Magnetic Shielding Foil is the Quick Economical Solution to Many Problems

If you need relatively few shields, or are experimenting, or designing, or trying to locate and eliminate an unexpected magnetically emanating source during production, foil is your quick, economical solution. Not only may you save days or weeks of valuable time, you also may eliminate designing, tooling and manufacturing costs for prefabricated shields. In addition, you may gain another cost reducing objective — that of compacting assemblies because magnetically reacting components can now be placed closer to each other without operating disabilities.

The convenience of foil ductility permits cutting with ordinary scissors, hand shaping and trimming into the required outline and applying immediately. The amount of shielding needed in an application can be swiftly and easily determined by trial and error at a saving of many days' time and frustration especially to designers and researchers.

Single or multiple layers can be used until the desired shielding level is attained. Adhesive backed foils are available to hold foil shields in place.

When shielding requirements dictate using a graded permeability shielding system, the low permeability foil should be positoned closest to the field source. This is accomplished by the low permeability foil diverting the major portion of the field, permitting the high permeability to operate in a lower reluctance mode. Low permeability materials tend to have high saturation flux densities.

In a number of individual research applications, this hand-cut, hand-formed foil magnetic shield solves the entire shielding problem. In other experiemental applications and in various production applications, prefabricated shields might serve better. Economics and time are the determining factors.

On the production line, unanticipated magnetic fields may be discovered that affect the performance of the component or system being manufactured or assembled. The handiness of foil shielding could provide a quick, effective cost-saving solution, holding downtime to minutes or hours rather than days or weeks.

Shielding Small Motors Effectively

Another practical example of foil's advantages is typified by Model SMS-70F "triple action" flexible magnetic shields for small motors. The foil sheilds: 1) Add dB's safely to small motor compatibility performance by diverting interfering magnetic radiation. 2) Provide excellent electrical and thermal conductivity. 3) Save design time and costs.

Applications are in tight packaging areas such as avionics, where sensitive instruments are in close proximity to interference radiating from small motors.

Construction consists of high permeability, flexible .010" (0.254mm) thick foil alloy. The foil shield may be used both as a self-sufficient shield and as an auxiliary shield over the motor's normal steel case when case shielding alone is inadequate.

Major factors in diverting radiation effectively are a carefully calculated large bend radius and sufficient overlaps to handle the magnetic fields.

Should the radiating field be strong enough to saturate the high permeability alloy, low permeability alloy may be used by itself or in addition to the high permeability alloy foil. It will absorb a higher total flux than an equal thickness of alloy and will not make ripples in the field (high gradient regions) to the same extent as would a high permeability layer.

Model SMS-70F Performance Test Data

Using a 3-layer cylindrical motor shield of .010" (0.254mm) flexible foil, closed at one end and 3" (76.2mm) from motor axis:

1) Without shield, 400 Hz. radiated field, 177m Gauss. With shield, 80dB less.
2) Without shield, 10 KHz radiated field, .64 Gauss. With shield, approx. 85 dB less.
3) Spacing effect. If space permits, an additional 15 dB can be obtained, approximately, by spacing the outer layer to a radius of 1.4 x the inner shield radius (a shield of 2 equal layers).

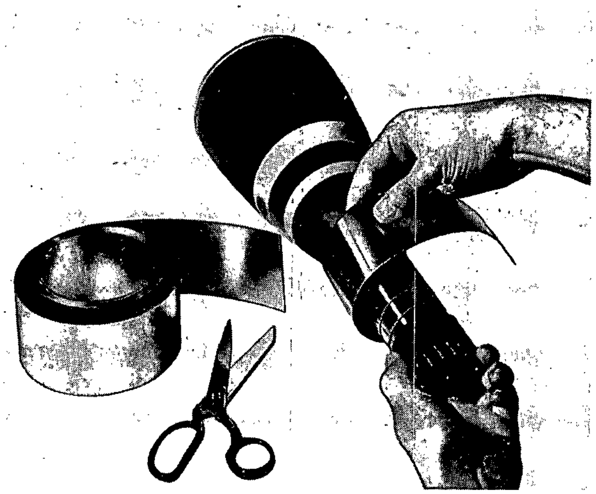

Figure 1: Flexible foil is cut easily with scissors and quickly wrapped around CRT neck to provide needed shielding.

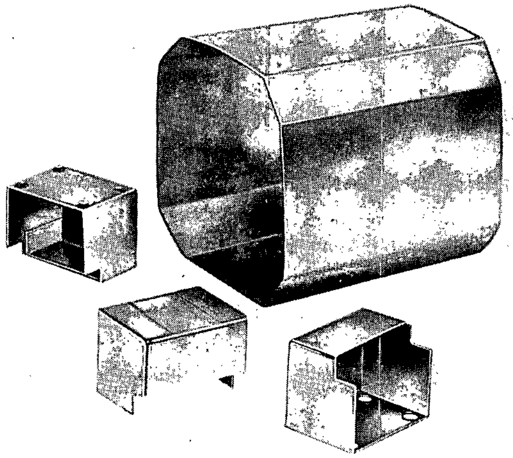

Figure 2: Model SMS-70F "triple action" magnetic shields.

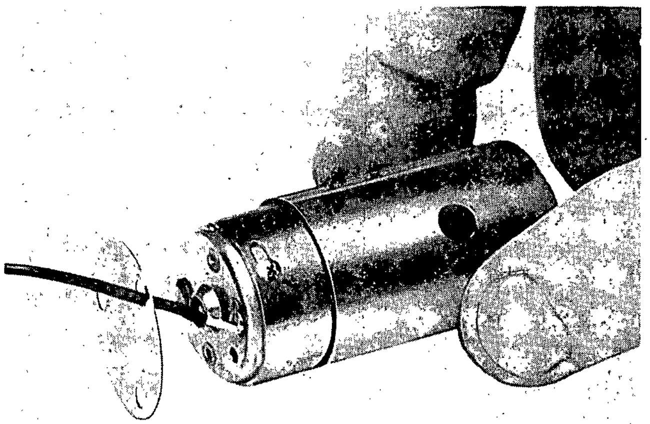

Figure 3: Foil shield wrapped around motor case & foil shielding of cable entry.

An Approach to Creating the Optimum Shield

Which should be shielded — the source of the undesired field or the affected sensor? If a choice exists, some analysts have concluded it is best to shield the source if at all practical.

In any shielding problem it should be remembered, too, that more than just figures may be needed to design a magnetic shield. The reason is that it is difficult to predict precisely how a magnetic field affects a given piece of ferro magnetic alloy, except for a few basic shapes.

Certain estimates must be made in initial calculations of shielding performance expected in a magnetic shielding structure. A number must be established to express the anticipated flux density "H" to which the shield will be exposed. Then an additional estimate must be made that this flux exposure will result in a line density "B" in the shielding material derived from the BH curve for the specific alloy used and the geometry, using a standard shape (cube or cylinder) to represent the desired shape of shield to a first approximation.

Fortunately, in foil shielding, this problem can be empirically solved regardless of shape complexity. For many practical purposes this solves the problem. All that remains is the cutting, trimming, shaping and applying of the foil shields, using normal trial and error means to achieve optimum shielding.

When purchased, foil should arrive fully annealed and ready for immediate use. It should not be subjected to severe forming or welding. However, ordinary cutting and shaping should not affect its shielding properties.

Foil Quality Control Procedure

The procedure is described if, for any reason, you may wish to duplicate it.

The standard inspection set-up should permit continual monitoring of the attenuation capabilities of a strip of foil. A table and adjustable guides on the table's surface direct the foil's travel properly past the test probe area. A controllable magnetic field radiation should be constructed.

Basically used are two solenoid type coils wound on bobbins having a central hole large enough to accommodate a 3/8" dia. soft iron pole piece. These coils are two standard windings removed from commercial 110 AC solenoids — each coil of approximnately 6000 turns of #36 enameled wire. A soft iron pole piece 3/8" OD and approximately 3¼" long is positioned in the assembly, and the two coils connected series aiding. The outside terminations are brought out to a standard AC plug. At the top end of the pole piece, a "flux" sensor made by winding a single layer coil consisting of ten turns of #20 enameled wire is brought out in a twisted pair.

The assembly is then mounted below the table with the top end of the pole piece approximately 1" below the table's surface. A non-magnetically permeable frame locates the magnetic field generator assembly below the table. The top portion of this assembly, holding the calibrated magnetic field probe, is adjustable vertically. A hole or slot in the table is vertically cut normal to the direction of the foil's travel. This slot is wide enough to allow entry of the field test probe. The twisted pair on the flux intensity sensor is brought out and connected to a Hewlett-Packard VTVM (#1), Model 400B or equivalent. The shielded plug on the calibrated magnetic field probe is connected to another VTVM (#2) of the same type. The AC plug from the solenoid winding is connected to a Variac. The calibrated magnetic field probe is then lowered into positon with its field reference plane parallel and in line with the table's surface. The voltage on the Variac is adjusted until the output voltage on the VTVM (#2) indicates 5 oersteds. (In this case the calibrated magnetic field probe had a sensivity of 20 mv per Gauss at 60Hz.) The output of the flux sensor coil is then noted on the VTVM (#1). The sole purpose of the flux sensor is to have a reference to re-establish the flux density appearing at the surface of the table at any time simply by adjusting the Variac for the corresponding voltage.

The calibrated probe is then positioned slightly above the table and locked into position. This position would not be critical and only requires that a reasonable mechanical clearance be maintained between it and the foil. Always maintaining VTVM (#1) at its original setting, the VTVM (#2) reading is noted and designated E1. The foil is then slid under the field probe and across the table. A second voltage, designated E2, is read from VTVM (#2).

This article was prepared for ITEM by Richard D. Vance, President, Ad-Vance Magnetics, Inc.