Traveling-Wave Tube

HELIX-TRANSMISSION-LINE TYPE
FREQUENCY RANGE, 2320-2680 Mc
LOW-NOISE AMPLIFIER TYPE

NF = 4.5 db
31-db GAIN
SOLENOID FOCUSING

For Use in Input Stage of Radar, Scatter Propagation, and Other Microwave Receivers, and in IF Amplifiers

Electrical:

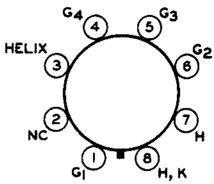
Heater, for Unipotential Cathode:		
Voltage (AC or DC)	5.0 ± 5%	volts
Current at heater volts = 5.0	0.65	amp
Starting current	Must never exceed 4 amperes, even momentarily	
Minimum cathode heating time	1	minute
Frequency range	2320 to 2680	Mc
Minimum cold insertion loss	60	db

Mechanical:

Operating Position	Any
Cooling	Natural
Maximum Overall Length	19.50"
Shell Diameter	1.375" ± 0.005"
Weight	1.5 lbs
Collector-Terminal Connector[a]	Special Banana Jack
RF Connectors:[b]	
Input terminal	Type N UG-18B/U Plug
Output terminal	Type N UG-18B/U Plug
Base	Octal 8-Pin

BOTTOM VIEW

Pin 1 - Grid No.1
Pin 2 - No Connection
Pin 3 - Helix
Pin 4 - Grid No.4
Pin 5 - Grid No.3
Pin 6 - Grid No.2
Pin 7 - Heater
Pin 8 - Heater, Cathode



Maximum and Minimum Ratings, *Absolute-Maximum Values:*

DC Collector Voltage	800	max.	volts
DC Helix Voltage	500	max.	volts
DC Grid-No.4 Voltage	500	max.	volts
DC Grid-No.3 Voltage	300	max.	volts
DC Grid-No.2 Voltage	75	max.	volts
DC Grid-No.1 Voltage	20	max.	volts
DC Collector Current	500	max.	μa
DC Helix Current	5[c]	max.	μa
DC Cathode Current	500	max.	μa
Magnetic Field Strength	650[d]	min.	gauss

RF Power Input:			
Peak	500	max.	watts
Average	1.0	max.	watts
Metal-Shell Temperature (At hottest point)	175	max.	°C

Typical Operation at 2500 Mc:

DC Collector Voltage	600	volts
DC Helix Voltage	375	volts
DC Grid-No.4 Voltage	325	volts
DC Grid-No.3 Voltage	70	volts
DC Grid-No.2 Voltage (Approx.)	10	volts
DC Grid-No.1 Voltage	10	volts
DC Collector Current	150	μa
DC Helix Current	0.5	μa
DC Grid-No.4 Current, DC Grid-No.3 Current, DC Grid-No.2 Current, DC Grid-No.1 Current	each less than 1 μa	
Magnetic Field Strength	850[e]	gauss
Gain (Low level)	31	db
Power Output (Saturated)	1.0	mw
Noise Figure	4.5	db

a Connection to the collector terminal may be made with a banana-type plug similar to a Raytheon Test Jack 27-1594G21 fitted with an insulator from HH Smith Type 211 banana plug.

b Both rf-input and rf-output terminals employ semi-rigid 50-ohm coaxial lines.

c During alignment of the tube in the magnetic focusing field, the helix current may exceed this value for short periods, but should never exceed 10 μa.

d This value of field strength will focus the electron beam, but noise figure will not be optimum.

e Typical peak value for RCA Solenoid, Type MW4901 (See *Characteristics of RCA-MW4901 Solenoid*).

CHARACTERISTICS RANGE VALUES

	Note	*Min.*	*Max.*	
Heater Current	1	0.45	0.85	amp
Input VSWR:				
Non-operating	2,3	–	1.3	
Operating	1,4	–	1.5	
Output VSWR:				
Non-operating	2	–	1.5	
Operating	1,4	–	3	
DC Helix Voltage	1,4	335	405	volts
DC Grid-No.4 Voltage	1,4	150	400	volts
DC Grid-No.3 Voltage	1,4	25	100	volts
Saturated Power Output	1,4	1.0	–	mw
Small-Signal Gain	1,4	28	34	db
Noise Figure	1,4	–	5.0	db

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Note 1: With heater voltage of 5.0 volts.

Note 2: With no electrode voltages applied.

Note 3: Any tube having a non-operating input VSWR higher than 1.3 but less than 1.5 may be considered acceptable if the operating VSWR is less than 1.5.

Note 4: With electrode voltages and magnetic focusing field adjusted for minimum noise figure at 2500 Mc.

OPERATING CONSIDERATIONS

The *rated values for collector voltage, helix voltage, grid-No.4 voltage, and grid-No.3 voltage are high enough to be dangerous to the user.* Care should be taken during adjustment of circuits, especially when exposed circuit parts are at high dc potential.

The *power supply* for the 8379 should be capable of holding ripple voltage sufficiently low to prevent phase distortion, and should have adequate regulation to prevent a change in operating conditions which might increase the noise figure. Provision should be made for monitoring helix current, collector current, and cathode current.

The rated *heater voltage* of 5.0 volts should be applied for at least 1 minute to allow the cathode to reach normal operating temperature before voltages are applied to the other electrodes.

The *magnetic field* required for focusing the electron beam of the 8379 may be obtained from a solenoid such as the RCA-MW4901 or equivalent. The field must have a distribution as shown in *Characteristics of RCA-MW4901 Solenoid.* A uniform field provided by a solenoid or permanent magnet of at least 800 gauss starting 2 inches from the groove near the base end of the metal shell and continuing for at least nine inches along the tube axis can provide equivalent focusing.

Initial Alignment Procedure

Apply rated heater voltage to the 8379 for one minute. Then connect operating voltages as shown under *Typical Operation* to all other tube electrodes except grid No.2. Grid-No.2 voltage may then be applied, and increased until cathode current reaches approximately 50 microamperes.

If the tube is incorrectly aligned within the magnetic field, some of the beam current will be drawn to the helix and increase the helix current. The axial alignment of the 8379 within the magnetic focusing field should then be adjusted to produce a minimum value of helix current. Grid-No.2 voltage should then be increased until collector current is approximately 150 microamperes. Readjust alignment of the tube and magnetic focusing field until a minimum value of helix current is again obtained. Helix current of the 8379 when properly aligned in the magnetic focusing field is usually less than one microampere. Collector current should be checked to see if it is essentially the same as cathode current. Such a condition is another indication that the tube is properly aligned in the magnetic field. If a solenoid is used to supply the magnetic focusing field, check the solenoid current and readjust it, if necessary, to obtain the specified field-strength value.

The above alignment procedure need not be repeated so long as the adjustments are not disturbed.

Lowest-Noise-Figure Adjustment Procedure

In order to operate the 8379 at the lowest noise figure, it is necessary to adjust the electrode voltages as follows: With the 8379 connected in its circuit, and with either noise input or signal input, adjust the helix voltage to give maximum output at the operating frequency. This value of helix voltage simultaneously produces optimum tube gain and lowest noise figure. Next, with no input signal, vary dc grid-No.1, grid-No.3, and grid-No.4 supply voltages alternately until the receiver output reaches a minimum value. The voltages are now adjusted to operate the 8379 at its lowest noise figure for the particular frequency to which the equipment is tuned. If the strength of the magnetic focusing field changes, it will be necessary to repeat the above adjustment procedure with regard to grid-No.1, grid-No.3, and grid-No.4 voltage.

Preamplifier in Radar Receivers

In the usual type of radar system, a portion of the transmitter pulse leaks through the TR tube to the crystal mixer in the receiver, overloads the crystal, and gradually impairs its performance. If, however, the crystal is preceded by the 8379 in a preamplifier stage, the traveling-wave tube serves as a crystal-protection device because of its saturation characteristic. See accompanying *Saturation Characteristics* curve. From this curve, it will be noted that the saturated power output of the 8379 is about 1 milliwatt which will not harm the crystal. Therefore, the spike-leakage limit of the TR tube can be eased and thus eliminate the need for supplying "keep-alive" voltage to the TR tube. Furthermore, the ability of the 8379 to withstand an rf peak power input of as much as 500 watts or an average power input of as much as 1 watt makes it possible to employ a TR tube with lower attenuation.

Additional advantages offered by the 8379 in a preamplifier stage include: (1) reduction of the overall noise figure of the radar receiver; (2) improved receiver recovery time; (3) better TR tube life, and (4) reduction of local oscillator radiation. All of these advantages contribute to improved radar-system operation.

Phase-Sensitive Applications

When the 8379 is used in phase-sensitive radar system or in a microwave relay system where frequency-modulated information is amplified, even a small amount of phase distortion

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can adversely affect performance. The following table shows for each tube electrode the values of rms ripple voltage which will cause a peak-to-peak change in rf phase of approximately 1 degree.

Tube Electrode	Typical Operating DC Volts	Approx. RMS Ripple Volts For Peak-to-Peak Phase Shift of 1°
Grid No.1	10	0.1
Grid No.2	10	0.1
Grid No.3	70	0.5
Grid No.4	325	3.5
Helix	375	0.024
Collector	600	6.7

For the RCA Solenoid Type MW4901 operated at 90 volts dc, a peak-to-peak change in rf phase of approximately 1° will be caused by an rms ripple voltage of 7.7 volts.

Input Matching Considerations

In general, the *voltage standing wave ratio* (VSWR) will increase as the electron-beam current of the tube is increased. This "hot VSWR" is a direct function of gain and can be attributed to reflections of the amplified wave at a discontinuity along the slow-wave structure. In contrast, the VSWR with no voltages applied to the tube, is referred to as the "cold VSWR". This "cold VSWR" determines the transfer of input signal energy to the helix and, therefore, the noise figure of the 8379 is not degraded by the "hot VSWR". In general, it will be found that when the input to the 8379 is adjusted for optimum matching under "cold" conditions, the same adjustment will provide optimum matching under "hot" conditions. A typical input matching characteristic is given in the accompanying curve for the 8379 under "cold" conditions.

Notes On Associated Microwave Circuitry.

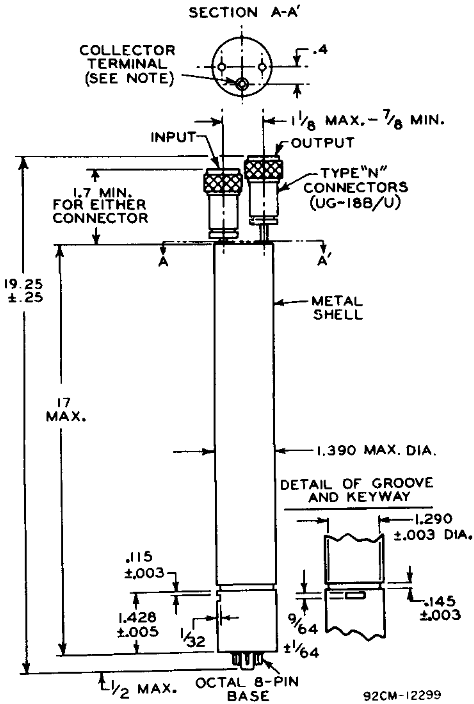
A low-noise traveling-wave tube used in a superheterodyne circuit will cause a 3 db degradation in noise figure unless a filter is used at the output of the traveling-wave tube to remove noise generated at the image frequency.

Whenever the output of the 8379 is connected to a filter, signals in the reject band of the filter are reflected back into the tube. As these signals travel back through the tube, they suffer little attenuation until they are absorbed by the attenuator. Should there be appreciable reflection from the attenuator or another discontinuity inside the traveling-wave tube, oscillations may occur, depending on the gain within the tube from the attenuator or discontinuity to the output end of the tube.

The 8379 is designed to be short-circuit stable, i.e., the power reflected from a short-circuited output termination will be insufficient to cause oscillation when the 8379 is operating at a normal value of beam current. If the beam current is increased sufficiently above this value, the gain of the tube will increase until oscillation takes place.

When a high-gain microwave amplifier tube such as the traveling-wave tube is employed, special care must be taken to prevent distortion of oscillations resulting from feedback through circuitry external to the tube. Some types of filters may show satisfactory attenuation characteristics in and near the frequency band of interest. However, oscillations can still occur due to "holes" in the filter characteristic at frequencies outside the band of interest. Attenuation of filters should therefore be checked over wide bands and the holes, if any, can be filled by supplementary, simple filters.

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

Note: Special Banana Jack--Mates with Raytheon Test Jack 27-1594G21 fitted with an insulator from an HH Smith Type 211 Banana Plug.

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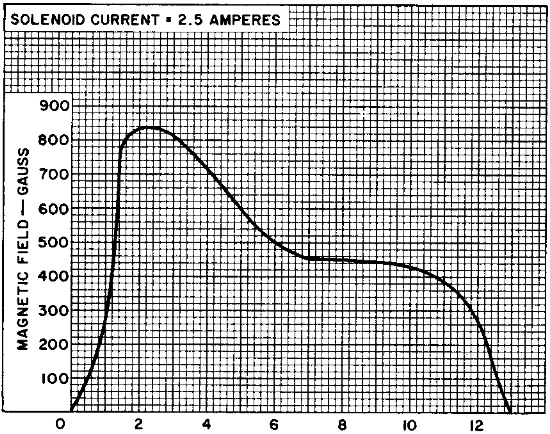
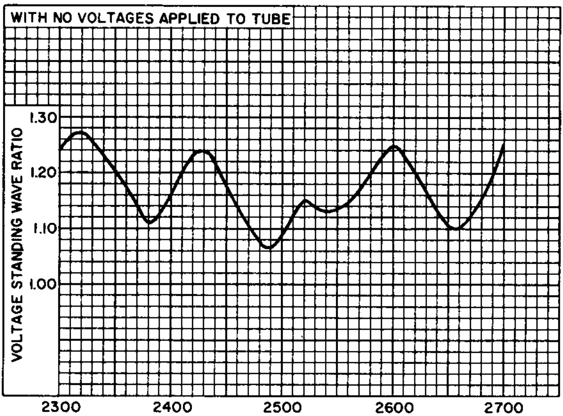
Characteristics of RCA-MW4901 Solenoid



DISTANCE FROM REFERENCE GROOVE — INCHES

92CS-12298

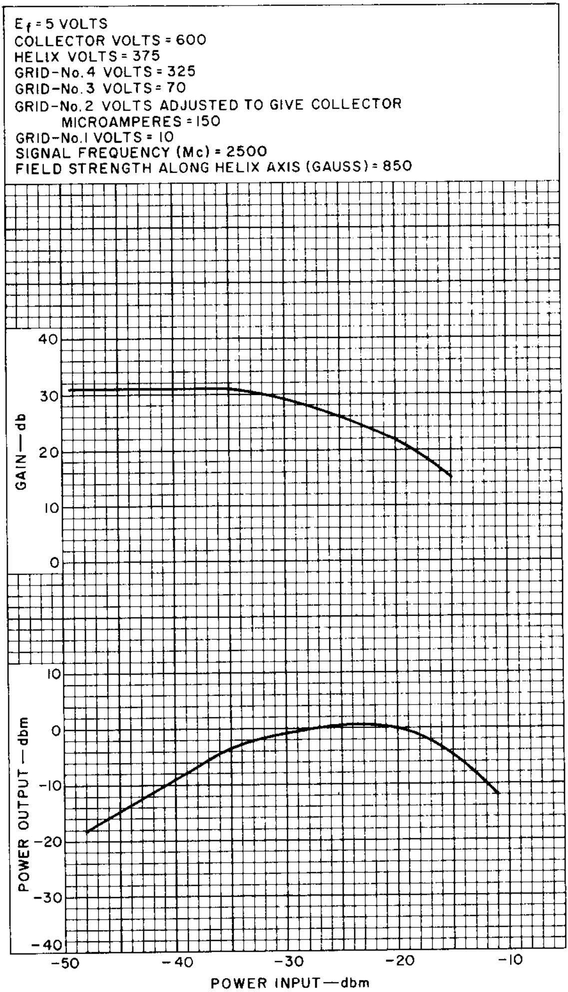
Input-Matching Characteristic



FREQUENCY — Mc

92CS-12295

Saturation Characteristics



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