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GB 2351789 A **US 20060285267 A1**

(58) Field of Search:
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(54) Abstract Title: **Safety system for a structure**

(57) The invention relates to a safety system 1 for a building or other structure and comprises a fall arrest or restraint apparatus mounted to a building 10 and a lightening protection arrangement comprising a metallic earthing conductor strip 4 connected to the fall arrest or restraint apparatus. The apparatus may indude one or more fixing posts 3 secured to the building such that a metallic restraint cable 2 extends between the fixing posts and connects to the conductor strip 4. The arrangement may also include electrically non-conductive fixings 8 and 9 used to connect the apparatus to the structure. A later embodiment relates to a method of providing a safety system for a structure.

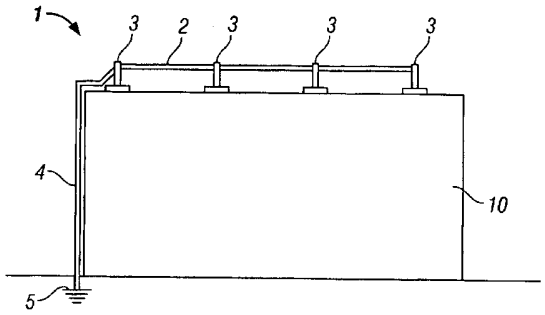

FIG. 1

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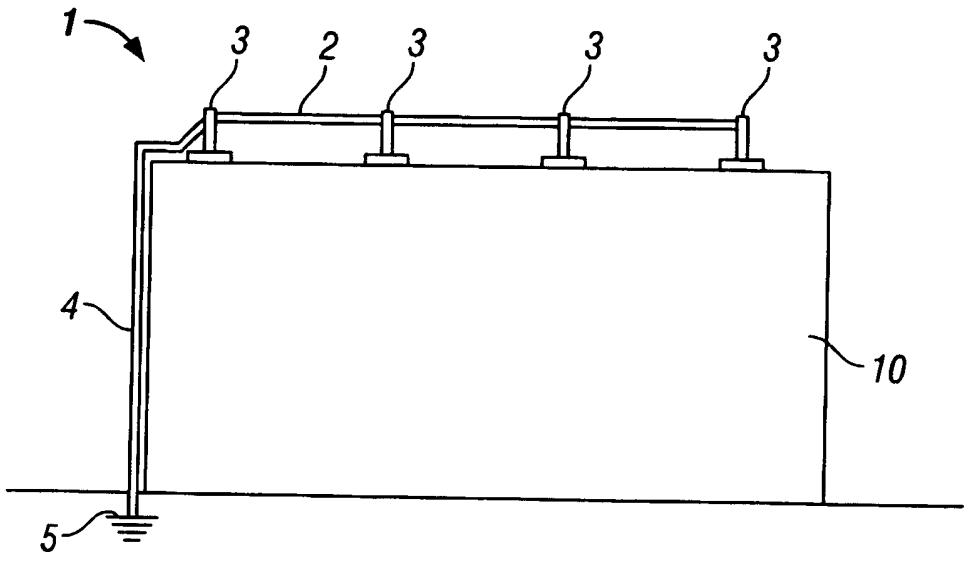

FIG. 1

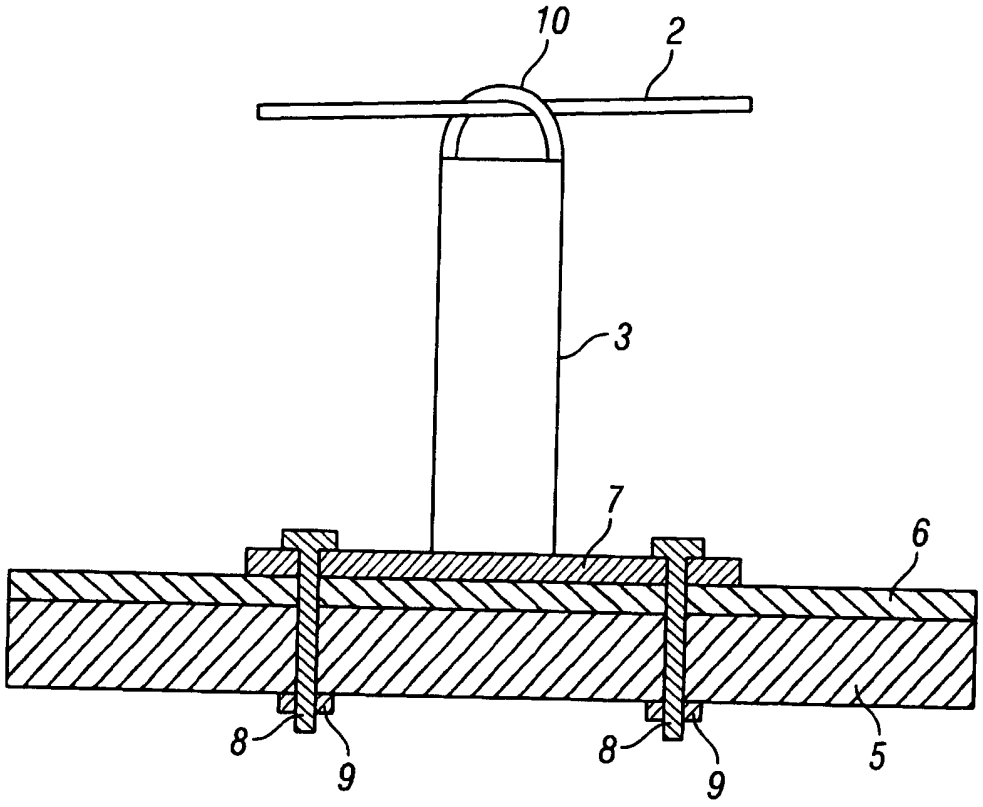

FIG. 2

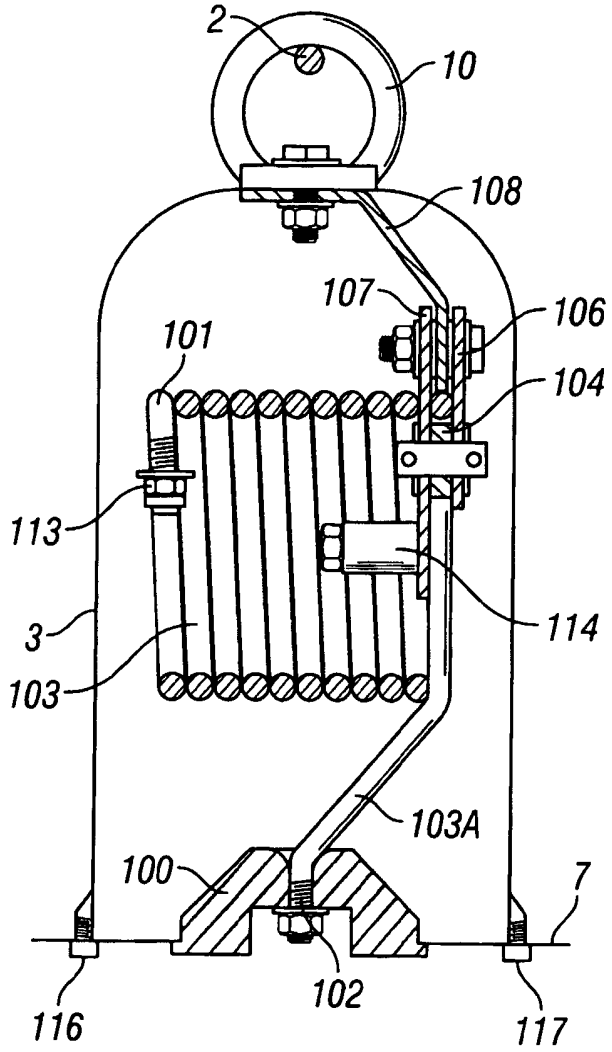

FIG. 3

Safety System for a Structure

The present invention relates to a safety system for a structure, particularly to a lightning protection and safety system, for a building or elevated structure.

Fall arrest or restraint systems are known for use in restraining persons working in elevated situations, for example on the roof of a building. Such a system is disclosed in, for example, EP1282460. In such an exemplary system a safety line attached to a user is connected to a metallic cable running around a defined path (for example stepped in from the edge of the building roof). The metallic cable is restrained by passing through eyes provided at the upper end of a metallic support post which is fixed to the building structure (for example fixed to the roof).

An improved arrangement has now been devised.

According to a first aspect, the present invention provides a safety system for a structure, the safety system comprising;

fall arrest or restraint apparatus;

a lightening protection arrangement including an earthing conductor line connected to the fall arrest or restraint apparatus.

The fall arrest or restraint apparatus may comprise one or more fixing posts arranged to be secured to a structure. In such an embodiment, typically, a metallic restraint cable extends between spaced fixing posts.

It is preferred that the arrangement includes fixings to connect the fall arrest or restraint apparatus to the structure, the fixings being substantially non-electrically conductive and/or non-metallic. The fixings may comprise bolts. The fixings beneficially comprise a plastics material. In one embodiment the fixings advantageously comprise a fibre reinforced

plastics material bolts. This gives the required mechanical strength but ensures that electrical conduction to the internal skin or layer of a roof structure does not occur.

In certain embodiments the earthing conductor line is connected to a metallic post comprising the fall arrest or restraint apparatus. Alternatively, the earthing conductor line is connected to a metallic cable extending between posts comprising the fall arrest or restraint apparatus.

The earthing conductor may be of a generally known construction and may for example comprise an elongate metallic strip, such as a copper strip, extending to a ground terminal. Beneficially, the earthing conductor line extends, externally of the structure, to a ground terminal.

It is preferred that the fall arrest or restraint apparatus comprises one or more fixing posts arranged to be secured to a structure, a respective fixing post comprising an energy absorber arranged to become plastically deformed upon application of a predetermined load to the fixing post.

Preferably, the energy absorber comprises a store of plastically deformable material and deployment means to deploy the plastically deformable material upon application of predetermined load to the fixing post. In one embodiment, the store of plastically deformable material is formed as a coil. Beneficially, the fixing post comprises a metallic casing surrounding the energy absorber.

It is preferred that the fixing post is arranged to fold, deform or collapse from an upright position, a upon application of predetermined load.

Beneficially, the fall arrest or restraint apparatus comprises one or more fixing posts arranged to be secured to a structure, a respective fixing post comprising a tubular body having a cap portion closing an end of the body.

It is preferred that the fall arrest or restraint apparatus comprises one or more fixing posts arranged to be secured to a structure by means of a plurality of non-conductive bolts extending through a flange portion of the post, a respective fixing post comprising a tubular body having a cap portion closing an end of the body.

In an alternative aspect, the present invention provides a method of providing a safety system for a structure, the method comprising connecting an earthing conductor line of a lightening protection arrangement to fall arrest or restraint apparatus secured to the structure.

Preferably, the fall arrest or restraint apparatus is secured to the structure by means of non-electrically conductive fixings, more preferably non-electrically conductive fibre reinforced plastics bolts.

The invention will now be further described, by way of eaxample only, with reference to the accompanying drawings, in which;

Figure 1 is a schematic representation of a safety system for a structure in accordance with the present invention;

Figure 2 is a schematic view of an upright fixing post used in the system of figure 1; and,

Figure 3 is a schematic view of the internal structure of a preferred embodiment of upright post for use in the system of the invention.

Referring to the drawings, there is shown a safety system 1 for a building structure 10. The safety system 1 comprises a rooftop mounted fall arrest or restraint system such as that generally described in EP1281460. The fall arrest or restraint system comprises a series of spaced tubular fixing posts 3 mounted in an upright position and having a metallic base flange bracket 7 for mounting the post and an eye 10 at the upper end of the post 3. A metallic flexible cable 2 in tension extends through and contacts the respective eyes 10. The structure and operation of the posts 3 is described in detail below. In cable based fall

arrest systems on structures such as roofs, the cable needs to be spaced well clear of the roof to avoid such things as sagging cables and fall arrest system travellers and shackles from damaging the roof surface. The post 3 outer wall assists in supporting the cable to provide the necessary spacing and protects the internal components from the weather and other environmental effects.

Importantly and in accordance with the invention, the building structure is provided with a lightning protection arrangement comprising an earthing conductor line 4 in the form of a conductive metallic strip extending from a ground terminal 5 at its lower end to be connected at its upper end to the rooftop mounted fall arrest or restraint system. The upper end of the earthing conductor line 4 may be connected to the cable 2 or to one of the metallic fixing posts 3. Any lightning strike preferentially attracted to the metallic components of the rooftop mounted fall arrest or restraint system will be conducted via the cable 2 and posts 3 to the upper connection terminal of the earthing conductor line 4 and directed via the earthing conductor line 4 to ground.

The generalised roofing structure disclosed in figure 1 is typical of that found in many buildings in that the mounting flange bracket 7 rests on a bituminous membrane layer 6 provided above a metallic building roof skin 5 (such as a profiled metallic panel). By ensuring that the mechanical fixings used to secure the mounting flange bracket to the roof structure are non metallic and non electrically conductive, arcing and/or welding damage to the fixings and the metallic roof structure can be avoided in the event of a lightning strike, therefore reducing the risk of damage to the structural integrity of the rooftop mounted fall arrest or restraint system. In this regard fibre reinforced plastics threaded anchor bolts 8 are used as the fixings, arranged to engage with threaded fixing discs 8 provided on the underside of the metallic roof panel 5.

In a preferred embodiment of upright post 3 used in the fall arrest system, and as shown in figure 3, coiled energy absorber store 101 is a helically wound coil store of at least partially yielding material 103 such as stainless steel rod, one end of which is passed around roller 104 and rigidly fixed to raised feature 110 on mounting flange bracket 7. Mounting flange

bracket 7 is rigidly attached to the roof structure using the glassfibre reinforced plastics bolts as described above.

Roller 104 is free to rotate about pin 105 with the axis of rotation being parallel to the axis of the helical coil. Pin 105 is attached to a deployment structure comprising connected plates 106, 107 and 108 and also load pulling eye 109. The plates 106 and 107 are parallel and spaced apart on either side of the roller 104 to hold the roller 104 between them and define a channel through which the material 103 from the coiled store passes. The pin 105 is attached to the plates 106 and 107. The plate 108 links the plates 106 and 107 to the load pulling eye 109. Fall arrest system cable 112 passes through the load pulling eye 10. A guide 114 is rigidly attached to plate 107 and projects into the inside of the helical coil.

When an increasing load is applied to eye 109 in any direction above mounting flange bracket 7, plate 108 tends to straighten together with the part 103a of helical coil material 103 between roller 104 and raised feature 110 until the load is sufficient to begin pulling and yielding coiled material 103 over roller 104. The guide 114 projects from the plate 107 into the interior of the coiled store 101. Guide 114 is formed by a roller and is in contact with the inner surface of the coil on the opposite side of the roller 104 to the entry direction of the coil material 103 when pulling of the coil material 103 over the roller 104 occurs. Guide 114 counteracts the tendency for the axis of the helical store to move relative to the axis of roller 104 and therefore ensures a constant degree of yielding of material 101.

Typically, for use in a fall arrest system the load required to begin yielding and deployment of the material 103 is about 10kN. This provides the desired safety margin for a typical roof able to support a maximum load of about 20kN.

The yielding of the coiled material 103 as it passed over roller 104 is arranged to be plastic deformation, allowing the yielding coiled material to absorb large amounts of energy as it deploys from the helical store 101.

Guide 114 is shown as operating within the helical coil in order to achieve a compact absorber but a guide could alternatively be located outside the coil.

In practice, the force required to be applied at eye 10 to initiate and continue yielding of material 103 in this manner has been found to remain substantially constant as the absorber deploys. On deployment, the helically wound coil 101 moves with roller 104 and the other parts of the deployment structure away from mounting flange bracket 7 as the coiled material 101 unwinds around roller 104.

Figure 3 shows the absorber housed in a metallic casing comprising the outer wall of the post 3 which is attached to the mounting flange bracket 7 by fastenings 116 and 117. In cable based fall arrest systems on structures such as roofs, the cable needs to be spaced well clear of the roof to avoid such things as sagging cables and fall arrest system travellers and shackles from damaging the roof surface. The post 3 outer wall assists in supporting the absorber to provide the necessary spacing and protects the internal components from the weather and other environmental effects. However, a problem with this spacing requirement is that when load is applied at eye 10 in a direction substantially parallel to the plane of a roof, the torque applied on the roof and fixings between the energy absorber and the roof due to the couple generated by the separation between eye 10 and the roof can become too high, tending to twist roof sheeting and to apply an undesirable pull out load on screws fixing the absorber to the roof. In order to overcome this problem the absorber is able to rotate about the raised feature 110 by bending of the section 103a of material 103 until the absorber is in line with the direction of the force applied to the eye 10. The couple acting on the roof and fixings is then reduced to the couple generated by the much smaller distance between the roof and the top of the raised feature 110, greatly reducing the torque applied on the roof and fixings. This makes the pull out force applied to any screws relatively small, most of the load acting as a shear force.

In order to prevent bending of the material 103 under low loads the casing 115 supports the absorber, holding the eye 109 in a fixed position relative to the . The casing 115 is designed to resist becoming detached from mounting flange bracket 7 until the load on eye 10 has reached a pre-determined size. At this point the fastenings 116 and 117 fail and allow casing 115 to part from mounting flange bracket 7. This predetermined detachment load is designed to be sufficiently low to avoid significantly damaging the roof and is lower than the load required to deploy the material 103 from helical store 101 over the roller 104.

Further increases of load on eye 10 may then reach a size where the absorber begins to deploy such that casing 115 follows the movement of helical store 101 and eye 10 away from the mounting flange bracket 7 on deployment, as shown in Figure 4. Factors determining the choice of this pre-determined load at which casing 115 parts from mounting flange bracket 7 are partly to do with avoiding accidental damage to the absorber and bracket by personnel, particularly because personnel may use the absorber and bracket as a convenient purchase point for maintaining their balance or arresting a slip (as opposed to a fall). However, there is also the important consideration of withstanding the pre-tensioning of cable 112 suspended between absorbers and the possibility of personnel applying accidental loading on the cable leading to the possibility of absorbers and brackets leaning prematurely.

Essentially the predetermined parting load should be high enough that parting will only occur in a fall arrest situation and low enough not to cause damage to the roof or fixings. A parting load of about 2500 N (2.5kN), that is, approximately one quarter of the deployment load, has been found to be effective in practice.

The outer casing of the post 3 provides a protective shell between the absorber and roof during absorber deployment because the absorber parts are contained within the casing. Whilst this is important to avoid or minimise damage to roofing, it also reduces the possibility of the absorber on deployment becoming caught on awkward surfaces in the path of deployment.

When a fall arrest event occurs the operation of the energy absorber is a follows. The energy absorber remains in place without moving until the loading applied to the eye 10 through the cable 2 reaches the detachment load. The fastenings 116 and 117 then fail, releasing the post casing from the mounting flange bracket 7. This separation allows the absorber to rotate about the anchor point 102 where the material 103 is attached to the raised feature 110 on the mounting flange bracket 7 so that the absorber is oriented in the same direction as the pulling force applied to the eye 10 by the cable 2.

This rotation of the absorber is allowed for by deformation of the material 103 in the region 103a between the roller 104 and the raised feature 110, which allows the distance of the eye 10 from the raised feature 110 to increase slightly.

During a fall arrest event the load applied to the eye 10 through the cable 2 will then increase beyond the deployment load required to plastically deform the coiled material 103 our of the coil 101 and over the roller 104. Under this load the eye 10 and attached parts of the energy absorber making up the deployment structure will move away from the raised section 110 in the direction of the load applied by the cable 2 as the material 103 is deployed out of the coil and around the roller 104.

The plastic deformation of the material 103 as it deploys out of the coil around the roller 104 absorbs energy, in the case of fall arrest the fall energy, and generates a substantially constant deployment force, which in a fall arrest system acts to slow and eventually stop the fall.

Eventually, all of the fall energy will be absorbed in plastically deforming the material 103, the fall arrest forces will drop too low to deploy the material 103 out of the coil 101 around the roller 104 and deployment of the material 103 will stop.

claims;

1. A safety system for a structure, the safety system comprising;

fall arrest or restraint apparatus;

a lightening protection arrangement including an earthing conductor line connected to the fall arrest or restraint apparatus.

2. A safety system according to claim 1, wherein the fall arrest or restraint apparatus comprises one or more fixing posts arranged to be secured to a structure.

3. A safety system according to claim 2, wherein a restraint cable extends between fixing posts.

4. A safety system according to any preceding claim, wherein the arrangement includes fixings to connect the apparatus to the structure, the fixings being substantially non-electrically conductive and/or non-metallic .

5. A safety system according to claim 4, wherein the fixings comprise bolts.

6. A safety system according to claim 4 or claim 5, wherein the fixings comprise a plastics material.

7. A safety system according to claim 6, wherein the fixings comprise a fibre reinforced plastics material.

8. A safety system according to any preceding claim, wherein the earthing conductor line is connected to a metallic post comprising the fall arrest or restraint apparatus.

9. A safety system according to any preceding claim, wherein the earthing conductor line is connected to a metallic cable extending between posts comprising the fall arrest or restraint apparatus.

10. A safety system according to any preceding claim, wherein the earthing conductor line extends, externally of the structure, to a ground terminal.

11. A safety system according to any preceding claim, wherein the earthing conductor comprises a metallic strip.

12. A safety system according to any preceding claim, wherein the fall arrest or restraint apparatus comprises one or more fixing posts arranged to be secured to a structure, a respective fixing post comprising an energy absorber arranged to become plastically deformed upon application of a predetermined load to the fixing post.

13. A safety system according to claim 12, wherein the energy absorber comprises a store of plastically deformable material and deployment means to deploy the plastically deformable material upon application of predetermined load to the fixing post.

14. A safety system according to claim 12 or claim 13, wherein the store of plastically deformable material is formed as a coil.

15. A safety system according to any of claims 12 to 14, wherein the fixing post comprises a metallic casing surrounding the energy absorber.

16. A safety system according to any of claims 12 to 15, wherein the fixing post is arranged to fold from an upright position upon application of predetermined load.

17. A safety system according toa any preceding claim in which the fall arrest or restraint apparatus comprises one or more fixing posts arranged to be secured to a

structure, a respective fixing post comprising a tubular body having a cap portion closing an end of the body.

18. A safety system according to any preceding claim, wherein the fall arrest or restraint apparatus comprises one or more fixing posts arranged to be secured to a structure by means of a plurality of non-conductive bolts extending through a flange portion of the post, a respective fixing post comprising a tubular body having a cap portion closing an end of the body.

19. A method of providing a safety system for a structure, the method comprising connecting an earthing conductor line of a lightening protection arrangement to fall arrest or restraint apparatus secured to the structure.

20. A method according to claim 19, wherein the fall arrest or restraint apparatus is secured to the structure by means of non-electrically conductive fixings.

21. A method according to claim 20 wherein the fall arrest or restraint apparatus is secured to the structure by means of non-electrically conductive fibre reinforced plastics bolts.

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Application No:	GB0722164.1	**Examiner:**	Mr Haydn Gupwell
Claims searched:	1-21	**Date of search:**	13 February 2008

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	None	GB2351789 A (HANEM SITE SAFETY EQUIPMENT LIMITED)
A	None	US2006/0285267 A1 (SCHULTE)

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

A62B; E04G; E06C

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
A62B	0035/04	01/01/2006
E04G	0021/32	01/01/2006