

TJ RADIO

TRANSMITTER-RECEIVER UNITS

EQUIPMENT DESIGN REQUIREMENTS

TOLL SYSTEMS

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transmitter-receiver portion of the TJ radio relay system.

- 1.02** Detailed reasons for reissue are covered at the end of this specification.

DESCRIPTION

- 1.03** Equipment covered by this specification provides the basic units (other than antenna and power supply) necessary to make up the transmitter-receiver portion of the TJ radio relay system. Each is assembled, wired, and tested as a unit. All power, alarm and IF connections, except for power to the receiver modulator and transmitter, are on a plug-in basis. Waveguide

components employ 0.400 inch by 0.900 inch waveguide. All units in a bay are powered from an ac rectifier in that bay. Each transmitter-receiver, transmitter only, or receiver only requires a complete rectifier. Protection against hazardous voltages is provided by an interlock system which shuts down all power to the bay should the klystron covers be opened or any unit (except the meter panel) be removed.

Receiver Modulator

- 1.04** The receiver modulator, J68372A, Fig. 1 is a solid-state version of the former J68372A and J68372B combination. It is a balanced crystal



Fig. 1—Receiver Modulator

connector or mixer which combines the incoming microwave signal with a signal from a beat oscillator to provide an intermediate frequency signal centered at 70 MHz. A bandpass waveguide filter selects the incoming frequency which passes through an isolator to the J99296AA, Lists 3 and 4 modulator preamplifier. This signal is combined in the modulator with an RF signal from the beat oscillator operating under control of an automatic frequency control (AFC) circuit in the receiver baseband amplifier and AFC unit. The resulting intermediate frequency, centered at approximately 70 MHz, is amplified by the integral preamplifier circuit. The preamplifier is a low noise, 4-stage transistor amplifier supplying approximately 34 dB of gain, resulting in an overall RF to IF conversion gain of approximately 25 dB. At the interface of the modulator and preamplifier provision has been made for monitoring the crystal currents and for a bridged input to the preamplifier. Access is provided for measuring the output of the beat oscillator and for modulating the oscillator with external test signals. An attenuator adjusts the beat oscillator energy level reaching the modulator. A switch, activated by the klystron cover, shuts off all power when the klystron is exposed. The receiver modulator is set up for a particular frequency by selecting the appropriate waveguide filter. The power requirements for the receiver modulator are as follows:

VOLTS		CURRENT DRAIN
ac	dc	
6.3		0.9 amperes
	-20	60 mA
	-50 to -200	1 uA
	400	35 mA

1.05 The receiver modulator consists of a waveguide hybrid and integral amplifier which mounts two waveguide input assemblies and provides coaxial output jacks. The input from the preceding waveguide run comprises the isolator, the image-rejection filter and a spring clamp to facilitate connection. The beating oscillator input mounts an attenuator, a coupler for frequency and

power-monitoring purposes, and a shielded klystron. The entire unit is assembled on a metal bracket for mounting in the bay. All connections except the 400-volt supply, which must be soldered, are on a plug-in basis. The unit is approximately 16-1/2 inches high, 6 inches wide and 10-3/8 inches deep.

Modulator-Preamplifier Power Supply

1.06 The modulator-preamplifier power supply (Fig. 2), is a Farion 15910 power supply. It physically replaces the J68372B IF preamplifier (which is rated Mfr Disc.) with an integral cord which supplies the 20 volts DC power to the J99296AA modulator-preamplifier unit. All operating controls and test jacks are mounted on the front of the chassis. All connections are on a plug-in basis. The entire unit occupies a space approximately 11-3/8 inches long, 3-1/2 inches wide, and 3-1/4 inches deep.

VOLTS		CURRENT DRAIN
ac	dc	
6.3		1.2 amperes
	200	63 mA

1.07 The IF preamplifier is assembled in a cast aluminum chassis 11 inches long and 3-1/2 inches wide. The apparatus is so arranged that the electron tubes and the input, output, power, and test jacks are mounted on the front of the chassis. All operating controls are mounted either directly below or through access holes in the chassis and are accessible from the front of the chassis. A cast aluminum cover encloses the apparatus mounted on the rear of the chassis. All connections to the preamplifier are on a plug-in basis. The entire unit including electron tubes occupies a space approximately 11-3/8 inches long, 3-1/2 inches wide, and 4-1/2 inches deep.

IF Main Amplifier

1.08 The IF main amplifier, J68372C, Fig. 3, is a 7-stage transformer coupled amplifier that supplies 16 to 56 dB of gain flat to within 0.25 dB from 60 to 80 MHz. Its output to the limiter-discriminator



Fig. 2—Modulator - Preamplifier Power Supply

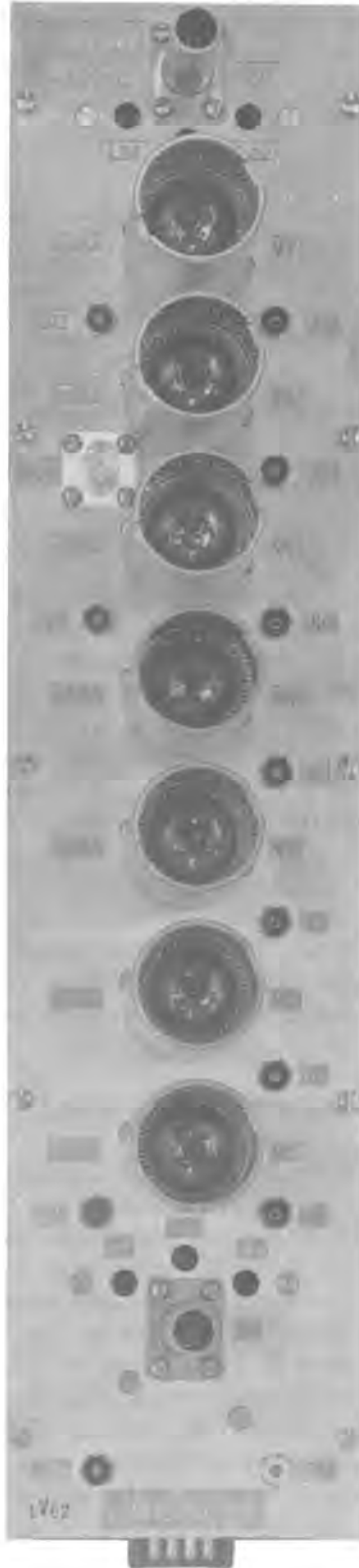


Fig. 3—IF Main Amplifier

is held essentially constant by an automatic gain control circuit which controls the gain of the first six stages. Input and output assemblies permit adjustment for optimum return loss between 60 and 80 MHz. Jacks are provided for measuring power supply voltages, bias voltage, and cathode voltage, and for connecting to a manual gain control circuit. The power requirements are as follows:

VOLTS		CURRENT DRAIN
ac	dc	
6.3		2.1 amperes
	200	35 mA (normal operation)
		95 mA (40-dB deep fade condition)

1.09 The IF main amplifier is assembled in a cast aluminum chassis 15-1/4 inches long and 3-1/2 inches wide. The apparatus is so arranged that the electron tubes and the input, output, power, and test jacks are mounted on the front of the chassis. All operating controls are mounted either directly below or through access holes in the chassis and are accessible from the front of the chassis. A cast aluminum cover encloses the apparatus mounted on the rear of the chassis. All connections to the amplifier are on a plug-in basis. The entire unit including electron tubes occupies a space approximately 15-1/2 inches long, 3-1/2 inches wide, and 4-1/2 inches deep.

IF Limiter-Discriminator

1.10 The IF limiter-discriminator, J68372D, Fig. 4, is a 3-state, double tuned, transformer-coupled limiter followed by an FM discriminator. An input assembly permits adjustment for optimum return loss between 60 and 80 MHz. The limiter stages remove any variations in signal amplitude, and the discriminator converts the FM signal to a video or baseband signal. This signal is then fed to the receiver baseband amplifier and receiver AFC. Means are provided for equalizing the bias on the



Fig. 4—IF Limiter—Discriminator

discriminator tubes and for making alignment tests. Jacks provide access for making power supply and cathode voltage tests. The power requirements are as follows:

VOLTS		CURRENT DRAIN
ac	dc	
6.3		1.85 amperes
	200	84 mA

1.11 The IF limiter-discriminator is assembled in a cast aluminum chassis 15-1/4 inches long and 3-1/2 inches wide. The apparatus is so arranged that the electron tubes and the input, output, power, and test jacks are mounted on the front of the chassis. All operating controls are mounted either directly below or through access holes in a chassis and are accessible from the front of the chassis. A cast aluminum cover encloses the apparatus mounted on the rear of the chassis. All connections to the limiter-discriminator are on a plug-in basis. The entire unit including electron tubes occupies a space approximately 15-9/16 inches long, 3-1/2 inches wide, and 4-1/2 inches deep.

Receiver Baseband Amplifier and AFC

1.12 The receiver baseband amplifier, J68372E,

Fig. 5, accepts the signal from the limiter-discriminator and transforms its impedance level to either a 75-ohm unbalanced or a 124-ohm balanced output signal. In the receiver AFC section, an error signal proportional to the deviation of the intermediate frequency from 70 MHz is obtained from the discriminator and amplified in a dc coupled differential amplifier. The output of the amplifier is used to shift the receiver beat oscillator repeller voltage in such a direction as to reduce the deviation of the intermediate frequency from 70 MHz. A clamping circuit prevents the beat oscillator from dropping out of oscillation, should the incoming signal to the receiver be lost. Means are provided for:

- (a) Adjusting the bias on the dc amplifier

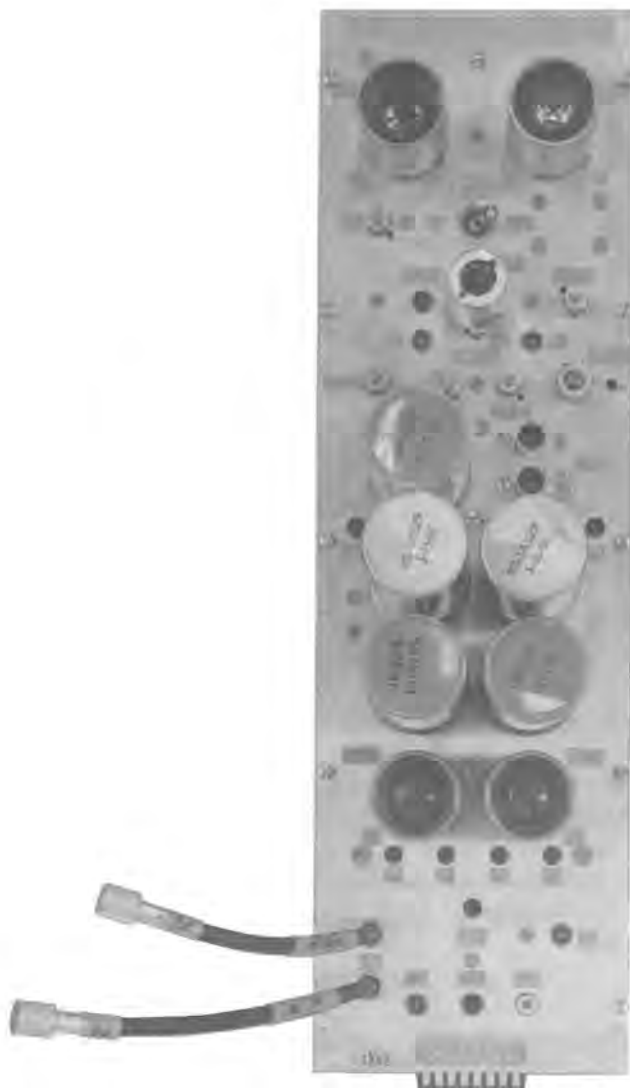


Fig. 5—Receiver Baseband Amplifier and AFC

- (b) Adjusting the receiver klystron repeller voltage
- (c) Disabling the AFC and clamp circuits
- (d) Setting frequency limits for the beat oscillator
- (e) Making tests of power supply, bias, and grid-to-cathode voltages.

The baseband output circuit, furnished by the factory for 124-ohm balanced operation, may be modified in the field for 75-ohm unbalanced operation. The power requirements are as follows:

VOLTS		CURRENT DRAIN
ac	dc	
6.3		1.2 amperes
	200	80 mA
	-400	Between 4 and 8 mA*

* This requirement depends on the adjustment of the CLAMP potentiometer.

1.13 The receiver baseband amplifier and AFC unit is assembled in a cast aluminum chassis 15-1/4 inches long and 4-1/2 inches wide. The apparatus is so arranged that the electron tubes and the input, output, power, and test jacks are mounted on the front of the chassis. All operating controls are mounted either directly below or through access holes in the chassis and are accessible from the front of the chassis. A cast aluminum cover encloses the apparatus mounted on the rear of the chassis. Coaxial cables connect the input of the amplifier to the limiter-discriminator. All connections to the unit are on a plug-in basis. The entire unit including electron tubes occupies a space approximately 15-9/16 inches long, 4-1/2 inches wide, and 6-1/2 inches deep.

Meter Panel

1.14 The meter panel, J68372F, Fig. 6, provides a meter and switch for checking:

- (a) The high voltages supplied from the power unit
- (b) The diode currents of the receiver modulator
- (c) Cathode currents and repeller voltages of the klystrons
- (d) The IF amplifier plate current.

A Sensitrol relay monitors the transmitter power output and provides an alarm circuit to indicate an off-air condition. A blower to cool the transmitter klystron is also included as part of the meter panel. A potentiometer provides for calibration of



Fig. 6—Meter Panel

the Sensitrol power monitor. The meter panel may be furnished:

- (e) For use with a receiver only, or
- (f) Complete, for use with either a transmitter-receiver bay or a transmitter only.

The power requirements are as follows:

VOLTS	CURRENT DRAIN
ac	ampere
117	0.1

1.15 The meter circuit components are assembled on an aluminum panel. The meters and operating controls are accessible from the front of the panel. The blower is fastened to the rear of the panel by rubber shock mountings and blows air through an opening in the panel into the transmitter klystron cover. All connections to the meter circuit are on a plug-in basis. The overall dimensions of the assembly are approximately 14 inches long, 4-1/2 inches wide, and 4-1/2 inches deep.

Transmitter Baseband Amplifier

1.16 The transmitter baseband amplifier, J68372G, Fig. 7, is a balanced 2-stage amplifier with a gain of 37.5 dB which is substantially independent of frequency from 30 Hz to 7.0 MHz. It is designed

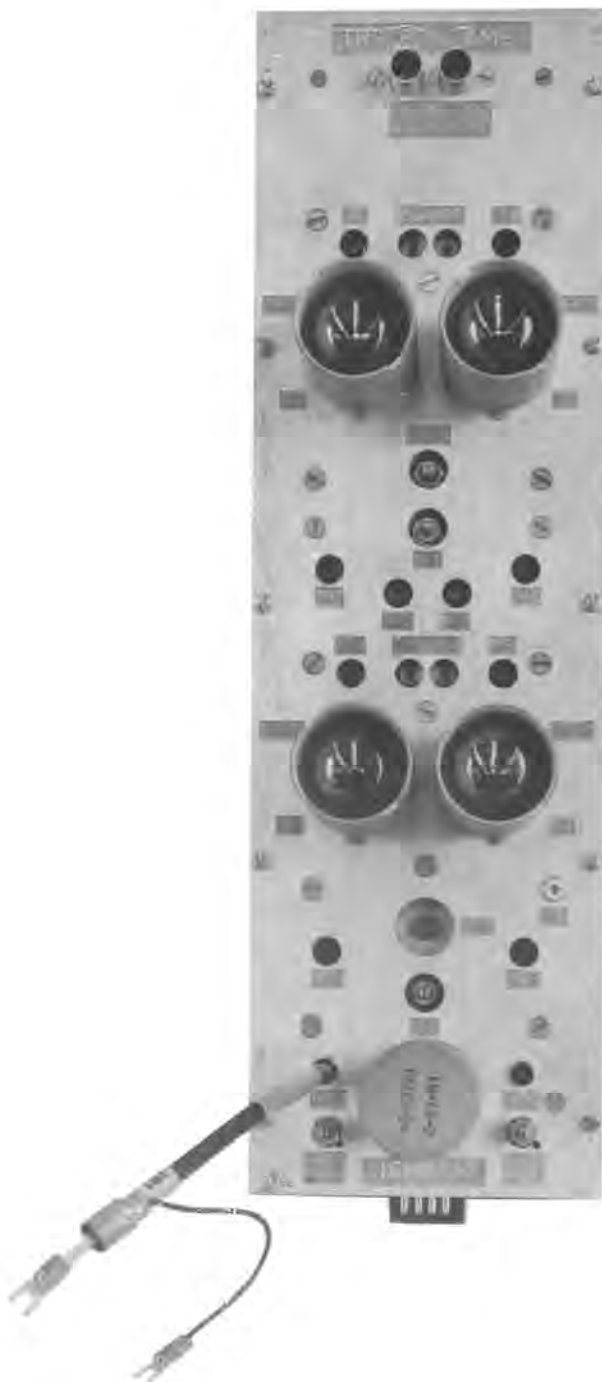


Fig. 7—Transmitter Baseband Amplifier

to hold signal distortion and the effects of low-frequency interference to a minimum. The input circuit furnished by the factory for 124-ohm balanced operation, may be modified in the field to accept 75-ohm unbalanced signals. The amplifier

delivers an unbalanced signal to the transmitter klystron. Means are provided for gain adjustment, bias adjustment, field alignment, and filament activity tests. The power requirements are as follows:

VOLTS		CURRENT DRAIN
ac	dc	
6.3		1.8 amperes
	200	125 mA

1.17 The transmitter baseband amplifier is assembled in a cast aluminum chassis 15-1/4 inches long and 4-1/2 inches wide. The apparatus is so arranged that the electron tubes and the input, output, power, and test jacks are mounted on the front of the chassis. All operating controls are mounted either directly below or through access holes in the chassis and are accessible from the front of the chassis. A cast aluminum cover encloses the apparatus mounted on the rear of the chassis. All connections to the amplifier except the output are on a plug-in basis. A 5-inch coaxial cable with spade lugs on the end connects the output to the transmitter klystron. The entire unit including electron tubes occupies a space approximately 15-9/16 inches long, 4-1/2 inches wide, and 6-1/2 inches deep.

Transmitter

1.18 The transmitter, J68372H, Fig. 8, provides a microwave output of approximately 1/2 watt in the frequency band from 10.7 to 11.7 GHz. A klystron, frequency modulated by the baseband signal and tuned by a servomotor under control of the transmitter AFC circuit, generates the microwave output signal. The transmitter output network generates an error signal whose magnitude and polarity depend on the drift or deviation of the klystron frequency from the frequency of the Invar reference cavity. This error signal is used to control the transmitter AFC circuit. A portion of the transmitter output is sampled in the transmitter output network and is used to drive a Sensitrol relay on the meter panel. The transmitter output network also connects the transmitter klystron

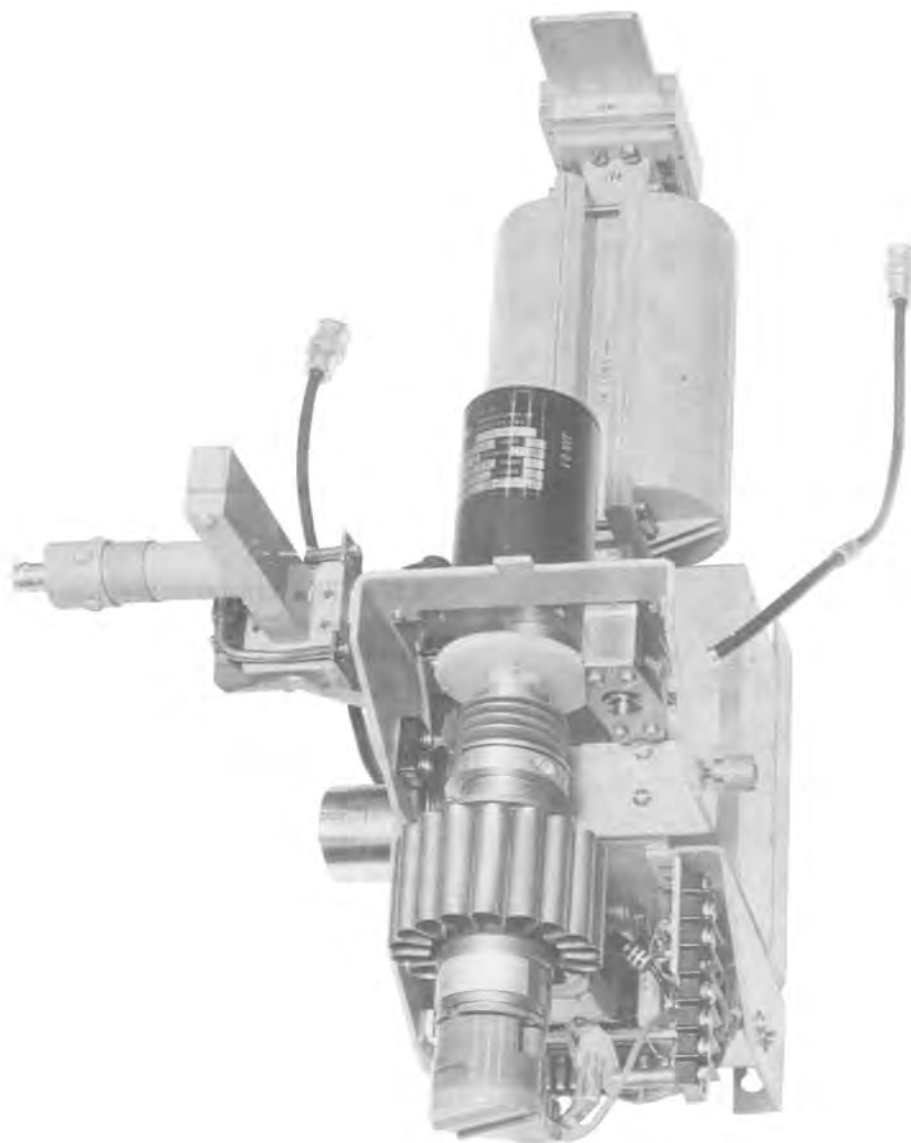


Fig. 8—Transmitter

output through an isolator and a waveguide switch to the channel-combining filters and the antenna system. A switch activated by the klystron cover shuts off all power when the klystron is exposed. The transmitter is factory adjusted to a specific frequency. The power requirements are as follows:

VOLTS		CURRENT DRAIN	
ac	dc		
	6.3	0.9	ampere
117	-400	0.09 1	ampere* uA

* This power is furnished through the transmitter AFC circuit.

1.19 The transmitter consists of three waveguide assemblies bolted to a network assembly. One leg is comprised of the klystron and tuning motor assembly, another is a tap for the power-monitoring detector, and the third is the connection through the isolator and switch to the antenna system. Coaxial cables from the network connect to the AFC circuit. The metal cover which encloses the klystron serves as protection from high voltage and directs air from the blower on the meter panel to the klystron. The entire unit is assembled on a metal bracket for mounting in the bay. The unit is approximately 19-1/2 inches high, 9-3/4 inches wide, and 8 inches deep.

Transmitter AFC

1.20 The J68372J transmitter AFC unit, Fig. 9, monitors and correct the frequency of the transmitter klystron. An integrated solid state circuit detects an error signal, due to a change in transmitter frequency, and initiates the klystron drive motor to return the klystron to its correct frequency. Means are also provided to:

- (a) Adjust the input of the integrated solid state circuit for greater sensitivity to changes in transmitter frequency.
- (b) Disable the circuit.
- (c) Monitor the error signal sent from the transmitter.
- (d) Decrease or increase transmitter frequency for test purposes.

1.21 The transmitter AFC unit is assembled in a cast-aluminum chassis 11 inches long and 3-1/2 inches wide. The apparatus is so arranged that all jacks and operating controls are mounted on the front of the chassis. The apparatus is enclosed in a cast-aluminum cover and is mounted so that it is vertical in the normal operating position. The entire unit occupies a space approximately 11-3/8 inches long, 3-1/2 inches wide, and 4-5/8 inches deep.

Tube Complement

1.22 The tube complement for all units included in this specification is shown in Table A.



Fig. 9—Transmitter AFC Unit

TABLE A

TABLE A																
UNIT	TUBES							DIODES					VAR	RELAYS		
	396A	417A	420A	435A	437A	445A	5726	400A *	HD-2187	KS-16410	KS-16412	KS-16411, L1 Matched Pair	100A	KS-16640, L4	KS-14075, L2	SM5DS-24V (L3)
Rec Mod												1				
IF Main Ampl				7				2								
Lim-Discr				5			1		6							
Rec Baseband Ampl	1	2	1				1									
Meter Panel														1	1	1
Xmtr Baseband Ampl					4											
Xmtr						1				2	1					
Xmtr AFC													3			
TOTAL	1	2	1	12	4	1	2	2	6	2	1	1	3	1	1	1

* These items are pigtail apparatus and are soldered in the circuit.

2. SUPPLEMENTARY INFORMATION

800-600-000—List of General Equipment Requirements Sections

J68371—804-336-151—Transmitter-Receiver

J99303—801-415-150—Short Haul Radio Systems TJ, TL-1, TL-2 and TM-1 Application Specification, Common Systems

X-67721—Manufacturing Testing Requirements for Transmitter-Receiver Bay

X-67722—Manufacturing Testing Requirements for

Transmitter Baseband Amplifier

X-67723—Manufacturing Testing Requirements for Transmitter AFC

X-67724—Manufacturing Testing Requirements for Receiver Modulator

X-67725—Manufacturing Testing Requirements for IF Preamplifier

X-67726—Manufacturing Testing Requirements for IF Main Amplifier

X-67727—Manufacturing Testing Requirements for IF Limiter-Discriminator

- X-67728—Manufacturing Testing Requirements for Receiver Baseband Amplifier and AFC
 X-67729—Manufacturing Testing Requirements for Meter Panel
 X-67730—Manufacturing Testing Requirements for Transmitter

3. DRAWINGS

WE J drawings listed should be ordered by referring to the prefix and base number and requesting the current dash (—) number

Circuits

- SD-59769-01—Application Schematic—Transmitter-Receiver Bay
 SD-59770-01—Transmitter-Baseband Amplifier
 SD-59771-01—Meter Panel
 SD-59772-01—Transmitter
 SD-59773-01—Transmitter AFC
 SD-59774-01—Receiver Modulator
 SD-59776-01—IF Preamplifier
 SD-59777-01—IF Main Amplifier
 SD-59778-01—IF Limiter-Discriminator
 SD-59779-01—Receiver Baseband Amplifier and AFC

Equipment

- ED-50179-30—Gear Train
 ED-59498-30—IF Limiter-Discriminator Plate 2 Subassembly
 ED-59499-30—IF Limiter-Discriminator Plate 3 Subassembly
 ED-59500-30—IF Limiter-Discriminator Plate 4 Subassembly
 ED-59502-30—IF Main Amplifier Filament and Plate Supply Subassembly
 ED-59503-30—IF Main Amplifier Input Subassembly
 ED-59504-30—IF Main Amplifier Plate 1 Subassembly
 ED-59505-30—IF Main Amplifier Plate 2 Subassembly
 ED-59506-30—IF Main Amplifier Plate 3 Subassembly
 ED-59507-30—IF Main Amplifier Output Subassembly
 ED-59508-30—IF Limiter-Discriminator Input Subassembly
 ED-59509-30—IF Limiter-Discriminator Plate 1 and 2 Subassemblies
 ED-59513-30—IF Limiter-Discriminator Interstage

Subassembly

- J68371A-()—Transmitter-Receiver Bay
 J68372A-()—Receiver Modulator
 J68372C-()—IF Main Amplifier
 J68372D-()—IF Limiter-Discriminator
 J68372E-()—Receiver Baseband Amplifier and AFC
 J68372F-()—Meter Panel
 J68372G-()—Transmitter Baseband Amplifier
 J68372H-()—Transmitter
 J68372J-()—Transmitter AFC
 J99296AA-()—Modulator Preamplifier Unit

4. EQUIPMENT

Note: Since TJ radio equipment is at a reduced production level, due to the introduction of the TL radio system, Part 4. Equipment of this specification is not being detailed because of extensive engineering effort required to update this section. Therefore, the current Western Electric Company drawings listed in Part 3. Drawings should be referred to for requirements and equipment detail.

5. GENERAL NOTES

- 5.01** If any J68372E, J68372G, or J68372J units are held in stock or otherwise out of service for a period of 18 months or more, electrolytic capacitors shall be connected to a source of direct current at suitable voltage and polarity as covered in Section 032-110-701.
- 5.02** A 683A tool is available for removing heat shields from the tubes.
- 5.03** A KS-16598, List 1 tool is available for removing KS-16411 diodes from the 1A modulator.
- 5.04** A KS-16632, List 1 tool is available for removing crystal holders from the 488A network.
- 5.05** A KS-13753 tube puller is available for removing electron tubes from their sockets.

List of A&M ONLY and MFR DISC. Equipment

EQUIPMENT	RATING	DETAILS	
		LAST SHOWN IN ISSUE	REPLACING EQUIPMENT
J68372B,L1	Mfr Disc.	2	J99296AA,L4
J68372B,L2	A&M Only	2	—
J68372D,L2	A&M Only	2	—
J68372E,L2	A&M Only	2	—
J68372F,L1	Mfr Disc.	1	J68372F,L3
L2	A&M Only	2	& L4
J68372F,L4	Mfr Disc.	2	J68372F,L5
L5	A&M Only	2	—
J68372G,L2	A&M Only	2	—
J68372J,L1	Mfr Disc.	1	J68372J,L2
& L2	Mfr Disc.	2	& L3

The above equipment has been replaced as indicated. Where A&M Only items appear, the issue numbers shown are those of the issue in which the rating was first applied.

6. REASONS FOR REISSUE

- (a) To correct description of the redesigned J68372J transmitter AFC unit. This unit no longer employs an optical amplifier to detect an error signal.

Bell Telephone Laboratories, Incorporated

Dept 4312

- (b) To provide a new cooling fan on the J68372F meter panel which has longer life. This fan is used for cooling the transmitter klystron.

- (c) To provide a new receiver modulator and power supply arrangement using the TL-2 (J99296AA) modulator-preamplifier unit as a replacement for the 1A modulator (part of the J68372A receiver modulator) and the J68372B IF preamplifier.

- (d) To provide new figures for the J68372A receiver modulator unit and the J68372J transmitter AFC unit.

- (e) To add a figure for the Farinon power supply used for operation of the modulator-preamplifier.

- (f) To bring up to date information covered in parts 1, 2, 3, and 5 of this specification and to eliminate Part 4. Equipment as current equipment information is listed under 3. Drawings and is covered by Western Electric Company drawings.

- (g) To revise electron tube, diode, relay, and transformer requirements, to convert this specification to 9 digits, and to revise the title of the specification to include Toll Systems.