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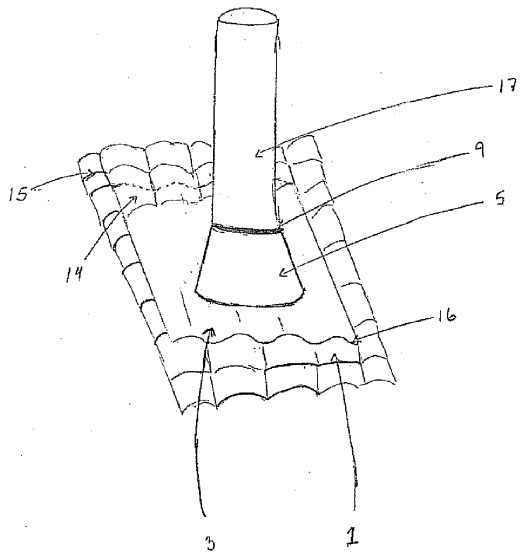
(54) Flashing with an elastic member

(57) This invention concerns a flashing for sealing a first aperture in an exterior cladding of a roof which allow passage of a substantially vertical member through said roof, said flashing comprises a support member adapted to be mounted over the first aperture made in the exterior cladding of the roof; and a truncated conical member or cylindrical member extending upwardly from said support member to fit around said substantially vertical member, where said truncated conical member or cylindrical member is attached to said support member; said truncated conical or cylindrical member comprises at least two openings, a first opening connected to the rim or connected adj acent to the rim of said second aperture of the support member, and a second opening; said first opening and said second opening being sized to allow passage there through of said substantially vertical member; where at least said second opening further is sized to seal against the outer surface of said substantially vertical member; and said truncated conical or cylindrical member is made of an elastic material.

Fig. 4



EP 2 431 552 A2

Description

Field of the Invention

[0001] The present invention relates to a flashing for sealing an aperture in an exterior cladding of a roof to allow passage of a substantially vertical member through said roof

Background of the Invention

[0002] In the construction industry a flashing is commonly used to seal the interstitial gap between the roof and a substantially vertical member such as a pipe, a venting duct or a chimney passing through an aperture made in the roof.

[0003] The flashing helps prevent rain from entering the aperture and hereby to damage the construction of the roof by inducing rot, which additionally can affect the indoor climate. Rain may enter the building even through minor gaps.

[0004] A flashing can consist of a first member, which is arranged along the exterior cladding of the roof and is connected with a second member which surrounds the lower part i.e. from the exterior cladding of the roof and upwards the substantially vertical member. To obtain a sealing between the second member and the substantially vertical member the top of the second member is tightened against the substantially vertical member and/or sealed by adding a sealing material to the interstitial gap between the second member and the substantially vertical member. These adjustments, in order to obtain an efficient sealing, is to be performed manually and can be both difficult and time-demanding.

Object of the Invention

[0005] It is therefore an object of the present invention to provide a flashing which can be easily installed and that creates an effective seal to prevent rain from entering the construction.

Description of the Invention

[0006] In order to address the object of the invention, a flashing for sealing a first aperture in an exterior cladding of a roof which allow passage of a substantially vertical member through said roof, said flashing comprises

- a support member adapted to be mounted over the first aperture made in the exterior cladding of the roof; said support member comprises a second aperture; said second aperture, in use, is aligned with said first aperture;
- a truncated conical member or cylindrical member extending upwardly from said support member to fit around said substantially vertical member, where said truncated conical member or cylindrical member is attached to said support member;
  - o said truncated conical or cylindrical member comprises at least two openings, a first opening connected to the rim or connected adjacent to the rim of said second aperture of the support member, and a second opening; said first opening and said second opening being sized to allow passage there through of said substantially vertical member; where said second opening further is sized to seal against the outer surface of said substantially vertical member;
  - o said truncated conical or cylindrical member is made of an elastic material.

[0007] The flashing consists of the support member which is to be arranged parallel on the exterior cladding of the roof of the building. The support member contains a second aperture, which, in use, is to be aligned with the first aperture formed in the roof of the building and wherein the substantially vertical member such as a pipe, ventilation duct or chimney is arranged. The support member is attached either to the exterior cladding of the roof, the interior cladding of the roof or the substantially vertical element in order for the support member to be arranged properly. The attachment can for example be performed by joint fillers, nails, screws, rivets, or bolts.

[0008] The support member is preferably plate-shaped and comprises two sides where one side faces towards the exterior cladding or the interior cladding of the roof while the other side faces upward and away from the exterior cladding or the interior cladding of the roof.

[0009] Attached to the support member is a truncated conical member or cylindrical member, which extends upwardly from the support member and surrounds the pipe, ventilation duct, or chimney. By upwardly is to be understood away from the roof i.e. the truncated conical member or cylindrical member is attached to the upward facing side of the support member.

[0010] The truncated conical member or cylindrical member is made from an elastic material, which enables the truncated conical member or cylindrical member to fit tightly to the pipe, ventilation duct, or chimney at least where the substantially vertical member is passed though the second opening. This induces sealing of the second opening of the truncated conical member or cylindrical member towards the surface of the pipe, ventilation duct, or chimney and water is prevented to pass through the first aperture of the exterior cladding.

[0011] Attaching a truncated conical or cylindrical member to the support member provides a more efficient draining of the water from the roof than if the flashing consisted only of a support member since the water do not as easily enter the attic and the roof construction. Furthermore, the water is prevented to be collected in puddles, which especially during winter-time can be destructive for roof construction due to the formation of ice. Especially, if the truncated conical member or cylindrical

member is cone-shaped the drainage of water is optimised since the water is drained efficiently towards and off the roof.

[0012] The flashing is easily handled when the truncated conical member or cylindrical member is formed as a truncated cone since the member is only provided with a tight fitting to the substantially vertical member at or close to the second opening.

[0013] The elastic properties of the truncated conical member or cylindrical member enable one size of truncated conical member or cylindrical member to fit and seal different types of substantially vertical members such as substantially vertical members of different sizes and dimensions for example with different diameters.

[0014] Furthermore, the elastic properties of the truncated conical member or cylindrical member enable one flashing to be used on multiple roofs though the sloping of the exterior cladding of the roof differs. The elastic properties enable the support member to be angled between 0 and 90° with regard to the truncated conical member or cylindrical member i.e. when the roof is flat the angle would be approximately 90° and if the pitched roof is 45° with regard to the ground, the angle would be approximately 45°.

[0015] The truncated conical member or cylindrical member of the flashing is composed of an elastic material. The handling of the flashing is dependent upon the characteristics of this elastic material. Thus, the thickness of the truncated conical member or cylindrical member is important for the easiness by which the flashing is arranged. The thicker the material, the more stiffness the truncated conical member or cylindrical member contains and the more difficult it will be to fit it sealingly to the substantially vertical member.

[0016] On the other hand, if the thickness is too small, the flashing will also be difficult to handle because it is too bendable. In addition, this can result in insufficient closure/contact with the substantially vertical member. Thus, a correct thickness is of major importance and is a balance between the listed disadvantages.

[0017] In an advantageous embodiment of the flashing, the elastic material of the truncated conical member or cylindrical member is of a thickness between 0.5 and 5.0 mm, more preferred between 1.5 and 4.0 mm, most preferred between 2.0 and 3.0 mm.

[0018] In a further advantageous embodiment of the flashing, the elastic material of the truncated conical member or cylindrical member is selected from ethylene propylene diene monomer rubber, nitrile rubber, silicone-rubber, neoprene and/or natural rubber.

[0019] Ethylene propylene diene monomer rubber (EPDM rubber) is an elastomer, which is characterized by a wide range of applications. The properties of EPDM rubber are ideel for the use as a elastic sealing since it is compatible with water as well as elastic in a way that lead to a sticking to the surface of the substantially vertical members through the roof such as ventilation pipes, chimneys etc. The elasticity of the material makes it ideel for fitting thightly to standard tubes or pipes when the diameter of the second opening is slightly smaller than the diameter of the substantially vertical member. Preferably, the diameter of the second opening is 5-70% smaller than the diameter of the substantially vertical member, preferably 5-30%, more preferred 5-20%. As an example the diameter of the substantially vertical member can be 350 mm or 400 mm while the diameter of the second opening is 300 mm or 350 mm, respectively.

[0020] Furthermore, the EPDM rubber is a well-known and well-characterised material. In one embodiment, the EPDM rubber is characterised by an elongation at failure of 200-430%, preferably 200-400%, more preferred 250-390%, most preferred 300-380%, a tearing strength of approximately 50-60kN/m and a tensile strength of approximately 8-10 MPa. The EPDM can stand tempetures between -45 to +130 degrees Celcius without change of properties. It exhibits satisfactory compatibility with a large number of compounds inclusing hot and cold water.

[0021] Nitrile rubber is a synthetic rubber copolymer of acrylonitrile and butadiene, which is generally resistant to oil, fuel, and other chemicals and with an ability to withstand a range of temperatures from -40°C to +120°C. Neoprene is a family of synthetic rubbers based on polychloroprene and is widely used as a base for adhesives and electrical insulations. Natural rubber is an elastic hydrocarbon polymer that is extracted from plants. All three mentioned materials possess properties similar to that of EPDM for example with regard to the large degree of elasticity. Other elastic materials are also to be considered, the four mentioned are only examples of such.

[0022] The truncated conical member or cylindrical member is attached to the support member. The connection between the truncated conical member or cylindrical member and the support member could be attached by either an adhesive means, like glue or double adhesive tape, hook-and-loop fastener, or the two materials could be assembled together by one or more fittings like nails, nuts, pop rivets, rivets, and/or screws.

[0023] Alternatively, the connection between the truncated conical member or cylindrical member and the support member can be obtained both by fittings and adhesive means. As an example the connection can be performed by joint filler made from silyl terminated modified polymers (MS-polymer) such as a MS-hybrid polymer of one-component such as PERFORM® adhesive, which forms an elastic joint. This caulking compound is known to be stable within a wide temperature range, such as from -40 to 90 degrees Celsius and is water-resistant.

[0024] Alternatively, the connection between the truncated conical member or cylindrical member and the support member can be formed by a two-component adhesive.

[0025] In a further alternative embodiment, the connection can be performed by attaching an adjustable clamp after installing the truncated conical member or cylindrical member and the support member. Hereby, the

two members are installed separately and following attached to one another by tightening an adjustable clamp. The adjustable clamp is arranged at a position where the truncated conical member or cylindrical member and the support member overlap. Hereafter, the adjustable clamp is tightened around the flashing for securing the truncated conical member or cylindrical member in relation to the support member. In one embodiment, the process of tightening the adjustable clamp is performed via adjustable means enabling a loop formed by the adjustable clamp to be adjusted by operating the adjustable means.

[0026] The adjustable clamp can be made from plastic or metal such as galvanized steel, stainless steel, or copper.

[0027] Forming the truncated conical member or cylindrical member as a truncated cone makes the handling of the flashing much easier since the truncated conical member or cylindrical member is only provided with a tight fitting to the substantially vertical member at or close to the second opening. The truncated conical member or cylindrical member can be formed as alternative three-dimensional shapes. For example, it can be a tube that fits tightly to the substantially vertical member just for a few centimetres close to the second opening while the rest of the truncated conical member or cylindrical member is larger without the member obtaining a truncated conical shape. Alternatively, the truncated conical member or cylindrical member can fit tightly along the entire length of the chimney.

[0028] The flashing can easily be installed on to the substantial vertical member and pulled down till the support member is arranged on the roof construction. Hereafter tiles can be placed upon the support member at least covering the edges of the support member. In one embodiment, the support member of the flashing can be hidden in the construction after the tiles have been placed properly. In a further embodiment, the flashing including the truncated conical member or cylindrical member can be hidden in the construction after placing the tiles properly. In a still further embodiment only one or more of the edges of the support member is covered by the tiles.

[0029] In a further advantageous embodiment, said support member further comprises a flange extending upwardly along the rim or adjacent to the rim of said second aperture, where said truncated conical member or cylindrical member can be attached to said flange. In a still further advantageous embodiment, said flange is an integrated part of said support member.

[0030] The support member can comprise a flange along the rim or adjacent to the rim of the second aperture where the flange preferably is substantially perpendicular to the surface of the support member. Hereby, the attachment of the truncated conical member or cylindrical member to the support member is easier since the inside of the truncated conical member or cylindrical member adjacent to the rim of the first opening can be attached to the flange instead of the rim of the first opening being attached to the rim or adjacent to the rim of the second aperture.

[0031] It is implicitly to be understood that the truncated conical member or cylindrical member can comprise a flange as well.

[0032] The flange can either be formed by bending the material of the support member along the rim of the second aperture or it can be a separate piece of material, which can be attached to both the support member and the truncated conical member or cylindrical member as a connector providing a larger area for attachment and thus the support member and the truncated conical member or cylindrical member will be more efficiently attached to one another. The separate piece of material could be pre-bend into a given shape.

[0033] The flange can be of a different material than the support member and/or the truncated conical member or cylindrical member.

[0034] The flange may be composed of plastic or a metal such as steel, stainless steel, galvanized steel or copper.

[0035] Advantageously, in case of an overlap between the truncated conical member or cylindrical member and the support member, the part of the truncated conical member or cylindrical member overlapping will constitute the outside of the flashing.

[0036] As a further embodiment the support member and the truncated conical member or cylindrical member can be formed from one piece of material and thus they are automatically attached to one another.

[0037] In a further advantageous embodiment, said support member is made from a plastically deformable material. In a still further advantageous embodiment, said support member further comprises a metallic lattice; said metallic lattice is preferably integrated in said plastically deformable material.

[0038] The support member is preferably made of a plastically deformable material which can be shaped into a form which corresponds to the exterior cladding of the roof for example tiles. Hereby, the fitting of the flashing to the roof construction is easily obtained and the flashing can be adapted to fit to existing constructions and multiple different constructions.

[0039] By plastically deformable material is to be understood any material which is capable of being formed into a given shape and hereafter maintain this particular shape.

[0040] The metallic lattice incorporated into the support member increases the preference of the support member to remain in a given shape. As an example the support member could be formed from PERFORM®.

[0041] Rain is prevented from entering under the support member of the flashing, when the support member is formed into the shape of the exterior cladding of the roof. The support member can be formed into the shape of the exterior cladding of the roof for example by using a hammer.

[0042] Furthermore, if tiles are arranged to partly over-

lap with the support member shaping of the support member enables the tiles to be arranged optimally preventing water from entering the inside of the roof.

[0043] In a further advantageous embodiment, the truncated conical member or cylindrical member is attached to said support member by a seam. In a still further advantageous embodiment, means for sealing are provided on said seam.

[0044] Uniting the truncated conical member or cylindrical member to the support member by a seam either by sewing or clipping enables an efficient and long-lasting attachment of the two members.

[0045] The seam can be made with multiple types of material such as wires, threads, or fibres. In a further embodiment, the seam is elastic.

[0046] In another embodiment, the seam is provided by using a strong thread sewing the members together using a specially adapted sewing machine.

[0047] In a further embodiment, the seam between the truncated conical member or cylindrical member and the support member can be performed by clipping the members together. The clips can be made from a material such as plastic or metal. In a still further embodiment, the clips are made from an elastic material.

[0048] After attaching the truncated conical member or cylindrical member to the support member by a seam, the seam can be provided with means for sealing, preferably on the seam. Hence, water and moisture is prevented from entering the inside of the flashing through the penetrations of the members i.e. where the members are penetrated. The means for sealing can be provided on either the inside or the outside of the flashing.

[0049] The means for sealing can be compounds such as silicone, glue, cover strips, joint sealing compounds as commonly known to the person skilled in the art. In one embodiment, the compounds form elastic joints.

[0050] This invention further describes a roof comprising a substantially vertical member passing through said roof and a first aperture in an exterior cladding of said roof and a flashing as described for sealing said first aperture where said flashing comprises a support member adapted to be mounted over the first aperture made in the exterior cladding of the roof; said support member comprises a second aperture; said second aperture, in use, is aligned with said first aperture and a truncated conical member or cylindrical member extending upwardly from said support member to fit around said substantially vertical member, where said truncated conical member or cylindrical member is attached to said support member; said truncated conical or cylindrical member comprises at least two openings, a first opening connected to the rim or connected adjacent to the rim of said second aperture of the support member, and a second opening; said first opening and said second opening being sized to allow passage there through of said substantially vertical member; where at least said second opening further is sized to seal against the outer surface of said substantially vertical member; and said truncated conical or cylindrical member is made of an elastic material.

[0051] When a substantially vertical member is arranged through the roof a first aperture is to be made in the roof in order for the substantially vertical member to be arranged herein. In order to prevent water to enter into the building through the first a flashing comprising a support member and a truncated conical and cylindrical member is pulled down from the top of the substantially vertical member passing the substantially vertical member through the second aperture, the first opening and the second opening of the flashing, till the support member is arranged on the exterior cladding of the roof. Preferably, then the support member is shaped into the form of the exterior cladding of the roof.

[0052] Hereafter tiles can be arranged partly on the support member. If for example the roof construction is a pitched roof the tiles is arranged on the upwards facing side of the support member at the upper end of the support member, while the support member is partly arranged over the tiles at the lower end of the support member. Upper and lower is here to be understood with regard to the ground.

Description of the Drawing

[0053]

Fig. 1 illustrates a three-dimensionally view of a flashing with a support member and an elastic truncated conical member or cylindrical member;

Fig. 2 illustrates a top-view of a flashing with a support member and an elastic truncated conical member or cylindrical member;

Fig. 3 illustrates a side-view of a flashing with a support member and an elastic truncated conical member or cylindrical member;

Fig. 4 illustrates a flashing installed at an exterior cladding of a roof;

Fig. 5 illustrates a side-view of a flashing installed at an exterior cladding of a roof;

Fig. 6 illustrates a three-dimensionally view of a flashing with a cone attached to a support member by a seam;

Fig. 7 illustrates a three-dimensionally view of a flashing with a cone attached to a support member by an adjustable clamp;

Fig. 8 illustrates a side-view of a further embodiment of a flashing installed at an exterior cladding of a roof.

Detailed Description of the Invention

[0054] Fig. 1 illustrates a three-dimensionally view of a flashing 1 with a support member 3 and an elastic truncated conical member or cylindrical member 5. In this particular embodiment, the truncated conical member or cylindrical member 5 is shown as a cone, more specifically a cone, attached to a rectangular support member

3. The first opening 7 of the truncated conical member or cylindrical member 5 is attached to the support member 3 while the second opening 9 if the truncated conical member or cylindrical member 5 is free and significantly smaller than the first opening 7. Hereby, a tight fitting to for example a chimney is obtained.

[0055] During installation, the flashing 1 is pulled onto the chimney arranging the top of the chimney into the second aperture 11 of the support member 3 and leading the top of the chimney through the first opening 7 and the second opening 9 of the truncated conical member or cylindrical member 5. The flashing 1 is pulled down until the support member 3 is arranged on the exterior cladding of the roof

[0056] Fig. 2 illustrates a top-view of a flashing 1 with a support member 3 and an elastic truncated conical member or cylindrical member 5 as also seen in fig. 1. In this particular view the obliqueness of the cone is easily seen. The obliqueness can be adjusted to fit to the particular roof and chimney type. It is of course implicitly to be understood that the truncated conical member or cylindrical member 5 can be formed as alternative three-dimensional shapes. For example, it can be a tube that fits tightly to the substantially vertical member just for a few centimetres close to the second opening 9 while the rest of the truncated conical member or cylindrical member 5 is larger without the member obtaining a truncated conical shape. Alternatively, the truncated conical member or cylindrical member 5 can fit tightly along the entire length of the chimney.

[0057] Fig. 3 illustrates a side-view of a flashing 1 with a support member 3 and an elastic truncated conical member or cylindrical member 5 as also illustrated in fig. 1 and 2. In this particular side view a flange 13, which can be at the perimeter of the second aperture 11, is illustrated. This flange 13 is arranged inside the truncated conical member or cylindrical member 5 and attached to the sides of the same.

[0058] Fig. 4 and fig. 5 illustrates a front view and a side-view of an exterior cladding of a roof embodied as tiles 15 comprising a substantially vertical member in the form of a chimney 17. The roof further comprises an interior cladding 19 and laths 21 onto which the tiles are arranged. The support member 3 of a flashing 1 is attached to the roof 15 and a truncated conical member or cylindrical member 5 surrounds part of the chimney 17. The truncated conical member or cylindrical member 5 seals at the second opening 9 along the outside of the chimney 17 preventing water to enter inside the second opening 9. The water is drained along the outside of the truncated conical member or cylindrical member 5, the support member 3 and the outside of the roof 15. Fig. 5 further illustrates an additional sealing 23 in relation with the interior cladding of the roof 19.

[0059] If the construction is a renovation of an elderly house or a new installation of a chimney, tiles can be removed from the place surrounding the chimney, the flashing 1 installed and the tiles 15 arranged partly on top of the support member 3 at the upper end 14 while the support member 3 is arranged partly on top of the tiles at the lower end 16 of the support member 3. Hereby, water is drained onto the support member 3 from the tiles and prevented from entering under the support member 3. Furthermore, the water is drained onto the tiles 15 at the lower end 16 of the support member 3 and prevented from entering under the tiles 15. It is implicitly to be understood that the tiles can be arranged on top of the support member 3 covering the support member 3 to a more or lesser extent and/or underneath the support member 3 to a more or lesser extent. As an example the tiles can cover the support member 3 from the upper end 14 to the truncated conical member or cylindrical member 5 and tiles can be arranged underneath the support member 3 from the truncated conical member or cylindrical member 5 and to the lower end 16.

[0060] Fig. 6 illustrates a three-dimensionally view of a flashing 1 with a support member 3 and the truncated conical member or cylindrical member 5 as described in fig. 1. The truncated conical member or cylindrical member 5 is attached to the support member 3 by a seam 25. The seam 25 can be sealed with means for sealing such as silicone by providing the silicone on the seam, preferably on the inside of the truncated conical member or cylindrical member 5.

[0061] Fig. 7 illustrates a three-dimensionally view of a flashing 1 with a support member 3 and a truncated conical member or cylindrical member 5 as described in fig. 1. The truncated conical member or cylindrical member 5 is attached to the support member 3 by an adjustable clamp 27. The adjustable clamp 27 is arranged on the outside of the truncated conical member or cylindrical member 5. The size of the adjustable clamp 27 is adjusted by the adjustable means 29 such that the clamp 27 will force the bottom of the truncated cone 5 against the flange of the support member 3. Hereby, the adjustable clamp 27 is tightened and the free end 31 of the adjustable clamp 27 is enlarged. The adjustable clamp 27 is arranged at an overlapping position between the support member 3 and the truncated conical member or cylindrical member 5.

[0062] Fig. 8 illustrates a side-view of an alternative embodiment of a flashing with a truncated conical member or cylindrical member 5 and a support member 3. Most features are common to fig. 5 and therefore not further described.

Claims

1. A flashing (1) for sealing a first aperture in an exterior cladding of a roof (15) which allow passage of a substantially vertical member (17) through said roof (15), said flashing (1) comprises

    - a support member (3) adapted to be mounted over the first aperture made in the exterior clad-

ding of the roof (15); said support member (3) comprises a second aperture (11); said second aperture (11), in use, is aligned with said first aperture;
- a truncated conical member or cylindrical member (5) extending upwardly from said support member (3) to fit around said substantially vertical member (19), where said truncated conical member or cylindrical member (5) is attached to said support member (3);

o said truncated conical or cylindrical member (3) comprises at least two openings, a first opening (7) connected to the rim or connected adjacent to the rim of said second aperture (11) of the support member (3), and a second opening (9); said first opening (7) and said second opening (9) being sized to allow passage there through of said substantially vertical member (17); where at least said second opening (9) further is sized to seal against the outer surface of said substantially vertical member (17);
o said truncated conical or cylindrical member (3) is made of an elastic material.

2. The flashing (1) according to claim 1 **characterised in that** said support member (3) further comprises a flange (13) extending upwardly along the rim or adjacent to the rim of said second aperture (11), where said truncated conical or cylindrical member (3) can be attached to said flange (13).

3. The flashing (1) according to claim 2 **characterised in that** said flange (13) is an integrated part of said support member (3).

4. The flashing (1) according to any of the preceding claims **characterised in that** said support member (3) is made from a plastically deformable material.

5. The flashing (1) according to claim 4 **characterised in that** said support member (3) further comprises a metallic lattice; said metallic lattice is preferably integrated in said plastically deformable material.

6. The flashing (1) according to any of the preceding claims **characterised in that** said truncated conical member or cylindrical member (5) is attached to said support member (3) by a seam.

7. The flashing (1) according to claim 6 **characterised in that** means for sealing are provided on said seam.

8. A roof comprising a substantially vertical member (17) passing through said roof and a first aperture in an exterior cladding of said roof (15) and a flashing (1) according to any of the claims 1-7 for sealing said first aperture where said flashing (1) comprises

- a support member (3) adapted to be mounted over the first aperture made in the exterior cladding of the roof (15); said support member (3) comprises a second aperture (11); said second aperture (11), in use, is aligned with said first aperture;
- a truncated conical member or cylindrical member (5) extending upwardly from said support member (3) to fit around said substantially vertical member (19), where said truncated conical member or cylindrical member (5) is attached to said support member (3);

o said truncated conical or cylindrical member (3) comprises at least two openings, a first opening (7) connected to the rim or connected adjacent to the rim of said second aperture (11) of the support member (3), and a second opening (9); said first opening (7) and said second opening (9) being sized to allow passage there through of said substantially vertical member (17); where at least said second opening (9) further is sized to seal against the outer surface of said substantially vertical member (17);
o said truncated conical or cylindrical member (3) is made of an elastic material.

Fig. 1

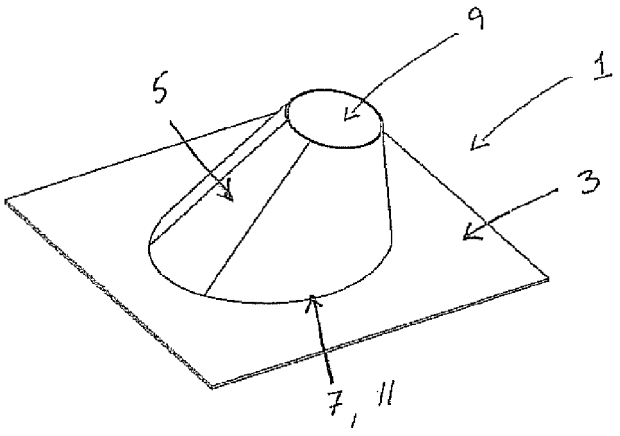


Fig. 2

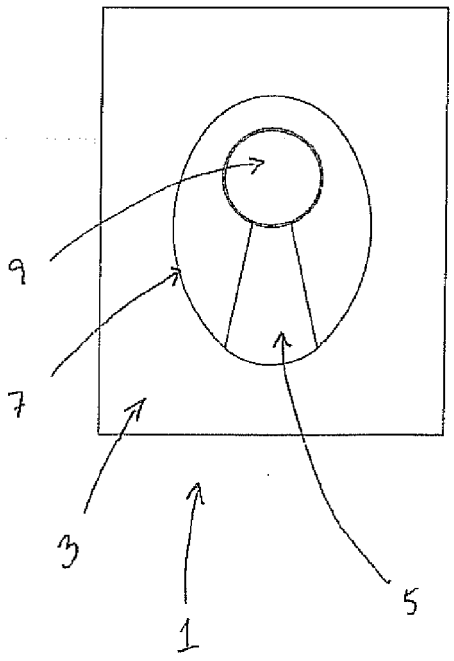


Fig. 3

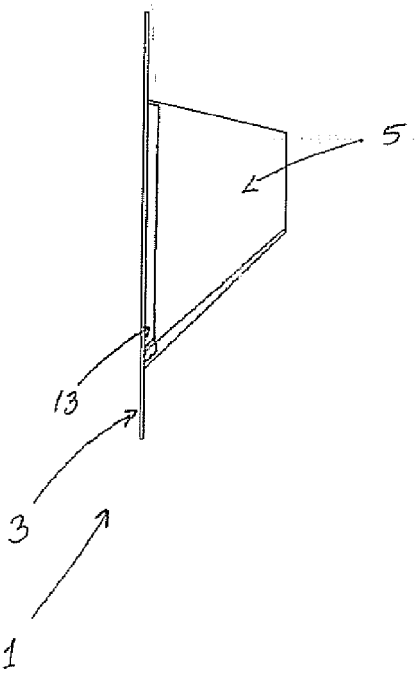


Fig. 4

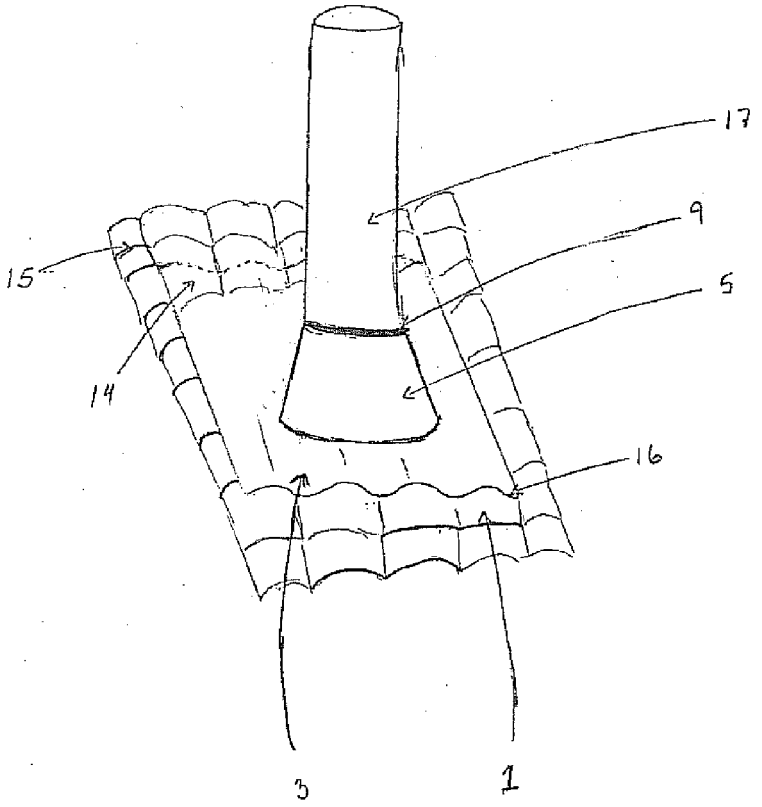


Fig. 5

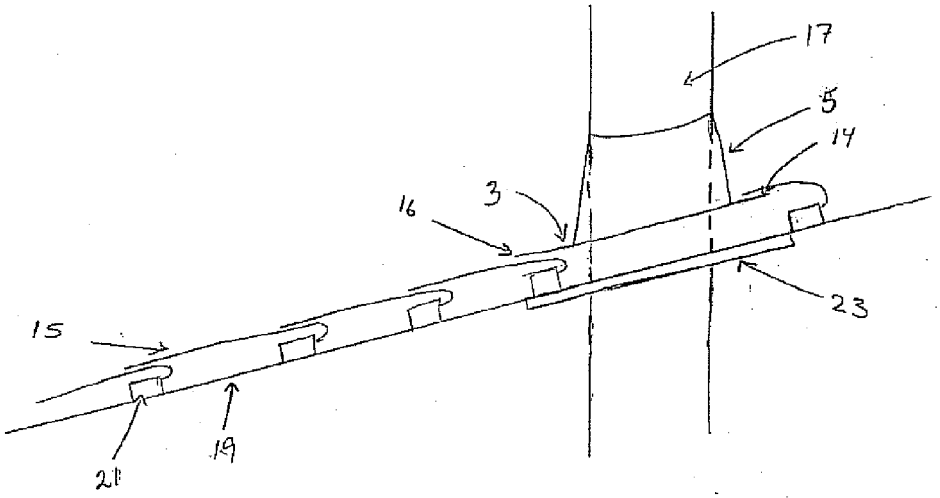


Fig. 6

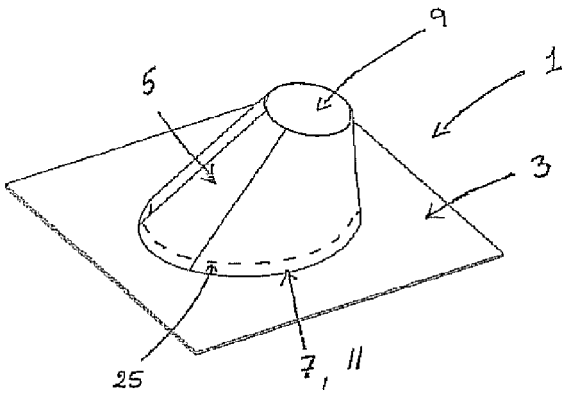


Fig. 7

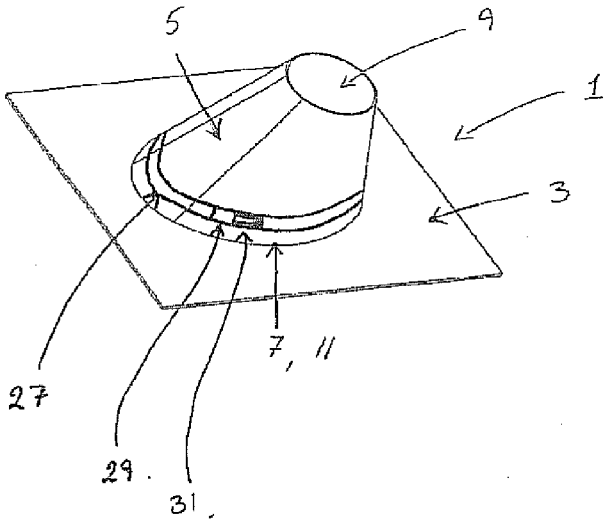


Fig. 8