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(12) # EUROPEAN PATENT APPLICATION

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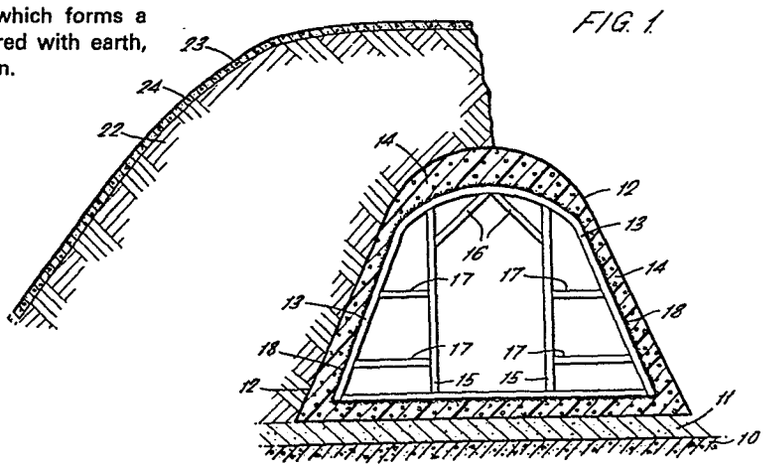
(54) **Shelters.**

(57) A nuclear shelter, particularly for construction by assembly from a kit of parts, has a load-bearing skeleton structure (13), e.g. of metal tubes (15, 16, 17) clamped together, which are capable of limited deformation under the pressure wave from blast. This structure is covered by mesh (18) supporting resilient material (14) which in turn is covered by an impermeable membrane (12), e.g. of butyl rubber, surrounding the whole structure. This membrane which forms a gas-tight and water-tight enclosure is covered with earth, sand or the like to give radiation protection.

FIG. 1.



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"SHELTERS"

This invention relates to shelters for use particularly against the effects of nuclear weapons.

It is well-known that, in the event of an attack using nuclear weapons, large numbers of people not immediately in the neighbourhood of a nuclear explosion could be protected, by means of a suitable shelter, from injury by flash, gamma rays, fall-out radiation and blast. Such shelters may also give protection against chemical and biological attacks.

It is known that protection against nuclear radiation can be provided by a layer of earth, sand, gravel or the like of an appropriate thickness, Even a thin layer gives some protection but typically a thickness of 1 to 1.25 metres would be considered desirable. The shelter structure is therefore designed to support the weight of such a covering. Such a soil covered structure gives protection against light and heat radiation. Protection against primary

nuclear radiation and flash can thus be achieved for people not in the immediate neighbourhood of a nuclear explosion by the provision of a soil covered structure provided that structure will withstand the blast effects. For protection against fall-out radiation, the shelter must be airtight and have a suitable air filtration system. Suitable air filters and air pumps are readily available and it is generally considered desirable to use a simple manually operable pump to provide exercise for people within a shelter.

Bearing in mind the general desirability, in the event of a nuclear attack, of avoiding movement of people in the open and the gathering of crowds, the desirability is recognised of providing large numbers of separate small shelters, e.g. associated with individual houses.

The present invention is directed to the provision of a form of shelter which can readily be erected to form an airtight structure and which, when covered with a layer of earth, sand, gravel or the like, is capable of giving a large measure of protection in regions where radiation effects are the primary threat to survival. As will be apparent from the following description, the shelter of the present invention can readily be made suitable for "do-it-yourself" construction.

According to this invention, a shelter comprises a load-bearing skeleton structure surrounded by an impermeable membrane with a layer of resilient material between the membrane and the skeleton structure, a closable access opening through the membrane and resilient material and air supply means for supplying air for breathing to the interior of the structure.

The skeleton structure conveniently is a metal framework, for example formed of steel tubes or of corrugated or flat plates. The framework is preferably shaped to define a structure having generally curved surfaces at least around the upper and side parts of the structure. It is generally convenient however for the structure to have a substantially flat base.

A generally rounded external shape for the shelter is desirable for withstanding blast.

A metal mesh or other support for the resilient material is preferably provided between the skeleton structure and the resilient material.

The impermeable membrane may be formed of a butyl rubber or other flexible polymeric material. The impermeable membrane over the skeleton structure serves to reduce the moisture content of the air inside the shelter, particularly when used in conjunction with a dessicant, so minimising corrosion of the load-bearing structure. The impermeable membrane may be fabricated as a bag having an access opening, in which case the framework is taken in through the access opening and

erected inside the bag. Alternatively the impermeable membrane may be formed in more than one unit, e.g. a base sheet and an upper sheet, which sheets are bonded together or sealed together with airtight seals. Such seals may be formed for example by using an inflatable tube or by using an airtight zip fastener. The access opening may likewise be sealed with an airtight zip fastener or with an inflatable seal. In yet another arrangement, the parts of the impermeable membrane and/or the access opening are sealed by provision of moulded edges which are mechanically clamped together.

Provision of fresh air inside the shelter may be effected in the known way. For example pump means may be provided for drawing air from outside the shelter through a filter; such pump means may have a manually operable mechanical drive and/or an electrical drive powered from a battery or batteries.

The type of shelter described above might typically be erected on a rigid base, for example the floor of a garage but the completely surrounding impermeable membrane extending underneath the framework as well as around the upper parts will serve to keep the interior of the shelter dry even if the shelter is exposed to weather or erected on damp ground or if moist sand or earth covers or lies around the shelter or if the shelter is partially or completely buried beneath the ground surface.

Preferably the structure has a covering of earth or sand or gravel or other particulate material. It will be readily appreciated that the amount of protection against radiation will depend on the thickness of the covering. Even 150 mm of earth will give a substantial measure of protection. Preferably however a much thicker layer of earth or gravel or sand, for example 1 to 1.25 metres thick would be provided. The user, after erecting the shelter, would put on as much cover as possible in the circumstances.

Preferably the structural members are arranged to permit of limited deformation of the structure under loads, for example either by resilience of individual structural members or by the provision of separate springs or other resilient elements, preferably with means for limiting deflection of the structure.

The type of structure described above can be designed to withstand a substantial pressure wave from blast, particularly if the shelter is partially or completely beneath the ground surface. The structure may deform under the pressure wave. This in itself leads to a further advantage when the shelter is covered with a layer of earth. The earth becomes compacted and forms a solid earth arch capable of withstanding significant external pressure loading.

The following is a description of one embodiment of the invention, reference being made to the accompanying drawings in which:-

Figure 1 is a diagrammatic section through a shelter forming one embodiment of the invention;

Figures 2, 3 and 4 are diagrams illustrating components of the structure;

Figure 5 is a plan view of one end of the shelter; and

Figure 6 is a sectional view along the line 6-6 of Figure 5.

Referring to Figure 1, the shelter is erected on firm ground, for example a concrete base 10 with a layer 11 of sand or gravel to form a bed. The shelter comprises essentially an outer impermeable barrier 12 and an inner skeleton structure 13 with foam padding 14 between the skeleton structure and the outer barrier 12. As seen in Figure 1, the skeleton structure 13 defines a generally curved assembly having a flat base but with no sharp angles apart from where the sides meet the base. In plan the structure is conveniently elongate with curved ends, e.g. of a generally elliptical form. Apart from the outer structural members defining the shape of the skeleton structure, there are a plurality of

load-bearing uprights such as the members 15 together with bracing and strengthening struts such as for example are shown at 16 and 17. The horizontal struts 17 towards the side of the structure are conveniently arranged as supports for bunks. The struts and other structural members are conveniently metal tubes which may be secured together by the use of clamps, for example clamps of the type described in U.K.Patent Specification No.1491242 in which the clamps grip the tubes and are locked against slipping along the tubes.

Over the skeleton structure is a layer of metal mesh 18 to form a support for the foam padding 14. The purpose of this padding, which is of non-flammable material, is to provide a support for the outer membrane barrier 12. This is of flexible or semi-flexible material chosen to be resistant to light, ozone, ultraviolet radiation and soil acids. A number of materials are available which might typically have a life of at least 15 years without significant corrosion or deterioration.

The foam padding 14 not only provides a resilient support for the membrane 12 but also creates an airspace between the internal structure and the membrane. This gives a measure of shock wave attenuation and also provides insulation reducing the temperature gradient

and therefore reducing the amount of condensation and precipitation within the shelter. Old tyres from automobiles and the like may be used between the support structure and the membrane 12 in addition to or alternatively to the foam padding material for this purpose.

The membrane 12 may be formed as a complete bag having an access opening closable by a flap or a separate member, conveniently of the same material as the membrane 12, the flap or other closure being sealable to the main membrane structure to form an airtight assembly. The seal may be effected by an airtight zip or by an inflatable tube to form a pressure seal or by a mechanical clamping arrangement.

It may be more convenient however to form the membrane 12 of two or more sheets of impermeable material which are sealed together after the sheets have been positioned under and over the skeleton structure 13 with its foam padding 14.

Provision is made for circulating filtered air through the structure. This is preferably done by a manually operable pump, the operation of which provides exercise for users of the shelter and economises on energy supplies. A battery-powered pump however is preferably also provided. Preferably a plurality of external openings are used for entry and exit of air;

this not only provides some safeguard in case of damage to an individual opening but also facilitates construction as the smaller sizes of the openings reduces the forces due to blast pressure on any one opening.

The unit thus far described, if erected inside a house or garage, would, on its own provide protection against residual radiation and also against attack by gas or biological weapons. Preferably however the whole structure is covered in earth, sand or aggregate as shown at 22. Even 150 mm of sand or earth will give a significant amount of protection but preferably this outer covering is of the order of 1 to 1.25 metres thick. In the embodiment illustrated in Figure 1 there is a smooth outer skin 23 of metal foil with a thin layer of concrete to give further protection against radiation and to hold the sand or aggregate in place.

The blast pressure waves from a nuclear explosion can cause fracturing of a rigid structure and it is preferable to make the structural assembly such that it has a significant amount of "give". Subsidence of the soil may also cause fracturing of a rigid assembly by excessive local loads, particularly with heavy coverings of earth or sand. For these reasons, the structural members are arranged to permit of deformation of the structure. This may be done in various ways.

Referring to Figure 2 there is shown one example of a curved load-bearing upright member 30 to give support in a vertical direction on a horizontal upper member 31, the lower end of the member 30 resting on a horizontal member 32. Excessive vertical load will cause deflection of the member 30, this deflection being limited, in this construction, by a secondary upright 33 which will come into contact with the members 31, 32 when the deflection of member 30 reaches a magnitude determined by the gaps 34 between the ends of the member 33 and the horizontals 31, 32. In this embodiment, the member 33 is carried on supports 35 from the member 30.

Figures 3 and 4 illustrate constructions in which a certain amount of "give" is permitted by the use of springs. Figure 3 shows two telescopically arranged tubes 40, 41 with a compression spring 42 limiting the travel of the tube 40 inside the tube 41. Figure 4 shows a construction in which two load-bearing tubes 50, 51 are axially aligned and are telescopically arranged over an inner guide tube 52. A compression spring 53 between the ends of the tubes 50, 51 limits their relative movement. Structural components such as have been shown in Figures 2, 3 and 4 may be used for the main load-bearing elements in the skeleton structure 13 of Figure 1.

The entrance to the shelter may be constructed as illustrated in Figures 5 and 6. The shelter structure has a door assembly 60 located within a passage 61 through the earth covering 22. This passage 61 leads towards a blast wall 62, of concrete, earth etc, giving protection against blast forces down the passage 61. At the two ends of a transverse passage 63 beside the wall 62 are outward opening doors 64, 65 each hinged along one of its side edges 66 and angled so that it closes under its own weight. In the event of blast along the passage 63, one of the doors 64, 65 may be jammed tightly shut but the other door will open and reclose under its own weight, acting as a relief valve for preventing excessive pressure along the passage 61. The passages 61 and 63 may have roofs, i.e. they are in the form of tunnels. The door assembly 60 in passage 61 preferably is constructed as one inwardly opening door 68 and another outwardly opening door 67 in a single door frame, preferably as heavy steel doors, the doors being covered with rubber or like resilient material on their facing surfaces. The doors 68, 67 are arranged so that, when closed towards one another, the rubber faces bite on the edge of a flange 69 in the door frame. The doors initially are mechanically latched in the closed position but, by means of an air pump, the

space between the doors is evacuated or partially evacuated to give a vacuum holding the doors together in sealing engagement with the door frame.

It will be noted that the construction of shelter described above may readily be assembled from a kit of component parts together with locally available materials such as earth or sand and without requiring any special tools other than those commonly available to householders.

CLAIMS:

1. A shelter comprising a load-bearing skeleton structure surrounded by an impermeable membrane with a layer of resilient material between the membrane and the skeleton structure, a closable access opening through the membrane and resilient material and air supply means for supplying air for breathing to the interior of the structure.

2. A shelter as claimed in claim 1 wherein the skeleton structure is a metal framework.

3. A shelter as claimed in claim 2 wherein the framework is formed of steel tubes.

4. A shelter as claimed in claim 2 wherein the framework is formed of flat or corrugated plates.

5. A shelter as claimed in any of the preceding claims wherein the framework is shaped to define a structure having generally curved surfaces at least around the upper and side parts of the structure.

6. A shelter as claimed in claim 5 wherein the framework for the structure has a substantially flat base.

7. A shelter as claimed in any of the preceding claims wherein a metal mesh or other support for the resilient material is provided between the skeleton structure and the resilient material.

8. A shelter as claimed in any of the preceding claims wherein the impermeable membrane is formed of a butyl rubber or other flexible polymeric material.

9. A shelter as claimed in any of the preceding claims wherein the impermeable membrane is fabricated as a bag having an access opening.

10. A shelter as claimed in any of claims 1 to 8 wherein the impermeable membrane is formed of two or more sheets sealed together with airtight seals.

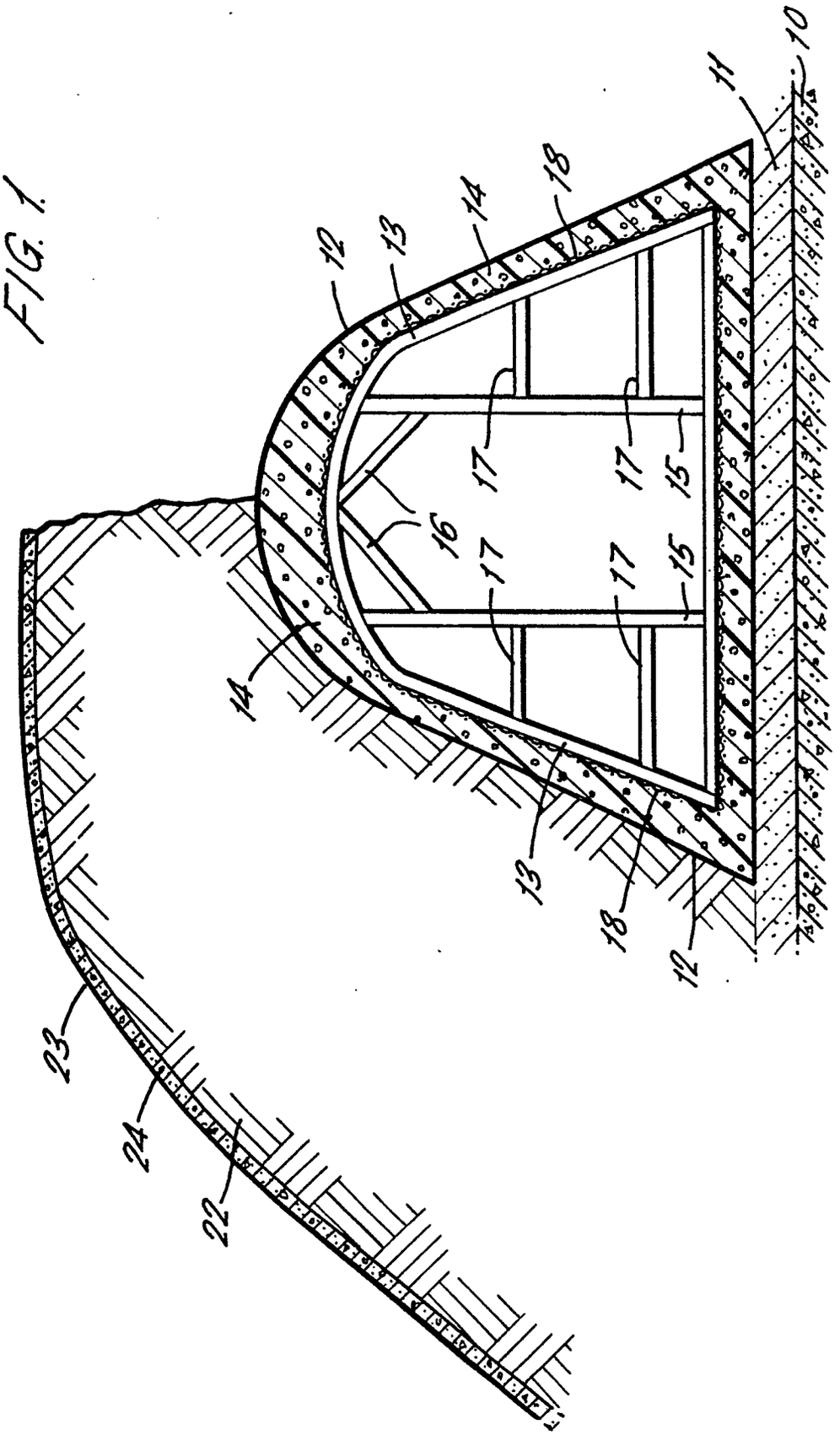
11. A shelter as claimed in any of the preceding claims and having a covering of earth or sand or gravel or other particulate material.

12. A shelter as claimed in any of the preceding claims wherein said structure is arranged to permit of limited deformation of the structure under loads.

13. A shelter as claimed in claim 12 wherein the structure comprises resilient structural members with means for limiting deflection of said members.

14. A shelter as claimed in claim 12 wherein the structure comprises spring-restrained telescopic members with means for limiting the telescopic deflection of said members.

FIG. 1.



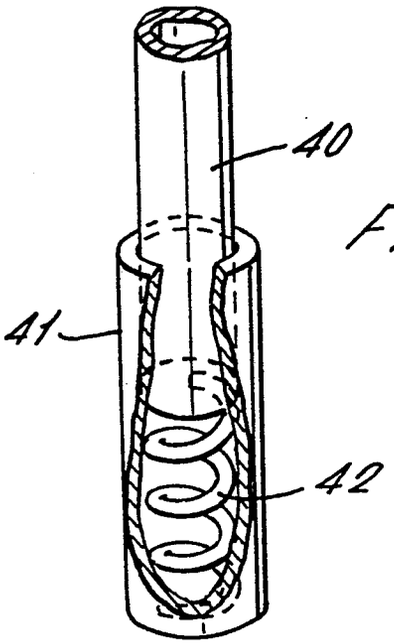
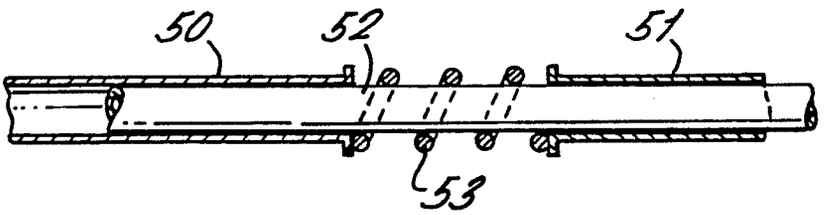


FIG. 3.

FIG. 4.



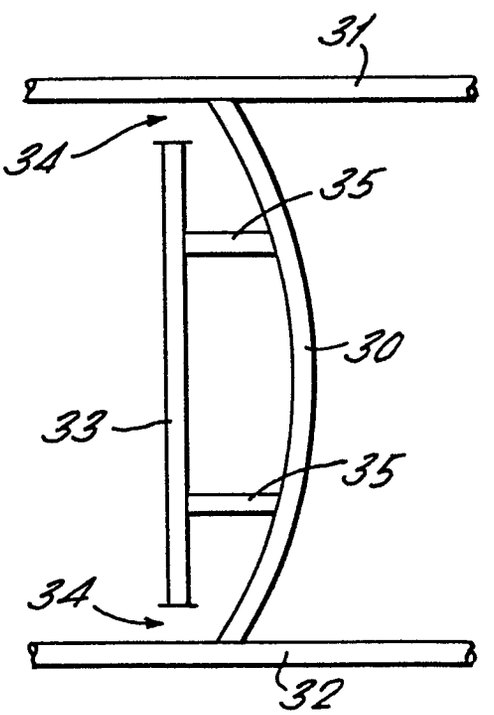


FIG. 2.

FIG. 5.

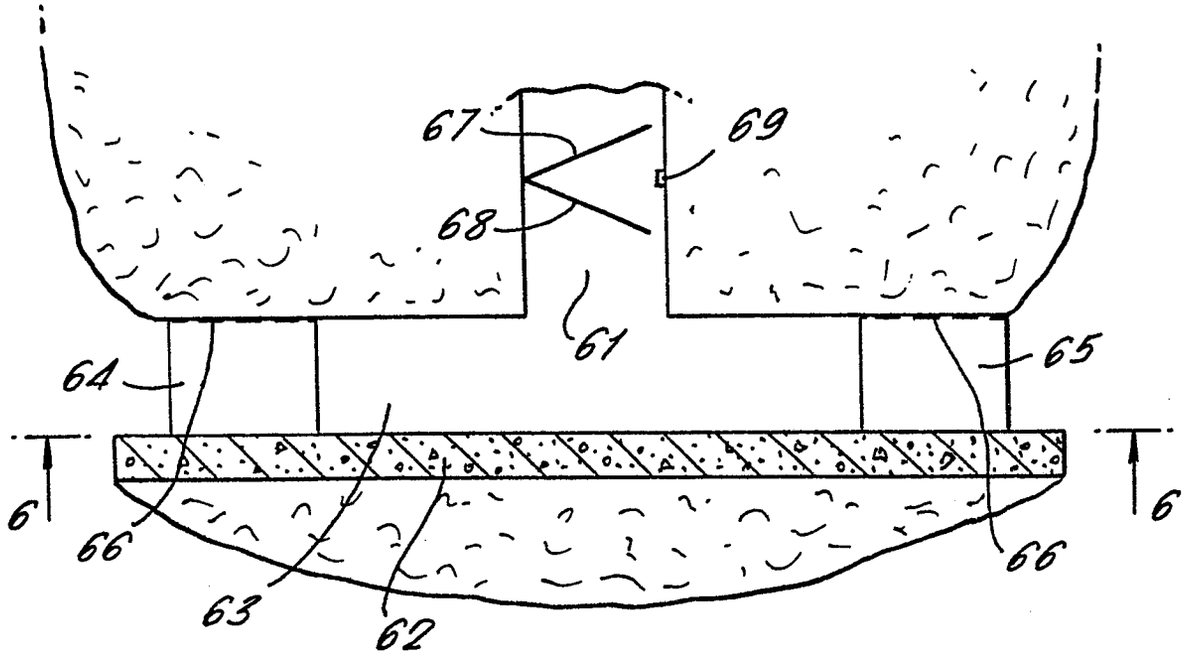
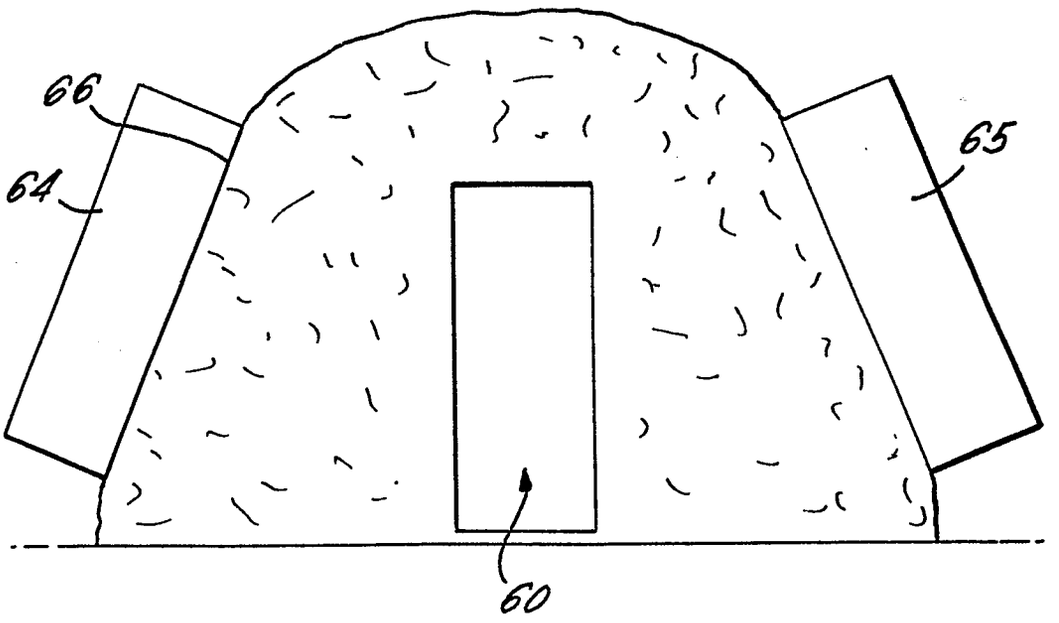


FIG. 6.



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Application number

EP 83 30 0136

EUROPEAN SEARCH REPORT

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
X	US-A-2 773 459 (SECHY) * Column 2, lines 23-43; column 3, lines 43-60; column 4, lines 8-36; column 5, lines 3-24; figures 3,6,8,9 *	1,2,4-7,11-13	E 04 H 9/10 E 04 B 1/98
Y		3,8,9	

Y	GB-A-1 137 182 (CADWELL) * Page 2, lines 53-59; page 4, lines 43-93; page 5, lines 44-114; figures 1-6 *	1,4-6, 8-10	

Y	GB-A-2 043 735 (ALLWELL) * Page 1, lines 84-117; page 2, lines 32-63; page 2, lines 76-84; figures 1,7,8 *	1-3,5, 6,8,9, 11	TECHNICAL FIELDS SEARCHED (Int. Cl. ³) E 04 H E 04 B F 16 F

A	FR-A- 855 851 (HEINEMAN)		

A	GB-A- 478 671 (MUIRHEAD)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15-04-1983	AYITER J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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