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(54) **METHOD AND APPARATUS FOR EXTRACTING MOISTURE AND/OR MOLD FROM A STRUCTURE OF A BUILDING**

VERFAHREN UND V0RRICHTUNG ZUM ENTFERNEN VON FEUCHTIGKEIT UND/ODER SCHIMMEL AUS EINER GEBÄUDEKONSTRUKTION

PROCEDE ET APPAREIL PERMETTANT D'EXTRAIRE L'HUMIDITE ET/OU LA MOISISSURE DE LA STRUCTURE D'UN BATIMENT

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Description

[0001] The present invention relates to a procedure and an apparatus for removing moisture and/or mould from a structure in a building.

[0002] Buildings damaged by the effects of moisture and mould are difficult to repair. For successful reparation, it is necessary that the structure affected by moisture be thoroughly dried. When a wood, stone or other structure, such as a concrete slab or wall structure gets wet, this will also quickly induce a growth of mould fungi. In conjunction with repairs, any mycocelial filaments in the structure must also be completely eliminated.

[0003] In prior art, several methods for drying of structures and elimination of mould are known. In a prior-art procedure, hot air is blown at the structure to be dried or into a space containing the structure. In addition, drying can also be accelerated by circulating the drying air in the space surrounding the structure to be dried. Another prior-art method for the drying of a structure is to use a fixed heating element so connected to the structure to be dried that the structure becomes warm and moisture is evaporated from it as effectively as possible. However, a problem with this method is a relatively long drying time, which further protracts the total repair time of the water damage, thus significantly increasing the costs. A further problem especially in the case of thick objects is that, with prior-art methods, the surface of the structure is heated to a relatively high temperature while the portions deeper inside the structure remain damp. This is because moisture tends to drift towards colder parts, so the hot outer surface of the structure constitutes a barrier to the drying of its deeper portions.

[0004] Yet another prior-art method for drying a structure is to apply microwave radiation to the object to be dried. However, microwave radiation is detrimental to health. When a drier using microwave radiation is used e.g. in an apartment, even the apartment below must be evacuated and also the space being dried must be continuously watched to keep outsiders away.

[0005] The object of the present invention is to eliminate the drawbacks described above. A specific object of the invention is to present a new type of procedure that allows faster drying of structures than is possible by earlier methods and which makes it possible to effectively combine the use of a heating element and air cooling for the drying of structures after water damage and for the elimination of mould.

[0006] A further object of the invention is to present a new apparatus for fast and economical drying of damp structures.

[0007] The procedure of the invention is presented in claim 1. The apparatus of the invention for implementing the procedure is presented in claim 15.

[0008] According to the invention, using infrared radiation generated by an infrared radiator, the structure is heated through its essential thickness to a raised temperature that is sufficient to remove moisture and possible mould, and the surface of the structure is cooled by continuous air flushing, wherein the air flow uniformely flushes the surface of the structure to be dried over the whole area under the infrared radiator, so that the surface temperature of the structure becomes lower than the inside temperature raised by heating, with the result that the moisture in the warm structure drifts towards the cooler surface and is removed from the surface by the air flushing. Thus, a temperature gradient is created in the structure. The moisture can evaporate from the surface and the mould and spores can be eliminated.

[0009] The duration of the first heating phase is of the order of a few hours and the duration of the subsequent cooling phase with no infrared radiation applied to the structure is substantially longer and may be even many times as long as the duration of the heating phase. To maintain a sufficient interior temperature, very short heating periods may be additionally used during the cooling phase. The essential point in the invention is the use of infrared radiation penetrating deep into the structure and the maintenance of a sufficient inside temperature as well as a somewhat lower surface temperature. Moisture is always removed from inside the structure towards a surface at a lower temperature. The cooler surface can be formed by applying air cooling to that surface of the structure towards which the moisture is to be removed.

[0010] The invention has the advantage that the procedure of the invention allows a significant reduction of the time consumed for the drying of structures. Infrared radiation penetrates deep into the structure to be dried, yet without heating the air near the surface because the radiation needs no medium, allowing simultaneous cooling of the surface by air flushing. Moisture can be removed to a desired direction. A further advantage of the invention is that the structure is very effectively dried throughout its thickness. Moreover, the procedure of the invention is not detrimental to health and therefore does not involve any extra health risk to persons working with the apparatus or to outsiders.

[0011] In an embodiment of the procedure, during the heating phase the structure is heated using infrared radiation with a wavelength in the near-infrared range. The wavelength is preferably larger than or equal to 900 nm. Such radiation has a particularly good ability to penetrate into concrete structures.

[0012] In an embodiment of the procedure, the infrared radiation is interrupted periodically and the surface is cooled continuously or periodically. The infrared radiation is preferably interrupted periodically so that the ratio of active radiation time to interrupted time is about 2:4.

[0013] In an embodiment of the procedure, the structure is heated to a temperature between 35 - 110°C, and the surface of the structure is cooled by an air flow so that the surface temperature is 3 - 8°C lower than the inside temperature. In view of mould elimination, the temperatures are so selected that the mould filaments and spores are destroyed. It is known that the growth of mould stops and most of the active filaments are destroyed when the temperature is 55 - 60°C. Spores can be destroyed at a temperature of 80 - 100 °C. The filaments of most decay fungi die at temperatures between 35 - 80°C.

[0014] In an embodiment of the procedure, the part of the structure to be dried is isolated from the environment so that a negative pressure can be created around it and air is drawn by suction from that area to create a continuous air flow flushing the surface of the structure to remove moisture as well as possible mould. A slight negative pressure continuously maintained creates a suction that effectively removes any moisture drifting to the surface as well as organic residue and spores. The exhaust air is preferably passed out of the building via a filter into the atmosphere.

[0015] In an embodiment of the procedure, air is blown at the surface of the structure to cool it. After the mould filaments and spores have been removed from the structure by suction, the cooling of the surface of the structure can be enhanced by subjecting the surface to a blast of cold atmospheric air. The air thus blasted is dehumidified using special filters so that the relative humidity of the air is about 10 - 12 %.

[0016] In the procedure, during the heating phase the structure is heated using an infrared radiation heater. The wavelength of the thermal radiation emitted by the infrared heater is appropriate for creating a heat that penetrates deep into the structure.

[0017] In an embodiment of the procedure, the heating, air suction and/or air blasting are activated and interrupted in accordance with a predetermined precept.

[0018] In an embodiment of the procedure, the temperature of the structure being dried, its humidity and/or other corresponding quantities essential to moisture and mould removal are monitored and, based on this monitoring, the heating and air blasting/suction are regulated. Moreover, the flow rate, temperature and humidity of the air being blown and/or sucked can be monitored. Based on measured quantities, reports can be printed out. A report may contain essential information regarding the progress of moisture and mould removal, such as temperature of the structure, air humidity, air temperature, process duration and/or other quantities to be defined.

[0019] According to the invention, in the apparatus for implementing the procedure of the invention, the heating element is a planar infrared radiator provided with a central through opening; and the apparatus comprises a controller arranged to control the operation of the heating element and the means for creating an air flow inside the casing in accordance with a predetermined precept. In its simplest form, the controller is e.g. a timer which switches electric power to the heating element on and off. The central opening in the infrared radiator is of essential importance to uniform cooling of the surface of the structure. Without a central opening in the radiator, cooling air will not flow to the central part of the planar infrared radiator, so the structure in the central part will be overheated. For instance, when a concrete slab with a thermal insulation of cellular plastic (Styrox) under it is being dried, the heat will easily burn through the insulation in the central area of the IR radiator if the surface cooling of the concrete slab is not functioning in that area.

[0020] In an embodiment of the apparatus, the wavelength of the infrared radiation emitted by the infrared radiator is in the near-infrared range.

[0021] In an embodiment of the apparatus, the wavelength of the infrared radiation emitted by the infrared radiator is longer than or equal to 900 nm, preferably about 900 - 3000 nm.

[0022] In an embodiment of the apparatus, the controller has been arranged to interrupt the infrared radiation periodically and to control a fan so as to make it work continuously or periodically.

[0023] In an embodiment of the apparatus, the controller has been arranged to interrupt the infrared radiation periodically so that the ratio of active radiation time to interrupted time is about 2:4.

[0024] In an embodiment of the apparatus, the means for creating a negative and/or positive pressure comprise an air duct opening to the inside of the casing and a fan disposed in the air duct to create suction and/or blowing.

[0025] In an embodiment of the apparatus, the apparatus comprises a first humidity sensor disposed inside the casing near the structure to be dried for the determination of humidity in the vicinity of the structure and for supplying the controller with a signal corresponding to the humidity.

[0026] In an embodiment of the apparatus, the apparatus comprises a second humidity sensor, which is disposed in the air duct for determining the humidity of the air flowing in it and for supplying the controller with a signal corresponding to the humidity.

[0027] In an embodiment of the apparatus, the apparatus comprises a first temperature sensor, which is disposed inside the casing in the vicinity of the structure to be dried for determining the temperature near the structure and supplying the controller with a signal corresponding to that temperature.

[0028] In an embodiment of the apparatus, the apparatus comprises a second temperature sensor, which is disposed in the air duct for determining the temperature of the drying air flowing in it and supplying the controller with a signal corresponding to that temperature.

[0029] Using the apparatus of the invention, it is also possible to implement a drying system that could be used e.g. in conjunction with the reparation of major water damage. The system can be implemented e.g. by connecting a necessary number of drying apparatus as provided by the invention to a common central control unit, which may be a computer or equivalent. In this case, the number of apparatus needed could be determined e.g. by the number of rooms or equivalent. Further, a computer in the system could collect humidity, temperature and flow data from the control means of each apparatus, analyse the data and control the temperature and flow rate in each apparatus individually, taking the overall situation regarding drying of the object into account. Moreover, the system may comprise an output device connected to the computer to allow the printing of reports relating to the drying, temperatures and humidity in different parts of the object, etc. Thus it is also possible to use different drying programmes found to be effective for different objects by simply providing the computer with a new programme.

[0030] In the following, the invention will be described by referring to the attached drawing, in which

Fig. 1 presents an embodiment of the apparatus of the invention in lateral longitudinal cross-section,
Fig. 2 presents another embodiment of the apparatus of the invention in perspective view,
Fig. 3 presents section III-III of Fig. 2,
Fig. 4 presents the infrared radiation of the apparatus in Fig. 2 as seen from below, and
Fig. 5 presents a section through an example structure dried using the procedure and apparatus of the invention.

[0031] Fig. 1 illustrates the principle of an apparatus for removing moisture and mould from a structure, such as a floor, wall or equivalent. In this figure, the apparatus is placed on a wet concrete bottom slab B having a thickness of e.g. 70 mm. Under the concrete slab there is an insulating layer with a plastic foil under it and sand under the foil. The apparatus comprises a casing 1, which is a box with one side open and which is used to isolate an area of the structure to be dried from the environment so that a negative pressure can be created in that area. The open side of the casing box 1 is placed against the structure to be dried. Mounted in the hollow space inside the casing 1 is an infrared heater panel 2, which emits heating radiation to the structure to be dried. The apparatus is provided with means 3, 4 for creating a negative and/or positive pressure inside the casing 1 to produce an air flow inside the casing. The casing 1 can be so set against the structure that a slight negative pressure can be generated inside the casing. Between the edge of the casing 1 and the surface of the structure B there is a narrow gap 10 about 5 - 15 mm wide, through which cool air can flow into the casing during suction so that this air flow continuously flushes the surface of the structure to be dried. Furthermore, the apparatus comprises a controller 5, which has been arranged to control the operation of the heater element 2 and the means 3 for creating an air flow inside the casing in accordance with a predetermined precept. The means for creating a negative and/or positive pressure consist of an air duct 3 which opens inside the casing, and a fan 4 disposed in the air duct 3 to produce suction and/or blowing.

[0032] Using the procedure of the invention, a 70 mm thick wet concrete slab as shown in Fig. 1 can be dried in 3 - 7 days. The structure is subjected to periodic infrared radiation from an IR radiation heater 2 by first heating the structure continuously for a given period so that it reaches a temperature of 60 - 75°C. At the same time, the surface of the structure is cooled by a continuous or periodic weak suction air flow, which is produced by means of the fan 4, whose suction side is connected to the air duct. After the inside temperature of the structure has risen to a suitable level sufficient for removing moisture and possible mould, the heating is interrupted for a substantially long period of time while suction is carried on to draw air from inside the casing, i.e. a negative pressure is maintained throughout this cooling phase. In this way, the temperature of the cooled surface of the structure becomes somewhat lower, e.g. about 3 - 8 °C lower than the temperature inside the structure raised by heating. Therefore, the moisture in the warm structure tends to drift towards the cooler surface, from where it effectively evaporates into the suction air due to the slight negative pressure. After the structure has been dried, its temperature can be raised for a short period of time to 100 - 110 °C to eliminate mould and spores from the surface of the structure and from the structure itself. After the elimination of mould and mould spores, the cooling of the surface can be further enhanced by blowing dry air at the surface of the structure.

[0033] By means of the controller 5, the suction and/or blowing of air is activated and interrupted in accordance with a predetermined precept provided in the controller 5.

[0034] The apparatus additionally comprises a first humidity sensor 6 disposed in the space inside the casing 1 near the structure to be dried to determine the moisture content in the vicinity of the structure and to give a signal corresponding to the humidity to the controller 5. A second humidity sensor 7 is placed in the air duct 3 to determine the moisture content of the air flowing in it and to give a signal corresponding to the moisture content to the controller 5. A first temperature sensor 8 is disposed in the space inside the casing near the structure to be dried to determine the temperature in the vicinity of the structure and to give a signal corresponding to that temperature to the controller 5. A second temperature sensor 9 is disposed in the air duct 3 to determine the temperature of the drying air flowing in it and to give a signal corresponding to this temperature to the controller 5. By means of the sensors, the temperature of the structure being dried, the humidity and/or other corresponding quantities essential in respect of removal of moisture and mould are monitored, and, based on this monitoring, the heating and suction/blowing of air are controlled. Other quantities that may be monitored are the flow rate, temperature and moisture content of the air being blown and/or sucked. The results can be printed out as a report giving essential information about the progress of the moisture and mould removal process, such as the temperature of the structure, air humidity, air temperature, process duration and/or other quantities to be determined.

[0035] Fig. 2 shows a perspective view of an apparatus corresponding to the one in Fig. 1. It can be seen from the figure that the casing 1 is a box-like case with four side walls 12 and a top wall 13, inside which an infrared radiator 2 as illustrated by Fig. 4 is suspended. The casing 1 in the example has a length of 1250 mm, a width of 650 mm and a height of 80 mm. As is shown in the sectioned view in Fig. 3, the casing has screwed legs 14 supporting it on a base, so that the gap 10 between the side walls 12 and the base can be adjusted as desired by turning the legs. As is further visible from the sectioned view in Fig. 3, the top wall 13 has in the middle of it a collared hole 15 forming an air duct. Mounted over the hole 15 is an aggregate consisting of a fan mechanism 4 and a controller 5, comprising a fan motor, a fault current protector and timers for the infrared radiator and the fan motor. The hole in the top wall 13 is aligned with the central hole 11 in the infrared radiator 2 shown in Fig. 3 and 4.

[0036] Fig. 4 shows a through hole 11 in the infrared radiator panel 2, which ensures that the air flow will uniformly flush the surface of the structure to be dried over the whole area under the infrared radiator 2. The resistance wire pattern 16 has been adapted to the hole 11. The length of resistance wire on the panel is about 100 metres. The IR radiator has been fitted to emit infrared radiation at a given wavelength. In a preferred case, infrared radiation in the near-infrared range is used, which has a good ability to penetrate into wet structures. The wavelength may be e.g. about 1000 nm.

[0037] In the examples in Fig. 1 and 3, the moisture is mainly removed via that surface which is cooled by air flushing and from whose direction the heating is applied. In the example in Fig. 3, the structure to be dried consists of a 70 mm thick concrete slab, with a 70 mm expanded polystyrene insulation under the slab and sand under the insulation. Such a structure could be dried in 5 weeks (35 days) by an air drying technique or in 0.5 weeks by using infrared radiation. By the method of the invention, a structure like this was dried in 3.5 days from an initial relative humidity value of 93% to a final humidity value of 60%. During infrared heating, the top surface of the concrete slab is at temperature a few degrees higher than the temperature inside the structure. When IR heating is switched off and air cooling is continuously active, the temperature of the top surface of the concrete slab becomes considerably lower than the temperature inside the structure. The difference may be as large as 50°C. Heating and cooling periods are repeated until the structure is dry.

[0038] Fig. 5 shows an example of another type of structure, which was dried by the method of the invention. Topmost in the structure is a concrete surface slab 17, under which there is a layer of expanded polystyrene 18 at the edges under the exterior walls. Under the insulation there is a 0.5 m thick layer of sand filling 19. Under the sand filling 19 there is a lower counter-slab 20, below which there was a bomb shelter space. The structure to be dried is at ground surface level. The sand filling 19 was very wet, with a relative humidity as high as about 95%, because water had been left in the sand filling during construction. The surface slab 17 had a relative humidity of about 80 -90%. In this case, no microwave radiator could be used because the bomb shelter 21 was in continuous use as a storage room for a pharmacopoeia for a hospital building. Instead, the structure was heated with an infrared radiator from the top side of the surface slab 17, but with the difference from the previous examples that in this case the cooling was performed using air blasting from the top side instead of suction. In addition, a negative pressure was generated in the bomb shelter space 21 below the structure. In this way, the moisture was driven downward and removed via holes in the counter-slab. The amount of water removed from the structure was 15 tons and the final humidity achieved was 60%, which means that the structure was completely dried.

Claims

1. Procedure for removing moisture and/or mould from a structure in a building, e.g. from a floor, wall or equivalent, in which procedure air is circulated in the vicinity of the structure to be dried and/or the structure is heated by applying periodic heating and cooling phases to it, wherein, using infrared radiation generated by an infrared radiator, the structure is heated through its essential thickness to a raised temperature that is sufficient for removing moisture and possible mould, and the surface of the structure is cooled via air flushing, wherein the air flow flushes the surface of the structure to be dried over the whole area under the infrared radiator, so that the surface temperature of the structure becomes lower than its inside temperature raised by heating, with the result that the moisture in the warm structure tends to drift towards the cooler surface and is removed from the surface by the air flushing.

2. Procedure as defined in claim 1, **characterised in that** during the heating phase the structure is heated using infrared radiation with a wavelength in the near-infrared range.

3. Procedure as defined in claim 1 or 2, **characterised in that** the wavelength of the infrared radiator is 900nm or more.

4. Procedure as defined in any one of claims 1-3, **characterised in that** the infrared radiation is interrupted periodically and the surface is cooled continuously or periodically.

5. Procedure as defined in any one of claims 1-4, **characterised in that** the infrared radiation is interrupted periodically so that the ratio of active radiation time to interrupted time is about 2:4.

6. Procedure as defined in any one of claims 1-5, **char-**

acterised in that the structure is heated to a temperature between 35-110°C.

7. Procedure as defined in any one of claims 1-6, **characterised in that** the surface of the structure is cooled by an air flow so that the surface temperature is 3-8°C lower than the inside temperature.

8. Procedure as defined in any one of claims 1-4, **characterised in that** the structural part to be dried is isolated from the environment so that a negative pressure can be created **in that** area, and air is continuously drawn by suction from said area to create an air flow flushing the surface of the structure and to remove moisture as well as possible mould.

9. Procedure as defined in any one of claims 1-8, **characterised in that** dry air is blown at the surface of the structure.

10. Procedure as defined in any one of claims 1-9, **characterised in that** the heating, air suction and/or air blasting are activated and interrupted in accordance with a predetermined precept.

11. Procedure as defined in any one of claims 1-10, **characterised in that** the air to be blasted is dehumidified.

12. Procedure as defined in any one of claims 1-11, **characterised in that** the temperature, humidity and/or other corresponding quantities essential to moisture and mould removal are monitored and, based on this monitoring, the heating and air blasting/suction are regulated.

13. Procedure as defined in any one of claims 1-12, **characterised in that** the flow rate, temperature and moisture content of the air being blasted and/or sucked are monitored.

14. Procedure as defined in any one of claims 1-13, **characterised in that** a report containing essential information regarding the progress of moisture and mould removal, such as temperature of the structure, air humidity, air temperature, process duration and/or other quantities to be defined, is printed out.

15. Apparatus for implementing a procedure as defined in any one of claims 1-14 for the removal of moisture and/or mould from a structure, such as a floor, wall or equivalent, said apparatus comprising a box-like casing (1), which is open on one side to be placed against the structure to be dried, and a heating element (2) mounted in the space inside the casing, and means (3, 4) for generating a negative and/or positive pressure to create an air flow inside the casing, wherein the heater element (2) is a planar infrared radiator provided with a central through opening (11) for air flushing the surface of the structure; and that the apparatus comprises a controller (5) arranged to control the operation of the heating element (2) and the means (3) for creating an air flow inside the casing in accordance with a predetermined precept, such that, in use, the structure is heated through its essential thickness to a raised temperature that is sufficient for removing moisture and possible mould, and the surface of the structure is cooled via air flushing so that the surface temperature of the structure becomes lower than its inside temperature raised by heating.

16. Apparatus as defined in claim 15, **characterised in that** the means for generating a negative and/or positive pressure comprise an air duct (3) that opens inside the casing, and a fan (4) for producing suction and/or blast in the air duct.

17. Apparatus as defined in claim 15 or 16, **characterised in that** the wavelength of the infrared radiation emitted by the infrared radiator (2) is in the near-infrared range.

18. Apparatus as defined in any one of claims 15-17, **characterised in that** the wavelength of the infrared radiation emitted by the infrared radiator (2) is 900nm or more.

19. Apparatus as defined in any one of claims 15-18, **characterised in that** the controller (5) has been arranged to interrupt the infrared radiation periodically and to control the fan (4) so as to make it work continuously or periodically.

20. Apparatus as defined in any one of claims 15-19, **characterised in that** the controller (5) has been arranged to interrupt the infrared radiation periodically so that the ratio of active radiation time to interrupted time is about 2:4.

21. Apparatus as defined in any one of claims 15-20, **characterised in that** the controller (5) has been arranged to control one or more apparatus.

22. Apparatus as defined in any one of claims 15-21, **characterised in that** it comprises a first humidity sensor (6), which is disposed inside the casing (1) near the structure to be dried to determine the moisture content in the vicinity of the structure and to supply the controller (5) with a signal corresponding to the moisture content.

23. Apparatus as defined in any one of claims 15-22, **characterised in that** it comprises a second humidity sensor (7), which is disposed in the air duct (3) to determine the moisture content of the air flowing in

it and to supply the controller (5) with a signal corresponding to the moisture content.

24. Apparatus as defined in any one of claims 15-23, **characterised in that** it comprises a first temperature sensor (8), which is disposed inside the casing in the vicinity of the structure to be dried to determine the temperature near the structure and to supply the controller (5) with a signal corresponding to that temperature.

25. Apparatus as defined in any one of claims 15-24, **characterised in that** it comprises a second temperature sensor (9), which is disposed in the air duct (3) to determine the temperature of the drying air flowing in it and to supply the controller (5) with a signal corresponding to that temperature.

Patentansprüche

1. Verfahren zum Entfernen von Feuchtigkeit und/oder Schimmel aus einer Struktur in einem Gebäude, beispielsweise einem Boden, einer Wand oder dem Äquivalent dazu, wobei bei dem Verfahren Luft in der Nähe der zu trocknenden Struktur umgewälzt wird und/oder die Struktur erwärmt wird, indem sie periodischen Erwärmungsund Abkühlphasen unterzogen wird, wobei die Struktur unter Verwendung von Infrarot-Strahlung die von einem Infrarot-Strahler generiert wird im Wesentlichen über ihre Dicke auf eine erhöhte Temperatur erwärmt wird, die ausreicht, um Feuchtigkeit und möglichen Schimmel zu entfemen, und die Oberfläche der Struktur über Luftspülung abgekühlt wird wobei der Luftstrom die Oberfläche der zu trocknenden Struktur über die ganze Fläche unter dem Infrarot-Strahler spült, so dass die Oberflächentemperatur der Struktur niedriger ist als ihre durch Erwärmen erhöhte Innentemperatur, wodurch die Feuchtigkeit in der warmen Struktur dazu neigt, zu der kühleren Oberfläche zu wandern, und an der Oberfläche durch das Luftspülen entfernt wird.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** während der Erwärmungsphase die Struktur unter Verwendung von Infrarot-Strahlung mit einer Wellenlänge im nahen Infrarot-Bereich erwärmt wird.

3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Wellenlänge des Infrarot-Strahlers 900 nm oder mehr beträgt.

4. Verfahren nach einem der Ansprüche 1-3, **dadurch gekennzeichnet, dass** die Infrarot-Strahlung periodisch unterbrochen wird und die Oberfläche kontinuierlich oder periodisch abgekühlt wird.

5. Verfahren nach einem der Ansprüche 1-4, **dadurch gekennzeichnet, dass** die Infrarot-Strahlung periodisch so unterbrochen wird, dass das Verhältnis von aktiver Strahlungszeit zu Unterbrechungszeit ungefähr 2:4 beträgt.

6. Verfahren nach einem der Ansprüche 1-5, **dadurch gekennzeichnet, dass** die Struktur auf eine Temperatur zwischen 35 und 110° erwärmt wird.

7. Verfahren nach einem der Ansprüche 1-6, **dadurch gekennzeichnet, dass** die Oberfläche der Struktur durch einen Luftstrom so abgekühlt wird, dass die Oberflächentemperatur 3 - 8°C unter der Innentemperatur liegt.

8. Verfahren nach einem der Ansprüche 1-4, **dadurch gekennzeichnet, dass** der zu trocknende strukturelle Teil gegenüber der Umgebung isoliert ist, so dass ein Unterdruck in dem Bereich erzeugt werden kann, und Luft kontinuierlich durch Sog aus dem Bereich abgesaugt wird, um eine Luftstromspülung der Oberfläche der Struktur zu erzeugen und Feuchtigkeit sowie möglichen Schimmel zu entfemen.

9. Verfahren nach einem der Ansprüche 1-8, **dadurch gekennzeichnet, dass** trockene Luft auf die Oberfläche der Struktur geblasen wird.

10. Verfahren nach einem der Ansprüche 1-9, **dadurch gekennzeichnet, dass** das Erwärmen, Luftabsaugen und/oder Luftaufblasen entsprechend einer vorgegebenen Regel in Gang gesetzt und unterbrochen werden.

11. Verfahren nach einem der Ansprüche 1-10, **dadurch gekennzeichnet, dass** die aufzublasende Luft entfeuchtet wird.

12. Verfahren nach einem der Ansprüche 1-11, **dadurch gekennzeichnet, dass** die Temperatur, die Feuchtigkeit und/oder andere entsprechende Größen, die für das Entfemen von Feuchtigkeit und Schimmel wichtig sind, überwacht werden und auf der Grundlage dieser Überwachung das Erwärmen und Luftaufblasen/absaugen reguliert werden.

13. Verfahren nach einem der Ansprüche 1-12, **dadurch gekennzeichnet, dass** die Strömungsmenge, die Temperatur und der Feuchtigkeitsgehalt der aufgeblasenen und/oder abgesaugten Luft überwacht werden.

14. Verfahren nach einem der Ansprüche 1-13, **dadurch gekennzeichnet, dass** ein Bericht, der wichtige Informationen bezüglich des Fortschritts des Entfernens von Feuchtigkeit und Schimmel, so beispielsweise bezüglich der Temperatur, der Struktur, der Luftfeuchtigkeit, der Lufttemperatur, der Dauer des Prozesses und/oder anderer zu definierender Größen, enthält, ausgedruckt wird.

15. Vorrichtung zum Ausführen eines Verfahrens, wie es in einem der Ansprüche 1-14 definiert ist, zum Entfernen von Feuchtigkeit und/Schimmel aus einer Struktur, wie beispielsweise einem Boden, einer Wand oder einem Äquivalent dazu, wobei die Vorrichtung ein kastenartiges Gehäuse (1), das an einer Seite, die an der zu trocknenden Struktur angeordnet wird, offen ist, und ein Heizelement (2), das in dem Raum im Inneren des Gehäuses angebracht ist, sowie Einrichtungen (3, 4) zum Schaffen eines Unter- und/oder Überdrucks zum Erzeugen eines Luftstroms im Inneren des Gehäuses umfasst, wobei das Heizelement (2) ein planer Infrarot-Strahler ist, der mit einer mittleren Durchgangsöffnung (11) zum Luftspülen der Oberfläche der Struktur versehen ist, und dass die Vorrichtung eine Steuerung (5) umfasst, die die Funktion des Heizelementes (2) und der Einrichtung (3) zum Erzeugen eines Luftstroms im Inneren des Gehäuses entsprechend einer vorgegebenen Regel so steuert, dass in Funktion die Struktur im Wesentlichen über ihre Dicke auf eine erhöhte Temperatur erwärmt wird, die ausreicht, um Feuchtigkeit und möglichen Schimmel zu entfemen, und die Oberfläche der Struktur über Luftspülung so abgekühlt wird, dass die Oberflächentemperatur der Struktur niedriger ist als ihre durch Erwärmen erhöhte Innentemperatur.

16. Vorrichtung nach Anspruch 15, **dadurch gekennzeichnet, dass** die Einrichtungen zum Schaffen eines Unter- und/oder Überdrucks eine Luftleitung (3), die sich im Inneren des Gehäuses öffnet, und ein Gebläse (4) umfassen, das Sog- und/oder Blaswirkung in der Luftleitung erzeugt.

17. Vorrichtung nach Anspruch 15 oder 16, **dadurch gekennzeichnet, dass** die Wellenlänge der von dem Infrarot-Strahler (2) emittierten Infrarot-Strahlung im nahen Infrarot-Bereich liegt.

18. Vorrichtung nach einem der Ansprüche 15-17, **dadurch gekennzeichnet, dass** die Wellenlänge der von dem Infrarot-Strahler (2) emittierten Infrarot-Strahlung 900 nm oder mehr beträgt.

19. Vorrichtung nach einem der Ansprüche 15-18, **dadurch gekennzeichnet, dass** die Steuerung (5) so ausgeführt ist, dass sie die Infrarot-Strahlung periodisch unterbricht und das Gebläse (4) so steuert, dass es kontinuierlich oder periodisch arbeitet.

20. Vorrichtung nach einem der Ansprüche 15-19, **dadurch gekennzeichnet, dass** die Steuerung (5) so ausgeführt ist, dass sie die Infrarot-Strahlung periodisch so unterbricht, dass das Verhältnis von aktiver Strahlungszeit zu Unterbrechungszeit ungefähr 2:4 beträgt.

21. Vorrichtung nach einem der Ansprüche 15-20, **dadurch gekennzeichnet, dass** die Steuerung (5) so ausgeführt ist, dass sie eine oder mehrere Vorrichtungen steuert.

22. Vorrichtung nach einem der Ansprüche 15-21, **dadurch gekennzeichnet, dass** sie einen ersten Feuchtigkeitssensor (6) umfasst, der im Inneren des Gehäuses (1) nahe an der zu trocknenden Struktur angeordnet ist, um den Feuchtigkeitsgehalt in der Nähe der Struktur zu bestimmen und der Steuerung (5) ein dem Feuchtigkeitsgehalt entsprechendes Signal zuzuführen.

23. Vorrichtung nach einem der Ansprüche 15-22, **dadurch gekennzeichnet, dass** sie einen zweiten Feuchtigkeitssensor (7) umfasst, der in der Luftleitung (3) angeordnet ist, um den Feuchtigkeitsgehalt der in sie hineinströmenden Luft zu bestimmen und der Steuerung (5) ein dem Feuchtigkeitsgehalt entsprechendes Signal zuzuführen.

24. Vorrichtung nach einem der Ansprüche 15-23, **dadurch gekennzeichnet, dass** sie einen ersten Temperatursensor (8) umfasst, der im Inneren des Gehäuses in der Nähe der zu trocknenden Struktur angeordnet ist, um die Temperatur nahe an der Struktur zu bestimmen und der Steuerung (5) ein dieser Temperatur entsprechendes Signal zuzuführen.

25. Vorrichtung nach einem der Ansprüche 15-24, **dadurch gekennzeichnet, dass** sie einen zweiten Temperatursensor (9) umfasst, der in der Luftleitung (3) angeordnet ist, um die Temperatur der darin strömenden Trockenluft zu bestimmen und der Steuerung (5) ein dieser Temperatur entsprechendes Signal zuzuführen.

Revendications

1. Procédé pour éliminer l'humidité et/ou la moisissure d'une structure d'un bâtiment, par exemple d'un plancher, d'un mur ou équivalent, procédé dans lequel de l'air est mis en circulation au voisinage de la structure à sécher, et la structure est chauffée par application de phases de chauffage et de refroidissement, dans lequel, à l'aide d'un rayonnement infrarouge généré par un radiateur à infrarouge, la structure est chauffée sur essentiellement toute son épaisseur à une température élevée qui est suffisante pour éliminer l'humidité et la moisissure éventuelle, et la surface de la structure est refroidie par un flux d'air dans lequel l'écoulement d'air balaye la surface de la structure afin d'être séchée sur toute la zone sous le radiateur à infrarouge de telle sorte que la température de la surface de la structure devienne inférieure à la température interne élevée par chauffage de celle-ci, ce qui a pour résultat que l'humidité dans la structure chaude tend à être entraînée vers la surface plus froide et est éliminée de la surface par le flux d'air.

2. Procédé selon la revendication 1, **caractérisé en ce que**, pendant la phase de chauffage, la structure est chauffée au moyen d'un rayonnement infrarouge ayant une longueur d'onde dans le domaine du proche infrarouge.

3. Procédé selon la revendication 1 ou 2, **caractérisé en ce que** la longueur d'onde du radiateur à infrarouge est de 900 nm ou plus.

4. Procédé selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** le rayonnement infrarouge est interrompu périodiquement et la surface est refroidie en continu ou de manière périodique.

5. Procédé selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** le rayonnement infrarouge est interrompu périodiquement de telle sorte que le rapport de la durée de rayonnement actif sur la durée d'interruption soit d'environ 2 : 4.

6. Procédé selon l'une quelconque des revendications 1 à 5, **caractérisé en ce que** la structure est chauffée jusqu'à une température comprise entre 35°C et 110°C.

7. Procédé selon l'une quelconque des revendications 1 à 6, **caractérisé en ce que** la surface de la structure est refroidie par un écoulement d'air de telle sorte que la température de la surface soit de 3 à 8°C inférieure à la température interne.

8. Procédé selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** la partie de la structure à sécher est isolée de l'environnement de telle sorte qu'une pression négative puisse être créée dans cette zone, et de l'air est prélevé en continu par aspiration à partir de ladite zone afin de créer un écoulement d'air balayant la surface de la structure et d'éliminer l'humidité ainsi que la moisissure éventuelle.

9. Procédé selon l'une quelconque des revendications 1 à 8, **caractérisé en ce que** de l'air sec est soufflé à la surface de la structure.

10. Procédé selon l'une quelconque des revendications 1 à 9, **caractérisé en ce que** le chauffage, l'aspiration d'air et/ou le soufflage d'air sont activés et interrompus selon un précepte prédéterminé.

11. Procédé selon l'une quelconque des revendications 1 à 10, **caractérisé en ce que** l'air à souffler est déshumidifié.

12. Procédé selon l'une quelconque des revendications 1 à 11, **caractérisé en ce que** la température, l'humidité et/ou d'autres quantités correspondantes essentielles à l'élimination de l'humidité et de la moisissure sont surveillées, et le chauffage et le soufflage/aspiration d'air sont régulés en fonction de cette surveillance.

13. Procédé selon l'une quelconque des revendications 1 à 12, **caractérisé en ce que** le débit, la température et la teneur en humidité de l'air qui est soufflé et/ou aspiré sont surveillés.

14. Procédé selon l'une quelconque des revendications 1 à 13, **caractérisé en ce qu'**un rapport contenant les informations essentielles concernant la progression de l'élimination de l'humidité et de la moisissure, telles que la température de la structure, l'humidité de l'air, la température de l'air, la durée du procédé et/ou d'autres quantités à définir, est imprimé.

15. Appareil pour la mise en oeuvre d'un procédé selon l'une quelconque des revendications 1 à 14, pour l'élimination de l'humidité et/ou de la moisissure d'une structure, telle qu'un plancher, un mur ou équivalent, ledit appareil comprenant une enveloppe du type boîte (1) qui est ouverte sur un côté destiné à être placé contre la structure à sécher, et un élément chauffant (2) monté dans l'espace situé à l'intérieur de l'enveloppe, et des moyens (3, 4) pour produire une pression négative et/ou positive afin de créer un écoulement d'air à l'intérieur de l'enveloppe, dans lequel l'élément chauffant (2) est un radiateur à infrarouge plan pourvu d'une ouverture traversante centrale (11) pour que l'air balaye la surface de la structure ; et l'appareil comprend un moyen de commande (5) conçu pour commander le fonctionnement de l'élément chauffant (2) et des moyens (3) pour créer un écoulement d'air à l'intérieur de l'enveloppe selon un précepte prédéterminé, de telle sorte que, en service, la structure soit chauffée sur essentiellement toute son épaisseur à une température élevée qui est suffisante pour éliminer l'humidité et la moisissure éventuelle, et que la surface de la structure soit refroidie par un flux d'air de telle sorte que la température de la surface de la structure devienne inférieure à la température interne élevée par chauffage de celle-ci.

16. Appareil selon la revendication 15, **caractérisé en ce que** les moyens pour produire une pression négative et/ou positive comprennent un conduit d'air (3) qui débouche à l'intérieur de l'enveloppe, et une soufflante (4) pour produire une aspiration et/ou un soufflage dans le conduit d'air.

17. Appareil selon la revendication 15 ou 16, **caractérisé en ce que** la longueur d'onde du rayonnement infrarouge émis par le radiateur infrarouge (2) est dans le domaine du proche infrarouge. .

18. Appareil selon l'une quelconque des revendications 15 à 17, **caractérisé en ce que** la longueur d'onde du rayonnement infrarouge émis par le radiateur infrarouge (2) est de 900 nm ou plus.

19. Appareil selon l'une quelconque des revendications 15 à 18, **caractérisé en ce que** le moyen de commande (5) a été conçu pour interrompre périodiquement le rayonnement infrarouge et pour commander la soufflante (4) de façon à la faire fonctionner en continu ou de manière périodique.

20. Appareil selon l'une quelconque des revendications 15 à 19, **caractérisé en ce que** le moyen de commande (5) a été conçu pour interrompre périodiquement le rayonnement infrarouge de telle sorte que le rapport de la durée de rayonnement actif sur la durée d'interruption soit d'environ 2 : 4.

21. Appareil selon l'une quelconque des revendications 15 à 20, **caractérisé en ce que** le moyen de commande (5) a été conçu pour commander un appareil ou plus.

22. Appareil selon l'une quelconque des revendications 15 à 21, **caractérisé en ce qu'**il comprend un premier capteur d'humidité (6) qui est placé à l'intérieur de l'enveloppe (1), à proximité de la structure à sécher, pour déterminer la teneur en humidité au voisinage de la structure et pour envoyer au moyen de commande (5) un signal correspondant à la teneur en humidité.

23. Appareil selon l'une quelconque des revendications 15 à 22, **caractérisé en ce qu'**il comprend un deuxième capteur d'humidité (7) qui est placé dans le conduit d'air (3) pour déterminer la teneur en humidité de l'air circulant dans celui-ci et pour envoyer au moyen de commande (5) un signal correspondant à la teneur en humidité.

24. Appareil selon l'une quelconque des revendications 15 à 23, **caractérisé en ce qu'**il comprend un premier capteur de température (8) qui est placé à l'intérieur de l'enveloppe, à proximité de la structure à sécher, pour déterminer la température au voisinage de la structure et pour envoyer au moyen de commande (5) un signal correspondant à cette température.

25. Appareil selon l'une quelconque des revendications 15 à 24, **caractérisé en ce qu'**il comprend un deuxième capteur de température (9) qui est placé dans le conduit d'air (3) pour déterminer la température de l'air de séchage circulant dans celui-ci et pour envoyer au moyen de commande (5) un signal correspondant à cette température.

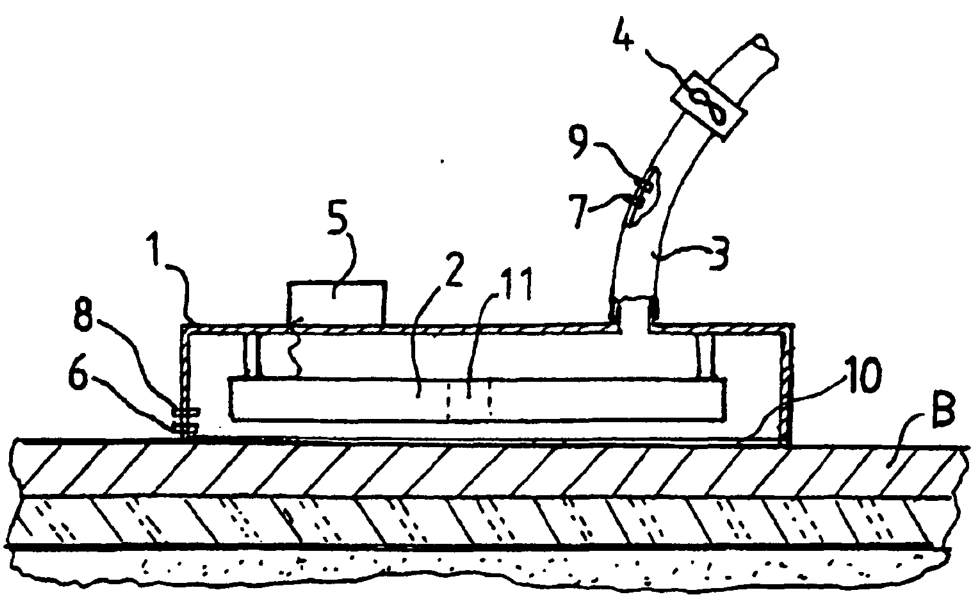

Fig 1

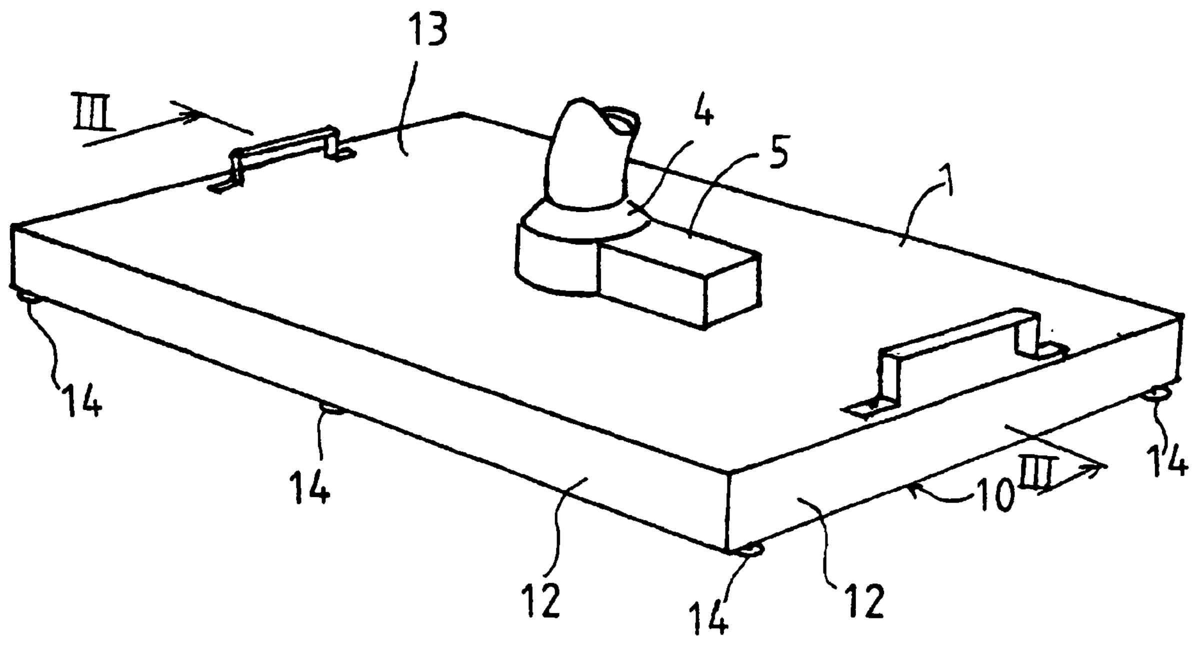

Fig 2

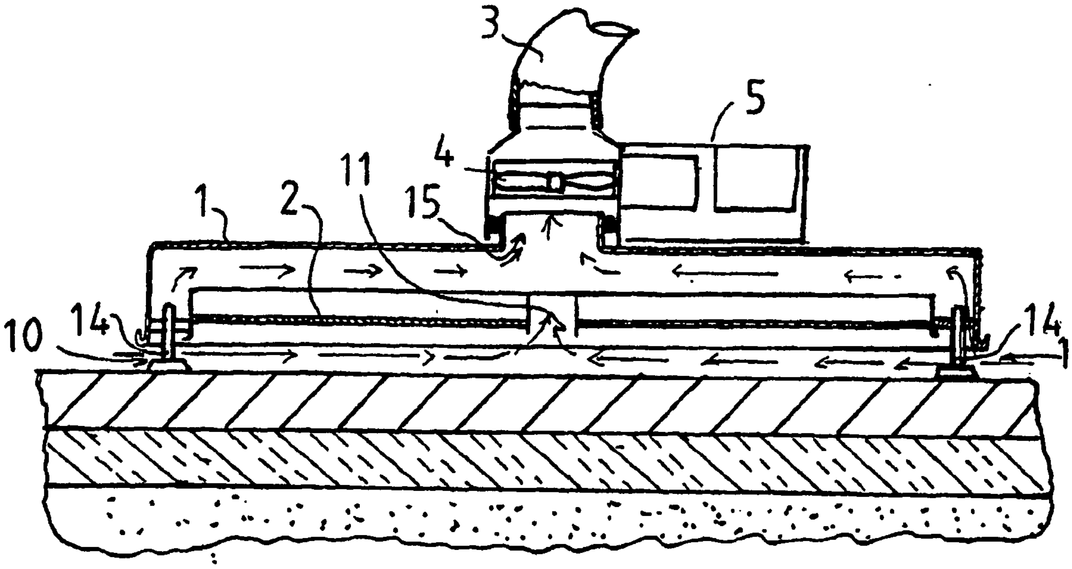

Fig 3

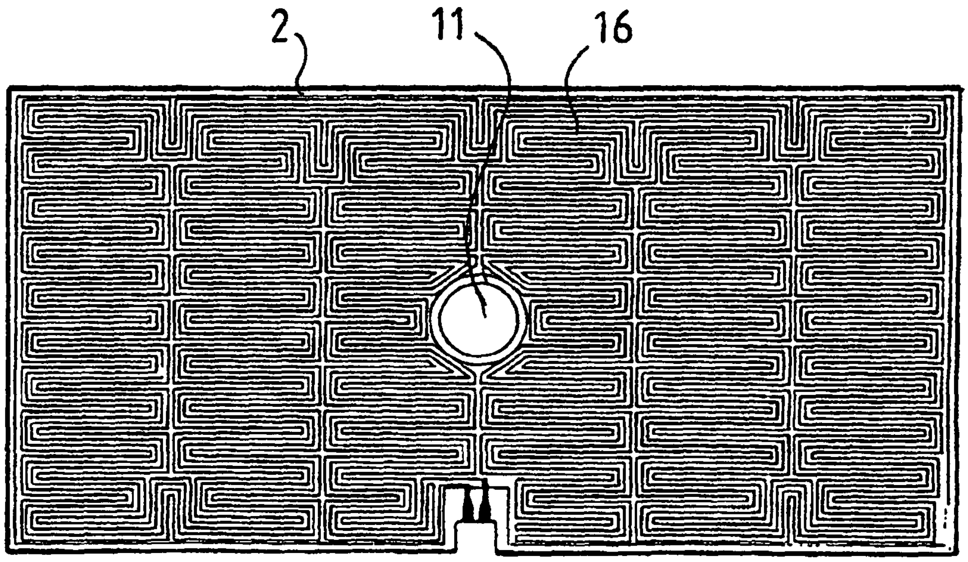

Fig 4

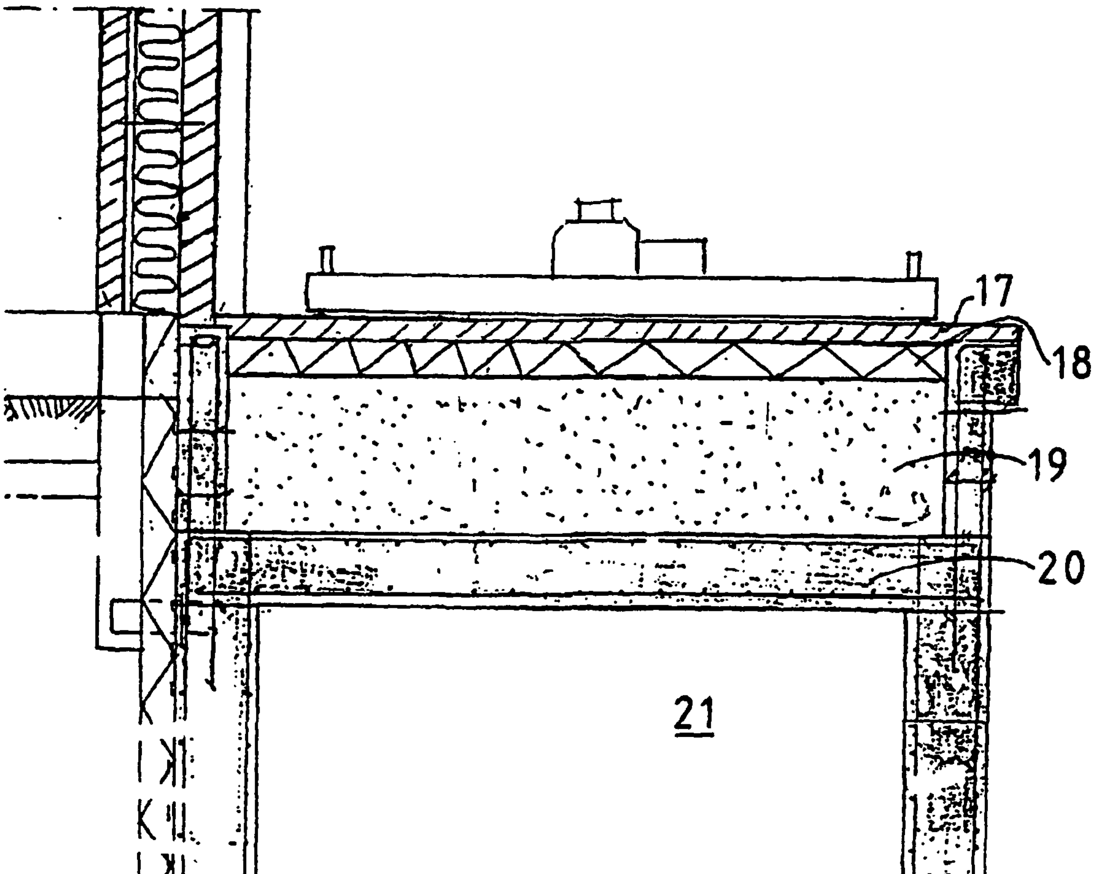

Fig 5