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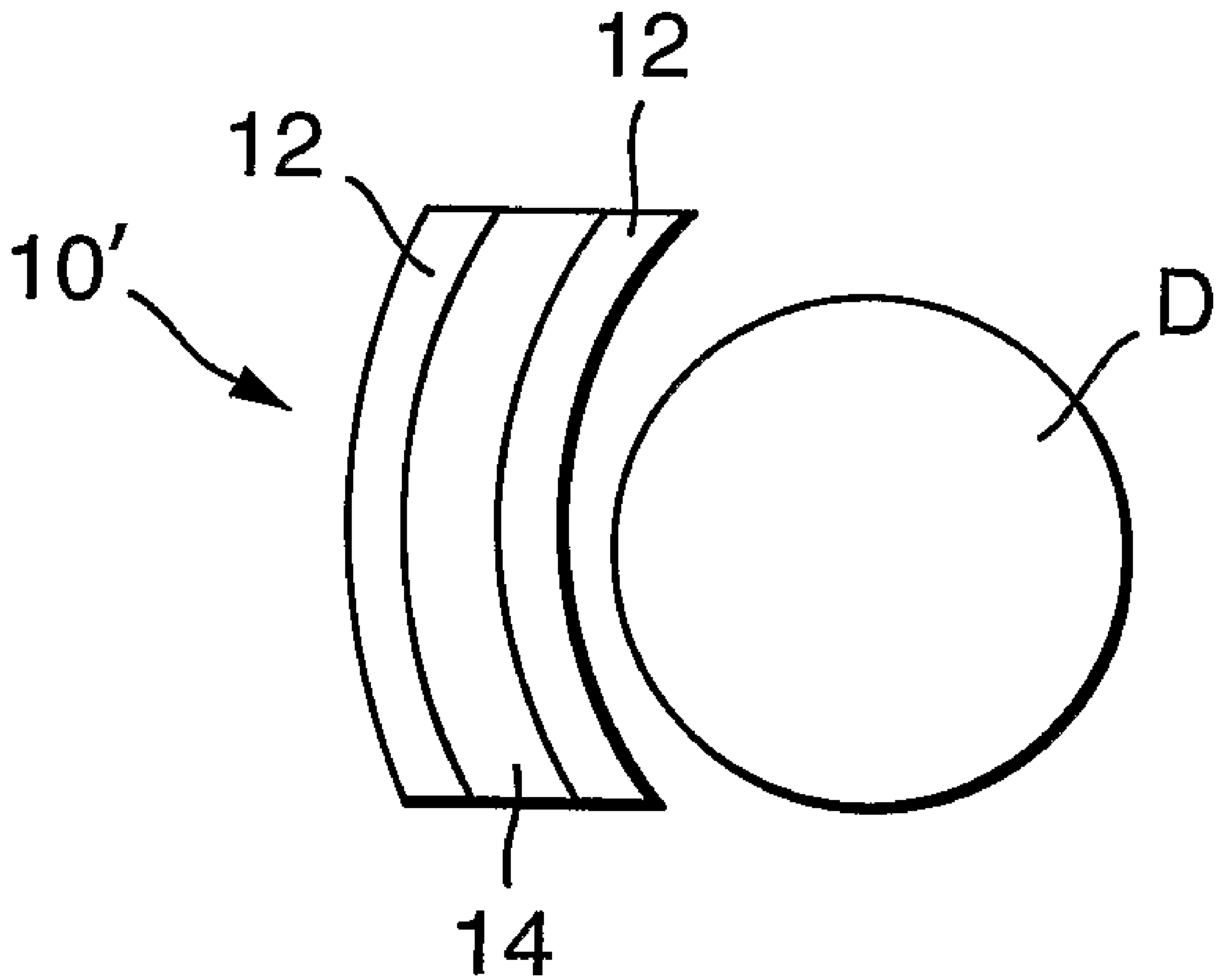

(57) Abrégé/Abstract:
A passive barrier (10, 10', 10") configured to mitigate blast waves and decelerate incident material to reduce the risk of a sympathetic explosion of a nearby explosive and/or damage to nearby objects. The barrier redirects the force of an incident blast

(57) Abrégé(suite)/Abstract(continued):
wave and the incident materials. The barrier can be erected near to explosive devices, inside vehicles transporting such devices or even exterior to the vehicle to protect it or personnel. The barrier can be configured to interlock with one or more barriers and can be formed with a foot or placed in a holder to increase its stability.

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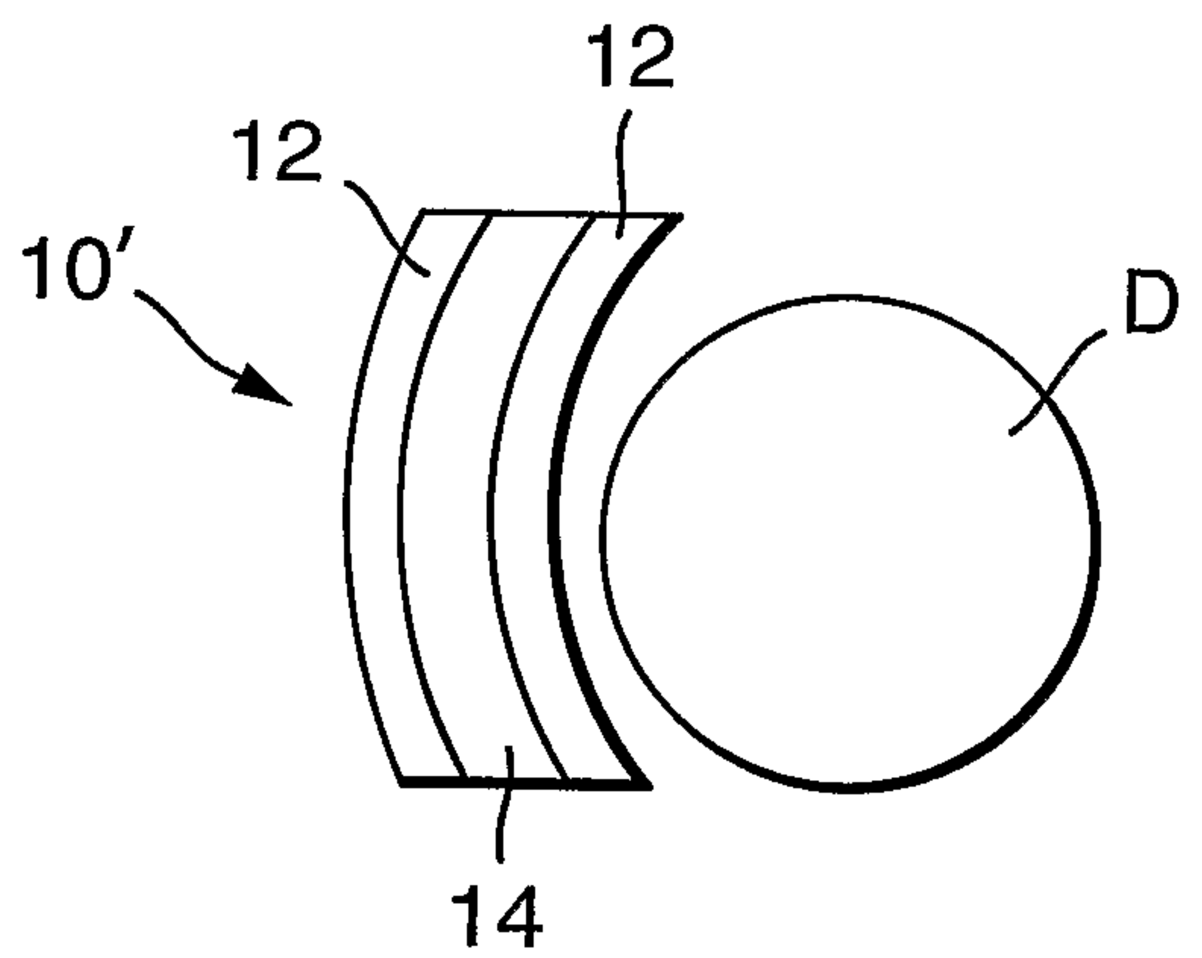

(57) Abstract: A passive barrier (10, 10', 10") configured to mitigate blast waves and decelerate incident material to reduce the risk of a sympathetic explosion of a nearby explosive and/or damage to nearby objects. The barrier redirects the force of an incident blast wave and the incident materials. The barrier can be erected near to explosive devices, inside vehicles transporting such devices or even exterior to the vehicle to protect it or personnel. The barrier can be configured to interlock with one or more barriers and can be formed with a foot or placed in a holder to increase its stability.

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A BARRIER

This invention relates to a barrier and more particularly to a barrier suitable for mitigating the effects of an explosion.

It is known that if an explosive device is detonated, it can detonate another explosive device nearby through the effect of the blast wave generated, and/or by the impact of fragments of the exploded item. In a situation where there are many explosives or explosive devices within a close proximity of one another it is essential to protect as many items as possible from the risk of being detonated by a nearby explosion.

After the detonation of a device, there are three principal mechanisms which may cause an explosion of another device, termed a sympathetic explosion. Firstly, the blast wave caused by the explosion of a first device can impact a nearby device with enough force to detonate it or at least damage it. However, the blast wave degrades quickly so the risk of devices being detonated falls off quickly with distance. Secondly, fragments of the exploded device and any other items nearby can become projectiles which radiate out from the device. These fragments, termed incident material, can impact a device with enough energy to detonate the device. The fragments can also cause damage to the device which could render it unstable and vulnerable to detonation. Thirdly, the blast wave can lift and/or carry objects in its path which then themselves become projectiles which can damage or detonate other devices.

It is known to use a barrier in a situation where explosives are stored or where there is the possibility that an explosion could occur. Such barriers may be reactive, for example, reactive armour, or passive, which do not have active components. Concrete has been employed in the past to make a passive barrier to withstand the destructive force of an explosion, such as the detonation of a bomb. However, barriers made from concrete take time to construct and once constructed are permanent. In a conflict situation, for example, it is required that explosive devices, such as missiles, are moved around and therefore the concrete barriers which have been built become disused and further barriers need to be constructed elsewhere. It is evident that this practice requires much time and material. One solution to this problem has been to use water filled barriers. Water is well known in the art for mitigating blasts. A water filled barrier may comprise one or more containers filled with water which is/are placed between the explosive device(s) and the item(s) to be protected. The containers overcome the previous problem as the barrier can be removed after use. However, the barrier needs to be erected where there is an adequate water supply. In an area where a water supply is poor, then the water to fill the containers also needs to be transported. The barriers are often bulky which can pose transportation problems and add to the cost of using them. Also, the act of filling the containers with water and emptying them will take time before they are useful. Once the barrier is in place it will prevent shock waves and particulates from detonating nearby explosives by acting as a shield. However, there is the possibility that the resulting blast and shock waves can move this barrier and cause it to impact the item to be protected which could result in physical damage to the item which causes it to detonate.

It is an object of the present invention to provide a barrier which is quick and easy to put in place and remove, and which provides adequate shielding from an explosion and which does not itself become a projectile capable of detonating an explosive device in the event of a blast.

Accordingly, the invention provides a passive barrier for mitigating blast waves and decelerating incident material to reduce the risk of sympathetic explosions, wherein the barrier is configured to redirect the force of an incident blast wave and to reduce the momentum of any incident material such that the mitigation of the effect of the blast wave and/or incident material causes the barrier to fragment thus rendering itself innocuous. The fragmenting of the barrier means that as the barrier moves under the force of the blast, it will break up into smaller pieces which are not heavy enough to cause detonation of a nearby device as they do not have a mass great enough to cause damage if they impact a device.

Although the invention can be employed in close proximity to explosives and explosive devices such as bombs and missiles it is not limited to such use.

The barrier can be used to prevent an explosion from detonating other explosives or devices nearby by protecting such devices. For example, the barrier can be placed between the missile warheads on an aeroplane, torpedoes in a submarine, between stationary vehicles carrying explosive devices or in civil or military explosives stores. The barrier can also be used in a vehicle for transporting and/or storing explosives. The barrier can further be used to surround a vehicle or vehicles to afford them greater protection. These uses are purely for illustration and do not restrict the scope of use of the invention.

The first embodiment of the barrier advantageously comprises at least one layer of a shock absorbing material covered at least on two opposing faces by a material which is robust in normal use but which is capable of fragmenting when exposed to an explosion.

The layer of shock absorbing material is advantageously a foam material and more advantageously a polyethylene foam. Even more advantageously the layer is made of Plastazote® which is a closed-cell, cross-linked polyethylene foam produced by Zotefoams plc.

A suitable material for the layers covering the shock absorbing material is fibre glass, advantageously a high strength composite fibre glass such as S2-glass® which is used under licence from NP Aerospace. This material is capable of disintegrating into innocuous fragments upon an impact but is otherwise structurally rigid making it an ideal material for use in the barrier.

The dimensions of the fibreglass layers are chosen so as to be strong enough to withstand the initial shock wave and slow down the fragments resulting from an explosion. The barrier may be of a thickness to prevent fragment perforation through the barrier, but this is not an essential feature of the invention. The barrier may also be optimised to a thickness whereby it may not prevent all of the fragments from striking the areas to be protected but it will slow them down to such an extent that the fragments will not have enough residual energy to cause damage resulting in a further detonation. Alternatively, the barrier may be optimised to prevent the passage of all the fragments. In all of these embodiments the barrier provides adequate protection from fragment impacts. In a first embodiment, as the barrier is bombarded with fragments it starts to delaminate. This de-lamination then means the barrier itself does not present a threat to adjacent munitions as the layers which make up the barrier are not themselves heavy enough to cause impact damage.

Whilst the inventors do not wish to be bound by this theory, they believe that the first embodiment of the barrier works in the following way. The shock wave is reflected by the composite fibre glass as there is a change in density from air to the barrier, i.e. low density to high density. A percentage of the wave may enter and pass through the composite fibre glass layer. When the shock wave reaches the back face of the composite fibre glass, there is another reflection of the wave as there is another change in material density. Some of the remaining force of the wave may pass through the foam layer and the process of wave reflection starts again when the wave encounters the second composite fibre glass layer. The foam prevents one fibreglass layer from striking the other fibreglass layer with significant force after being struck by a blast wave by decelerating the first layer. If air were used as the low density layer, the first fibreglass layer would strike the second fibreglass layer.

In a further embodiment, the barrier comprises a polyurethane layer surrounding an S2 fibre glass layer, the S2 fibreglass layer may be comprised of an S2 glass- foam-S2 glass structure as previously described. Impact resistant polyurethane foams are advantageous and are commercially available from General Plastics. The polyurethane layers and S2 glass will delaminate under the force of a blast and/or impact by incident material.

In a still further embodiment, an explosion mitigating barrier can be formed entirely of an impact resistant polyurethane foam. This foam collapses in on itself when impacted by blast fragments and therefore slows down their passage. A preferred foam is LAST-A-FOAM ® produced by General Plastics.

In yet a further embodiment, the barrier may be formed of an aluminium honeycomb structure. Such a structure is capable of slowing down blast fragments as much energy is absorbed in crushing a honeycomb structure. This embodiment has the advantage that the barrier has relatively little mass so it is not able to transmit sufficient energy upon impact to detonate an explosive device but which is capable of decelerating blast fragments.

The thickness of the layers used can be optimised for their required use. It is desirable to have a balance between the barrier being thick enough to perform its function adequately but which has a minimum mass so that it will not cause detonations if moved by the blast wave to impact a device.

The shape of the barrier may be selected to direct the shock waves and blast fragments in a particular direction. The man skilled in the art would know how to do this within the confines of the geometry of a given situation. Such shapes may be, for example, substantially planar, curved, cylindrical or diamond shaped. The barrier can be of any size which provides protection and which is capable of being moved and transported with ease. If a greater length or height barrier is required than that of a single barrier, then a plurality of barriers can be placed side by side and/or on top of one another until the desired length and/or height is achieved. In another advantageous embodiment of the invention, the barrier is configured so that it can interlock with other barriers of the invention. This will be achieved by any suitable means such as tongue and groove formations, dovetails or finger joints on the edges of the barrier. This feature gives the user the option of constructing a barrier of greater length and/or height which may be more suitable for use in environments where a large area needs to be protected, for example separating missiles on aeroplanes or providing a dividing wall between stores of explosive materials.

The barrier may be formed with a foot so that it can stand up without support. Alternatively, it may be placed in a holder to ensure stability or it may be suspended proximate to the item to be protected, for example, from the underside of a wing of an aeroplane. The stand, holder or suspender can be made of any suitable material which may also have blast attenuating properties. The stand, holder or suspender can also be weighted, if required, to provide greater stability.

The present invention will now be described with reference to the following drawings:
Fig. 1 shows a profile view of a first embodiment of the invention
Fig. 2 shows a profile view of a second embodiment of the invention
Fig. 3 shows a profile view of a third embodiment of the invention
Fig. 4 shows the barrier of Fig. 1 and 3 in use in a military situation
Fig. 5 shows a plan view of a further embodiment of the invention

In an advantageous embodiment as shown in fig. 1 it can be seen that the barrier 10 comprises multiple layers 12 and 14. Layers 12 and 14 are held together with fixings, such as glue or clips, which maintain the integrity of the barrier before exposure to a blast but which do not prevent the barrier from delaminating in the event of a blast. Layer 12 is comprised of S2-glass ® panels and layer 14 is comprised of Plastazote®.

Fig. 2 shows the barrier 10' in a curved configuration which is shaped so as to provide increased protection to an explosive device, D or the surrounding area. If the device, D is the item which is to be exploded, the explosion will be partially contained by the curved nature of the barrier 10'. If the device, D, is the item to be protected, then it will be protected from explosions occurring directly to the left of it (as shown in the figure) and also partially from above.

Fig 3 shows the barrier 10'' in another curved configuration wherein the barrier shrouds at least a portion of the explosive device D. Such a configuration is useful where there are explosive devices proximate to one another, for example, on an aeroplane or in a torpedo store.

Fig. 4 shows the barrier of the invention in use in a military situation. The barrier 10 is placed under the belly of an aeroplane 20 in between the missiles 16. Further barriers 10 are placed between neighbouring missiles on the aeroplane. The missiles 18 on the end of the wing of the aeroplane are shrouded by barriers 10'' having a curved configuration which follows the contours of the device to be protected. Further barriers can be placed adjacent the aeroplane to protect neighbouring objects such as other aeroplanes, missiles, store areas/rooms or personnel 26.

Figure 5 shows a further embodiment of the barrier which comprises a polyurethane layer 50 on two opposing faces of an S2 glass layer 52. The polyurethane layers are triangular in shape so as to deflect the blast wave and blast fragments (shown by arrows) away from the device D to be protected. In fig. 5, both polyurethane layers are triangular in shape which provides protection for devices at either end on the apex in case one of the devices detonates.

Whilst a three layer barrier is shown in the drawings, a barrier comprising five or more layers is also possible.

Whilst the feature of the barrier being moveable is important it is also envisaged that the barrier may be permanently or moveably fixed in place by any suitable means to provide protection.

Trials have shown that a sympathetic explosion of a 1000lb general purpose bomb can be mitigated with a shroud barrier (shown in the figures as 10'') comprising two 15-20mm fibreglass outer layers laminated on 12-15mm of expanded closed-cell cross-linked polyethylene foam. The weight of a 1350mm x 340mm x 60mm panel is 50 to 60kg.

The barrier technology has been proven to protect a 155mm shell placed behind the barrier of fig. 1 from being detonated sympathetically by the detonation of a 155mm shell the other side of the barrier.

CLAIMS

1. A passive barrier for mitigating blast waves and decelerating incident material to reduce the risk of sympathetic explosions, wherein the barrier is configured to redirect the force of an incident blast wave, reduce the momentum of any incident material such that the mitigation of the effect of the blast wave and/or incident material causes the barrier to fragment thus rendering itself innocuous.

2. A barrier according to claim 1 wherein the barrier comprises at least one layer of a shock absorbing material covered on at least two opposing faces by a material which is capable of fragmenting.

3. A barrier according to claim 2 wherein the shock absorbing material is a foam.

4. A barrier according to claim 3 wherein the foam is a polyethylene foam.

5. A barrier according to claim 4 wherein the foam is expandable polyethylene foam.

6. A barrier according to any one of claims 2 to 5 wherein the material which is capable of disintegrating is fibre glass.

7. A barrier according to claim 1 comprising one or more layers of a polyurethane foam.

8. A barrier according to claim 7 wherein the polyurethane foam is an impact resistant polyurethane foam.

9. A barrier according to claim 7 or 8 wherein there is a layer of fibre glass on or between the one or more layers of foam.

10. A barrier according to any preceding claim wherein the barrier is further configured to interlock with one or more barriers.

11. A barrier according to any preceding claim wherein the barrier is substantially planar.

12. A barrier according to any preceding claim wherein at least part of the barrier is curved.

13. A barrier according to any preceding claim wherein the barrier is retained in position by means of a foot, holder or by suspension.

14. A barrier substantially as hereinbefore described with reference to the accompanying drawings.

15. A plurality of barriers according to any preceding claim wherein the passage of all fragments is prevented.

16. A barrier comprising an aluminium honeycomb structure for decelerating fragments of a detonated device to reduce the risk of sympathetic explosions and which is configured to have minimal mass which is not adequate to detonate a nearby explosive device.

17. An explosive device comprising a barrier according to any one of claims 1 to 16.

18. A vehicle comprising a barrier according to any one of the claims 1 to 16.

Fig.1.

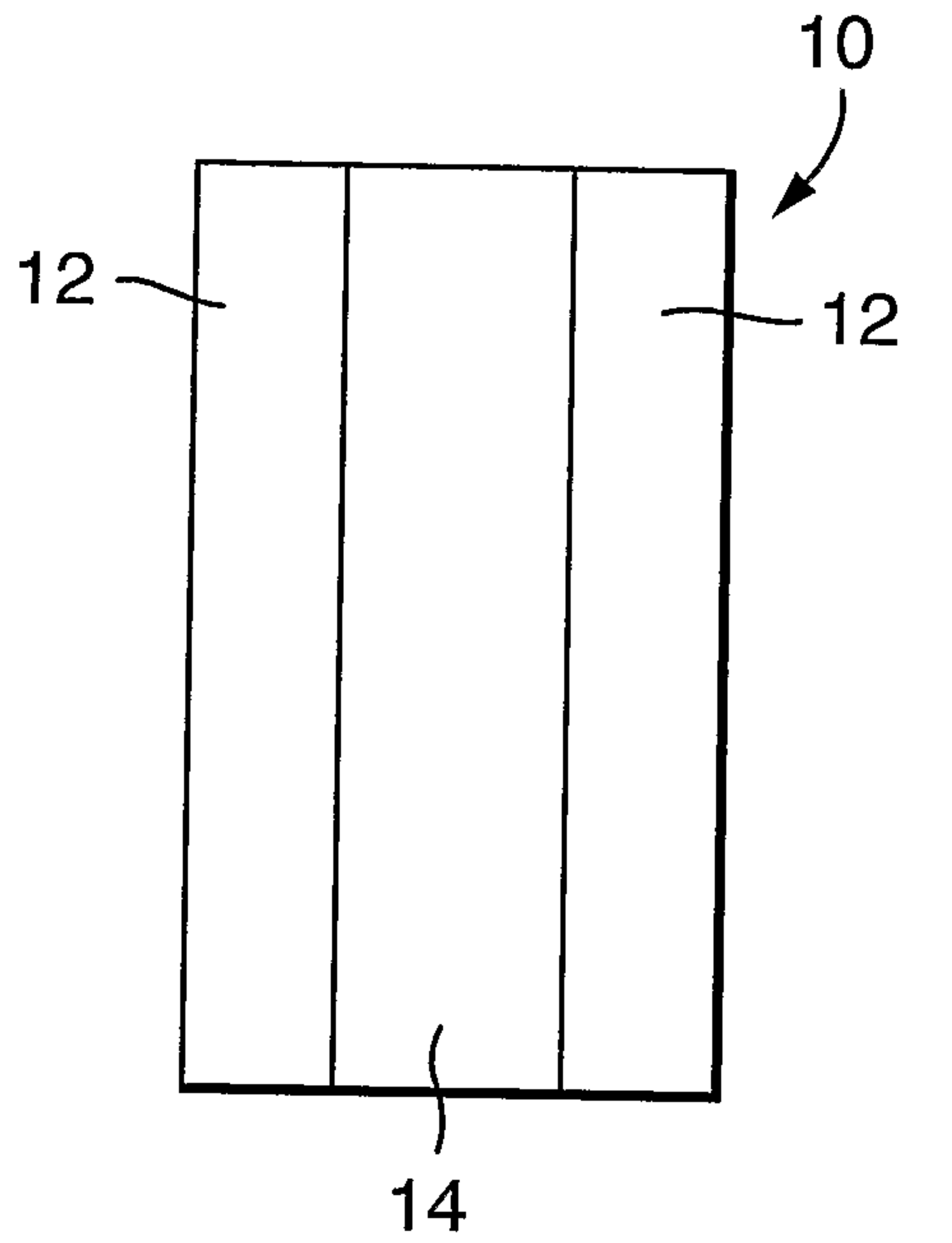


Fig.2.

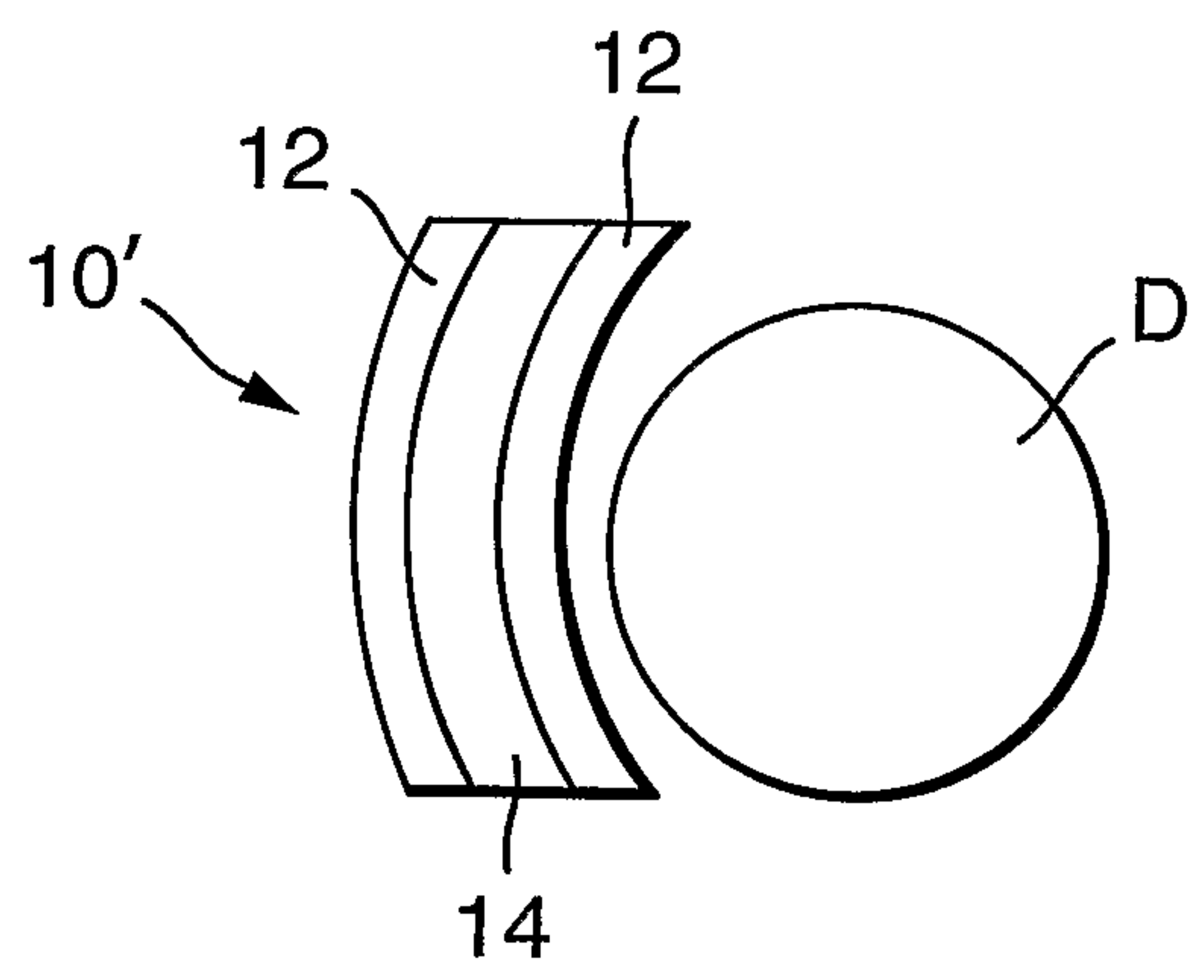


Fig.3.

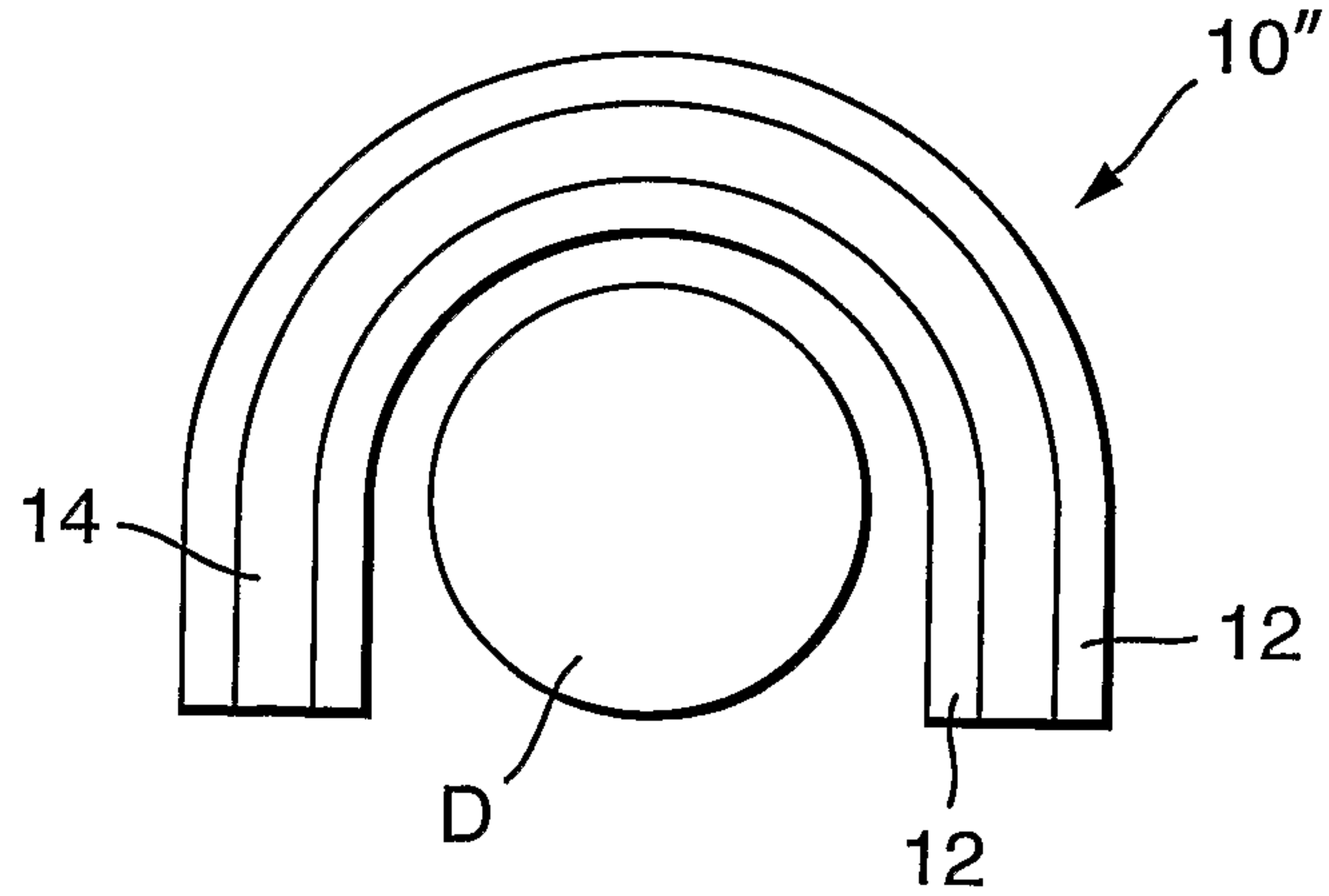


Fig.4.

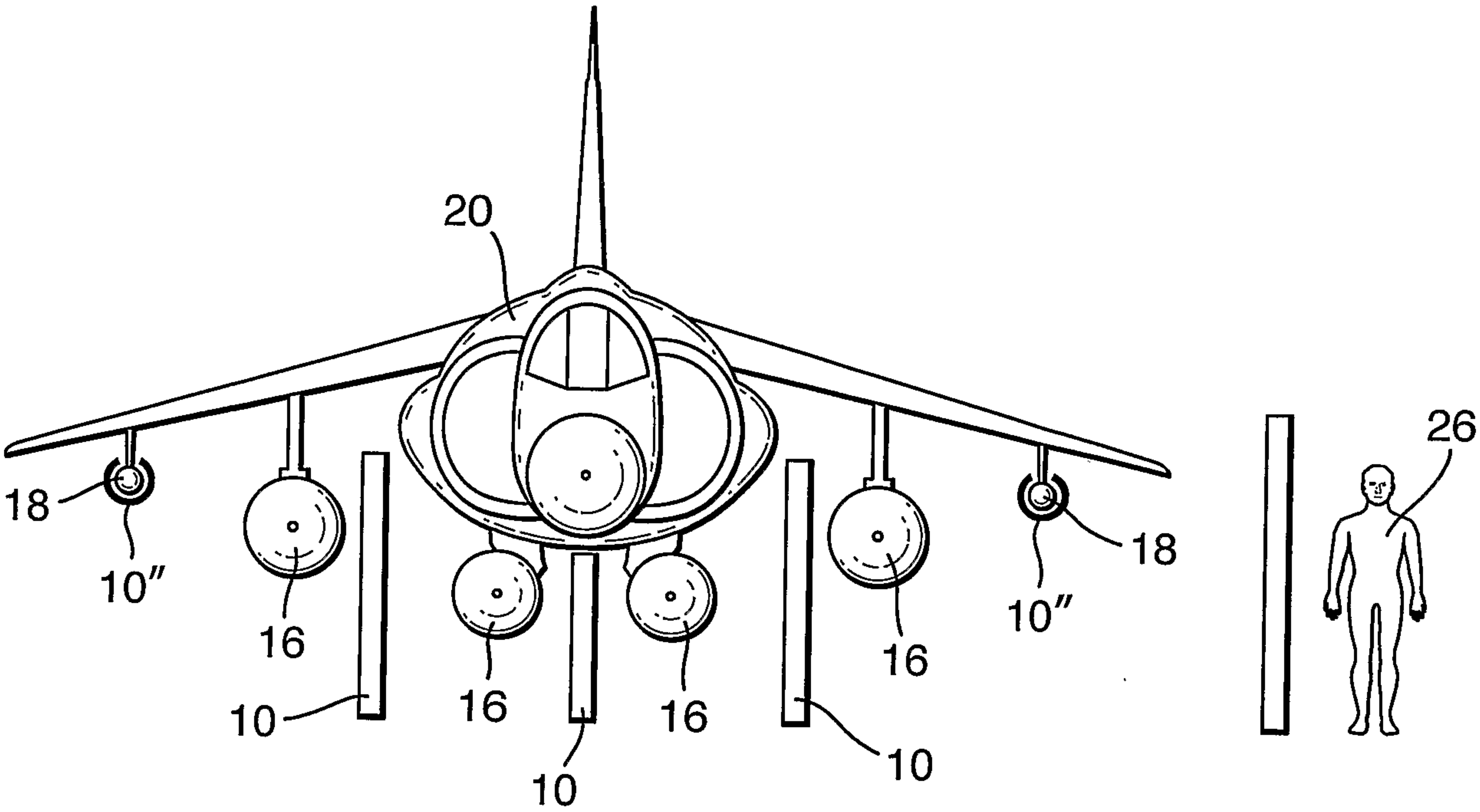
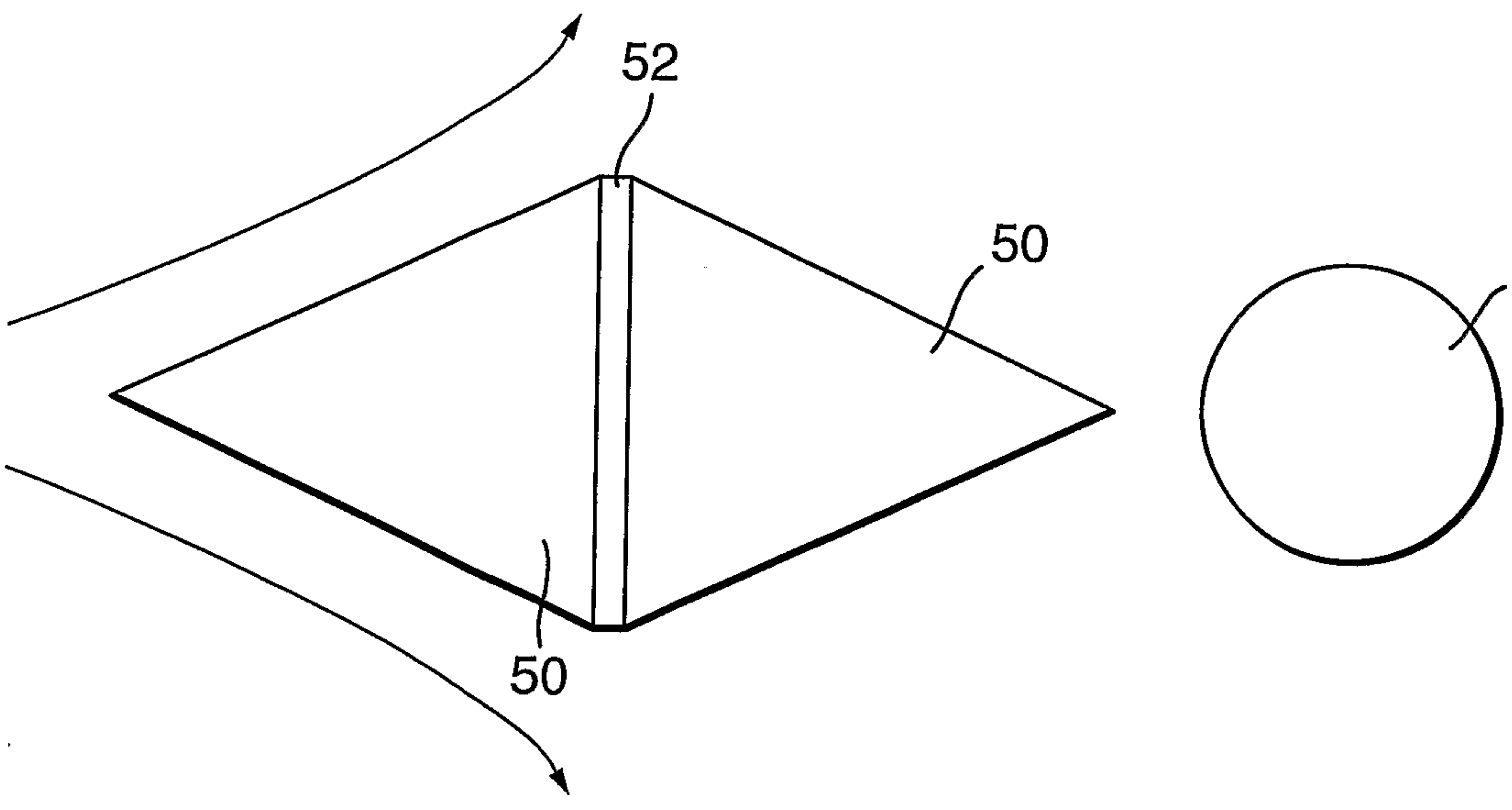
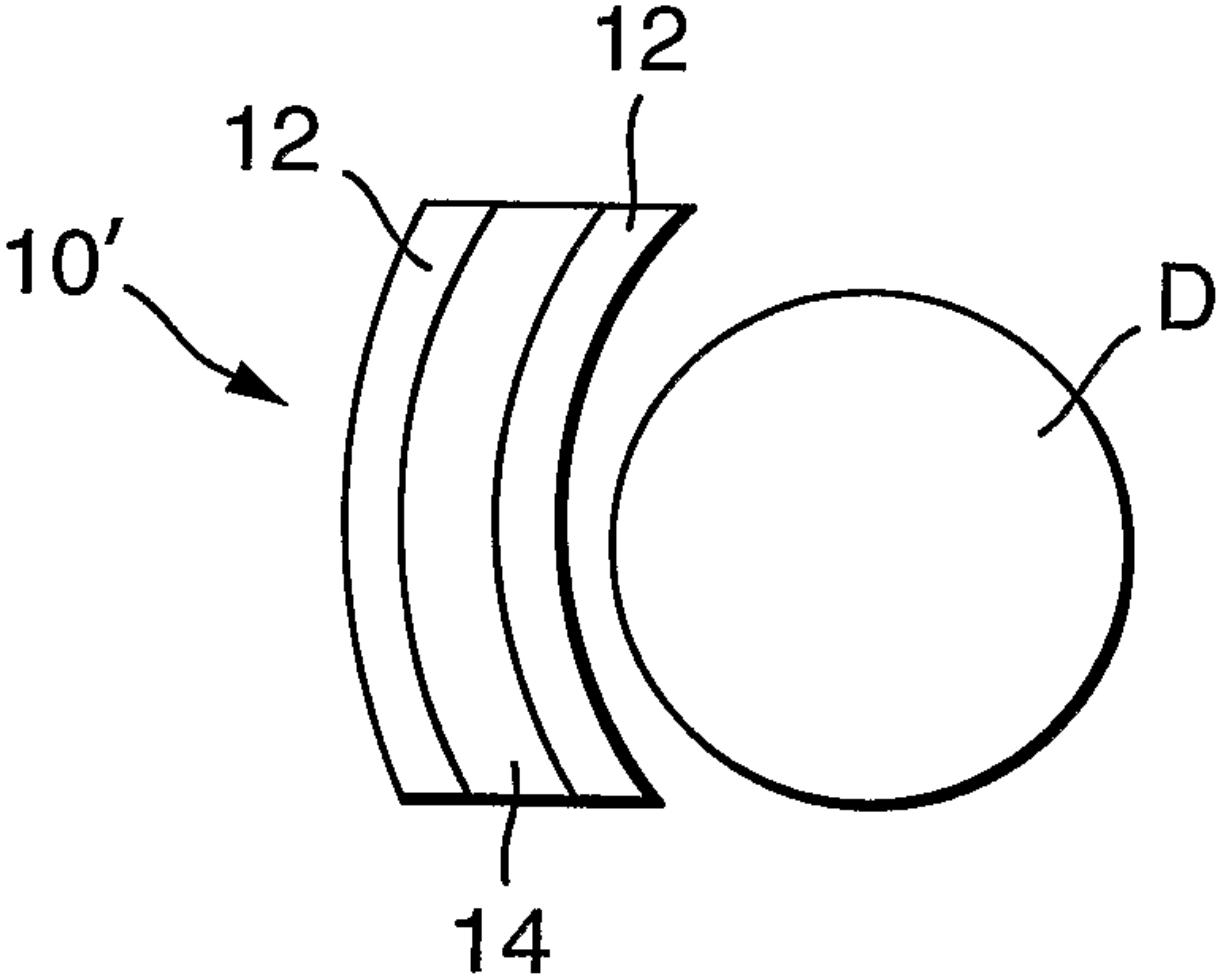


Fig.5.

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