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(54) **DEVICES AND METHODS TO PROVIDE AIR CIRCULATION SPACE PROXIMATE BUILDING INSULATION**

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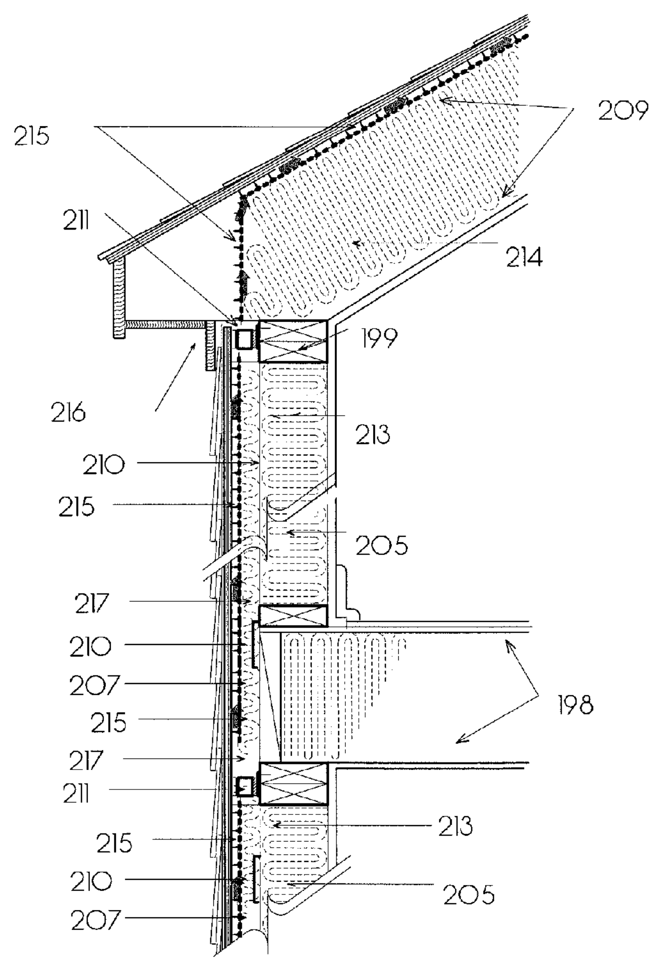
(57) **ABSTRACT**

Devices and associated methods are provided for improving ventilation of insulation material and building construction and renovation. Specifically, the present disclosure includes devices and system(s) to achieve the ventilation of exterior walls and roofs. Components of the system(s) consider shutdown of the ventilation process when it is not necessary, such as in winter, and in the event of fire, where the prevention of vertical and horizontal fire spread is desired.



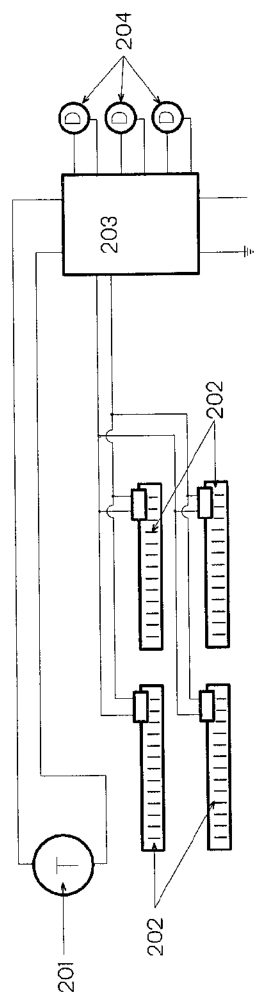

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Fig. 1

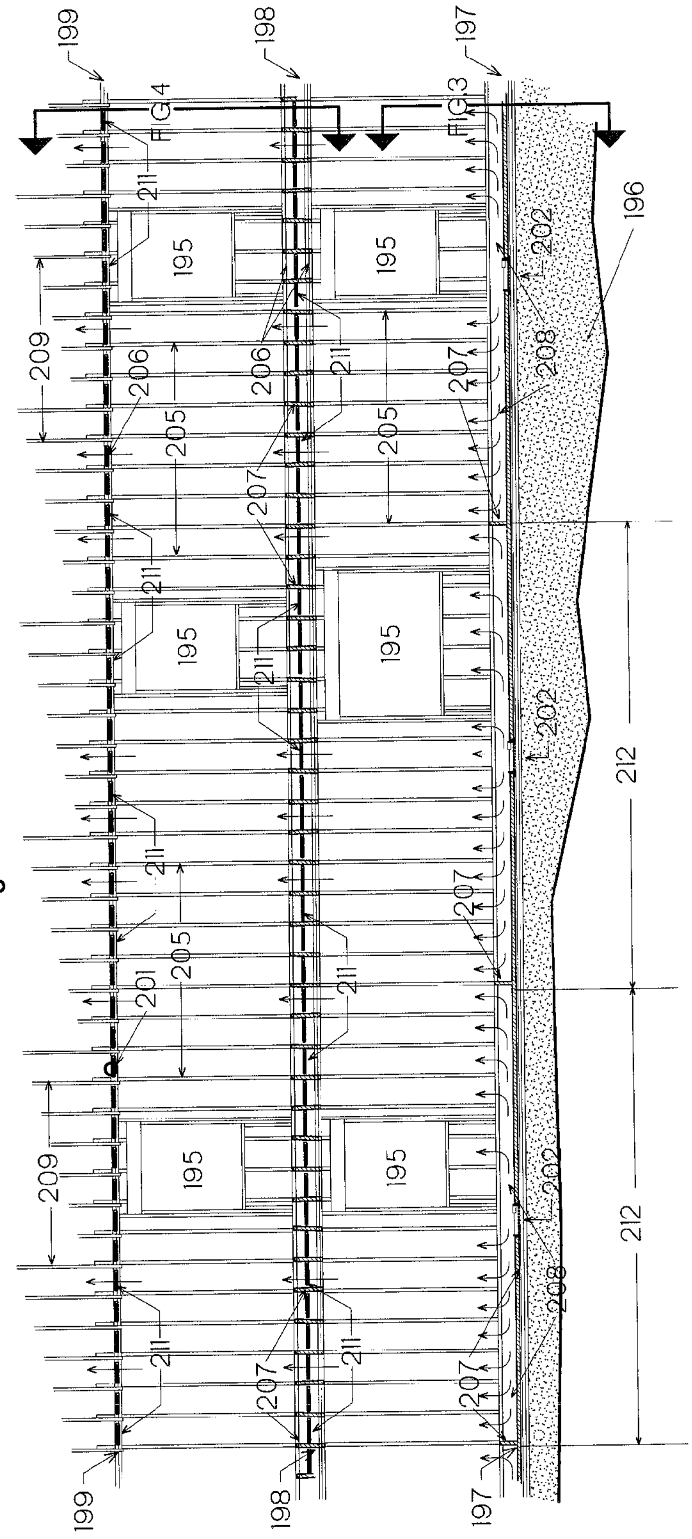
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FIG3
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Fig. 2

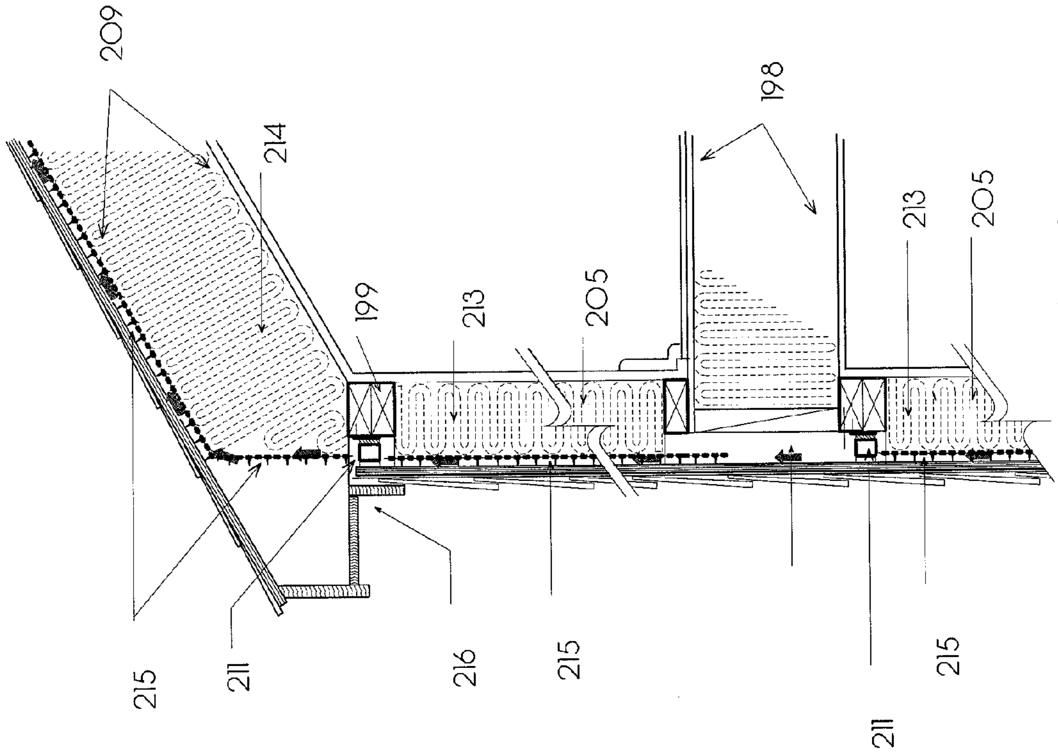
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Fig. 4

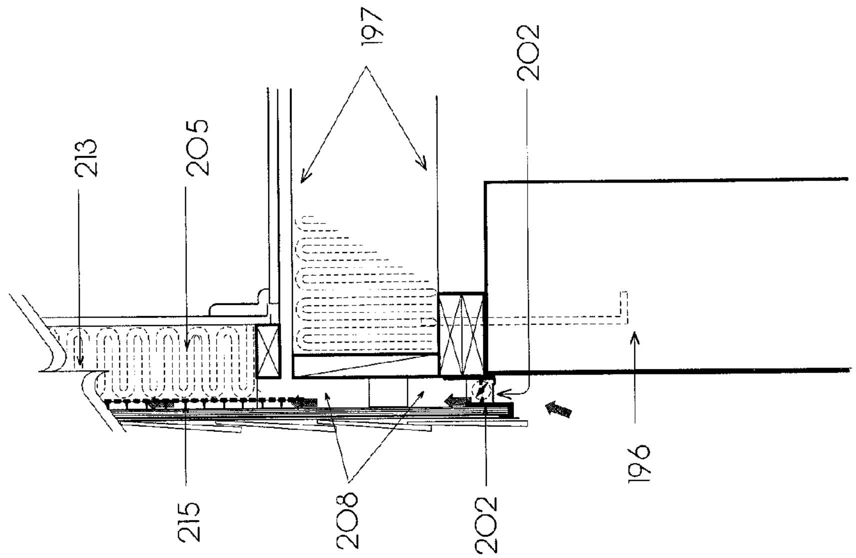
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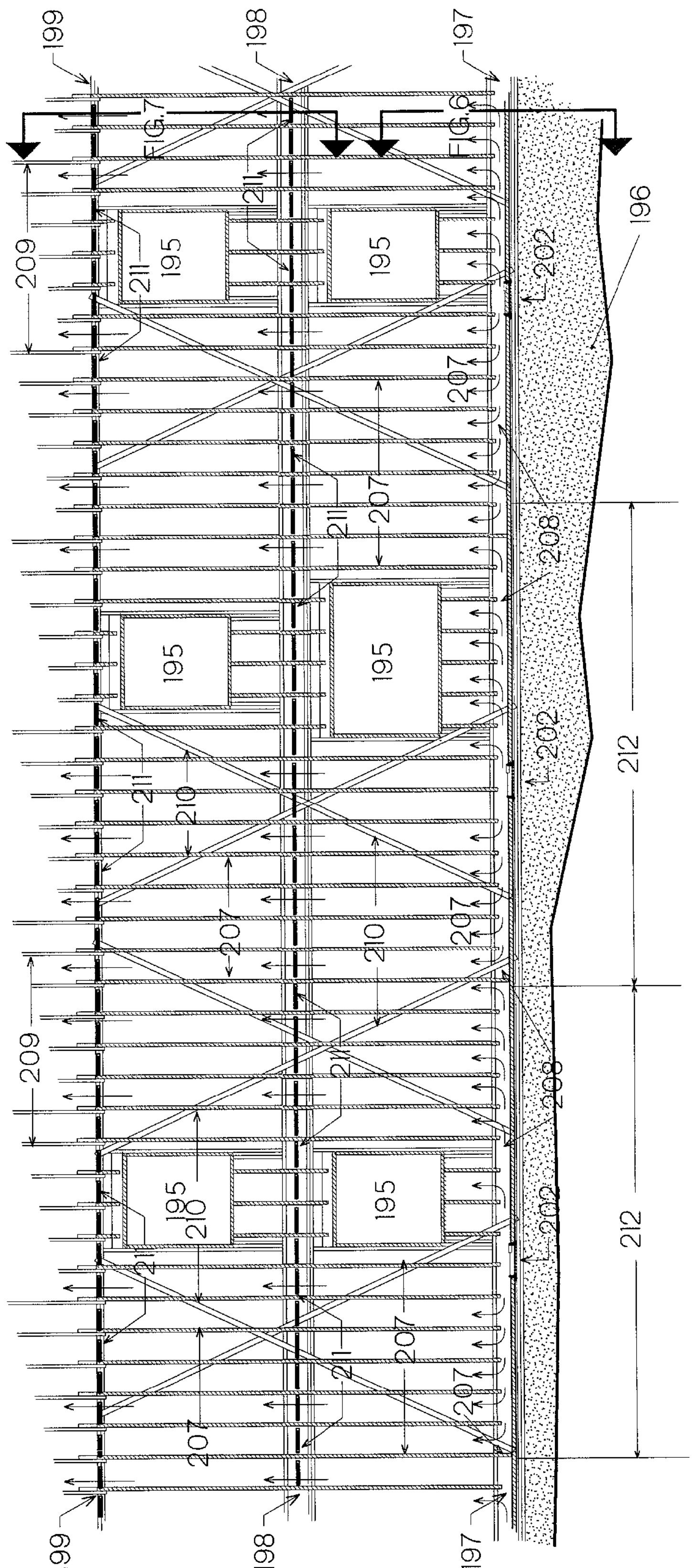
Fig. 3



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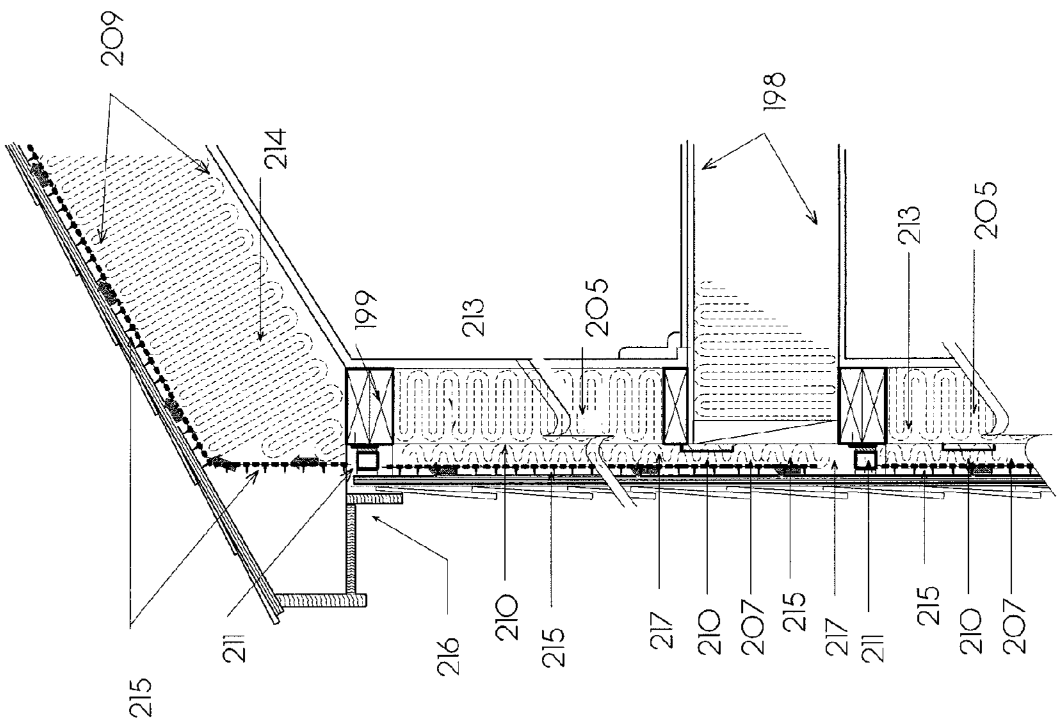
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Fig. 7

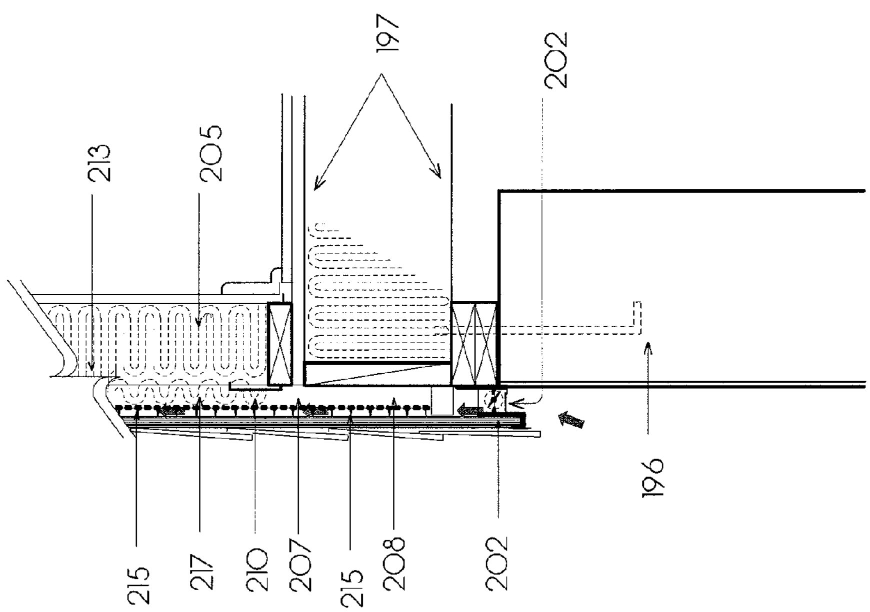
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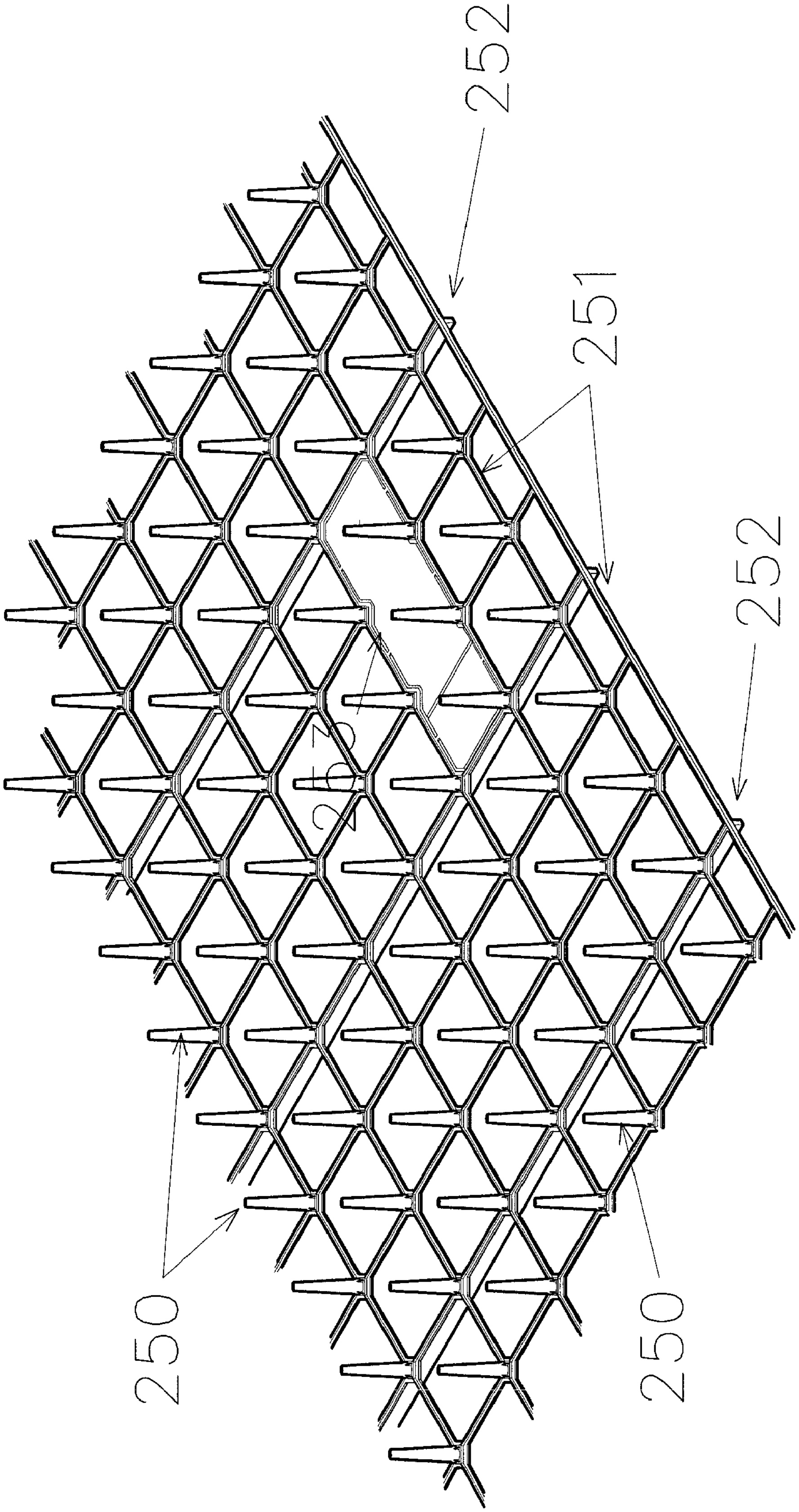
Fig. 6



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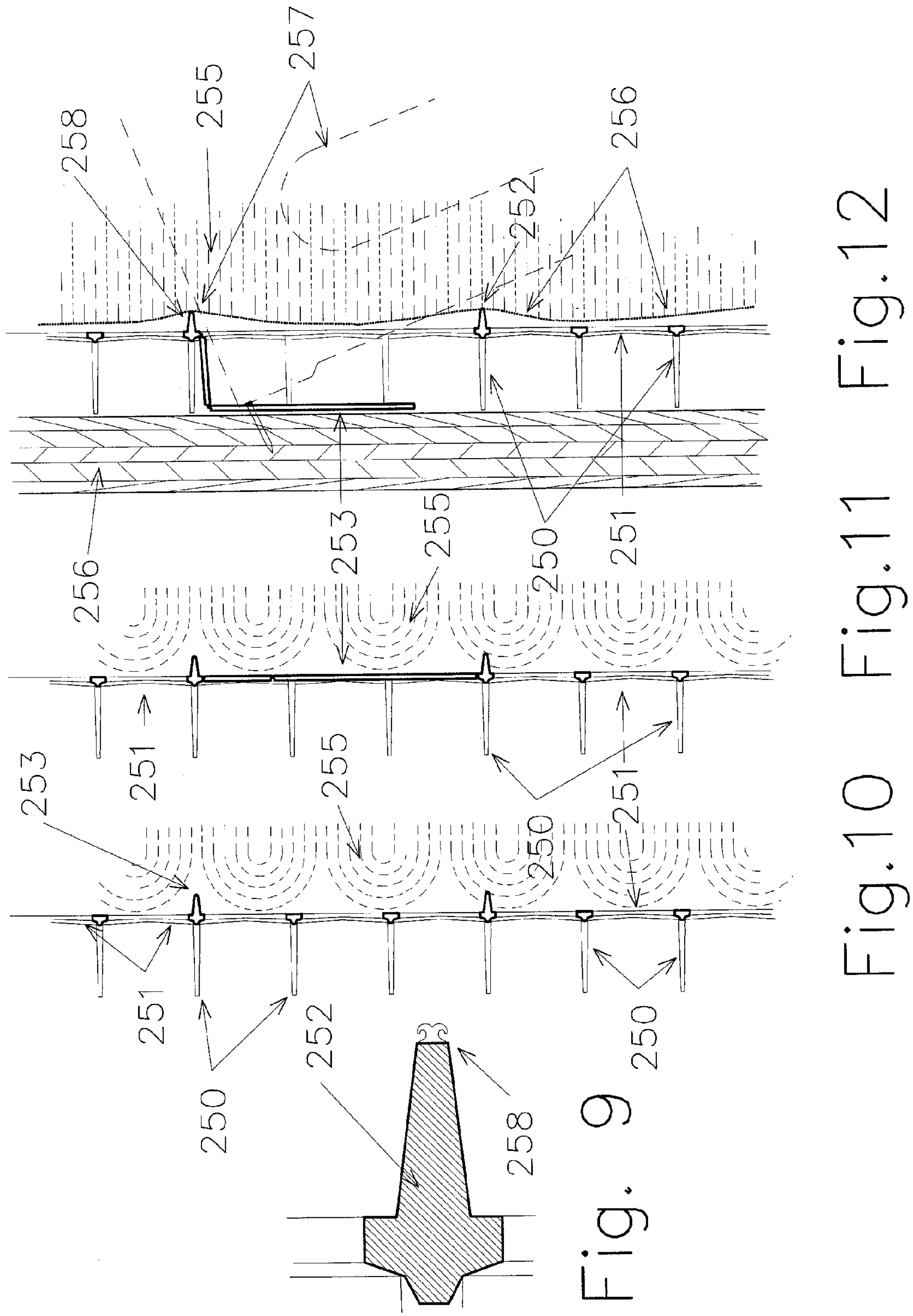
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Fig.11
Fig.12
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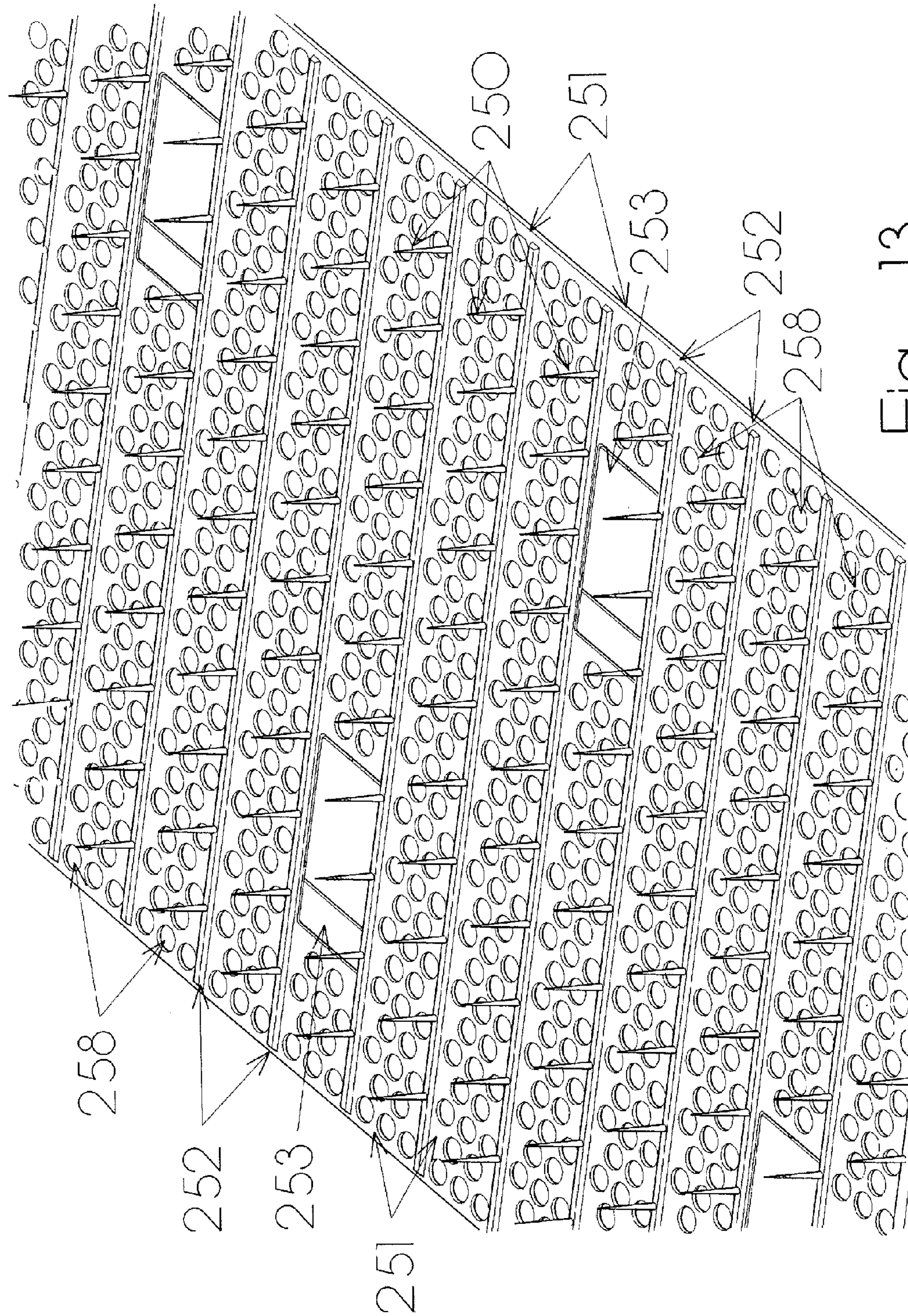

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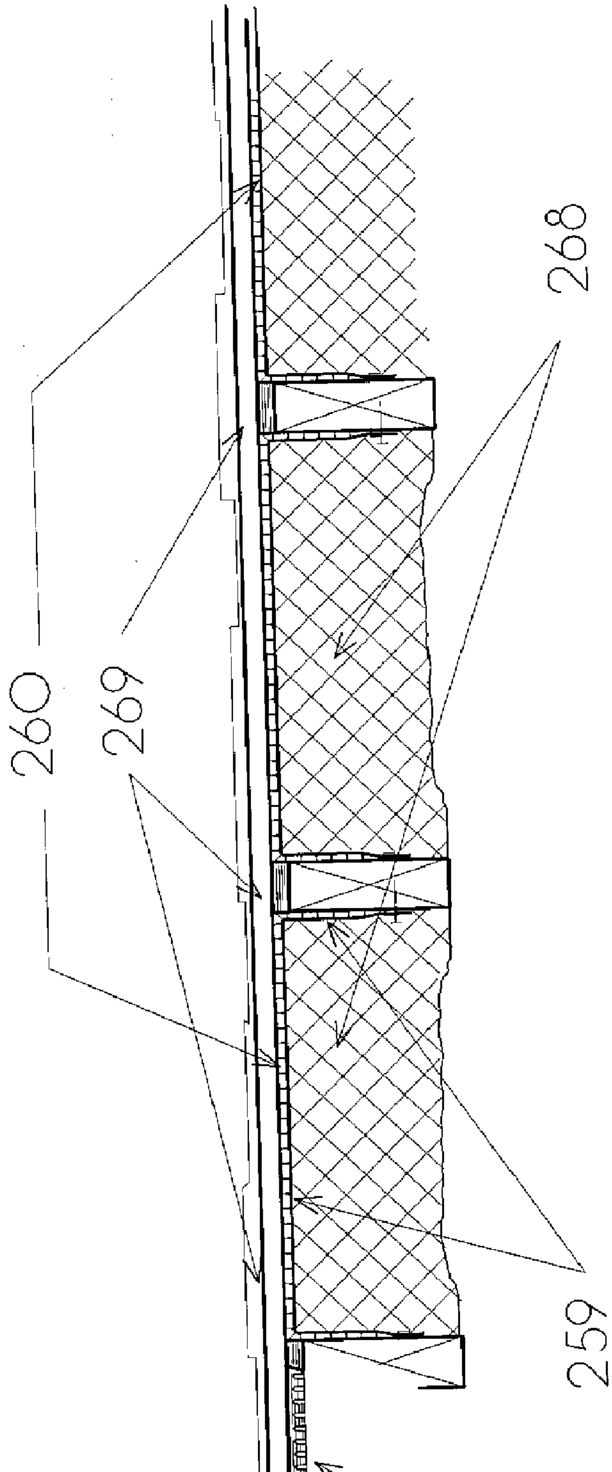

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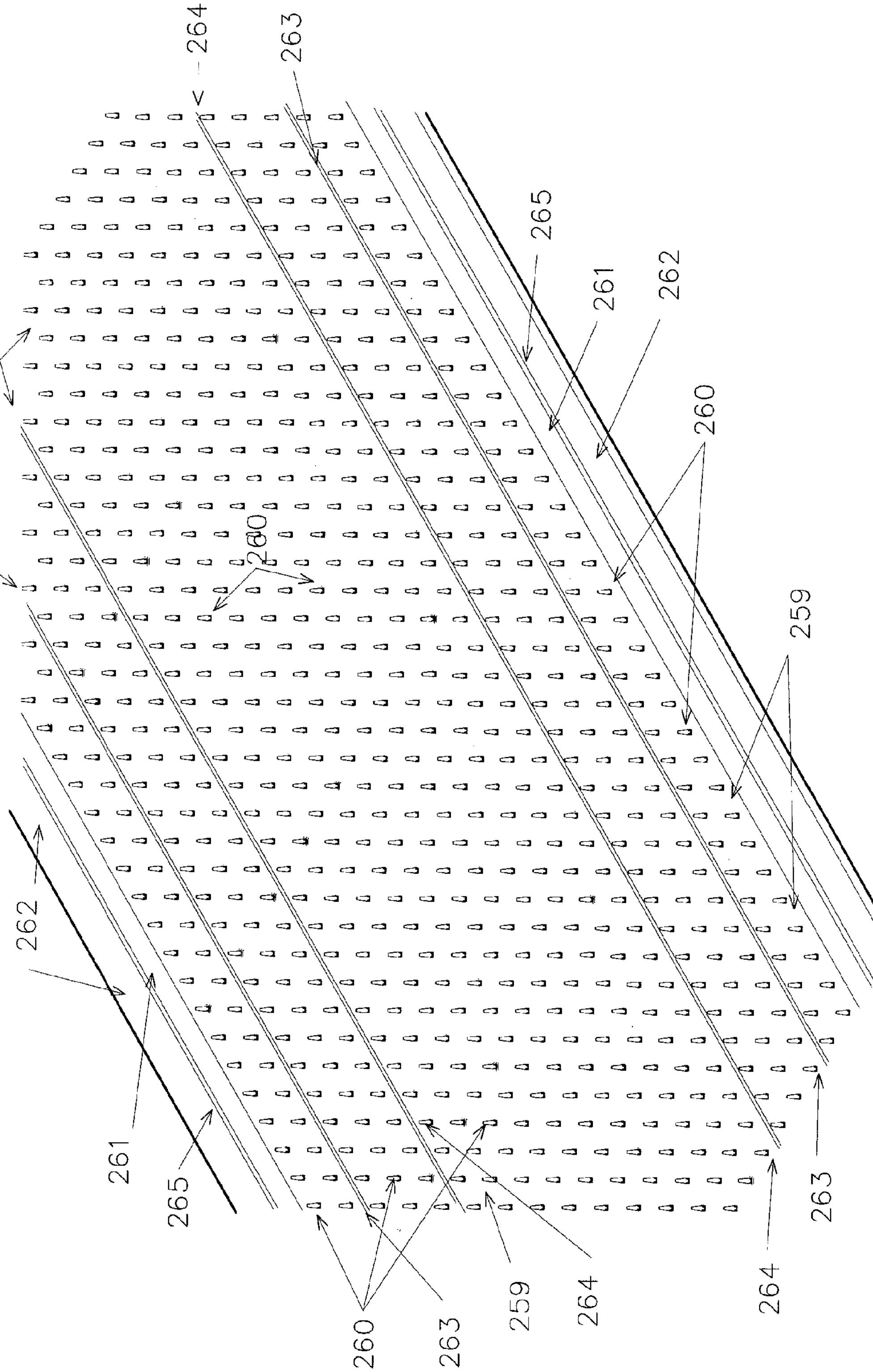
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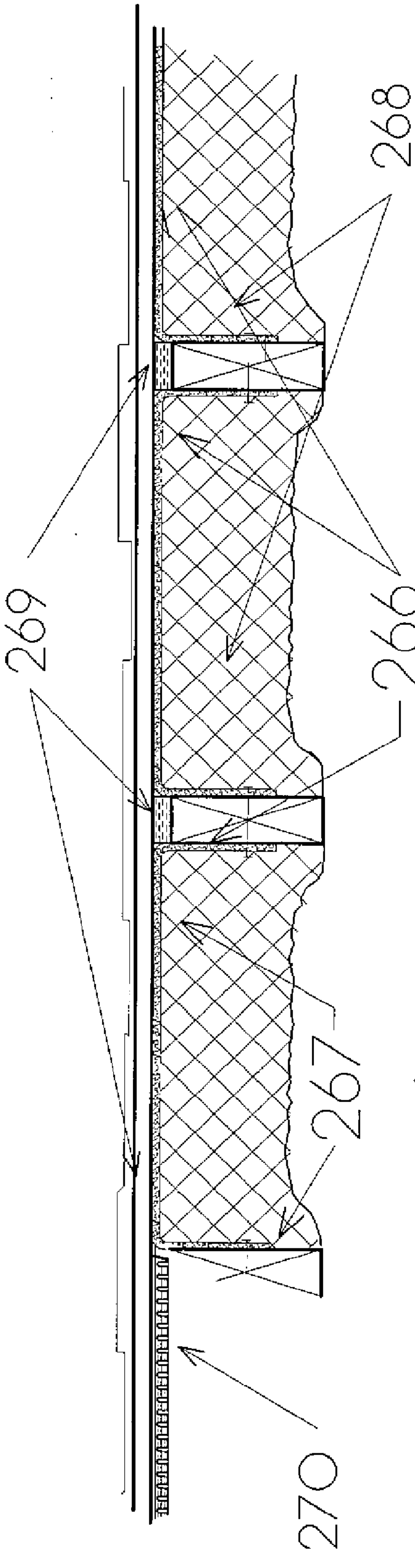
Fig. 15



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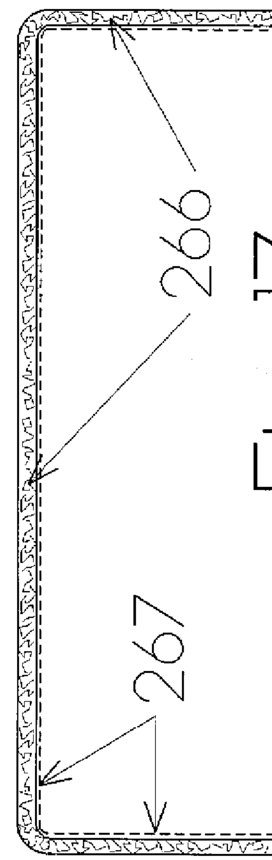

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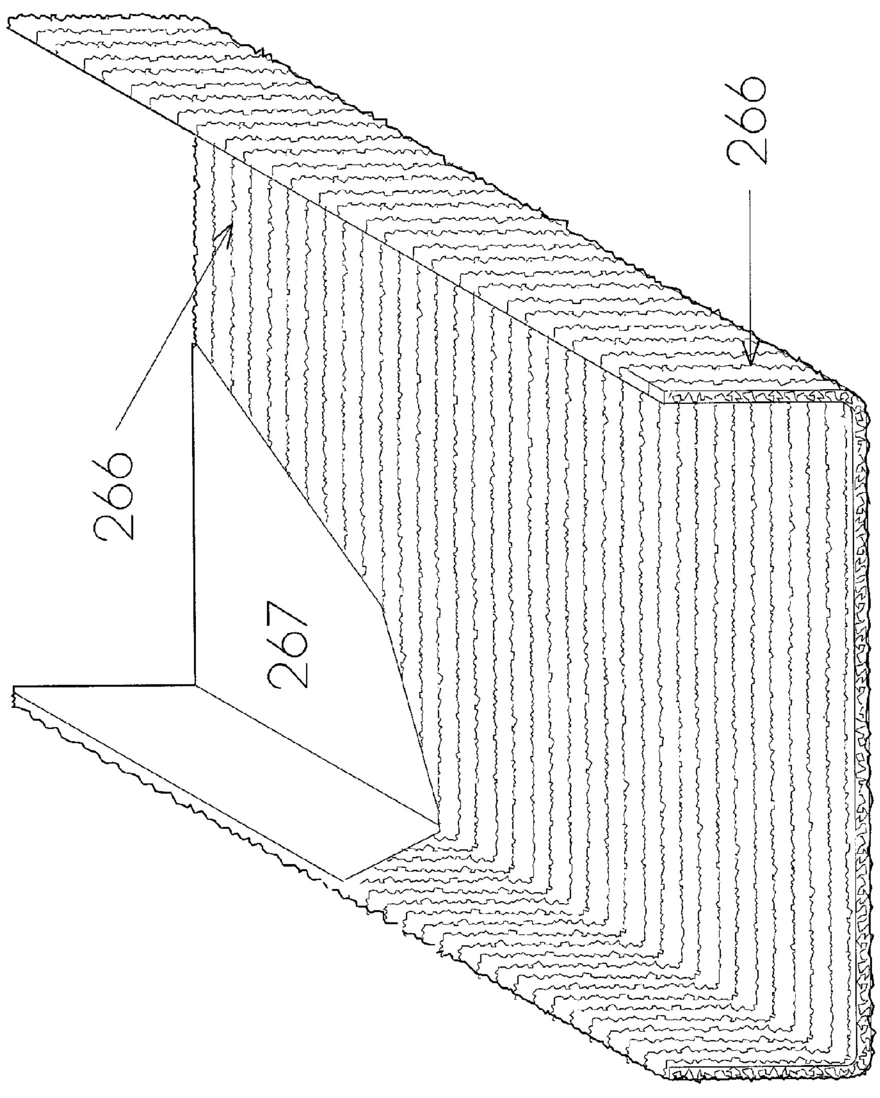

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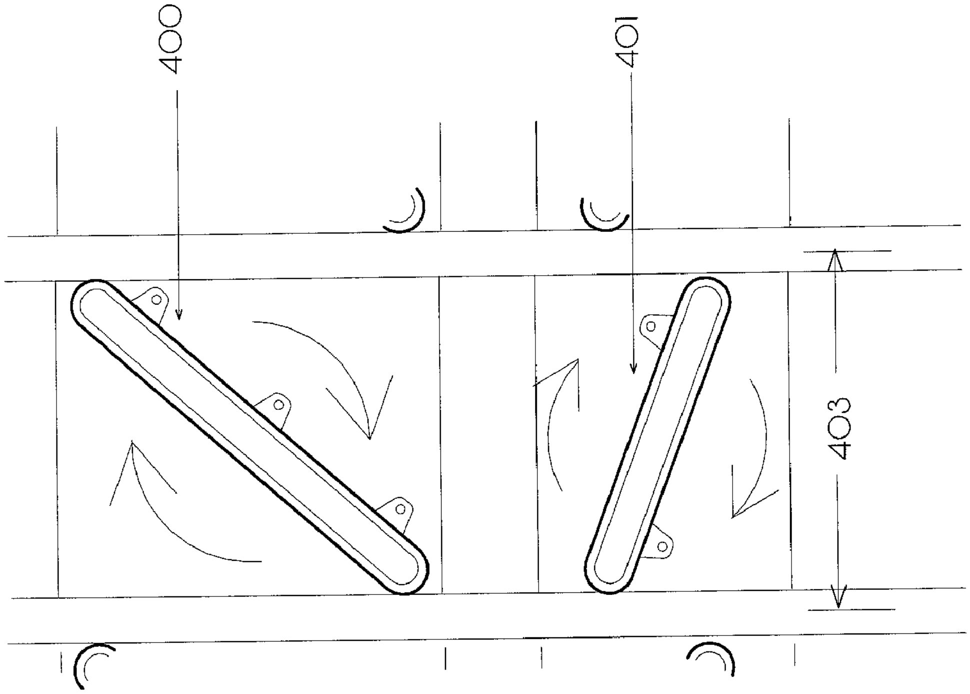

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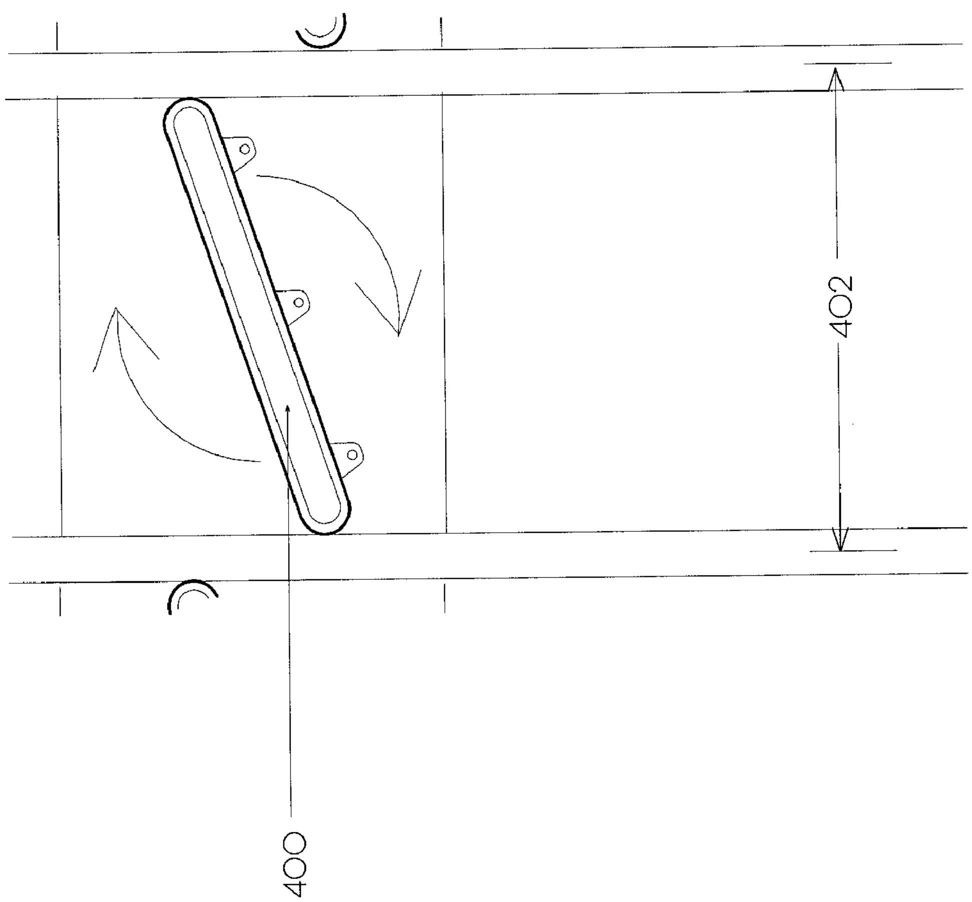

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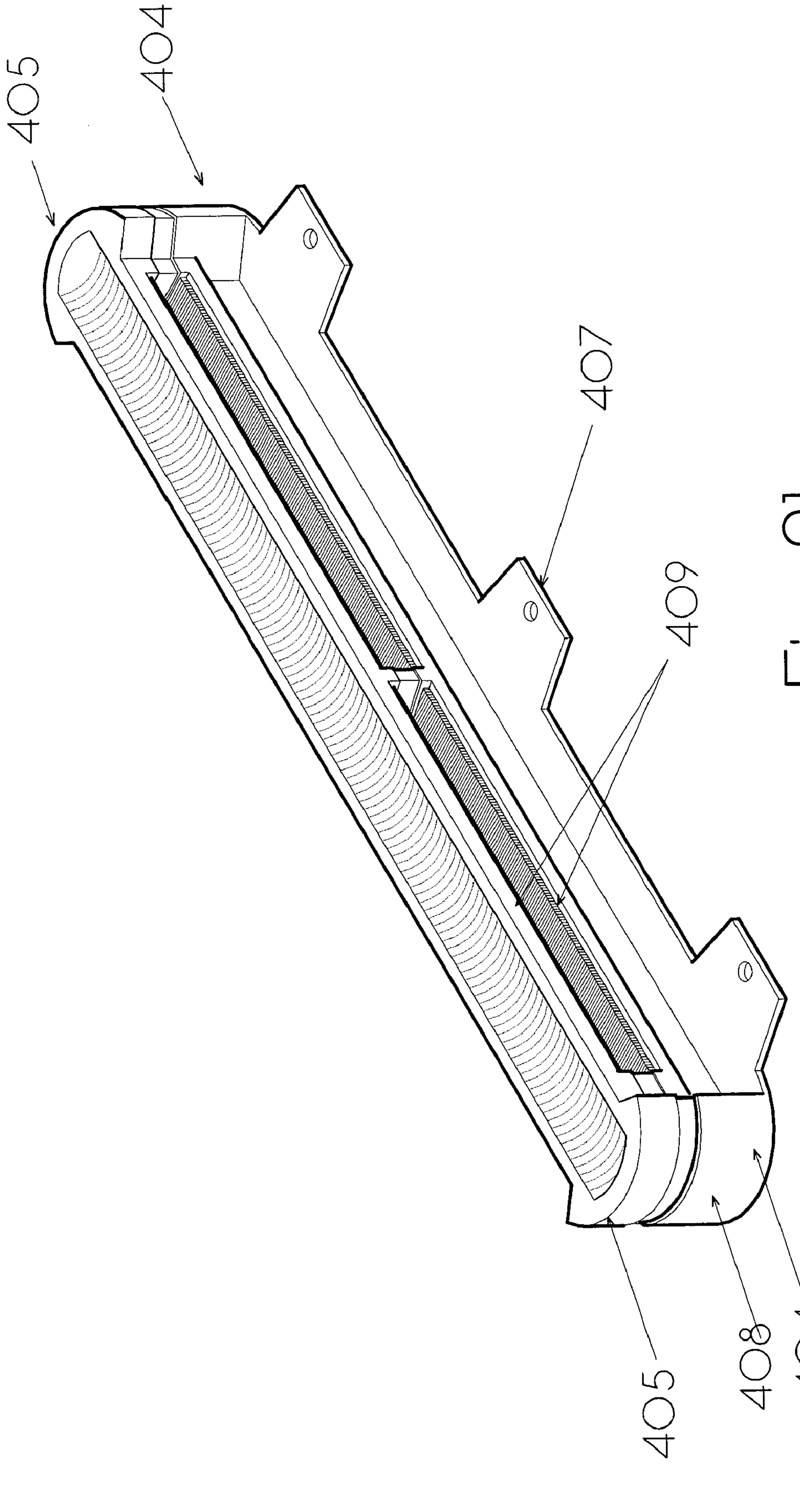

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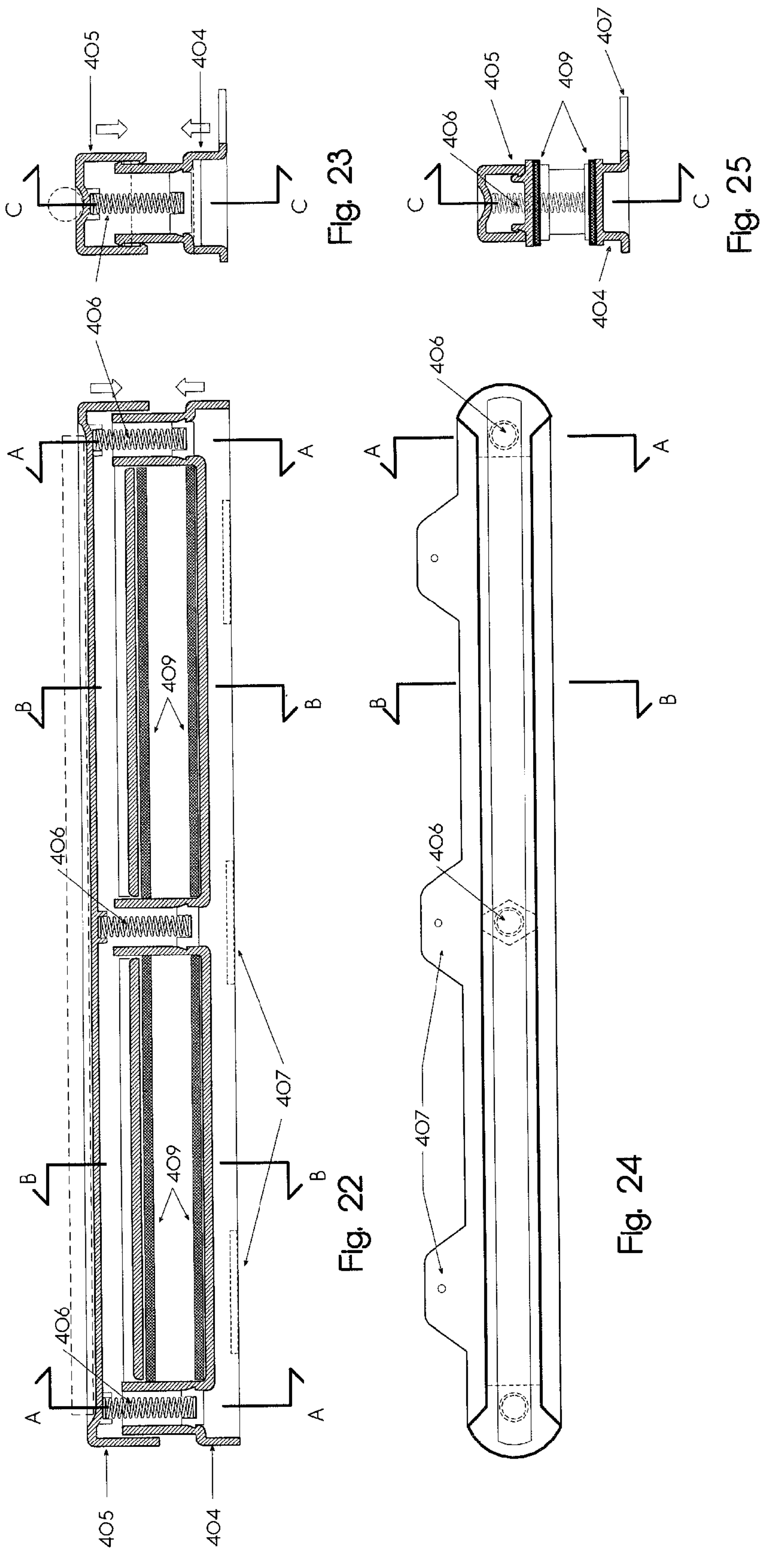

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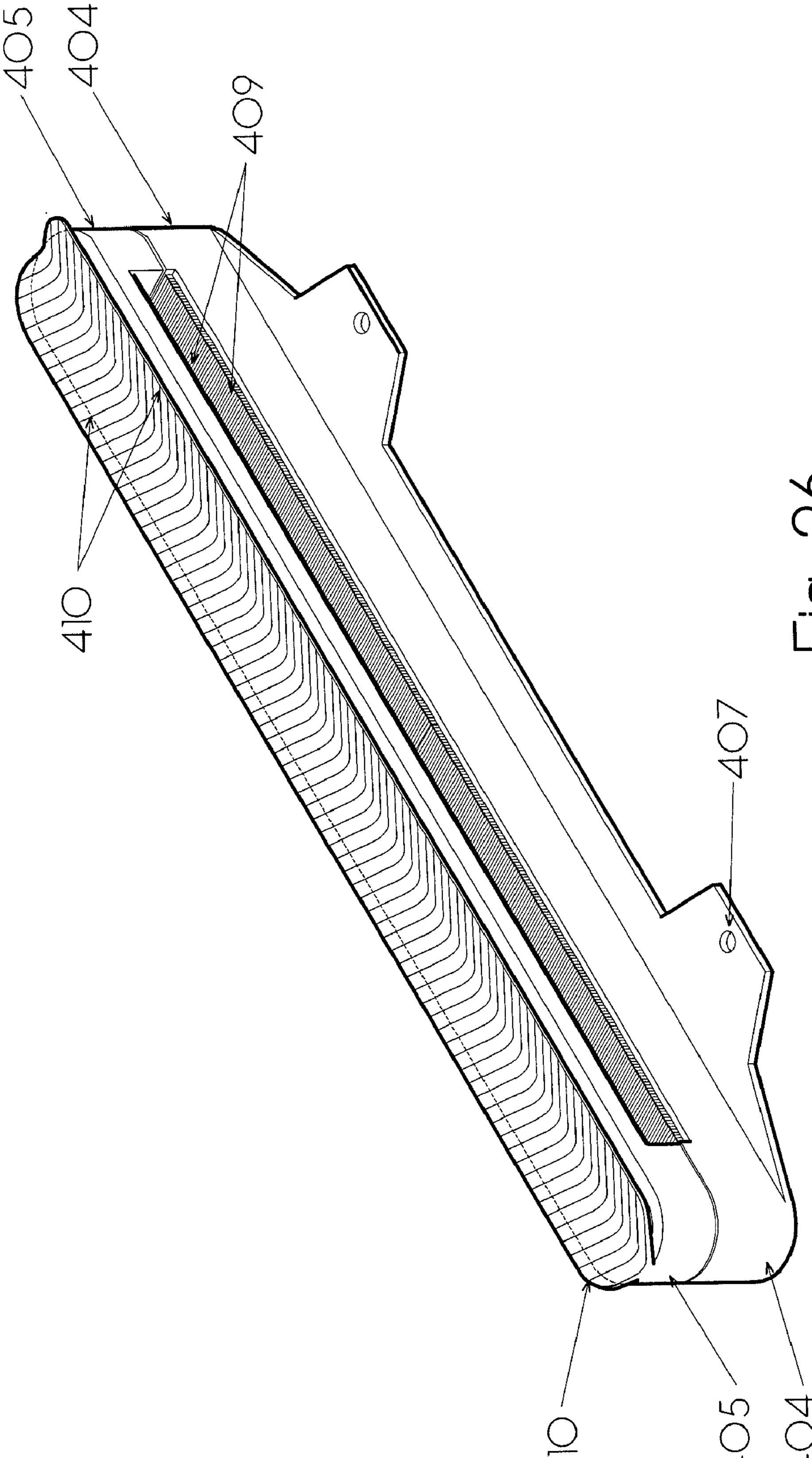
Fig. 23

Fig. 24

Fig. 25



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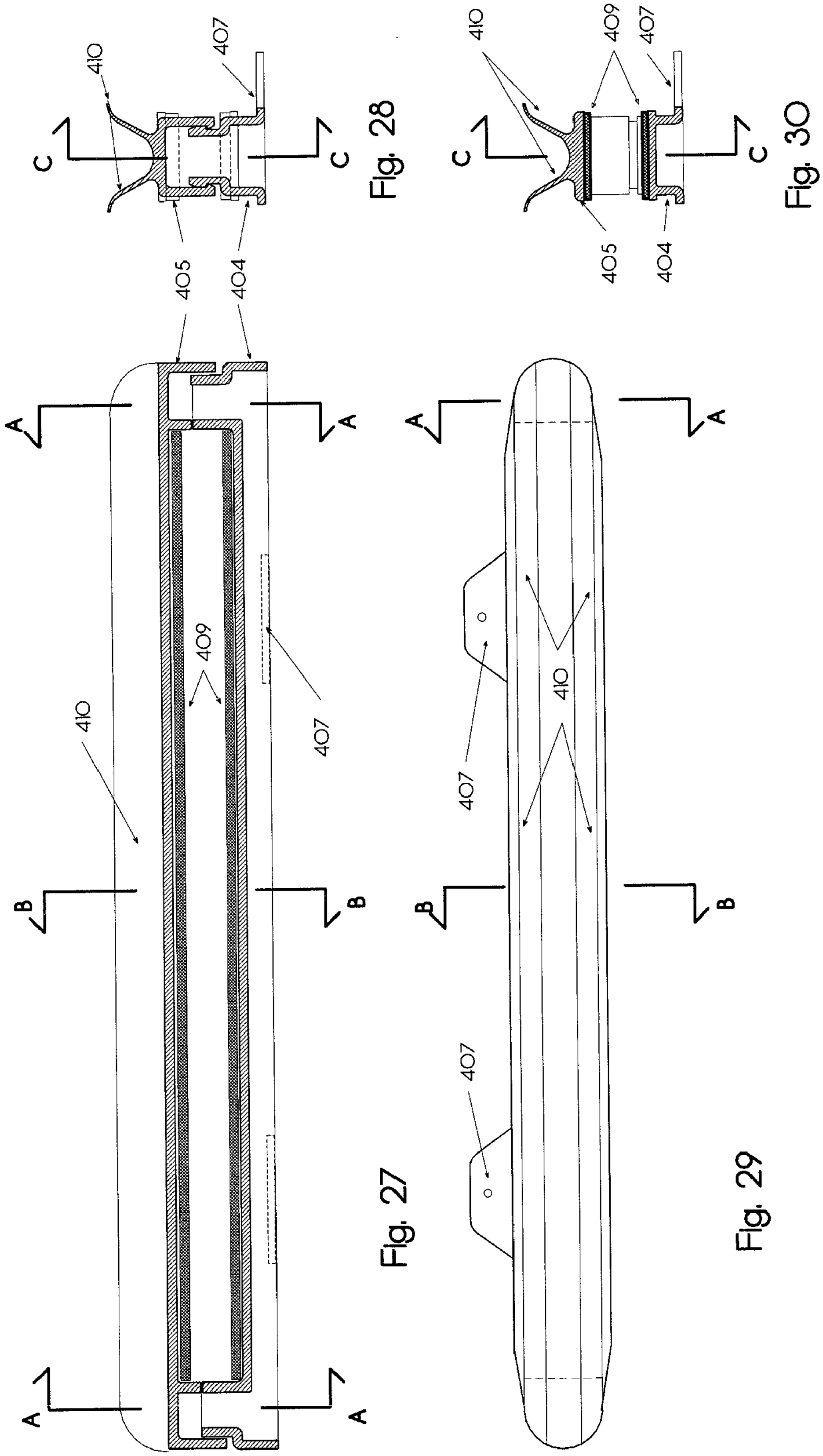

Fig. 27

Fig. 28

Fig. 29

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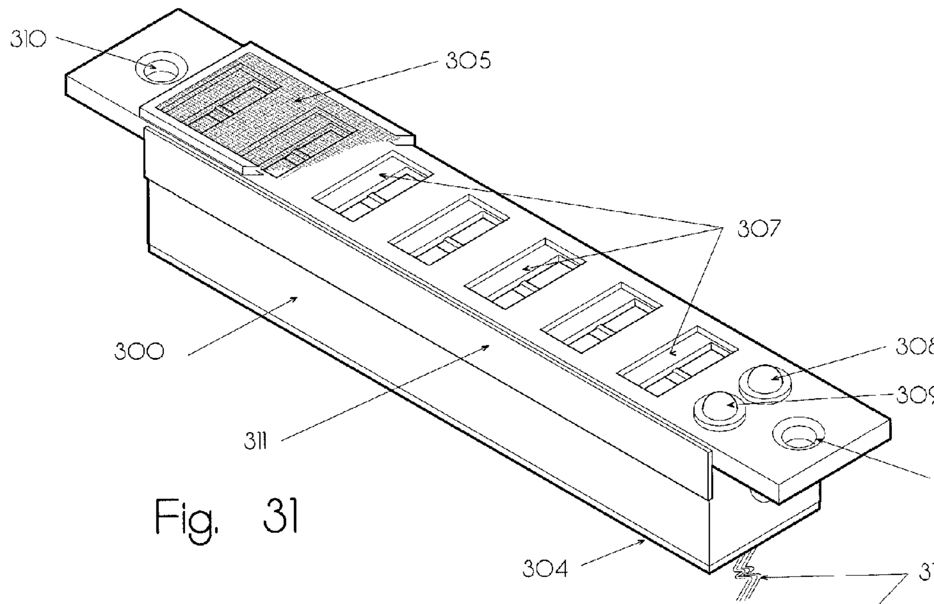
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Fig. 31

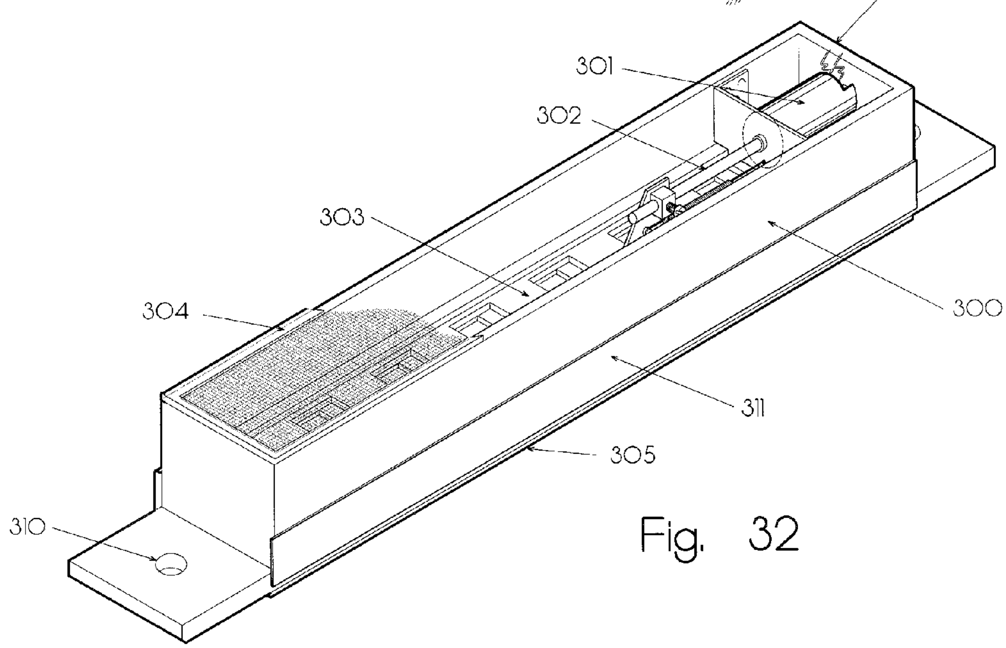
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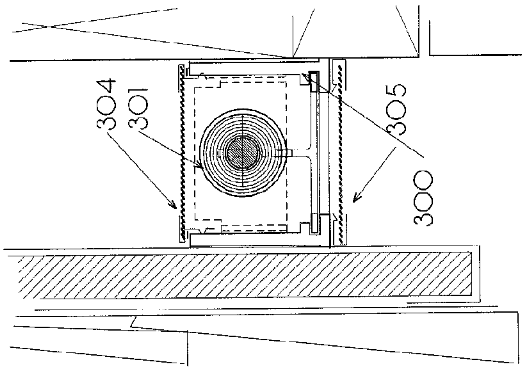
Fig. 32



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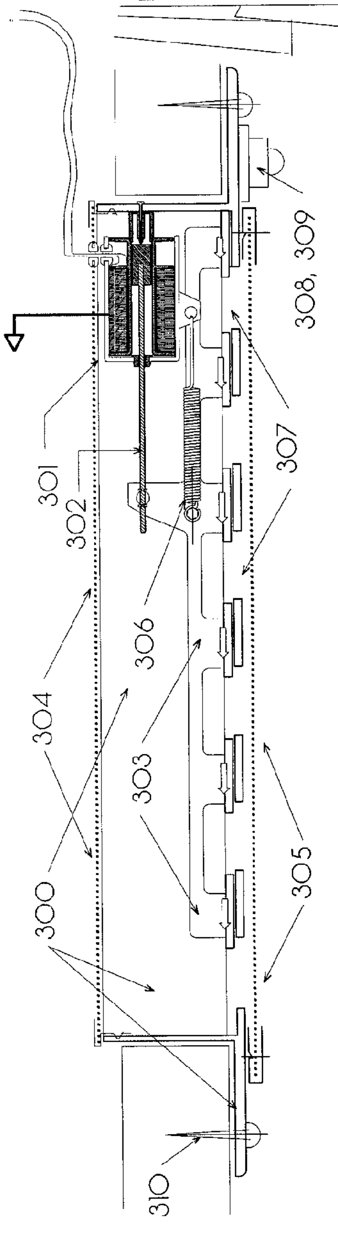
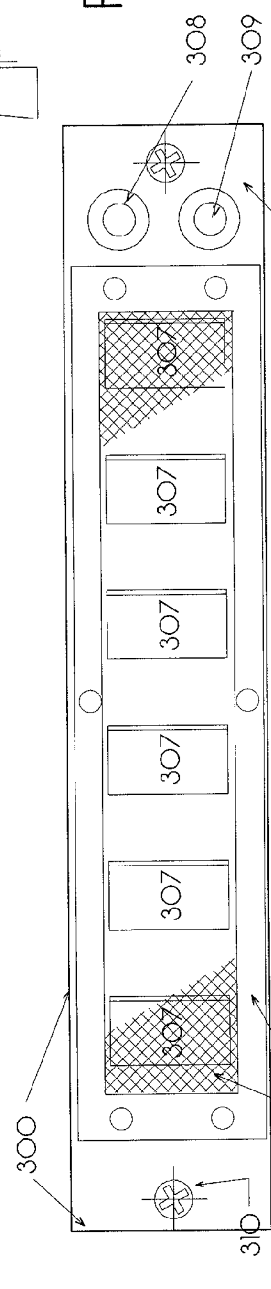


Fig. 33



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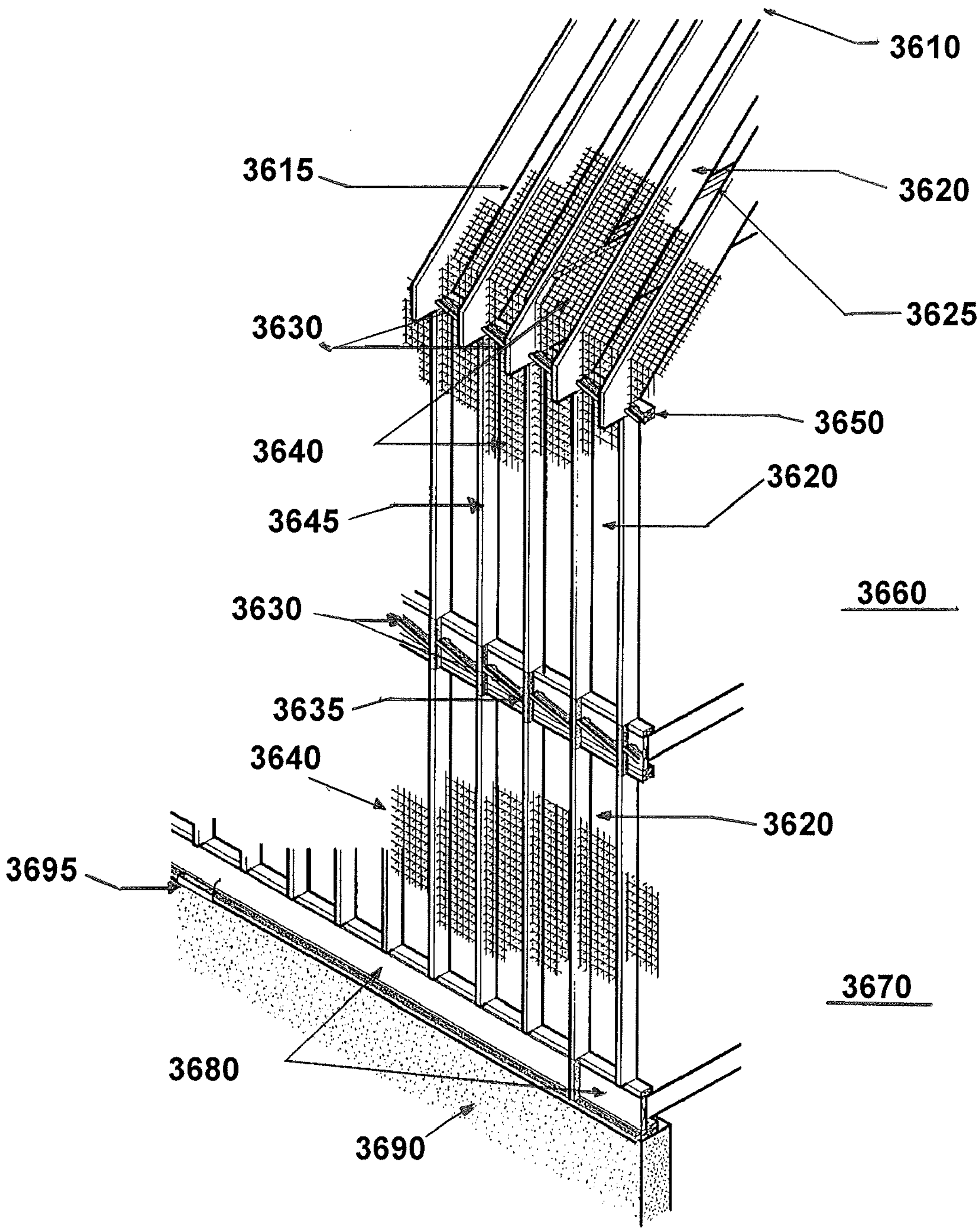
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Fig. 36

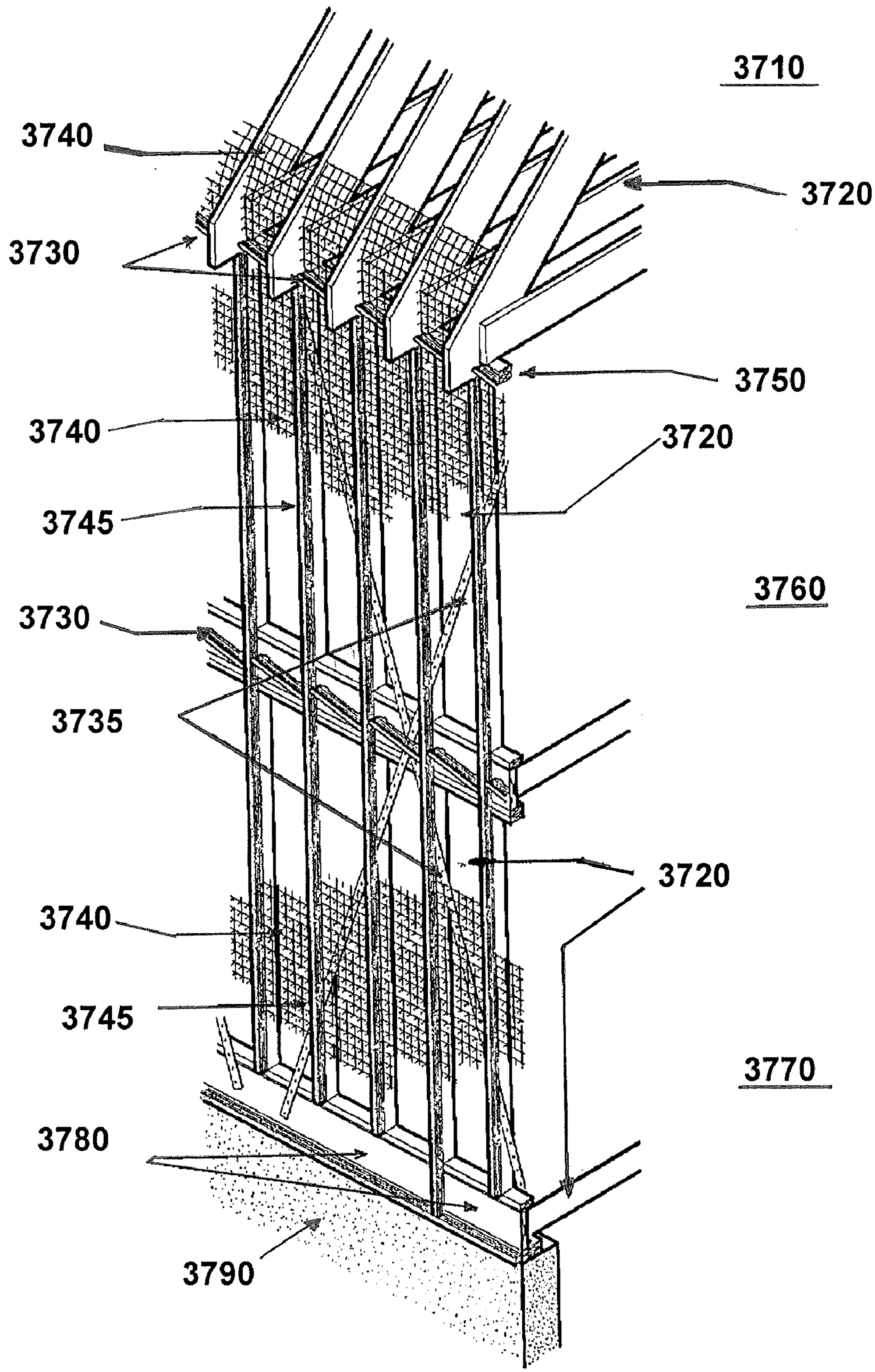
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Fig. 37

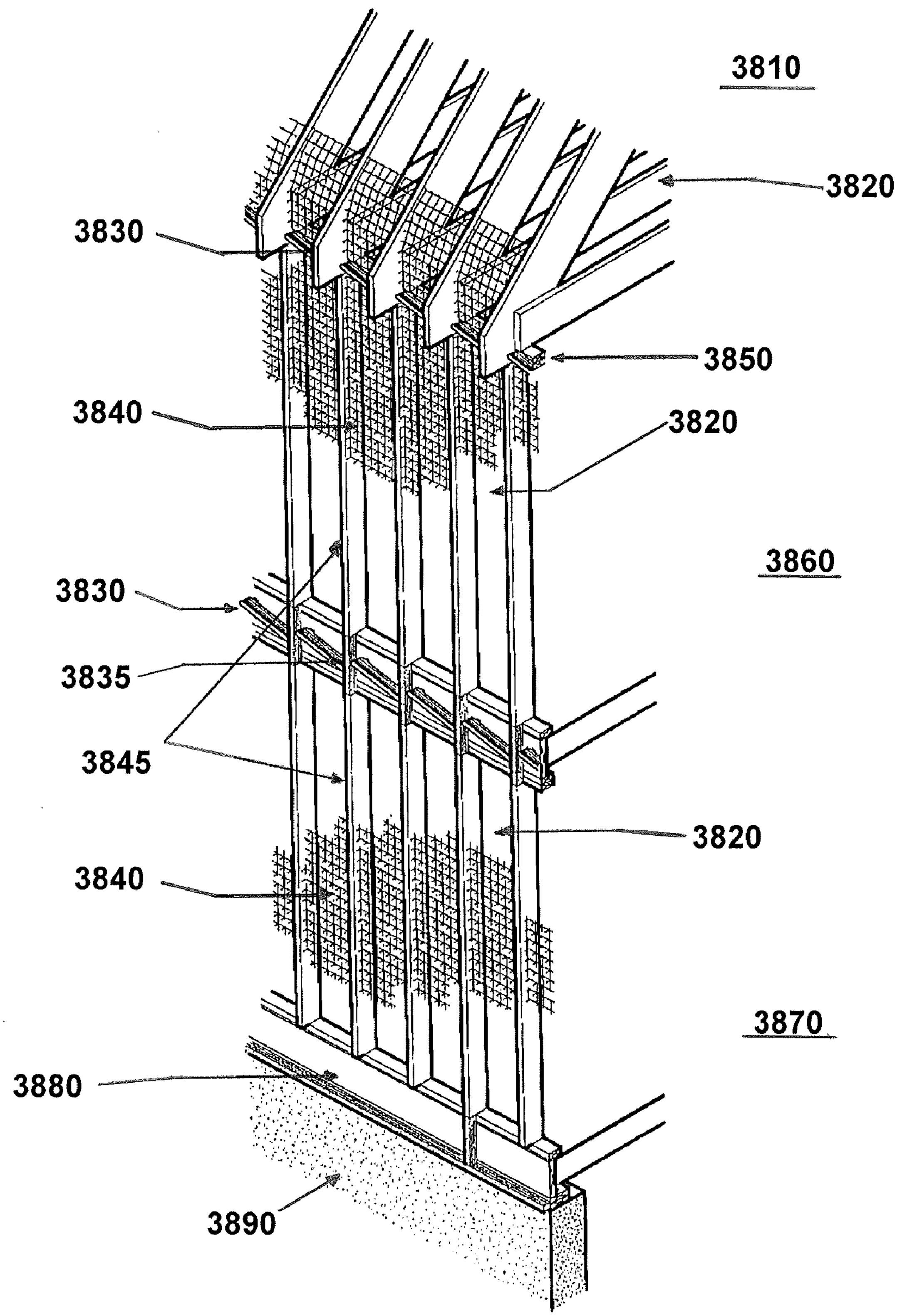
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Fig. 38

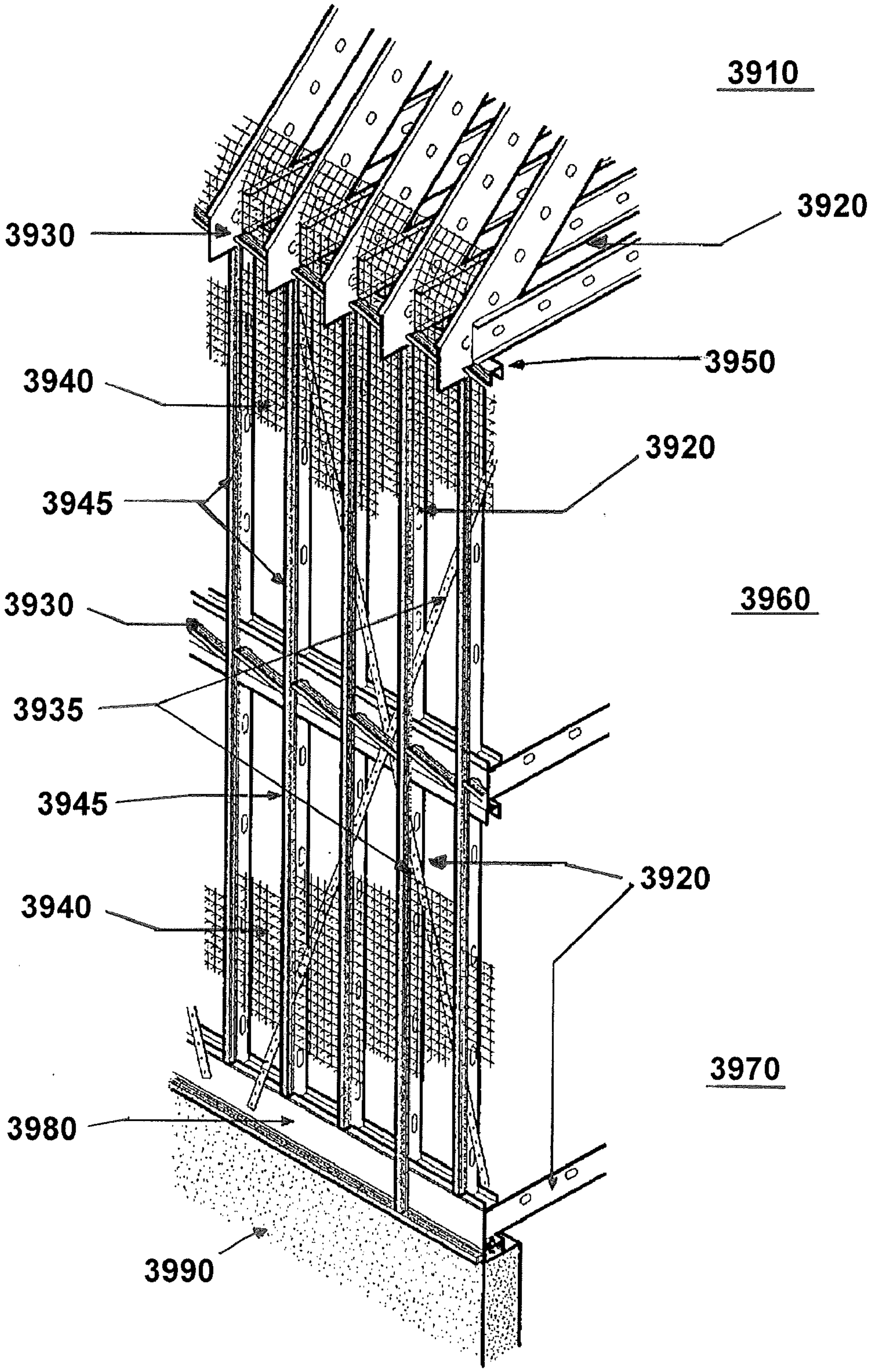
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Fig. 39

DEVICES AND METHODS TO PROVIDE AIR CIRCULATION SPACE PROXIMATE BUILDING INSULATION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application is a continuation-in-part of U.S. patent application Ser. No. 12/649,946, filed Dec. 30, 2009, which is a continuation of U.S. patent application Ser. No. 12/139,442, filed Jun. 13, 2008 and issued Feb. 12, 2010 as U.S. Pat. No. 7,654,051, which is a continuation-in-part of and claims priority to U.S. patent application Ser. No. 11/203,354, filed Aug. 12, 2005 and issued Dec. 2, 2008 as U.S. Pat. No. 7,458,189, which in turn claims the benefit of priority of U.S. Provisional Patent Application Ser. No. 60/634,823, filed Dec. 9, 2004. This patent application is a continuation-in-part of and further claims the benefit of priority to U.S. patent application Ser. No. 12/649,946, filed Dec. 30, 2009, which in turn claims the benefit of priority to U.S. patent application Ser. No. 12/139,442, filed Jun. 13, 2008, which in turn claims the benefit of priority of U.S. Provisional Patent Application Ser. No. 60/943,692, filed Jun. 13, 2007, and U.S. Provisional Patent Application Ser. No. 61/035,360, filed Mar. 10, 2008. This patent application further claims the benefit of priority to U.S. Provisional Patent Application Ser. No. 61/181,125, filed May 27, 2009 and U.S. Provisional Patent Application Ser. No. 61/321,130, filed Apr. 5, 2010. Each of the aforementioned patent applications is incorporated by reference herein in its entirety.

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BACKGROUND

[0003] 1. Field of the Disclosure

[0004] The present Disclosure Relates primarily to devices and system components for maintaining air circulation space proximate to thermal or other building insulation in order to facilitate the expulsion of heat and moisture from the insulation, such as in exterior walls and insulated roofs.

[0005] 2. Description of Related Art

[0006] Thermal insulation is required in buildings to provide a barrier in the exterior envelope construction to the transfer of thermal energy from outside the envelope into the structure as in summer where mechanical energy is used to remove heat from inside the building envelope and in cold weather periods to reduce the heat energy loss from inside the building outward.

[0007] As the Governments of nations around the world increase the required resistance to prevent this transfer with periodic increases in the required thermal resistance of building envelope construction, other factors are also increased which must be mitigated. One of these is an ever-increasing need for the ventilation of framed, insulated spaces. Up to the present day, there has been little or no effort by the insulating industry to ventilate insulated, framed spaces.

[0008] Roof construction requires ventilation of superheated air under roof sheathing to prevent deterioration of structures. This ventilation is provided for by the maintaining of an air space over thermal insulation. However, with ever-increasing thicker roof insulation required, and dimensional lumber having a nominal maximum depth of 12 inches, that space is impossible to maintain without a ventilating device to maintain a consistent air passage. The Insulation Industry has marketed a device for the last three decades that is designed to ventilate the roof below the roof sheathing, but by its nature excludes the fibrous insulation from the ventilation process.

[0009] Additionally, there has been no serious attempt to ventilate the thermal insulation un exterior framed walls. Fibrous building envelope insulating materials are dry when installed. They are rated for thermal resistance when they are dry, at perhaps 4% moisture content. From the moment the factory packaging is opened for the installation into framed wall cavities, they begin to absorb moisture with the resulting decrease in the thermal resistance rating—"R". It is believed by Applicant that most thermal insulation in tight buildings with no water influx problems is generally deteriorated to about half of its original R value after only a year or two in most climates, and that there is less deterioration in dry climes and greater deterioration in humid areas such as in the southeastern U.S. and along coastal shores and near bodies of water. Applicant further believes that this is because the absorbent fibrous insulation assumes some of the ambient moisture prevalent in its locale. Other factors influence the amount of acquired moisture a building structure and its thermal insulation absorbs. The kind of heating system influences the moisture, as well as the habits of a building's occupants, such as cooking involving unusual amounts of boiling water, hot, steamy showers and the frequency and number of occupants doing same. In addition to the aforementioned, leaks permitting water infiltration through the outer skin of the structure into the building frame and insulation such as due to roof and flashing leaks, poorly installed doors, windows, and building wrap and dried and cracked caulking and siding is not uncommon. Additionally, most structures are framed in wood, a renewable material. Out of necessity and because of exorbitant energy costs to kiln dry lumber, most framing is built from green lumber of species which are fast-growing and including significant moisture. The speed which most buildings are built at only allow weeks of drying time where the green lumber is nailed in place and allowed to lose some of its internal moisture instead of, ideally, six months or more in the view of Applicant. The frames are enclosed and insulated and then sealed with wall board. This wet wood then expels its extra moisture directly into the adjacent insulation providing a "jump-start" to a life of deterioration of the "R" value of the insulation.

[0010] This retention of moisture not only results in a major consumption of fossil fuels, depleting resources and potentially adding to such climatic issues such as global warming, but adds to the cost of owning, heating and cooling structures. In more extreme examples, mold supported by excessive moisture can cause respiratory distress and even death due to toxins, for example, by created by fungus growing on the mold.

[0011] While roof insulation is not currently directly ventilated, because of its much higher ambient operating temperatures, it probably does expel some acquired moisture because some of the moisture is forced from roof framing cavities as steam under pressure. No such ventilation exists for wall assemblies and ambient temperatures are lower in walls, likely resulting in little or no expulsion of accumulated water as steam. It is in exterior walls where moisture levels are greatest, particularly in the lower portions of walls. Moreover, the present use of baffles encourages horizontal fire spread as unrestricted vents in roof soffits provide fresh air that may feed fire spread in roofs. Currently, no industry attempts have been made to ventilate exterior walls.

SUMMARY OF ASPECTS OF THE DISCLOSURE

[0012] The present disclosure includes devices and system (s) to achieve the ventilation of exterior walls and roofs. Components of the system(s) consider shut-down of the ventilation process when it is not necessary, such as in winter, and in the event of fire, where the prevention of vertical and horizontal fire spread is desired. The present disclosure provides for control of air flow in the event of fire, among other things.

[0013] In one embodiment, a method of retrofitting a building structure is provided, including removing external sheathing from a plurality of vertically-oriented studs forming an external wall of a building, applying extension strips along the length of an outwardly-facing surface of each stud, and applying sheathing to the extension strips. If desired, the method can further include applying a spacer device to an inner surface of the sheathing between adjacent studs having a body that permits moisture to therethrough, and disposing insulation material proximate the spacer device, wherein the spacer device defines a vertically-oriented ventilation channel between the building sheathing and the insulation material, wherein the spacer body permits moisture to be passed from the insulation material to the ventilation channel.

[0014] In accordance with a further aspect, the method can include applying cross bracing to the studs and/or the extension strips. The method can also include constructing a horizontally-oriented air plenum proximate a lower portion of the building in fluid communication with a plurality of vertically-oriented ventilation channels disposed between the building sheathing and insulation material. The plenum is equal to or shorter than the horizontal length of the building where the plenum is located. Preferably, the plenum is less than about twenty feet long, and is located proximate a floor platform of the building. The method can also include disposing an air intake vent in fluid communication with the plenum. Preferably, the air intake vent can be selectively closed and opened. At least some of the studs are made from metal and/or wood. If desired, the method can further include disposing an active fire stop device between adjacent studs to permit vertical airflow in the space defined by the spacer device when the fire stop is in an open condition, and that prohibits vertical airflow when the fire stop is an a closed condition.

[0015] In accordance with another aspect, a method of retrofitting a building structure is provided, including removing external sheathing from a plurality of rafters forming a roof surface of a building, applying extension strips along the length of an outwardly-facing surface of each rafter, and applying sheathing to the extension strips. If desired, the method can further include applying a spacer device to an inner surface of the sheathing between adjacent rafters having a body that permits moisture to therethrough, and disposing insulation material proximate the spacer device, wherein the spacer device defines a ventilation channel parallel to the rafters between the building sheathing and the insulation material, wherein the spacer body permits moisture to be passed from the insulation material to the ventilation channel. In accordance with a further aspect, at least some of the rafters can be made from metal and/or wood.

[0016] The accompanying drawings, which are incorporated in and constitute part of this specification, are included to illustrate and provide a further understanding of the methods and systems of the disclosed embodiments. Together with the description, the drawings serve to explain principles of the disclosed embodiments.

BRIEF DESCRIPTION OF THE FIGURES

[0017] FIG. **1** is a schematic diagram of an exemplary low voltage control system in accordance with the disclosure.

[0018] FIG. **2** is an illustration of a first exemplary framing technique in accordance with the disclosure.

[0019] FIG. **3** is a partial wall section of FIG. **5**.

[0020] FIG. **4** is a second partial wall section of FIG. **5**.

[0021] FIG. **5** is an illustration of a second exemplary framing technique in accordance with the disclosure.

[0022] FIG. **6** is a third partial wall section of FIG. **5**.

[0023] FIG. **7** is a fourth partial wall section of FIG. **5**.

[0024] FIG. **8** is an exemplary spacer device provided in accordance with the present disclosure.

[0025] FIG. **9** is a cross section of a portion of a spacer device provided in accordance with the present disclosure.

[0026] FIG. **10** is a longitudinal section through the spacer device of FIG. **8** showing an exemplary installation condition.

[0027] FIG. **11** is a further section through the spacer device of FIG. **8**.

[0028] FIG. **12** is an exemplary ventilation device attached to sheathing and fabric added for blown-in insulation in accordance with the disclosure.

[0029] FIG. **13** is a second exemplary spacer device provided in accordance with the present disclosure.

[0030] FIG. **14** is a horizontal section through a framed wall with building sheathing attached having foamed-in-place polyiso or other such insulation and a first exemplary ventilation device in accordance with the disclosure as shown in FIG. **15**.

[0031] FIG. **15** is an isometric view of an exemplary ventilation device intended for use with spray-in expanding foam plastic insulation or similar material.

[0032] FIG. **16** is a horizontal section through a framed wall with building sheathing attached having foamed-in-place polyiso or other plastic insulation and a second exemplary ventilation device in accordance with the disclosure.

[0033] FIG. **17** is a section through a preformed, or formed-in-place portion of a ventilation device in accordance with the disclosure.

[0034] FIG. **18** is an isometric view of a ventilation device for spray-in foam insulation pre-formed for specific stud spacing folded to fit a framing bay.

[0035] FIG. **19** illustrates a framed wall space with stud framing on 16" centers including a fire stop device.

[0036] FIG. **20** illustrates a framed wall space with stud framing on **16"** centers including a plurality of fire stop devices.

[0037] FIG. **21** is an isometric view of a first embodiment of a fire stop in accordance with the disclosure.

[0038] FIGS. **22-25** are various views of the fire stop of FIG. **21**.

[0039] FIG. **26** is an isometric view of a second embodiment of a fire stop in accordance with the disclosure.

[0040] FIGS. **27-30** are various views of the fire stop of FIG. **26**.

[0041] FIGS. **31-35** are various views of an air shutter provided in accordance with the disclosure.

[0042] FIGS. **36-39** are various building constructions using devices and techniques provided in accordance with the disclosure.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0043] Reference will now be made in detail to the present preferred embodiments of the disclosure, examples of which are illustrated in the accompanying drawings. The method and corresponding steps of the disclosed embodiments will be described in conjunction with the detailed description of the system.

[0044] For purposes of illustration, and not limitation, FIG. **1** is a schematic diagram of an exemplary low voltage control system to control air intake to insulated framing bays. A temperature sensor switch **201** is illustrated which can be located on a roof soffit protected from the elements and direct sunlight. It is preferable to shut-off power to the intake solenoids, **202**, when ambient outside temperatures drop below a preset temperature such as 40 degrees F. Closing the cavities to cold air is desirable as cold air is naturally dry, and a static air space would add to the insulating values of the exterior wall assemblies. **203** indicates a central low voltage control unit which ties the intake solenoids with the smoke and fire detection alarm system. When a smoke or fire detector is triggered, power is turned-off to the solenoid valves. Additionally, if there is a power interruption to the structure, the ventilation system is shut-down.

[0045] A plurality of smoke and (or) fire detectors **204** can be provided. The solenoid intake valves are preferably equipped with diagnostic lights to allow the visual inspection of the system. Two LED elements, such as red and green, can be used. Accordingly, if the green light glows when the intake shutters are supposed to be open, it will be apparent that the shutter is working properly. If the shutter is supposed to be closed, such as in cold weather, or when a fire alarm test is being performed, the observer will note proper operation. If neither light is on, or not in the right color further investigation will be apparent to the occupant of the structure.

[0046] For purposes of further illustration, and not limitation, FIG. **2** is an illustration of the framing of a new building framed of wood, utilizing the projecting stud framing method to create a continuous vertical ventilation channel between each wall stud and extending vertically from the foundation to the roof soffit. **196** refers to a foundation wall, and a thermostatic control **201** is provided in the roof soffit to control the shutter solenoids in cold weather. Wall framing studs **205** are provided which are typically spaced at 16 inches on center. Spacings of 12 inches and 20 or 24" can also used but are far less common. The structure further includes roof rafters **209** which may or may not be insulated, as desired. An air space **206** is defined by the use of the projected framing method. If nominal 2×4 inch top and bottom wall plates are used with nominal 2×6 inch wood studs, the depth of the air passage by-passing floor structures **197** and **198** and top plate **199** will be approximately 2 inches. Framed openings **195** are further defined in the exterior wall as required for windows and doors. Filler strips **207** are also provided, preferably being approximately 2 inches thick and are used to fill-in between studs to form discrete air channels at floor structure **198** and top plate supporting roof framing **199** and at the inlet distribution plenum **208** which is adjacent to floor structure **197**. Vertical strips divide the plenum into horizontal lengths consistent with various Fire Code requirements.

[0047] Filler strips **207** may be of cut-down dimensional lumber or pre-formed strips made from composites such as “Homasote” material, a material made from recycled paper fibers by the Homasote Company (West Trenton, N.J.). At the plenum, a horizontal bottom closure of the same strips contain the solenoid controlled intake shutters, **202** which are ideally located near the center of each plenum space. Under typical present building requirements, horizontal spaces must be fire stopped every 20 linear feet. It therefore follows that the air intake plenums will have a suitable similar length. Active fire stops **211** are provided, located at floor and plate lines in order to prevent vertical fire spread. These fire stops **211** preferably incorporate an intumescent material that expands at temperatures of 300 degrees F., which can be expected to be reached if fire enters the framed space. The air gaps of the fire stops are thus closed preventing or mitigating the vertical spread of fire. In the event that the smoke or fire detection system is activated, or ambient exterior temperatures drop below a certain temperature, the solenoid-controlled intake shutters **202** are adapted to close to prevent the entrance of outside air into wall cavities.

[0048] For purposes of further illustration, and not limitation, FIG. **3** illustrates a partial wall section at the location shown on FIG. **5**. It illustrates the lower part of a framed wall formed with projecting wall studs **196** again refers to the foundation wall and **197** indicates the first floor structure. Arrows show the direction of air flow from the outside, through the solenoid controlled intake shutter, **202** and into the air plenum, **208** where incoming air is distributed horizontally to individual stud **205** bays which are insulated with fibrous insulation. The air passage is ensured by the ventilation device, **215**. The section illustrates the foundation outer surface and floor framing in one line and the projecting studs extending out approximately **2** inches to create the ventilation channel. FIG. **4** illustrates the upper portion of the same wall structure. Specifically, FIG. **4** illustrates the second floor structure and top plate flush with the wall studs **205** on the inside face and set back on the outside face to provide a ventilation space insured by the preferred ventilation device, **215**. Active fire stops incorporating intumescent material are shown attached to the floor framing **198** and top plate, **199**. Fibrous wall insulation **213** is provided, as well as roof insulation **214**, where the underside of the roof has conditioned space.

[0049] As illustrated, the ventilation device **215** maintains a ventilation space below the roof sheathing allowing superheated air to be ventilated out to a ventilation attic or roof vent system and also prove positive ventilation of heat and moisture from the roof insulation. Note that the roof soffit **216** is not ventilated as is presently done. In one embodiment, the roof eave assembly is caulked tight to ensure a positive flow up through the wall cavities and over the roof insulation and improves the present condition wherein horizontal fire spread is facilitated because of the use of unrestricted soffit vents.

[0050] For purposes of further illustration, and not limitation, FIG. **5** illustrates a portion of a 2 story framed wall in an existing building or a framing system employing metal studs. The existing studs or metal studs are not projecting to create vertical ventilation channels. The channels can be formed by applied filler strips **207** about 2" thick made from ripped-down two inch nominal framing lumber or pre-molded strips of composite material such as “Homasote” material. Wall bracing is preferably achieved using galvanized metal "X" bracing (i.e., cross-bracing), **210** of perforated or pre-drilled strapping of approximately 12 gauge by 2 inches wide. Where new or existing metal framing is used, the frame is plumbed, and the "X" bracing can be installed with screws or fillet welded. The filler strips are then preferably attached to the faces of studs and continuous from lowest floor platform **197** to top plate, **199**. Where an existing building is being retrofitted with the insulation ventilation system as disclosed herein, "X" bracing is preferably installed sequentially as existing sheathing is removed in order to maintain building plumb and bracing at all times. **195** illustrates framed openings, **196** indicates the foundation wall, **197** is the first floor platform, **198**, the second floor platform and **199** is the top plate. The active fire stops are **211**.

[0051] For purposes of further illustration, and not limitation, FIG. **6** is a partial section through the lower portion of an exterior wall shown in FIG. **5**. It indicates a framed wall without projecting studs as in normal construction. The ventilation channels at stud bays are formed by adding filler strips **207** to all studs **205** and run continuously over bottom plate (sill), box ends and end joists at each floor (**197**, **198**) level and top plate **199**. **196** refers to the foundation, **202** indicates a solenoid controlled inlet shutter set into openings in a horizontally installed length of filler strip that supports the lower projection of the building wall sheathing and encloses the air distribution plenum **208** at its bottom edge. **210** indicates exemplary steel "X" strapping attached to the face of wood or metal framing **205**. The filler strips **207** creating the vertical ventilation channels are then attached over the strapping **210** to the faces of the studs and other framers. The sheathing, which is preferably exterior plywood but may be other kinds of sheathing such as exterior gypsum sheathing is preferably attached to the filler strips **217** with long screws extending through the filler strips and into the wood or metal studs. The filler strips may be tacked to the framing, for example, with screws or a self adhesive backing to facilitate their installation and that of the sheathing. The insulation ventilation device is indicated by **215**.

[0052] For purposes of further illustration, and not limitation, FIG. **7** is a partial section through the upper portion of an exterior wall shown in FIG. **5**. It is the upper part of the wall section illustrated in FIG. **6**. **215** represents an exemplary insulation ventilation device shown between wall **213** roof **214** insulation and wall and roof sheathing. **211** depicts an active fire stop using intumescent strips. **216** indicates the soffit and fascia construction which is preferably assembled tight and caulked to insure a positive gravity air flow and maximum control over air entry by the solenoid controlled inlet valves to mitigate fire spread. **210** indicates preferably galvanized steel "X" bracing.

[0053] For purposes of further illustration, and not limitation, FIG. **8** illustrates a preferred example of a ventilation device. It may be molded of a plastic having good memory and capable of maintaining its shape at temperatures of at least 275 degrees F. 250 indicates the spacer struts which are about ⅝" long, but testing may result in a shorter or longer strut being used. **251** indicates the open backing of a gridwork of the same plastic and molded integrally with the struts. Deepened lateral ribs **252** insure greater stiffness in the width of the device to make handling and installation easier. Occasional deepened ribs may be used to aid in handling. In this illustration such a deepened rib is presented in every third row. Longitudinal ribs are preferably shallower to permit rolling up of the device for packaging and storage. **253** is a break-away panel which can be used for attachment to sheathing by stapler. It may contain trademark, indicia, or other product information.

[0054] For purposes of further illustration, and not limitation, FIG. **9** illustrates an example of a suitable shape of the cross-section through a deepened lateral rib of the ventilation device shown in FIG. **8**. **252** indicates the deepened portion and **258** indicates an occasional appendage designed to embed hooks into a filter fabric which would be employed for blown-in fibrous insulation to contain the small particulates of this kind of insulation.

[0055] For purposes of further illustration, and not limitation, FIG. **10** is a longitudinal section through the ventilation device in FIG. **8** showing the typical condition and cutting through the lateral grid members. **250** indicates spacer struts spaced approximately an inch apart in both directions and approximately ⅝" long. The plastic or other material used in this embodiment of the ventilation device is preferably flexible, with excellent memory and moderately high temperature operating range. The struts, **250**, ideally will be able to be bent parallel to the plane of the grid body **251** to permit rolling-up for compact storage and handling. **253** is an exemplary occasional fabric attachment appendage. **255** represents fibrous thermal insulation.

[0056] For purposes of further illustration, and not limitation, FIG. **11** illustrates a similar longitudinal section as in FIG. **10**, but through one of the occasional break away panels **253**. **250** indicates spacer struts, **251**, the gridwork, **255**, fibrous insulation blankets and **253** the solid break away panel that has weak connections on the two long sides and one end. The other short end is preferably thin and flexible and acts as a hinge. A second weak, flexible line can be provided within the solid panel to provide a second fold for the panel to facilitate attachment to building sheathing.

[0057] For purposes of still further illustration, and not limitation, FIG. **12** shows an exemplary ventilation device attached to sheathing and fabric added for blown-in insulation. **256** indicates the building sheathing, **250**, the spacing struts, **251**, the grid backing, **256**, the fabric attachment, **255** the insulation which would be blown-in and **253** shows the attachment panel broken out of the grid backing **251** and stapled to the inside face of the sheathing. **257** points to broken lines indicating a stapling gun. FIG. **13** is an isometric view of another preferred embodiment of a device for ventilating fibrous insulation. It incorporates a solid backing **251**, which is perforated **258**, with integral spacer struts **250**, and may have integral lateral stiffener bars, **252**. The backing **251** may have occasional panels that have weak connectors on three sides and thin fold area on one side as one located within the panel to facilitate the attachment to the back face of building sheathing as in the previous embodiment. The perforations **258** may be more numerous and smaller in size for use with blown-in fibrous insulation.

[0058] For purposes of yet further illustration, and not limitation, FIG. **14** is a horizontal section through a framed wall with building sheathing attached. The wall is insulated with sprayed-in poly iso or other formulation of rigid insulation. An exemplary ventilation device is shown and indicated as **259**. The ventilation device preferably has a solid backing and creates an air space between the wood framing, sheathing and foam insulation, **261**. This is to permit trapped moisture of green framing lumber (or from other sources, such as a roofing leak) to gradually be convected to the atmosphere through frame leakage such as joints in plywood, and lapped building wrap. When liquid expanding foams are sprayed against wood framing and sheathing, the pre-expanded liquid binds with the surface of wood and provides a permanent seal locking in the wood's moisture and providing a medium for organic growth that can result in rot of the structure. Ventilation devices and associated techniques are provided to prevent this. Device **259** is preferably turned at the top and bottom of each cavity to protect the top and bottom plates.

[0059] As further depicted in FIG. **14**, to enhance the escape of trapped moisture, a wicking pad **269** can be provided between each stud face and sheathing to encourage moisture to wick away from wet lumber and into the ventilation channel defined by the ventilation device **259**. Wicking pads are preferably made from "Homasote" material that is preferably not treated for water repellency of suitable thickness (e.g., ½ inch) and width (e.g. 1.5 inches) and length (e.g., the length of the stud). The illustrated spandrel strips **270** can also be provided, for example, proximate the edge of each building platform (e.g., floor joist outer faces and box ends at floor plates such as **3660**, **3670** depicted in FIG. **36** if foam insulation is used in lieu of fiberglass or cellulose insulation) between floors and at the top plate (such as at a second floor/attic interface) to provide vertically-oriented grooves to permit moisture to travel from floor to floor up through the ceiling plate into an attic space and eventually out of a ridge vent or other vent.

[0060] By way of further illustration, and not limitation, FIG. **15** is an isometric view of an exemplary ventilation device intended for use with spray-in expanding foam plastic insulation as shown in FIG. **14**. This embodiment preferably maintains a separation of approximately ¼" between the wood framing, sheathing and the insulation. The device has spacing struts **260**, which are approximately ¼" long and about an inch apart in either direction in the plane of the ventilation device. As with the other ventilation devices, the tips of the struts contact the sheathing but also the framers. **261** points to the solid backing, **262** is an exemplary attachment area where staples may be applied for attachment to wood framing. Additionally, occasional staples may be applied through the device into the sheathing for attachment. Lines **263** are weakened folds for 16" on center stud spacing. Lines **264** are weakened fold lines for 12" stud spacing, Lines **265** are weakened fold lines for flexing to permit the attachment areas to sit squarely against wood framers for stapling.

[0061] For purposes of further illustration, and not limitation, FIG. **16** is a horizontal section through a framed wall with building sheathing attached. The wall cavity is insulated with sprayed-in poly iso or other formulation of rigid insulation. An exemplary ventilation device is shown, **266** made from entangled net technology as manufactured by Colbond, Inc. U.S. Pat. No. 4,212,692 discloses a method of forming the "entangled net" material, which is incorporated by reference herein in its entirety. The thickness of device **266** is preferably about ¼". **261** indicates the foam insulation. **267** indicates an impervious membrane, such as polyethylene film. Attachment of the film may be made by stapler at any location, or be pre-attached during manufacture. **269** indicates wicking pads attached to studs between stud faces and sheathing to provide a path for escaping moisture. **270** indicates the grooved spandrel strips that will provide channels for air movement.

[0062] For purposes of further illustration, and not limitation, FIG. **17** is a section through a preformed, or formed-in-place portion of this embodiment of ventilation device for foamed-in-place insulation in wood construction. **266** is the body of the preferred device approximately ¼" thick. **267** is an impervious membrane such as polyethylene. The foam is sprayed against the membrane attached to the installed device fabricated of Entangled Net technology as described in other patent applications incorporated by reference herein. FIG. **18** is an isometric view of a ventilation device for spray-in foam insulation pre-formed for specific stud spacing folded to fit a framing bay. **266** is the body of the preferred ventilation device. It is pre-folded to fit common framing centers, or folded in place. **267** is an impermeable membrane which may be pre-attached to the device, or it may be attached after, but prior to application of the insulation. It must act as a separator between the device and the foam application. FIG. **19** illustrates a framed wall space with stud framing on **16**" centers, which is the most commonly used spacing. **402** indicates a **16** inch dimension to the center of the wall framing studs. **400** indicates a pre-molded active fire stop which is slightly longer than the space is wide. Tight end closure is obtained by rotation until the fire stop jambs at the ends. The fire stop body must be as air tight as possible to be most effective.

[0063] For purposes of still further illustration, and not limitation, FIG. **20** illustrates a framed wall space with stud framing on 12" centers. This spacing is less common than 16" and a spacing less than 16" might be more commonly encountered where dimensions of a wall result in some bays having lesser dimensions. **403** indicates a 12" or otherwise less than 16" dimension for studs. **400** indicates a fire stop for 16" spacing used with a greater skew to fit into a smaller space. **401** indicates a shorter active fire stop unit which might be available if it were found that there was a sufficient market to warrant a manufacture of a shorter device.

[0064] FIG. **21** is an isometric view of a preferred embodiment of an active fire stop using internal springs to maintain a seal between the floor or plate framing line and the building sheathing. The bottom half **404**, of the molded plastic or composite fire stop preferably snaps into the upper half, **405** after intumescent material **409** is applied with adhesive or a self-adhesive backing to the flat portions forming the upper and lower ventilating surfaces. **404** is the curved end that is jammed against the wood framing or filler strip stud extensions to maintain a tight seal. **405** indicates the top face of the fire stop. It is preferably pushed-in by the sheathing as the sheathing is installed. As this happens, the assembly is compressed along with the internal springs for an optimal seal. **407** indicates tabs for nailing the fire stop to the building framing. The top surface has an indentation to accommodate a portion of foam backer rod if necessary to improve the seal.

[0065] By way of further example, FIG. **22** is a longitudinal vertical section (C-C) through a preferred device using internal springs to maintain a seal between sheathing and framing as is shown in FIG. **21**. It shows how **404**, the bottom half snaps into **405**, the top half. **406** indicates the compression springs which are preferably protected against corrosion. **404** and **405** are ideally molded from a plastic or composite that has a moderately high heat resistance over 350 degrees F. **409** indicates the applied intumescent strips which expand approximately 20 times their thickness when exposed to the heat of a fire, at about 300 degrees F. **407** indicates the attachment tabs. The dashed line on top of **405** indicates a possible length of foam backer rod to improve the seal if necessary. FIG. **23** is a lateral vertical section through the active fire stop through A-A. It illustrates how **404**, the bottom half snaps into the top half **405**. **406** indicates one of the compression springs. FIG. **24** is a view of the top of a fire stop as shown in FIG. **21**. Springs **406** are located each end and a central spring if required. **407** indicates the attachment tabs. FIG. **25** is a lateral vertical section B-B, through the controlled air passages. **404** is the bottom half, **405** is the top half. **406** indicates a compression spring and **407**, the attachment tab. **409** indicates the intumescent strips attached to the top and bottom air passage surfaces.

[0066] For purposes of further illustration, and not limitation, FIG. **26** is an isometric view of another embodiment of a preferred active fire stop utilizing intumescent strips. Unlike the previous embodiment, the top and bottom seal is not maintained by compression springs. This version maintains the seal by compressing a finned top **410** form that is integral with the upper casting **405**. **409** indicates the intumescent strips. **407** shows the attachment tabs. FIG. **27** is a longitudinal vertical section (C-C) of the preferred embodiment in FIGS. **26**. **404** and **405** are the bottom and top halves which are snapped together after the intumescent strips **409** are applied to the upper and lower surfaces of the air passage slot. **407** indicates the attachment tab and **410** is the integral top fin which compresses against the building sheathing as it is applied to the framing. FIG. **28** is a transverse vertical section (A-A) of the ventilation device in FIG. **27**. **404** and **405** are the bottom and top halves. The top half **405** has the compression fins **410** at its upper portion. **407** indicates the attachment tabs.

[0067] FIG. **29** is a plan view of the previous device. **407** indicates the attachment tabs and **410** the compression fins to maintain an air seal. FIG. **30** is a transverse vertical section (B-B) through the ventilation slot of the previous device. **404** and **405** are the bottom and top halves. The top half includes the compression fins **410**. The bottom half includes the attachment tabs **407**.

[0068] For purposes of further illustration, and not limitation, FIG. **31** is an isometric view of a solenoid-controlled air shutter which is also referred-to as **202** in FIG. **1**. The view is of the device turned up-side-down, showing a view of the bottom side. **300** is the housing of the shutter preferably molded of plastic, composites or formed from aluminum. **304** is a debris screen to catch particulates loosened by air movement which might jam movement of the shutter. Occasional cleaning of this screen may be appropriate. **305** is an insect screen to prevent insects from entering the ventilation space. **307** indicates the shutter air openings. **308** and **309** are red and green indicator lights or other colors as desired. They indicate whether the shutter is open or closed. Green would indicate "open" and red might indicate "closed. In normal operation all of the air inlet shutters should be the same color, or no light at all. A typical residence might require a minimum of 6 shutters. **310** indicates a hole for attachment at the bottom of the plenum. **311** is a gasket, if necessary to enhance the air seal. It might be of self-adhesive foam tape or other compressible material. **312** indicates the signal and power cable to link the shutters to the low voltage temperature sensing and fire protection system.

[0069] For purposes of further illustration, and not limitation, FIG. **32** is an isometric view of the solenoid-controlled air shutter described in FIG. **31**. It is shown in the position as it is used. This view permits observation of the activating mechanism. **300** is the housing that encloses the electromagnetic solenoid **301** which is electrically energized when the shutter is open allowing air into the system. Unlike most solenoid coils, it is designed to remain on constantly without creating excessive heat or power consumption. A return spring closes the shutter if there is a fire, if the temperature drops below a selected temperature, or if there is a power failure. **302** is a non-magnetic rod connecting the moving iron coil core with the shutter mechanism **303**. **304** is the debris screen. **305** is the insect screen. **310** indicates a screw hole for attachment. **311** is a gasket, if necessary to improve the air seal. **312** points to the signal and power cable.

[0070] For purposes of further illustration, and not limitation, FIG. **33** is a vertical longitudinal section through the preferred air intake shutter as described in FIGS. **31** and **32**. **300** is the housing containing the solenoid, shutter and return spring. **301** indicates the electromagnetic coil of copper wire wound on a non-metallic bobbin with an iron housing. A moving iron core has a non-magnetic rod **302** linking the core to the moving part of the shutter **303**. A return spring **306** closes the shutter when power to the coil is discontinued. **304** is the debris screen and **305** is the insect screen. **307** are the air inlet holes of non-moving part (housing **300**) of the shutter. **308** and **309** are the LED elements to aid in diagnostics. **310** indicates exemplary attachment screw holes.

[0071] FIG. **34** is a bottom view of the air inlet shutter. **300** is the housing which includes flange ears at each end for attachment to the building. **305** an the insect screen. The air inlet holes **307** are part of the housing **300**. **308** and **309** are the diagnostic lights and **310** are holes for attachment to the horizontal closure strip of the air distribution plenum. FIG. **35** is a transverse vertical section through the air shutter described in FIGS. **32**, **33** and **34**. It is shown installed at the bottom of the air distribution plenum portion of a ventilated exterior wall. **300** is the housing **301** is the solenoid coil. **304** indicates the debris screen to prevent particulates from the insulation and framing from jamming the mechanism. **305** indicates the insect screen.

[0072] FIGS. **36-39** provide further illustration of how devices and techniques described herein can be employed in various types of building structures.

[0073] For example, FIG. **36** illustrates a wall-roof assembly with a cathedral ceiling, for example, with two inch by six inch nominal dimensional lumber studs **3645** that project outwardly beyond four inch nominal base plates to create vertical channels outside the second floor platform **3660**. Preferably, filler strips **3635** are used to make the channels continuous. The structure further includes a first floor platform **3670** and insulated rafters **3615** tied to one another, for example, by a collar beam **3625**. Ventilation spacers **3640** are provided in the wall and cathedral ceiling/roof structures. While fiberglass or cellulose insulation would also be included in locations designated **3620**, it is not illustrated in this drawing to facilitate illustration of other components of the system. In addition, active firestops **3630** are also provided to control fire spread in the event of a building fire at the second floor platform **3660** and proximate the top plate **3650**. In operation, ventilation air is taken into the structure at air intake shutter **3695** at the base of the building proximate foundation **3690**. An air intake plenum is defined in the space between the sheathing and the first floor platform **3670** that spans a desired horizontal distance along the wall structure of the building. As illustrated, a filler strip **3635** can be provided along the first floor platform **3670** that limits the length of the plenum **3680**. Each plenum can be, for example, less than twenty feet in length under present fire code regulations, wherein each plenum **3680** has a dedicated air intake shutter

3695, whereby each plenum is in fluid communication with the spacer devices 3640 and the portion of the ridge vent 3610 that are above it. As such, when shutter 3695 is open, air can enter plenum, and proceed, for example, by natural convection, up through the vertical channels defined by pairs of studs 3645 to the ridge vent 3610, removing moisture from the insulation. In the event of fire, the firestops and shutter close to reduce the spread of fire.

[0074] By way of further example, FIG. 37 illustrates a retrofitted wall-roof assembly similar to FIG. 36 with an attic space 3710, but preferably an existing structure that is originally made from two inch by four inch nominal dimensional studs and then retrofitted to include two inch square nominal dimensional stud extensions 3745 along the studs and past the second floor platform 3760. Preferably, "X" bracing straps 3735 are applied to the structure as existing sheathing is removed during the retrofitting procedure. Ventilation spacers 3740 are provided in the wall and roof structures. As with the embodiment of FIG. 36, while fiberglass or cellulose insulation would also be included in locations designated 3720, it is not illustrated in FIG. 37 to facilitate illustration of other components of the disclosed system. An addition, active firestops 3730 are also provided to control fire spread in the event of a building fire at the second floor platform 3760 and proximate the top plate 3750. In operation, ventilation air is taken into the structure at an air intake shutter (not shown) or similar structure at the base of the building proximate foundation 3790. An air intake plenum 3780 is defined in the space between the sheathing and the first floor platform 3770 that spans a desired horizontal distance along the wall structure of the building. As with the embodiment of FIG. 36, each plenum can be, for example, between eight and sixteen feet long, wherein each plenum 3780 is in fluid communication with the spacer devices 3740 and the portion of the ridge vent that are above it. Operation of the ventilation flowpaths and firestops is the same as described with respect to FIG. 36. It will be further appreciated that the above-described retrofitting procedure can equally be applied to a building with metal framing.

[0075] FIG. 38 illustrates a building structure similar to FIG. 36, but having an unfinished or ventilation attic 3810 in lieu of a cathedral ceiling. Thus, as with FIG. 36, two by six inch nominal studs 3845 are used projecting beyond four inch wide base plates and past the second floor platform 3860. Stud filler strips 3735 are applied to the edge of the second floor platform 3860 as well as to the first floor platform 3870 to limit the length of air intake plenum 3880. Ventilation spacers 3840 are provided in the wall and roof structures. As with the embodiment of FIG. 36, while fiberglass or cellulose insulation would also be included in locations designated 3820, it is not illustrated in FIG. 38 to facilitate illustration of other components of the disclosed system. An addition, active firestops 3830 are also provided to control fire spread in the event of a building fire at the second floor platform 3860 and proximate the top plate 3850. As with the preceding two embodiments, ventilation air is taken into the structure at an air intake shutter (not shown) or similar structure at the base of the building proximate foundation 3890 into air intake plenum 3880. Operation of the ventilation flowpaths and firestops is the same as described with respect to FIGS. 36-37.

[0076] FIG. 39 illustrates a building structure similar to FIG. 38 having an unfinished or ventilation attic 3910, but being made from metal framing. Two by four inch metal framing is depicted having vertical extensions 3945 can be, for example, two inch nominal cross sectional diameter wood, or a fibrous material such as "Homasote" material of any desired thickness (e.g., 0.25 inches thick or greater). Extension strips 3945 are used to project beyond the four inch wide base metal framing and past the second floor platform 3960 as well as selectively to the first floor platform 3970 to limit the length of air intake plenum 3980. "X" bracing strips 3935 are provided to brace the structure. Ventilation spacers 3940 are provided in the wall and roof structures. As with the embodiments of FIGS. 36-38, while fiberglass or cellulose insulation would also be included in locations designated 3920 including between the ceiling joists proximate the attic space 3910, it is not illustrated in FIG. 39 to facilitate illustration of other components of the disclosed system. An addition, active firestops 3930 are also provided to control fire spread in the event of a building fire at the second floor platform 3960 and proximate the top plate 3950. As with the preceding three embodiments, ventilation air is taken into the structure at an air intake shutter (not shown) or similar structure at the base of the building proximate foundation 3990 into air intake plenum 3980. Operation of the ventilation flowpaths and firestops is the same as described with respect to FIGS. 36-39.

[0077] It will be further appreciated that the structures of FIGS. 36-39 can be modified as disclosed herein to use spray foam insulation using techniques, for example, described herein with respect to FIG. 14, whereby wicking members can be provided outside of 2 by four inch framing, and spandrel pieces can be provided underneath the sheathing along the first floor platforms, second floor platforms and the platform that separates the second floor from the attic.

[0078] The methods and systems of the present invention, as described above and shown in the drawings, provide for insulation and associated systems with superior properties to those of the prior art. It will be apparent to those skilled in the art that various modifications and variations can be made in the devices and methods of the disclosed embodiments without departing from the spirit or scope of the disclosure. Thus, it is intended that the present disclosure include modifications and variations that are within the scope of the subject disclosure and equivalents.

What is claimed is:

1. A method of retrofitting a building structure, comprising:

a) removing external sheathing from a plurality of vertically-oriented studs forming an external wall of a building;

b) applying extension strips along the length of an outwardly-facing surface of each stud; and

c) applying sheathing to the extension strips.

2. The method of claim **1**, further comprising;

a) applying a spacer device to an inner surface of the sheathing between adjacent studs having a body that permits moisture to therethrough; and

b) disposing insulation material proximate the spacer device, wherein the spacer device defines a vertically-oriented ventilation channel between the building sheathing and the insulation material, wherein the spacer body permits moisture to be passed from the insulation material to the ventilation channel.

3. The method of claim **2**, further comprising applying cross bracing to the studs.

4. The method of claim **2**, further comprising applying cross bracing to the extension strips.

5. The method of claim 2, further comprising constructing a horizontally-oriented air plenum proximate a lower portion of the building in fluid communication with a plurality of vertically-oriented ventilation channels disposed between the building sheathing and insulation material.

6. The method of claim 5, wherein the plenum is shorter than the horizontal length of the building where the plenum is located.

7. The method of claim 6, wherein the plenum is less than about twenty feet long.

8. The method of claim 5, wherein the plenum is located proximate a floor platform of the building.

9. The method of claim 5, further comprising disposing an air intake vent in fluid communication with the plenum.

10. The method of claim 9, wherein the air intake vent can be selectively closed and opened.

11. The method of claim 2, wherein at least some of the studs are made from metal.

12. The method of claim 2, wherein at least some of the studs are made from wood.

13. The method of claim 2, further comprising disposing an active fire stop device between adjacent studs to permit vertical airflow in the space defined by the spacer device when the fire stop is in an open condition, and that prohibits vertical airflow when the fire stop is an a closed condition.

14. A method of retrofitting a building structure, comprising:

a) removing external sheathing from a plurality of rafters forming a roof surface of a building;
b) applying extension strips along the length of an outwardly-facing surface of each rafter; and
c) applying sheathing to the extension strips.

15. The method of claim 1, further comprising;

a) applying a spacer device to an inner surface of the sheathing between adjacent rafters having a body that permits moisture to therethrough; and
b) disposing insulation material proximate the spacer device, wherein the spacer device defines a ventilation channel parallel to the rafters between the building sheathing and the insulation material, wherein the spacer body permits moisture to be passed from the insulation material to the ventilation channel.

16. The method of claim 15, wherein at least some of the rafters are made from metal.

17. The method of claim 16, wherein at least some of the rafters are made from wood.

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