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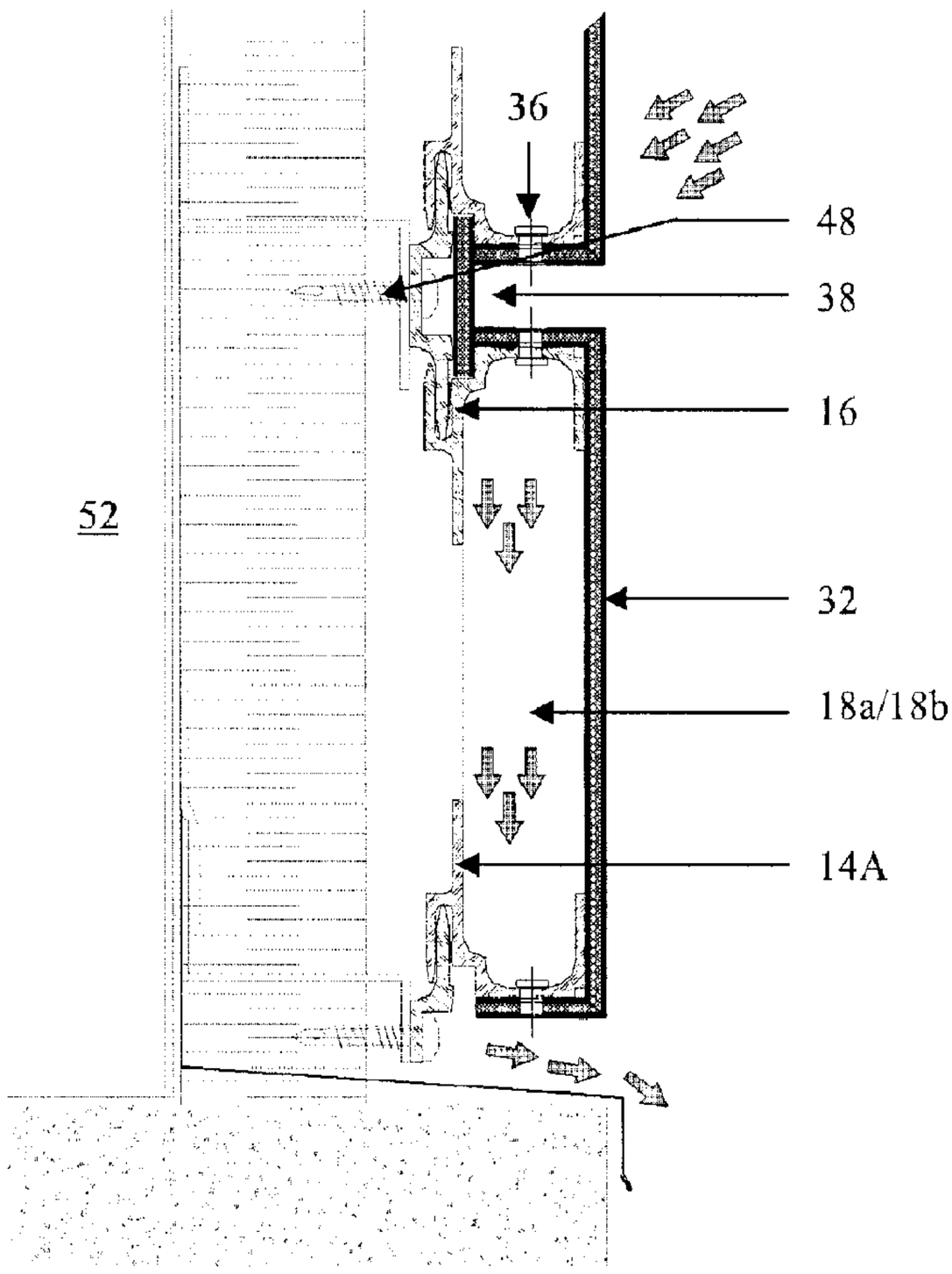
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(54) Titre : SYSTEME DE FIXATION DE PANNEAUX MURAUX EN ALUMINIUM A JOINTS VIFS
(54) Title: DRY JOINT ALUMINUM WALL PANEL ATTACHMENT SYSTEM



(57) Abrégé/Abstract:
A dry joint aluminum wall panel attachment system for attaching a wall panel to an exterior building wall. The system has a bracket assembly fastened to the exterior wall, an attachment clip having a central fastening surface fastened to the bracket assembly and

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(57) Abrégé(suite)/Abstract(continued):
a pair of symmetric wing members. A generally C-shaped panel perimeter strip sits inside a corner of the wall panel and extends along an inside portion of the side surface with a slot adapted to engage and interlock one of the wing members of the attachment clip. An infill strip is disposed within the slot between the attachment clip and rivets to cover the fastener. The system is held together non-adhesively and the wall panel is ventilated at least partially through the rivets to permit ingress and egress of air and moisture to provide a pressure-balanced and moisture-drained interior environment.

ABSTRACT

A dry joint aluminum wall panel attachment system for attaching a wall panel to an exterior building wall. The system has a bracket assembly fastened to the exterior wall, an attachment clip having a central fastening surface fastened to the bracket assembly and a pair of symmetric wing members. A generally C-shaped panel perimeter strip sits inside a corner of the wall panel and extends along an inside portion of the side surface with a slot adapted to engage and interlock one of the wing members of the attachment clip. An infill strip is disposed within the slot between the attachment clip and rivets to cover the fastener. The system is held together non-adhesively and the wall panel is ventilated at least partially through the rivets to permit ingress and egress of air and moisture to provide a pressure-balanced and moisture-drained interior environment.

DRY JOINT ALUMINUM WALL PANEL ATTACHMENT SYSTEM

FIELD OF THE INVENTION

The invention relates to wall panel systems, and more particularly to methods of attaching wall panels to exterior surfaces.

BACKGROUND OF THE INVENTION

There are numerous problems with known aluminum wall panel attachment systems. Conventionally, such systems relied upon adhesive or caulk to "seal" the aluminum panel from the elements. However, under heat and cold and moisture, the adhesive or caulk breaks down compromising the stability of the system and giving an undesirable appearance. Even when such a seal is functional, there a tendancy for undesirable effects on the aluminum panels as the interior environment can trap heat which affects the panels, creating "oil-canning" or popping in response to the pressure differential. In spite of such seals, such systems can also trap moisture in the wall cavity, which results in oxidation of parts and staining or deterioration of exterior wall surfaces.

More recently systems have been developed according to the "rainscreen principle" in which the wall cavity is vented, resulting in a temperature and pressure equalized system with adequate moisture drainage. However, such systems can be difficult to install, relying on many components to be milled or adapted on-site, and requiring excessive labour cost and specialty materials. No suitable system has been developed which applies the rainscreen principle, while providing cost-effective simple installation.

SUMMARY OF THE INVENTION

A dry joint aluminum wall panel attachment system is provided. The system comprises

a bracket assembly fastened to the exterior wall;

an attachment clip fastened to the bracket assembly by a fastener, the attachment clip having a central fastening surface fastened to the bracket assembly and at least one wing member extending outwardly from the central fastening surface;

a wall panel having an exterior flat surface and at least two side surfaces bent generally perpendicularly to the exterior flat surface and defining a hollow interior portion;

a panel perimeter strip fastened to one side surface of the wall panel, the perimeter strip comprising:

a generally C shaped body member sitting inside a corner of the wall panel and extending along an inside portion of the side surface, and

a receiving member integrally attached to the body member that extends beyond the side surface of the wall panel and provides a slot adapted to engage and interlock the wing member of the attachment clip, thus connecting the wall panel to the attachment clip and thereby to the wall;

an infill strip dimensioned to fit in the slot of the panel perimeter strip proximate to the attachment clip so as to cover the fastener;

wherein the system is held together non-adhesively and wherein the wall panels are ventilated to permit ingress and egress of air and moisture to provide a pressure-balanced and moisture-drained interior environment.

Preferably, the attachment clip (here aluminum) comprises two wing members, each adapted to engage a panel perimeter strip of an adjacent wall panel.

Preferably, the bracket assembly (here steel) comprises two back-to-back L angle brackets fastened to each other to form a generally Z shaped assembly, a first end of which is for attachment to the wall and a second end of which is for fastening to the attachment clip (such as a threaded fastener).

The wall panels comprise an aluminum composite material, which is preferably routed and bent to form the exterior and side surfaces. The panel perimeter strip (here aluminum) may be pre-assembled to the wall panel before installation to the wall. Preferably the panel perimeter strip is fastened to the wall panel by rivet. This rivet may contribute to the ventilation of the panel system.

The infill strip (here aluminum composite) may be engaged with the slot of the panel perimeter strip prior to installing an adjacent wall panel. Alternatively, the infill strip may be introduced to the slots of two adjacent panel perimeter strips after two adjacent wall panels have been installed.

Preferably, the system further comprises an isolation tape which is applied between the attachment clip and the bracket assembly.

The system may further comprise a panel stiffener component placed inside the hollow interior portion of the wall panel to reinforce the exterior surface of the panel and prevent deforming or popping of the wall panel.

BRIEF DESCRIPTION OF THE FIGURES

Fig. 1 shows a simplified cut-through view of the dry joint aluminum wall panel attachment system, according to the preferred embodiment.

Fig. 2 shows a panel perimeter strip used in the attachment system.

Fig. 3 shows an attachment clip used in the attachment system.

Fig. 4 shows a cut-through view of a panel stiffener optionally used in the attachment system.

Fig. 5 shows a cut-through view of the aluminum composite material (ACM) used in the panels.

Figs. 6, 7, 8 show progressive steps in the formation of an ACM panel for use in the present system.

Fig. 9 shows a cut-through view of an infill strip used in the attachment system.

Fig. 10 shows a detailed view of the preferred placement of the infill strip in the attachment system.

Fig. 11 shows a simplified elevational view of the sub-framing used before mounting the ACM panels in the present system.

Fig. 12 shows a detailed view of the complete attachment system with sub-framing.

Figs. 13, 14, 15 show progressive steps in the installation of panels in the present system (first method).

Fig. 16 shows a view of the installation of lengths of infill strip in the present system (second method).

Fig. 17 shows a view of a finished wall paneled exterior.

Fig. 18 shows a cut-through view of an alternative panel perimeter strip.

Figs. 19-20 show cut-through views of two versions of an alternative panel stiffener.

DETAILED DESCRIPTION

The present panel attachment system **10** uses an extruded aluminum attachment system for fastening fabricated panels to all building surfaces. The system's strength is further enhanced by the use of an extruded perimeter frame design.

The system **10** is designed to the standard of the rainscreen principle. Simply, it is designed so that the wall cavity is vented, resulting in a pressure equalized system as seen in Figure 1. Controlled moisture drainage within the system, coupled with this equalized pressure, contributes to effective, maintenance free construction.

The extrusion process begins with an aluminum billet, the material from which the profiles are extruded. The billet must be softened by heat prior to extrusion process. The heated billet is placed into the extrusion press, a powerful hydraulic device wherein a ram pushes a dummy block that forces the softened metal through a precision opening, known as a die, to produce the required shapes. The extruded shape may have a mill or anodized finish.

The system includes a panel perimeter strip **14** (Figure 2), which is attached to the ACM panel **32** using counter sunk rivets **36**. The panel perimeter strip is designed to fit together with the attachment clip **16** (Figure 3). The custom designed extrusion allows for maximum attachment area without foregoing structural integrity.

The attachment clip **16** (Figure 3) is used on site to attach the panel perimeter strip **14** to the building as illustrated in Figure 12. The clip **16** is designed so as to interlock with the panel perimeter strip **14** while holding the infill strip **38** (Figure 10) securely in place.

The system optionally includes a panel stiffener **18** component (Figure 4), which may be used on large sized panels. The stiffener **18** is used to prevent the popping or "oil canning" of the panel. As the panel heats up, the panel expands and makes a popping sound. The stiffener **18** reinforces the panel to reduce this effect.

The panel stiffener **18** may comprise a hollow tube, as shown in Figure 4. An internally reinforced panel stiffener **18A, 18B** may alternatively be used for greater stability (see Figs. 19, 20). Where panel stiffeners are used, the panel perimeter strip may be adapted to better locate and secure the stiffener component. A panel perimeter strip **14A** having profile as shown in Fig. 18 may be advantageous for this purpose. The extended interior lip of the panel perimeter strip operates to secure the panel stiffener component.

Panel stiffeners may be provided in different sizes depending on the wind pressures to which the panel will be exposed. A larger width panel stiffener **18B** may be advantageous where there are greater wind loads on the panel system or if less deflection on the panel is desired. It will be appreciated that the construction of the panels also provides a basic level of rigidity and stiffeners are not necessarily required.

As shown in Figure 5, the aluminum composite material **20** (ACM) consists of a core of low density polyethylene **24** sandwiched between two sheets of aluminum **22** (each approximately .5 mm thick). The finish face of the aluminum is coated with a polyvinylidien fluoride coating. The inner aluminum layer is typically coated with chrome or polyester coatings. The standard thickness of the panel is 5/32" (4mm) but thickness may range from 1/8" (3mm) to ¼" (6mm), depending on customer preference or structural requirements.

A finished ACM panel **32** may be fabricated from a flat sheet of ACM **26** using different types of router and cutting bits **28** (Figure 6). After the sheet of ACM has been cut and routed, it is then bent along the router lines to form the finished panel **32** (Figure 7). The

newly shaped panel **32** is then assembled with the panel perimeter strip **14** using a panel rivet **36** to complete the finished panel (Figure 8). A standard panel rivet for this application is 3/16" diameter.

There are various methods to accomplish the routing and cutting process:

Method 1

Handheld router (not shown): A handheld router is used more often when reworking a panel to a different size. This method requires the simplest tool set up, but is the most labour-intensive method of fabrication due to the lengthy time for setup and layout of each different panel.

Method 2

Vertical table saw (not shown): A vertical table saw can also be used, both to cut and rout the panels. Custom "V" routing blades can be purchased to rout the panels. Panel design is limited using the vertical table saw in itself. Using it in combination with the hand held router has its advantages, but it is still a costly way to manufacture panels.

Method 3

CNC-Machine (not shown): The computer numerically controlled (CNC) machine is a complete and concise way to manufacture panels. Once the panel has been designed by a CAD operator it is then sent directly to the machine. This machine has been found to be very useful and economical for manufacturing panels. This is the applicants' preferred method for cutting and routing panels.

The infill strip (Figure 9) is typically cut to a width of approximately 1-1/4" (32mm) for a ½" (13mm) joint. The infill strip replaces the conventional caulk joint, giving the panel system a clean, maintenance free appearance. The infill strip also is used to hide the fasteners **36** for the attachment clip (Figure 10).

As shown in Figure 11, to install the panel system, sub framing is first constructed using two back-to-back galvanized steel "L" angles **40** (Figure 12); the two "L" angles allow the installer to level the substrate in all 3 axes before installation of panels. The sub framing is typically installed horizontally at each horizontal joint as shown in Figure 11. The method of installation of the framing at its correct installation measurements starts at the bottom of the substrate wall and moves up, making sure that each row is level to the previous row installed.

A layer of isolation tape **42** may be applied to the back of aluminum attachment clips **16** (Figure 3) to prevent direct contact between the galvanized steel sub framing and the aluminum attachment clip and thus prevent galvanic action (electrolytic decay of the aluminum) over time. Preferably, stainless steel self-drilling screws are used to fasten aluminum attachment clips to steel sub framing **40**. After determining a logical order of installation, each panel is to be plumbed and leveled to ensure a tight and concise fit form panel to panel.

Infill strip is preferably shipped in long lengths and are to be cut to fit on site. The strips may have a protective plastic coating, which is then removed from the face of the infill strips before installing them. These infill strips can be installed one or two ways:

First, as shown in Figures 13-15, the infill strips may be slipped in before the adjacent panel is installed when the edge of the joint is not accessible, or when the infill strip has a curve or bend in it. The infill strip **38** is fitted into the space between the panel **32** return and the attachment clips **14** as illustrated in Figure 13 and Figure 14. Then an adjacent panel **32'** is installed so that the infill strip **38** and attachment clip **16** engage into the slots in the panel edge at the perimeter strip **14'** (Figure 15).

As an alternative method of installation, the installer can slide the infill strip **38** in from the end (Figure 16), which allows for a simplified installation of the panels. The infill strips are not installed until an area is complete. This means that panels can be adjusted for straightness and position even after adjacent panels have been installed. The difficulty with this method is that the end of the joint will not always be accessible (i.e. wall or window frame) and the infill strip **38** may have a tendancy to catch on the attachment clips as it is being slid into the joint. To aid in the sliding of the strip, a tool may be used to pull the leading edge over the clips (not shown).

The finish faces of the panels may have a protective film **50** to protect against minor abrasions that may occur during handling and installation. The protective film may be peeled back from the returns of the panels before installing. To keep the panels clean and free of construction debris, generally the protective plastic film **50** is only removed from the faces of the panels once the landscaping has been completed, as seen in Figure 17.

The foregoing description illustrates only certain preferred embodiments of the invention. The invention is not limited to the foregoing examples. That is, persons skilled in the art will appreciate and understand that modifications and variations are, or will be, possible

to utilize and carry out the teachings of the invention described herein. Accordingly, all suitable modifications, variations and equivalents may be resorted to, and such modifications, variations and equivalents are intended to fall within the scope of the invention as described and within the scope of the claims.

CLAIMS

What is claimed is:

1. A dry joint aluminum wall panel attachment system for attaching a wall panel to an exterior building wall, the system comprising:

a bracket assembly fastened to the exterior wall;

an attachment clip fastened to the bracket assembly by a fastener, the attachment clip having a central fastening surface fastened to the bracket assembly and a pair of integrally formed wing members, each wing member extending outwardly from the central fastening surface in a substantially symmetrical manner;

a wall panel having an exterior flat surface and at least two side surfaces bent generally perpendicularly to the exterior flat surface and defining a hollow interior portion;

a panel perimeter strip fastened to one side surface of the wall panel, the perimeter strip comprising:

a generally C-shaped member sitting inside a corner of the wall panel and extending along an inside portion of the side surface, and

a receiving member integrally attached to the C-shaped member that extends beyond the side surface of the wall panel and provides a slot adapted to engage and interlock one of the wing members of the attachment clip, thus connecting the wall panel to the attachment clip and thereby to the wall;

one or more rivets provided along the side surface of the wall panel to connect the side surface to the receiving member of the panel perimeter strip;

an infill strip non-sealingly disposed within the slot of the panel perimeter strip between the attachment clip and the one or more rivets so as to cover the fastener, the infill strip being fabricated from a substantially rigid material compromising aluminum, polyethylene, or combinations thereof;

wherein:

the system is held together non-adhesively and the wall panel is ventilated at least partially through the one or more rivets to permit ingress and egress of air and moisture to provide a pressure-balanced and moisture-drained interior environment.

2. The attachment system of claim 1, wherein the bracket assembly comprises two back-to-back L angle brackets fastened to each other to form a generally Z shaped assembly, a first end of which is for attachment to the wall and a second end of which is for fastening to the attachment clip.

3. The attachment system of claim 1, wherein the wall panel comprises an aluminum composite material.

4. The attachment system of claim 1, wherein the wall panel comprises an aluminum composite material which is routed and bent to form the exterior and side surfaces.

5. The attachment system of claim 1, wherein the fastener comprises a threaded fastener.

6. The attachment system of claim 1, wherein the panel perimeter strip is pre-assembled to the wall panel before installation to the wall.

7. The attachment system of claim 1, wherein the infill strip is engaged with the slot of the panel perimeter strip prior to installing an adjacent wall panel.

8. The attachment system of claim 1, wherein the infill strip is introduced to the slots of two adjacent panel perimeter strips after two adjacent wall panels have been installed.

9. The attachment system of claim 1, wherein the system further comprises an isolation tape which is applied between the attachment clip and the bracket assembly.

10. The attachment system of claim 1, wherein the attachment clip comprises an aluminum attachment clip.

11. The attachment system of claim 1, wherein the bracket assembly comprises a steel bracket assembly.

12. The attachment system of claim 1, wherein the infill strip comprises a strip of aluminum composite material.

13. The attachment system of claim 1, wherein the panel perimeter strip is made of aluminum.

14. The attachment system of claim 1, wherein the system further comprises a panel stiffener component placed inside the hollow interior portion of the wall panel to reinforce the exterior flat surface of the wall panel and prevent deforming or popping of the wall panel.

15. A method for installing a first wall panel to an exterior building wall, the first wall panel having an exterior flat surface and at least two side surfaces bent inwardly at an angle to the exterior flat surface and defining a hollow interior portion, and the method comprising:

operatively connecting an attachment clip to a wall surface of the exterior building wall, the attachment clip having a central fastening surface and at least two opposing wing members extending outwardly from the central fastening surface;

providing a first panel perimeter strip comprising:

a generally C-shaped member sitting inside a corner of the first wall panel and extending along an inside portion of the side surface, and

a receiving member integrally attached to the C-shaped member that extends beyond the side surface of the first wall panel and provides a slot adapted to engage and interlock a first of the at least two wing members of the attachment clip, thus connecting the first wall panel to the attachment clip and thereby to the wall;

fastening the first wall panel to the first panel perimeter strip along one side surface of the first wall panel;

providing a through-opening through the first wall panel, thereby permitting fluid communication from an atmosphere into the hollow interior portion of the first wall panel and so as to permit ingress and egress of air and moisture to provide a pressure-balanced and moisture-drained interior environment for the first wall panel; and

sliding an infill strip into the slot of the first panel perimeter strip between the attachment clip and the through opening;

wherein the attachment clip and the panel perimeter strip are held together non-adhesively.

16. The method of claim 15, further comprising fastening a bracket assembly to the exterior building wall; and wherein:

the step of operatively connecting the attachment clip to the wall surface of the exterior building wall comprises fastening the attachment clip to the bracket assembly by at least one fastener; and

the infill strip covers the fastener of the bracket assembly.

17. The method of claim 16, wherein the two wing members of the attachment clip are each adapted to engage a receiving member of a panel perimeter strip.

18. The method of claim 17, wherein:

fastening the first wall panel to the first panel perimeter strip comprises running at least one rivet through the first panel perimeter strip and through the one side surface of the first wall panel; and

the through-opening through the first wall panel defines the at least one rivet such that the interior portion of the first wall panel is ventilated at least partially through the at least one rivet.

19. The method of claim 18, wherein the infill strip is fabricated from a substantially rigid material comprising a metal material, a polycarbonate material, polyethylene, or combinations thereof.

20. The method of claim 16, wherein the bracket assembly comprises two back-to-back L angle brackets fastened to each other to faun a generally Z shaped assembly, a first end of which is for attachment to the wall and a second end of which is for fastening to the attachment clip.

21. The method of claim 15, wherein the first wall panel comprises an aluminum composite material.

22. The method of claim 15, wherein the first wall panel comprises an aluminum composite material which is routed and bent generally perpendicularly to form the exterior and side surfaces.

23. The method of claim 16, wherein the fastener comprises a threaded fastener.

24. The method of claim 16, wherein the panel perimeter strip is pre-assembled to the first wall panel before being fastened to the bracket assembly.

25. The method of claim 16, further comprising:

providing a second panel perimeter strip in accordance with the first panel perimeter strip;

attaching a second panel perimeter strip to a second of the at least two opposing wing members of the attachment clip;

fastening a second wall panel to the second panel perimeter strip along one side surface of the second wall panel such that the side surface of the second wall panel faces the side surface of the first wall panel; and

providing a through-opening through the second wall panel, thereby permitting fluid communication from the atmosphere into the hollow interior portion of the second wall panel.

26. The method of claim 25, wherein the infill strip is engaged with the slot of the first panel perimeter strip prior to installing the second wall panel.

27. The method of claim 25, wherein:

the first panel perimeter strip and the second panel perimeter strip are adjacent one another; and

the infill strip is introduced to the slots of the first and second adjacent panel perimeter strips after two adjacent wall panels have been installed.

28. The method of claim 25, further comprising:

applying an isolation tape between the attachment clip and the bracket assembly.

29. The method of claim 16, wherein the bracket assembly comprises steel.

30. The method of claim 15, wherein the infill strip comprises a strip of aluminum composite material.

31. The method of claim 25, further comprising:

installing a panel stiffener component inside the hollow interior portion of the first and second wall panels to reinforce the exterior surfaces of the wall panels and preventing deforming or popping of the wall panels.

32. A method for installing wall panels to an exterior wall of a building, each of the wall panels being polygonal and having an exterior flat surface and at least two side surfaces bent inwardly at an angle to the respective exterior flat surfaces and defining a hollow interior portion, and the method comprising:

operatively connecting a plurality of attachment clips to a wall surface of the exterior building wall, wherein:

each of the attachment clips has a central fastening surface and two opposing wing members, and

each wing member extends outwardly from the central fastening surface in a substantially symmetrical manner;

providing an elongated first panel perimeter strip and an elongated second panel perimeter strip, each panel perimeter strip comprising:

a generally C-shaped member configured to reside inside a corner of the wall panel and to extend along an inside portion of the side surface, and

a receiving member integrally attached to the C-shaped member that extends beyond the side surface of the wall panel and provides a slot adapted to interlock a first of the opposing wing members of an attachment clip;

fastening the first panel perimeter strip along a first side surface of the first wall panel; fastening the second panel perimeter strip along a first side surface of the second wall panel;

sliding the first panel perimeter strip onto a first wing member of an attachment clip, thereby connecting the first wall panel to the wall;

sliding the second panel perimeter strip onto a second opposing wing member of the attachment clip, thereby connecting the second wall panel to the wall such that the first side surfaces of the first and second wall panels are adjacent;

wherein:

the attachment clips and the panel perimeter strips comprise a wall panel attachment system, and

the wall panel attachment system is held together non-adhesively.

33. The method of claim 32, further comprising:

placing an infill strip into the slot of the first panel perimeter strip between the attachment clip and one or more through openings.

34. The method of claim 33, wherein the infill strip comprises a strip of aluminum composite material.

35. The method of claim 33, wherein the infill strip is fabricated from a substantially rigid material comprising a metal material, a polycarbonate material, polyethylene, or combinations thereof.

36. The method of claim 33, wherein the infill strip is engaged with the slot of the first panel perimeter strip prior to installing the second wall panel to the wall.

37. The method of claim 33, wherein the infill strip is introduced to the slots of the first and second adjacent panel perimeter strips after the two adjacent wall panels have been installed to the wall.

38. The method of claim 33, wherein the first wall panel and the second wall panel each have one or more through-openings that permit fluid communication from an atmosphere into the hollow interior portion of the wall panel so as to permit ingress and egress of air and moisture to provide a pressure-balanced and moisture-drained interior environment for the wall panel.

39. The method of claim 38, further comprising:

fastening a bracket assembly to the exterior building wall; and wherein:

the step of operatively connecting the attachment clip to the first wall panel of the exterior building wall comprises fastening the attachment clip to the bracket assembly using one or more fasteners; and

the infill strip covers the one or more fasteners of the bracket assembly.

40. The method of claim 39, wherein:

fastening the first panel perimeter strip to the first wall panel comprises running at least one rivet through the first panel perimeter strip and through the one side surface of the wall panel; and

the through-opening through the wall panel defines the at least one rivet such that the interior portion of the wall panel is ventilated at least partially through the at least one rivet.

41. The method of claim 39, wherein the first bracket assembly comprises two back-to-back L angle brackets fastened to each other to form a generally Z shaped assembly, a first end of which is for attachment to the wall and a second end of which is for fastening to the attachment clip.

42. The method of claim 39, wherein each of the one or more fasteners comprises a threaded fastener.

43. The method of claim 39, wherein the first panel perimeter strip is fastened to the first wall panel before being fastened to the first bracket assembly.

44. The method of claim 38, further comprising:

installing a panel stiffener component inside the hollow interior portion of the first and second wall panels to reinforce the exterior surfaces of the wall panels and preventing deforming or popping of the wall panels.

45. The method of claim 32, wherein each of the wall panels comprises an aluminum composite material.

46. The method of claim 32, wherein each of the wall panels comprises an aluminum composite material which is routed and bent generally perpendicularly to form the exterior and side surfaces.

47. The method of claim 39, further comprising:

applying an isolation tape between the attachment clip and the bracket assembly.

48. The method of claim 39, wherein the bracket assembly comprises steel.

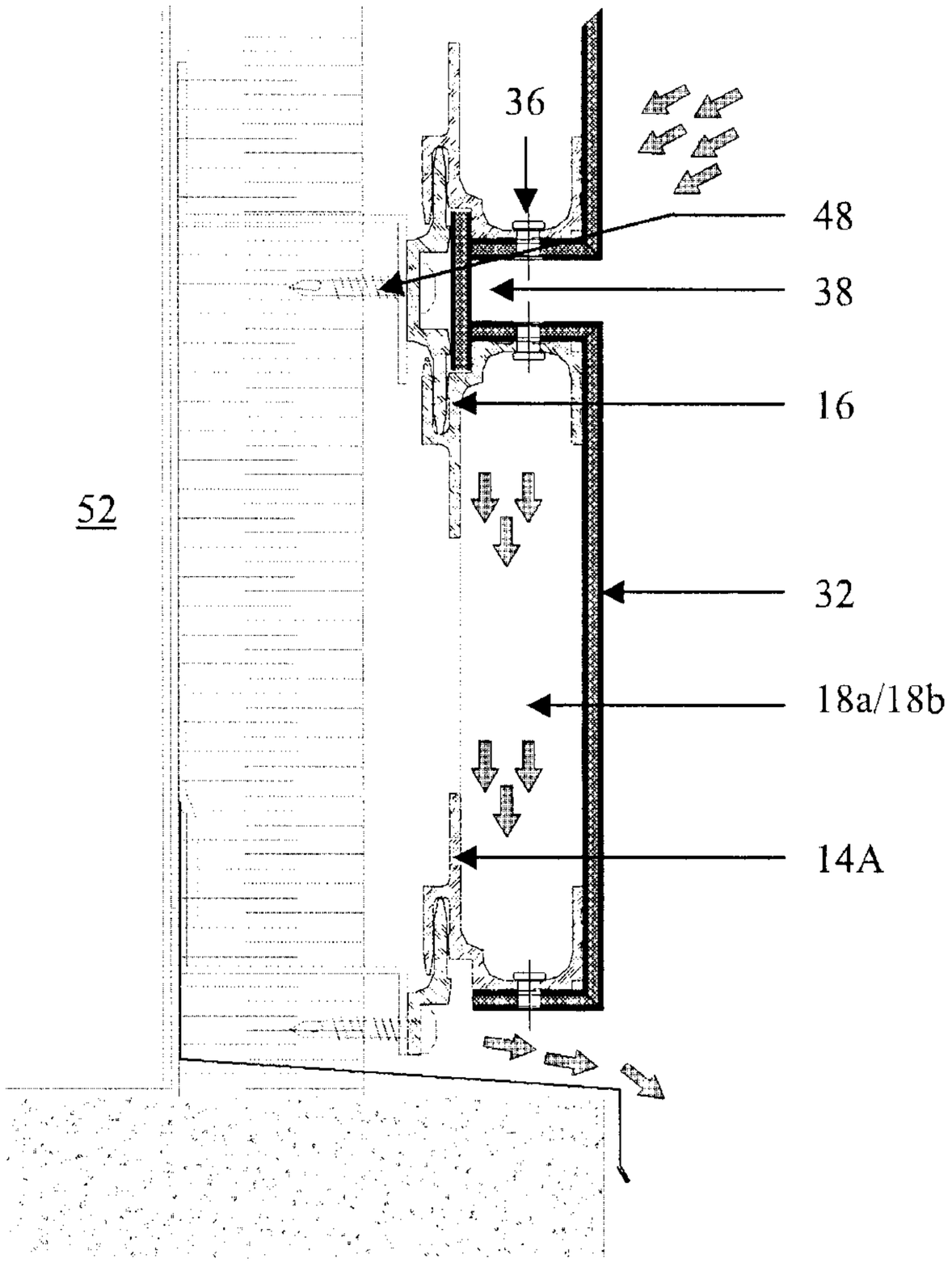


Figure 1

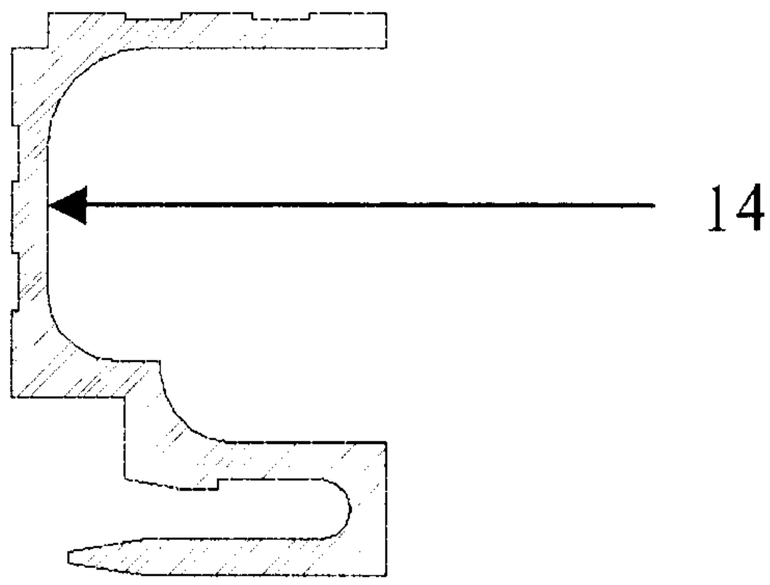


Figure 2

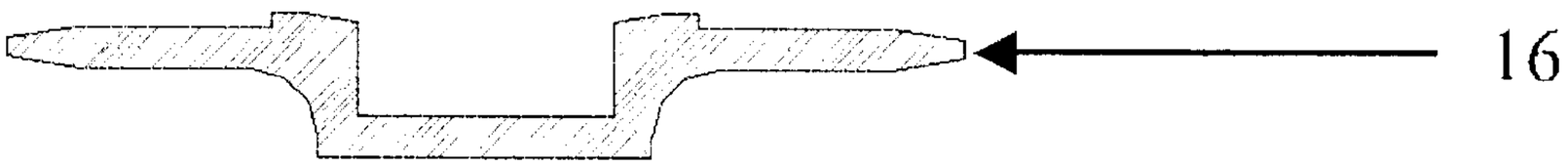


Figure 3

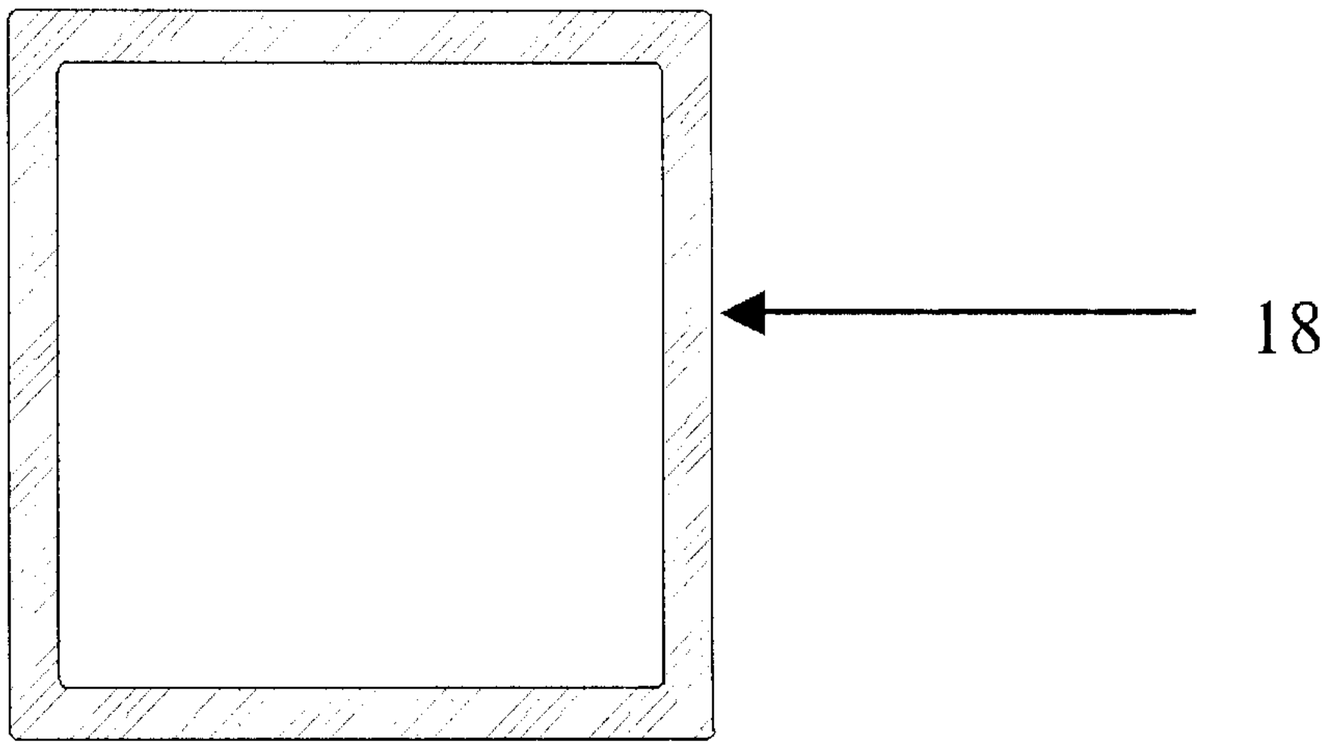


Figure 4

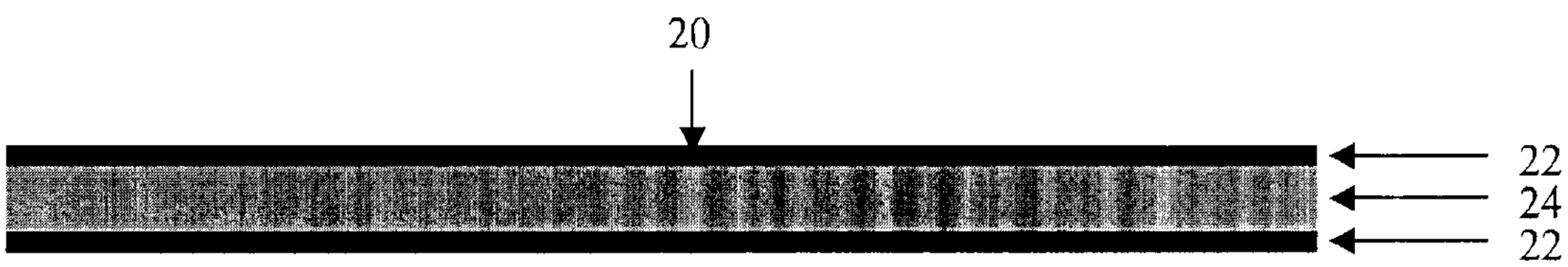


Figure 5

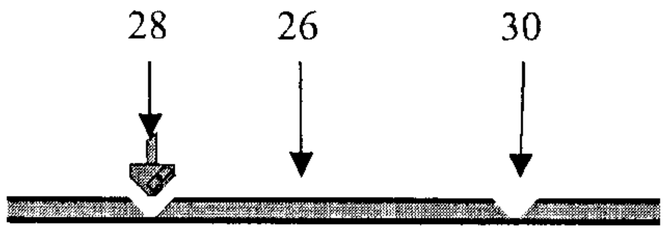


Figure 6

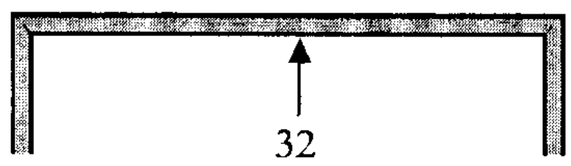


Figure 7

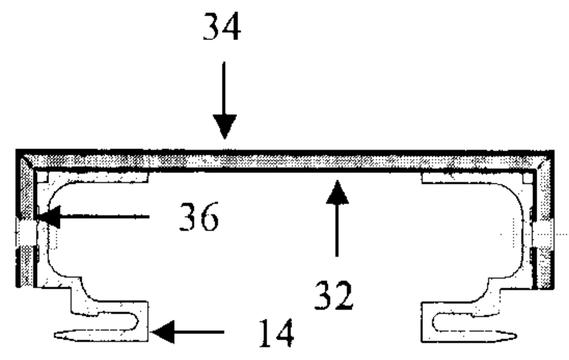


Figure 8

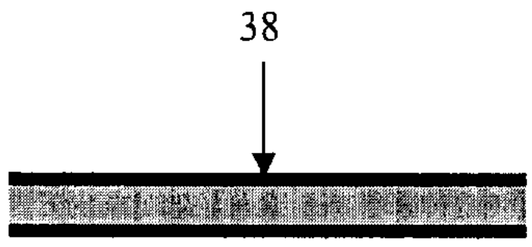


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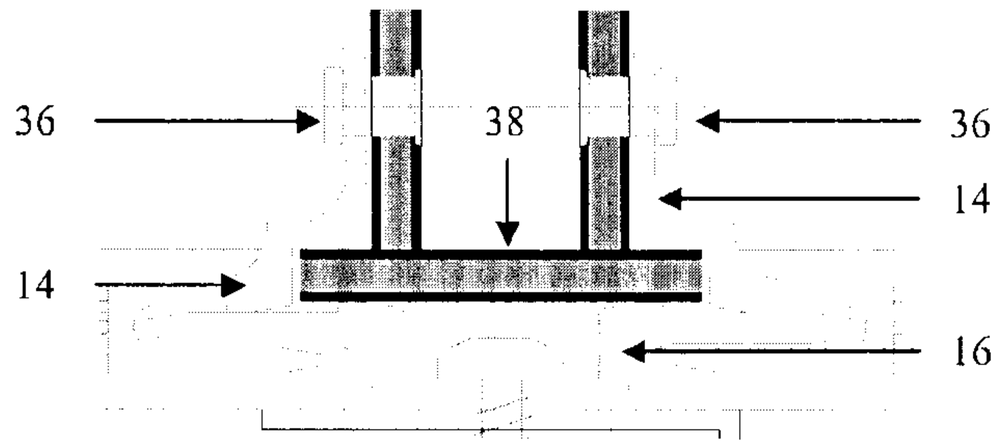


Figure 10

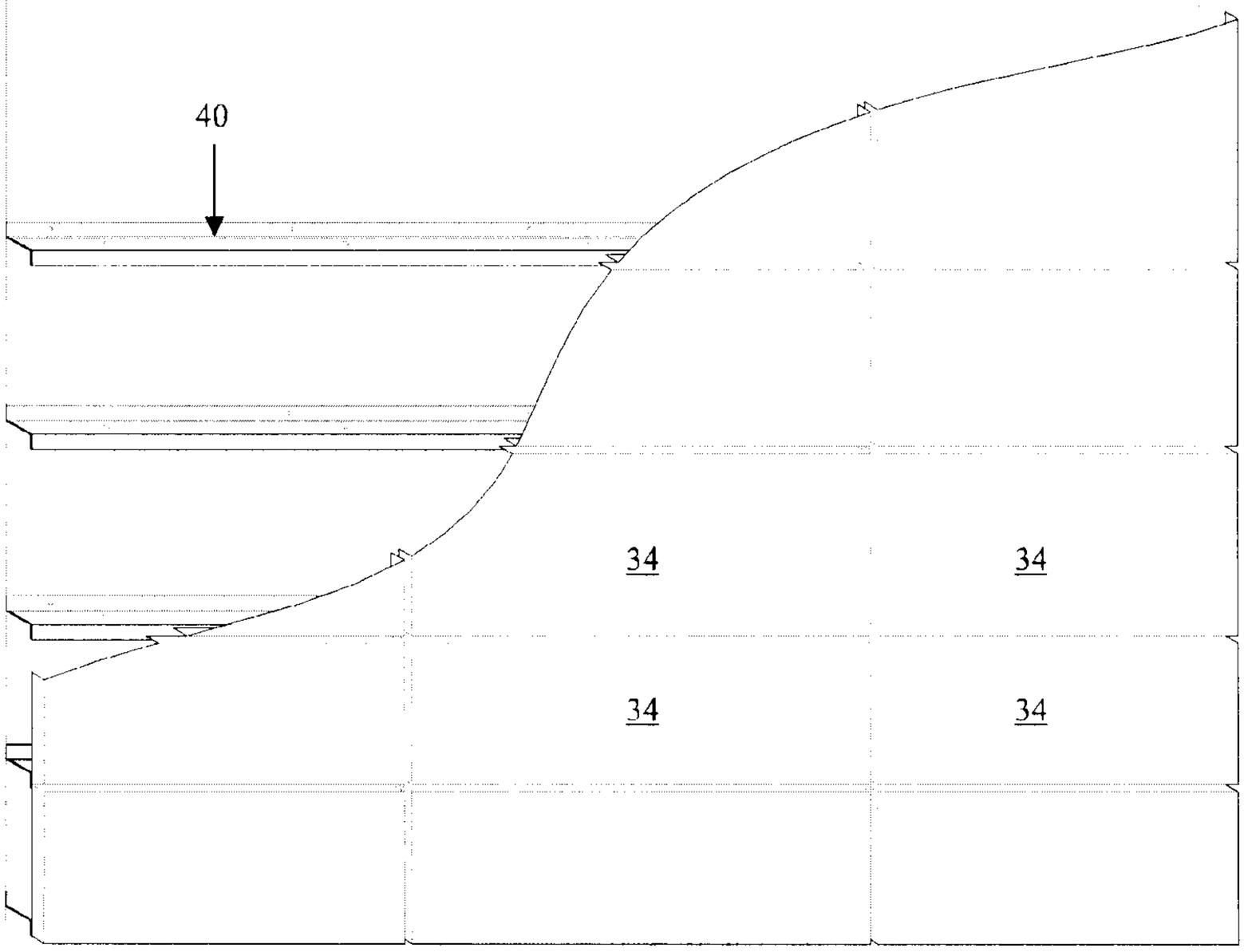


Figure 11

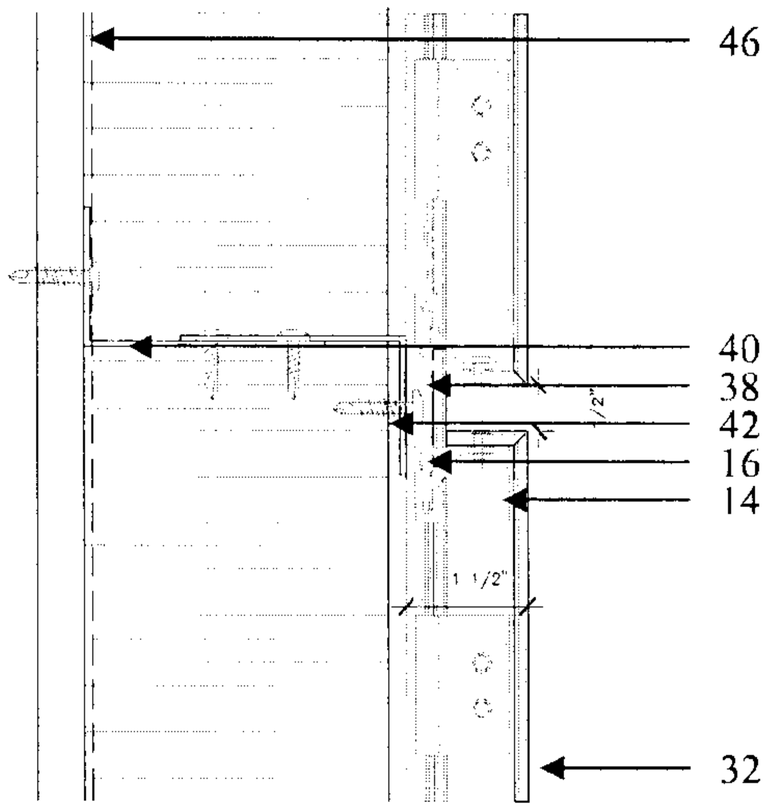


Figure 12

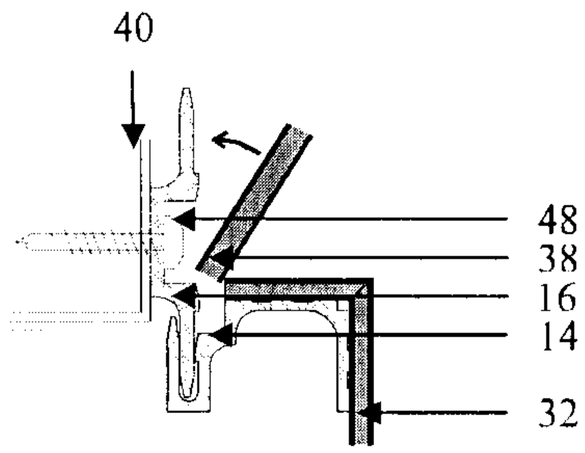


Figure 13

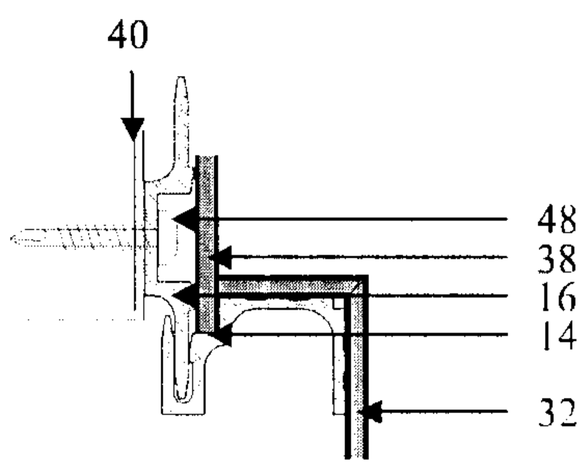


Figure 14

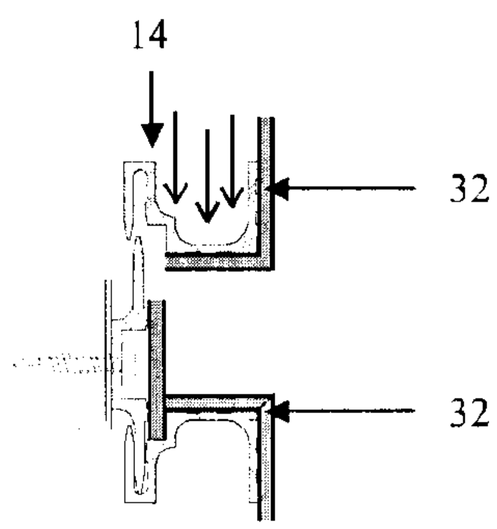


Figure 15

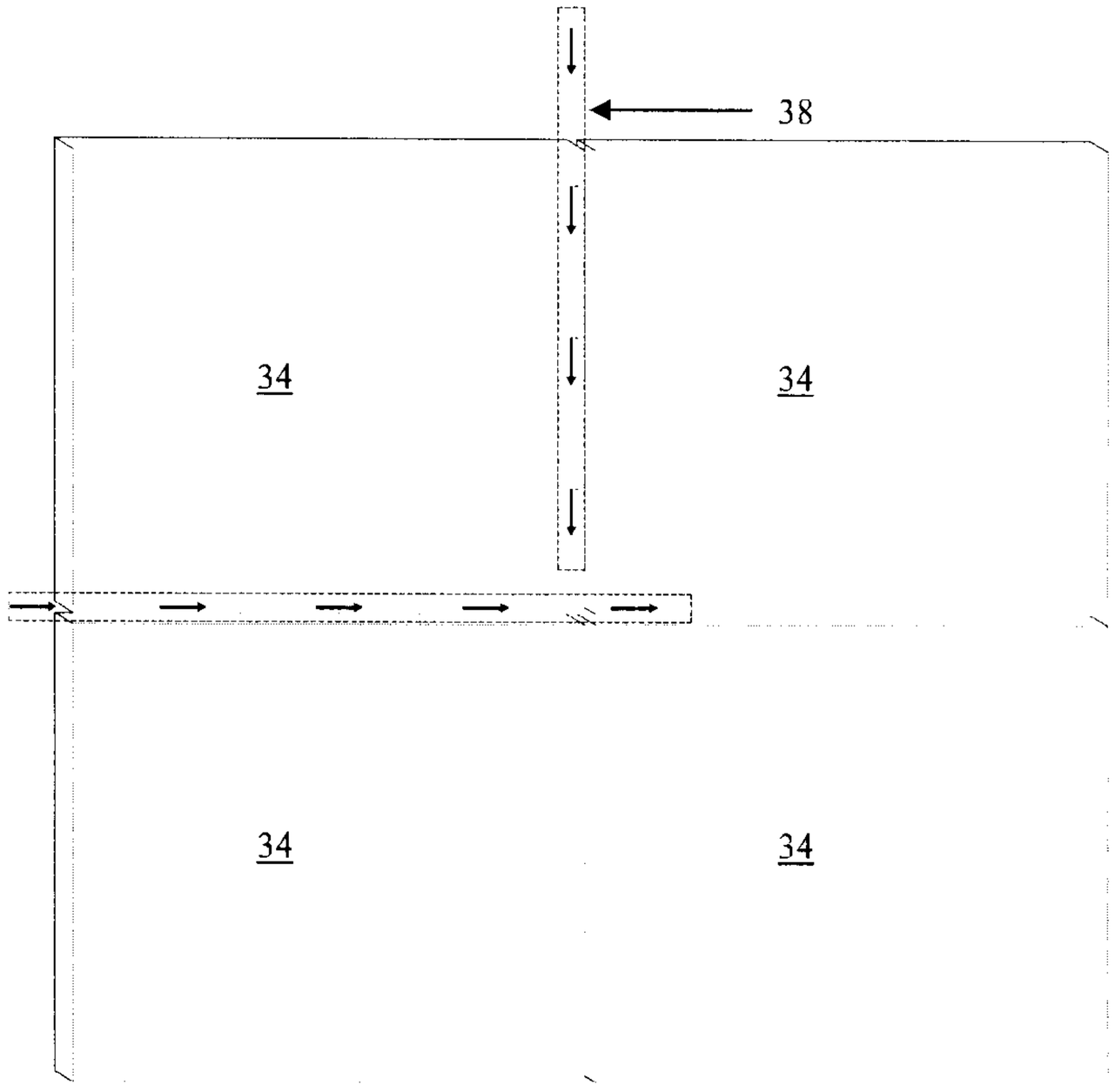


Figure 16

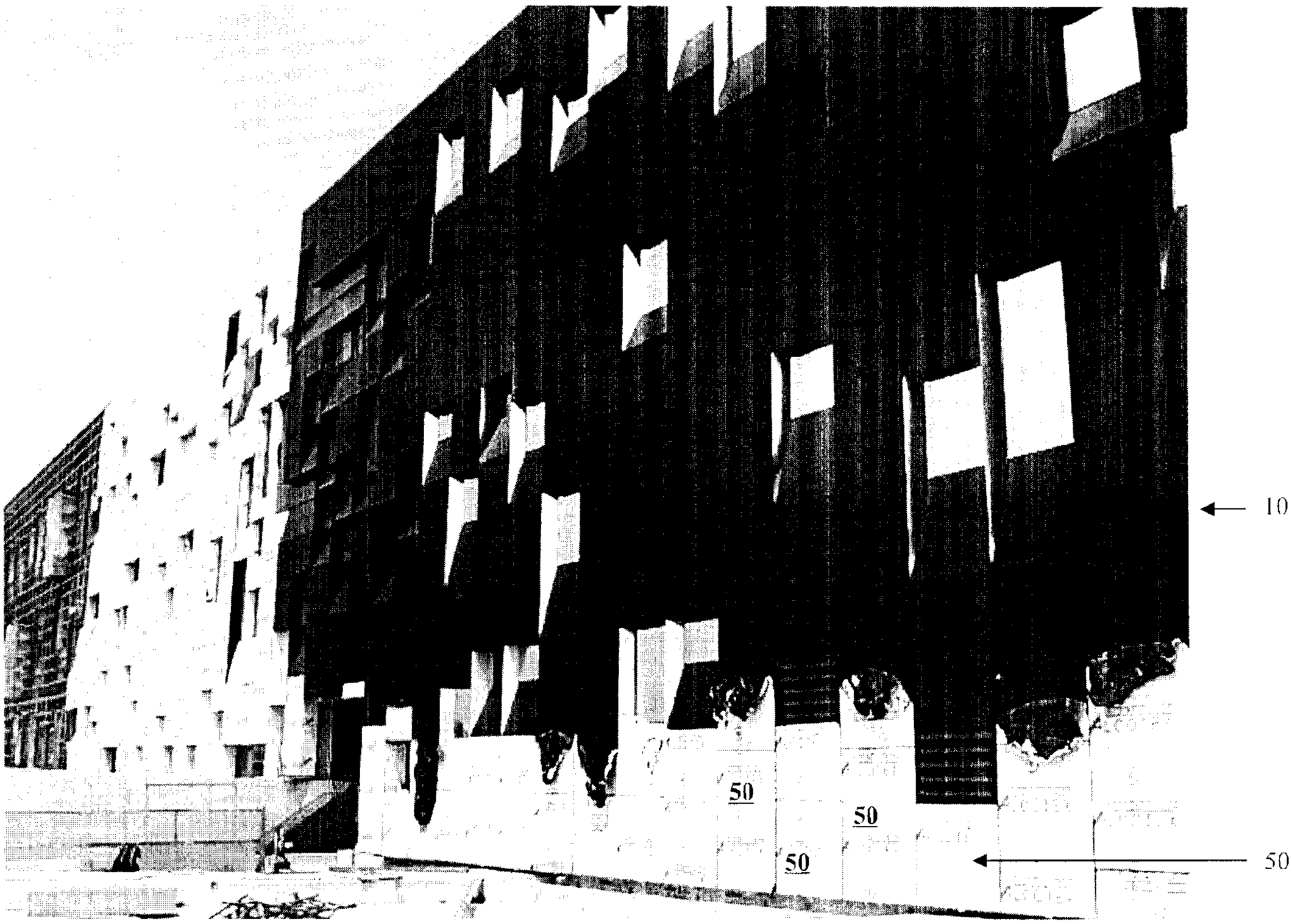


Figure 17

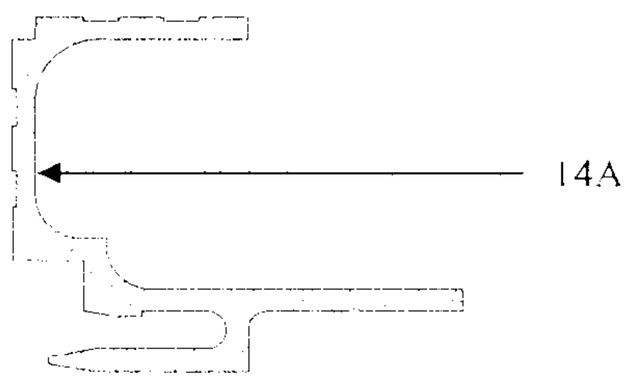


Figure 18

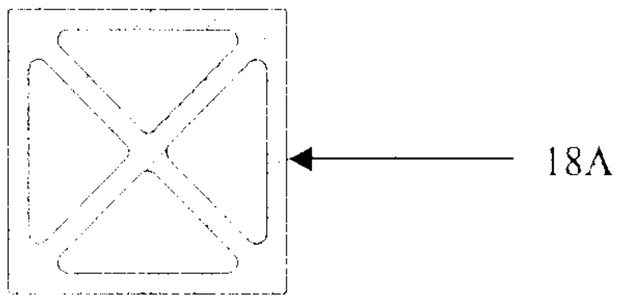


Figure 19

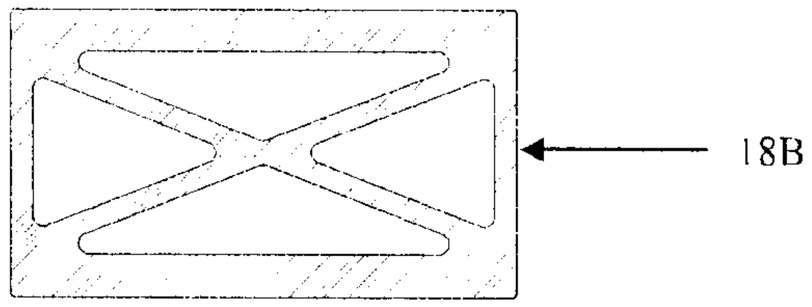
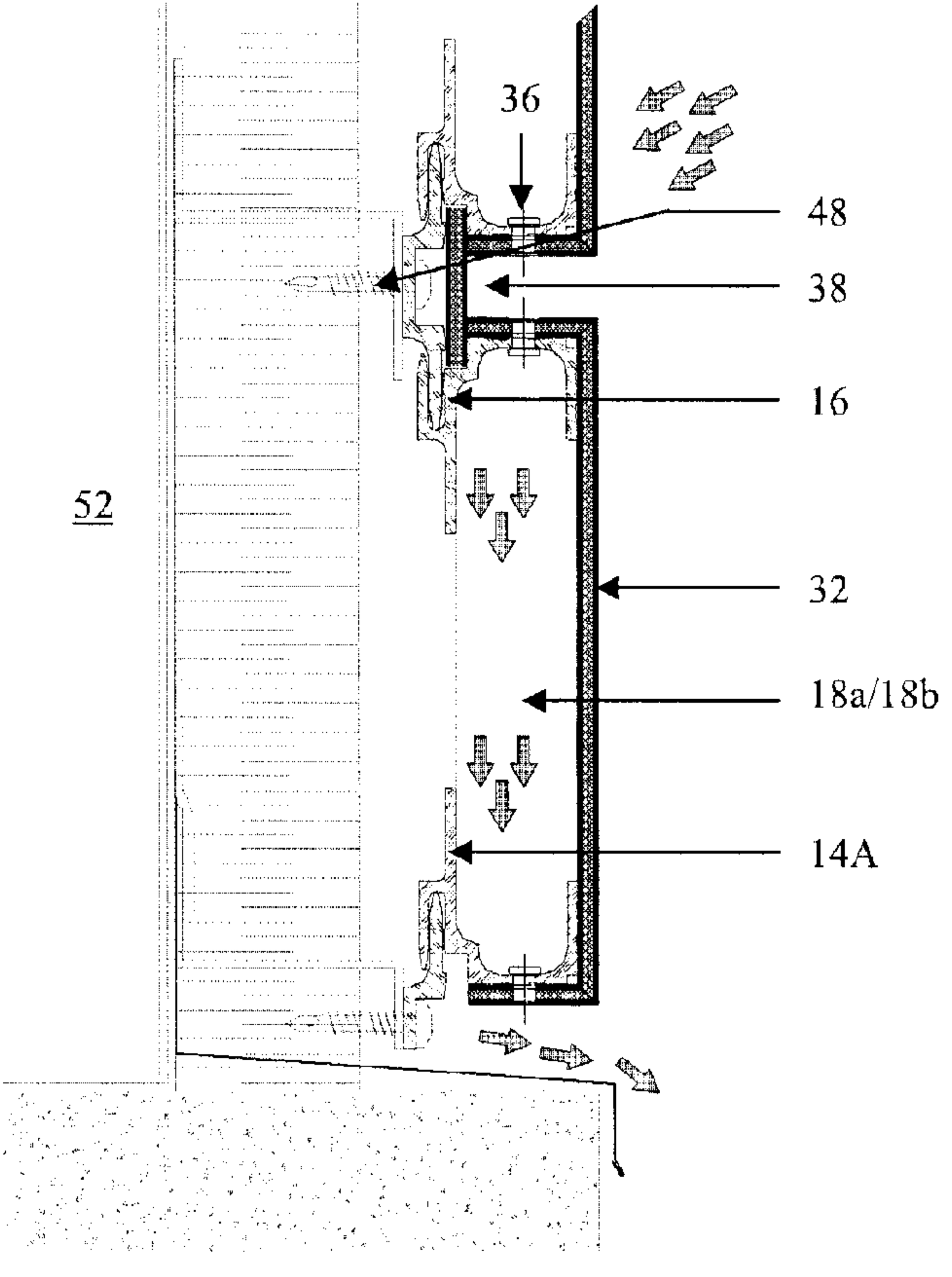


Figure 20


36
48
38
16
52
32
18a/18b
14A