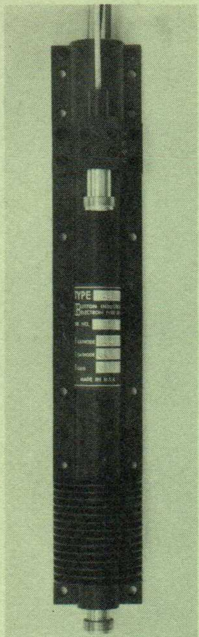
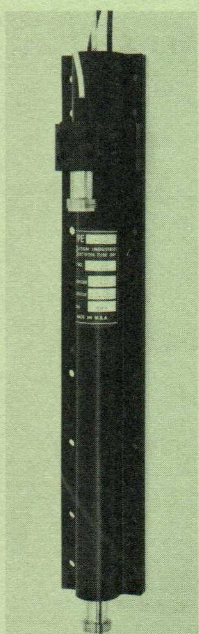




Installation and Operation Manual

for LITTON CW and PULSE TRAVELING WAVE TUBES

LITTON INDUSTRIES
Electron Tube Division

960 INDUSTRIAL ROAD, SAN CARLOS, CALIFORNIA

RECEIVING INSTRUCTIONS

This traveling wave tube has been carefully tested and inspected before shipment and every precaution has been taken to protect this device from damage during transit.

A. When unit arrives, open the container and carefully remove the material packed around the tube.

B. Visually inspect the tube for any damage.

C. Should the tube be damaged, please notify your nearest Litton representative for further instructions. (See back cover for telephone number)

DO NOT OPERATE THE TUBE

D. If everything appears to be intact, proceed with the following installation instructions.

CAUTION: Read **all** instructions carefully before operating tube.

CW OPERATION

RECOMMENDED PROCEDURES and EQUIPMENT

Scope

This document contains **generalized** information pertaining to the operation of Litton traveling wave tubes. For information on specific tube types or where there may be concern regarding the type of environment in which tubes are being operated, refer to Item 5.

1. Power Supply

The Power Supply to be used with the TWT should be capable of supplying cathode and grid voltages adjustable plus or minus 5% from the values on the tube data sheet. Litton recommends the following power supply requirements.

	Cathode	Grid	Filament
Regulation	± 1% min.	± 1% min.	± 3% min.
Ripple	100 millivolts peak to peak max.	100 millivolts peak to peak max.	

Should this unit be used in coherent systems where stringent phase or modulation requirements are paramount, regulation and ripple requirements must be considered accordingly. Filament voltage may be either ac or dc and 60 – 90 second delay for proper warm-up should be incorporated into the power supply before the application of any high voltages.

2. Cooling

Litton CW traveling wave tubes are designed to be either conduction cooled, air cooled, or a combination of both. Figure 1 shows a typical installation. Litton CW TWTs require a conduction surface equivalent to approximately 250 square inches of 1/8 inch aluminum for proper cooling at room ambient conditions. Larger heat sinks, forced air cooling, or both, may be required in environments such as specified in Mil–E–5400. Litton 10 Watt traveling wave tubes require the same conduction surface and 0.25 lbs. to 0.5 lbs. of forced air through the collector cooling fins. **Never** allow the temperature measured at the collector end of any tube to exceed +140 °C. Silicon grease is recommended between the tube and mounting area for better heat transfer. Secure the tube snugly; do not exert excessive force when tightening the mounting screws. Monitoring collector temperature is recommended during initial operation. The collector temperature should stabilize at less than 100°C for long life operation.

Note: Consult Litton applications' engineering about cooling requirements for tubes with power outputs greater than 10 Watts CW or if the tube is to be operated with a depressed collector.

3. **Installation**

Installation and turn-on procedures for proper operation of this unit are listed on page 3. The operator must be absolutely certain that the voltages specified on the tube label and the test data sheet are "pre-set," preferably on a dummy load equivalent to tube impedance. After proper heater warm-up, cathode and grid voltages must be applied "simultaneously." **Never!!** apply grid or cathode voltages separately or bring them up slowly. **Never!!** allow the power supply rise time to exceed 80 milliseconds from the instant of turn on to full data sheet value voltages. **Never!!** operate without R.F. loads or terminations.

4. **Special Considerations**

During initial testing, it is important to monitor helix current (described in the installation and turn-on procedures). This is an indication of proper focusing and the current should never exceed 4.0 milliamps with no rf drive. The helix current will normally stabilize around 1.0 milliamps or less after an initial turn-on surge caused by the rise time of the power supply. This surge should never exceed 100 milliseconds. It is recommended that an interlock circuit be incorporated into the power supply which will remove the high voltage should the helix current exceed 4.0 milliamps. If this unit is to be used in an airborne application where monitoring the helix current is impractical, the current should be noted to be in accordance with the data sheet and then tied directly to ground. The helix current will rise during application of rf drive. This is quite normal, caused by bunching of the electron beam. Note: If an interlock circuit is used, the maximum allowable impedance between helix and ground is 15,000 ohms. **Never!!** apply R.F. drive power without proper R.F. load.

5. Any questions pertaining to the operation of these tubes should be directed to Litton Industries Electron Tube Division, 960 Industrial Road, San Carlos, California, Area Code 415, 591-8411, Attention: Linear Beam Department.

TUBE INSTALLATION and TURN–ON PROCEDURE

FOR CW OPERATION

1. For maximum life, this device must be mounted to an adequate heat sink or have sufficient air cooling supplied to maintain temperature of 100°C or less measured at the collector end of the tube. The collector temperature may rise to 140°C for short periods of operation without harmful effects.

2. With the tube disconnected, pre-set voltages. (Note 1)

3. Connect color-coded flying leads. (See Hook-up diagram below and Note 2)

4. Apply filament voltage and allow three minutes for heater warm-up.

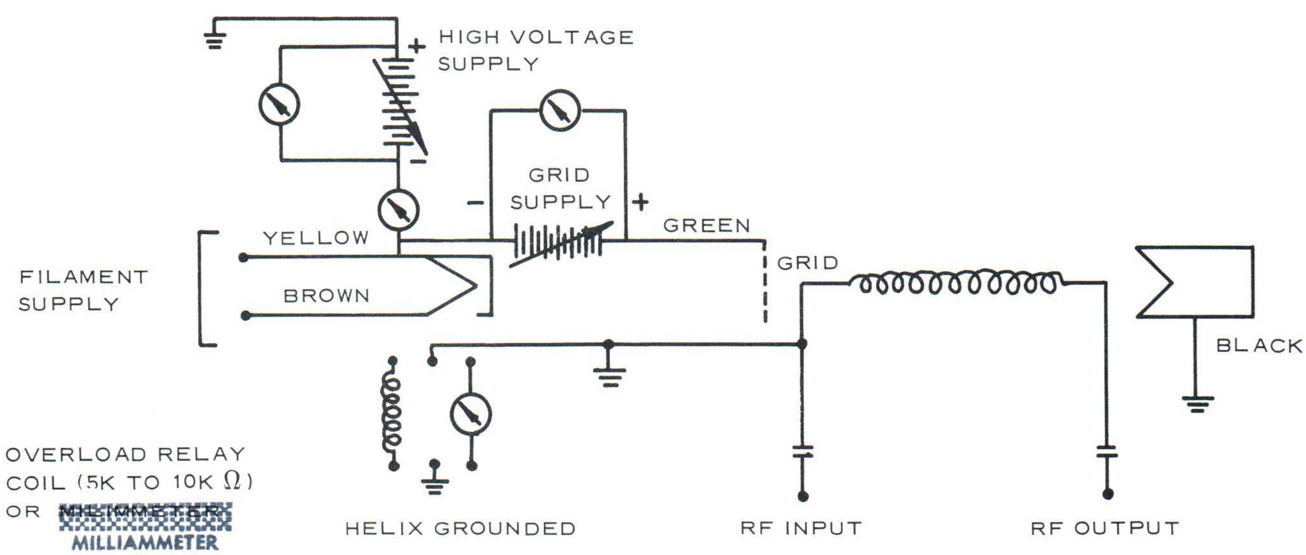
5. Apply all voltages simultaneously. With no rf drive, the helix current should never exceed 3.0 mA after initial turn-on surge. (Note 3)

6. Check that voltages and currents are in accordance with data sheet values. Apply rf drive.

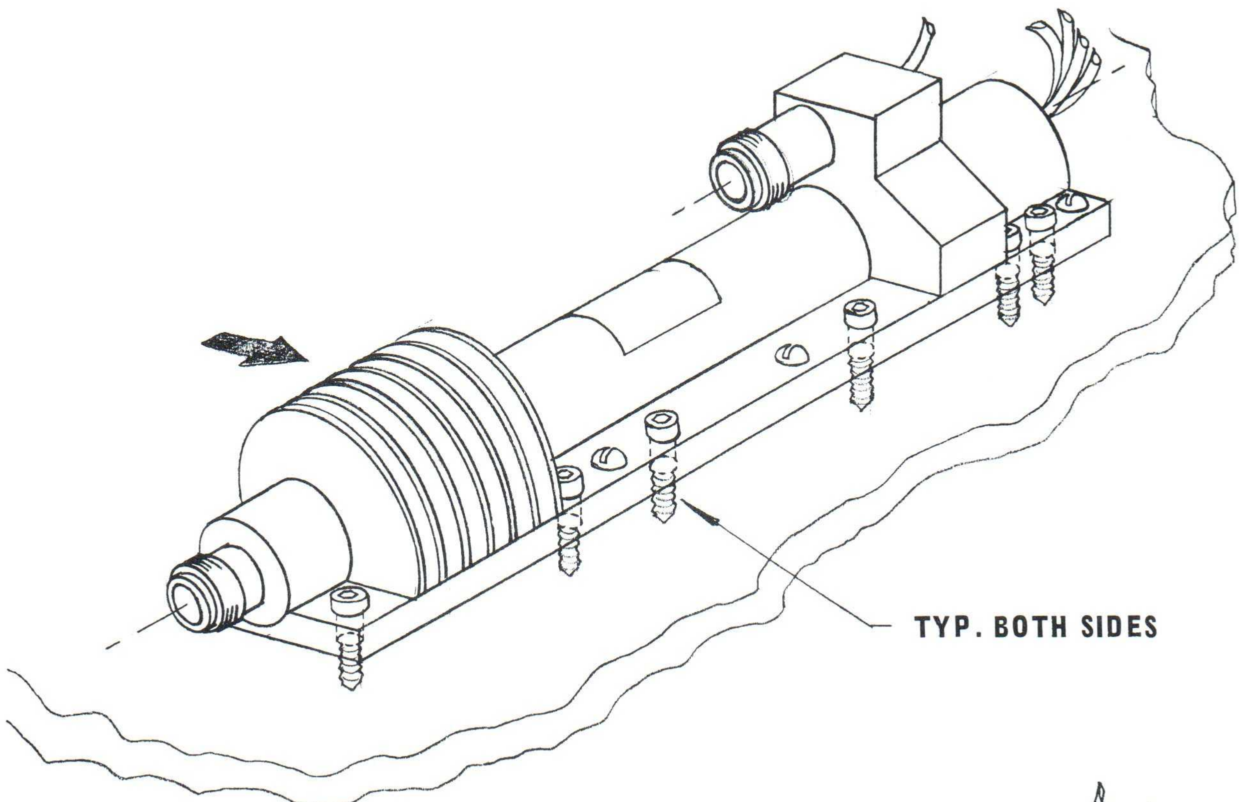
Note 1. Values to be specified on enclosed test data sheet.

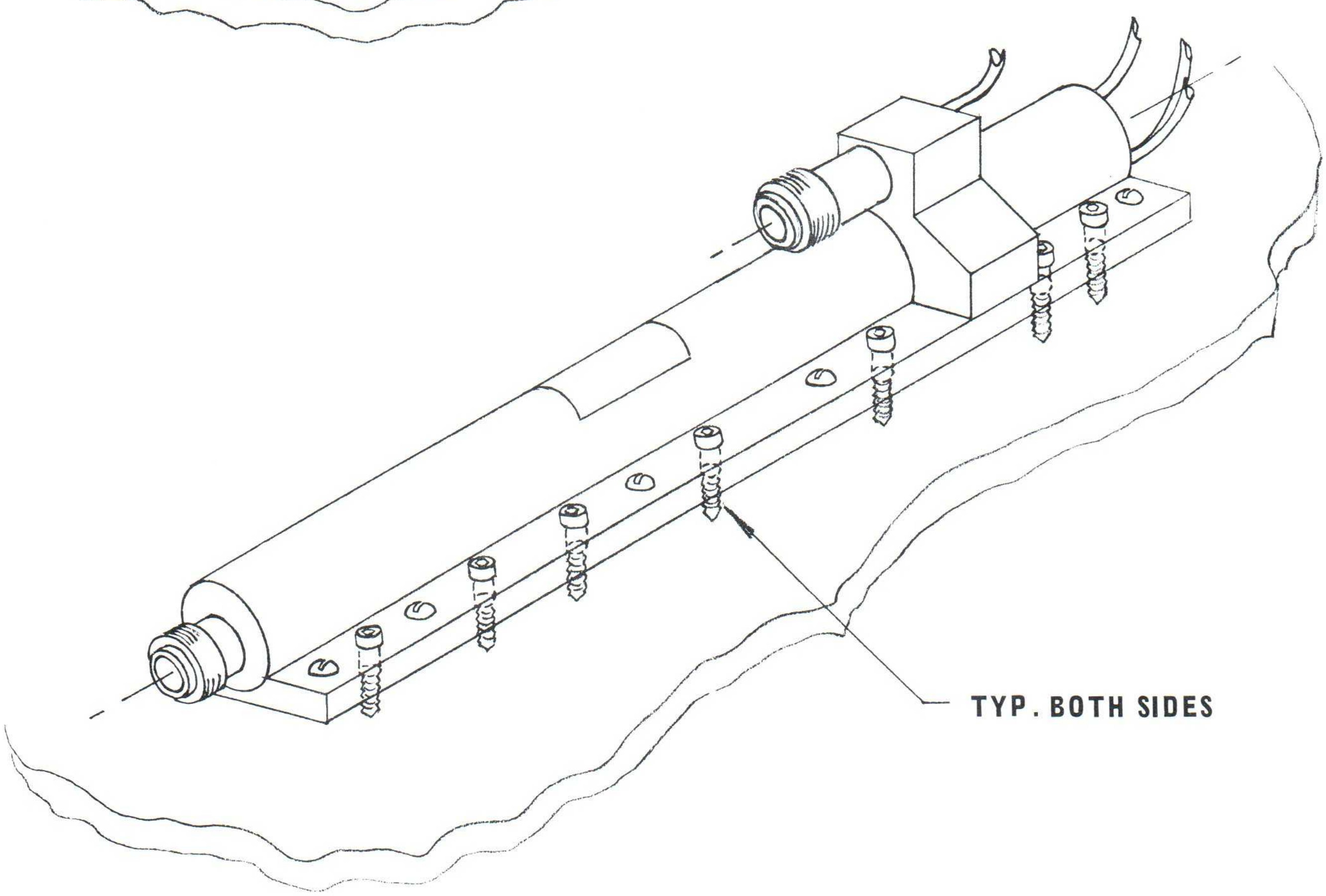
Note 2. Connect helix (shielded lead opposite rf input) to ground through a milliammeter or high voltage overload relay coil set to trip at 4.0 mA.

Note 3. Small helix and grid voltage adjustments may be necessary to optimize beam focusing.



CW HOOK-UP DIAGRAM





TYPICAL INSTALLATION

Figure 1

PULSED OPERATION

INSTALLATION INSTRUCTIONS

1. **Mount the tube** on a flat metal base or frame which covers all of the tube base surface area. Tighten machine screws securely into mounting holes (See tube outline drawing for location of mounting holes).

   The tube must not be operated above 0.001 duty cycle without heat sink cooling or forced air. If properly mounted, the tube can generally be cooled by conduction alone. Maximum allowable collector temperature measured at the point where the orange collector lead is attached to the tube is 115°C.

   Keeping the mounting surface to which the tube is attached below 70°C is generally sufficient at sea level, but forced air may be necessary at high altitudes to provide adequate cooling. Be sure the frame or base plate is FLAT. Use of metal oxide filled silicon grease such as General Electric INSUL-GREASE G-641 (Silicone Products Department, Waterford, N. Y.) to improve heat transfer between tube and heat sink is strongly recommended.

   Be careful not to strip the threads in the aluminum base plate or to screw the machine screws in too deep . The black anodizing used on the mounting blocks is an electrical insulator. Use of a separate ground lead is necessary for good grounding of the tube. The ground lead from the tube must be securely attached to the B+ return lead of the power supply.

2. **Attach the leads** from the tube to the appropriate connection on the power supply. Check all connections to see that they are correctly made. Reversing the cathode and heater leads, for example, will cause premature tube failures. If a collector lead is supplied, it must be grounded. A meter may be inserted in the line if collector current is monitored. Also, a 10 ohm resistor may be used and the collector pulse viewed across the resistor with an oscilloscope.

   The helix is connected to the tube body. Helix current cannot be monitored directly unless the power supply has a single point or terminal for B+ return. In this case, helix current can be monitored as shown on the schematic hook up diagram and helix overcurrent protection can be provided in the circuit.

   It is necessary to provide some reliable method for setting up the proper beam current in the tube. Simultaneous monitoring of helix current and collector current or cathode current and collector current can be used to accomplish this. Remember that grid current must be subtracted from cathode current to determine beam current.

3. **Securely connect the r.f. input and output** to the connectors on the tube. Never apply r.f. drive with the tube operating and the r.f. output open or short circuited.

OPERATING INSTRUCTIONS

1. Apply voltages to the tube as shown on the name plate and tube test data sheets. Voltages must be applied in the following sequence:

   a. **Heater Voltage E_f** – Set E_f to 6.3 volts. Allow three minutes for warmup before applying grid pulse voltage. Grid bias and beam voltage can be applied immediately.

   b. **Grid Bias E_c** – Set grid bias (E_c) = -as specified in the tube data sheet provided. Adequate negative grid bias must **always** be applied to prevent DC grid and cathode current from being drawn. **Never** apply beam voltage before grid bias voltage is applied, but grid bias and beam voltage can be applied simultaneously. A low voltage interlock is desirable to prevent damage to the tube because of insufficient grid bias or failure of the bias power supply.

   c. **Beam Voltage E_{ws}** – Set E_{ws} at the value specified on the tube data sheet. Note that the cathode is negative with respect to ground.

   d. **Grid Pulse Voltage e_c** – Set e_c as specified on the data sheet and monitor the specified undriven collector current i_b. Until familiarity is obtained with tube operation, the grid pulse repetition rate should be set for a 0.001 duty cycle or less. Grid pulse voltage is measured with respect to the cathode, and is positive.

   CAUTION! Above 0.002 duty cycle grid pulse voltage must be applied at the proper level quickly. Never turn the grid pulse voltage up slowly at high duty as tube damage will result.

2. **APPLY R.F. DRIVE.** After all voltages have been applied, the tube is ready for r.f. testing. CONSULT the tube's specific test data sheet for proper operation and limitations. After familiarity with tube operation is obtained and the equipment is checked out, the duty cycle can be increased to the maximum. Turn off voltages in the reverse order from turn on.

3. **CAUTIONS.** Properly operated, the tube will give reliable trouble free service, but because of the helix slow wave circuit used, safe operation becomes much more critical as duty cycle increases.

   a. **Avoid overdriving the tube.** At high duty, excessive overdrive can quickly destroy the tube. R.F. input power should be no greater than that required for saturated output.

3. **CAUTIONS, cont'd**

b. Do not operate grid pulse voltage at other than rated values. Slowly turning up the grid pulse voltage from zero may cause destruction of the tube at high duty. Both high and low grid pulse voltage can cause damage.

c. Before operating the tube at high duty, be sure the operating voltages and currents correspond to those on the tube data sheet and that the power supply voltages do not change excessively with duty cycle. Familiarity with tube operation at low duty should be obtained before operating the tube at full duty.

APPLICATION DATA

1. Typical performance test data is included with the tube.

   Variation of the operating voltages and current will cause changes in the tube performance which is typical for helix tubes of this type. Maximum small signal gain occurs at a beam voltage lower than that voltage which produces maximum power. In general, increasing the beam voltage above that voltage which produces maximum small signal gain will cause the gain to decrease, particularly at the high frequency end of the band.

   Saturated power will increase at the lower end of the band and decrease at the high end of the band. Increasing the grid pulse voltage will increase gain and power significantly until a maximum is reached. Further increases in grid pulse voltage will cause high helix current interception and may also cause oscillations.

   CAUTION! Do not operate the tube above rated grid pulse voltage or allow the tube to oscillate at a duty cycle greater than 0.002. At higher duty cycle the defocusing of the beam which occurs will cause excessive heating of the helix and may seriously shorten the life of the tube or destroy it. At .002 duty or above it is absolutely necessary to operate the tube at -- or very near -- the proper voltage and currents to avoid damage.

   NOTE: Rated or full specification operation of the tube may not necessarily be at maximum power. Consult the tube test data sheet supplied with each tube before departing significantly from recommended operating conditions.

   This tube is equipped with a grid having a high amplification factor in order to minimize the pulsing voltage and power requirements. Therefore, small, lightweight solid state power supplies may be used for critical airborne applications. The grid is able to control the tube performance dramatically with only small changes in voltage. In critical applications, both the grid bias and grid pulse voltages must be closely regulated to avoid excessive variation caused by line voltage fluctuations or by duty cycle changes.

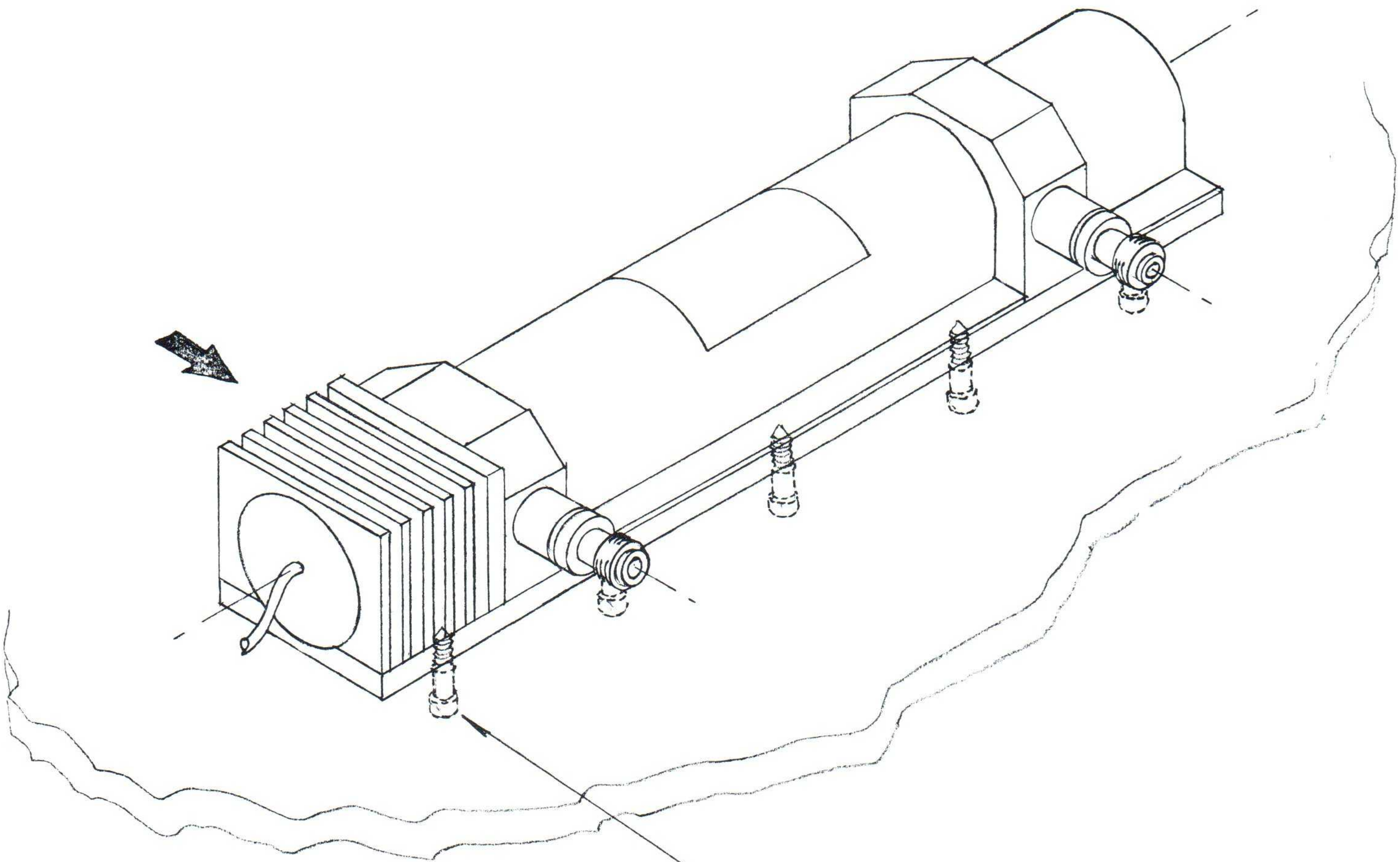
   If desired, the grid bias (and, therefore, the total grid pulse above bias) may be increased. The recommended bias provides for minimum pulse requirements.

2. **Arc Protection.** Although the tubes have been especially treated during assembly and processing, there is some possibility of an occasional arc inside the tube between grid or cathode and ground. Consideration should be given to equipping the power supply with a crowbar if the stored energy exceeds 5 joules. If used, the crowbar should operate in the order of microseconds to prevent

most of the stored energy from being dissipated in the tube where it may damage the cathode and cause loss of emission. If the modulator has a fast acting crowbar, the crowbar operation may induce transients which cause very large voltages to appear across the heater and cathode connections. This should be checked before damage occurs. These voltages frequently will burn out the tube heater unless protection is provided. One type of safeguard which will normally protect the heater is as follows: A 1μf, 1000-volt capacitor in parallel with the heater and an inductance, in the order of 1 millihenry, or more, in series. Be sure the inductance is in the heater leg and not in the cathode leg where it may affect the pulse shape.

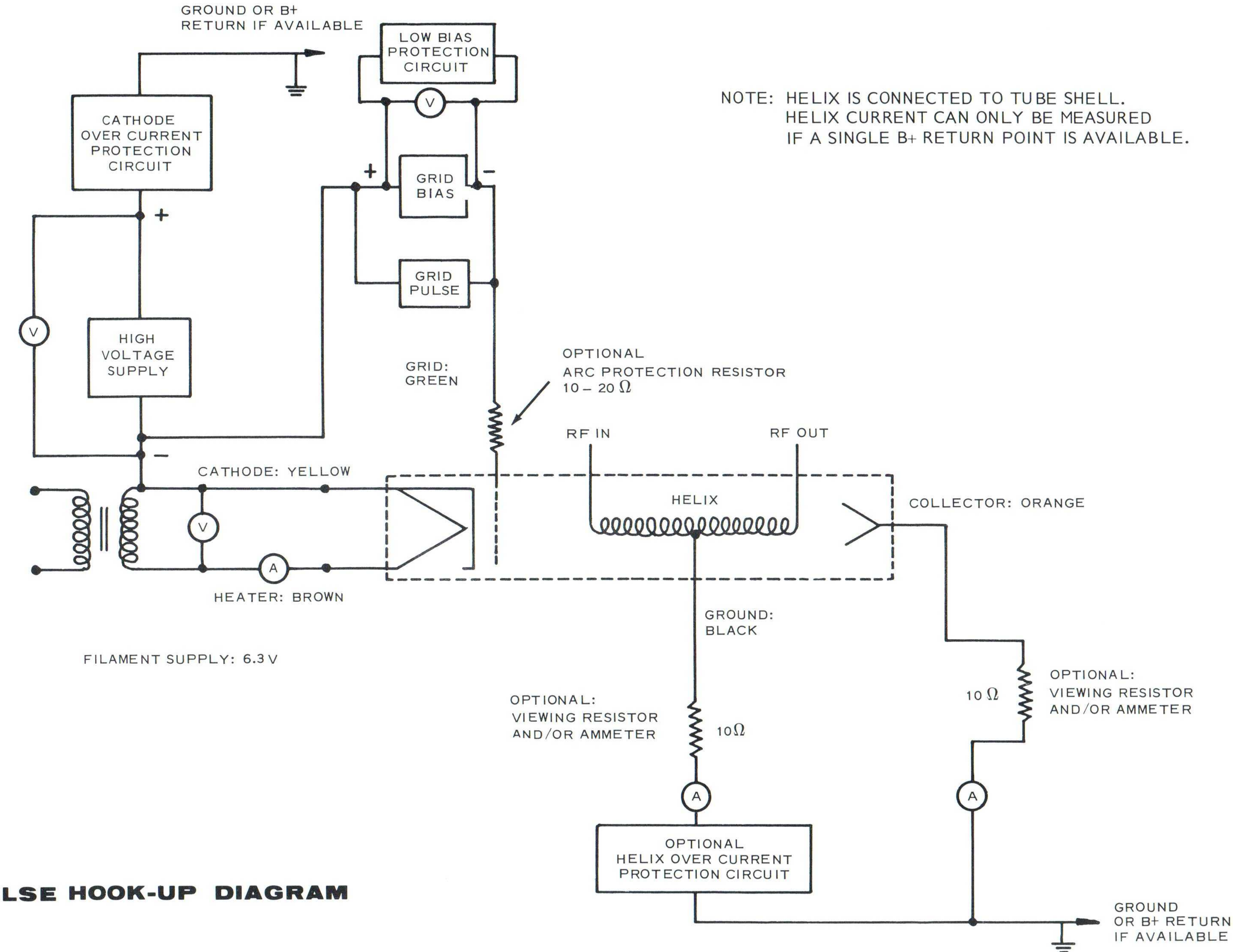
If the stored energy is low or a crowbar is not desired, partial tube and power supply protection can be provided by inserting a 10 to 20 ohm non-inductive resistor in series with the grid lead to the tube. This slightly increases grid pulse requirements because of the voltage drop across the resistor, but it performs a current limiting function in case of an arc.

In any event, if a crowbar is not used, an over current protection circuit should be included with the power supply so that the high voltage is removed from the tube if cathode current exceeds maximum ratings.



TYPICAL INSTALLATION

Figure 2



NOTE: HELIX IS CONNECTED TO TUBE SHELL.
HELIX CURRENT CAN ONLY BE MEASURED
IF A SINGLE B+ RETURN POINT IS AVAILABLE.

PULSE HOOK-UP DIAGRAM

For your convenience Litton applications engineers are located at the following regional offices:

NORTHEAST
335 Bear Hill Road
Waltham, Massachusetts 02154
(617) 889-2238

EAST
191 Main Street
Manasquan, New Jersey 08736
(201) 223-4160

DISTRICT OF COLUMBIA
1875 Connecticut Avenue, NW
Suite 1013, Universal Building North
Washington, D.C. 20009
(202) 462-8833

SOUTH
1213 Watson Boulevard
Warner Robins, Georgia 31093
(912) 923-3397

MID-WEST
333 West First Street
Dayton, Ohio 45402
(513) 223-3285

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(714) 548-4986

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