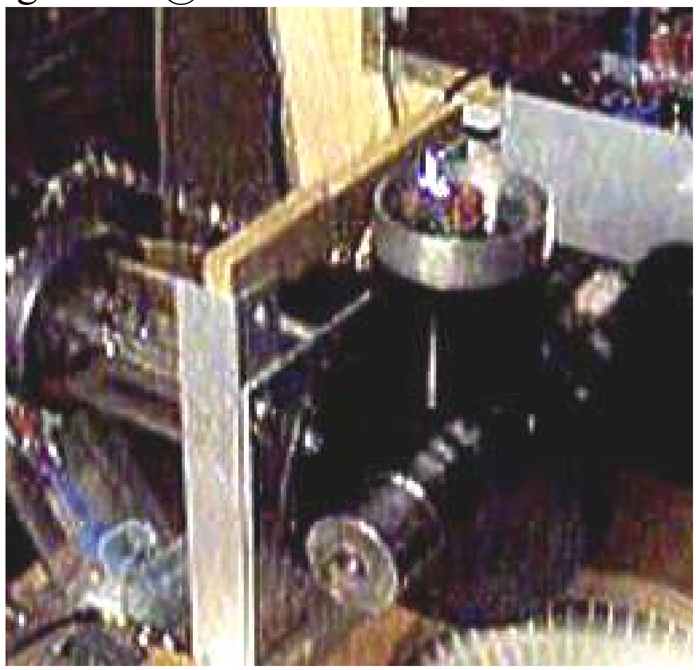
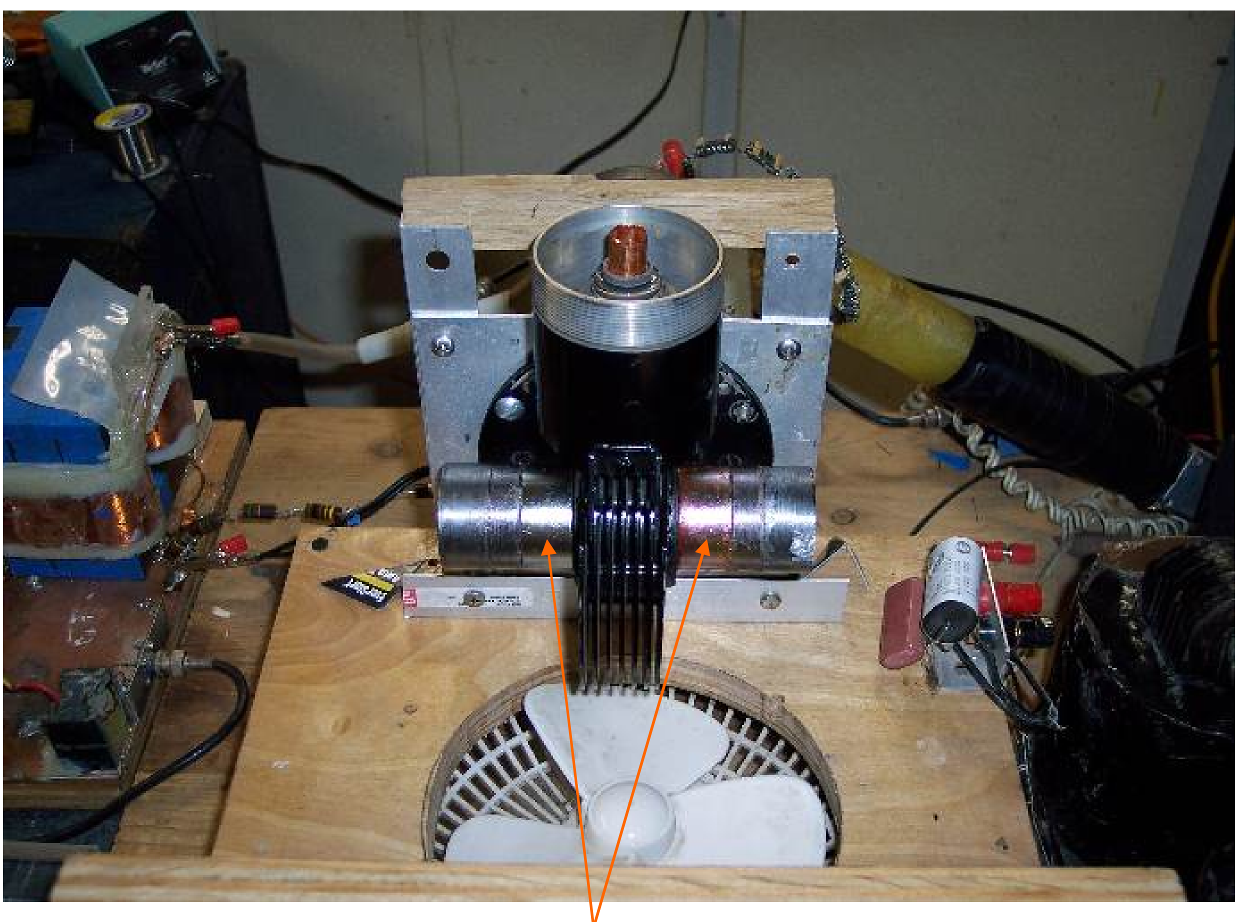
4J31 Magnetron Experiment using N52 Neodymium Large NdFeB Rare Earth Magnets

1 Mega Watt @ 2.9 GHz S -Band RF !!

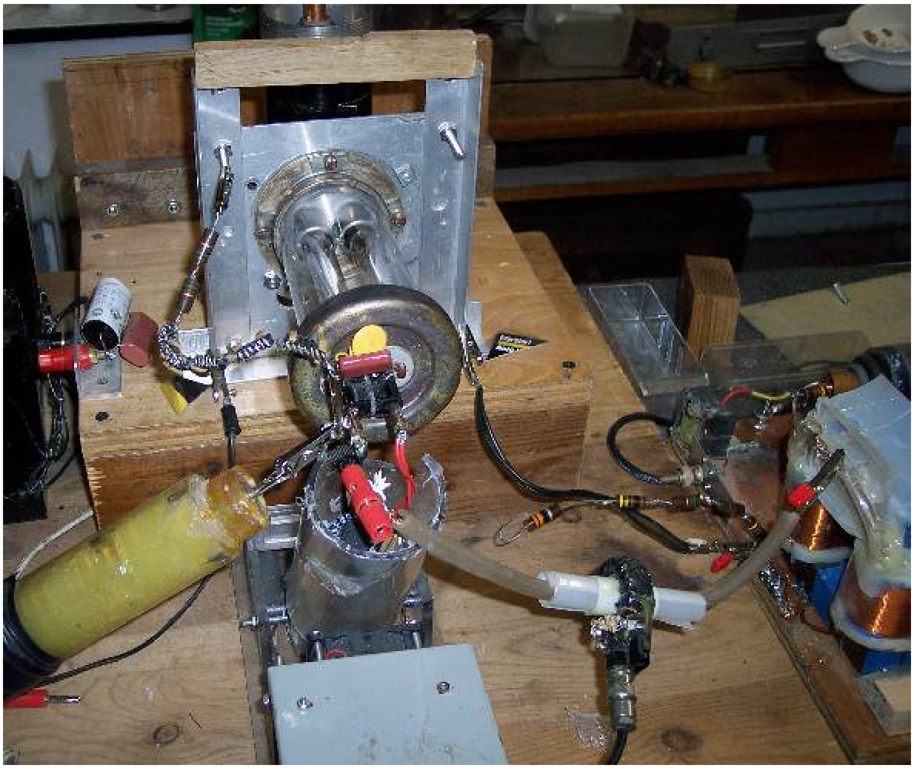
Was having difficulty getting a sharp image because my digital camera was complaining about being in a 1 Mega Watt @ 2.9 GHz environment





N52 Neodymium Large NdFeB Rare Earth Magnets 40X20mm

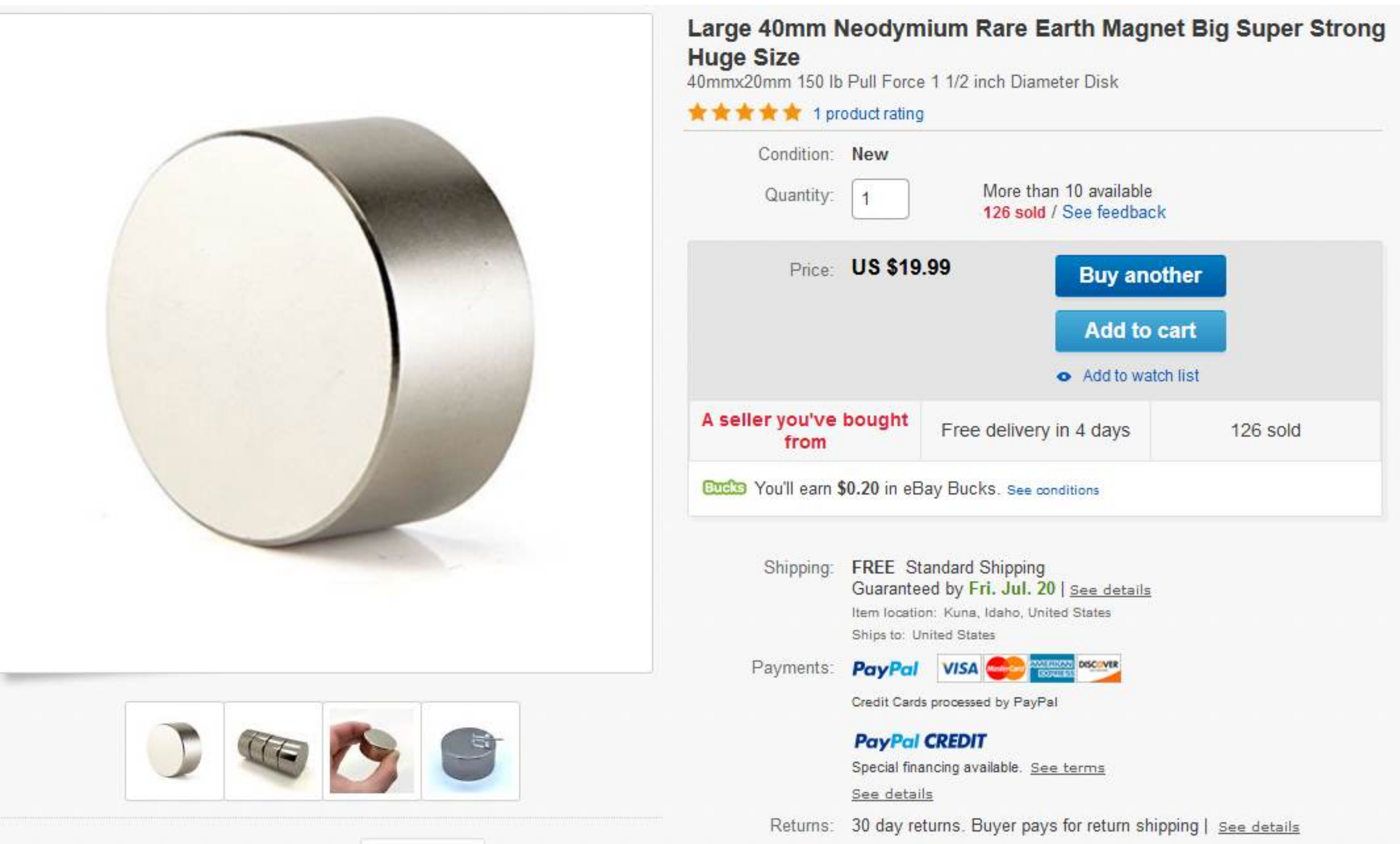
Rear View



Side View

The purpose of this experiment was to demonstrate the use of N52 Neodymium Large NdFeB Rare Earth Magnets to provide the magnetic field. To determine the feasibility of replacing the usual massive and heavy magnetron magnets with lighter weight NdFeB Rare Earth Magnets.

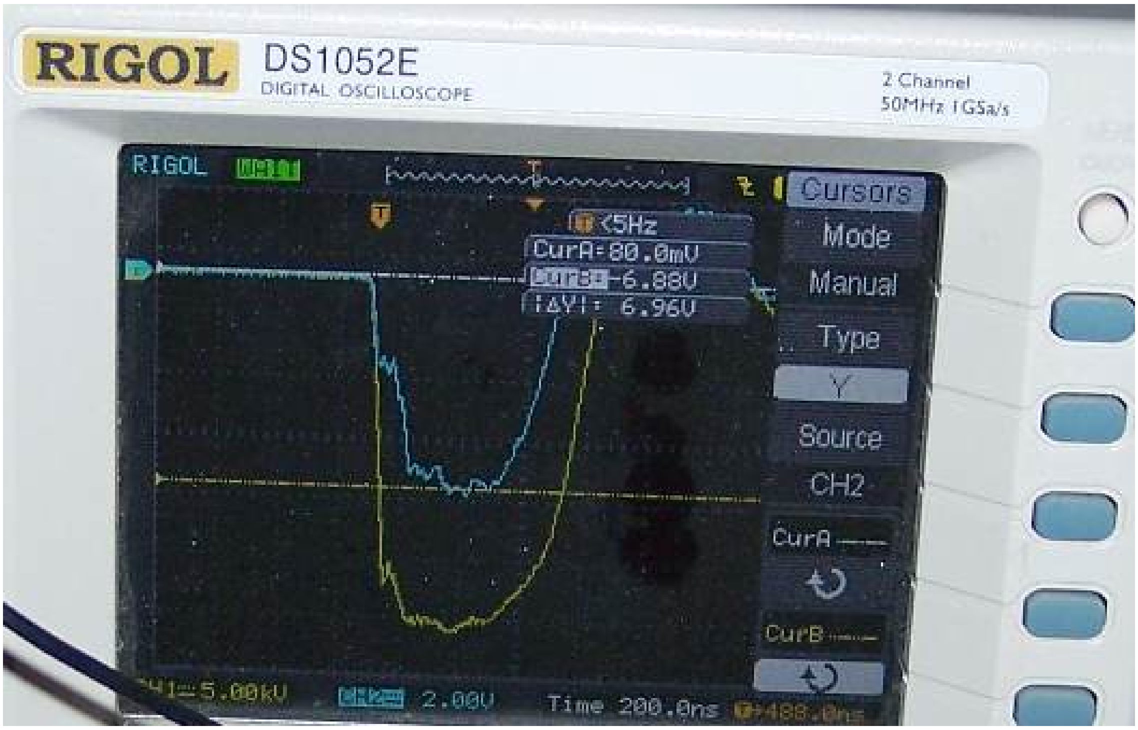
I purchased from eBay two 40mm X 20mm such magnets:



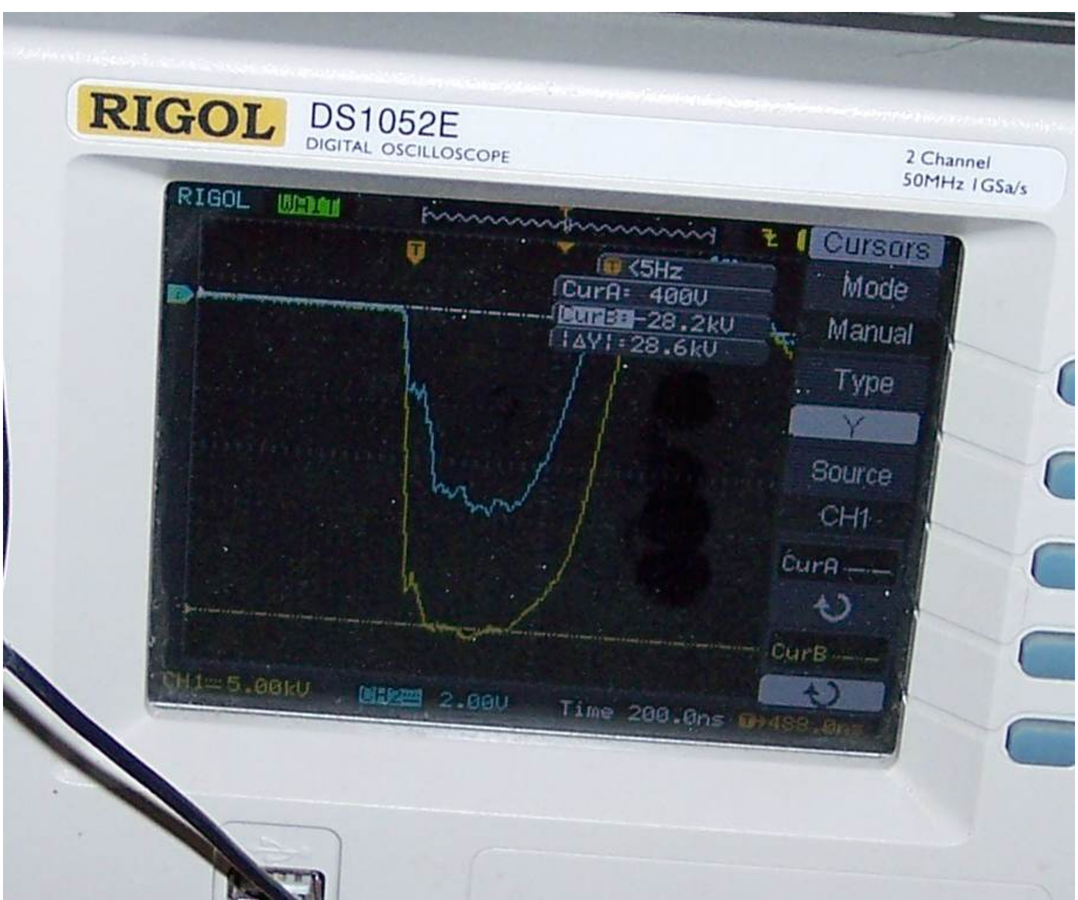
I used the The K&J Magnetic Gap Calculator => see pg 6

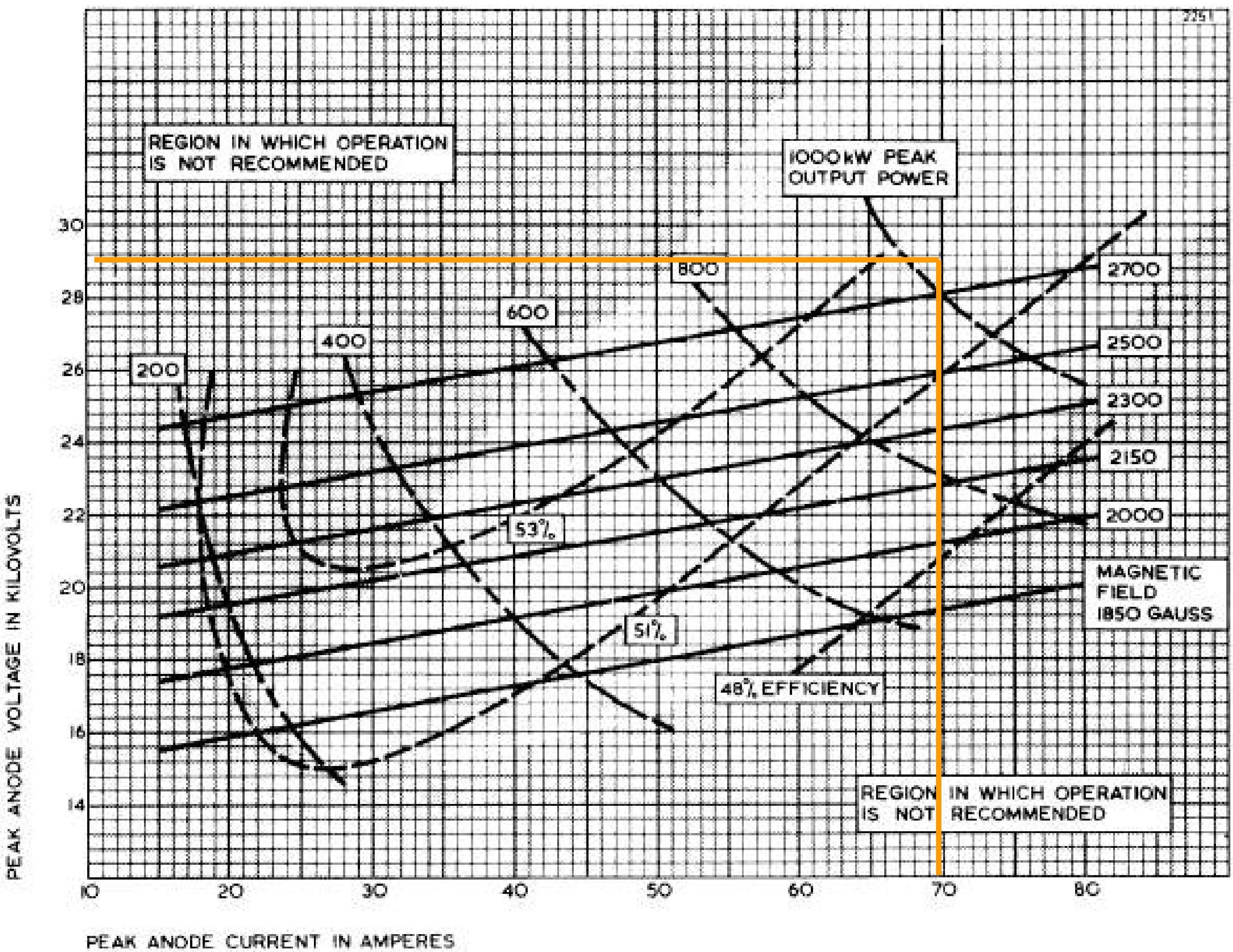
CAUTION: These magnets are very dangerous; they can crush the bones in your finger tips!

~ 70 AMPS Peak



28.6 KV Peak @ Cathode





From the above it appears that the magnetic flux density is probably closer to 2800 Gauss

It also seems that I was in the 1 Mega Watt region.

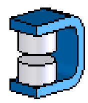
REF: https://www.kjmagnetics.com/gap.calculator.asp

The K&J Magnetic Gap Calculator | Pull Force | Repelling | Magnetic Field | Thickness | Gap | Units

Select Configuration:

○ Two Disc Magnets

◉ Two Disc Magnets with Yoke



○ Two Disc Magnets with Yoke & Iron Cones

Grade: N35

Diameter: 40 mm

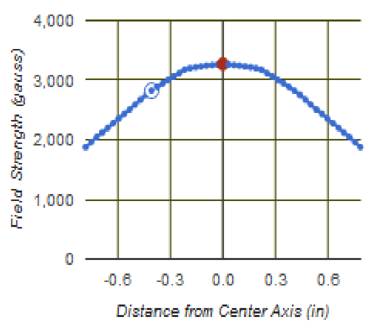
Thickness: 20 mm

Gap: 1.5 in

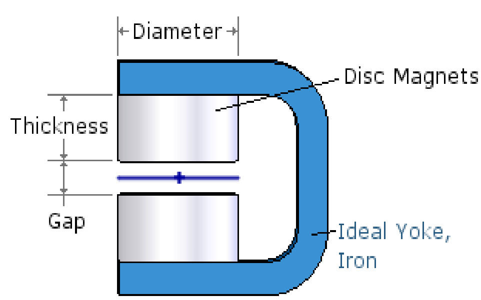
Calculate

This Gap Calculator estimates the magnetic field strength between two neodymium magnets separated by a small gap, with an ideal iron yoke as a return path.

Magnetic Field Strength @ the Center: **3270** gauss



The graph above depicts the magnetic field strength in the vertical direction, along a line equidistant between the two magnets, as shown below.



I wanted to get some idea how uniform the field is in the 1.5” gap. I wanted to keep the relative field distribution but lower the B flux density value so I replaced the N52 value for N35; being that I was not using exactly the yoke.

REF: Microwave Magnetrons V6

[1] The magnetrons numbered 4J31 through 4J35 are fixed-frequency pulsed oscillators with an anode-block and cathode structure identical with that of the 4J76 and 4J77. These magnetrons have operating characteristics quite similar to those of the tunable series, and they are mechanically interchangeable with types 4J74 to 4J77. The frequencies lie in the range 2700 to 2900 Mc/sec, with the different types separated by changes in strap capacitance.

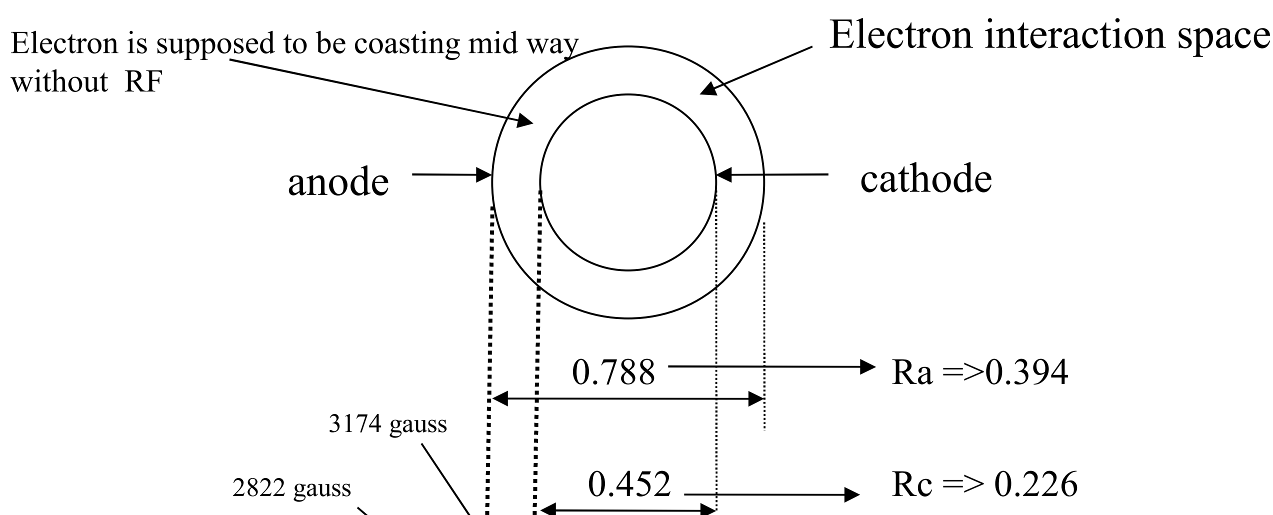
The group of tubes from 4J36 through 4J41 has an anode-block and cathode structure identical with that of the 4J70 and 4J71; these types are mechanically and electrically interchangeable with the 4J70 to 4J73 group. The frequencies are fixed and lie between 3400 and 3700 Mc/sec.

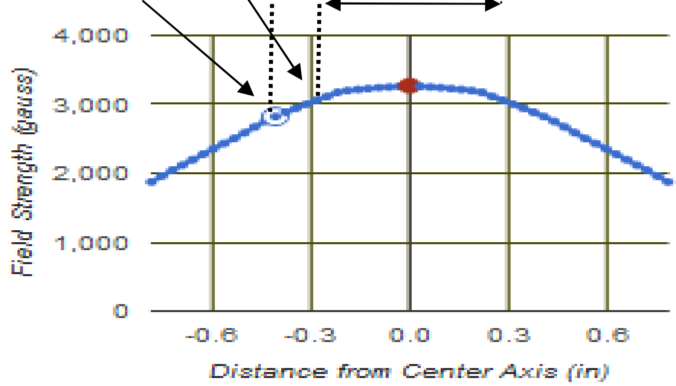
[2] Data for Sec. 19·6 submitted by R. T. Young, Jr.

TABLE 19·11.—DIMENSIONS IN INCHES OF 4J70 AND 4J77 MAGNETRONS

a. Anode-block Dimensions: See Fig. 19·1*c*

Type No.	a	b*	d_a	d_c	h	t
4J70	1.561	1.476	0.788	0.452	0.788	0.138
→ 4J77	1.561	1.748	0.788	0.452	0.788	0.138





The midway avg. Value is about 2998 which is still a little high compared to 2800 gauss; however I decided to use this to get an idea for the gap's field uniformity for these specific magnets 40X20mm

REF: Microwave Magnetrons V6

19JLY18 P8

13·4. Field Uniformity.—The efficiency of a magnetron depends upon the magnetic-field uniformity within the interaction space. Except at the very ends of the interaction space (see Sec. 12·11), a uniform field is desirable.

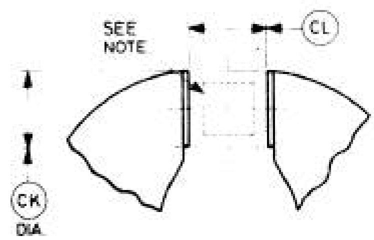
The need for uniformity arises from the large changes in current that result from small changes in magnetic fields. The performance chart of a typical magnetron is shown in Fig. 19·44, and from this it may be seen that a change in field from 5100 to 5330 gauss results in a 2 to 1 change in current. Thus, a variation of this amount in magnetic field along the height of the anode will result in operation over the low-field regions at twice the current density of the high-field regions. Damage to the cathode at these low-field high-current points has frequently been observed. Axial uniformity to better than 5 per cent is a safe rule to follow.

For magnetrons having separate magnets with flat pole pieces, this condition is satisfied if the gap length is equal to or less than the gap diameter, provided the anode diameter of the magnetron is less than half the gap diameter. When tubes have attached magnets, often the pole

See next pg.

* Assuming avg flux density ~3000 Gauss avg.; 174 differential from the center of the electron interaction space ; roughly 6%; therefore exceeded the 5% limit.
* The gap is 1.5" and the gap dia. 40mm => 1.57"; gap length ~ gap dia.; Da = 0.788" but 2X 0.788 = 1.57" is slightly larger than the gap dia. So the "less than half" is not met. However based on the gap requirements 1.5" gap by 1.5" gap dia. is specified which seems puzzling regarding the latter condition specified.

PERMANENT MAGNET SPECIFICATION



Ref	Inches	Millimetres
CK	1.500	38.10
CL	1.500 $^{+0.010}_{-0.000}$	38.10 $^{+0.25}_{-0.00}$

Millimetre dimensions have been derived from inches.

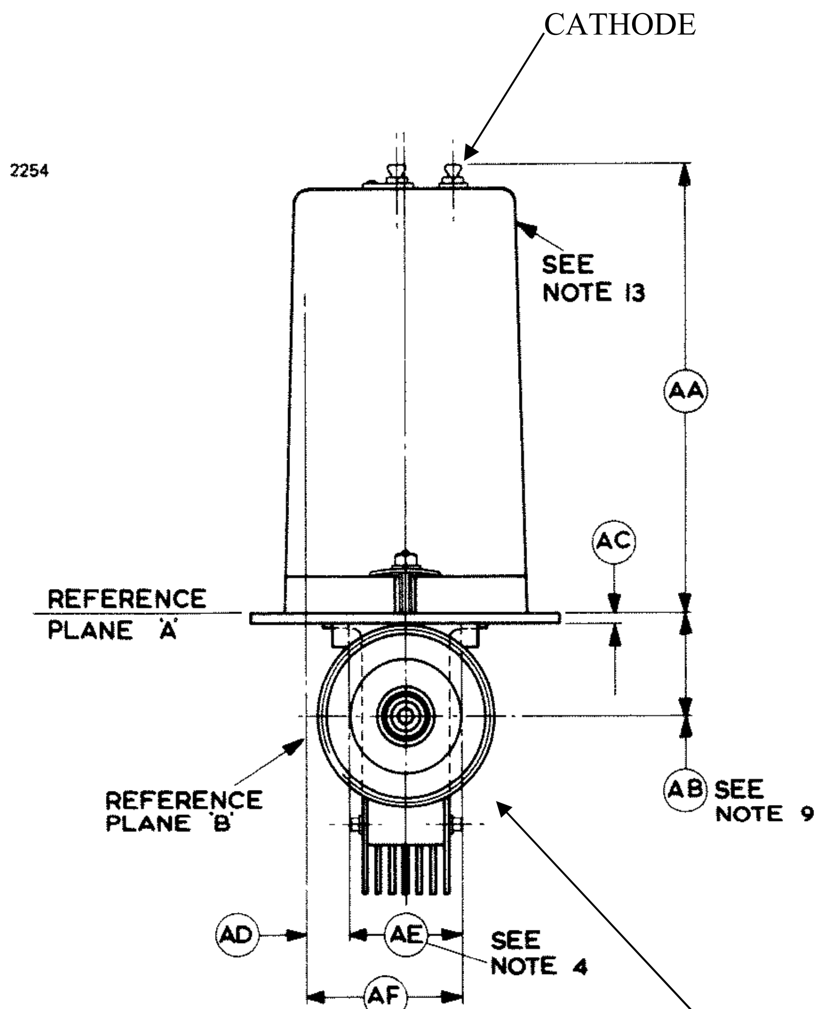
Note The variation of magnetic field within a cylinder 1.000 inch (25.4mm) long and 0.900 inch (22.86mm) diameter situated centrally and coaxially between the poles must not exceed ± 140 gauss.

8. The valve is designed for use with a separate magnet which must conform with the specification given at the top of page 11. The axis of the magnetic field must be coincident with the axis of the anode, and the north pole of the magnet must be adjacent to the cathode terminal. A suitable magnet, type MA228, is available.

If an electro-magnet is used, the pole tip dimensions should be as shown on page 11.

To meet this specification I magnetized a needle to make a homemade compess for my north seeking pole reference; which was used to determine the NdFeB Rare Earth Magnet polarity. Next using:

OUTLINE



COMMENTS:

*I was surprised as to how relatively well the magnetron operated near the 1 Mega Watt region provided that the output loading was suitable; its stability was very sensitive to its output loading.

* It appears that NdFeB Rare Earth Magnets can be used for providing the magnetron’s magnetic flux field.