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(54) **DYNAMIC FOAM INSULATION/SHADING SYSTEM WITH INFLATABLE BAGS**

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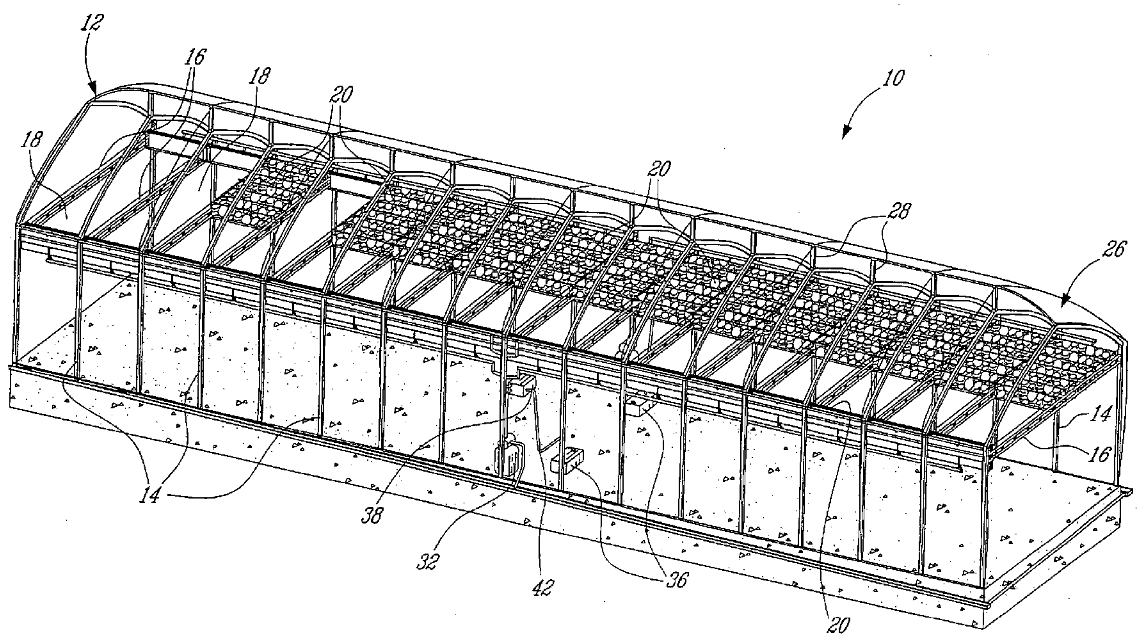
(57) **ABSTRACT**

A building insulation/shading system comprises a dynamic fluid foam generator and a plurality of deployable/retractable flexible containers mounted to the building structure. Each container has an inlet connected to the dynamic fluid foam generator and an outlet for draining the liquid resulting from the degradation of the insulation foam directed in the container by the foam generator. The containers are movable between an expanded operational position in which the flexible containers are filled with dynamic fluid insulation foam and a retracted storage position in which the flexible containers have been emptied and retracted along the sides of the building.



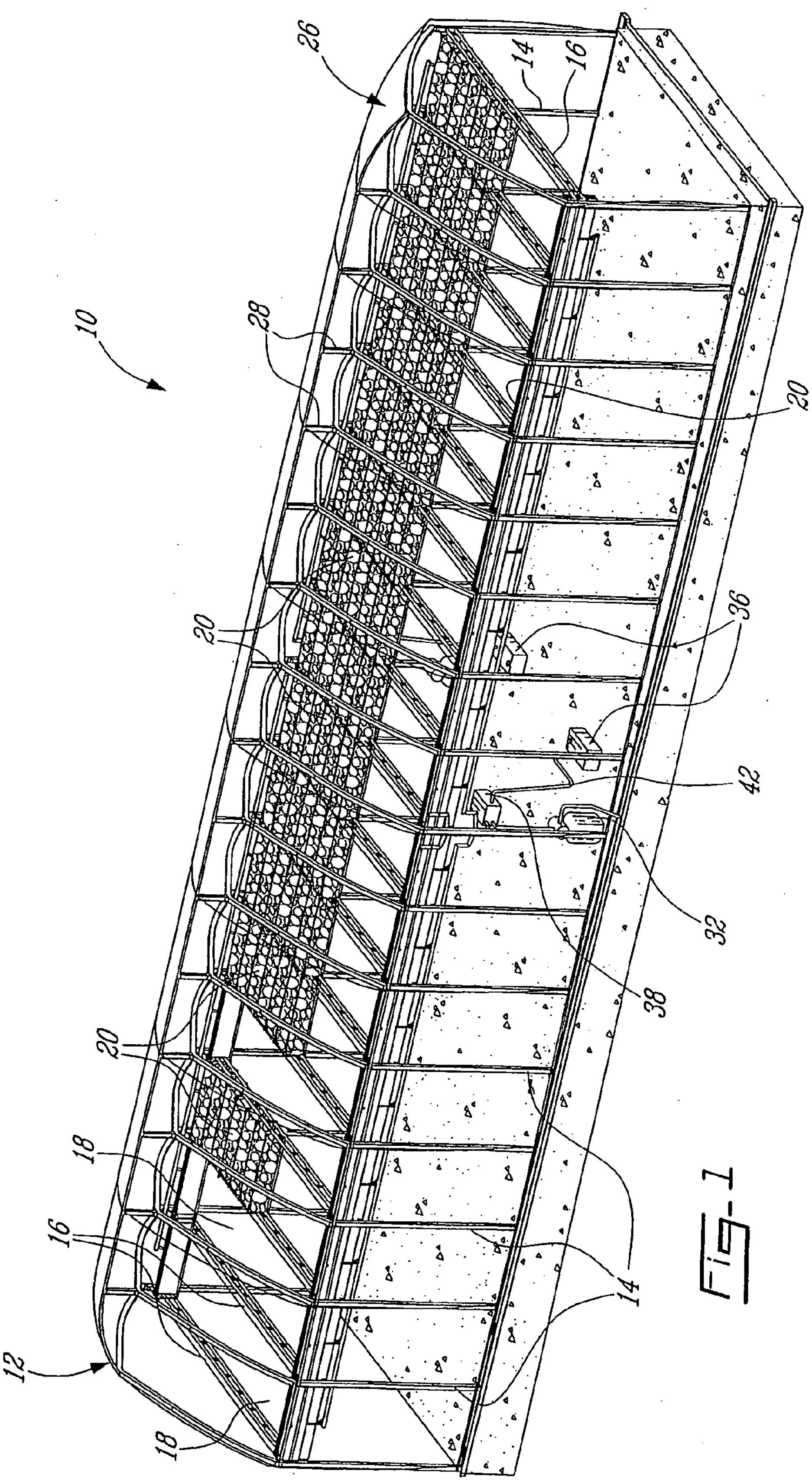


Fig-1

Fig-2

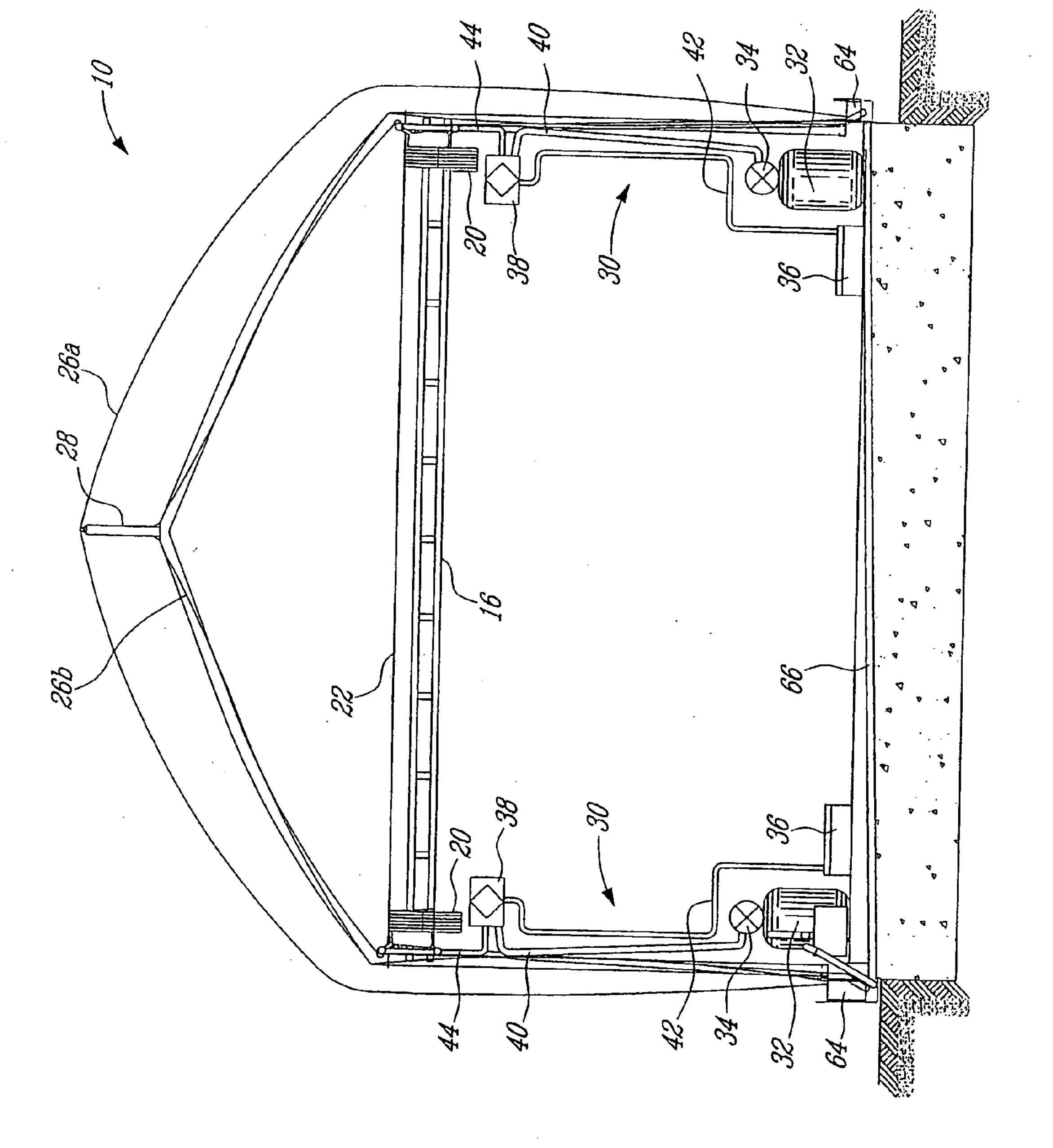


Fig-3

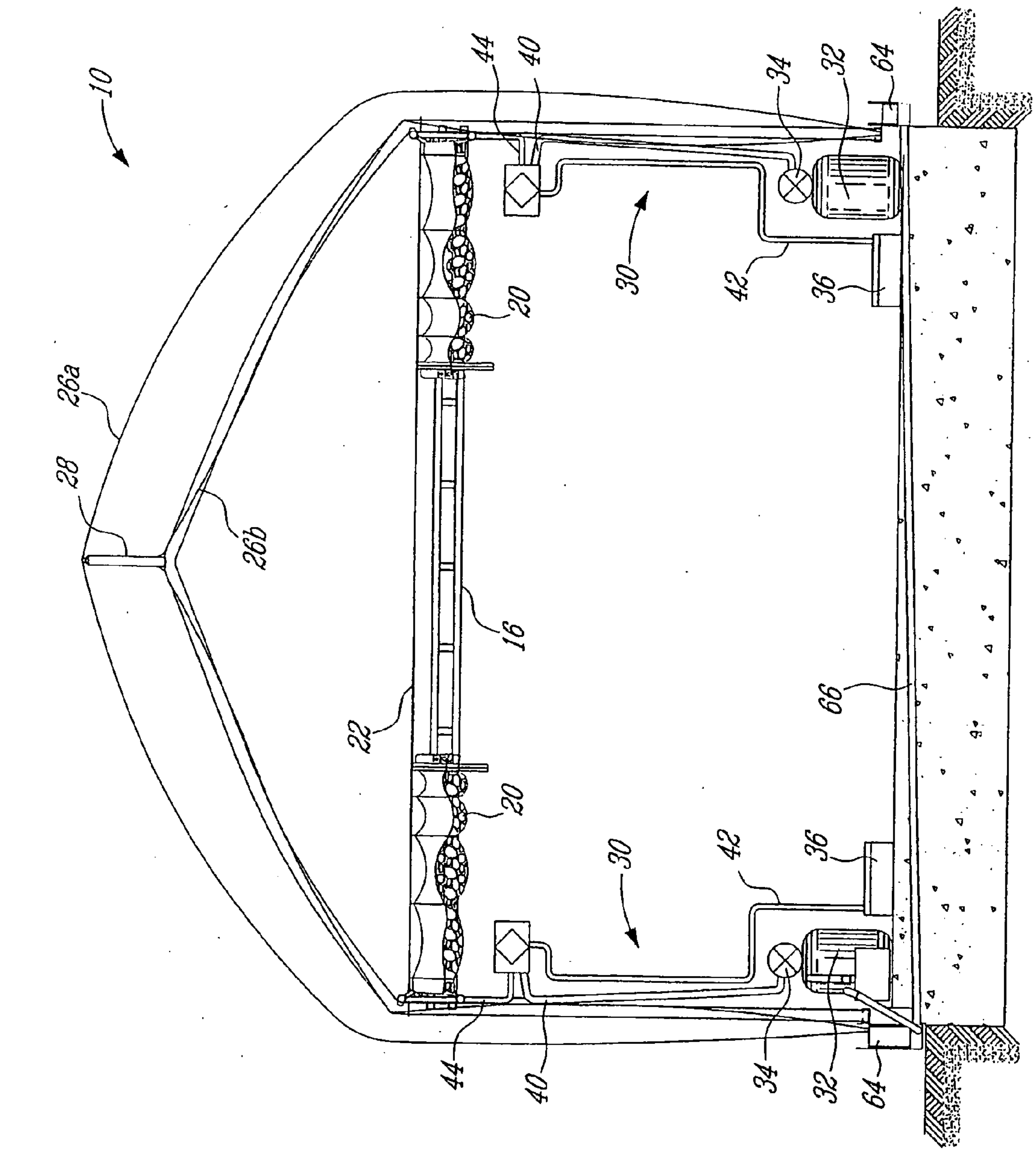

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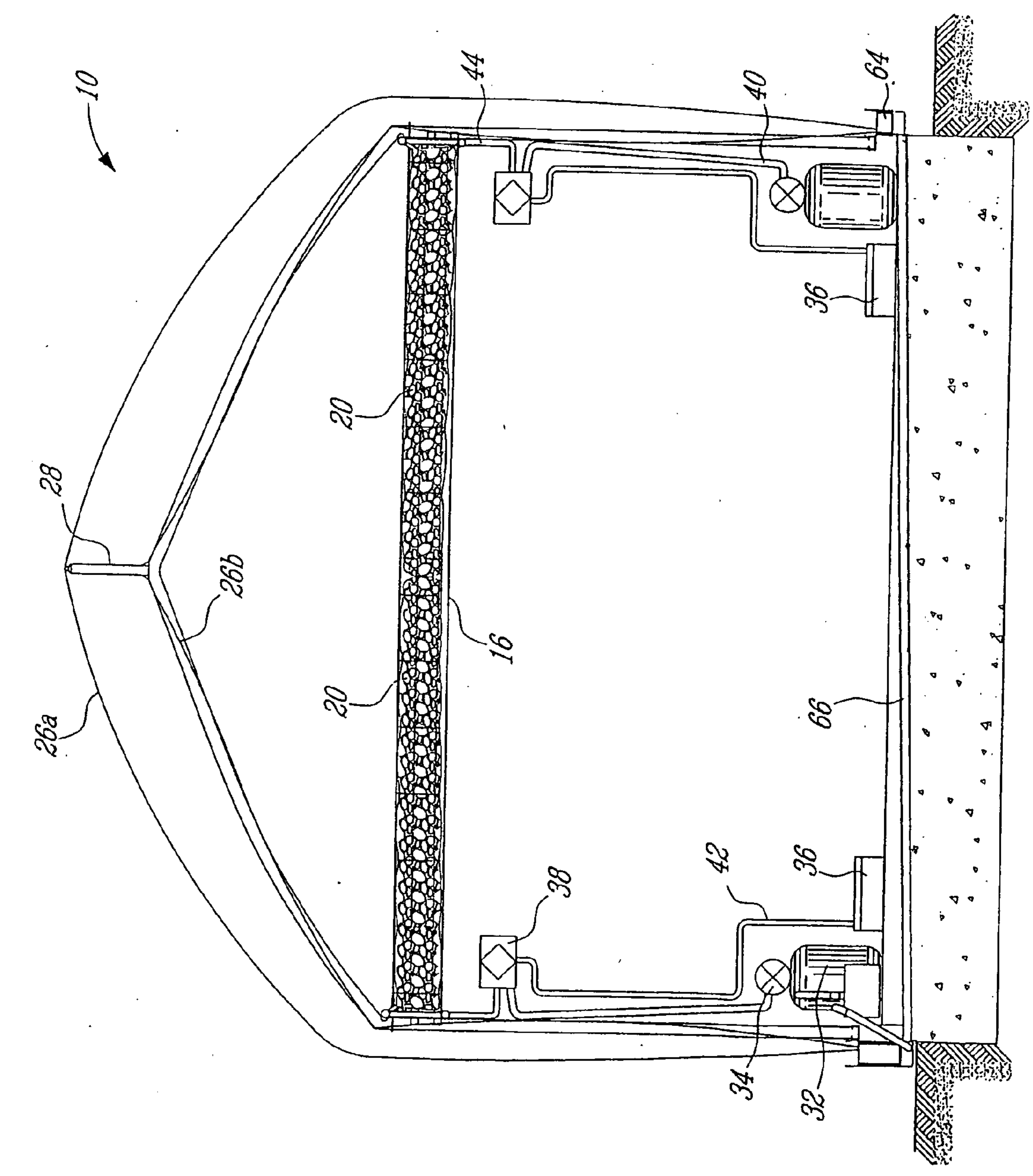
Fig-4



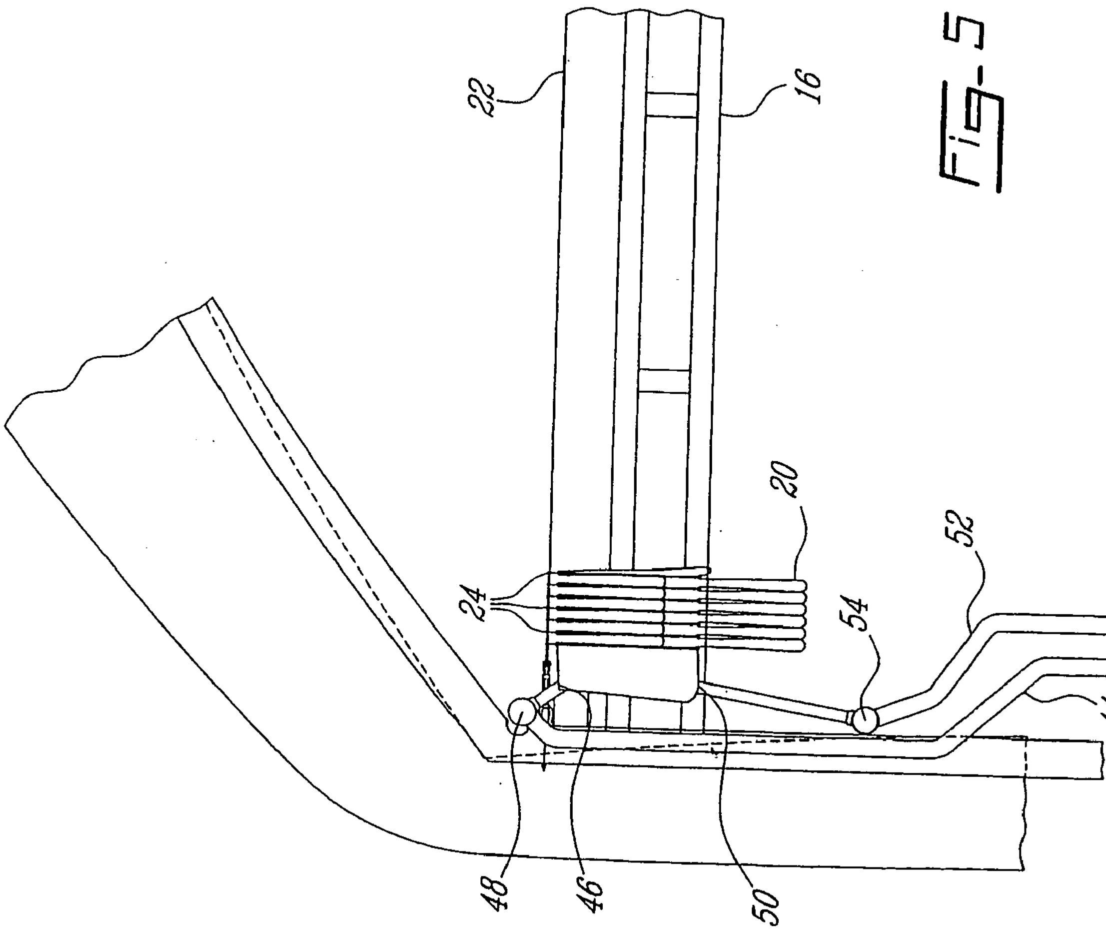
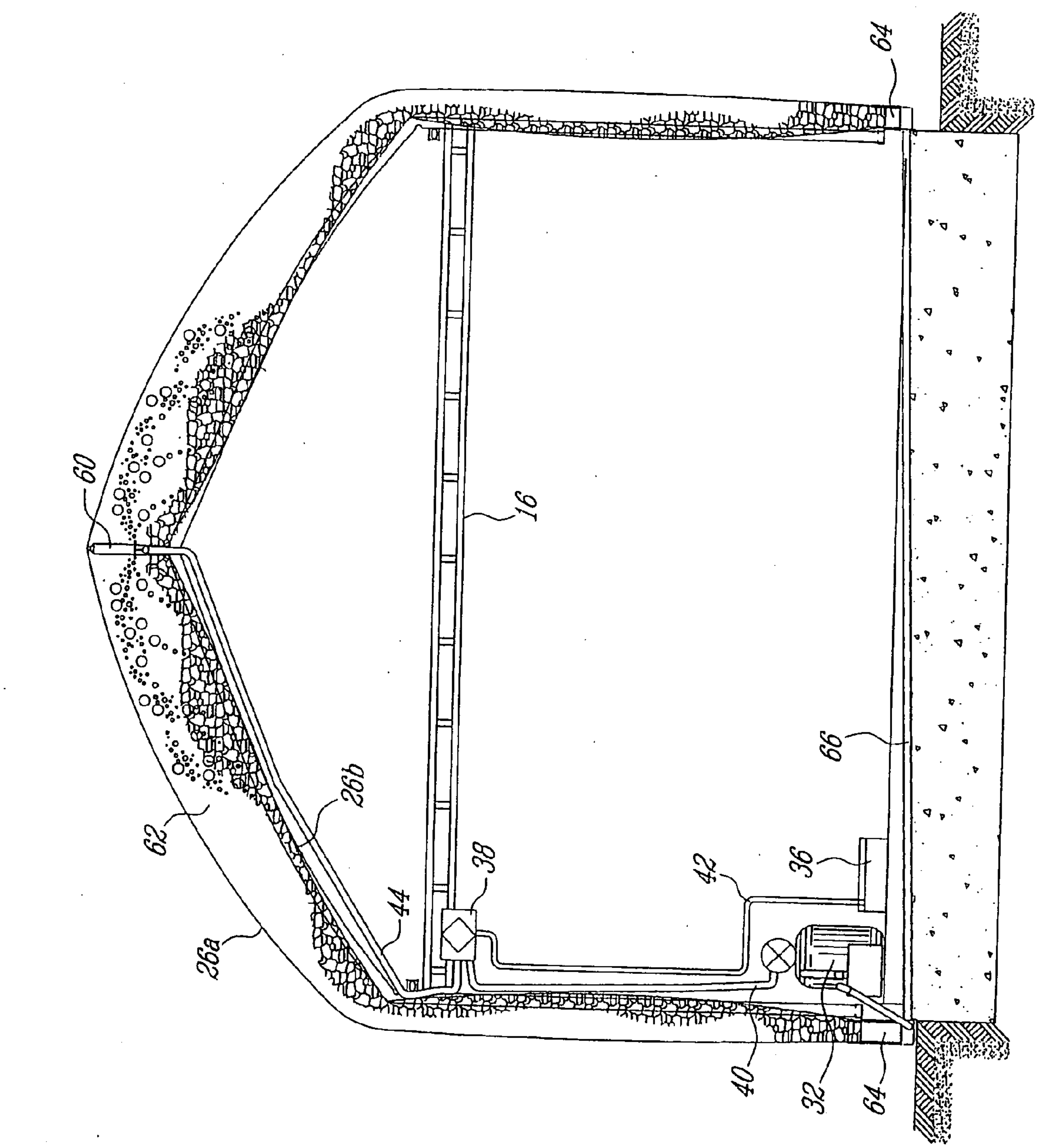


Fig-5

Fig-6



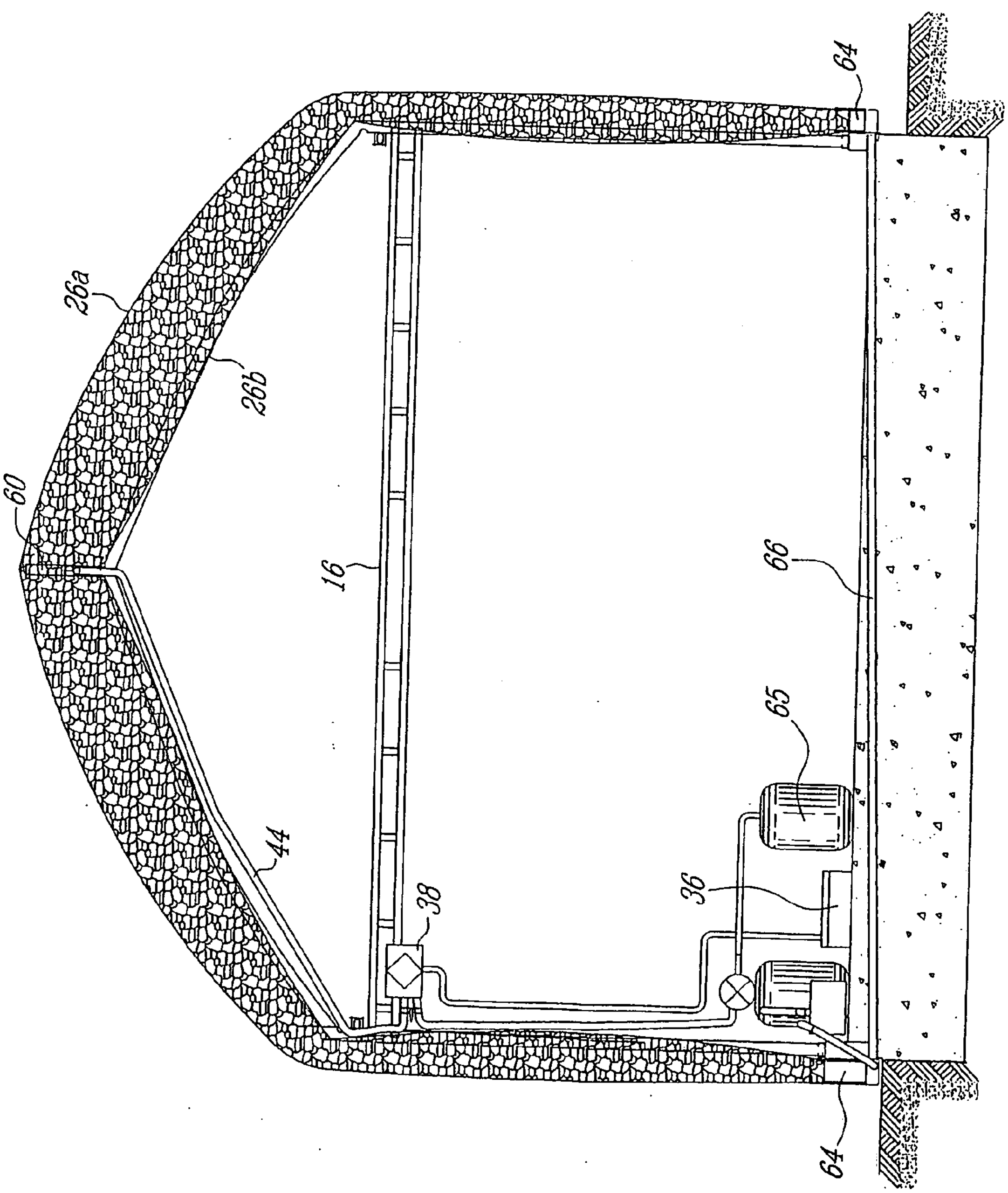


Fig-7

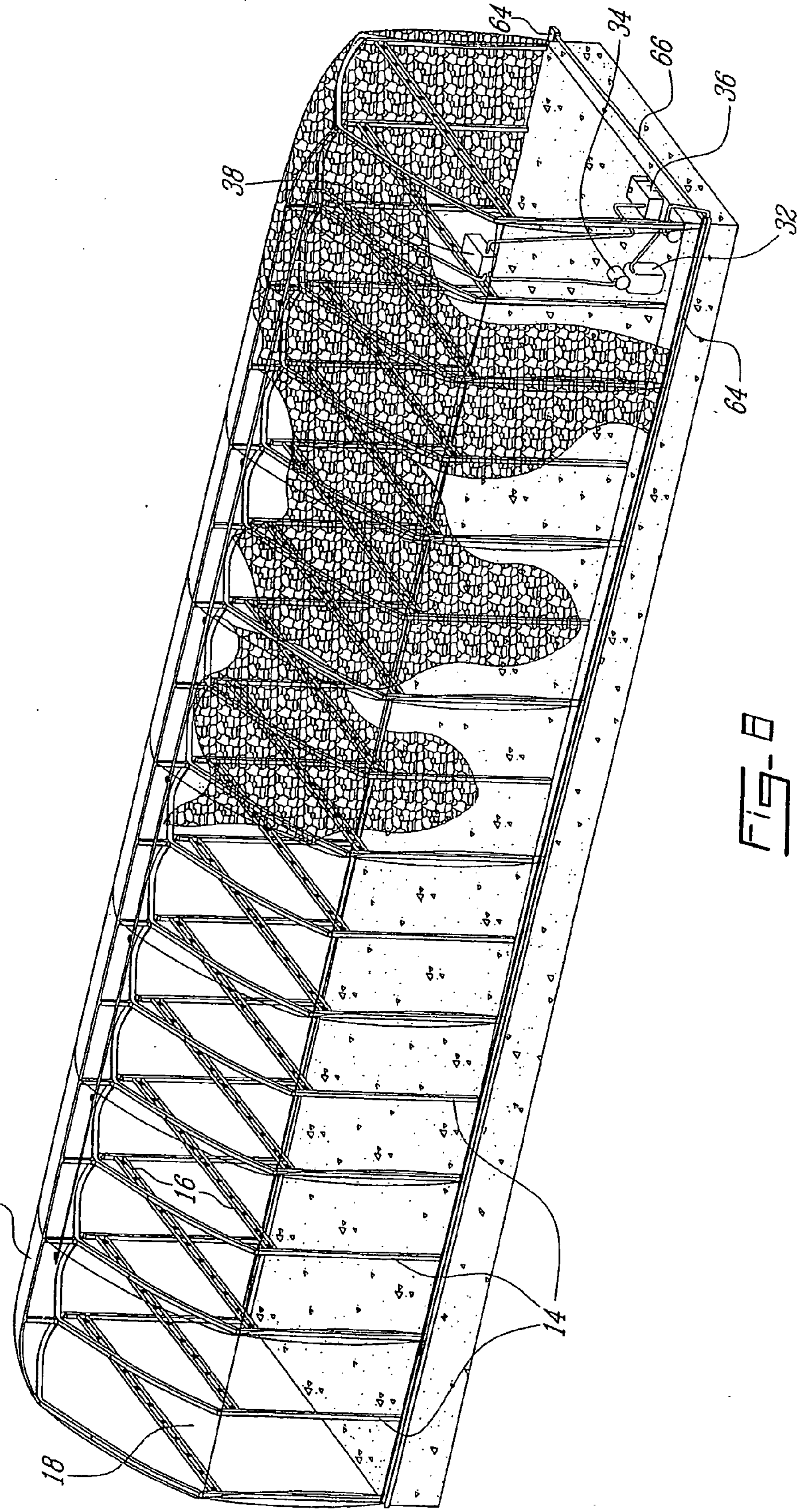
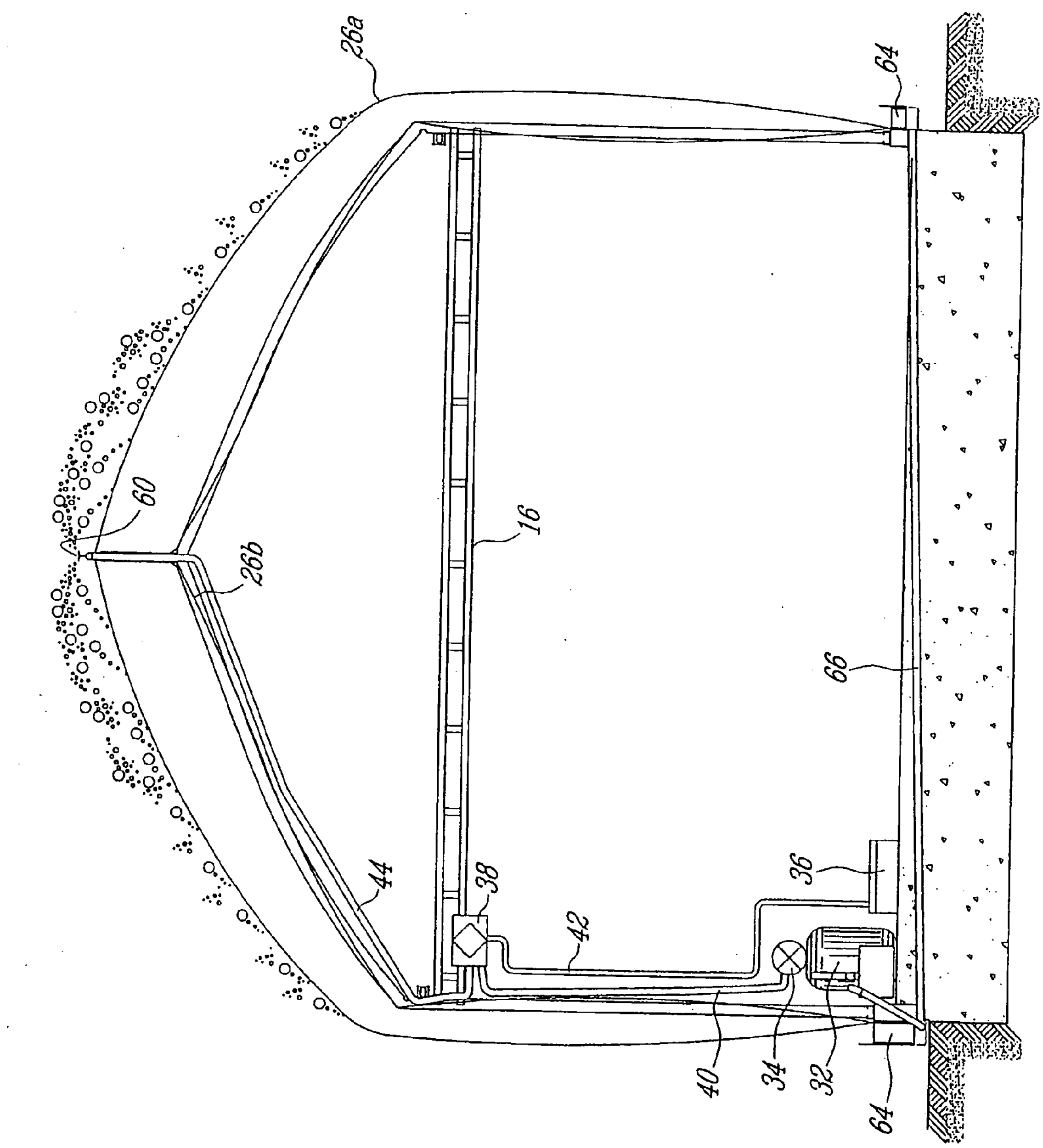


Fig-8

Fig-9



DYNAMIC FOAM INSULATION/SHADING SYSTEM WITH INFLATABLE BAGS

RELATED APPLICATION(S)

[0001] This application is a continuation of International Patent Application No. PCT/CA2004/001083 filed on Jul. 23, 2004, which claims benefit of U.S. Provisional Patent Application No. 60/489,116 filed on Jul. 23, 2003, which are herein incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention generally relates to a system and a method for periodically insulating and/or shading a building structure, such as a greenhouse, an atrium or any structure or part thereof having glass or plastic roofs, walls of fixed or flexible materials.

[0004] 2. Description of the Prior Art

[0005] Building structures having cavities formed between double light transmitting roof or wall membranes for receiving degradable or replaceable foam insulation are known. The roof and wall cavities can be periodically filled with degradable foam to provide shading or thermal insulation. However, when it is desired to let the light pass through the building envelope in order to take advantage of the solar energy, the foam can be readily dissolved and removed from the cavities. Examples of such buildings can be found in U.S. Pat. No. 3,672,184 and No. 4,562,674. One problem with such buildings is the difficulty to fit the foam generating system into a roof structure without causing major changes to the roof of the building. Also, it impedes the light transmission or the ventilation through the roof. Indeed, to date, no system allows providing foam only to certain sections of the roof, while leaving other roof cavities empty. The roof surface has to be completely covered with the foam with no possibility of allowing light to pass through a given section of the roof. Furthermore, with the prior art foam insulation systems, it is not possible to open the roof for allowing natural ventilation. The roof has to be of a permanent nature. When the insulation system is not being used, the day light still has to pass through double skin membranes to penetrate the building envelope. This reduces the intensity of the light penetrating the building envelope.

SUMMARY OF THE INVENTION

[0006] It is therefore an aim of the present invention to provide a new replaceable insulation/shading foam system which includes a dynamic insulation foam container that can be retracted to a storage position when not being used.

[0007] It is also an aim of the present invention to simplify and increase the flexibility of installation of a dynamic liquid foam insulation/shading system in a building structure.

[0008] It is a further aim of the present invention to minimize the cost involved in the installation of a dynamic liquid foam insulation/shading system in a building structure.

[0009] Therefore, in accordance with the present invention, there is provided an insulation/shading system for a building structure, comprising a dynamic fluid foam generator, a plurality of inflatable/deflatable containers adapted to be mounted to the building structure, each of said plurality of containers having an inlet connected to said dynamic fluid foam generator for allowing filling of the flexible containers with a dynamic fluid insulation foam and an outlet for draining the liquid resulting from the degradation of the insulation foam, said containers being movable between an expanded operational position in which the containers are filled with said dynamic fluid insulation foam and a retracted storage position in which the dynamic fluid insulation foam has been substantially emptied from the containers.

[0010] In accordance with a further embodiment of the present invention, there is provided a method for periodically insulating/shading a building structure comprising the steps of: a) mounting a plurality of inflatable/deflatable bags to the building structure, b) generating a degradable fluid insulation foam, and c) deploying the bags from a retracted state to an expanded state and filling the bags with the degradable fluid foam.

[0011] In accordance with a still further general feature of the present invention, there is provided a system for periodically thermally shielding/shading a building structure with a degradable fluid foam for insulation and shading, the system comprising a foam generator adapted to produce the degradable fluid foam, a distribution pipe connected to an outlet of the foam generator for receiving the foam, and a number of sprinklers connected to the distribution pipe for spray-applying the foam on the building structure exterior or interior.

[0012] In accordance with a still further general aspect of the present invention, there is provided a system for periodically insulating/shading a transparent building structure, comprising a number of sprinklers spraying liquid foam onto a membrane adapted to be mounted to the building structure, and a foam return line for recuperating the liquid which result from the degradation of the foam over time.

[0013] Another feature of the present invention involves a containerization of the foam system that will be readily mounted to the building structure by using a series of expandable/retractable bags. The bags can be filled with liquid foam or vacuumed to a tight package when not in use. The use of extendable/retractable bags in a dynamic fluid foam insulation system allows reducing the whole attachment system to the existing structure with minimal modifications. It also provides for the full control of the application of the dynamic insulation system for new and existing structures. Finally, it permits the modularization of the system for multiple uses.

[0014] Another feature of the present invention is directed to a system for washing the exterior of a greenhouse, comprising a number of sprinklers distributed along a distribution line connected to a source of washing fluid, the sprinklers extending outwardly of the greenhouse for spray-applying a washing fluid on the exterior of the greenhouse.

[0015] In accordance with another general feature of the present invention, there is provided a method of periodically producing a sound insulation, comprising the steps of: providing a source of foaming solution consisting essentially of a surfactant and water, providing a source of pressurized air, and mixing the foaming solution with the pressurized air to generate dynamic liquid foam.

[0016] The present invention is further generally characterized by the combined use of a delivery system of the liquid foam using air pressure to enlarge the flexible containers (e.g. the inflatable/deflatable bags) and enhance the foam insulation quality and the use of a vacuum system to collapse the foam and reduce the flexible container to a tight small volume in order not to impede light transmission when the system is not being used.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Having thus generally described the nature of the invention, reference will now be made to the accompanying drawings, showing by way of illustration a preferred embodiment thereof, and in which:

[0018] **FIG. 1** is a perspective view of a greenhouse equipped with liquid foam filled deployable and retractable bags in accordance with a preferred embodiment of the present invention;

[0019] **FIG. 2** is a front elevation view of the greenhouse illustrating the foam generator which feeds the deployable and retractable bags with high density fluid insulation foam, the bags being shown in a retracted position;

[0020] **FIG. 3** is a front elevation view of the greenhouse illustrating the bags in a partially deployed position;

[0021] **FIG. 4** is a front elevation view of the greenhouse illustrating the bags in a fully deployed position;

[0022] **FIG. 5** is an enlarged front view of a portion of the greenhouse illustrating the details of the liquid foam supply and return circuits of one the bags;

[0023] **FIG. 6** is a front elevation view of the greenhouse illustrating the wall and roof cavities of the greenhouse in the process of being filled up with liquid foam sprayed through a series of sprinklers connected to the foam distribution line of a mixing chamber in which a foaming solution is mixed with pressurized air in order to produce foam in accordance with a second embodiment of the present invention;

[0024] **FIG. 7** is a front elevation view of the greenhouse illustrating the roof and wall cavities filled with the foam produced in the mixing chamber; and

[0025] **FIG. 8** is a perspective view of the greenhouse shown with the wall and roof cavities thereof partly filled up with liquid foam sprayed by the sprinkler of the foam distribution line.

[0026] **FIG. 9** is a front elevation view of the greenhouse with sprinklers extending out of the greenhouse roof structure to spray-apply a layer of foam on the outer surface of the structural membrane covering the greenhouse skeletal framework.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] As will be seen hereinafter, the present invention is generally directed to a flexible or permanent insulation foam container system designed to provide for modular insulation of solar structures of many different types. The example shown in the Figures is applied to a hoop style greenhouse. However, it is understood that the present invention could also be installed in variable connected gutter systems as well as other types of greenhouses or building structures, such as residential, commercial or industrial buildings. The object is to provide a method and a system for effectively insulating roof or wall by sections or completely with containers, such as flexible bags, that are transparent or translucent or non transparent. This is accomplished by bringing dynamic fluid insulation foam to selected sections of the building structure so as to insulate or shade these sections.

[0028] Now referring to **FIG. 1**, there is shown a hoop style greenhouse **10** having a conventional skeletal framework **12** including among others a number of vertical supporting columns **14** and transversal horizontal trusses **16**. Each pair of adjacent transversal trusses **16** defines a bay **18**. In accordance with the present invention, inflatable/deflatable bags **20** are selectively deployable in the bays **18**. In the illustrated embodiment, there is provided two series of bags **20**, one on each side of the greenhouse **10** (see FIGS. **1** to **4**). Each bay **18** thus contains two opposed facing bags **20** adapted to be deployed to bring the opposed facing distal ends thereof in contact with each other so as to completely close the bay **18**. In **FIG. 1**, some of the bags **20** on the right side of the building **10** are deployed while all the bags **20** on the left side are retracted. The bags **20** are deployable in a transversal direction with respect to the greenhouse **10**, i.e. in a direction parallel to horizontal trusses **16**. Similar bags could also be provided between adjacent pairs of vertical columns **14** for deployment along a vertical direction.

[0029] Each bag **20** is supported by at least one cable **22** (**FIG. 2**) that stretches from one side of the structure to the other, thereby allowing the bag **20** to slide along the cable by eye rings **24** (**FIG. 5**) or other attachments. There may be more than one cable **22** per side of the bag **20**. Each cable **22** may have attachment on either side of the bag **20**, the center of the bag **20**, and on top and bottom thereof. This would depend on the size of the bag **20** and the weight of the material. The bags **20** are generally 10 feet long by 5 feet wide but this may vary to as small as 1 foot width and, depending on the circumstances they may be anywhere from 4 inches deep to 15 inches deep or more, depending on the need, the location, the climatic conditions and other dictates of the location and the style of the structure.

[0030] As best shown in FIGS. **2** to **4**, the greenhouse **10** has a double layer covering membrane **26** stretched over the skeletal framework **12**. The covering membrane **26** can be made out of a polyethylene sheet or other materials such as polycarbonate, glass or other forms of plastic to form the skin of the greenhouse **10**. An expansion bar **28** is provided at the top of the structure to maintain a minimum distance between the inner **26***a* and the outer **26***b* layers of the covering membrane **26**. It is not necessary in this application that there be a double layer skin membrane to the building as the operation of the insulation foam bags **20** is totally independent of the actual roof system of the greenhouse **10**. However, if such a double layer covering membrane is already in place on the framework **12** of the greenhouse **10**, the liquid foam insulation system of the present invention can be easily installed to work within the existing structural design. It is noted that in some climatic regions, the bags **20** could also be arranged to combine together and form the roof system of the greenhouse **10** in place of the covering membrane **26**.

[0031] As shown in FIGS. **2** to **4**, each series of bags **20** is connected to a foam generator **30** generally comprising a surfactant reservoir **32**, a pump **34**, an air blower **36** and a mixing chamber **38**. The reservoir **32** contains a foaming solution consisting essentially of a surfactant and water. The foaming solution can be provided in the form of a concentrated solution derived from a hydrolyzed protein concentrate base, such as used in the fire fighting foam art. The foaming solution is pumped into the mixing chamber **38** by the pump **34** via a supply line **40**. While the foaming solution is being pumped in to the mixing chamber **38**, the air blower **36** is operated to inject pressurized air into the mixing chamber **38** via an air injection line **42**. The surfactant solution is injected at a pressure between 30 psi to 80 psi while the air is injected at pressures varying from about 10 psi to about 100 psi. As opposed to conventional foam generators where a soap solution is sprayed onto a screen by a fan at the entry of the wall and roof cavities, the above-described foam generator provides for the production of a high density liquid with very fine bubbles from a central location upstream of the bags **20**. This provides better insulation properties and thus permits to reduce the size of the containers receiving the foam.

[0032] The liquid foam being produced in the mixing chamber **38** is supplied under air pressure to the bags **20** via a distribution pipe **44**, which acts as a secondary mixing chamber. That is to say that while the foam is traveling along the distribution pipe **44**, the foaming process continues. The distribution pipe **44** is at least 10 feet long and has a diameter of about 1 inch or greater.

[0033] As shown in **FIG. 5**, each bag **20** has an inlet **46** at a top end thereof for receiving the foam from the distribution pipe **44**. A valve **48** is preferably provided at the inlet **46** of each bag **20** for allowing the bags **20** to be individually and separately filled with foam. In this way, bags of a same series can be deployed while others can remain retracted as shown in **FIG. 1**. Each bag **20** is further provided at a bottom end thereof with an outlet **50** connected to a return line **52** to permit drainage of the liquid resulting from the degradation of the foam in the bags **20**. A valve **54** is preferably provided at the outlet **50** of each bag **20** to allow for pressure differentiation between the inlet and the outlet thereof. Once the bags **20** have been filled, the valves **54** remain open to allow for continuous draining of excess fluid from the liquid foam, to be returned to the reservoir via the return line **52**. The inlet valves **48** and the outlet valves **54** are controlled individually for each of the bag connections so as to modulate the flow of material in and out.

[0034] The selectively openable bag inlets **46** and bag outlets **50** provide for the enlargement of the bags **20** by air pressure or by foam pressure while allowing liquid emanating from the liquid foam during the insulation process or at the end of the foam cycle to be drained off by gravity or by using a vacuum. Either the cables **22** or the bags **20** may be designed at an angle of slope so as to maintain a constant drainage slope towards the bag outlets **50**.

[0035] **FIG. 2** shows the bags **20** in a folded state. The bags **20** are retracted on the sides of the building, thereby allowing light to enter into the building envelope through the roof structure thereof.

[0036] **FIG. 3** shows the bags **20** in the process of being deployed. At this stage, the bags **20** are only partially filled with liquid foam. The inlet valves of the bags **20** to be deployed are opened and the foam generators **30** are operated to direct a completed foam product at the inlets **46** of the bags **20** via the distribution pipes **44**. The bags **20** are gradually filled with the foam, thereby causing the deployment thereof from their storage position shown in **FIG. 2**. The outlet valves **54** can be periodically opened during the bag filling process to allow air to be pushed out of the bags **20** by the foam and also to permit liquid to drain off the bags **20**.

[0037] **FIG. 4** shows the bags **20** fully expanded to a point where they touch and interact with the corresponding bags **20** coming from the other side. The bags **20** extend along the transversal trusses **16** so as to fill in the bays **18** with a soft attachment of the bag material touching on the aluminum or steel bracing. Once the bag filling process has been completed, the inlet valves **48** are closed.

[0038] The bags **20** may be slid by hand, air pressure or foam pressure and returned to their storage position (**FIG. 2**) folded by mechanical means, hand or vacuum pressure. The emptying operation could, for instance, be achieved by using a typical roller device which can roll up the material and empty it of any contents at the same time.

[0039] The bags **20** may have a further attachment to rinse them periodically with a sprinkler (not shown) on the inside of each bag. Also it is noted that sectional bags could be fixed within the roof section of the building and provided with a number of openings for allowing for foam insertion by pressure, exhaust outlets for excess air and separate outlets to vacuum the deteriorating foam back to the reservoir.

[0040] The liquid foam filled expandable and collapsible bags are advantageous in that they can form both the roof section and exterior side wall of the building. They can also be installed within roof membranes, glass or plastic, or walls. Moreover, as described hereinbefore, the bags **20** are retractable on demand so that they are completely removed to the greatest extent, i.e. about 98%, from the natural light penetration through the exterior wall or through the open or covered roof.

[0041] An additional benefit of the present system is that the bags **20** can be selectively individually expanded to cover selected building sections to be shaded or insulated, at will, on a timed or manual basis. The bags **20** can be made of transparent materials or colored materials for the benefit of certain crops and growing patterns. Varying the thickness of liquid foam insulation is applicable when shading, cooling or insulating. Alternatively, the foam itself could be colored. By varying the density of the coloring of the foam, the foam can have different effects on the plants in the greenhouse.

[0042] One further benefit of the system is that by using the dynamic liquid foam, it is possible to chill the insulation inside the expanded bags **20** and create condensation on the lower surface thereof which can then be collected as a method of dehumidification within the building structure. A heat exchanger (not shown) can be coupled to the surfactant reservoir **32** to cool or heat the surfactant solution depending if it is, desired to cool or heat the interior space of the building structure.

[0043] In addition of thermally shielding and shading the building, the dynamic liquid foam can also be used as a new method of providing sound insulation. For sound insulation purposes, the foam can be generated and delivered to the wall and roof cavities as per the way described hereinbefore in connection with thermal insulation and shading applications.

[0044] According to a further aspect of the present invention, the above-described foam generator **30** is coupled to a series of sprinklers **60** distributed along the distal end portion of the distribution line **44** to spray-apply a fine density fluid insulation foam into the roof or wall cavities **62** defined between the inner and outer layer of the covering membrane **26** (FIGS. **6** to **8**) or, alternatively, onto the exterior of the covering membrane **26** of the building structure (**FIG. 9**).

[0045] As shown in FIGS. **6** to **8**, the sprinklers **60** can be advantageously positioned in the roof cavities **62** to spray a uniform layer of foam between the layers **26***a* and **26***b*. The use of the sprinklers **60** is advantageous in that the density of foam is more uniformly distributed in the cavities **62** and it allows varying the density or the thickness of the layer foam that is being applied. **FIGS. 6 and 8** show the cavities **62** in the process of being filled with the dynamic insulation foam. In **FIG. 7**, the filling operation has been completed. The liquid resulting from the degradation of the foam in the cavities **62** is directed by gravity into gutters **64** mounted along the sides of the building at the bottom of the wall cavities **62**. It is understood that the gutters **64** could also be mounted at the top of the building structure. A return pipe **66** is provided for allowing the liquid collected into the gutters **64** to be redirected back into the surfactant reservoir **32**. The sprinklers could also extend below the truss structure for spray applying a layer of foam on a retractable drape or membrane mounted to trusses **16**. The trusses **16** would have sprinklers on the interior of the solar structure spraying on the flat drape that is horizontally stretched between trusses **16**, except for a moderate slope to one end on the interior.

[0046] According to the embodiment shown in **FIG. 9**, the sprinklers **60** extend outwardly above the roof structure of the greenhouse **10** for spray-applying a layer of insulation foam on the outer surface of the covering membrane **26**. A by-pass could be provided for selectively connecting the distribution line **44** to a washing liquid reservoir **65** (**FIG. 7**) in order to spray a washing liquid on the covering membrane **26** or between the layers **26***a* and **26***b* thereof via the sprinklers **60**.

[0047] The use of such a sprinkler system with a surfactant solution of 1% to 5% surfactant concentration can advantageously be used as a shading system in a given solar structure. The benefit of using this liquid foam, in various degrees of generated foam, is that it enables the operator to shade the sunlight and create a better dispersion of sunrays within the solar structure.

[0048] Generation of the liquid foam can be handled by two methods: one using a foam generator, which creates the normal liquid foam, or using a sprinkler system with a surfactant based solution spraying a light foam on the desired surface. This combination will result in a lower level of shading than the standard liquid foam. The result of using the liquid foam, in these various densities and foam placement methods, enables the user to vary the quality of foam and the intensity of shading delivered. In so doing, the operator, in different climates and different sunlight conditions, can reduce the Photosynthetically Active Radiation (PAR) and the direct sunlight effects on the interior space. This will have the following results:

[0049] Direct sunlight energy, at peak hours, can be reduced from 1,000 W/m^2 to approximately 800 w/m^2, or lower, when required. The coating of liquid foam absorbs and reflects a portion of the infrared waves, thus reducing the solar radiation penetrating the structure.

[0050] PAR can be reduced from 1000 nm to 600 nm, or lower, when required. The coating of liquid foam filters a portion of the visible light allowing only the amount of desired light to penetrate.

[0051] The above description is meant to be exemplary only, and one skilled in the art will recognize that changes may be made to the embodiments described without department from the scope of the invention disclosed.

1. An insulation/shading system for a building structure, comprising a dynamic fluid foam generator, a plurality of inflatable/deflatable containers adapted to be mounted to the building structure, each of said plurality of inflatable/deflatable containers having an inlet connected to said dynamic fluid foam generator for allowing filling of the containers with a dynamic fluid insulation foam and an outlet for draining the liquid resulting from the degradation of the insulation foam, said inflatable/deflatable containers being movable between an expanded operational position in which the containers are filled with said dynamic fluid insulation foam and a retracted storage position in which the dynamic fluid insulation foam has been substantially emptied from the containers, and wherein the dynamic fluid foam generator is located outside the inflatable/deflatable containers, the foaming process being initiated externally of the inflatable/deflatable containers by the foam generator.

2. The insulation/shading system as defined in claim 1, wherein at least some of said containers are individually deployable.

3. The insulation/shading system as defined in claim 1, wherein first and second valves are respectively provided at said inlet and said outlet of at least some of said containers.

4. The insulation/shading system as defined in claim 1, wherein each of said plurality of containers defines a drainage slope to direct the liquid resulting from the degradation of the insulation foam to the outlet of the container.

5. The insulation/shading system as defined in claim 1, wherein a source of vacuum is connected to the outlets of the containers to collapse the containers and empty the containers from the content thereof.

6. The insulation/shading system as defined in claim 1, wherein said containers are retractable along at least one side of the building structure.

7. The insulation/shading system as defined in claim 1, wherein said containers are slidable along a guiding system spanning the building structure.

8. The insulation/shading system as defined in claim 1, wherein the containers are mounted via slides to cables stretched across the building structure.

9. The insulation/shading system as defined in claim 1, wherein said fluid foam generator comprises a reservoir containing a foaming solution, a pump for pumping the foaming solution into a mixing chamber where the foaming solution is mixed with pressurized air, and a secondary mixing chamber along which the foaming process continues before the foam be directed into the containers.

10. The insulation/shading system as defined in claim 9, wherein an air blower is provided to discharge pressurized air into the mixing chamber as the foaming solution is being injected therein.

11. A method for periodically insulating/shading a building structure comprising the steps of: a) mounting a plurality of inflatable/deflatable bags to the building structure, b) generating degradable fluid foam outside of said inflatable/deflatable bags, and c) deploying the bags from a retracted state to an expanded state and filling the bags with the pre-formed degradable fluid foam.

12. The method as defined in claim 11, wherein step b) comprises the step of creating a high density liquid foam by injecting pressurized air in a fluid containing a foaming agent and water.

13. The method as defined in claim 12, wherein the high density liquid foam is obtained by separately injecting pressurized air and a surfactant in a mixing chamber.

14. The method as defined in claim 11, comprising the step of using air pressure to carry the fluid foam from a mixing chamber to the bags via a piping network.

15. The method as defined in claim 11, wherein each bag has a selectively closable inlet, and wherein step c) comprises the steps of: selecting a section of the building to be insulated, and opening the inlets of the bags located in this section.

16. A system for periodically thermally shielding/shading a building structure with a degradable fluid foam for insulation and shading, the system comprising a foam generator adapted to produce the degradable fluid foam, a distribution pipe connected to an outlet of the foam generator for receiving the foam, and a number of sprinklers connected to the distribution pipe for spray-applying the foam on the building structure interior or exterior.

17. The system as defined in claim 16, wherein the foam generator comprises a reservoir containing a surfactant solution, a pump for pumping the surfactant solution from the reservoir into a mixing chamber, and an air blower for injecting pressurized air into said mixing chamber while the surfactant solution is being pumped therein in order to produce the degradable fluid foam.

18. The system as defined in claim 16, further comprising foam containers provided on the building structure for receiving the foam from the sprinklers.

19. The system as defined in claim 18, wherein said foam containers are provided in the form of wall or roof cavities defined between first and second structural membranes mounted to building structure.

20. The system as defined in claim 16, wherein said sprinklers extend outwardly of said building structure for spray-applying a layer of foam on the exterior of the building structure.

21. A system for periodically insulating/shading a transparent building structure, comprising a number of sprinklers spraying liquid foam onto a membrane adapted to be mounted to the building structure, and a foam return line for recuperating the liquid which result from the degradation of the foam over time.

22. The system as defined in claim 21, wherein the sprinklers are mounted along a distribution line connected to a source of liquid foam.

23. The system as defined in claim 22, wherein said source of liquid foam comprises a mixing chamber in which pressurized air and a surfactant solution are separately injected.

24. A system for washing the exterior of a greenhouse, comprising a number of sprinklers distributed along a distribution line connected to a source of washing fluid, the sprinklers extending outwardly of the greenhouse for spray-applying a washing fluid on the exterior of the greenhouse.

25. A method of producing a sound insulation, comprising the steps of: providing a source of foaming solution consisting essentially of a surfactant and water, providing a source of pressurized air, and mixing the foaming solution with the pressurized air to generate dynamic liquid foam.

* * * * *