier is applied to a pulse-generating circuit consisting of C903, CR914 and L901. C903 and L901 form a resonant circuit which is shock excited into oscillation by each positive-going leading edge of the squaring amplifier output. CR914 clamps the oscillation after the first half-cycle. The result is an output pulse approximately 4 volts in magnitude and 7 microseconds in width. This positive pulse is coupled by means of C904 to the base of drive amplifier transistor Q908. Q908 is connected as a common emitter amplifier and is normally conducting, with its collector at +6 volts, as a result of the negative bias supplied by R940 and R943.

5.h.(2) The positive pulse applied to the base of Q908 drives the transistor into cutoff for the duration of the pulse. This output from the collector of Q908 is a series of 7 microsecond drive pulses swinging from approximately +6 volts to -6 volts. These drive pulses are applied to the start-stop distributor through R942. C927, C928, CR913 and CR915 eliminate noise on the +6 volt and +1.5 volt power supplies and on the incoming drive signal.

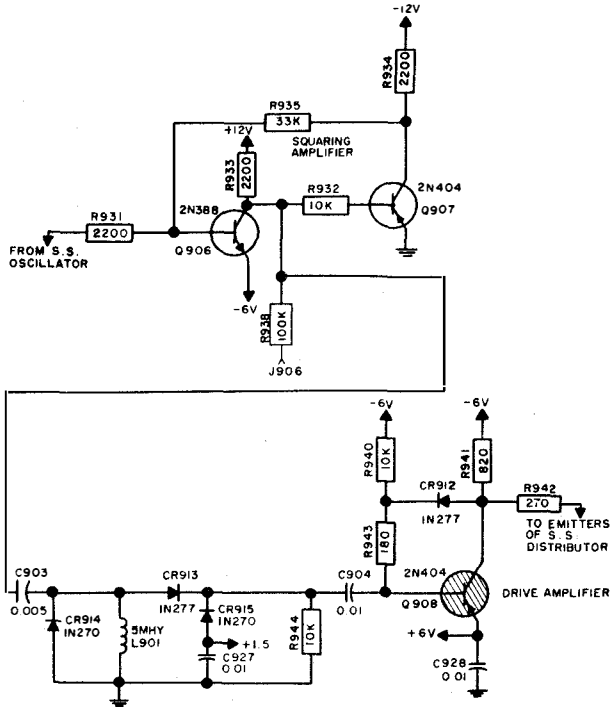


Figure 4-17. Squaring Amplifier

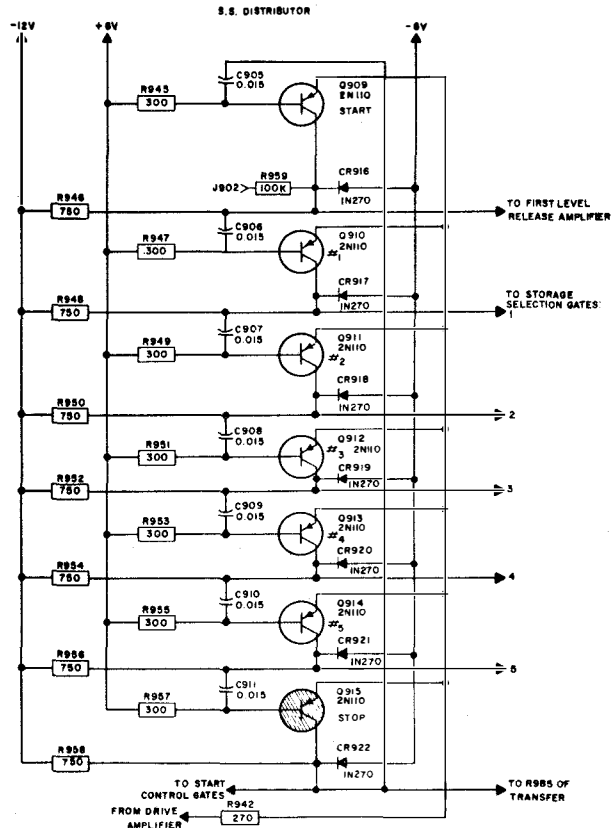


Figure 4-18 Start - Stop Distributor

5.i. START-STOP DISTRIBUTOR (Figure 4-18)

5.i.(1) Point-contact type transistors Q909 through Q915 inclusive are connected to form a ring distributor. The start-stop distributor ring consists of seven elements, one each for the start element, the five code elements, and the stop element of the start-stop signal.

5.i.(2) The negative-resistance property of point-contact transistors is used in which two stable states, on and off, of a single transistor element form the basic sequential switching functions. The on state is defined as the state of heavy conduction in which the transistor is passing about 16 milliamperes through the collector. The off state is that in which the transistor is in a high resistance state. In the off state the emitter is biased negative and the emitter current is practically zero.

5.i.(3) With reference to the start-stop distributor circuit, it will be noted that all emitters of transistors Q909 through Q915 are connected to a common emitter load resistance R942 which is connected to the positive 6 volt bus through the drive amplifier Q908. Q908 is normally biased into saturation so that the collector-to-emitter potential is essentially zero.

From a static viewpoint, as collector potential is applied to the ring transistors, one transistor will turn on. The unit having the lowest collector-to-base resistance (highest current gain) will turn on initially since that particular base reaches an on bias first. The current through the transistor divides between the base and emitter load approximately according to the current gain of the transistor. In case of a current gain of two the current divides equally with 8 milliamperes in the emitter and 8 milliamperes in the base. A bias potential of -4 volts is applied to the off transistor emitters and holds them in the off state. The collector to ground on voltage is approximately 0, and the off voltage is -6 maintained by clamp diodes CR916 to CR922.

5.i.(4) The dynamic action of the ring may now be described. As mentioned above, negative-going drive pips of approximately 7 microseconds in duration and of 12 volts amplitude are applied to the common emitter bus through R942. Each of these drive pulses will turn off the conducting ring element. The collector potential of that element swings sharply negative and generates a charging current through the capacitor (C905 through C911) connected to the base of the following transistor. This charging current generates a negative voltage which, applied to the following base, primes the stage. At the end of the 7 microsecond switching period, the primed transistor will turn on. In this manner, each stage of the distributor will be fired in turn. Each stage will prime the next when the negative 12 volt pulse is applied, and the primed stage fires when the 12 volt pulse ends.

5.i.(5) The output is taken at the collector. The output of Q909 is applied to the first-level release amplifier Q916. Outputs of Q910 to Q914 are applied to the storage selection gates. An output from Q915 is applied to the start-control gate and transfer circuit.

5.j. STORAGE SELECTION GATES

5.j.(1) The storage selection gates consist of five identical transistor AND gates, one for each code pulse in the start-stop signal. The output of the corresponding code element of the start-stop distributor is applied to the emitter of Q927 through capacitor C920. The signal is applied to the base of Q927 through R1001.

5.j.(2) Initially, the emitter potential of Q927 is held at -6 volts by the potential applied through R1003. The common base lead is connected to the junction of R914 and R916. R914 is connected to the line relay, and R916 is connected to the +6 volt supply. The base potential of Q927 may, therefore, be -5 volts or +6 volts

depending on the condition present at the line relay. Since the emitter of Q927 is connected to a -6 volt potential, Q927 is normally non-conducting. A -12 volts appears at the collector through R1002 at this time.

5.j.(3) As each element of the start-stop distributor fires, however, a positive going transient is applied to the corresponding emitter connection of Q927. These pulses are +6 volts in amplitude. If the voltage present at the base of Q927 is -5 signifying a mark, Q927 will saturate and a positive-going 12 volt spike will appear at the collector. On the other hand, providing the potential at the base is +6 volts signifying a space, the emitter will remain more negative than the base even with the positive going spike impressed, and the transistor will not conduct. As each element of the start-stop distributor conducts, a pulse is generated at the corresponding collector of Q927 whenever a mark is present in the incoming start-stop signal. The output of each gate is applied to a corresponding first-level flip-flop.

5.k. FIRST LEVEL STORAGE AND FIRST LEVEL RELEASE AMPLIFIER (Figure 4-19)

5.k.(1) The first level storage consists of five identical junction-transistor flip-flops, one for each code pulse in the start-stop signal. These flip-flops are formed by transistors

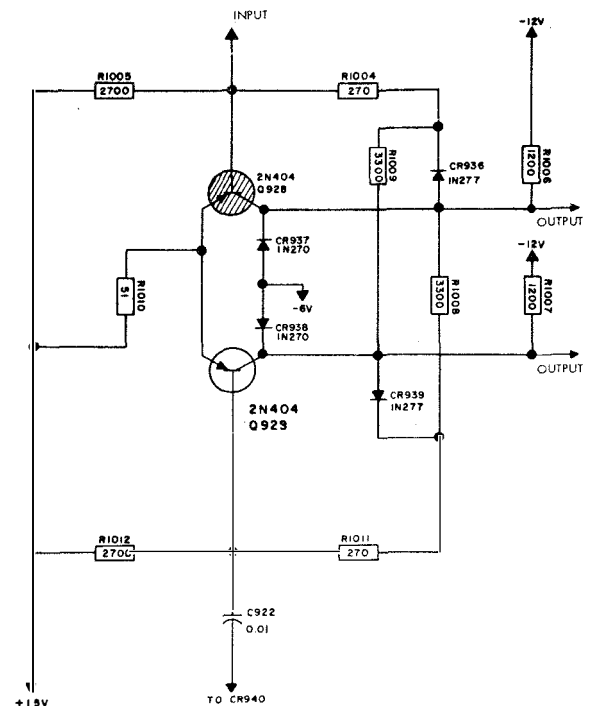


Figure 4-19. Flip-Flop

Q928-1 through Q928-5 and Q929-1 through Q929-5, with Q928 normally conducting. Q928 is switched by a positive pulse applied to its base through C921 from the storage selection gates. The output from the collector of Q929 swings from -6 volts to 0 voltage and is applied to the corresponding storage transfer gate.

5.k.(2) First-level release-amplifier transistor Q916 is connected as a common collector amplifier and isolates its start-stop distributor input from the first-level storage. The output of Q916 swings from -6 to 0 voltage and is applied to each first-level storage flip-flop where it is sharply differentiated by C922. Only the positive pulse is passed by CR940 and applied to the base of Q929. This positive pulse triggers the flip-flop and causes Q929 to cut off and Q928 to conduct. Thus the flip-flop is reset to its normal condition. The first-level release amplifier also supplies a pulse which is applied to the transfer prime circuit.

5.l. STORAGE TRANSFER GATES - The storage-transfer gates consist of five identical AND gates, one for each code pulse in the start-stop signal. These gates are formed by diodes CR941-1 through CR941-5 and CR942-1 through CR942-5 and resistor R1013-1 through R1013-5. The output of the transfer amplifier Q923 and the output of the corresponding storage element of the first-level storage are applied as inputs to each gate. When both inputs are 0 voltage, the output of the gate will be 0 voltage. However, if either output is -6 volts, the output of the gate will be -6 volts. The output of each gate is applied to a corresponding second-level storage flip-flop.

5.m. SECOND LEVEL STORAGE (Figure 4-20)

5.m.(1) The second-level storage consists of six identical junction-transistor flip-flops, one for each code pulse in the start-stop signal and one for blank indication. The first five flip-flops are formed by transistors Q930-1 through Q930-5 and Q931-1 through Q931-5 with Q930 normally conducting. CR943 passes only the positive signal transition from the storage transfer gate output to C923 where it is sharply differentiated into a positive impulse. This impulse is applied to the base of Q930 and triggers the flip-flop by causing Q930 to cut off and Q931 to conduct. The output from the collectors of Q931-1 through Q931-5 swing from -6 to 0 voltage and are applied to the multiplexer unit through terminals T, U and V of J910 and terminals A and B of J911. The outputs from the collectors of Q930-1 through Q930-5 swing from 0 to -6 volts and are applied to the multiplexer unit through terminals D, E, H, J and N of connector J911.

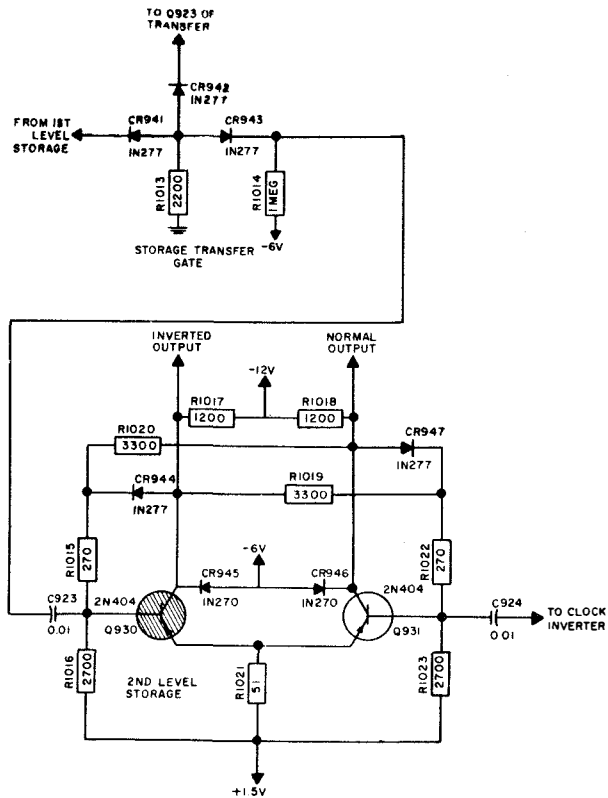


Figure 4-20. Second-Level Storage

5.m.(2) The no. 6 flip-flop in the second-level storage consists of transistors Q932 and Q933 with Q932 normally conducting. The output of the transfer amplifier Q923 is applied to CR948 which passes only the positive signal transition to C925 where it is differentiated into a positive pulse. This pulse is applied to the base of Q932, triggering the flip-flop and causing Q932 to cut off and Q933 to conduct. The output from the collector of Q933 swings from -6 to 0 voltage and is applied to the multiplexer unit through terminal P of J911. The output from the collector of Q932 swings from 0 to -6 volts and is applied to the multiplexer through terminal R of J911.

5.m.(3) The second-level storage is reset by a signal supplied by the clock-inverter transistor Q926. This transistor is normally biased into cutoff by a +2 volt potential at the base developed by divider R998 and R997. The clock input from the multiplexer unit is applied through C919 to the base of Q926. The signal is differentiated by C919, the negative-going transition of which, when applied to the base of Q926, drives that stage into saturation. A positive-going spike is therefore generated at the collector of Q926 and is applied to the second level storage to reset any conducting elements. It is also applied to the clock-delay circuit as explained below.

5.n. CLOCK DELAY CIRCUIT

5.n.(1) The clock delay transistors Q924 and Q925 comprise a univibrator circuit. Q924 is normally conducting and Q925 is normally cut off. The clock-delay circuit is driven from a signal supplied by the clock inverter. The pulse is applied to the base of Q924, triggering the univibrator and causing Q924 to cut off and Q925 to conduct. After a timed interval, determined by the fixed time constant of C918, R995, R989 and R988 and the variable voltage applied to R989, the circuit switches back to its stable condition with Q924 conducting.

5.n.(2) The inverted output of the transfer prime circuit is applied to R989 and controls the time delay produced by the clock delay univibrator. Thus, when the voltage applied to R989 from the collector of Q917 is -6 volts, the univibrator will time out an interval of approximately 3 milliseconds. When the voltage applied to R989 is 0, the univibrator will time out an interval of approximately 6 milliseconds. The output from the collector of Q924 swings from 0 to -6 volts and is applied to the emitter of the transfer firing gate through C916.

5.o. TRANSFER FIRING GATE

5.o.(1) The transfer firing gate operates in a manner identical to the storage-selection gates described previously. Transistor Q919 is normally biased to cutoff by a -6 volts applied to the emitter through R972. The base is connected through R970 to the collector of transfer prime transistor Q917. When 0 voltage is present at the base of Q919, signifying that the transfer prime circuit has not been fired, no output can be generated by a differentiated positive-going pulse applied at the emitter since the emitter is a full 6 volts more negative than the base.

5.o.(2) On the other hand, when the base of Q919 is at -6 volts, signifying that the transfer prime circuit has been fired, a positive-going pulse applied at the emitter will be passed and present at the collector of Q919. The positive-going pulse at the emitter is supplied through C916 which differentiates the negative-going square wave supplied by the clock delay. The positive-going pulse generated by the transfer firing gate is applied to the transfer circuit through C914.

5.p. TRANSFER

5.p.(1) Transfer transistors Q920, Q921, Q922 and Q923 comprise a circuit capable of operation as either a flip-flop or a univibrator. Q920 is normally conducting and Q921 is normally cut off. The output of the transfer firing gate, and the output of the stop element, Q915,

of the start-stop distributor are applied as inputs to the transfer circuit. When the stop element Q915 is conducting (collector at 0 voltage) Q922 is biased into cutoff by the voltage developed at the junction of R984 and R985. In this condition, cross coupling from the collector of Q920 to the base of Q921 is via C915 and R979. Thus the circuit functions as a univibrator.

5.p.(2) If, on the other hand, Q915 is non-conducting, Q922 is saturated and receiving bias current through R985 from the -6 volt potential present at the collector of Q915. In this condition, an additional cross-coupling circuit is available from the collector of Q920 through R977, Q922 and R981 to the base of Q921. The circuit is stable in each of its two states and will function as a flip-flop. Thus, when a positive pulse is applied to the base of Q920 through C914, the circuit triggers and causes Q920 to cut off and Q921 to conduct. The circuit will either reset after a time out interval, or will remain in the set condition until the stop element of the start-stop distributor next fires at which time the circuit will be reset.

5.p.(3) The output of the transfer is applied to a common collector-buffer amplifier Q923 and thence to the storage transfer gates. Q923 serves to isolate the transfer from the storage transfer gates.

5.q. TRANSFER PRIME - Transfer prime transistors Q917 and Q918 comprise a standard flip-flop. Q917 is normally conducting and Q918 is normally cut off. The output of the first-level release amplifier Q916 is applied to C912 and CR923 which passes only the positive signal transition to the base of Q917. Q917 is triggered and forces Q917 to cut off and Q918 to saturate. The output, taken at the collector of Q917, is applied to the transfer firing gate and to the clock delay circuit. The transfer prime flip-flop is returned to its normal condition by the inverted output of the transfer applied to the base of Q918 through C913.

6. MULTIPLEXER-DEMULTIPLEXER (TD-134/UGC-1) (Figures 4-21, 4-31 & 6-29)

6.a. GENERAL (Figure 4-31)

6.a.(1) In the Transmitting Group, the multiplexer-demultiplexer accepts multiwire signals from the transmitting code converters and combines them into multiplex signals which it supplies to the output amplifiers. See paragraph 3.c.(2) of Section 1. In the Receiving Group, this unit accepts multiplex signals from the synchronizer amplifier and furnishes multiwire signals to the receiving code converters.

6.a.(2) The general circuits of the multiplexer-demultiplexer are divider no. 2, divider

no. 3, divider no. 4, signal distributor (divider no. 5), channel distributor (divider no. 6), divider no. 7, signal matrix and signal sampling pulse gate.

6.a.(3) The dividers and distributors are transistor ring circuits that function in a manner similar to the start-stop distributor of the transmitting code converter. Associated with each ring is a drive circuit similar to the start-stop distributor drive.

6.a.(4) Dividers 2, 3 and 4 are used almost exclusively for frequency division. The output frequencies of these rings are shown in Table 4 of Section 1. The signal and channel distributors are used to distribute the incoming or outgoing multiplex signal. Divider no. 7 is used as a frequency divider to provide an output for use with associated auxiliary equipment. Certain elements of rings 2 and 3 and the channel distributor are connected through switches to change the number of elements in the ring and thus provide the correct output frequency for a given speed and channel position.

6.a.(5) Input drive pulses are coupled to the distributor drive circuit associated with divider no. 2. These input pulses are originated at the crystal-oscillator subpanel located in the power supply. Ring dividers 2, 3 and 4 reduce the pulse frequency to a rate required by the signal distributor. The signal distributor, in turn, drives the channel distributor. Outputs from the signal and channel distributors are applied to the signal matrix.

6.a.(6) The signal matrix consists of 24 similar groups of 4 diodes and a load resistor, connected in an AND-OR gating configuration called a star.

6.a.(7) As a multiplexer (transmitting function) the matrix is operated as follows. Each star is operated as an AND gate which is primed from three sources: the signal received from the converters, the signal distributor and the channel distributor. All three must be present (0 voltage) simultaneously to produce an output signal. The fourth diode in each group is connected in common with all corresponding diodes so that a 24-element OR-type gate results which will accept a signal from any one of the 24 diode groups.

6.a.(8) Signals from respective channel code converters in the form of d.c. voltages (0 to -6 volts) are introduced into the matrix through diodes labeled A1, A2, ---A6; B1, B2, ---B6 and so on. These signals are read by the appropriate signal and channel distributors which sample each converter second-level storage flip-flop (24 in all for 4 channel operation)

and generate the multiplex signal. The multiplex signal is supplied as normal and inverted signals and is applied to the output amplifier drawer.

6.a.(9) The multiplex signal generated in the matrix must be assembled with certain pulses inverted (mark for space) in order to provide transitions during an idle signal period. These transitions are necessary for synchronizing purposes. Elements 2, 3 and 4 of channel A plus all of channels C and D are inverted for this purpose. Since each converter supplies both a normal and inverted output, the proper output is connected to the proper matrix diode. Thus, inverted outputs are connected to A2, A3, A4 and all of C and D.

6.a.(10) As a demultiplexer (receiving function) the matrix functions as follows: Multiplexer signals are received from the synchronizer-amplifier unit. These signals are connected through the signal polarity switch and applied to the matrix on two wires. One wire carries the normal signal, and the other carries the inverted signal. Each wire is connected to the appropriate diode to compensate for the inversions in the transmitted multiplex signal. Signals which have been inverted at the transmitter will appear on the inverted signal lead, and signals which were not inverted appear on the normal signal lead. The signal and channel distributors at the demultiplexer perform functions complementary to those of the multiplexer. The distributors, by sampling each of the 24 stars in turn, separate the information contained in the multiplex signal and route it to the proper code converter through diodes A1, A2, ---A6; B1, B2, etc.

6.a.(11) The sampling pulse gate is used at the receive terminal only. Element no. 4 of the divider no. 4 (a seven element divider) is gated with element 2 of divider no. 3 to create a narrow pulse of the order of 1 millisecond. This pulse occurs at the nominal center of each incoming multiplex signal element, and is used by the synchronizer-amplifier as a sampling pulse to sample the incoming signal.

6.a.(12) When the multiplex is used with auxiliary equipment, the no. 6 output from divider no. 4 is employed for signal sampling. This output is therefore available at one of the connectors.

6.a.(13) An output from the A6 matrix star is also required at the receive terminal for use with auxiliary equipment and is provided.

6.a.(14) To detect phase relationships between the incoming signal and the local drive, additional phase lead and phase lag outputs are

required. Two OR gates, one of which gates elements 1, 2, 3 and 4 (phase lag) of divider 4 and the other of which gates elements 5, 6 and 7 (phase lead) of divider 4, are employed to generate these signals.

6.a.(15) A circuit is provided for monitor operation of the channel distributor by means of a milliammeter.

6.a.(16) For the detailed treatment of circuits and their operation which follows, refer to the schematic wiring diagram of Figure 6-29 in addition to the illustration referred to in the text.

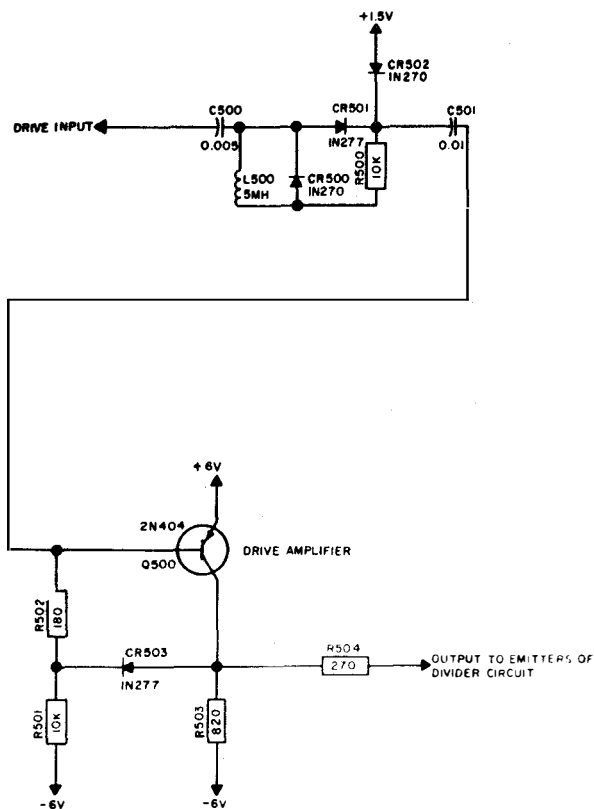


Figure 4-21 Drive Circuit for Divider No. 2

6.b. DIVIDER NO. 2 AND DRIVE (Figure 4-21)

6.b.(1) Drive pulses, varying from -6 to 0 voltage are divided down from the crystal oscillator frequency and supplied to the divider no. 2 drive amplifier. By means of divider no. 2, the input drive-pulse frequency is decreased by a factor of 3, 4 or 5. The frequency of the drive pulses into divider no. 2 are:

WPM	Frequency - CPS
60	15,750
75	15,750
100	15,407.6

6.b.(2) The input to the drive circuit is a positive-going square wave (-6 to 0 voltage) obtained from the crystal oscillator binary. When the square wave is applied to the circuit consisting of C500 in series with L500, a brief current flows and a voltage pulse is developed across L500. This pulse gradually decays to zero as the current through the circuit consisting of L500 shunted by CR500 decreases to zero. When the input square wave goes negative, C500 discharges, but the presence of CR500 shunting L500 prevents the reverse flow of current through L500. The junction between R500 and CR502 is clamped to approximately +1.5 volts by CR502. Therefore, the bottom 1.5 volts of the pulse developed across L500 is removed resulting in an output pulse approximately 4 volts in magnitude and 7 microseconds in width.

6.b.(3) C500 and L500 may also be viewed as a resonant circuit that is shock excited by the square wave input; CR500 clamps the output at zero after the first half-cycle. CR501 blocks current flow from the 1.5 volt supply through L500 to ground. The output pulse is coupled by C501 to the base of drive-amplifier transistor Q500. Q500 is connected to a common emitter amplifier and is normally conducting. The collector is at approximately +6 volts, and CR503 clamps the junction of R501 and R502 to +6 volts also. The positive pulse applied to the base of Q500 drives the transistor into cutoff for the duration of the pulse. The output, taken from the collector of Q500, is thus a series of 7 microsecond pulses swinging from approximately +6 volts to -6 volts.

6.b.(4) These pulses are applied to the ring circuit of divider no. 2, each pulse causing the conducting element to cut off and the next element to conduct. The action is identical to that of the start-stop distributor described in paragraph 5.i. of this section. The switching arrangement provides a frequency division of three (position 3), four (position 2) or five (position 1). Operating the switch merely changes the number of transistors in the ring.

6.b.(5) The collector output of each element of the divider is a 7 volt pulse varying in potential from -6 to +1 volt. Output from the collector of Q501 is fed into C507 and is the input to the drive amplifier for divider no. 3.

6.c. DIVIDER NO. 3 AND DRIVE

6.c.(1) Seven volt input drive pulses are obtained from the collector of Q501 and vary in potential from -6 to +1 volt. The method of operation of divider no. 3 and drive is similar to operation of divider no. 2 and drive.

6.c.(2) A portion of the channel selection switch S502 is located in the circuitry of the

divider. The switch permits equipment operation in two, three or four channels. Position 1 of the switch (two channel operation) utilizes the six elements of the divider. Position 2 of the switch (three channel operation) utilizes four elements of the divider and eliminates Q511 and Q512. Position 3 of the switch (four channel operation) utilizes three elements of the divider and eliminates Q510, Q511 and Q512 from the divider.

6.c.(3) The collector output of each element of the divider is a +7 volt pulse varying from -6 volts to +1 volt.

6.d. DIVIDER NO. 4 AND DRIVE

6.d.(1) Seven volt input drive pulses from the collector of Q507 are brought into C515 and is the input for the drive amplifier of divider no. 4. Operating characteristics are the same as the preceding divider circuits.

6.d.(2) The collector output of each element of the divider is a +7 volt pulse varying from -6 volts to +1 volt.

6.e. SIGNAL DISTRIBUTOR AND DRIVE

6.e.(1) Seven volt input drive pulses are obtained from the collector of Q514 and vary from -6 to +1 volt. These pulses are applied through diode CR538 to capacitor C524 which couples the pulse to the ringing circuit of the drive. In addition, drive pulses are supplied through diode CR542 to capacitor C549 which couples the pulse to the ringing circuit and is furnished only when framing the equipment. Diodes CR538 and CR542 prevent the normal drive pulses from being coupled into the framing drive pulse circuit and, likewise, prevent the framing drive pulses from being coupled into the normal drive pulse circuit. Except for the two drive input circuits, the operating characteristics of divider no. 5 and drive are identical to divider no. 2 and drive.

6.e.(2) The collector output of each element of the divider is a +7 volt pulse varying in potential from -6 to +1 volt.

6.f. CHANNEL DISTRIBUTOR AND DRIVE

6.f.(1) Seven volt input drive pulses are obtained from the collector of Q522. Divider no. 6 and drive operates in the same manner as divider no. 2 and drive.

6.f.(2) A portion of the channel selection switch S502 is located in the circuitry of the divider. The switch permits selection of two, three or four-channel operation. Position 1 of the switch (two-channel operation) utilizes two

elements of the divider and eliminates Q533 and Q534 from the divider. Position 3 of the switch (four-channel operation) utilizes all 4 elements of the divider.

6.f.(3) The collector output of each element of the divider is a +7 volt pulse (-6 to +1 volt).

6.f.(4) The collector output of Q531 is d.c. coupled through R580 to the base of voltage amplifier Q530. When Q531 is conducting, +1.2 volt appears at the base of Q530 holding that stage cut off. A -12 volt potential therefore appears at the collector which, when applied to R577, R576, CR550 and M500, prevents current flow. When Q531 is not conducting, on the other hand, the -6 volts applied to R580 causes bias current to flow and causes Q530 to saturate. Current now flows since the collector is at 0 or ground potential. Operation of the channel distributor may therefore be observed as a pulsating movement of the indicating hand of M500.

6.g. DIVIDER NO. 7 AND DRIVE

6.g.(1) Seven volt drive pulses are obtained from the collector of Q502 and coupled in at C548. Functioning of the ringing circuit, drive and divider ring circuit is identical to that of divider no. 2.

6.g.(2) Output, at the collector of Q536, is a +7 volt pulse (-6 to +1 volt).

6.h. SAMPLING PULSE GATE AND PHASING OUTPUT SIGNAL

6.h.(1) The phase-lagging output signal is generated by means of diodes CR666, CR530, CR531 and CR532 which have common cathode connections through R554 to -12 volts. The anode connections of these diodes are respectively made to the collectors of transistors Q514 through Q517 of divider no. 4. In addition, the phase-leading output signal is generated by means of diodes CR533 through CR535 which have common cathode connections through R555 to -12 volts. The anode connections of these diodes are respectively made to the collectors of transistors Q518, Q519 and Q520.

6.h.(2) The sampling pulse gate is composed of diodes CR536 and CR537 and resistor R556. The cathode of CR536 is connected to the collector of transistor Q508. When Q508 is off, its collector potential is -6 volts which permits CR536 to conduct and produce -6 volts across R556. When Q508 is on, its collector potential is +1 volt so that CR536 does not conduct. The cathode of CR537 is connected to the collector of transistor Q517 of divider no. 4. When Q517 is off, its collector potential is at -6 volts which permits CR537 to conduct and produce -6 volts

across R556. When Q517 is on, its collector potential is at +1 volt which prevents CR536 from conducting. When diodes CR536 or CR537 or both are conducting, -6 volts is developed across R556. When neither diode conduct, 0 voltage is produced across R556. The voltage developed across R556 is applied to the base of Q528 which is an emitter follower. The output in the emitter circuit of Q528 is a positive pulse varying from -6 volts to 0 voltage and occurs only for the period that transistors Q508 and Q517 are both on at the same time.

6.h.(3) The signal-sampling-pulse output switch, S501, is required when auxiliary equipment is used with the Multiplex Set. The auxiliary equipment requires the output signal generated by Q528, and the multiplex equipment requires the output of Q519. When the auxiliary equipment is not used, the output of Q528 is employed for operation of the multiplex equipment.

6.i. SIGNAL MATRIX

6.i.(1) General - The signal matrix circuit is composed of four sections fed by the A, B, C and D converters. Each section contains six AND gates with each gate composed of four diodes and a resistor.

6.i.(2) Multiplexer Operation

6.i.(2)(a) A clock pulse, signal-distributor pulse and signal-information pulse is applied to each gate. The clock pulse determines which of the four sections is to be used. The signal-distributor pulse determines which of the six gates in a section is to be used, and the signal-information pulse will appear as either a marking or spacing impulse. These three pulse sources are wired to three of the four diodes that make up each gate. The fourth diode is used for the output signal of the gate, which appears across the resistor.

6.i.(2)(b) Since the operation of each gate is identical, the operation of the no. 1 gate for the A section only will be described. The gate is composed of diodes CR559 through CR562 and resistor R595. The A clock pulse is generated by means of Q531 and is applied to the diode CR559. When Q531 is off, -6 volts is applied to the diode which conducts and produces -6 volts across R595. When Q531 is on, +1 volt is applied to the diode which cannot conduct and does not produce a voltage across R595.

6.i.(2)(c) The signal-distributor pulse is generated by means of Q522 and is applied to diode CR562. When Q522 is off, -6 volts is applied to the diode which conducts and produces -6 volts across R595. When Q522 is on, +1 volt is applied to the diode which cannot conduct and does not produce a voltage across R595.

6.i.(2)(d) The signal-information pulse is generated in the transmitting code converter and is applied to diode CR561. The pulse varies in potential from -6 to +1 volt. When the potential is -6 volts (space) the diode conducts and produces -6 volts across R595. When the potential is +1 volt (mark) the diode cannot conduct and does not produce a voltage across R595. The junction is at ground potential for a mark and -6 volts for a space.

6.i.(2)(e) When -6 volts exists across R595, diode CR560 cannot conduct. This potential can be caused by one or more diodes (CR559, CR561 and CR562) conducting. With 0 voltage across R595, due to the above diodes not conducting, CR560 will conduct and produce -1 volt across R595. Input to the output amplifier is -1 to -6 volts.

6.i.(2)(f) The above details can be summarized as follows: With any transistor in the channel or signal distributors on, the corresponding diodes cannot conduct. This leaves a specific gate open to respond to the input signal. A space produces -6 volts at the junction; a mark produces -1 volt at the junction. The timing is such that when A(Q531) of the channel distributor is on, elements 1 through 6 of the signal distributor go on in sequence, thus opening each gate in channel A. The same action would follow for channels B, C and D.

6.i.(2)(g) The output signal of CR560 is connected with other diode outputs (5 and 6 on channel A) to the positive signal output terminal (normal signal). Diode outputs not common to CR560 (2, 3 and 4 on channel A) are connected to the negative signal output terminal (inverted signal). These two outputs are joined in the cabinet wiring to become the matrix input to the output amplifier.

6.i.(3) Demultiplexer Operation

6.i.(3)(a) Demultiplexer operation is the inverse of multiplexer operation. Timing of channel and signal distributors is identical to that for multiplexer operation as described above. However, the diodes and leads that carried the signal output for multiplexer operation now become the signal input for demultiplexer operation. The diodes connected to A1, A2, ---B1, B2 etc. now carry the output of the demultiplexer and delivers signals to the receiving code converters. Signal input pulses from the synchronizer (0 voltage for mark, -6 volts for space) are applied to diode CR560.

6.i.(3)(b) With 0 voltage across R595, due to CR559, CR560, and CR562 not conducting, CR561 will conduct to the input flip-flop of the receiving code converter and produce -1 volt across R595.

7. OUTPUT AMPLIFIER (AM-1 /UGC-1) (Figures 4-32 & 6-39)

7.a. GENERAL (Figure 4-32)

7.a.(1) The output amplifier accepts multiplex signals from the multiplexer-demultiplexer and amplifies them to voltage levels suitable for use by local or remote signal circuits. See paragraph 3.c.(3) of section 1.

7.a.(2) The general circuits comprising the output-amplifier are the inverted-text amplifier, voltage translator, line-relay drive, line-relay voltage-amplifier output, a.c. generator and auxiliary outputs.

7.a.(3) The input, received from the matrix located in the multiplexer-demultiplexer, is amplified, inverted and made available for use by associated auxiliary equipment at voltage and power levels compatible with the equipment. The signal is returned by the associated equipment, reinverted and reduced to voltage levels compatible with multiplex circuitry.

7.a.(4) The signal passes through the signal selector switch to the line-relay drive. At the line-relay drive an output oscillator is keyed and its output amplified and applied to the line relay.

7.a.(5) The keyed oscillations of the line-relay drive are passed through an isolation transformer where the signal is demodulated and used to key the multiplex line. The line relay output is a keyed, ungrounded, neutral signal of 20 or 60 milliamperes, battery for which must be externally supplied.

7.a.(6) An output from the line-relay drive also keys the voltage-amplifier output circuit. This circuit supplies a keyed signal of up to 50 volts, the negative side of which is grounded.

7.a.(7) The a.c. pattern, used for test and lineup purposes at the receive terminal, is generated by a binary circuit which receives its drive from ring 4 located in the multiplexer-demultiplexer. The output of the a.c. generator is made available to the multiplex output circuits at the signal selection switch.

7.a.(8) In addition, special outputs are supplied for use with associated auxiliary equipment. These outputs are supplied at voltage and power levels compatible with similar outputs supplied by the Electronic Multiplex Set.

7.a.(9) For the detailed treatment of the circuits and their operation which follows, refer to the schematic wiring diagram of Figure 6-39.

7.b. A.C. GENERATOR

7.b.(1) The a.c. generator is essentially a bi-stable multivibrator identical to those found in the transmitting and receiving code converters. This circuit, however, is connected to function as a binary. Two PNP junction transistors, Q400 and Q401, are used. One conducts into saturation and the other is held cut off. The circuit is triggered from one stable state to the other by a positive drive pulse received from ring no. 4 in the multiplexer-demultiplexer. This pulse is applied to the junction of C400 and C401.

7.b.(2) For descriptive purposes, it is assumed that Q400 is conducting and Q401 is cut off. The potential at the collector of Q400 is therefore +1 volt and at Q401 it is -6 volts. The +1 volt potential is applied through R403 to the junction of C400 and CR400 and charges C400 to +1 volt. Since CR400 is also connected to the junction of R404, R401 and CR401, which is also at +1 volt, CR400 is unbiased.

7.b.(3) The -6 volt potential at the collector of Q401 is connected to the junction of C401 and CR405 and charges C401 to -6 volts. The cathode of CR405 is connected to the junction of CR404, R405 and R407 which are also at +1 volt. CR405 is therefore negatively biased 7 volts. A +6 volt drive pulse, when applied to C400 and C401, will pass through CR400 and R401 to the base of Q400. This same pulse will be inhibited by CR405. Q400 will thus be made non-conductive, and Q401 will saturate. The next drive pulse will be passed by CR405 and inhibited by CR400 in the same manner. Q401 will be driven into cut off and Q400 will conduct, and so on. The output, taken at the collector of Q400, is applied to S400, the signal selection switch.

7.c. INVERTED TEXT AMPLIFIER

7.c.(1) The normal and inverted multiplex signals are received from the matrix, located in the multiplexer-demultiplexer, and applied to the base of buffer amplifier Q406. Q406 is an NPN transistor connected in the common collector configuration. The input and output of this amplifier is a signal having voltage limits of -1 and -6 volts. This signal is applied to R421 and the base of Q407.

7.c.(2) With -1 volt present at the emitter of Q406, the potential developed by divider R421 and R422 at the base of Q407 is approximately +2 volts. Since the emitter of Q407 is grounded, the emitter-base diode is reverse biased, and the transistor is cut off.

7.c.(3) With -6 volts at the emitter of Q406, the base-emitter diode of Q407 is forward biased

and sufficient bias current flows to saturate the stage.

7.c.(4) When Q407 is cut off, current flows from the -12 volt supply through collector load resistor R423 and through R424 into the emitter of Q408. Q408 is an NPN transistor connected in the common base configuration. Current flow in the emitter generates current flow in the collector and the transistor saturates. Ground potential (0 voltage) appears at the collector.

7.c.(5) With Q407 saturated, the collector potential has 0 voltage. The voltage developed at the emitter of Q408 is now positive with reference to ground, having been developed by divider R424 and R425. Q408 is back biased and a +50 volts appears at the collector.

7.c.(6) When -1 volt (signifying a multiplex mark signal) is received from the matrix, a 0 voltage pulse is generated at Q408. When -6 volts (signifying a multiplex space) is received, +50 volts is generated at Q408. The signal is therefore inverted at Q408 (mark when space at matrix and space when mark at matrix.) This 0 to +50 volts signal is made available to auxiliary equipment which may be employed in conjunction with the 4 channel multiplex. The signal is processed by the auxiliary equipment and returned to the multiplex. When auxiliary equipment is not used, the appropriate terminals are shorted, and the signal generated by Q408 is applied directly to R427 and the base of Q409.

7.d. VOLTAGE TRANSLATOR - Q409 reinverts the signal and generates a signal, the voltages of which are acceptable to multiplex circuitry. With +50 volts applied to R427 (signifying a multiplex space), +1.5 volts exist at the base of Q409 and is limited by CR406. Q409 is therefore non-conductive. With 0 voltage applied (signifying a multiplex mark), bias current flows from the -12 volt supply through R428 and saturates the transistor. The output of this stage is applied to S400.

7.e. SIGNAL SELECTION SWITCH - S400 is a four-position switch which determines the signal to be transmitted. Constant mark, constant space, alternating marks and spaces and the multiplex signal may be selected for transmission. The first three signals are generally used for circuit lineup. The output of S400 is applied to R431 and the base of Q410.

7.f. LINE RELAY DRIVE

7.f.(1) Q410, Q411 and Q412 constitute a circuit very similar in operation to the start-stop oscillator and control circuit found in the transmitting and receiving code converters.

Q412 is an oscillator whose oscillation is controlled by Q410 and Q411.

7.f.(2) With 0 or ground potential (mark) applied to R431, the voltage generated by divider R431 and R432 at the base of Q410 is slightly positive. Q410 is therefore cut off and -12 volts appears at its collector. This potential, when applied through R434, biases CR407 and CR408 into non-conduction. This voltage, when applied through R435, develops a voltage at the base of Q411 which biases that transistor non-conductive. The oscillator Q412 is free to oscillate. Oscillations occur about the -6 volt potential applied to the base of Q412 and are approximately 12 volts peak to peak in amplitude.

7.f.(3) With -6 volts (space) applied at R431, Q410 conducts into saturation and ground potential appears at the collector. This potential is applied to R434 and R435. CR407 now becomes forward biased and current flows through CR407, R434 and the transistor Q410. A -6 volts is therefore applied to the anode of CR408.

7.f.(4) Zero voltage at the collector of Q410 generates bias current for Q411. Electrons flow from the -6 volt supply at the emitter of Q411 through the emitter-base diode and R435 to the collector of Q410.

7.f.(5) Should the oscillator be generating a negative half cycle (more negative than -6 volts at the base of Q412) at the instant a space is applied, CR408 will conduct and the oscillation will be quenched. Likewise, should the oscillator be generating a positive half cycle (more positive than -6 volts) at the instant a space is applied, CR409 will conduct and quench oscillation. Oscillations are therefore quenched immediately upon receipt of a space regardless of the period of the oscillator cycle.

7.f.(6) Q412 and associated components constitute an oscillator very similar in operation to the start-stop oscillators previously discussed. The basic difference is frequency of oscillation. The oscillator is tuned to oscillate at approximately 33KC. The circuit is essentially a common collector amplifier with in phase current feedback through R438 to the junction of C407 and C408 in the base circuit. The output is taken at the emitter and applied to power amplifiers Q413 and Q414.

7.f.(7) Q413 and Q414 are PNP, NPN buffer power amplifiers connected in parallel. The positive going half cycle is passed and amplified by Q414, while the negative going half cycle is passed and amplified by Q413. The output taken at the common emitter connection is passed through C409 to isolation transformer T400.

7.g. LINE RELAY

7.g.(1) The line-relay transistors Q415, Q416, Q417, Q419 are electrically isolated from chassis ground. Operating potentials are supplied by the external battery and an isolated local 12 volt supply. Q417 and Q419 are connected in series with the d.c. line. They are designed to short circuit (saturate) in response to a marking impulse generated by the oscillator, and to become open (cut off) in response to a spacing impulse generated by the oscillator. Oscillation occurs at Q412 for a mark; no oscillation occurs for a space.

7.g.(2) When the multiplex signal is spacing (no oscillation), Q415 and Q416 are non-conductive since the base and emitter of both transistors are connected through the secondary of T400. No bias current may therefore flow.

7.g.(3) R444 and R445 form a voltage divider across the isolated 12 volt supply. The junction of R444 and R445 is approximately 4 volts less positive than the positive terminal of the isolated supply. Since the positive terminal is connected to the base of Q417 through R446, and the junction of R444 and R445 is connected to the emitter of Q417, Q417 is biased to cutoff.

7.g.(4) R456, R457 and R458 are connected to form a divider across the external battery. Assuming a 130 volt supply and Q419 and Q417 non-conductive, approximately 1 milliampere flows through the divider. The junction of R457 and R458 is approximately 63 volts less negative than the negative battery terminal, and the junction of R456 and R457 is 4 volts less negative than the voltage at the R457-R458 junction. Since the emitter of Q419 is connected at the R457-R458 junction, and the base of Q419 is connected at the R456-R457 junction, Q419 is also non-conductive. Line current is therefore limited to 1 milliampere. The cathode of CR412 is connected through R444 to the positive terminal of the line battery, and the anode of CR412 is connected through R455 to a point which is approximately 63 volts more negative. Therefore CR412 is biased in the back direction and is consequently non-conductive.

7.g.(5) When a marking signal (oscillation) is received at the secondary of T400, the resulting signal is applied to the base of Q415 and the base of Q416. The transistors saturate alternately as their respective bases swing negative with respect to the common emitter connection. The result is a negative potential applied from the isolated negative 12 volt supply through Q415 and Q416 to R447. Bias current flows in the base-emitter diode of Q417 and saturates that stage. The collector of Q417 rises immediately to that of the positive line battery terminal.

Since the negative isolated supply potential is approximately 8 volts more negative than the positive line battery supply (drop across R444), CR412 becomes forward biased, and current flows from the negative isolated supply through CR412, R455 and the base-emitter diode of Q419. Q419 is biased into saturation and allows line current to flow.

7.g.(6) CR410 and CR411 are 75 volt Zener diodes connected in series. These diodes limit the maximum voltage which may be externally applied. Should the external line battery voltage exceed 150 volts, these diodes will become conductive.

7.g.(7) R448 is a rheostat for limiting the line current. Meter M400 indicates the line current. F400 is a fuse for protecting transistors and diodes against overload.

7.g.(8) Remote-local switch S401 permits operation of a send-receive terminal back to back on a local basis. When S401 is switched to local, battery is furnished by the -12 volt supply. When operated locally, the voltage developed across R456 is insufficient to back bias CR412. Consequently, bias current flows during a multiplex space as well as during a mark and saturates Q419. However, Q417 keys as before and permits normal operation of the relay circuit.

7.h. OUTPUT VOLTAGE AMPLIFIER - Certain keying devices are voltage-keyed rather than current-keyed. In order that the multiplex be compatible with such equipment, a keyed voltage output is supplied. This output is generated by Q418 which receives its drive from Q410. The collector of Q410 swings to -12 volts for a multiplex mark and 0 voltage for a multiplex space. When -12 volts (mark) is applied through R450 to the base of Q418, Q418 becomes non-conductive since the base is negative with respect to the emitter. Conversely, when 0 voltage is applied, bias current flows through R451 and saturates Q418. R459 is a potentiometer connected to the +50 volt supply. Any collector supply from 0 to +50 volts may therefore be employed. The output is taken at the collector: 0 voltage is a space, and some positive voltage, depending upon the setting of R459, is a mark.

7.i. AUXILIARY OUTPUTS

7.i.(1) In addition to the inverted multiplex signal, certain other outputs are required to pulse associated auxiliary equipment. An auxiliary clock output, signal distributor output, and channel B clock output are required. These outputs must be at certain voltage and power levels to be compatible with existing auxiliary equipment.

7.i.(2) Q402-1 and Q403-1 generate a series of 37 volt positive-going pulses. Input is received from the no. 7 divider located in the multiplexer-demultiplexer. The input, varying between -6 and 0 voltage, is passed by buffer amplifier Q402, is differentiated by C404-1 and is applied to common base amplifier Q403-1. The positive-going pulses saturate Q403-1, the base of which is returned to +37 volts. Divider R413-1 and R412-1 provide a voltage slightly less positive than +37 volts which, when applied to the emitter of Q403-1, holds the transistor in cutoff except when driven by the input signal.

7.i.(3) Q402-2 and Q403-2 are identical to the circuit previously discussed. The input is received from the channel B clock amplifier located in the multiplexer-demultiplexer. The channel B clock amplifier determines the rate at which positive pulses are generated.

7.i.(4) Q404 and Q405 combine to form a circuit capable of generating negative-going 24 volt pulses. The input is received from divider no. 4 located in the multiplexer-demultiplexer. The input is passed through buffer amplifier Q404, C406 and R418 to the base of Q405. Q405 is normally saturated and bias current flows from ground through R417 and R418. The input drives Q405 into cutoff and thereby generates negative pulses at the collector of Q405.

8. SYNCHRONIZER-AMPLIFIER (SN- /UGC-1) (Figures 4-22 through 4-27 & 6-57)

8.a. GENERAL (Figure 4-33)

8.a.(1) The synchronizer-amplifier accepts multiplex signals from a local or remote line, amplifies them and furnishes them to the multiplexer-demultiplexer. It also maintains the correct phase relationship between the incoming signals and the frequency derived from the local crystal oscillator. See paragraph 3.d.(1) of Section 1.

8.a.(2) The synchronizer maintains an optimum phase position between the local frequency standard and an incoming signal under the control of the frequency standard at the distant station. Optimum phase position exists when the receiving equipment interrogates the incoming signal at the midpoint of the pulses. If corrective measures are not taken, this phase position will change due to the small frequency difference between the transmitting and receiving frequency standards.

8.a.(3) Instantaneously, the phase position will also be affected by variations in the propagation delay of the radio path and extraneous pulses produced by atmospheric or man-made

noise. Since the advance or delay in phase due to the latter two items will tend to cancel or average zero over a long period of time, the synchronizer disregards these effects and acts only to insert the difference frequency (+ or -) between the frequency standards.

8.a.(4) In Figure 4-33 the logic functions can be divided into three main groups: (a) the input relay, (b) the phase sensing and phase correcting circuits and (c) the framing circuits (framing refers to alignment on a channel to channel and signal pulse to signal pulse basis between the transmitting and receiving terminals.) In the paragraphs which follow, the numbers in parenthesis refer to the blocks of Figure 4-19.

8.a.(5) Input Relay

8.a.(5)(a) The input relay electrically isolates the multiplex signalling circuit from the Receiving Multiplex Group. The signals are amplified, squared and inverted. Sampling pulses are applied to the signal, and normal and inverted outputs are supplied to the diode matrix in the demultiplexer. Signal transitions are coupled to the phase-correcting circuits.

8.a.(5)(b) The input relay (1) accepts an incoming multiplex signal containing two, three or four channels. A transistorized line relay is used which is able to repeat the signal pulses with a minimum of distortion while electrically isolating the input circuit. An output amplifier (2) raises the level and inverts the input signal to +50 volts for keying auxiliary equipment where required.

8.a.(5)(c) An input attenuator (3) inverts the phase and reduces the level of the returned signal from the auxiliary equipment to the standard signal level. The attenuator drives phase inverter (4) and an AND gate (5). The phase inverter (4) drives a second AND gate (6). A signal sampling pulse which is derived from the demultiplexer unit is applied to AND gates (5) and (6). AND gate (5) thus provides an output for the interval of the signal-sampling pulse only when the normal signal is marking. AND gate (6) produces an output only when the inverted signal is marking. Isolating amplifiers (7) and (8) couple the normal and inverted signal pulses to the diode matrix in the demultiplexer unit.

8.a.(6) Phase Sensing (Figure 4-22)

8.a.(6)(a) In the phase sensing circuits, the phase position of the pulses derived from the signal transitions is compared to the local frequency standard. If the local standard is too advanced in phase, it is retarded by inhibiting

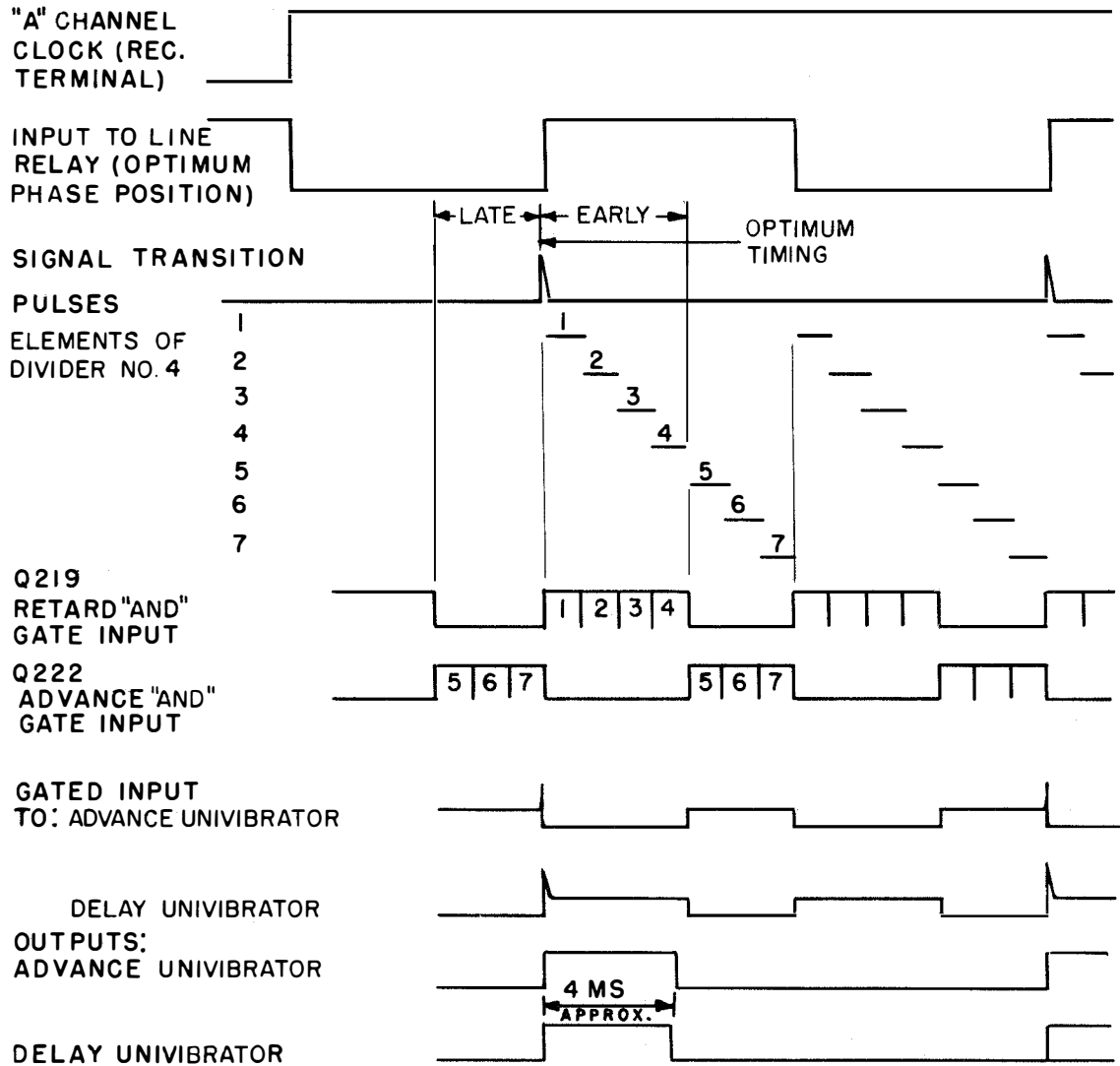


Figure 4-22 . Timing Diagram of Phasing Circuits

the drive pulses. A large capacitor acts to prevent instantaneous changes in phase position from causing correction.

8.a.(6)(b) The input relay (1) also drives an AND gate (9) to which the channel A clock signal is also applied. This AND gate produces positive pulses for space to mark signal transitions occurring during channel A clock pulses. This is shown in the timing diagram of Figure 4-20. The positive pulses are lengthened to 150 microseconds in a pulse shaping circuit (10). An isolating amplifier (11) couples these pulses into two AND gates (12) and (13). AND gate (12) also has inputs from elements 1, 2, 3 and 4 of divider no. 4 in the demultiplexer via an isolating amplifier (14). These elements are associated with a lagging phase relationship. Elements 5, 6 and 7, which are associated with an early or leading phase relationship, are applied to AND gate (13) via isolating amplifier (15).

8.a.(6)(c) It should be noted that the optimum phase condition exists when the signal transition pulses overlap the advance and retard gates between pulses 1 and 7 as shown in Figure 4-20. Later in the description it will be apparent that transitions arriving in the above designated phase position will not result in correction. However, if the transitions occur earlier or later than this interval, the signal transition pulses will coincide only with the corresponding AND gate input pulse, and action will begin to return the phase relationship to the optimum position.

8.a.(7) Phase Correcting

8.a.(7)(a) Assuming that the phase of the incoming signal is leading the local standard, there will be coincidence of the signal transition pulse with the phase lead gate. Each time that a signal transition occurs during channel A clock pulse, an output will be produced by advance AND gate (13). A normalizing univibrator (16) times out a fixed millisecond pulse which charges a large capacitor (17) in a positive direction via a constant current transistor circuit (18). These constant current pulses are shown in the top line of Figure 4-23

8.a.(7)(b) Since the energy in one pulse is a very small percentage of the total energy needed to raise the potential of this capacitor from 0 to a critical voltage (+6 volts), the voltage of the capacitor will increase only a very small increment for each input pulse. If the phase leading condition persists for a sufficiently long time (approximately 20 seconds), the capacitor potential will become more positive than +6 volts. An isolating amplifier (19) couples this potential to a level sensing circuit (20). The output of the level sensing circuit is raised to the proper level by a phase inverter (21).

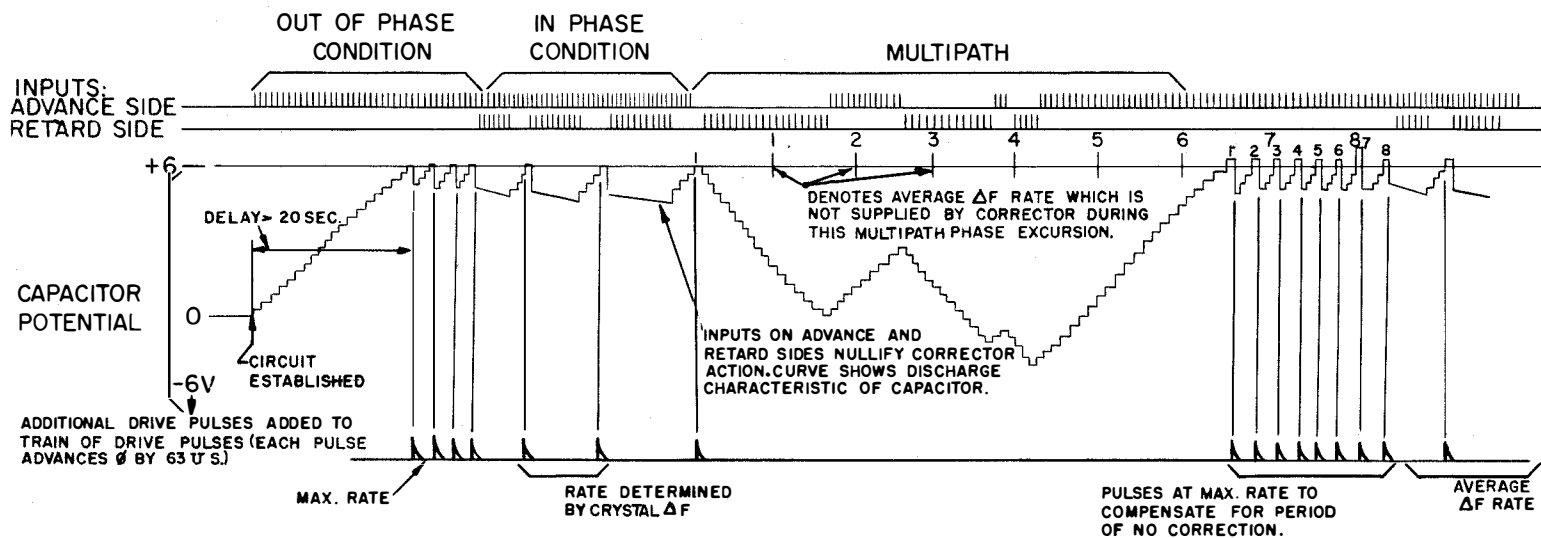
8.a.(7)(c) A positive output voltage from the above circuit turns off one side of the advance flip-flop circuit (22). A discharge circuit (23) connected to the flip-flop immediately begins to discharge the capacitor so that, after a short period, the initial positive d.c. potential applied to the flip-flop via circuit (20) and (21) is removed. The flip-flop remains in its primed condition, however, until the next channel A clock pulse is received. It then triggers back to its initial condition and at the same time triggers the ADD univibrator (23) which is set for a period of approximately 40 microseconds. The output of this univibrator, which is applied to an AND gate (24), gates in an additional drive pulse through OR gate (25) and amplifier (26) to the train of drive pulses obtained from the (1) side of binary no. 2 in divider no. 1.

8.a.(7)(d) The added pulse is derived from the (0) side of binary no. 2 so it falls between adjacent pulses in the train. The addition of this drive pulse thus advances the phase of the local standard by the period of one drive pulse, and makes it more nearly in phase with the assumed leading input signal. Figure 4-23 shows that additional advance drive pulses are generated with relatively little delay, once the initial charging of the capacitor takes place. Pulses are added to the drive-pulse train until the phase sensing circuits detect coincidence of the signal-transition pulse with the phase-lag gate. At this time, the retard portion of the corrector begins to operate and nullifies the positive increase of charge on the capacitor produced by the advance side.

8.a.(7)(e) The action of the retard portion of the corrector is identical to that of the advance side with few exceptions. The capacitor is discharged in a negative direction, and a level of -6 volts is recognized. At this point the level-sensing circuit develops a positive voltage to drive a flip-flop as above. Operation of the subtract univibrator interrupts for a period of 70 microseconds the train of pulses from (1) side of binary no. 2 in AND gate (27) and thus retards the phase of the local standard by one drive pulse.

8.a.(8) Operation and Metering

8.a.(8)(a) A high impedance voltmeter connected to the tank capacitor indicates the condition of the local crystal oscillator (fast or slow). Under conditions of varying propagation delay (multipath), the input transitions may be coincident first on the advance side and then on the delay side. This is shown in Figure 4-23 in the portion marked "multipath." Due to the long delay period which the tank capacitor provides, no action is taken by the corrector until a majority of transitions coincide with pulses gating the fast or slow sides.



NOTES:

1. RECEIVING CRYSTAL OSC. IS SLOW.
2. CAPACITOR CHARGING CHARACTERISTIC STEPS GREATLY EXAGGERATED FOR CLARITY.
3. ΔF IS THE DIFFERENCE BETWEEN TRANSMITTER CRYSTAL FREQUENCY AND RECEIVER CRYSTAL FREQUENCY.
4. INPUTS ARE 4 MILLISEC. PULSES FROM ADVANCE AND DELAY UNIVIBRATORS.

8.a.(8)(b) After the necessary correction has been made, the transition pulse will be coincident with both the add and subtract sides. In this condition, the pulse put in by the add side is exactly cancelled by the pulse from the subtract side and nullifies corrector action. Under normal operation, the meter indication will return toward zero following correction, but the reading will seldom reach zero since need for additional correction will occur before that point is reached.

8.a.(9) Framing Circuits

8.a.(9)(a) The framing circuits are used by the operator to frame the receiver with the transmitter on a signal pulse and channel basis. Thus, when no. 6 pulse in channel A is transmitted, the receiver is looking for no. 6 in channel A. Framing can be done by semi-automatic or manual means. In both cases, an input pulse is derived from the start-stop distributor in the receiving code converter of channel A.

8.a.(9)(b) Semi-automatic framing can be done only when channel A is idle. Each out of phase condition operates the A start-stop distributor and generates a new framing pulse which advances framing by one signal pulse. When an in-frame point is reached, the A code converter recognizes the idle signal, the start-stop distributor stops and no further framing pulses are produced. Manual framing can be done under traffic conditions by viewing copy on channel A. Use of a flip-flop in the manual circuit insures that invariably one advancement pulse is obtained for each closure of the framing switch. A relay is used in the circuit so that framing can be accomplished either locally or remotely.

8.a.(10) Special Auxiliary Outputs - Inverted multiplex signals, auxiliary clock pulses, signal sampling pulses, and pulses from the A-6 star in the demultiplexer matrix are amplified to the proper power or voltage level so that certain auxiliary equipment can be interconnected with the Set.

8.a.(11) For the detailed treatment of the circuits and their operation that follows, refer to the schematic wiring diagram of Figure 6-57 as well as other illustrations indicated in the text.

8.b. INPUT RELAY

8.b.(1) Oscillator

8.b.(1)(a) By means of local-remote switch S200, a local or remote input signal line may be selected. The transistor line relay will accept either a 20 ma. or 60 ma. neutral time-

division multiplex signal. The multiplex signal current flows through line current meter M200, line-current variable resistor R218 and resistor R211 in parallel with R212 and slicing-level variable resistor R217. By means of variable resistor R217, a voltage is applied to the collector of Q202. Q202 and associated components form a Hartley-type oscillator with a natural frequency of oscillation between 250 and 300 kc. The frequency of oscillation is determined by the inductance of the primary winding of transformer T200, its distributed capacitance and capacitor C203.

8.b.(1)(b) It is assumed that a marking condition is the flow of current in the line-relay circuit and a spacing condition is the absence of current flow in the line-relay circuit. Assuming a marking condition is applied to the line relay, a d.c. voltage is applied to Q202 which causes the transistor circuit to oscillate. Oscillation will continue for the period that the marking condition exists and is sustained by positive feedback from terminal 1 of the transformer through resistor R213 to the base of transistor Q202. By means of resistor R215 and capacitor C204, a fixed d.c. voltage is maintained on the emitter of transistor Q202 and holds the operating point of the oscillator at approximately 8 milliamperes.

8.b.(1)(c) Assuming a spacing condition is applied to the line relay, 0 voltage is applied to transistor Q202 and the transistor circuit is unable to oscillate. Inductor L200 and capacitor C202 form a filter that prevents the oscillator frequency from appearing on the local or remote signal lines, and it also prevents short noise bursts from causing the oscillator to oscillate.

8.b.(2) Demodulator and Amplifier - The output signal of the line relay oscillator is transformer-coupled to the secondary winding of T200 and produces a +.08 volt between the base and emitter of transistor Q208, a demodulator. The output signal of transistor Q208 is an inverted multiplex signal of approximately 9 volts amplitude and varies in potential from approximately +3 to -6 volts. This signal is applied through resistor R232 to a filter network composed of capacitor C206, diode CR213 and resistor R234. This circuit removes the portion of the oscillator frequency passed by Q208. The filtered multiplex signal is applied through resistor R233 to the base of transistor Q209. Transistor Q209 amplifies and inverts the signal applied to its base and produces a normal multiplex signal on its emitter that varies in potential from approximately 0 to -6 volts.

8.c. INVERTED TEXT AMPLIFIER - The output signal of the line relay amplifier is furnished to two circuits. One of these is through

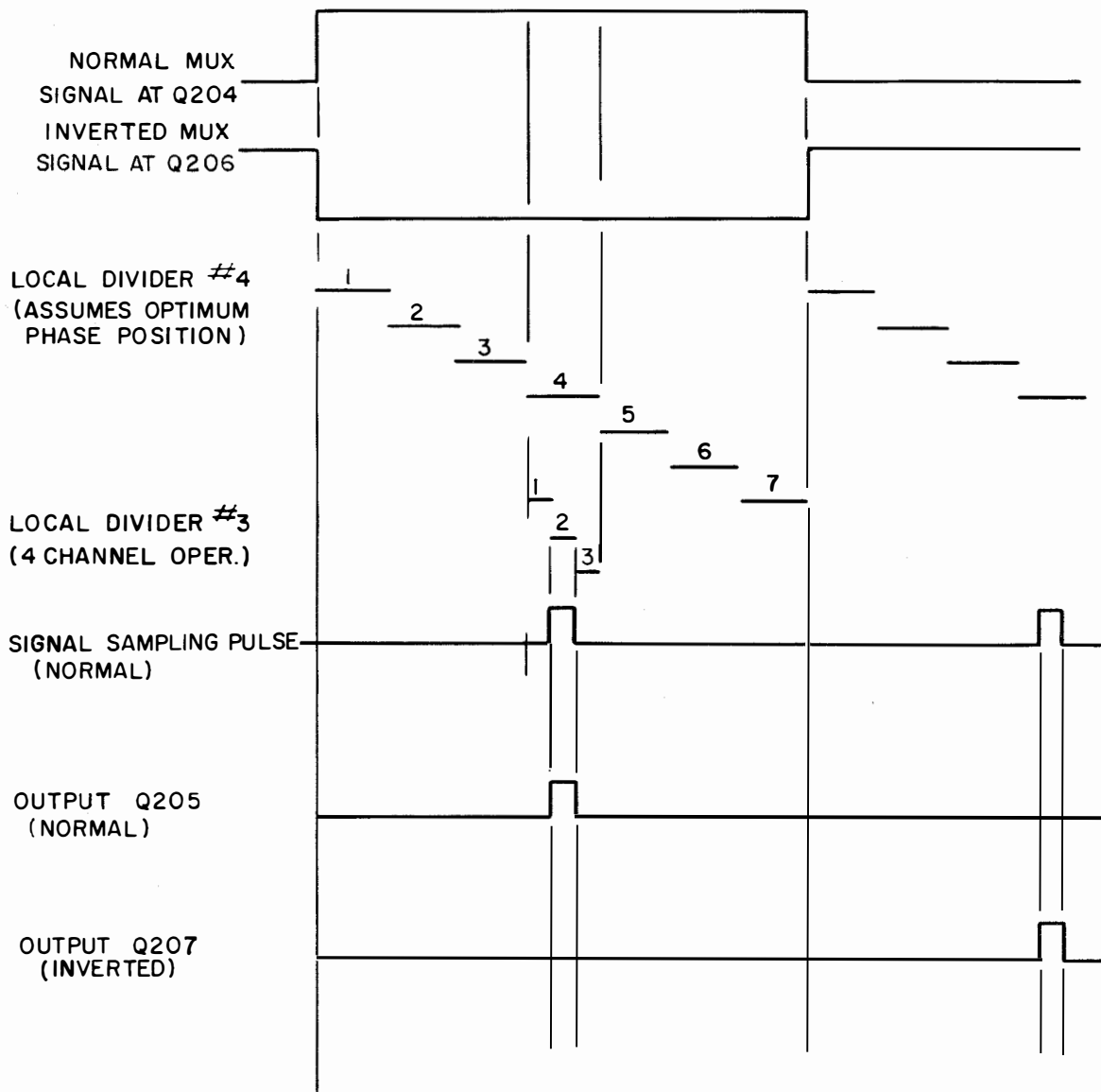


Figure 4-24. Timing Diagram of Signal Sampling

resistor R236 to the base of Q210, the inverted text amplifier. The signal on the base of transistor Q210 varies in potential from approximately 0 to -2.2 volts. The result is an inverted multiplex signal in the collector circuit of transistor Q210 which varies in potential from approximately 0 to +50 volts. The output signal of transistor Q210 is furnished to connector J1200 on the rear plate of the receive cabinet for use by auxiliary equipment.

8.d. ATTENUATOR, INVERTER, SAMPLING AND OUTPUT AMPLIFIER CIRCUITS

8.d.(1) Signal Attenuator and Amplifier

8.d.(1)(a) The signal attenuator is comprised of resistors R219 and R220 connected as a voltage divider. The base of amplifier Q203 and a diode clamp CR206, referenced to +1.5 volts, are connected to the junction. The voltage divider is proportioned so that the base of Q203 will be made negative for input signals which are less positive than 25 volts.

8.d.(1)(b) When inverted input signals are supplied from auxiliary equipment (0 voltage marking, +90 volts spacing), Q203 conducts into saturation for the marking pulses resulting in 0 voltage at its collector. For spacing pulses, Q203 is cut off resulting in -6 volts (clamped by CR207) at its collector. Diode CR206 prevents the base potential from rising above +1.5 volts and thereby protects the transistor.

8.d.(1)(c) If the auxiliary equipment is not used, the output of Q210 is coupled to the auxiliary input terminal by a dummy plug inserted into J1200 on the back plate. Under this condition, +50 volts is supplied for a spacing signal. Operation of Q203 is identical to that described above with the normal multiplex signal appearing at the collector.

8.d.(2) Phase Inverter - The output of Q203 is coupled to emitter follower Q204. The normal multiplex output signal from transistor Q204 is applied to resistor R224. Resistors R224 and R223 form a voltage divider. A marking pulse, 0 voltage, applied to resistor R224 will produce approximately -0.1 volt at the base of transistor Q206 and the junction of resistors R224 and R223. Transistor Q206 is cut off when its base is positive and its collector potential is -6 volts. Transistor Q206 conducts when its base is negative and its collector potential is 0 voltage. The output signal of phase-inverter transistor Q206 is an inverted multiplex signal varying in potential from approximately 0 to -6 volts. Thus the output signals of transistors Q204 and Q206 are 180° out of phase with each other.

8.d.(3) Signal-Sampling Gates(Figure 4-24)

8.d.(3)(a) Two signal-sampling gates are used in the synchronizer. One, the normal gate is composed of diodes CR209 and CR210 and resistor R228; the other, the inverted gate, is composed of diodes CR208 and CR212 and resistor R227. The purpose of the gates is to furnish an output signal from two input signals when the two input signals have a particular relationship.

8.d.(3)(b) Since the operation of the normal and inverted signal-sampling gates is identical, operation of only the normal will be described. Signal sampling pulses varying in amplitude from 0 to -6 volts are derived in the multiplexer-demultiplexer and furnished to CR210. The signal-sampling pulse rate is the same as the multiplex signal rate. The signal sampling pulses are of short time duration and appear in the center of each multiplex signal pulse (assuming that the phase-correcting circuits are operating). The normal multiplex signal, varying in amplitude from 0 to -6 volts, is applied to diode CR209. When the signals applied to diodes CR209 and CR210 are both at -6 volts potential, or when one applied signal is at -6 volts and the other signal is at 0 voltage, -6 volts will exist across resistor R228. 0 voltage will appear across R228 only during the relatively short time that a sampling pulse is present, and then only if the signal level from Q204 is 0 voltage.

8.d.(4) Output Amplifiers - Two output amplifiers are utilized in the synchronizer. One is transistor Q205, the normal output amplifier, and the other is transistor Q207, the inverted output amplifier. The two are emitter follower amplifiers and the emitter output will be identical to the base signal. The output of these amplifiers is a series of sharp positive pulses varying in potential from -6 to 0 voltage. Due to the use of the normal and inverted multiplex signals in the signal sampling gates, a positive pulse will appear in the output of only one of the output amplifiers at any one time. The output signals of the output amplifiers are furnished to the multiplexer-demultiplexer where they are used to prime the code converter inputs.

8.e. SYNCHRONIZING CIRCUITS

8.e.(1) Multiplex Signal Synchronizing Gate and Amplifier

8.e.(1)(a) The output signal of the demodulator amplifier Q209 is applied to differentiating capacitor C207 as well as to the inverted-text amplifier Q210. The output of capacitor C207 is a series of alternately positive and negative "spikes" approximately 6 volts in am-

plitude. A positive spike is produced when the normal multiplex signal changes from a spacing condition to a marking condition, and a negative spike is formed when the normal multiplex signal changes from a marking condition to a spacing condition.

8.e.(1)(b) The channel A clock pulse is derived in the multiplexer-demultiplexer and is furnished to resistor R241; this pulse varies in amplitude from 0 to -6 volts. The sum of two signals will appear at the junction of capacitor C207 and resistor R241. When the channel A clock pulse is applied to resistor R241 (-6 volt condition), diode CR215 cannot pass the +6 volt spike due to -1.5 volt bias applied through resistor R242 to the negative side of the diode. However, during the period of time that the channel A clock pulse is present (0 voltage) and a positive 6 volt distorted spike is furnished by capacitor C207, diode CR215 will conduct and furnish a positive spike of approximately 4.5 volt amplitude and 150 microseconds base width to capacitor C208.

8.e.(1)(c) Capacitor C208 couples the above positive spike to the base of emitter-follower-amplifier transistor Q211. The base of transistor Q211 is normally at -6 volts. It is connected through clamp diode CR216 to -6 volts and resistor R243 to -12 volts. Since transistor Q211 is an emitter follower, the emitter signal follows the base signal, and the output signal will be a series of +4 volt spikes varying in amplitude from -6 to -1.5 volts.

8.e.(2) Phase Lead and Lag Amplifiers AND Gates (Figure 4-22)

8.e.(2)(a) Seven pulses (varying from -6 to +1 volt) of equal time duration, which are furnished by divider no. 4 in the multiplexer-demultiplexer and the total period of which is equal to a multiplex signal pulse, are applied to the phase lead and lag amplifiers. The no. 1 through 4 pulses are applied via an OR gate in the demultiplexer to the base of the phase-lag amplifier, transistor Q219, and the no. 5 through 7 pulses are applied via a second OR gate to the base of phase-lead amplifier, transistor Q222.

8.e.(2)(b) Since transistors Q219 and Q222 are emitter-follower amplifiers with emitter resistors R273 and R289 returned to ground, the emitter output signal of the two amplifiers will vary between approximately 0 and -6 volts, and the two signals will be 180° out of phase with each other. The phase-lead and lag gates are identical in operation and circuitry. The phase-lag gate is composed of diodes CR221, CR222 and CR223 and resistor R271, and the phase lead gate is composed of diodes CR228, CR229 and CR230 and resistor R287.

8.e.(2)(c) Operation of only the phase-lag gate will be described. The signal which is furnished to diode CR222 is a series of positive spikes from transistor Q211 varying in amplitude from -1.5 to -6 volts, and the signal which is furnished to diode CR223 is a positive pulse from transistor Q219 varying in amplitude from 0 to -6 volts. When either or both of the signals applied to diodes CR222 and CR223 are at a negative potential, a negative voltage will exist across resistor R271 and will prevent conduction by diode CR221. When both signals applied to diodes CR222 and CR223 are at a more positive potential than the -5 volts supplied by R270 and R269, diode CR221 will conduct, and a positive output pulse will be supplied to the retard univibrator.

8.e.(2)(d) The optimum phase condition between the signal transition positive spikes and the phase-lead and lag pulses occurs when an output is obtained from each gate for each positive spike, as shown in Figure 4-22.

8.e.(3) Retard and Advance Univibrators

8.e.(3)(a) The retard and advance univibrators are identical in operation and circuitry. Operation of only the retard univibrator will be described. The positive spike output of the phase-lag gate is applied to the junction of resistors R269 and R270 and is coupled by means of capacitor C219 to the base of normally on transistor Q217. The positive spike applied to the base of transistor Q217 drives the base of the transistor positive with respect to its emitter and turns the transistor off.

8.e.(3)(b) The collector potential of transistor Q217 changes from approximately +1 to -6 volts as Q217 turns off. Base current flows from the -6 volt collector junction of Q217 through R258 to the base of Q218 and turns it on. Its collector potential rapidly changes from -6 to +1 volt, and C214 will discharge to the new value through CR220 which is biased in the forward direction. The discharge path is through CR220, the on transistor Q218, R259, the internal impedances of the +1.5 and -6 volt supply, and R264. The discharge current biases the base of Q217 in a positive direction and keeps Q217 cut off.

8.e.(3)(c) After approximately 4 milliseconds, the discharge current has decreased to a point where the base potential of Q217 becomes more and more negative owing to the connection of R264 to -6 volts. When a critical negative base potential is reached, enough base current flows into Q217 to cause it to begin to conduct, and its collector potential rises from -6 volts to a more positive value. This reduces the base current of Q218 proportionately so that

it tends to turn off. Since Q218 is in the discharge path of C214, the base current is further reduced, and a rapid switching action occurs.

8.e.(3)(d) When collector Q218 returns to -6 volts, diode CR220 will be cut off. C214 then charges to -6 volts through R266. When charging from collector Q218, the action of CR220 and R266 disconnects C214 and tends to produce a more square output pulse. The output of the retard and advance univibrator is a positive, 4 millisecond pulse, varying between approximately +1 and -6 volts. It is obtained from the collector circuit of the normally off transistors Q218 and Q221.

8.e.(4) Retard Constant-Current Generator and Amplifiers (Figure 4-31)

8.e.(4)(a) Transistor Q225, the retard constant-current generator, functions as a switch with a current-limiting resistor in the emitter circuit as shown in Figure 4-25. The base and emitter are returned through appropriate resistors to -12 volts, and for all practical purposes, Q225 is off when no signal is applied to its base. The positive pulse from the collector of transistor Q218 is coupled through capacitor C213 and resistor R268 and drives the base of transistor Q225 from -12 to -8 volts for the duration of the pulse. With transistor Q225 on, the emitter will be at -8 volts also. Current-limiting resistors R293 and R294 will limit the C220 discharging current to a safe value. The discharge path is from the output side of C220, through transistor Q225, resistor R293 and variable resistor R294 to the -12 volt side of C220.

8.e.(4)(b) The above current flow produces a more negative voltage at the junction of resistor R300 and integrating capacitor C220 as C220 discharges. If no other signal is furnished to capacitor C220 than that from transistor Q225, the charge on capacitor C220 will decrease with each pulse of energy furnished by transistor Q225. Since C220 is being discharged by a constant current source, the capacitor voltage will decrease in a linear fashion with each applied current pulse.

8.e.(4)(c) The voltage on capacitor C220 is representative of the charge on the capacitor. This voltage is indicated by M201 connected in series with R300. C220 is connected to the base of transistor Q224 which is an emitter follower amplifier. With a negative voltage on the emitter of Q224 in excess of -6 volts (the potential across R292 due to the -6 volt emitter-base connection of normally on transistor Q223), diode CR236 conducts and produces the same voltage across resistor R292. The voltage across resistor R292 is applied to the base of

normally on transistor Q223. As the voltage on the base of transistor Q223 is made more negative, transistor Q223 turns off. The voltage on the collector of transistor Q223 will change from approximately -6 to +2 volts when Q223 turns off.

8.e.(5) Advance Constant-Current Generator and Amplifiers (Figure 4-25)

8.e.(5)(a) Transistor Q230, the advance constant-current generator, is connected as a switch with a current limiting resistor in the emitter circuit. The base and emitter are connected through resistors R308 and R309 to integrating capacitor C220, and, for all practical purposes, Q230 is in the off condition when no signal is applied to its base. The positive pulse from the collector of transistor Q221 is a.c.-coupled through capacitors C226 and C216 and polarity-maintaining resistor R284 to the base of transistor Q230. This pulse drives the base of transistor Q230 to +4 volts with respect to the potential of C220 and causes Q230 to turn on for the duration of the pulse.

8.e.(5)(b) With transistor Q230 on, the emitter will be at nearly the same voltage as the base, and a limited current flows through Q230 and charges C220 in a positive direction. Current flow is from +12 volts through transistor Q230, resistor R308, variable resistor R309 and C220 to -12 volts. This current flow produces a positive voltage at the junction of resistor R300 and integrating capacitor C220 and causes a positive charge to build up on C220. If no other signal is furnished to capacitor C220 than that from transistor Q230, the charge on capacitor C220 will increase with each pulse furnished by Q230.

8.e.(5)(c) The voltage on capacitor C220 is representative of the charge on the capacitor and is furnished to the base of transistor Q230, an emitter follower. With a positive voltage on the emitter of transistor Q229 in excess of +6 volts, diode CR240 conducts and produces the same voltage across resistor R307. The voltage across resistor R307 is applied to the base of normally on transistor Q229. When the voltage on the base of transistor Q229 exceeds +6 volts, Q229 turns off.

8.e.(5)(d) The voltage on the collector of transistor Q228 will change from approximately +6 to -12 volts when Q228 turns off. Prior to transistor Q228 turning off, its collector voltage is at approximately +6 volts which is applied through resistor R304 to the base of transistor Q227. This voltage holds the base of Q227 positive with respect to its emitter and causes transistor Q227 to be on. When transistor Q228 turns off, its collector voltage changes to ap-

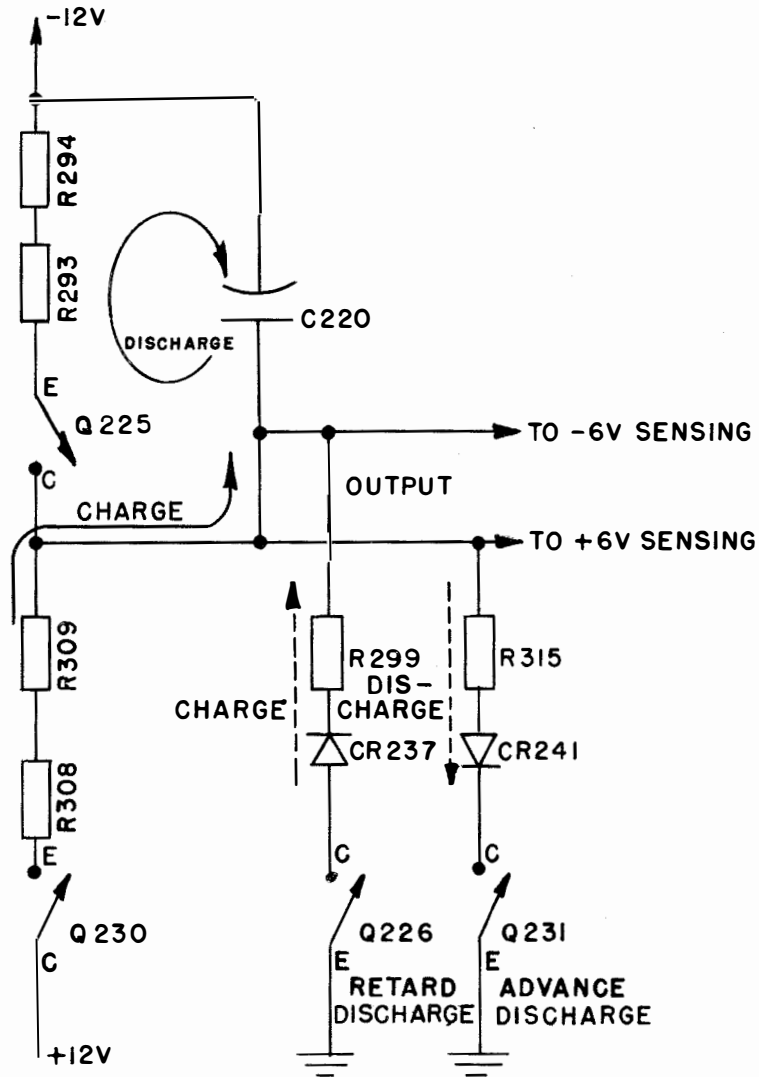


Figure 4-25. Simplified Circuit of Integrating Capacitor C220

proximately -12 volts which is applied through resistor R304 to the base of transistor Q227. This voltage holds the base of Q227 negative with respect to its emitter and causes transistor Q227 to turn off. When transistor Q227 turns off, its collector voltage changes from approximately -6 to +2 volts.

8.e.(6) Retard and Advance Flip-Flops

8.e.(6)(a) The purpose of these flip-flops is to provide buffer storage for the level-sensing circuit outputs. These outputs occur at random times and cause the flip-flop to be set to its (1) state. A short time later, channel A clock resets the flip-flop. A pulse having a fixed phase relationship with pulses in the train of drive pulses to be altered is produced.

8.e.(6)(b) The retard and advance flip-flops are identical in operation and circuitry. Operation of only the retard flip-flop will be described. When transistor Q223 turns off, its collector voltage changes from approximately -6 to +2 volts. With +2 volts on the collector of transistor Q223, diode CR235 conducts and furnishes a positive voltage to the base of transistor Q232-1 which is normally on. When the base of transistor Q232-1 is driven positive, Q232-1 turns off, and the collector voltage changes from approximately +1 to -6 volts. With transistor Q232-1 off, -6 volts is furnished to the series resistor network composed of R324-1 and R321-1. This circuit drives the base of transistor Q233-1 negative and turns Q233-1 on. With transistor Q233-1 on, the collector voltage of Q233-1 changes from approximately -6 to +1 volt. The +1 volt on the collector of transistor Q233-1 is applied through resistors R316-1 and R319-1 to the base of transistor Q232-1 which holds Q232-1 in the off condition.

8.e.(6)(c) The flip-flop remains in this state for variable periods depending on when the flip-flop was operated with respect to the channel A clock which is used as the reset pulse. With the flip-flop in this condition, the output from collector Q232-1 is -6 volts and drives the retard discharge circuit as will be described later. The positive channel A clock pulse is differentiated by capacitor C221-1 into a positive and negative spike, each of which is approximately 6 volts in amplitude. The negative spike is blocked by diode CR242-1, but the positive spike causes the diode to conduct, and the spike will appear on the base of transistor Q233-1. The spike causes transistor Q233-1 to turn off, and its collector voltage changes from approximately +1 to -6 volts.

8.e.(6)(d) The -6 volts on the collector of transistor Q233-1 is applied through resis-

tors R316-1 and R319-1 to the base of transistor Q232-1 and turns Q232-1 on. With transistor Q232-1 on, its collector voltage changes from -6 to +1 volt. This voltage is applied through resistors R324-1 and R321-1 to the base of transistor Q233-1 and reinforces the original positive pulse and holds Q233-1 off.

8.e.(6)(e) A positive-going transition appears at collector Q232-1. This pulse is coupled through C222-1 and CR247-1 to the on base of the subtract gate univibrator Q235-1.

8.e.(7) Retard Discharge (Figure 4-25)

8.e.(7)(a) The purpose of the discharge circuits is to slightly alter the potential of capacitor C220 following sensing of the critical voltage level. This is done to insure that the phase position is allowed to stabilize after correction so that the corrector will not overshoot the optimum phase position. It is convenient to refer to both add and subtract circuits as discharge circuits when actually, as can be seen in Figure 4-23, operation of the retard circuit performs a charging operation.

8.e.(7)(b) When transistor Q232-1 turns off, its collector voltage changes from approximately +1 to -6 volts. The -6 volts is applied to resistor R296 and causes the voltage at the junction of resistors R297 and R296 to become negative. This voltage drives the base of normally off transistor Q226 negative and causes the transistor to turn on. When Q226 is switched on, its collector is made near ground potential and biases CR237 in the forward direction. C220 charges through current limiting resistor R299, CR237 and Q226 from ground.

8.e.(7)(c) This charge current brings the potential of capacitor C220 nearer to ground potential from its previous critical -6 volt level. Thus the output of Q223 drops to -6 volts from its previous positive output voltage, and Q232-1 does not immediately turn off following turn on by the reset clock pulse. Charge of the capacitor toward ground potential occurs during the variable period between set and reset of the flip-flop. When the flip-flop is reset, the collector voltage of Q232 returns to +1 volt, and the base of Q226 is driven positive and drives Q226 off. Its collector potential falls to approximately -12 volts, reverse biasing CR237 and halting the charge action.

8.e.(8) Advance Discharge

8.e.(8)(a) The purpose of this discharge circuit is the same as for the retard discharge circuit described above, except that this circuit discharges to C220 to ground after sensing the +6 volts.

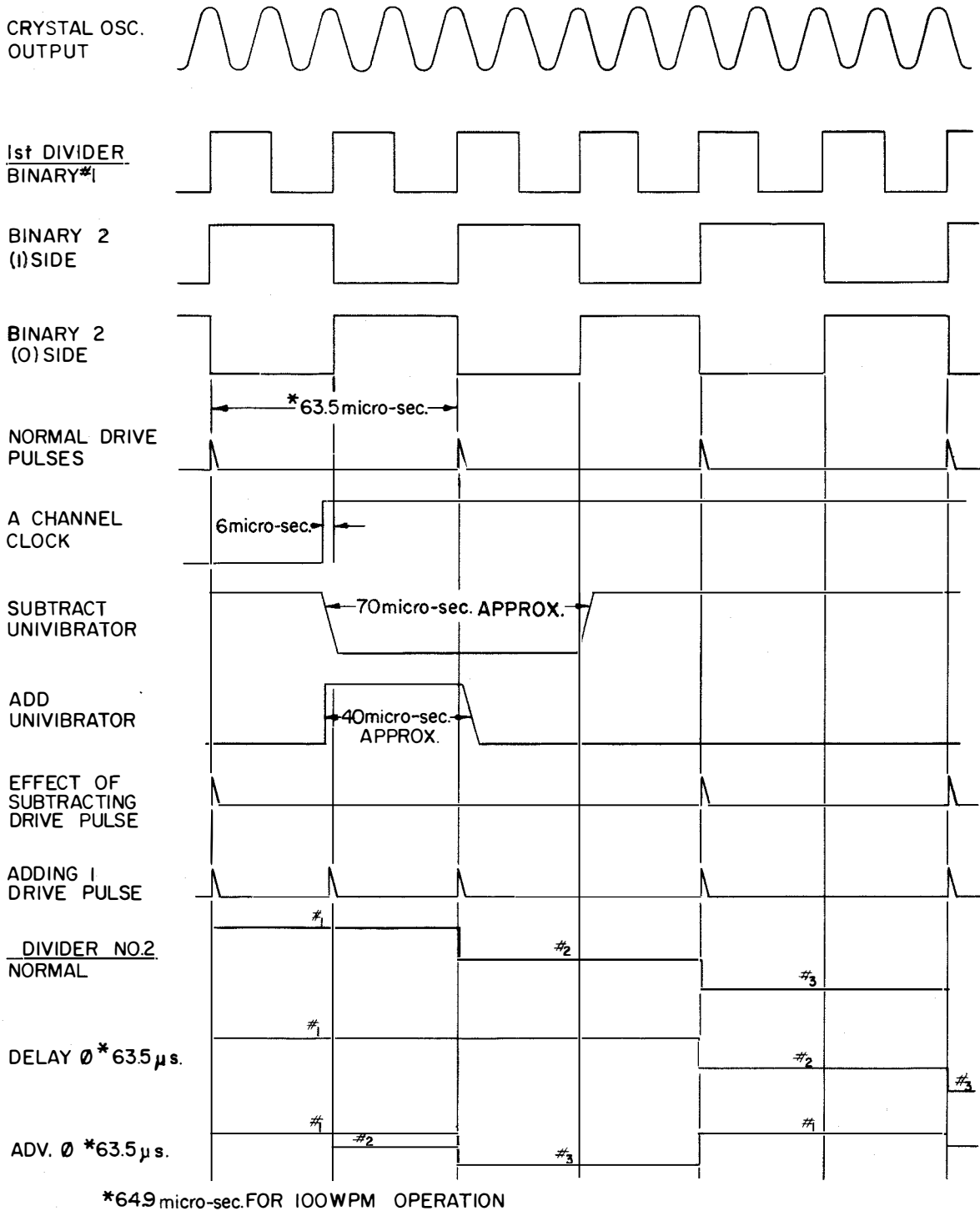


Figure 4-26. Timing Diagram of Phase Correction

8.e.(8)(b) When transistor Q232-2 turns on, its collector voltage changes from approximately -6 to +1 volt. The +1 volt is applied to resistor R312 and causes the voltage at the junction of resistor R312 and R313 to become positive. This voltage drives the base of normally off transistor Q231 (NPN) positive and causes the transistor to turn on.

8.e.(8)(c) When Q231 switches on, diode CR241 is forward biased, and C220 discharges through R315, CR241 and Q231 to ground. This action continues until the advance flip-flop is reset. At this time, the base of Q231 is driven in the off direction, and the +12 volt collector potential reverse biases CR241 and opens the discharge circuit.

8.e.(9) Subtract Gate Univibrator (Figure 4-26) - The subtract-gate univibrator acts to generate a pulse of the proper width which will block one drive pulse in the train of pulses supplied to divider no. 2 in the demultiplexer. When the retard flip-flop is reset by A clock, the collector potential of Q232 changes from -6 to +1 volt. This positive transition is coupled through C222-1 and forward biases CR247-1. A positive transition at the base of Q235-1 results. This transistor (normally on) turns off and a cycle of monostable operation begins. The circuit is identical to that for the retard univibrator described previously (paragraph 8.e.(3)) except that the time constant in the normally on base circuit is adjusted by R335-1 so that the period of the output pulse is 70 microseconds. This output is taken from the collector of the normally on Q235-1. The collector potential is at a nominal +1 volt except for a 70 microsecond period each time the univibrator operates when the potential drops to -6 volts.

8.e.(10) Add Gate Univibrator (Figure 4-26) - The add-gate univibrator is identical to that of the subtract-gate univibrator. R335-2 is adjusted to give an output pulse of 40 microseconds. The output is taken from the collector of normally off Q234-2. The output potential is at a nominal -6 volts except for a 40 microsecond period each time the univibrator operates when the potential rises to +1 volt.

8.e.(11) Subtract and Add Gates

8.e.(11)(a) The subtract and add gates are identical. They perform similar functions in the modification of the train of output drive pulses. The gates are also similar to the channel A gate described in paragraph 8.e.(2) above.

8.e.(11)(b) R337 in the subtract gate is connected to the collector (at +1 volt) of normally on Q235-1. Diode CR252 is coupled to the base of an on transistor Q236. The voltage at

the base of Q236 is approximately +1 volt (slightly negative with respect to its emitter). Thus there is no d.c. bias on CR252 under normal conditions.

8.e.(11)(c) Divider no. 1, the second binary, is coupled to the subtract gate by C225. C225, in combination with R337, CR252, R338 and the base emitter diode of Q236, form a differentiating network. The square pulse driving the subtract gate is differentiated as a series of positive and negative spikes at the junction of C225 and CR252. Positive spikes forward bias CR252 and are passed to the base of Q236. The negative spikes are blocked by the reverse resistance of CR252.

8.e.(11)(d) Each time that the retard univibrator operates, the junction of CR252 and R337 drops to -6 volts just before a positive transition arrives through C225. CR252 is reverse biased for this one pulse and one pulse is subtracted from the pulse train.

8.e.(11)(e) The add gate normally blocks the input pulses which are received from the opposite collector of the second binary of divider no. 1. When the add univibrator operates, the add gate is enabled to pass one of these pulses which is added to the pulse train between two adjacent pulses.

8.e.(12) Output Amplifier - The output amplifier consists of Q236 and Q237. Drive pulses are coupled to the base of Q236 from CR252 and CR253 which form an OR gate. Q236 turns off for the positive input pulses and produces a collector swing from +1.5 volts to a slightly negative voltage as the base of Q237 draws current. At the collector of Q237 there appears the train of positive drive pulses having voltage levels of 0 to -12 volts.

8.f. FRAMING CIRCUITS

8.f.(1) General

8.f.(1)(a) Framing is an operation required during initial circuit lineup to obtain the correct relationship between the incoming multiplex signal and the operation of the local multiplexer-demultiplexer. When the Receiving Group is in frame with the incoming multiplex signal, there is exact coincidence between channel and signal pulses produced by the local and distant groups. This is accomplished by advancing the phase position of divider no. 5 in the demultiplexer by integral numbers of signal pulse periods:

8.f.(1)(b) In order that the added drive pulses from the framing circuit do not coincide with the normal drive pulses, there must be a

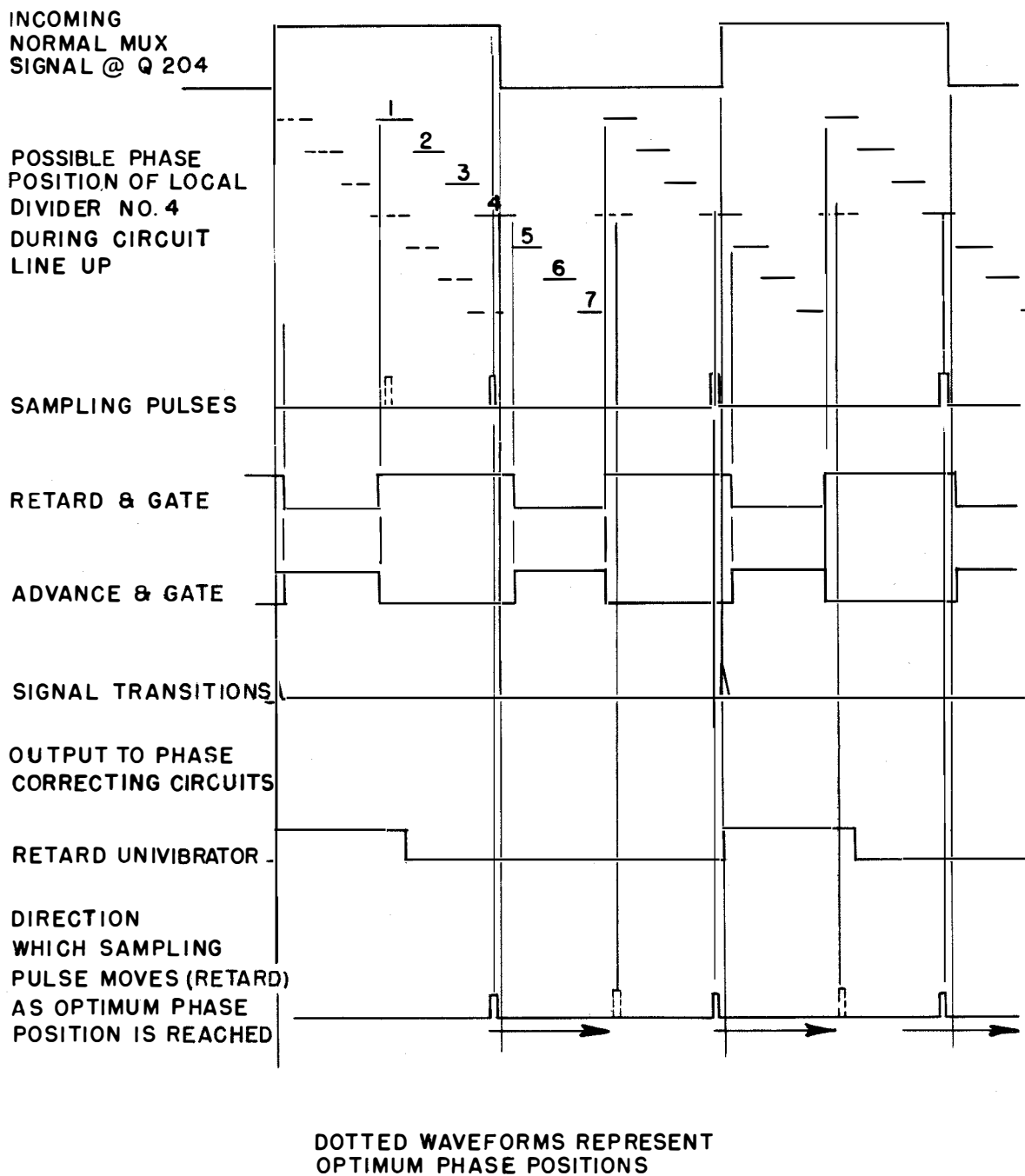


Figure 4-27. Phase Correction from Initial Phase Position

definite phase relationship between the two. The output of the start element of channel A receiving code converter is an ideal source of such pulses since framing pulses derived from its output are displaced approximately 2 milliseconds from the closest normal drive pulse.

8.f.(2) Semi-Automatic Operation

8.f.(2)(a) Since the channel A start-stop distributor is used as the source of the framing pulses, semi-automatic framing is possible when no traffic is being transmitted over channel A. Under this situation, if an out-of-frame condition exists, channel A converter will receive a character which triggers the start-stop distributor each time it is received. The start pulse from this distributor is coupled through S201 in the AUTO position and appears at contact 7 of the framing relay K200. When the operator depresses the framing switch S202, the pulses at pin 7 of K200 are connected through an output lead to the demultiplexer. At the demultiplexer, diode CR542 and C549 pass only the positive transition to the drive amplifier circuit for the signal distributor ring.

8.f.(2)(b) Each time that the channel A receiving code converter recognizes a character, a framing pulse advances the relative position of the receiving-signal distributor (with respect to the transmitting signal distributor) by one pulse. This action continues until the channel A converter recognizes the idle channel A signal pattern. The start-stop distributor ceases to operate and the framing action stops. The operator may now open the framing switch.

8.f.(3) Manual Operation

8.f.(3)(a) Under poor radio propagation conditions, or under conditions where there is traffic on channel A it may be necessary to frame the equipment step-by-step. A framing flip-flop comprised of Q200 and Q201 is included so that, each time that the framing switch is depressed, one frame pulse will be added to the drive pulse train for the signal distributor.

8.f.(3)(b) With S201 in the manual position, the framing output lead is connected to the output of the flip-flop, the collector of Q201. When K200 is not operated, positive pulses are coupled through C205, armature 11, contact 1 of K200, CR200 and C200 to the base of Q201 and hold Q201 off. The collector of Q201 is -6 volts.

8.f.(3)(c) When the framing switch is depressed, the next positive pulse supplied by the channel A start-stop distributor is supplied through C205, armature 11, contact 2 of K200, CR205 and C201 to the base of Q200. Q200 turns off and Q201 turns on and produces one positive framing pulse which advances the signal distributor.

8.f.(4) Special Framing Considerations

8.f.(4)(a) Figure 4-27 shows a possible phase position between the local frequency dividers and the incoming signal during initial start-up operations. Study of this timing diagram shows that initially the sampling pulses sense the signal pulses near the trailing end of the pulses. As the synchronizer establishes optimum phase, the sampling pulses are pulled into the pulse following the initial one. This means that it would be possible to frame the equipment only to have the receiver pull out of step by one pulse as the synchronizer operates.

8.f.(4)(b) A special circuit has been included in the synchronizer to move the phase position of the sampling pulse to coincide with the correct signal pulse during the framing operation. When the framing relay is operated, armature 3 connects to contact 4 and closes a by-pass connection from the retard univibrator output through C219 and CR238 to the base of retard flip-flop Q232.

8.f.(4)(c) Thus when the initial phase position is retard, pulses are subtracted from the drive pulse train each time the retard univibrator is triggered by a signal transition. No by-pass circuit has to be included on the advance side since the add gate will never cause the sampling position to move from its initial position on one pulse to an adjacent pulse.

8.g. AUXILIARY CIRCUITS

8.g.(1) Auxiliary Signal Sampling Amplifier - Repetitive positive pulses varying in potential from approximately -6 to 0 voltage are applied to coupling capacitor C212 from the emitter of transistor Q528 in the multiplexer-demultiplexer. The pulses drive the base of Q216 positive with respect to the emitter. Since Q216 was previously on due to +12 volts being applied to the emitter, it turns off when the base is driven positive. The output signal at the collector of Q216 is at +12 volts except for the duration of the sampling pulse at which time the collector voltage drops to near -12 volts.

8.g.(2) Auxiliary A-6 Amplifier

8.g.(2)(a) The output signal from resistor R600 in the no. 6 gate of the A section in the matrix of the multiplexer-demultiplexer, when present, is a positive pulse varying in potential from approximately -6 to 0 voltage. This signal is applied to the base of transistor Q214, an emitter follower amplifier, and produces the same signal across the emitter resistor R250 of Q214. This signal is coupled through capacitor C211 to the junction of resistors R251, R252 and R253. With no signal furnished by capacitor

C211, the voltage at the junction of resistors R251 and R253 holds the emitter of transistor Q215 at approximately +35 volts.

8.g.(2)(b) Since the base of transistor Q215 is returned to +37 volts, it is positive with respect to its emitter and Q215 is off. With transistor Q215 off, its collector voltage is approximately 0 since R254 is returned to ground. However, when a signal is furnished by capacitor C211, the voltage at the positive junction of resistors R551 and R553 rises above 37 volts. The emitter of transistor Q215 becomes positive with respect to its base and turns Q215 on for the duration of the signal on the emitter. With transistor Q215 on, its collector voltage is approximately +37 volts and a positive output pulse from 0 to +37 volts is produced.

8.g.(3) Auxiliary Clock Amplifier - The input signal to the auxiliary clock amplifier is a repetitive positive pulse obtained from the no. 1 element of divider no. 7 in the multiplexer-demultiplexer. This pulse varies in amplitude from approximately -6 to +1 volt and is furnished to the base of transistor Q212. The auxiliary clock amplifier is identical to the auxiliary A-6 amplifier except that the output signal is a.c.-coupled through C210 from collector Q213 to the auxiliary equipment. The output is a train of pulses which are approximately 37 volts peak to peak at a rate determined by the speed of operation.

9. RECEIVING CODE CONVERTER (CV-407/UGC-1) (Figures 4-34, 4-35 & 6-47)

9.a. GENERAL (Figure 4-34)

9.a.(1) The receiving code converter accepts multiwire signals from the multiplexer-demultiplexer and converts them to start-stop signals suitable for operation of start-stop receiving equipment. See paragraph 3.d.(3) of Section 1. The general circuits making up the unit are the storage, traffic recognizer, start control, start-stop oscillator, start-stop distributor, signal gates and output relay.

9.a.(2) The storage circuits consist of five junction-transistor flip-flops corresponding to the first five code pulses in the multiplex signal. Each time that a marking element is detected in the demultiplexer matrix, the corresponding storage element will receive an input pulse which fires the storage element. When a complete character sequence has been received, a number of storage elements representing the character will be in the on condition. An output from each of the storage elements is applied to the signal gates.

9.a.(3) The traffic-recognizer and start-control circuits consist of a junction transistor flip-flop together with gates for controlling operation of the start-stop oscillator. The primary purpose of these circuits is to insure that the start-stop distributor is operated only when a character has been received. The firing of each storage element and/or receipt of a no. 6 input from the multiplexer-demultiplexer generates a positive pulse which is passed through an OR gate circuit to the traffic recognizer. The traffic recognizer, which is normally on, will be turned off by the first such pulse which is received from each character group. The output of the traffic recognizer is applied to the start-control gates. This signal, together with a clock pulse from the demultiplexer, controls operation of the start-stop oscillator. Whenever the traffic recognizer has been set, the next clock pulse received will trigger the start-stop oscillator. A third input to the start-control circuit from the start-stop distributor insures that the start-stop oscillator, once triggered, will oscillate through a complete cycle before coming to rest. The traffic recognizer is reset, in turn, by the start element of the start-stop distributor. The traffic recognizer will then remain on until the next character sequence is received by the storage.

9.a.(4) The start-stop oscillator and control circuits, the squaring and drive amplifier and the start-stop distributor are identical to corresponding circuits in the transmitting code converter. When the start-stop oscillator is unclamped, it begins oscillating at a frequency whose period is equal to the width of the code element in the start-stop signal (22 milliseconds at 368 opm). The oscillator output, after being shaped by the squaring amplifier, is used to generate drive pulses for firing the elements of the start-stop distributor. An output from the stop element of the distributor is applied to the start-control gate, and, when the stop element fires, the control gate produces an output which clamps the oscillator. As a result, no additional drive pulses are generated, and the start-stop distributor comes to rest with the stop element conducting. The start-stop oscillator will remain clamped, and the stop element of the start-stop distributor will remain conducting until the traffic recognizer is again operated by a received character. An output from each of the code elements of the distributor is applied to the signal gates.

9.a.(5) The signal gates consist of five diode AND gates, one for each code pulse in the start-stop signal. Each gate has two inputs applied to it, one from the corresponding storage element and one from the corresponding distributor element. Each signal gate will produce a marking output when both its storage

input and distributor input are marking simultaneously. The output of each of the signal gates is combined in an OR gate circuit and then applied to the output relay circuits. Thus, as the start-stop distributor performs its distributing cycle, the character stored in the storage elements is formed by the signal gates into a start-stop signal and applied to the output relay circuits.

9.a.(6) An output from the stop element of the start-stop distributor is also applied to the OR gate circuit and, when it conducts, provides the marking output corresponding to the stop pulse of the start-stop signal. Since there is no output from the start element of the start-stop distributor to the OR gate circuit, a spacing output corresponding to the start pulse will be supplied to the output relay circuits during the interval that the start element is conducting.

9.a.(7) Before the storage elements can respond to a new code pattern being impressed upon them, the previous character must have been released. The five storage flip-flops are released by the start-stop distributor. As each distributor element fires, a release pulse is generated which turns off the preceding storage element.

9.a.(8) The output-relay circuit consists of a transistor output amplifier which drives a mercury contact line relay. The line relay isolates the start-stop circuit from the telegraph terminal equipment. The relay contacts will close the external circuit when a marking signal is applied to the output amplifier.

9.a.(9) In the channel A receiving code converter only, an output from the start element of the start-stop distributor is supplied to the synchronizer unit for framing.

9.a.(10) A monitor jack permits monitoring of the output start-stop circuit by a start-stop receiving equipment.

9.a.(11) The five storage elements are connected to an octal receptacle. The neon indicator may be plugged into the receptacle and a visual indication of characters in storage obtained.

9.a.(12) Identical converters are used on each channel in the Receiving Group, even though the external connections may differ. These units are interchangeable.

9.a.(13) For the detailed treatment of the circuits and their operation that follows, refer to the timing diagram of Figure 4-27 and the schematic wiring diagram of Figure 6-47.

9.b. STORAGE

9.b.(1) The storage circuits consist of five identical junction-transistor flip-flops. The first five storage elements are formed by transistors Q703-1 through Q703-5 and Q704-1 through Q704-5. Q703 is normally conducting. Input pulses from the demultiplexer matrix are applied to the five storage elements via C703-1 through C703-5. An output diode located in the demultiplexer unit passes only the positive signal transition from its corresponding matrix AND gate to C703 where it is sharply differentiated into a positive impulse. This impulse is applied to the base of Q703. It triggers the flip-flop and causes Q703 to cut off and Q704 to conduct. The output from the collectors of Q704-1 through Q704-5 swing from -6 to 0 voltage and are applied to the signal gates of Q704 and the traffic recognizer.

9.b.(2) To prepare for the next incoming character, each of the first five storage elements is released by the firing of a start-stop distributor element. The distributor output pulse is sharply differentiated by C704-1 through C704-5 but only the positive pulse is passed through CR712 and applied to the base of Q704. The positive pulse triggers the flip-flop, causes Q704 to cut off and Q703 to conduct. Thus each storage element is returned to its normal condition before the next input pulse arrives from the demultiplexer unit.

9.c. TRAFFIC RECOGNIZER - The traffic recognizer is a flip-flop circuit. The rise in collector potential when Q704 turns on is passed by diode CR707 and is differentiated by C702 into a positive-going spike which is applied to the base of Q701 (normally on). Since outputs from each of the storage elements, as well as the no. 6 input from the demultiplexer, are applied to the base of Q701, the receipt of any or all of these pulses will turn Q701 off. Having been turned off, the collector potential of Q701 drops from 0 to -6 volts. This signal is applied to CR705 of the start control gate. The traffic recognizer is reset by a positive-going pulse received from the start element of the start-stop distributor. This pulse is applied through C700 and CR700 to the base of Q700.

9.d. START CONTROL GATE

9.d.(1) CR705 and CR706 combine with R710 to form an AND gate. Providing either of the inputs to CR705 and CR706 are at 0 voltage, potential at their junction will be 0. If both inputs are at -6 volts, the potential at the junction will be -6 volts. Therefore, so long as traffic-recognizer transistor Q701 is conducting, the potential at the junction of CR705 and CR706 will remain at 0 voltage. This potential is applied

to CR717 which combines with CR718 and R712 to form a second AND gate. The diodes are polarized so that they will conduct when -6 volts is applied and become cut off whenever 0 voltage is applied. Since the potential applied to CR718 originates at the stop element of the start-stop distributor, which is assumed to be conducting and at 0 voltage, the diodes are non-conducting. In this condition, bias current flows through R712 and R727 to the base of Q705 saturating that stage and holding the start-stop oscillator clamped.

9.d.(2) As mentioned above, receipt of a signal causes Q701 to be made non-conducting and, in turn, causes the collector potential to fall to -6 volts. This potential is applied to CR705. At this instant, the potential at the emitter of Q702 is 0 voltage (see Figure 4-27). A short time later, however, the potential at Q702 will fall to -6 volts and drive the junction of CR705 and CR706 to -6 volts. This potential, applied to CR717, drives the voltage at the junction of CR717 and CR718 to -6 volts. The -6 volt potential, when applied to R727, drives Q705 into cutoff and unclamps the start-stop oscillator which then completes a cycle. Operation of the start-stop oscillator steps the start-stop distributor. The first drive pulse generated by the oscillator turns off the stop element and fires the start element of the distributor which causes a -6 volt potential to be applied to CR718. The oscillator must therefore remain unclamped until the stop element of the start-stop distributor next fires.

9.e. **START-STOP OSCILLATOR, CONTROL AMPLIFIER AND CLAMP** - When Q705 is saturated, the start-stop oscillator is clamped, and when Q705 is cut off, the oscillator is unclamped. With Q705 saturated, -6 volts appears at the collector. This potential is applied through R728 to the base of Q706. Bias current flows and Q706 becomes saturated and 0 voltage appears at the collector. This voltage is applied through clamp adjust potentiometer R730 to the junction of CR719 and CR720. These diodes become forward biased and allow current to flow through CR719 and L700 to the -6 volt supply. Oscillation is effectively swamped. Conversely, with Q705 cut off, +12 volts appears on the collector. The emitter-base diode of Q706 is then back biased and the transistor is cut off. Negative 12 volts appears on the collector which back biases CR719 and CR720. The oscillator is free to cycle. Operation of the start-stop oscillator and squaring amplifier is identical to that described for the transmitting code converter (see paragraph 5.f. of this section).

9.f. **START-STOP DISTRIBUTOR AND DRIVE AMPLIFIER** - The operation of the start-stop distributor and drive amplifier is identical

to that described for the transmitting code converter (see paragraph 5.i. of this section). In addition to generating the start-stop signal, the start-stop distributor supplies an input to the start control gate, resets the traffic recognizer and resets the five storage flip-flops in turn. All of these functions have been discussed.

9.g. SIGNAL GATES

9.g.(1) The signal gates consist of five identical AND gates, one for each code pulse in the start-stop signal. Each gate is formed by diodes CR713 and CR715 and resistor R723. The output of the corresponding storage element and the output of the corresponding code element of the start-stop distributor are applied as inputs to each gate. When both inputs are at 0 voltage, the output of the gate will be 0 voltage. However, if either input is -6 volts, the output of the gate will be -6 volts.

9.g.(2) The output of each gate is applied to an OR gate circuit consisting of diodes CR714-1 through CR714-5 and CR716. The output of the stop element of the start-stop distributor is also applied to this OR gate. When all inputs to the OR gate are -6 volts, the output of the gate will be -6 volts. However, if any one of the six inputs is 0 voltage, the output of the gate will be 0 voltage. The output of this gate is applied to the output amplifier.

9.h. LINE RELAY CIRCUIT

9.h.(1) The signal is applied to the base of Q711, an emitter-follower buffer amplifier. As mentioned above, the signal applied is 0 voltage for a marking condition and -6 volts for a space. This signal is then applied through R750 to the base of Q712. R750 and R751 are connected to form a voltage divider.

9.h.(2) When the voltage at the emitter of Q711 is 0, the voltage at the junction of R750 and R751 is slightly positive. The emitter-base diode of Q712 is therefore biased in the reverse direction and the transistor is cut off. Conversely, when the voltage at the emitter of Q711 is -6 volts, the voltage at the base of Q712 attempts to go negative. Since the base-emitter diode of Q712 is now biased in the forward direction, bias current flows and the transistor saturates.

9.h.(3) One side of the line relay K700 is connected to the collector of Q712 and the other side to ground. When the transistor is cut off, signifying a mark, current flows through R752 and the relay and closes the contact. When the transistor is saturated, however, the relay winding is effectively shorted and no current flows through the winding. The contact, being spring loaded, now opens.

9.h.(4) Several components of the converter are used in the external telegraph loop. Z700 is an arc suppressor for protection of the line relay contacts. Monitoring jack J700 permits monitoring the external loop signals with start-stop equipment. Variable resistor R724 is for fine adjustment of line current, and meter M700 gives visual indication of this current.

10. POWER-OSCILLATOR (Figure 6-8)

10.a. GENERAL

10.a.(1) The power-oscillator is a combination power supply and crystal-oscillator. The power-supply provides a.c. and d.c. voltages to the major units of the Transmitting and/or Receiving Group. The crystal oscillator furnishes accurately-timed drive pulses necessary for multiplexing. See paragraph 3.e. of Section 1.

10.a.(2) The a.c. power input for the Set is connected to the primary of a power transformer. The d.c. supplies are conventional full-wave rectifiers with inductor-capacitor filters. Inasmuch as the voltage margins in the multiplex groups are sufficient to tolerate $\pm 10\%$ variations in the output voltages resulting from line voltage changes, the d.c. voltages are not regulated. A -12 volt supply voltage is set to its nominal value by means of a tap switch on the primary of the power transformer. This selected primary voltage thus adjusts all of the supply voltages near their nominal values. Fine adjustment of certain outputs is provided.

10.a.(3) The frequency drive pulses are derived from a temperature-controlled crystal oscillator. The pulses drive a 4:1 divider that consists of two binaries, each of which divides by two.

10.a.(4) For the detailed treatment of the circuits and their operation which follows, refer to the schematic wiring diagram of Figure 6-8.

10.b. **POWER INPUT** - The a.c. power input (see Table 1 of Section 1) is led to the power oscillator through plug P1400 and receptacle J101 located on the rear plate (see Figure 1-3). Two convenience receptacles J102 and J103 are connected directly across the power source and are protected by fuse F101. From J101 the power passes through a double-pole power switch S101 to tap switch S102 and the primary of the power transformer T101. Each side of the input is guarded by a blown fuse indicator which includes a fuse (F102 and F103) and a neon lamp.

10.c. POWER SUPPLY

10.c.(1) T101 is a stepdown transformer having 2% primary taps and multiple secondary

taps which produce the various output voltages. All of the d.c. supplies are full wave rectifiers using the common center tap 23 as reference (ground) except the isolated 12 volt supply which floats with respect to ground (T101 terminals 14, 15, 16). The proper a.c. input voltage can be obtained by means of the tap switch S102 and voltmeter M101. With voltmeter switch S103 in the -12 volt position, the tap switch is adjusted until the -12 volt supply produces its nominal voltage.

10.c.(2) Following the setting of the tap switch, variable resistors R102, R103 and R104 are adjusted to give nominal values for the +12, +6 and -6 volt supplies respectively. The variable resistances are low-resistance, 25-watt units. Increasing their resistance increases their IR drop and reduces the available output voltage. Variable resistor R101 is in shunt with +50 volt supply. The +37 volt supply is derived from the tap on this resistance. R106, R109, and R111 are fixed shunt resistors which are used to bring the various outputs not having individual adjustments to their nominal value, or, if an adjustment is provided, to bring the range of adjustment within limits.

10.c.(3) 12.6 volts a.c. is obtained from terminals 11 and 13 of T101 and is supplied to the crystal oscillator oven. 6.3 volts a.c. is obtained from terminals 12 and 13 and is supplied to the synchronizer amplifier for powering the framing relay. All output voltages are supplied to interconnecting connectors J106 and J107.

10.d. CRYSTAL OSCILLATOR AND FIRST DIVIDER

10.d.(1) The crystal oscillator consists of a crystal and a silicon transistor operating in a modified Colpitts oscillator circuit. Battery (ground) is supplied to the oscillator transistor through a dropping resistor and a 4700 ohm resistor at the collector. Negative 12 volts is supplied to the emitter. A Zener diode, bypassed by a capacitor connected from the emitter to the termination of the collector load resistance, holds the oscillator supply voltage at a constant 9 volts. This eliminates the possibility of the oscillator frequency changing with fluctuating line voltage. An 82000 ohm resistor supplies the necessary base current and biases the transistor so that the collector current is approximately 1.5 milliamperes. The connection of this resistor to the collector also provides inverse feedback to the amplifier circuit (see paragraph 10.d.(4) below).

10.d.(2) The crystal is driven from the collector at the oscillator transistor. A pi tank circuit is tuned to resonance with the crystal frequency. Its high input impedance provides a

good impedance match for the crystal. The 0.002 UF and 0.005 UF capacitors provide impedance matching. The feedback to the base of the transistor is taken across the 0.005 UF capacitor. Approximately 500 ohms impedance to ground appears at this point. Consequently, there is a good impedance match to the base of the oscillator transistor. The crystal frequency can be varied by tuning the external trimmer capacitor C120.

10.d.(3) The output is taken from the junction of the tank inductor and the 0.002 UF capacitor where approximately 2000 ohms impedance to ground exists. A transistor is connected at this junction in an emitter follower circuit and the signal is coupled to the base through a 0.005 UF capacitor. Inasmuch as this circuit's input impedance, which is determined largely by base-biasing resistances, is in the order of 30,000 ohms, there is practically no loading of the crystal oscillator by the output circuit. The negative base bias established by the voltage-divider resistors (82K and 47K) allows the emitter follower to conduct when the signal goes positive, but to cut off when the signal goes sufficiently negative. The output signal is sinusoidal but with the bottom part of the negative cycles clipped off.

10.d.(4) The output of the oscillator is connected to the LOC terminal on E101. Another terminal on E101, marked EXT, is connected through coax cable to an input connector J105 to permit use of an external frequency standard. The LOC (or EXT) terminal is strapped to the center terminal of E101 which brings the signal out to pin J of J112.

10.d.(5) The transistor amplifier on Z101 is connected as a grounded emitter with its base returned through 10,000 ohms to ground. This transistor is normally conducting. Output is taken at the collector which is at approximately 0 voltage under idle conditions. As the input signal drives the base positive, the transistor becomes back biased, conduction decreases and the output voltage goes more negative. The input signal begins to drop back to zero, but the 0.01 capacitor and 4700 ohm resistor provide a long time constant and keep the base slightly positive. When the input signal goes negative and drives the base negative, the collector voltage goes back to zero and stays there until the next positive pulse. The output at the collector is a relatively-squared half-sine wave.

10.d.(6) The positive 12 volt transitions are differentiated by the 0.002 UF capacitors and the 5600 ohm resistors in the input to the first binary. Operation of the binary circuit was described previously in paragraph 7.b. of this section. At the output terminal, pin J of J111, only one positive transition is produced for two positive input transitions.

10.d.(7) Operation of the second binary is identical to the first, and a frequency division of two again results. The output signals from the collectors of the second binary have a nominal amplitude of 6 volts (0 to -6 volts) and are 180° out of phase with respect to each other. The collector output terminals H and J of J110 are brought out to the interconnecting connectors (J106 and J107) on the rear plate. Pin H of J110 is connected to pin R of J106 and J107; pin J of J110 is connected to pin P of J106 and J107.

10.e. MONITOR CIRCUITS

10.e.(1) Frequency meter M102 utilizes tuned reeds to give an indication of frequency. The meter is divided into 3 areas with 5 reeds per area. The ends of the reeds are bent at right angles and painted white so that they are visible against the black background of the meter face. The center reed of each group is tuned to resonate when one of the frequencies from the squaring amplifiers of the code converters is applied; i.e., 45.45 cps for 60 wpm operation, 56.87 cps for 75 wpm operation and 74.2 cps for 100 wpm operation. The two reeds in each group adjacent to the center reeds are tuned to frequencies 2% above and below the center frequencies. The two reeds at the extremes of each group are tuned to 4% above and below the center frequencies.

10.e.(2) The frequency meter is driven by a PNP emitter-follower amplifier mounted on Z101. When an input of 12 volts peak to peak is obtained from the squaring amplifier (test pin no. 3) of either of the code converters, the center reed of the proper wpm section will vibrate with an amplitude of approximately 0.250 inch.

11. NEON INDICATOR (Figure 6-36)

11.a. GENERAL - The neon indicator provides a visual indication of the operation of the transmitting and receiving code converters. This is accomplished by monitoring the operation of the second-level storage element of the transmitting converter and the storage elements of the receiving converter. See paragraph 3.c.(4) of Section 1. For the detailed treatment of circuit operation which follows, refer to schematic wiring diagram of Figure 6-36.

11.b. POWER SUPPLY

11.b.(1) A.C. power is supplied to the unit through P408 to the primary of power transformer T401. Neon indicator DS407 glows when primary power is applied.

11.b.(2) The secondary of T401 is connected to CR413 and the B+ power supply-connection.

CR413 provides half wave rectification of the a.c. input, and R481 and C410 filter the resulting pulsating d.c. voltage. R479 and R480 form a voltage divider whose center point is grounded. Two voltages are therefore generated with reference to cabinet or chassis ground, +40 volts and -60 volts. These voltages are applied to the six neon indicator circuits.

11.c. NEON LIGHT CIRCUITS

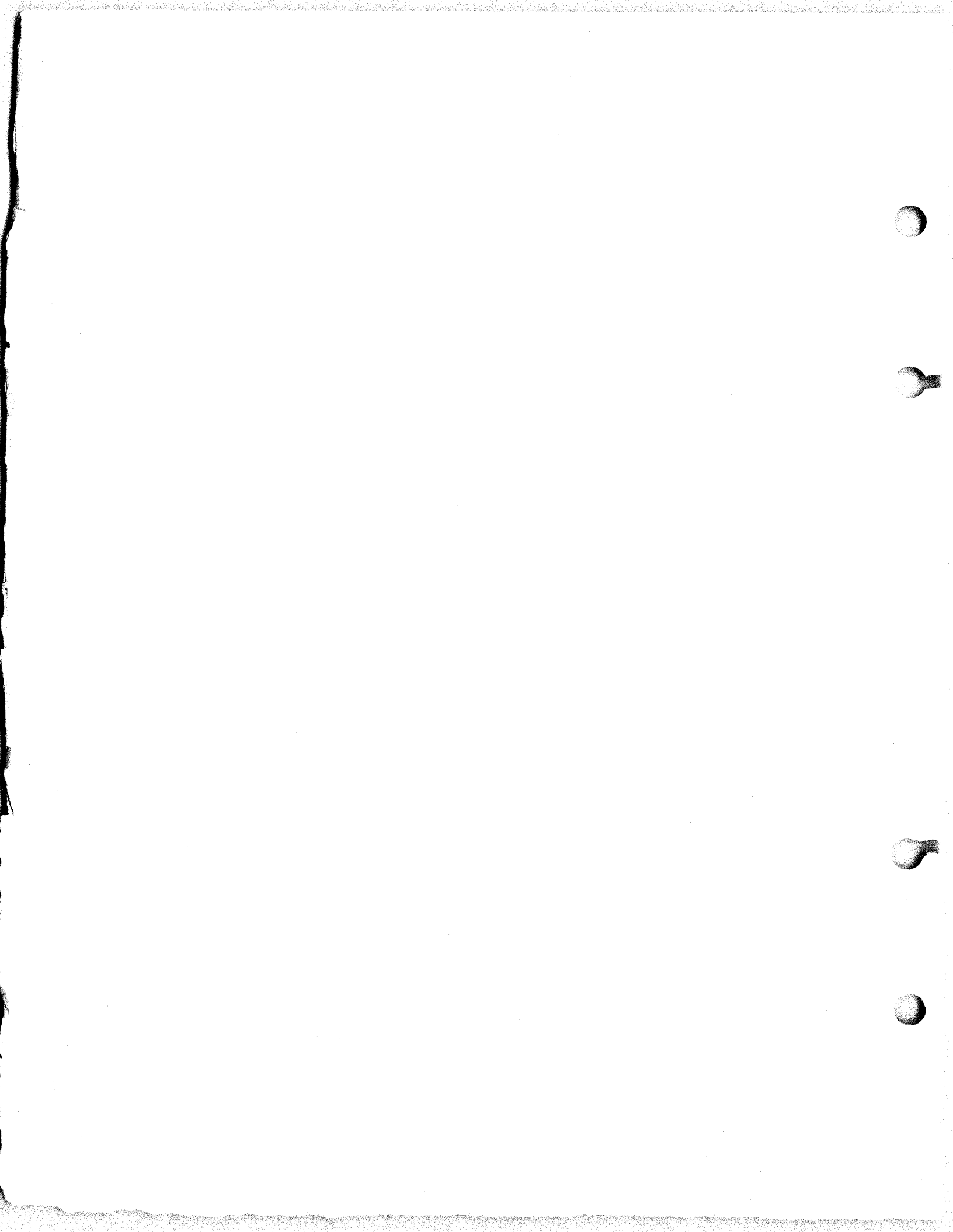
11.c.(1) The six neon light circuits are identical to each other, and operate independently. Each of the neon indicators, DS401 to DS406, receive a drive from an associated transistor, Q419 to Q424 respectively.

11.c.(2) The collectors of the driver transistors are returned to the -60 volt supply through resistors R483, R459, R463, R467, R471 and R475. The emitters are returned to ground. The bases are connected to their respective inputs through resistors R485, R461, R465, R469, R473 and R477, and also to the +40 volt supply through resistors R486, R462, R466, R470, R474 and R478. The operation of one circuit will now be discussed since all are identical.

11.c.(3) When input no. 1 is connected, and is at zero volts, the voltage appearing at the base of Q419 will be slightly positive with respect to the emitter due to the divider effect of R485 and R486. Since the base-emitter diode of PNP transistor Q419 is then back biased, that transistor is non-conductive. The negative supply potential is therefore applied, through R483 and R484 to a terminal of DS401. Since the other terminal of DS401 is connected directly to the +40 volt supply, approximately 100 volts appears across DS401. This potential is sufficient to fire the indicator. Approximately 1 milliampere of current flows.

11.c.(4) When a -6 volt signal is supplied at input no. 1, the voltage at the base of Q419 becomes negative with respect to the emitter. Bias current flows and the transistor saturates. Since the emitter is grounded, 0 voltage appears at the collector, and at the junction of R483 and R484. This voltage is applied to DS401. Since only 40 volts, which is inadequate to fire the neon unit, now appear across the terminals of DS401, the light is extinguished.

11.c.(5) Consequently DS401 fires whenever 0 voltage is applied at input no. 1, and is extinguished when -6 volts is applied. The other indicators operate in an identical fashion.



START-STOP SIGNALS INTO TRANSMITTING CODE CONVERTERS	OUTPUTS FROM TRANSMITTING CODE CONVERTERS				WIRING BETWEEN CODE CONVERTER AND MUXER	6-WIRE PARALLEL SIGNALS INTO MATRIX OF MULTIPLEXER				WIRING BETWEEN MUXER AND OUTPUT AMPLIFIER	SEQUENTIAL SIGNALS INTO OUTPUT AMPLIFIER				OUTPUT AMPLIFIER	MULTIPLEX SIGNAL INTO SYNCHRONIZER - AMPLIFIER															
	S 1 2 3 4 5 Sp	A 1 2 3 4 5 6	B 1 2 3 4 5 6	C 1 2 3 4 5 6		D 1 2 3 4 5 6	A 1 2 3 4 5 6	B 1 2 3 4 5 6	C 1 2 3 4 5 6		D 1 2 3 4 5 6	A 1 2 3 4 5 6	B 1 2 3 4 5 6	C 1 2 3 4 5 6		D 1 2 3 4 5 6	A 1 2 3 4 5 6	B 1 2 3 4 5 6	C 1 2 3 4 5 6	D 1 2 3 4 5 6											
M M M M M M M* (IDLE, 4 CHAN)	S S S S S S	S S S S S S	S S S S S S	S S S S S S	Inverts 2, 3 and 4 pulses on channel A and all pulses on channels C and D.	S M M M S S	S S S S S S	M M M M M M	M M M M M M	The matrix of the multiplexer produces signals on two lines: pulses 1, 5 and 6 of channel A and all pulses of channel B come out on a "normal" line; pulses 2, 3 and 4 of channel A and all pulses of channels C and D come out on an "inverted line."	NOR. INV. S M M M S S S S S S S S M M M M M M	S S S S S S	M M M M M M	M M M M M M	Nor. & inv. signals are combined by output amplifier into a multiplex signal which is transmitted on the common teletypewriter channel.	S M M M S S	S S S S S S	M M M M M M	M M M M M M												
S S S S S S M (BLANK, 4 CHAN)	S S S S S M	S S S S S M	S S S S S M	S S S S S M		S M M M S M	S S S S S M	M M M M M S	M M M M M S		NOR. INV. S M M M S S S S S S M M M M M S	S S S S S M	M M M M M S	M M M M M S		S M M M S M	S S S S S M	M M M M M S	M M M M M S												
S M M M M M M (LETTERS, 4 CHAN)	M M M M M M	M M M M M M	M M M M M M	M M M M M M		M S S S M M	M M M M M M	S S S S S S	S S S S S S		NOR. INV. M S S S M M M M M M S S S S S S S S S S S S	M M M M M M	S S S S S S	S S S S S S		M S S S M M	M M M M M M	S S S S S S	S S S S S S												
S M S M S M M (Y, 4 CHAN)	M S M S M M	M S M S M M	M S M S M M	M S M S M M		M M S M M M	M S M S M M	S M S M S S	S M S M S S		NOR. INV. M M S M M M S M S M M S M S M S S S M S M S S	M S M M	M S M M	S M S M S S		S M S M S S	M S M S M M	M S M S M M	S M S M S S	S M S M S S											
* Absence of start pulses (spacing) block input of succeeding marking pulses, and the receiving code converters deliver all spacing pulses.											TEST SIGNALS																				
												STEADY MARK					M M														
												STEADY SPACE					S S														
											REVERSALS					<table border="0"> <tr> <td>M S M S M S</td> <td>M S M S M S</td> <td>M S M S M S</td> <td>M S M S M S</td> </tr> <tr> <td>↑</td> <td>↑</td> <td>↑</td> <td>↑</td> </tr> <tr> <td>S M S M S M</td> <td>S M S M S M</td> <td>S M S M S M</td> <td>S M S M S M</td> </tr> </table>				M S M S M S	M S M S M S	M S M S M S	M S M S M S	↑	↑	↑	↑	S M S M S M	S M S M S M	S M S M S M	S M S M S M
M S M S M S	M S M S M S	M S M S M S	M S M S M S																												
↑	↑	↑	↑																												
S M S M S M	S M S M S M	S M S M S M	S M S M S M																												
																(Above two signals can be changed from one to the other by operating framing switch.)															

Figure 4-28 Multiplex Signaling

SYNCHRONIZER AMPLIFIER	MULTIPLEX SIGNAL INTO DEMULTIPLEXER				WIRING INTO DEMULTIPLEXER MATRIX	SEQUENTIAL SIGNALS INTO MATRIX OF DEMULTIPLEXER				6-WIRE PARALLEL SIGNALS INTO RECEIVING CODE CONVERTERS				RELAYS OF RECEIVING CODE CONVERTERS	START-STOP SIGNALS FROM CODE CONVERTERS				PAGE PRINTER RESPONSE								
	A 1 2 3 4 5 6		B 1 2 3 4 5 6			C 1 2 3 4 5 6		D 1 2 3 4 5 6		A 1 2 3 4 5 6		B 1 2 3 4 5 6			C 1 2 3 4 5 6		D 1 2 3 4 5 6		A S 1 2 3 4 5 Sp		B S 1 2 3 4 5 Sp		C S 1 2 3 4 5 Sp		D S 1 2 3 4 5 Sp		A
Using the normal multiplex signal, the synchronizer creates an additional inverted signal. Both are then sent to demultiplexer.	NOR.	S M M M S S	S S S S S S	M M M M M M	M M M M M M	NOR.	S	S S	S S S S S S	S S S S S S	S S S S S S	S S S S S S	S S S S S S	M M M M M M	M M M M M M	M M M M M M	M M M M M M	IDLE (4 CHANNELS)									
	INV.	M S S S M M	M M M M M M	S S S S S S	S S S S S S	INV.	S S S											S S S S S S M	S S S S S S M	S S S S S S M	S S S S S S M	BLANK (4 CHANNELS)					
	NOR.	S M M M S M	S S S S S M	M M M M M S	M M M M M S	NOR.	S	S M	S S S S S M	S S S S S M	S S S S S M	S S S S S M	S S S S S M	S S S S S M	M M M M M M	M M M M M M	M M M M M M	M M M M M M	S M M M M M M	S M M M M M M	S M M M M M M	S M M M M M M	LETTERS (4 CHANNELS)				
	INV.	M S S S M M	M M M M M M	S S S S S S	S S S S S S	INV.	M M M	M M	M M M M M M	M M M M M M	M M M M M M	M M M M M M	M M M M M M	M M M M M M					S M S M S M M	S M S M S M M	S M S M S M M	S M S M S M M	Y (4 CHANNELS)				
	NOR.	M M S M M M	M S M S M M	S M S M S S	S M S M S S	NOR.	M	M M	M S M S M M	M S M S M M	M S M S M M	M S M S M M	M S M S M M	M S M S M M	M M M M M M	M M M M M M	M M M M M M	M M M M M M	S M S S S M M	S M M M M M M	M M M M M M M	M M M M M M M	Z LTRS IDLE IDLE				
	INV.	S S M S S S	S S S S S S	S S S S S S	S S S S S S	INV.	S S S	M M	M M M M M M	S S S S S S	S S S S S S	S S S S S S	S S S S S S	S S S S S S					S S M M M S M	S S S S S S S	M M M M M M M	M M M M M M M	C IDLE IDLE IDLE				
	NOR.	S S S S S S	S S S S S S	S S S S S S	S S S S S S	NOR.	S	S S	S S S S S S	M M M M M M	M M M M M M	M M M M M M	M M M M M M	M M M M M M	S M M M S S	S S S S S S	M M M M M M	M M M M M M	S M M M S M M	M M M M M M M	M M M M M M M	M M M M M M M	FIGS Y R R				
	INV.	M M M M M M	M M M M M M	M M M M M M	M M M M M M	INV.	M M M												S M S M S M M	S M S M S M M	S S M S M S M	S S M S M S M	SPCE R Y Y				
NOR.	M S M S M S	M S M S M S	M S M S M S	M S M S M S	NOR.	M	M S	M S M S M S	S M S M S M	S M S M S M	S M S M S M	S M S M S M	S M S M S M	M M S M M S	M S M S M S	S M S M S M	S M S M S M	S M M S M M M	S M S M S M M	S S M S M S M	S S M S M S M						
INV.	S M S M S M	S M S M S M	S M S M S M	S M S M S M	INV.	S	S M	S M S M S M	M S M S M S	M S M S M S	M S M S M S	M S M S M S	M S M S M S	S S M S S M	S M S M S M	M S M S M S	M S M S M S	S S S M S S M	S S M S M S M	S M S M S M M	S M S M S M M						
NOR.	S M S M S M	S M S M S M	S M S M S M	S M S M S M	NOR.	S	S M	S M S M S M	M S M S M S	M S M S M S	M S M S M S	M S M S M S	M S M S M S	S S M S S M	S M S M S M	M S M S M S	M S M S M S	S S M S S M	S M S M S M M	S M S M S M M	S M S M S M M						
INV.	M S M S M S	M S M S M S	M S M S M S	M S M S M S	INV.	M S M S												S S S M S S M	S S M S M S M	S M S M S M M	S M S M S M M						

Figure 4-28 Multiplex Signaling

CLOCK DELAY INCREASE

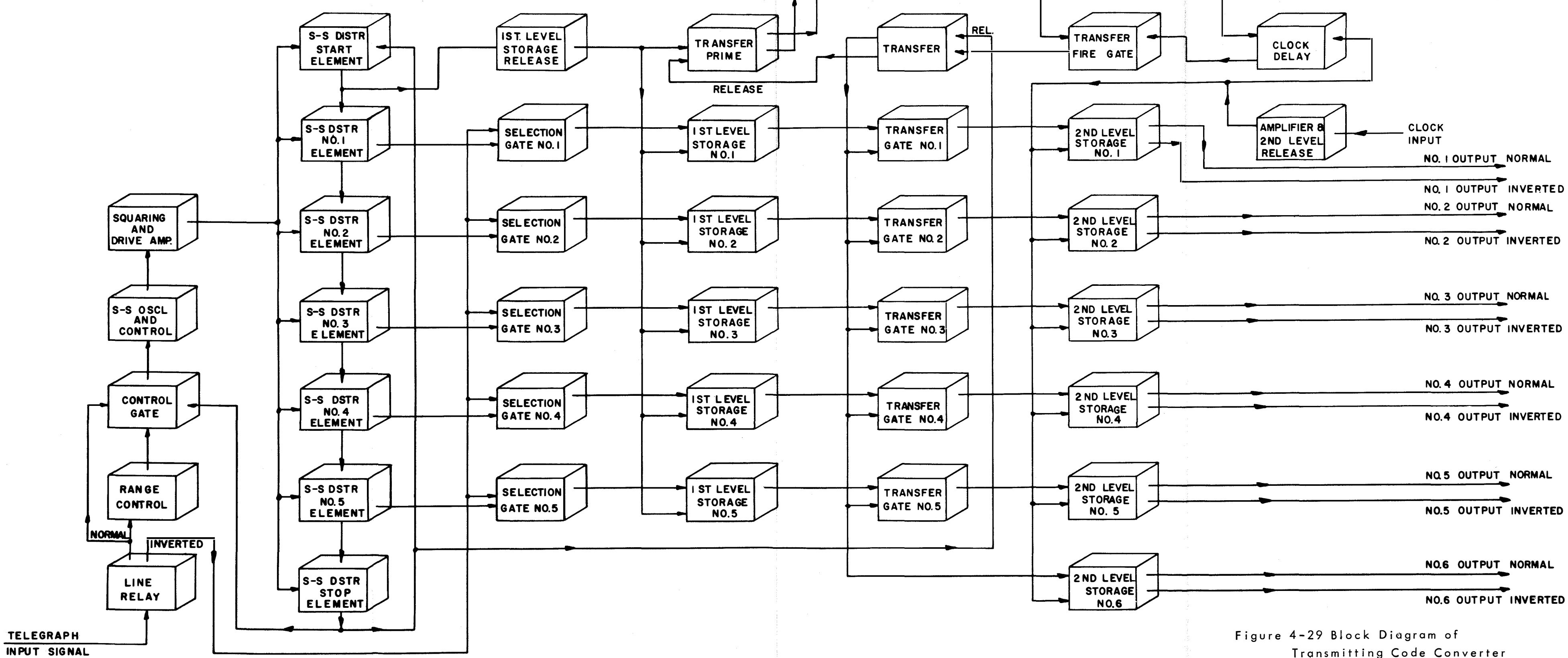


Figure 4-29 Block Diagram of Transmitting Code Converter

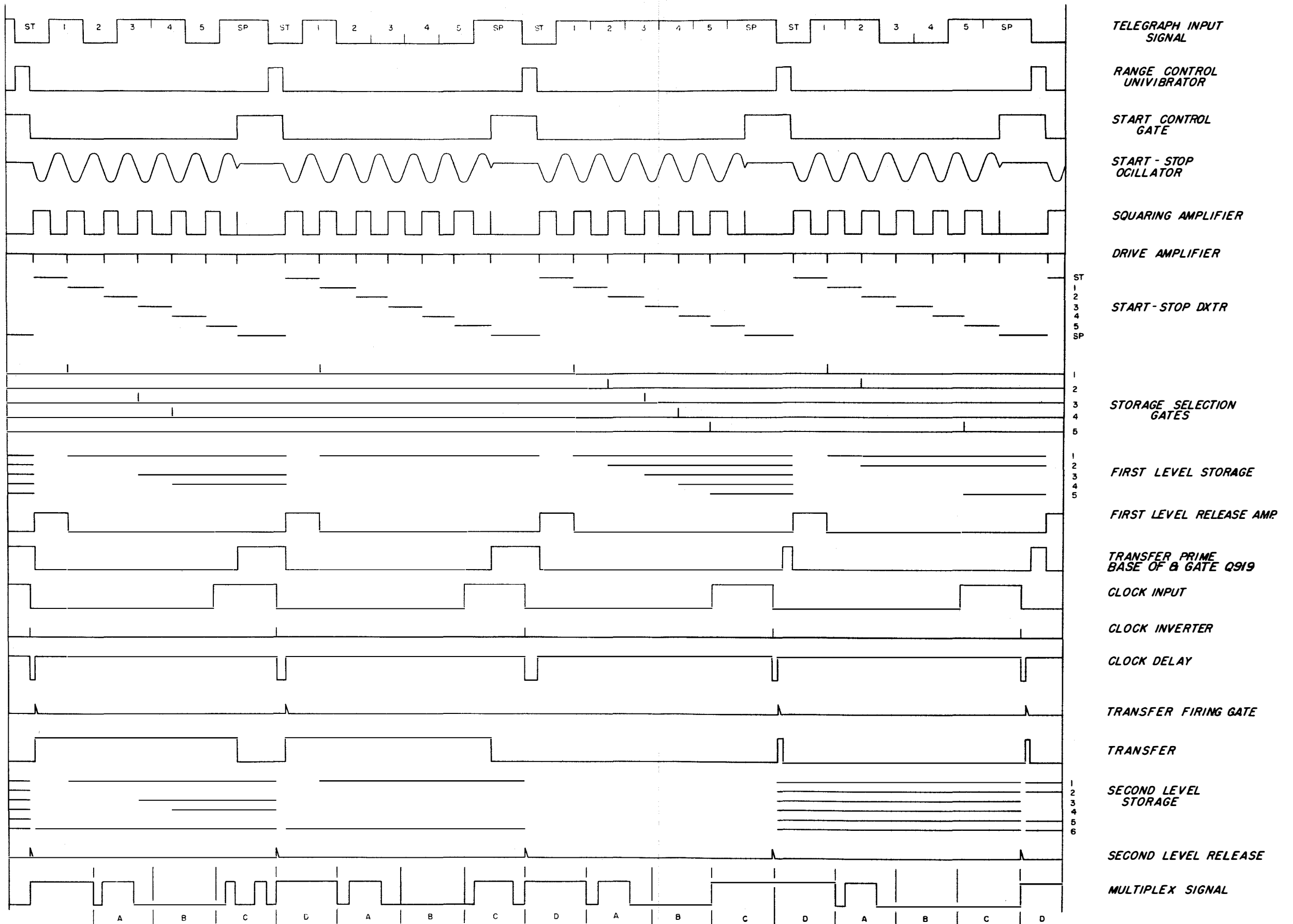


Figure 4-30 Timing Diagram of Transmitting Code Converter
4-53, 4-54

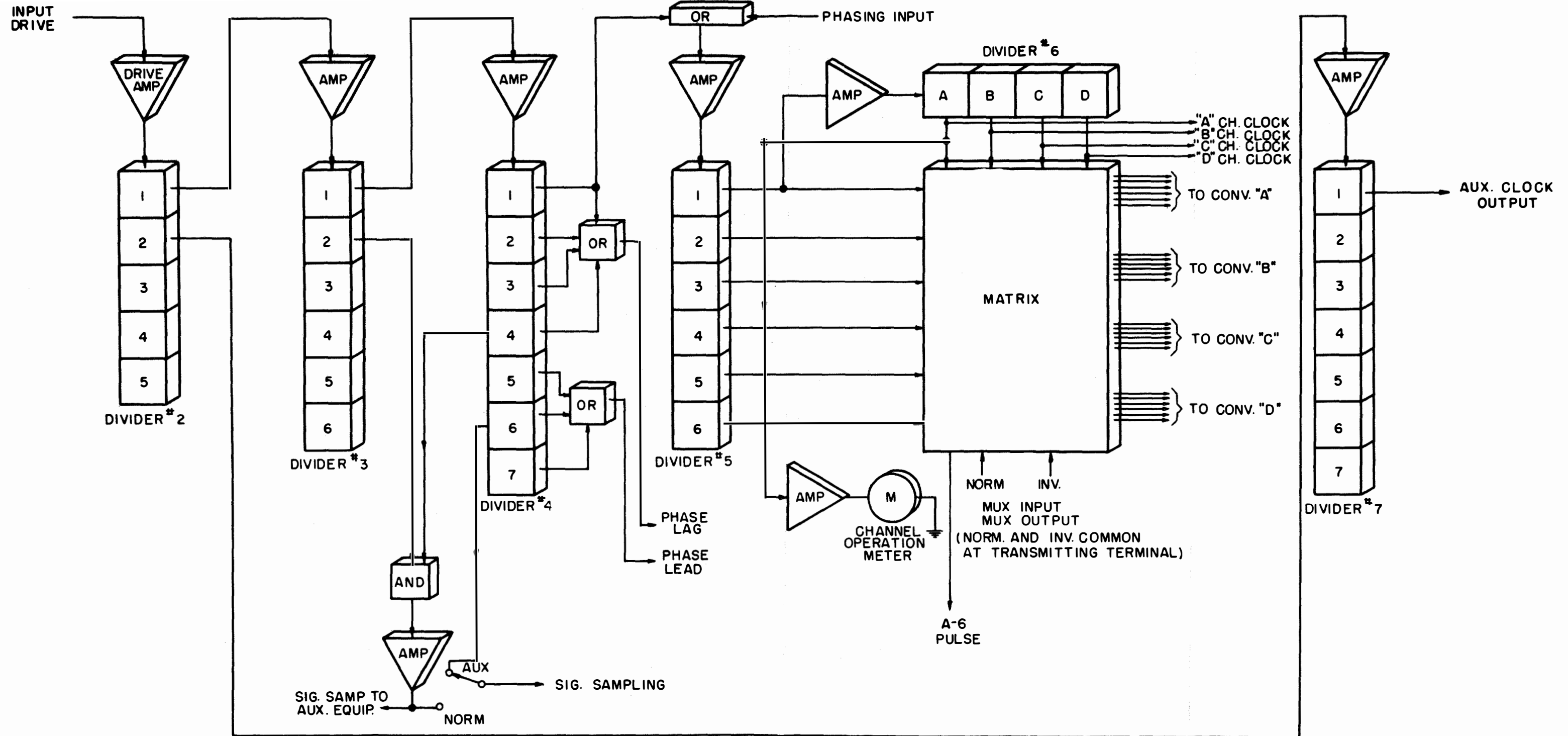


Figure 4-31 Block Diagram of
Multiplex - Demultiplexer

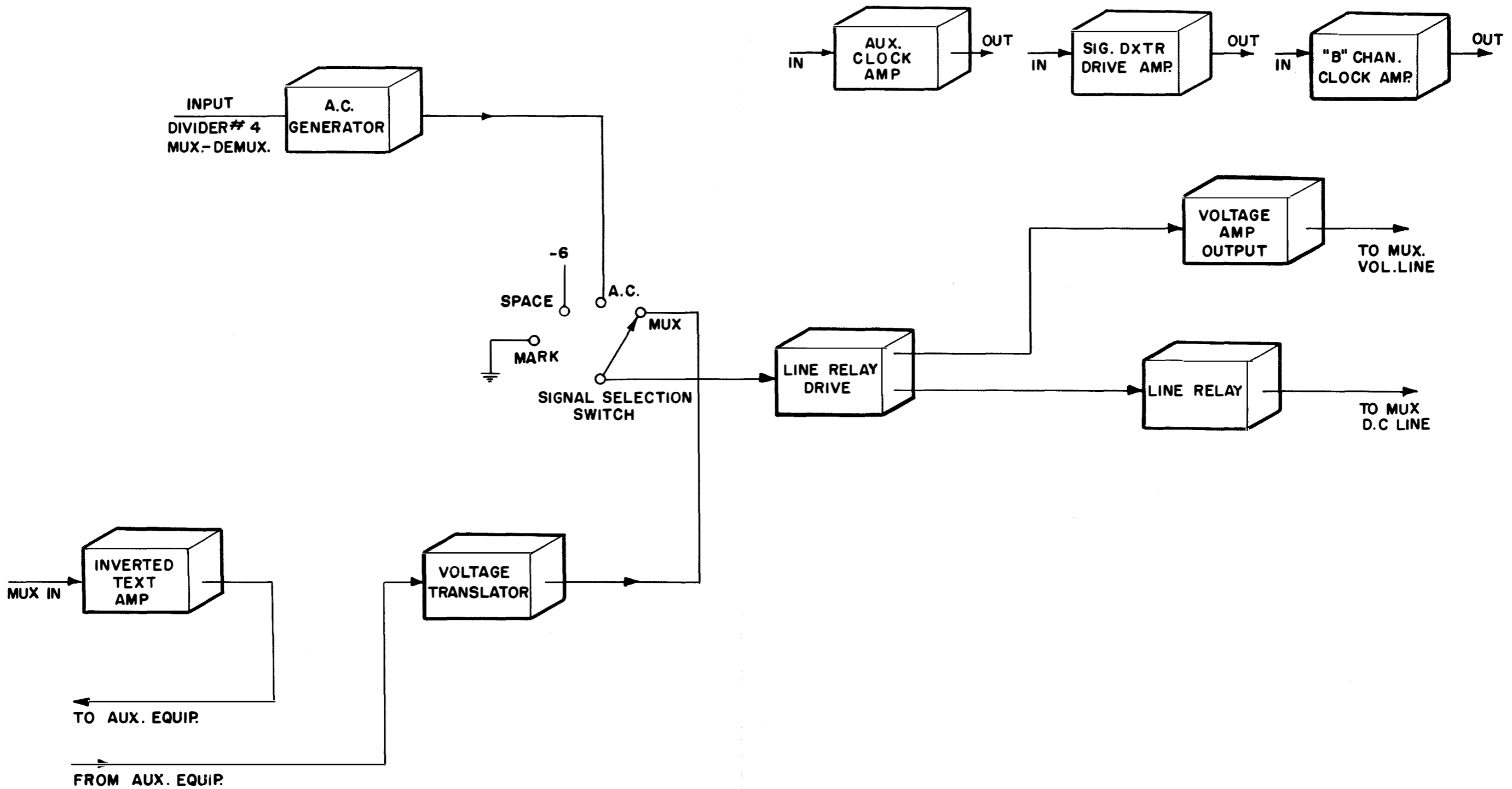


Figure 4-32 Block Diagram of Output Amplifier

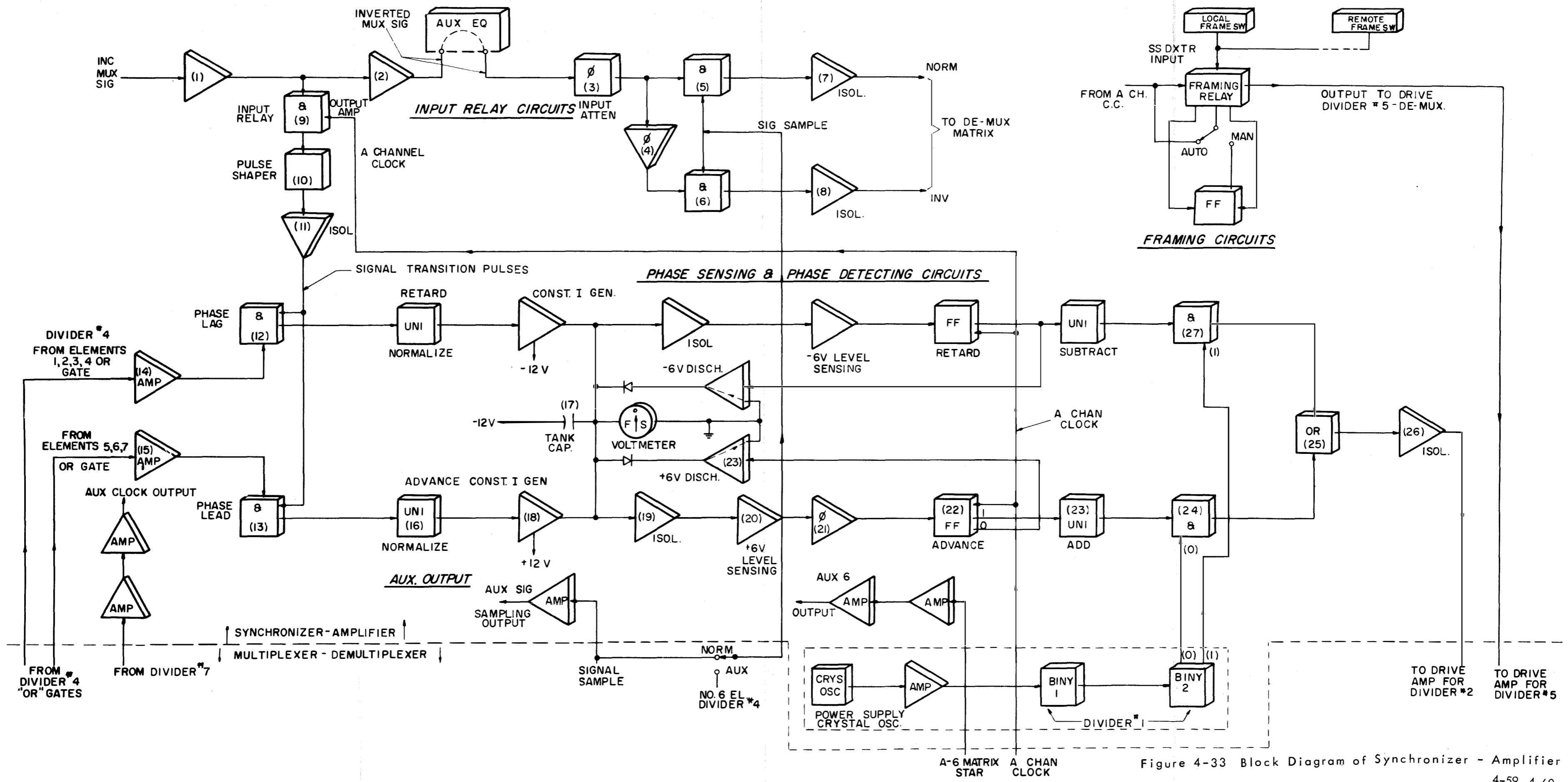


Figure 4-33 Block Diagram of Synchronizer - Amplifier 4-59, 4-60

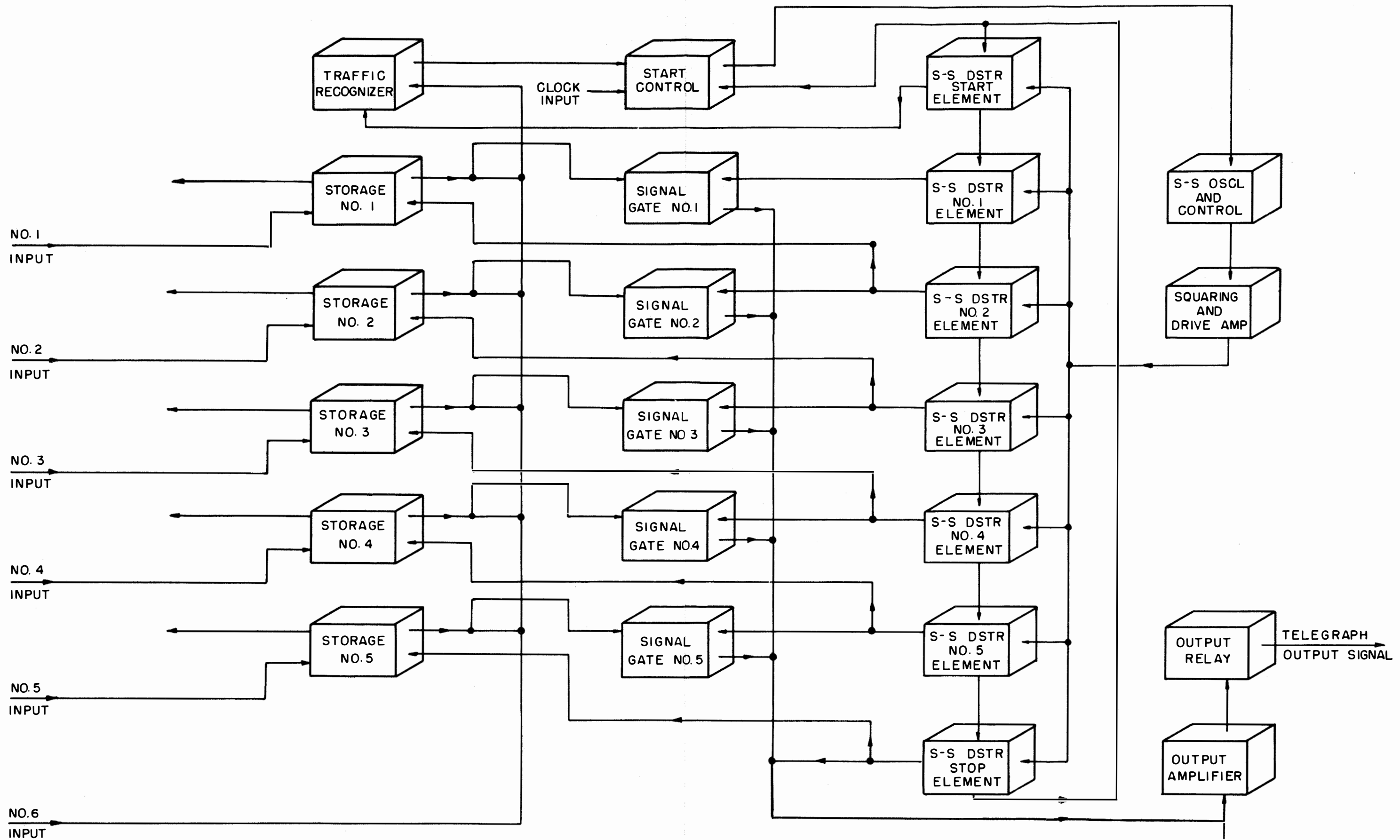


Figure 4-34 Block Diagram of Receiving Code Converter

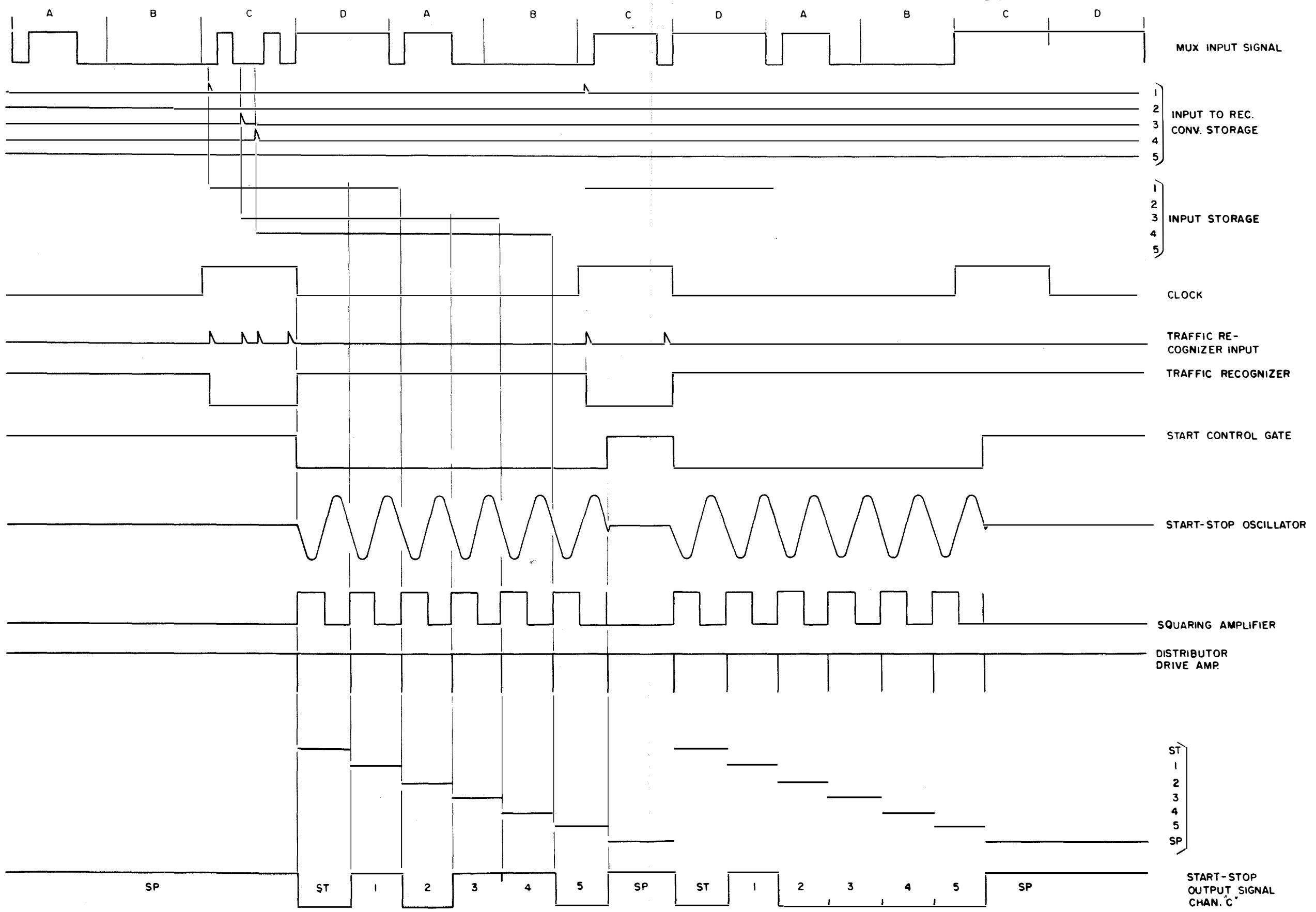
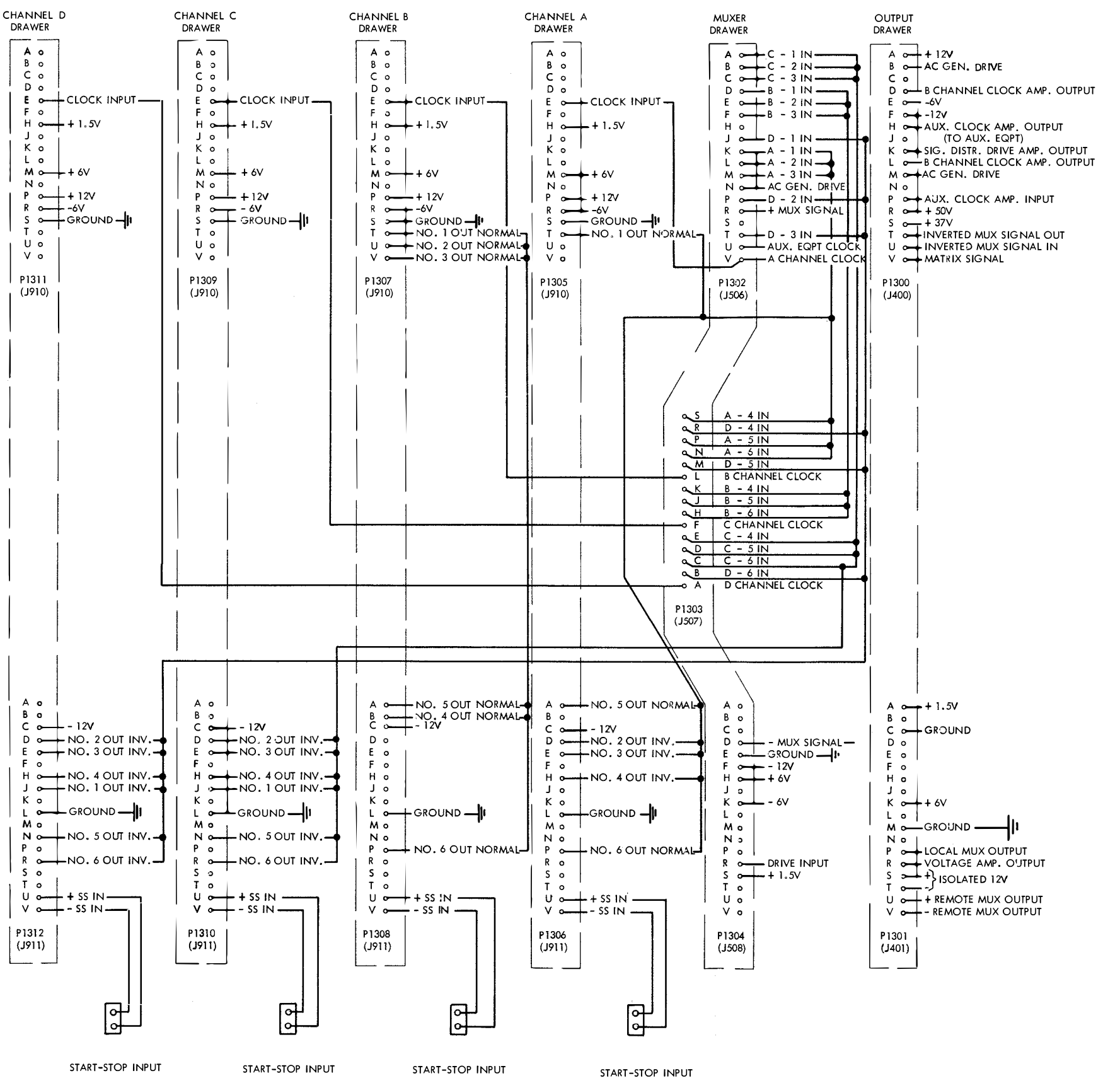
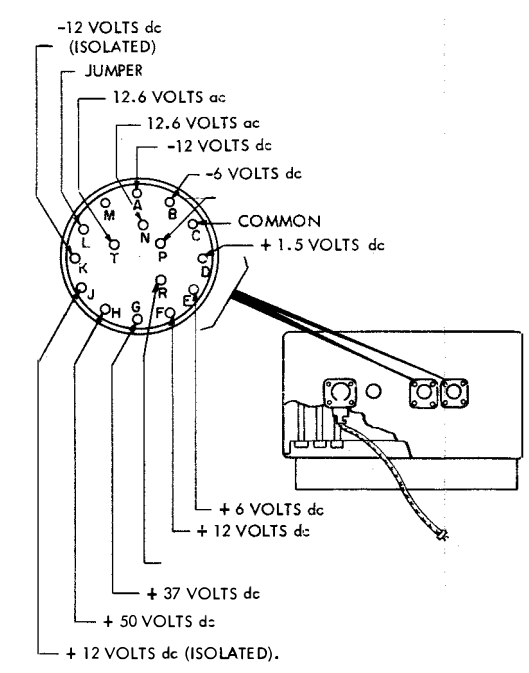


Figure 4- 35 Timing Diagram of Receiving Code Converter

REAR VIEW OF TRANSMITTING GROUP



REAR VIEW OF POWER - OSCILLATOR



REAR VIEW OF RECEIVING GROUP

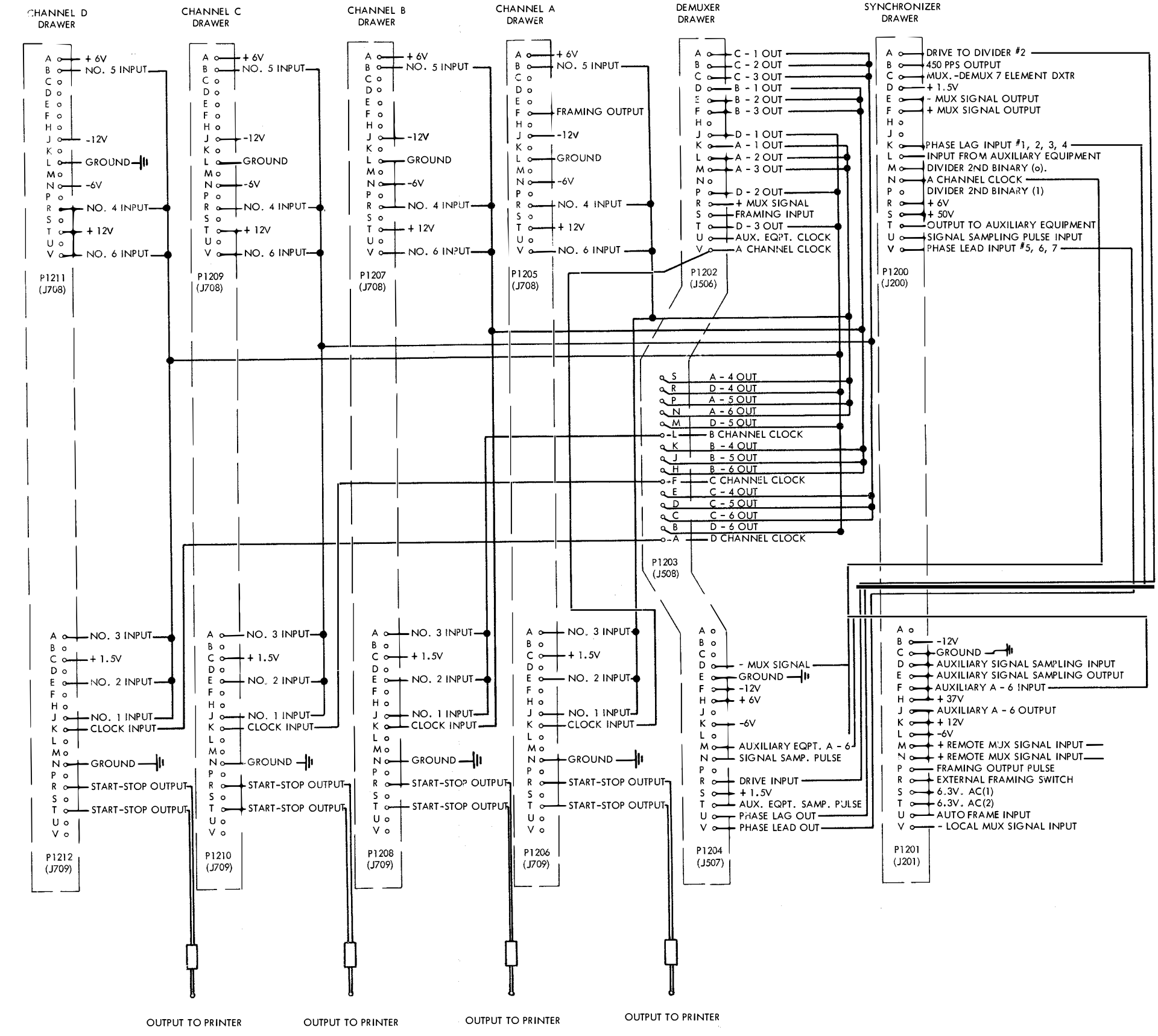


Figure 4-36 Signal Path Between Drawers

SECTION 5

TROUBLE-SHOOTING

1. GENERAL

1.a. Trouble-shooting is a maintenance procedure based upon a visual inspection, overall trouble-shooting and functional section trouble-shooting. This approach is calculated to insure reliable operation of the equipment and to direct the technician in the service routine when trouble is experienced. The information contained in the charts that follow is planned to provide the maintenance personnel with an efficient means for locating and clearing the trouble. It is necessary for the technician to be thoroughly familiar with the principles of operation of the various circuits before attempting any maintenance procedure.

1.b. When the source of trouble is analyzed, refer to Section 6 for detailed information with regard to the repair of the major unit. Note the adjusting requirements, typical waveforms for each drawer, and the circuit wiring diagrams (actual and schematic) which are to supplement the functional section trouble-shooting procedure. Section 7 furnishes a description and the ordering information for the individual components. Major test points (identified by a star with a number inscribed) on the tables of this Section are cross referenced with the waveforms in Section 6. In a similar manner, minor test points (identified by a circle with a letter inscribed) are shown in Section 6. Do not disassemble the unit farther than is absolutely necessary. Avoid storing the drawers in such a manner that they may fall against a sharp object and damage the etched circuit.

2. VISUAL INSPECTION

2.a. Visual observation and past performance often provide an early indication of impending trouble. The correction of a minor fault observed during a routine maintenance check may eliminate major repairs and prevent a shut down of the equipment. The suggested approach is as follows:

2.b. **FEELING** - This technique may be employed to discern an abnormal temperature rise on certain electrical components such as the power supply reactor, resistor or fuse. The cause may be traced to an overload resulting from a faulty capacitor, etc. Since the equipment may be operated in a high ambient temperature, exercise care in determining an overheated condition.

2.c. **LISTENING** - With regard to the associated mechanical equipment that function with the multiplex, excessive vibration, bearing noise, and arcing at electrical contacts represents the auditory observations that should be noted when the units are in operation.

2.d. **INSPECTING** - This action is relied upon to note the state of cleanliness, the amount of wear on certain mechanical parts, dirty contacts, loose connections and worn cables. Check to see that each transistor socket is equipped with its transistor. The transistor should be seated firmly in the socket.

3. OVERALL TROUBLE-SHOOTING

3.a. **PRELIMINARY CHECK** - The speed setting (60, 75 & 100 WPM) of the major units in the Transmitting Group should coincide with the speed selected for the A, B, C & D channel start-stop transmitters. It should be noted that the AN/FGC5 operates at 60 or 75 WPM. The line current (20 or 60 MA) should be compatible for all units involved. In a similar manner, the major units of the Receiving Group must be checked for speed and line current to insure that they are compatible with the equipment at the distant terminal and the local printers.

3.b. When trouble is reported, the technician must first determine whether the trouble is in the TM200 equipment or in associated terminal equipment. Usually, this is best accomplished by patching similar equipment into the circuit until the trouble is isolated. Both transmitting and receiving stations may have to do this before the faulty equipment is found.

3.c. Following the above procedure, the trouble will have been localized to a specific TM200 equipment or to a specific Transmitting or Receiving Group.

4. FUNCTIONAL SECTION TROUBLE-SHOOTING

4.a. **PRELIMINARY CHECKS** - Make sure that the fuses, indicator lamps and control settings are in condition for operation. The cable and connector assembly attached to each drawer should be clamped firmly in position (see Figure 6-4) and make good contact with each board.

TABLE 5-0. TEST EQUIPMENT AND SPECIAL TOOLS

DESCRIPTION	FUNCTION	IDENTIFICATION
Neon Lamp Indicator Unit	Indicates presence or absence of pulses in code converters.	TMN200
Voltmeter	Measures voltage in power supply	M101 (143634)
Vibrating Reed Frequency Meter	Checks Start-Stop Oscillator Frequency	M102 (143623)
Test Lead Assembly	Connects Test Points to J104 input for M102.	143809
Page Printer for 60 WPM Tape Reader for 60 WPM, that generates neutral start-stop signal	Output device Input device	
Oscilloscope	Checks waveforms, measures amplitude and timing characteristics of pulses.	Tektronix Type 531 or equivalent.
Transistor test set	Checks alpha and beta characteristics of transistors. Checks leakage characteristics of transistors.	

4.b. TEST EQUIPMENT AND SPECIAL TOOLS - In addition to the test equipment listed in Table 5-0, a Neon Test Unit TMN200 is included in the Output-Amplifier drawer TMXU201. When the TMN200 is plugged into a source of 115 a.c., the octal plug can be connected to octal sockets which are part of the 4 transmitting or 4 receiving code converter drawers. When the start-stop pattern is known, the pulse omissions or additions can be detected by viewing the neon lamps.

4.c. FUNCTIONAL SECTION TROUBLE-SHOOTING CHARTS.

4.c.(1) The tables that follow in this section permit one to trace the fault to a specific cir-

cuit or circuit component. Substitution of a transistor that is suspected to be faulty with a good transistor is a recommended procedure. However, do not remove all transistors at one time with the expectation of improving the performance. In general, the transistors are "proven in" and should not require a full scale replacement.

4.c.(2) When trouble has been localized to a specific circuit and a transistor is suspected of being faulty, it is desirable to be able to measure its parameters so that the condition of the transistor is definitely established. For this reason a transistor checker is specified as a necessary piece of test equipment.

TABLE 5-1. TM200 MULTIPLEX SYSTEM TROUBLE SHOOTING CHART

STEP	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	Distant Terminal asks for Signal Check	Good copy received at distant terminal Meter M400 should be vibrating for idle or active mux output	If distant terminal reports all channels faulty, check Meter M400. If meter reading OK, and distant terminal still reports all channels faulty, check distributor cycle Meter M500.
2	Observe that channels switch is set to proper number of channels	Meter M500 should be vibrating	If meter reading is OK, trouble may be in associated equipment or distant terminal. If meter reading is incorrect, check drawers of transmitting group.
	Distant Terminal reports one channel or 1 pulse faulty		Refer to trouble shooting chart for Transmitting Code Converter.
	All local printers garble		Check Meter M200
1	Go through framing procedure	Mux line current Meter M200 should be vibrating for input mux signal	If meter reading OK, proceed with step 2. If meter reading incorrect, check drawers of receiving group.
2	Observe that channels switch is set to proper number of channels	Distributor Cycle Meter M500 should be vibrating	If meter reading OK, trouble may be in associated equipment or at distant terminal. If meter reading is incorrect, check drawers of receiving group

TABLE 5-2. TM200 MULTIPLEX, TYPICAL TROUBLES

TROUBLE	NATURE OF TROUBLE	SYMPTOM
Transmitting converter defective.	Defective circuit in transmitting distributor.	Distant receiver reports garbling on one channel only. Equipment garbles when operated locally. Monitor printer prints good copy.
Multiplex signalling rate incorrect.	Defective circuit or improper switching position in Multiplexer-Demultiplexer at transmitting terminal.	Distant receiver reports garbling on all channels. Equipment garbles when operated locally.
No output from output amplifier, constant mark, or constant space.	Defective circuit in output amplifier, or improper switch position.	Distant receiver reports loss of multiplex signal. Equipment fails locally.
Receiving converter defective.	Defective circuit in receiving converter.	Local receiving terminal garbles on one channel only. Equipment garbles when operated locally.
Multiplex receiving distribution rate not compatible with transmitter.	Defective circuit or improper switch position in receiving multiplexer-demultiplexer.	Local receiving terminal garbles on all channels. Equipment garbles when operated locally.
No output from receiving control amplifier synchronizer drawer.	Defective circuit in receiving control amplifier synchronizer drawer.	Loss of multiplex signal to receiving converters. Multiplex line current meter indicates receipt of a multiplex signal.
Maximum receiving crystal oscillator correction rate not adequate to make up for frequency difference between transmitting and receiving terminals.	Phase correction circuits in synchronizer not operating correctly. Crystal oscillators not operating at same frequency.	Equipment periodically drifts out of frame. Continuous correction as indicated by phase meter.
Synchronizer defective.	Defective circuit in synchronizer.	Equipment drifts out of frame. No correction indicated by phase meter.

TRANSMITTING CODE CONVERTER - TMCX201

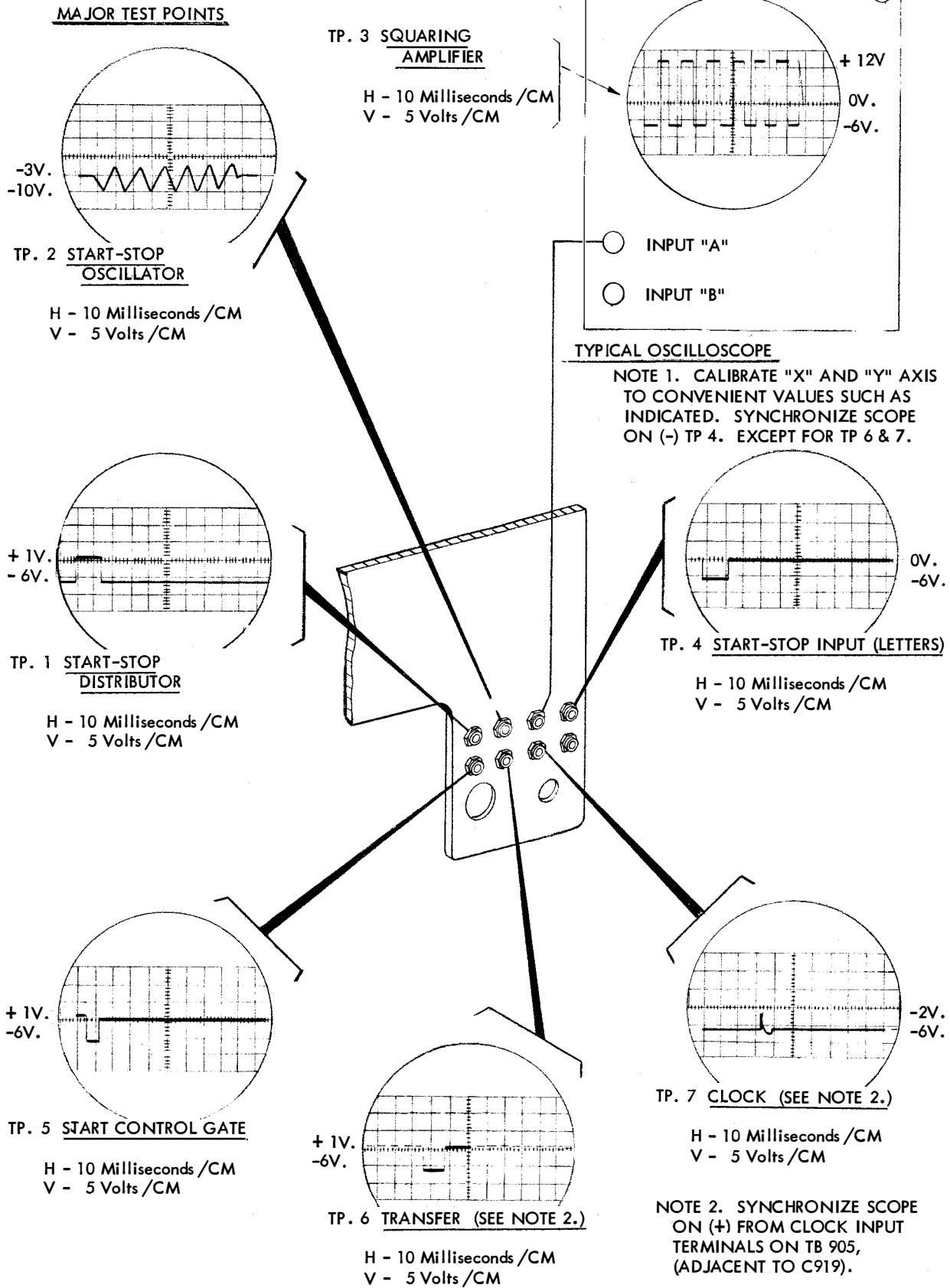


Figure 5-1 Major Test Points - TMCX-201

TABLE 5-3. TMCX201 TRANS. CODE CONVERTER TROUBLE SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	J901	Connect Neon Signal Indicator TMN-200 to J901. Arrange to supply transmitting code converter with an all mark start-stop telegraph signal from the associated sending apparatus	All lamps of TMN-200 flash on and off at varying intervals but displaying a beat pattern at roughly one in 8 seconds. The #6 lamp will appear to be on all the time except for a brief extinction at the roughly 8 second interval.	<p>If any one lamp fails to come on, check flip flops for that bit in both levels of storage step 16.</p> <p>If any one lamp fails to extinguish check flip-flop for that bit in both levels of storage step 16.</p> <p>If no lamps come on, check power supply connections into transmitting code converter (Make sure TMN-200 is operating properly by plugging into a transmitting code converter known to be in operating condition) Check position of channels switch on multiplexer unit. If all is normal, check signal input circuit step 17.</p>
2	TP1	Connect the vertical input of oscilloscope to Test Point 1, J902. Set horizontal sweep to 10 ms/cm, connect negative external sync. to test point 4.	Waveform in Figure 5-1, TP 1.	<p>If signal is normal, start-stop oscillator, oscillator control, squaring & Driving Amplifiers and start-stop distributor are functioning normally. Proceed to Step 10.</p> <p>If indication is not normal, remove Q904 on TB902 from socket. If waveform is now normal but free running, go to step 7. If still not normal proceed to step 3.</p>
3	TP3	Connect vertical input of oscilloscope to Test Point 3. Adjust and sync. as in step 2. Remove Q904 on TB902 from its socket. This will allow the oscillator to free run.	Square waves as shown in Figure 5-1, TP3, except free running.	<p>If indication is normal, SS oscillator and squaring amplifier are functioning, proceed to step 5.</p> <p>If indication is not normal, step 4.</p>
4	TP2	Connect vertical input of oscilloscope to Test Point 2, J903. Adjust and sync. as in step 2. Q904 removed from socket.	Sine waves as shown in Figure 5-1, TP 2, except free running and without clamp interval.	<p>If indication is normal, squaring amplifier has failed per indication of step 3. Check Q906 and Q907 on TB902 and associated circuitry.</p> <p>If indication is not normal, start-stop oscillator has failed. Check Q905, S900 and associated components and circuitry. Be sure also to check wiring back to Q904 socket as a short here could prevent oscillator from operating. When repair has been completed, replace Q904.</p>

TABLE 5-3. TMCX201 TRANS. CODE CONVERTER TROUBLE SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDEICATION	NEXT STEP
5	Collector of Q908	Connect vertical input oscilloscope to collector of Q908 (left end of R941 on TB903). Set scope for internal sync. (negative). Q904 removed from socket.	Very narrow (less than 10 microseconds) negative pulses, at bit rate. (Because these pulses are quite narrow, it may be necessary to increase scope intensity to see them).	<p>If indication is normal, driver amplifier is functioning, proceed to step 6.</p> <p>If indication is not normal, driver amplifier has failed. Check Q908 (TB903), CR913, CR914, CR915, L901 and all associated circuitry.</p>
6	Collector of S-S distributor	Using the oscilloscope or a volt meter of 1,000 ohms/volt or higher, set on 15 volt range. Measure voltage on collector of each element of start-stop distributor Q909 through Q915 (collectors are accessible on left end of 750 ohm resistors just to right of each transistor in start-stop distributor on TB903).	Cutoff transistors should measure about -6 volts. Conducting transistors about +1 volts, since ring should be cycling if not defective. Meter will flicker at character rate.	<p>Since ring is being driven with normal pulse, any transistor whose collector voltage is constantly +1 volts is not being turned off. Check that transistor (Q909 through Q915) and the transistor following it in the ring. Check the resistors, coupling capacitor, diodes and all wiring and voltages associated with these defective stages.</p> <p>When trouble has been located and repair made, replace Q904.</p>
7	TP5	Connect vertical input oscilloscope to Test Point 5 (J906). Adjust and sync as in step 2. Q904 removed from socket.	Rectangular waveform similar to Figure 5-1 TP5 except a free running positive pulse about +1 volts and about 1/2 bit duration running through wave shape.	<p>If wave shape is normal except for absence of free running +12vpulse, trouble is in Range Control Univibrator. Check Q900, Q901, Q902 and associated circuitry and gate CR906, CR907. If -6 volt portion of wave is missing, check diode gates, CR904 and CR905.</p> <p>If wave is normal, the oscillator control amplifier and oscillator clamp are defective; check Q903 and Q904 and associated circuitry. When repair is completed, replace Q904.</p>
8	TP2	Connect vertical input of scope to Test Point 2, (J903), Adjust horizontal for 10 ms/cm. external sync (negative) to TP4.	Sine wave waveform Figure 5-1 TP 2. Note especially there should be 6 full cycles between clamp intervals. Clamp should be 1.42 the period of the oscillations.	<p>If more or less than 6 cycles of sine wave sometimes appear, SS distributor is mis-firing on some pulses. Proceed to step 9.</p> <p>If 6 cycles consistently appear, but clamp interval is different than 1.42 bits, adjust oscillator frequency (L900) until operation is normal. If unit is outside its range of adjustment, check circuit of Q905, S900 etc. For final adjustment see Fig. 6-10.</p>

TABLE 5-3. TMCX201 TRANS. CODE CONVERTER TROUBLE SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
9	Collectors Start-Stop Distributor	Connect vertical input of oscilloscope to collectors of each element of start stop distributor in turn Q909 through Q915. (collectors are accessible on left end of 750 ohm resistors just to right of each transistor of start-stop distributor on TB 903. Adjust and sync scope as in step 8.	Wave form of Figure 5-1, TP1, except positive pulse will appear in progressively more advanced position as scope input connection is moved farther along ring.	If any collector fails to show a positive pulse, it is not being brought out of cutoff. Check that transistor and the one preceding it and their associated circuitry. If any transistor stays on for more than one bit, check that transistor and the one following it and their associated circuitry.
10	TP7	Connect vertical input of oscilloscope to Test Point 7, J908. Adjust horizontal to 10 ms/cm and connect external sync (positive) to clock input terminal on TB905 (adjacent to C919).	Wave form of Figure 5-1.	If indication is normal, proceed to step 11. If indication is not normal, clock inverter is defective, check Q926, clock input, and associated circuitry.
11	TP6	Connect vertical input of oscilloscope to Test Point 6, J907. Adjust and sync as in step 10.	Wave form shown in Figure 5-1, TP6.	If wave form is normal, check diode gates CR941, CR942, CR943, and wiring to them for failure of 2nd level storage. If wave form is absent, step 12.
12	Collector for Q921	Connect vertical input of oscilloscope to collector Q921 (accessible on left end of CR931 just to right of Q921). Adjust and sync. as in step 10.	Wave form shown in Figure 5-1, TP6.	If waveform is normal, emitter follower Q923 is defective per indication of step 11. Check Q923 and associated circuitry. If waveform is absent or not normal, proceed to step 13.
13	Collector for Q919	Connect vertical input of oscilloscope to collector Q919 (accessible on right end R971 just to left of Q919). Adjust and sync. as in step 10.	A narrow positive triangular wave form as shown for Transfer Firing gate on timing diagram.	If waveform is normal, transfer circuit is defective, from indication of step 12. Check Q920, Q921, Q922 and associated circuitry. If indication is not normal, step 14.
14	Emitter Q919	Connect vertical input of scope to emitter Q919 (accessible on left end of C916 just below Q919). Adjust and sync as in step 10.	Narrow triangular negative spike followed by very narrow positive spike, separated by duration of clock delay.	If indication is normal, proceed to step 15. If indication is not normal, check clock delay circuit Q924 and Q925 and associated circuitry.

TABLE 5-3. TMCX201 TRANS. CODE CONVERTER TROUBLE SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
15	Base Q919	Connect vertical of scope to base of Q919 (accessible at right end of R970 just to left of Q919.) Adjust scope to 10 ms/cm and connect ext sync (negative) to TP4.	Transfer prime wave form shown in timing diagram.	If indication is normal, Q919 is defective per the indication in step 13. If indication is not normal, transfer prime and release amplifier are defective; check Q916, Q917, Q918, and associated circuitry.
16		Trace signal on TB board number corresponding to signal pulse which is failing. Verify that defective pulse is not being received from the transmitter distributor. Plug monitor printer into J900.	0 volts lever is mark, -6 volts is space. Monitor printer indication okay.	Check Q921, Q928, Q929, Q930, Q931 and associated circuitry.
17	M900	Apply start stop signal.	Meter should show pulsating indication.	If meter has no indication, check ext. battery and line circuits; M900, J900. If meter has steady indication, check transmitter distributor. If indications are normal, check K900 and proceed to step 2.

TABLE 5-4 TMCX201 TRANSMITTING CODE CONVERTER, TYPICAL TROUBLES		
TROUBLE	NATURE OF TROUBLE	SYMPTOM
Start-stop oscillator off frequency and/or range univibrator output time duration incorrect.	Readjust start-stop oscillator frequency and/or reset range adjustment.	Occasional error in multiplex signal, one channel only. Errors show gain or loss of fifth pulse.
Irregular start-stop oscillator operation.	WPM selector switch S700 improperly set. Squaring amplifier Q906 and Q907 defective. Distributor drive circuit Q908 defective. Start-stop distributor Q909-Q915 defective. Clamp adjust potentiometer R920 improperly adjusted.	Garbled multiplex signal, one channel only.
Failure of first or second level storage.	Defective transistor in storage level associated with gain or loss of a signal pulse. Q928, Q929, Q930, Q931.	Consistent gain or loss of one pulse as indicated on neon indicator TMN200.
Failure of transfer circuit.	Transfer circuit defective - transfer prime circuit defective, clock delay circuit defective, transfer firing gate defective.	Loss of traffic on one channel only.
Transfer circuit self-timed transfer pulse too narrow (less than .1 millisecond)	Defective component in transfer circuit.	Loss of traffic immediately following transmission of speed differential blank.
No output, or incorrect output, from line relay.	Line relay defective. No line current. TB907 improperly strapped.	Garbled output, no output, one channel only.

MULTIPLEXER - DEMULTIPLEXER - TMD 201

MAJOR TEST POINTS

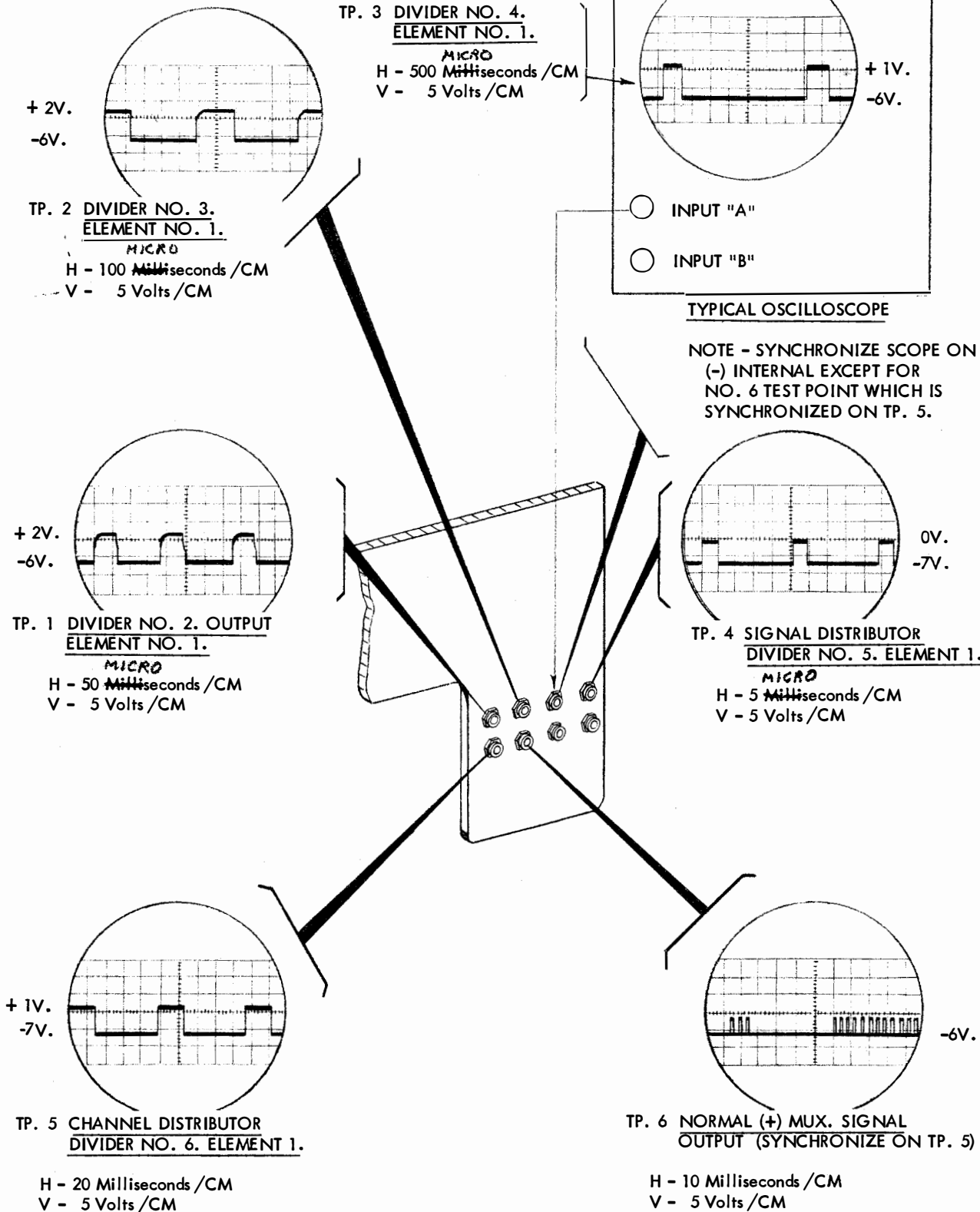


Figure 5-2 Major Test Points - TMD 201

TABLE 5-5. TMD201 DEMULTIPLEXER-MULTIPLEXER TROUBLE SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	M500	Observe channel indicator meter.	Meter needle vibrating at channel rate.	<p>If indication is normal, proceed to step 7 or 7A.</p> <p>If meter needle is stationary or vibration at an incorrect rate, proceed to step 2.</p>
2	TP 5	Connect vertical input of oscilloscope to Test Point 5 (J504).	<p>4 Channel: Pulse having a width one-fourth of period.</p> <p>3 Channel: Pulse having a width one-third of period.</p> <p>2 Channel: Pulse having a width one-half of period.</p>	<p>If indication is normal, trouble is in channel indicator. Check Q530, M500 and associated circuitry.</p> <p>If indication is not normal, proceed to step 3.</p>
3	TP 4	Connect oscilloscope to Test Point 4 (J503).	Pulse having a width one-sixth of period.	<p>If indication is normal, trouble is in Divider No. 6. Check Q529, Q531, Q532, Q533, Q534 and associated circuitry.</p> <p>If indication is not normal, proceed to step 4.</p>
4	TP 3	Connect oscilloscope to Test Point 3 (J502).	Pulse having a width one-seventh of period.	<p>If indication is normal, trouble is in Divider No. 5. Check Q521, Q522, Q523, Q524, Q525, Q526, Q527 and associated circuitry.</p> <p>If indication is not normal, proceed to step 5.</p>
5	TP 2	Connect oscilloscope to Test Point 2 (J501)	<p>4 Channel: Pulse having a width one third of period.</p> <p>3 Channel: Pulse having a width one fourth of period.</p> <p>2 Channel: Pulse having a width one sixth of period.</p>	<p>If indication is normal, trouble is in Divider No. 4. Check Q513, Q514, Q515, Q516, Q517, Q518, Q519, Q520 and associated circuitry.</p> <p>If indication is not normal, proceed to step 6.</p>
6	TP 1	Connect oscilloscope to Test Point 1 (J500)	<p>60 WPM: Pulse having a width one-fifth of period.</p> <p>75 WPM: Pulse having a width one-fourth of period.</p> <p>100 WPM: Pulse having a width one-third of period.</p>	<p>If indication is normal, trouble is in Divider No. 3. Check Q506, Q507, Q508, Q509, Q511, Q512 and associated circuitry.</p> <p>If indication is not normal, trouble is in Divider No. 2. Check Q500, Q501, Q502, Q503, Q504, Q505 and associated circuitry.</p>

TABLE 5-5. TMD201 DEMULTIPLEXER-MULTIPLEXER TROUBLE SHOOTING CHART

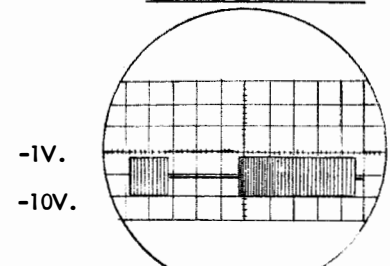
STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
7	TP 6	<u>Unit used as De Muxer</u> Connect oscilloscope to test point 6 (J505). Supply idle signal to unit.	Multiplex idle signal TP 6 Figure should be visible.	If indication is not normal, trouble is in Synchronizer Amplifier Unit.
7A	TP 6	<u>Unit used as Muxer</u> Connect oscilloscope to Test Point 6 (J505). Supply idle converter signals to unit.	Multiplex idle signal TP 6 Figure should be visible.	If indication is not normal, check matrix components.

TABLE 5-6 TMD201 MULTIPLEXER-DEMULTIPLEXER TYPICAL TROUBLES

TROUBLE	NATURE OF TROUBLE	SYMPTOMS
Channel selection switch or words per minute switch in improper position.	Channel selection switch or words per minute switch in improper position.	Receiver reports garbling on all channels. Equipment will not frame.
One or more ring circuits not properly functioning.	One or more ring drive circuits not functioning. Q500, Q506, Q513, Q521, Q529 defective.	Receiver reports garbling on all channels. Equipment will not frame.
One or more ring circuits functioning improperly.	One or more ring circuits fail to function, or function improperly. Q501-Q505, Q507-Q512, Q514-Q520, Q522-Q527, Q531-Q534 defective.	Receiver reports garbling on all channels. Equipment will not frame.
NORM-AUX switch in NORM position.	NORM-AUX switch (S503) in NORM position. Place in AUX. position.	When multiplex is used in conjunction with auxiliary equipment, receiver garbles on all channels.
No signal sampling output in NORM position of NORM-AUX switch.	Q528 defective.	No signal sampling output with NORM-AUX switch in NORM. Garbling on all channels.
No auxiliary clock output.	Divider Number 7 defective. Q535-Q542 defective.	Auxiliary equipment fails to function.

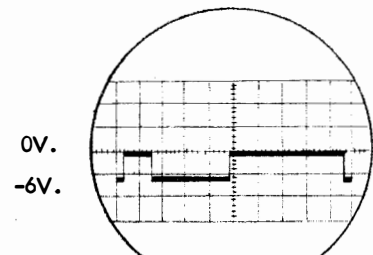
OUTPUT AMPLIFIER - TMXU 201

MAJOR TEST POINTS



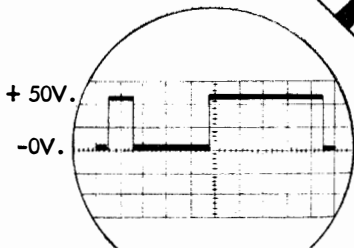
TP. 2 OUTPUT LINE RELAY OSCILLATOR

H - 10 Milliseconds /CM
 V - 5 Volts /CM



TP. 1 MUX. SIGNAL AMPLIFIER

H - 10 Milliseconds /CM
 V - 5 Volts /CM

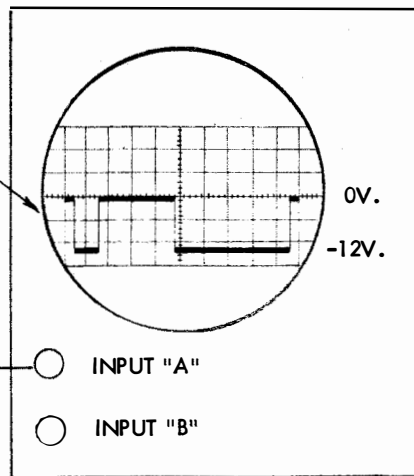


TP. 5 VOLTAGE AMPLIFIER OUTPUT

H - 10 Milliseconds /CM
 V - 20 Volts /CM

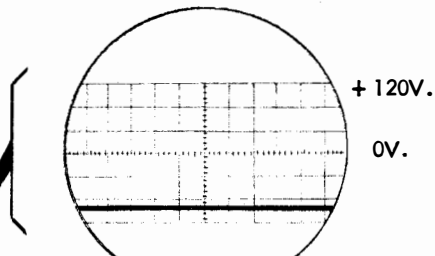
TP. 3 OUTPUT LINE RELAY AMPLIFIER (LOCAL)

H - 10 Milliseconds /CM
 V - 5 Volts /CM



TYPICAL OSCILLOSCOPE

NOTE - SYNCHRONIZE SCOPE FROM TEST POINT NO. 5 IN MULTIPLEXER-DEMULTIPLEXER.



TP. 3 WITH RESPECT TO TP. 4 REMOTE 120 VOLT OUTPUT CKT.

H - 10 Milliseconds /CM
 V - 50 Volts /CM

Figure 5-3 Major Test Points - TMXU 201

TABLE 5-7 TMXU201 OUTPUT AMPLIFIER TROUBLE SHOOTING CHART

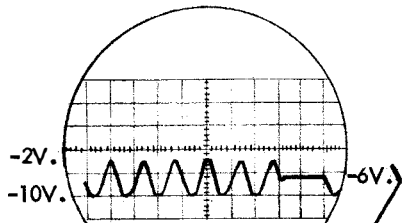
STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	M400	Equipment in operation on remote output circuit. Check to see that Distributor Cycle meter indication on Multiplexer is normal	Meter needle should be fluctuating.	If indication is not normal, proceed to step 2.
2	M400	Set S401 in the Output Amplifier and S200 in the Synchronizer - Amplifier to LOCAL. Selector switch S400 on MUX.	Meter needle should be fluctuating.	If indication is now normal, check remote circuit battery or external keyer. If indication is not normal, proceed to step 3.
3	TP3	Connect oscilloscope to TP3.	Waveform Fig. TP3	If indication is normal, check F400, M400. If no signal, proceed to step 4.
4	M400	Set S400 to AC	Meter should read near 30 milliamperes (60 ma nominal)	If indication is normal, check Q406, Q407, Q408, Q409, Aux. equipment, or dummy plug in J1300.
5	TP2	Connect oscilloscope to TP2	Waveform Fig. TP2	If indication is normal, check Q413, Q414, Q415, Q416, Q417, Q419, CR411, CR412, isolated 12v supply. If indication is not normal, proceed to step 6.
6	TP5	Connect oscilloscope to TP5	Waveform Fig. TP5	If indication is normal, check Q411, Q412. If indication is not normal, check Q418, Q410.

TABLE 5-8 - OUTPUT AMPLIFIER - TYPICAL TROUBLES

TROUBLE	NATURE OF TROUBLE	SYMPTOMS
LOCAL, REMOTE switch improperly set.	Reset LOCAL, REMOTE switch.	No line current on Mux. line current meter.
Output relay functioning improperly.	Twelve volts isolated supply faulty. Line relay transistors Q415, Q416, Q417, Q419 defective.	No line current on Mux. line current meter.
Keying mode switch S400 improperly set.	Reset switch S400 to MUX	Constant line current, or no line current, on line current meter.
Line relay oscillator not functioning.	Defective line relay oscillator Q412. Defective relay drive transistors Q413, Q414. Defective oscillator drive transistor circuits Q406, Q407, Q408, Q409 and Q410.	Constant line current, or no line current, on line current meter.

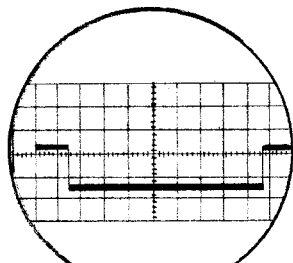
RECEIVING CODE CONVERTER

MAJOR TEST POINTS



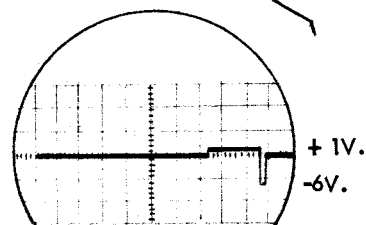
TP 2 START-STOP OSCILLATOR

H - 10 Milliseconds /CM
V - 5 Volts /CM



TP 1 START PULSE OF S. S. DISTRIBUTOR

H - 10 Millisec. /CM
V - 5 Volts /CM

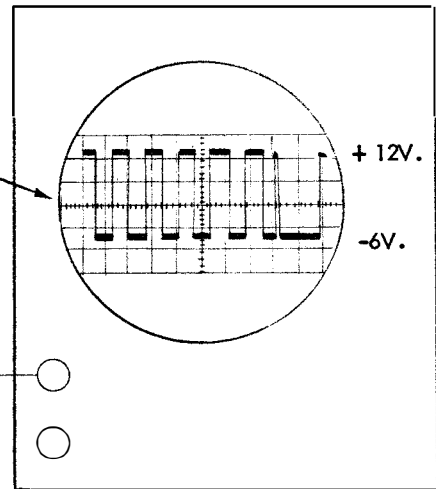


TP 5 START-CONTROL GATE

H - 10 Milliseconds /CM
V - 5 Volt /CM

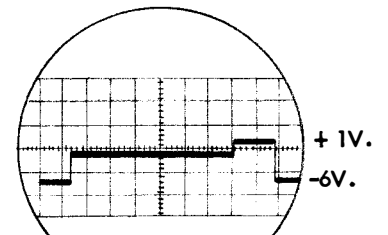
TP 3 SQUARING AMPLIFIER

H - 10 Milliseconds /CM
V - 5 Volts /CM



TYPICAL OSCILLOSCOPE

NOTE - SYNCHRONIZE SCOPE FROM CLOCK INPUT TERMINAL ON TB 702 (2ND TERMINAL FROM LOWER RIGHT CORNER).



TP 4 START-STOP OUTPUT

H - 10 Milliseconds /CM
V - 5 Volts /CM

Figure 5-4 Major Test Points - TMCR 201

TABLE 5-9. TMCR201 RECEIVING CODE CONVERTER, TROUBLE SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	J706	Connect Neon Signal Indicator TMN200 to J706. Arrange to supply receiving code converter with all MARK signal from receiving multiplexer demultiplexer	All lamps of TMN200 flash on and off at character rate. All lamps appear to come on simultaneously, but go off in rapid sequence in order 6, 1, 2, 3, 4, 5.	<p>If indication is normal, step 10</p> <p>If any one lamp fails to light, check flip-flop for that bit, step 15</p> <p>If any one lamp fails to extinguish or lamp is erratic, step 12</p> <p>If all lamps come on and stay on, proceed to step 2.</p> <p>If no lamps come on, check power supply connections and signal input connections into receiving code converter. (Make sure TMN200 is operating properly by plugging into a receiving code converter known to be in operating condition)</p>
2	TP3	Connect vertical input of oscilloscope to Test Point 3 (J703) and adjust Horizontal sweep to 10 ms per cm. Connect external sync. (negative) to clock input terminal on TB702 (2nd terminal from lower right corner)	Wave form of Figure 5-4 TP3	<p>If indication is normal, or continuous square waves moving across scope face, SS. oscillator and squaring amplifier are functioning; proceed to step 5.</p> <p>If wave form is absent or erratic, step 3.</p>
3	TP3	Same as step 2 -- Remove Q706 (TB704) from its socket to permit the start-stop oscillator to free run.	Continuous square waves similar to Figure 5-4 TP3, but free running. Neon Indicator connected in step 1 should have all lights flashing. (Not necessarily in sequence indicated in step 1)	<p>If neon indicator and scope indication are normal, start stop oscillator, squaring amplifier, distributor driver, distributor and flip flops are functioning, proceed to step 8.</p> <p>If scope indication is normal and neon indication is still not normal, start-stop oscillator and squaring amplifier are functioning. Proceed to step 5. If neither indication is normal, step 4.</p>
4	TP2	Connect vertical input of oscilloscope to Test Point 2 (J702). Adjust Horizontal sweep and sync as in Step 2. Q706 (TB704) removed from socket	Continuous sine waves similar to Figure 5-4 TP2 but free running and not clamped.	If indication is normal, start-stop oscillator is functioning, but squaring amplifier has failed per indication of step 3. Check Q708 and 709 and associated circuitry (TB704)

TABLE 5-9. TMCR201 RECEIVING CODE CONVERTER, TROUBLE SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
5	Col-lector Q710	Connect vertical input of oscilloscope to Q710 collector (on TB703 right end of R744 just above Q710), with Q706 removed from socket. Adjust horizontal sweep of scope to 1 ms/cm. Use internal sync (Negative)	Narrow negative pulses (+6v to -6v) at bit rate. Because these are very narrow pulses, it may be necessary to turn up scope brightness.)	<p>If wave form is absent or incorrect, the start-stop oscillator is not functioning. Check Q707, switch S700, for faulty operation or dirty contacts, and associated oscillator circuitry. Also check circuit back to Q706 socket, as a short here would prevent normal operation. When repair has been made, replace Q706.</p> <p>If indication is normal, Driver Amplifier is functioning. Proceed to step 6.</p> <p>If indication is not normal, Driver Amplifier is not functioning. Check Q710 and associated driver circuitry.</p>
6	TP1	Connect vertical input of oscilloscope to Test Point 1 (J701). Adjust scope as in step 2, Q706 removed from socket.	Wave form similar to Fig. 5-4 TP1, but free running	<p>If indication is normal, ring counter is functioning properly. Proceed to step 8.</p> <p>If indication is not normal, ring counter is not functioning properly. To determine which element is not functioning, proceed to step 7.</p>
7	Col-lectors of Ring	Use a voltmeter of 1,000 ohms per volt or higher, set on Range of 15V or more. Measure collector voltage of each ring element (left end of 750 ohm resistors on TB703) Q706 removed from socket.	Cut off transistors should measure -6 volts. Conducting transistor about plus 1 volts. Since ring should be cycling if not defective, meter would flicker at character rate.	<p>Since ring is being driven with normal pulse, any transistor whose collector voltage is constantly +1 volts is not being turned off. Check that transistor (Q713 through Q719) and the transistor following it in the ring, check the resistors, coupling capacitor, diodes & all wiring & voltages associated with the defective stage.</p> <p>When trouble has been located and repairs made, replace Q706.</p>
8	TP5	Connect the vertical input of the oscilloscope to TP5 (J705). Adjust and sync as in step 2. Q706 removed from socket.	<p>Positive clock pulse.</p> <p>A shifting rectangular wave between about plus 1v and -6 volts, having a small positive step (about plus 1v)</p>	<p>If signal is normal, proceed to step 9</p> <p>If signal is a constant level, trouble is in either traffic recognizer flip-flop Q700, Q701 and associated circuitry, or in clock emitter followe</p>

TABLE 5-9. TMCR201 RECEIVING CODE CONVERTER, TROUBLE SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
9	Collector of Q705	Connect vertical input of oscilloscope to collector Q705 on TB704. (Right end of R726) Sweep and sync as in step 2. Q706 removed from socket.	similar to Figure Plus 12V with a narrow negative pulse to -6v free running through it.	Q702 and circuitry. If only clock wave form appears (see timing diagram) trouble is in Q700, Q701 and circuitry. Check also CR705, CR706. If small step is missing, trouble is in clock emitter follower Q702 and circuitry. If indication is not normal, control gate and control amplifier are not functioning. Check Q705, CR717 & CR718 and associated circuitry. If indication is normal, SS oscillator clamp is not functioning. Replace Q706, check Q706 and associated circuitry.
10	TP4	Connect vertical input of oscilloscope to TP4 (J704). Adjust Horizontal sweep to 10 ms per cm, connect external sync to clock input terminal TB702 (2nd terminal from lower right corner) Replace Q706 if it has previously been removed from socket.	With an all MARK signal in, waveform shown in Figure 5-4 for TP4.	If indication is normal, proceed to step 11. If indication is not normal, diode gates are not all functioning properly. Check CR713, CR714, CR715 -1, -2, -3, -4, -5, CR716 and associated circuitry.
11	M700	All MARK input signal	Meter reads approximately 50 ma on 60 ma circuit and 16 ma on a 20 ma circuit, and vibrates at character rate.	If meter reads constant 60 ma (20 ma) relay is held over constantly and not releasing for start pulse. Check K700, Q711, Q712. Check relay contact circuit for short. If meter reads 0 ma, check for open in external battery circuit. Open K700 or resistors or meter in line circuit, or Q711, Q712 and associated circuitry.
12	TP2	Connect vertical input of oscilloscope to Test Point 2 (J702) arrange sweep for 10 ms per cm deflection, and connect external sync to clock input terminal on TB702 (2nd terminal from lower right corner)	Wave form of Figure 5-4 TP2. Note especially there should be six cycles of sine wave. Length of clamp period should be about 1 1/4 cycles.	If indication is normal and one of lamps in step 1 was failing to extinguish, check flip-flop for that bit, step 14. If indication is not normal, as indicated by clamp period being other than 1 1/4 cycles, but 6 full cycles appear, adjust oscillator frequency (L700) to make normal

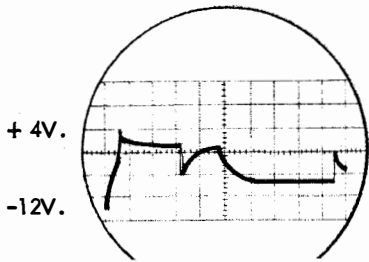
TABLE 5-9. TMCR201 RECEIVING CODE CONVERTER, TROUBLE SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
				<p>indication. Final adjustment should be as described under Adjustments. If proper frequency is outside range of adjustment, check frequency determining elements L700, C705A-B, switch S700 and oscillator transistor Q701 and associated circuitry.</p> <p>If the indication shows other than 6 full cycles of sine wave, either continuously or erratically, trouble is in Ring start-stop distributor. Step 13.</p>
13	Collectors of SS Dist.'s	Connect vertical input of oscilloscope to successive collectors of start-stop distributor Q713 through Q719 (Collector is on left end of 750 ohm resistor, TB703)	Q713-Q718, positive pulse of one bit duration on during Start, 1, 2, 3, 4, 5 bits of character respectively; Q719 positive pulse of 1.28 bit duration during stop pulse interval.	<p>If one collector wave shape indicates that transistor is not cutting off reliably, added cycles will appear in SS oscillator output. Replace transistor failing to fire, and/or one following it.</p> <p>If one collector wave shape indicates that transistor is failing to conduct, replace it and look for the one which is firing in its place. Replace it also if necessary.</p>
14	Base Q704	Connect vertical input of oscilloscope to base of Q704 of suspected flip-flop. (left end R721) Arrange sweep for 10 ms/cm deflection and connect external sync to clock input terminal TB702 (2nd terminal from lower right corner)	Narrow positive pulse at instant that flip flop is to be reset.	<p>If indication is normal, trouble is in flip-flop circuit, check Q703, Q704 and associated circuitry.</p> <p>If indication is not normal, check coupling from SS distributor element that resets that flip-flop and input gate CR712.</p>
15	Base Q703	Connect vertical input of oscilloscope to Base of Q703 of suspected flip flop (upper end of R715); Horizontal and sync as in step 14.	Narrow positive pulse at instant that flip-flop is to be set. (early part of trace)	<p>If indication is normal, trouble is in flip-flop circuit. Check Q703, Q704 and associated diodes and circuitry.</p> <p>If indication is not normal, check coupling from input circuit, and input multiplexer de-multiplexer.</p>

TABLE 5-10. TMCR201 RECEIVING CODE CONVERTER, TYPICAL TROUBLES

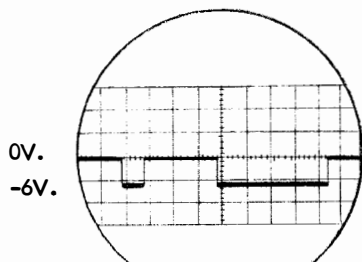
TROUBLE	NATURE OF TROUBLE	SYMPTOMS
Start-stop oscillator off frequency.	Start-stop oscillator frequency out of adjustment. Reset frequency adjustment.	Occasional error in printed copy. Poor range on output printer. Errors show gain or loss of fifth pulse.
Irregular start-stop oscillator operation.	WPM selector switch S700 improperly set. Squaring amplifier Q708, Q709 defective. Distributor drive circuit Q710 defective. Start-stop distributor Q713-Q720 defective. Clamp adjust potentiometer R730 improperly adjusted.	Garbled copy, transposition of pulses, loss of printer synchronism.
Failure of storage circuit.	Defective transistor in storage circuit associated with gain or loss of the signal pulse Q703, Q704.	Consistent gain or loss of one pulse, as indicated by received copy and on neon indicator TMN200.
No output or incorrect output from line relay.	Line relay defective, line relay drive, Q711, Q712, defective.	Garbled output, no output, one channel only.

SYNCHRONIZER AMPLIFIER - TMS 201
MAJOR TEST POINTS



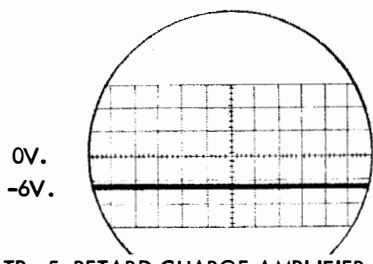
TP. 2 "A" CHANNEL AND MUX. SIGNAL GATE

H - 5 Milliseconds /CM
 V - 5 Volts /CM



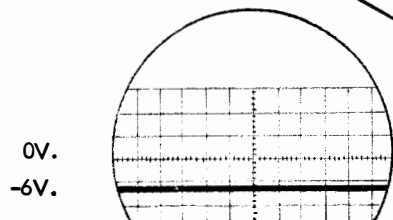
TP. 1 MUX. SIGNAL (INV.)

H - 10 Milliseconds /CM
 V - 5 Volts /CM



TP. 5 RETARD CHARGE AMPLIFIER (NO CORRECTION)

H - 20 Milliseconds /CM
 V - 5 Volts /CM

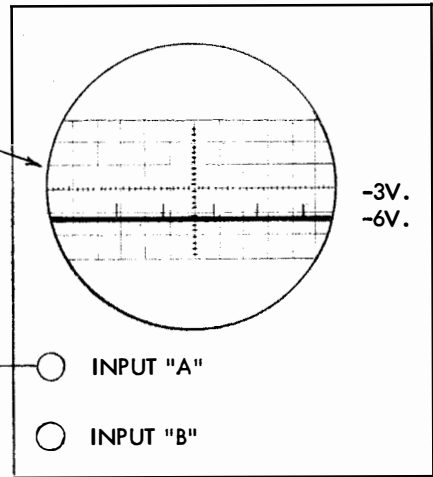


TP. 6 ADVANCE CHARGE AMPLIFIER (NO CORRECTION)

H - 20 Milliseconds /CM
 V - 5 Volts /CM

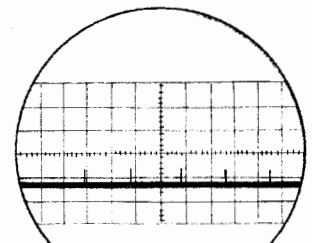
TP. 3 PHASE LAG GATE

H - 50 Milliseconds /CM
 V - 5 Volts /CM



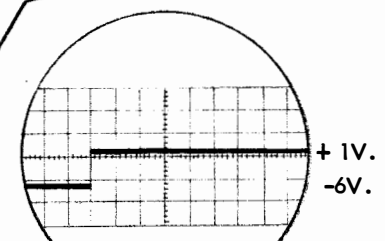
TYPICAL OSCILLOSCOPE

NOTE 1 - CALIBRATE "X" AND "Y" AXIS TO CONVENIENT VALUES SUCH AS INDICATED. SYNCHRONIZE SCOPE ON TP. 5 IN THE MUX. / DEMUX. DRAWER.



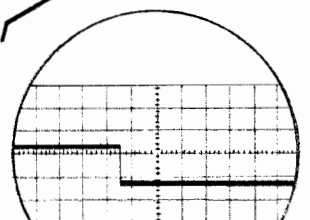
TP. 4 PHASE LEAD GATE

H - 50 Milliseconds /CM
 V - 5 Volts /CM



TP. 8 ADD GATE UNIVIBRATOR

H - 20 Milliseconds /CM
 V - 5 Volts /CM



TP. 7 SUBTRACT GATE UNIVIBRATOR

H - 20 Milliseconds /CM
 V - 5 Volts /CM

TABLE 5-II. TMS201 SYNCHRONIZER-AMPLIFIER, TROUBLE SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	M200	Apply known mux signal to unit.	Meter reading should fluctuate	If no signal, check position of local remote switches, external circuits. If indication normal, proceed to step 2.
2	TP2	Connect oscilloscope to test point 2. Horizontal sweep set to 10 ms/cm. Sync. internally	Waveform Fig 5-5, TP2	If no signal, check Q209, Q208, Q202 and associated circuitry. If normal, proceed to step 3.
3	TP1	Connect oscilloscope to test point 1.	Waveform Fig 5-5, TP1	If no signal, check that auxiliary equipment is operating, or if auxiliary equipment is not used, that dummy plug is plugged to J1200. Check Q210, Q203, Q204, Q206. If normal, proceed to step 4.
4	TP3	Connect oscilloscope to test point 3, 4. Apply AC multiplex signal to unit.	Waveforms Fig 5-5, TP3, 4	If no pips on either TP, check Q221, Q211, Q219. If pips normal on TP3, proceed to step 5. If pips normal on TP4, proceed to step 9.
5	M201	Apply AC signal.	Phase meter (M201) should be moving in FAST direction.	If meter reads near 0 or is not increasing in FAST direction, check Q217, Q218, Q225, Q226. If meter indication is normal, or off scale in FAST direction, proceed to step 6.
6	TP5	Connect oscilloscope to TP5	Waveform Fig 5-5, TP5. Signal appears periodically at very slow rate.	If no signal, check Q223, Q224. If signal is normal, proceed to step 7.
7	TP7	Connect oscilloscope to TP7. Trigger scope from leading edge (plus) of A channel clock at C221-1 on TB207-1. Set sweep for 10 ms/cm.	Waveform Fig 301, TP7.	If no signal, check Q232-1, Q233-1, Q234-1, Q235-1. Check that output pulse is correct width. If signal is normal, proceed to step 8.

TABLE 5-11. TMS201 SYNCHRONIZER-AMPLIFIER, TROUBLE SHOOTING CHART

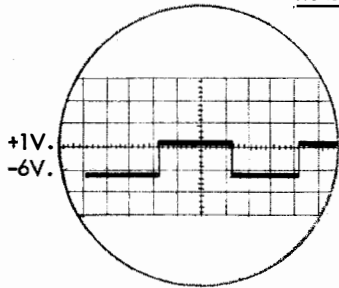
STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
8		View wave form at collector of Q237, TB209.	Waveform should consist of train of flat-topped positive pulses. Rise time of positive transitions less than 2 micro-seconds.	If no signal, check Q237, Q236. Verify that signal is supplied by Power-Oscillator.
9	M201	Apply AC signal.	Phase meter (M201) should be moving in SLOW direction.	If meter reads near 0 or is not increasing in slow direction, check Q220, Q221, Q230, Q231. If indication is normal, or off-scale in slow direction, proceed to step 10.
10	TP6	Connect oscilloscope to TP6.	Waveform Figure 5-5, TP6. Signal appears periodically at very slow rate.	If no signal, check Q229, Q228, Q227. If indication normal, proceed to step 11.
11	TP8	Connect oscilloscope to TP8. Trigger scope from leading edge (plus) of A channel clock at C221-1 on TB207-1. Set sweep for 10 ms/cm.	Waveform Figure 5-5, TP7.	If no signal, check Q232-2, Q233-2, Q234-2, Q235-2. If indication is normal, proceed to step 8.

TABLE 5-12. TMS201 SYNCHRONIZER-AMPLIFIER, TYPICAL TROUBLES

TROUBLE	NATURE OF TROUBLE	SYMPTOMS
Out of frame. Synchronizer fails to generate synchronizing impulses.	Reframe. "Add" or "Subtract" gate univibrators are defective. Retard or advance flip flops are defective. Level sensing circuits, Q225, Q223, Q226, Q229, Q228, Q227, Q224 are defective. Retard and advance univibrators are defective.	Output of all channels garbled. Phase meter reads plus or minus off scale. Receiving terminal drops out of frame.
Crystal frequency differential between the transmitting and receiving terminal exceeds 1 cycle.	Trim crystal oscillator frequency in power oscillator unit.	Phase meter shows phase kicks but receiver will not maintain synchronism.
Maximum correction rate is less than one every three seconds on either add or subtract, or both.	Adjust current generator potentiometers R294, R309.	Phase meter shows phase kicks but receiver will not maintain synchronism.
Discharge circuits defective.	Defective discharge circuits, Q226, Q231. Leaky integration capacitor C220.	Phase meter fails to reach correction point on either add or subtract.
LOCAL-REMOTE switch	Reset LOCAL-REMOTE switch.	No line current on Mux line current meter.
Input line relay, no output.	Input line relay defective. Check Q202, Q208, Q209, Q210. Check slicing level adjustment R217. P1200 removed or loose on rear of receiving group housing. (Auxiliary equipment not plugged in.)	No multiplex output to converters. Mux line signal meter functioning properly.

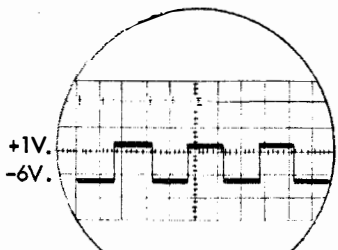
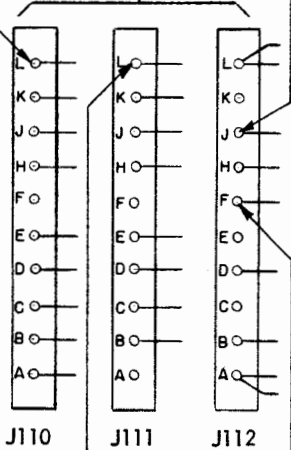
POWER - OSCILLATOR - TMPU 201

MAJOR TEST POINTS



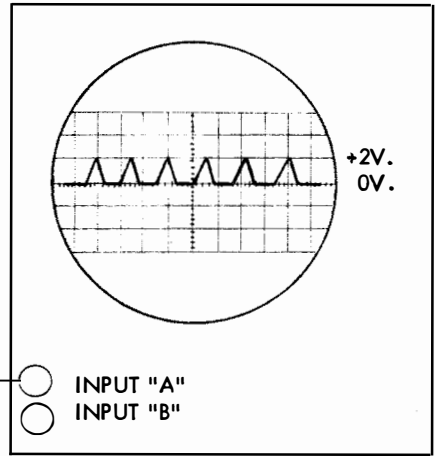
BINARY 2 OF DIVIDER #1
H-10 Milliseconds/CM
V- 5 VOLTS/CM

NOTE 2 - BOTTOM VIEW OF CONNECTORS FOR CIRCUIT BOARDS Z101, Z102-1 AND Z102-2.



BINARY 1 OF DIVIDER #1
H-10 Milliseconds/CM
V-5V/CM

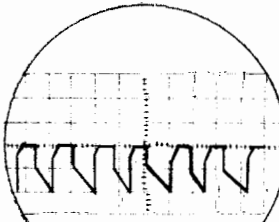
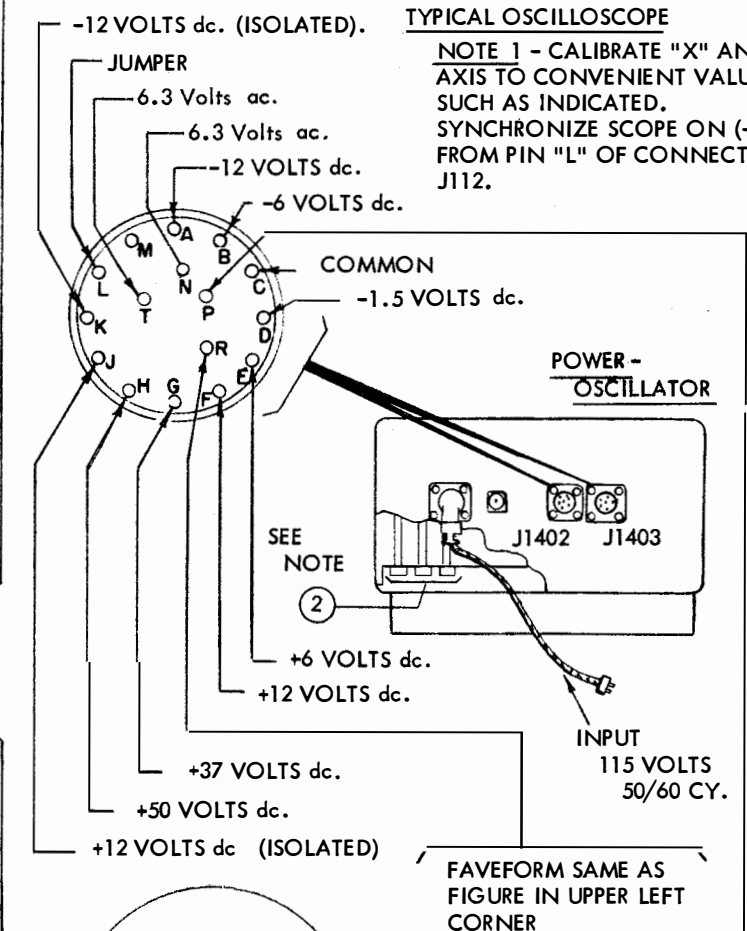
CRYSTAL OSCILLATOR OUTPUT
H-10 Milliseconds/CM
V- 2 VOLTS/CM



INPUT "A"
INPUT "B"

TYPICAL OSCILLOSCOPE

NOTE 1 - CALIBRATE "X" AND "Y" AXIS TO CONVENIENT VALUES SUCH AS INDICATED. SYNCHRONIZE SCOPE ON (-) FROM PIN "L" OF CONNECTOR J112.



CRYSTAL OSCILLATOR AMPLIFIER
H-10 Milliseconds/CM
V- 5 VOLTS/CM

FAVEFORM SAME AS FIGURE IN UPPER LEFT CORNER

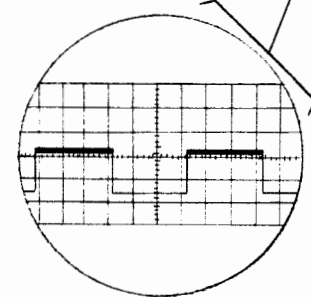


Figure 5-6 Major Test Points - TMPU 201

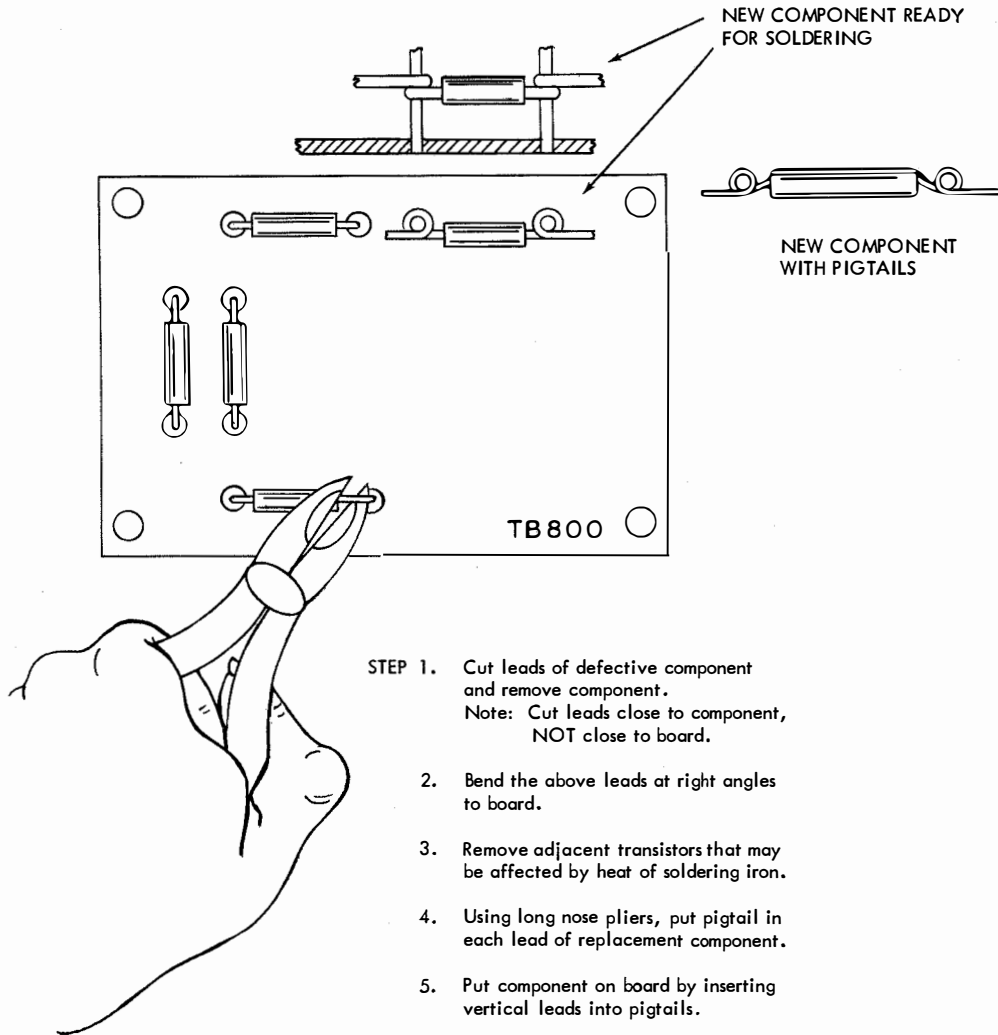
TABLE 5-13. TMPU201 POWER-OSCILLATOR, TYPICAL TROUBLES

TROUBLE	NATURE OF TROUBLE	SYMPTOMS
One or more power supplies defective.	Blown fuse, defective rectifier.	No output voltage recorded by M101 on one or more positions.
No oscillation.	Crystal oscillator defective (Z103, Z104).	No multiplex output.
No output from second binary. Oscillator functioning.	First or second binary defective, Z102.	No multiplex output.
Crystal oven not functioning.	Defective crystal oven.	Receiver cannot maintain synchronism. Crystal indicator lamp fails to cycle.
Crystal oscillator oscillating at incorrect frequency.	Improper oscillator assembly inserted in operating socket. Interchange oscillator assemblies.	Receiver garbles on all channels. Cannot maintain synchronism.
Transmit-receive frequency differential greater than one cycle.	Adjust frequency C120.	Receiver cannot maintain synchronism, synchronizer indicates constant add or subtract correction.

TABLE 5-14. TMN200 NEON LAMP INDICATOR TROUBLE SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1		View "power" neon light	Should be on when AC voltage is applied to Unit.	<p>If light is off, check convenience outlet, and fuse in power supply.</p> <p>If light is on, proceed with step 2.</p>
2		Plug J407 into an operating code converter.	Neon lamps should flash on and off.	<p>If lamps fail to fire, check corresponding transistor and lamp itself or power supply voltages.</p> <p>If lamps fail to extinguish, check corresponding transistor or power supply voltage.</p>

TOOLS REQUIRED:
 DIAGONAL CUTTERS
 LONG NOSE PLIERS
 23-1/2 WATT PENCIL SOLDERING
 IRON



- STEP 1. Cut leads of defective component and remove component.
 Note: Cut leads close to component, NOT close to board.
2. Bend the above leads at right angles to board.
 3. Remove adjacent transistors that may be affected by heat of soldering iron.
 4. Using long nose pliers, put pigtail in each lead of replacement component.
 5. Put component on board by inserting vertical leads into pigtails.
 6. Solder component leads.
- CAUTION**
 Etched circuits and components may be damaged by overheating.
7. Trim excess leads.
 8. Replace transistors removed in Step 3.

Figure 6-1 Procedure For Replacing Components.

SECTION 6

MAINTENANCE

1. INTRODUCTION

1.a. This section presents the procedure for the adjustment and maintenance of the Multiplex Set to insure optimum equipment performance. The adjustments are arranged in the order that should be followed if a complete readjustment of each major unit is undertaken. CAUTION --- Make certain that the nominal voltages are supplied to the transmitter and receiver before attempting a readjustment. Allow time for the oscillator oven to reach a stable temperature.

1.b. The waveforms that are shown in the test illustrate the actual operation of the circuit. Since the calibration of the oscilloscope and the zero axis are given, the actual ON-OFF potentials may be read directly from the waveforms. In general, voltages read in this manner are more reliable than voltages read by a meter on account of the ON-OFF nature of signals being observed. Also, the timing relationships are shown since the sweep trigger is indicated for each waveform.

1.c. New maintenance procedures must be used for electronic equipment using transistors and germanium diodes to perform functions formerly handled by electron tubes. Deterioration of electron tubes is generally recognized as the principal cause of failure in electronic equipment. The high temperature and the high operating potentials (200 to 300 volts) which are characteristic of equipment using electron tubes are contributing factors in failure of circuit components other than tubes. Therefore, periodic maintenance and marginal checking routines are required to detect possible failures in both tubes and other circuit components.

1.d. Transistors are in the same class of reliability as the crystal rectifier. Experience indicates that transistors normally have an indefinite life span when they are hermetically sealed from the effects of moisture and other contamination. Transistorized equipments provide an ideal environment for long service life from all circuit components because no heaters are required and operating potentials are low (6 to 12 volts dc). Therefore, frequent maintenance and marginal checking routines used in equipments with electron tubes are not required when transistors are used in circuits designed with adequate margins.

1.e. A 10,000 hour maintenance interval is suggested. It is recommended that transistors not be removed for testing at this time. Instead, it is recommended the following items be checked and corrective action taken as required.

1.e.(1) Visual Inspection --- Remove any dust accumulation, replace any discolored components or the related faulty component responsible for the discoloration and check lead and cable dressing, paying attention to scuffed or frayed leads.

1.e.(2) Margins --- Check operating margins by varying the input line voltage + 10 per cent. This is accomplished by shifting the position of the Power-Oscillator ac line switch (S102) above and below its nominal setting. In this manner, certain maximum and minimum voltage limits may be established for which traffic can still be handled when the units are in good adjustment. Any marked deviation from the desired range would indicate reduced performance. The marginal method of checking has been instituted to detect imminent failures and to provide a reasonable guarantee that the equipment will continue to operate without error for a long period of time.

1.e.(3) Analysis --- Readjustment of the controls on the unit may be all that is required to improve the voltage range. If normal operation of the unit is impaired or interrupted by a defective part the source of trouble may then be isolated within a particular section of the circuit. Refer to Figure 6-1 for the correct procedure in replacing a defective component.

CAUTION

Do not use excessive heat or hold the soldering iron in contact with the etched circuit board for an extended length of time. Wherever possible, use the long nose pliers as a heat sink between the connection to be soldered and the printed circuit board. A small soldering iron such as the pencil type - 23 1/2 watt is a necessity. The tip of the iron should be cleaned and tinned at regular intervals to insure a good connection. Avoid a cold solder joint.

2. ADJUSTMENTS

2.a. The adjustments are arranged in the

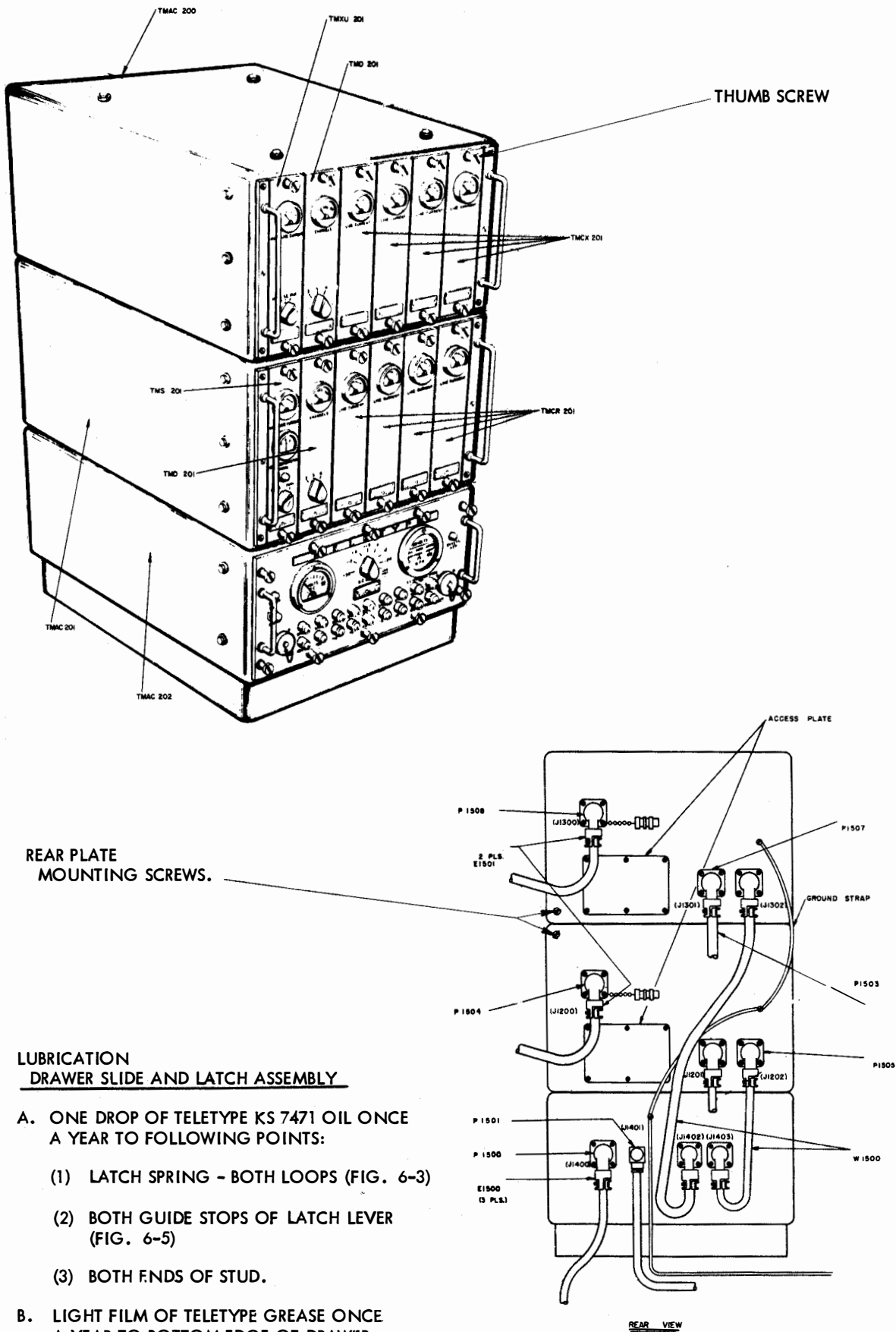


Figure 6-2 Equipment Connectors

order that should be followed if a complete re-adjustment of the Transmitting and Receiving equipment is undertaken. The capital letter that precedes the adjustment indicates the sequence to be followed on a particular page. Test equipment listed in Table 5 is not furnished with the Multiplex Set; however, the table will serve as a guide in the selection of the test equipment that may be at hand. It should be noted that a high quality oscilloscope - stable and with high gain - is necessary to observe the small changes in the wave pattern. The conventional tools (screwdrivers, pliers, and wrenches) such as listed in Teletype Bulletin 1124B should enable the technician to disassemble and reassemble the unit.

2.b. The respective waveforms which appear opposite the test points are representative of the patterns which may be obtained on an electronic oscilloscope (not furnished) such as the Tecktronic Type 531 or equivalent. The variations of the test equipment used and the positioning of the oscilloscope controls (calibration) may result in variations of the pattern shown. However, certain characteristics of the waveforms are to be observed and positioned with respect to the reference points that are noted. It will be necessary to calibrate the oscilloscope with a known external voltage if a calibration feature is not incorporated in the oscilloscope used. Select a convenient amplitude for the time and voltage coordinates that will enable the associated scale to be readily interpreted. Reference to the left, right, bottom, front or rear applies to the major units as viewed from the front or operator's position.

2.c. Prior to any adjustment, all voltages supplied by the power-oscillator should be set at their nominal value with the load connected. In general, the variable resistors (except the line current adjust) located in each drawer should be positioned at the mid-point of their range at the start of a complete readjustment operation. Refer to Table 3-1 for normal positions of the operation controls.

3. DISASSEMBLY AND REASSEMBLY

3.a. **GENERAL** --- The cabinet, drawers and connecting cables are arranged to permit rapid access to the internal controls and circuit boards of each drawer. With the upper and lower thumbscrews loosened, each drawer may be pulled forward approximately 4 inches to gain access to the controls at the front of each drawer. When it is desired to inspect the complete circuit board, the drawer may be pulled farther toward the front until the latch engages its stop. Note the moisture seals (gaskets) located between each drawer front panel and the cabinet. The same arrangement is used to seal the rear pan-

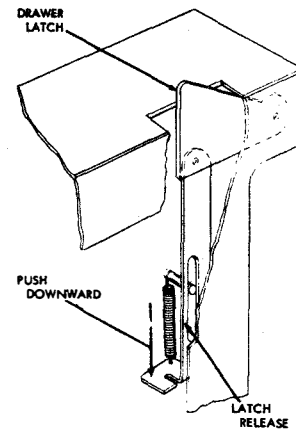


Figure 6-3 Drawer Latch

els of each cabinet. **CAUTION** --- Exercise care in removing the drawers and panels so as not to damage the gaskets.

3.b. REMOVING DRAWERS FROM CABINETS

3.b.(1) Loosen the upper and lower thumbscrews that secure the drawer to the cabinet. Rotate the thumbscrews counter-clockwise until they are disengaged.

3.b.(2) Using the thumbscrews as handles, pull the drawer forward until it engages its latch.

3.b.(3) Depress the latch located at the rear, just under the top of the drawer (See Figure 6-3) and pull the drawer out as far as the cable will permit.

3.b.(4) Tilt the front of the drawer downward to permit access to the rear of the drawer. Release the quarter-turn fastener at the rear of

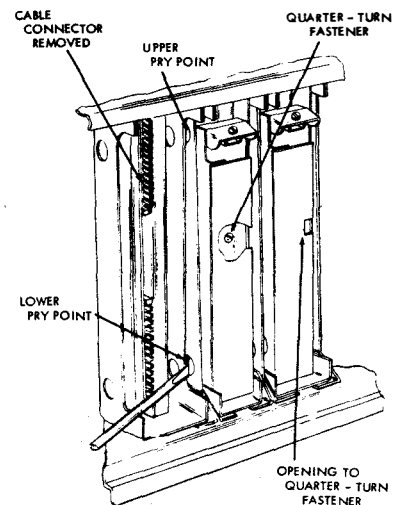


Figure 6-4 Cable Connector Assembly

the drawer with a screwdriver, and work the rear connector assembly free of the drawer.

3.c. INSTALLING DRAWER

3.c.(1) Align rear connector assembly with the rear end of the drawer, and press mating connectors together.

3.c.(2) Turn quarter-turn fastener with a screwdriver to lock assembly in place.

NOTE: Manually squeeze mating connectors together to assure good contact.

3.c.(3) Align the drawer and slide it into its slot.

3.c.(4) Align thumbscrews and tighten them by turning in a clockwise direction until they are secure.

3.d. REMOVING POWER SUPPLY FROM CABINET

3.d.(1) Loosen the 10 thumbscrews on the front panel, slide drawer forward until all 10 thumbscrews are disengaged.

3.d.(2) Slide chassis drawer forward several inches. Reach into the cabinet at the upper left area and release latch shown in Fig. 6-5.

3.d.(3) Pull drawer forward until most of the chassis is out of the cabinet. Be careful not to drop the unit.

3.d.(4) Disconnect the "AN" type connectors located at the rear of the power supply chassis.

3.d.(5) Remove the power supply.

3.e. To install, reverse the above procedure:

3.e.(1) Install drawer so that one or two inches of the drawer extend into the cabinet.

3.e.(2) Connect AN type connectors and slide drawer inward.

3.e.(3) Line up the 10 thumbscrews, start the screws slowly and tighten them securely.

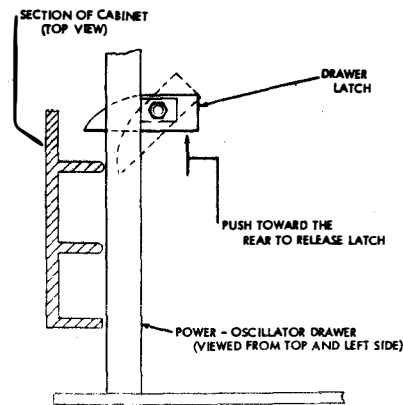


Figure 6-5 Power-Oscillator Drawer Latch

3.f. REMOVING BACKS FROM CABINETS (Transmitting and Receiving Only)

3.f.(1) Remove the 22 screws which secure the back panel to the cabinet.

3.f.(2) Remove the back panel from the cabinet. The panel will now be held only by the cables. If it is desired to remove the back panel completely, loosen the quarter-turn fastener on each drawer and gently separate the connectors.

3.f.(3) Disconnect ground strap from the panel. The method of replacement is the reverse of the above. However, it is important to press the connectors together firmly before tightening the quarter-turn fasteners, and again, after tightening, to assure circuit continuity.

3.g. REMOVING BACK FROM POWER SUPPLY CABINET

3.g.(1) Remove the 12 machine screws which fasten the back to the cabinet.

3.g.(2) Separate the back from the cabinet.

3.g.(3) Disconnect the AN type connectors.

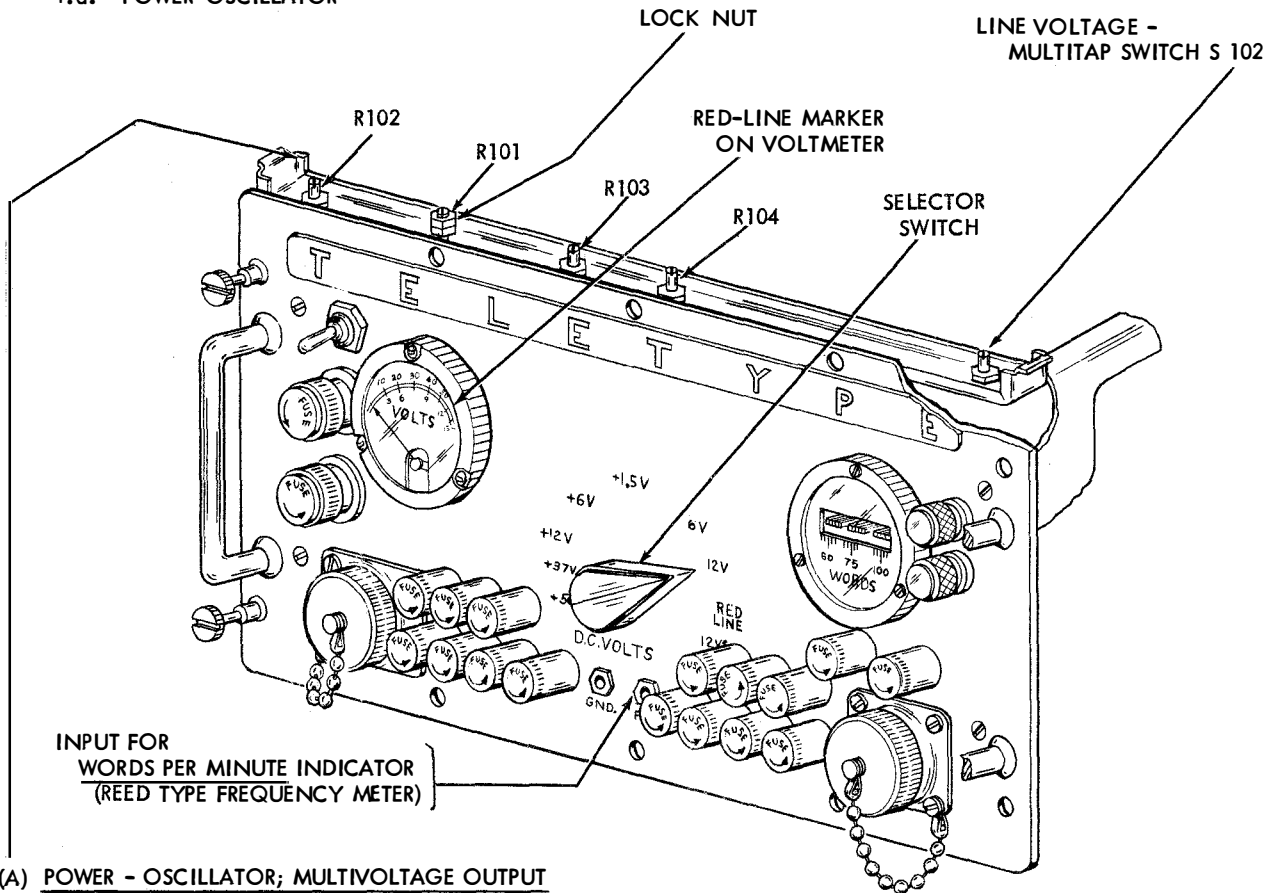
3.g.(4) Disconnect the ground strap from the back.

3.g.(5) Remove the back.

3.g.(6) The method of replacement is the reverse of the disassembly procedure described above.

4. SPECIFIC ADJUSTMENTS

4.a. POWER-OSCILLATOR



(A) POWER - OSCILLATOR; MULTIVOLTAGE OUTPUT REQUIREMENTS --- (REFER TO NOTES 1 & 2; CHECK REQUIREMENT 1 PRIOR TO ADJUSTING 2, 3, 4 & 5)

1. WITH SELECTOR SWITCH MOVED TO POSITION MARKED "RED LINE", VOLTMETER NEEDLE SHOULD NOT DEVIATE FROM THE SCRIBED RED LINE BY MORE THAN \pm VOLT. TO ADJUST --- POSITION TAP SWITCH S101 ONE STEP AT A TIME. (RE-FRAME RECEIVING GROUP).
2. R101 --- WITH SELECTOR SWITCH MOVED TO POSITION MARKED " + 37 VOLTS"
MIN. + 35 VOLTS _____ MAX. + 39 VOLTS.
TO ADJUST --- WITH ITS LOCK NUT LOOSENED, POSITION CONTROL SHAFT OF "R101".
3. R102 --- WITH SELECTOR SWITCH MOVED TO POSITION MARKED " + 12 VOLTS"
MIN. + 11.8 VOLTS _____ MAX. + 12.2 VOLTS.
TO ADJUST --- WITH ITS LOCK NUT LOOSENED, POSITION CONTROL SHAFT OF "R102".
4. R103 --- WITH SELECTOR SWITCH MOVED TO POSITION MARKED " + 6 VOLTS"
MIN. + 5.8 VOLTS _____ MAX. + 6.2 VOLTS.
TO ADJUST --- WITH ITS LOCK NUT LOOSENED, POSITION CONTROL SHAFT OF "R103".
5. R104 --- WITH SELECTOR SWITCH MOVED TO POSITION MARKED " -6 VOLTS"
MIN. -5.8 VOLTS _____ MAX. -6.2 VOLTS.
TO ADJUST --- WITH ITS LOCK NUT LOOSENED, POSITION CONTROL SHAFT OF "R104" TOWARD THE RIGHT OR LEFT.

NOTE 1 -- SWITCH S102 WILL NOT REQUIRE FREQUENT ADJUSTMENT. INITIAL ADJUSTMENT SHOULD BE MADE AT TIME OF INSTALLATION AND CHECKED AT DIFFERENT TIMES OF THE DAY FOR SEVERAL WEEKS. THE PURPOSE OF THE ADJUSTMENT IS TO SET POWER SUPPLY OUTPUT VOLTAGES SO THAT THEY WILL APPROXIMATE THEIR NOMINAL VALUES AT ALL TIMES.

NOTE 2 -- UNDER NORMAL OPERATING CONDITIONS, THE POWER LINE FLUCTUATIONS WILL BE MORE OR LESS PREDICTABLE. ADJUSTMENT SHOULD BE MADE WHEN LINE VOLTAGE IS KNOWN TO BE AT ITS MEAN VALUE. ONCE MADE, IT IS NOT NECESSARY TO REFINED THE ADJUSTMENT UNLESS IT IS NOTED THAT OUTPUT VOLTAGES DEVIATE MORE THAN 2% FROM THEIR NOMINAL VALUES A MAJOR PART OF THE TIME. THE MULTIPLEX GROUPS WILL OPERATE SATISFACTORILY WITH LINE VOLTAGE VARIATIONS OF \pm 10%.

Figure 6-6 Power Supply, Voltage Requirements

CAUTION --- DO NOT DISTURB OSCILLATOR FREQUENCY ADJUSTMENT UNLESS Z103 OR Z104 ARE INTERCHANGED OR OSCILLATOR IS KNOWN TO HAVE DEVIATED FROM ASSIGNED FREQUENCY.

NOTE 1. --- TERMINALS (1) AND (2) SHOULD BE STRAPPED UNLESS AN EXTERNAL OSCILLATOR IS TO BE USED IN PLACE OF Z103 OR Z104. THEN STRAP 2 & 3.

(A) CRYSTAL OSCILLATOR

PRELIMINARY --- MAKE SURE THAT CORRECT OSCILLATOR IS IN SOCKET J113. PLACE POWER SWITCH S101 IN ITS ON POSITION AND ALLOW (APPROX.) 10 MINUTES FOR CRYSTAL OVEN TO WARM-UP. AMBER LAMP SHOULD GLOW STEADILY AND THEN FLASH ON AND OFF AT REGULAR INTERVALS.

REQUIREMENTS ---

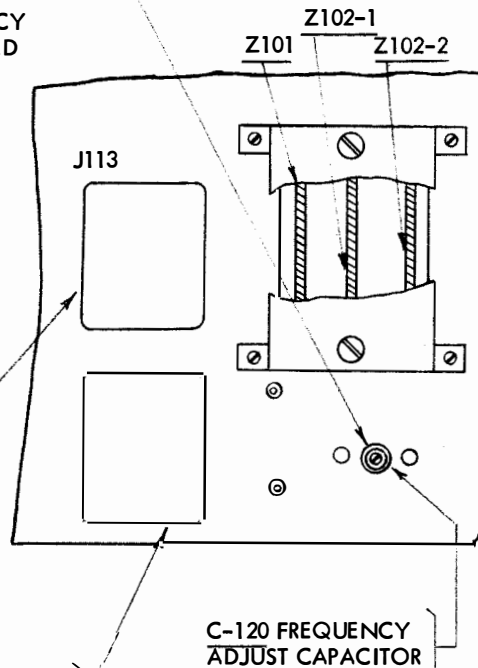
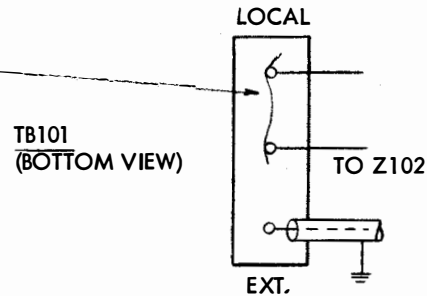
1. Z103 SHOULD HAVE A NOMINAL FREQUENCY OF 63.000 KILDCYCLES. (OUTPUT OBTAINED AT PIN "F" J113.
2. Z104 SHOULD HAVE A NOMINAL FREQUENCY OF 61.63043 KILOCYCLES. (Z103 REMOVED AND Z104 INSTALLED)

TO ADJUST --- WITH (FREQUENCY ADJUST) CAPACITOR LOCK NUT LOOSENED, POSITION CAPACITOR (C120) CONTROL SHAFT SLOWLY TO WARD THE RIGHT OR LEFT. (REFER TO NOTE 2 AND 3.)

Z103 { 60 W.P.M.
75 W.P.M.
OR
Z104 { 100 W.P.M.

ALTERNATE OSCILLATOR HELD IN RESERVE FOR CHANGE IN SPEED. (NOT CONNECTED).

C-120 FREQUENCY ADJUST CAPACITOR



TERMINAL ALIGNMENT

NOTE 2 --- For mutual compatibility of all stations in a system, one transmitting group should be designated as the master group. The frequency of the master group should be calibrated by means of a primary standard. If a primary standard is not available, a secondary standard can be used provided it is calibrated (just prior to adjustment) against a signal transmitted from radio station WWV.

NOTE 3 --- After oscillator of master group is calibrated, frequency of distant terminal crystal oscillator should be adjusted while receiving a multiplex signal. Procedure --- Observe excursion of needle on phase

meter M201 of synchronizer. If needle moves to the slow side, receiving oscillator is oscillating at a frequency which is lower than transmitting terminal and C120 should be adjusted so as to increase oscillating frequency slightly. If the indication is toward fast side, the opposite condition is true, and crystal oscillator frequency should be decreased by adjusting C120 in opposite direction. As frequency of distant crystal oscillator becomes more nearly equal to the transmitting frequency, the longer will be the interval before it can be determined what the new relationship is between distant and master station.

Figure 6-7 Crystal Oscillator,

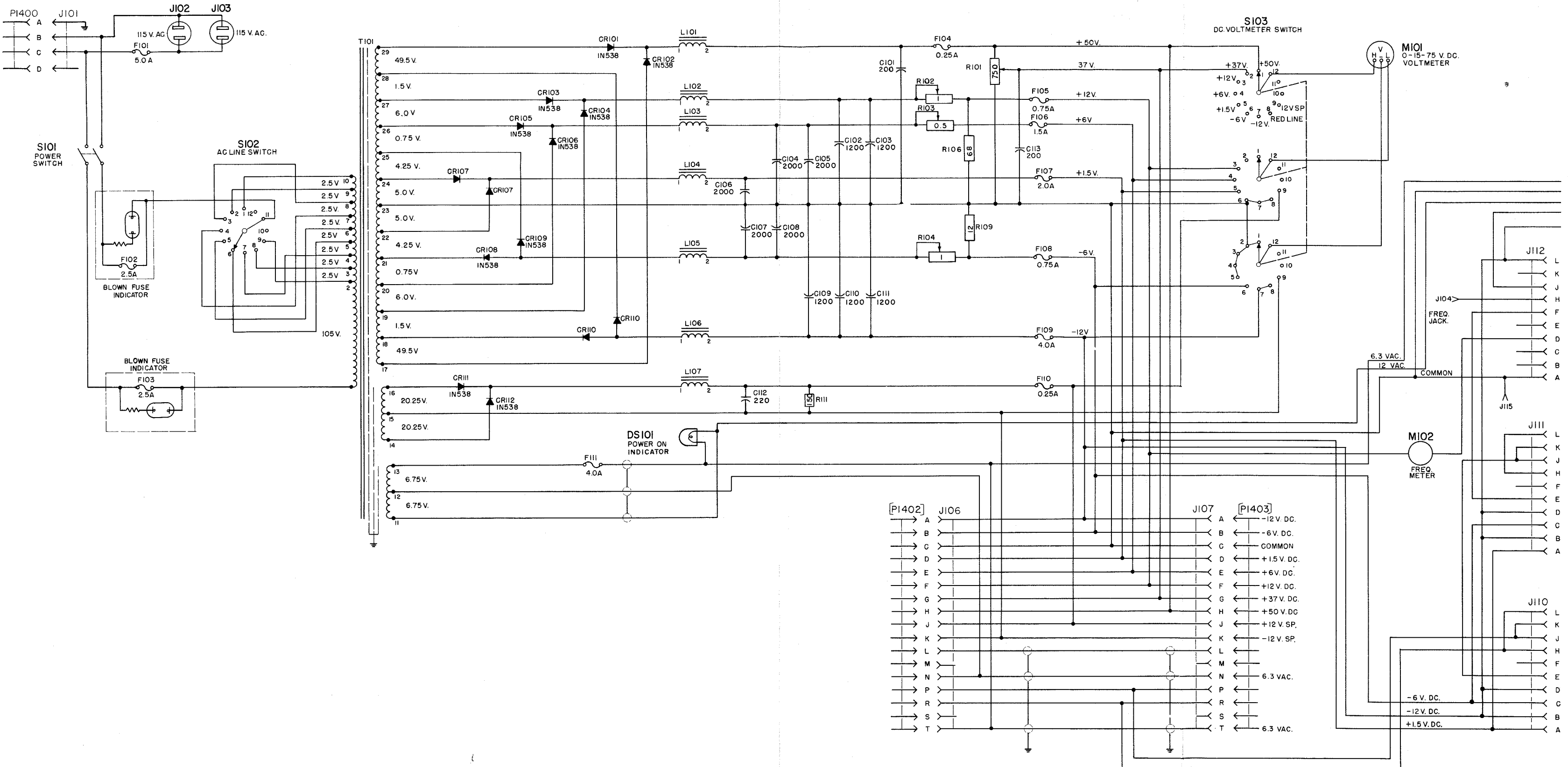
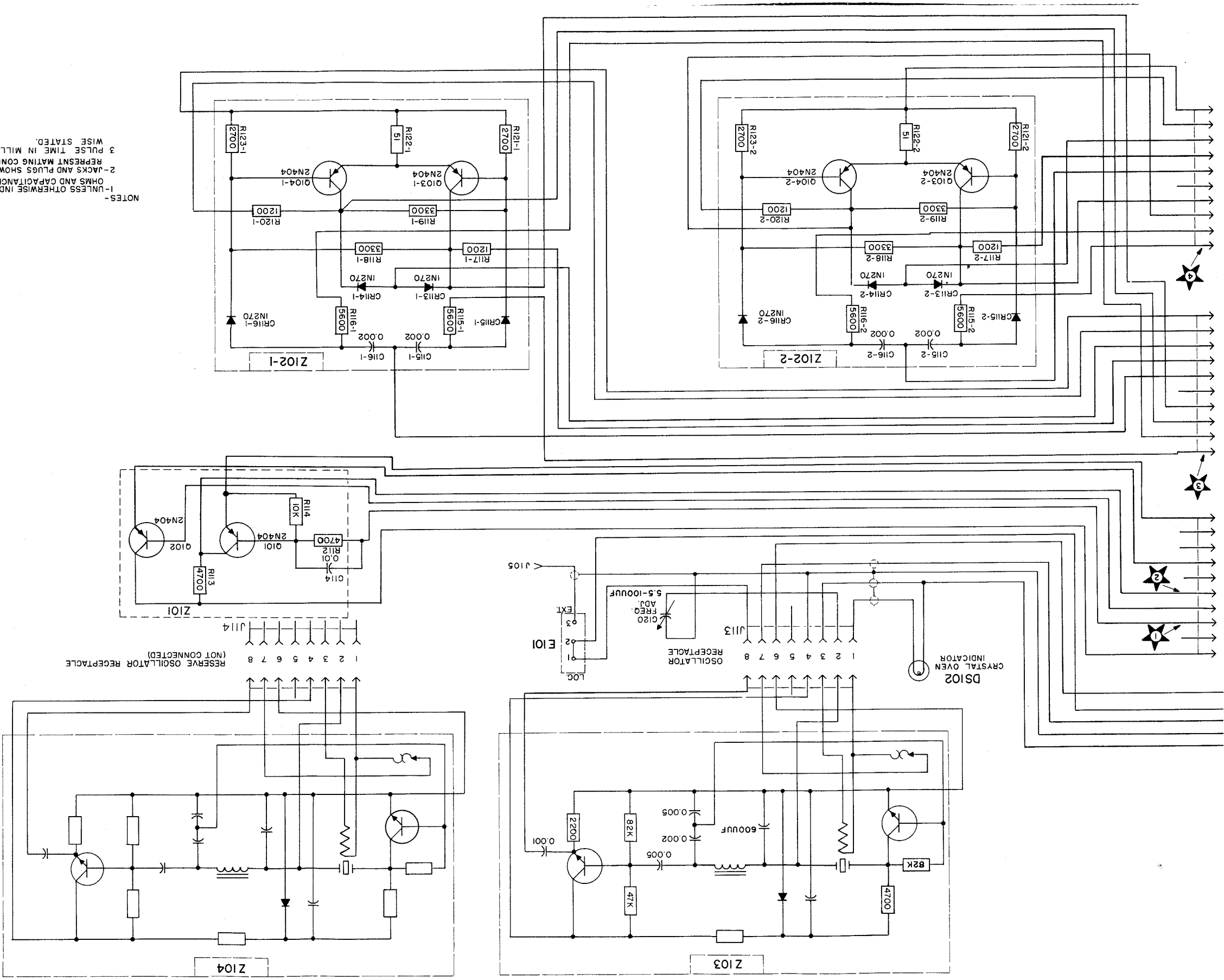


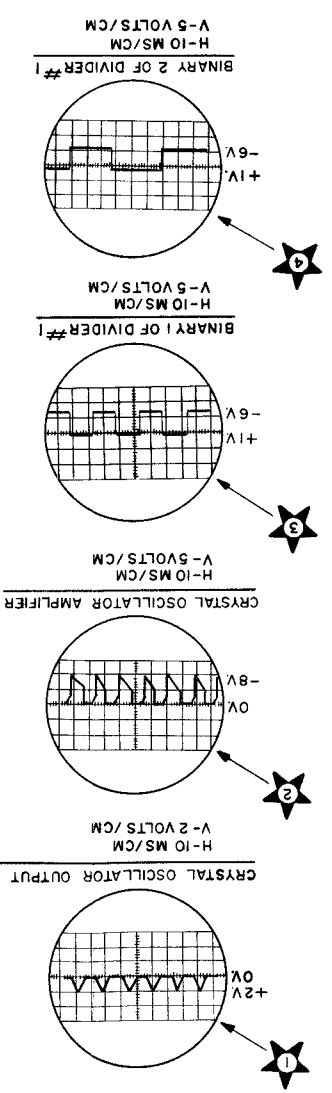
Figure 6-8 Schematic Wiring Diagram Power (Supply) Oscillator TMPU 201

Figure 6-8 Schematic Wiring Diagram Power (Supply) Oscillator MPU 201



NOTES-

- 1- UNLESS OTHERWISE INDICATED, RESISTANCE VALUE ARE IN OHMS AND CAPACITANCE VALUES ARE IN MICROFARADS (UF).
- 2- JACKS AND PLUGS SHOWN IN PARENTHESIS [P1402], J106, ETC. REPRESENT MATING CONNECTORS.
- 3 PULSE TIME IN MILLISECONDS (MS) UNLESS OTHERWISE STATED.



NOTES:
 1. WIRING LEGEND
 DISTANT TERMINATING AREA
 DISTANT TERMINAL DESIGNATION
 WIRE COLOR CODE
 4-R-G

2. COLOR CODE
 BK BLACK
 BL BLUE
 BR BROWN
 G GREEN
 O ORANGE
 P PURPLE
 R RED
 S SLATE
 W WHITE
 Y YELLOW

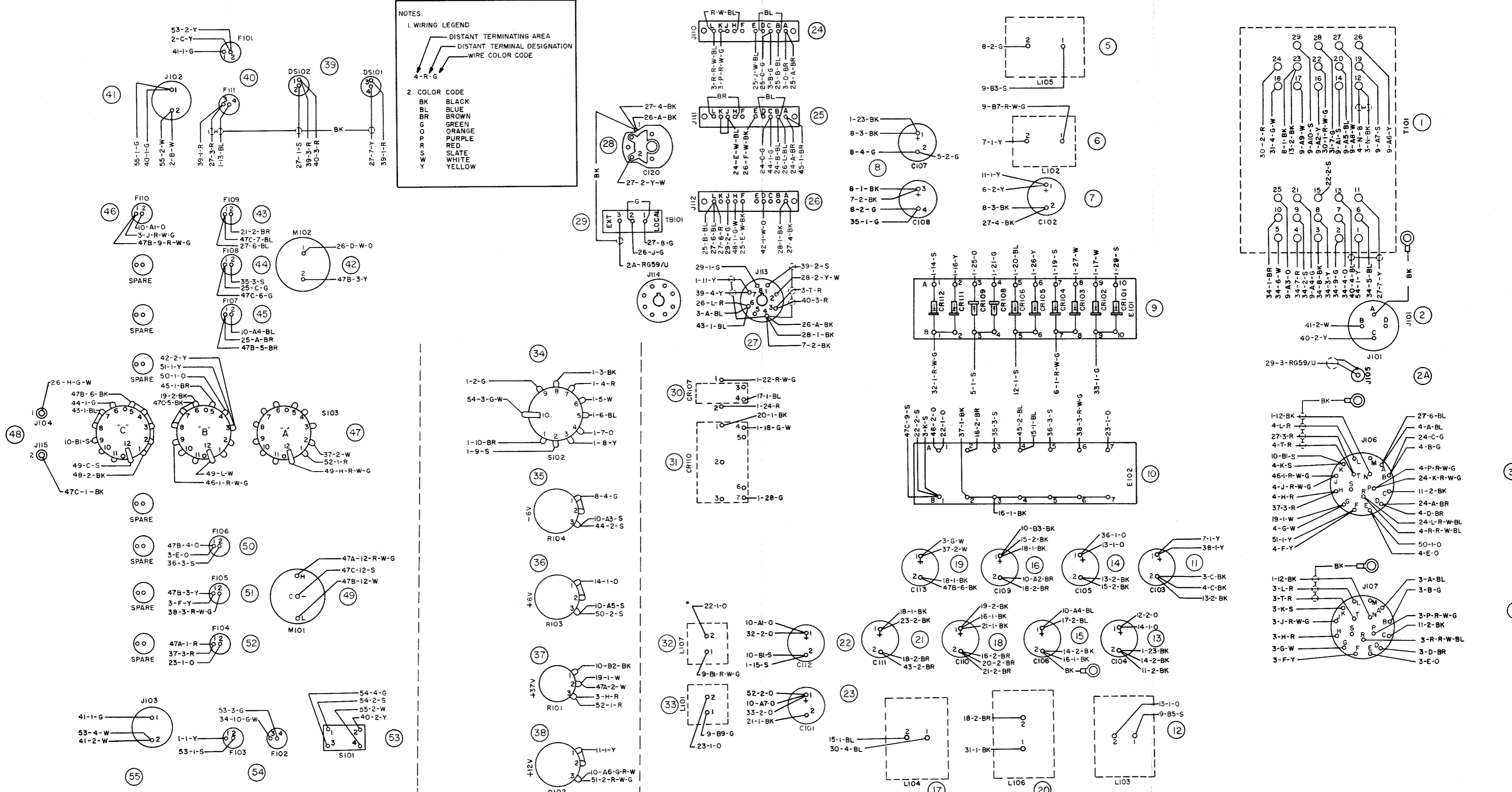


Figure 6-9 Actual Wiring Diagram Power (Supply) - Oscillator TMPU 201

NO.	NOTES																								
1.	ALL WIRES #18 GAUGE EXCEPT THOSE MARKED WITH AN ASTERISK WHICH ARE #22 GAUGE.																								
2.	WIRING LEGEND: A-K-W																								
3.	COLOR CODE: <table border="0"> <tr> <td>BK</td> <td>BLACK</td> <td>R</td> <td>RED</td> </tr> <tr> <td>BL</td> <td>BLUE</td> <td>S</td> <td>SLATE</td> </tr> <tr> <td>BR</td> <td>BROWN</td> <td>Y</td> <td>YELLOW</td> </tr> <tr> <td>G</td> <td>GREEN</td> <td>W</td> <td>WHITE</td> </tr> <tr> <td>O</td> <td>ORANGE</td> <td>V</td> <td>VIOLET</td> </tr> <tr> <td>P</td> <td>PURPLE</td> <td></td> <td></td> </tr> </table>	BK	BLACK	R	RED	BL	BLUE	S	SLATE	BR	BROWN	Y	YELLOW	G	GREEN	W	WHITE	O	ORANGE	V	VIOLET	P	PURPLE		
BK	BLACK	R	RED																						
BL	BLUE	S	SLATE																						
BR	BROWN	Y	YELLOW																						
G	GREEN	W	WHITE																						
O	ORANGE	V	VIOLET																						
P	PURPLE																								
4.	SPARE LEAD-TAPE OTHER END.																								
5.	GROUND STRAP CABLE TO BE CONNECTED TO BOTTOM SIDE OF CABINET.																								

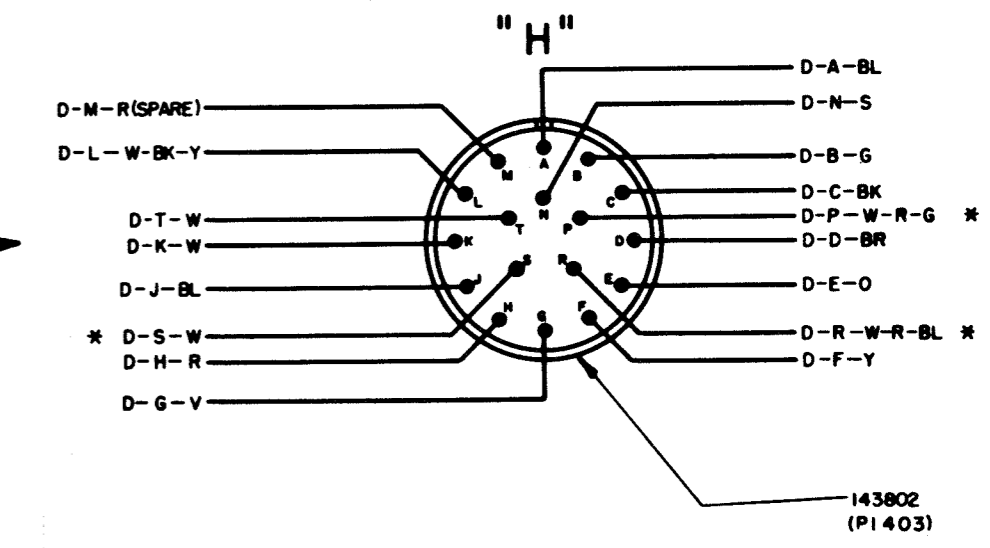
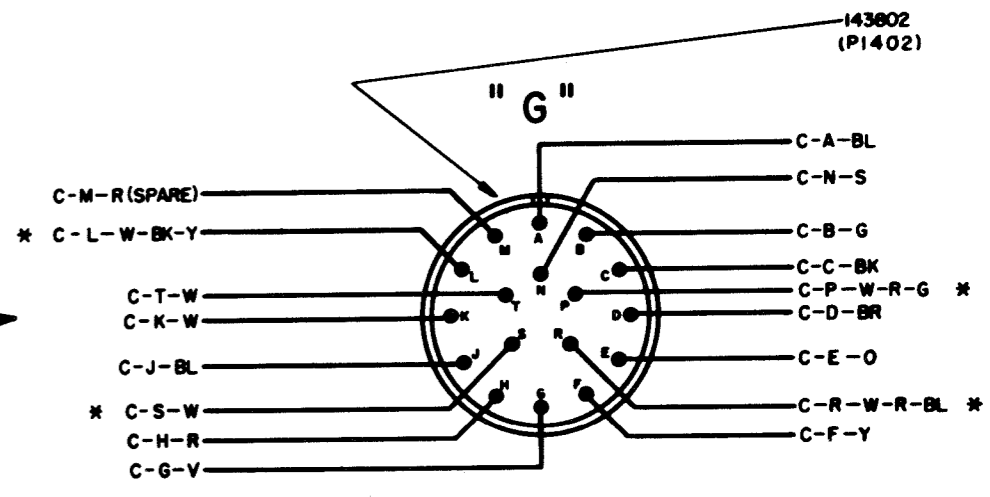
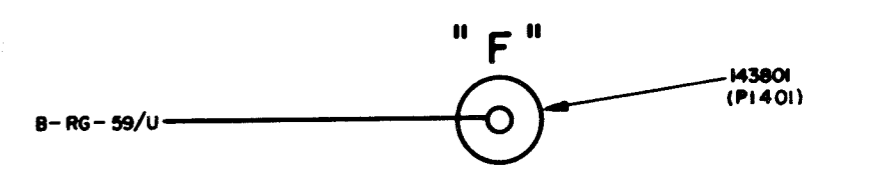
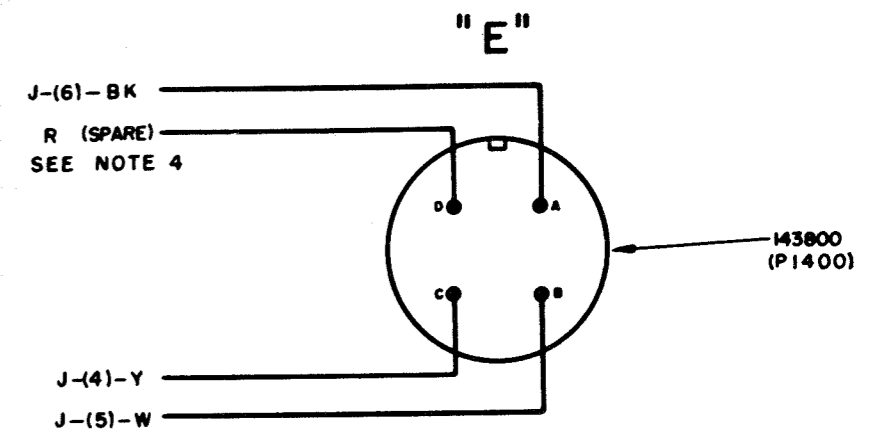
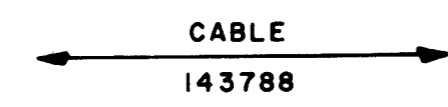
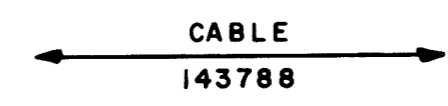
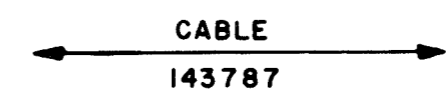
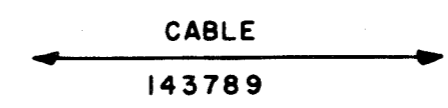
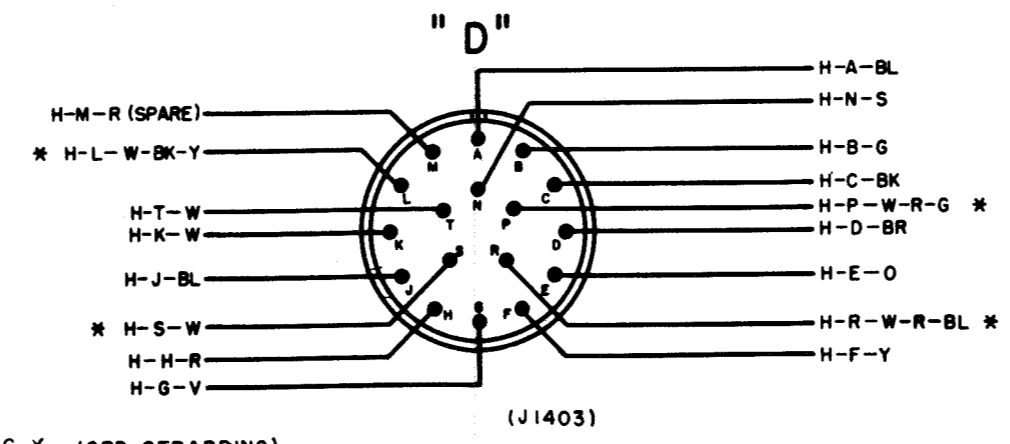
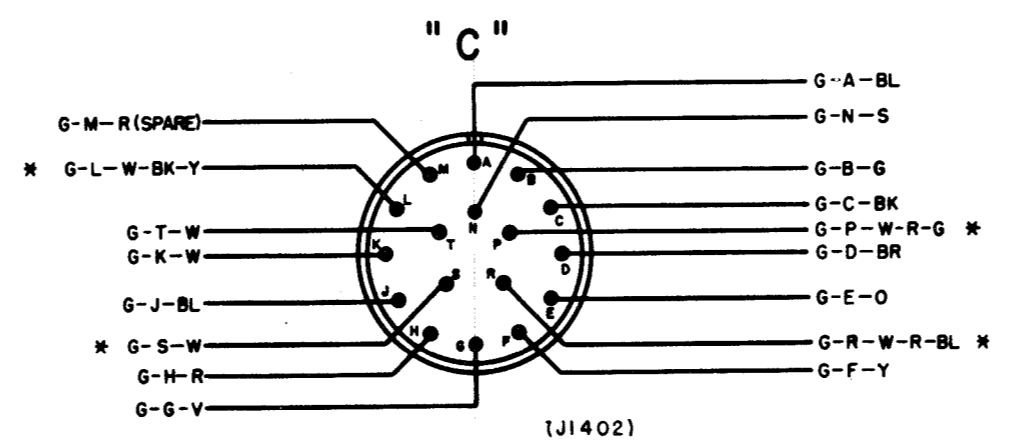
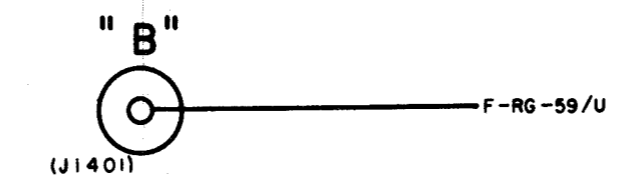
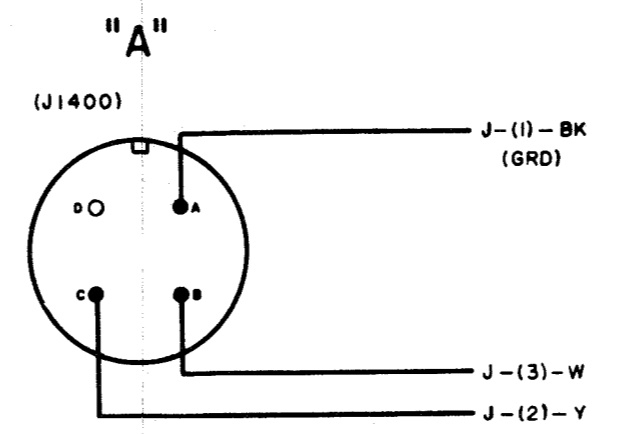
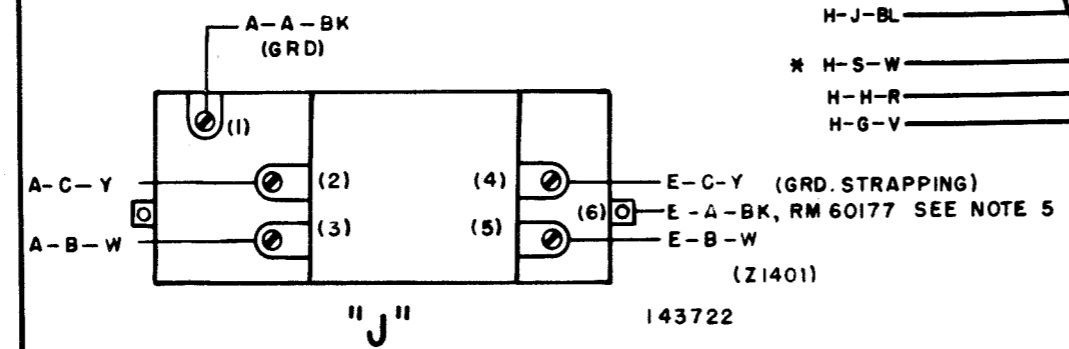
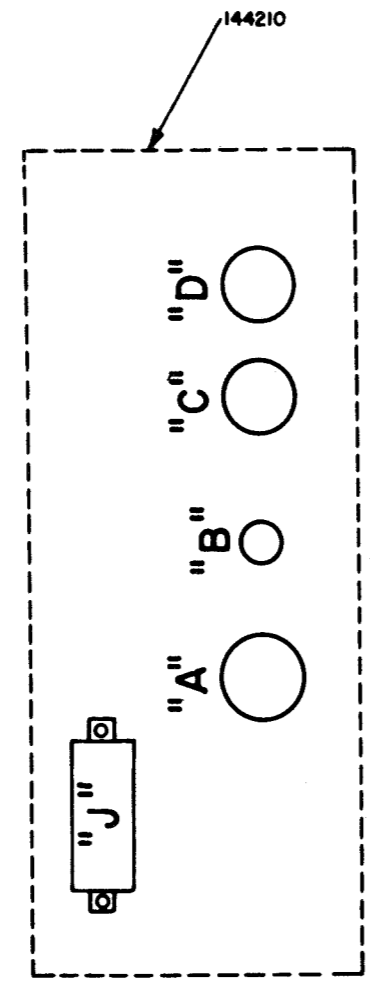


Figure 6-10 Cable Assembly Power Supply TMPU 201 To Cabinet TMAC 202

4.b. TRANSMITTING CODE CONVERTER

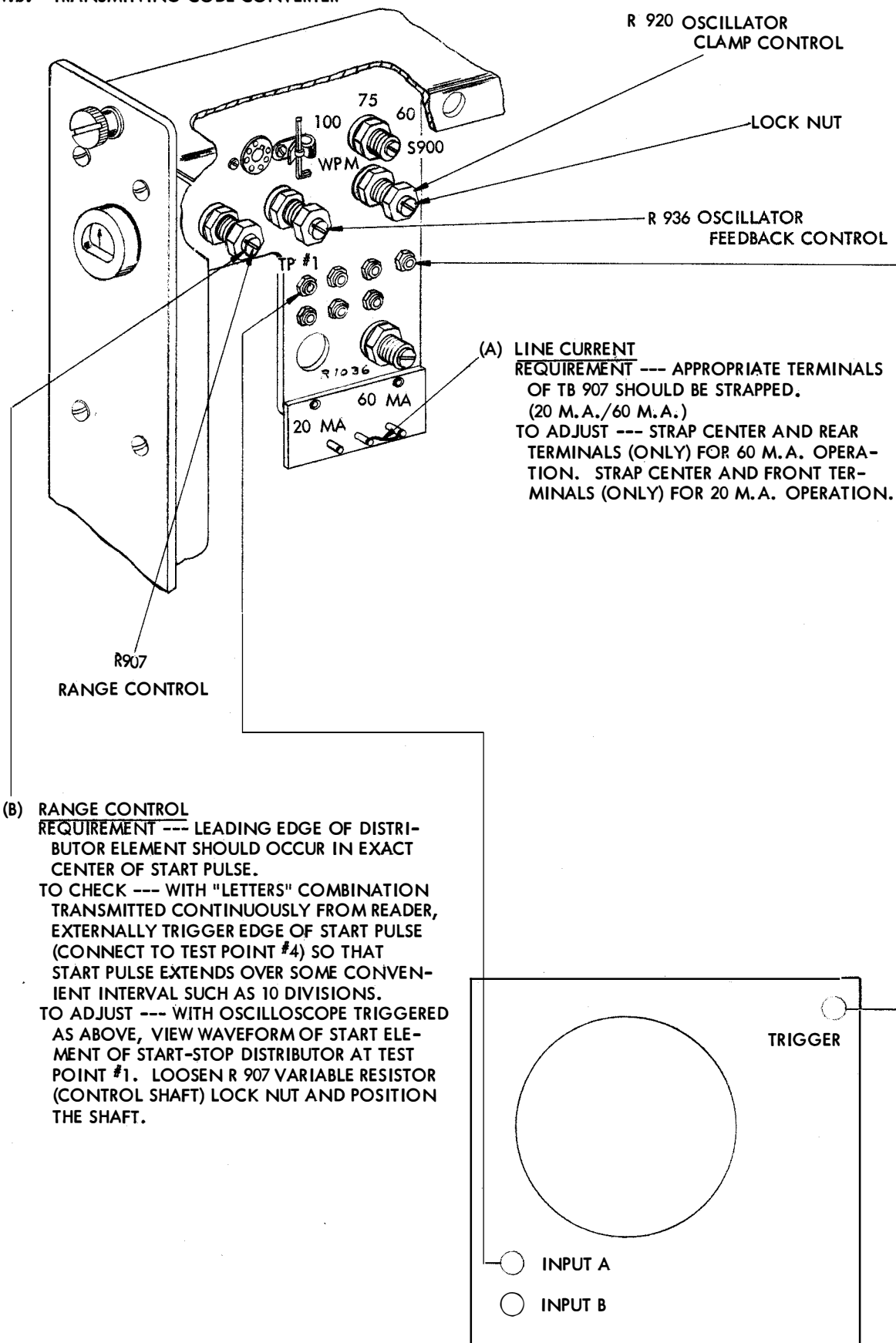


Figure 6-11 Oscillator Adjustment

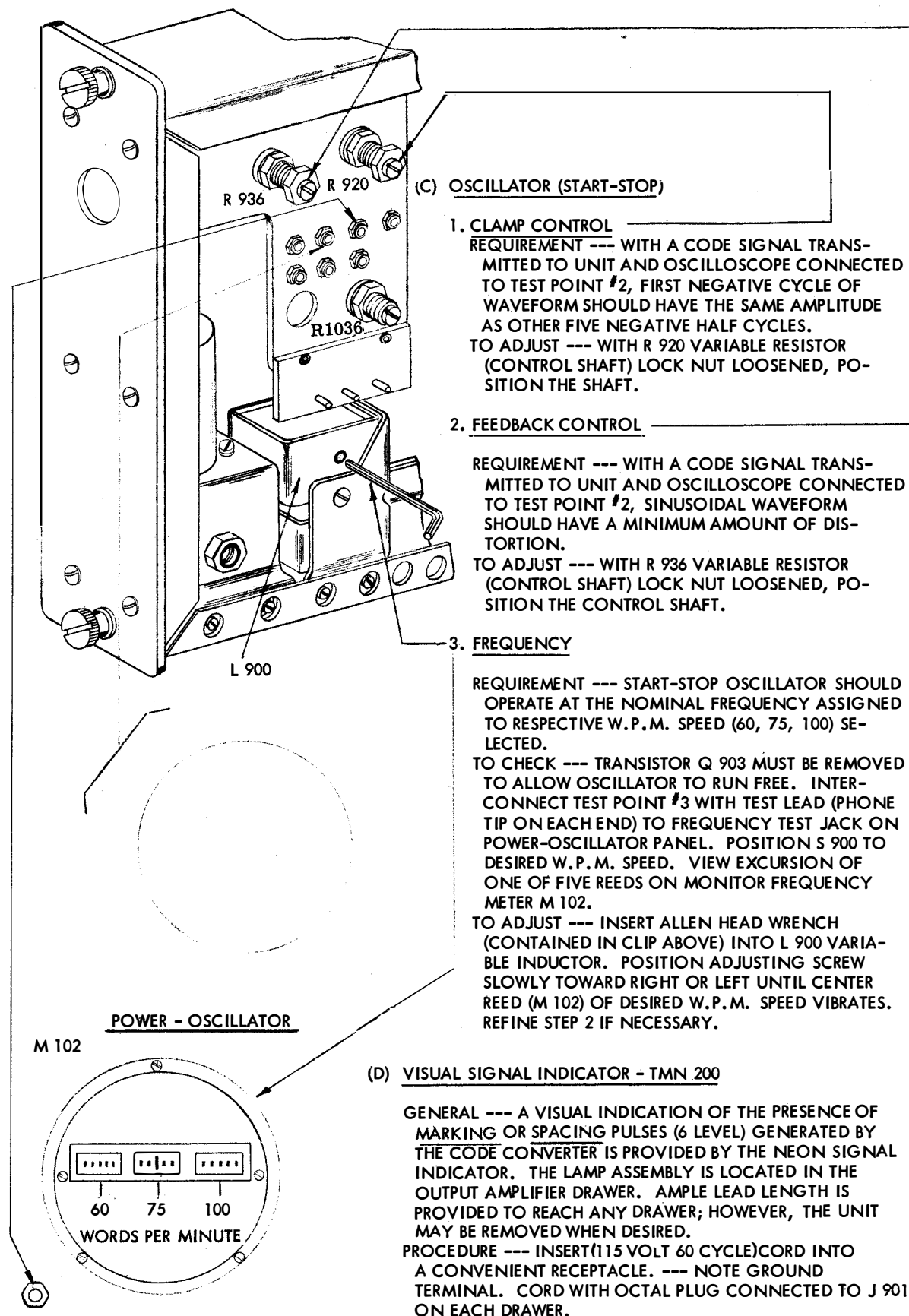


Figure 6-12 Oscillator Frequency

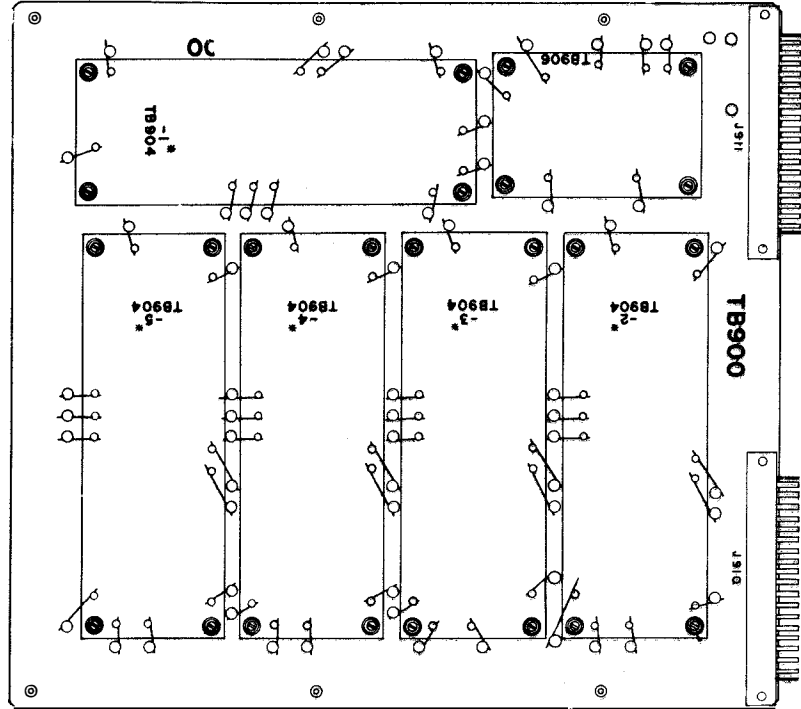
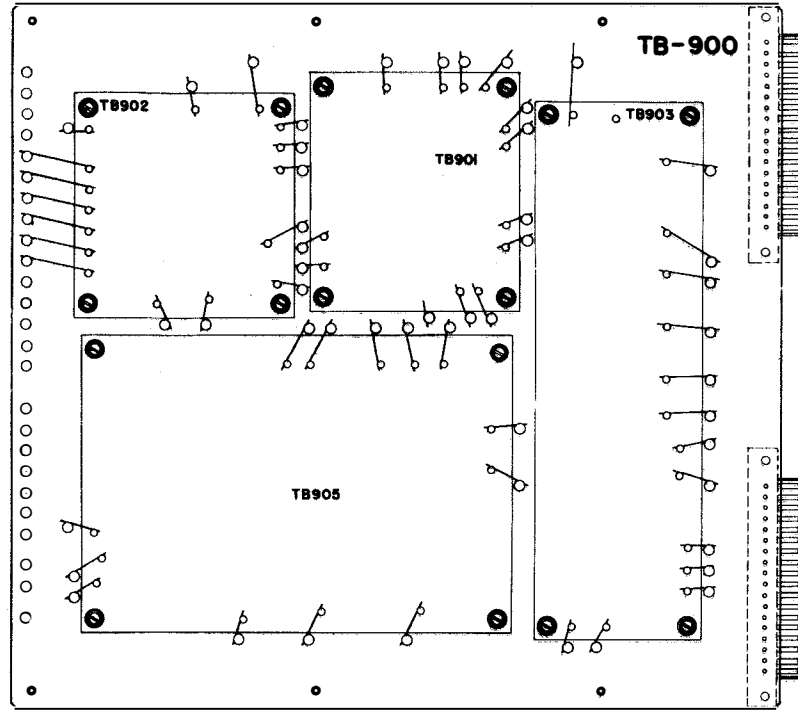


Figure 6-13 Circuit Board - TB 900

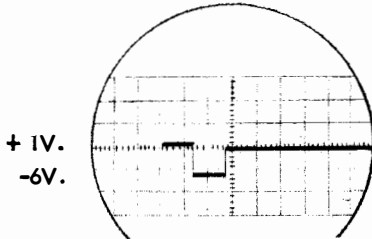
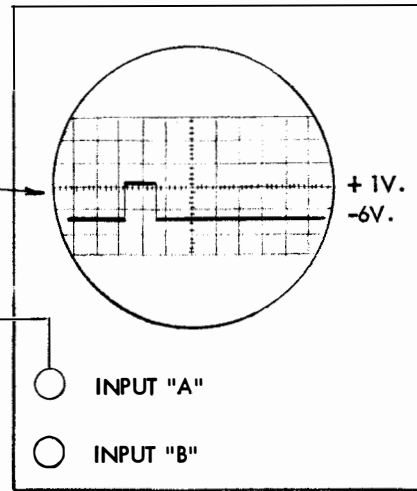
TRANSMITTING CODE CONVERTER

MINOR TEST POINTS

TP. (A) RANGE CONTROL
(OPTIMUM SETTING)

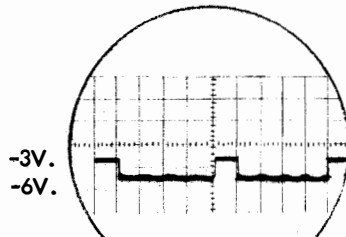
H - 5 Milliseconds / CM
V - 5 Volts / CM

CONNECT TO TEST POINT (A) SHOWN ON PAGE 6-17



TP. (B) START CONTROL
GATE (OPTIMUM SETTING)

H - 5 Milliseconds / CM
V - 5 Volts / CM

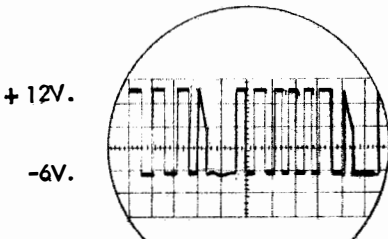
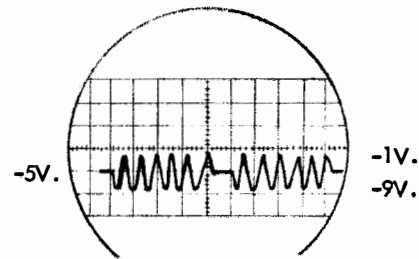


TYPICAL OSCILLOSCOPE

NOTE 1. CALIBRATE "X" AND "Y" AXIS TO CONVENIENT VALUES SUCH AS INDICATED. SYNCHRONIZE SCOPE ON (-) TP 4

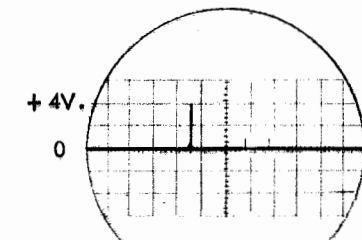
TP. (C) "AND" GATE
S.S. OSC. CONTROL AMP.

H - 20 Milliseconds / CM
V - 5 Volts / CM



TP (E) SQUARING AMPLIFIER

H - 20 Milliseconds / CM
V - 5 Volts / CM

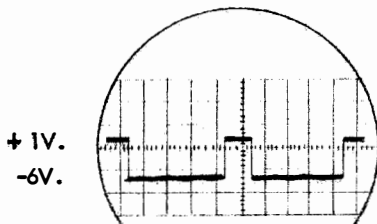


TP (F) NEGATIVE CLAMP

H - 2 Milliseconds / CM
V - 2 Volts / CM

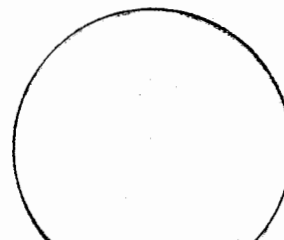
TP. (D) START-STOP OSCILLATOR

H - 20 Milliseconds / CM
V - 5 Volts / CM



TP. (H) START-STOP DISTRIBUTOR START ELEMENT

H - 20 Milliseconds / CM
V - 5 Volts / CM



TP. (G) DRIVE AMPLIFIER

H - 20 Milliseconds / CM
V - 5 Volts / CM

Figure 6-14 Wave-forms, Transmitting Code Converter

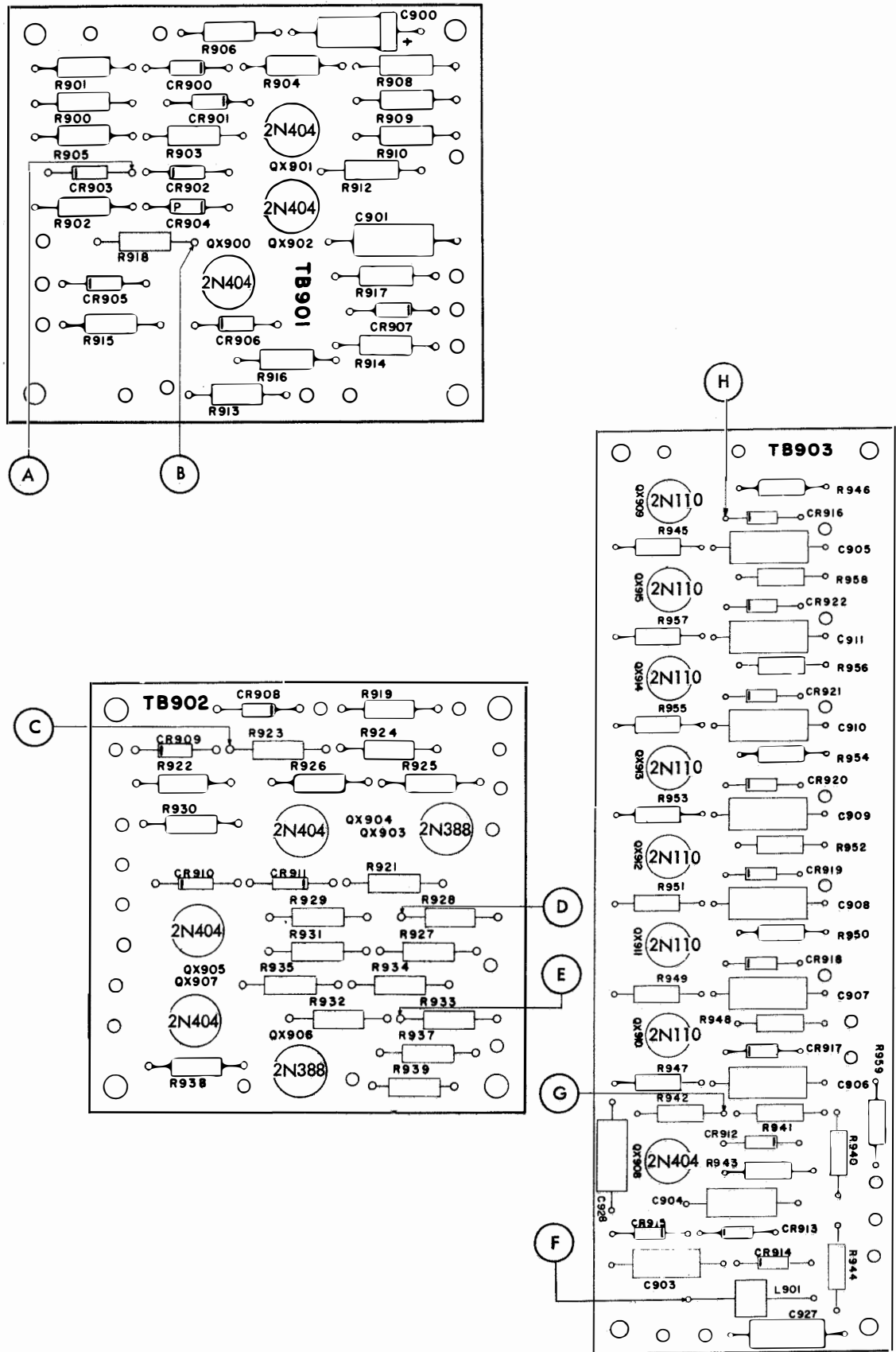


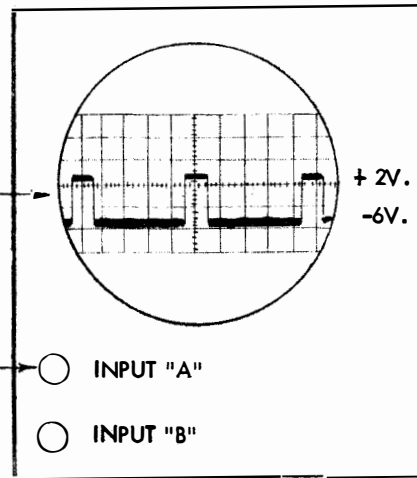
Figure 6-15 Circuit Boards - TB 901, TB 902 & TB 903

TRANSMITTING CODE CONVERTER - TMCX 201

MINOR TEST POINTS

TP. (I) 1ST LEVEL RELEASE

H - 20 Milliseconds / CM
V - 5 Volts / CM

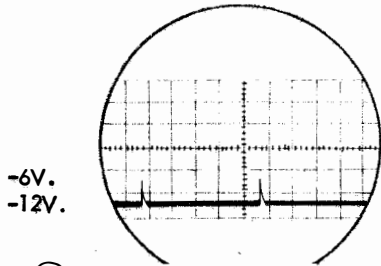


CONNECT TO TEST POINT (I) SHOWN ON PAGE 6-19

INPUT "A"

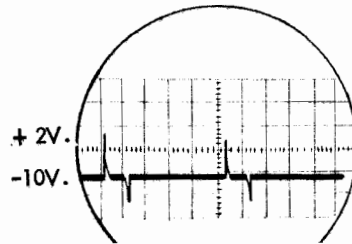
INPUT "B"

TYPICAL OSCILLOSCOPE NOTE 1 - CALIBRATE "X" AND "Y" AXIS TO CONVENIENT VALUES SUCH AS INDICATED. SYNCHRONIZE SCOPE ON (-) TP 4



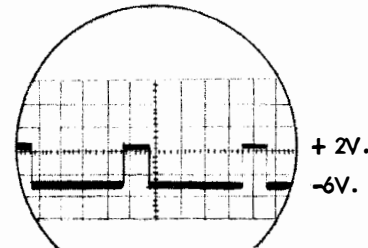
TP. (J) STORAGE SELECTION GATE (COLLECTOR Q927)

H - 20 Milliseconds / CM
V - 5 Volts / CM



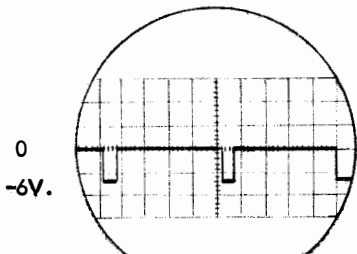
TP. (K) GATED AMPLIFIER

H - 20 Milliseconds / CM
V - 5 Volts / CM



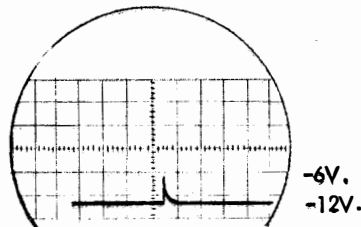
TP. (L) TRANSFER PRIME (COLLECTOR)

H - 20 Milliseconds / CM
V - 5 Volts / CM



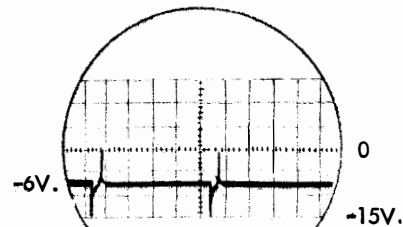
TP. (M) 1ST LEVEL STORAGE

H - 20 Milliseconds / CM
V - 5 Volts / CM



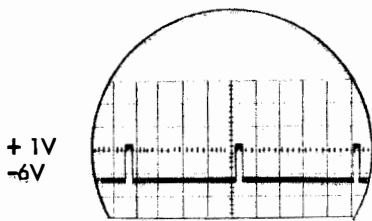
TP. (N) TRANSFER FIRING GATE (COLLECTOR)

H - 20 Milliseconds / CM
V - 5 Volts / CM



TP. (O) TRANSFER FIRING GATE (EMITTER)

H - 20 Milliseconds / CM
V - 5 Volts / CM



TP. (P) 2ND LEVEL STORAGE (COLLECTOR)

H - 20 Milliseconds / CM
V - 5 Volts / CM

Figure 6-16 Wave-forms, Transmitting Code Converter

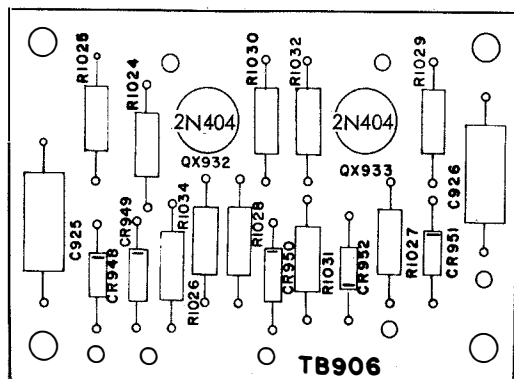
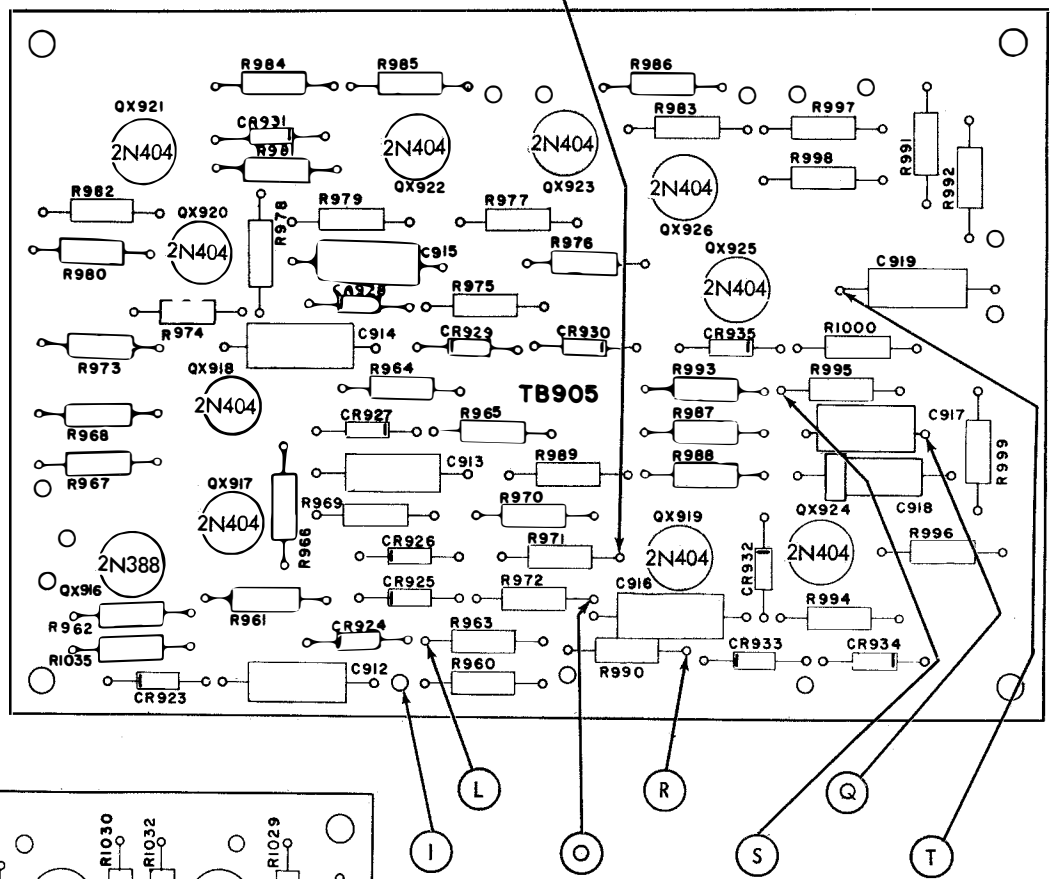
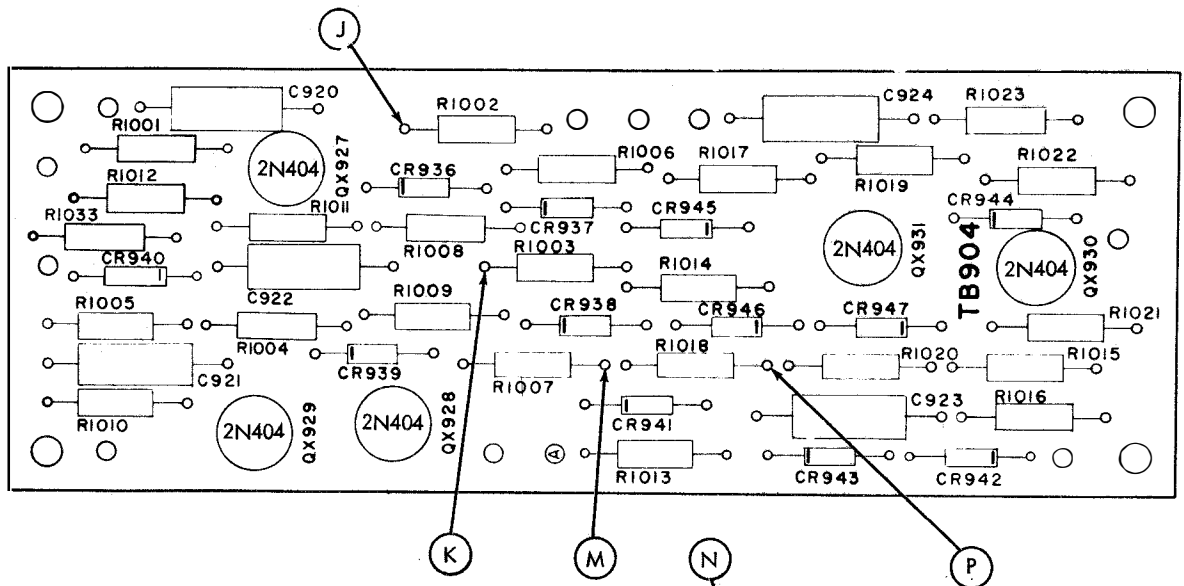


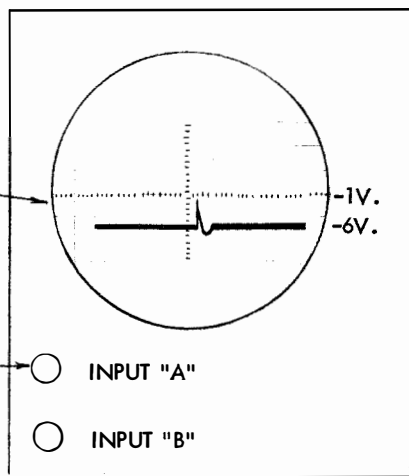
Figure 6-17 Circuit Boards - TB 904, TB 905 & TB 906

TRANSMITTING CODE CONVERTER - TMCX 201

MINOR TEST POINTS

TP. (Q) CLOCK INVERTER
(COLLECTOR)

H - 20 Milliseconds /CM
V - 5 Volts /CM



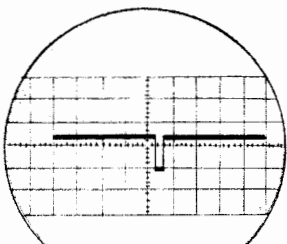
CONNECT TO
TEST POINT (Q)
SHOWN ON
PAGE 6-22

INPUT "A"
INPUT "B"

TYPICAL OSCILLOSCOPE

NOTE 1 - CALIBRATE "X" AND "Y" AXIS
TO CONVENIENT VALUES SUCH AS
INDICATED. SYNCHRONIZE SCOPE
ON (-) TP. 4.

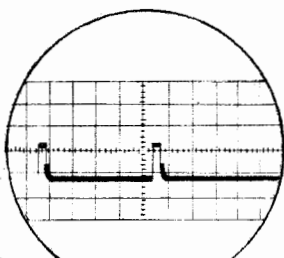
+ 1V.
-6V.



TP. (R) CLOCK DELAY
(COLLECTOR Q924)

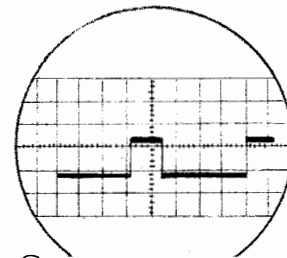
H - 20 Milliseconds /CM
V - 5 Volts /CM

+ 1V.
-6V.



TP. (S) CLOCK DELAY
(COLLECTOR Q925)

H - 20 Milliseconds /CM
V - 5 Volts /CM

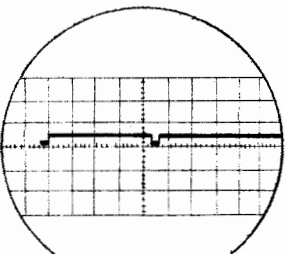


+ 1V.
-6V.

TP (T) CLOCK INPUT

H - 20 Milliseconds /CM
V - 5 Volts /CM

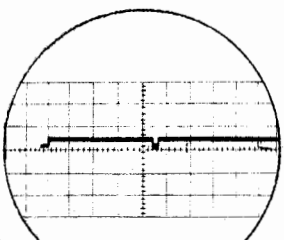
+2.0V.
+0.05V.



TP. (U) CLOCK DELAY

H - 20 Milliseconds /CM
V - 5 Volts /CM

+ 2.0V
+ 0.05V



TP (V) 2ND LEVEL STORAGE
(INPUT TO Q932)

H - 20 Milliseconds /CM
V - 5 Volts /CM

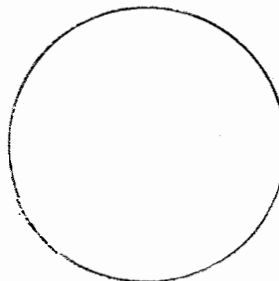
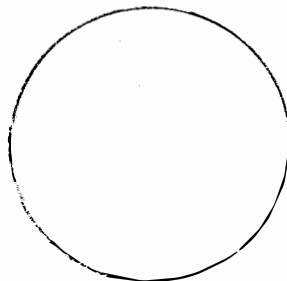


Figure 6-18 Wave-forms, Transmitting Code Converters

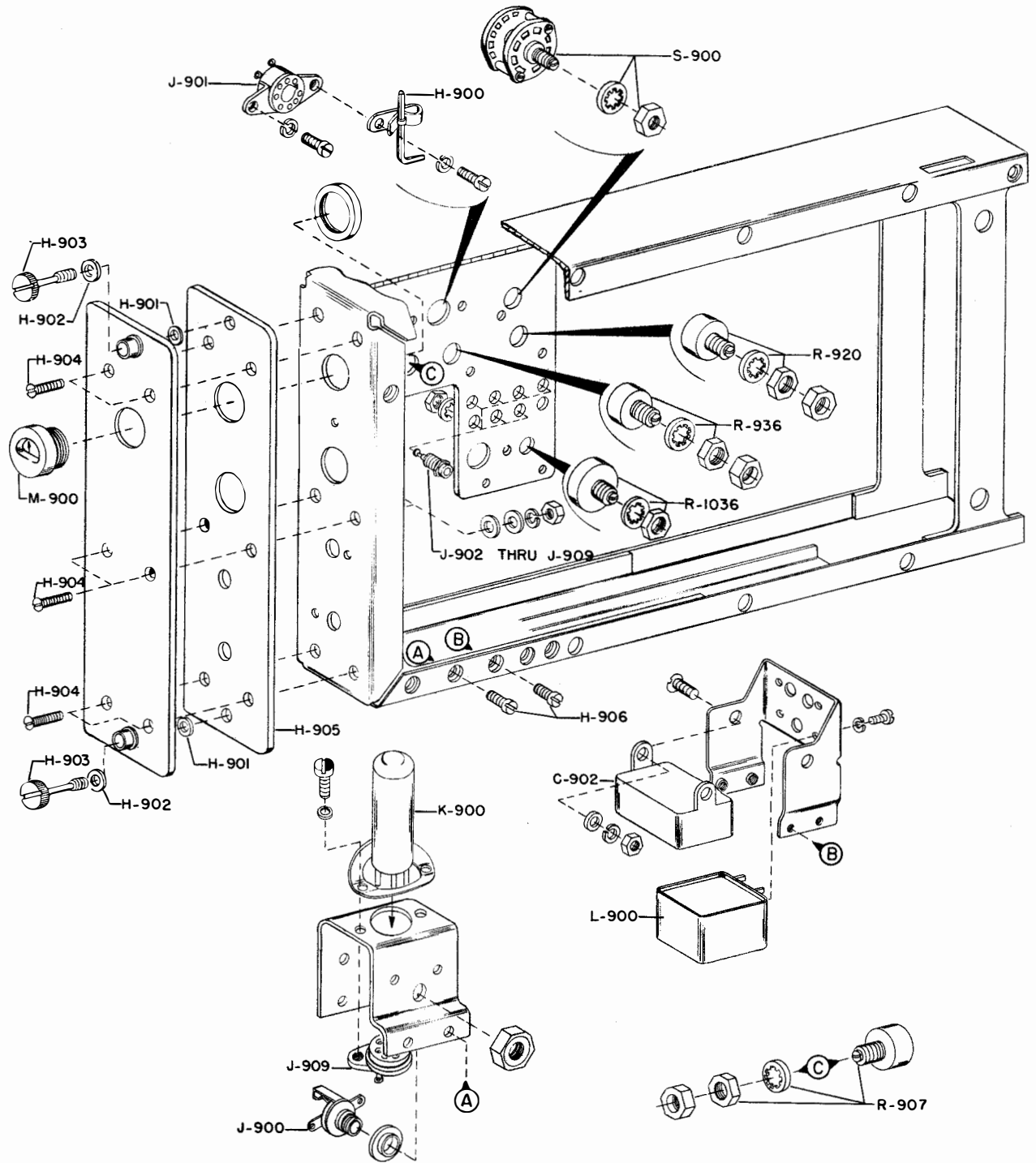
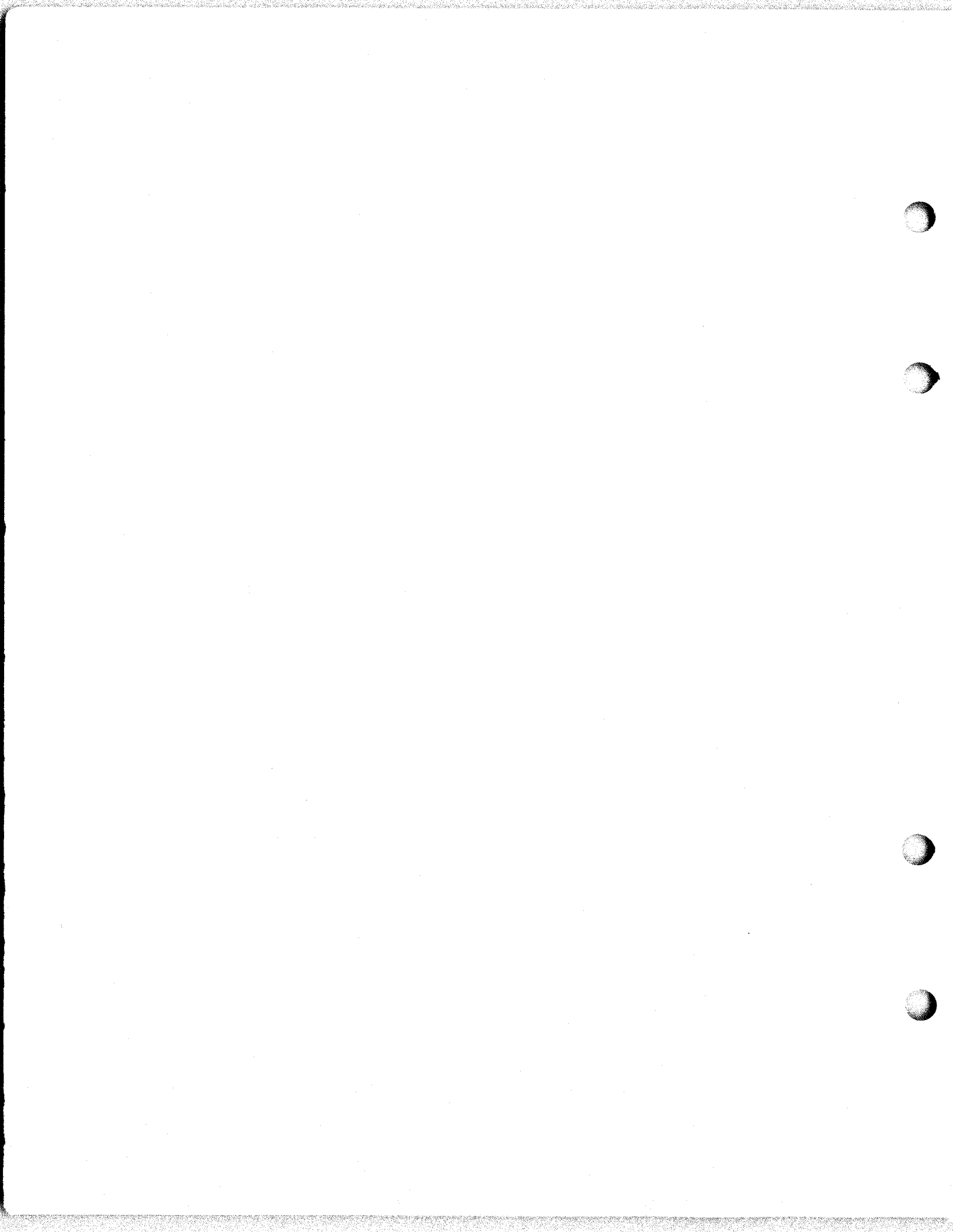
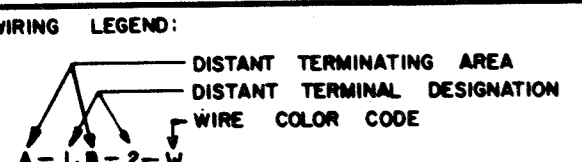


Figure 6-19 Transmitting Code Converter, TMCX 201



NOTES

WIRING LEGEND:

1A 

1B **TERMINAL DESIGNATIONS ENCLOSED IN PARENTHESIS ARE NOT MARKED ON COMPONENTS.**

COLOR CODE:

BK	BLACK
BL	BLUE
BR	BROWN
G	GREEN
O	ORANGE
P	PURPLE
R	RED
S	SLATE
Y	YELLOW
W	WHITE
V	VIOLET

2.

3. **ALL TERMINALS AS VIEWED FROM SOLDERED END EXCEPT "A FB" AND "A FC."**

4. **AREAS "C" AND "L", TERMINALS "A" THROUGH "D" ARE SOCKET SIDE PINS.**

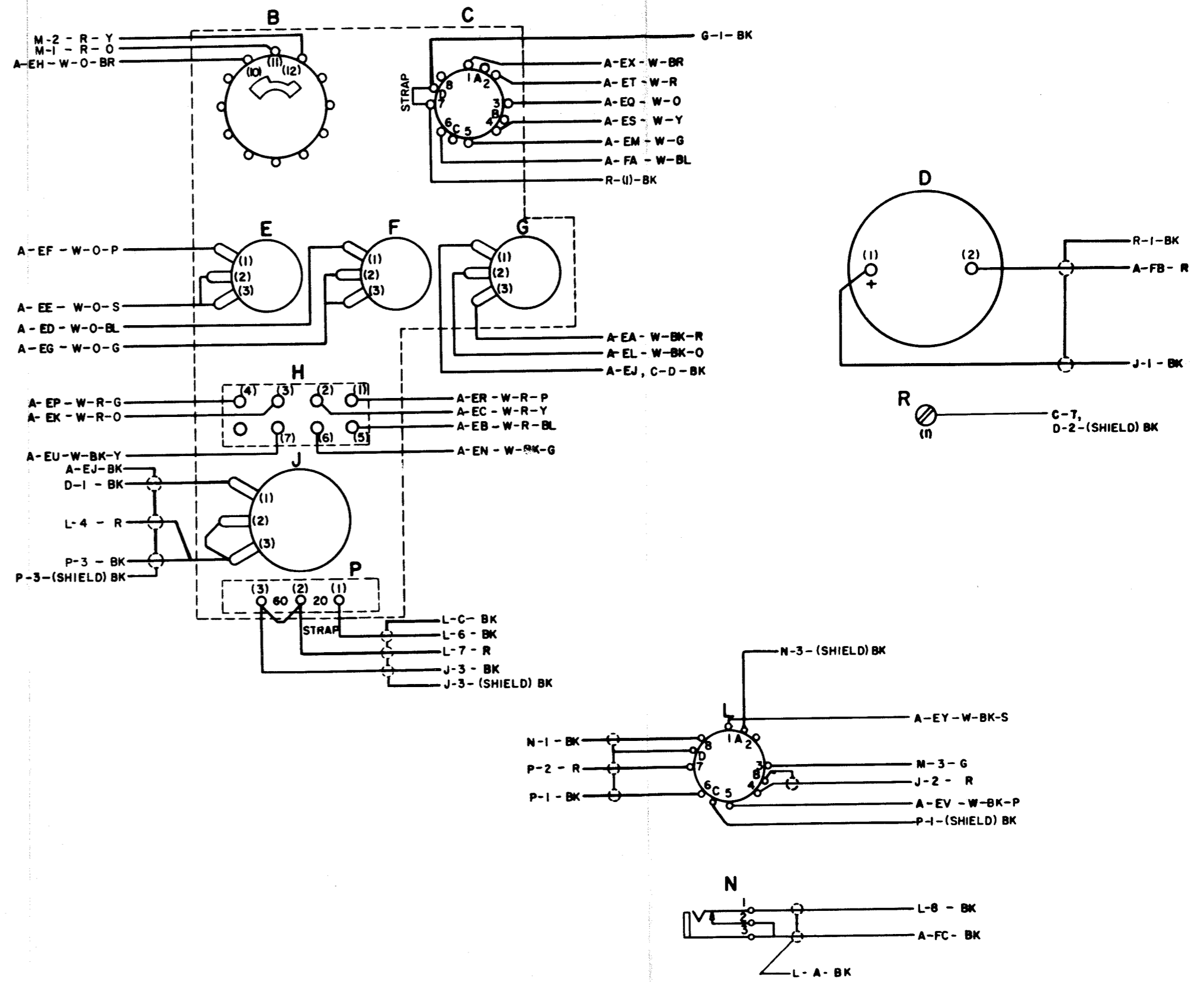
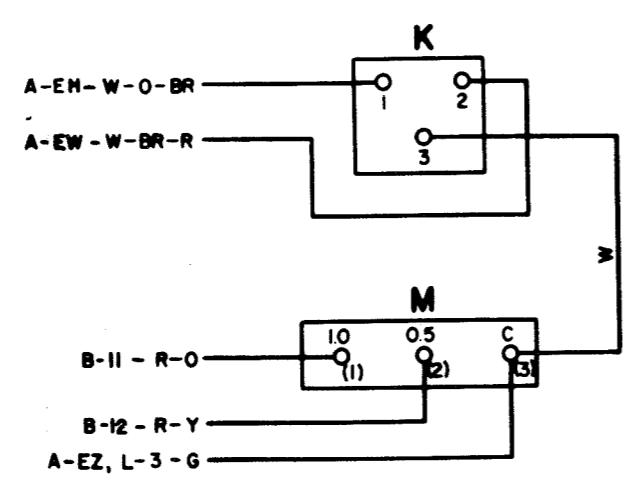
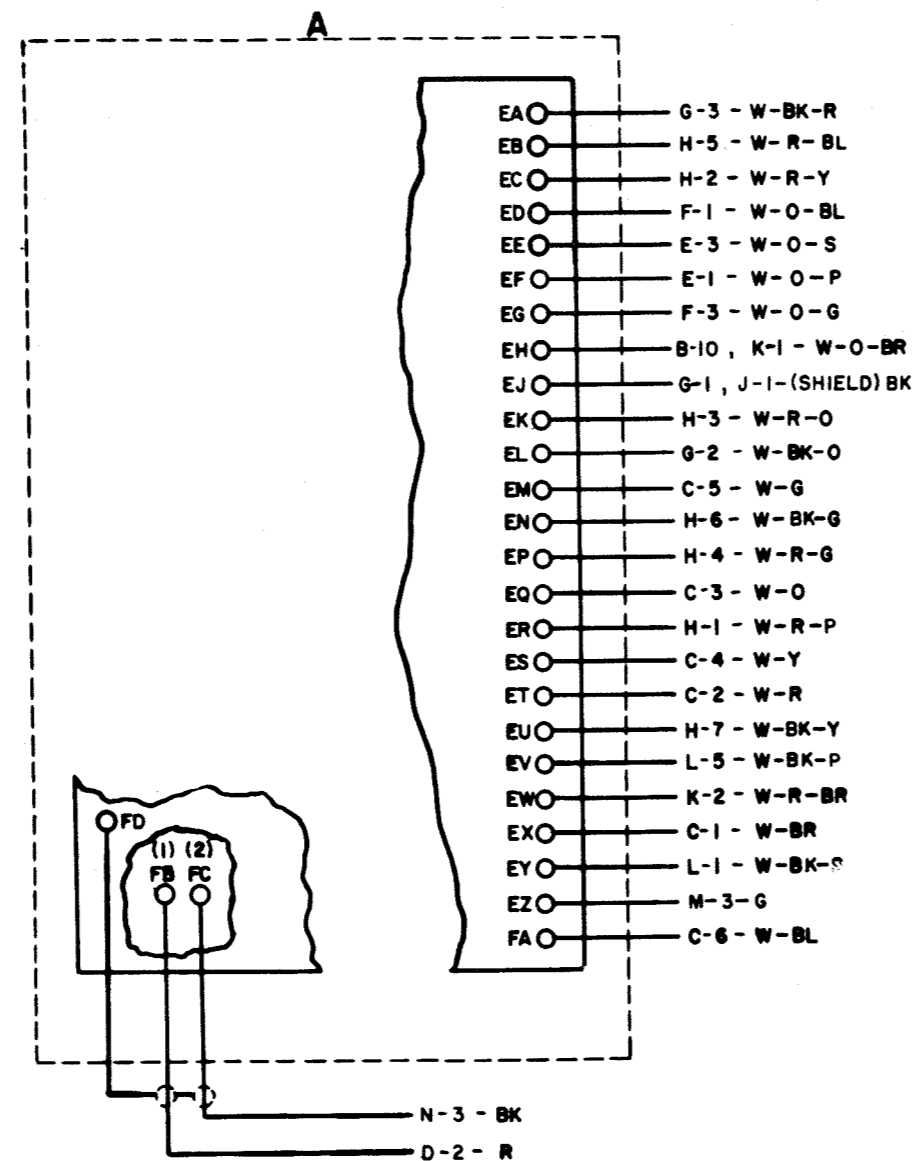


Figure 6-20 Cable Assembly - TMCX 201 6-23; 6-24

- P1305
 - P1307
 - P1309
 - P1311
- A ← J910
- B ←
- C ←
- D ←
- E ← CLOCK INPUT
- F ←
- H ← +1.5V
- J ←
- K ←
- L ←
- M ← +6V
- N ←
- P ← +12V
- R ← -6V
- S ← GND
- T ← NO.1 OUT NORMAL
- U ← NO.2 OUT NORMAL
- V ← NO.3 OUT NORMAL

- P1306
 - P1308
 - P1310
 - P1312
- A ← J911 NO.5 OUT NORMAL
- B ← NO.4 OUT NORMAL
- C ← -12V
- D ← NO.2 OUT INVERTED
- E ← NO.3 OUT INVERTED
- F ←
- H ← NO.4 OUT INVERTED
- J ← NO.1 OUT INVERTED
- K ←
- L ←
- M ←
- N ← NO.5 OUT INVERTED
- P ← NO.6 OUT NORMAL
- R ← NO.6 OUT INVERTED
- S ←
- T ←
- U ← (+) START-STOP IN
- V ← (-) START-STOP IN

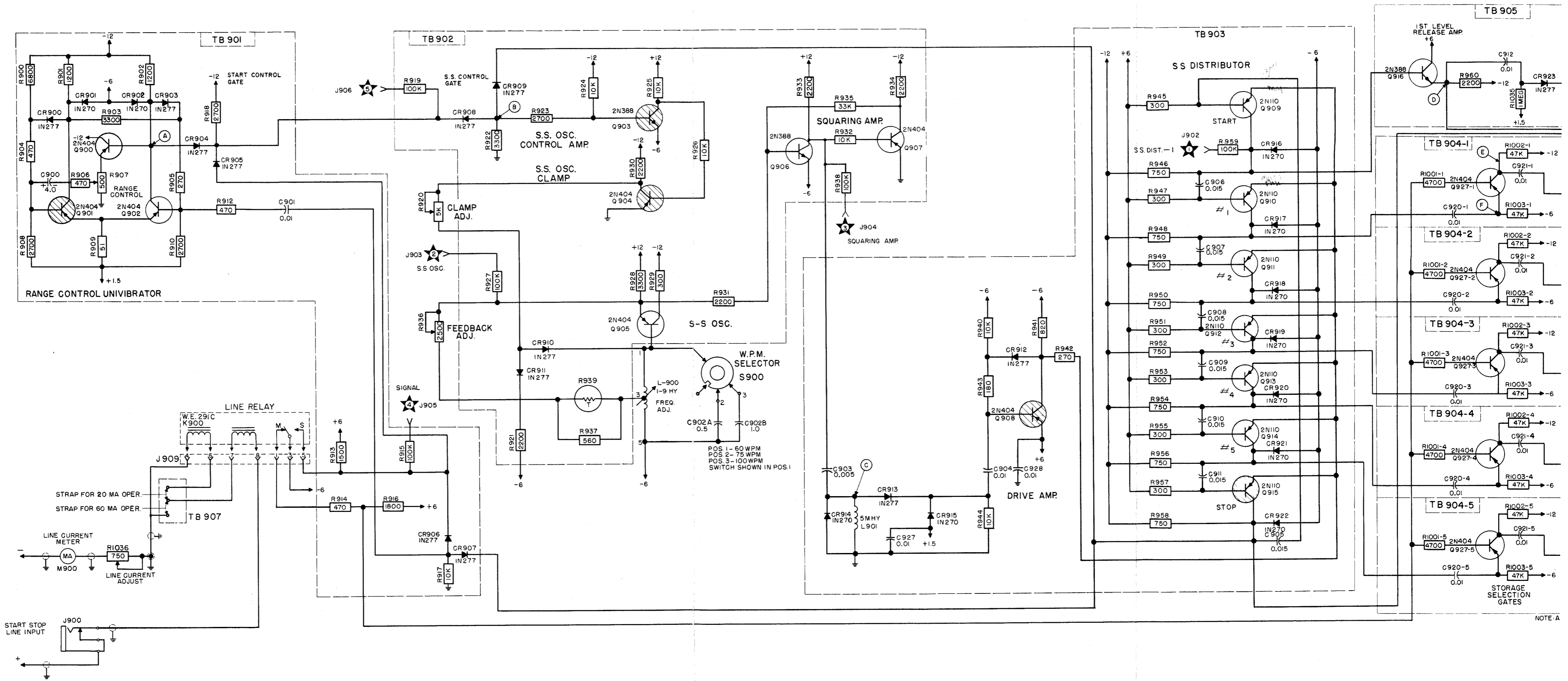
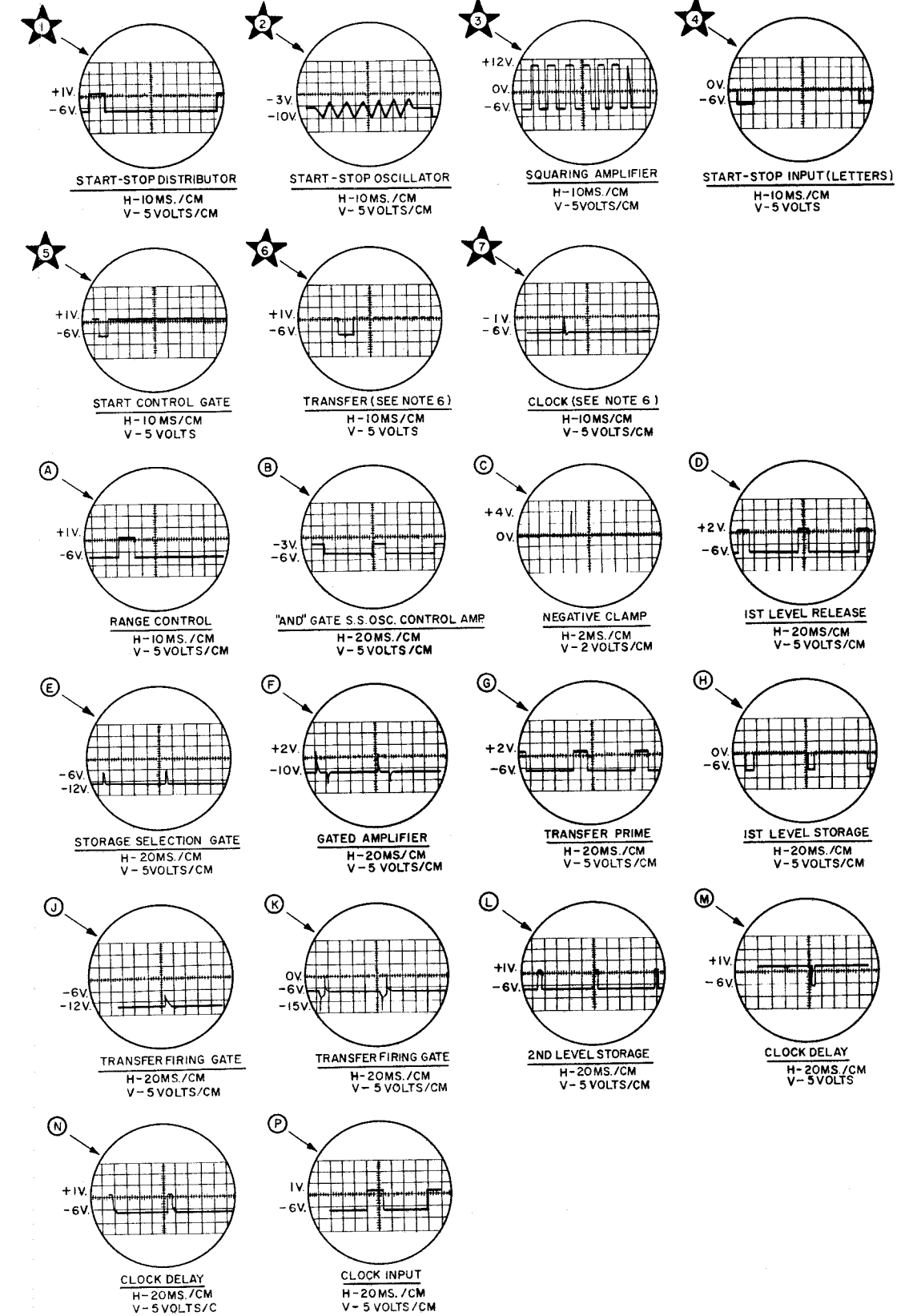
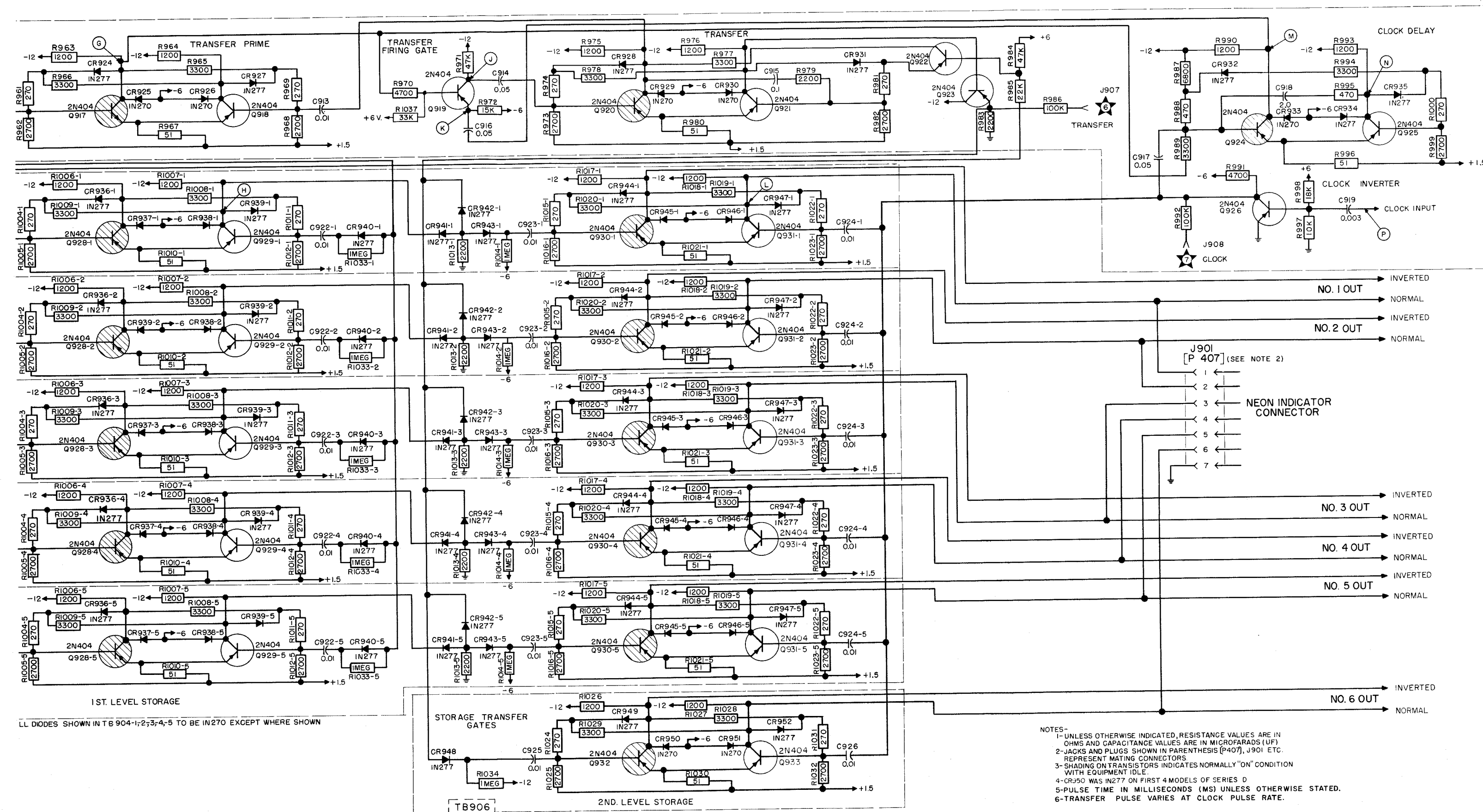


Figure 6-21 Schematic Wiring Diagram Transmitting Code Converter TMCX 201



NOTES-
 1- UNLESS OTHERWISE INDICATED, RESISTANCE VALUES ARE IN OHMS AND CAPACITANCE VALUES ARE IN MICROFARADS (UF)
 2- JACKS AND PLUGS SHOWN IN PARENTHESIS (P407), J901 ETC. REPRESENT MATING CONNECTORS
 3- SHADING ON TRANSISTORS INDICATES NORMALLY "ON" CONDITION WITH EQUIPMENT IDLE.
 4- CR950 WAS IN277 ON FIRST 4 MODELS OF SERIES D
 5- PULSE TIME IN MILLISECONDS (MS) UNLESS OTHERWISE STATED.
 6- TRANSFER PULSE VARIES AT CLOCK PULSE RATE.

Figure 6-21 Schematic Wiring Diagram
 Transmitting Code Converter TMCX 201

4.c. MULTIPLEXER - DEMULTIPLEXER

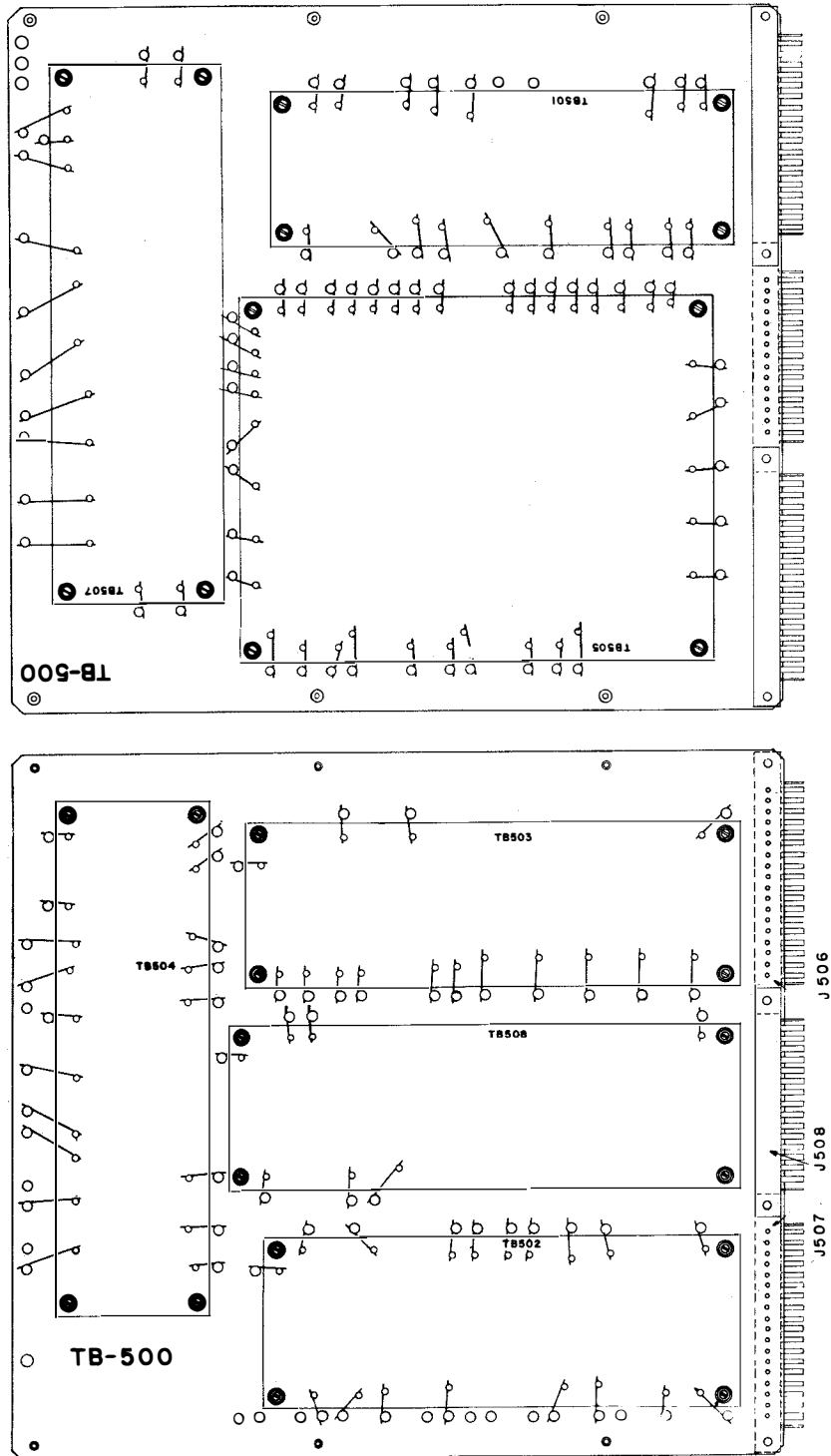


Figure 6-22 Circuit Board - TB 500

MULTIPLEXER - DEMULTIPLEXER - TMD 201

MINOR TEST POINTS

TP. (A) NORMAL SIGNAL SAMPLING (Q 528)
EMITTER FOLLOWER OUTPUT PULSE

H - 10 Milliseconds /CM
V - 5 Volts /CM

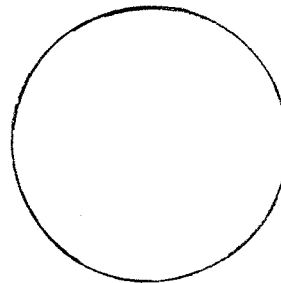
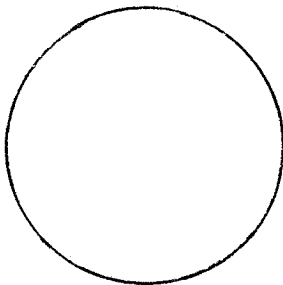
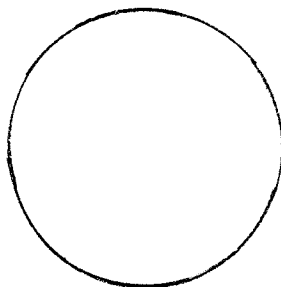
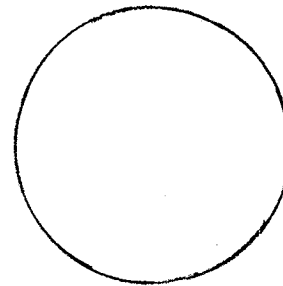
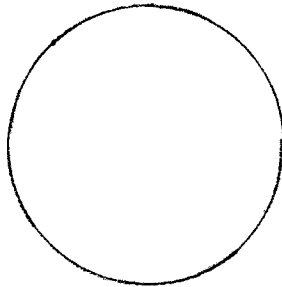
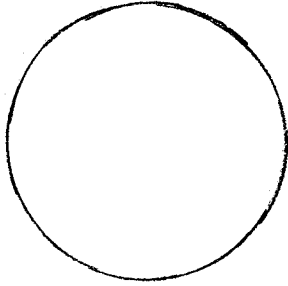
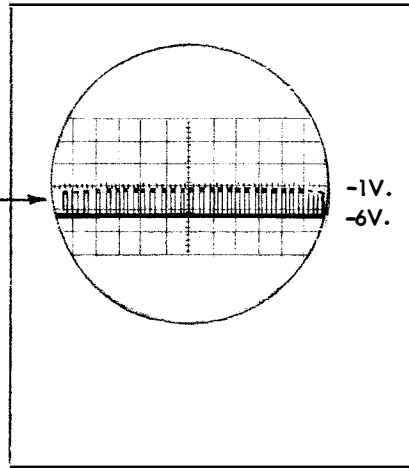


Figure 6-23 Wave-form, Multiplexer - Demultiplexer

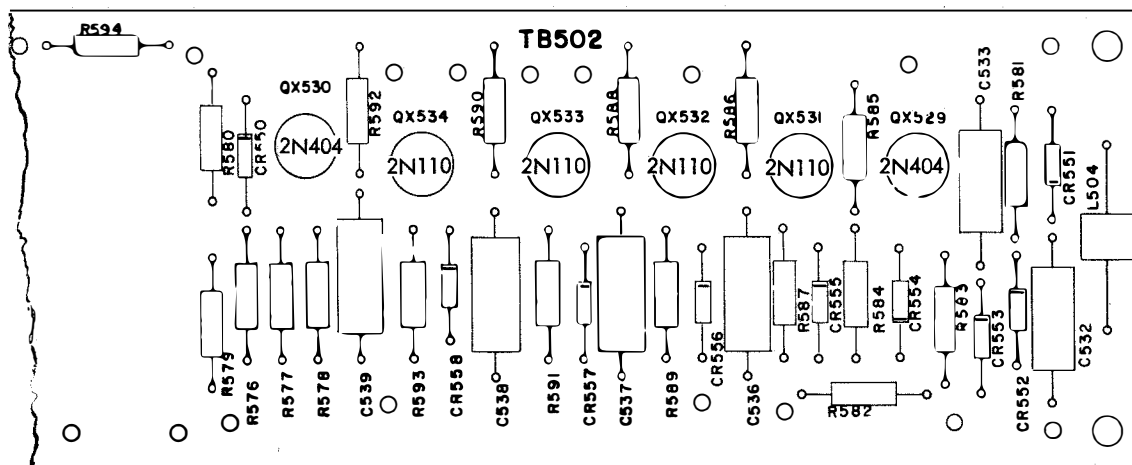
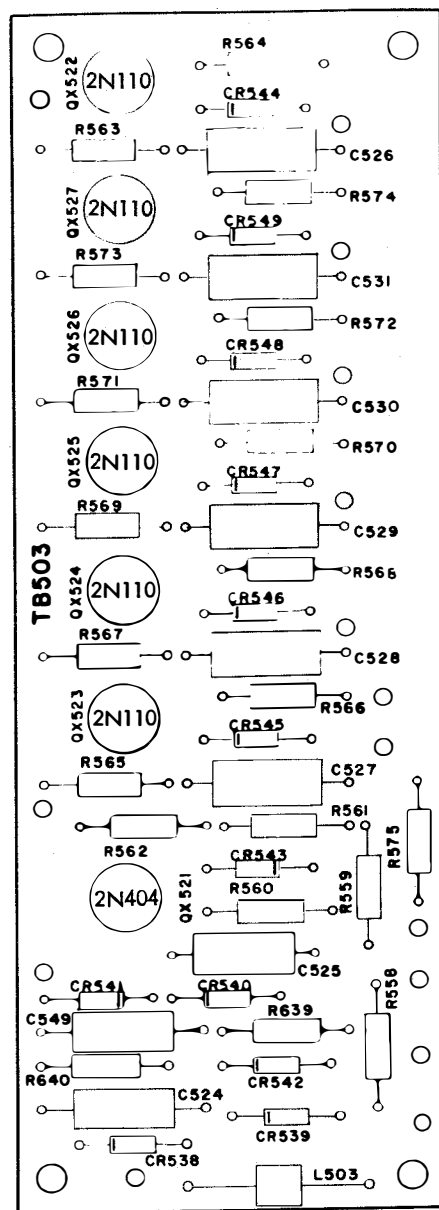
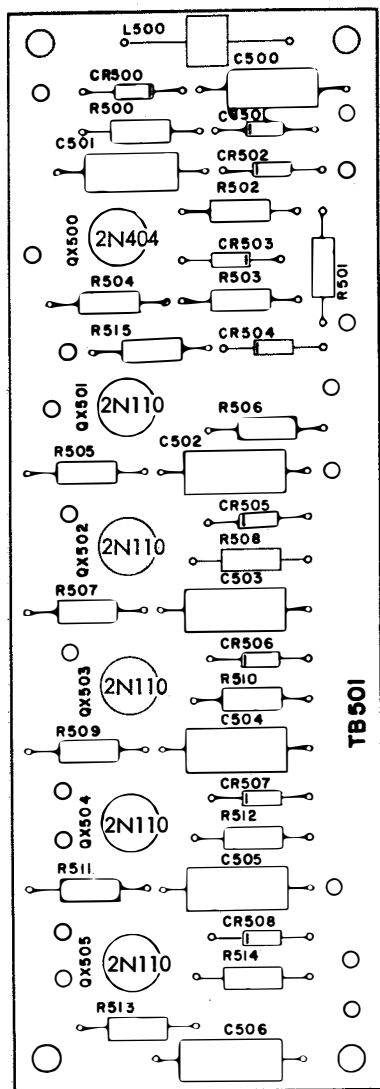
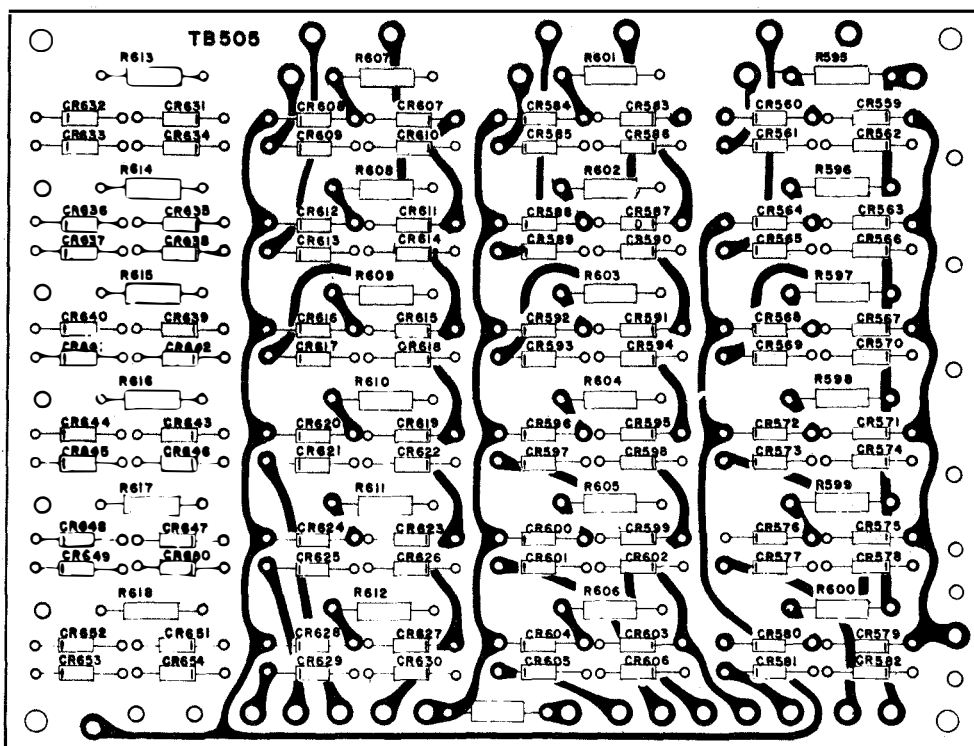
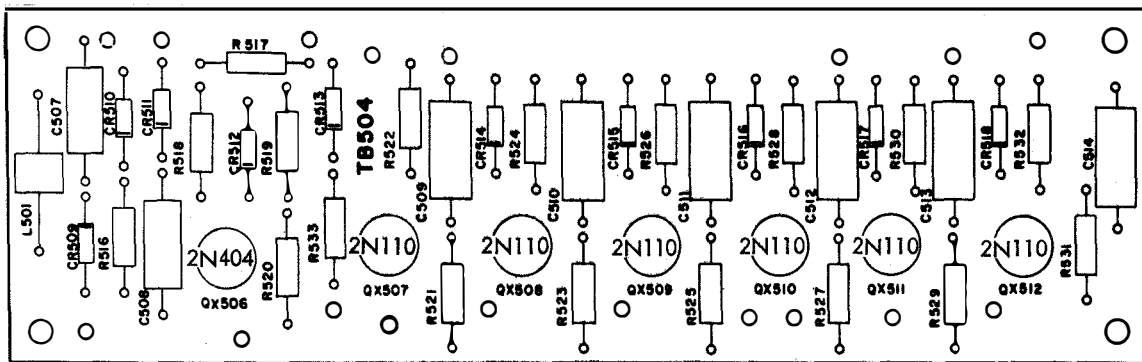


Figure 6-24 Circuit Boards - TB 501, TB 502, TB 503



R 619

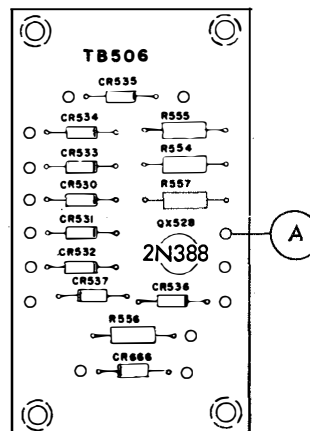


Figure 6-25 Circuit Boards - TB 504, TB 505, TB 506

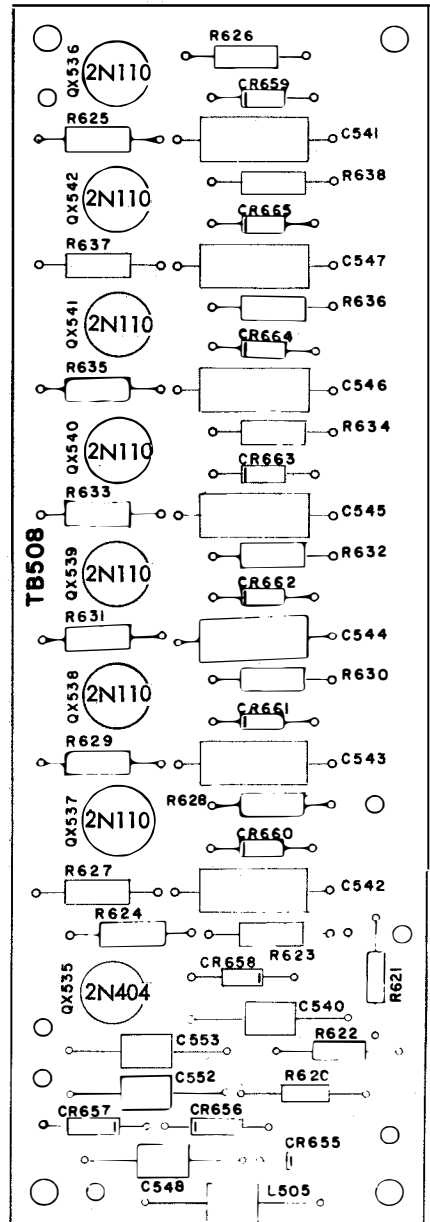
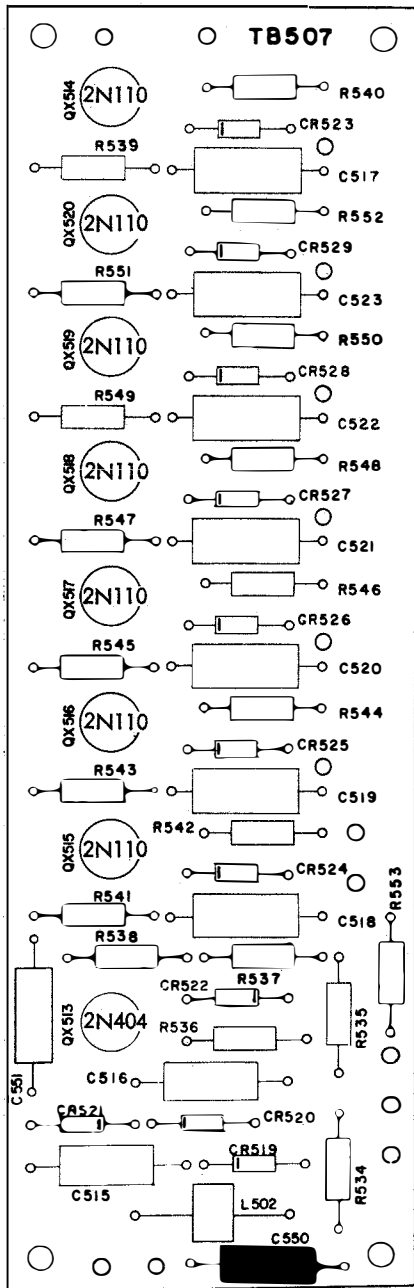


Figure 6-26 Circuit Board - TB 507, TB 508

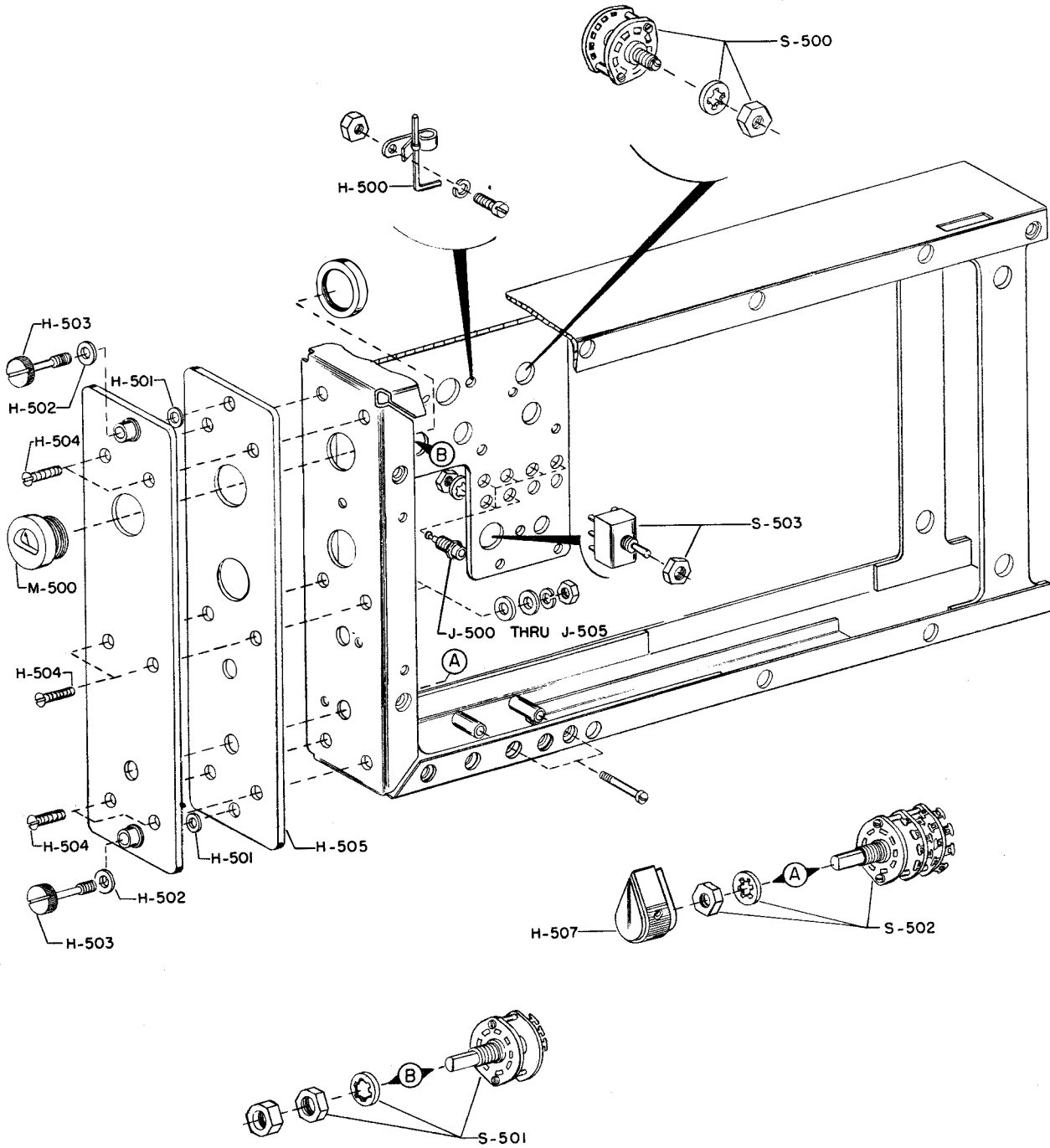


Figure 6-27 Multiplexer - Demultiplexer TMD 201

NO **NOTES**

1A **WIRING LEGEND:**
 DISTANT TERMINATING AREA
 DISTANT TERMINAL DESIGNATION
 WIRE COLOR CODE
 A-1, B-2-W

1B **TERMINAL DESIGNATIONS ENCLOSED IN PARENTHESIS ARE NOT MARKED ON COMPONENTS.**

2. COLOR CODE:

BK	BLACK
BL	BLUE
BR	BROWN
G	GREEN
O	ORANGE
P	PURPLE
R	RED
S	SLATE
Y	YELLOW
W	WHITE
V	VIOLET

3. ALL TERMINALS AS VIEWED FROM SOLDERED END.

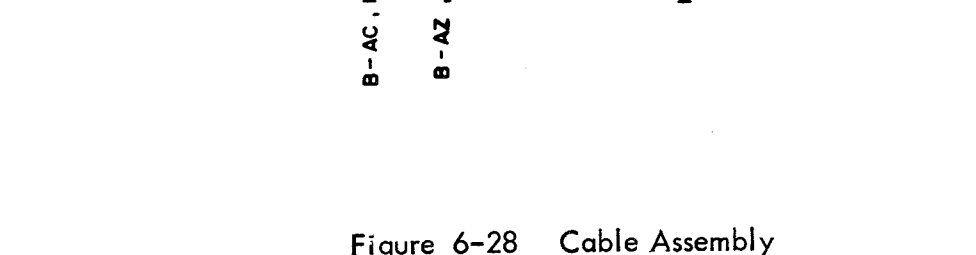
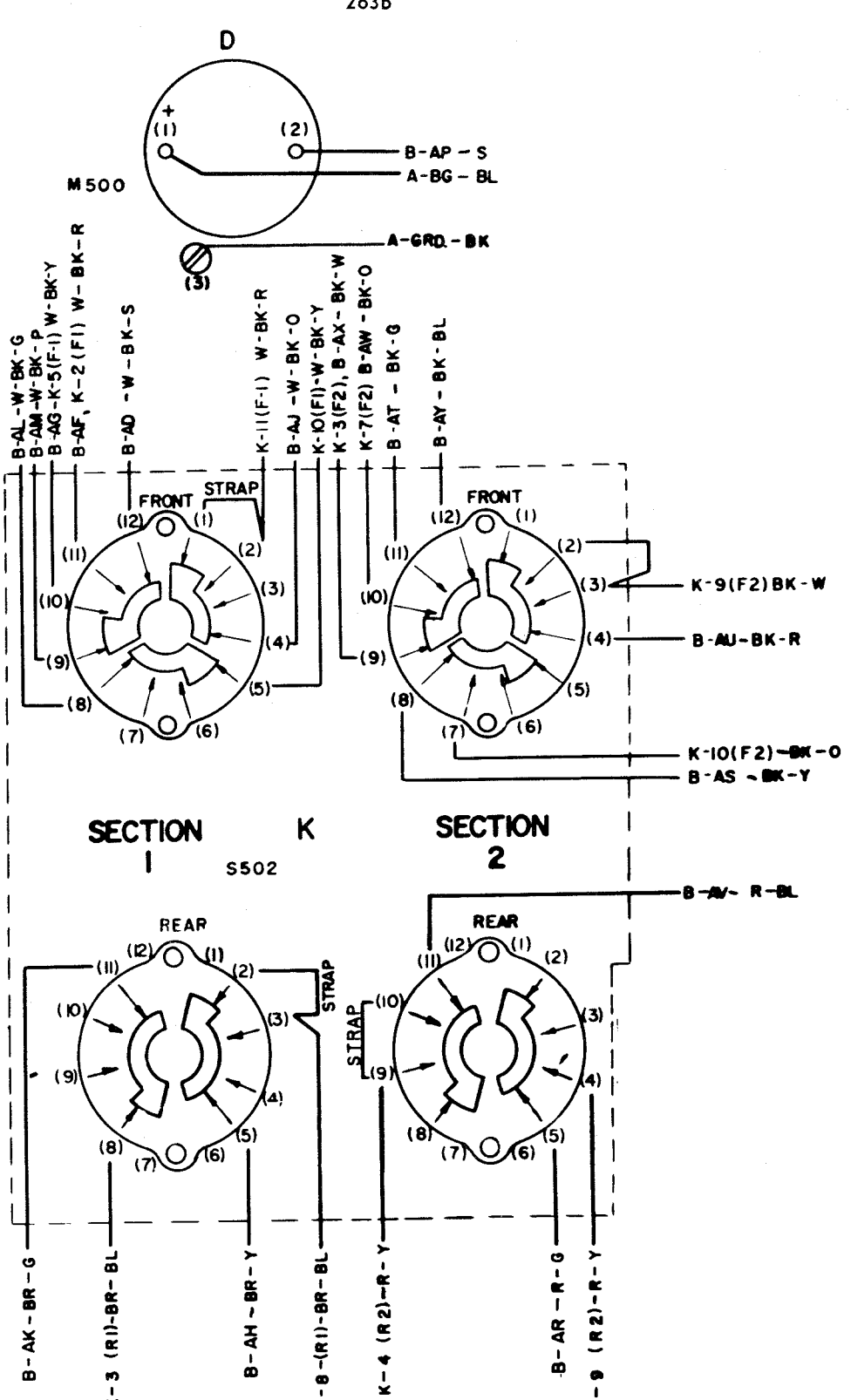
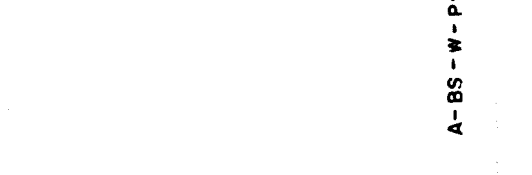
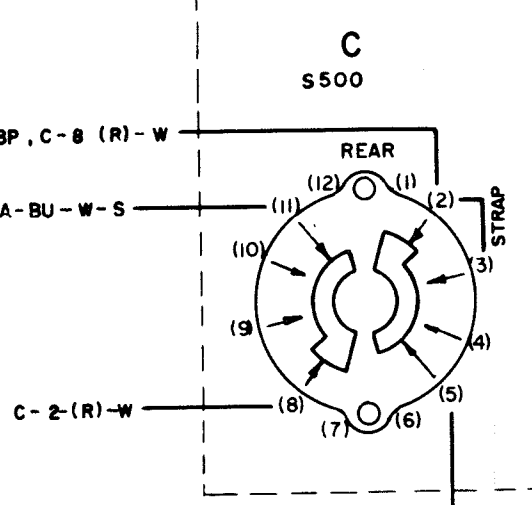
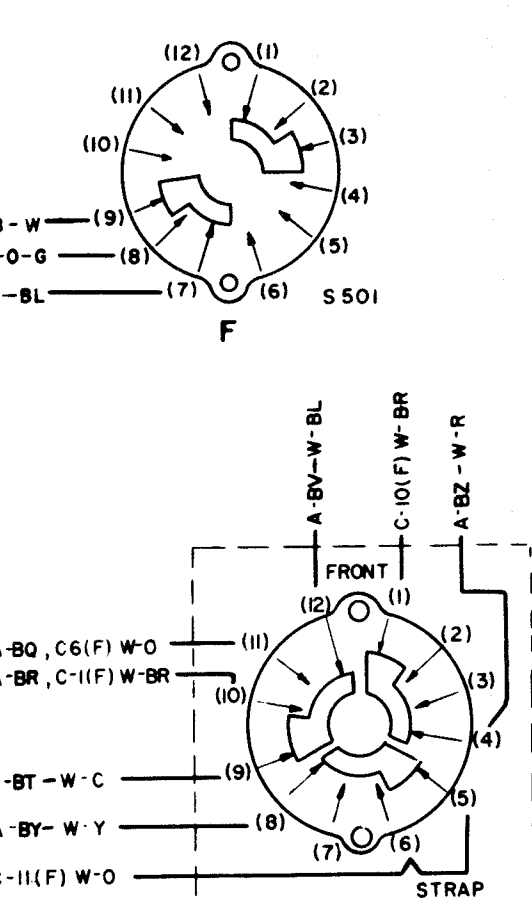
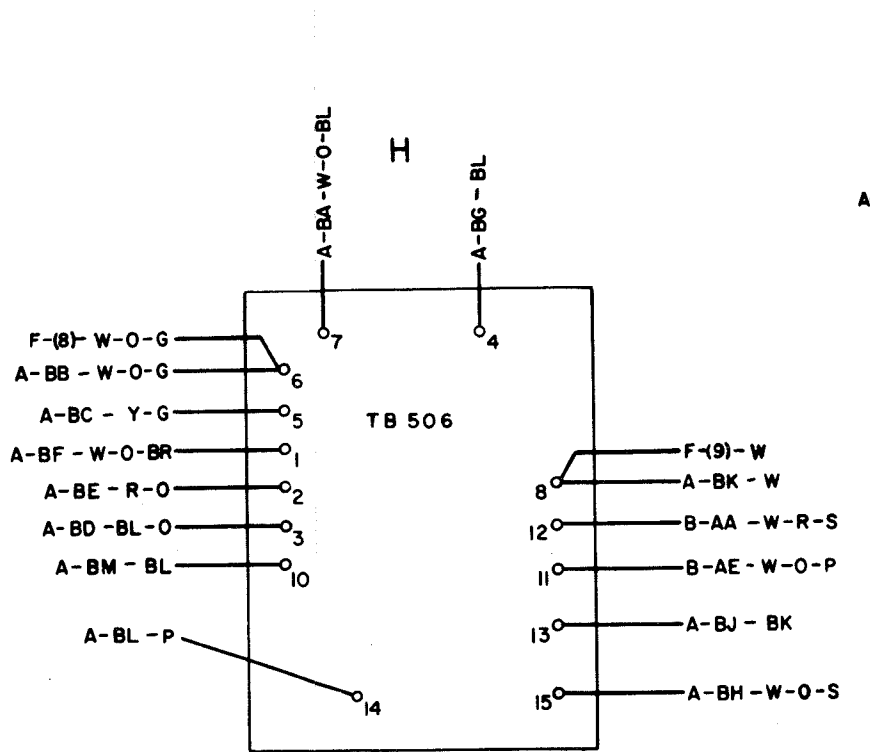
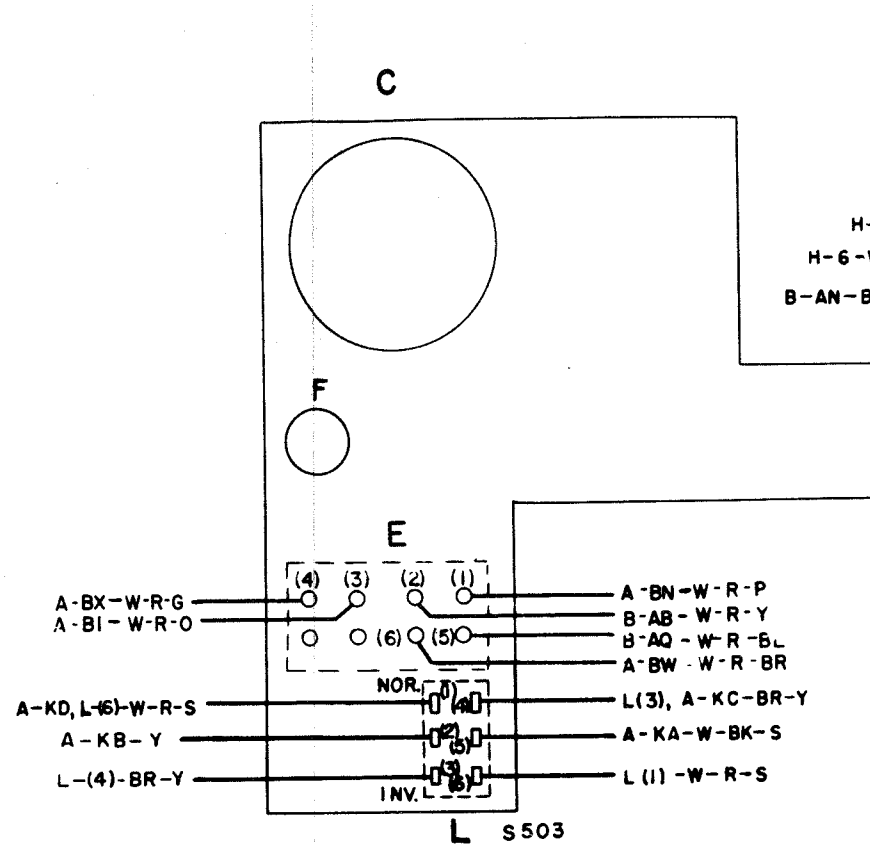
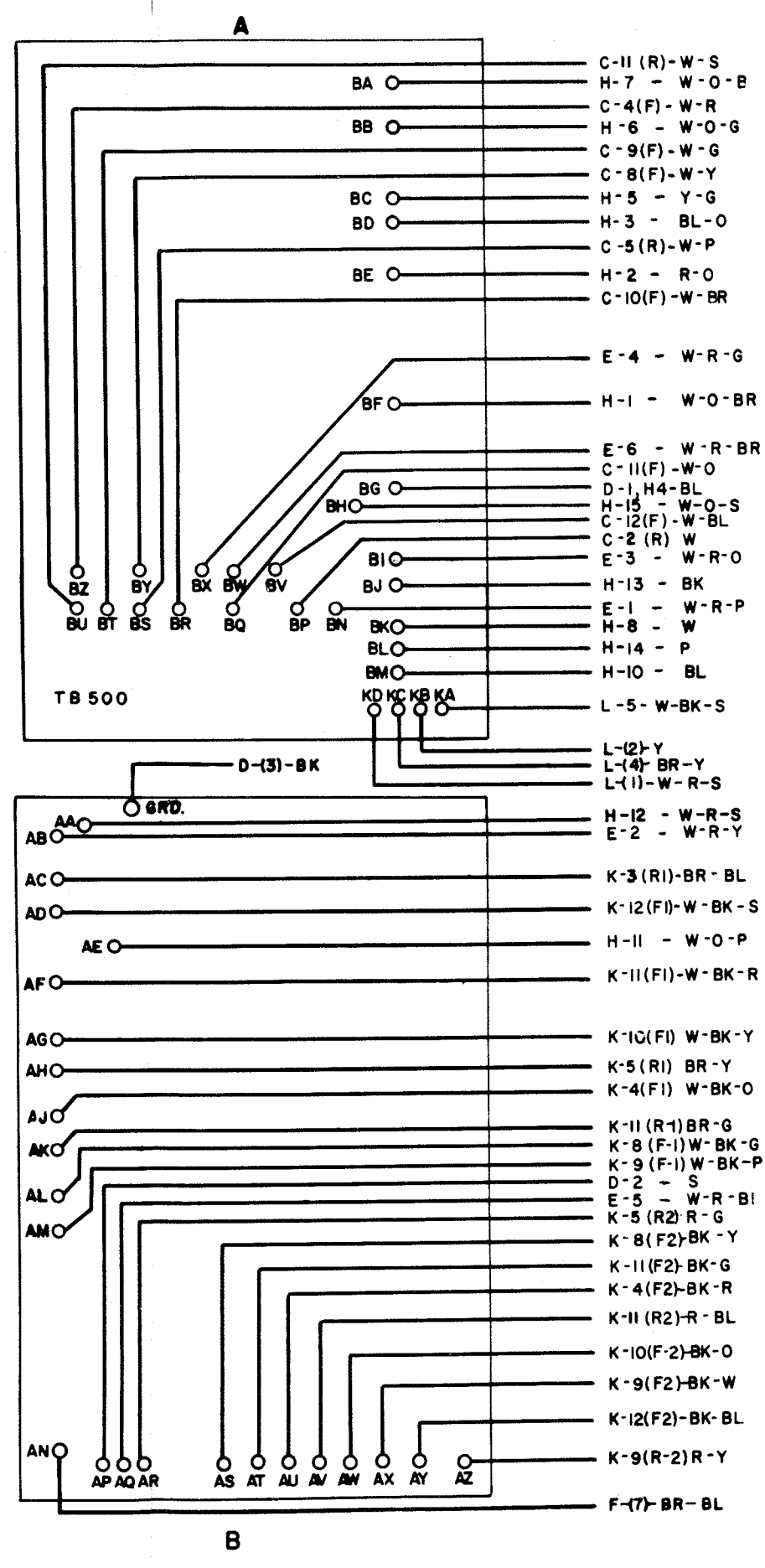


Figure 6-28 Cable Assembly 6-33; 6-34

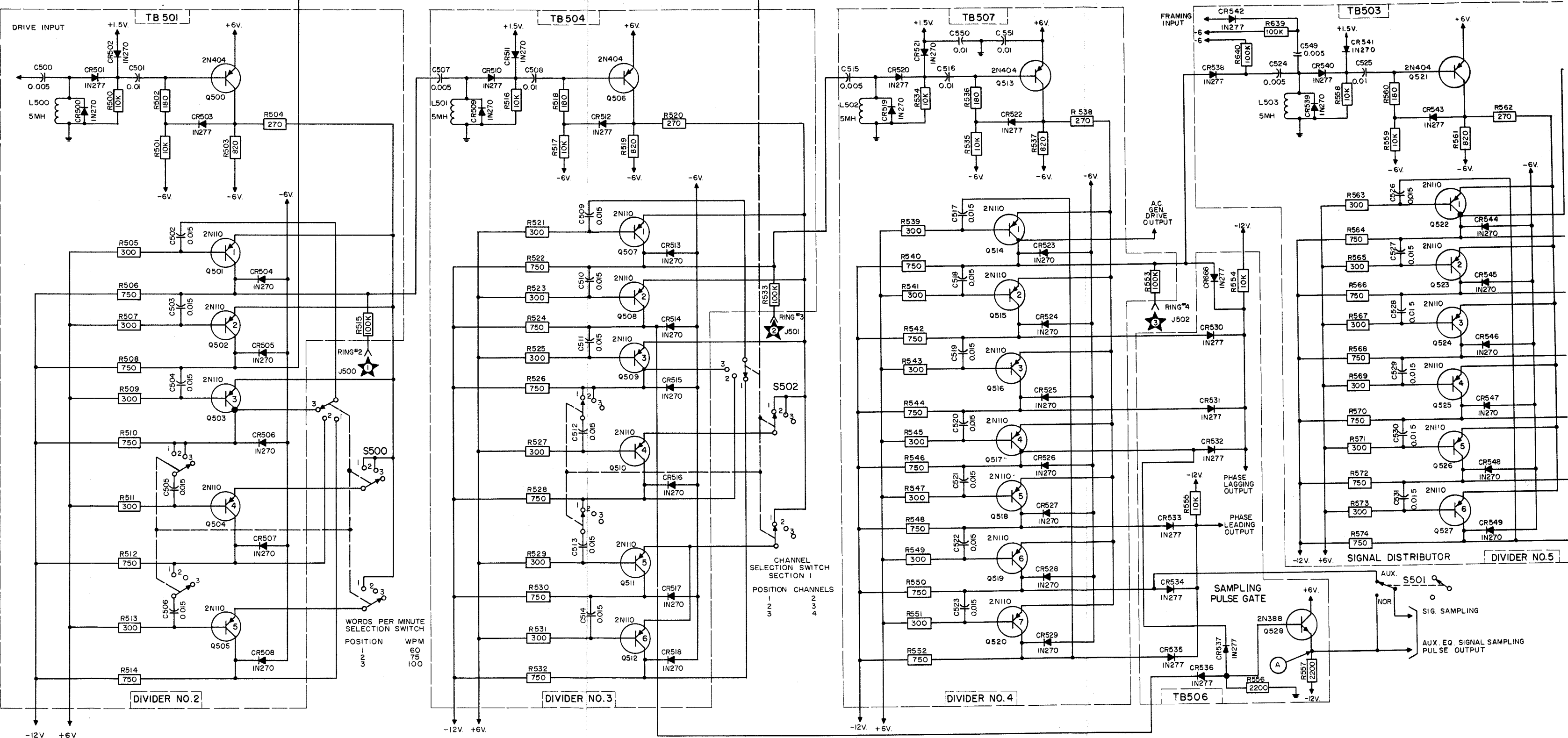
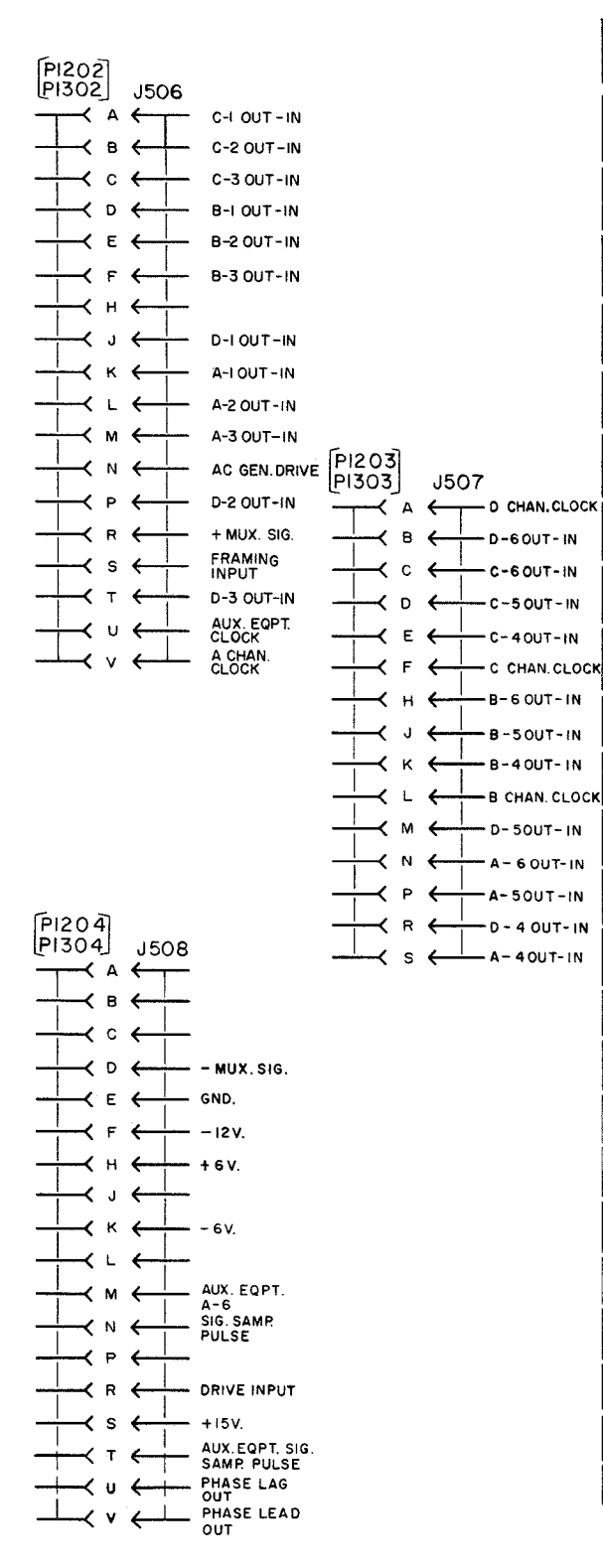


Figure 6-29 Schematic Wiring Diagram Multiplexer - Demultiplexer TMD 201

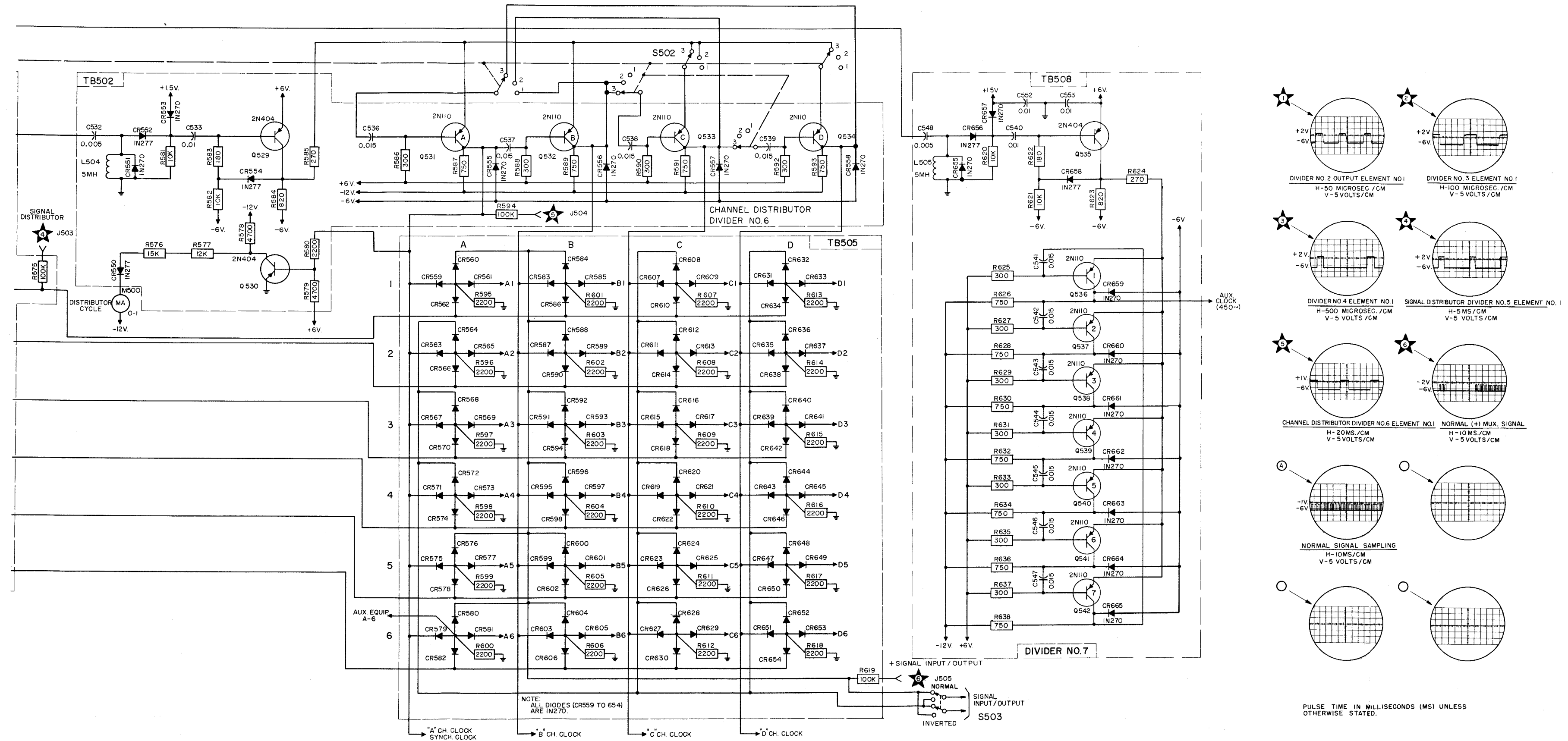


Figure 6-29 Schematic Wiring Diagram
Multiplexer - Demultiplexer TMD 201

4.d. OUTPUT AMPLIFIER

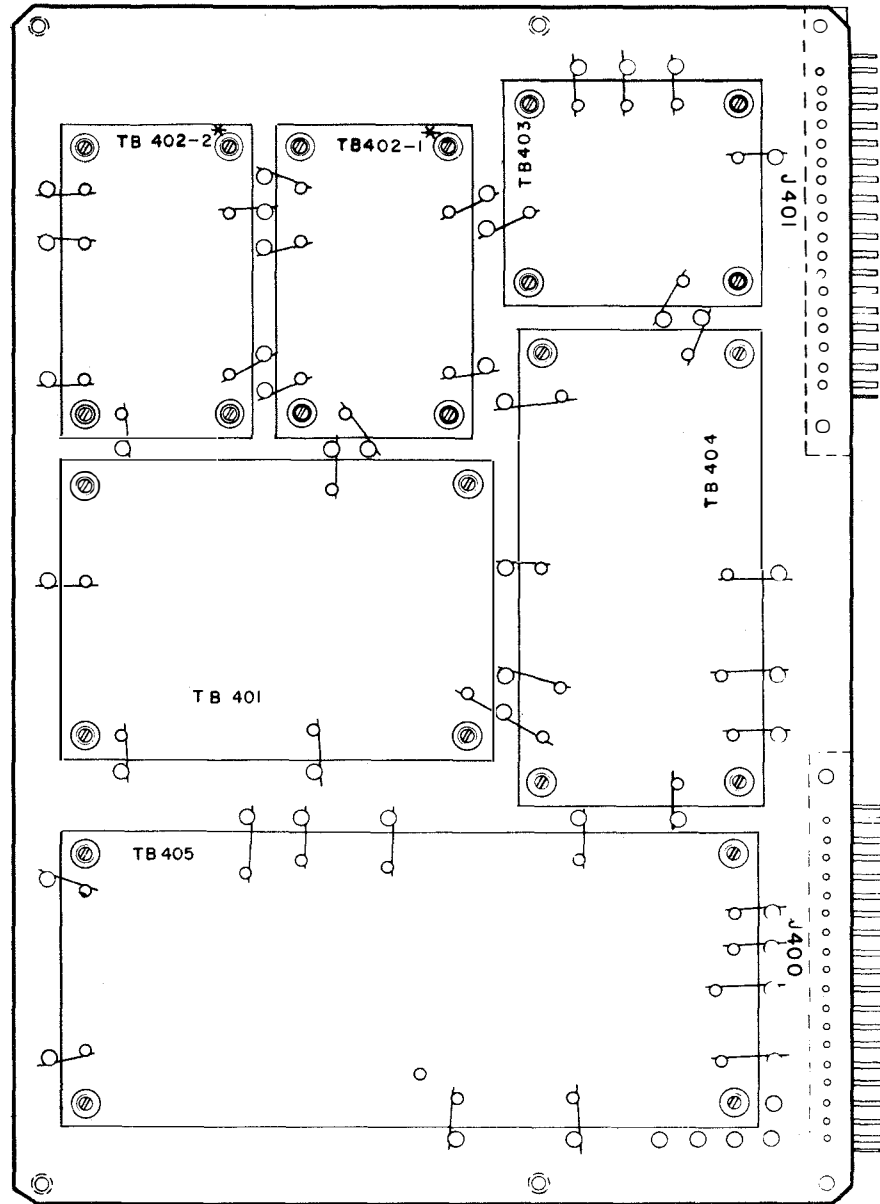


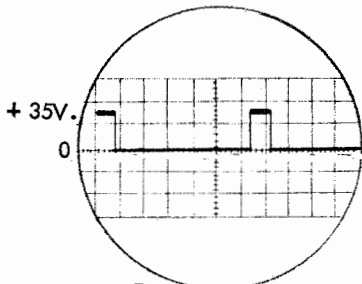
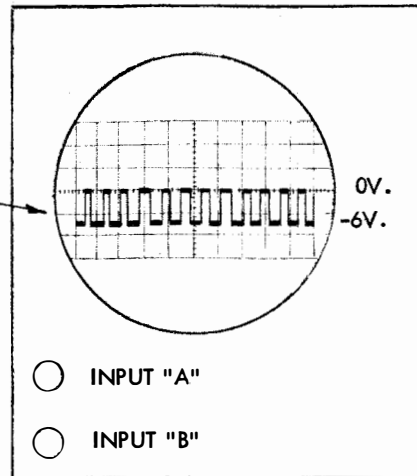
Figure 6-30 Circuit Board TB 400

OUTPUT AMPLIFIER

MINOR TEST POINTS

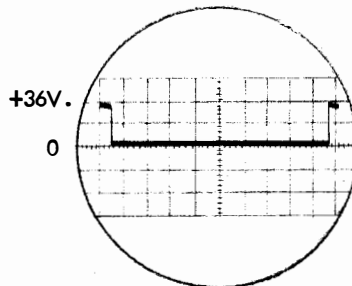
TP. (A) A.C. GENERATOR

H - 10 Milliseconds/CM
V - 5 Volts/CM
(Internal Syn.)



TP (B) AUX. CLOCK
AMP. OUTPUT

H 200 Microseconds/CM
V 20 Volts/CM

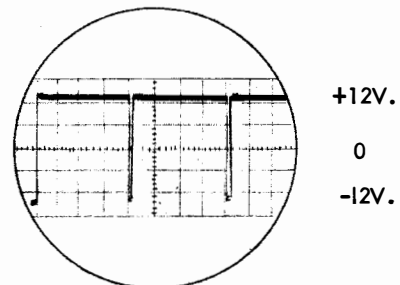


TP. (C) "B" CHANNEL CLOCK
AMP. OUTPUT

H - 10 Milliseconds/CM
V - 20 Volts/CM

TYPICAL OSCILLOSCOPE

NOTE - CALIBRATE "X" AND "Y" AXIS TO CONVENIENT VALUES SUCH AS INDICATED. SYNCHRONIZE SCOPE ON "A" CHANNEL CLOCK EXCEPT WHERE NOTED.



TP. (D) SIGNAL DISTRIBUTOR
DRIVE AMP. OUTPUT

H - 1 Milliseconds/CM
V - 5 Volts/CM

Figure 6-31 Wave-forms, Output Amplifier

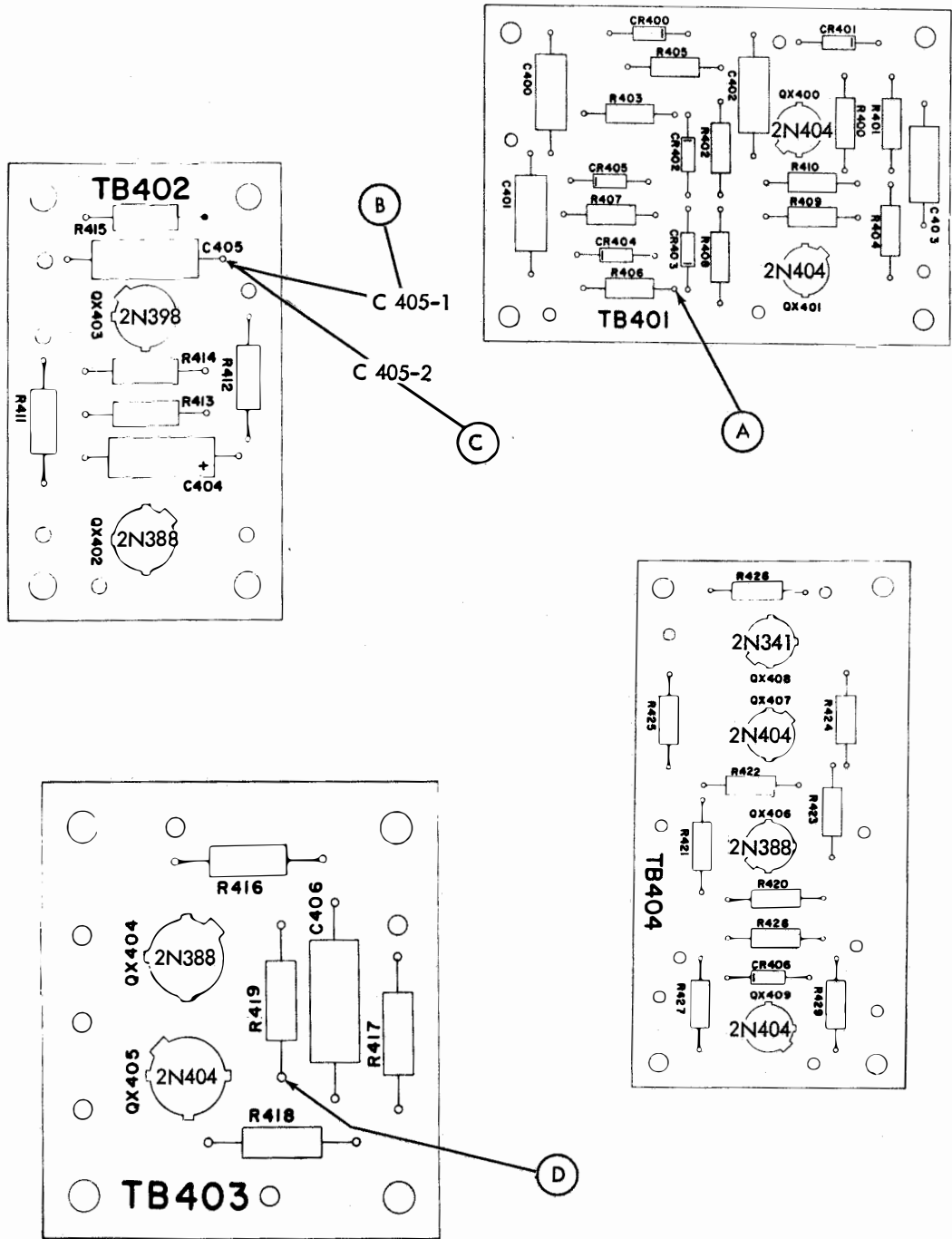


Figure 6-32 Circuit Boards, TB 401, TB 402, TB 403 & TB 404

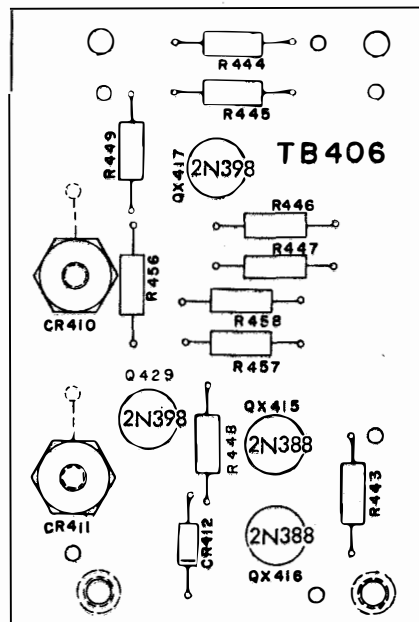
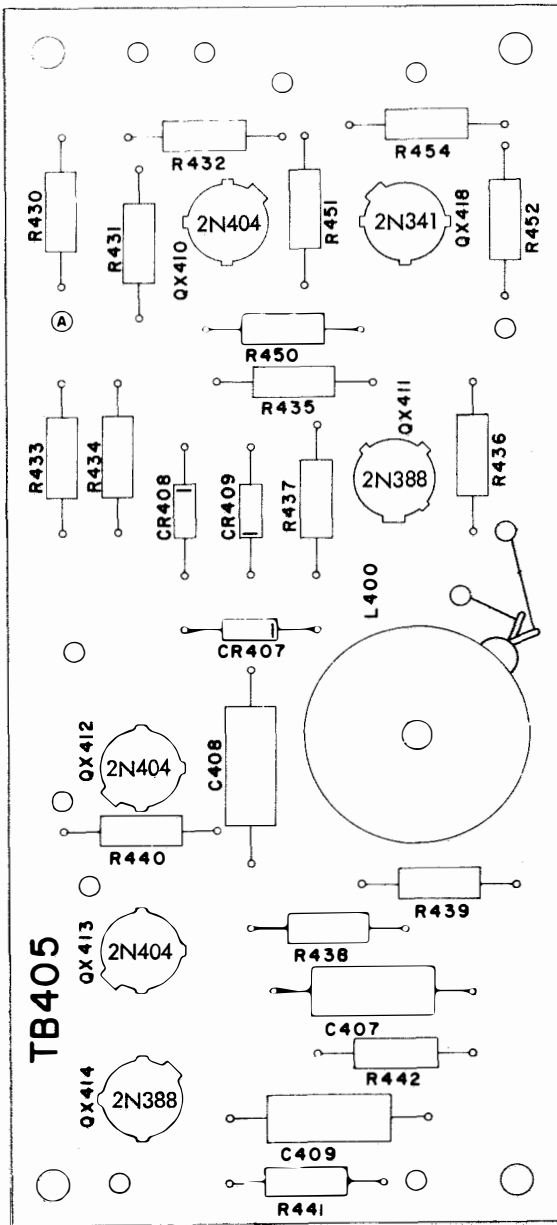


Figure 6-33 Circuit Boards, TB 405 & TB 406

Neon Lamp Indicator, TMN200

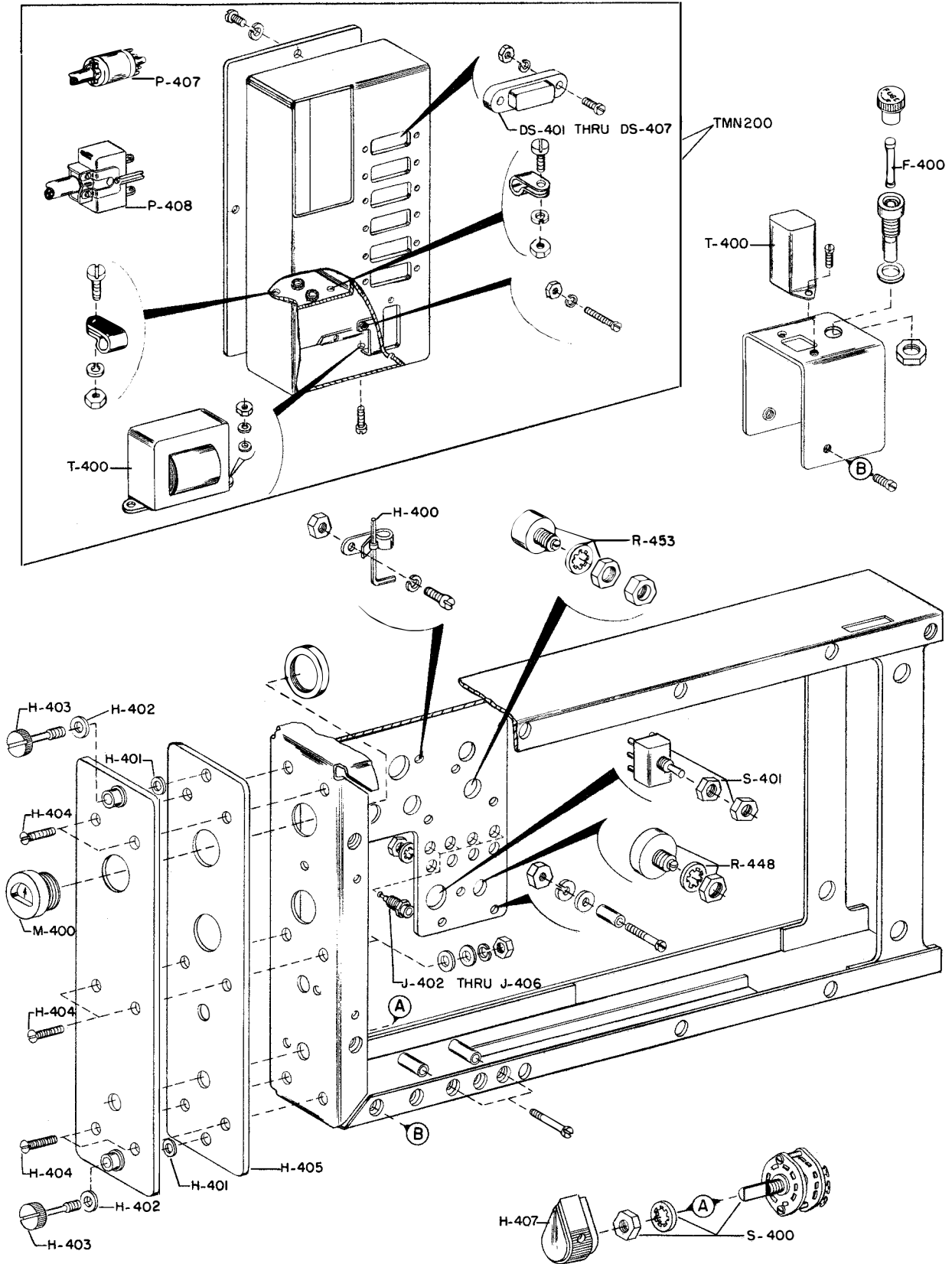


Figure 6-34 Output Amplifier, TMXU 201

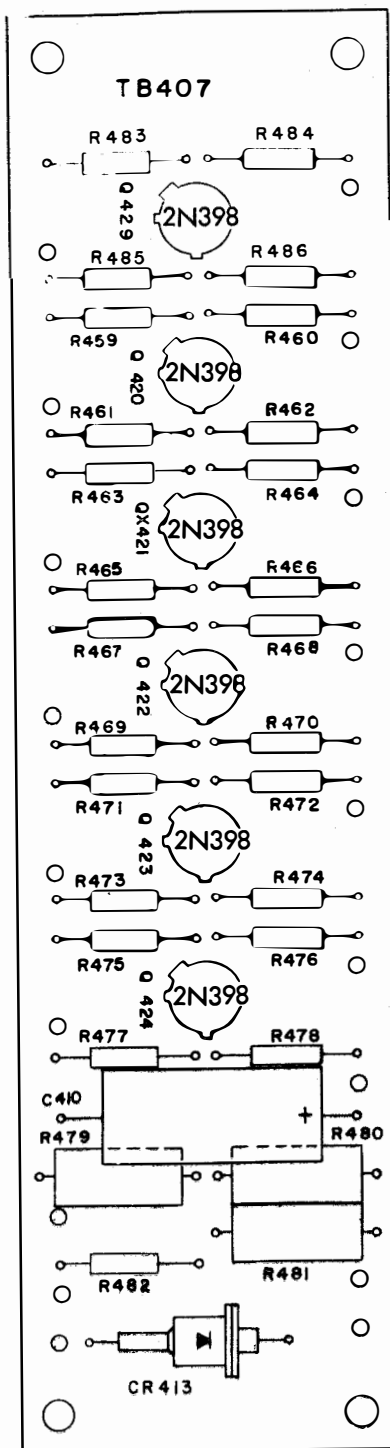
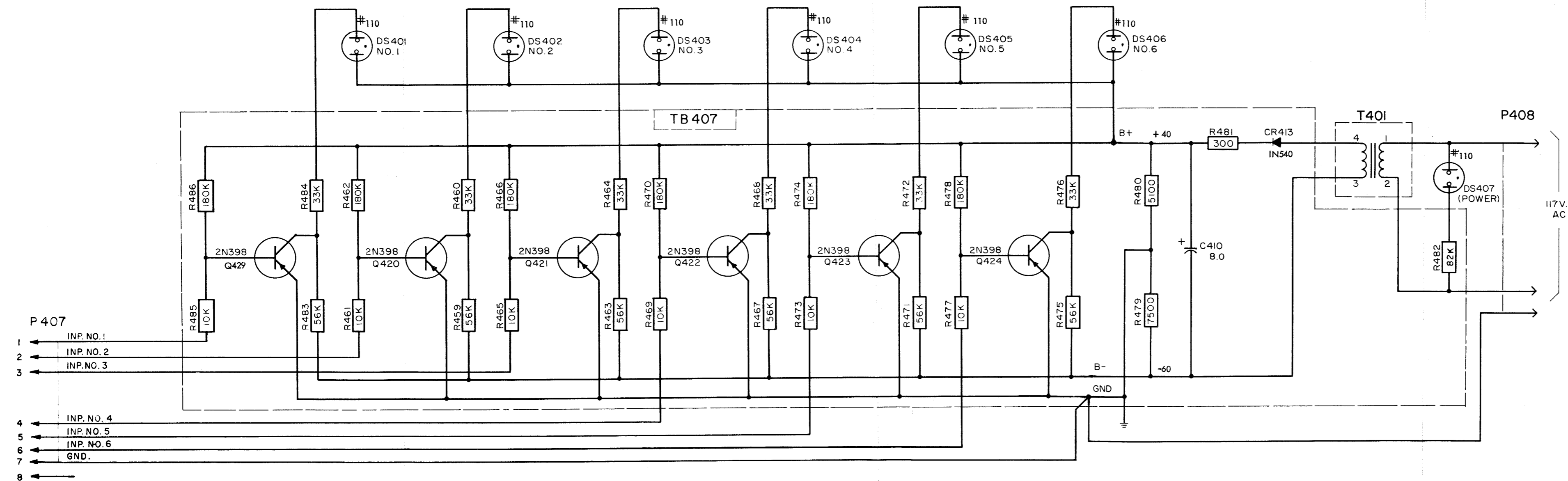


Figure 6-35 Circuit Board, TB 407



NOTES
 1-UNLESS OTHERWISE INDICATED,RESISTANCE VALUES ARE IN OHMS AND CAPACITANCE VALUES ARE IN MICROFARADS (UF).
 2-ON SOME EARLY MODELS THE FOLLOWING NUMBERING ERRORS APPEARED:

CORRECT NO.	INCORRECT NO.
R 483	R 455
R 484	R 456
R 485	R 457
R 486	R 458
CR 413	CR 412

Figure 6-36 Schematic Wiring Diagram
 Neon Lamp Indicator TMN 200
 6-43; 6-44

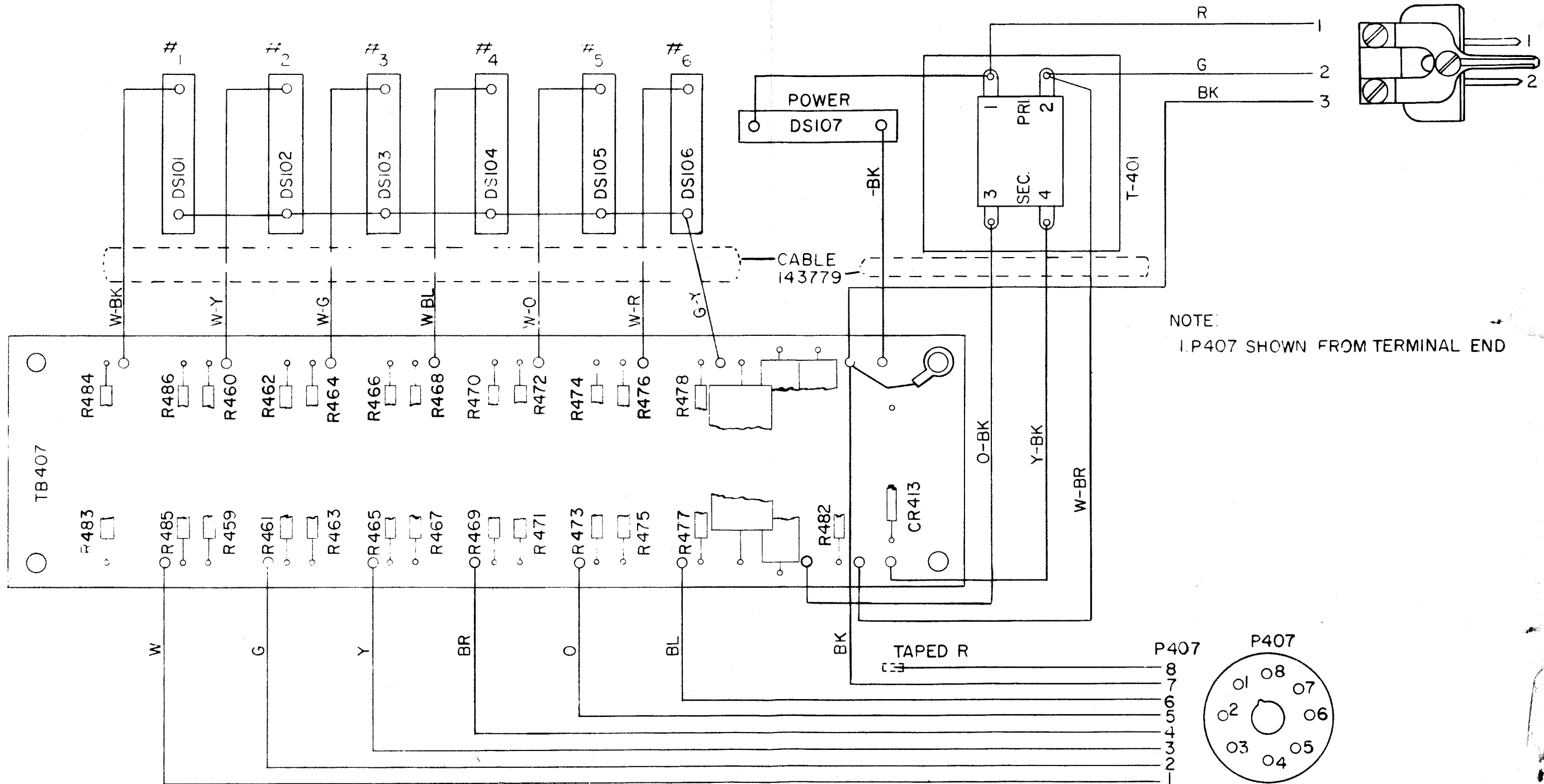


Figure 6-37 Actual Wiring Diagram Neon Lamp Indicator TMN 200

NOTES																							
1A	<p>WIRING LEGEND:</p> <p>DISTANT TERMINATING AREA DISTANT TERMINAL DESIGNATION WIRE COLOR CODE</p> <p>A-1, B-2-W</p>																						
1B	<p>TERMINAL DESIGNATIONS ENCLOSED IN PARENTHESIS ARE NOT MARKED ON COMPONENTS.</p>																						
2.	<p>COLOR CODE:</p> <table border="0"> <tr><td>BK</td><td>BLACK</td></tr> <tr><td>BL</td><td>BLUE</td></tr> <tr><td>BR</td><td>BROWN</td></tr> <tr><td>G</td><td>GREEN</td></tr> <tr><td>O</td><td>ORANGE</td></tr> <tr><td>P</td><td>PURPLE</td></tr> <tr><td>R</td><td>RED</td></tr> <tr><td>S</td><td>SLATE</td></tr> <tr><td>Y</td><td>YELLOW</td></tr> <tr><td>W</td><td>WHITE</td></tr> <tr><td>V</td><td>VIOLET</td></tr> </table>	BK	BLACK	BL	BLUE	BR	BROWN	G	GREEN	O	ORANGE	P	PURPLE	R	RED	S	SLATE	Y	YELLOW	W	WHITE	V	VIOLET
BK	BLACK																						
BL	BLUE																						
BR	BROWN																						
G	GREEN																						
O	ORANGE																						
P	PURPLE																						
R	RED																						
S	SLATE																						
Y	YELLOW																						
W	WHITE																						
V	VIOLET																						
3.	<p>ALL TERMINALS AS VIEWED FROM SOLDERED END</p>																						

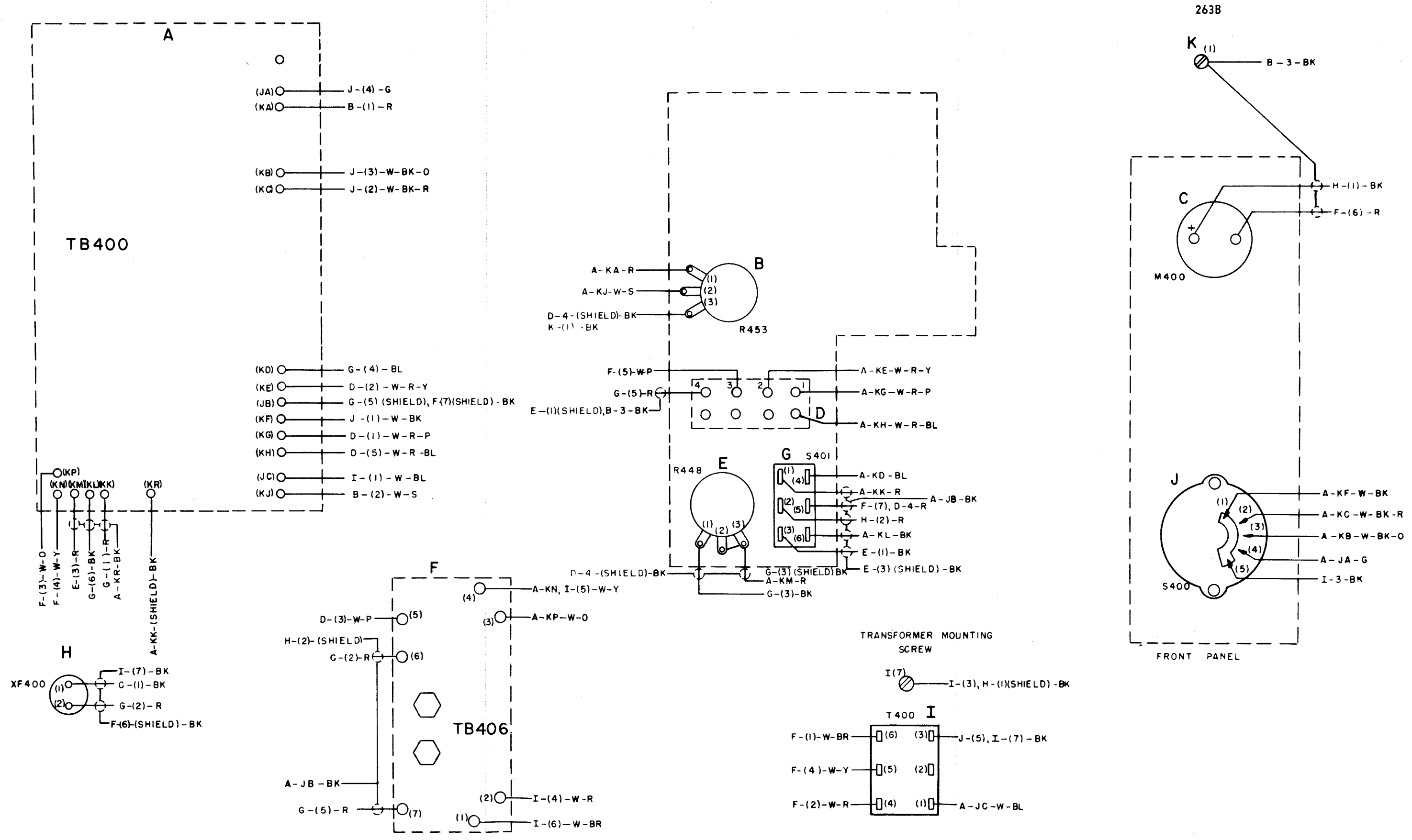


Figure 6-38 Cable Assembly Output Amplifier, TMXU 201 6-47; 6-48

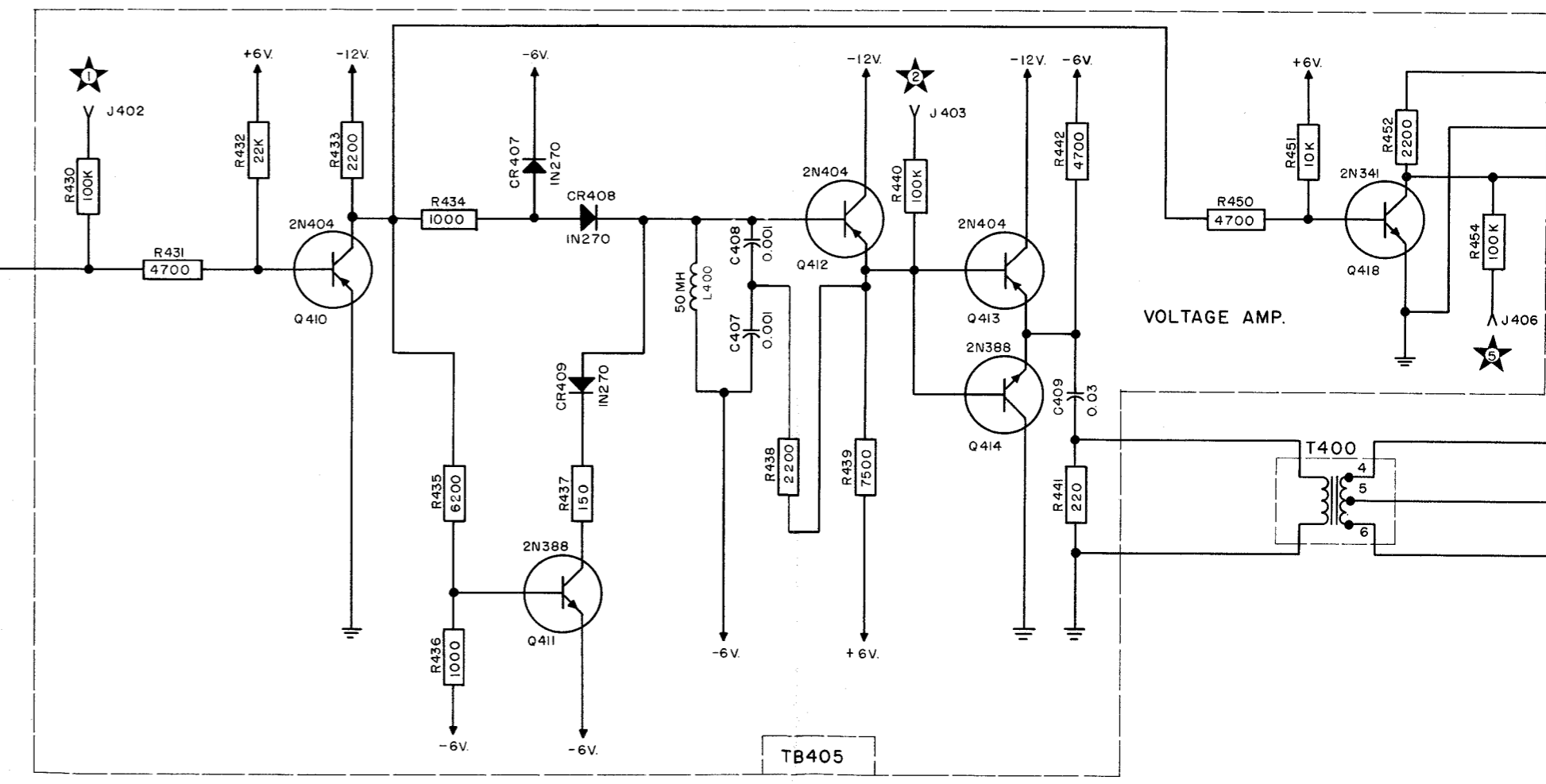
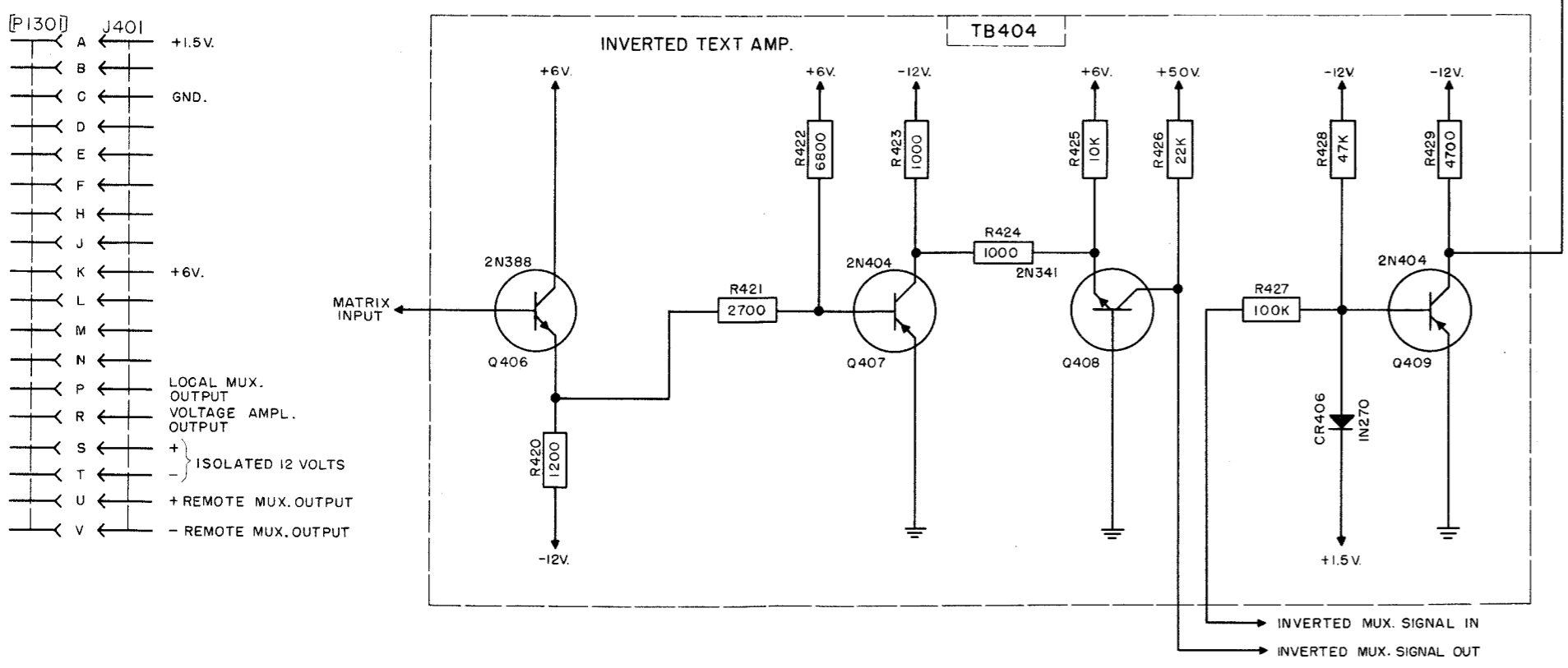
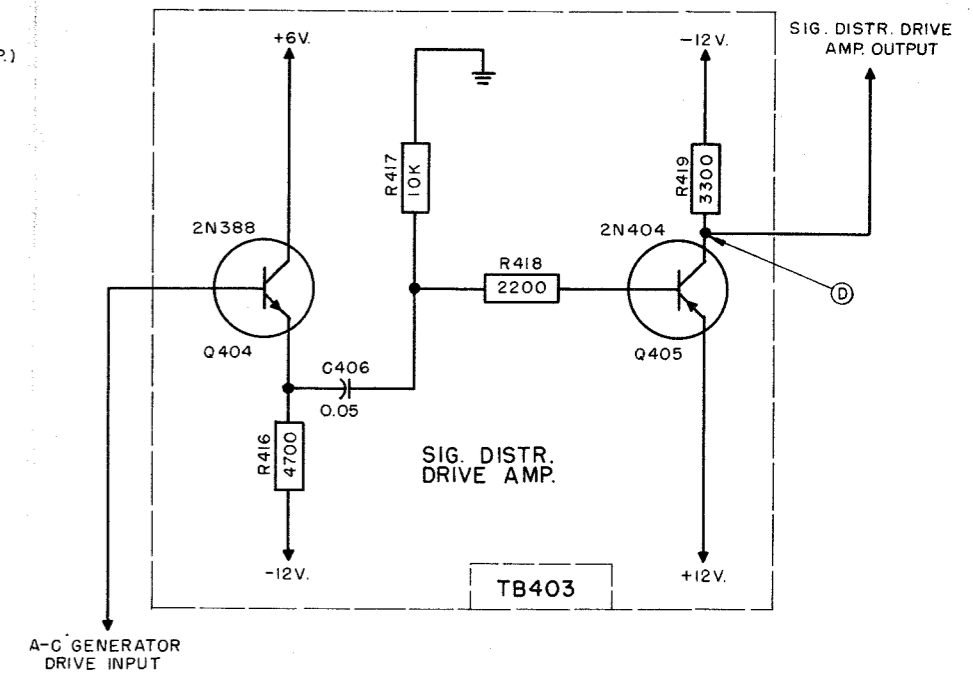
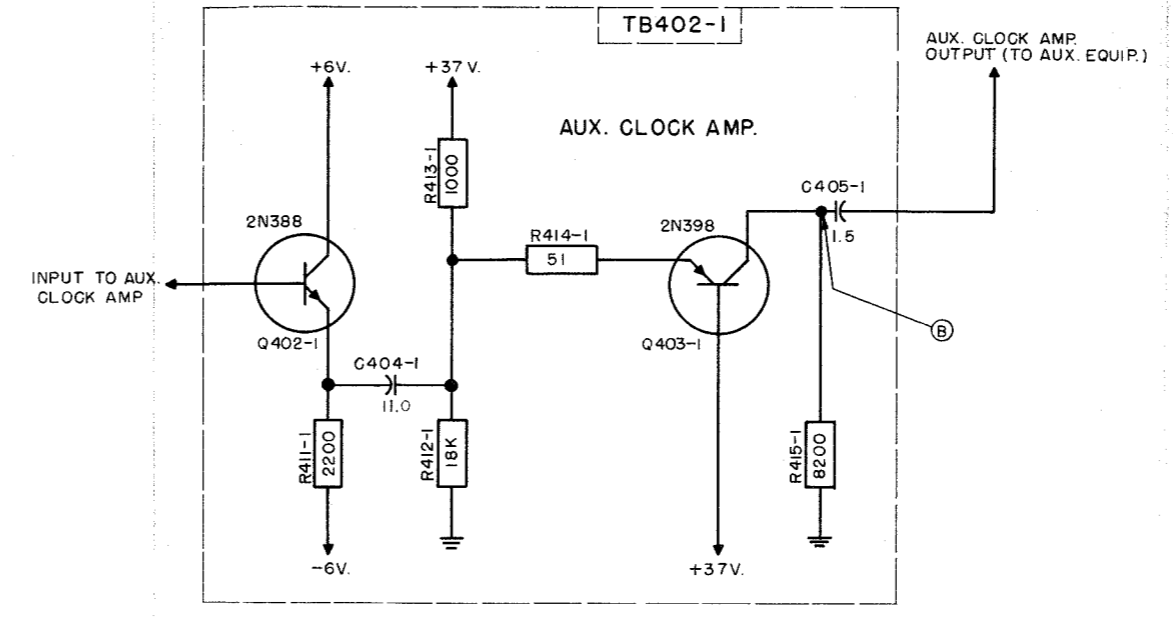
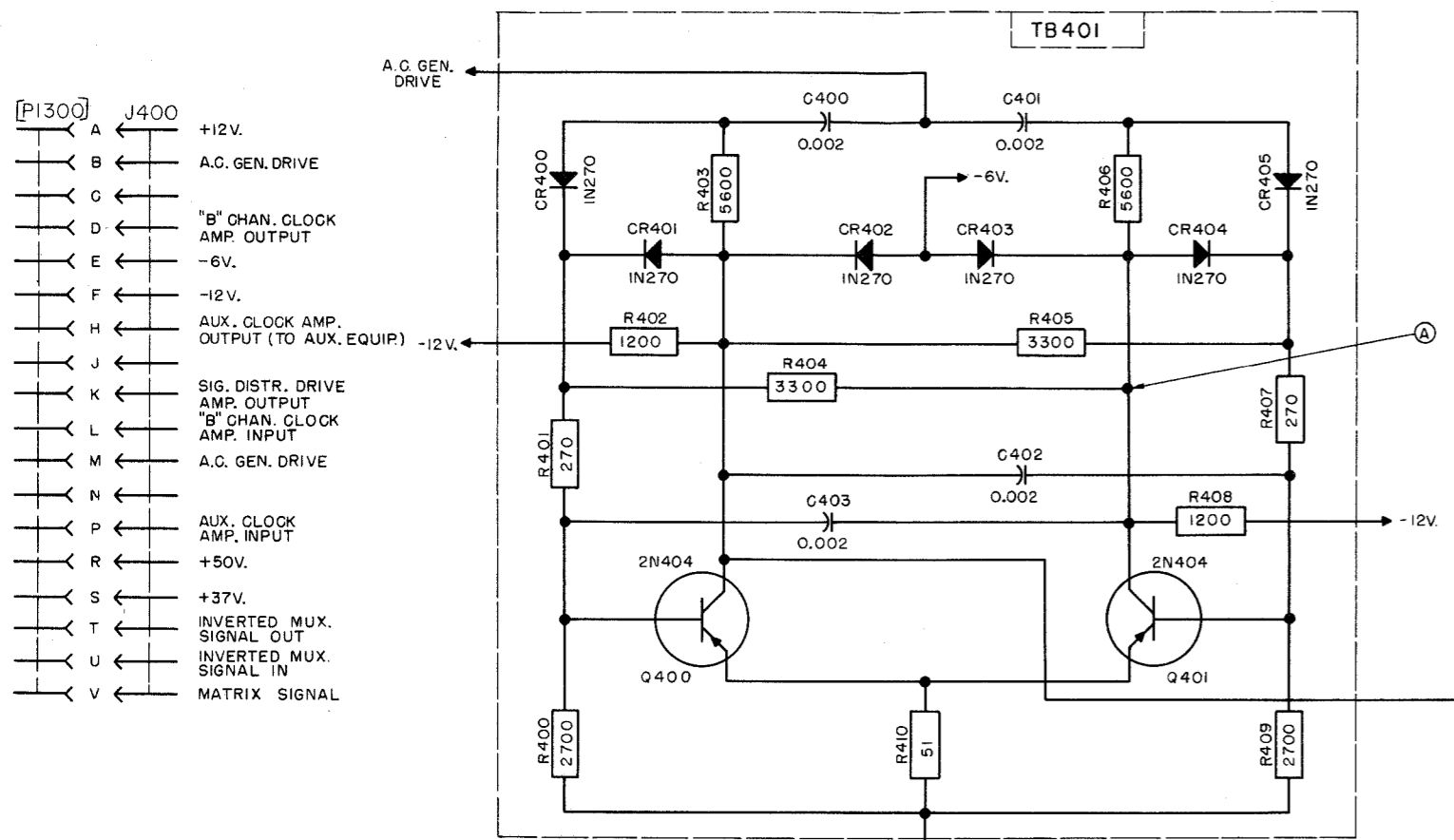


Figure 6-39 Schematic Wiring Diagram Output Amplifier TMXU 201

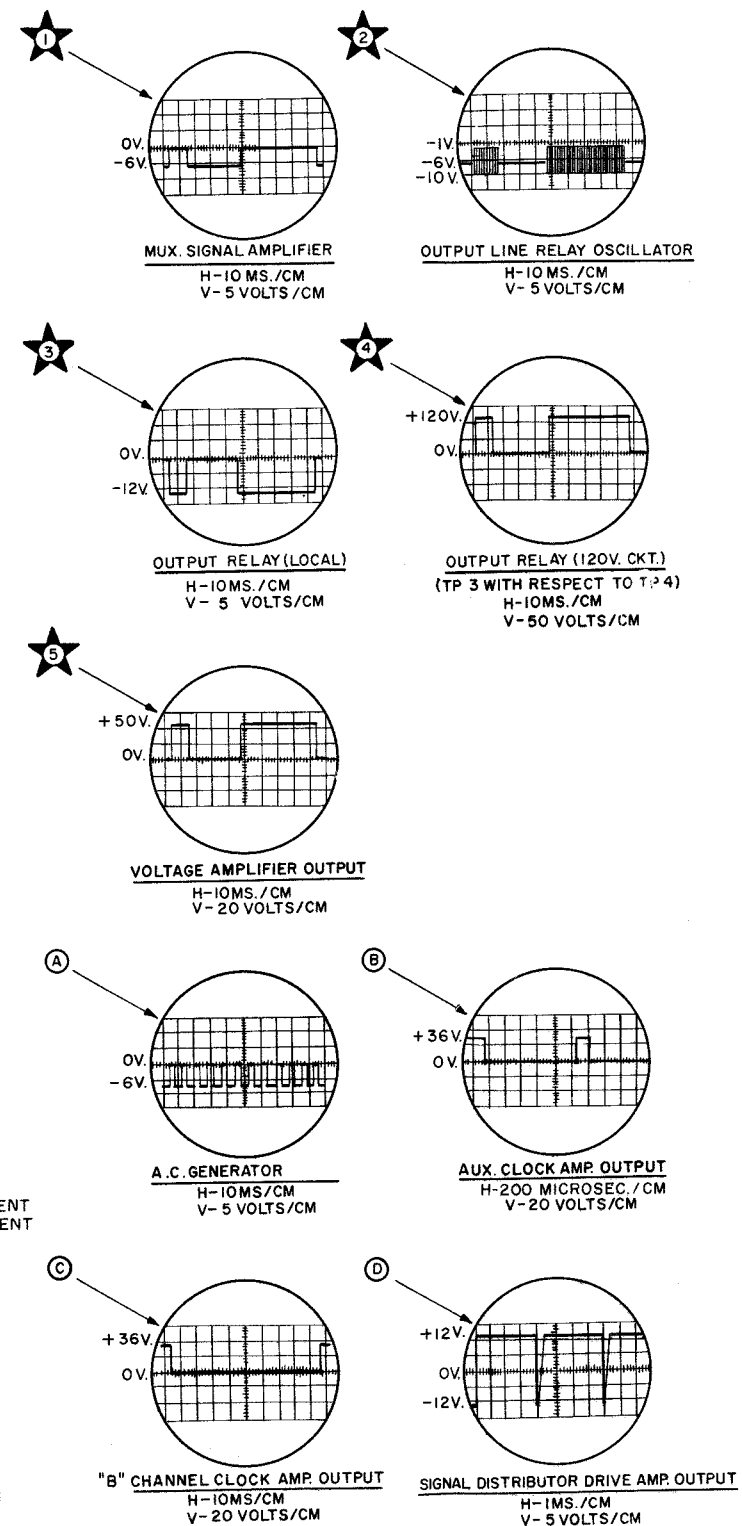
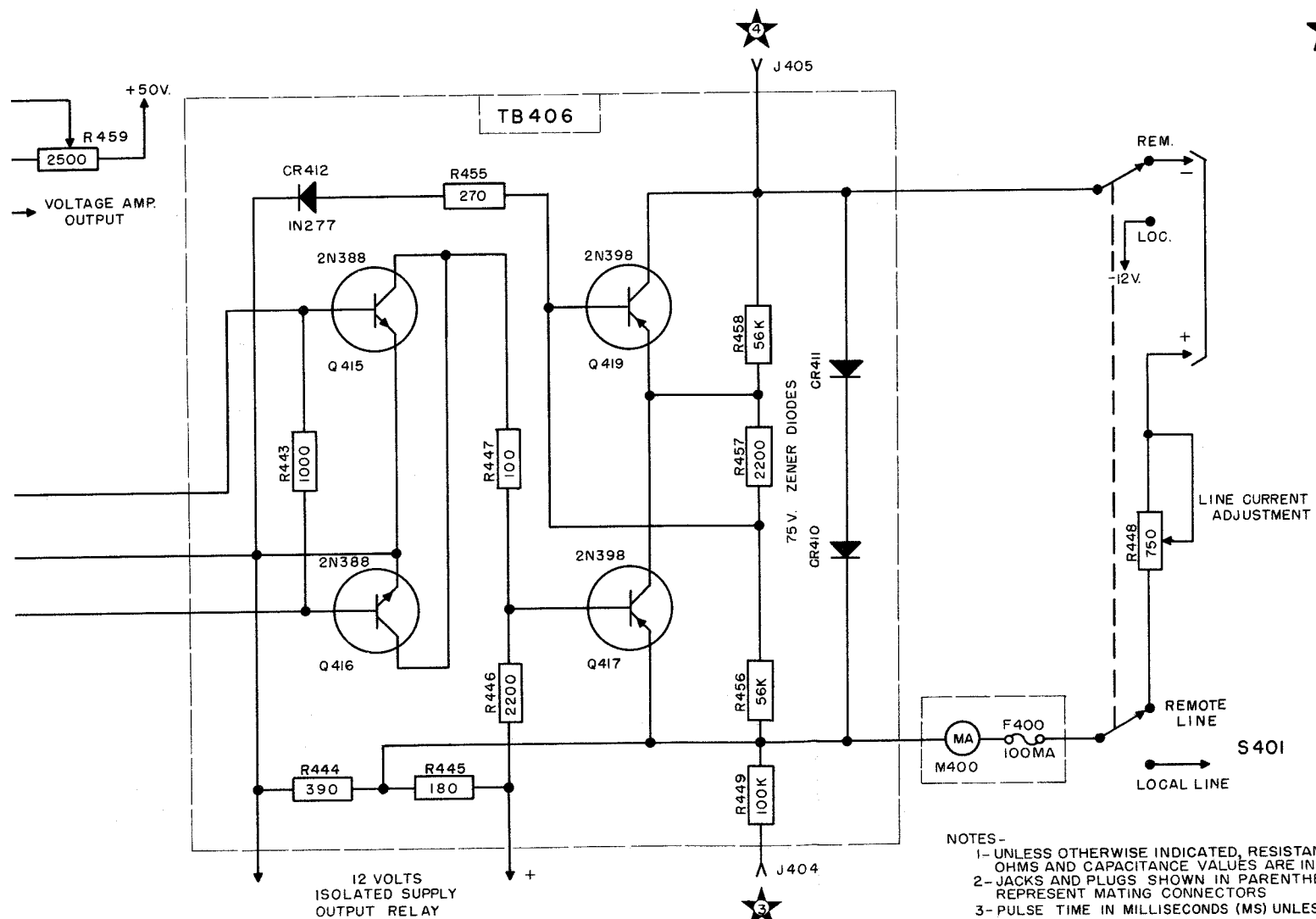
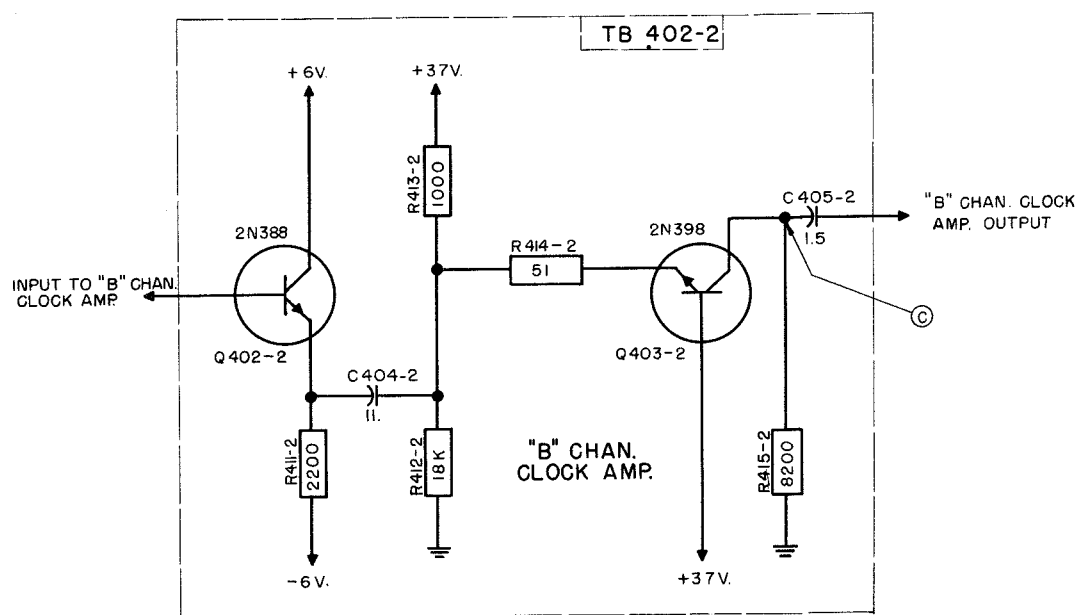
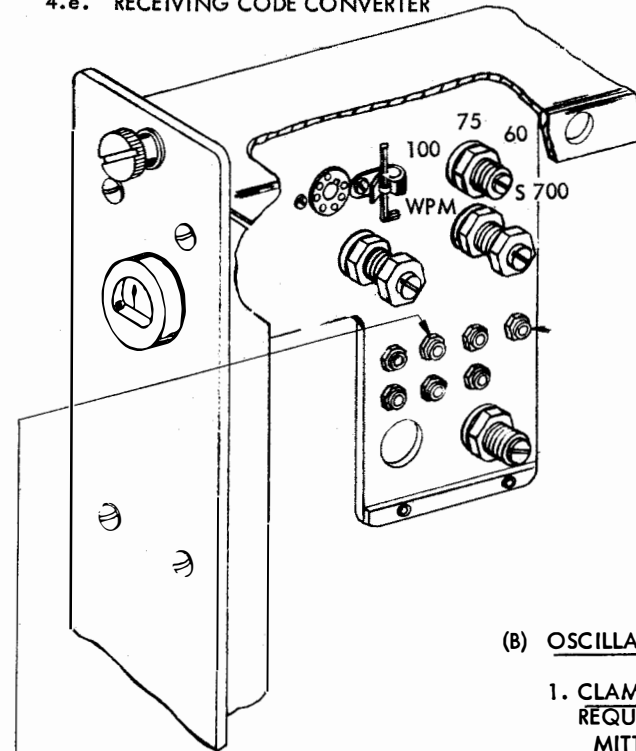


Figure 6-39 Schematic Wiring Diagram
Output Amplifier TMXU 201

- NOTES-
- 1- UNLESS OTHERWISE INDICATED, RESISTANCE VALUES ARE IN OHMS AND CAPACITANCE VALUES ARE IN MICROFARADS (UF).
 - 2- JACKS AND PLUGS SHOWN IN PARENTHESIS P1300, J400 ETC. REPRESENT MATING CONNECTORS
 - 3- PULSE TIME IN MILLISECONDS (MS) UNLESS OTHERWISE STATED.

4.e. RECEIVING CODE CONVERTER

(A) LINE CURRENT
CHECK LINE CURRENT
INDICATOR M 700

READJUST R 724 (20 OR
60 MA) AS REQUIRED.

(B) OSCILLATOR (START-STOP)1. CLAMP CONTROL

REQUIREMENT --- WITH A CODE SIGNAL TRANSMITTED TO UNIT AND OSCILLOSCOPE CONNECTED TO TEST POINT #2, FIRST NEGATIVE CYCLE OF WAVEFORM SHOULD HAVE THE SAME AMPLITUDE AS OTHER FIVE NEGATIVE HALF CYCLES.

TO ADJUST --- WITH R 730 VARIABLE RESISTOR (CONTROL SHAFT) LOCK NUT LOOSENED, POSITION THE SHAFT.

2. FEEDBACK CONTROL

REQUIREMENT --- WITH A CODE SIGNAL TRANSMITTED TO UNIT AND OSCILLOSCOPE CONNECTED TO TEST POINT #2, SINUSOIDAL WAVEFORM SHOULD HAVE A MINIMUM AMOUNT OF DISTORTION.

TO ADJUST --- WITH R 740 VARIABLE RESISTOR (CONTROL SHAFT) LOCK NUT LOOSENED, POSITION THE CONTROL SHAFT.

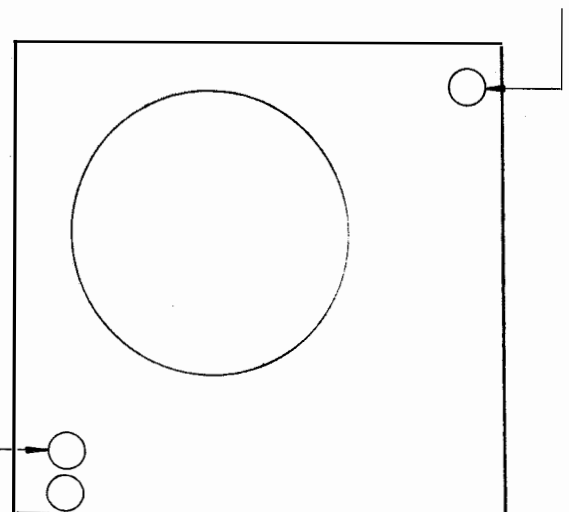
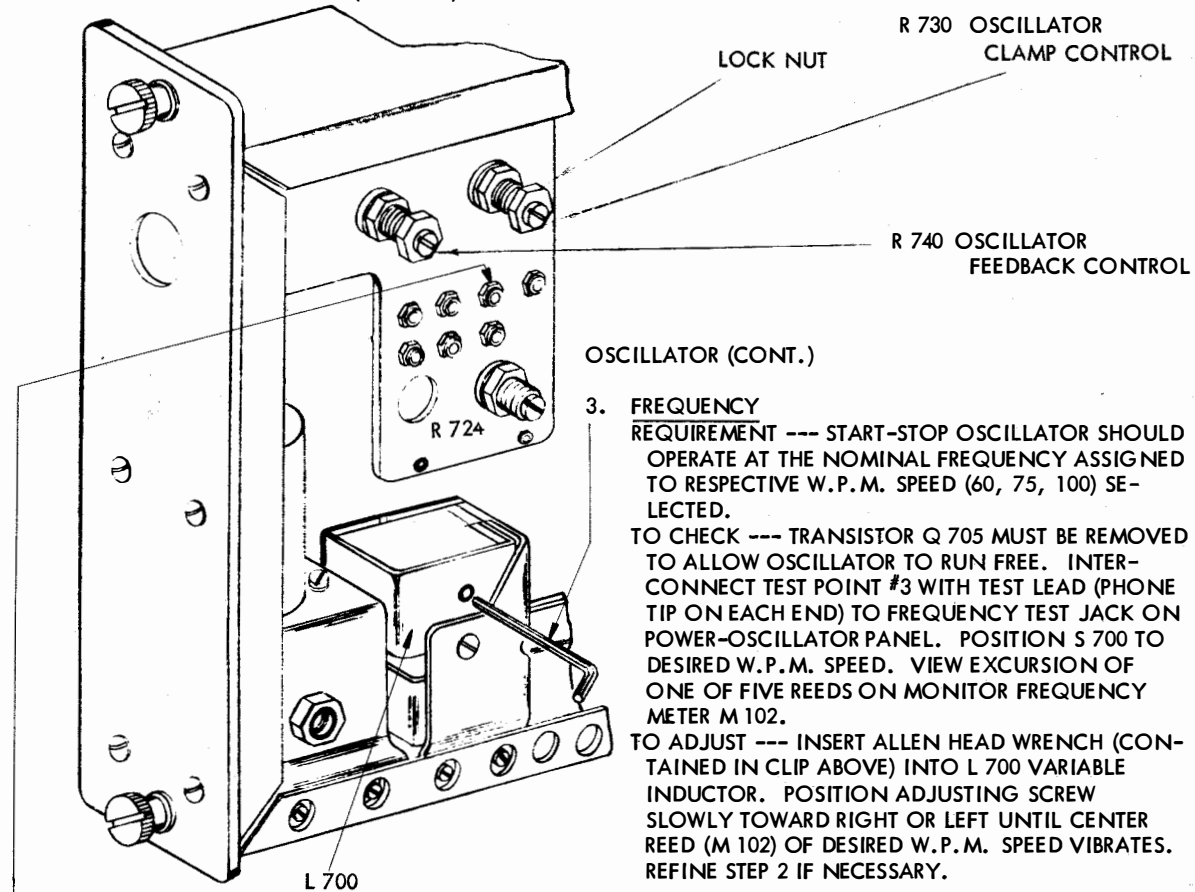


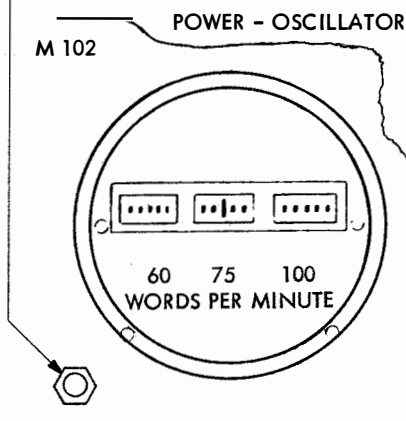
Figure 6-40 Oscillator, Adjustment

RECEIVING CODE CONVERTER (CONTD.)



NOTE --- REMOVING WRENCH WILL CAUSE FREQUENCY TO DECREASE - MAKE ALLOWANCE

(D) VISUAL SIGNAL INDICATOR - TMN 200



GENERAL --- A VISUAL INDICATION OF THE PRESENCE OF MARKING OR SPACING PULSES (6 LEVEL) GENERATED BY THE CODE CONVERTER IS PROVIDED BY THE NEON SIGNAL INDICATOR. THE LAMP ASSEMBLY IS LOCATED IN THE OUTPUT AMPLIFIER DRAWER. AMPLE LEAD LENGTH IS PROVIDED TO REACH ANY DRAWER; HOWEVER, THE UNIT MAY BE REMOVED WHEN DESIRED.

PROCEDURE --- INSERT (115 VOLT 60 CYCLE) CORD INTO A CONVENIENT RECEPTACLE. --- NOTE GROUND TERMINAL. CORD WITH OCTAL PLUG CONNECTED TO J 706 ON EACH DRAWER.

Figure 6-41 Oscillator, Frequency Adjustment

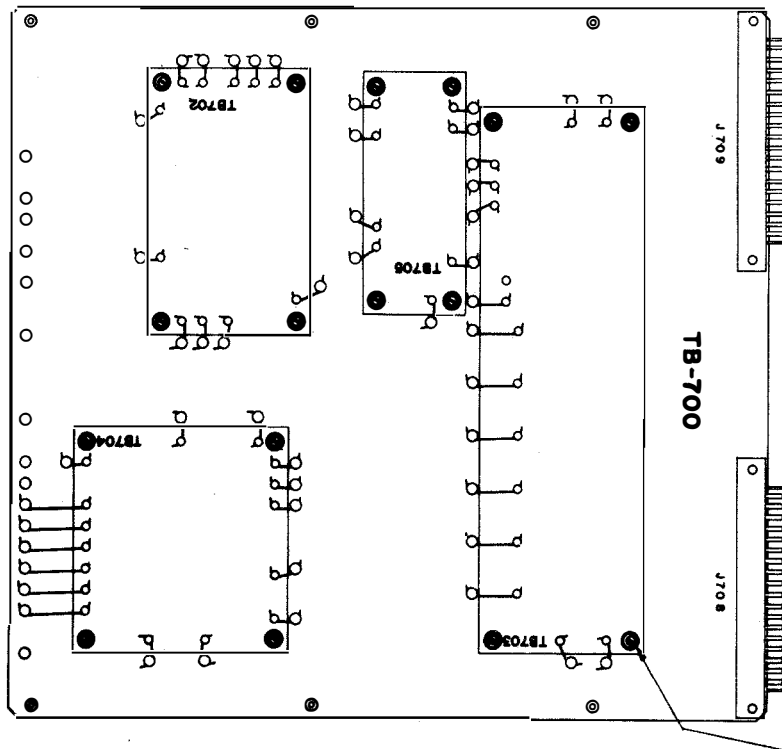
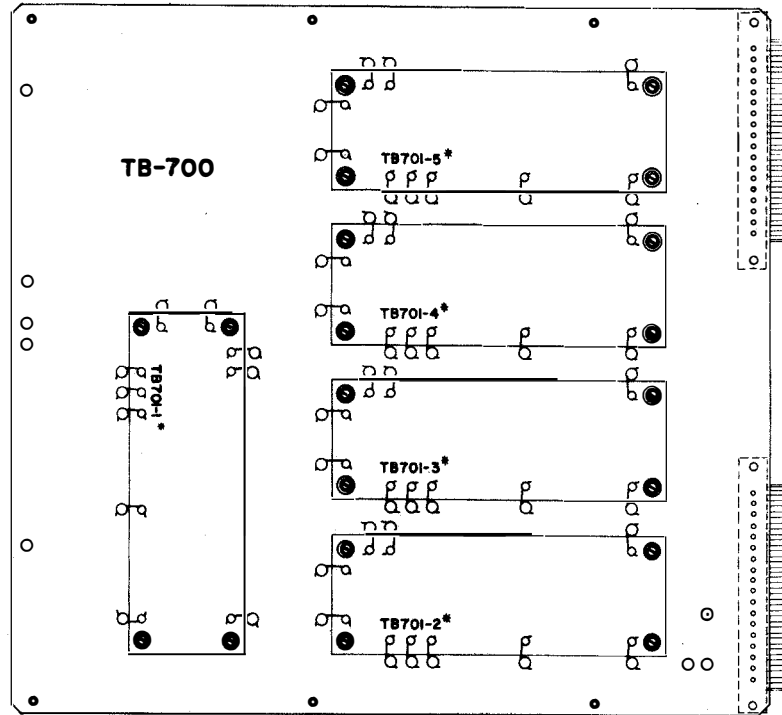
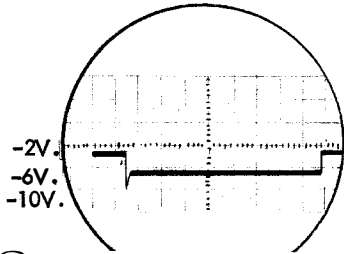
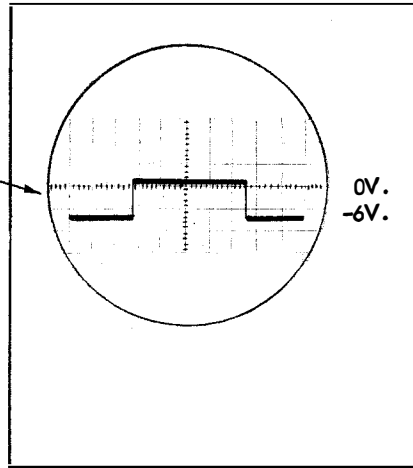


Figure 6-42 Circuit Board TB 700

RECEIVING CODE CONVERTER

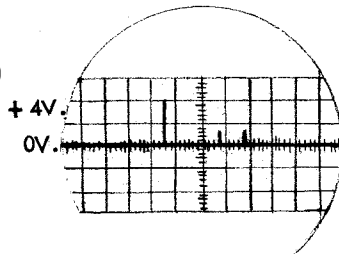
TP (A) NORMAL "ON" SIDE OF NO. 1 STORAGE ELEMENT (Q703-1)

H - 10 Milliseconds / CM
V - 5 Volts / CM



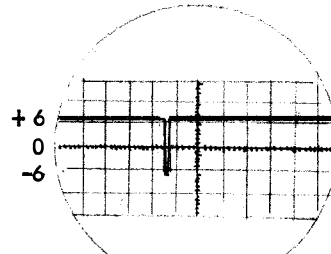
TP (B) START-STOP OUTPUT, LINE RELAY DRIVE AMPLIFIER (Q712)

H - 10 Milliseconds / CM
V - 5 Volts / CM



TP (C) NEGATIVE CLAMP

H - 2 Milliseconds / CM
V - 2 Volts / CM



TP (D) DRIVE AMPLIFIER

H - 2 Milliseconds / CM
V - 5 Volts / CM

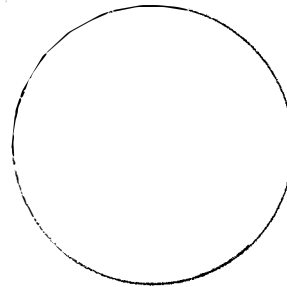
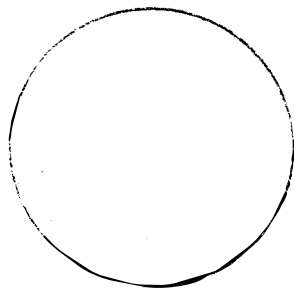
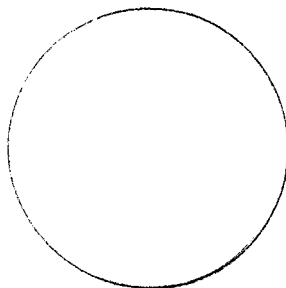
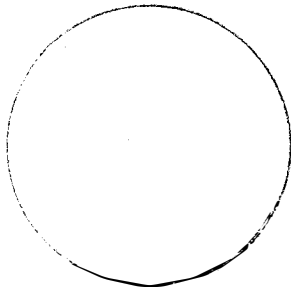


Figure 6-43 Wave-forms

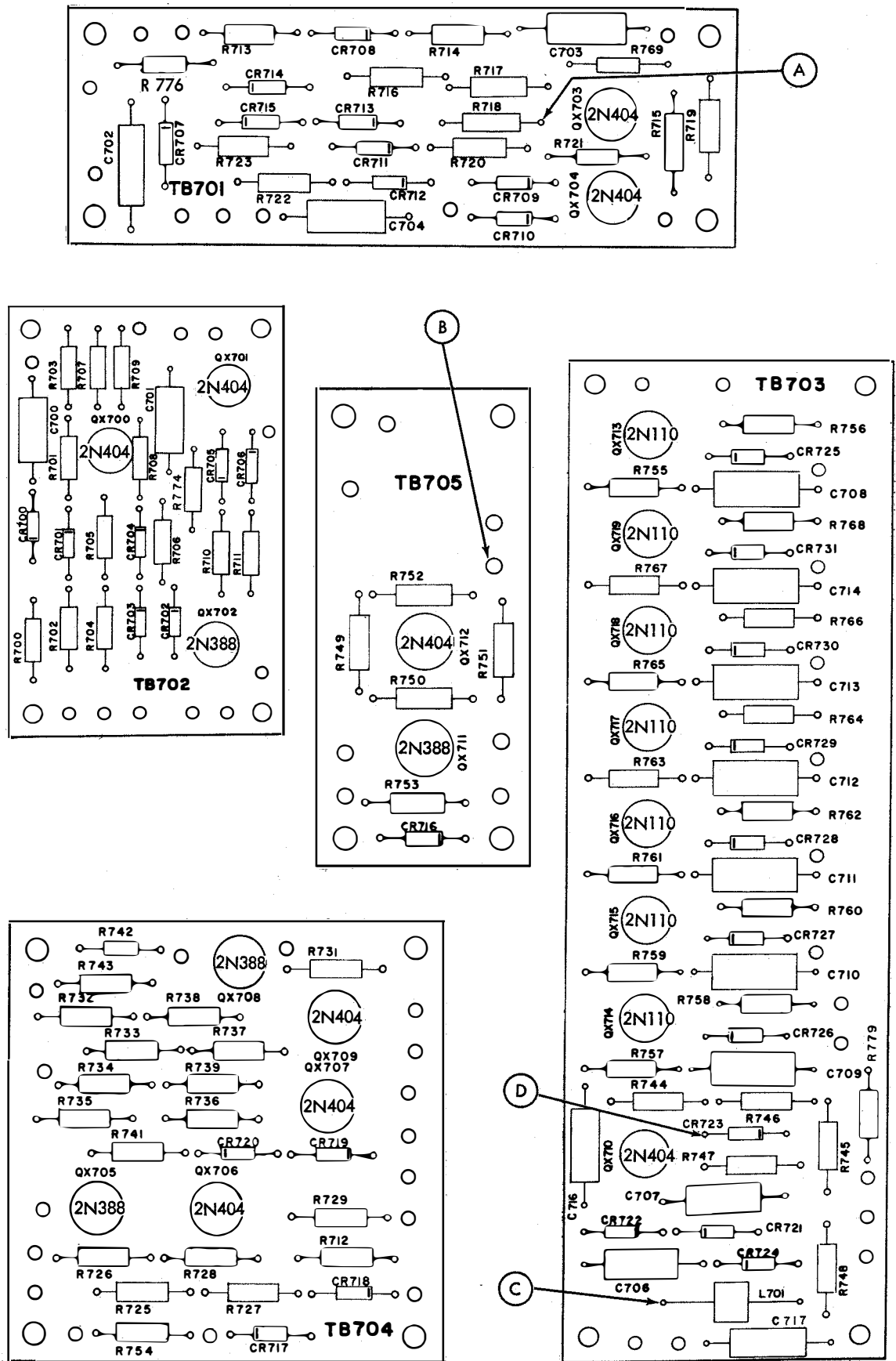


Figure 6-44 Circuit Boards, TB 701, TB 702, TB 703, TB 704, TB 705

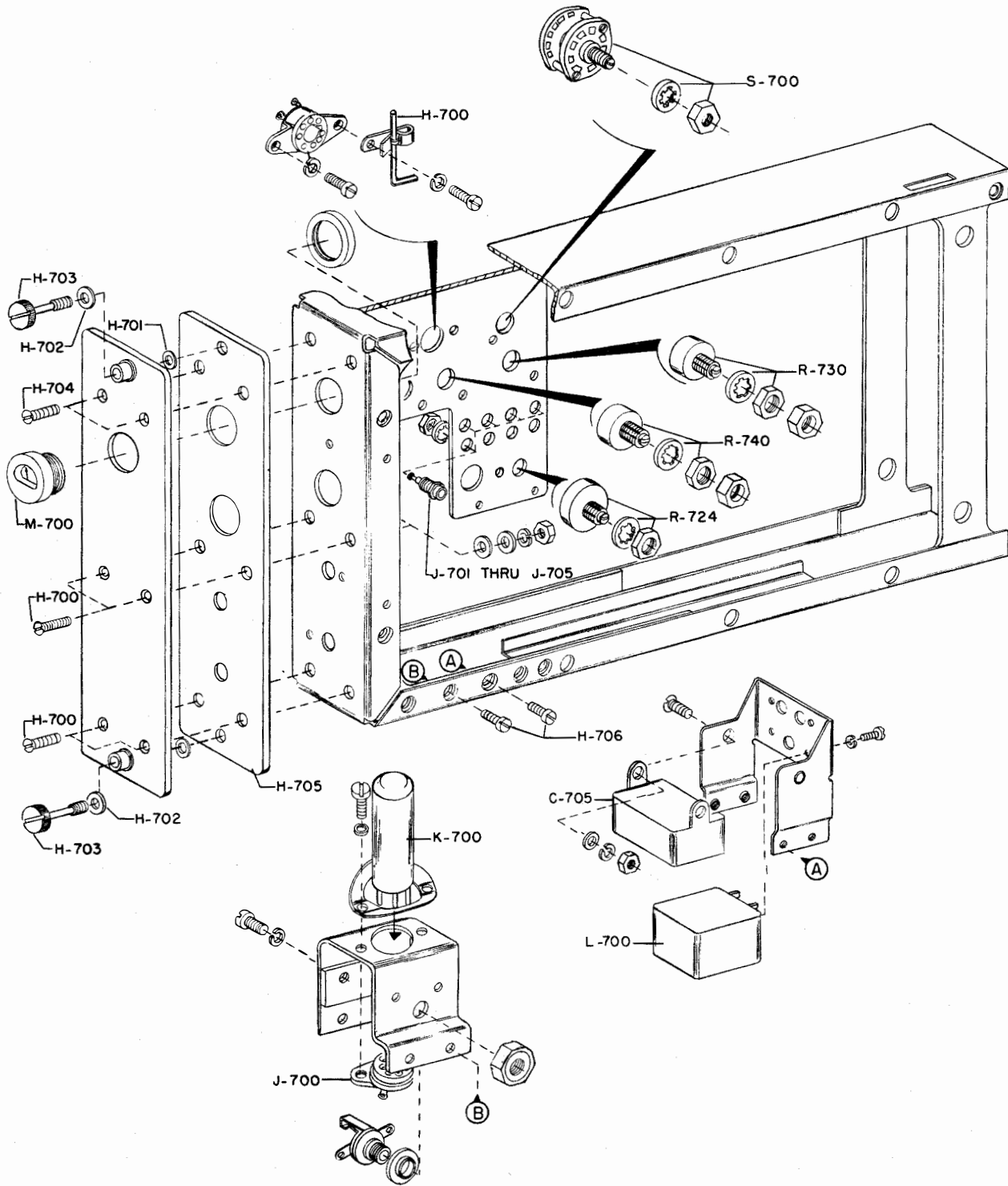
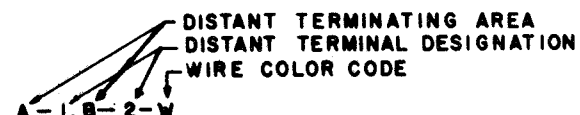


Figure 6-45 Receiving Code Converter

NO	NOTES
1A	WIRING LEGEND: 
1B	TERMINAL DESIGNATIONS ENCLOSED IN PARENTHESIS ARE NOT MARKED ON COMPENTS.
2.	COLOR CODE: BK BLACK BL BLUE BR BROWN G GREEN O ORANGE P PURPLE R RED S SLATE Y YELLOW W WHITE V VIOLET
3.	ALL TERMINALS AS VIEWED FROM SOLDERED END EXCEPT TERMINALS IN AREA "A" WITH PREFIX "C".
4.	AREAS "C" AND "K", TERMINALS "A" THROUGH "D" ARE SOCKET SIDE PINS.

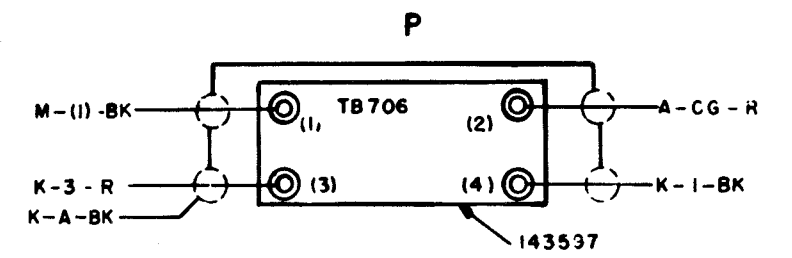
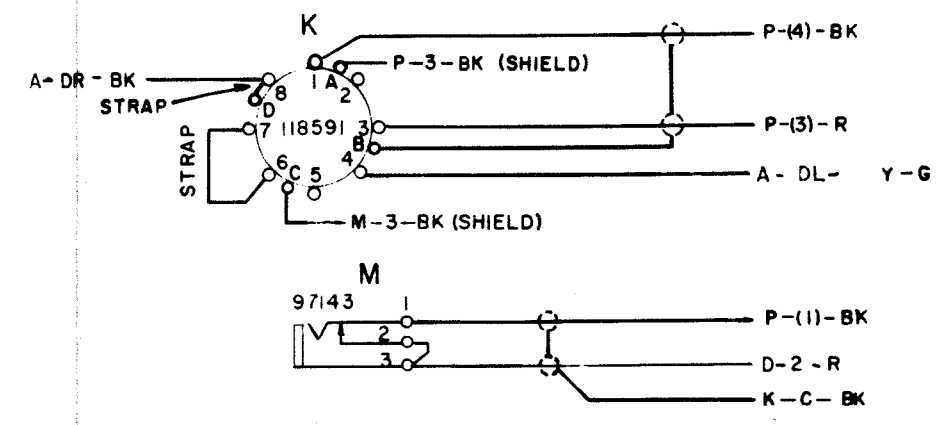
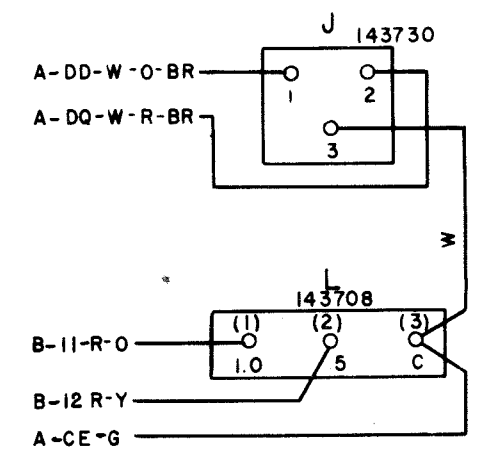
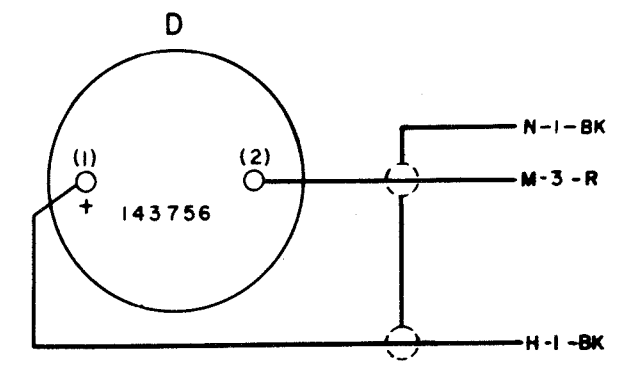
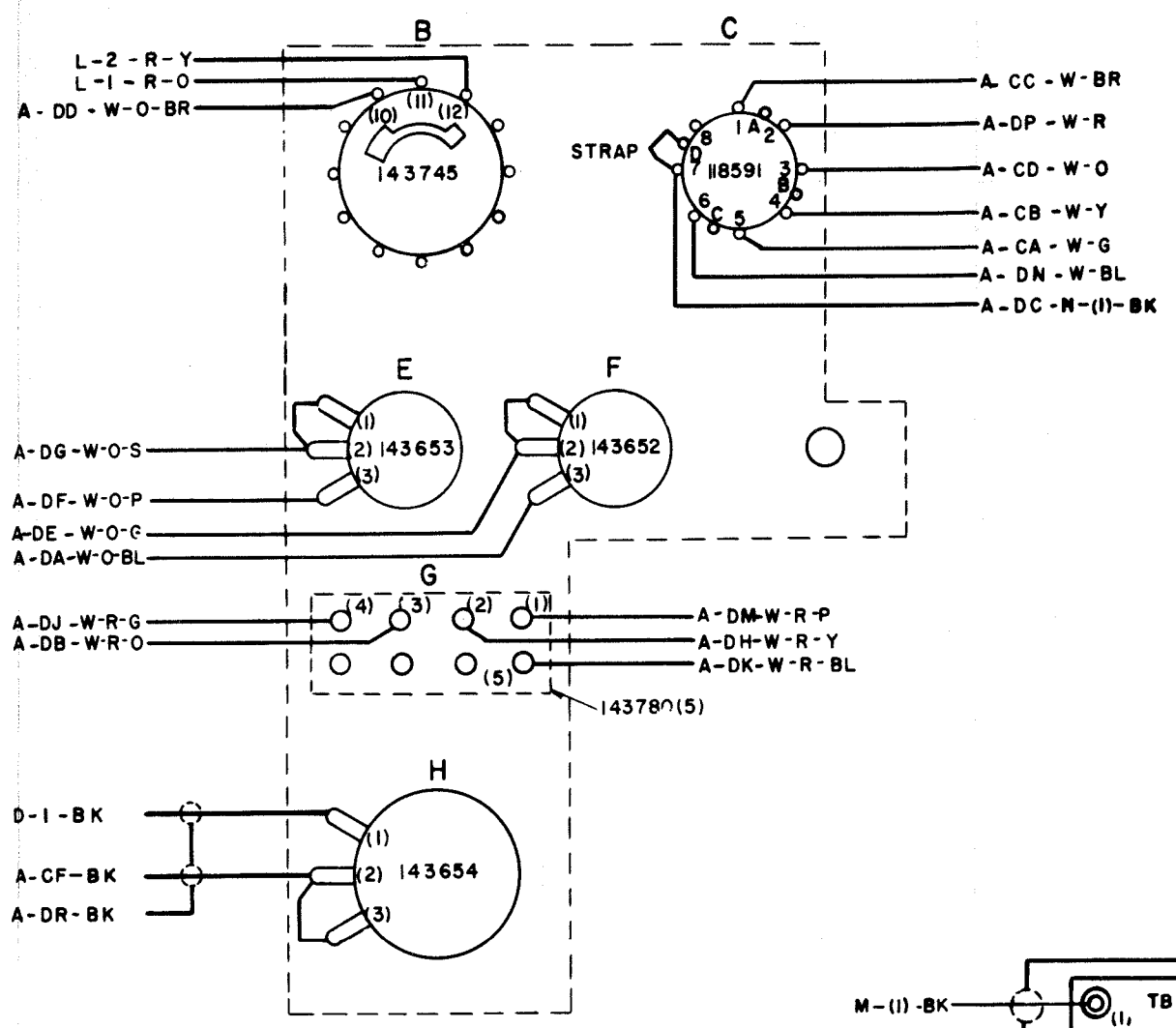
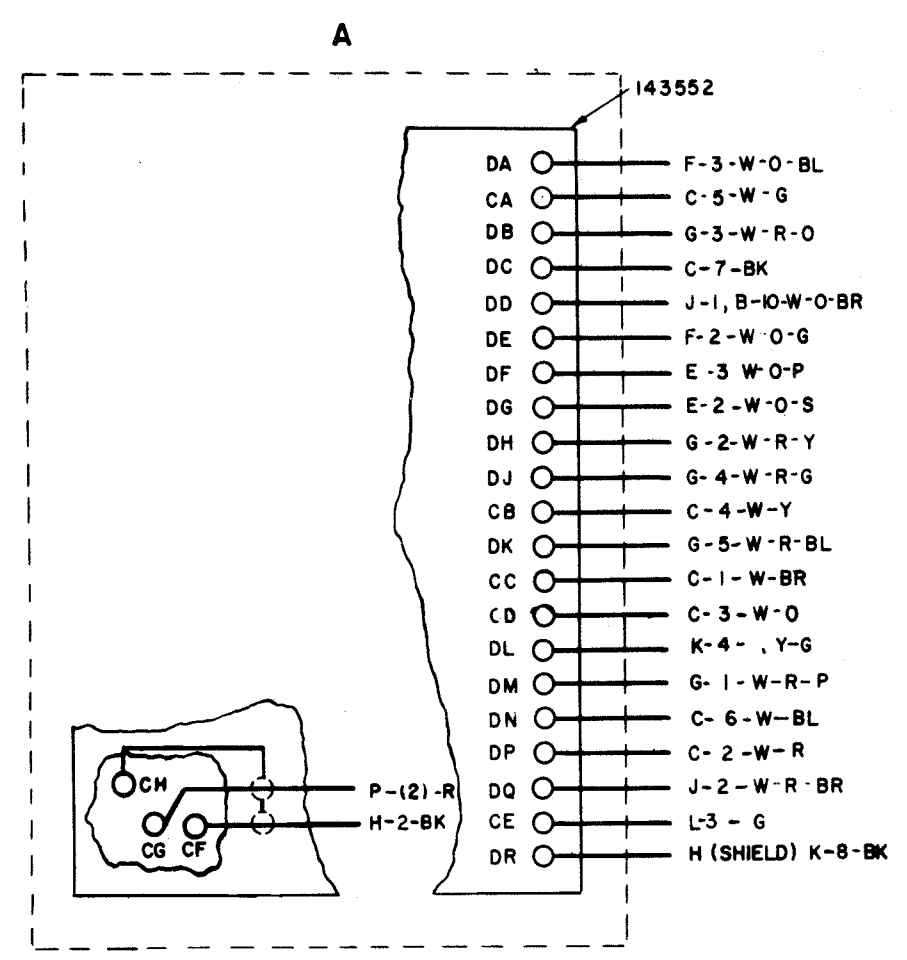


Figure 6-46 Cable Assembly Receiving Code Converter 6-57; 6-58

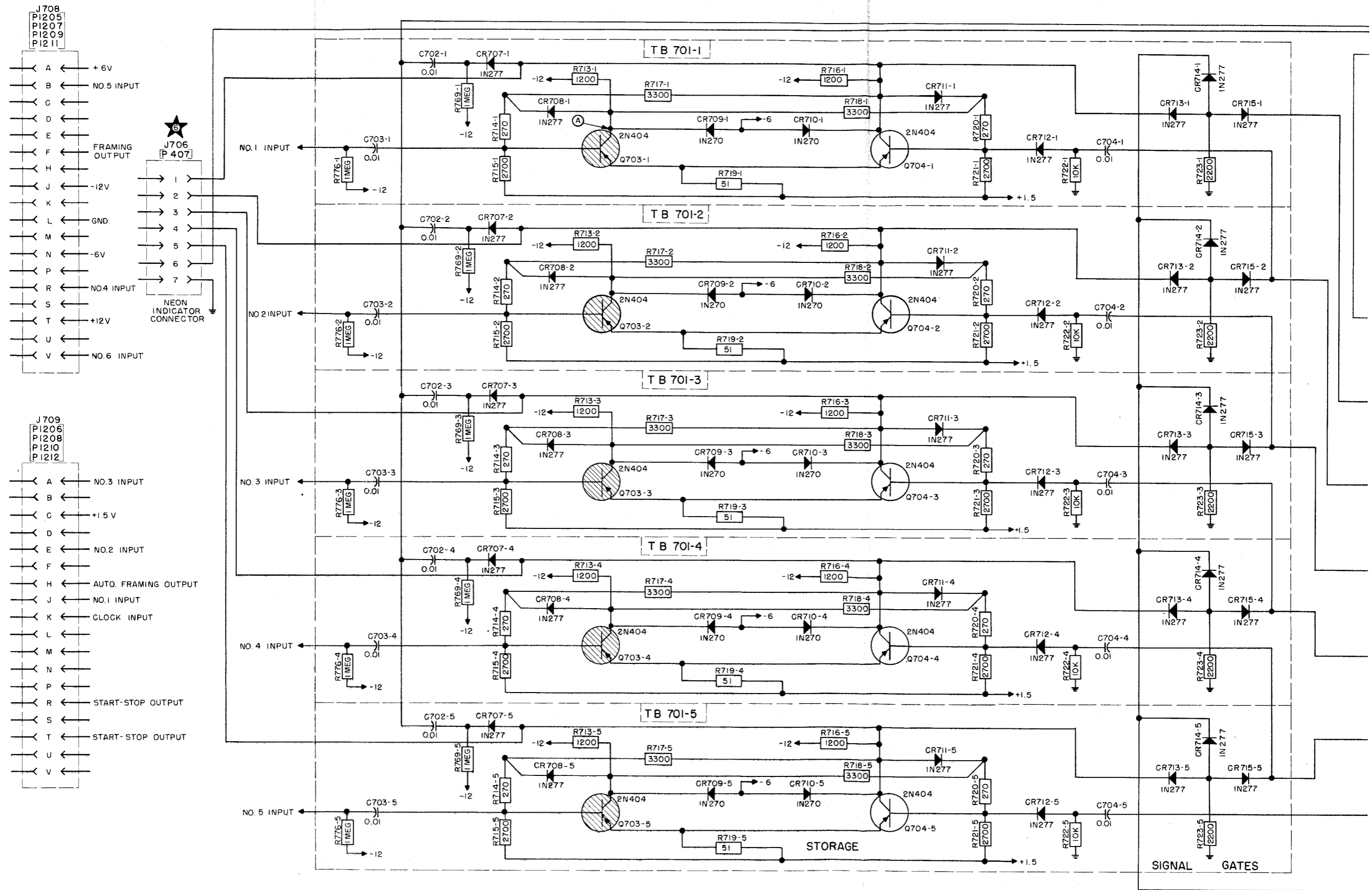


Figure 6-47 Schematic Wiring Diagram Receiving Code Converter TMCR 201

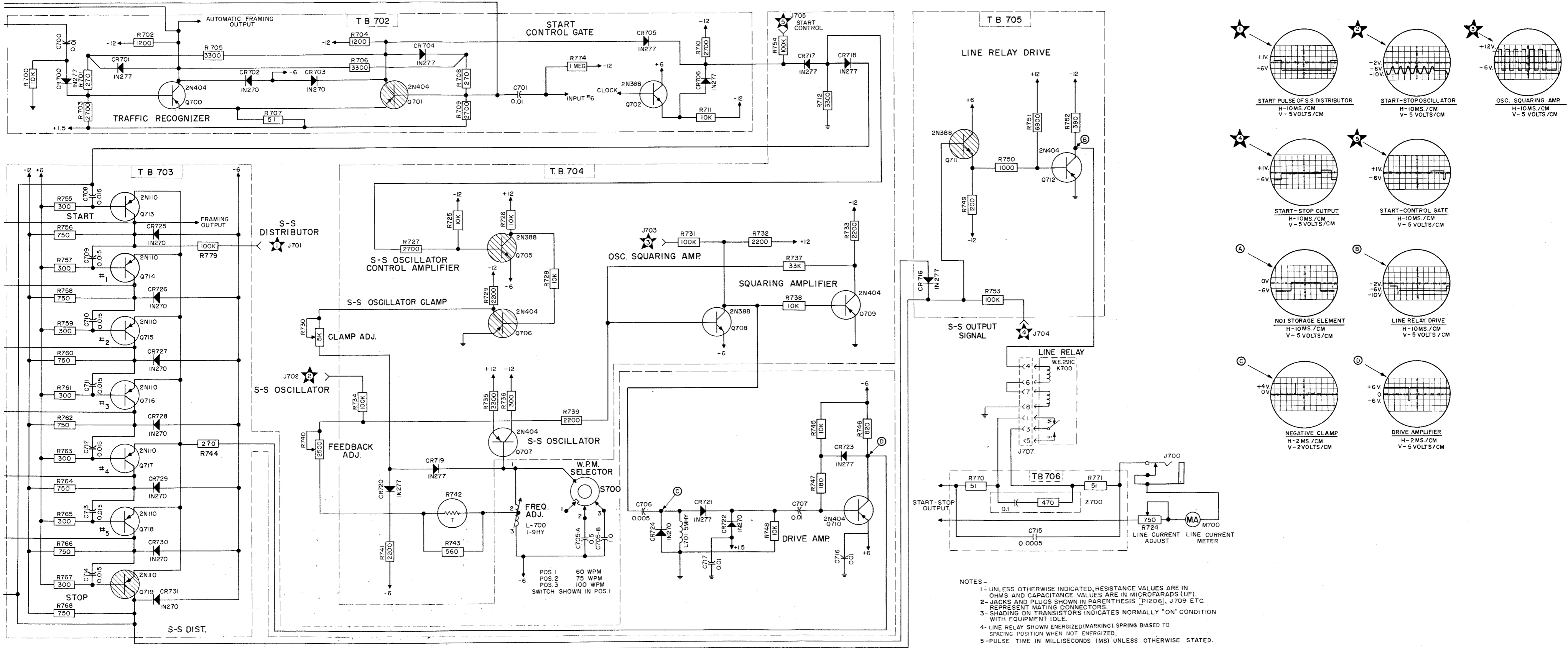
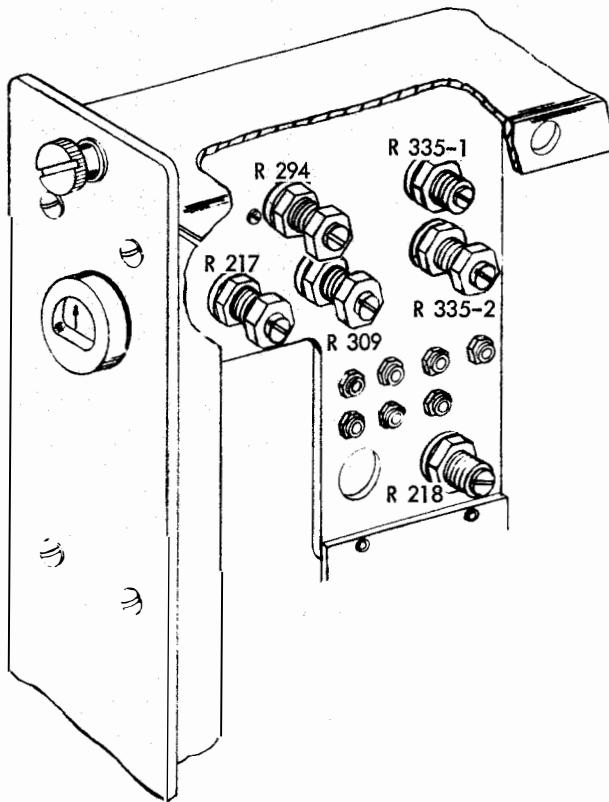


Figure 6-47 Schematic Wiring Diagram
Receiving Code Converter TMCR 201



A. SLICING LEVEL

REQUIREMENTS FOR 60 MA OPERATION --

- (1) WITH SWITCH S 200 IN ITS REMOTE POSITION AND A STEADY MARKING CONDITION RECEIVED FROM THE EXTERNAL BATTERY, METER M 200 SHOULD INDICATE A CURRENT OF 30 MA.

TO ADJUST --- WITH RHEOSTAT R 218 (CONTROL SHAFT) LOCK NUT LOOSENED, TURN SHAFT TOWARD THE RIGHT OR LEFT.

- (2) WITH OSCILLOSCOPE CONNECTED TO COLLECTOR OF Q210, SHAFT OF POTENTIOMETER R 218 SHOULD BE POSITIONED SO THAT COLLECTOR VOLTAGE JUST CHANGES FROM 0 TO + 50 VOLTS. TO CHECK REQUIREMENT IT IS NECESSARY TO MAKE ADJUSTMENT.

TO ADJUST --- WITH R 218 (CONTROL SHAFT) LOCK NUT LOOSENED, POSITION THE SHAFT.

REQUIREMENT FOR 20 MA OPERATION --

SAME AS ABOVE EXCEPT EXTERNAL LINE RHEOSTAT ADJUSTED FOR 10 MA (M 200) WHEN RECEIVING A STEADY MARKING CONDITION FROM REMOTE LOOP.

B. CONSTANT CURRENT GENERATORS

REQUIREMENTS --- (SYNCHRONIZER NEED NOT BE IN FRAME).

- (1) WITH SWITCH S 200 (SYNCHRONIZER) AND SWITCH S 401 (OUTPUT AMPLIFIER) IN THEIR LOCAL POSITION, TRANSMIT 4 CHANNEL "A-C" REVERSALS FROM THE OUTPUT AMPLIFIER. INDICATOR M 201 (PHASE CORRECTION METER) SHOULD READ ZERO CURRENT. TO ADJUST --- WITH R 294 AND R 309 (CONTROL SHAFT) LOCK NUT LOOSENED, TURN EACH CONTROL SHAFT FULLY COUNTERCLOCKWISE THEN ADVANCE CONTROLS SLOWLY.

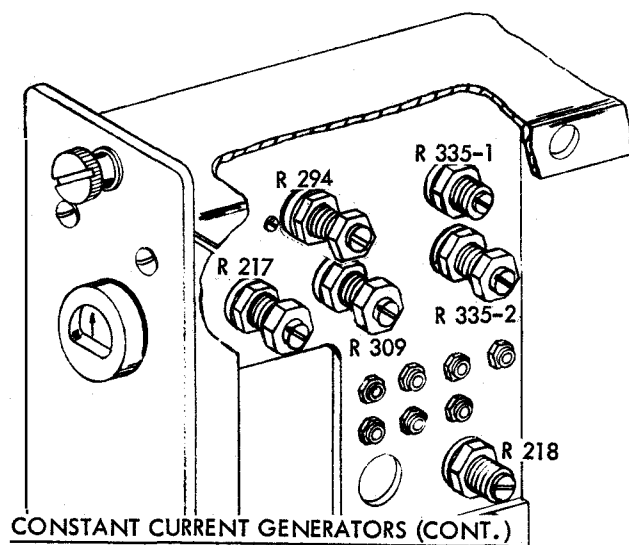
PROCEDURE --- VIEW SIGNAL WITH OSCILLOSCOPE CONNECTED TO TEST POINT #8. SYNCHRONIZE OSCILLOSCOPE SWEEP WITH LEADING EDGE OF "A" CHANNEL CLOCK PULSE (AVAILABLE AT C 221-1 AND C 221-2). SET OSCILLOSCOPE SWEEP RATE AT 10 MICROSECONDS/CM AND OBSERVE THAT SINGLE PHASING PULSE OCCURS AT RELATIVE LONG INTERVALS. THE FOLLOWING TABLE LISTS SUGGESTED DELAY PERIODS BEFORE GENERATION OF A PHASING PULSE WHEN FOUR CHANNEL "A-C" REVERSALS ARE RECEIVED AND ONLY THE ADD CORRECTION CIRCUIT IS ACTIVE. IT IS RECOMMENDED THAT ADJUSTMENT BE MADE AT SPEED OF OPERATION TO BE USED. (THE SUDDEN SMALL DROP IN INDICATION OF M 201 AS ITS CURRENT APPROACHES + 50 MICRO-AMPERES MAY BE USED AS AN INDICATION OF A PHASING PULSE IF DESIRED.)

W.P.M.	ZERO (MID SCALE) READING ON M 201 TO FIRST ADD PULSE
60	12 SECONDS \pm 1 SECOND
75	11 SECONDS \pm 1 SECOND
100	8 SECONDS \pm 1 SECOND.

NOTE ---

UNDER ACTUAL FIELD CONDITIONS, IT MAY BE FOUND THAT OTHER DELAY PERIODS PROVIDE A BETTER MATCH FOR THE MULTIPATH DELAYS NORMALLY ENCOUNTERED. EXERCISE CARE WHEN LONGER DELAYS ARE USED, THAT CORRECTIVE ACTION IS NOT LOST ON A TWO CHANNEL 60 W.P.M. IDLE SIGNAL.

Figure 6-48 Synchronizer, Adjustment



- (2) ADJUSTMENT OF THE CONSTANT CURRENT GENERATORS FOR 100 W.P.M. OPERATION ONLY, WILL BE DESCRIBED. WITH METER M 201 AT STEADY ZERO READING, DISABLE RETARD FLIP FLOP BY REMOVING TRANSISTOR Q 218 FROM ITS SOCKET AND NOTE TIME REQUIRED FOR FIRST PHASING PULSE. ROTATE CONTROL SHAFT OR R 309 CLOCKWISE TO INCREASE DELAY PERIOD, COUNTERCLOCKWISE TO DECREASE DELAY PERIOD. AFTER A CHANGE IN SETTING OF RHEOSTAT R 309, REPLACE TRANSISTOR Q 218. THE NEEDLE OF METER M 201 WILL SWING OVER TO OPPOSITE SIDE OF THE METER AND THEN IT WILL APPROACH ZERO READING. ADJUST RHEOSTAT R 294 FOR ZERO READING.
- (3) REPEAT REQUIREMENT B (2) UNTIL A DELAY PERIOD OF 7-9 SECONDS IS REACHED.
- (4) ADJUSTMENT OF CONSTANT CURRENT GENERATORS AT 60 AND 75 W.P.M. SPEED IS IDENTICAL TO REQUIREMENT B (2) EXCEPT FOR THE PERIOD OF TIME. (SEE CHART).
- (5) IF TRANSISTORS IN SUBTRACT CIRCUITS (Q 217 THROUGH Q 226) ARE REPLACED, IT IS ONLY NECESSARY TO READJUST R 294 (SUBTRACT CURRENT GENERATOR) FOR ZERO BALANCE AS IN REQUIREMENT B (2) ABOVE.
IF TRANSISTORS IN THE ADD CIRCUITS (Q 220 THROUGH Q 231) ARE REPLACED, R 309 SHOULD BE ADJUSTED FOR ZERO BALANCE AS IN REQUIREMENT B (2) ABOVE.

C. SUBTRACT GATE UNIVIBRATOR

- (1) CONNECT OSCILLOSCOPE TO TEST POINT NUMBER 7. USE SAME EXTERNAL SYNCHRONIZING SIGNAL AND SWEEP RATE AS DESCRIBED IN ABOVE REQUIREMENT B (2). LOOSEN LOCK NUT ON RHEOSTAT R 335-1. REMOVE TRANSISTORS Q 219 AND Q 221 FROM THEIR SOCKETS WHILE RECEIVING 4 CHANNEL A-C REVERSALS ON LOCAL OPERATION AND NOTE WIDTH OF PHASING SUBTRACT PULSE ON OSCILLOSCOPE. THE PULSE WIDTH SHOULD BE 70 MICROSECONDS. TO INCREASE PULSE WIDTH ROTATE RHEOSTAT R 335-1 CLOCKWISE AND TO DECREASE PULSE WIDTH ROTATE RHEOSTAT R 335-1 COUNTERCLOCKWISE.
- (2) REPLACE TRANSISTORS Q 219 AND Q 221 IN THEIR SOCKETS AND TIGHTEN LOCK NUT ON RHEOSTAT R 335-1.

D. ADD GATE UNIVIBRATOR

- (1) CONNECT OSCILLOSCOPE TO TEST POINT NUMBER 8. USE SAME EXTERNAL SYNCHRONIZING SIGNAL AND SWEEP RATE AS DESCRIBED IN ABOVE REQUIREMENT B (2). LOOSEN LOCK NUT ON RHEOSTAT R 335-2. REMOVE TRANSISTOR Q 218 AND Q 222 FROM THEIR SOCKETS WHILE RECEIVING 4 CHANNEL A-C REVERSALS ON LOCAL OPERATION AND NOTE WIDTH OF PHASING ADD PULSE ON OSCILLOSCOPE. THE PULSE WIDTH SHOULD BE 40 MICROSECONDS. TO INCREASE PULSE WIDTH, ROTATE RHEOSTAT R 335-2 CLOCKWISE AND TO DECREASE PULSE WIDTH ROTATE RHEOSTAT R 335-2 COUNTERCLOCKWISE.
- (2) REPLACE TRANSISTOR Q 218 AND Q 222 IN THEIR SOCKETS AND TIGHTEN LOCK NUT ON RHEOSTAT R 335-2.

Figure 6-49 Synchronizer, Adjustment

4.f. SYNCHRONIZER - AMPLIFIER

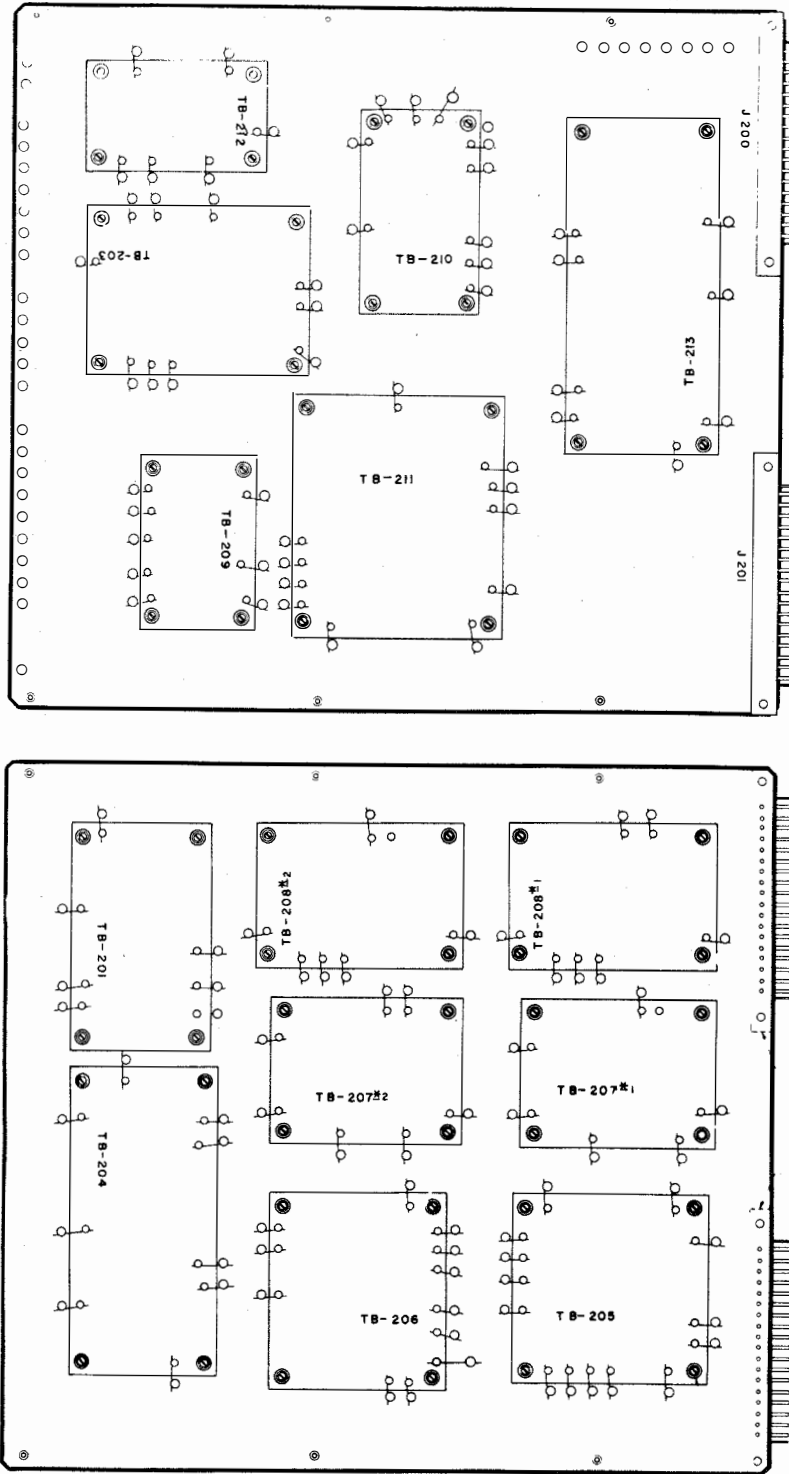


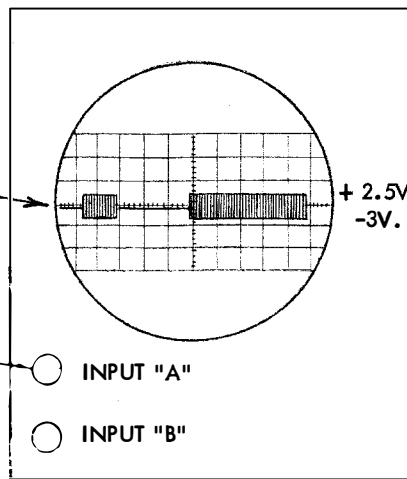
Figure 6-50 Circuit Board TB 200

SYNCHRONIZER

MINOR TEST POINTS

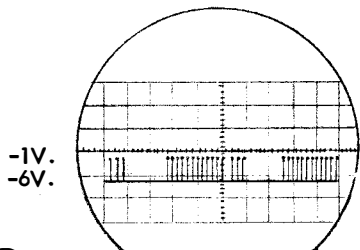
TP (A) LINE RELAY OSCILLATOR
Q202 COLLECTOR

H - 10 Milliseconds / CM
V - 5 Volts / CM



TYPICAL OSCILLOSCOPE

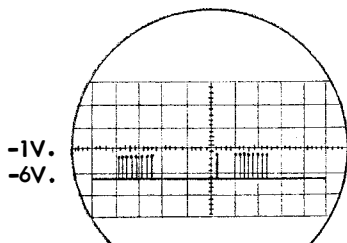
NOTE 1 - CALIBRATE "X" AND "Y" AXIS TO CONVENIENT VALUES SUCH AS INDICATED. SYNCHRONIZE SCOPE ON "A" CHANNEL (SYN.) EXCEPT WHERE NOTED.



TP (B) (+) MUX. SIGNAL OUTPUT
(Q205)

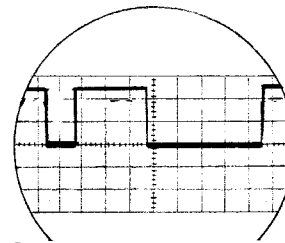
H - 10 Milliseconds / CM
V - 5 Volts / CM

CONNECT TO TEST POINT (A) SHOWN ON PAGE 6-52



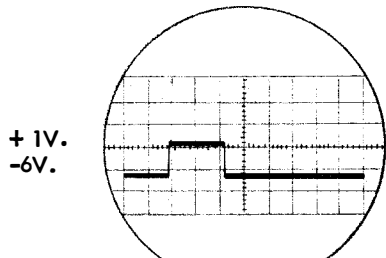
TP (C) (-) MUX. SIGNAL OUTPUT (Q207)

H - 10 Milliseconds / CM
V - 5 Volts / CM



TP (D) OUTPUT TO AUX. EQUIPMENT (Q210)

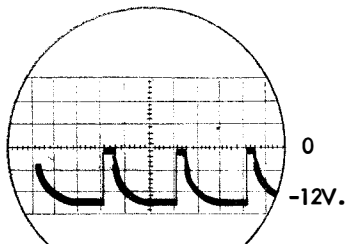
H - 10 Milliseconds / CM
V - 20 Volts / CM



TP (E) RETARD UNIVIBRATOR
(Q218) OUTPUT

H - 2 Milliseconds / CM
V - 5 Volts / CM

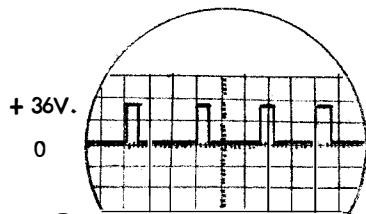
NOTE - SYN ON PHASE LAG



TP (F) DRIVE TO DIVIDER NO. 2
(Q237)

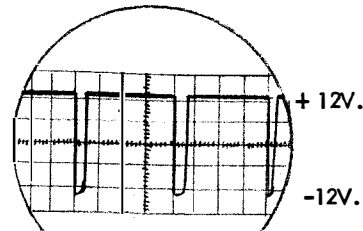
H - 20 Microseconds / CM
V - 5 Volts / CM

NOTE - SYN. ON DIVIDER NO. 2



TP (H) AUX. CLOCK AMP. OUTPUT

H - 500 Microseconds / CM
V - 20 Volts / CM



TP (G) AUX. SIGNAL SAMPLING OUTPUT

H - 1 Millisecond / CM
V - 5 Volts / CM

Figure 6-51 Wave-forms

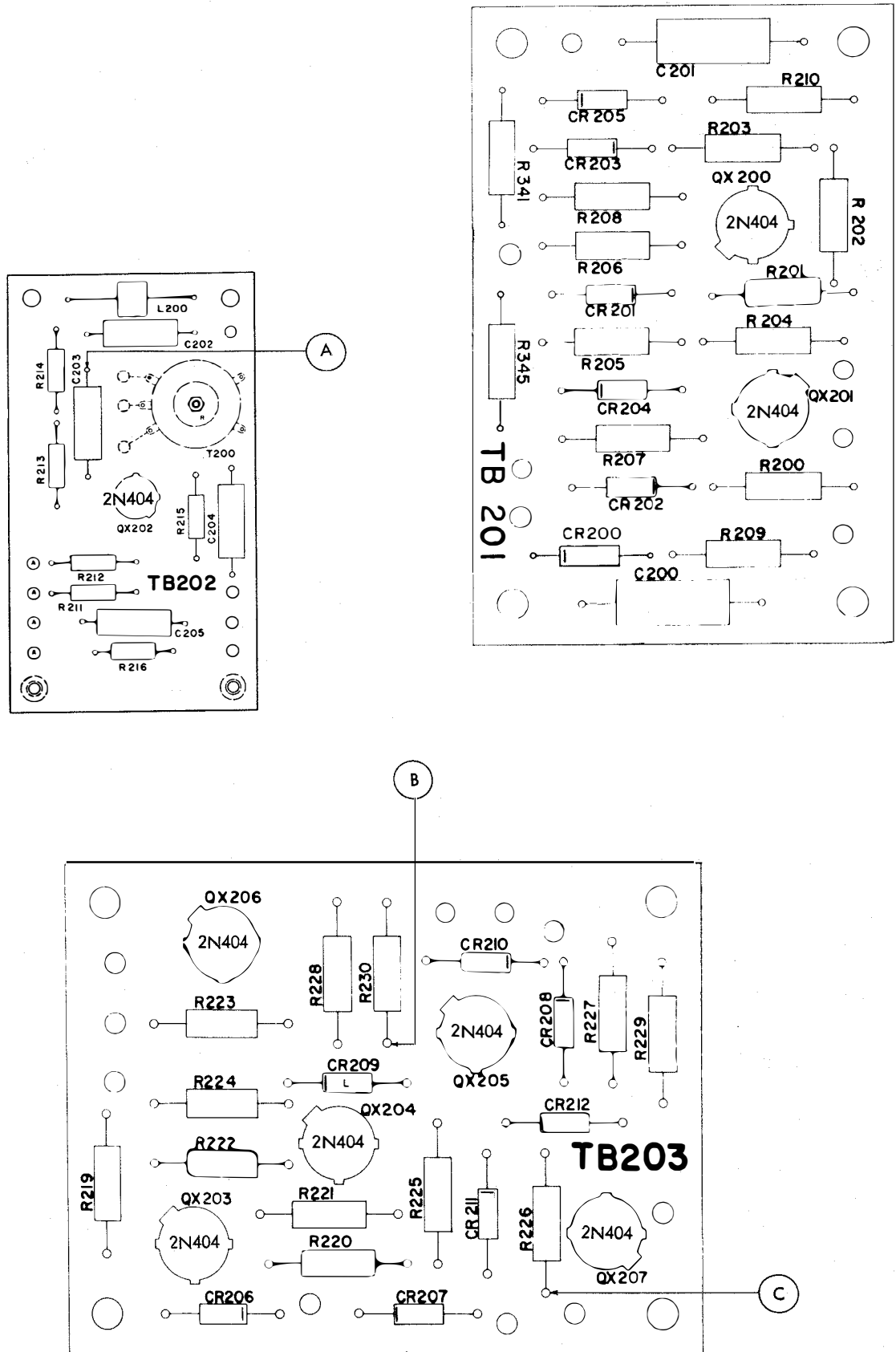


Figure 6-52 Circuit Boards, TB 201, TB 202 & TB 203

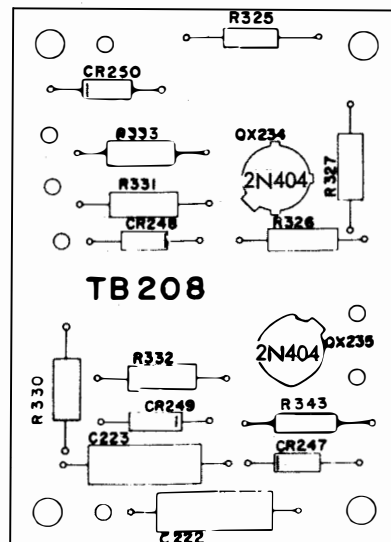
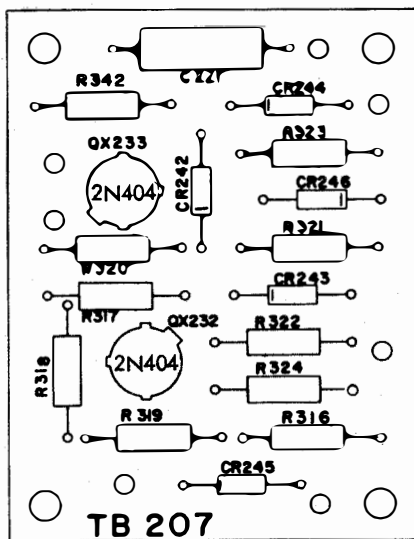
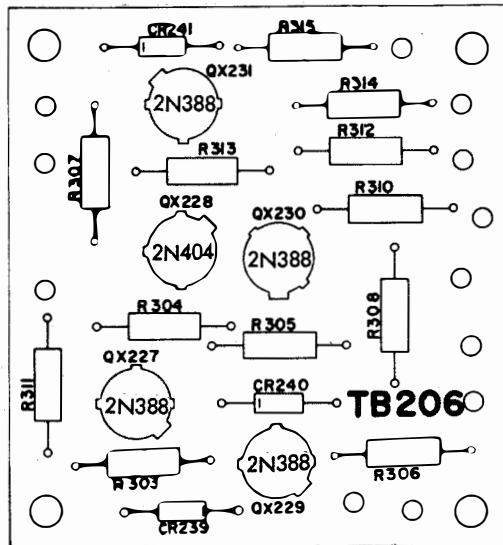
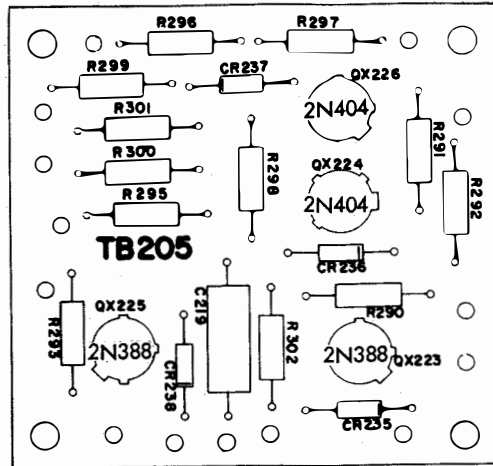
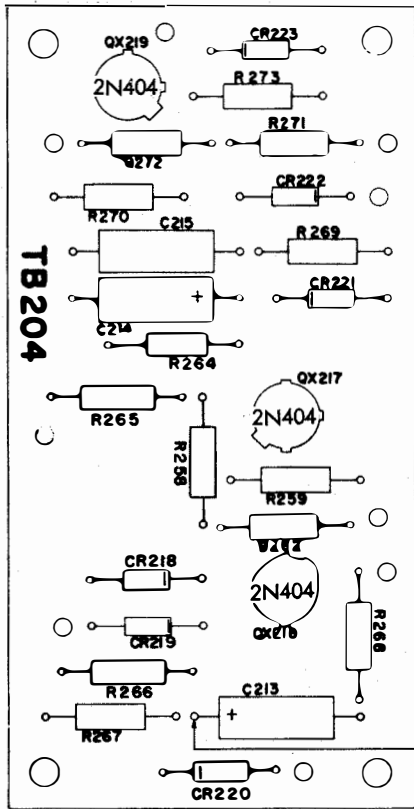


Figure 6-53 Circuit Boards, TB 204, TB 205, TB 206, TB 207 & TB 208

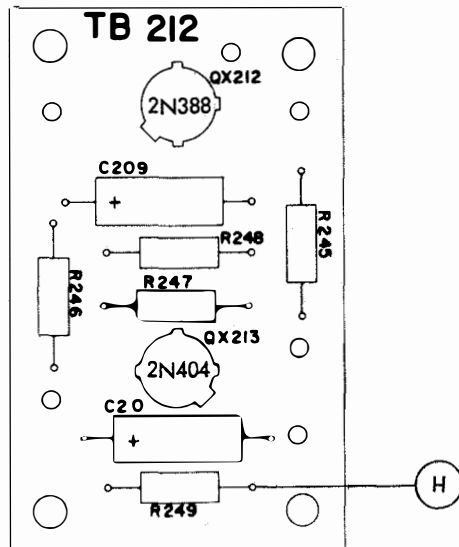
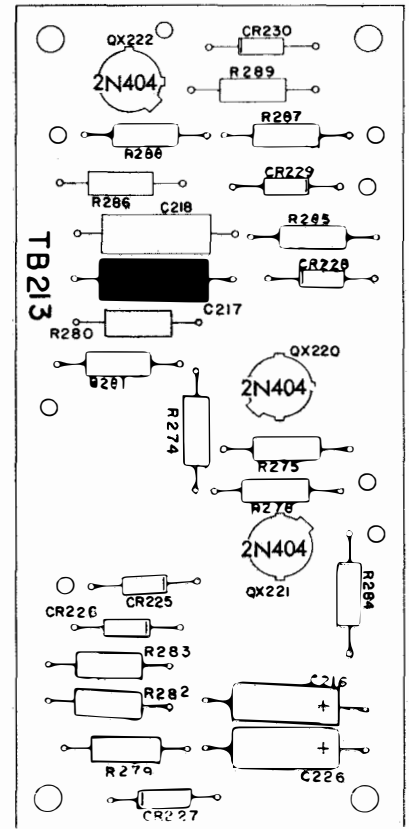
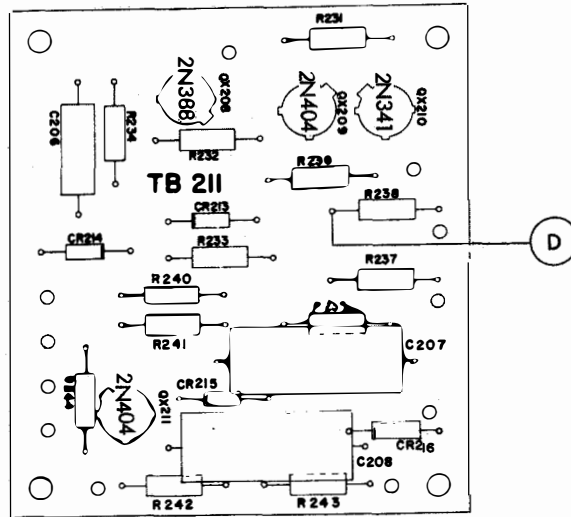
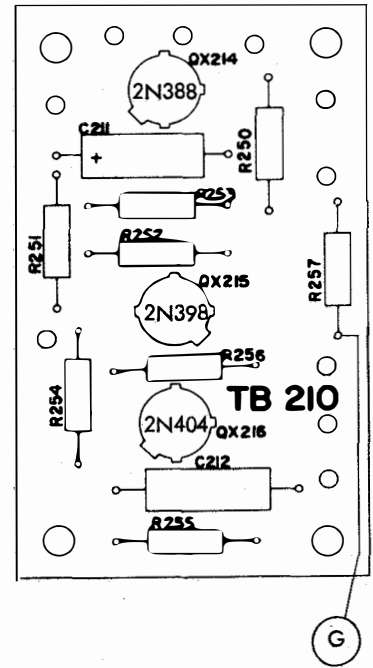
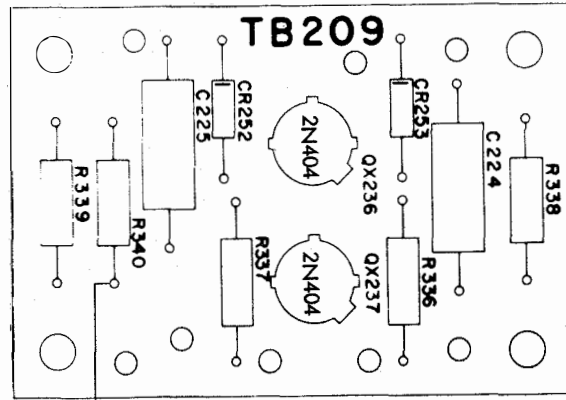


Figure 6-54 Circuit Board, TB 209, TB 210, TB 211, TB 212 & TB 213

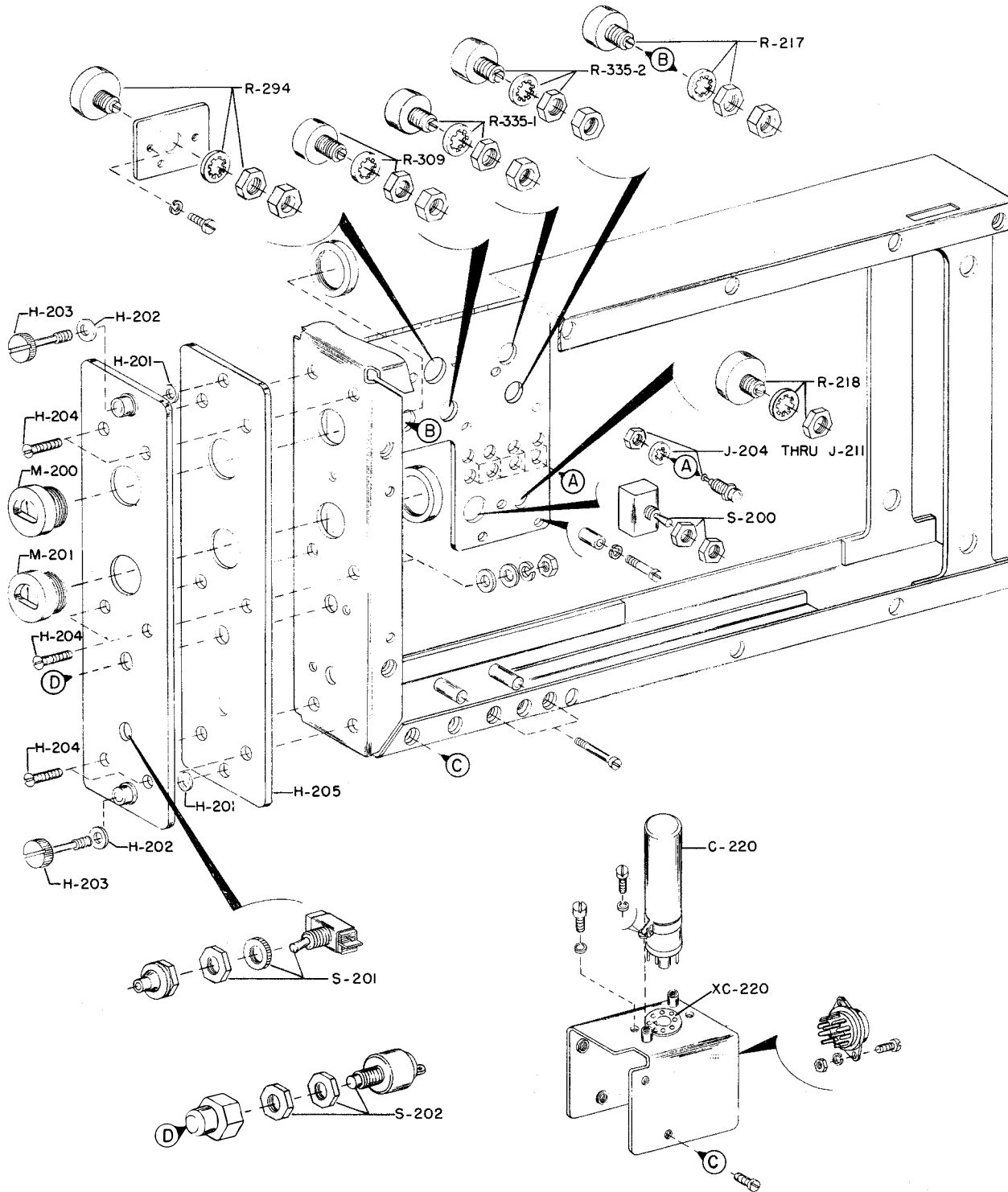


Figure 6-55 Synchronizer - Amplifier, TMS 201

NO	NOTES																						
1A	<p>WIRING LEGEND</p> <p>DISTANT TERMINATING AREA DISTANT TERMINAL DESIGNATION WIRE COLOR CODE</p>																						
1B	<p>TERMINAL DESIGNATIONS ENCLOSED IN PARENTHESIS ARE NOT MARKED ON COMPONENTS.</p>																						
2.	<p>COLOR CODE:</p> <table border="0"> <tr><td>BK</td><td>BLACK</td></tr> <tr><td>BL</td><td>BLUE</td></tr> <tr><td>BR</td><td>BROWN</td></tr> <tr><td>G</td><td>GREEN</td></tr> <tr><td>O</td><td>ORANGE</td></tr> <tr><td>P</td><td>PURPLE</td></tr> <tr><td>R</td><td>RED</td></tr> <tr><td>S</td><td>SLATE</td></tr> <tr><td>Y</td><td>YELLOW</td></tr> <tr><td>W</td><td>WHITE</td></tr> <tr><td>V</td><td>VIOLET</td></tr> </table>	BK	BLACK	BL	BLUE	BR	BROWN	G	GREEN	O	ORANGE	P	PURPLE	R	RED	S	SLATE	Y	YELLOW	W	WHITE	V	VIOLET
BK	BLACK																						
BL	BLUE																						
BR	BROWN																						
G	GREEN																						
O	ORANGE																						
P	PURPLE																						
R	RED																						
S	SLATE																						
Y	YELLOW																						
W	WHITE																						
V	VIOLET																						
3.	<p>ALL TERMINALS AS VIEWED FROM SOLDERED END EXCEPT IN AREA "T"</p>																						
4.	<p>AREA "P" TERMINALS "A" THROUGH "D" ARE SOCKET SIDE PINS.</p>																						

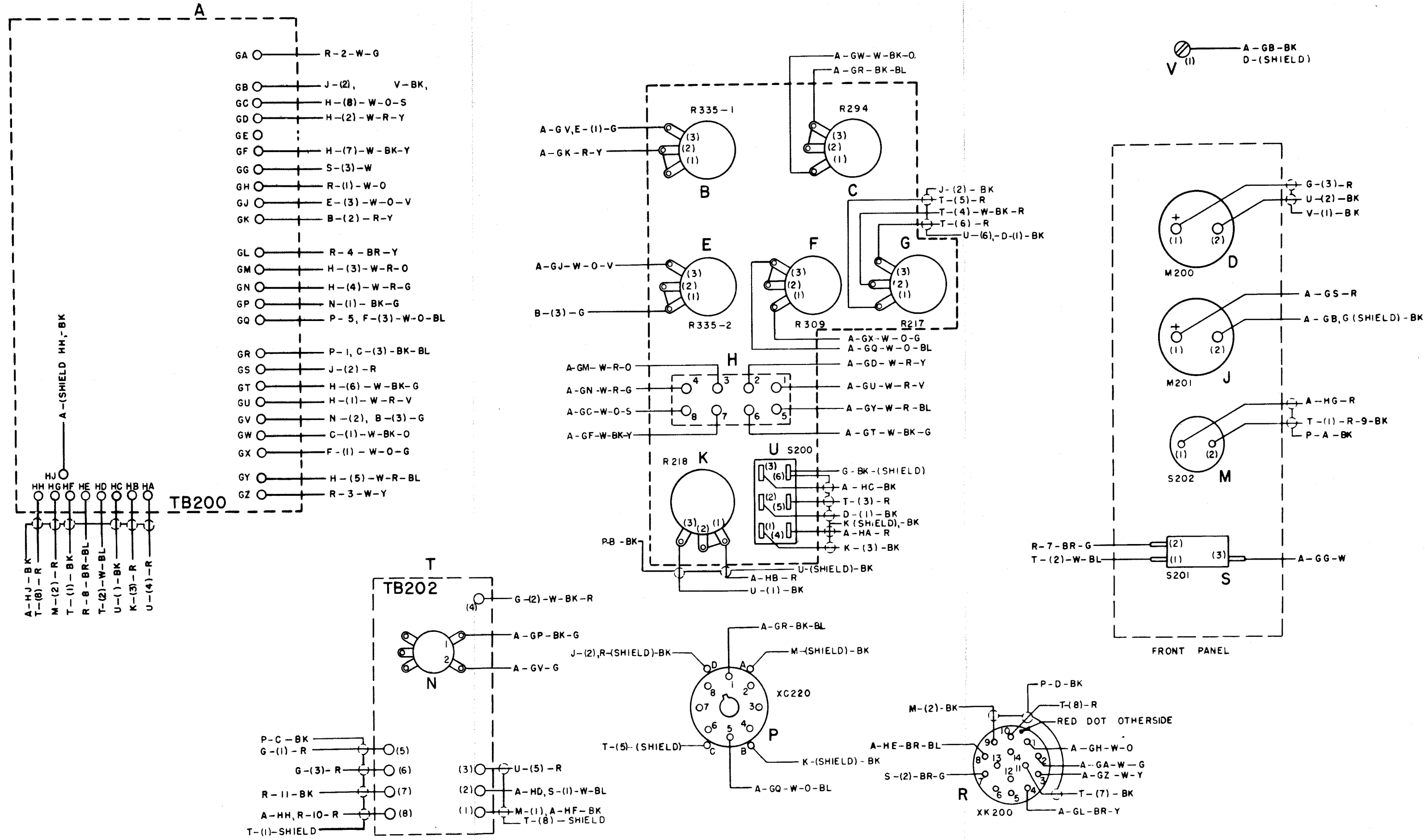


Figure 6-56 Cable Assembly Synchronizer Amplifier 6-69; 6-70

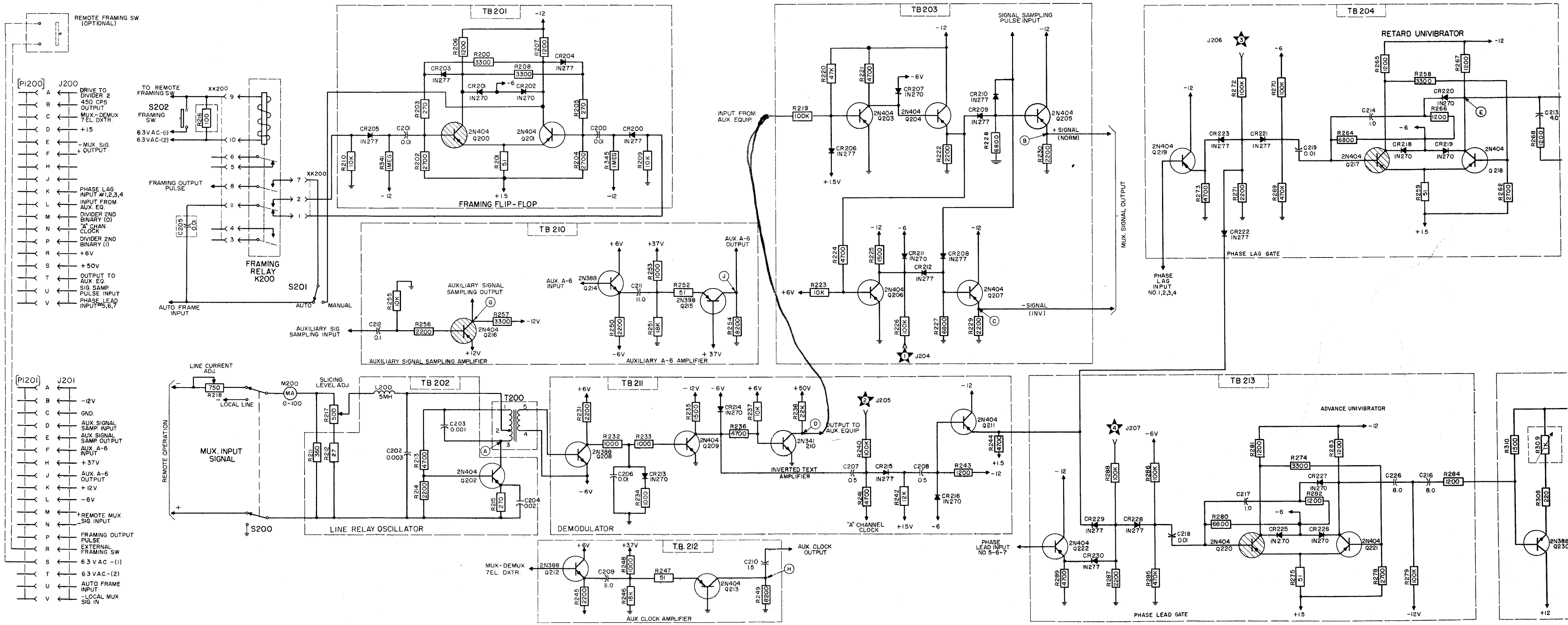
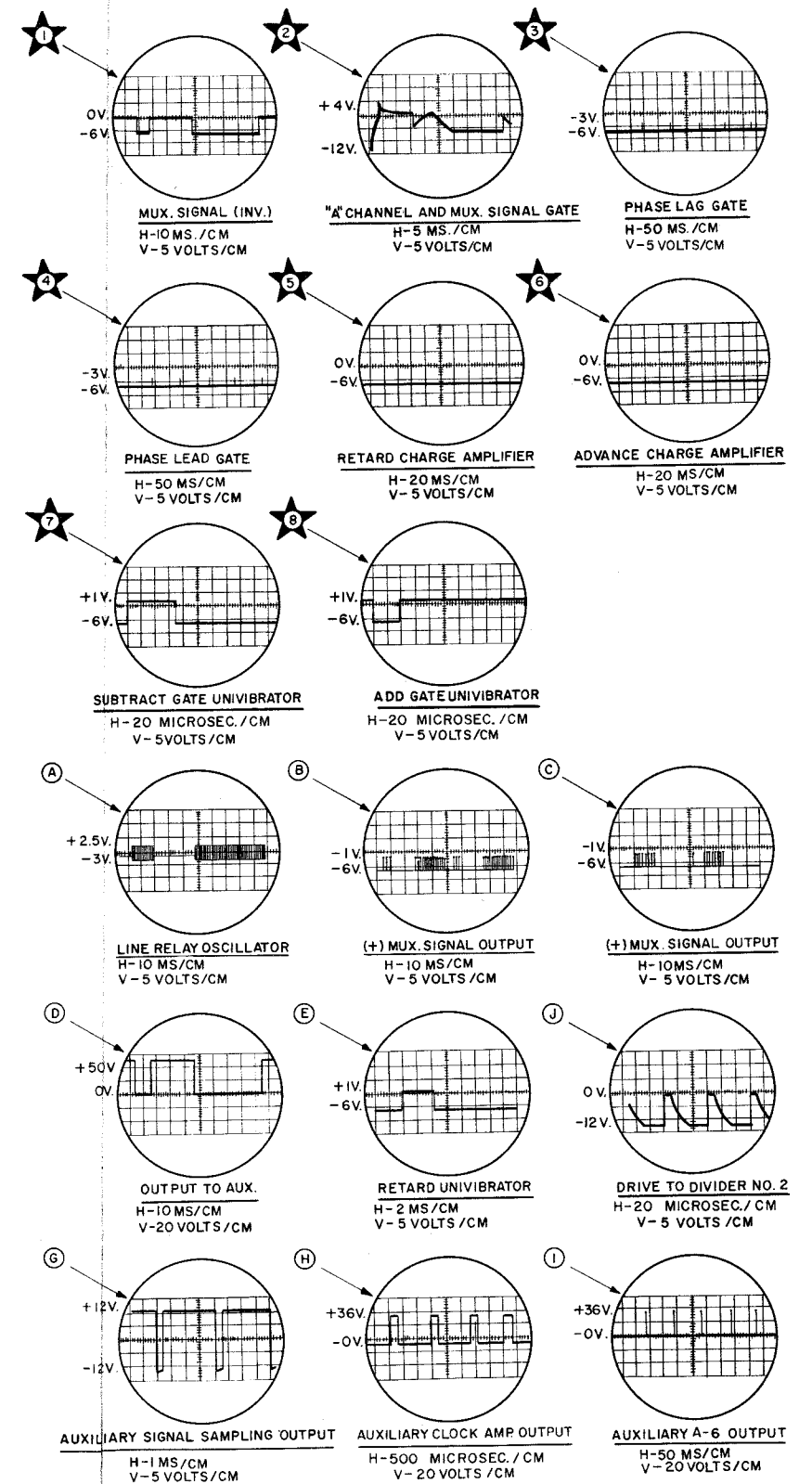
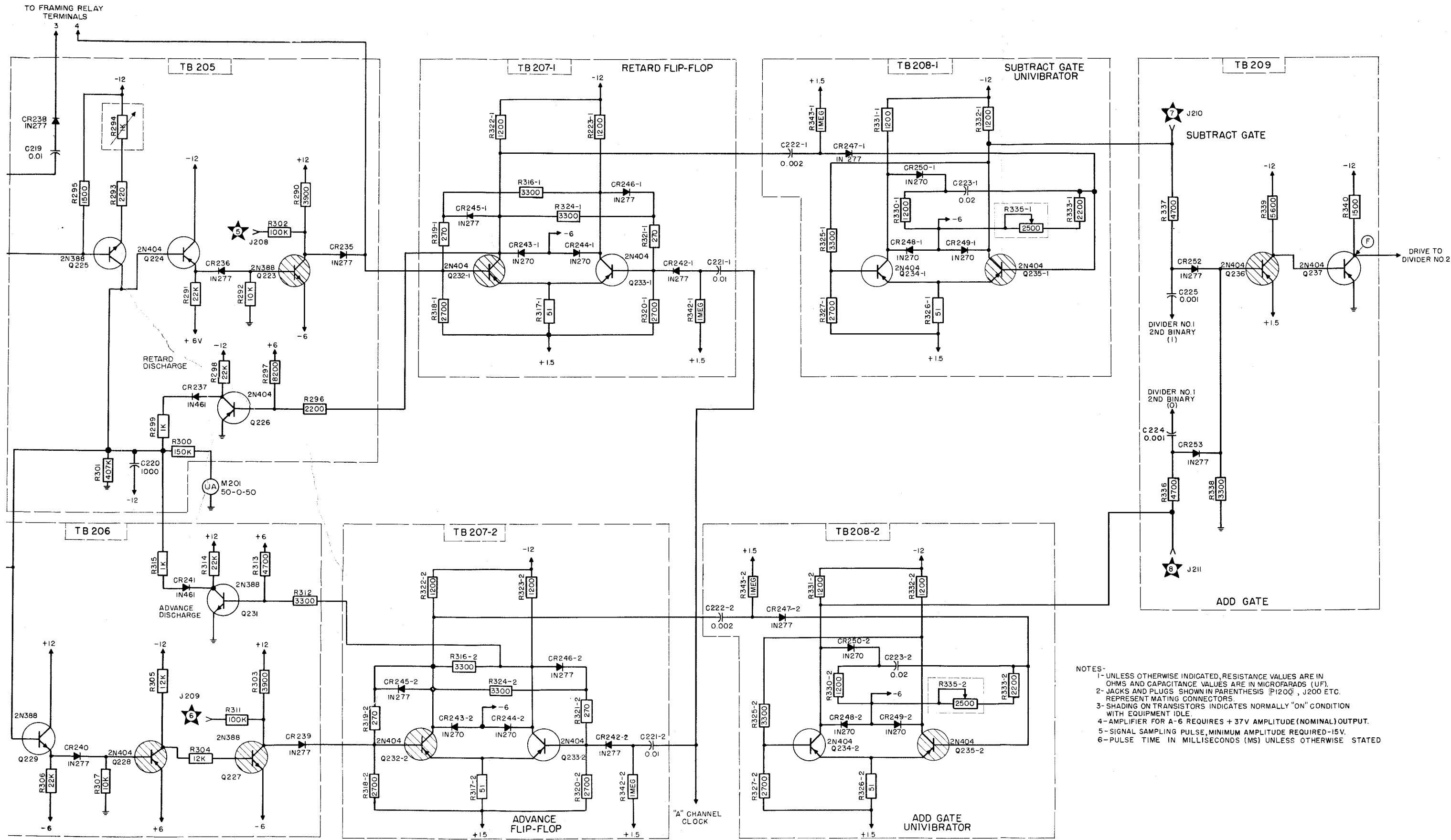
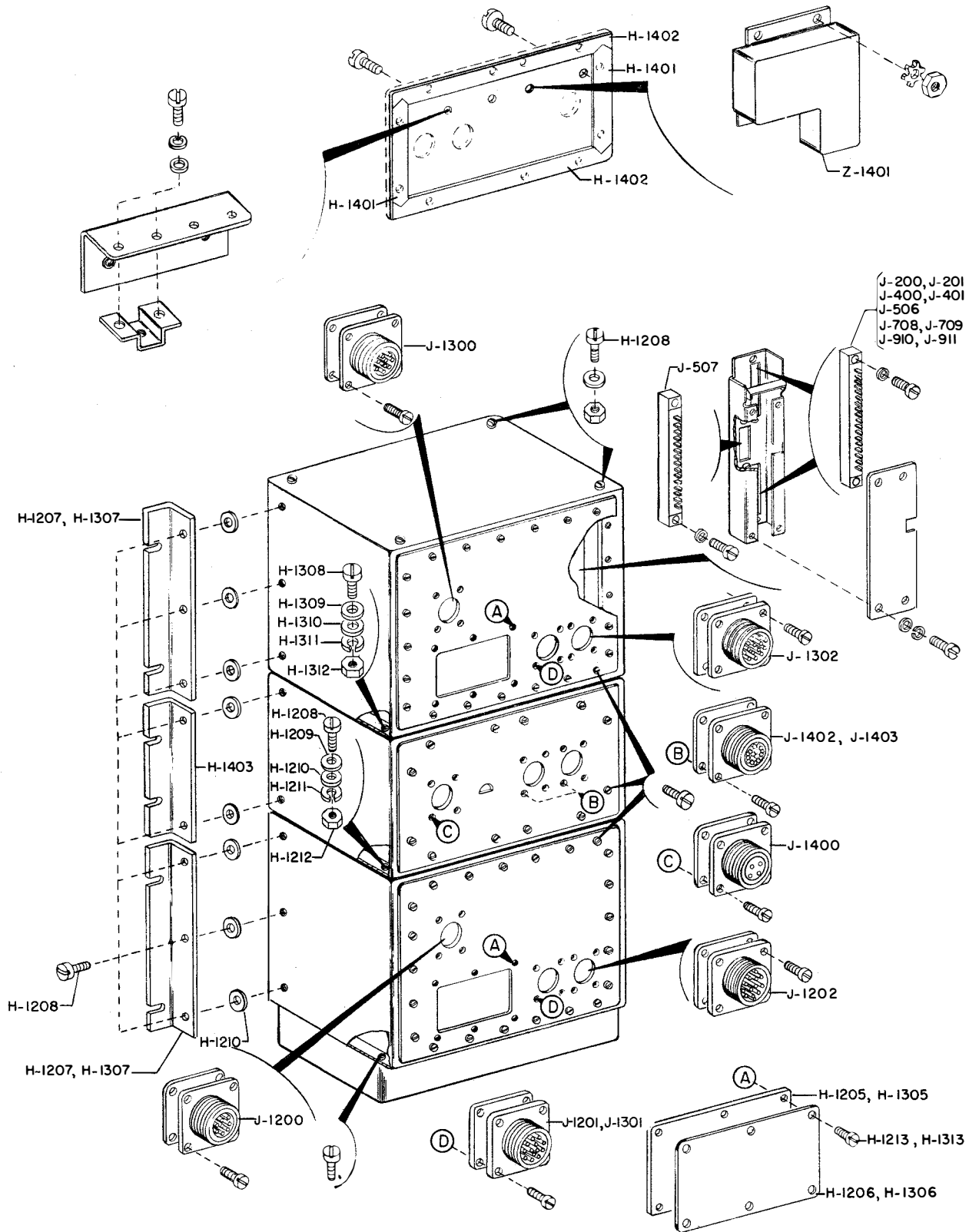


Figure 6-57 Schematic Wiring Diagram Synchronizer - Amplifier TMS 201

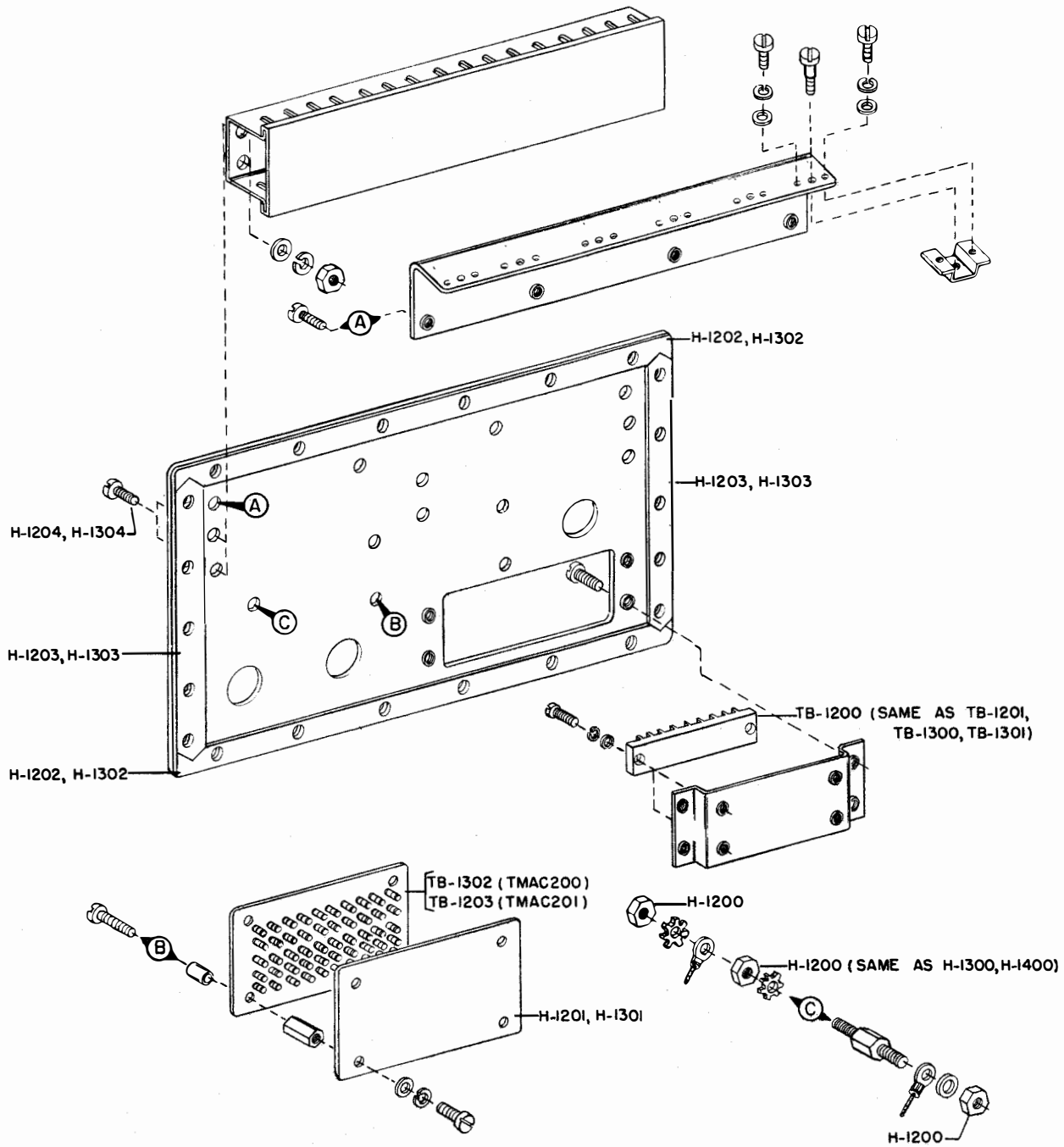


- NOTES-
- 1- UNLESS OTHERWISE INDICATED, RESISTANCE VALUES ARE IN OHMS AND CAPACITANCE VALUES ARE IN MICROFARADS (UF).
 - 2- JACKS AND PLUGS SHOWN IN PARENTHESIS (J200, J200 ETC.) REPRESENT MATING CONNECTORS.
 - 3- SHADING ON TRANSISTORS INDICATES NORMALLY "ON" CONDITION WITH EQUIPMENT IDLE.
 - 4- AMPLIFIER FOR A-6 REQUIRES +37V AMPLITUDE (NOMINAL) OUTPUT.
 - 5- SIGNAL SAMPLING PULSE, MINIMUM AMPLITUDE REQUIRED -15V.
 - 6- PULSE TIME IN MILLISECONDS (MS) UNLESS OTHERWISE STATED.

Figure 6-57 Schematic Wiring Diagram Synchronizer - Amplifier TMS 201



J-200, J-201
J-400, J-401
J-506
J-708, J-709
J-910, J-911



SECTION 7
PARTS LIST

1. INTRODUCTION

1.a. Reference designations (previously referred to as circuit symbols) are assigned to identify maintenance parts of the equipment. These designations are located beside the parts that they identify on the wiring diagrams and sub-assemblies in section 6. The letter of the reference designation indicates the generic group that the part is in (capacitors, resistors, transistors). The numbers differentiate between parts of the same generic group. Parts of the first major unit are numbered 200 to 399, etc. For example, C216 designates capacitor number 216 in the second group.

1.b. Table 7-1 is arranged according to the groups of reference designations that apply to a major unit. Thus when the reference designation of a part is known, this table will furnish ready reference to the major unit in which it is used.

1.c. Table 7-2 provides the description and ordering information for each part. The first column lists the reference designation of each part. The second column names and describes the part. The third column indicates its use. The fourth column is subdivided to show the manufacturer's five-digit code and catalogue designation.

1.d. Table 7-3 is a list of manufacturer's names and addresses arranged in the order of the five-digit code numbers referred to in Table 7-2.

1.e. Table 7-4 is a list of maintenance parts arranged in Teletype part number sequence. Opposite the part number appears the number of the wiring diagrams in which that part appears. In general, most parts will appear more than once in a specific wiring diagram (major unit). A specific part can be identified or located by reference to the appropriate section of Table 7-2.

TABLE 7-1, MULTIPLEX SET, LIST OF MAJOR UNITS

Ref. Desig.	Qty	MAJOR UNITS															
101-199	1	Power-Oscillator TMPU 201															
200-399	1	Synchronizer Amplifier TMS 201															
400-499	1	Output Amplifier TMXU 201 & Neon Lamp Indicator TMN 200															
500-699	2	Multiplexer-Demultiplexer TMD201															
700-799	4	Receive Code Converter TMCR 201															
900-1099	4	Transmit Code Converter TMCX 201															
1200-1299	1	Receive Group Cabinet TMAC 201															
1300-1399	1	Transmit Group Cabinet TMAC 202															
1400-1499	1	Power-Oscillator Cabinet TMAC 200															
1500-1599	1	Connections TM 200															
<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; width: 33%;">TRANSMITTING GROUP</th> <th style="text-align: left; width: 33%;">RECEIVING GROUP</th> <th style="text-align: left; width: 33%;">POWER GROUP</th> </tr> </thead> <tbody> <tr> <td>1 Transmit Group Cabinet</td> <td>1 Receive Group Cabinet</td> <td>1 Power-Oscillator Cabinet</td> </tr> <tr> <td>4 Transmit Code Converter</td> <td>4 Receive Code Converter</td> <td>1 Power-Oscillator</td> </tr> <tr> <td>1 Multiplexer-Demultiplexer</td> <td>1 Multiplexer-Demultiplexer</td> <td></td> </tr> <tr> <td>1 Output Amplifier</td> <td>1 Synchronizer Amplifier</td> <td></td> </tr> </tbody> </table>			TRANSMITTING GROUP	RECEIVING GROUP	POWER GROUP	1 Transmit Group Cabinet	1 Receive Group Cabinet	1 Power-Oscillator Cabinet	4 Transmit Code Converter	4 Receive Code Converter	1 Power-Oscillator	1 Multiplexer-Demultiplexer	1 Multiplexer-Demultiplexer		1 Output Amplifier	1 Synchronizer Amplifier	
TRANSMITTING GROUP	RECEIVING GROUP	POWER GROUP															
1 Transmit Group Cabinet	1 Receive Group Cabinet	1 Power-Oscillator Cabinet															
4 Transmit Code Converter	4 Receive Code Converter	1 Power-Oscillator															
1 Multiplexer-Demultiplexer	1 Multiplexer-Demultiplexer																
1 Output Amplifier	1 Synchronizer Amplifier																

TABLE 7-2 --- POWER - OSCILLATOR Tmpu 201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
C101	CAPACITOR, FIXED, ELECTROLYTIC DIELECTRIC; 1 Section, 100 vdcw, 200 UF.	Filter for 50 vdc output	143624	56389	CE41C20-1H	
C102	CAPACITOR, FIXED, ELECTROLYTIC DIELECTRIC; 1 Section, 25 vdcw, 1200 UF.	Filter for 12 vdc output	143621	56289	CE41C12-2F	
C103	Same as C102					
C104	CAPACITOR, FIXED, ELECTROLYTIC DIELECTRIC; 1 Section, 15 vdcw, 2000 UF.	Filter for 6 vdc output	143620	56289	CE41C20-2E	
C105	Same as C104	Filter for 6 vdc output				
C106	Same as C104	Filter for 1.5 vdc output				
C107	Same as C104	Filter for 6 vdc output				
C108	Same as C104	Filter for 6 vdc output				
C109	Same as C102	Filter for 12 vdc output				
C110	Same as C102	Filter for 12 vdc output				
C111	Same as C102	Filter for 12 vdc output				
C112	CAPACITOR, FIXED, ELECTROLYTIC DIELECTRIC; 1 Section, 50 vdcw, 220 UF.	Filter for isolated 12 vdc	143622	56289	CE41E22-1G	
C113	Same as C101	Filter for 37 vdc output				
C114	CAPACITOR, FIXED, CERAMIC DIELECTRIC; 1 Section, 75 vdcw, 0.01 UF.		143687	86335	MIN-M	
C115	CAPACITOR, FIXED, CERAMIC DIELECTRIC; 1 Section, 75 vdcw, 0.002 UF		143688	86335	MIN-N	
C116	Same as C115					
C120	CAPACITOR, VARIABLE, AIR DIELECTRIC; 27 Plates, 5 UUF-to-100 UUF, Screwdriver Adj.	Oscillator Frequency Adjust (Z103 or Z104)	143718	80583	APC-100	
CR101	SEMICONDUCTOR DEVICE, DIODE, Silicon IN538	Rectifier for 50 vdc output	143616	0350B	IN538	
CR102	Same as CR101	Rectifier for 50 vdc output				
CR103	Same as CR101	Rectifier for 12 vdc output				
CR104	Same as CR101	Rectifier for 12 vdc output				
CR105	Same as CR101	Rectifier for 6 vdc output				
CR106	Same as CR101	Rectifier for 6 vdc output				
CR107	SEMICONDUCTOR DEVICE SET, DIODE; Silicon (4JA411FC1AD1)	Rectifier for 1.5 vdc output	143615	03508	4JA411 FC1AD1	
CR108	Same as CR101	Rectifier for 6 vdc output				
CR109	Same as CR101	Rectifier for 6 vdc output				
CR110	SEMICONDUCTOR DEVICE SET, DIODE; Silicon (4JA411FC1BD2)	Rectifier for 12 vdc output	143617	03500	4JA411 FC1802	
CR111	Same as CR101	Rectifier for Isolated 12 vdc output				
CR112	Same as CR101	Rectifier for Isolated 12 vdc output				
CR113	SEMICONDUCTOR DEVICE, DIODE; IN270 GERMANIUM Gold-Bonded, Glass type. Per Spec. MIL-E-1		143711	99180	IN270	
CR114	Same as CR113					
CR115	Same as CR113					
CR116	Same as CR113					
DS101	DIAL LIGHT; 12 volts	Indicates A. C. power "ON"	143613	72619	134-5030W XP14-352	
DS102	DIAL LIGHT; 12 volts	Indicates crystal oven "ON"	143613	72619	134-5030W XP14-373	
E101	TERMINAL BOARD; plastic	Strap for loc. or ext crystal osc.	143793	39433	143793	
F101	FUSE, CARTRIDGE, 5A MDL-5	Protection for Convenience outlet J102 & J103	129920	71400	MDL-5	
F102	FUSE, CARTRIDGE, 2.5A MDL 2.5	Power supply Input Protection	143610	71400	MDL 2.5	
F103	Same as F102					
F104	FUSE, CARTRIDGE; 1/4 Amp. AGC1/4		118510	71400	AGC1/4	
F105	FUSE, CARTRIDGE, 3/4A AGC3/4	Protection for 12 vdc output	143630	71400	AGC3/4	
F106	FUSE, CARTRIDGE, 1/5A AGC1-1/2	Protection for 6 vdc output	143631	71400	AGC1-1/2	
F107	FUSE, CARTRIDGE, 2.0A AGC 2	Protection for 1.5 vdc	120166	71400	ABC 2	
F108	Same as F105	Protection for 6 vdc output				
F109	FUSE, CARTRIDGE, 4.0A MTH 4	Protection for 12 vdc output	129919	71400	MTH 4	
F110	Same as F104	Protection for Isolated 12 vdc				
H101	GASKET	Front plate side Gaskets		04650	MC-544	
H102	GASKET	Front plate Top & Bottom		04650	MC-545	
H103	GASKET	Gasket		04650	MC-546	
H104	PACKING, PREFORMED	Gasket for M101		04650	MC-547	
H105	PACKING, PREFORMED	Gasket for M102		04650	MC-548	
H106	PACKING, PREFORMED					

TABLE 7-2 --- POWER - OSCILLATOR TMPU 201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
J101	CONNECTOR, RECEPTACLE, ELECTRICAL; 4 Contacts	Power Connector	143797	02660	AN3102A- 22-10P	
J102	CONNECTOR, RECEPTACLE, ELECTRICAL;	Convenience Outlet	143606	02660	97-4085	
J103	Same as J102	Convenience Outlet				
J104	CONNECTOR, RECEPTACLE ELECTRICAL ; Contacts	Input Jack for M102	143780	78947	119052F	
J105	CONNECTOR, RECEPTACLE, ELECTRICAL	Input Jack for external oscillator	143798	78947	31-207	
J106	CONNECTOR, RECEPTACLE, ELECTRICAL; 17 Contacts	DC power output connectors	143799	02660	AN3102A- 20-295	
J107	Same as J106					
J110	CONNECTOR, RECEPTACLE, ELECTRICAL; 10 Contacts	Receptacle for Z102-1 card	143781	02660	143-010- 01	
J111	Same as J110	Receptacle for Z102-2 card				
J112	Same as J110	Receptacle for Z101 card				
J113	CONNECTOR, RECEPTACLE, ELECTRICAL; 8 Contacts	Receptacle for Z103 or Z104 Crystal Oscillator (Active)	118591	71785	51B13	
J114	Same as J113	Receptacle for Z103 or Z104 Crystal Oscillator (reserve)				
J115	CONNECTOR, RECEPTACLE, ELECTRICAL;					
L101	REACTOR, FIXED, INDUCTANCE TYPE; 1 Section	Filter with C101 for 50 vdc output	143600	04650	RF741	
L102	REACTOR, FIXED, INDUCTOR TYPE; 1 Section	Filter with C102 & C103 for 12 vdc output	143601	04650	RF769	
L103	REACTOR, FIXED INDUCTOR TYPE; 1 Section	Filter with C104 & C105 for 6 vdc output	143602	04650	RF760	
L104	Same as L103	Filter with C106 for 1.5 vdc output				
L105	REACTOR, FIXED INDUCTOR TYPE; 1 Section	Filter with C107 & C108 for 6 vdc output	143603	04650	RF768	
L106	REACTOR, FIXED INDUCTOR TYPE; 1 Section	Filter with C109, C110, & C111 for 12 vdc output	143604	04650	RF740	
L107	Same as L101	Filter with C112 for Isolated 12 vdc output				
M101	METER; D.C. 0-15-75 volts	DC Output Voltage Measurement	143634	65092	1531	
M102	METER; Frequency	Multivoltage type Start-Stop Oscillator Frequency Measurement	143623	04650	M264	
Q101	TRANSISTOR, GERMANIUM; Junction Contact type, PNP Configuration - 2N404		143735	81453	2N404	
Q102	Same as Q101					
Q103	Same as Q101					
Q104	Same as Q101					
R101	RESISTOR, VARIABLE; WW 750 ohms, 4 W. 1 Section	Voltage Adjustment for 37V	143654	75042	RA30LAS B751A	
R102	RESISTOR, VARIABLE WW 1.0 ohms, 25 W. 1 Section	Voltage Adjustment for 12V	143625	04650	RH135	
R103	RESISTOR, VARIABLE; WW 0.5 ohm 25 W. 1 Section	Voltage Adjustment for +6V	143626	04650	RH136	
R104	Same as R102	Voltage Adjustment for -6V				
R106	RESISTOR, FIXED; WW 68 ohm, 5 watts	Bleeder resistor for 12V	143627	04650		
R109	RESISTOR, FIXED; WW 12 ohm, 5 watts	Bleeder resistor for 6V	143628	04650		
R111	RESISTOR, FIXED, WW 150 ohm, 5 watts	Bleeder resistor for isolated 12 volts	143629	04650		
R112	RESISTOR, FIXED, COMPOSITION; 1 Section, 4700 ohms $\pm 5\%$ 0.5 W. (RC20BF472J)		118146	01121	EB4725	
R113	Same as R112					
R114	RESISTOR, FIXED, COMPOSITION; 1 Section, 10,000 ohms $\pm 5\%$ 0.5 W (RC20BF103J)		118180	01121	EB1035	
R115	RESISTOR, FIXED, COMPOSITION; 1 Section, 5600 ohms $\pm 5\%$ 0.5 W. (RCBF562J)		118186	01121	EB5625	
R116	Same as R115					

TABLE 7-2 --- POWER - OSCILLATOR TMPU 201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
R117	RESISTOR, FIXED, COMPOSITION; 1 Section, 1,200 ohms $\pm 5\%$ 0.5 W. (RC20BF122J)		137441	01121	EB1225	
R118	RESISTOR, FIXED, COMPOSITION; 1 Section, 3300 ohms $\pm 5\%$, 0.5 W		129351	01121	EB3325	
R119	Same as R118					
R120	Same as R117					
R121	RESISTOR, FIXED, COMPOSITION; 1 Section, 2700 ohms $\pm 5\%$, 0.5 W. (RC20BF272J)		118144	01121	EB2725	
R122	RESISTOR, FIXED, COMPOSITION; 1 Section, 51 ohms $\pm 5\%$, 0.5 W. (RC20GF510J)		143656	01121	EB5105	
R123	Same as R121					
S101	SWITCH, TOGGLE; D. P. S. T. 2 position, on-off	Main power "ON-OFF"	143608	15605	ST52K	
S102	SWITCH, ROTARY; S. P. 9. T.	Line Voltage Tap, Multivoltage	143609	04650	111-9	
S103	SWITCH, ROTARY; 3. P. 9. T.	Voltmeter Switch, Multivoltage	143633	71590	PA-1009	
T101	TRANSFORMER, POWER; Tapped Primary & Secondary	Supplies Multivoltage AC to Rectifier	143614	04650	T2201	
XDS101	LAMP HOLDER, PILOT LIGHT; sub miniature	Socket for DS101				
XDS102	LAMP HOLDER, PILOT LIGHT;	Socket for DS102	143635			
XF101	FUSEHOLDER; Extractor post type	Socket for F101	143619			
XF102	FUSEHOLDER; With Blown Fuse Indicator		143632			
XF103	Same as XF102					
XF104	Same as XF101					
XF105	Same as XF101					
XF106	Same as XF101					
XF107	Same as XF101					
XF108	Same as XF101					
XF109	Same as XF101					
XF110	Same as XF101					
Z101	CRYSTAL OSCILLATOR, DRIVE	Crystal oscillator drive, (buffer) M102 Amplifier	143869			
Z102-1	COUNTER, ELECTRICAL	Binary Counter 1st stage	143868			
Z102-2	Same as Z102-1	Binary Counter 2nd stage				
Z103	CRYSTAL UNIT, QUARTZ; With oven and amplifier hermetically sealed 60 & 75 W. P. M.	Supplies 63 KC	143785	75378	143785	
Z104	CRYSTAL UNIT, QUARTZ; With oven and amplifier, hermetically sealed 100 W. P. M.	Supplies 61.63043KC	143786	75378	143786	

SYNCHRONIZER - AMPLIFIER - TMS 201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
C200	CAPACITOR, FIXED, CERAMIC DIELECTRIC; 1 Section, 75 vdcw, 0.01 UF	Differentiating (Q201)	143687	86335	MIN-M	
C201	Same as C200	Differentiating (Q200)				
C202	CAPACITOR, FIXED, METALIZED PAPER DIELECTRIC; 1 Section, 200 vdcw, 0.003 UF, plastic sleeve	Low Pass Filter with L200	137302	00656	P123ZN- GP	
C203	CAPACITOR, FIXED, METALIZED PAPER DIELECTRIC; 1 Section, 200 vdcw, 0.001 UF, plastic sleeve	Oscillator Tuning (T200)	137301	00656	P123ZN- GP	
C204	CAPACITOR, FIXED, METALIZED PAPER DIELECTRIC; 1 Section, 200 vdcw 0.02 UF	Bypass (Emitter Q202)	137311	00656	P123ZN- GP	
C205	Same as C200	Coupling to K200 Contacts				
C206	Same as C200	RC filter with R232				
C207	CAPACITOR, FIXED, METALIZED PAPER; 1 Section, 200 vdcw, 0.5 UF \pm 20%, plastic sleeve	Differentiating (Q209)	137310	00656	P123ZN- GP	
C208	Same as C207	dc Isolation (Q211)				
C209	CAPACITOR, FIXED, TANTALYTIC DIE- LECTRIC; 1 Section, 100 vdcw, 11.0 UF -15% +50%	Coupling (R246, R247, R248)	143704	21520	CW37D- 110MSP	
C210	CAPACITOR, FIXED, TANTALYTIC DIE- LECTRIC; 1 Section, 125 vdcw, 1.5 UF -15% +50%	Output Coupling (Q213)	143683	21520	CW35DIR- 5NSP	
C211	Same as C209	Coupling (R251, R252, R253)				
C212	CAPACITOR, FIXED, METALIZED PAPER DIELECTRIC; 1 Section, 200 vdcw, 0.1 UF, \pm 20%, plastic sleeve	Differentiating (Q216)	137307	00656	P123ZN- GP	
C213	CAPACITOR, FIXED, TANTALYTIC, DIELECTRIC; 1 Section, 60 vdcw 4.0 UF, -15% +50%	Coupling (Q225)	143682	21520	CW35DO- 40LSP	
C214	CAPACITOR, FIXED, TANTALYTIC, DIELECTRIC; 1 Section, 35 vdcw, 1.0 UF, -20% +20%	One-Shot Timing (Q217 & Q218)	143684	21520	STA-177	
C215	Same as C200	Input Coupling (Q219)				
C216	CAPACITOR, FIXED, TANTALYTIC DIE- LECTRIC; 1 Section, 30 vdcw, 8.0 UF -15% +50%	Coupling (Q230)	143716	21520	CW35DO- 80JSP	
C217	Same as C214	One-Shot Timing (Q220 & Q221)				
C218	Same as C200	Input Coupling (Q220)				
C219	Same as C200	Coupling (K200)				
C220	CAPACITOR, FIXED, ELECTROLYTIC DIELECTRIC; 1 Section, 25 vdcw, 1,000 UF -10% +250%	Integrator (Q225)	143705	56289	CE51C- 102F	
C221-1	Same as C200	Input Coupling (Q221-1 & Q221-2)				
C222-1	CAPACITOR, FIXED, CERAMIC DIELECTRIC; 1 Section, 75 vdcw, 0.002 UF -0% +100%	Output Coupling (Q234-1 & Q235-1)	143688	86335	MIN-N	
C223-1	CAPACITOR, FIXED, "VISCOFILM" DIE- LECTRIC; 1 Section, 25 vdcw, 0.02 UF \pm 10%	One-Shot Timing (Q234-1 & Q235-1)	143695	74861	2188	
C224	Same as C203	Differentiating (Add Gate)				
C225	Same as C203	Differentiating (Subtract Gate)				
C226	Same as C216	Coupling (Q230)				
CR200	SEMICONDUCTOR DEVICE, DIODE; GERMANIUM GOLD-BONDED, GLASS TYPE, MIL-E-1	Suppresses Negative pulse (Q201)	143710	99180	1N277	
CR201	SEMI-CONDUCTOR DEVICE, DIODE; GERMANIUM GOLD-BONDED, GLASS TYPE, MIL-E-1	-6 Volt Clamp (Q200)	143711	99180	1N270	
CR202	Same as CR201	-6 Volt Clamp (Q201)				
CR203	Same as CR200	Non-saturating (Q200)				
CR204	Same as CR200	Non-saturating (Q201)				
CR205	Same as CR200	Suppresses Negative pulse (Q200)				
CR206	Same as CR201	+ 1.5 Volt Clamp (Q203)				
CR207	Same as CR201	-6 Volt Clamp (Q203)				
CR208	Same as CR200	"AND" gate with CR212				
CR209	Same as CR200	"AND" gate with CR210				
CR210	Same as CR200	"AND" gate with CR209				
CR211	Same as CR201	-6 Volt Clamp (Q206)				

SYNCHRONIZER - AMPLIFIER - TMS 201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
CR212	Same as CR200	"AND" gate with CR208				
CR213	Same as CR201	Base Bias Clamp (Q209)				
CR214	Same as CR201	-6 Volt Clamp (Q209)				
CR215	Same as CR200	Inhibit Gate with R241				
CR216	Same as CR201	-6 Volt Clamp (Q211)				
CR218	Same as CR201	-6 Volt Clamp (Q217)				
CR219	Same as CR201	-6 Volt Clamp (Q218)				
CR220	Same as CR201	Collector Disconnect (Q218)				
CR221	Same as CR200	Suppresses Negative pulse				
CR222	Same as CR200	"AND" gate with CR223				
CR223	Same as CR200	"AND" gate with CR222				
CR225	Same as CR201	-6 Volt Clamp (Q220)				
CR226	Same as CR201	-6 Volt Clamp (Q221)				
CR227	Same as CR201	Collector Disconnect				
CR228	Same as CR200	Suppresses Negative pulse				
CR229	Same as CR200	"AND" Gate with CR230				
CR230	Same as CR200	"AND" Gate with CR229				
CR235	Same as CR200	Isolating (Q223)				
CR236	Same as CR200	Isolating (Q224)				
CR237	SEMICONDUCTOR DEVICE, DIODE; SILICON, GLASS TYPE	Discharge Circuit Isolation	143712	73293	1N461	
CR238	Same as CR200	Suppresses Negative pulse				
CR239	Same as CR200	Isolating (Q227)				
CR240	Same as CR200	Isolating (Q229)				
CR241	Same as CR237	Discharge Circuit Isolating (Q231)				
CR242-1	Same as CR200	Suppresses Negative pulse (Q233-1)				
CR243-1	Same as CR201	-6 Volt Clamp (Q243-1 & Q243-2)				
CR244-1	Same as CR201	-6 Volt Clamp (Q244-1 & Q244-2)				
CR245-1	Same as CR200	Non-saturating (Q232-1 & Q232-2)				
CR246-1	Same as CR200	Non-saturating (Q233-1 & Q233-2)				
CR247-1	Same as CR200	Suppresses Negative pulses (Q232-1)				
CR248-1	Same as CR201	-6 Volt Clamp (Q234-1)				
CR249-1	Same as CR201	-6 Volt Clamp (Q235-1)				
CR250-1	Same as CR201	Collector Disconnect				
CR252	Same as CR200	Inhibit Gate (Subtract Gate)				
CR253	Same as CR200	Inhibit Gate (Add Gate)				
H201	RING, RETAINING;	Retains H203	144131	94222	58-41-0-63	
H202	WASHER, COMPOSITION; NEOPRENE, Compound 2381, 0.250 ID, 0.500 OD, 0.031 thick	Provides drip tight seal.	144163	75543	144163	
H203	THUMBSCREW; 1/4-20 thread	Retains drawer in cabinet	144129	94222	58-21-109-56	
H204	SCREW, MACHINE; 6-40 x .438, flat head	Mounting Hardware	102755	59432	102755	
H205	GASKET, PANEL; nonmetallic, special section	Provides drip tight seal	144096	59432	144096	
J200	CONNECTOR, RECEPTACLE, ELECTRICAL; 18 Contacts, male printed circuit connector.	Circuit Board Upper Connector	143770	02660	133-018-03	
J201	Same as J200	Circuit Board Lower Connector				
J204	JACK, TIP; phone tip, Red	Test Point No. 1	143780	49956	276-1594G4	
J205	Same as J204	Test Point No. 2				
J206	Same as J204	Test Point No. 3				
J207	Same as J204	Test Point No. 4				
J208	Same as J204	Test Point No. 5				
J209	Same as J204	Test Point No. 6				
J210	Same as J204	Test Point No. 7				
J211	Same as J204	Test Point No. 8				
K200	RELAY, ELECTRICAL; armature type, 2 make (form A), 1 break (form B), 1 make break (form C), hermetically sealed, 6.3 vac coil.	Framing (With Remote Control)	143717	71482	RP4461-G39	
L200	COIL, RADIO FREQUENCY; universal wound type, 5.0 MH \pm 5%	Low Pass Filter with C202	137380	82208	MO305 CODE 52 Series 100	
M200	AMMETER; 0-100 MA DC, 1" sealed round meter	Line Current Meter	143756	16688	Series 100	
M201	AMMETER; scale 50-0-50 microamps, 1" sealed round meter	Oscillator Frequency Indicator	143757	16688	Series 100	

SYNCHRONIZER - AMPLIFIER - TMS 201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO	MFG'S		NOTES
				CODE	DESIG.	
Q200	TRANSISTOR, GERMANIUM; junction contact type, PNP configuration.	Framing Flip-Flop with Q201	143735	81453, 02735	2N404	
Q201	Same as Q200	Framing Flip-Flop with Q200				
Q202	Same as Q200	Input Relay Oscillator (Mux. Signal)				
Q203	Same as Q200	Input Attenuator (Aux.)				
Q204	Same as Q200	Emitter Follower				
Q205	Same as Q200	Isolation Amplifier				
Q206	Same as Q200	Inverter Amplifier				
Q207	Same as Q200	Isolation Amplifier				
Q208	TRANSISTOR, GERMANIUM; junction contact type, NPN configuration.	AC Amplifier	143743	93332	2N388	
Q209	Same as Q200	Demodulator Amplifier				
Q210	TRANSISTOR, SILICON; junction contact type, NPN configuration.	Inverted Output Amplifier	143740	01295	2N341	
Q211	Same as Q200	Isolation Amplifier				
Q212	Same as Q208	Emitter Follower				
Q213	Same as Q200	Aux. Clock Amplifier				
Q214	Same as Q208	Emitter Follower				
Q215	TRANSISTOR GERMANIUM; junction contact type, PNP configuration.	Aux. A-6 Output	143741	02735	2N398	
Q216	Same as Q200	Aux. Signal Sampling				
Q217	Same as Q200	Retard One-Shot Univibrator (Q218)				
Q218	Same as Q200	Retard One-Shot Univibrator (Q217)				
Q219	Same as Q200	Emitter Follower				
Q220	Same as Q200	Advance One-Shot Univibrator (Q22)				
Q221	Same as Q200	Advance One-Shot Univibrator (Q22))				
Q222	Same as Q200	Emitter Follower				
Q223	Same as Q200	-6 Volt Level Sensing				
Q224	Same as Q200	Isolation Amplifier				
Q225	Same as Q208	Constant Current Generator				
Q226	Same as Q200	Retard Discharge				
Q227	Same as Q208	Inverter				
Q228	Same as Q200	+ 6 Volts Level Sensing				
Q229	Same as Q208	Isolation Amplifier				
Q230	Same as Q208	Constant Current Generator				
Q231	Same as Q208	Advance Discharge				
Q232-1	Same as Q200	Retard Flip-Flop with Q233-1				
Q232-2	Same as Q200	Advance Flip-Flop with Q233-2				
Q234-1	Same as Q200	Subtract Gate One-Shot with Q235-				
Q234-2	Same as Q200	Add Gate One-Shot with Q235-2				
Q236	Same as Q200	Amplifier (Subtract/Add Gate)				
Q237	Same as Q200	Inverter				
R200	RESISTOR, FIXED, COMPOSITION; 1 Section, 3300 ohms \pm 5%, 0.5 W	Base Bias (Q200)	129851	01121	EB3325	
R201	RESISTOR, FIXED, COMPOSITION; 1 Section, 51 ohms \pm 5%, 0.5 W (RC20GF510J)	Emitter Bias (Q200 & Q201)	143656	01121	EB5105	
R202	RESISTOR, FIXED, COMPOSITION; 1 Section, 2700 ohms \pm 5%, 0.5 W (RC20BF272J)	Base Bias (Q200)	118144	01121	EB2725	
R203	RESISTOR, FIXED, COMPOSITION; 1 Section, 270 ohms \pm 5%, 0.5 W (RC20BF271J)	Non-saturating (Q200)	118725	01121	EB2715	
R204	Same as R202	Base Bias (Q201)				
R205	Same as R203	Non-saturating (Q201)				
R206	RESISTOR, FIXED, COMPOSITION; 1 Section, 1200 ohms \pm 5%, 0.5 W (RC20BF122J)	Collector Load (Q200)	137441	01121	EB1225	
R207	Same as R206	Collector Load (Q201)				
R208	Same as R200	Base Bias (Q201)				
R209	RESISTOR, FIXED, COMPOSITION; 1 Section, 10,000 ohms \pm 5%, 0.5 W (RC20BF103J)	C205 Discharge thru. K200	118180	01121	EB1035	
R210	Same as R209	C205 Discharge thru. K200				
R211	RESISTOR, FIXED, COMPOSITION; 1 Section, 360 ohms \pm 5%, 0.5 W (RC20GF361J)	Line Battery Resistance	143669	01121	EB3615	

SYNCHRONIZER - AMPLIFIER - TMS 201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
R212	RESISTOR, FIXED, COMPOSITION; 1 Section, 27 Ohms \pm 10%, 0.5 W (RC20BF270K)	Slicing Level (Fixed)	118721	01121	EB2701	
R213	RESISTOR, FIXED, COMPOSITION; 1 Section, 4700 ohms \pm 5%, 0.5 W (RC20BF472J)	Base Bias (Q202)	118146	01121	EB4725	
R214	RESISTOR, FIXED, COMPOSITION; 1 Section, 2200 ohms \pm 5%, 0.5W	Base Bias (Q202)	129852	01121	EB2225	
R215	Same as R203	Emitter Bias (Q202)				
R216	Same as R212	K200 Shunt				
R217	RESISTOR, VARIABLE, COMPOSITION; 1 Section, 500 ohms, 2W., linear taper.	Slicing Level Adjust	143651	01121	JLU5011 SD4040L	
R218	RESISTOR, VARIABLE; ww, 750 ohms \pm 10%, 4W, linear taper.	Line Current Adjust	143654	71450	RA-30L-A SB751A	
R219	RESISTOR, FIXED, COMPOSITION; 1 Section, 100 K ohms \pm 5%, 0.5 W (RC20BF104J)	Base Current Limiting (Q203)	118720	01121	EB1045	
R220	RESISTOR, FIXED, COMPOSITION; 1 Section, 47,000 ohms \pm 5%, 0.5 W (RC20BF473J)	Base Bias (Q203)	118154	01121	EB4735	
R221	Same as R213	Collector Load (Q203)				
R222	Same as R214	Emitter Load (Q204)				
R223	Same as R209	Base Bias (Q206)				
R224	Same as R213	Base Current Limiting (Q206)				
R225	RESISTOR, FIXED, COMPOSITION; 1 Section, 1500 ohms \pm 5%, 0.5W (RC20BF152J)	Collector Load (Q206)	137442	01121	EB1525	
R226	Same as R219	Isolating (TP No. 1)				
R227	RESISTOR, FIXED, COMPOSITION; 1 Section, 6800 ohms \pm 5%, 0.5 W (RC20BF682J)	"AND" Gate Load (CR208/CR212)	118147	01121	EB6825	
R228	Same as R227	"AND" Gate Load (CR209/CR210)				
R229	Same as R214	Emitter Load (Q207)				
R230	Same as R214	Emitter Load (Q205)				
R231	Same as R214	Collector Load (Q208)				
R232	RESISTOR, FIXED, COMPOSITION; 1 Section, 1000 ohms \pm 5%, 0.5 W (RC20BF102J)	RC Filter with C206	137440	01121	EB1025	
R233	Same as R232	Base Current Limiting (Q209)				
R234	Same as R232	Base Bias with R232 (Q209)				
R235	Same as R225	Collector Load (Q209)				
R236	Same as R213	Base Current Limiting (Q210)				
R237	Same as R209	Base Bias (Q210)				
R238	RESISTOR, FIXED, COMPOSITION; 1 Section, 22,000 ohms \pm 5%, 0.5 W (RC20BF223J)	Collector Load (Q210)	118177	01121	EB2235	
R240	Same as R219	Isolating (TP No. 2)				
R241	Same as R213	Inhibit Gate with CR215				
R242	RESISTOR, FIXED, COMPOSITION; 1 Section, 12,000 ohms \pm 5%, 0.5 W (RC20BF123J)	C208 Discharge	118149	01121	EB1235	
R243	Same as R206	Base Bias (Q211)				
R244	Same as R213	Emitter Load (Q211)				
R245	Same as R214	Emitter Load (Q212)				
R246	RESISTOR, FIXED, COMPOSITION; 1 Section, 18,000 ohms \pm 5%, 0.5W (RC20BF183J)	Emitter Bias (Q213)	118151	01121	EB1835	
R247	Same as R201	Emitter Current Limiting (Q213)				
R248	Same as R232	Emitter Bias (Q213)				
R249	RESISTOR, FIXED, COMPOSITION; 1 Section, 8,200 ohms \pm 5%, 0.5 W (RC20BF822J)	Collector Load (Q213)	137444	01121	EB8225	
R250	Same as R214	Emitter Load (Q214)				
R251	Same as R246	Emitter Bias (Q215)				
R252	Same as R201	Emitter Current Limiting (Q215)				
R253	Same as R232	Emitter Bias (Q215)				
R254	Same as R249	Collector Load (Q215)				
R255	Same as R209	C212 Discharge				

SYNCHRONIZER-AMPLIFIER - TMS 201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
R256	Same as R214	Base Current Limiting (Q216)				
R257	Same as R200	Collector Load (Q216)				
R258	Same as R200	Base Bias (Q218)				
R259	Same as R201	Emitter Bias (Q217 & Q218)				
R262	Same as R202	Base Bias (Q218)				
R264	Same as R227	One-Shot Timing (Retard Univibrator)				
R265	Same as R206	Collector Load (Q217)				
R266	Same as R206	C214 Charge				
R267	Same as R206	Collector Load (Q218)				
R268	Same as R206	Base Current Limiting (Q225)				
R269	RESISTOR, FIXED, COMPOSITION; 1 Section, 470K ohms \pm 5%, 0.5 W (RC20BF474J)		118165	01121	EB4745	
R270	Same as R219	Gate Bias (phase Lag Gate)				
R271	Same as R214	Gate Bias (phase Lag Gate)				
R272	Same as R219	"AND" Gate Load				
R273	Same as R213	Isolating (TP No. 3)				
R274	Same as R200	Emitter Load (Q219)				
R275	Same as R201	Base Bias (Q221)				
R278	Same as R202	Emitter Bias (Q220 & Q221)				
R279	Same as R219	Base Bias (Q221)				
R280	Same as R227	C226, C216 Bias				
R281	Same as R206	One-Shot Timing (Q220 & Q221)				
R282	Same as R206	Collector Load (Q220)				
R283	Same as R206	C217 Charge				
R284	Same as R206	Collector Load (Q221)				
R285	Same as R269	Base Current Limiting (Q230)				
R286	Same as R219	Gate Bias with CR228				
R287	Same as R214	Gate Bias with CR228				
R288	Same as R219	"AND" Gate Load				
R289	Same as R213	Isolating (TP No. 4)				
R290	RESISTOR, FIXED, COMPOSITION; 1 Section, 3900 ohms \pm 5%, 0.5 W (RC20GF392J)	Emitter Load Q222	143667	01121	EB3925	
R291	Same as R238	Collector Load (Q223)				
R292	Same as R209	Emitter Load (Q224)				
R293	Same as R247	Base Current Limiting (Q223)				
R294	RESISTOR, VARIABLE; composition, 1 Section, 1000 ohms	Emitter Current Limiting (Q225)	143655	01121	JLU1021 SD4040L	
R295	Same as R225	Retard Current Adjust. (Q225)				
R296	Same as R214	Base Bias (Q225)				
R297	Same as R249	Base Current Limiting (Q226)				
R298	Same as R238	Base Bias (Q226)				
R299	Same as R232	Collector Load (Q226)				
R300	RESISTOR, FIXED, COMPOSITION; 1 Section, 150K ohms \pm 5%, 0.5 W (RC20BF154J)	Discharge Current Limiting	118159	01121	EB1545	
R301	Same as R269	M201 Current Limiting				
R302	Same as R219	C220 Discharge				
R303	Same as R290	Isolating (TP No. 5)				
R304	Same as R242	Collector Load (Q227)				
R305	Same as R242	Base Current Limiting (Q227)				
R306	Same as R238	Collector Load (Q228)				
R307	Same as R209	Emitter Load (Q229)				
R308	RESISTOR, FIXED, COMPOSITION; 1 Section, 220 ohms \pm 5%, 0.5 W (RC20BF221J)	Base Current Limiting (Q228)	118724	01121	EB2215	
R309	Same as R294	Emitter Current Limiting (Q230)				
R310	Same as R225	Advance Current Adjust				
R311	Same as R219	Base Bias (Q230)				
R312	Same as R200	Isolating (TP. No. 6)				
R313	Same as R213	Base Current Limiting (Q231)				
R314	Same as R238	Base Bias (Q231)				
R315	Same as R232	Collector Load (Q231)				
R316-1	Same as R200	Discharge Current Limiting				
R317-1	Same as R201	Base Bias (Q232-1)				
R318-1	Same as R202	Emitter Bias (Q232-1 & Q233-1)				
R319-1	Same as R203	Base Bias (Q232-1)				
		Non-saturating Bias (Q232-1)				

SYNCHRONIZER - AMPLIFIER - TMS 201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
R320-1	Same as R202	Base Bias (Q233-1)				
R321-1	Same as R203	Non-saturating Bias (Q233-1)				
R322-1	Same as R206	Collector Load (Q232-1)				
R323-1	Same as R206	Collector Load (Q233-1)				
R324-1	Same as R200	Base Bias (Q233-1)				
R325-1	Same as R200	Base Bias (Q234-1)				
R326-1	Same as R201	Emitter Bias (Q234-1 & Q235-1)				
R327-1	Same as R202	Base Bias (Q234-1)				
R330-1	Same as R206	C223-1 Discharge				
R331-1	Same as R206	Collector Load (Q234-1)				
R332-1	Same as R206	Collector Load (Q235-1)				
R333-1	Same as R206	One-Shot Timing (Q234-1 & Q235-1)				
R335-1	RESISTOR, VARIABLE; composition, 1 Section, 5000 ohms		143653	01121	JLU5021 SD4040L	
R336	Same as R213	Subtract Gate/Add Gate Control				
R337	Same as R213	Inhibit Gate with CR253				
R338	Same as R200	Inhibit Gate with CR252				
R339	RESISTOR, FIXED, COMPOSITION; 1 Section, 5600 ohms \pm 5%, 0.5 W (RC20BF562J)	Base Current Limiting (Q236)	118186	01121	EB5625	
R340	Same as R225	Collector Load (Q236)				
R341	RESISTOR, FIXED, COMPOSITION; 1 Section, 1.0 Meg \pm 5%, 0.5 W (RC20BF105J)	Collector Load (Q237)	118169	01121	EB1055	
R342-1	Same as R341	C201 Discharge with Q200				
R343-1	Same as R341	C221-1 Discharge				
R345	Same as R341	C222-1 Discharge				
S200	SWITCH, TOGGLE; DPDT, 125V, 5A	C200 Discharge with Q201	118659	04009	82305BS	
S201	SWITCH, TOGGLE; SPDT	Local-Remote Switch	82344	04009	21350	
S202	SWITCH, PUSH; S.P., momentary make	Auto-Manual Framing	118589	70087	3DO5-5P	
T200	TRANSFORMER, RADIO FREQUENCY; 2 Windings. Pri. (4-5) DC Resistance 1.16 ohms; Nominal Inductance at 1000 Cy. 54 UH. Sec. (1-3) DC Resistance 4.2 ohms, Nominal Inductance at 1000 Cy. 285 UH. Tapped at 0.94 ohms.	Framing Switch	143791	85544		
XK200	SOCKET 14 PIN.	Input Relay Isolation	137294	71785	54A18372	
XC220	SOCKET	K200 Connector	118591	71785	51B 13416-A EXP9680G	
XQ200 thru XQ241	SOCKET, TRANSISTOR;	C220 Connector	143759	71785		
		Transistor Sockets				

OUTPUT AMPLIFIER - TMXU201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
C400	CAPACITOR, FIXED, CERAMIC DIELECTRIC; 1 Section, 75 VDCW, 0.002 UF -0% +100%	Input Coupling Capacitor	143688	86335	MIN-N	
C401	Same as C400	Input Coupling Capacitor				
C402	Same as C400	Gross Coupling Capacitor				
C403	Same as C400	Gross Coupling Capacitor				
C404-1	CAPACITOR, FIXED, TANTALYTIC DIELECTRIC; 1 Section, 100 VDCW, 11.0 UF -15% +50% CW37D110MSP	Coupling Capacitor	143704	21520	CW37D 110MSP	
C405-1	CAPACITOR, FIXED, TANTALYTIC DIELECTRIC, 1 Section, 125 VDCW, 1.5 UF -15% +50%	Output Coupling	143683	21520	CW35D IR5NSP	
C406	CAPACITOR, FIXED, METALIZED PAPER DIELECTRIC; 1 Section, 200 VDCW, 0.05 UF ± 20%, plastic sleeve	Differentiating with R417	137306	00656	P123ZNGF	
C407	CAPACITOR, FIXED, METALIZED PAPER DIELECTRIC; 1 Section, 200 VDCW, 0.001 UF ± 25%, plastic sleeve	Oscillator Tuning	137301	00656	P123ZNGF	
C408	Same as C407	Oscillator Tuning				
C409	CAPACITOR, FIXED, METALIZED PAPER DIELECTRIC; 1 Section, 200 VDCW, 0.03 UF ± 20%, plastic sleeve	Coupling Capacitor	137305	00656	P123ZNGF	
CR400	SEMICONDUCTOR DEVICE, DIODE; Germanium Gold-Bonded, Glass Type, MIL-E-1	Input Pulse Steering	143711	99180	1N270	
CR401	Same as CR400	Non-Saturating				
CR402	Same as CR400	-6 Volt Clamp				
CR403	Same as CR400	-6 Volt Clamp				
CR404	Same as CR400	Non-Saturating				
CR405	Same as CR400	-6 Volt Clamp				
CR406	Same as CR400	-1.5 Volt Clamp				
CR407	Same as CR400	-6 Volt Clamp				
CR408	Same as CR400	Isolating				
CR409	Same as CR400	Isolating				
CR410	SEMICONDUCTOR DEVICE, DIODE; 1N1372, Zener Type	Serge Protection	143713	28959	HZPR-75 1N1372	
CR411	Same as CR410	Serge Protection				
CR412	SEMICONDUCTOR DEVICE, DIODE; Germanium Gold-Bonded, Glass Type, MIL-E-1	Isolating	143710	99180	1N277	
F400	FUSE, CARTRIDGE; 1/10 amp, MDL 1/10	Overload Protection	120394	71400	MDL 1/10 amp. 564	
H400	KEY, SOCKET-HEAD SCREW; 5/64 hex, L shape	Allen Head Screw	110271	70276		
H401	RING, RETAINING	Retains H403	144131	94222	58-41-0-68	
H402	WASHER, COMPOSITION; NEOPRENE, compound 2381, 0.250ID, 0.500 OD, 0.031 thick	Provides driptight seal.	144163	75543	144163	
H403	THUMBSCREW; 1/4-20 thread	Retains drawer in cabinet	144129	94222	58-21-109-56	
H404	SCREW, MACHINE; 6-40 x .438, flat head		102755	59432	102755	
H405	GASKET, PANEL; nonmetallic, special section	Provides driptight seal.	144096	59432	144096	
H407	KNOB, POINTER; for 1/4" shaft, black molded composition	Control Knob	144168	49956	Mirror 90-5-2	
J400	CONNECTOR, RECEPTACLE, ELECTRICAL; 18 Contacts, Male Printed Circuit Connector	Circuit Board Connector	143770	02660	133-018- 03	
J401	Same as J400	Circuit Board Connector				
J402	JACK, TIP; Phone-tip, Red	Test Point No. 1	143780	81453	276-15- 94G4	
J403	Same as J402	Test Point No. 2				
J404	Same as J402	Test Point No. 3				
J405	Same as J402	Test Point No. 4				
J406	Same as J402	Test Point No. 5				
L400	COIL, RADIO FREQUENCY; Toroid Plastic Moulded, 50 MH	Oscillator Tank	143720	88063	MP608- 23B	
M400	AMMETER; 0 to 100MA, 1" sealed round meter	Output Line Current Meter	143756	16688	Series 100	
Q400	TRANSISTOR, GERMANIUM; Junction Contact Type, PNP Configuration	ac - generator	143735	81453	2N404	
Q401	Same as Q400	ac - generator				

OUTPUT AMPLIFIER - TMXU201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
Q402-1	TRANSISTOR, GERMANIUM; Junction Contact Type, NPN Configuration	Emitter Follower	143743	93332	2N388	
Q403-1	TRANSISTOR, GERMANIUM; Junction Contact Type, PNP Configuration	Auxiliary Clock Amp.	143741	02735	2N398	
Q404	Same as Q402-1	Emitter Follower				
Q405	Same as Q400	Amplifier				
Q406	Same as Q402-1	Emitter Follower				
Q407	Same as Q400	Amplifier				
Q408	TRANSISTOR, SILICON; Junction Contact Type, NPN Configuration	Voltage Amplifier	143740	01295	2N341	
Q409	Same as Q400	Input Amplifier				
Q410	Same as Q400	Oscillator Clamp				
Q411	Same as Q402-1	Oscillator Clamp				
Q412	Same as Q400	Oscillator				
Q413	Same as Q400	Driver				
Q414	Same as Q402-1	Driver				
Q415	Same as Q402-1	Demodulator				
Q416	Same as Q402-1	Demodulator				
Q417	Same as Q403-1	Output Line Relay				
Q418	Same as Q408	Output Voltage Amp.				
Q419	Same as Q403-1	Output Line Relay				
R400	RESISTOR, FIXED, COMPOSITION; 1 Section, 2700 ohms, $\pm 5\%$, 0.5 W (RC20BF272J)	Base Bias	118144	01121	EB2725	
R401	RESISTOR, FIXED, COMPOSITION; 1 Section, 270 ohms, $\pm 5\%$, 0.5 W. (RC20BF271J)	Non-saturating Bias	118725	01121	EB2715	
R402	RESISTOR, FIXED, COMPOSITION; 1 Section, 1200 ohms $\pm 5\%$, 0.5 W. (RC20BF122J)	Collector Load	137441	01121	EB1225	
R403	RESISTOR, FIXED, COMPOSITION; 1 Section, 5600 ohms $\pm 5\%$, 0.5 W (RC20BF562J)	Steering Diode Bias	118186	01121	EB5625	
R404	RESISTOR, FIXED, COMPOSITION; 1 Section, 3300 ohms, $\pm 5\%$, 0.5 W (RC20BF332J)	Base Bias	129851	01121	EB3325	
R405	Same as R404	Base Bias				
R406	Same as R403	Collector Load				
R407	Same as R401	Non-saturating				
R408	Same as R402	Collector Load				
R409	Same as R400	Base Bias				
R410	RESISTOR, FIXED, COMPOSITION; 1 Section, 51 ohms $\pm 5\%$, 0.5 W (RC20GF510J)	Emitter Bias	143656	01121	EB5105	
R411-1	RESISTOR, FIXED, COMPOSITION; 1 Section 2200 ohms $\pm 5\%$, 0.5 W (RC20BF222J)	Emitter Load	129852	01121	EB2225	
R412-1	RESISTOR, FIXED, COMPOSITION; 1 Section, 18,000 ohms $\pm 5\%$, 0.5 W (RC20BF183J)	Voltage Divider with R413-1	118151	01121	EB1835	
R413-1	RESISTOR, FIXED, COMPOSITION; 1 Section, 1000 ohms $\pm 5\%$, 0.5 W (RC20BF120J)	Voltage Divider with R12-1	137440	01121	EB1025	
R414-1	Same as R410	Emitter Current Limiting				
R415-1	RESISTOR, FIXED, COMPOSITION; 1 Section, 8200 ohms $\pm 5\%$, 0.5 W. (RC20BF822J)	Collector Load	137444	01121	EB8225	
R416	RESISTOR, FIXED, COMPOSITION; 1 Section, 4700 ohms $\pm 5\%$, 0.5 W (RC20BF472J)	Emitter Load	118146	01121	EB4725	
R417	RESISTOR, FIXED, COMPOSITION; 1 Section, 10,000 ohms $\pm 5\%$, 0.5 W (RC20BF103J)	Differentiating with C406	118180	01121	EB1035	
R418	Same as R411	Base Current Limiting				
R419	Same as R404	Collector Load				
R420	Same as R402	Emitter Load				
R421	Same as R400	Base Current Limiting				
R422	RESISTOR, FIXED, COMPOSITION; 1 Section, 6800 ohms $\pm 5\%$, 0.5 W (RC20BF682J)	Base Bias	118147	01121	EB6825	
R423	Same as R413	Collector Load				
R424	Same as R413	Base Current Limiting				
R425	Same as R417	Base Bias				
R426	RESISTOR, FIXED, COMPOSITION; 1 Section, 22,000 ohms $\pm 5\%$, 0.5 W (RC20BF223J)	Collector Load	118177	01121	EB2235	
R427	RESISTOR, FIXED, COMPOSITION; 1 Section, 100,000 ohms $\pm 5\%$, 0.5 W (RC20BF104J)	Base Current Limiting	118720	01121	EB1045	
R428	RESISTOR, FIXED, COMPOSITION; 1 Section, 47,000 ohms $\pm 5\%$, 0.5 W (RC20BF473J)	Base Bias	118154	01121	EB4735	
R429	Same as R416	Collector Load				
R430	Same as R427	Isolating				

OUTPUT AMPLIFIER - TMXU201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
R431	Same as R416	Base Current Limiting				
R432	Same as R426	Base Bias				
R433	Same as R411	Collector Load				
R434	Same as R413	Clamp Current Limiting				
R435	RESISTOR, FIXED, COMPOSITION; 1 Section, 6200 ohms $\pm 5\%$, 0.5 W (RC20GF622J)	Base Current Limiting	143668	01121	EB6225	
R436	Same as R413	Base Bias				
R437	RESISTOR, FIXED, COMPOSITION; 1 Section, 150 ohms $\pm 5\%$, 0.5 W (RC20GF151J)	Base Bias	143658	01121	EB1515	
R438	Same as R411	Clamp Current Limiting				
R439	RESISTOR, FIXED, COMPOSITION; 1 Section, 7500 ohms $\pm 5\%$, 0.5 W (RC20GF752J)	Emitter to Base Feed back	143664	01121	EB7525	
R440	Same as R427	Emitter Load				
R441	RESISTOR, FIXED, COMPOSITION; 1 Section, 220 ohms $\pm 5\%$, 0.5 W (RC20BF221J)	Isolating	118724	01121	EB2215	
R442	Same as R416	Ringing Suppressor				
R443	Same as R413	Emitter Load				
R444	RESISTOR, FIXED, COMPOSITION; 1 Section, 390 ohms $\pm 5\%$, 0.5 W (RC20GF391J)	Ringing Suppressor	143662	01121	EB3915	
R445	RESISTOR, FIXED, COMPOSITION; 1 Section, 180 ohms $\pm 5\%$, 0.5 W (RC20BF181J)	Voltage Divider with R445	137430	01121	EB1815	
R446	Same as R411	Voltage Divider with R444				
R447	RESISTOR, FIXED, COMPOSITION; 1 Section, 100 ohms $\pm 5\%$, 0.5 W (RC20BF101J)	Base Bias	137438	01121	EB1015	
R448	RESISTOR, VARIABLE: WW, 1 Section, 750 ohms $\pm 10\%$, 4W, linear taper	Base Current Limiting	143654	71450	RA-30L-A SB751A	
R449	Same as R427	Base Current, Vernier Adjustment				
R450	Same as R416	Isolating				
R451	Same as R416	Base Current Limiting				
R452	Same as R411	Base Bias				
R453	RESISTOR, VARIABLE; composition, 1 Section, 2500 ohms	Collector Load	143652	01121	JLU2521 SD4040L	
R454	Same as R427	Collector Supply Potentiometer				
R455	Same as R401	Isolating.				
R456	RESISTOR, FIXED, COMPOSITION; 1 Section, 56,000 ohms $\pm 5\%$, 0.5 W (RC20BF563J)	Voltage Divider with R457, R458	118156	01121	EB5635	
R457	Same as R411	Emitter to Base Bias				
R458	Same as R456	Voltage Divider with R456, R457				
S400	SWITCH, ROTARY: 1 Section, SP4T insulation: bakelite, silver plated brass contacts	Signal Selector	143748	76854	143748	
S401	SWITCH, TOGGLE; DPDT	Remote - Local	118659	04009	82305BS	
T400	TRANSFORMER; 600 ohm Pri 600 ohm SEC	Isolating.	137492	96253	TTI-2664	
XQ400 thru XQ419	SOCKET, TRANSISTOR;		143759	71785	EXP9680G	

NEON LAMP INDICATOR ASSEMBLY - TMN200

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
C410	CAPACITOR, FIXED, ELECTROLYTIC DIELECTRIC; 1 Section, 150 VDCW, 8.0 UF	Filter	143692	74861	15RMV8	
CR413	SEMICONDUCTOR DEVICE, DIODE; Silicon type MIL-E-1	Power Rectifier	143715	99180	IN540	
DS401	LAMP, GLOW;	Indicator Light-Element No. 1	143760	72765	110	
DS402	Same as DS401	thru Element No. 6				
to 406		Power "ON" indicator				
DS407						
P407	CONNECTOR, PLUG, ELECTRICAL; with cable clamp, octal	Input Signal Plug	143762	02660	86-PM8- 11	
P408	PLUG, CONNECTOR; military standard Part No. M591185-1 Spec. Mil-C-3767	Power Input Plug	143763	97539	UP121M	
Q429	TRANSISTOR, GERMANIUM; Junction contact type, PNP configuration		143741	00467	2N398	
Q420	Same as Q429	DS 401 Amplifier-Element No. 1				
Q421	Same as Q429	DS 402 Amplifier-Element No. 2				
Q422	Same as Q429	DS 403 Amplifier-Element No. 3				
Q423	Same as Q429	DS 404 Amplifier-Element No. 4				
Q424	Same as Q429	DS 405 Amplifier-Element No. 5				
R459	RESISTOR, FIXED, COMPOSITION; 1 Section, 56,000 ohms \pm 5%, 0.5 W (RC20BF563J)	Current Limiting - DS 402	118156	01121	EB5635	
R460	RESISTOR, FIXED, COMPOSITION; 1 Section, 33,000 ohms \pm 5%, 0.5 W (RC20BF333J)	Voltage Divider with R459	118153	01121	EB3335	
R461	RESISTOR, FIXED, COMPOSITION; 1 Section, 10,000 ohms \pm 5%, 0.5 W (RC20BF103J)	Base Current Limiting - Q420	118180	01121	EB1035	
R462	RESISTOR, FIXED, COMPOSITION; 1 Section, 180,000 ohms \pm 5%, 0.5 W (RC20BF184J)	Base Bias - Q420	143666	01121	EB1845	
R463	Same as R459	Current Limiting - DS 403				
R464	Same as R460	Voltage Divider with R463				
R465	Same as R461	Base Current Limiting - Q421				
R466	Same as R462	Base Bias - Q421				
R467	Same as R459	Current Limiting - DS 404				
R468	Same as R460	Voltage Divider with R467				
R469	Same as R461	Base Current Limiting - Q422				
R470	Same as R462	Base Bias - Q422				
R471	Same as R459	Current Limiting - DS 405				
R472	Same as R460	Voltage Divider with R471				
R473	Same as R461	Base Current Limiting - Q423				
R474	Same as R462	Base Bias - Q423				
R475	Same as R459	Current Limiting - DS 406				
R476	Same as R460	Voltage Divider with R475				
R477	Same as R461	Base Current Limiting - Q424				
R478	Same as R462	Base Bias - Q424				
R479	RESISTOR, FIXED, COMPOSITION; 1 Section, 7,500 ohms \pm 5%, 2 W	Voltage Divider with R480	143672	01121	HB7525	
R480	RESISTOR, FIXED, COMPOSITION; 1 Section, 5,100 ohms, \pm 5%, 2 W	Voltage Divider with R479	143671	01121	HB5125	
R481	RESISTOR, FIXED, COMPOSITION; 1 Section, 300 ohms \pm 5%, 2 W	C410 - Current Limiting	143670	01121	HB3015	
R482	RESISTOR, FIXED, COMPOSITION; 1 Section, 82,000 ohms \pm 5%, 0.5 W (RC20BF823J)	DS 407 - Current Limiting	118182	01121	EB8235	
R483	Same as R459	Current Limiting for DS-401				
R484	Same as R460	Voltage Divider with R483				
R485	Same as R461	Base Current Limiting Q429				
R486	Same as R462	Base Bias Q429				
T401	TRANSFORMER	Power Transformer	143761			
XQ401	SOCKET, TRANSISTOR	Socket for Q420 thru Q424	143759	71785	EXP9680G	
thru		also Q429.				
XQ407						

MULTIPLEXER - DEMULTIPLEXER - TMD201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
C500	CAPACITOR, FIXED, METALIZED PAPER DIELECTRIC; 1 Section, 200 VDCW, 0.005 UF Plastic Sleeve	Coupling, Tuning with L500	137303	00656	P123ZNGF	
C501	CAPACITOR, FIXED, CERAMIC DIE- LECTRIC; 1 Section, 75 VDCW, 0.01 UF	Coupling to Q500	143687	86335	MIN-M	
C502	CAPACITOR, FIXED, CERAMIC DIE- LECTRIC; 1 Section, 75 VDCW, 0.015 UF	Priming for Q501	143707	86335	MIN-N	
C503	Same as C502	Priming for Q502				
C504	Same as C502	Priming for Q503				
C505	Same as C502	Priming for Q504				
C506	Same as C502	Priming for Q505				
C507	Same as C500	Coupling, Tuning with L501				
C508	Same as C501	Coupling to Q506				
C509	Same as C502	Priming for Q507				
C510	Same as C502	Priming for Q508				
C511	Same as C502	Priming for Q509				
C512	Same as C502	Priming for Q510				
C513	Same as C502	Priming for Q511				
C514	Same as C502	Priming for Q512				
C515	Same as C500	Coupling, Tuning with L502				
C516	Same as C501	Coupling to Q513				
C517	Same as C502	Priming for Q514				
C518	Same as C502	Priming for Q515				
C519	Same as C502	Priming for Q516				
C520	Same as C502	Priming for Q517				
C521	Same as C502	Priming for Q518				
C522	Same as C502	Priming for Q519				
C523	Same as C502	Priming for Q520				
C524	Same as C500	Coupling, Tuning with L503				
C525	Same as C501	Coupling to Q521				
C526	Same as C502	Priming for Q522				
C527	Same as C502	Priming for Q523				
C528	Same as C502	Priming for Q524				
C529	Same as C502	Priming for Q525				
C530	Same as C502	Priming for Q526				
C531	Same as C502	Priming for Q527				
C532	Same as C500	Coupling, Tuning with L504				
C533	Same as C501	Coupling to Q529				
C536	Same as C502	Priming for Q531				
C537	Same as C502	Priming for Q532				
C538	Same as C502	Priming for Q533				
C539	Same as C502	Priming for Q534				
C540	Same as C501	Coupling to Q535				
C541	Same as C502	Priming for Q536				
C542	Same as C502	Priming for Q537				
C543	Same as C502	Priming for Q538				
C544	Same as C502	Priming for Q539				
C545	Same as C502	Priming for Q540				
C546	Same as C502	Priming for Q541				
C547	Same as C502	Priming for Q542				
C548	Same as C500	Coupling, Tuning with L505				
C549	Same as C500	Coupling, Tuning with L503				
C550	Same as C501	Filter, -1.5 Volt (Q513)				
C551	Same as C501	Filter, -6.0 Volt (Q513)				
C552	Same as C501	Filter, -1.5 Volt (Q535)				
C553	Same as C501	Filter, -6.0 Volt (Q535)				
CR500	SEMICONDUCTOR DEVICE, DIODE; IN270, Germanium, Gold-Bonded, Glass Type, MIL-E-1	Clamps Negative pulse to ground (Q500)	143711	99180	IN270	
CR501	SEMICONDUCTOR DEVICE, DIODE; IN277, Germanium, Gold-Bonded, Glass Type, MIL-E-1	Rejects Negative pulse (Q500)	143710	99180	IN277	
CR502	Same as CR500	-1.5 Volt Clamp (Q500)				
CR503	Same as CR501	Non-saturating (Q500)				
CR504	Same as CR500	-6 Volt Clamp (Q501)				
CR505	Same as CR500	-6 Volt Clamp (Q502)				
CR506	Same as CR500	-6 Volt Clamp (Q503)				

MULTIPLEXER - DEMULTIPLEXER - TMD201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
CR507	Same as CR500	-6 Volt Clamp (Q504)				
CR508	Same as CR500	-6 Volt Clamp (Q505)				
CR509	Same as CR500	Clamps Negative pulse to Gnd.				
CR510	Same as CR501	Rejects Negative pulse (Q506)				
CR511	Same as CR500	-1.5 Volt Clamp (Q506)				
CR512	Same as CR501	Non-saturating				
CR513	Same as CR500	-6 Volt Clamp (Q507)				
CR514	Same as CR500	-6 Volt Clamp (Q508)				
CR515	Same as CR500	-6 Volt Clamp (Q509)				
CR516	Same as CR500	-6 Volt Clamp (Q510)				
CR517	Same as CR500	-6 Volt Clamp (Q511)				
CR518	Same as CR500	-6 Volt Clamp (Q512)				
CR519	Same as CR500	Clamps Negative pulse to Gnd.				
CR520	Same as CR501	Rejects Negative pulse (Q513)				
CR521	Same as CR500	-1.5 Volt Clamp (Q513)				
CR522	Same as CR501	Non-saturating (Q513)				
CR523	Same as CR500	-6 Volt Clamp (Q514)				
CR524	Same as CR500	-6 Volt Clamp (Q515)				
CR525	Same as CR500	-6 Volt Clamp (Q516)				
CR526	Same as CR500	-6 Volt Clamp (Q517)				
CR527	Same as CR500	-6 Volt Clamp (Q518)				
CR528	Same as CR500	-6 Volt Clamp (Q519)				
CR529	Same as CR500	-6 Volt Clamp (Q520)				
CR530	Same as CR501	Phase Lag "OR" (Q515)				
CR531	Same as CR501	Phase Lag "OR" Gate (Q516)				
CR532	Same as CR501	Phase Lag "OR" Gate (Q517)				
CR533	Same as CR501	Phase Lead "OR" Gate (Q518)				
CR534	Same as CR501	Phase Lead "OR" Gate (Q519)				
CR535	Same as CR501	Phase Lead "OR" Gate (Q520)				
CR536	Same as CR501	Sampling pulse "AND" Gate (Q528)				
CR537	Same as CR501	Sampling pulse "AND" Gate (Q528)				
CR538	Same as CR501	Isolating (Q521)				
CR539	Same as CR500	Clamps Negative pulse to Gnd. (Q521)				
CR540	Same as CR501	Rejects Negative pulse (Q521)				
CR541	Same as CR500	-1.5 Volts Clamp (Q521)				
CR542	Same as CR501	Isolating (Q521)				
CR543	Same as CR501	Non-saturating (Q521)				
CR544	Same as CR500	-6 Volt Clamp (Q522)				
CR545	Same as CR500	-6 Volt Clamp (Q523)				
CR546	Same as CR500	-6 Volt Clamp (Q524)				
CR547	Same as CR500	-6 Volt Clamp (Q525)				
CR548	Same as CR500	-6 Volt Clamp (Q526)				
CR549	Same as CR500	-6 Volt Clamp (Q527)				
CR550	Same as CR501	M500 Meter Rectifier				
CR551	Same as CR500	Clamps Negative pulse to Gnd.				
CR552	Same as CR501	Rejects Negative pulse (Q529)				
CR553	Same as CR500	-1.5 Volt Clamp (Q529)				
CR554	Same as CR501	Non-saturating				
CR555	Same as CR500	-6 Volt Clamp (Q531)				
CR556	Same as CR500	-6 Volt Clamp (Q532)				
CR557	Same as CR500	-6 Volt Clamp (Q533)				
CR558	Same as CR500	-6 Volt Clamp (Q534)				
CR559	Same as CR500	A-1 Element "AND" Gate				
CR560	Same as CR500	A-1 Element "AND" Gate				
CR561	Same as CR500	A-1 Element "AND/OR" Gate				
CR562	Same as CR500	A-1 Element "AND/OR" Gate				
CR563	Same as CR500	A-2 Element "AND" Gate				
CR564	Same as CR500	A-2 Element "AND" Gate				
CR565	Same as CR500	A-2 Element "AND/OR" Gate				
CR566	Same as CR500	A-2 Element "AND/OR" Gate				
CR567	Same as CR500	A-3 Element "AND" Gate				
CR568	Same as CR500	A-3 Element "AND" Gate				
CR569	Same as CR500	A-3 Element "AND/OR" Gate				
CR570	Same as CR500	A-3 Element "AND/OR" Gate				
CR571	Same as CR500	A-4 Element "AND" Gate				
CR572	Same as CR500	A-4 Element "AND" Gate				
CR573	Same as CR500	A-4 Element "AND/OR" Gate				
CR574	Same as CR500	A-4 Element "AND/OR" Gate				

MULTIPLEXER - DEMULTIPLEXER - TMD201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
CR575	Same as CR500	A-5 Element "AND" Gate				
CR576	Same as CR500	A-5 Element "AND" Gate				
CR577	Same as CR500	A-5 Element "AND/OR" Gate				
CR578	Same as CR500	A-5 Element "AND/OR" Gate				
CR579	Same as CR500	A-6 Element "AND" Gate				
CR580	Same as CR500	A-6 Element "AND" Gate				
CR581	Same as CR500	A-6 Element "AND/OR" Gate				
CR582	Same as CR500	A-6 Element "AND/OR" Gate				
CR583	Same as CR500	B-1 Element "AND" Gate				
CR584	Same as CR500	B-1 Element "AND" Gate				
CR585	Same as CR500	B-1 Element "AND/OR" Gate				
CR586	Same as CR500	B-1 Element "AND/OR" Gate				
CR587	Same as CR500	B-2 Element "AND" Gate				
CR588	Same as CR500	B-2 Element "AND" Gate				
CR589	Same as CR500	B-2 Element "AND/OR" Gate				
CR590	Same as CR500	B-2 Element "AND/OR" Gate				
CR591	Same as CR500	B-3 Element "AND" Gate				
CR592	Same as CR500	B-3 Element "AND" Gate				
CR593	Same as CR500	B-3 Element "AND/OR" Gate				
CR594	Same as CR500	B-3 Element "AND/OR" Gate				
CR595	Same as CR500	B-4 Element "AND" Gate				
CR596	Same as CR500	B-4 Element "AND" Gate				
CR597	Same as CR500	B-4 Element "AND/OR" Gate				
CR598	Same as CR500	B-4 Element "AND/OR" Gate				
CR599	Same as CR500	B-5 Element "AND" Gate				
CR600	Same as CR500	B-5 Element "AND" Gate				
CR601	Same as CR500	B-5 Element "AND/OR" Gate				
CR602	Same as CR500	B-5 Element "AND/OR" Gate				
CR603	Same as CR500	B-6 Element "AND" Gate				
CR604	Same as CR500	B-6 Element "AND" Gate				
CR605	Same as CR500	B-6 Element "AND/OR" Gate				
CR606	Same as CR500	B-6 Element "AND/OR" Gate				
CR607	Same as CR500	C-1 Element "AND" Gate				
CR608	Same as CR500	C-1 Element "AND" Gate				
CR609	Same as CR500	C-1 Element "AND/OR" Gate				
CR610	Same as CR500	C-1 Element "AND/OR" Gate				
CR611	Same as CR500	C-2 Element "AND" Gate				
CR612	Same as CR500	C-2 Element "AND" Gate				
CR613	Same as CR500	C-2 Element "AND/OR" Gate				
CR614	Same as CR500	C-2 Element "AND/OR" Gate				
CR615	Same as CR500	C-3 Element "AND" Gate				
CR616	Same as CR500	C-3 Element "AND" Gate				
CR617	Same as CR500	C-3 Element "AND/OR" Gate				
CR618	Same as CR500	C-3 Element "AND/OR" Gate				
CR619	Same as CR500	C-4 Element "AND" Gate				
CR620	Same as CR500	C-4 Element "AND" Gate				
CR621	Same as CR500	C-4 Element "AND/OR" Gate				
CR622	Same as CR500	C-4 Element "AND/OR" Gate				
CR623	Same as CR500	C-5 Element "AND" Gate				
CR624	Same as CR500	C-5 Element "AND" Gate				
CR625	Same as CR500	C-5 Element "AND/OR" Gate				
CR626	Same as CR500	C-5 Element "AND/OR" Gate				
CR627	Same as CR500	C-6 Element "AND" Gate				
CR628	Same as CR500	C-6 Element "AND" Gate				
CR629	Same as CR500	C-6 Element "AND/OR" Gate				
CR630	Same as CR500	C-6 Element "AND/OR" Gate				
CR631	Same as CR500	D-1 Element "AND" Gate				
CR632	Same as CR500	D-1 Element "AND" Gate				
CR633	Same as CR500	D-1 Element "AND/OR" Gate				
CR634	Same as CR500	D-1 Element "AND/OR" Gate				
CR635	Same as CR500	D-2 Element "AND" Gate				
CR636	Same as CR500	D-2 Element "AND" Gate				
CR637	Same as CR500	D-2 Element "AND/OR" Gate				
CR638	Same as CR500	D-2 Element "AND/OR" Gate				
CR639	Same as CR500	D-3 Element "AND" Gate				
CR640	Same as CR500	D-3 Element "AND" Gate				
CR641	Same as CR500	D-3 Element "AND/OR" Gate				
CR642	Same as CR500	D-3 Element "AND/OR" Gate				

MULTIPLEXER - DEMULTIPLEXER - TMD201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
CR643	Same as CR500	D-4 Element "AND" Gate				
CR644	Same as CR500	D-4 Element "AND" Gate				
CR645	Same as CR500	D-4 Element "AND/OR" Gate				
CR646	Same as CR500	D-4 Element "AND/OR" Gate				
CR647	Same as CR500	D-5 Element "AND" Gate				
CR648	Same as CR500	D-5 Element "AND" Gate				
CR649	Same as CR500	D-5 Element "AND/OR" Gate				
CR650	Same as CR500	D-5 Element "AND/OR" Gate				
CR651	Same as CR500	D-6 Element "AND" Gate				
CR652	Same as CR500	D-6 Element "AND" Gate				
CR653	Same as CR500	D-6 Element "AND/OR" Gate				
CR654	Same as CR500	D-6 Element "AND/OR" Gate				
CR655	Same as CR501	Clamps Negative pulse to Gnd.				
CR656	Same as CR501	Rejects Negative pulse (Q535)				
CR657	Same as CR500	-1.5 Volt Clamp (Q535)				
CR658	Same as CR501	Non-saturating (Q535)				
CR659	Same as CR500	-6 Volt Clamp (Q536)				
CR660	Same as CR500	-6 Volt Clamp (Q537)				
CR661	Same as CR500	-6 Volt Clamp (Q538)				
CR662	Same as CR500	-6 Volt Clamp (Q539)				
CR663	Same as CR500	-6 Volt Clamp (Q540)				
CR664	Same as CR500	-6 Volt Clamp (Q541)				
CR665	Same as CR500	-6 Volt Clamp (Q542)				
CR666	Same as CR501	Phase Lag "OR" gate (Q514)				
H500	KEY, SOCKET HEAD SCREW; 5/64 hex, L shape	For adjusting L500	110271	70276	564	
H501	RING, RETAINING;	Retains H503	144131	94222	58-41-0-63	
H502	WASHER, COMPOSITION: NEOPRENE compound 2381, 0.250 ID, 0.500 OD, 0.031 thick	Provides drip tight seal	144163	75543	144163	
H503	THUMBSCREW; 1/4-20 thread	Retains drawer in cabinet	144129	94222	58-21-109-56	
H504	SCREW, MACHINE; 6-40 x .438, flat head		102755	59432	102755	
H505	GASKET, PANEL; nonmetallic, special section	Provides drip tight seal	144096	59432	144096	
H506	SCREW, MACHINE; 4-40 x 1", fillister head, steel		113178	59432	113178	
H507	KNOB, POINTER; for 1/4" shaft, black molded composition	Mounting Hardware	144168	49956	Mirror 90-5-2	
J500	JACK, TIP; Phone tip, Red	Channel Selector				
J501	Same as J500	Test Point No. 1	143780	81453	276-1594-64	
J502	Same as J500	Test Point No. 2				
J503	Same as J500	Test Point No. 3				
J504	Same as J500	Test Point No. 4				
J505	Same as J500	Test Point No. 5				
J506	CONNECTOR, RECEPTACLE, ELECTRICAL; 18 Contacts, Male Printed Circuit Connector	Circuit Board Upper Connector	143770	02660	133-018-08	
J507	CONNECTOR, RECEPTACLE, ELECTRICAL; 15 Contacts, Male Printed Circuit Connector	Circuit Board Center Connector	143772	02660	133-015-08	
J508	Same as J506	Circuit Board Lower Connector				
L500	COIL, RADIO FREQUENCY; Universal Wound Type 5.0 MH \pm 5%	Series tuned with C500	137380	82208	MO305 Code 52	
L501	Same as L500	Series tuned with C507				
L502	Same as L500	Series tuned with C515				
L503	Same as L500	Series tuned with C524				
L504	Same as L500	Series tuned with C532				
L505	Same as L500	Series tuned with C548				
M500	AMMETER; 0-1 MA DC 1" Sealed Round Meter	Distributor Cycle Meter	143755	16688	Series 100	
Q500	TRANSISTOR, GERMANIUM; Junction Contact type, PNP Configuration	Drive Amplifier	143735	81453	2N404	
Q501	TRANSISTOR, GERMANIUM; Point Contact Type	Divider No. 2 - Element No. 1	143736	88600	2N110	
Q502	Same as Q501	Divider No. 2 - Element No. 2				
Q503	Same as Q501	Divider No. 2 - Element No. 3				
Q504	Same as Q501	Divider No. 2 Element No. 4				
Q505	Same as Q501	Divider No. 2 - Element No. 5				
Q506	Same as Q500	Drive Amplifier				
Q507	Same as Q501	Divider No. 3 - Element No. 1				

MULTIPLEXER - DEMULTIPLEXER - TMD201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
Q508	Same as Q501	Divider No. 3 - Element No. 2				
Q509	Same as Q501	Divider No. 3 - Element No. 3				
Q510	Same as Q501	Divider No. 3 - Element No. 4				
Q511	Same as Q501	Divider No. 3 - Element No. 5				
Q512	Same as Q501	Divider No. 3 - Element No. 6				
Q513	Same as Q500	Drive Amplifier				
Q514	Same as Q501	Divider No. 4 - Element No. 1				
Q515	Same as Q501	Divider No. 4 - Element No. 2				
Q516	Same as Q501	Divider No. 4 - Element No. 3				
Q517	Same as Q501	Divider No. 4 - Element No. 4				
Q518	Same as Q501	Divider No. 4 - Element No. 5				
Q519	Same as Q501	Divider No. 4 Element No. 6				
Q520	Same as Q501	Divider No. 4 - Element No. 7				
Q521	Same as Q500	Drive Amplifier				
Q522	Same as Q501	Divider No. 5 - Element No. 1				
Q523	Same as Q501	Divider No. 5 - Element No. 2				
Q524	Same as Q501	Divider No. 5 - Element No. 3				
Q525	Same as Q501	Divider No. 5 - Element No. 4				
Q526	Same as Q501	Divider No. 5 - Element No. 5				
Q527	Same as Q501	Divider No. 5 - Element No. 6				
Q528	TRANSISTOR, GERMANIUM; Junction Contact Type, NPN Configuration	Emitter Follower	143743	90139	2N388	
Q529	Same as Q500	Drive Amplifier				
Q530	Same as Q500	Distributor Cycle Meter Drive				
Q531	Same as Q501	Divider No. 6 - Element No. 1				
Q532	Same as Q501	Divider No. 6 - Element No. 2				
Q533	Same as Q501	Divider No. 6 - Element No. 3				
Q534	Same as Q501	Divider No. 6 - Element No. 4				
Q535	Same as Q500	Drive Amplifier				
Q536	Same as Q501	Divider No. 7 Element No. 1				
Q537	Same as Q501	Divider No. 7 - Element No. 2				
Q538	Same as Q501	Divider No. 7 - Element No. 3				
Q539	Same as Q501	Divider No. 7 - Element No. 4				
Q540	Same as Q501	Divider No. 7 - Element No. 5				
Q541	Same as Q501	Divider No. 7 - Element No. 6				
Q542	Same as Q501	Divider No. 7 - Element No. 7				
R500	RESISTOR, FIXED, COMPOSITION; 1 Section, 10,000 ohms \pm 5%, 0.5 W (RC20BF103J)	C501 Discharge Base Bias (Q500)	118180	01121	EB1035	
R501	Same as R500					
R502	RESISTOR, FIXED, COMPOSITION; 1 Section, 180 ohms \pm 5%, 0.5 W (RC20BF181J)	Non-saturating (Q500)	137430	01121	EB1815	
R503	RESISTOR, FIXED, COMPOSITION; 1 Section, 820 ohms \pm 5%, 0.5 W (RC20BF821J)	Collector Load (Q500)	137439	01121	EB8215	
R504	RESISTOR, FIXED, COMPOSITION; 1 Section, 270 ohms \pm 5%, 0.5 W (RC20BF271J)	Common Emitter Load	118725	01121	EB2715	
R505	RESISTOR, FIXED, COMPOSITION; 1 Section, 300 ohms \pm 5%, 0.5 W (RC20GF301J)	Base Bias (Q501)	143657	01121	EB3015	
R506	RESISTOR, FIXED, COMPOSITION; 1 Section, 750 ohms \pm 5%, 0.5 W (RC20GF751J)	Collector Load (Q501) Base Bias (Q502)	143660	01121	EB7515	
R507	Same as R505	Collector Load (Q502)				
R508	Same as R506	Base Bias (Q503)				
R509	Same as R505	Collector Load (Q503)				
R510	Same as R506	Base Bias (Q504)				
R511	Same as R505	Collector Load (Q504)				
R512	Same as R506	Base Bias (Q505)				
R513	Same as R505	Collector Load (Q505)				
R514	Same as R506	Base Bias (Q505)				
R515	RESISTOR, FIXED, COMPOSITION; 1 Section, 100K ohms \pm 5%, 0.5 W (RC20BF104J)	Isolating (Divider No. 2) C508 Discharge Base Bias (Q506) Non-saturating (Q506)	118720	01121	EB1045	
R516	Same as R500					
R517	Same as R500					
R518	Same as R502					

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REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
R519	Same as R503	Collector Load (Q506)				
R520	Same as R504	Common Emitter Load				
R521	Same as R505	Base Bias (Q507)				
R522	Same as R506	Collector Load (Q507)				
R523	Same as R505	Base Bias (Q508)				
R524	Same as R506	Collector Load (Q508)				
R525	Same as R505	Base Bias (Q509)				
R526	Same as R506	Collector Load (Q509)				
R527	Same as R505	Base Bias (Q510)				
R528	Same as R506	Collector Load (Q510)				
R529	Same as R505	Base Bias (Q511)				
R530	Same as R506	Collector Load (Q511)				
R531	Same as R505	Base Bias (Q512)				
R532	Same as R506	Collector Load (Q512)				
R533	Same as R515	Isolating (Divider No. 3)				
R534	Same as R500	C516 Discharge				
R535	Same as R500	Base Bias (Q513)				
R536	Same as R502	Non-saturating (Q513)				
R538	Same as R504	Common Emitter Load				
R539	Same as R505	Base Bias (Q514)				
R540	Same as R506	Collector Load (Q514)				
R541	Same as R505	Base Bias (Q515)				
R542	Same as R506	Collector Load (Q515)				
R543	Same as R505	Base Bias (Q516)				
R544	Same as R506	Collector Load (Q516)				
R545	Same as R505	Base Bias (Q517)				
R546	Same as R506	Collector Load (Q517)				
R547	Same as R505	Base Bias (Q518)				
R548	Same as R506	Collector Load (Q518)				
R549	Same as R505	Base Bias (Q519)				
R550	Same as R506	Collector Load (Q519)				
R551	Same as R505	Base Bias (Q520)				
R552	Same as R506	Collector Load (Q520)				
R553	Same as R515	Isolating (Divider No. 4)				
R554	Same as R500	"OR" gate Load (Q514)				
R555	Same as R500	"OR" gate Load (Q518)				
R556	RESISTOR, FIXED, COMPOSITION; 1 Section, 2,200 ohms \pm 5%, 0.5 W	"AND" gate Load	129852	01121	EB2225	
R557	Same as R556	Emitter Load (Q528)				
R558	Same as R500	C525 Discharge				
R559	Same as R500	Base Bias (Q521)				
R560	Same as R502	Non-saturating bias				
R561	Same as R503	Collector Load (Q521)				
R562	Same as R504	Common Emitter Load				
R563	Same as R505	Base Bias (Q522)				
R564	Same as R506	Collector Load (Q522)				
R565	Same as R505	Base Bias (Q523)				
R566	Same as R506	Collector Load (Q523)				
R567	Same as R505	Base Bias (Q524)				
R568	Same as R506	Collector Load (Q524)				
R569	Same as R505	Base Bias (Q525)				
R570	Same as R506	Collector Load (Q525)				
R571	Same as R505	Base Bias (Q526)				
R572	Same as R506	Collector Bias (Q526)				
R573	Same as R505	Base Bias (Q527)				
R574	Same as R506	Collector Bias (Q527)				
R575	Same as R515	Isolating (Divider No. 5)				
R576	RESISTOR, FIXED, COMPOSITION; 1 Section, 15,000 ohms \pm 5%, 0.5 W (RC20BF153J)	Current Limiting - M500 Meter	118150	01121	EB1535	
R577	RESISTOR, FIXED, COMPOSITION; 1 Section, 12,000 ohms \pm 5%, 0.5 W (RC20BF123J)	Current Limiting - M500 Meter	118149	01121	EV1235	
R578	RESISTOR, FIXED, COMPOSITION; 1 Section, 4,700 ohms \pm 5%, 0.5 W (RC20BF472J)	Collector Load (Q530)	118146	01121	EB1235	
R579	Same as R578	Base Bias (Q530)				
R580	Same as R556	Base Current Limiting (Q530)				
R581	Same as R500	C533 Discharge				
R582	Same as R500	Base Bias				
R583	Same as R502	Non-saturating Bias				

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REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG 'S		NOTES
				CODE	DESIG.	
R584	Same as R503	Collector Load (Q529)				
R585	Same as R504	Common Emitter Load				
R586	Same as R505	Base Bias (Q531)				
R587	Same as R506	Collector Load (Q531)				
R588	Same as R505	Base Bias (Q532)				
R589	Same as R506	Collector Load (Q532)				
R590	Same as R505	Base Bias (Q533)				
R591	Same as R506	Collector Load (Q533)				
R592	Same as R505	Base Bias (Q534)				
R593	Same as R506	Collector Load (Q534)				
R594	Same as R515	Isolating (Divider No. 6)				
R595	Same as R556	Gate Load - Element A-1				
R596	Same as R556	Gate Load - Element A-2				
R597	Same as R556	Gate Load - Element A-3				
R598	Same as R556	Gate Load - Element A-4				
R599	Same as R556	Gate Load - Element A-5				
R600	Same as R556	Gate Load - Element A-6				
R601	Same as R556	Gate Load - Element B-1				
R602	Same as R556	Gate Load - Element B-2				
R603	Same as R556	Gate Load - Element B-3				
R604	Same as R556	Gate Load - Element B-4				
R605	Same as R556	Gate Load - Element B-5				
R606	Same as R556	Gate Load - Element B-6				
R607	Same as R556	Gate Load - Element C-1				
R608	Same as R556	Gate Load - Element C-2				
R609	Same as R556	Gate Load - Element C-3				
R610	Same as R556	Gate Load - Element C-4				
R611	Same as R556	Gate Load - Element C-5				
R612	Same as R556	Gate Load - Element C-6				
R613	Same as R556	Gate Load - Element D-1				
R614	Same as R556	Gate Load - Element D-2				
R615	Same as R556	Gate Load - Element D-3				
R616	Same as R556	Gate Load - Element D-4				
R617	Same as R556	Gate Load - Element D-5				
R618	Same as R556	Gate Load - Element D-6				
R619	Same as R515	Isolating (TP6)				
R620	Same as R500	C54D Discharge				
R621	Same as R500	Base Bias (Q535)				
R622	Same as R502	Non-saturating Bias (Q535)				
R623	Same as R503	Collector Load (Q535)				
R624	Same as R504	Common Emitter Load				
R625	Same as R505	Base Bias (Q536)				
R626	Same as R506	Collector Load (Q536)				
R627	Same as R505	Base Bias (Q537)				
R628	Same as R506	Collector Load (Q537)				
R629	Same as R505	Base Bias (Q538)				
R630	Same as R506	Collector Load (Q538)				
R631	Same as R505	Base Bias (Q539)				
R632	Same as R506	Collector Load (Q539)				
R633	Same as R505	Base Bias (Q540)				
R634	Same as R506	Collector Load (Q540)				
R635	Same as R505	Base Bias (Q541)				
R636	Same as R506	Collector Load (Q541)				
R637	Same as R505	Base Bias (Q542)				
R638	Same as R506	Collector Load (Q542)				
R639	Same as R515	C549 Discharge (Q521)				
R640	Same as R515	C524 Discharge (Q521)				
S500	SWITCH, ROTARY; 1 Section, 3 Position, 5 Poles, Insulation: Bakelite, Silver Plated Brass Contacts	Word per Minute Selector	143746	76854	143746	
S501	SWITCH, ROTARY; 1 Section, 2 Position, 3 Poles, Non-Shorting, Insulation: Bakelite, Silver Plated Brass Contacts	Auxiliary - Normal Switch	143749	76854	143749	
S502	SWITCH, ROTARY; 2 Section, 3 Position, 5 Poles, Insulation: Bakelite, Silver Plated Brass Contacts	Channel Selector	143747	76854	143747	
S503	SWITCH, TOGGLE; DPDT	Normal - Inverted Signal	118659	04009	82305BS	
XQ500 thru XQ542	SOCKET, TRANSISTOR;	Connector for Transistors	143759	71785	EXP9680G	

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REF DESIG	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO	MFG'S		NOTES
				CODE	DESIG.	
C700	CAPACITOR, FIXED, CERAMIC DIELECTRIC; 1 Section, 75 vdcw, 0.01 UF	Differentiating (Q700)	143687	86335	MIN-M	
C701	Same as C700	Coupling to Q701				
C702	Same as C700	Differentiating Input to Q701				
C703	Same as C700	Differentiating Input to Q703				
C704	Same as C700	Differentiating Input to Q704				
C705	CAPACITOR, FIXED, "VISCOFILM" DIELECTRIC; 2 Section, (A) 0.5 UF, and (B) 1.0 UF, in case	Start- Stop Oscillator Tuning (Q707)	143708	74861	2089	
C706	CAPACITOR, FIXED, METALIZED PAPER DIELECTRIC; 1 Section, 0.005 UF \pm 25% 200 vdcw	Series tuned with L701 Coupling to Q710	137303	00656	P123ZNGP	
C707	Same as C700					
C708	CAPACITOR, FIXED, CERAMIC DIELECTRIC; 1 Section, 75 vdcw, 0.015 UF	Priming for Q713	143707	86335	MIN-N	
C709	Same as C708	Priming for Q714				
C710	Same as C708	Priming for Q715				
C711	Same as C708	Priming for Q716				
C712	Same as C708	Priming for Q717				
C713	Same as C708	Priming for Q718				
C714	Same as C708	Priming for Q719				
C715	CAPACITOR, FIXED, MICA DIELECTRIC; 1 Section, 470 UUF	r.f. Filter (Relay)	118314			
C716	Same as C707	-6 Volt Filter (Q710)				
C717	Same as C700	-1.5 Volt Filter				
CR700	SEMICONDUCTOR DEVICE, DIODE; Germanium Gold-Bonded, Glass Type, MIL-E-1	Rejects Negative pulses Non-saturating (Q700)	143710	99180	1N277	
CR701	Same as CR700					
CR702	SEMICONDUCTOR DEVICE, DIODE; Germanium Gold-Bonded, Glass Type, MIL-E-1	-6 Volt Clamp (Q700)	143711	99180	1N270	
CR703	Same as CR702	-6 Volt Clamp (Q701)				
CR704	Same as CR700	Non-saturating (Q701)				
CR705	Same as CR700	"OR" Gate (TB702)				
CR706	Same as CR700	"OR" Gate (TB702)				
CR707	Same as CR700	"OR" Gate (Q703-1 thru. -5)				
CR708	Same as CR700	Non-saturating (Q703-1 thru. -5)				
CR709	Same as CR702	-6 Volt Clamp (Q703-1 thru. -5)				
CR710	Same as CR702	-6 Volt Clamp (Q704-1 thru. -5)				
CR711	Same as CR700	Non-saturating (Q704-1 thru. -5)				
CR712	Same as CR700	Rejects Negative pulses				
CR713	Same as CR700	"AND" gate (CR713-1 thru. -5)				
CR714	Same as CR700	"OR" gate (CR713-1 thru. -5)				
CR715	Same as CR700	"AND" gate (CR715-1 thru. -5)				
CR716	Same as CR700	"OR" gate (TB705)				
CR717	Same as CR700	"AND" gate (TB704)				
CR718	Same as CR700	"AND" gate (TB704)				
CR719	Same as CR700	Isolating				
CR720	Same as CR700	Clamp to -6 Volts				
CR721	Same as CR700	Rejects Negative pulses				
CR722	Same as CR702	-1.5 Volt Clamp				
CR723	Same as CR700	Non-saturating (Q710)				
CR724	Same as CR702	Clamps Negative pulses to GND.				
CR725	Same as CR702	-6 Volt Clamp (Q713)				
CR726	Same as CR702	-6 Volt Clamp (Q714)				
CR727	Same as CR702	-6 Volt Clamp (Q715)				
CR728	Same as CR702	-6 Volt Clamp (Q716)				
CR729	Same as CR702	-6 Volt Clamp (Q717)				
CR730	Same as CR702	-6 Volt Clamp (Q718)				
CR731	Same as CR702	-6 Volt Clamp (Q719)				
H700	KEY, SOCKET HEAD SCREW; 5/64, hex, L shape	For adjusting L700	110271	70276	564	
H701	RING, RETAINING;	Retains H703	144131	94222	58-41-0-63	
H702	WASHER, COMPOSITION; NEOPRENE, compound 2381, 0.250 ID, 0.500 OD, 0.031 thick	Provides drip tight seal.	144163	75543	144163	
H703	THUMBSCREW; 1/4-20 thread	Retains drawer in cabinet	144129	94222	58-21-109-56	
H704	SCREW, MACHINE; 6-40 x .438, flat head		102755	59432	102755	

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REF DESIG	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
H705	GASKET, PANEL; nonmetallic, special section	Provides drip tight seal	144096	59432	144096	
H706	SCREW, MACHINE; 4-40 x 11/64", fillister head, steel	Mounting Hardware	109152	59432	109152	
J700	JACK, TELEPHONE; leaf type, J4 Contact Arrangement	Monitor Jack	97143	80331	12A	
J701	JACK, TIP; phone tip, red	Test Point No. 1	143780	49956	276-1594G4	
J702	Same as J701	Test Point No. 2				
J703	Same as J701	Test Point No. 3				
J704	Same as J701	Test Point No. 4				
J705	Same as J701	Test Point No. 5				
J707	SOCKET ELECTRON TUBE, OCTAL; Copper Base Alloy Contacts	Neon Test Lamp Connector	118591	71785	51B13416A	
J708	CONNECTOR, RECEPTACLE, ELECTRICAL; 18 Contacts, Male Printed Circuit Connector	Circuit Board Upper Connector	143770	02660	133-018-03	
J709	Same as J708	Circuit Board Lower Connector				
K700	RELAY, ELECTRICAL; Armature Type, Mercury Switch Contacts	Output Line Relay	143790	88600	291C	
L700	INDUCTOR, VARIABLE; 1-9H	Start-Stop Oscillator Inductor	143730	93713	SH-8538	
L701	COIL, RADIO FREQUENCY; Universal Wound Type, 5.0 MH \pm 5%	Series Tuned with C706	137380	82218	MO305-Code 52	
M700	AMMETER; 0-100 MA DC, 1" sealed round meter	Line Current Meter	143756	16688	Series 100	
Q700	TRANSISTOR, GERMANIUM; junction contact type, PNP configuration	Traffic Recognizer Flip Flop	143735	81453	2N404	
Q701	Same as Q700	Traffic Recognizer Flip-Flop				
Q702	TRANSISTOR, GERMANIUM; junction contact type, NPN configuration	Emitter Follower	143743	93332	2N388	
Q703	Same as Q700	Storage Flip-Flop (Q703-1 to -5)				
Q704	Same as Q700	Storage Flip-Flop (Q704-1 to -5)				
Q705	Same as Q702	Oscillator Control Amplifier				
Q706	Same as Q700	Start-Stop Oscillator Clamp				
Q707	Same as Q700	Start-Stop Oscillator				
Q708	Same as Q702	Squaring Amplifier				
Q709	Same as Q700	Squaring Amplifier				
Q710	Same as Q700	Drive Amplifier				
Q711	Same as Q702	Emitter Follower				
Q712	Same as Q700	Line Relay Driver				
Q713	TRANSISTOR, GERMANIUM; point contact type	S. S. Distributor; Start Element	143736	88600	2N110	
Q714	Same as Q713	S. S. Distributor; No. 1 Element				
Q715	Same as Q713	S. S. Distributor; No. 2 Element				
Q716	Same as Q713	S. S. Distributor; No. 3 Element				
Q717	Same as Q713	S. S. Distributor; No. 4 Element				
Q718	Same as Q713	S. S. Distributor; No. 5 Element				
Q719	Same as Q713	S. S. Distributor; Stop Element				
R700	RESISTOR, FIXED, COMPOSITION; 1 Section, 10,000 ohms \pm 5%, 0.5 W (RC20BF103J)	C700 Discharge	118180	01121	EB1035	
R701	RESISTOR, FIXED, COMPOSITION; 1 Section, 270 ohms \pm 5%, 0.5 W (RC20BF271J)	Non-saturating Bias (Q700)	118725	01121	EB2715	
R702	RESISTOR, FIXED, COMPOSITION; 1 Section, 1,200 ohms \pm 5%, 0.5 W (RC20BF122J)	Collector Load (Q700)	137441	01121	EB1225	
R703	RESISTOR, FIXED, COMPOSITION; 1 Section, 2,700 ohms \pm 5%, 0.5 W (RC20BF272J)	Base Bias (Q700)	118144	01121	EB2725	
R704	Same as R702	Collector Load				
R705	RESISTOR, FIXED, COMPOSITION; 1 Section, 3,300 ohms \pm 5%, 0.5 W (RC20BF332J)	Base Bias (Q700)	129851	01121	EB3325	
R706	Same as R705	Base Bias (Q701)				
R707	RESISTOR, FIXED, COMPOSITION; 1 Section, 51 ohms \pm 5%, 0.5 W (RC20GF510J)	Emitter Bias	143656	01121	EB5105	
R708	Same as R701	Non-saturating Bias				
R709	Same as R703	Base Bias (Q701)				
R710	Same as R703	"OR" gate Load (Q702)				
R711	Same as R700	Emitter Load (Q702)				
R712	Same as R705	"AND" gate Load				
R713	Same as R702	Collector Load (Q703-1 to -5)				
R714	Same as R701	Non-saturating Bias (Q703-1 to -5)				
R715	Same as R703	Base Bias (Q703-1 to -5)				
R716	Same as R702	Collector Load (Q704-1 to -5)				
R717	Same as R705	Base Bias (Q703-1 to -5)				
R718	Same as R705	Base Bias (Q704-1 to -5)				
R719	Same as R707					

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REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
R720	Same as R701	Non-saturating Bias (Q704-1 to -5)				
R721	Same as R703	Base Bias (Q704-1 to -5)				
R722	Same as R700	C704 Discharge				
R723	RESISTOR, FIXED, COMPOSITION; 1 Section, 2,200 ohms \pm 5%, 0.5 W (RC20BF222J)	"AND" gate Load (TB701-1 to -5)	129852	01121	EB2225	
R724	RESISTOR, VARIABLE; WW, 1 Section, 750 ohms \pm 10%, 4 W, linear taper	Vernier Line Current Adjust (J700)	143654	71450	RA-30L-A- SB751A	
R725	Same as R700	Base Bias (Q705)				
R726	Same as R700	Collector Load (Q705)				
R727	Same as R703	Base Current Limiting (Q705)				
R728	Same as R700	Base Current Limiting (Q706)				
R729	Same as R723	Collector Load (Q706)				
R730	RESISTOR, VARIABLE; composition, 1 Section, 5,000 ohms	Clamp Current Adjust (Q706)	143653	01121	JLU5021 SD4040L	
R731	RESISTOR, FIXED, COMPOSITION; 1 Section, 100 K \pm 5%, 0.5 W (RC20BF104J)	Isolating (Tp-3 Osc.)	118720	01121	EB1045	
R732	Same as R723	Collector Load (Q708)				
R733	Same as R723	Collector Load (Q709)				
R734	Same as R731	Isolating (TP2. S.S. Osc.)				
R735	Same as R705	Emitter Load (Q707)				
R736	RESISTOR, FIXED, COMPOSITION; 1 Section, 300 ohms \pm 5%, 0.5 W (RC20GF301J)	Current Limiting (Q707)	143657	01121	EB3015	
R737	RESISTOR, FIXED, COMPOSITION; 1 Section, 33,000 ohms \pm 5%, 0.5 W (RC20BF333J)	Positive Feedback (Q708)	118153	01121	EB3335	
R738	Same as R700	Base Current Limiting (Q709)				
R739	Same as R723	Base Current Limiting (Q708)				
R740	RESISTOR, VARIABLE; composition, 1 Section, 2,500 ohms	Feedback Adjustment (SS. Osc.)	143652	01121	JLU2521 SD4040L	
R741	Same as R723	Shunt Load on Clamp				
R742	RESISTOR, THERMAL;	Thermal Feedback Compensation	143650	83186	31D7	
R743	RESISTOR, FIXED, COMPOSITION; 1 Section, 560 ohms \pm 5%, 0.5 W (RC20GF561J)	Temperature Compensating Shunt	143659	01121	EB5615	
R744	Same as R701					
R745	Same as R700	Base Bias (Q710)				
R746	RESISTOR, FIXED, COMPOSITION; 1 Section, 820 ohms \pm 5%, 0.5 W (RC20BF821J)	Collector Load (Q710)	137439	01121	EB8215	
R747	RESISTOR, FIXED, COMPOSITION; 1 Section, 180 ohms \pm 5%, 0.5 W (RC20BF181J)	Collector Load (Q710)	137430	01121	EB1815	
R748	Same as R700	Non-saturating Bias (Q710)				
R749	Same as R702	C707 Discharge				
R750	RESISTANCE, FIXED, COMPOSITION; 1 Section, 1,000 ohms \pm 5%, 0.5 W (RC20BF102J)	Emitter Load (Q711)	137440	01121	EB1025	
R751	RESISTANCE, FIXED, COMPOSITION; 1 Section, 6,800 ohms \pm 5%, 0.5 W (RC20BF682J)	Base Current Limiting (Q712)	118147	01121	EB6825	
R752	RESISTANCE, FIXED, COMPOSITION; 1 Section, 390 ohms \pm 5%, 0.5 W (RC20GF391J)	Base Bias (Q712)	143662	01121	EB3915	
R753	Same as R731	Collector Load (Q712)				
R754	Same as R731	Isolating (TP4. S.S. Output)				
R755	Same as R736	Isolating (TP5. Start Control)				
R756	RESISTOR, FIXED, COMPOSITION; 1 Section, 750 ohms \pm 5%, 0.5 W (RC20GF751J)	Base Bias (Q713)	143660	01121	EB7515	
R757	Same as R736	Collector Load (Q713)				
R758	Same as R756	Base Bias (Q714)				
R759	Same as R736	Collector Load (Q714)				
R760	Same as R756	Base Bias (Q715)				
R761	Same as R736	Collector Load (Q715)				
R762	Same as R756	Base Bias (Q716)				
R763	Same as R736	Collector Load (Q716)				
R764	Same as R756	Base Bias (Q717)				
R765	Same as R736	Collector Load (Q717)				
R766	Same as R756	Base Bias (Q718)				
R767	Same as R736	Collector Load (Q718)				
R768	Same as R756	Base Bias (Q719)				
R769	Same as R774	Collector Load (Q719)				
R770	Same as R707	C702-1 Discharge (C702-1 to -5)				
R771	Same as R707	r.f. Filter (TB706)				
		r.f. Filter				

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REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
R774	RESISTOR, FIXED, COMPOSITION; 1 Section, 1.0 Meg \pm 5%, 0.5 W (RC20BF105J)	C701 Discharge (Input No. 6)	118169	01121	EB1055	
R776	Same as R774	C703 Discharge (C703-1 to -5)				
R779	Same as R731	Isolating TP 1				
S700	SWITCH, ROTARY; 1 Section, 3 Position, 1 Pole, non-shorting, insulation: bakelite, silver plated brass contacts	Words per Minute Switch	143745	76854	143745	
XQ700 thru XQ719	SOCKET, TRANSISTOR;		143759	71785	EXP9680G	
Z700	SUPPRESSOR, ARC	Connector for Transistors Electrical Noise Suppressor	154166	59432	154166	

TRANSMITTING CODE CONVERTER - TMCX201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
C900	CAPACITOR, FIXED, TANTALYTIC DIELECTRIC; 1 Section, 60 VDCW, 4 UF -15% +50%	Range Delay Timing	143682	21520	CW35DO-40LSP	
C901	CAPACITOR, FIXED, CERAMIC DIELECTRIC; 1 Section, 75 VDCW, 0.01 UF ± 20%		Differentiating Input to Q902	143687	86335	MIN-M
C902	CAPACITOR, FIXED, "VISCOFILM" DIELECTRIC; 2 Section, (B) 1.0 UF and (A) 0.5 UF, in case	Start-Stop Oscillator Timing	143708	74861	2089	
C903	CAPACITOR, FIXED, METALIZED PAPER DIELECTRIC; 1 Section, 200 VDCW, 0.005 UF, ± 25%, plastic sleeve		Coupling, tuning with L901	137303	00656	P123ZNGF
C904	Same as C901	Coupling to Q908	143707	86335	MIN-N	
C905	CAPACITOR, FIXED, CERAMIC DIELECTRIC; 1 Section, 75 VDCW, 0.015 UF -20%+100%	Priming for Q909				
C906	Same as C905	Priming for Q910				
C907	Same as C905	Priming for Q911				
C908	Same as C905	Priming for Q912				
C909	Same as C905	Priming for Q913				
C910	Same as C905	Priming for Q914				
C911	Same as C905	Priming for Q915				
C912	Same as C901	Differentiating Input to Q917				
C913	Same as C901	Differentiating Input to Q918				
C914	CAPACITOR, FIXED, METALIZED PAPER DIELECTRIC; 1 Section, 200 VDCW, 0.05 UF ± 20%, plastic sleeve	Coupling to Q920	137306	00656	P123ZNGF	
C915	CAPACITOR, FIXED, METALIZED PAPER DIELECTRIC; 1 Section, 200 VDCW, 0.1 UF ± 20%, plastic sleeve		Short Transfer Timing	137307	00656	P123ZNGF
C916	Same as C914	Differentiating Input to Q919				
C917	Same as C914	Coupling to Q924				
C918	CAPACITOR, FIXED, TANTALYTIC DIELECTRIC; 1 Section, 100 VDCW, 2 UF -15%, +20%	Clock Delay Timing	137314	21520	PP28100-C1	
C919	CAPACITOR, FIXED, METALIZED PAPER DIELECTRIC; 1 Section, 200 VDCW, 0.003 UF ± 25%, plastic sleeve		Differentiating, input to Q926	137302	00656	P123ZNGF
C920	Same as C901	Differentiating, input to Q927				
C921	Same as C901	Coupling to Q928				
C922	Same as C901	Differentiating, input to Q929				
C923	Same as C901	Differentiating, input to Q930				
C924	Same as C901	Coupling to Q931				
C925	Same as C901	Differentiating, input to Q932				
C926	Same as C901	Coupling to Q933				
C927	Same as C901	By pass Filter + 1.5 Volt (Q908)				
C928	Same as C901	Bu pass Filter + 6 Volts (Q908)				
CR900	SEMICONDUCTOR DEVICE, DIODE; Germanium Gold-Bonded, Glass type, MIL-E-1	Non-saturating (Q901)	143710	99180	1N277	
CR901	SEMICONDUCTOR DEVICE, DIODE; Germanium Gold-Bonded, Glass Type, MIL-E-1		-6 Volt Clamp	143711	99180	1N270
CR902	Same as CR901	-6 Volt Clamp				
CR903	Same as CR900	Non-saturating				
CR904	Same as CR900	"OR" gate (Q900)				
CR905	Same as CR900	"OR" gate (Q900)				
CR906	Same as CR900	"AND" gate (Q902)				
CR907	Same as CR900	"AND" gate (Q902)				
CR908	Same as CR900	"AND" gate (Q903)				
CR909	Same as CR900	"AND" gate (Q903)				
CR910	Same as CR900	Isolating (Q905)				
CR911	Same as CR900	Clamp to -6 Volt (Q905)				
CR912	Same as CR900	Non-saturating (Q908)				
CR913	Same as CR900	Rejects Negative pulse (Q908)				
CR914	Same as CR901	Clamps Negative pulse to GND.				
CR915	Same as CR901	+ 1.5 Volt Clamp (Q908)				
CR916	Same as CR901	-6 Volt Clamp (Q909)				
CR917	Same as CR901	-6 Volt Clamp (Q910)				
CR918	Same as CR901	-6 Volt Clamp (Q911)				

TRANSMITTING CODE CONVERTER - TMCX201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
CR919	Same as CR901	-6 Volt Clamp (Q912)				
CR920	Same as CR901	-6 Volt Clamp (Q913)				
CR921	Same as CR901	-6 Volt Clamp (Q914)				
CR922	Same as CR901	-6 Volt Clamp (Q915)				
CR923	Same as CR900	Rejects Negative Pulses (Q917)				
CR924	Same as CR900	Non-saturating (Q917)				
CR925	Same as CR901	-6 Volt Clamp (Q917)				
CR926	Same as CR901	-6 Volt Clamp (Q918)				
CR927	Same as CR900	Non-saturating (Q918)				
CR928	Same as CR900	Non-saturating (Q920)				
CR929	Same as CR901	-6 Volt Clamp (Q920)				
CR930	Same as CR901	-6 Volt Clamp (Q921)				
CR931	Same as CR900	Non-saturating (Q921)				
CR932	Same as CR900	Non-saturating (Q924)				
CR933	Same as CR901	-6 Volt Clamp (Q924)				
CR934	Same as CR901	-6 Volt Clamp (Q925)				
CR935	Same as CR900	Non-saturating (Q925)				
CR936	Same as CR900	Non-saturating (Q428)				
CR937	Same as CR901	-6 Volt Clamp (Q428)				
CR938	Same as CR901	-6 Volt Clamp (Q429)				
CR939	Same as CR900	Non-saturating (Q929)				
CR940	Same as CR900	Rejects Negative Pulse				
CR941	Same as CR900	"AND" gate				
CR942	Same as CR900	"AND" gate				
CR943	Same as CR900	"AND" gate				
CR944	Same as CR900	Non-saturating (Q930)				
CR945	Same as CR901	-6 Volt Clamp (Q930)				
CR946	Same as CR901	-6 Volt Clamp (Q931)				
CR947	Same as CR900	Non-saturating (Q931)				
CR948	Same as CR900	Rejects Negative Pulses				
CR949	Same as CR900	Non-saturating				
CR950	Same as CR901 (Note: On 1st 4 units of series D, CR950 was Same as CR900)	-6 Volt Clamp (Q932)				
CR951	Same as CR901	-6 Volt Clamp (Q933)				
CR952	Same as CR900	Non-saturating (Q933)				
H900	KEY, SOCKET HEAD SCREW; 5/64, hex, L shape	For Adjusting L900	110271	70276	564	
H901	RING, RETAINING;	Retains H903	144131	94222	58-41-0-63	
H902	WASHER, COMPOSITION; NEOPRENE, Compound 2381, 0.250ID, 0.500OD, 0.031 thick	Provides driptight seal.	144163	75543	144163	
H903	THUMBSCREW; 1/4-20 thread	Retains drawer in cabinet	144129	94222	58-21-109-56	
H904	SCREW, MACHINE; 6-40 x .438, flat head	Mounting Hardware	102755	59432	102755	
H905	GASKET, PANEL; nonmetallic, special section	Provides drip tight seal	144096	59432	144096	
H906	SCREW, MACHINE; 4-40 x 11/64", fillister head, steel	Mounting Hardware	109152	59432	109152	
J900	JACK, TELEPHONE; leaf type, J4 Contact Arrangement	Monitor Jack	97143	90331	12A	
J901	SOCKET, ELECTRON TUBE, OCTAL; Copper Base Alloy Contacts	Neon Test Lamp Assembly - Connector	118591	71785	51B13416A	
J902	JACK, TIP; Phone Tip, red	Test Point No. 1	143780	49956	276-1594G4	
J903	Same as J902	Test Point No. 2				
J904	Same as J902	Test Point No. 3				
J905	Same as J902	Test Point No. 4				
J906	Same as J902	Test Point No. 5				
J907	Same as J902	Test Point No. 6				
J908	Same as J902	Test Point No. 7				
J909	Same as J901	Test Point No. 8				
J910	CONNECTOR, RECEPTACLE, ELECTRICAL; 18 Contacts, Male Printed Circuit Connector	Circuit Board Upper Connector	143770	02660	133-018-03	
J911	Same as J910	Circuit Board Lower Connector				
K900	RELAY, ELECTRICAL; Armature Type, Mercury Switch Contacts	Input Line Relay	143790	88600	291C	
L900	INDUCTOR, VARIABLE; 1-9H	Start-Stop Oscillator Inductor	143730	93713	SH-8538	

TRANSMITTING CODE CONVERTER - TMCX201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
L901	COIL, RADIO FREQUENCY; Universal Wound Type, 5.0 MH \pm 5%	Series Tuned with C903	137380	82208	MO305	
M900	AMMETER; 0-100 MA DC, 1" Sealed Round Meter		143756	16688	Code 52 Series 100	
Q900	TRANSISTOR, GERMANIUM; Junction Contact Type, PNP Configuration	Line Current Meter	143735	81453	2N404	
Q901	Same as Q900		Feedback Emitter Follower			
Q902	Same as Q900	Range Delay-one Shot with Q902				
Q903	TRANSISTOR, GERMANIUM; Junction Contact Type, NPN Configuration	Range Delay-one Shot with Q901	143743	90139	2N388	
Q904	Same as Q900	Oscillator Control Amplifier				
Q905	Same as Q900	Oscillator Clamp				
Q906	Same as Q903	Start-Stop Oscillator				
Q907	Same as Q900	Squaring Amplifier with Q907				
Q908	Same as Q900	Squaring Amplifier with Q906				
Q909	TRANSISTOR; Point Contact Type	Drive Amplifier	143736	88600	2N110	
Q910	Same as Q909	S.S. Distributor - START Element				
Q911	Same as Q909	S.S. Distributor - No. 1 Element				
Q912	Same as Q909	S.S. Distributor - No. 2 Element				
Q913	Same as Q909	S.S. Distributor - No. 3 Element				
Q914	Same as Q909	S.S. Distributor - No. 4 Element				
Q915	Same as Q909	S.S. Distributor - No. 5 Element				
Q916	Same as Q903	S.S. Distributor - STOP Element				
Q917	Same as Q900	1st LEVEL Release Amp.				
Q918	Same as Q900	Transfer Prime Flip-Flop (with Q918)				
Q919	Same as Q900	Transfer Prime Flip-Flop (with Q917)				
Q920	Same as Q900	Transfer Firing Gate				
Q921	Same as Q900	Transfer Flip-Flop with Q921				
Q922	Same as Q900	Transfer Flip-Flop with Q920				
Q923	Same as Q900	Feedback Amplifier				
Q924	Same as Q900	Transfer Amplifier				
Q925	Same as Q900	Clock Delay, One-Shot with Q925				
Q926	Same as Q900	Clock Delay, One-Shot with Q924				
Q927-1	Same as Q900	Clock Inverter				
Q928-1	Same as Q900	Gated Amplifier				
Q929-1	Same as Q900	First Level Storage with Q929				
Q930-1	Same as Q900	First Level Storage with Q928 (1 to 5)				
Q931-1	Same as Q900	2nd Level Storage with Q931 (-1 to -)				
Q932	Same as Q900	2nd Level Storage with Q930 (-1 to -)				
Q933	Same as Q900	Storage for No. 6 pulse with Q933				
R900	RESISTOR, FIXED, COMPOSITION; 1 Section, 6,800 ohms \pm 5%, 0.5 W (RC20BF682J)	Base Bias (Q901)	118147	01121	EB6825	
R901	RESISTOR, FIXED, COMPOSITION; 1 Section, 1,200 ohms \pm 5%, 0.5 W (RC20BF122J)	Collector Load (Q901)	137441	01121	EB1225	
R902	Same as R901	Collector Load (Q902)				
R903	RESISTOR, FIXED, COMPOSITION; 1 Section, 3,300 ohms \pm 5%, 0.5 W	Base Bias (Q902)	129851	01121	EB3325	
R904	RESISTOR, FIXED, COMPOSITION; 1 Section, 470 ohms \pm 5%, 0.5 W (RC20BF471J)	Non-saturating Bias (Q901)	137602	01121	EB4715	
R905	RESISTOR, FIXED, COMPOSITION; 1 Section, 270 ohms \pm 5%, 0.5 W (RC20BF271J)	Non-saturating Bias (Q902)	118725	01121	EB2715	
R906	Same as R904					
R907	RESISTOR, VARIABLE; WW, 1 Section, 500 ohm	Range Delay Control	143651	01121	JLU5011 SD4040L	
R908	RESISTOR, FIXED, COMPOSITION; 1 Section, 2,700 ohms \pm 5%, 0.5 W (RC20BF272J)	Base Bias (Q901)	118144	01121	EB2725	
R909	RESISTOR, FIXED, COMPOSITION; 1 Section, 51 ohms \pm 5%, 0.5 W (RC20GF510J)	Emitter Bias (Q901 & Q902)	143656	01121	EB5105	
R910	Same as R908	Base Bias (Q902)				
R912	Same as R904	Current Limiting (Q902)				
R913	RESISTOR, FIXED, COMPOSITION; 1 Section, 1,500 ohms \pm 5%, 0.5 W (RC20BF152J)	K900 - Spacing Contact Load	137442	01121	EB1525	
R914	Same as R904	Voltage Divider with R916				
R915	RESISTOR, FIXED, COMPOSITION; 1 Section, 100 K ohms \pm 5%, 0.5 W (RC20BF104J)	Isolating (TP4)	118720	01121	EB1045	
R916	RESISTOR, FIXED, COMPOSITION; 1 Section, 1,800 ohms \pm 5%, 0.5 W (RC20BF182J)	Voltage Divider with R914)	137443	01121	EB1825	

TRANSMITTING CODE CONVERTER - TMCX201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
R917	RESISTOR, FIXED, COMPOSITION; 1 Section 10,000 ohms \pm 5%, 0.5 W (RC20BF103J)	"AND" Gate Load	118180	01121	EB1035	
R918	Same as R908	"OR" Gate Load				
R919	Same as R915	Isolating (TP5.)				
R920	RESISTOR, VARIABLE; composition, 1 Section, 5,000 ohms	Clamp Current Control	143653	01121	JLU5021 SD4040L	
R921	RESISTOR, FIXED, COMPOSITION; 1 Section, 2,200 ohms \pm 5%, 0.5 W	Shunt Load on Clamp	129852	01121	EB2225	
R922	Same as R903	"AND" Gate Load				
R923	Same as R908	Base Bias Voltage Divider (Q903)				
R924	Same as R917	Base Bias Voltage Divider				
R925	Same as R917	Collector Load				
R926	Same as R917	Base Current Limiting				
R927	Same as R915	Isolating (TP No. 2)				
R928	Same as R903	Emitter Load (Q905)				
R929	RESISTOR, FIXED, COMPOSITION; 1 Section, 300 ohms \pm 5%, 0.5 W (RC20GF301J)	Current Limiting (Q905)	143657	01121	EB3015	
R930	Same as R921	Collector Load (Q904)				
R931	Same as R921	Base Current Limiting (Q906)				
R932	Same as R917	Base Current Limiting (Q907)				
R933	Same as R921	Collector Load (Q906)				
R934	Same as R921	Collector Load (Q907)				
R935	RESISTOR, FIXED, COMPOSITION; 1 Section, 33,000 ohms \pm 5%, 0.5 W (RC20BF333J)	Positive Feedback (Q906)	118153	01121	EB3335	
R936	RESISTOR, VARIABLE; composition, 1 Section, 2,500 ohms	Feedback Control	143652	01121	JLU2521 SD4040L	
R937	Same as R929	Temperature Compensation Shunt				
R938	Same as R915	Isolating (TP No. 3)				
R939	RESISTOR, THERMAL	Thermal Feedback Compensation	143650	83186	31D7	
R940	Same as R917	Base Bias (Q908)				
R941	RESISTOR, FIXED, COMPOSITION; 1 Section, 820 ohms \pm 5%, 0.5 W (RC20BF821J)	Collector Load (Q908)	137439	01121	EB8215	
R942	Same as R905	Common Emitter Load				
R943	RESISTOR, FIXED, COMPOSITION; 1 Section, 180 ohms \pm 5%, 0.5 W (RC20BF181J)	Non-saturating Bias (Q908)	137430	01121	EB1815	
R944	Same as R917	C904 Discharge				
R945	Same as R929	Base Bias (Q909)				
R946	RESISTOR, FIXED, COMPOSITION; 1 Section, 750 ohms \pm 5%, 0.5 W (RC20GF751J)	Collector Load (Q909)	143660	01121	EB7515	
R947	Same as R929	Base Bias (Q910)				
R948	Same as R946	Collector Load (Q910)				
R949	Same as R929	Base Bias (Q911)				
R950	Same as R946	Collector Load (Q911)				
R951	Same as R929	Base Bias (Q912)				
R952	Same as R946	Collector Load (Q912)				
R953	Same as R929	Base Bias (Q913)				
R954	Same as R946	Collector Load (Q913)				
R955	Same as R929	Base Bias (Q914)				
R956	Same as R946	Collector Load (Q914)				
R957	Same as R929	Base Bias (Q915)				
R958	Same as R946	Collector Load (Q915)				
R959	Same as R915	Isolating TP No. 1)				
R960	Same as R921	Emitter Load (Q916)				
R961	Same as R905	Non-saturating (Q917)				
R962	Same as R908	Base Bias (Q917)				
R963	Same as R901	Collector Load (Q917)				
R964	Same as R901	Collector Load (Q918)				
R965	Same as R903	Base Bias (Q918)				
R966	Same as R903	Base Bias (Q917)				
R967	Same as R909	Emitter Bias (Q917 & Q918)				
R968	Same as R908	Base Bias (Q918)				
R969	Same as R905	Non-saturating Bias (Q918)				
R970	RESISTOR, FIXED, COMPOSITION; 1 Section, 4,700 ohms \pm 5%, 0.5 W (RC20BF472)	Base Current Limiting (Q919)	118146	01121	EB4725	
R971	RESISTOR, FIXED, COMPOSITION; 1 Section, 47 K ohms \pm 5%, 0.5 W (RC20BF473J)	Collector Load (Q919)	118154	01121	EB4735	
R972	RESISTOR, FIXED, COMPOSITION; 1 Section, 15,000 ohms \pm 5%, 0.5 W (RC20BF153J)	Emitter Load (Q919)	118150	01121	EB1535	

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REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
R973	Same as R908	Base Bias (Q920)				
R974	Same as R905	Non-saturating Bias (Q920)				
R975	Same as R901	Collector Load (Q920)				
R976	Same as R901	Collector Load (Q921)				
R977	Same as R903	Collector Load (Q922)				
R978	Same as R903	Base Bias (Q920)				
R979	Same as R921	Base Current Limiting (Q921)				
R980	Same as R909	Emitter Bias (Q920 & Q921)				
R981	Same as R905	Non-saturating Bias (Q921)				
R982	Same as R908	Base Bias (Q921)				
R983	Same as R921	Emitter Load (Q923)				
R984	Same as R971	Base Bias (Q922)				
R985	RESISTOR, FIXED, COMPOSITION; 1 Section, 22,000 ohms \pm 5%, 0.5 W (RC20BF223J)	Base Bias (Q922)	118177	01121	EB2235	
R986	Same as R915	Isolating (TP No. 6)				
R987	Same as R900	Base Bias (Q924)				
R988	Same as R904	Non-saturating Bias (Q924)				
R989	Same as R903	Base Bias (Q924)				
R990	Same as R901	Collector Load (Q924)				
R991	Same as R970	Collector Load (Q924)				
R992	Same as R915	Isolating (TP No. 7)				
R993	Same as R901	Collector Load (Q925)				
R994	Same as R903	Base Bias (Q925)				
R995	Same as R904	Base Current Limiting (Q924)				
R996	Same as R909	Emitter Bias (Q924 & Q925)				
R997	Same as R917	Base Bias (Q926)				
R998	RESISTOR, FIXED, COMPOSITION; 1 Section, 18,000 ohms \pm 5%, 0.5 W (RC20BF183J)	Base Bias (Q926)	118151	01121	EB1835	
R999	Same as R908	Base Bias (Q925)				
R1000	Same as R905	Non-saturating Bias (Q925)				
R1001-1	Same as R970	Base Current Limiting (Q927-1)				
R1002-1	Same as R971	Collector Load (Q927-1)				
R1003-1	Same as R971	Emitter Load (Q927-1)				
R1004-1	Same as R905	Non-saturating Bias (Q928-1)				
R1005-1	Same as R908	Base Bias (Q928-1)				
R1006-1	Same as R901	Collector Load (Q928-1)				
R1007-1	Same as R901	Collector Load (Q929-1)				
R1008-1	Same as R903	Base Bias (Q929-1)				
R1009-1	Same as R903	Base Bias (Q928-1)				
R1010-1	Same as R909	Emitter Bias (Q928-1 & Q929-1)				
R1011-1	Same as R905	Non-saturating Bias (Q929-1)				
R1012-1	Same as R908	Base Bias (Q929-1)				
R1013-1	Same as R921	"AND" Gate Load				
R1014-1	RESISTOR, FIXED, COMPOSITION; 1 Section, 1.0 Meg \pm 5%, 0.5 W (RC20BF105J)	C923-1 Discharge	118169	01121	EB1055	
R1015-1	Same as R905	Non-saturating Bias (Q930-1)				
R1016-1	Same as R908	Base Bias (Q930-1)				
R1017-1	Same as R901	Collector Load (Q930-1)				
R1018-1	Same as R901	Collector Load (Q931-1)				
R1019-1	Same as R903	Base Bias (Q931-1)				
R1020-1	Same as R903	Base Bias (Q930-1)				
R1021-1	Same as R909	Emitter Bias (Q930-1 & Q931-1)				
R1022-1	Same as R905	Non-saturating Bias (Q931-1)				
R1023-1	Same as R908	Base Bias (Q931-1)				
R1024	Same as R905	Non-saturating Bias (Q932)				
R1025	Same as R908	Base Bias (Q932)				
R1026	Same as R901	Collector Load (Q932)				
R1027	Same as R901	Collector Load (Q933)				
R1028	Same as R903	Base Bias (Q933)				
R1029	Same as R903	Base Bias (Q932)				
R1030	Same as R909	Emitter Bias (Q932 & Q933)				
R1031	Same as R905	Non-saturating Bias (Q933)				
R1032	Same as R908	Base Bias (Q933)				
R1033-1	Same as R1014	C922-1 Discharge				
R1034	Same as R1014	C925 Discharge				
R1035	Same as R1014	C912 Discharge				
R1036	RESISTOR, VARIABLE; WW, 750 ohms \pm 10%, 4 W, linear taper	Vernier Line Current Control	143654	71450	RA-30L-A SB751A	

TRANSMITTING CODE CONVERTER - TMCX201

REF DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
R 1037	Same as R 935					
S900	SWITCH, ROTARY; 1 Section, 3 Position, 1 Pole, non-shorting, insulation: bakelite, silver plated brass contacts	Word Per Minute Switch	143745	76854	143745	
XQ900 thru XQ933	SOCKET, TRANSISTOR	Connector for Transistors	143759	71785	EXP680G	

REF. DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
RECEIVER CABINET -- TMAC 201						
H1200	NUT, HEX; 10-32	Ground Terminal Clamp Nut	130289	59433		
H1201	COVER; Power Board, Fiber	Guard	143795	59433		
H1202	GASKET, REAR PLATE; Upper and Lower	Moisture Seal	144102	59433		
H1203	GASKET, REAR PLATE; Right and Left	Moisture Seal	144103	59433		
H1204	SCREW; 10-32 x 1/2	Mounting Hardware	144134	59433		
H1205	GASKET; Terminal Cover	Moisture Seal	144097	59433		
H1206	COVER; Terminal Board	Guard and R.F. Shield	144109	59433		
H1207	BRACKET; Rack Mounting	Supports Front of Cabinet in Relay Rack	144056	59433		
H1208	SCREW WITH MOISTURE SEAL; 1/4-20 x 1/2	Moisture Seal Mounting Hardware	144135	59433		
H1209	WASHER, FLAT;	Mounting Hardware	113115	59433		
H1210	WASHER, FLAT; Neoprene	Moisture Seal	144163	59433		
H1211	WASHER, LOCK;	Mounting Hardware	104451	59433		
H1212	NUT, HEX; 1/4-20	Mounting Hardware	92146	59433		
H1213	SCREW, FIL.; 4-40 x 3/8	Mounting Hardware	144184	59433		
J1200	CONNECTOR, RECEPTACLE, ELECTRICAL; 10 Contact	Cable Connector for Auxiliary Outputs	118585	02660		AN3102-18-1P
J1201	CONNECTOR, RECEPTACLE, ELECTRICAL; 20 Contact	Cable Connector for Signal Outputs and Control Pulses	143796	02660		AN3102A-20-29PZ
J1202	CONNECTOR, RECEPTACLE, ELECTRICAL; 20 Contact	Cable Connector for Power Input	143765	02660		AN3102A-20-29P
TRANSMITTER CABINET -- TMAC 201						
H1300	NUT, HEX; 10-32	Ground Terminal Clamp Nut	130289	59433		
H1301	COVER; Power Board, Fiber	Guard	143795	59433		
H1302	GASKET, REAR PLATE; Upper and Lower	Moisture Seal	144102	59433		
H1303	GASKET, REAR PLATE; Right and Left	Moisture Seal	144103	59433		
H1304	SCREW; 10-32 x 1/2	Mounting Hardware	144134	59433		
H1305	GASKET; Terminal Cover	Moisture Seal	144097	59433		
H1306	COVER; Terminal Board	Guard and R.F. Shield	144109	59433		
H1307	BRACKET; Rack Mounting	Supports Front of Cabinet in Relay Rack	144056	59433		
H1308	SCREW WITH MOISTURE SEAL; 1/4-20 x 1/2	Moisture Seal, Mounting Hardware	144135	59433		
H1309	WASHER, FLAT;	Mounting Hardware	113115	59433		
H1310	WASHER, FLAT; Neoprene	Moisture Seal	144163	59433		
H1311	WASHER, LOCK;	Mounting Hardware	104451	59433		
H1312	NUT, HEX; 1/4-20	Mounting Hardware	92146	59433		
H1313	SCREW, FIL; 4-40 x 3/8	Mounting Hardware	144184	59433		
J1300	CONNECTOR, RECEPTACLE, ELECTRICAL; 10 Contacts	Cable Connector for Auxiliary Output	118585	02660		AN3102-18-1P
J1301	CONNECTOR, RECEPTACLE, ELECTRICAL; 20 Contacts	Cable Connector for Signal Inputs and Control Pulses	143796	02660		AN3102A-20-29PZ
J1302	CONNECTOR, RECEPTACLE, ELECTRICAL; 20 Contacts	Cable Connector for Power Input	143765	02660		AN3102A-20-29P
POWER-OSCILLATOR CABINET -- TMAC 202						
H1400						
H1401	GASKET, REAR PLATE; Right and Left	Moisture Seal	144099	59433		
H1402	GASKET, REAR PLATE; Upper and Lower	Moisture Seal	144100	59433		
H1403	BRACKET, RACK MOUNTING;	Support Front of Cabinet	144063	59433		
H1404						
J1400	CONNECTOR, RECEPTACLE, ELECTRICAL; 4 Contacts	AC Input	143797	02660		AN3102A-22-10P
J1402	CONNECTOR, RECEPTACLE, ELECTRICAL;	DC Output	143802	02660		AN3102A-20-29P
J1403	Same as J1402	DC Output				

REF. DESIG.	NAME AND DESCRIPTION	LOCATING FUNCTION	TELETYPE PART NO.	MFG'S		NOTES
				CODE	DESIG.	
Z1401	POWER LEADS, FILTER;	Electrical Noise Suppressor				
CABLE CONNECTORS FOR TM200						
P1500	CONNECTOR, PLUG, ELECTRICAL; 4 contacts	ac Input	143800	02660	AN310BA- 22-10S	
P1501	CONNECTOR, PLUG, ELECTRICAL; 1 contact coaxial	External Standard Frequency Input.	143801		31-850	
P1502	CONNECTOR, PLUG, ELECTRICAL; 20 contacts	Power-Oscillator Output	143802	02660	AN2108A- 20-29P	
P1503	CONNECTOR, PLUG, ELECTRICAL; 20 contacts	Receiver Output	143803	02660	AN3108A- -20-29SZ	
P1504	CONNECTOR, PLUG, ELECTRICAL; 10 contacts	Receiver Auxiliary Output				
P1505	CONNECTOR, PLUG, ELECTRICAL; 20 contacts	Receiver and/or Transmitter power Input	143807	02660	AN3103A- 20-29S	
P1507	Same as P1503	Transmitter Output				
P1508	Same as P1504	Transmitter Auxiliary Output				

TABLE 7-3, LIST OF MANUFACTURERS

<u>Code</u>	<u>Name</u>	
00656	Aerovox Corporation	New Bedford, Mass.
01121	Allen-Bradley	Milwaukee, Wisc.
01295	Texas Instruments, Inc.	Houston, Texas
02660	Amphenol Electronics Corp.	Chicago, Ill.
02735	RCA SemiConductor Div.	Somerville, N. J.
04009	Arrow, Hart & Hegeman Electric Co.	Hartford, Conn.
04650	Power Equipment Co.	Galion, Ohio
04655	Ohmite Manufacturing Co.	Skokie, Ill.
16688	Dejur-Amsco Corp.	Long Island City, N. Y.
21520	Fansteel Metallurgical Corp.	North Chicago, Ill.
28959	Hoffman Electronics Corp.	Evanston, Ill.
49956	Raytheon Manufacturing Co.	Waltham, Mass.
56289	Sprague Electric Co.	North Adams, Mass.
59433	Teletype Corporation	Chicago, Ill.
70276	Allen Manufacturing Co.	Hartford, Conn.
71400	Bussman Fuse Division	St. Louis, Mo.
71450	Chicago Telephone Supply Corp.	Elkhart, Ind.
71482	C.P. Clare & Co.	Chicago, Ill.
71785	Cinch Manufacturing Corp.	Chicago, Ill.
73293	Hughes Aircraft Co.	Los Angeles, Calif.
74861	Industrial Condenser Corp.	Chicago, Ill.
75378	James Knights Co.	Sandwich, Ill.
75543	LaVelle Rubber Co.	Chicago, Ill.
76854	Oak Manufacturing Co.	Chicago, Ill.
80331	Utah Radio Products	Huntington, Ind.
81453	Raytheon Manufacturing Co.	Newton, Mass.
82208	Linell Engineering Corp.	Oak Park, Ill.
83186	Victory Engineering Co.	Newark, N. J.
85544	Burnell & Co., Inc.	New York, N. Y.
86335	Glenco Corp.	Metuchen, N. J.
88063	Communication Accessories Corp.	Hickman Mills, Mo.
88600	Western Electric Co.	Chicago, Ill.
93713	United Transformer Co., Mfrs. Div.	Chicago, Ill.
94222	South Chester Corp.	Lester, Pa.
96253	Transformer Technicians, Inc.	Chicago, Ill.
97539	Automatic & Precision Mfg.	Yonkers, N. Y.
99180	Transitron, Inc.	Melrose, Mass.
	Wyeth Engineering, Inc. (Z1401 Filter)	Chicago, Ill.

TABLE 7-4 - NUMERICAL PARTS LIST

PART NO.	DESCRIPTION	REFERENCE DESIGNATIONS	PAGE NUMBER	
			WD'S	CIRCUIT BOARDS
82344	SWITCH, TOGGLE; S.P. D.T.	S201		
92146	NUT, HEX; 1/4-20	H1212		
97143	JACK, Telephone; Leaf type, J4	J700, J900		
102755	SCREW, Machine; 6-40 x .438	H204, 404, 504, 704, 904		
104451	WASHER, Lock	H1211		
109152	SCREW, Fil; 4-40 x 11/64"	H706, 906		
110271	KEY, Socket Head Screw; 5/64 hex	H400, 500, 700, 900		
113115	WASHER, Flat	H1210		
113178	SCREW 4-40 x 1", Fil.	H506		
118144	RESISTOR, FIXED; 2,700 ohms, 1/2W.	R121-1, 202, 400, 703, 908		
118146	RESISTOR, FIXED; 4,700 ohms 1/2W.	R112, 213, 416, 578, 970		
118147	RESISTOR, FIXED; 6,800 ohms 1/2W.	R227, 422, 751, 900		
118149	RESISTOR, FIXED; 12,000 ohms 1/2W.	R242, 577		
118150	RESISTOR, FIXED; 15,000 ohms 1/2W.	R576, 972		
118151	RESISTOR, FIXED; 18,000 ohms 1/2W.	R246, 412-1, 998		
118153	RESISTOR, FIXED; 33,000 ohms 1/2W.	R460, 737, 935, 1037		
118154	RESISTOR, FIXED; 47,000 ohms 1/2W.	R220, 428, 971		
118156	RESISTOR, FIXED; 56,000 ohms 1/2W.	R456, 459		
118159	RESISTOR, FIXED; 150,000 ohms 1/2W.	R300		
118165	RESISTOR, FIXED; 470,000 ohms 1/2W.	R269		
118169	RESISTOR, FIXED; 1.0 Meg, 1/2W.	R341, 639, 774, 1014-1		
118177	RESISTOR, FIXED; 51 ohms 1/2W.	R238, 426, 985		
118180	RESISTOR, FIXED; 10,000 ohms 1/2W.	R114, 209, 417, 461, 500, 700, 917		
118186	RESISTOR, FIXED; 5,600 ohms 1/2W.	R115-1, 339, 403		
118510	FUSE, CARTRIDGE; 1/4 Amp.	F104		
118589	SWITCH, PUSH S.P., Momentary Make	S202		
118591	SOCKET, OCTAL	J113, XC220, J707, 901		
118659	SWITCH, TOGGLE; D.P. D.T.	S200, 401, 503		
118720	RESISTOR, FIXED; 100,000 ohms 1/2W.	R219, 427, 515, 731, 915		
118724	RESISTOR, FIXED; 220 ohms 1/2W.	R308, 441		
118725	RESISTOR, FIXED; 270 ohms 1/2W.	R203, 401, 504, 701, 905		
120166	FUSE, CARTRIDGE; 2.5A.	F107		
120394	FUSE, CARTRIDGE; 1/10 A.	F400		
129351	RESISTOR, FIXED; 33,000 ohms 1/2W.	R118		
129851	RESISTOR, FIXED; 3,300 ohms 1/2W.	R200, 404, 705, 903		
129852	RESISTOR, FIXED; 2,200 ohms 1/2W.	R214, 411-1, 723, 921		
129919	FUSE, CARTRIDGE; 4.0A.	F109		
129920	FUSE, CARTRIDGE; 5.0A	F101		
130289	NUT, HEX; 10-32	H1200, 1300, 1400		
137294	SOCKET, OCTAL	XC200		
137301	CAPACITOR; 0.001 UF, 200 vdcw.	C203, 407		
137302	CAPACITOR; 0.003 UF, 200 vdcw.	C202, 919		
137303	CAPACITOR; 0.005 UF, 200 vdcw.	C500, 706, 903		
137305	CAPACITOR; 0.03 UF, 200 vdcw.	C409		
137306	CAPACITOR; 0.05 UF, 200 vdcw.	C406, 914		
137307	CAPACITOR; 0.1 UF, 200 vdcw.	C212, 915		
137310	CAPACITOR; 0.5 UF, 200 vdcw.	C207		
137311	CAPACITOR; 0.02 UF, 200 vdcw.	C204		
137314	CAPACITOR; 2.0 UF, 100 vdcw.	C918		
137380	COIL (Choke) R.F. 5.0 MH	L200, 500, 701, 901		
137430	RESISTOR, FIXED; 180 ohms, 1/2W.	R445, 502, 747, 943		
137438	RESISTOR, FIXED; 100 ohms, 1/2W.	R212, 447		
137439	RESISTOR, FIXED; 820 ohms, 1/2W.	R503, 746, 941		
137440	RESISTOR, FIXED; 1,000 ohms, 1/2W.	R232, 413-1, 750		
137441	RESISTOR, FIXED; 1,200 ohms 1/2W.	R117-1, 206, 402, 702, 901		
137442	RESISTOR, FIXED; 1,500 ohms, 1/2W.	R225, 913		
137443	RESISTOR, FIXED; 1,800 ohms, 1/2W.	R916		
137444	RESISTOR, FIXED; 8,200 ohms, 1/2W.	R249, 415-1		
137492	TRANSFORMER; 600 ohm pri. 600 ohm	T400		
137602	RESISTOR, FIXED; 470 ohms, 1/2W.	R904		
143600	REACTOR; 50 vdc Filter	L101		
143601	REACTOR; 12 vdc Filter	L102		
143602	REACTOR; 6 vdc Filter	L103		
143603	REACTOR; 6 vdc Filter	L105		
143604	REACTOR; 12 vdc Filter	L106		
143606	RECEPTACLE, Convenience Outlet	J102		

PART NO.	DESCRIPTION	REFERENCE DESIGNATIONS	PAGE NUMBER	
			WD'S	CIRCUIT BOARDS
143608	SWITCH, TOGGLE; D.P.S.T. 2	S101		
143609	SWITCH, ROTARY; S.P.9.T.	S102		
143610	FUSE, CARTRIDGE; 2.5A	F102		
143613	DIAL LIGHT, 12 Volts	DS101, 102		
143614	TRANSFORMER, POWER; Tapped	T101		
143615	RECTIFIER; Silicon Diode	CR107		
143616	RECTIFIER; IN538	CR101		
143617	RECTIFIER; Silicon Diode	CR110		
143619	FUSEHOLDER; Extractor post type	XF101		
143620	CAPACITOR; 2,000 UF, 15 vdcw.	C104		
143621	CAPACITOR; 1,200 UF, 25 vdcw.	C102		
143623	METER; Frequency - W.P.M.	M102		
143624	CAPACITOR; 200 UF, 100 vdcw.	C101		
143625	RESISTOR, VARIABLE; WW, 1.0 ohm	R102		
143626	RESISTOR, VARIABLE; WW, 0.5 ohm	R103		
143627	RESISTOR; WW, 68 ohms, 5W.	R106		
143628	RESISTOR; WW, 12 ohms, 5W.	R109		
143629	RESISTOR; WW, 150 ohms, 5W.	R111		
143630	FUSE, CARTRIDGE; 3/4 A	F105		
143631	FUSE, CARTRIDGE; 1/5 A	F106		
143632	FUSEHOLDER; Blown Fuse Indicator	XF102		
143633	SWITCH, ROTARY; 3.P.9.T.	S103		
143634	VOLTMETER; dc 0-15-25 Volts	M101		
143635	LAMPHOLDER; 12 Volt, Oven Ind.	XDS102		
143650	RESISTOR, THERMAL;	R742, 939		
143651	RESISTOR, VARIABLE; 500 ohms, 2W.	R217, 907		
143652	RESISTOR, VARIABLE; 2,500 ohms	R453, 740, 936		
143653	RESISTOR, VARIABLE; 5,000 ohms	R335-1, 730, 920		
143654	RESISTOR, VARIABLE; WW, 750 ohms	R101, 218, 448, 724, 1036		
143655	RESISTOR, VARIABLE; 1,000 ohms	R294		
143656	RESISTOR, FIXED; 51 ohms, 1/2W.	R122-1, 201, 410, 707, 909		
143657	RESISTOR, FIXED; 300 ohms, 1/2W.	R505, 736, 929		
143658	RESISTOR, FIXED; 150 ohms, 1/2W.	R437		
143659	RESISTOR, FIXED; 560 ohms, 1/2W.	R743		
143660	RESISTOR, FIXED; 750 ohms 1/2W.	R506, 756, 946		
143662	RESISTOR, FIXED; 390 ohms, 1/2W.	R444, 752		
143664	RESISTOR, FIXED; 7,500 ohms, 1/2W.	R439		
143666	RESISTOR, FIXED; 180,000 ohms 1/2W	R462		
143667	RESISTOR, FIXED; 3,900 ohms, 1/2W.	R290		
143668	RESISTOR, FIXED; 6,200 ohms, 1/2W.	R435		
143669	RESISTOR, FIXED; 350 ohms, 1/2W.	R211		
143670	RESISTOR, FIXED; 300 ohms, 1/2W.	R481		
143671	RESISTOR, FIXED; 5,100 ohms, 1/2W.	R480		
143672	RESISTOR, FIXED; 7,500 ohms, 1/2W.	R479		
143682	CAPACITOR; 4.0 UF, 60 vdcw	C213, 900		
143683	CAPACITOR; 1.5 UF, 125 vdcw	C210, 405-1		
143684	CAPACITOR; 1.0 UF, 35 vdcw	C214		
143687	CAPACITOR; 0.01 UF, 75 vdcw	C114, 200, 501, 700, 901		
143688	CAPACITOR; 0.002 UF, 75 vdcw	C115-1, 222, 400		
143692	CAPACITOR; 8.0 UF, 150 vdcw	C410		
143695	CAPACITOR; 0.02 UF, 25 vdcw	C223		
143696	CAPACITOR; 470 UUF, Mica.	C715		
143704	CAPACITOR; 11.0 UF, 100 vdcw	C209, 404-1		
143705	CAPACITOR; 1,000 UF, 25 vdcw	C220		
143707	CAPACITOR; 0.015 UF, 75 vdcw	C502, 708, 905		
143708	CAPACITOR; (a) 0.5 UF; (b) 1.0 UF	C705, 902		
143710	DIODE; IN277	CR200, 412, 501, 700, 900		
143711	DIODE; IN270	CR113-1, 201, 400, 500, 702, 901		
143712	DIODE; IN461	CR237		
143713	DIODE; IN1372, Zener Type	CR410		
143715	DIODE; IN540	CR413		
143716	CAPACITOR; 8.0 UF, 30 vdcw	C216		
143717	RELAY, Sealed, 6.3 Vac Coil	K200		
143718	CAPACITOR, VARIABLE; 5UUF-100UUF	C120		
143720	COIL; R.F., 50 MH.	L400		
143730	INDUCTOR; R.F., 50 MH.	L700, 900		

PART NO.	DESCRIPTION	REFERENCE DESIGNATIONS	PAGE NUMBER	
			WD'S	CIRCUIT BOARDS
143735	TRANSISTOR; PNP, 2N404	Q101, 200, 400, 500, 700, 900		
143736	TRANSISTOR; Point Contact, 2N110	Q501, 713, 909		
143740	TRANSISTOR; NPN, 2N341	Q210, 408		
143741	TRANSISTOR; PNP, 2N398	Q215, 403-1, 419		
143743	TRANSISTOR; NPN, 2N388	Q208, 402-1, 528, 702, 903		
143745	SWITCH, ROTARY; 3 position, 1 pole.	S700, 900		
143746	SWITCH, ROTARY; 3 position, 5 poles.	S500		
143747	SWITCH, ROTARY; 3 pos, 5 poles.	S502		
143748	SWITCH, ROTARY; S.P.4.T.	S400		
143749	SWITCH, ROTARY; 2 pos., 3 poles.	S501		
143755	AMMETER, 0 to 1 MA. dc	M500		
143756	AMMETER, 0 to 100 MA. dc	M400, 700, 900		
143759	SOCKET, Transistor	XQ200-241, QX401-407, QX500-542, QX700-719, QX900-933		
143760	LAMP, Glow	DS401		
143761	TRANSFORMER, POWER; Neon Ind.	T401		
143762	CONNECTOR; plug, with cable	P407		
143763	PLUG; power input	P408		
143770	CONNECTOR; printed circuit	J200, 400, 506, 708, 910		
143772	CONNECTOR; printed circuit	J507		
143780	CONNECTOR; phone tip	J104, 204, 402, 500, 701, 902		
143781	CONNECTOR; printed circuit board	J110		
143790	RELAY; Mercury Switch Contact	K700, 900		
143791	TRANSFORMER; Isolation	T200		
143793	TERMINAL BOARD	E101		
143795	COVER, Power Board	H1201, 1301		
143797	CONNECTOR, Power	J101		
143798	CONNECTOR, Coaxial	J105		
143799	CONNECTOR; dc power	J106		
143785	CRYSTAL UNIT; 63 KC	Z103		
143786	CRYSTAL UNIT; 61.63043 KC	Z104		
143868	COUNTER; Binary	Z102-1, 102-2		
143869	CRYSTAL DRIVE; Circuit Board	Z101		
144056	BRACKET	H1207, 1307		
144063	BRACKET	H1403		
144096	GASKET	H205, 405, 505, 705, 905		
144097	GASKET	H1205, 1305		
144099	GASKET	H1401		
144100	GASKET	H1402		
144102	GASKET	H1202, 1302		
144103	GASKET	H1203, 1303		
144109	COVER ASSEMBLY	H1206, 1306		
144129	THUMBSCREW	H203, 403, 503, 703, 903		
144131	RING, Retaining	H201, 401, 501, 701, 901		
144135	SCREW 1/4-20	H1208, 1308, 1408		
144163	WASHER, Neoprene	H202, 402, 502, 702, 902, 1209		
144168	KNOB, Pointer	H407, 507		
144184	SCREW 4-40	H1204, 1304		
154166	SUPPRESSOR, Arc	Z700		

