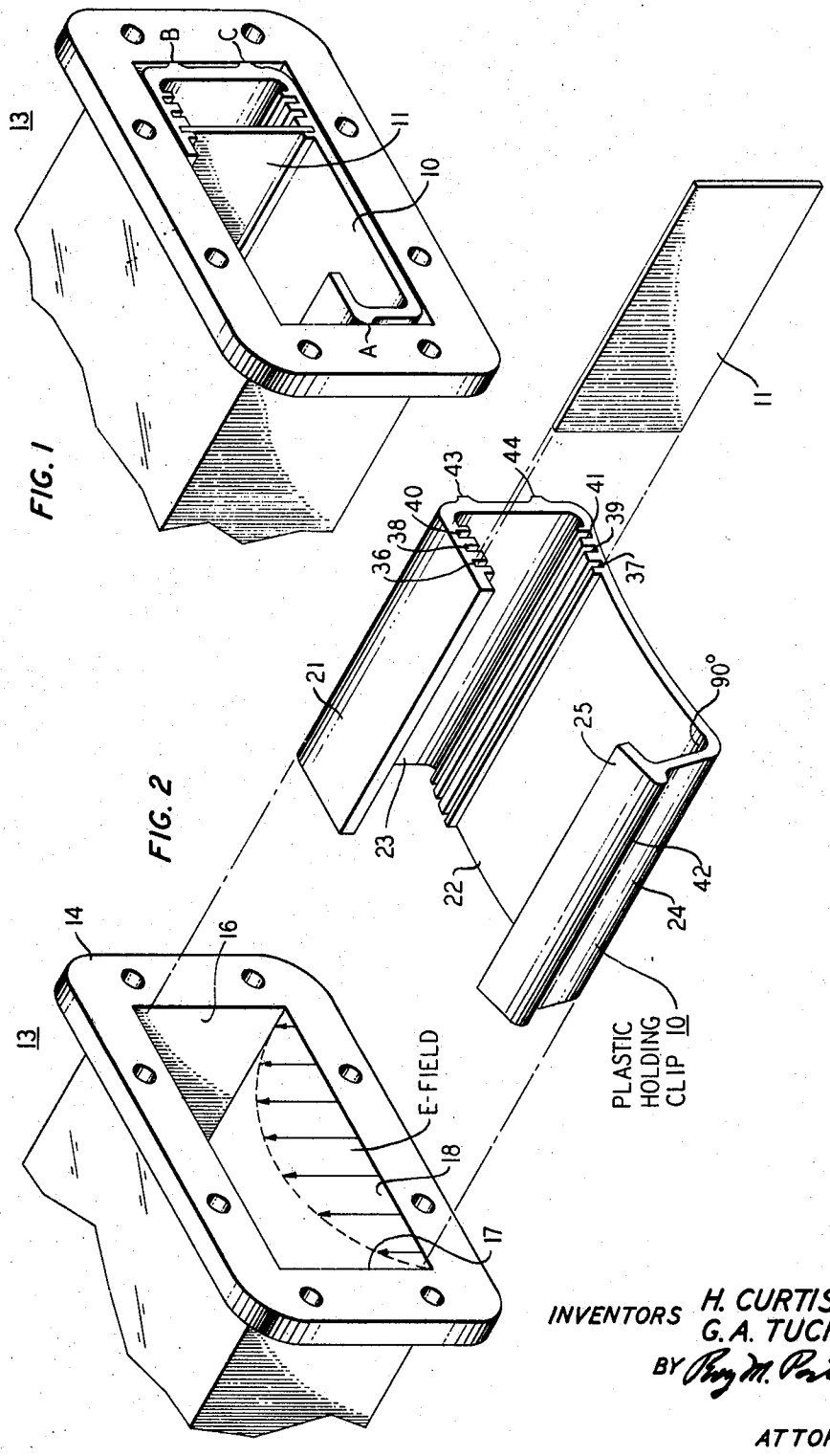
Dec. 30, 1969 H. CURTIS III, ET AL 3,487,340

HOLDER FOR MOUNTING ELEMENTS WITHIN A WAVEGUIDE

Filed Aug. 9, 1968 2 Sheets-Sheet 1




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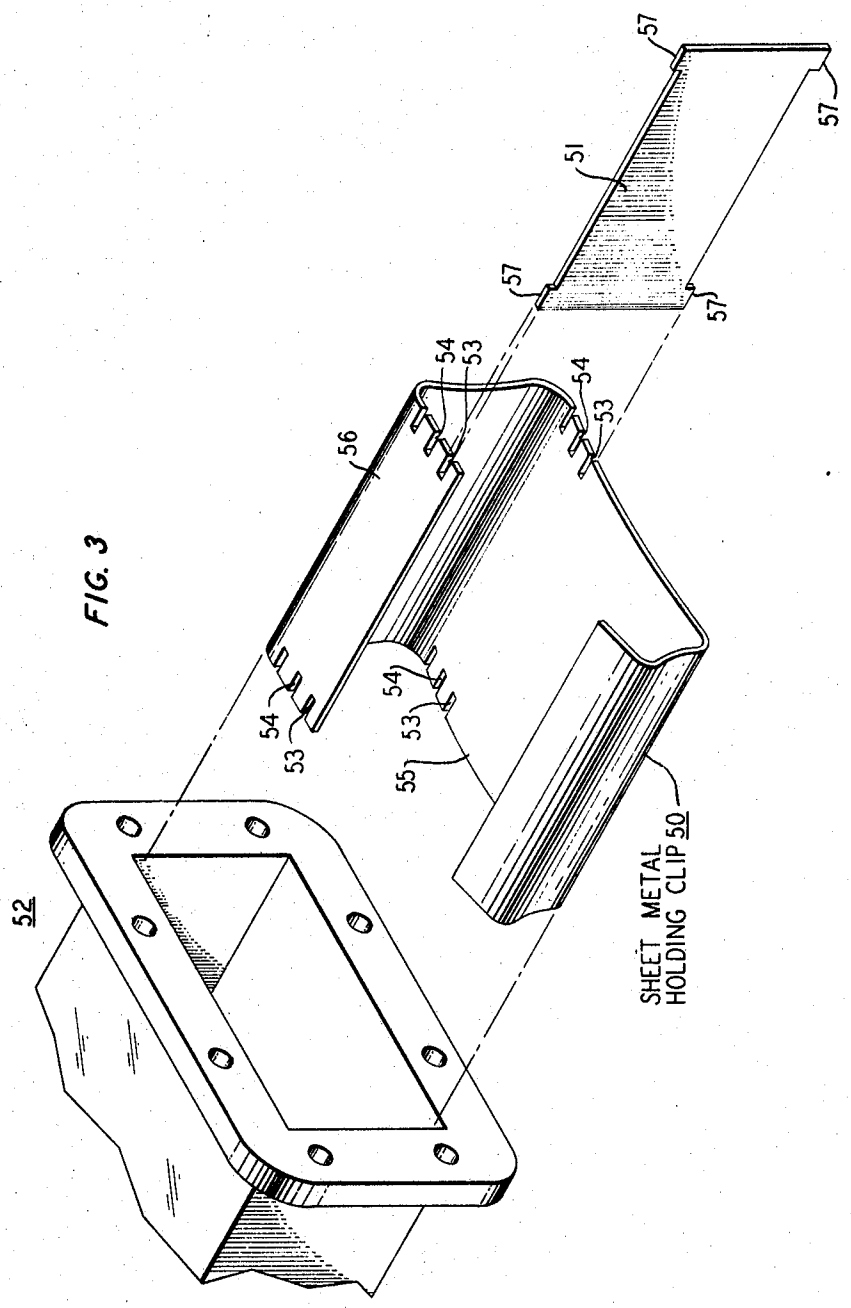



FIG. 3

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# HOLDER FOR MOUNTING ELEMENTS WITHIN A WAVEGUIDE

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U.S. Cl. 333—81 10 Claims

## ABSTRACT OF THE DISCLOSURE

A holding clip designed for fixedly securing a rigid rectangular element within a rectangular waveguide is fabricated from a resilient member which is shaped to exert two independent forces. The clip comprises two pairs of sides forming a uniform near-rectangular cross-section throughout its length and is inserted lengthwise into the waveguide. The first pair of sides press outward to form a friction fit against one pair of waveguide walls, while the second pair of sides press inward securing the element between them. Channels on the interior surfaces of the second pair of sides provide alternative positions for the element.

## Background of the invention

This invention relates to waveguide devices, and more particularly to a holder for mounting passive elements within a waveguide.

In the waveguide art rigid elements are positioned within a hollow waveguide to perform a variety of functions. Devices such as attenuators, isolators and phase shifters may require a means for mounting such an element or vane. Conventionally vanes, either resistive or ferrite or dielectric, are fixedly mounted by means of threaded studs attached to one of the narrow walls of a rectangular waveguide. Vanes have also been mounted by being passed through a slot in a broad waveguide wall. Alternatively, mounting has been performed by permanently binding the element to a waveguide wall with some form of adhesive or by imbedding it in a solid dielectric.

Often relocation of the vane or adjustment of its position within the waveguide is necessary, as for example, to change the effective attenuation of an attenuator vane. The stud mounting has been adapted to provide continuous adjustment but imbedding or adhering the vane to the waveguide structure provides immovable mounting. Inserting an element through an opening in the waveguide wall likewise provides unalterable positioning even though the insertion depth may be variable.

For greatest flexibility not only should the location of the element be variable, but insertion and complete removal of the element should also be possible without producing a lasting effect upon the waveguide structure. Neither the permanent nor the movable mountings enable a vane to be inserted and removed simply. Each of the conventional methods tends to alter the waveguide structure and requires factory machining or substantial in-field alteration of the guide, such as drilling holes or sawing slots in the waveguide wall. Thus, using conventional techniques, it is costly to modify an existing waveguide run by mounting a removable vane within the guide.

## SUMMARY OF THE INVENTION

In accordance with the invention, a unique combination of bending moment and inward and outward friction producing forces in a thin resilient member is utilized



to hold a vane within a clip and in turn, the clip within a rectangular waveguide. More particularly, the holding clip is fabricated from a resilient material which is thin so that it produces only a minimum of undesired microwave reflections. The material is bent or molded to form a section of a four-sided hollow body of near-rectangular cross-section in which two adjacent sides have been truncated so that the rectangular cross-section is incomplete. When mounted, the clip forms an external cross-sectional shape substantially similar to the internal rectangular cross-section of the waveguide.

The first pair of opposing sides press inward and the rigid rectangular element, or vane, is positioned between them. The remaining two sides of the clip press outward against a corresponding pair of opposing waveguide walls so as to provide a friction fit between the clip and the waveguide. This permits ready insertion and removal of the clip by contracting the clip manually, but unintentional movement of the clip within the guide is prevented.

The untruncated one of the two inward pressing sides, which joins the sides of the first (outward-pressing) pair is formed in an arch. The curvature of this arch is chosen such that the bending moment, which results from the outward-pressing forces created when the clip is inserted into a waveguide will cause the arched sides to straighten out. The rigid vane, mounted between the inward-pressing arched and truncated opposing sides, tends to bend the untruncated outward-pressing side, and this interaction of inward and outward-pressing forces causes the vane to be securely held to the clip by a first friction fit and the clip to be securely positioned in the waveguide by a second friction fit. Channels in the facing surfaces of the inward-pressing sides define alternative locations for the vane.

The novel holding clip exhibits advantages over the prior art in that it provides a fixed mount for a vane in a rectangular waveguide without resort to adhesives or openings in the waveguide wall. An existing waveguide may, therefore, be inexpensively refitted without any alteration of the external configuration. The vane is, however, adjustably movable in finite predetermined steps, and may also be readily removed without any structural effect upon the waveguide.

## Brief description of the drawings

FIG. 1 is a perspective view of a vane mounted within a waveguide in accordance with one embodiment of the invention;

FIG. 2 is an exploded view of the embodiment of FIG. 1; and

FIG. 3 is an exploded view of a second embodiment of the invention.

## Detailed description

FIGS. 1 and 2 illustrate the novel clip **10** for holding a planar element or vane **11** rigidly within a waveguide **13**. FIG. 1 shows element **11** fixedly mounted and FIG. 2 shows the assembly in an exploded view.

Waveguide **13** is part of a waveguide section the remainder of which is not shown. Flange **14** connects waveguide **13** to additional waveguide lengths by conventional means such as bolting flange **14** to a mating flange on the additional length, not shown.

Clip **10** is formed, either by bending or molding, from a stable, elastic material so that the clip exhibits spring-like characteristics. A suitable material is a high performance plastic such as polyphenylene oxide, specifically a modified form commercially available under the tradename Noryl. A thin high strength metal having good

electrical conductivity, such as copper-beryllium, would also be acceptable.

When in position, clip **10** must conform as nearly as possible to the interior shape of waveguide **13** in order to minimize microwave reflections. In order to accomplish this, clip **10** is composed of five planar members **21** through **25**. It should be noted that for the $TE_{10}$ wave commonly used for transmission in rectangular waveguide, the E field is perpendicular to broad wall **18** and near zero in proximity to narrow walls **16** and **17**. (This is shown in FIG. 2.) Members **23** and **24** located parallel to and in close proximity with walls **16** and **17**, respectively, will therefore intercept a minimum E field. Members **21** and **22** are substantially perpendicular to the E field and will also have minimal effect on the field if they are thin relative to the internal dimensions of waveguide **13**. Member **25**, which will be discussed below is also perpendicular to the field and likewise produces inconsequential effects upon microwave propagation.

First portions of clip **10** support element **11** essentially perpendicular to wall **18**. Elastic deflection of member **21** relative to member **22** creates a friction fit which secures element **11**. The compressive force must be sufficient to secure element **11** without deforming it but must permit its manual removal. The clip is shaped to conform to these characteristics by conventional techniques such as bending or molding the resilient material.

Lateral movement of element **11** is prevented by a pair of parallel channels **36** and **37** formed in the facing sides of members **21** and **22**, respectively. Each channel is sufficiently wide to accommodate an edge of element **11**. Alternative lateral positions are provided in finite steps by additional pairs of channels such as **38** and **39** and **40** and **41**. If element **11** is an attenuator vane, such as is formed by rigid thin dielectric plate having a lossy surface layer of, for example, sputtered tantalum film on a ceramic substrate, the various lateral positions will provide varying degrees of attenuation as is well known in the art. Element **11** may be slid into and out of a specific pair of channels after pressure has been applied to separate slightly members **21** and **22**.

A second friction fit between narrow walls **16** and **17** and members **23** and **24** secure clip **10** within waveguide **13**. By means similar to the formation of the compressive force between members **21** and **22** described above, the clip is formed so that members **23** and **24** tend to spread apart. Members **23** and **24** may be compressed by an external force and clip **10** inserted into waveguide **13**; when the external force is removed members **23** and **24** tend to press outward against walls **16** and **17** to form a friction fit which prevents unwanted movement of clip **10** and element **11** secured to it.

Member **22** is arched when unstressed and preferably is dimensioned narrower than corresponding waveguide wall **18**, so that the outward-pressing forces will act at A, B, and C, as shown in FIG. 1 to straighten member **22** when clip **10** is inserted into waveguide **13**. Element **11** further stiffens clip **10**, and the friction holding clip **10** between walls **16** and **17** is increased. Simultaneously, the pressure on element **11** by members **21** and **22** is increased, thus improving the friction fit between those members and element **11**.

Member **25** attached to member **24** extends internally from the overall rectangular cross-section of clip **10** for a short distance. Member **25** thus acts as a tab through which the clip may be removed from the waveguide **13** by means of commonly available tools such as a pair of pliers. Specifically, by rotating the tab slightly relative to the waveguide wall **17**, the starting friction is greatly reduced and removal of clip **10** is facilitated.

For in improved friction fit the exterior face of member **24** is provided with a linear rib **42** which makes contact with wall **17** at a well-defined area A, and the exterior side of member **23** has similar ribs such as **43** and **44** to make defined contact with wall **16**, over areas B and C, respectively.

FIG. 3 illustrates a modified holding clip **50** for mounting an element **51** within a waveguide **52**. This embodiment is designed for sheet metal construction of clip **50**. It is structurally identical with the embodiment of FIG. 1 except that in place of the pairs of channels in the embodiment of FIGS. 1 and 2, clip **50** has a set of four parallel slots **53** cut out of opposing members **55** and **56** for supporting element **51** within the clip. Element **51**, which again may be an attenuator vane, is provided with extensions **57** each of which fits into one of the slots **53**. An alternative position of element **51** may be provided by placing extensions **57** into other sets of slots such as **54**.

The simplicity of the holding clip permits an installer to disengage a waveguide section from an adjacent section readily insert an element which may be an attenuator vane, and reconnect the waveguide sections. This procedure can be rapidly accomplished at any joint in an existing waveguide run without costly and permanent physical alteration of the waveguide structure.

In all cases it is to be understood that the above-described arrangements are merely illustrative of a small number of the many possible applications of the principles of the invention. Numerous and varied other arrangements in accordance with these principles may readily be devised by those skilled in the art without departing from the spirit and scope of the invention.

We claim:

**1.** A device for holding a solid element rigidly in a predetermined position within a waveguide comprising a resilient unitary body completely internal to said waveguide, first portions of said body securing said element to said body and second portions of said body bearing against the interior walls of said waveguide.

**2.** A clip for holding a solid elment rigidly within a rectangular waveguide comprising a resilient unitary body having, when inserted within said waveguide, four planar members the first two of said members being substantially parallel to each other and the two remaining members being substantially parallel to each other and substantially orthogonal to said first two members, said first two members exerting pressure toward one another and securing said element between one another, and said two remaining members exerting pressure apart from one another and against the walls of said waveguide.

**3.** A clip as claimed in claim **2** wherein one of said first two members is arched when in an unstressed state and said arched member produces outward pressing forces against said waveguide when inserted within said waveguide.

**4.** A clip as claimed in claim **2** wherein each of said first two members have on the interior surface at least one channel parallel to a similar channel on the interior surface of the other of said first two members for securing said element between them.

**5.** A clip as claimed in claim **4** wherein said first two members each have a plurality of channels for alternatively locating said element.

**6.** A clip as claimed in claim **2** wherein said body may be repeatedly inserted and removed from said waveguide.

**7.** A clip as claimed in claim **2** wherein said four members are thin relative to the internal dimensions of said waveguide and wherein each of said four members are positioned parallel to and in close proximity with an individual one of said waveguide walls.

**8.** A clip as claimed in claim **2** wherein said body includes a fifth member extending internally from said remaining four members for extraction of said clip from said waveguide.

**9.** An attenuator comprising a waveguide, a resistive vane, and a holder of unitary structure completely internal to said wave guide for rigidly supporting said vane in a predetermined position within said waveguide, first por-

tons of said holder providing a first friction fit with said vane and second portions of said holder providing a second friction fit with the walls of said waveguide.

10. An attenuator as claimed in claim 9 wherein said waveguide has a rectangular cross-section and said first portions include two first planar members and said second portions include two second planar members, said two first members and said two second members forming an external cross-sectional shape substantially similar to the internal cross-section of said waveguide.



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