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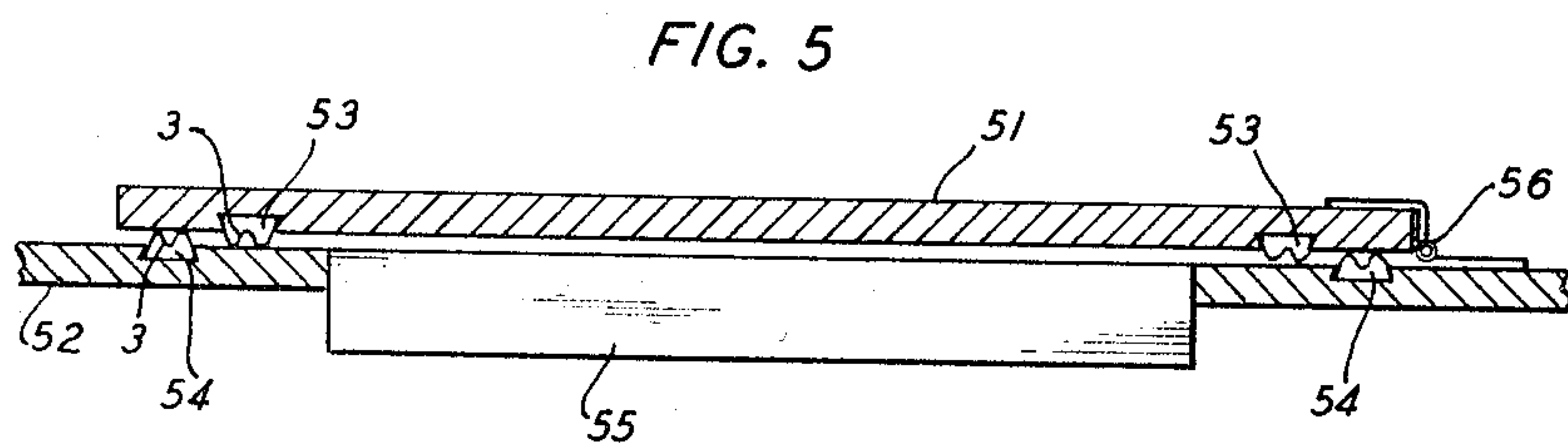
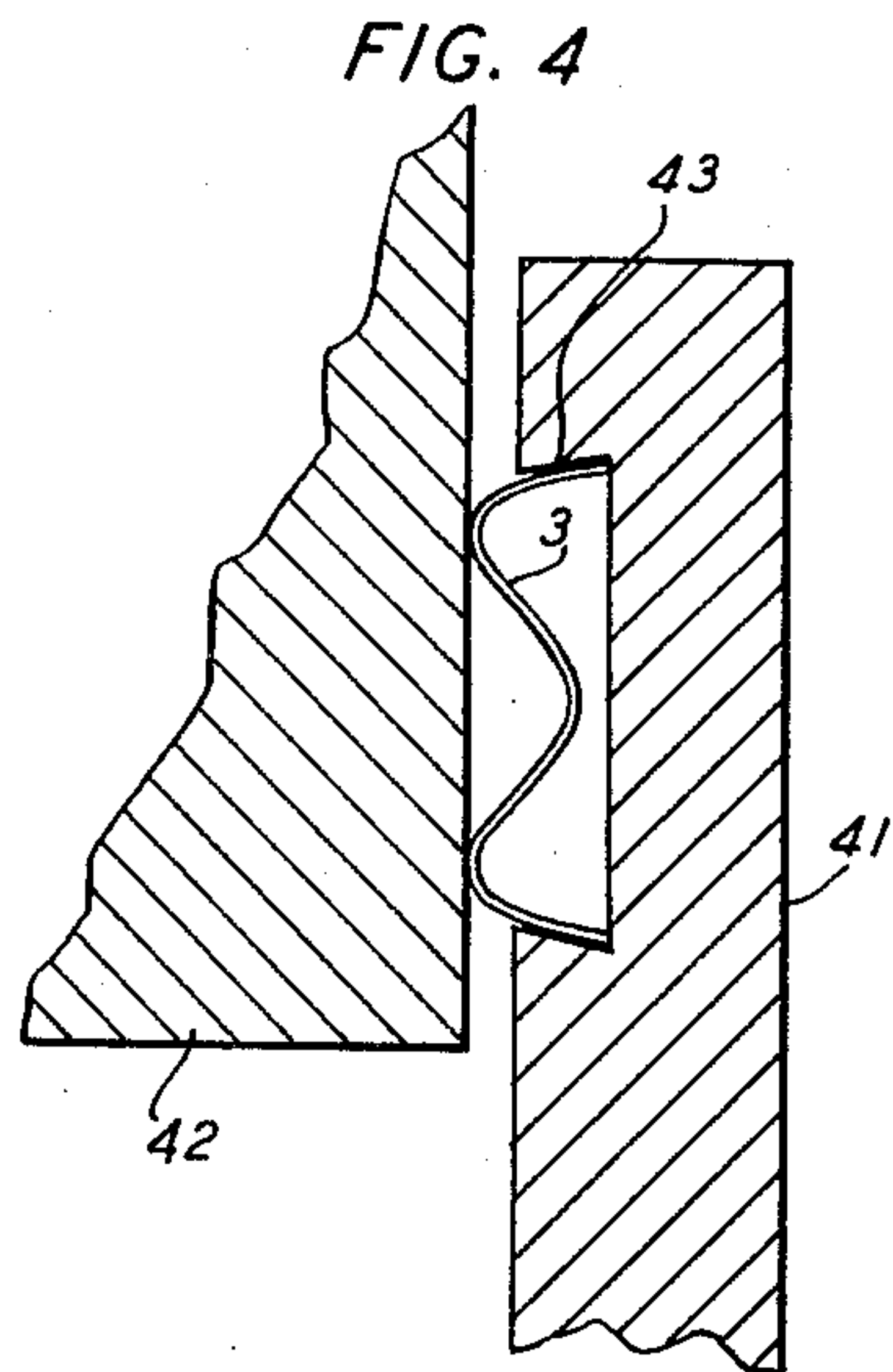
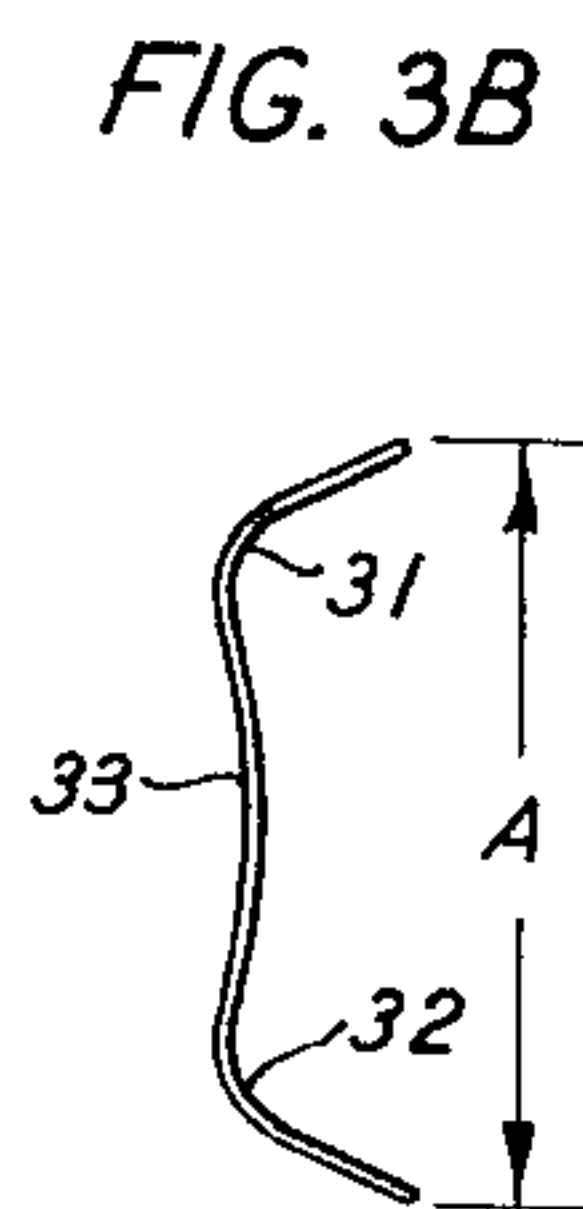
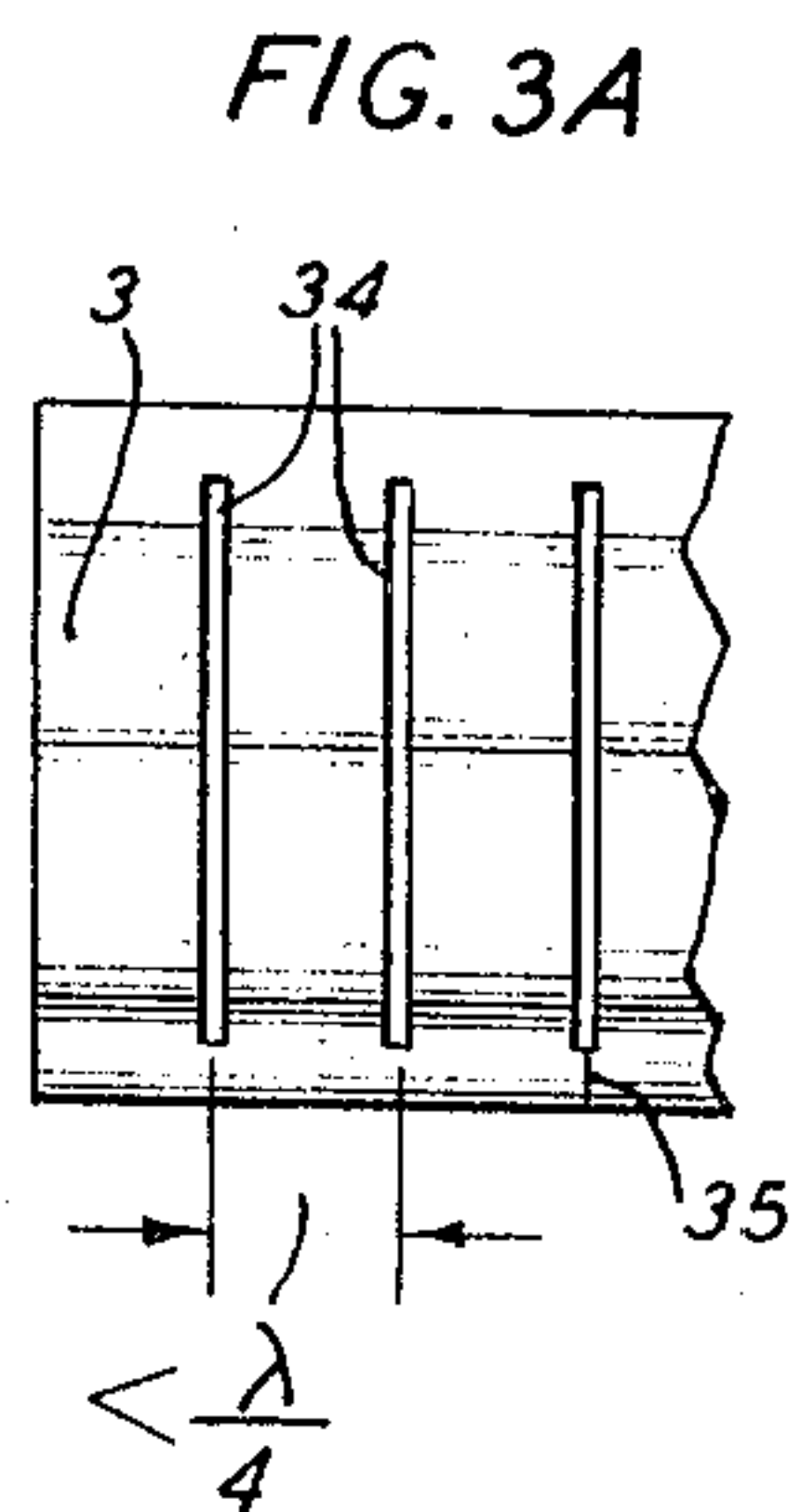
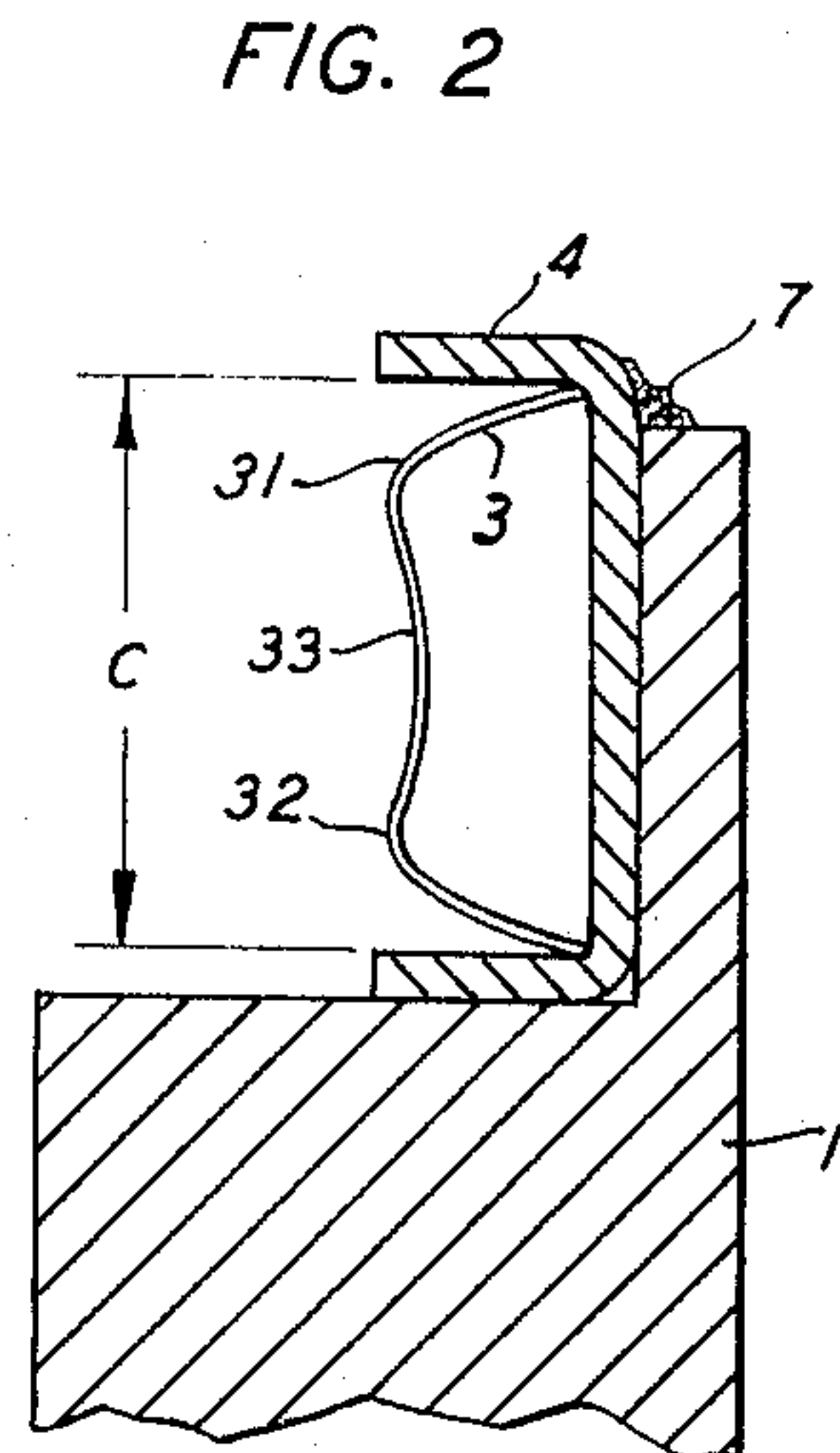
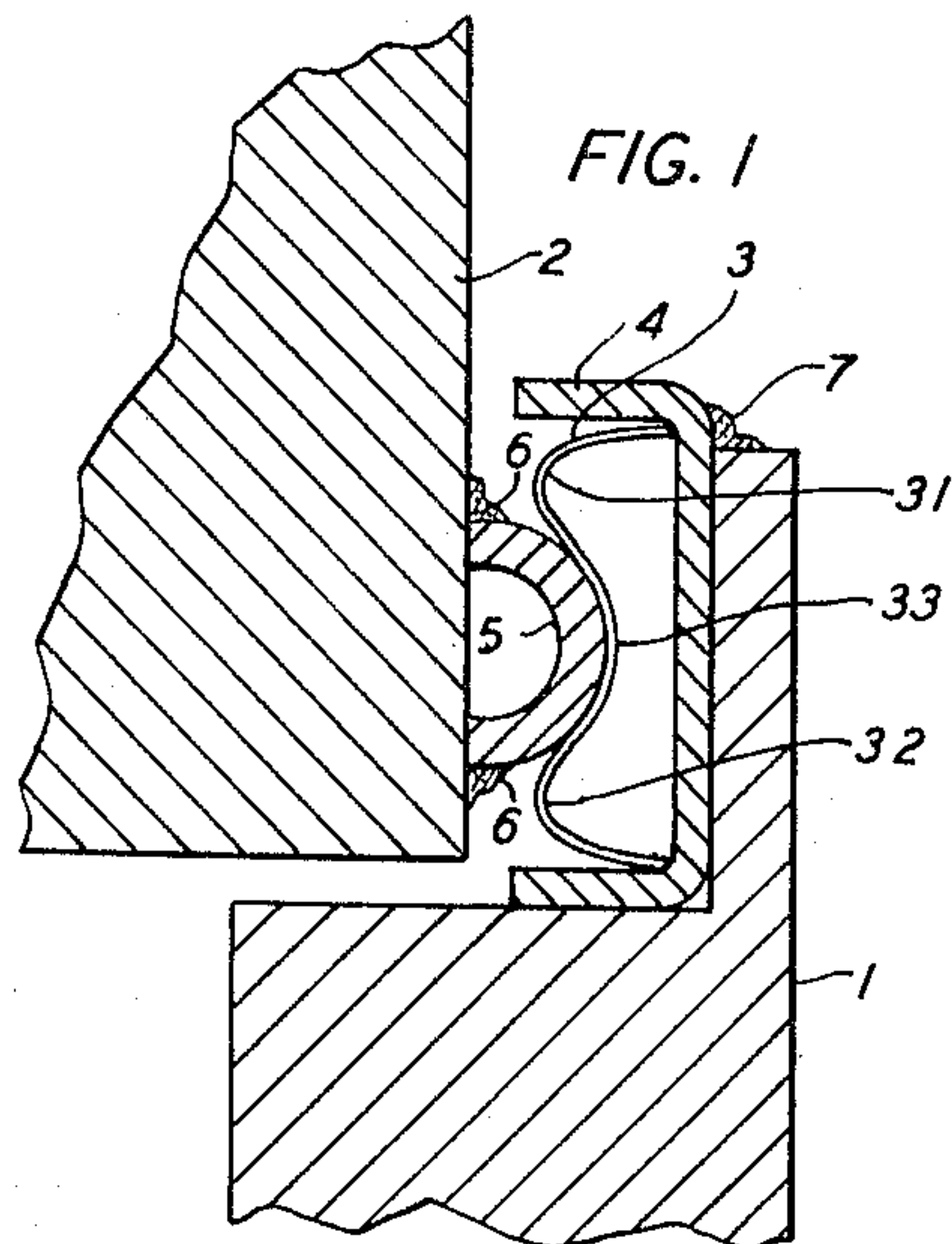
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3,304,360

RADIO FREQUENCY GASKET FOR SHIELDED ENCLOSURES

Filed June 3, 1964

2 Sheets-Sheet 1



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RADIO FREQUENCY GASKET FOR SHIELDED ENCLOSURES

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2 Sheets-Sheet 2

FIG. 6

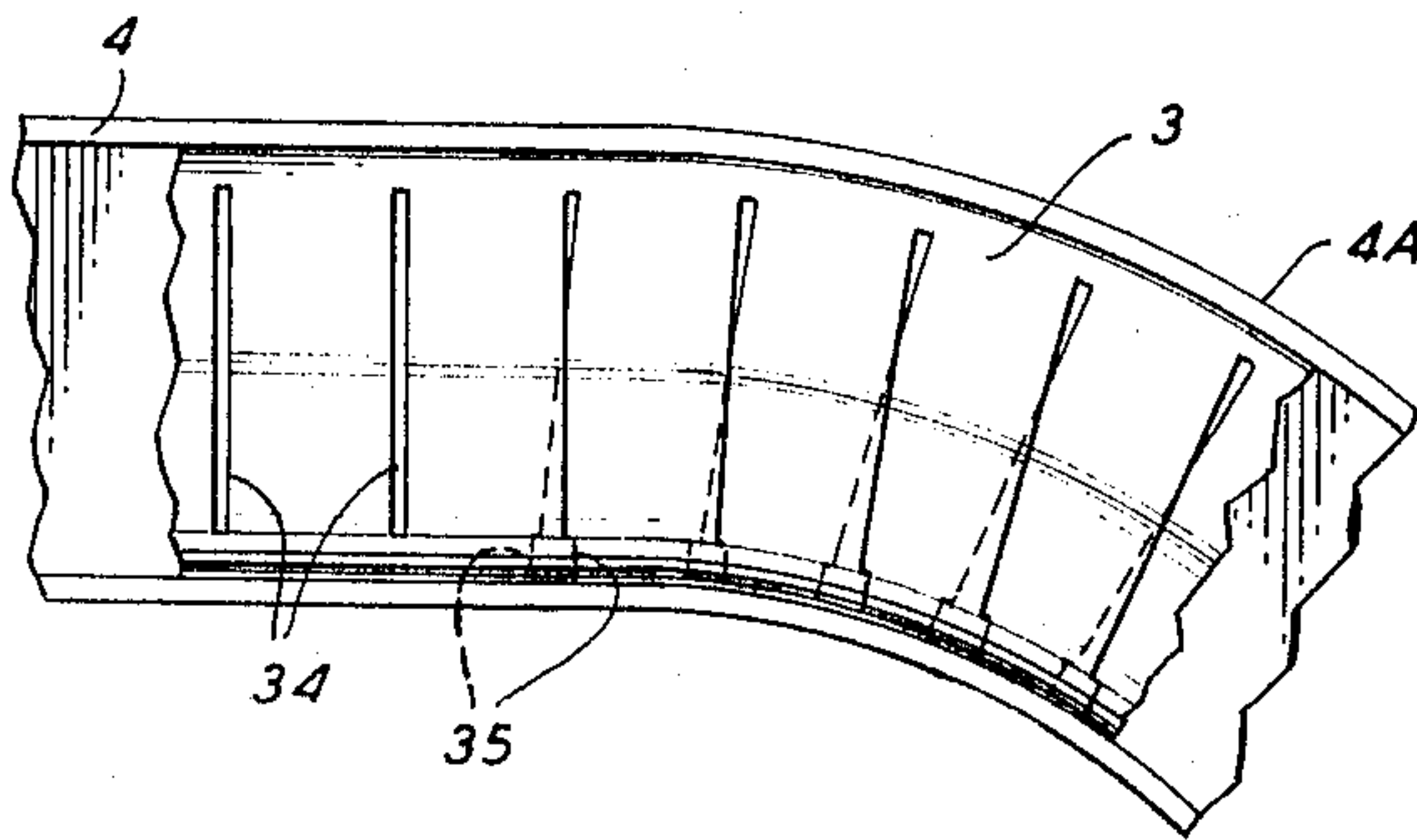
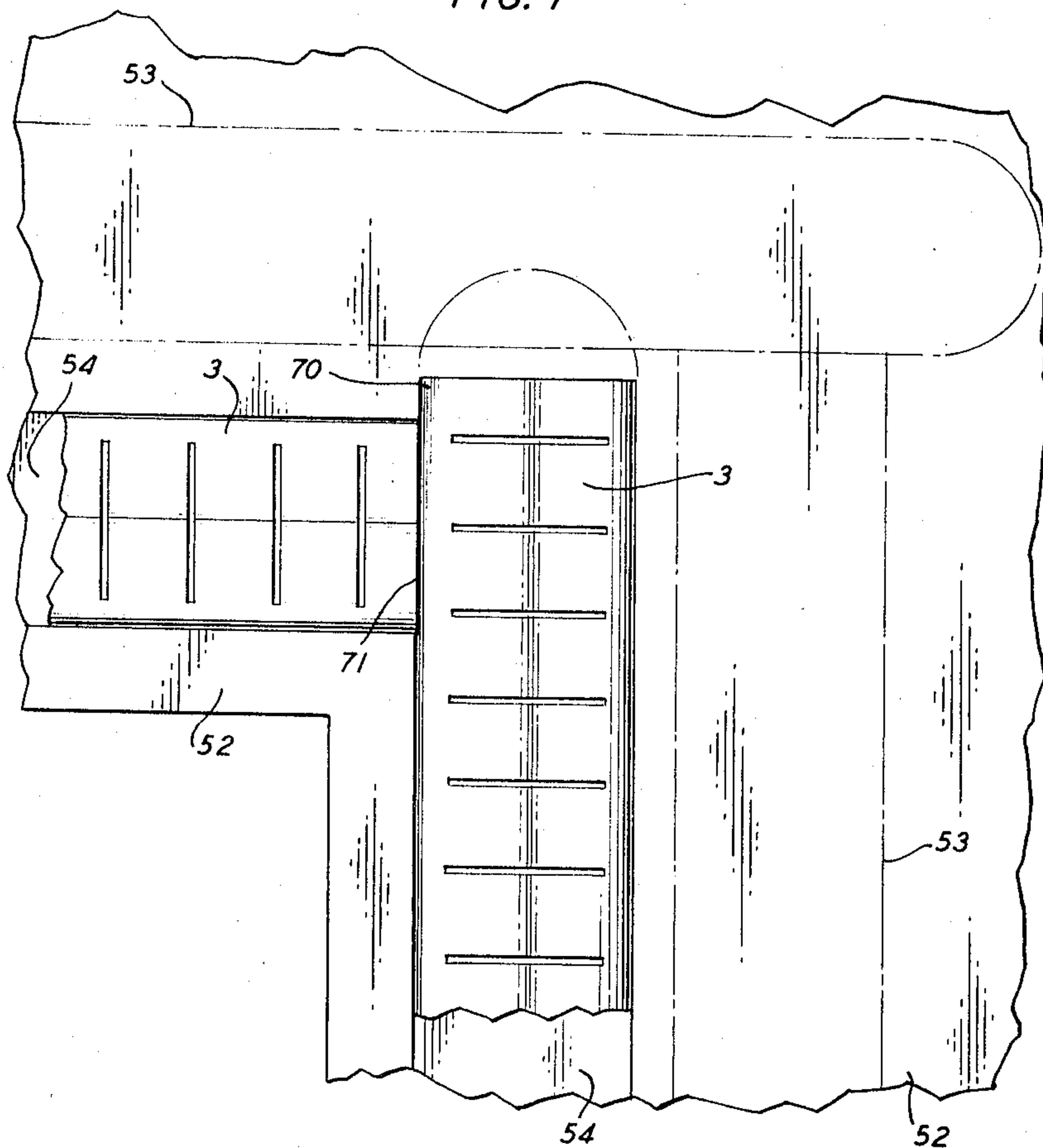


FIG. 7



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RADIO FREQUENCY GASKET FOR SHIELDED ENCLOSURES

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9 Claims. (Cl. 174—35)

This invention relates to the art of radio frequency electric shielding and more particularly to a radio frequency gasket for the openings in shielded enclosures.

Radio frequency gaskets have been constructed of metallic wool or fabric, sometimes embedded in rubber, or of a plurality of spring fingers which are secured by soldering, welding or brazing, or by the use of bolts or rivets to either the door or the jamb of the opening. Many of these prior art structures are relatively expensive, are quite susceptible to damage or deterioration and require considerable force to close the door or cover to which they are attached. Those which are constructed of conductive material embedded in rubber or of wool-like material tend to take a permanent set and lose their shielding efficiency after being in use for a time.

It is desirable that the gasket material be easily and economically constructed and installed, that it be rugged, easily maintained, require little force to shut the enclosure, provide efficient shielding and remain reliable over extended periods of time. These desirable characteristics have been difficult of achievement in any single structure.

It is an object of this invention to economically, efficiently and reliably seal the opening to a shielded enclosure.

It is a further object of this invention to permit the opening and closing of such shielding enclosures with the application of very little force.

A still further object is to permit easy and rapid cleaning and replacement of the gasket material without tools.

The foregoing objects are achieved by this invention which comprises a radio frequency gasket for the opening in a shielded enclosure in which a channel of conductive material contains a thin, flexible conductive strip having a width greater than that of the channel. The strip is held in the channel by friction derived from bending the strip as it is inserted in the channel. In one embodiment of the invention, this channel is made integral with either a door or its jamb so that, as the door is closed, the flexible gasket strip is deflected to closely conform to any irregularities and thereby electrically seal the opening against leakage of radio frequency energy. In another embodiment, a cooperating rigid conductive bar is positioned to enter the channel and deflect the flexible gasket material, thereby making a continuous electrical contact along its length. In either case, the flexible gasket strip is easily withdrawn and replaced without tools.

The invention may be better understood by reference to the accompanying drawings, in which:

FIG. 1 illustrates one embodiment of the invention comprising a channel, the flexible gasket strip and a rigid conductive bar cooperating to seal the opening;

FIG. 2 illustrates the channel and gasket strip separated from its cooperating rigid bar, as when the door is open;

FIGS. 3A and 3B are plan and end views, respectively, illustrative of a preferred form of the flexible conductive gasket strip of this invention;

FIG. 4 illustrates a second embodiment of the invention in which the flexible gasket strip is used without a cooperating rigid conductive bar;

FIG. 5 illustrates a cross section through a typical installation in which the gasket material is used around the doorway of a shielded room; and

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FIGS. 6 and 7 illustrate methods of installing the gaskets at the corners of the door.

In FIG. 1, reference numerals 1 and 2 designate a door and door jamb of a shielded room. Either part 1 or part 2 may comprise the door, the other part comprising the jamb. For the moment it may be assumed that part 1 is the door and part 2 is the door jamb. As is customary in the construction of shielded rooms, the walls are made of metal of sufficient thickness to give desired attenuation against transmission of radio frequency radiation there-through and the door is likewise of metal of similar thickness. Channel 4 is welded to the door 1 at 7 and a rigid conductive bar 5 is welded to the door jamb at 6, it being so positioned as to be centrally located within the opening of channel 4. A flexible strip of conductive material 3 is frictionally held within channel 4 in the position shown and, as the door is closed, the rigid conductive bar 5 engages the flexible conductive strip 3 and deflects it inwardly, thereby making a continuous electrical contact along its entire length.

The flexible strip 3 is shown in its initially installed position in FIG. 2. This strip is preferably made of beryllium copper having a typical substantially uniform thickness of approximately 3 mils and it is preferable that the strip be gold plated to a thickness of approximately 0.0001 inch. The flexible material 3, before installing in channel 4, appears as shown in FIGS. 3A and 3B. It may be fabricated in strips of from one to two feet in length and may be made without the slits 34 shown in FIG. 3A provided suitable continuous contact can be assured. However, it has been found in practice that slits 34 effectively separate the strip into a series of flexible fingers and assures better continuous contact. The widths of these slits 34 should be as narrow as can be conveniently fabricated and the distances between them should be less than a quarter wavelength of the highest frequency to be attenuated. FIGS. 3A and 3B show both a plan and cross section view of the flexible strip, the cross section view of FIG. 3B showing that the strip has been preformed into a shape somewhat resembling the letter M. It is desirable that the curvatures at 31 and 32 be approximately as shown in the figure and that the central curvature, in the reverse direction at 33, have a longer radius. The dimension A should be substantially longer than the dimension C of FIG. 2, the latter being the width of the opening in the channel. When the flexible strip is installed in the channel, the curvatures at 31, 32 and 33 will be changed somewhat and will conform approximately to the shape shown in FIG. 2. As installed, the curvature at 33 in FIG. 2 may disappear, that is to say, this section may be nearly flat, or may even reverse in direction, particularly when used with the embodiment shown in FIG. 1.

A further simplification of the invention appears in FIG. 4 in which a door 41 and a door jamb 42 are shown to cooperate in closing the entrance to a shielded room. In this embodiment, the rigid bar 5 shown in FIG. 1 is not used and contact is, instead, made along two parallel lines directly against the conductive door jam 42. The flexible strip 3 is here inserted in a groove formed directly in the metallic door 41 rather than in a separate channel, such as channel 4 shown in FIGS. 1 and 2. The bottom of the groove in the door may be somewhat wider so that the sides are slanted inwardly as shown at 43 in FIG. 4. This inward slant tends to held retain the spring more securely in position. However, it is found in practice that under ordinary conditions, the straight sides as shown in FIGS. 1 and 2 work quite satisfactorily so that straight sides could, alternatively, be used in the embodiment of FIG. 4 as well. In this embodiment, it is desirable, although not essential, that there remain some definite curvature at 33 near the central portion of the

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spring as shown in FIG. 2 to insure that, as the door is closed, the deflection is taken up in the spring by the central portion of the spring moving inwardly as illustrated in FIG. 4. It has been found that this makes a very positive continuous contact along two lines on the metallic surface of the door jamb. As before, the groove could, alternatively, be in the door jamb 42 instead of in the door as illustrated.

FIG. 5 shows a cross section through a typical installation using the embodiment of FIG. 4. In this figure, the metallic wall 52 of the room has an access opening therein with a threshold 55. The threshold comprises a step up from the door side of the enclosure so as to provide wall space below the opening for the gasket material to continue around the bottom of the door. It is to be understood, of course, that the gasket material extends around the entire door. The door 51, in this case, contains two grooves 53, 53 extending around its periphery for retaining the flexible gasket strips 3 of this invention. Just outside of these gaskets will be found other similar grooves 54, 54 in the enclosure wall 52, these also extending entirely around the periphery of the door. The door 51 is illustrated as mounted by suitable hinges 56. Other details of the door hardware, which are conventionally used with such enclosures, have been deleted for the sake of clarity.

The gasket material is customarily formed into a circular arc to change direction at the corners of the door. To facilitate bending strip 3 to conform with a curved channel, several adjacent slits 34 are extended through to the edge by cutting with shears, the cut being illustrated by line 35 in FIG. 3A. This permits the flexible fingers included between the cuts 35 to either overlap or spread apart at their cut ends and readily conform to the shape of the curved channel but still present a cross section substantially like that shown in FIG. 2.

FIG. 6 shows a portion of typical corner employing the channel construction of FIG. 1. Channel 4 is here shown to have a curved portion 4A and that part of flexible strip 3 included in this curved portion has been cut as shown at 35 so that the flexible fingers overlap as shown to accommodate the curve. As previously mentioned, strip 3 may, alternatively, be inserted with the cuts at the outer radius so that the fingers spread instead of overlap as illustrated.

FIG. 7 illustrates a butt construction adaptable to a door with right angle corners. The metallic wall 52, corresponding, for example, with wall 52 of FIG. 5, contains grooves 54, 54 milled therein to receive strips 3, the horizontal strip forming a butt joint 71 with the side of the vertical strip while the latter preferably extends above the horizontal one as at 70. Preferably, the grooves 53, 53 in the door, shown only in outline, are milled to cause the butt joint for its strips to lie perpendicular to the joint 71.

This invention, which is quite obviously of a very simple character, has been found in practice to be the equivalent of the best shielding materials so far available and has the added advantages of being very easily and economically constructed and installed and very easily replaced without the use of any solder, welding or brazing or without the use of any fastener such as a rivet or bolt and also without the use of any tools. By reference to FIGS. 2, 3A and 3B, it will be quite evident that this highly flexible gasket strip is very easily deflected at its center by merely pressing in with the fingers. As these strips are from one to two feet in length, the finger merely catches the end of the strip and pulls it out to remove it from the channel. It is replaced by merely manually bending it so that its parallel edges have a dimension less than the dimension C of the channel and then simply pushing it into position, its own flexibility securely holding it by friction inside the channel.

Another advantage of this invention is that it is very rugged, notwithstanding the fact that the strip material

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is quite thin. It has been found that this material is not easily damaged by contact with clothing, cables or other foreign objects and, because it is made of a very durable material, it does not readily deteriorate. The ruggedness is increased somewhat by the embodiment shown in FIGS. 1 and 2 in that the flexible strip, when installed, is wholly below the legs of the channel, thereby offering additional protection to the gasket material. However, this feature necessitates the use of a rigid conductive bar, such as bar 5, which must enter the channel to deflect and make contact with the spring. This also necessitates considerable care in the alignment of the door so that the channel 4 and the rigid bar 5 are properly centered to avoid interference and damage.

Another advantage of the invention over much of the prior art is that, due to the great flexibility of the gasket material, very little force is required to close the door. Also, because of this flexibility, the gasket material cannot take a permanent set but will always remain flexible, thus increasing the reliability of contact as required for satisfactory shielding. Tests of this shielding have shown that a single unit, such as that shown in FIGS. 1 and 4, will give about 55 db attenuation while the double unit, as shown in FIG. 5, provides about 100 db attenuation.

While beryllium copper has been mentioned as a suitable gasket material for the practice of this invention, it is quite evident that other conductive materials could be used in its stead without departing from the scope of the invention. Also, while the invention has been specifically illustrated as adapted to the door of a shielded room, it is equally applicable to similar shielded enclosures such as shielded boxes.

What is claimed is:

1. A radio frequency gasket means for the door to an access opening in a wall of a shielded enclosure, said gasket means comprising a rigid channel member of conductive material surrounding said opening near the edge thereof, a thin flexible strip of solid conductive material having a substantially uniform thickness which is small compared to its crosswise dimension and a crosswise dimension greater than the inside width of said channel member, said strip being flexed about its long axis and positioned inside said channel member forcibly engaging two opposite inside surfaces thereof with an intermediate portion extending convexly outwardly so that it may be forcibly deflected inwardly between said door and said enclosure wall in continuous electrical contact as said door is closed.

2. The combination of claim 1 wherein said flexible strip contains a plurality of centrally located parallel-positioned slots extending substantially perpendicular to its lengthwise dimension, spaced apart a distance no greater than one-fourth of a wavelength of the highest frequency to be attenuated and having lengths less than the crosswise dimension of said strip.

3. The combination of claim 1 wherein said flexible strip is preformed to have an approximate M-shaped endwise cross section comprising two curved portions having substantially equal radii of curvature in the same direction joined by a portion curved in the opposite direction which has a radius of curvature longer than said equal radii.

4. The combination of claim 3 wherein said strip contains a plurality of centrally located parallel-positioned slots extending substantially perpendicular to its lengthwise dimension, spaced apart a distance no greater than one-fourth of a wavelength of the highest frequency to be attenuated and having lengths less than the crosswise dimension of said strip.

5. A radio frequency gasket means for the door to an access opening in a wall of a shielded enclosure, said gasket means comprising a rigid channel member of conductive material surrounding said opening near the edge thereof, a thin flexible strip of solid conductive material having a substantially uniform thickness which is small

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compared to its crosswise dimension and a crosswise dimension greater than the inside width of said channel member, said strip being flexed about its long axis and positioned inside said channel member forcibly engaging two opposite inside surfaces thereof with an intermediate portion extending convexly outwardly, a second rigid member of conductive material having external cross section dimensions less than the inside cross section dimensions of said channel member, said two rigid members being made effectively integral with said door and said enclosure, respectively, and so positioned that said second rigid member will enter said channel member to forcibly deflect said flexible strip in continuous electrical contact as said door is closed.

6. The combination of claim 5 wherein the convexly outwardly extending portion of said flexible strip remains wholly inside said channel member when the door is opened.

7. The combination of claim 5 wherein said flexible strip contains a plurality of centrally located parallel-positioned slots extending substantially perpendicular to its lengthwise dimension, spaced apart a distance no greater than one-fourth of a wavelength of the highest frequency to be attenuated and having lengths less than the crosswise dimension of said strip.

8. The combination of claim 5 wherein said flexible strip is preformed to have an approximate M-shaped endwise cross section comprising two curved portions hav-

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ing substantially equal radii of curvature in the same direction joined by a portion curved in the opposite direction which has a radius of curvature longer than said equal radii.

9. The combination of claim 8 wherein said strip contains a plurality of centrally located parallel-positioned slots extending substantially perpendicular to its lengthwise dimension, spaced apart a distance no greater than one-fourth of a wavelength of the highest frequency to be attenuated and having lengths less than the crosswise dimension of said strip.

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