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DESCRIPTION

TECHNICAL FIELD

[0001] The present invention relates to a fire and smoke containment services transit unit and an associated method. Embodiments of the present invention find application in the field of passive fire protection.

BACKGROUND ART

[0002] Prior art transit units are known whereby services, such as cables, pipes, etc., are routed through barriers (for example walls, floors, ceilings and service shafts), in a manner that provides a degree of passive fire protection. It is desirable for such transit units to exhibit integrity characteristics (i.e. where the product provides resistance to the passage of flames or hot gasses for a predetermined time) and insulation characteristics (i.e. where one side of the product is exposed to an elevated temperature and the other side of the product must not exceed a pre-determined temperature rise within a predetermined time). It has been appreciated by the inventor of the present application that typical prior art transit units, such as the Abesco[®] CT120 and CT240 cable transit units for example, perform relatively well in relation to the integrity characteristics; however they typically perform fairly poorly in relation to the insulation characteristics.

[0003] In an attempt to improve the insulation characteristics of the prior art units, it is known to apply a thermally non-conducting wrap to the transit units and the services passing there through. These are held in place with steel strapping that is mechanically fixed in a permanent manner. However, it has been appreciated by the inventor of the present application that this approach suffers from draw backs when attempting to retro-fit additional services through the transit unit (i.e. at some later time after the initial installation has been completed). In particular, the wrap material must be cut off and replaced with a new wrap system and new steel strapping requiring the use of specialised tools each time the services passing through the transit unit are to be altered.

[0004] JP5460910 discloses a fire protection construction in which a metallic outer casing 7 houses a buffer member 23 that is wrapped around thermal expansion material 13, which in turn is wrapped around services 5a and 5b. The application of heat causes the thermal expansion material 13 to expand as shown in figure 11. JP5576576 discloses a similar fire protection construction also having a metallic outer casing 11.

[0005] US2006/0070319 discloses a firewall sleeve system for preventing the propagation of fire along services. The front housing 10 and the rear housing 11 are each metallic and are installed into a barrier as shown for example in figure 2. The metallic top cover 12 engages

with the rear housing 11. A fire retarding sealing material 35, along with the services, is inserted into the opening, as shown for example in figure 4.

[0006] WO2004/096369 discloses a method that makes use of a fire-resistant elastomeric foam to make a fire-tight sealing of an opening in a wall through which services have been fed. As shown in figures 3, 4 and 5, various shapes of foam material 4a, 4b, 4c and 4d are fixed into the opening 2 in a self-clamping manner such that individual services are embedded within the foam, which expands when subject to a temperature increase as shown in figure 9.

[0007] DE202012002553 discloses a ring-shaped device comprising two halves that are pivotally connected at hinged joint and that may be retained in position by clasps. An intumescent material, in the form of a pair of thin semi-circular rings, is disposed inside the housing.

SUMMARY OF THE INVENTION

[0008] It is an object of the present invention to overcome, or substantially ameliorate, one or more of the disadvantages of the prior art, or to provide a useful alternative.

[0009] According to the present invention there is provided a fire and smoke containment services transit unit according to claim 1.

[0010] In one embodiment at least two portions of the material are interconnected by a bracket. Preferably the bracket has a discontinuity such that the bracket does not extend continuously from the first end to the second end.

[0011] In one embodiment at least two portions of the material are hingedly interconnected. Preferably a hinge forming the hinged interconnection has a discontinuity such that the hinge does not extend continuously from the first end to the second end.

[0012] According to a second aspect of the present invention there is provided a method of routing at least one service through a barrier according to claim 7.

[0013] One embodiment of the method includes the step of affixing a first mounting flange to the services transit unit on a first side of the barrier. In some embodiments a second mounting flange is affixed to the services transit unit on an opposite side of the barrier. Preferably the first and/or second mounting flanges are constructed from a material having a thermal conductivity of less than 5 watts per meter per Kelvin and more preferably less than 0.5 watts per meter per Kelvin. In one embodiment the material from which the first and/or second mounting flanges are constructed is, or includes, calcium silicate or magnesium oxide.

[0014] Preferably the method includes the step of placing a first piece of foam around the at least one service and packing the first piece of foam into the first opening and placing a second

piece of foam around the at least one service and packing the second piece of foam into the second opening. In one embodiment the first and second pieces of foam are each formed from graphite impregnated foam. Preferably the first and second pieces of foam are each shaped so as to form a friction fit around the at least one service and the internal opening of the unit.

[0015] In another aspect of the present invention there is provided a method of altering the service or services threaded through a fire and smoke containment services transit unit, the method being according to claim 15.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

[0016]

Figure 1 is a perspective view of an embodiment of a services transit unit prior to the application of fire and smoke containment materials to the interior thereof;

Figure 2 is a perspective view of the embodiment once fire and smoke containment materials have been applied to the interior thereof;

Figure 3 is a front view of the embodiment prior to the application of fire and smoke containment materials to the interior thereof;

Figure 4 is a front view of the embodiment once fire and smoke containment materials have been applied to the interior thereof;

Figure 5 is a sectional view of the embodiment taken along line B-B of figure 3;

Figure 6 is a sectional view of the embodiment taken along line A-A of figure 4;

Figure 7 is a perspective view of the embodiment as installed within a hole in a wall;

Figure 8 is a perspective view of an installed embodiment as viewed from the opposite side of the wall as compared to that shown in figure 7;

Figure 9 is a front view of a first alternative embodiment of the transit unit;

Figure 10 is a side view of the first alternative embodiment of the transit unit;

Figure 11 is a front view of a second alternative embodiment of the transit unit; and

Figure 12 is a side view of a second alternative embodiment of the transit unit.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

[0017] Referring to the figures, the fire and smoke containment services transit unit 1 includes a casing 2, which is constructed from a material having a thermal conductivity of less than 5 watts per meter per Kelvin and more preferably less than 0.5 watts per meter per Kelvin. Examples of suitable materials include calcium silicate boards, such as Orbit FR[®] board, which has a thermal conductivity of approximately 0.137 watts per meter per Kelvin or Maxilite[®] board, which has a thermal conductivity of approximately 0.14 watts per meter per Kelvin. Another example of a suitable material is Promatect H[®] board, which has a thermal conductivity of approximately 0.242 W/m.K, as sold by Promat Australia Pty Ltd[®] in Adelaide, South Australia. Further examples include Vermiclux[®] and Supalux[®] which each have a conductivity of less than 5 W/m.K, or Monolux, which has a thermal conductivity of approximately 0.18 W/m.K, as sold by Intumex Asia Pacific[®] in Northmead, NSW, Australia. Another example is Fyrchek[®] Plasterboard, which has a thermal conductivity of approximately 0.18 W/m.K, as sold by CSR Gyprock[®] in Sydney, NSW, Australia. However, it will be appreciated by those skilled in the art that other materials, such as magnesium oxide, graphite and/or high melting point thermoplastics for example, having a thermal conductivity of less than 5 watts per meter per Kelvin may be utilised to form the casing 2.

[0018] It has been appreciated by the inventor that the thermal conductivity of the material used in the present invention provides better insulation characteristics as compared to the material typically used to form the casing of the typical prior art transit units. For example, in the Abesco CT120[®] and CT240[®] cable transit units the casing is formed from mild steel, which has a thermal conductivity of approximately 53 W/m.K. Hence, it is anticipated that embodiments of the present invention are likely to outperform the typical prior art transit units in relation to the desired insulation characteristics.

[0019] The casing defines a first opening 3 at a first end 4 and a second opening 5 at the second end 6, which is opposite the first end 4. Intermediate the first and second ends 4 and 6 is the internal volume 7 that is encased by the casing 2. The internal volume 7 and each of the openings 3 and 5 are sized to allow services 8 such as cables, pipes, etc to be threaded through the services transit unit, as shown for example in figures 3 to 5, 7 and 8. The preferred embodiment may also be used in situations where blank openings must be provided within a fire barrier. The first and second openings 3 and 5 and the internal volume 7 of the preferred embodiment are rectangular shaped so as to allow at least one standard sized cable tray to pass through the barrier without requiring the cable tray to be cut down to size. However, it will be appreciated that the casing 2 of the transit unit 1 may take other shapes, such as circular, square, etc.

[0020] An intumescent material 9 is housed centrally within the internal volume 7. Prior to exposure to the heat of a fire, the intumescent material 9 maintains a slim profile as shown in the figures and hence there is plenty of space in the internal volume 7 to accommodate the services 8. However, when the transit unit 1 is exposed to the heat associated with a building fire, it swells and thereby seals the internal volume 7 against the passage of fire, smoke or

heated gases through the transit unit 1. An example of a suitable intumescent material 9 is Kerafix Flexpan 200®. In the preferred embodiment it is a 2 mm thick material, which is laminated in 4 layers. In another embodiment, the intumescent material 9 has a uniform thickness comprised of a single layer of material.

[0021] Additional strips of casing material 18, or metallic "ramps", are disposed on either side of the intumescent material 9. The additional strips of casing material 18 have a total thickness that is slightly greater than the thickness of the intumescent material 9. Hence, this results in a slight recessing of the intumescent material 9 relative to the additional strips, which minimises the risk of the intumescent material 9 being potentially displaced by the insertion of, and removal from, services 8 into the transit unit 1.

[0022] In another embodiment (not illustrated), the single portion of intumescent material 9 mentioned above is replaced with a parallel pair of portions of intumescent material, which are separated by a central gap. Hence, once exposed to the heat of a fire, the two separate portions of intumescent material expand with an air gap being formed between them. This air gap advantageously has the potential to further contribute to the thermal insulative performance of the transit unit. Such an air gap may be utilised to obtain better thermal insulative performance from the same total amount of intumescent material as compared to the embodiment described in the preceding two paragraphs. Alternatively, the air gap may be utilised to obtain the same thermal insulative performance from a lesser total amount of intumescent material.

[0023] As best shown, for example, in figures 1 and 3, three portions 10, 11 and 12 of the casing material are interconnected by a pair of brackets 13 and 14 that each have an L-shaped profile. Rivets secure each face of the brackets 13 and 14 to the respective portions 10, 11 and 12. The brackets 13 and 14 are manufactured from 1.1mm Zinccan® steel, which has a substantially higher thermal conductivity as compared to the casing material. Together the brackets 13 and 14 define a discontinuity, which can be clearly seen, for example, in figure 1. This stops the brackets 13 and 14 from extending continuously from the first end 4 to the second end 6, which, in turn avoids conduction by the brackets 13 and 14 of heat from one side of the transit unit 1 to the other. This assists the transit unit 1 to provide desirable insulation characteristics.

[0024] In some embodiments of the invention the casing 2 is formed as a continuous loop without the use of any hinges. However, the illustrated embodiment more readily allows for the unit 1 to be installed around existing services that cannot be easily disturbed, such as pipes for example, because portions 12 and 15 of the casing material are hingedly interconnected by a pair of piano hinges 16 and 17. An example of a suitable hinge is the Windeyer® continuous hinge, which may be sourced from Windeyer® in Minto, NSW, Australia. Together the hinges 16 and 17 define a discontinuity such that the hinge does not extend continuously from the first end 4 to the second end 6, which can be clearly seen, for example, in figure 1. This avoids conduction by the hinges 16 and 17 of heat between the first and second ends 4 and 6, which

assists the transit unit 1 to provide desirable insulation characteristics.

[0025] The use of rivets 23 to affix the brackets 13 and 14 and the hinges 16 and 17 is advantageous because the rounded heads of the rivets have a low likelihood of snagging or fouling the services 8 as they are being threaded into or out of the internal volume 7 of the transit unit 1. Additionally, the rivets 23 have a low likelihood of causing injury as compared to other types of fasteners that have sharp exposed edges.

[0026] The preferred embodiment of the transit unit 1 may be used when wishing to route services through a barrier, such as a fire rated wall 19, and the method for doing so commences with the step of forming a hole in the wall 19. Typically the hole is sized to receive the transit unit 1 with a tolerance of approximately 5 - 10 mm. Next the transit unit 1 is positioned within the hole. Preferably a fire retardant material is used as packing to approximately centralise the transit unit 1 within the hole 19. Once positioned in this manner, the transit unit 1 provides a passage through the wall extending from the first opening 3, through the internal volume 7 and out the second opening 5, through which the services 8 are threaded.

[0027] The next step in the method is to affix a first mounting flange 20 to the transit unit 1 on a first side of the wall 19. In some embodiments, such as those illustrated in figures 9 to 12, the positioning of a single planar board 26 suffices to affix the transit unit 29 within the hole 28. This means that the transit unit 29 can be installed into the barrier from one side of the wall 27 only, which is particularly useful for applications in which it is difficult to gain access to the other side of the barrier. In these embodiments the planar board 26 attaches to the wall 27 and the mounting flange of the transit unit 29 is attached to the board 26. However, other embodiments, such as that illustrated in figures 1 to 8, also require a second mounting flange 21 to be affixed to the transit unit 1 on the opposite side of the wall 19. The mounting flanges 20 and 21 are sized so as to provide a friction fit when slid over the outer surface of the casing 2. When installed, they should be pushed firmly against the wall so as to secure the transit unit 1 relative to the wall 19. The first and second mounting flanges 20 and 21 are constructed from a material having a thermal conductivity of less than 5 watts per meter per Kelvin, and more preferably less than 0.5 watts per meter per Kelvin. This further reduces the potential for heat to transfer from a side of the transit unit 1 that is exposed to a fire to the other side. In the preferred embodiment the first and second mounting flanges 20 and 21 are constructed from a material that is, or includes, calcium silicate, such as the aforementioned Maxilite® board. Brackets 22 and rivets 23 are utilised to form the Maxilite® board into the L-shaped lengths that are joined to form the first and second mounting flanges 20 and 21.

[0028] Figures 1 to 8 illustrate an embodiment in which the hole 19 in the barrier is only 5 to 10 mm bigger than the transit unit 1. However, in some circumstances the hole may be larger and/or irregularly shaped. For example, in figures 9 and 10 the hole 28 in the wall 27 is substantially larger than the outer surface of the single transit unit 29. Similarly, in figures 11 and 12 the hole 28 in the wall 27 is substantially larger than the outer surfaces of the pair of transit units 29. To cope with this circumstance, the planar board 26 in the alternative

embodiments illustrated in figures 9 to 12 is larger than the mounting flanges 20 and 21 of the earlier described embodiment. More particularly, the planar board 26 extends for a greater distance, for example 5 cm, around the outer surface of the transit unit 29. Hence the planar board 26 provides a boarder around the transit unit 29 that shrouds the otherwise exposed oversized or irregularly shaped hole.

[0029] For some embodiments, not covered by the claims, and particularly those intended to be installed into barriers having irregularly shaped holes, intumescent material is also placed on the external surfaces of the casing 2, which swells in response to heat so as to more firmly affix the transit unit 1 within the irregularly shaped hole. This is particularly advantageous for installing from one side only of the barrier, since the external intumescent material will assist to affix the transit unit 1 within the hole in the event of a mechanical failure of the single mounting flange.

[0030] The next step in the method is to pack pieces of graphite impregnated foam into the first and second openings 3 and 5. Each piece of graphite foam 24 and 25 is firstly slit, trimmed and/or otherwise shaped so as to form a friction fit around the services 8. Additionally, the outer edge of each of the pieces of graphite foam 24 and 25 are shaped so as to form a snug friction fit with the internal volume 7 of the casing 2. The first piece of graphite foam 24 is placed around the services 8 and packed into the first opening 3. Similarly, on the other side of the transit unit 1, the second piece of graphite foam 25 is placed around the services 8 and packed into the second opening 5. In the event of a fire, the pieces of graphite impregnated foam 24 and 25 provide a first line of defence, which 'buys time' whilst the intumescent material 9 is swelling in response to the heat. The swollen intumescent material 9 then provides a more resilient fire and smoke barrier, which can last up to four hours.

[0031] Once installation of the transit unit 1 is completed, the services 8 are routed through the wall 19 using the transit unit 1 in the manner illustrated, for example, in figures 7 and 8.

[0032] It is occasionally necessary to alter the service or services 8 that were threaded through the transit unit 1, for example to remove old cables and/or to retrofit new ones. The first step in this process is to remove the first piece of foam 24 from the first opening 3 and the second piece of foam 26 from the second opening 5. Next the services 8 that were previously threaded through the transit unit 1 are altered as required (i.e. redundant or faulty services may be removed and/or new services may be threaded through the transit unit 1). The next step is to alter the first piece of foam 24 and the second piece of foam 25 to provide

[0033] a friction fit around the altered services. If new services 8 have been added, it may be necessary to re-shape the two pieces of graphite foam 24 and 25 so that they fit snugly around the new services. If redundant or faulty services have been removed, it may be necessary to shape new pieces of graphite foam 24 and 25 so as to fit around the new service configuration. Finally, the first and second pieces of foam 24 and 25 are placed within the first opening 3 and the second opening 5. Importantly, during the process of altering the services 8 it is not necessary to remove the transit unit 1 from the wall 19. Additionally, the embodiment of the

invention dispenses with the prior art requirement to remove old thermally non-conducting wrapping and subsequently to install fresh thermally non-conducting wrapping.

[0034] The process to manufacture the transit units 1 commences with cutting of the calcium silicate board material to form the portions 10, 11, 12 and 15 on a table saw or the like. Also, the additional strips 18 are cut to size. Next the brackets 13 and 14 are riveted so as to connect portions 10, 11 and 12 using 12 mm steel rivets. The hinges 16 and 17 are then riveted so as to connect portions 12 and 15 using 12 mm steel rivets. Crosslinking PVA glue is then used to fix additional strips 18 onto the casing 2, leaving a gap that is intended for the intumescent material 9. The glued components are then placed in a heated hydraulic door press. Next the intumescent material 9 is cut to length and fixed using double-sided tape to the interior of the casing 2 in the gap that was left between the additional strips 18. Next the two pieces of graphite foam 24 and 25 are cut to size on a table saw, band saw, or the like, and inserted into the casing 2. Finally, lengths of calcium silicate board which will form the first and second mounting flanges 20 and 21 are cut to size and brackets 22 and 12 mm steel rivets 23 are used to form them into the L-shaped first and second mounting flanges 20 and 21, which are packaged loosely within the casing 2. It will be appreciated, however, that the first and/or second mounting flanges 20 and 21 may take alternative forms, for example they may be shaped as planar strips, blocks, etc.

REFERENCES CITED IN THE DESCRIPTION

Cited references

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Patent documents cited in the description

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- [US20060070319A \[0005\]](#)
- [WO2004096369A \[0006\]](#)
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Patentkrav**1. Gennemgangsenhed til føringer til brand- og røginddæmning indbefattende:**

et hus (2), der definerer en første åbning (3) ved en første ende (4), en anden åbning (5) ved en anden ende (6) og et indvendigt volumen (7) mellem den første og den anden ende;

et opkvældende materiale (9), der er indeholdt i det indvendige volumen (7), hvilket opkvældende materiale reagerer på varme og svulmer op inde i det indvendige volumen;

hvor det indvendige volumen (7), der indbefatter det opkvældende materiale (9), og hver af åbningerne (3, 5) er dimensioneret således, at mindst én føring (8) kan føres gennem føringerne gennemgangsenhed;

hvor huset (2) er fremstillet af et husmateriale med en varmeledningsevne på mindre end 5 watt pr. meter pr. Kelvin;

kendetegnet ved inklusion af første og andet stykke af grafitimprægneret skum (24, 25), hvor det første stykke af grafitimprægneret skum (24) er således udformet, at det danner en friktionspasning inde i den første åbning (3), og det andet stykke af grafitimprægneret skum (25) er således udformet, at det danner en friktionspasning inde i den anden åbning (5), og hvor hvert stykke af grafitimprægneret skum (24, 25) kan formes til friktionspasning omkring den mindst ene føring (8).

2. Gennemgangsenhed til føringer til brand- og røginddæmning ifølge krav 1, hvor mindst to dele af husmaterialet er sammenkoblet med et beslag (13, 14).

3. Gennemgangsenhed til føringer til brand- og røginddæmning ifølge krav 2, hvor beslaget (13, 14) har en diskontinuitet, således at beslaget ikke strækker sig kontinuerligt fra den første ende (4) til den anden ende (6).

4. Gennemgangsenhed til føringer til brand- og røginddæmning ifølge et hvilket som helst af de foregående krav, hvor mindst to dele af husmaterialet (12, 15) er hængslende sammenkoblet.

5. Gennemgangsenhed til føringer til brand- og røginddæmning ifølge krav 4, hvor et hængsel (16, 17), der danner den hængslede sammenkobling, har en diskontinuitet, således at hængslet ikke strækker sig kontinuerligt fra den første ende (4) til den anden ende (6).

5 **6.** Gennemgangsenhed til føringer til brand- og røginddæmning ifølge et hvilket som helst af de foregående krav, hvor husmaterialet har en varmeledningsevne på mindre end 0,5 watt pr. meter pr. Kelvin, og hvor husmaterialet er, eller indbefatter, calciumsilicat eller magnesiumoxid.

10 **7.** Fremgangsmåde til dirigering af mindst én føring gennem en barriere, hvilken fremgangsmåde omfatter følgende trin:

dannelse af et hul i barrieren (19), således at hullet er dimensioneret til at modtage en gennemgangsenhed til føringer til brand- og røginddæmning (1) som defineret i et hvilket som helst af kravene 1 til 6;

15 placering af gennemgangsenheden til føringer til brand- og røginddæmning som defineret i et hvilket som helst af kravene 1 til 6 inde i hullet for således at tilvejebringe en passage gennem barrieren (19); og
føring af den mindst ene føring (8) gennem gennemgangsenheden til føringer til brand- og røginddæmning (1).

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8. Fremgangsmåde ifølge krav 7, der indbefatter trinnet med fastgørelse af en første monteringsflange (20) på føringernes gennemgangsenhed (1) på en første side af barrieren (19).

25

9. Fremgangsmåde ifølge krav 8, der indbefatter fastgørelse af en anden monteringsflange (21) på føringernes gennemgangsenhed (1) på en modstående side af barrieren (19) end den side, hvor den første monteringsflange (20) blev fastgjort.

30 **10.** Fremgangsmåde ifølge krav 9, hvor første og/eller anden monteringsflanger (20, 21) fremstilles af et materiale med en varmeledningsevne på mindre end 5 watt pr. meter pr. Kelvin.

11. Fremgangsmåde ifølge krav 9, hvor første og/eller anden monteringsflanger (20, 21) fremstilles af et materiale med en varmeledningsevne på mindre end 0,5 watt pr. meter pr. Kelvin.

5 **12.** Fremgangsmåde ifølge et hvilket som helst af kravene 9 til 11, hvor det materiale, hvoraf de første og/eller anden monteringsflanger (20, 21) er fremstillet, er, eller indbefatter, calciumsilicat eller magnesiumoxid.

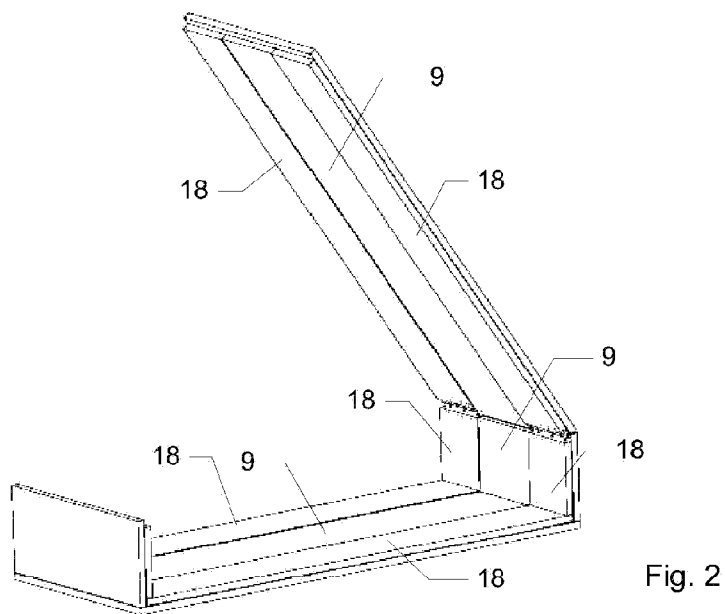
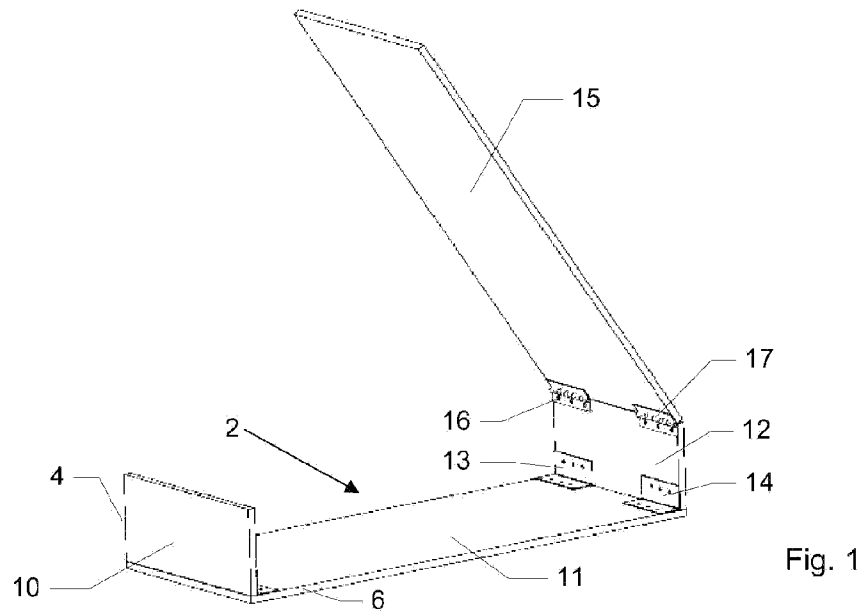
10 **13.** Fremgangsmåde ifølge et hvilket som helst af kravene 7 til 12 indbefattende trinnet med placering af et første stykke af grafitimprægneret skum (24) omkring den mindst ene føring (8) og emballering af det første stykke af grafitimprægneret skum (24) i den første åbning (3) og placering af et andet stykke af grafitimprægneret skum (25) omkring den mindst ene føring (8) og emballering af det andet stykke af grafitimprægneret skum (25) i den anden åbning (5).

15 **14.** Fremgangsmåde ifølge krav 13, hvor det første og andet stykke af grafitimprægneret skum (24, 25) hvert kan formes for således at danne en friktionspasning omkring den mindst ene føring (8).

20 **15.** Fremgangsmåde til ændring af den føring eller de føringer (8), der føres gennem en gennemgangsenhed til føringer til brand- og røginddæmning (1), hvilken gennemgangsenhed til føringer til brand- og røginddæmning er som defineret i krav 1 og monteres inde i et hul i en barriere (19), hvilken fremgangsmåde omfatter følgende trin:

25 fjernelse af det første stykke af grafitimprægneret skum (24) fra den første åbning (3) og fjernelse af det andet stykke af skum (25) fra den anden åbning (5);
 ændring af den føring eller de føringer (8), der føres gennem gennemgangsenheden (1);
 ændring af det første stykke af grafitimprægneret skum (24) og det andet stykke af grafitimprægneret skum (25) for at tilvejebringe en friktionspasning omkring de ændrede føringer (8) og
30 placering af det første stykke af grafitimprægneret skum (24) inde i den første åbning (3) og det andet stykke af grafitimprægneret skum (25) inde i den anden åbning (5).

DRAWINGS



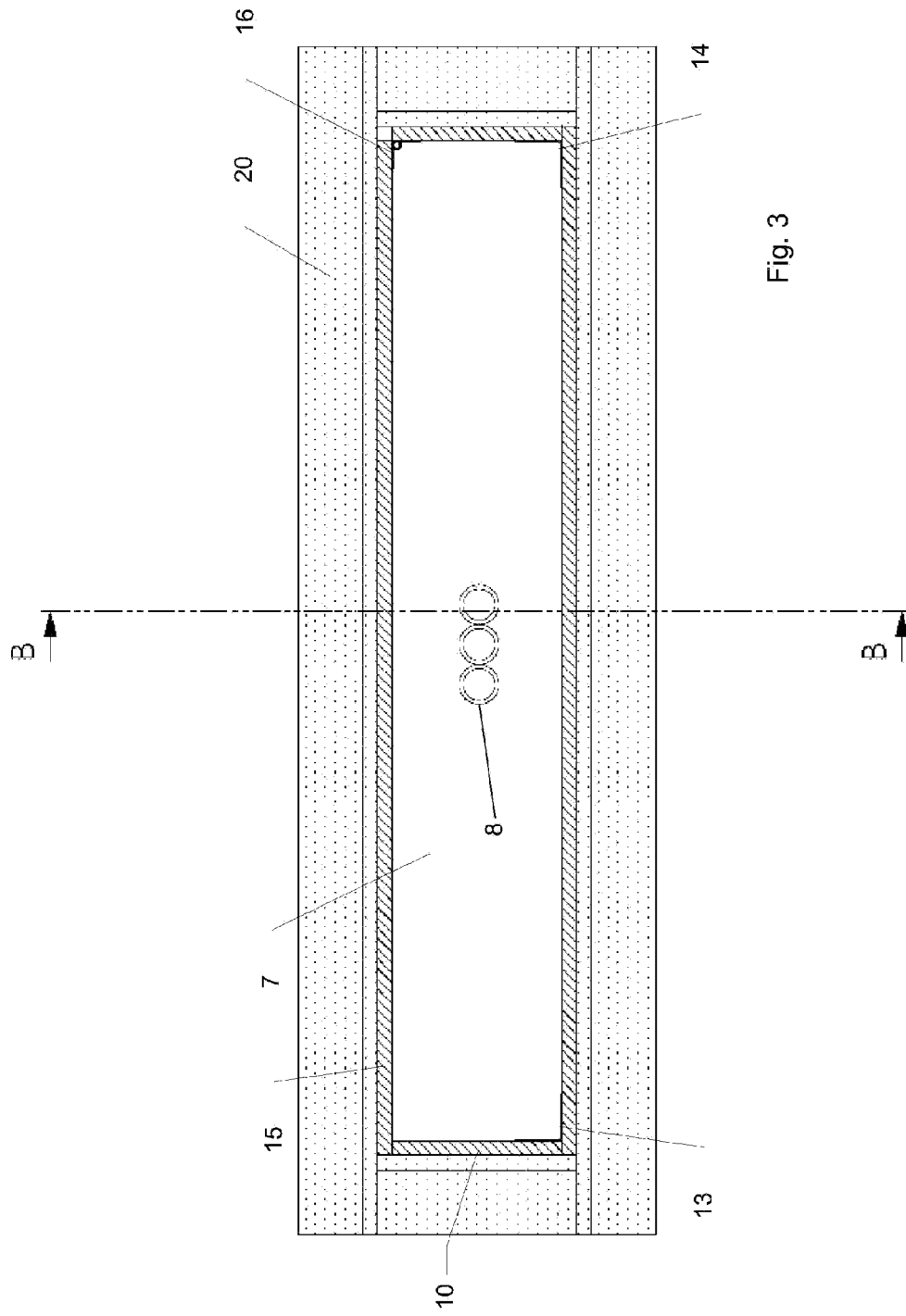


Fig. 3

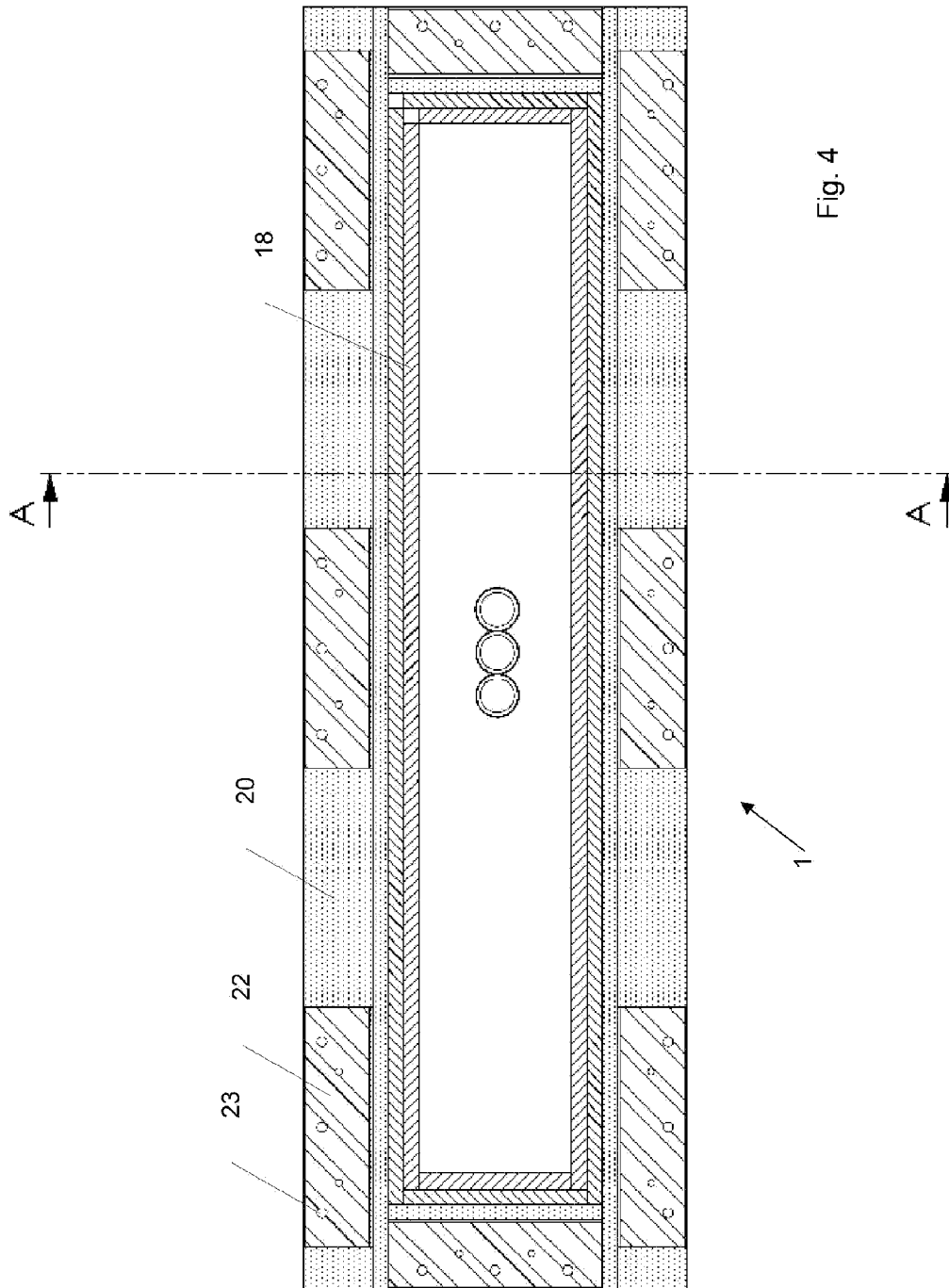
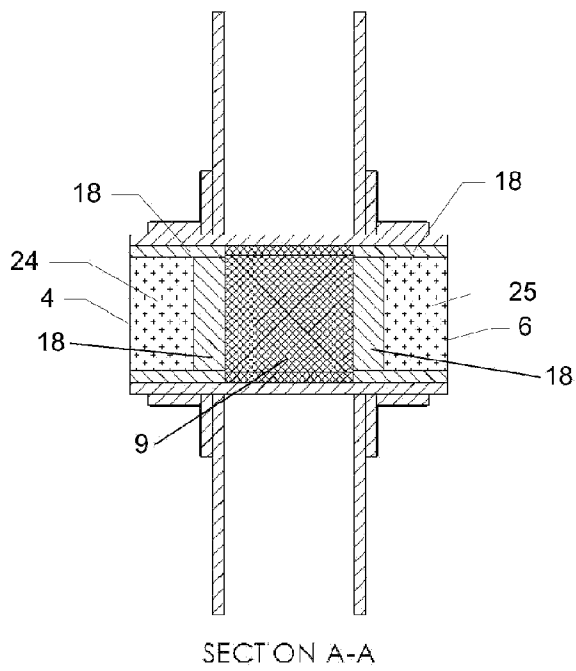
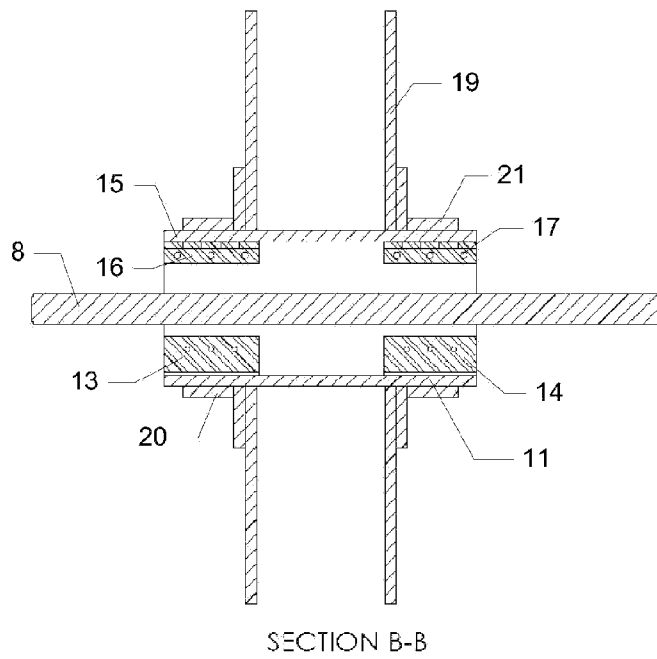


Fig. 4



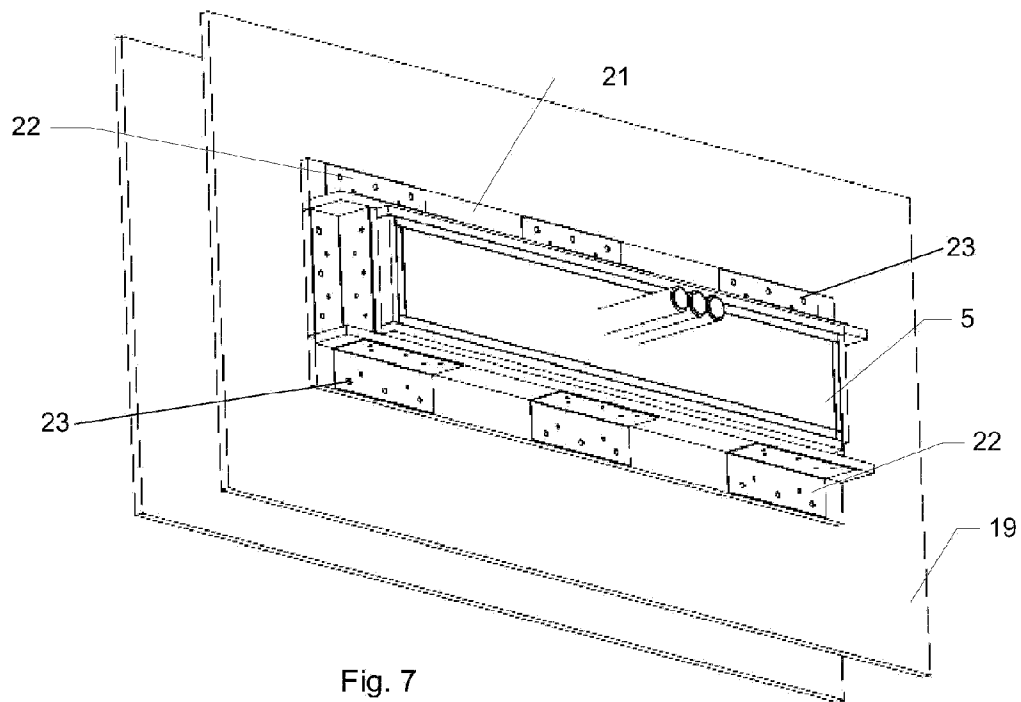


Fig. 7

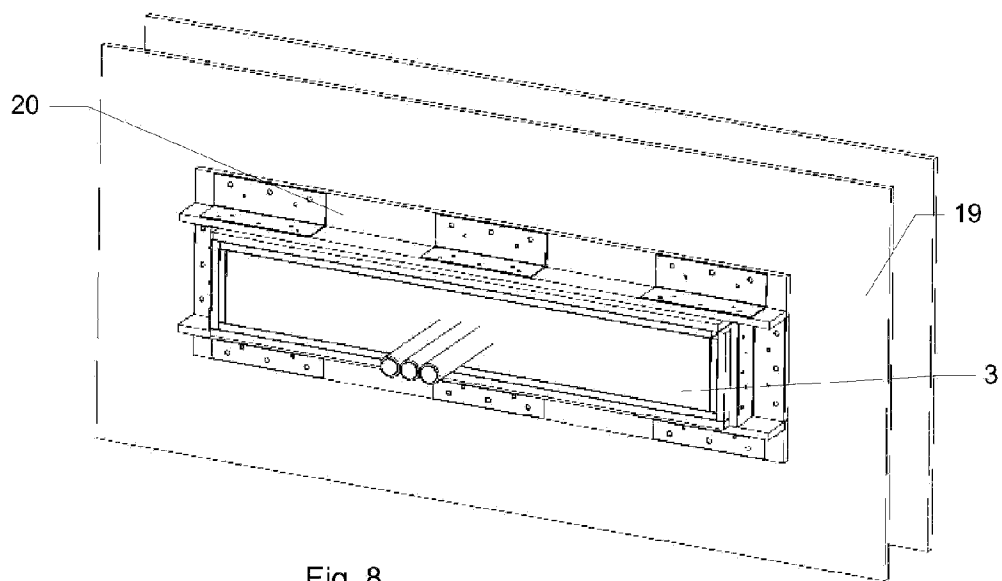


Fig. 8

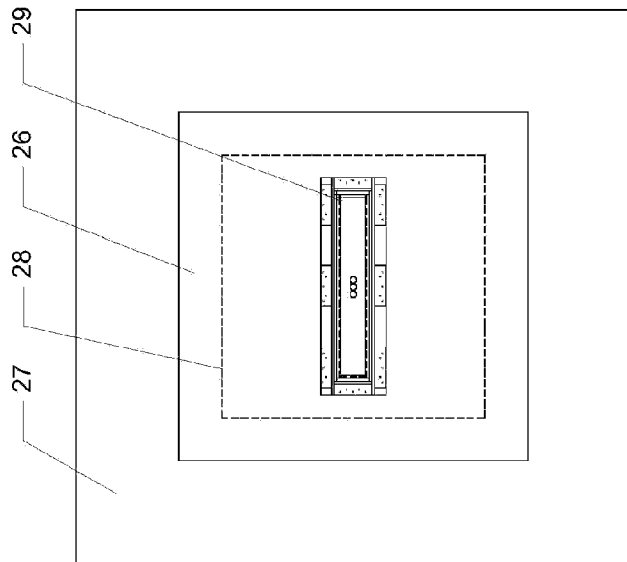


Fig. 9

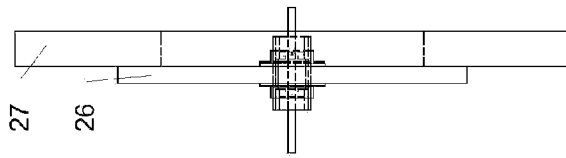


Fig. 10

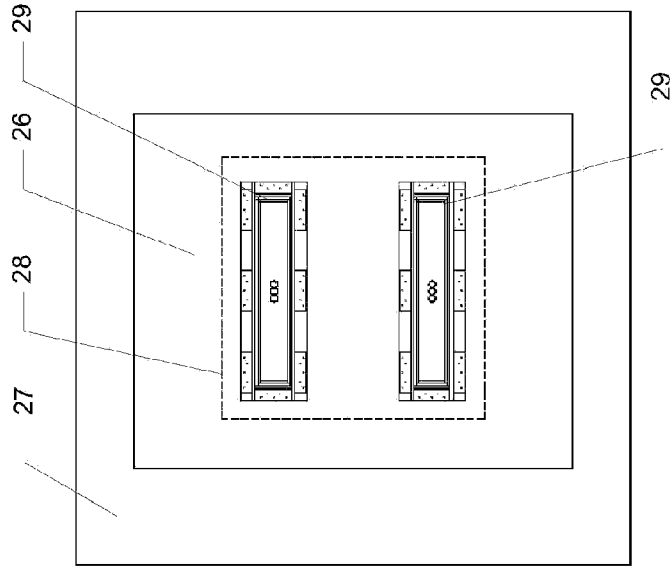


Fig. 11

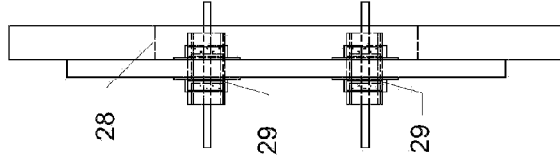


Fig. 12