Magnetic Shielding for the Bendix Resistance Strip Multiplier*

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As a detector in our studies of long-lived autoionizing atoms in an atomic beam[1] we have used a Bendix Model 306 magnetic electron multiplier with several modifications. These modifications may be of interest in other applications. In order to prevent interaction of the magnetic field in the multiplier with other magnetic fields present in the apparatus, a magnetic circuit has been designed which permits proper multiplier operation within an iron shield. An attempt to shield the unmodified detector was unsuccessful since the shield seriously distorted the multiplier field. Also, the original grid and cathode have been removed, and the atomic beam is allowed to pass between the dynode and field strips near the input end of the multiplier. Most of the metastable atoms that reach the detector decay with the emission of an

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electron and a positive ion and the electrons which are accelerated to the dynode strip by a transverse electric field initiate the multiplication process. The ions also produce secondary electrons at the surface of the resistance strips but with negligible efficiency at the energies to which they are accelerated.[2]

The modified detector is shown in Fig. 1. The shield is a soft iron (Armco) box with 1/4-in. walls.[3] The glass dynode and field strips are supported from the front wall of the box with the Kel-F mounts taken from the unmodified unit. Three 1.067-in. long by 1.687-in. diameter cylindrical Alnico V magnets produce the magnetic field and the iron casing is utilized as a flux return path. The iron pole piece is shaped to give a field of maximum uniformity over the multiplication region. The beam enters the detector through a small slit in the front wall. Unfortunately, in addition to metastable atoms, photons and charged particles are also present in the beam and may give rise to unwanted secondary electrons. Charged particles are effectively eliminated by a transverse electric field formed by a pair of plates mounted adjacent to and outside of the entrance slit of the multiplier. The production of photoelectrons at the

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pole piece has been reduced by cutting a large (1/4 by 1 in.) exit slit through the pole piece, magnets and back wall to allow the photon beam to pass completely through the detector.

The field in the multiplication region is approximately 300 G and is uniform to better than 10% over this region. As the magnetic field distribution is similar to that of the original multiplier, we expect that the gain and other performance characteristics are essentially the same as well. An external field of 300 G produces a field of less than 3 G within the shield. The leakage field outside of the case arising from the multiplier magnets is less than 3 G. Thus the modified multiplier may be used in applications where the large external field of the unshielded multiplier would be undesirable (e.g., in the detection of charged particles). By reinstalling the Bendix grid and cathode, this detector may be used for detection of charged particles or metastable atoms and photons in the same way as the original multiplier. (Clearly the particles must be admitted through a side hole in this case.)

References

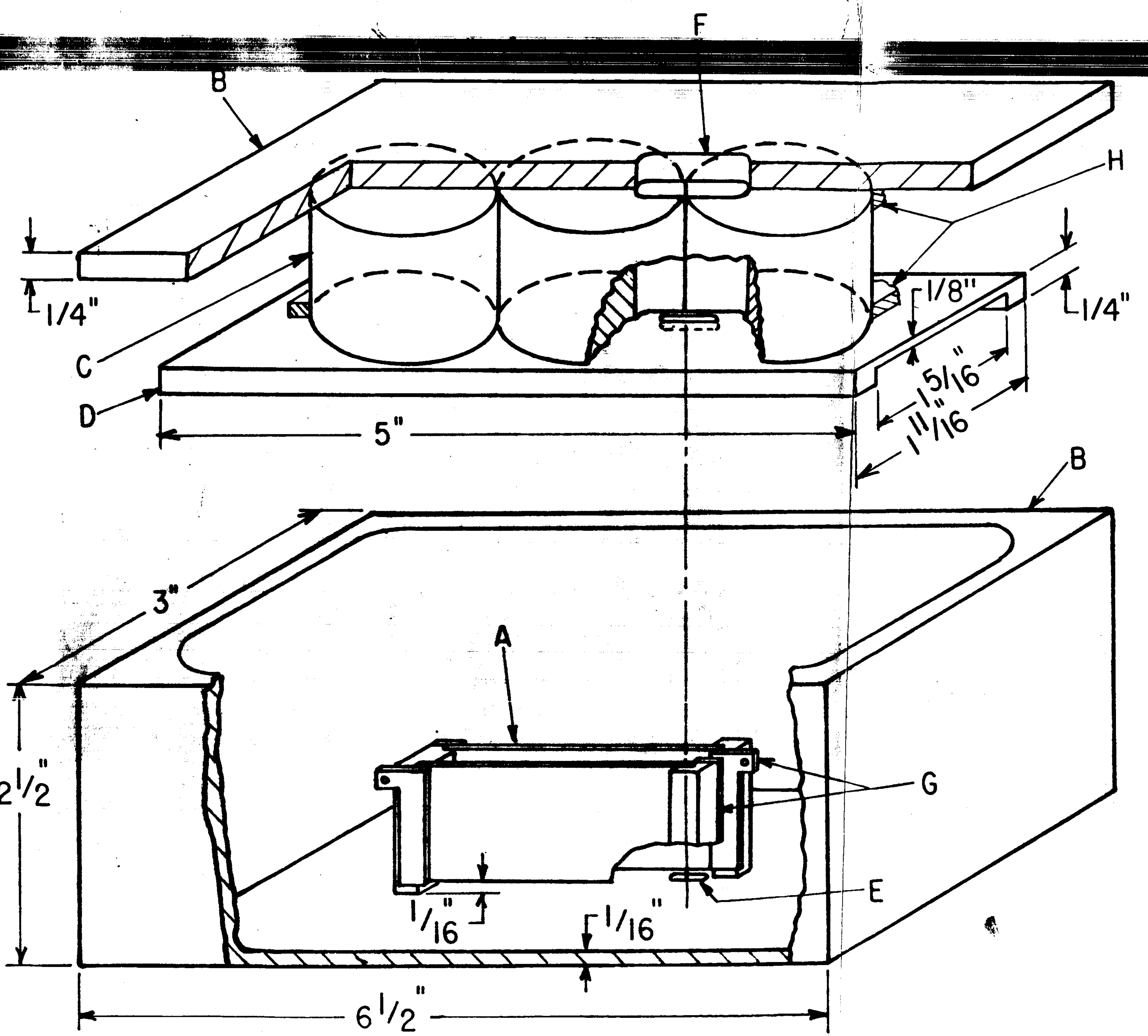
(1) P. Feldman and R. Novick, Phys. Rev. Letters 11, 278 (1963).

(2) P. M. Waters, Phys. Rev. 111, 1053 (1958).

(3) Because of the rapid decay of the metastable atoms, we have made the front wall as thin as possible so as to minimize the distance between the beam source and the detection region. The front wall is 1/16 in. thick.

Figure Caption

FIG. 1. Magnetically shielded resistance strip multiplier. A--Field and dynode strip assembly. B--Magnetic shield (Armco). C--Permanent magnets (Alnico V). D--Pole piece (Armco). E--Beam entrance slit. F--Exit slit. G--Clamps to replace grid and cathode assembly (stainless steel). H--Magnet and pole piece locating plates (three 1.687-in. holes in each of two brass plates).



F
B
H
1/4"
1/8"
1/4"
C
1 5/16"
D
1 11/16"
5"
B
3"
A
G
2 1/2"
E
1/16"
1/16"
6 1/2"