DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CARE OF MAGNETRON TUBES

Department of the Army, Washington 25, D. C., 12 October 1953

1. General. *a*. The pulsed magnetron has become the standard source of high-power radio-frequency energy for microwave radar. Because this tube constitutes the entire r-f portion of the radar transmitter, including the resonant circuit, tube elements, and pre-set antenna coupling network within a single vacuum envelope, it requires special attention and handling by the field user. Since the average magnetron is much more expensive and requires more material and manufacturing facilities than the conventional receiving tube, do not discard it at the first sign of malfunction; subject it to all possible remedial measures. When such measures are applied, many tubes that would otherwise be discarded will give satisfactory service for hundreds of hours.

b. Before magnetrons for field radar use are placed in supply depots, they are carefully tested by Government inspection personnel, at the place of manufacture, for mechanical and electrical defects. Theoretically, this inspection should insure that any defects encountered in the field application of magnetrons are caused by one of the following:

(1) Vacuum failure during shipping and storage.
(2) Mechanical breakage during shipping or installation.
(3) Improper environmental conditions.

2. Instructions. *a*. The magnetron, like all other electron tubes, depends on a high degree of vacuum between its elements to operate properly. A poor vacuum in the tube results in high magnetron average current and arcing. Arcing is evidenced by fluctuations of the magnetron current meter.

b. Because the magnetron contains massive metal parts, it is difficult to remove all traces of absorbed gasses from the tube elements during its manufacture. Despite careful processing, which includes heating to high temperatures during evacuation, some gas remains in

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the metal parts of the tube. During long periods of storage, this occluded gas may be liberated into the envelope of the tube and spoil the vacuum. Although this liberated gas is usually sufficient in quantity to cause instability, it is seldom enough to warrant discard of the tube. Such tubes can easily be conditioned by proper handling when in the radar equipment.

c. When placing a new magnetron (or one that has been idle for several weeks) in operation, the warm-up period should be extended to 1 hour if tactically possible. Some tubes have a getter built into the cathode which absorbs gasses when heated, but even tubes that lack this feature will benefit from a long warm-up period before the application of high voltage, because improved cathode activation will result.

d. After the warm-up period, apply the pulse voltage at the lowest value available from the radar modulator. If a choice of pulse duration and/or repetition rate is available, use the lowest value of these while breaking in the magnetron. If the magnetron is normal, the applied pulse voltage can be increased immediately to the point where the rated current (for that duty cycle) is reached. If the magnetron is gassy, anode current sufficient to actuate the overload relay in the equipment may be drawn at very low voltage. If overload relay kick out occurs at the lowest operating level available, recycle the modulator at least 10 times to allow the high pulse voltage to reduce the residual gas. For a salvageable tube, this should reduce the gas current sufficient to prevent actuation of the overload relay. The procedure from this point on is the same as for tubes that are only slightly gassy. Gradually increase the applied pulse voltage to a point where gentle arcing occurs, as evidenced by slight fluctuations of the magnetron anode current meter. If violent arcing occurs at any point, reduce the voltage until the arcing subsides; otherwise degradation of tube stability will result. When operation becomes relatively stable at any one point, again increase the anode voltage until the threshold of instability is again reached or until normal operating current and voltage are reached. When the normal operating level is reached, for the shortest pulse duration at which the radar operates, repeat the above procedure for each successively higher pulse duration.

e. Tubes that draw sufficient anode current to actuate the overload breaker and do not respond after being overload-recycled 10 times are defective because of a cathode-anode short or an air leak. Remove such a tube from the equipment and check it for continuity (between the cathode and anode) with an ohmmeter. Tubes with excessive gas pressure can be easily identified because they draw from 30 to 40 percent more heater current than a normal tube. In equipments where the heater voltage is metered, this overload will sometimes be evident because of the lower voltage reading. Tubes falling into either of these categories are unusable and must be discarded.

f. Lengthy conditioning of magnetrons, from the spare stock of a radar equipment, can be avoided by operating all tubes in the transmitter on a rotation plan. If each tube is used for a few days every 3 months, the accumulation of excessive gas within it will be avoided and it will be ready for immediate operation when needed. This preparedness is important when it becomes tactically necessary to change fixed-frequency magnetrons to avoid interference.

3. Installation Notes. *a*. New magnetrons usually are shipped with one or more devices (such as dust covers and protective boots) over the cathode and output fittings to avoid drainage or breakage. Just prior to installation these should be removed carefully so that the tube can be visually inspected for possible damage. Most shipping damage will be evident because of broken glass. Before installation, it is recommended that the ohmmeter test mentioned above be used to detect a possible anode-cathode short circuit.

b. The permanent magnets that are used with magnetrons are damaged easily by improper treatment. The strength of the magnet is reduced if it contacts any magnetic materials such as tools, other magnets, or steel panels. For this reason, many radar equipments are equipped with a set of nonmagnetic tools for use in magnetron installation. Symptoms of insufficient magnet strength are high anode current at lower than normal applied voltage, and reduced power output. Another environmental cause of poor magnetron operation in an equipment is high standing wave ratio in the output transmission line. Magnetrons are designed to operate into a matched line, but will display satisfactory frequency stability and power output into a VSWR of 1.5 to 1. Any condition, such as a damaged transmission line, defective rotary joints or stub supports, or reflecting objects close to the antenna, that causes the VSWR to be higher than 1.5 to 1 can cause poor operation.

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