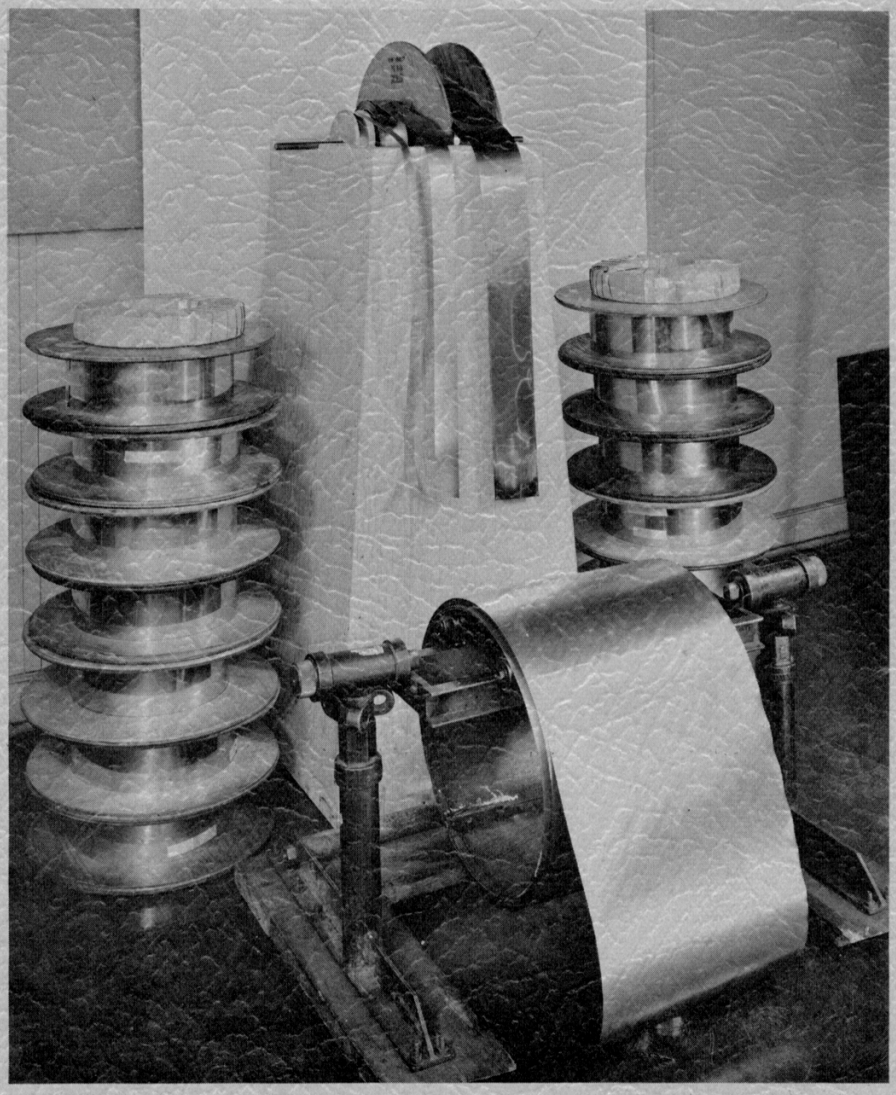
# DO-IT-YOURSELF MAGNETIC/ELECTROSTATIC SHIELDS USING NETIC AND CO-NETIC FOILS

## VERSATILE, FLEXIBLE – SIMPLE TO APPLY



MAGNETIC SHIELD DIVISION PERFECTION MICA CO.
1322 No. Elston Avenue • EVerglade 4-2122 • Chicago, Illinois 60622
ORIGINATORS OF PERMANENTLY EFFECTIVE NETIC CO-NETIC MAGNETIC SHIELDING

eem File System electronic engineers master Sec. 2500

Every satellite and virtually all guidance devices increase reliability with NETIC and CO-NETIC magnetic shielding alloys. Excellent shielding effectiveness to weight ratio.

## CONFIGURATIONS

Cuts easily with ordinary scissors to desired pattern necessary to generate conformal enclosure of components or small systems within limits of the aforementioned widths. Ductility permits simple hand forming.

## SHIELDS BOTH HIGHER & LOWER MAGNETIC FIELD INTENSITIES

Higher intensities are shielded by Netic foil alloys. Lower intensities are shielded by Co-Netic foil alloys. Combinations of both extend flux intensity shielding range.

The sequence of alloys and number of layers can be determined on a realistic basis by direct observation of their shielding effectiveness on the very components or systems to be shielded. Accordingly, the shielding effectiveness can be judged immediately by the systems functional improvement under actual operational conditions.

## ELECTROSTATIC SHIELDING

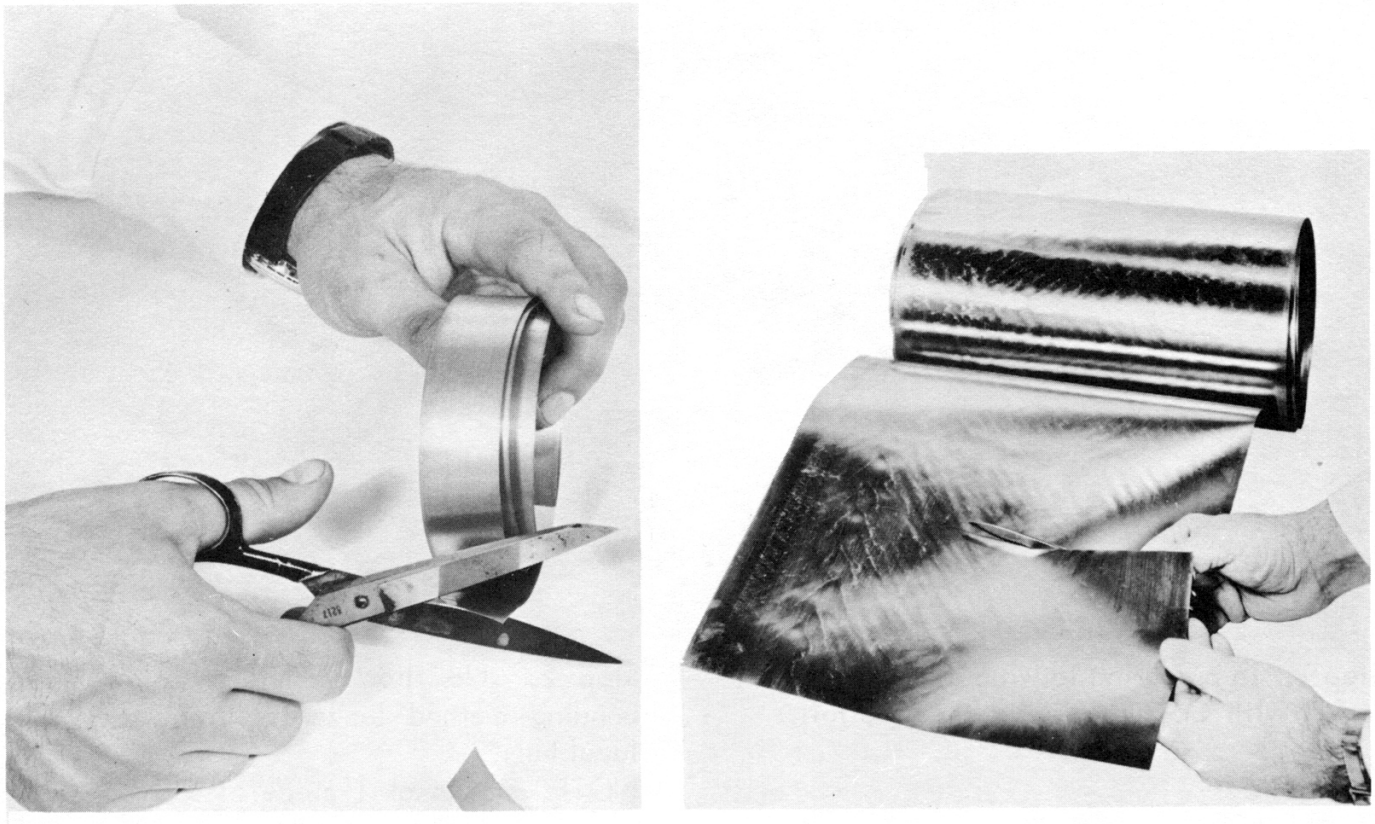
When grounded, either Netic or Co-Netic foils also provide electrostatic shielding in most instances.

## UNIQUE FEATURES

Furnished final annealed ready for use. Both Netic and Co-Netic exhibit low retentivity and low shock sensitivity. Therefore the foils can be bent, formed, sheared and pierced without significantly reducing shielding effectiveness.

## PRESENT EVALUATION & PRODUCTION APPLICATIONS

Ideal for initial laboratory or experimental evaluation. Convenience of foils simplifies the problem of determining areas necessary to shield in a system. The amount of shielding and combination of alloys would also be indicated on completion of these tests. This in most instances saves considerable valuable time and cost over a more laborious, academic type of approach involving careful analysis of all individual component characteristics and calculation of shielding necessary. After initial satisfactory evaluation, the same design using the foils has found general application in production.

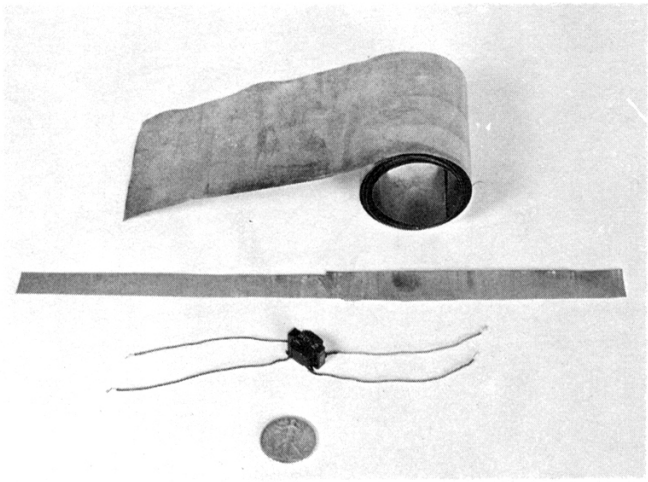


Cuts readily with ordinary scissors

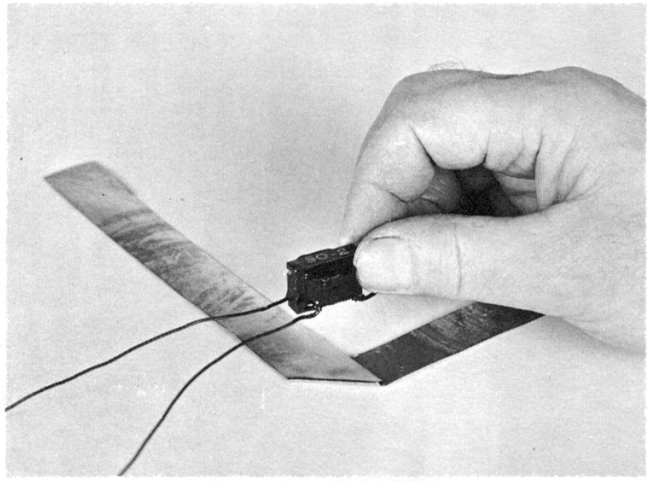
Attenuation attained with a single layer .004 thick, is:

| | Low Level 60 cycles |
|---|---|
| NETIC S3-6 | 6 - 12 DB |
| CO-NETIC AA | 20 - 24 DB |

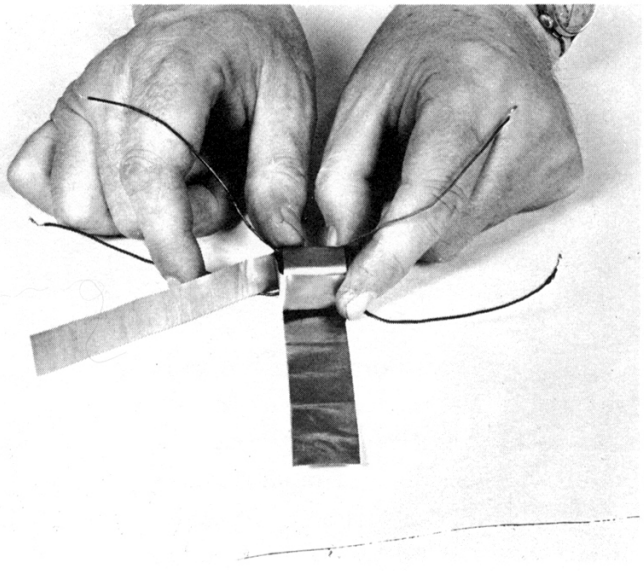
The above figures were obtained by interposing a plane of foil normal to the axis of a directed field. The intensity of this field at its point of contact with the metal, was estimated to be approximately five gauss. By increasing the number of layers, the attenuation can be improved. It is suggested that the optimum number of layers be determined empirically under actual operating conditions. In some instances additional improvement can be obtained by interposing a non-magnetic separator between the sheets. To assure electrostatic shielding, it is necessary that the shield be grounded. Since the material is relatively ductile, it can be wrapped around small components. Refer to Manual 101-122, page 9 for suggestions on attenuation measurements.



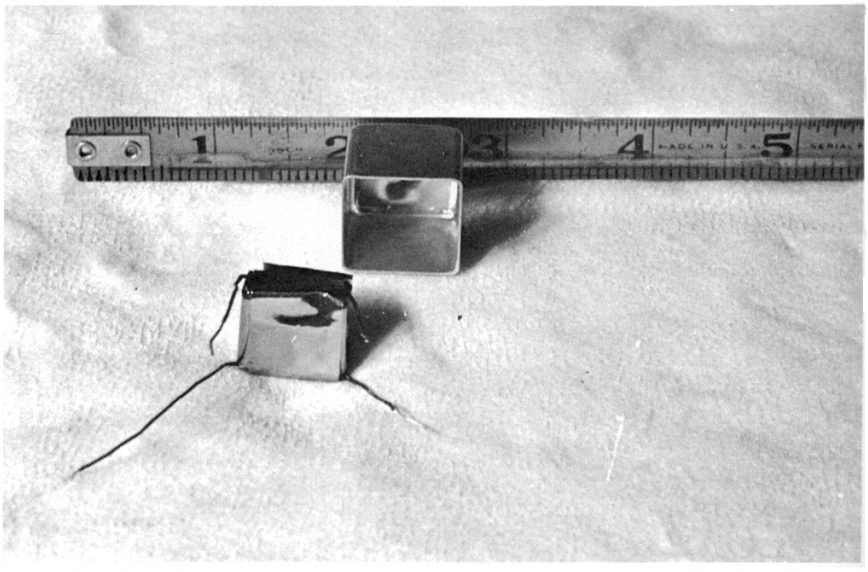
Step 1. In preparing to wrap audio transformer with Co-Netic or Netic S3-6 foil.



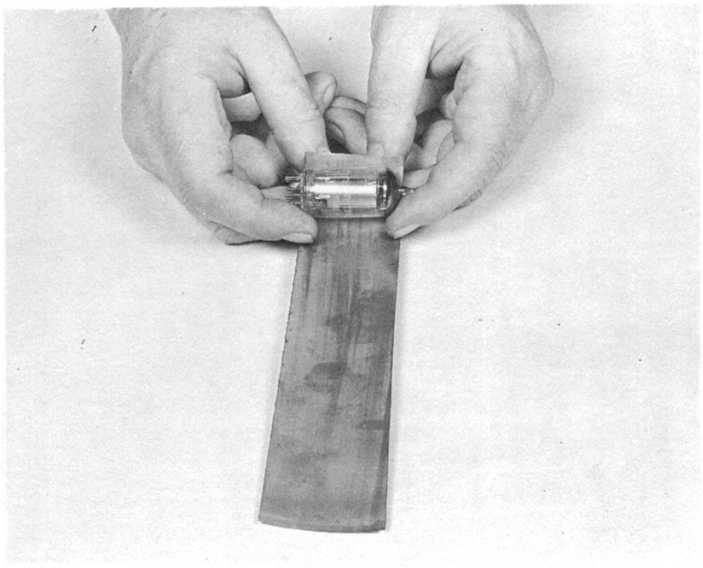
Step 2. No flux carried to a gap (because bending method leaves no gap) to cause low level hum.
NOTE - made of 1 piece of foil.



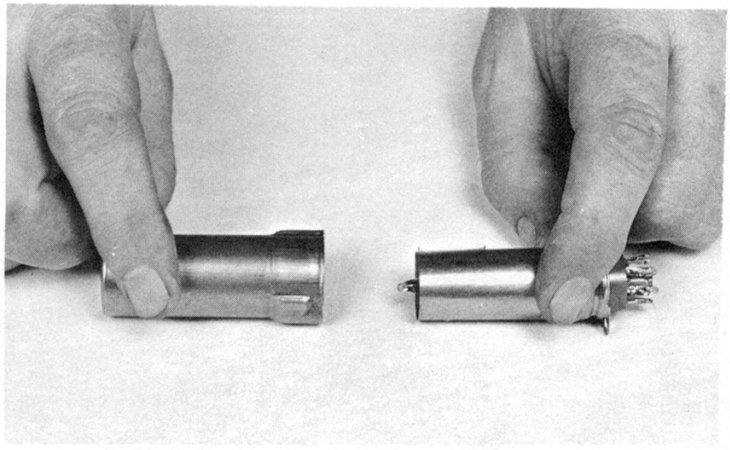
Step 3. Two or more wraps recommended.



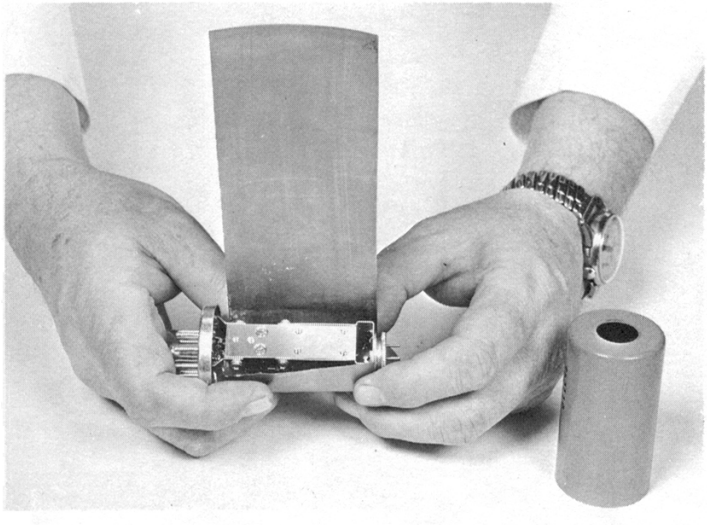
Small audio transformer wrapped in Co-Netic or Netic foil and slipped into aluminum can, or use gummed tape, insulating tape or rubber band to insure foil being held in place. However, foil is soft and will generally stay in wrapped condition.



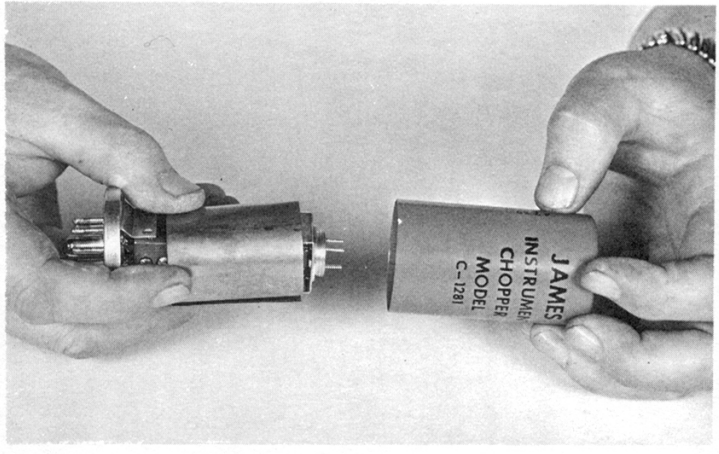
Wrapping protective Co-Netic foil to shield vacuum tube to prevent hum pickup. Two wraps recommended.



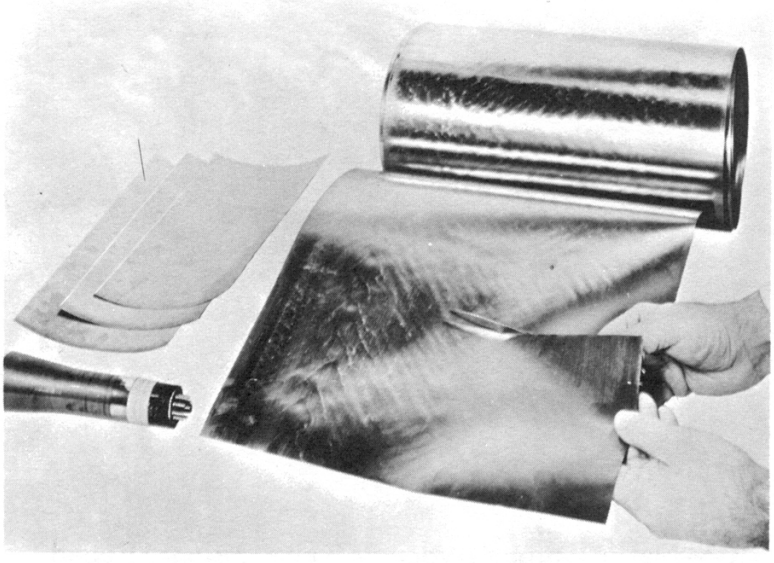
Co-Netic wrapped vacuum tube being slipped into an aluminum can. Actual application. Two or more wraps recommended.



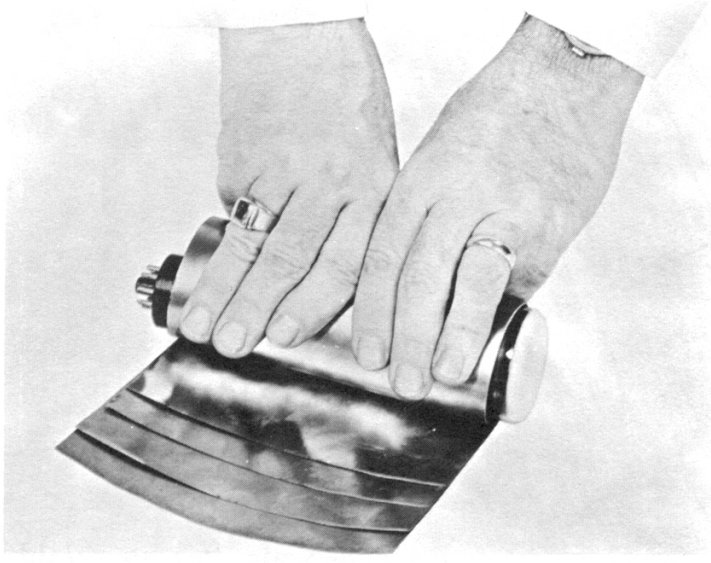
Wrapping relay with protective Co-Netic or Netic S3-6 foil. Two wraps recommended.



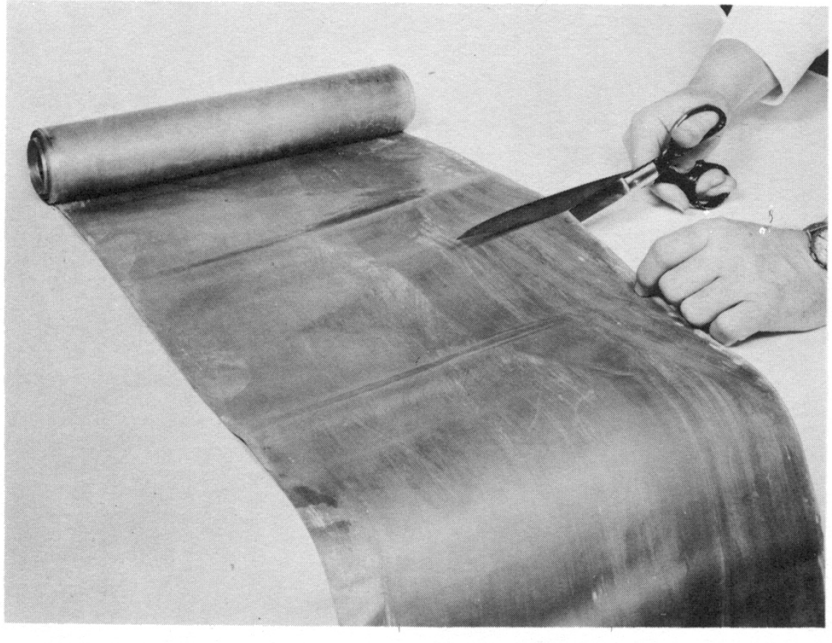

Foil wrapped chopper inserted in aluminum shield which has little if any shielding value at low frequencies. This photo illustrates how almost any component could be shielded that has non-magnetic cover.



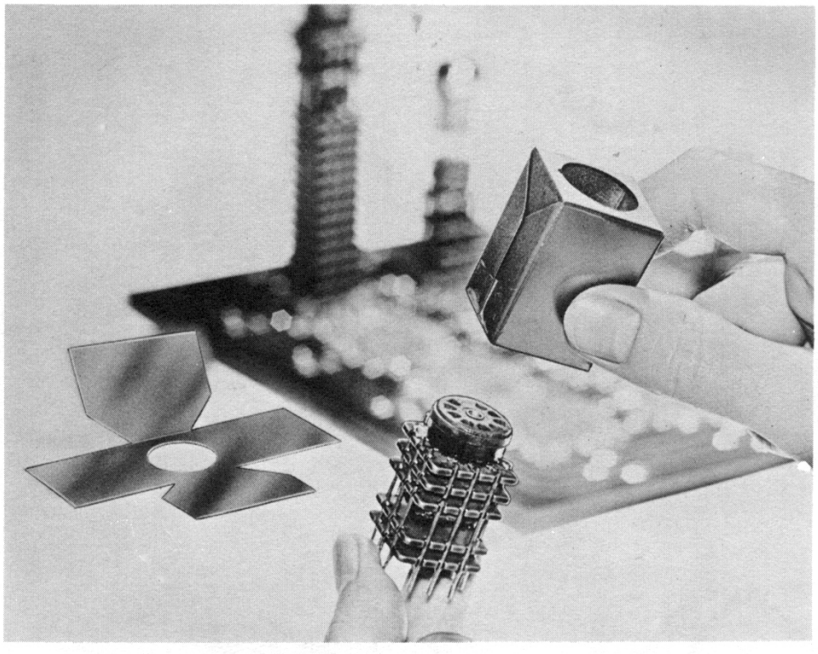
Co-Netic foil being cut with ordinary scissors to shield CRT.



An easy, economical. and efficient method to shield a CRT with 2 layers of Netic foil on outside and 2 layers of Co-Netic foil on the inside.

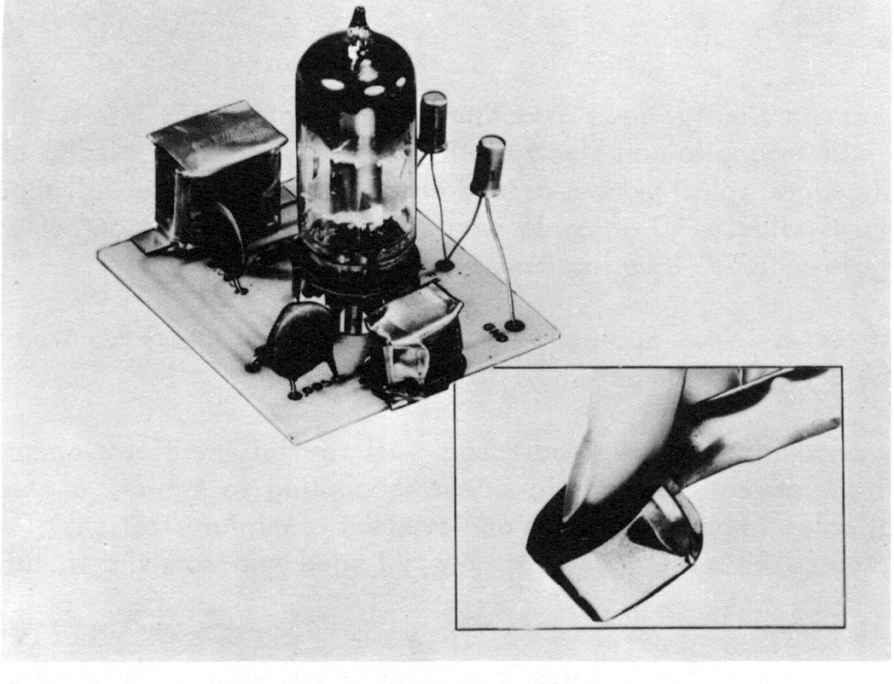


Method to use in shielding a room with foil. Performance data available on request.

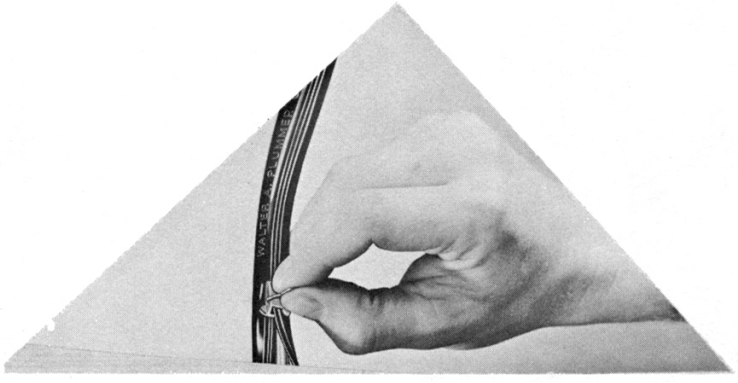


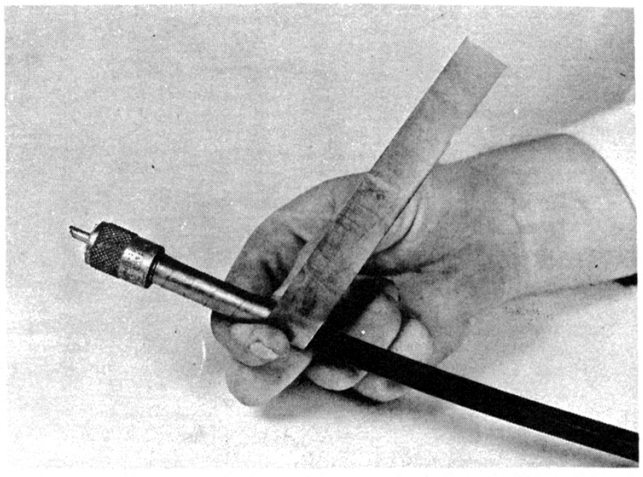
MAGNETIC SHIELDING ALLOYS for printed circuit modules.

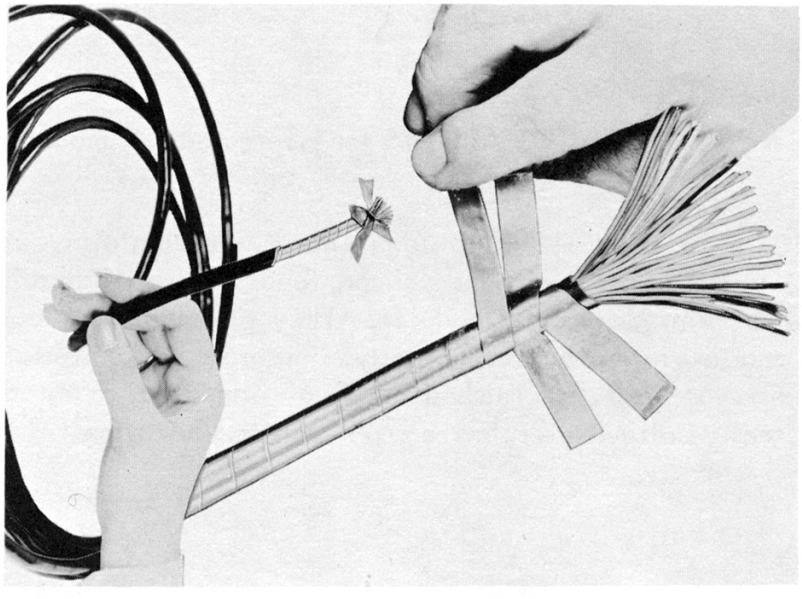
NETIC and CO-NETIC flexible magnetic shielding alloys can be cut with scissors and hand-formed to desired configuration to cover printed circuit modules. They attenuate fields of high and low intensity, respectively, and provide electrostatic shielding as well. Furnished in final annealed form, the nonretentive alloys are relatively not sensitive to shock.



# MAGNETIC AND ELECTROSTATIC CABLE SHIELDING







Cable shielding has previously been associated with electrostatic interference. It is now possible to have both magnetic and electrostatic shielding, by using NETIC and CO-NETIC foils wrapped in a counter spiral manner around the cable or wire. The foil should be applied in strips - 1/4" to 1" wide. OD of cable would be partial determinant of width selected. Greater flexibility is achieved by using narrow strips.

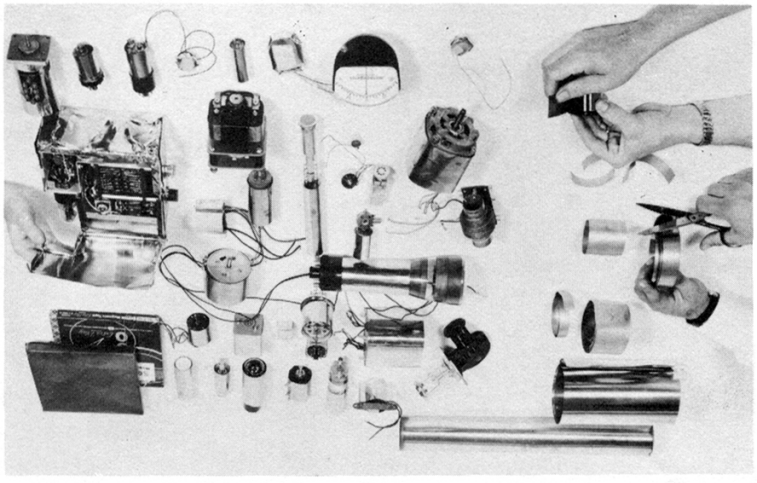
Photo above illustrates a 4 wrap application. Actual number of layers required in any specific situation should be determined empirically.

Shielded lead-in conductors to shielded rooms will restrict the fields about these cables effectively. With the advent of magnetic shielding applied to cables, a greater degree of efficiency is available, in addition to the achievement of miniaturization. The components, whether they be source or sensing devices, are shielded and now the radiating conductors can be shielded.

The Zippertubing Company of Los Angeles, can provide you with an efficient and economical means of holding the foil wraps in place. See illustration above. They also have in stock, our NETIC and CO-NETIC foils.

Reprinted from RESEARCH/DEVELOPMENT, Magazine

# "Foiling" Magnetic Interference



**By C. M. JORGENSEN, Chief Engineer**
Magnetic Shield Division
Perfection Mica Company
Chicago, Illinois

IT IS PROBABLY SAFE to say that all R & D engineers have experienced unanticipated functional difficulties with their prototype units during final evaluation tests. The problems in many instances are associated with magnetic phenomena caused by magnetically sensitive components or items in themselves radiators of magnetic fields. These components, placed in close proximity to each other, (a situation many times unavoidable due to packaging considerations) can be the source of extremely elusive difficulties. We will discuss approaches effective in resolving such problems.

Prior to 1957, ferro-magnetic alloys of relatively high permeability in a thickness of five mils (.005 in.) or less were available only in narrow width strip. In such form, their principal application was as a core material.

At this time, several alloys exhibiting interesting magnetic properties were successfully produced by Magnetic Shield Division in random lengths and in widths up to approximately 20 inches. These alloys also exhibit low strain or shock sensitivity. In a final annealed state, they display sufficient ductility or malleability to permit hand-cutting, forming, banding, or wrapping around an item with an ease somewhat comparable to that of enclosing an item with aluminum foil. Because of this the materials have generally become known as "foils".

Engineers who raise a question about the effect to the original magnetic properties of the foils after subjecting them to the strains of cutting and folding, etc., do so because of prior experience with the extreme strain sensitivity of available core materials. To make foils useful as a shielding or diversionary material for magnetic fields, a major characteristic needed would be that of low strain or shock sensitivity. Relatively low shock sensitivity has been incorporated in the alloys so that strain effect introduced by folding or wrapping does not result in serious degradation of the shielding effectiveness.

It may be of interest to the investigator to observe the buffering effects accomplished when a laminated structure of "Netic and "Co-Netic" is used. Co-Netic alloy, being of relatively high permeability, suffers reduction of effective permeability as the flux density increases. This is an inherent characteristic of all magnetic materials and a degratory one as far as shielding is concerned. One way to solve this would be to increase the thickness of the magnetically conducting material, thereby permitting more flux lines in the material before reaching a point where the permeability is reduced to any significant degree. The other approach would be to introduce an alloy lamina between the source of the field and the high permeability shielding material which would act as a buffer to sufficiently divert the field before coming in contact with the lower reluctance material. This can be accomplished to a satisfactory extent by using a "Netic S3-6" foil as an over-lay on the Co-Netic.

The Netic foil should always be positioned in such a way that it intercepts the interference field first. Using this technique makes it possible to accommodate a wider range of flux intensities for a given thickness of high permeability shield-

**Top: Possible uses of shielding: s/nchros, meters, shaded pole motors, magnetic tape, electronic assemblies, electron beam devices, and magnetically sensitive materials.**

Then the cylinder should be placed directly over the glass envelope and temporarily taped together. The investigator can then observe the effects of a single layer of material.

If this proves inadequate, a second cylinder can be wrapped around the assembly, with the lap seam positioned somewhere about 180 degrees from the first seam. Again, effectiveness should be evaluated. If the results still are not within the desired range, it would be well to try a third layer, this time using "Netic S3-6" foil. This layer, being of lower permeability material, should be considered basically as a buffer for the Co-Netic alloy. If a significant increase in shielding is noted, it indicates that the field source being diverted is of relatively large magnitude. That is, before the Netic material is placed over the Co-Netic, this field appears to have sufficient intensity to degrade the effective permeability of the Co-Netic material. (The induced flux circulating in the Co-Netic foil is sufficient to cause a reduction in effective permeability.) Interposing a lamina of Netic material between the Co-Netic and the field source results in the Netic material (which is capable of carrying a high order of flux density but not as effective in attenuation as the Co-Netic) acting as a buffer agent, thus diverting a major portion of this interfering field.

The sequence of this experiment can be repeated if the investigator so desires, insulating between each successive cylindrical layer, again evaluating after each step. This insulation could be a dielectric material or a non-magnetic foil material such as aluminum or copper.

Under critical shielding conditions, in which ac fields are involved, the conductive shunt shields show improvements. In the case of dc fields, dielectric material appears to offer the simplest solution. It should be noted that in the great majority of instances involving relatively low flux density fields, introduction of a separating media between laminas is not of significant value. This may be partially explained by the facts that (1) the shielding alloys inherently have some form of oxide on the surface, and (2) since the shields are made up as discreet individual enclosures, a magnetic discontinuity between layers is created by the very nature of the assembly.

Once the engineer has arrived at the minimum amount of material and complexity of structure necessary to accomplish his ends, he can have such a unit fabricated in a more rugged and solid structure from heavier stock material. Sometimes foil solution is incorporated in production items, perhaps because of weight considerations.

Another problem commonly encountered is one of shielding an input type of transformer which is to be incorporated in a relatively high gain system. General practice is to enclose such a transformer in a metal housing to protect it physically and facilitate mounting. For this illustration let us assume that the transformer enclosure is made of a non-magneitc material or cold rolled steel. For evaluation purposes, assume that the transformer is readily removable, or a transformer and separate case has been procured.

With the amplifier in operation, the amount of hum present in its output is noted prior to any additional shielding. The transformer is then wrapped with a single layer of Co-Netic AA foil, having been first covered with some form of tape or insulating paper so that its laminations will not come into direct contact with the shielding foil. The foil is cut and formed to enclose the transformer. The leads are brought out and the foil tucked around them to close up any gaps. After the effect of the single layer has been determined, a second layer can be added, etc., until sufficient reduction of interference has been accomplished.

In instances where multilamina shields of this type are found necessary, paritcularly in instances involving high density flux fields, there is some indication that separating the layers with a dielectric media or a non-magnetic conductive foil is advantageous. In all instances where the transformer case is of non-ferrous material, the outer layer of foil should be Netic. Once a sufficiently effective shield structure has been built up, it can generally be placed within the original transformer housing and positioned in any of a variety of ways. A common method is to fill in the voids with casting resin.

If desired, a final production shield structure can be made by hydroforming a structure with the equivalent number of layers determined necessary by the experimenter. In this instance the shielding effectiveness will undoubtedly be greater than with foil, due to the fact that the structure would be made of drawn stock and of heavier gauge material (because it is necessary to use heavier gauge in any drawing operation). It is always possible that the increased shielding effectiveness of such a structure might make it possible to reduce the number of layers. We are finding that in many instances the final production solution to a problem, such as discussed, has been the use of foil. Since this foil would be within the normal shell enclosure of the transformer, appearance is not a factor.

We have discussed two shielding problems involving the diversion of an external field. In the case where it is desirable to determine the amount of shielding necessary to enclose a field, the procedure would be physically the same as previously described, but the sequence of materials would be reversed. In

this case, we are considering a problem in which the minimum field is external and the maximum field is internal.

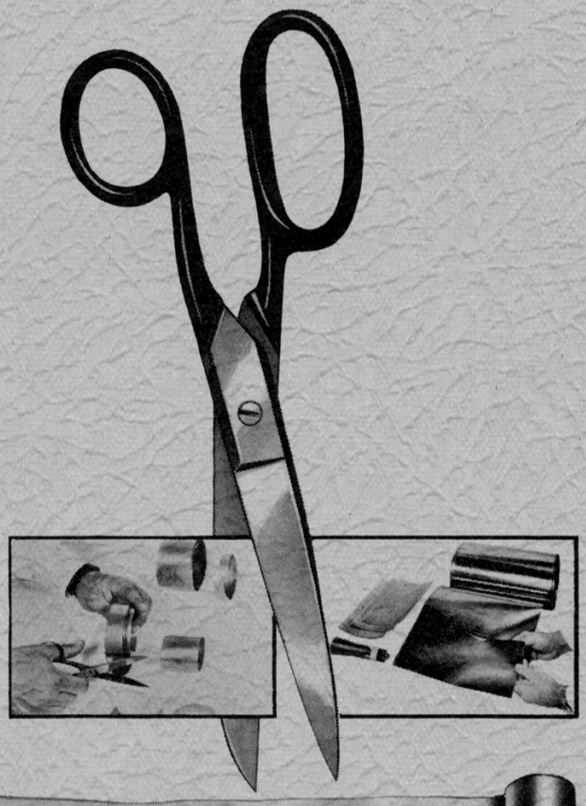
Let us consider a small power transformer. This unit would first have to be enclosed in Netic material with maximum separation between the first layer of Netic material and the transformer structure itself. That is, insulating spacers around the transformer and core should be as thick as possible. This will space the first layer of Netic away from maximum leakage areas. If the field requires further reduction, a layer of Co-Netic material should be tried. Generally speaking, in the case of power transformers, the best final solution would be a box-like enclosure consisting of heavier gauges of Netic material on the inside with, perhaps, a single layer of Co-Netic material on the outside.

Space does not permit discussion of the multitude of applications of these foils, the investigator's ingenuity being the only limit. One thing that should not be forgotten in solving these interference problems is that plates or planes of the material judiciously placed in positions of field concentration can, in many instances, serve as very effective diversionary shields. By experimentally positioning such pieces of this material in the areas where the fields are being generated or causing difficulties, the effects can readily be evaluated by observation of the functional effects of the operating equipment. By proper grounding of the shield structure, electrostatic shielding of the component will be simultaneously accomplished.

Our engineering department is most anxious to cooperate with anyone in the design of electro-magnetic shielding components. Descriptive literature is available on request. A probe that will facilitate measurement of shielding permeability is available. ■

# DO-IT-YOURSELF MAGNETIC SHIELDS

**from versatile Netic and Co-Netic Foils**

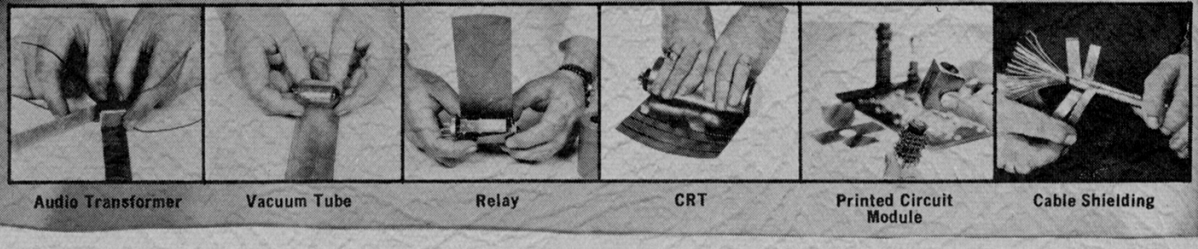


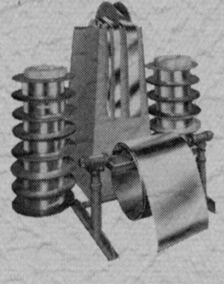
## CUT IT!

Cuts easily with an ordinary scissors to any size or outline. Flexible foils are stocked in thicknesses from .002″ and in continuous lengths 4″, 15″ and 19-3/8″ wide.

## WRAP IT!

**Your component is quickly wrapped and protected—within seconds—regardless of its contour or location. Foil takes minimum space. Typical applications illustrated.**



Co-Netic and Netic magnetic shieldings are ideal for initial laboratory or experimental evaluation. They are also available for production applications or to fit automated operations (illustrated at left). Component performance may be dramatically enhanced because Co-Netic and Netic alloys stop degradation from unpredictable magnetic fields. When grounded, they effectively shield electrostatic as well as magnetic fields over a wide range of intensities. The alloys are not significantly affected by dropping, vibration or shock and do not require periodic annealing.

Every satellite and virtually all guidance devices increase reliability with Netic and Co-Netic magnetic shielding alloys. Use these highly adaptable foils to save valuable space, weight, time and money.

**Prevent Magnetic Tape Degradation** with Netic and Co-Netic containers during shipment or storage. Available in single or multiple reel capacities in round or rectangular containers and large storage vaults. Particularly valuable in maintaining original fidelity of recorded data on programming tapes, telemetering, broadcast, video and hi-fi tapes. Low residual magnetism.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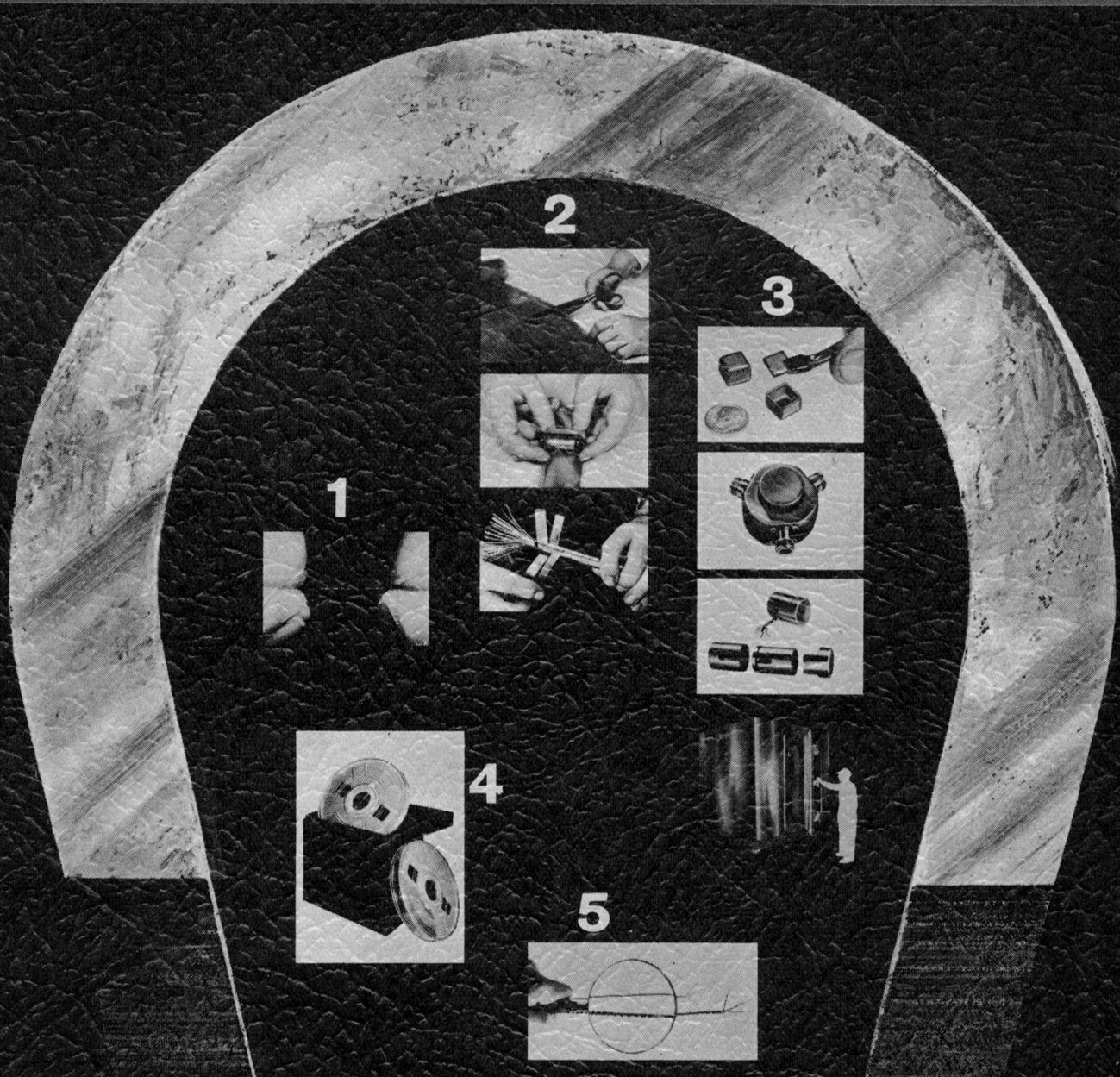
# MAGNETIC SHIELD DIVISION

Perfection Mica Company / EVerglade 4-2122

1322 N. ELSTON AVENUE
CHICAGO 22, ILLINOIS

*ORIGINATORS OF PERMANENTLY EFFECTIVE NETIC CO-NETIC MAGNETIC SHIELDING*




# NETIC & CO-NETIC MAGNETIC SHIELDINGS

**1** **Microdiameter Co-Netic AA wire** drawn from extremely high permeability Co-Netic AA alloy. Diameter is $5.0 \times 10^{-4}$ inches (0.25 circular mills). The wire displays magnetic properties and is offered for experimental investigation as to applications.

**2** **Foil shields** (Netic & Co-Netic) can be quickly cut to any shape with a pair of scissors . . . then applied in seconds. Furnished in final annealed state in rolls up to 15" wide. Non-retentive. Not affected significantly by vibration or shock. Aids miniaturization, reliability.

**3** **Shielding inclosures** (Netic & Co-Netic) for components and structures ranging from micro-modules to mobile shielding rooms. Non-shock sensitive. Non-retentive. Never require rejuvenation. Have negligible residual magnetism. Shielding containers for shipping magnetrons.

**4** **Magnetic tape containers** (Netic & Co-Netic) keep data in its original condition and unaffected by exposure to unpredictable magnetic fields during transportation or storage. Particularly valuable in maintaining original fidelity of recorded data on automated programming tapes, telemetering, broadcast video and hi-fi tapes. No residual magnetism. No periodic annealing required.

**5** **Inter 8 wire** restricts magnetic field normally radiated from a current carrying wire. Unique figure-8 weave is exclusive with Magnetic Shield Division.

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