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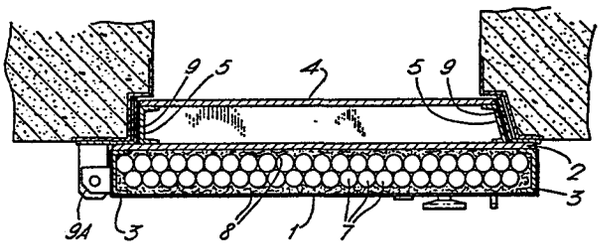
(54) Security barrier structure.

(57) A barrier structure particularly for use in protective doors designed to resist explosive charges applied to their outer surfaces, comprises a multiplicity of water-filled containers 7 located behind the outer door plate 1. The purpose of the water is to absorb the shock and thermal energy of an explosion occurring at or near the outer plate 1 and thus shield the rearward portions 2,4 of the structure from the damaging effects of the blast. For thief-resisting applications (Figs 3 and 4, not shown) the structure also comprises various layers of different materials selected for resistance to other, non-explosive burglary tools, disposed rearwardly of the explosion-resistant water layer.



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Security Barrier Structure

The present invention relates to security barrier structures and aims in particular to provide a structure having a high degree of resistance to penetration by the action of explosive charges applied to the outer surface of the structure. Barriers in accordance with the invention are intended especially for use in the construction of doors for buildings or other structures which are liable to come under explosive attack at the hands of burglars or saboteurs for example, although they may also find utilisation in the walls or other fixed boundaries of such structures.

The prior art provides many barrier structures intended for use in, for example, the doors of bank vaults and the like security enclosures, which are designed to provide a high degree of resistance to penetration with drills, punches, flame-cutting equipment and other mechanical and thermal tools commonly appropriated by burglars. Generally speaking,

however, the materials and modes of construction employed in these structures are not well suited to resist the effects of high-explosive surface charges of even modest proportions. It is to the provision of structures providing protection from this kind of attack that the invention is principally directed, it being recognised that there is currently a demand for the protection of various kinds of building from explosive attacks which may be mounted not with burglarious intent but with the aim simply of causing damage to the structure and its contents or occupants. Clearly, any such structure must be designed to withstand the physical shock of the blast. Furthermore, we believe that another significant factor contributing to the potential damage of a structure when an explosive charge is detonated at or near its surface is the near-instantaneous release of thermal energy in the explosion, which is not only per se destructive to material within its influence but also exacerbates the blast pressure effects.

Consequently, we believe that successfully to resist attacks of the nature indicated above a structure should be designed to withstand both the mechanical and thermal effects of an explosion and with this aim in mind the invention proposes an explosion-resistant barrier structure comprising a rearward portion adapted to provide a physical barrier between the two sides of the structure; a forward portion spaced from the rearward portion and providing the exposed face of the structure; and a multiplicity of liquid-filled receptacles packed into a space between said forward and rearward portions and adapted to protect said rearward portion from the effects of an explosive charge detonated at or near to said exposed surface.

The purpose of the aforesaid liquid-filled receptacles is to absorb much of both the physical shock and the thermal energy released on detonation of an explosive charge at or near to

the exposed surface of the structure, so that the rearward portion of the structure can be protected from these influences and retain its integrity as a physical barrier notwithstanding the partial destruction or breaching of the portions of the structure in front of it. In this respect we believe it is imporant, from the point of view of shock absorption, to provide the liquid in a multiplicity of individual receptacles with certain free spaces between them rather than as, say, a single reservoir filling the space between the forward and rearward portions of the structure - the tendency in the latter case would be for shock waves to be transmitted through the reservoir to the rearward portion. Problems of potential leakage of the liquid would also be more serious in the case of a single reservoir.

Preferably, the aforesaid liquid is water, conveniently provided in plastics containers, water being admirably suited to the thermal absorption task by virtue of its high specific and latent heats and also, of course, having the advantage of ready availability and minimal cost.

In structures according to the invention provided for thief-resisting applications, eg in bank vaults and the like, the aforesaid rearward portion of the structure will be constructed with materials chosen for resistance to penetration by the different kinds of tools likely to be found in the thieves' armoury, and an example of the invention exhibiting such construction will be more particularly described hereinafter. However, this is not an essential feature of the invention and in other applications, where a high degree of resistance to attack with tools other than explosives is not necessarily required, the rearward portion may be of relatively simple construction sufficient for the

purpose of providing a chosen degree of separation between the two sides of the structure (presupposing that the forward and intermediate portions might be breached by an explosive attack).

In general, the forward portion of the structure need comprise little more than an outer finishing layer of the structure, eg a steel sheet, although in some embodiments this area of the structure may be developed to still further enhance resistance to explosive attacks or for other special purposes. It is desirable for this forward portion to be suitably mounted, such as by means of rivets, to enable it to become detached from the remainder of the structure relatively easily under the influence of an outward force exerted on the forward portion - with this arrangement, the forward portion may become detached under the influence of the blast pressure transmitted to the interior of the structure if the forward portion is breached by an explostion at or near its exposed surface. This detachment of the forward portion serves to dissipate the effects of the explosion and so allow the blast to be spread over a larger area of the liquid layer than might be the case if the forward portion remained rigidly secured to the rest of the structure. The liquid layer is therefore protected from a concentration of the blast in a relatively small area and may thus be better able to absorb its effects.

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

Figures 1 and 2 are respectively horizontal and vertical sections through one embodiment of a blast-resistant door made in accordance with the invention; and

Figures 3 and 4 are respectively horizontal and vertial sections through a second embodiment of a barrier structure in accordance with the invention, for incorporation in a blast and thief-resistant door.

Referring to Figures 1 and 2 the illustrated door comprises essentially a double box-like structure. One "box" is composed of a steel plate 1 - which provides the outer face of the structure - attached to an intermediate steel plate 2 via framing sections 3. The other "box" is composed of a steel backplate 4 welded to the plate 2 via framing sections 5 and horizontal stringers 6. Within the first of these compartments there is a multiplicity of sealed water-filled plastics containers 7 packed into the space between plates 1 and 2 with layers of slag wool 8. In the completed door structure the rearward compartment between plates 2 and 4 houses a driving and locking mechanism (not shown) to throw door bolts into the associated frame 9, to which the door is hinged at 9A.

The purpose of the water layer in this structure is, as indicated above, to confer resistance to an explosive attack upon the door by acting to absorb the shock effects and thermal energy released by an explosion at or near the outside doorplate 1. To demonstrate the efficacy of this type of structure the following test was conducted.

A test specimen was constructed generally in accordance with Figures 1 and 2 hereof and having the following chracteristics: the overall thickness of the structure was 343mm; plate 1 was 3mm thick mild steel; plates 2 and 5 were both 20mm thick mild steel; and the water layer comprised 434 approximately ½ litre containers 7. The specimen was

supported in a rig to simulate its mounting to the associated door frame and a 5kg charge of type PE4 (Cyclonite-based) plastic explosive was applied to the surface of plate 1. When the charge was detonated the plate 1 was destroyed and the water dissipated, but the plates 2 and 4 remained intact and bolted to the frame, with some plastic deformation, so that the barrier as a whole was not breached.

Turning now to Figures 3 and 4 these show another embodiment of the invention which is designed to provide not only resistance to explosive attacks but also to penetration with other known types of burglary tool. This barrier again exhibits a double box-like structure, one "box" comprising a steel plate 10 - which provides the outer face of the structure - attached to an intermediate steel plate 11 via framing sections 12, and the other "box" comprising a steel backplate 13 welded to the plate 11 via framing sections 14 and horizontal stringers 15. The first of these compartments is divided internally by a steel mesh 16 and houses a multiplicity of sealed water-filled plastics containers 17 packed into the space between the mesh 16 and plate 10 with layers of slag wool 18. Behind the mesh 16 there is disposed a layer of timber 19 and a cast aluminium slab 20. Within the other compartment, between plates 11 and 13, there is a double layer of timber 21 and a double layer of slab graphite 22 on a bed of cold cast filler material 23.

This particular example of the invention is intended for incorporation in a door which does not itself house any boltwork or locking mechanism but where locking is achieved by bolts thrown into engagement with the door from a mechanism housed in the associated frame (not shown). Detentions for these bolts will be provided in the door where indicated at 24 in Figure 3.

As in the previous example, the water layer constituted by containers 17 in this structure is provided to confer resistance to an explosive attack upon the door. The other layers of material 19,20,21 and 22 are provided to confer resistance to penetration by other types of burglary tool as explained below. The timber layer 19, by virtue of its poor thermal conductivity, may assist the water layer in insulating the rearward portions of the structure from the thermal effects of an explosion at or near the surface of the plate 10, and also to absorb some of the physical shock. Moreover, since timber, though combustible, does not melt under the influence of thermal tools such as an oxy-acetylene torch or thermic lance, this material can offer a useful degree of resistance to penetration by such tools. The presence of the steel mesh 16 will prevent the ready extraction of large areas of the timber layer 19, by whatever means. The aluminium slab 20 is also resistant to penetration by thermal tools, at least of the oxy-acetylene class, by virtue of its ability rapidly to dissipate heat away from the point of attack. Furthermore the ductility of this metal makes it difficult to penetrate with a jackhammer or the like percussive tool. Still further, this soft metal tends to clog the bits of diamond core drills and similar abrasive tools so that penetration through the material with this kind of tool is likewise resisted. The timber layers 21 present a further impediment to thermal attack and the graphite layers 22 are provided as the last line of defence to the thermic lance, penetration through this material being very slow due to the very high melting point of graphite. As this door does not embody the locking mechanism it is not vulnerable to "point" attacks with small-diameter carbide-tipped drills, for example; rather it is designed primarily to resist the formation of "handhole" or "bodyhole" size apertures through the door for which the kinds of tool

previously mentioned will be the most likely candidates. It follows from this that adequate resistance to the kinds of attacks envisaged can be provided without the inclusion of ultra-hard elements in the structure - such as the alumina or corundum nuggets frequently bound into the barrier structures of safe and strongroom doors to provide resistance to drilling attacks. The avoidance of these hard materials - which tend also to be brittle and therefore liable to crack under shock loading - may further enhance the overall resistance of the structure to explosive attack.

In order to demonstrate the blast-resistance of this composite type of structure the following test was conducted.

A test specimen was constructed substantially in accordance with Figures 3 and 4 hereof and having the following characteristics: the overall thickness of the structure was 540mm; plate 10 was 4mm thick mild steel; plates 11 and 13 were both 30mm thick mild steel; the water layer comprised 126 two-litre containers 17; timber layer 19 was composed of 50mm thick maranti boards; the aluminium slab 20 was 50mm thick; each timber layer 21 was composed of 19mm thick South African pine boards, with the boards in the two layers running at right angles to each other; and each graphite layer 22 was composed of 50mm thick slabs. The specimen was supported in a rig to simulate its mounting to the associated door frame and a 15kg charge of type H6 (Cyclonite-based) plastic explosive was applied to the surface of plate 10. When the charge was detonated the plate 10 was destroyed, the water dissipated, and a hole was formed in the timber layer 19 in line with the seat of the explosion. However, the aluminium slab 20 and the whole of the remainder of the structure behind that slab remained intact and bolted to its frame, with some plastic deformation, so that the barrier as a whole was not breached and would retain resistance to penetration with the other kinds of tool previously discussed.

CLAIMS

1. An explosion-resistant barrier structure comprising a rearward portion (2/4, 11/13) adapted to provide a physical barrier between the two sides of the structure; and a forward portion (1,10) spaced from the rearward portion (2/4, 11/13) and providing the exposed face of the structure; characterised by a multiplicity of liquid-filled receptacles (7,17) packed into a space between said forward (1,10) and rearward (2/4, 11/13) portions and adapted to protect said rearward portion (2/4, 11/13) from the effects of an explosive charge detonated at or near to said exposed surface.

2. A structure according to claim 1 wherein said receptacles comprise water-filled plastics containers (7/17).

3. A structure according to claim 1 or claim 2 wherein said forward portion (1,10) is mounted such as to enable it to become detached from the remainder of the structure (2-4, 11-14) relatively easily under the influence of an outward force exerted upon said forward portion (1,10).

4. A structure according to any preceding claim comprising a layer of timber (19/21) disposed rearwardly of said liquid-filled receptacles (17).

5. A structure according to any preceding claim comprising a layer of cast aluminium (20) disposed rearwardly of said liquid-filled receptacles (17).

6. A structure according to any preceding claim comprising a layer of graphite (22) disposed rearwardly of said liquid-filled receptacles (17).

7. A structure according to any preceding claim in the form of an explosion-resistant door comprising a forward compartment defined between a front plate (1) and an intermediate plate (2) of the structure, and a rearward compartment defined between said intermediate plate (3) and a rear plate (4) of the structure; said forward compartment containing said liquid-filled receptacles (7) and said rearward compartment housing mechanism for fastening the door to an associated frame (9).

8. A structure according to any preceding claim in the form of an explosion-resistant door comprising a forward compartment defined between a front plate (10) and an intermediate plate (11) of the structure, and a rearward compartment defined between said intermediate plate (11) and a rear plate (13) of the structure; said forward compartment containing said liquid-filled receptacles (17) and said rearward compartment containing one or more layers of material (21,22) resistant to penetration by non-explosive burglary tools.

9. An assembly comprising a structure according to any preceding claim in the form of an explosion-resistant door; a frame (9) to which said door is hinged (9A); and means for fastening the door to the frame whereby said rearward portion of the door (2/4, 11/13) can remain fastened to the frame in the absence of said forward portion of the door (1,10).

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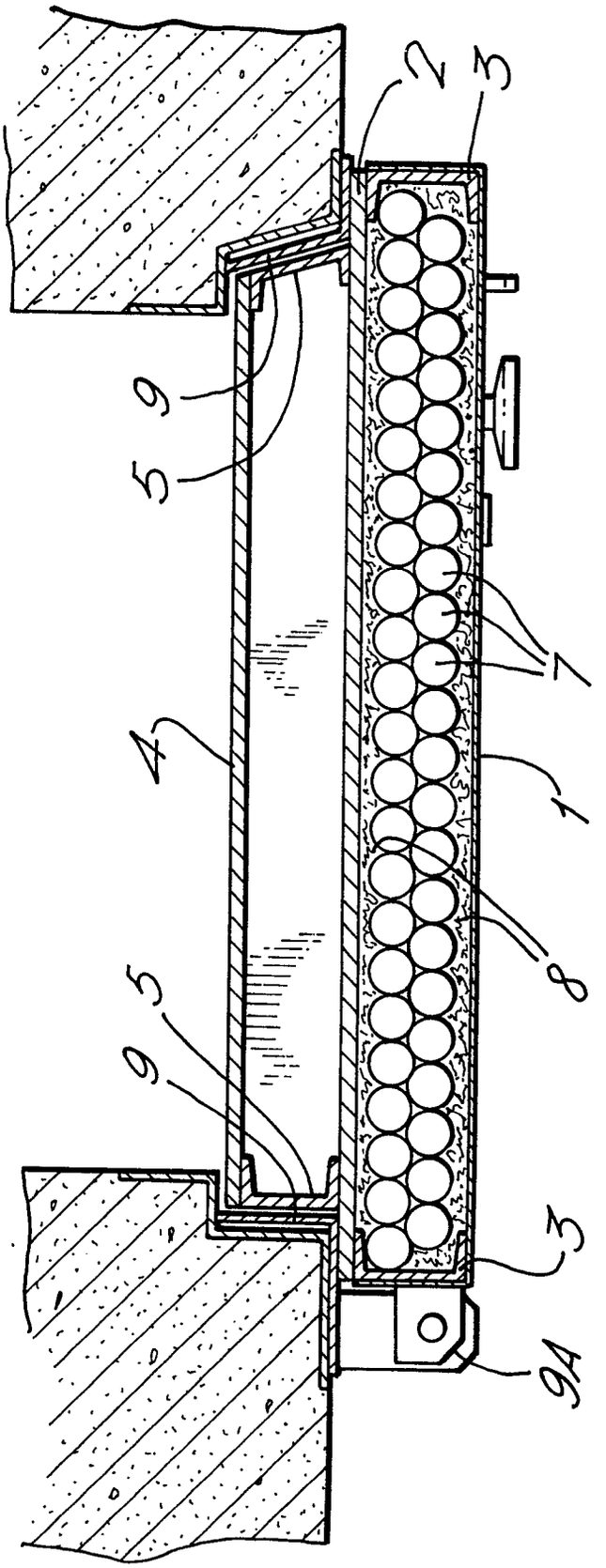

Fig.1.

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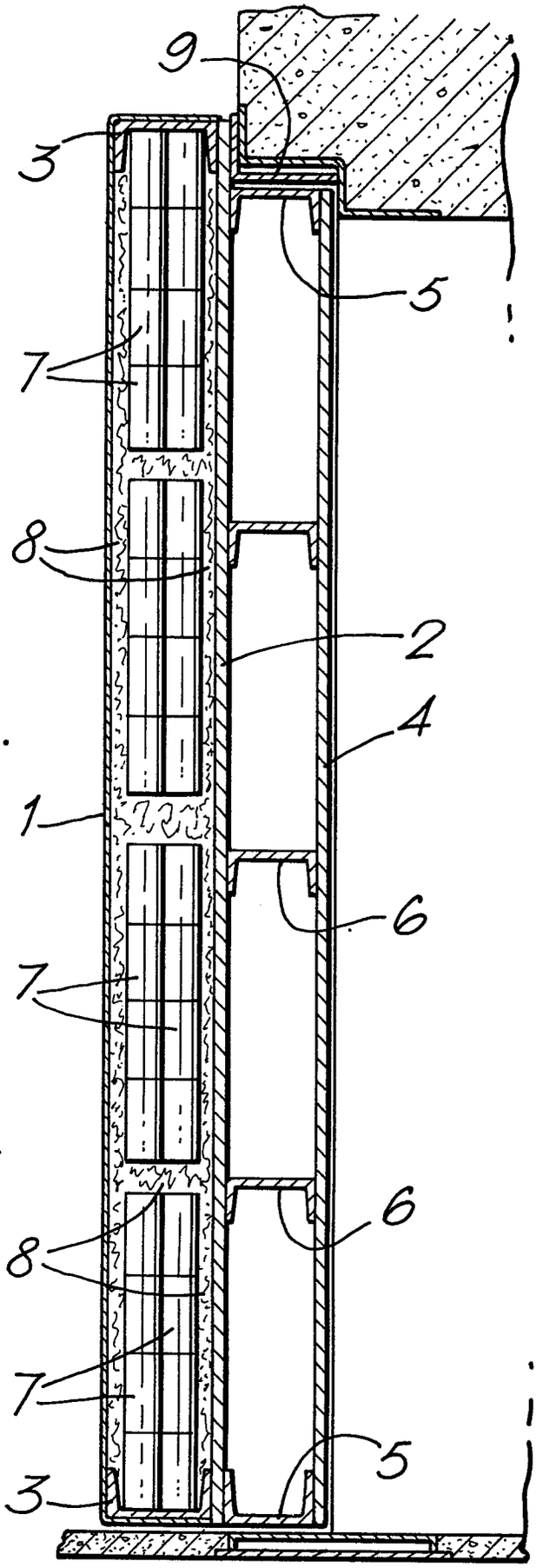

Fig.2.

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Fig.3.

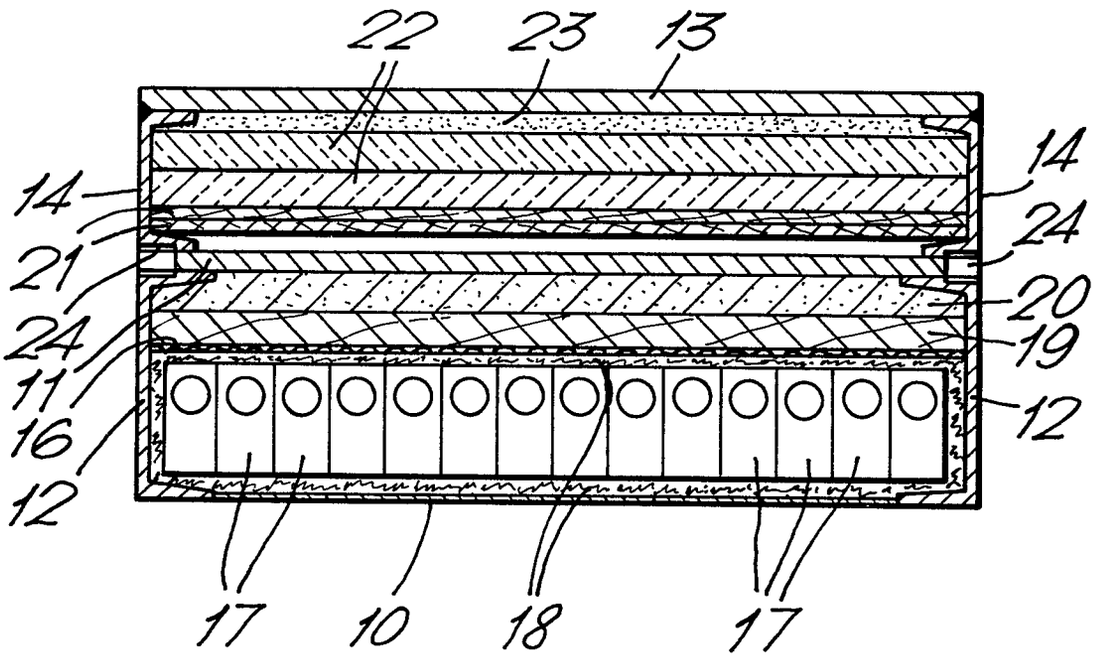

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Fig.4.