(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 899 406 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.03.1999 Bulletin 1999/09

(51) Int Cl.6: **E05G 1/024**

(21) Application number: **98306526.9**

(22) Date of filing: **17.08.1998**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **23.08.1997 GB 9717838**

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(54) **Security receptacle**

(57) A method of manufacturing a safe body comprising a top wall, base wall back wall and two side walls includes the steps of (i) providing a hollow structure (1) defining inner and outer surfaces (2, 3) of the top, base and side walls and the inner surface (4) of the back wall, (ii) orientating the front of the structure lowermost, (iii) filling the structure with elements of hard material (6) in its portions corresponding to the top, base, back and side walls, (iv) injecting resin (9) into the structure, which resin expands upwardly to form a matrix of expanded elastomer (9') through the interstices between the elements of hard material within those portions of said structure corresponding to the top, base and side walls, and (v) injecting resin to form an expanded elastomer into that portion of the structure corresponding to the back wall, said resin expanding to form a matrix of expanded elastomer (13) through the interstices between the elements of hard material within the portion of the structure corresponding to the back wall, with the matrices of steps (iv) and (v) becoming bound together.

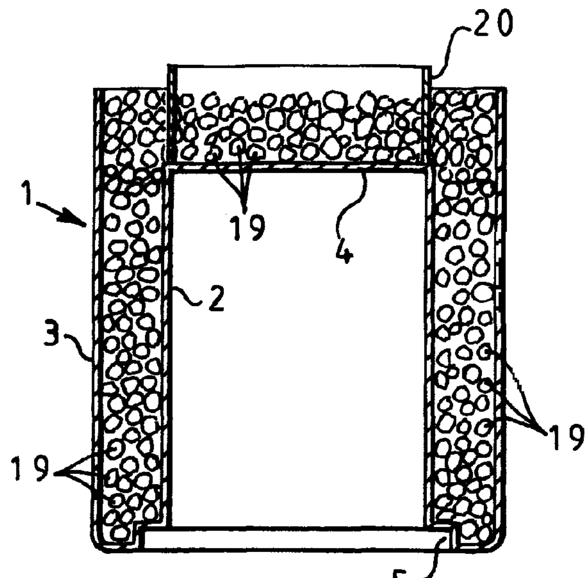

FIG 11

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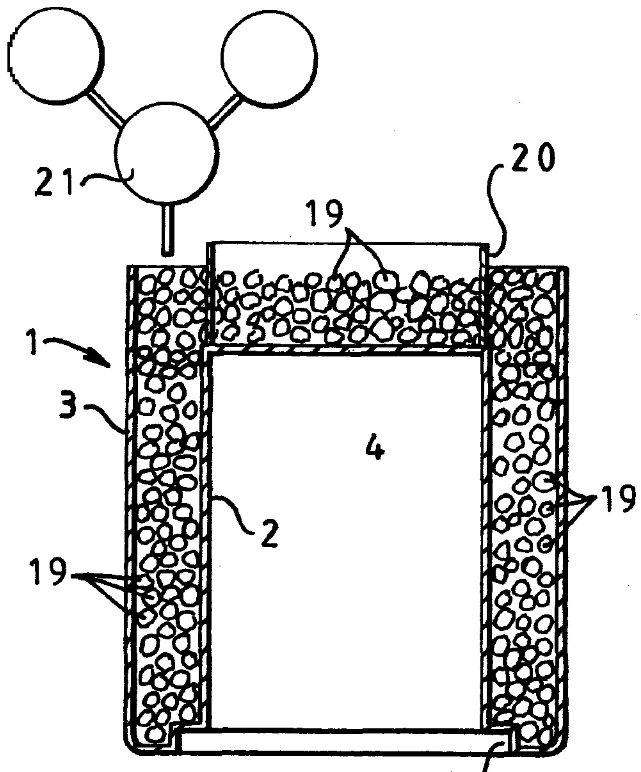

FIG 12

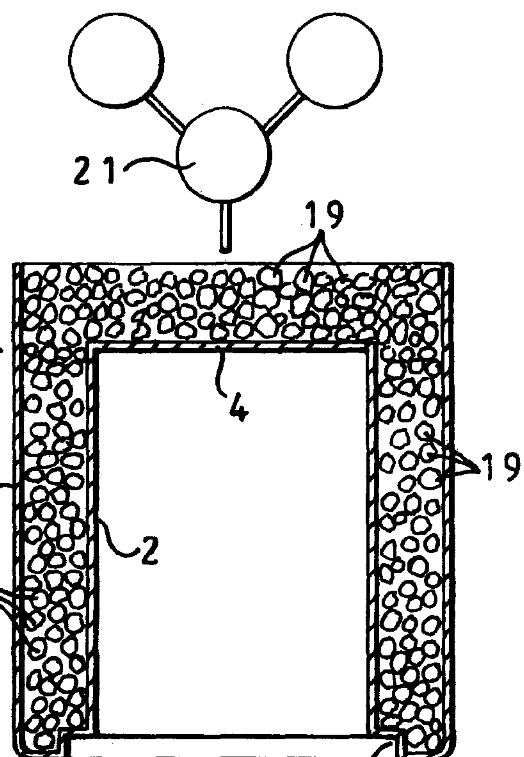

FIG 13

Description

[0001] The present invention relates to the manufacture of thief-resistant safes or the like security receptacles which incorporate in their structure a composite penetration-resistant barrier material comprising elements of hard material bound together by a cast elastomeric matrix.

[0002] Barrier materials of the above kind are known e.g. from GB-A-1427033, GB-A-1513609, DE-A-3241526 and GB-A-2197362. To reduce the cost of a barrier of this kind it has been proposed in EP-A-0348556 to use low-cost fillers such as sand or gravel in the elastomeric matrix. We propose an alternative approach in which an "expanded", that is to say foamed or microcellular, elastomer is used in place of the "solid" elastomer as the matrix material. In particular, it has been found that grades of expanded polyurethane with a porosity of up to 70% can perform adequately as the matrix material. For a given volume of barrier the mass of elastomer in the matrix can therefore be much reduced, with corresponding reduction of the material cost. The processing time for an expanded elastomer is also more rapid and the plant requirements are less than in the case of the solid material. The weight of the finished product is also reduced somewhat. In addition the amount of elastomer needing to be recovered during any eventual recycling is much reduced.

[0003] Expanded elastomers are produced by use of suitable foaming agents in their reactive components. For example expanded polyurethane can be produced by the inclusion of water in the polyol component which reacts with the isocyanate to generate CO_2. We have found that expanded polyurethane matrices for a composite barrier material of the above kind can be successfully cast either horizontally or vertically, that is to say (i) where the material is permitted to expand in a horizontal plane but to a required thickness which is small relative to the horizontal dimensions of the volume occupied, or (ii) where the material is constrained to expand upwardly in a vertical plane but to a required width which is small relative to the height of the volume occupied. No economical system of precursor chemistry has yet been found, however, which will give controlled expansion, in the desired density range, throughout the combination of vertical and horizontal dimensions that would be required to cast the matrix for the body of a safe, from a single point of entry.

[0004] To explain, a safe body can be viewed as a five-sided open box structure, that is to say a top wall, base wall, back wall and two side walls, with an open front to receive the safe door. It is traditional, in the case of high quality safes, to cast the barrier material (or at least the matrix in the case of a composite barrier material) into the safe body in a single operation to form a monolithic "bell" structure conforming to the shape of the aforesaid five sides of the body. This avoids the occurrence of joints in the barrier material, which could constitute a security weakness. The present invention seeks to provide methods for the manufacture of a safe body using a composite barrier material with an expanded elastomer matrix which can achieve as far as possible a similar "bell" structure.

[0005] In one aspect, the present invention resides in a method for manufacturing the body of a safe comprising a top wall, base wall, back wall and two side walls, the method comprising the steps of: (i) providing a hollow structure to define the inner and outer surfaces of said top, base and side walls and the inner surface of said back wall; (ii) supporting said hollow structure with its portion corresponding to the front of the safe body lowermost; (iii) placing into said structure elements of hard material to occupy those portions corresponding to said top, base and side walls and optionally that portion corresponding to said back wall; (iv) directing into the lower region of said structure (as thus orientated) a quantity of resin to form an expanded elastomer; (v) allowing said resin to expand upwardly to form a matrix of expanded elastomer through the interstices between said elements of hard material within those portions of said structure corresponding to said top, base and side walls; (vi) if not done so at step (iii), placing elements of hard material into said structure to occupy that portion corresponding to said back wall; (vii) directing a quantity of resin to form an expanded elastomer into that portion of said structure corresponding to said back wall; and (viii) allowing said resin of step (vii) to expand to form a matrix of expanded elastomer through the interstices between said elements of hard material within that portion of said structure corresponding to said back wall, said matrix of step (viii) becoming intimately bound to said matrix of step (v).

[0006] In another aspect, the invention resides in a method for manufacturing the body of a safe comprising a top wall, base wall, back wall and two side walls, the method comprising the steps of: (i) providing a hollow structure to define the inner and outer surfaces of said top, base and side walls; (ii) supporting said hollow structure with its portion corresponding to the front of the safe body lowermost; (iii) placing into said structure elements of hard material to occupy those portions corresponding to said top, base and side walls; (iv) directing into the lower region of said structure (as thus orientated) a quantity of resin to form an expanded elastomer; (v) juxtaposing to the top of said structure (as thus orientated) a panel to form said back wall of the safe body, said panel including a composite barrier material comprising elements of hard material bound together by a cast matrix of expanded elastomer; and (vi) allowing said resin of step (iv) to expand upwardly to form a matrix of expanded elastomer through the interstices between said elements of hard material within those portions of said structure corresponding to said top, base and side walls, said matrix of step (vi) becoming intimately bound to said matrix of step (v).

[0007] In a further aspect, the invention resides in a method for manufacturing the body of a safe comprising a top wall, base wall, back wall and two side walls, the method comprising the steps of: (i) providing a hollow structure to define the inner and outer surfaces of said top, base and side walls and the inner surface of said back wall; (ii) supporting said hollow structure with its portion corresponding to the front of the safe body lowermost; (iii) placing into said structure elements of hard material to occupy those portions corresponding to said top, base and side walls and optionally that portion corresponding to said back wall; (iv) directing into the upper region (as thus orientated) of that portion of said structure corresponding to said top, base and side walls a quantity of resin to form an expanded elastomer and allowing said resin to flow towards the lower region thereof but not into that portion corresponding to said back wall; (v) if not done so at step (iii), placing elements of hard material into said structure to occupy that portion corresponding to said back wall; (vi) directing a quantity of resin to form an expanded elastomer into that portion of said structure corresponding to said back wall; and (vii) allowing said resin of steps (iv) and (vi) to expand to collectively form a matrix of expanded elastomer through the interstices between said elements of hard material within the whole of said structure. Preferably this method also includes the step, after step (vi), of applying to said structure a further structure to define the outer surface of said back wall, where said further structure constrains the expansion of said resin such that the density of the resultant expanded elastomer is higher than the free rise density thereof.

[0008] The invention will now be more particularly described, by way of example, with reference to the accompanying schematic drawings, in which:-

Figures 1 to 8 illustrate successive stages in the manufacture of the body of a safe in accordance with a first embodiment of the invention;
Figures 9 and 10 illustrate successive stages of a second embodiment thereof; and
Figures 11 to 14 illustrate successive stages of a third embodiment thereof.

[0009] Referring to Figure 1, there is illustrated in cross-section a structure 1 which may for example be fabricated from sheet steel or moulded in glass-reinforced plastics and comprises the inner and outer finishing skins 2 and 3 of the two side walls, top wall and base wall of a safe body, together with the inner finishing skin 4 of the back wall. A rebated door opening 5 is defined around the front edges of the side, top and base walls.

[0010] The structure 1 is supported in a suitable jig (not shown) with the door opening 5 lowermost and, as shown in Figure 2, the space between the two skins 2 and 3 which forms the side, top and base walls of the safe body is
filled with loose nuggets 6 (not drawn to scale) of a hard and refractory material which in the finished product will provide resistance to attack by means of mechanical and thermal cutting tools. The chosen material may be any one of the materials well known for this purpose in the manufacture of thief-resistant safes, such as sintered or fused alumina or zirconia, Turkish Emery or other minerals such as quartzite, granite or basalt, or other granular materials such as silicon carbide. At the same time or immediately prior to inserting the nuggets 6, respective tubes 7 are positioned within each of those wall spaces for the subsequent step of resin injection.

[0011] Next, a measured quantity of mixed polyurethane resin 9 is injected into the lower region of the space between the two skins 2 and 3. As schematically indicated in Figure 3, this is pumped into the structure from a conventional mixing head 8 fed with the respective polyol and isocyanate components of the resin, and which is connected to the tubes 7 to distribute the resin evenly into each of the four nugget-filled wall spaces. The tubes 7 are then withdrawn. The polyol includes a foaming agent and the quantities are so chosen that the resin 9 foams upwardly through the interstices between the nuggets 6 in the space between the skins 2 and 3 to a height corresponding to that of the rear wall skin 4. As shown in Figure 4, there thus results a matrix of expanded polyurethane 9' which when fully cured will strongly bind the nuggets 6 together and to the skins 2 and 3 in the side, top and base walls of the safe body.

[0012] Turning to Figure 5, the remaining space within the structure 1, that is to say the space above the skin 4 and the formed barrier 6/9 which is destined to form the back wall of the safe body, is filled with loose nuggets 10 of the same material as nuggets 6, together with the installation of a tube 11. Then, as indicated in Figure 6, a measured quantity of mixed polyurethane resin (not shown) is injected into that space through the tube 11 from a conventional mixing head 12 fed with the respective polyol and isocyanate components. As in the case of the previous polyurethane injection the polyol includes a foaming agent, and in this case the quantities are so chosen that the resin expands through the interstices between the nuggets 10 to fill the remaining space to the height of that layer of nuggets. As shown in Figure 7, there thus results a second matrix of expanded polyurethane 13, which when fully cured will strongly bind the nuggets 10 together and to the skin 4. It also forms an intimate bond with the fresh polyurethane 9' in the side, top and base walls of the body. The structure can be finished, as shown in Figure 8, with a rear skin panel 14 attached to the skin 3.

[0013] To provide a useful economic advantage compared with the manufacture of safe bodies with "solid" polyurethane matrices, while maintaining the penetration-resistant integrity of the composite barrier material, the porosity of the expanded polyurethane in the matrices 9' and 13 is preferably at least 30% but not more than 70%. The optimum density valve depends upon the specific grade of product, but will preferably be within the range 450 to 600 kg/m^3. Provided that the second polyurethane injection (Fig 6) follows the first (Fig 3) sufficiently rapidly, the two matrices will bond together strongly and their interface will not constitute a security weakness of the overall structure. The polyurethane formulation need not be the same in each case, however, and indeed the first injection will be optimised for the deep foaming required to fill the side, top and base walls of the body (vertical casting) while the second injection will be optimised for the wider but shallower foaming required to fill the back wall (horizontal casting).

[0014] In a variant of the above-described process, the whole of the space within the structure 1 - i.e. corresponding to the side, top, base and back walls - is filled with the hard nuggets 6/10 in one operation, together with the installation of the tubes 7 and 11, at the Figure 2 stage. The subsequent polyurethane injection is still accomplished in two stages (Figs. 3 and 6), however.

[0015] A more significant variation will now be described with reference to Figures 9 and 10. In this process the same steps as described above with reference to Figures 1 to 3 are performed. The back wall of the safe is prepared separately, however. As shown in Figure 9, the back wall 15 comprises a plate 16 upon which a composite barrier material comprising hard and refractory nuggets 17 bound within an expanded polyurethane (elastomer) matrix 8 has been formed. This can be prepared by placing the plate in a suitable mould form, filling with the nuggets 17 and then casting in the resin, (which need not be the same as resin 9), to form the matrix 18.

[0016] As soon as the polyurethane resin has been injected into the space between the skins 2 and 3 as at Figure 3, the tubes 7 are withdrawn and the prepared back wall 15 is brought into place. The back wall 15 is held in the jig in its correct final position relative to the structure 1 while the resin foams up between the skins 2 and 3 to form the matrix 9' (Figure 10) in the side, top and base walls of the body (provision will be made for venting air displaced from the space between the skins 2 and 3 as the polyurethane rises). If the polyurethane 18 of the back wall 15 is still sufficiently fresh when assembled with the structure 1, the polyurethane cast in-situ as the matrix 9' can bond to it sufficiently strongly to resist separation of the back wall as a whole in an attack upon the safe. Additionally or alternatively, the back wall 15 may be provided with mechanical anchors such as perforated or convoluted metal strips (not shown) which extend from that wall into the space between the skins 2 and 3 and become embedded in the matrix 9' when the latter is formed.

[0017] This second embodiment of the invention where the back wall is prepared separately from the remainder of the safe body may be found preferable when safes are made on a flow line to achieve manufacturing efficiencies, as only one polyurethane injecting operation need take place actually on the flow line. It is also particularly advantageous in the case of safes designed as enclosures for automated teller machines (ATMs). Such an enclosure must be provided with apertures through its back wall (i.e. the wall which is in practice presented to the customers) to dispense money and take in deposits and special measures must be taken to design in and adequately protect these apertures. The second embodiment of the present invention therefore provides a convenient way in which a range of different safes configured to particular ATM designs can be produced by using different backs on an otherwise common body structure.

[0018] A further embodiment of the invention will now be described with references to Figures 11-14. In this case the structure 1 of Figure 1 is prepared and supported as before, and the whole of the hollow space, i. e. corresponding to the sides, top, base and back wall of the safe, is filled with loose nuggets 19 of hard and refractory material. No tubes are installed in this case but, as shown in Figure 11, a rectangular frame 20 constructed from thin metal plate is temporarily positioned over the inner skin 4 of the back wall, to segregate the top of the structure into a central portion above the skin 4 and an outer ring above the space between the skins 2 and 3. Next, a measured quantity of mixed polyurethane resin (not shown) is poured from above the structure into the space between the skins 2 and 3. As indicated in Figure 12, this is accomplished by traversing a mixing head 21 around the top of the structure, to the outside of the frame 20, perhaps making several revolutions, while the mixed resin, containing a foaming agent, is dispensed at a predetermined rate. The passage of the mixing head is timed so that the requisite quantity of resin passes into the outer ring of the structure, evenly distributed around the four wall spaces. In the interval before the foaming commences, the resin percolates down between the nuggets 19 under gravity, into the space between the skins 2 and 3, the frame 20 serving to ensure that none of it spills into the segregated space above the skin 4.

[0019] The frame 20 is then removed and immediately afterwards a second measured quantity of the same or a different resin (not shown) is poured from the mixing head 21 into the top of the structure, as indicated in Figure 13. The head 21 may be traversed around the whole of the top of the structure to evenly distribute the resin into the space which will form the back wall of the safe. A back finishing skin 22 is then positioned to the structure as shown in Figure 14, and firmly held in place in the jig while the resin foams. The nuggets 19 could be placed in the segregated portion corresponding to the back wall only after the first foaming has been effected. This single shot casting embodiment is most convenient.

[0020] The quantities of resin poured in at the Figures 12 and 13 stages are chosen so that they will collectively expand to form a matrix 23 of selected density filling the interstices between the nuggets 19 in the whole of the safe body structure. More particularly, the first quantity is chosen to fill the side, top and base walls at this den-

sity up to the level of the skin 4 while the second quantity is chosen to fill the back wall. The resin in this case is chosen to have a free rise density less than the desired density of the matrix material. In other words, where it not for the application of the back panel 22 before the material foams, it would expand to the extent of overflowing from the structure. Vent holes are provided in the structure to allow displaced air to escape while the material is initially expanding, but these are plugged as soon as the polyurethane reaches them. It has been found that the effect of constraining the expansion of the polyurethane in this way is to improve the homogeneity of the resultant matrix material, i.e. tends to equalise the cell size in the matrix throughout the structure. By way of example, to produce
a matrix 23, of expanded polyurethane with a density of between 450 and 600 kg/m^3, the free rise density of the material used in this process is preferably within the range 200-250 kg/m^3, most preferably around 230 kg/m^3.

[0021] When fully cured, the resultant homogeneous matrix 23 strongly binds the nuggets 19 together and to the skins 2, 3, 4 and 22. To improve the resistance to delamination of the skin 22 it may be provided with welded-on mechanical anchors (not shown) such as perforated or convoluted metal strips projecting into the mass of matrix material in the back wall of the safe. To resist delamination generally it is possible to coat some or all of the internal surfaces of the structure with an adhesive primer to provide a chemical bond. This is in addition to, or instead of, use of the anchors etc mentioned above.

[0022] It is within the scope of the invention for any of the finishing skins such as 1, 2, 4, 14, 17 or 22 in the above-described embodiments to be dispensed with and to replace them with mould forms against which the polyurethane is cast to define the relevant external surfaces of the safe body.

Claims

1. A method for manufacturing the body of a safe comprising a top wall, base wall, back wall and two side walls, the method comprising the steps of: (i) providing a hollow structure to define the inner and outer surfaces of said top, base and side walls and the inner surface of said back wall; (ii) supporting said hollow structure with its portion corresponding to the front of the safe body lowermost; (iii) placing into said structure elements of hard material to occupy those portions corresponding to said top, base and side walls and optionally that portion corresponding to said back wall; (iv) directing into the lower region of said structure (as thus orientated) a quantity of resin to form an expanded elastomer; (v) allowing said resin to expand upwardly to form a matrix of expanded elastomer through the interstices between said elements of hard material within those portions of said structure corresponding to said top, base and side walls; (vi) if not done so at step (iii), placing elements of hard material into said structure to occupy that portion corresponding to said back wall; (vii) directing a quantity of resin to form an expanded elastomer into that portion of said structure corresponding to said back wall; and (viii) allowing said resin of step (vii) to expand to form a matrix of expanded elastomer through the interstices between said elements of hard material within that portion of said structure corresponding to said back wall, said matrix of step (viii) becoming intimately bound to said matrix of step (v).

2. A method as claimed in Claim 1, wherein different resins are directed into the lower region of said structure and into that portion of said structure corresponding to said back wall respectively.

3. A method as claimed in Claim 1 or Claim 2, wherein at step (vi) elements of hard material are placed in said structure to occupy that portion corresponding to said back wall.

4. A method as claimed in Claim 3, wherein at step (iii), or immediately prior thereto, tubing means are inserted into the structure for injecting said resin into the portions corresponding to said top, base and side walls.

5. A method as claimed in Claim 4, wherein at step (vi) tube means is inserted into that portion of the structure corresponding to said back wall for injecting resin as at step (vii).

6. A method as claimed in Claim 1 or Claim 2, wherein at step (iii) elements of hard material are placed in said structure to occupy that portion corresponding to said back wall.

7. A method as claimed in Claim 6, wherein at step (iii) tubing means are inserted into the structure for initially injecting resin as at step (iv) and thereafter injecting resin as at step (vii).

8. A method as claimed in any one of the preceding claims, wherein after step (viii) the structure is formed with an outer surface of said back wall.

9. A method for manufacturing the body of a safe comprising a top wall, base wall, back wall and two side walls, the method comprising the steps of: (i) providing a hollow structure to define the inner and outer surfaces of said top, base and side walls and the inner surface of said back wall; (ii) supporting said hollow structure with its portion corresponding to the front of the safe body lowermost; (iii) placing into said structure elements of hard material to occupy

those portions corresponding to said top, base and side walls; (iv) directing into the lower region of said structure (as thus orientated) a quantity of resin to form an expanded elastomer; (v) juxtaposing to the top of said structure (as thus orientated) a panel to form said back wall of the safe body, said panel including a composite barrier material comprising elements of hard material bound together by a cast matrix of expanded elastomer and (vi) allowing said resin of step (iv) to expand upwardly to form a matrix of expanded elastomer through the interstices between said elements of hard material within those portions of said structure corresponding to said top, base and side walls, said matrix of step (vi) becoming intimately bound to said matrix of step (v).

10. A method as claimed in any one of Claims 9 in which said panel is prepared by placing a plate in a mould, filling the mould with hard material and casting in the resin to form the barrier material.

11. A method as claimed in Claim 10, wherein an aperture is formed through said panel.

12. A method as claimed in any one of Claims 9 to 11, wherein at step (iii), or immediately prior thereto, tubing means are inserted into the structure for injecting said resin into said top, base and side walls.

13. A method as claimed in Claim 12, wherein once step (iv) has been effected said tubing means are withdrawn and the panel is held in a jig in its correct final position whilst step (vi) is completed.

14. A method as claimed in any one of Claims 9 to 13, wherein said panel has mechanical anchors which extend into at least some of the spaces defined between said inner and outer surfaces of said top, base and side walls respectively so as to become embedded in the matrix of step (vi).

15. A method as claimed in any one of Claims 9 to 14, wherein the resin and the elastomer are different materials.

16. A method for manufacturing the body of a safe comprising a top wall, base wall, back wall and two side walls, the method comprising the steps of: (I) providing a hollow structure to define the inner and outer surfaces of said top, base and side walls and the inner surface of said back wall; (ii) supporting said hollow structure with its portion corresponding to the front of the safe body lowermost; (iii) placing into said structure elements of hard material to occupy those portions corresponding to said top, base and side walls and optionally that portion corresponding to said back wall; (iv) directing into the upper region (as thus orientated) of that portion of said structure corresponding to said top, base and side walls a quantity of resin to form an expanded elastomer and allowing said resin to flow towards the lower region thereof but not into that portion corresponding to said back wall; (v) if not done so at step (iii), placing elements of hard material into said structure to occupy that portion corresponding to said back wall; (vi) directing a quantity of resin to form an expanded elastomer into that portion of said structure corresponding to said back wall; and (vii) allowing said resin of steps (iv) and (vi) to expand to collectively form a matrix of expanded elastomer through the interstices between said elements of hard material within the whole of said structure.

17. A method as claimed in Claim 17, which also includes the step, after step (vi), of applying to said structure a further structure to define the outer surface of said back wall, where said further structure constrains the expansion of said resin such that the density of the resultant expanded elastomer is higher than the free rise density thereof.

18. A method as claimed in Claim 17, wherein said further structure has mechanical anchors which extend into said expanded elastomer in the back wall.

19. A method as claimed in any one of Claims 16 to 18, wherein a frame is positioned over the inner wall of the back wall to provide a segregated space from which the resin of step (iv) is excluded.

20. A method as claimed in Claim 19, wherein the frame is removed after step (iv) and steps (v), (vi) and (vii) or steps (vi) and (vii) are then carried out.

21. A method as claimed in any one of Claims 16 to 20, wherein at step (iii) elements of hard material are placed in said structure to occupy that portion corresponding to said back wall.

22. A method as claimed in any one of Claims 16 to 20, wherein at step (v) elements of hard material are placed in said structure to occupy that portion corresponding to said back wall.

23. A method as claimed in any one of the preceding claims, wherein the resin includes respective polyol and isocyanate components which react to form expanded polyurethane.

24. A method as claimed in Claim 23, wherein the porosity of the expanded polyurethane is at least 30% but not more than 70%.

25. A method as claimed in Claim 23 or Claim 24, wherein the density of the expanded polyurethane is between 450 and 600 kg/m^3.

26. A method as claimed in Claim 25, wherein the resin has a free rise density of 200 to 250 kg/m^3.

27. A method as claimed in any one of the preceding claims, wherein the hard material is loose nuggets.

28. A method as claimed in any one of Claims 1 to 27, wherein the hard material is a refractory material.

29. A safe body as produced by the method of any one of Claims 1 to 8, or Claims 9 to 15, or Claims 16 to 22.

30. A method substantially as hereinbefore described, with reference to, and as shown in Figures 1 to 8, or Figures 9 and 10, or Figures 11 to 14 of the accompanying drawings.

31. A safe body substantially as hereinbefore described, with reference to, and as shown in Figure 8, or Figure 10, or Figure 14 of the accompanying drawings.

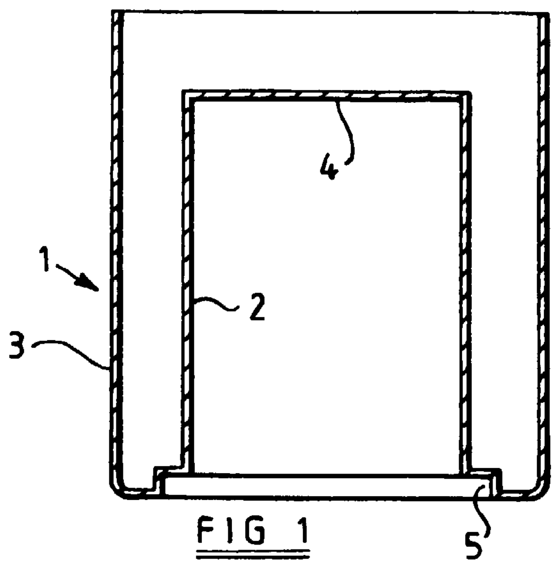

FIG 1

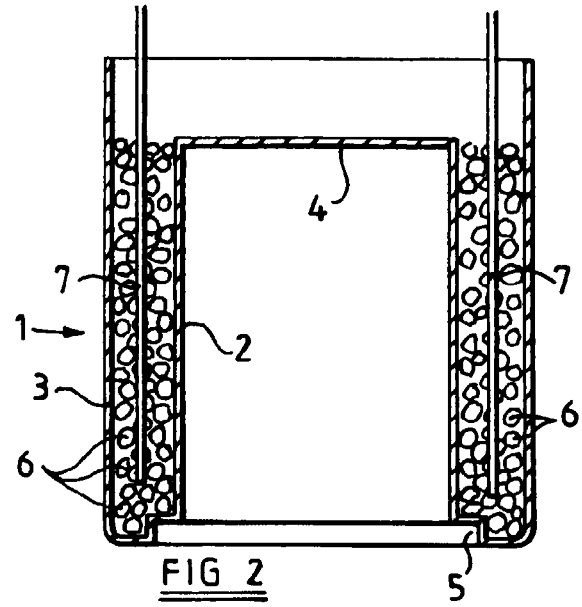

FIG 2

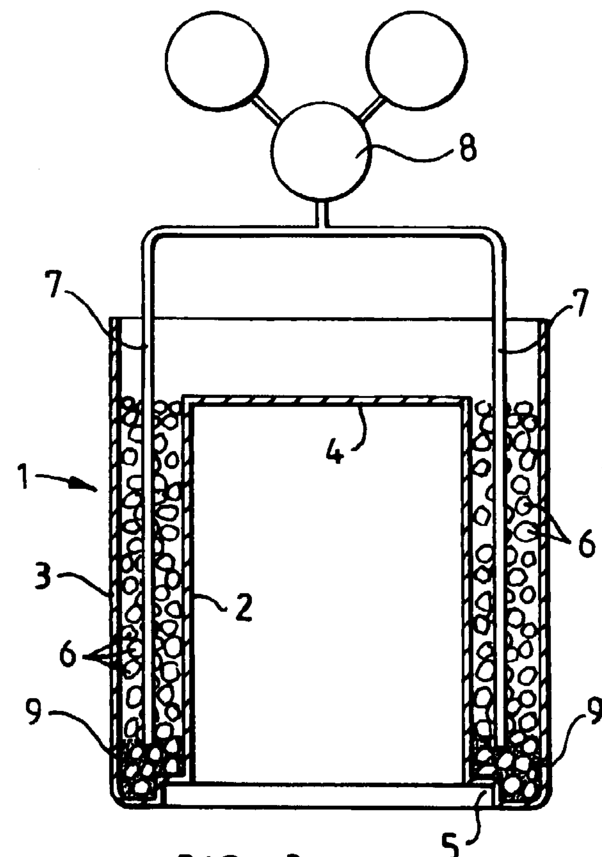

FIG 3

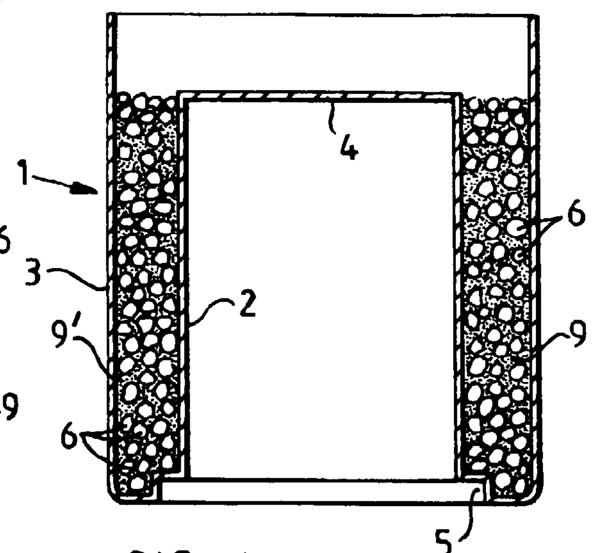

FIG 4

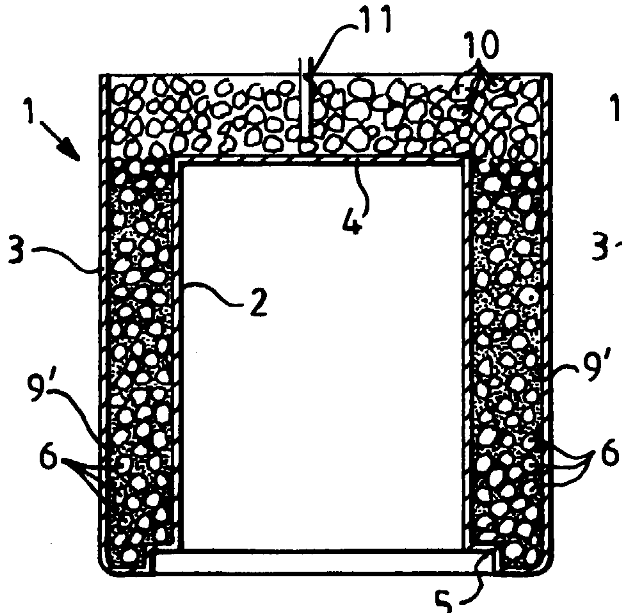

FIG 5

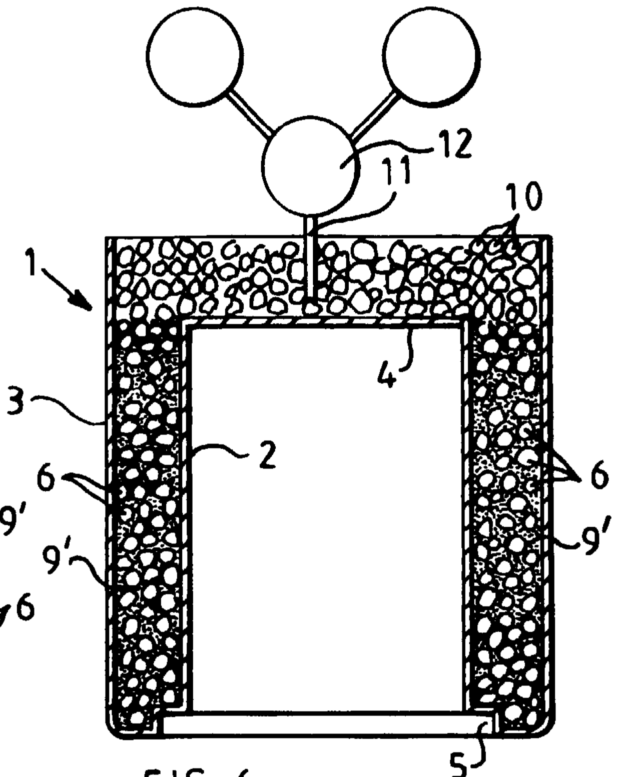

FIG 6

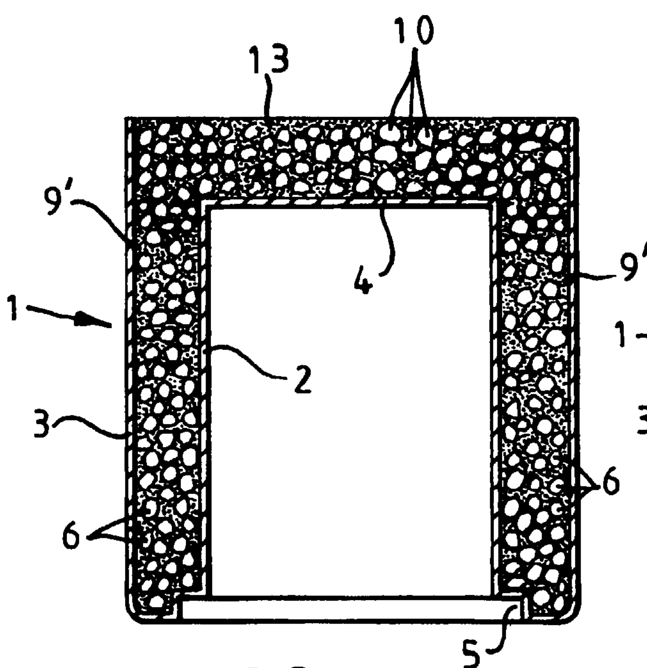

FIG 7

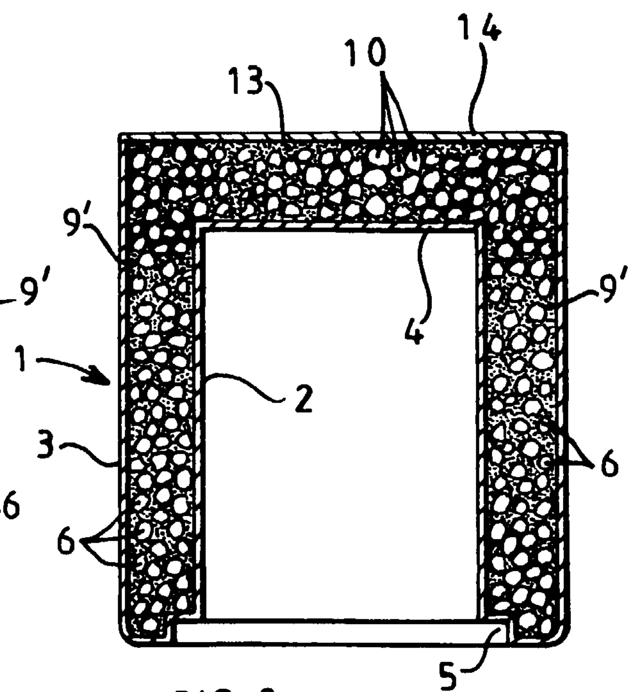

FIG 8

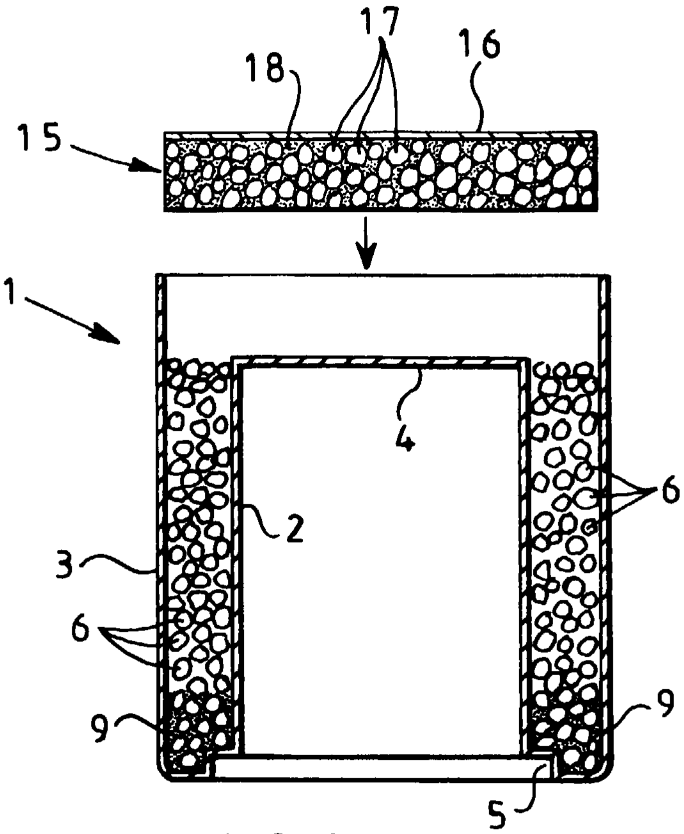

FIG 9

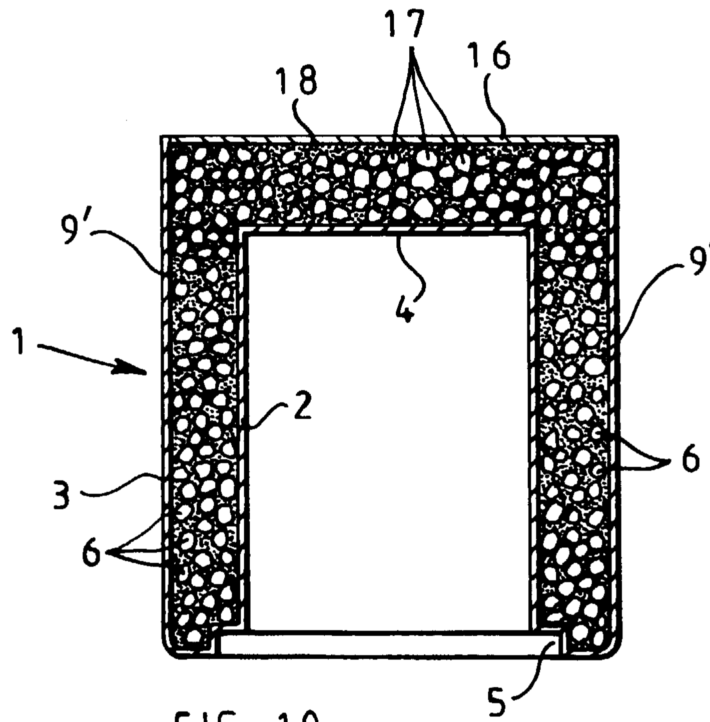

FIG 10

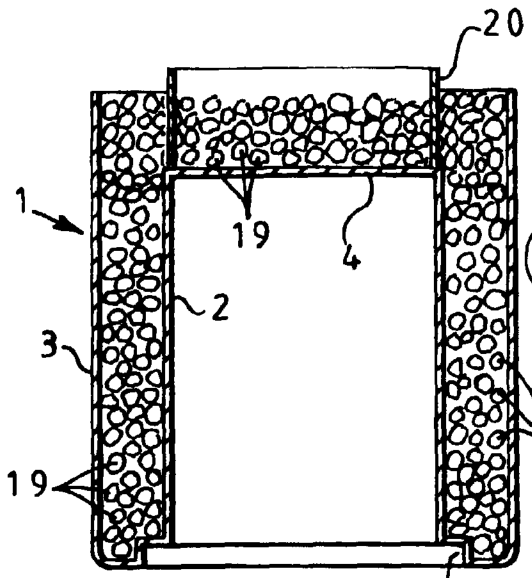

FIG 11

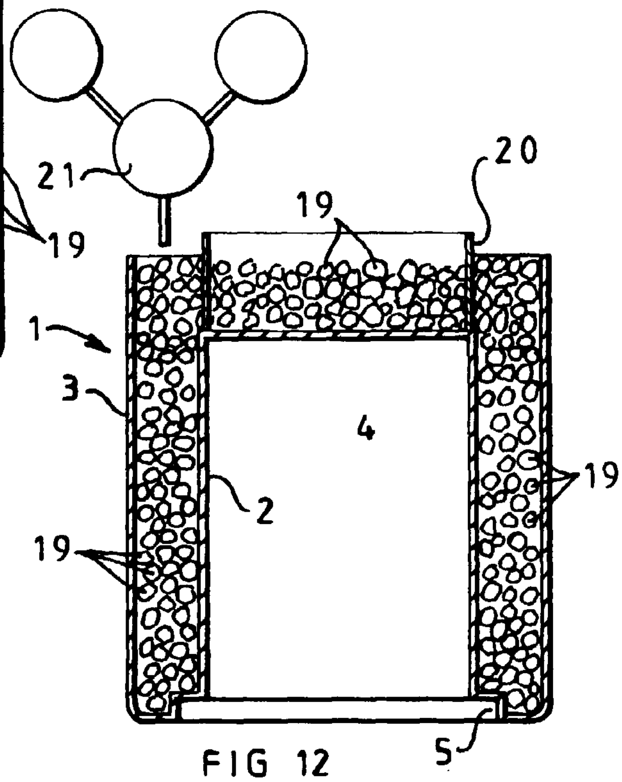

FIG 12

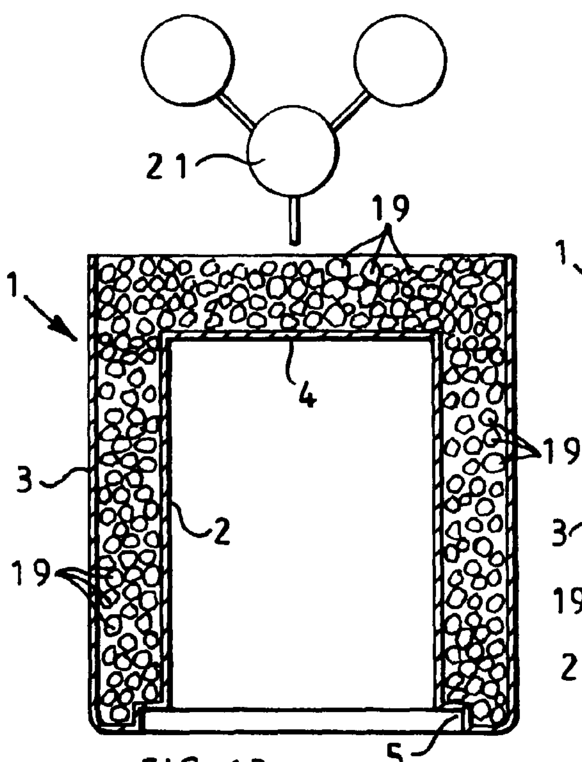

FIG 13

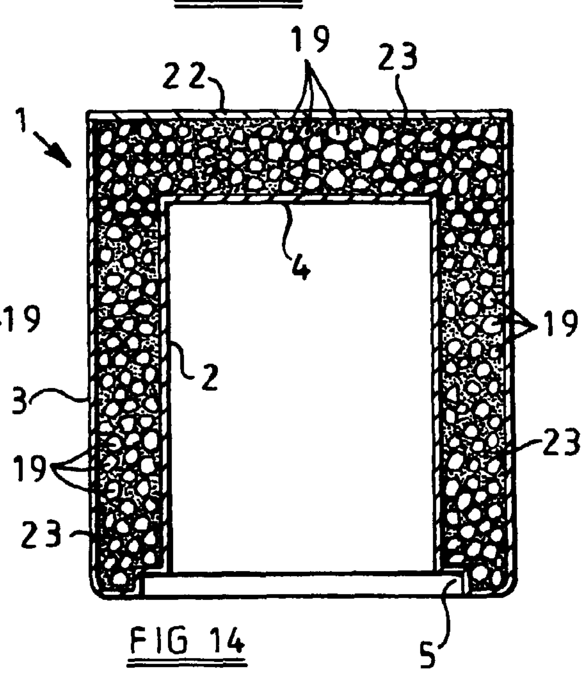

FIG 14