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# (54) Radiation shielding bricks

(57) A radiation shielding brick for use in building dry walls to form radiation-proof enclosures and other structures is square in shape and comprises a sandwich of an inner layer 1 of lead or similar shielding material between outer layers 2, 3 of plastics material, for structural stability. The ability to mechanically interlock adjacent bricks is provided by shaping the edges as cooperating external and internal V-sections, as shown under references 5 and 6 respectively. Relatively leak-free joints are ensured by enlarging the width of the layer 1 in the edge region.

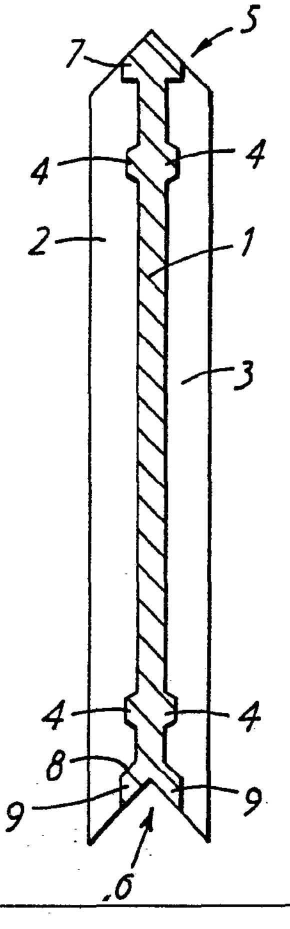


FIG. 1

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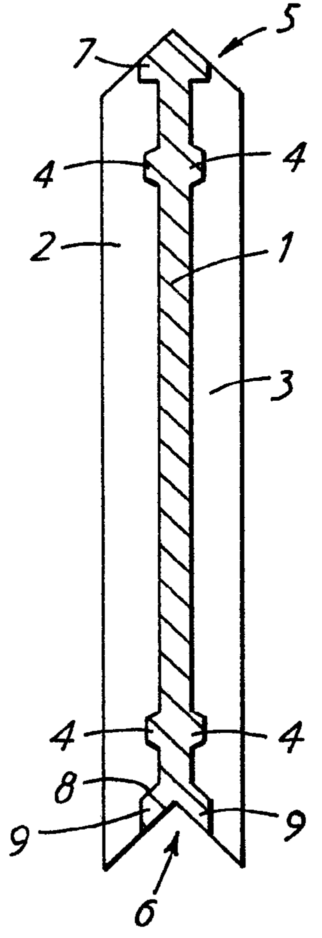


FIG.1

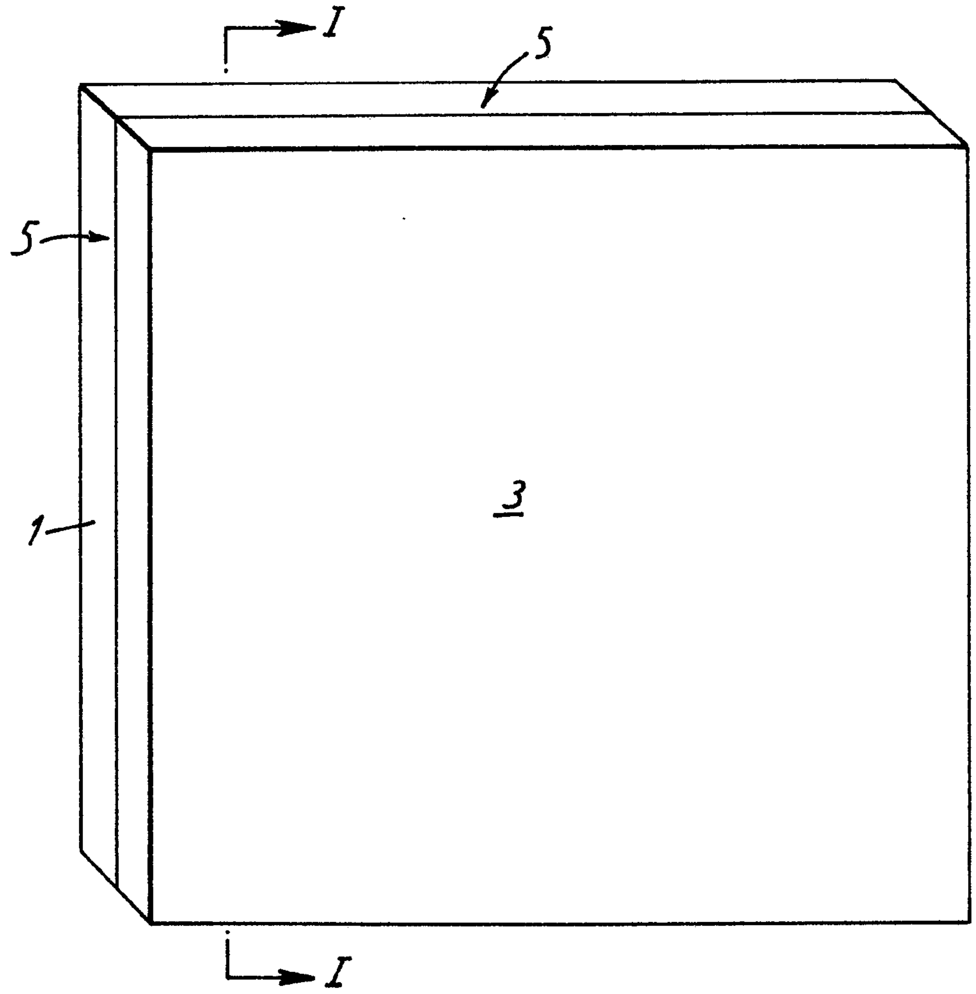


FIG.2

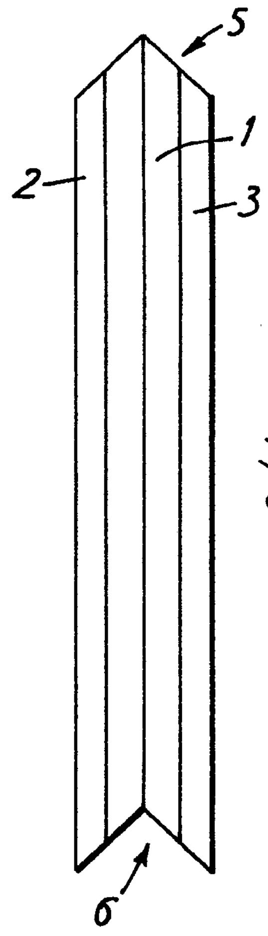


FIG.3

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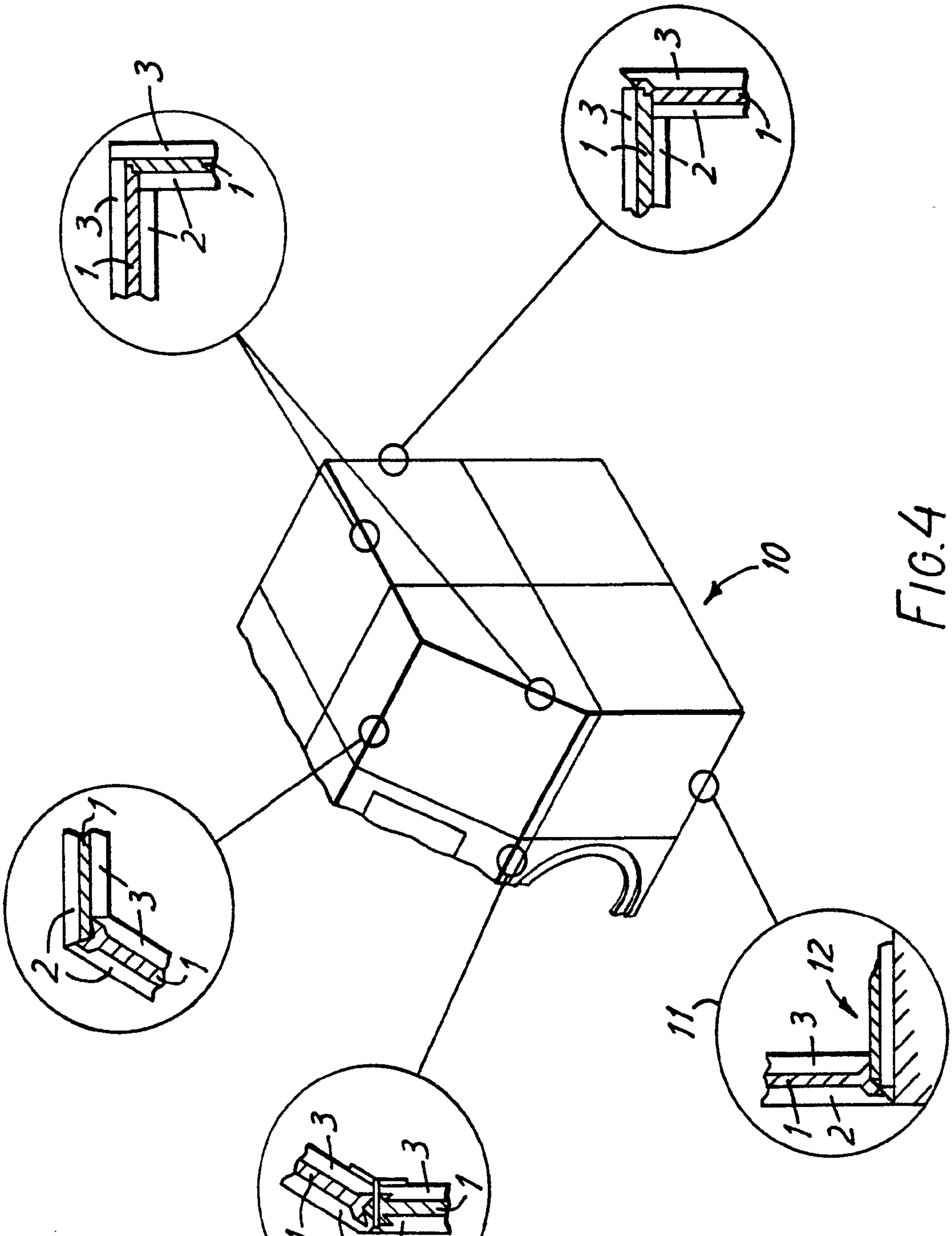


FIG.4

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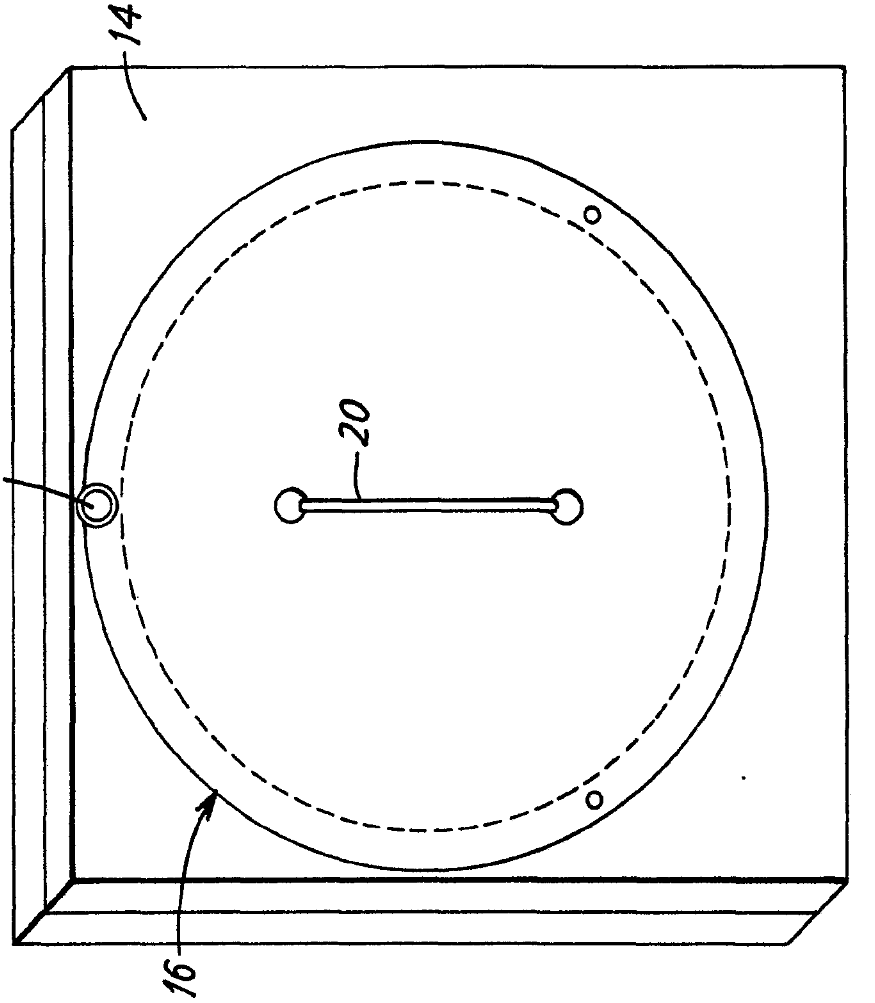


FIG.6

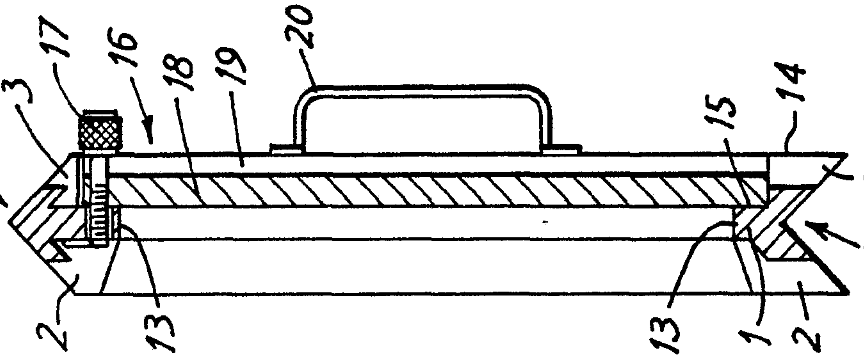


FIG.5

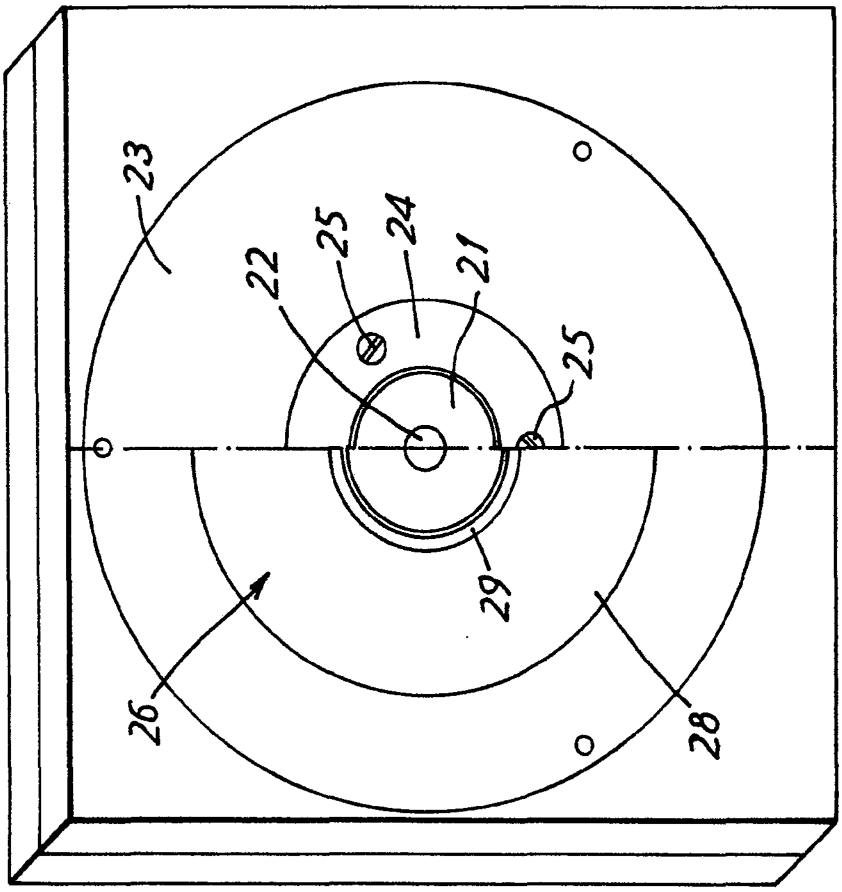


FIG.9

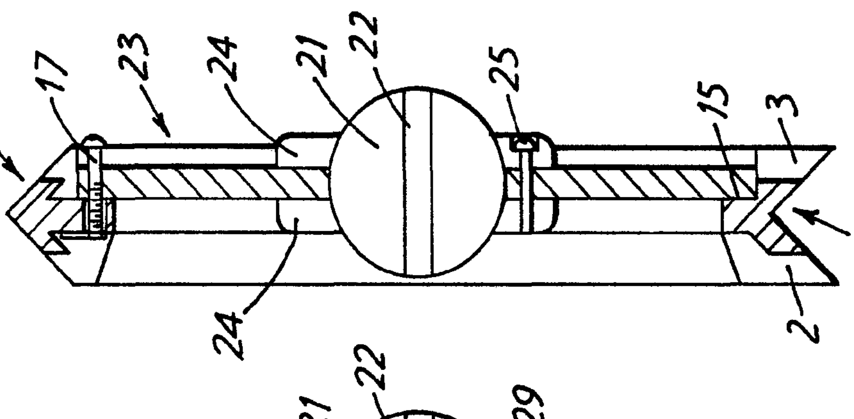


FIG.8

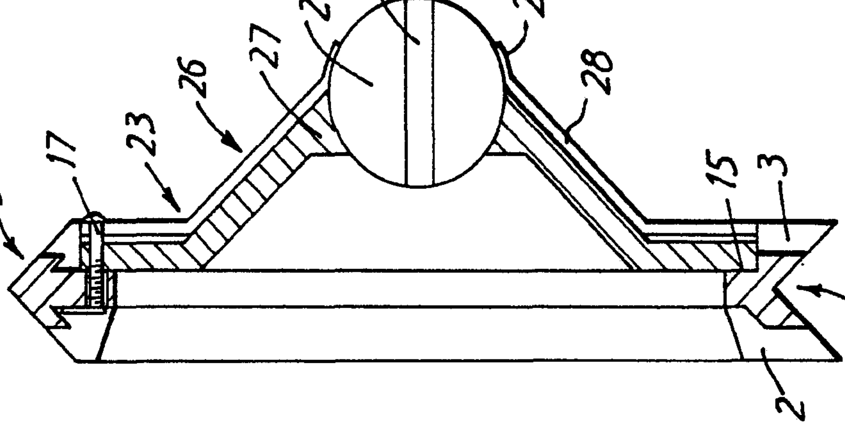


FIG.7

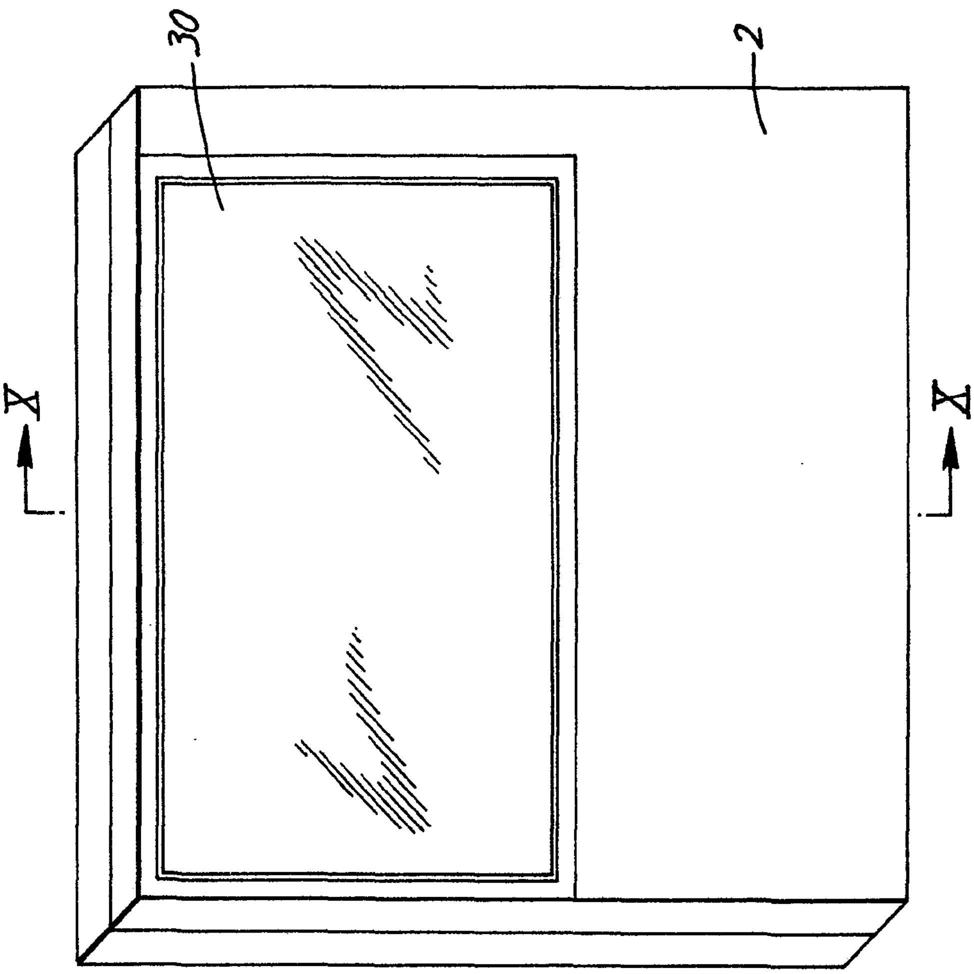


FIG.11

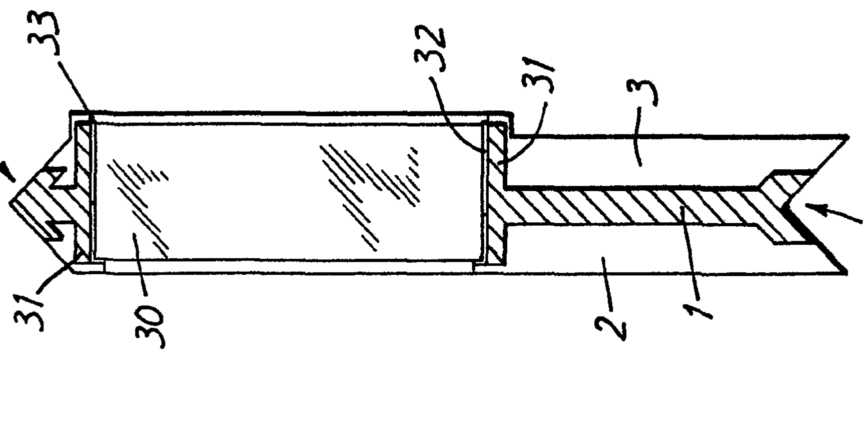


FIG.10

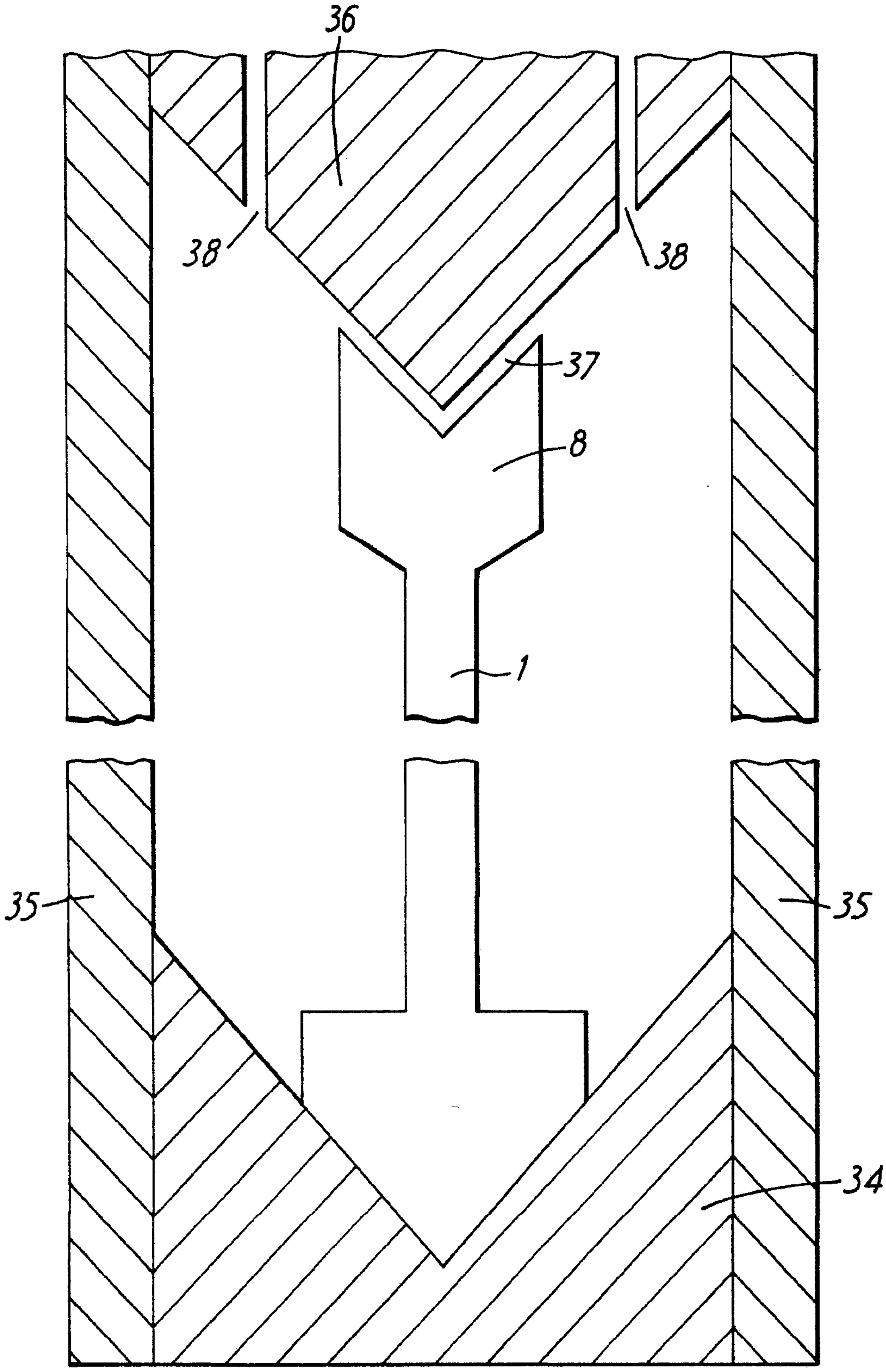


FIG.12

SPECIFICATION
**Radiation shielding bricks**

This invention relates to radiation shielding bricks.

When gamma-emitting radionuclides are handled in quantity by manufacturers or users, it is necessary to carry out work behind suitable radiation shielding. Such shields are required by hospitals and factories, and by laboratories which handle radioactive materials for research purposes, process and package them for sale to the medical establishments and industry, or treat them for safe disposal.

The great majority of shielding bricks are used in permanent or semi-permanent installations. Sometimes, however, local shields may be used for relatively short periods — perhaps for just one simple operation — and then require rebuilding for an entirely different purpose. In this case, it is important that the system used may easily be handled by semi-skilled or unskilled labour, with the minimum of mechanical assistance. Wherever possible, the bricks should be limited in weight, and not easily damaged by repeated handling.

Interlocking lead bricks have been used for these purposes for many years. They are convenient to handle when shielding is being constructed or demounted. A range of components such as lead glass windows, glove apertures, and ball joint tongs are designed to be compatible with these systems.

Presently made lead bricks are shaped in a chevron pattern in order to permit interlocking of adjacent bricks to give a mechanically stable construction and to eliminate gaps ("short paths") through which radiation can escape. The bricks are normally made of a 4% antimonial lead alloy which is harder than pure lead and therefore more resistant to damage. The bricks are made in a standard nominal size of 4 inches by 4 inches, with standard thicknesses of 2 inches, 4 inches and sometimes greater.

The smallest thickness of lead brick in routine manufacture is 2 inches (50 mm). Walls built of bricks of smaller thickness lack mechanical stability. However, many operations with gamma emitting radionuclides do not require as much as two-inch thickness of shielding. Thus for working even with large amounts of commonly used medical radionuclides such as iodine—125 or technitium—99m, lead thickness of 0.1" to 0.5" may be entirely satisfactory. At present, shielding with lead of this thickness is usually carried out by using the disadvantage that the shielding cannot readily be made compatible with standard components such as windows and tongs. Furthermore, its assembly requires the use of skilled craftsmen.

The present invention seeks to eliminate or reduce the disadvantages of known bricks by providing a composite radiation shielding brick made up of a layer of metal for shielding laminated with a layer of plastics material to increase the thickness of the brick to thereby provide mechanical stability. In a preferred embodiment the brick takes the form of a sandwich of a layer of metal between two layers of plastics material. Preferably the metal is lead or a lead alloy.

The composite brick of this invention may be shaped around its edge in various ways in order to provide for mechanical interlocking of adjacent bricks and also to eliminate leakage paths for radiation. There are many possibilities, and some of these are to be described hereinafter. Preferably the thickness of the lead layer within the brick is increased locally at the mating regions to ensure that shielding is not impaired at the joins between bricks.

There are advantages to be gained in making the external shape and size of the bricks compatible with that of existing standard components, such as windows, glove apertures, and ball joint tongs, so that these components can be used directly with the composite bricks of this invention. On the other hand it is thought likely to be more satisfactory to have such components specially designed and manufactured. Furthermore, because the composite bricks of this invention are, size for size, of much reduced weight, a much larger standard brick is possible, thus leading to lower assembly times and fewer joints. For example a standard brick of 12 inches (or 330 mm) square is considered a practical possibility.

In order that the invention may be better understood, several embodiments will now be described by way of example only and with reference to the accompanying drawings in which:—

Figure 1 is a section on lines I—I of Figure 2 showing one embodiment of a composite brick in accordance with the invention;

Figures 2 and 3 are side and edge elevations respectively of the brick of Figure 1;

Figure 4 shows five different examples of corner connections using bricks as shown in Figures 1 to 3;

Figures 5 and 6 are a section and side elevation respectively of the brick of this invention adapted to form a closeable access or inspection aperture;

Figures 7 and 8 are sectional views of two embodiments of tong sphere units made in the manner of the bricks of this invention;

Figure 9 is a two-part side elevation showing on the left side and the right side the tong sphere units of Figures 7 and 8 respectively;

Figures 10 and 11 are a section and side elevation respectively of a window made in the manner of the bricks of this invention; and

Figure 12 is a simplified diagrammatic section through a mould suitable for use in manufacturing the bricks of this invention.

Referring firstly to Figures 1, 2 and 3 the brick comprises a layer 1 of metal, for example lead or lead alloy, sandwiched between two layers 2, 3 of hard plastics material. It may be found necessary to form projections 4 on both sides of the lead layer in order to ensure firm retention of the plastics layers with respect to the lead layer. Good adhesion of the plastics layer can, however, be ensured without the use of projections 4 by applying to the surface of the lead layer a suitable primer, such as lead oxide paint, or an adhesive, or by etching of the lead surface.

The bricks are shaped at their edges so that they may be mechanically interlocked with other bricks to form a structural wall. To this end, two sides of each brick are chamfered to form a protruding V-section, as shown under reference 5. The other two sides of each brick are formed with a re-entrant V-shaped groove 6 which corresponds in shape and dimension to the protruding section 5. Sections 5 and 6 form male and female components respectively which may interlock with corresponding components on other bricks to form a structurally stable wall. It is anticipated that the standard brick will be formed with two adjacent female edges and two adjacent male edges, as shown in Figure 2; however, the alternative in which each brick is formed with opposite male edges and opposite female edges will probably also be available.

In order to ensure than the shielding is not impaired at the joins between adjacent bricks, the lead layer 1 is enlarged around its perimeter in the manner illustrated in Figure 1. The two edges of the layer 1 which are associated with the male component are formed in the manner of an arrow head 7. The two edges associated with the female component are formed in the manner of an arrow tail 8. As will be explained more fully later, it is likely that the externally showing faces of the lead layer 1 in the region of the female component will not be flush with the adjacent plastics material, as shown, but will be slightly set back therefrom, thus leading to a potential gap between the lead layer 1 of adjacent bricks of up to 2 mm. This gap forms a leakage path for radiation which is blocked by the wings 9 of the tail 8 of the layer 1. To ensure no diminution of the shielding, these wings 9 must be at least as thick as the rest of the lead layer 1.

The shape of the brick is shown as being square (Figure 2) but other shapes are possible: indeed it is likely that a standard small-size brick will be produced. This will be rectangular in shape and will be such that three mounted together along their long sides will equal in size and shape the square brick shown. A typical size for the brick shown in Figures 1 to 3 is 300 mm. by 300 mm. with a thickness of 50 mm. Typically the lead layer 1 is 12 mm. in thickness, but this latter depends upon the degree of screening required. The small size brick referred to above will typically be 300 mm. by 100 mm.

Referring now to Figure 4 there is shown an enclosure 10 made from composite bricks of the type described above. The corners of the enclosure, be they at 90° or greater angles, can be dealt with in various ways, and the purpose of Figure 4 is primarily to illustrate some of these. All of the joints involve machining of the edge portions of the corner bricks to ensure both structural stability and a leakage-free joint. At a later date special corner bricks may be produced to avoid said machining. It is felt that the drawings, when taken in conjunction with the reference numerals used previously, are self-explanatory and will therefore not be described further except to point out that detail 11 shows the connection of a wall with a floor 12 of the enclosure.

Figures 5 to 11 show various specially designed components for use in enclosures and screens built with the bricks described above.

Figures 5 and 6 show an inspection or access aperture. The aperture itself, which is circular and typically of 240 mm. diameter, is formed in a standard 300 mm. square brick such as described above, and is given the reference 13. The outer face 14 of the brick is rebated around the aperture down to the level of the lead layer 1, thus forming an annular ledge 15 against which a removable door 16 can be mounted by means of bolts 17. The door 16 is circular in shape, to correspond with the aperture, and is formed as a laminate of metal 18, for example lead, and plastics 19, for example PVC, and has a handle 20 to assist removal. It will be seen that the overlapping of the lead layers in the region of the ledge 15 ensures that there is not reduction in the level of the screening. The bolts 16 are made of steel which itself has a screening effect equivalent to the lead.

Figures 7 to 9 show two types of tong sphere unit; that shown in Figure 8 and the right hand half of Figure 9 is the normal type, and comprises a steel sphere 21 having an aperture 22 therethrough for receiving tongs (not shown) by which items within the protected area may be handled with the safety from the exterior. The sphere 21 is mounted centrally within a circular door 23 which is of similar construction and is similarly mounted to the door 16 of Figures 5 and 6. Annular plates 24 are mounted sandwich fashion on opposite sides of the lead layer of door 23 to thus increase the area of contact between the sphere 21 and the door 23. The plates 24 are through-bolted by means of bolts 25.

The tong sphere unit shown in Figure 7 and the left-hand half of Figure 9 is a modified type particularly for use in enclosures of small size. Here the sphere 21 is offset in an outwards direction, typically by about 100 mm. (this latter dimension being the distance between the inside surface of the brick and the centre of the sphere). The door 23 has a central conical portion 26 and is thickened at 27 to provide an enlarged area for mounting of the sphere. A shroud 28 of plastics material is vacuum formed about the exterior of the door 23 and has a collar 29, once again to increase the area of contact between the sphere 21 and the door 23. Otherwise the construction is identical to the sphere unit of Figure 8.

Figures 10 and 11 illustrate a brick formed with a window 30 through which the protected area may be viewed. The window is made of 2 inch thick screening glass and has a typical size of 250 mm. by 150 mm. The glass is mounted in an otherwise standard brick of 300 mm. square in which is cut a suitably sized rectangular aperture. It will be noted that the edges of the window aperture are formed with a full width lead reveal 31, the space 32 between the reveal and the edge of the glass being filled with lead wool. The full-width reveal 31 is necessary because of the poor screening properties of the glass which latter, as can be seen, has to be of full brick width in order not to reduce the degree of screening in this region. A transparent cover 33 is formed on the exterior of the window for surface protection purposes. It is probable that circular windows will also be incorporated into the range of products.

A typical method of manufacturing the above-described bricks will now be described with particular reference to Figure 12. The lead layer 1 is supplied as a casting and is seated as shown on the shaped base-plate 34 of a mould. The flat sides of the mould are shown under reference 35 and the shaped to plate of the mould partly shown under reference 36. It will be noted that a small space 37 — typically 1 mm. — is left between the top plate 36 of the mould and the tail 8 of the lead layer 1. This is to allow for variations in the size of the insert 1 which cannot be cast to an accurate size. The brick as a whole, on the other hand, needs to be manufactured to fairly close tolerances in order to ensure stability in walls fabricated using the bricks. Existing lead bricks need to be machined to size after casting and this expensive process is eliminated by the above-described method. The plastics material is introduced into the mould cavity (actually two cavities since lead layer 1 acts as an almost complete partition) through two apertures 38 in the top plate 36. Preferably the plastics is a two-part type in which a hardener, mixed immediately prior to its introduction into the cavity, causes hardening of the plastics material within the cavity. A foam structural polyurethane has been found suitable for this purpose. During setting, the material expands to fill the cavity and may flash over the space 37. This flash, if it occurs, can either be chipped off or retained as desired.

The above described method enables bricks to be manufactured to the close tolerances required for structural stability without the need for expensive machining of the lead. This fact, together with the much lower amount of expensive lead or lead allow needed, enables the bricks to be produced much more cheaply than solid lead bricks are lighter in weight, a much larger brick can be used, thus effecting an additional cost saving in reduced erection time.

A further advantage of the bricks described above is that it may be possible to make the lead insert from pure lead, rather than the much more expensive lead-antimony alloy referred to above. The reason why alloy is used in existing bricks is to eliminate creep and to improve resistance to damage, particularly of the sharp edges and corners of the bricks. In the bricks described herein, the lead layer 1, being sandwiched between adjacent plastics layer is, to a large extent, supported and protected thereby and therefore the softer, and cheaper, lead can be used without fear of damage.

CLAIMS

1. A radiation shielding brick comprising a layer of metal for radiation shielding laminated with at least one layer of plastics material to provide mechanical stability.

2. A radiation shielding brick as claimed in claim 1 wherein said metal layer is sandwiched between two of said layers of plastics material.

3. A radiation shielding brick as claimed in claim 1 comprising a plurality of alternate layers of metal and plastics material.

4. A radiation shielding brick as claimed in any one of claim 1 to 3 which is shaped around its edge in such a way as to provide a mechanical interconnection for adjacent bricks.

5. A radiation shielding brick as claimed in claim 4 wherein the brick is of square or rectangular shape and wherein each edge of one pair of adjacent edges is so shaped as to mechanically fit into one or the other edge of the other pair of adjacent edges on another brick.

6. A radiation shielding brick as claimed in claim 5 wherein each edge of said one pair of adjacent edges is formed as a pair of sloping surfaces brought to a line contact in the manner of a ridge and where each edge of said other pair of edges on each brick is formed as a pair of inwardly sloping surfaces brought to a line contact in the manner of a valley.

7. A radiation shielding brick as claimed in any one of the preceding claims wherein the thickness of said metal layer is increased in the region of the edges of the brick in order to maintain shielding in joints between adjacent bricks.

8. A radiation shielding brick as claimed in any one of the preceding claims wherein said metal is lead.

9. A radiation shielding brick substantially as hereinbefore described with reference to the accompanying drawings.

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