EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

EM15LS

INDUSTRIAL MAGNETRON

25 kW
915 Mc.

The Eimac EM15LS is a rugged power magnetron designed specifically for industrial processing. It is designed to operate in the industrial and scientific frequency allocation of 915 ±15 Mc. A power output of 25 kW can be obtained into a matched load at an efficiency of approximately 80%. Long operating life in severe industrial environment is assured through use of a directly heated pure tungsten spiral cathode. Further, ruggedness is assured through exclusive use of metal-ceramic construction. Every effort has been made in the design of this tube to keep water cooling pressure and purity requirements down to minimize cooling cost. The magnetic field is provided by an electromagnet which is an integral part of waveguide coupler Type H-195. This coupler mates with 9¾" x 4⅞" waveguide.

The magnetron may be operated with a fixed magnetic field or with the electromagnet connected in series with the anode. The latter mode of operation greatly reduces the variation in output power due to supply voltage changes.

Anode voltage for the EM15LS is normally supplied from a full wave three-phase rectifier with or without filter choke. The degree of filtering in any particular application is dictated by the permissible amplitude and frequency modulation of the rf output power. These are mainly determined by the anode current ripple.

CHARACTERISTICS

ELECTRICAL

Filament:	
Heating Time	10 seconds
Starting Voltage (±5%)	13 volts ac
Starting Current	115 amperes ac
Maximum Inrush Current	250 amperes
Cold Resistance	0.03 ohms
Output Power	25 kilowatts
Frequency	915 ±15 Mc

MECHANICAL

Maximum Dimensions:		
Length	17 inches	
Diameter	7 inches	
Weight	25 pounds	
Output Coupling (rf)	(See outline drawing)	
Mounting Position Preferred	Vertical	
Cooling: Water and Forced Air	*Flow Rate*	*Pressure Drop*
Anode	3 gpm	30 psi
Electromagnet	0.25 gpm	30 psi
Output Window	20 cfm	2" H_2O
Stem	5 cfm	2" H_2O

POWER SUPPLY REQUIREMENTS

Electromagnet Voltage, dc	50 volts
Electromagnet Current, dc	4 amperes
Filament Voltage, ac	14 volts
Filament Current, ac	120 amperes

MAXIMUM RATINGS

Anode Voltage (dc)	14 kilovolts
Anode Current (dc)	3 Amperes
Anode Dissipation	15 Kilowatts
Load VSWR	2.5:1
Seal Temperature	175°C
Water Outlet Temperature	70°C

TYPICAL OPERATION

Frequency	915	915	megacycles
Output Power	20	25	kilowatts
Anode Voltage	11.5	12.5	kilovolts dc
Anode Current	2.1	2.4	amperes dc
Efficiency	83	83	percent
Filament Voltage	11	10.8	volts ac
Filament Current	106	103	amperes ac
VSWR	3:1*	2.5:1*	
Electromagnet Current	3.3	3.6	amperes dc

*Efficiency with mismatched load depends upon phase angle of the load. Efficiencies listed can be obtained with matched load or at selected phase angles.

NOTES

1. COOLING

Both air and water cooling must be applied before anode voltage is applied.

2. FILAMENT ADJUSTMENTS

Before the anode voltage is applied, the filament current must be set for 115 amperes and held there for 10 seconds. When the magnetron begins operating, the heater current should be reduced immediately to compensate for back bombardment. The filament current given above is for a matched rf load. Maximum life of this magnetron will be obtained if the filament voltage is decreased during operation until the filament resistance V_f/I_f is the same as that when the magnetron is not oscillating; i.e., V_{fo}/I_{fo}. When the rf load is reasonably constant in magnitude and phase, filament voltage and current can be reduced a fixed amount using manual switch control. However, when the variation of the load mis-match and phase is considerable, more accurate compensation should be provided by automatic control.

3. POWER SUPPLY

The short circuit characteristics of the anode supply must be such that the peak anode current is limited to 25 amperes in case of an arc in the magnetron. If the leakage reactance of the transformer, plus the resistance of the rectifiers, transformer and filter choke do not provide this degree of current limiting, a series resistor is recommended in the anode supply to achieve the additional current limiting required.

4. OPERATION WITH SERIES FIELD

With the coil of the electromagnet connected in series with the anode as shown in Fig. 4, the magnetron threshold voltage V_T (approx. equal to the anode voltage at zero anode current, see Fig. 3) becomes proportional to the anode current and curve of V_a against I_a for steady currents, and is obtained as given in Fig. 5. The slope of this characteristic, which depends upon the number of turns in the coil, is much greater than that with fixed field (compare with Fig. 3), and

hence the power changes with supply voltage variations are correspondingly reduced. This is one advantage of the series field mode of operation.

Operating points to the left of the line can be reached by supplying a biasing current through the coil. Assuming an initial biasing current, the behavior is then as follows: as the anode voltage, and hence current, rises from zero, the increasing voltage drop across the magnet coil causes a decrease in the biasing current, and a V_aI_a characteristic of reduced slope* is obtained. Beyond the branch point shown in Fig. 5, the biasing current is zero and full series field behavior is obtained. The characteristic is raised or lowered in accordance with the biasing current and threshold voltage V_T, and with a fixed supply voltage this enables the power output to be controlled in an economical way by varying the magnet current. Since the slope of the characteristic depends upon the magnet coil resistance, there is a slight drift of the operating point as the coil warms up. This can be minimized by making R_b large compared with R_m or by using a bias supply which behaves as a constant current source.

With series field, anode voltage cannot be applied instantaneously without biasing field current, because a transient voltage approximately equal to the anode supply voltage is developed across the magnet coil. A recommended method of starting is therefore to increase the biasing current to raise V_T above the no load voltage of the anode supply, switch on the anode voltage, and then reduce the biasing current until the required operating point is reached.

With series field, the stability against load mismatch remains the same as that with fixed field, but the variation in anode impedance V_a/I_a, with phase of load VSWR is reduced by a self-regulating action. This leads to a power variation (see Fig. 2 for example) which is mainly determined by efficiency changes.

Precautions should be taken to prevent excessive load reflection as stipulated in the maximum ratings, since operation in unwanted modes is always possible with series field, following a cessation of oscillation in the proper mode.

5. INSTALLATION

The EM15LS is constructed from metal and ceramic. Reasonable care should be taken to protect the tube from excessive shocks when handling and after installation. The mounting position is with axis vertical, either up or down.

Connection between the magnetron and the H-195 is made by a copper washer retained on a flange on the tube at the base of the dome window. The tube must be seated squarely in the electromagnet, and the retaining screws tightened up uniformly to ensure proper contact at the washer. A new washer should be used each time the magnetron is inserted. A new washer is supplied with each new tube purchased.

The magnetron dome window is forced-cooled by air ducted over the dome by a flanged insulating cylinder. To obtain proper cooling it is necessary to ensure a uniform gap between the cylinder and dome.

The cathode terminals must be securely clamped to make proper contact and avoid overheating. Cooling is by forced air through a duct attached to the small cathode terminal. The terminal temperature should not exceed 175°C.

*In proportion to $\frac{R_b}{R_b+R_m}$, where R_b is the effective internal impedance of the biasing supply, and R_m the magnet resistance.

For additional information or information regarding a specific application, write to Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, California.

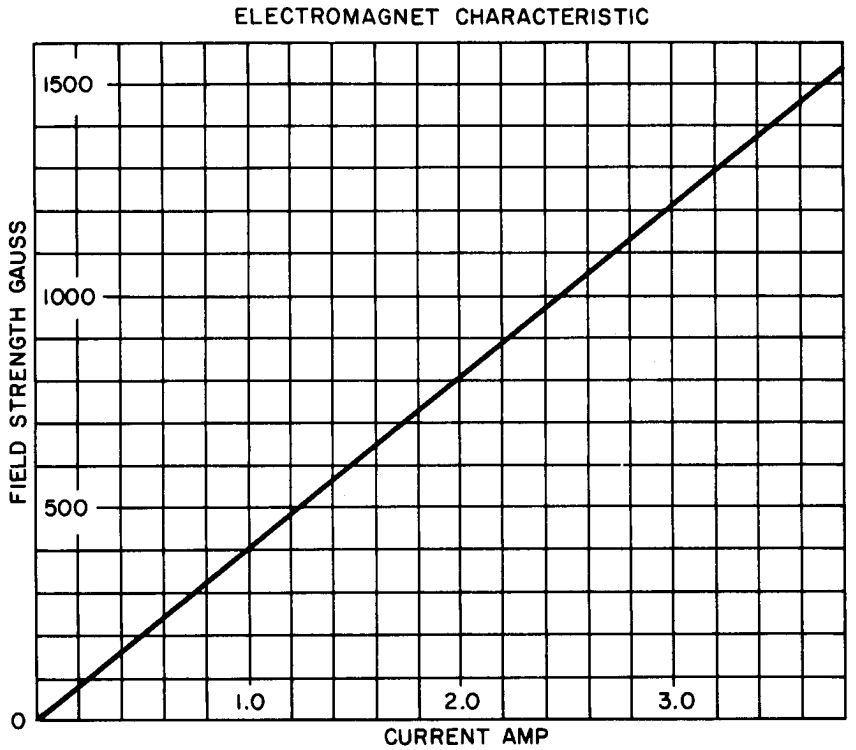
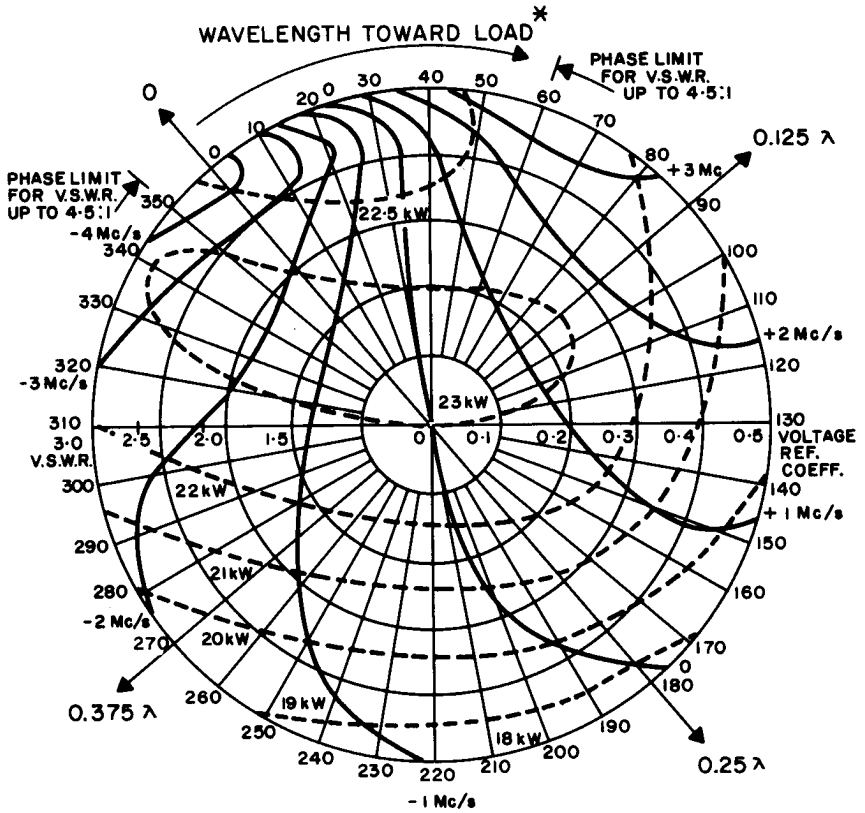


fig. 1



TYPICAL RIEKE DIAGRAM

fig. 2

Va = 12.5 kv
Ia = 2.4 a
f = 915 Mc

* ZERO WAVELENGTH IS AT FLANGE OF LAUNCHER AND INDICATES VOLTAGE MINIMUM AT THE FLANGE.

PERFORMANCE CHART

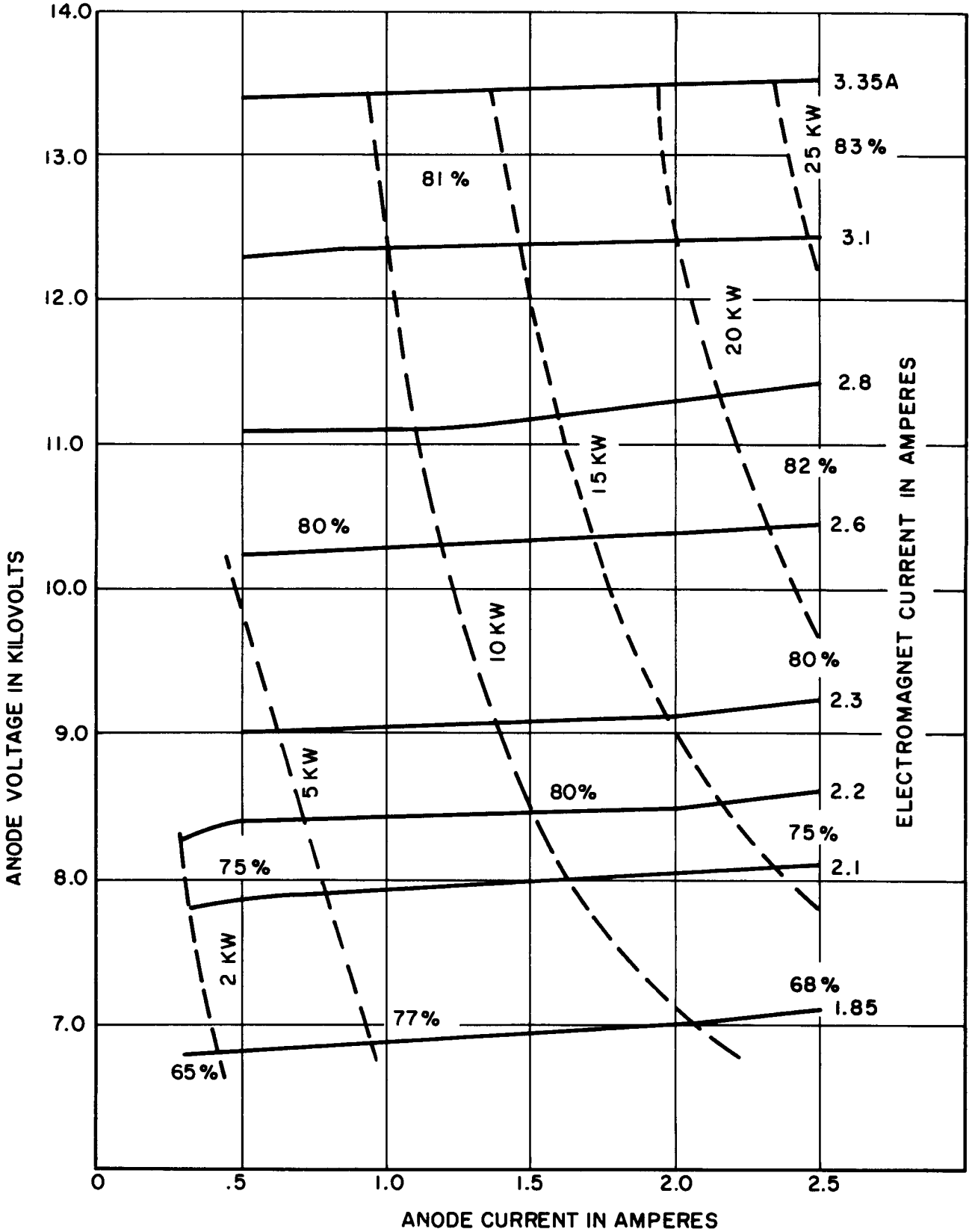
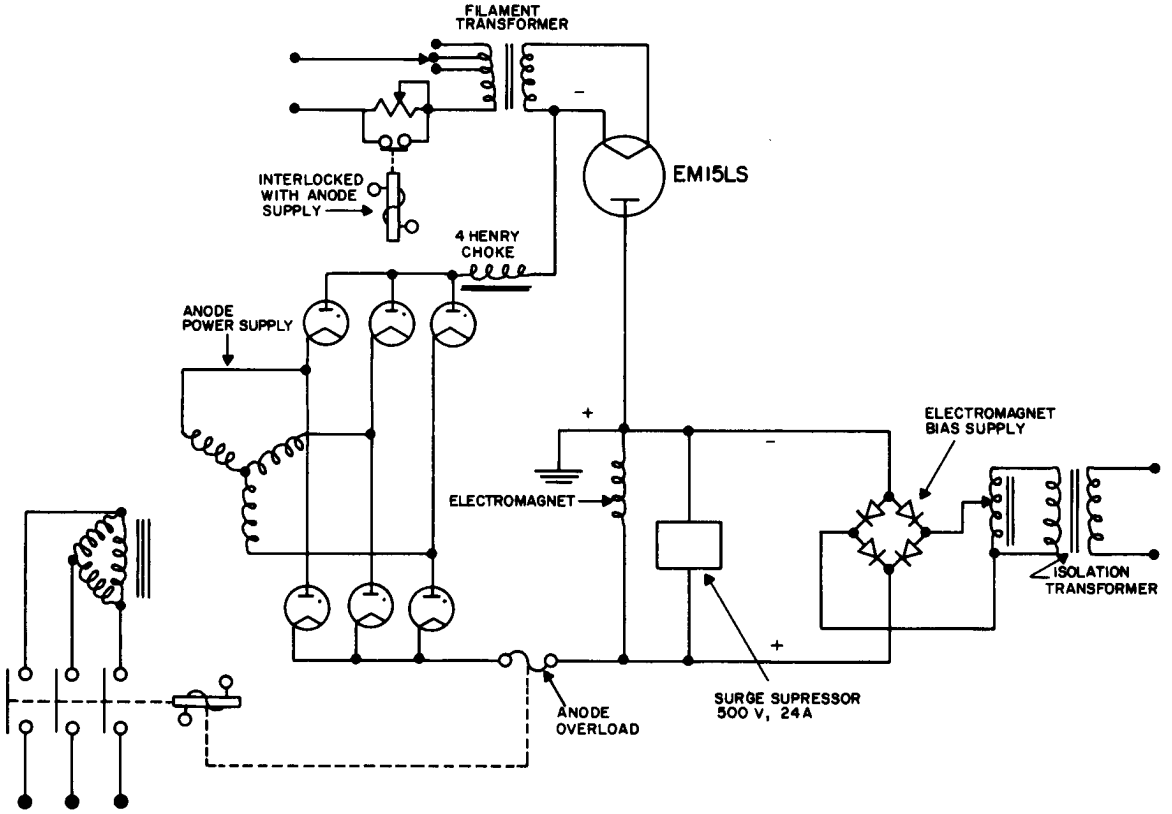


fig. 3



ELEMENTARY CIRCUIT FOR OPERATION WITH SERIES FIELD

fig. 4

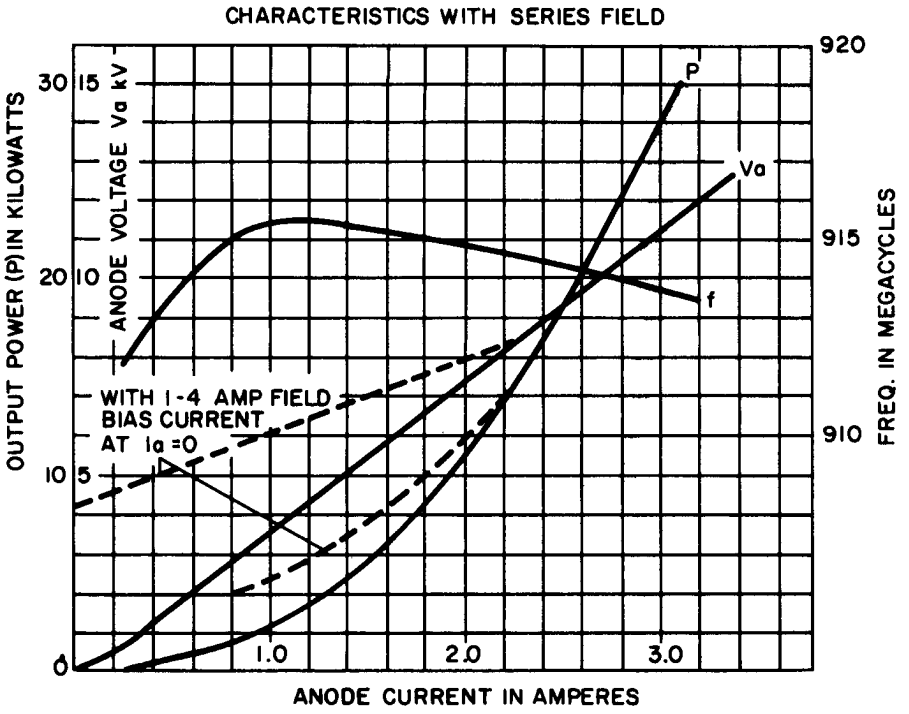
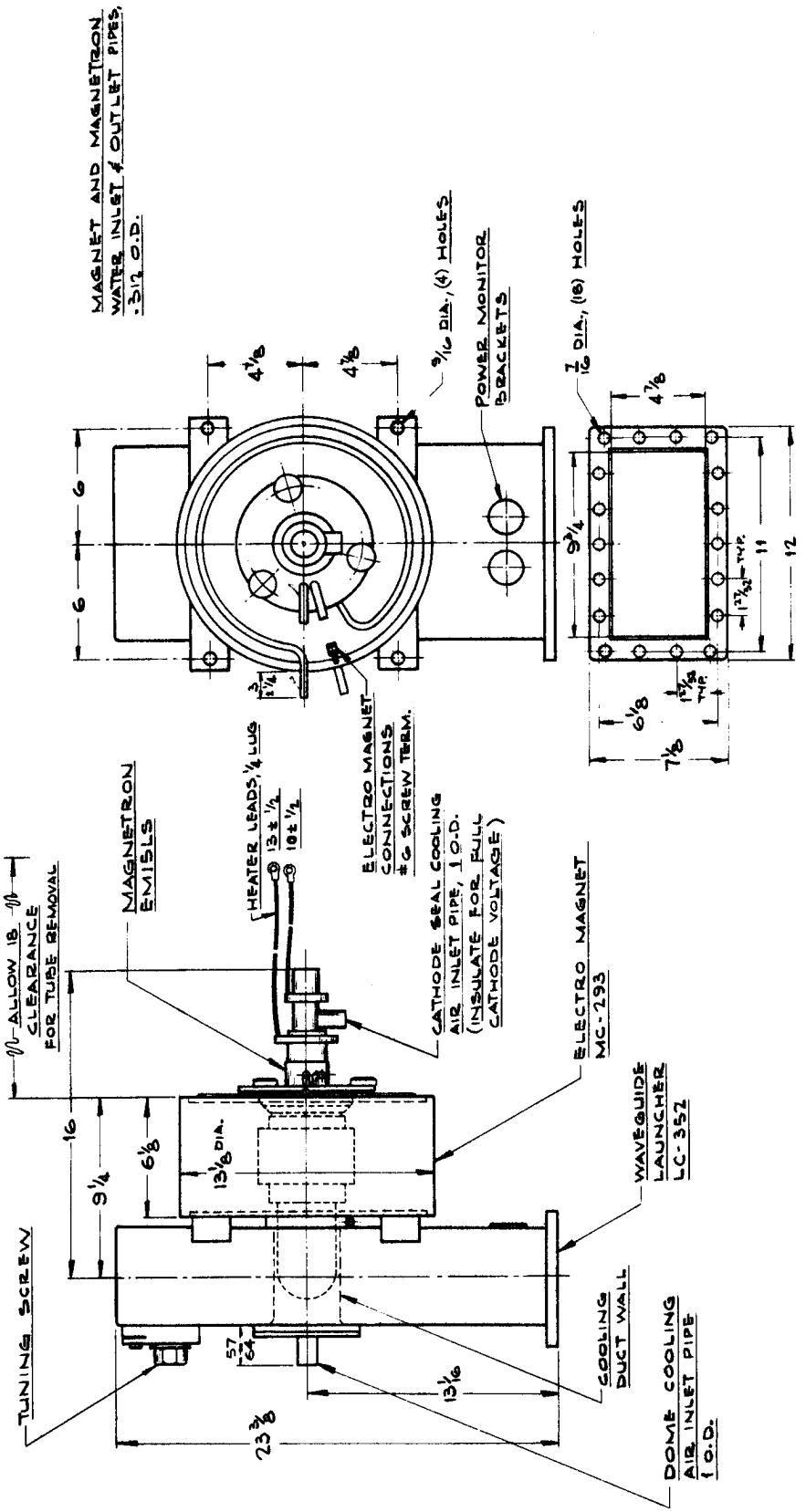
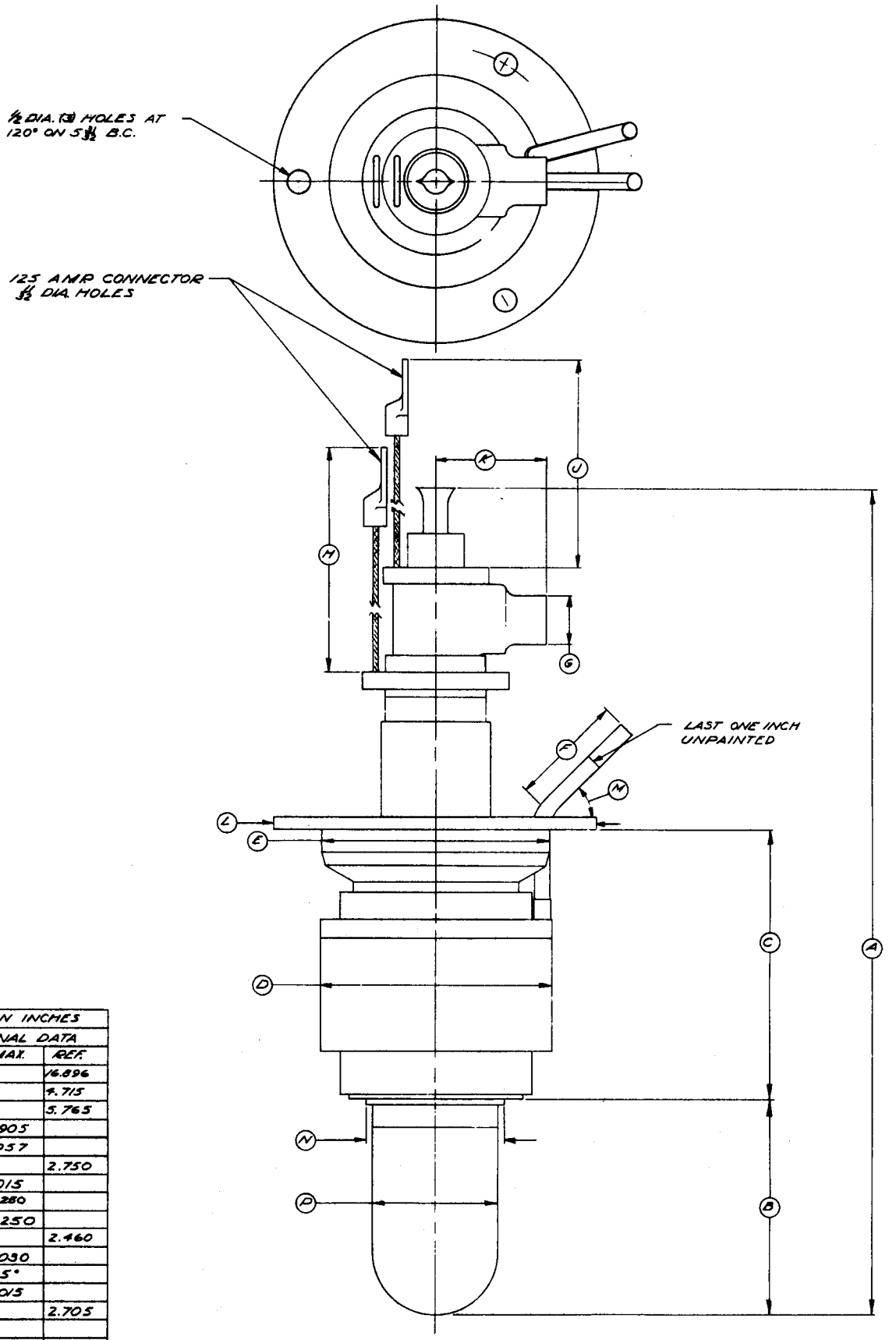


fig. 5

EM-15LS MAGNETRON AND H-195 WAVEGUIDE COUPLER





DIMINSIONS IN INCHES			
DIMINSIONAL DATA			
DIM.	MIN.	MAX.	REF.
A			16.896
B			9.715
C			5.765
D	4.855	4.905	
E	4.917	4.957	
F			2.750
G	.985	1.015	
H	10.500	11.280	
J	12.500	13.250	
K			2.460
L	6.970	7.030	
M	25°	45°	
N	2.985	3.015	
P			2.705

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