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Hilgemann

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[54] **STRUCTURAL BUILDING COMPONENT WITH HEAT EXCHANGE MEANS**

[75] Inventor: **Hans Hilgemann,** Recklinghausen, Germany

[73] Assignee: **CTC GmbH,** Hamburg, Germany

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[51] **Int. Cl.** **F24h 1/02**

[58] **Field of Search** 165/49, 47, 53, 54

[56] **References Cited**

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Primary Examiner—Charles Sukalo

Attorney, Agent, or Firm—Michael S. Striker

[57] **ABSTRACT**

A steel reinforcing mesh is supported on a base layer system by distancing portions which maintain it at a predetermined spacing. Conduits for circulation of heat exchange medium overlie and are supported by the reinforcing mesh, and a structural layer of hardenable material is provided on the base layer system, surrounding and embedding the reinforcing mesh and the conduit.

16 Claims, 4 Drawing Figures

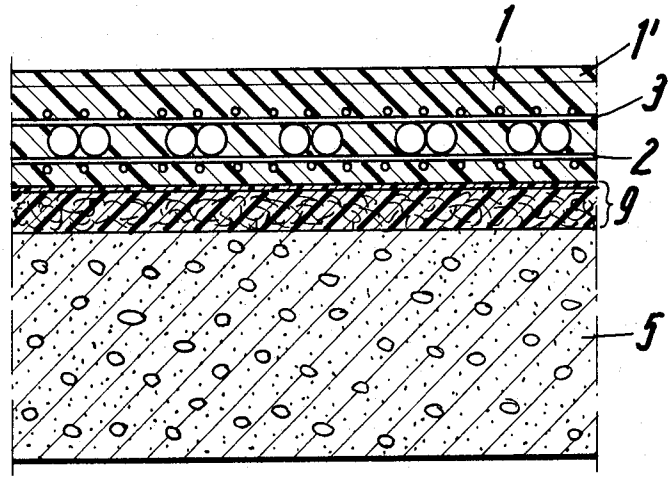


Fig.1

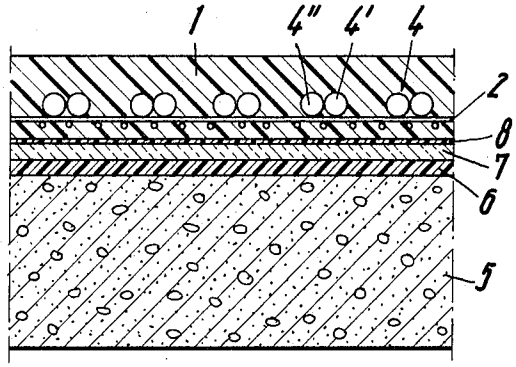


Fig.2

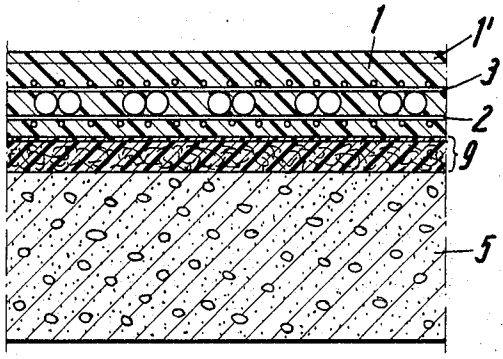


Fig.3

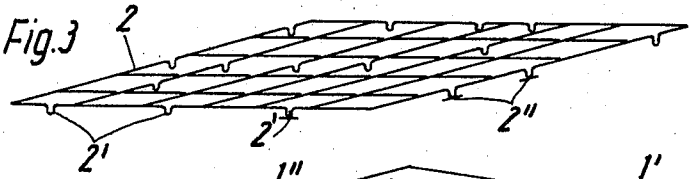
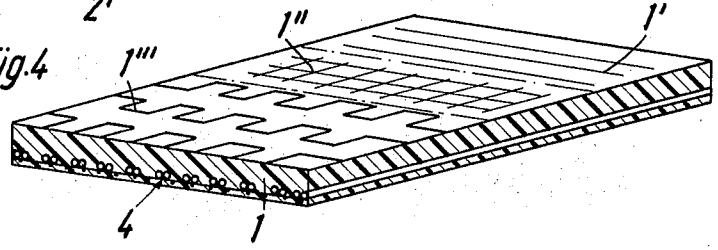


Fig.4



STRUCTURAL BUILDING COMPONENT WITH HEAT EXCHANGE MEANS

BACKGROUND OF THE INVENTION

The present invention relates to a structural building component in general, and more particularly to a structural building component with heat exchange means.

It is known to provide structural building components with heat exchange means. Such building components are deposited on a base, for instance a concrete foundation or the like. They have embedded in them conduits through which heat exchange fluid is circulated. The problem which has arisen with these prior-art constructions, however, is that the conduits are capable only of linearly heating the building component, that is that they do not provide even heating over the entire exposed surface of the building component. Attempts have been made to overcome this problem by providing the material of the building component, in which the conduits are embedded, of such thickness above the conduits (that is between the conduits and the exposed surface of the component) as to have at least some lateral distribution of the heating or cooling effect in the direction from the conduits to the exposed surface. However, the greater this thickness is, the more slowly the building component will be able to follow fluctuations in the amount of heat or coolness which is transmitted into it from the embedded conduits. In other words, if an increase or decrease in the heat or coolness is desired, a substantial amount of time must pass before the changed requirements are in fact reflected by a changed surface temperature of the component. This is evidently undesirable in terms of the comfort of users who are present in a room in which the building component is utilized.

In addition, the prior-art constructions have the disadvantage that the greater thickness required for the material embedding the conduits necessarily involves higher expenses for the material. In addition, such building components are provided underneath the conduits with one or more thermally insulating layers, and the significant weight of the thick upper layer in which the conduits are embedded is such that the insulating layers are undesirably compressed, reducing their thermally insulating function. Besides this there is the further consideration that the greater the weight of the building component itself, the more the underlying base (for instance, a concrete foundation) must be strengthened in order to be able to support this weight, resulting in a further cost increase.

SUMMARY OF THE INVENTION

Accordingly, it is a general object of the present invention to provide such a structural building component of the type here under construction, which is not possessed of the disadvantages of the prior art.

More particularly it is an object of the present invention to provide such a structural building component in which uniform temperature at the upper or exposed surface of the building component is assured.

An additional object of the invention is to provide such a structural building component in which the thickness of the layer of material in which the conduit or conduits is embedded, need be at most 35 mm or can be even less, contrary to the minimum of 35 mm which heretofore has been required by industrial standards relating to the manufacture of such components, but

which will nevertheless have such high resistance to tensile damage, breaking damage and pressure damage that its full reliability and safety is assured.

In pursuance of these objects, and others which will become apparent hereafter, one feature of the invention resides in such a component or arrangement as described herein, which briefly stated comprises base layer means, a steel reinforcing mesh above the base layer means and comprising downwardly extending distancing portions engaging the same, and conduit means overlying and carried by the reinforcing mesh. The conduit means is adapted to have a heat-exchange medium circulated therethrough. There is further provided a structural layer of hardenable material which is on the base layer means and which surrounds and embeds the reinforcing mesh and the conduit means.

A thus constructed structural building component will have a strength which is such that all requirements made of it in the conventional use to which such building components are subjected, will be reliably met even if the total thickness of the building component is merely on the order of 50 mm.

The conduit means advantageously utilizes a spirally or otherwise convoluted conduit, which may but need not be of synthetic plastic material, and which has inflow portions for the incoming heat exchange medium and return flow portions for the spent heat exchange medium. Of course, more than a single conduit can be provided and the inflow portions and the return flow portions need not be part of one and the same conduit but can be parts of more than one conduit which are suitably connected with one another. However, the inflow and return flow portions must have at least substantially identical flow cross-sections and each inflow portion should extend in parallelism with an outflow or return flow portion so that in the two associated portions the heat exchange medium will advance in counterflow. Over the entire length of the two associated portions the latter should have a common abutment face in order to provide for direct heat exchange with it. With such a construction a completely even surface temperature at the upper surface of the structural building component is achieved, and because this assures an even thermal expansion or contraction of the entire component, fractures due to differential stresses within the component are reliably avoided. Moreover, the reduced thickness of the structural layer of hardenable material which is possible in accordance with the present invention, taken in conjunction with the completely even and uniform surface temperature, assures that the structural building component according to the invention is thermally much more flexible than what is known from the prior art. In other words, the component according to the present invention responds much more rapidly to changes in the amount of heat or coolness transmitted to it via the circulating heat exchange means.

It is advantageous to provide the distancing portions of the steel reinforcing mesh by simply forming noses or projections on the reinforcing mesh, in that portions of the rods forming the reinforcing mesh are suitably bent out of the general plane of the latter. It is further advantageous to provide the free ends of these noses or projections with pressure plates by means of which the mesh contacts and is supported on the base layer means. It is clear that the steel reinforcing mesh will be maintained at a spacing above the base layer means, ex-

cept for the distancing portions which extend to and into engagement with the latter. Because of this the hardenable material of the structural layer can be cast onto the base layer means in such a manner that it will completely embed the conduit means and the steel reinforcing mesh, that is that it will flow between the conduit means and steel reinforcing mesh and the upper surface of the base layer means. Because the steel reinforcing mesh is thus completely embedded in the material of the structural layer, it can effectively act to provide its reinforcing function, strengthening the structural component according to the present invention in a manner not known from the prior art.

In addition, it is not necessary to raise the steel reinforcing mesh locally off the base layer means when the conduit means is to be connected to the steel reinforcing mesh, for instance by means of appropriate clips, tapes or the like. The rods are readily accessible for fastening the portions of the conduit means to them.

The component according to the present invention has the additional advantage that the steel reinforcing mesh is no longer in direct contact with the base layer means beneath it except at the small points of engagement with the distancing portions. This is advantageous, especially insofar as the steel reinforcing mesh is intended to serve to avoid local overheating of the material of the structural layer —to the extent that this might at all be possible— and it will be appreciated that the mesh is now spaced by a relatively thin and thermally conductive layer of the material of the layer which is interposed between it and the base layer means but which nevertheless provides a sufficient amount of insulation.

The component according to the present invention can be further strengthened by placing on top of the conduit means an additional steel reinforcing mesh which is also completely embedded in the material of the structural layer. This additional steel reinforcing mesh can be provided but need not have the distancing portions of the first-mentioned mesh.

An increase in the strength of the component can further be obtained, and the possibility of development of fissures due to shrinkage can be further removed and further reduced, in that the upper or exposed surface of the structural layer is provided with grooves which may extend in parallelism with the portions of the conduit means, which may advantageously extend transversely of these portions, or which may be embossed in form of sinuous or convoluted configurations of other-than straight (i.e., non-linear) shape. The latter expedient is particularly advantageous if the building component is to be used in an outdoor installation.

It has been found that a building component according to the present invention is particularly advantageous from a technical and economical point of view, if it has an overall thickness of less than 65 mm, if the conduit means has an outer diameter of between substantially and 22 mm, and if the diameter of the rods of which the steel reinforcing mesh is composed is between substantially 2 and 5 mm. The general plane of the downwardly directed side of the reinforcing mesh should be upwardly spaced from the lower surface of the structural layer (i.e., the interface of the latter with the base layer means) by at least 3 mm.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a fragmentary vertical section through one embodiment of the invention;

FIG. 2 is a view similar to FIG. 1, illustrating a somewhat different embodiment of the invention;

FIG. 3 illustrates in fragmentary perspective view a steel reinforcing mesh for use with the embodiments of FIGS. 1 and 2; and

FIG. 4 is a fragmentary perspective view, partly sectioned, of a structural building component according to the present invention with reinforcing depressions provided in its upper surface.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Discussing firstly the embodiment illustrated in FIG. 1 it is pointed out that reference numeral 5 identifies a base or support, for instance a foundation of concrete. On this support 5 there is provided the structural building component according to the present invention. In the embodiment of FIG. 1 the component utilizes a layer 6 of synthetic plastic material, for instance styrofoam, on which there is deposited a layer 7 of glass wool, rock wool or the like which serves with the styrofoam layer 6 for thermally insulating purposes, as well as for sound retardation. On top of the layer 7 is deposited a relatively thin layer 8 which may be of synthetic plastic material or an appropriately treated paper and which serves as a vapor and liquid barrier.

The layers 6–8 together constitute in this embodiment the base layer means, and supported on the layer 8 is a steel reinforcing mesh 2 which is shown in more detail in FIG. 3. In conventional manner the mesh 2 is of crossed wires or rods which are suitably connected with one another. In order to maintain it spaced upwardly from the surface of the layer 8, the mesh 2 is provided with downwardly extending distancing portions 2′ which are advantageously formed by bending portions of the various rods of the mesh downwardly out of the general plane of the latter. It is advantageous, but not absolutely necessary, that the free ends of the projections 2′ be provided with abutment plates or portions 2″, for instance by welding them to the portions 2′ and in order to distribute the area of contact and hence the weight of the mesh 2 over a wider surface area of the layer 8.

Mounted on top of the mesh 2, and secured to the rods thereof in suitable manner, for instance by tapes, by tying with wire, by suitable clamps or the like, is the conduit means 4 which is arranged in pairs of conduit portions 4′ and 4″. The conduit portions 4′ and 4″ of each pair are in engagement with one another over at least substantially their entire length for direct heat exchange between them, and the fresh incoming heat exchange medium flows in one direction through one of the conduit portions (4′ or 4″) whereas the spent returning heat exchange medium flows in the opposite direction through the other conduit portion (4″ or 4′) of the respective pair.

The conduit means 4 and the reinforcing mesh 2 are embedded in their entirety in the hardenable material

of the structural layer **1**, which can be poured over them and which will not only form a thickness above the upper general plane of the conduit means **4** but will also form a (lesser) thickness underneath the mesh **2**, between the same and the upper surface of the layer **8**.

The embodiment in FIG. **2** differs from that of FIG. **1** in certain respects. Insofar as like components are involved, like reference numerals have been utilized.

In FIG. **2** it will be seen that the layers **6, 7** and **8** of FIG. **1** have been combined into a single unit **9**, for instance by admixing the glass or rock wool of the layer **7** with the styrofoam or other plastic material of the layer **6**, forming a single layer to the upper surface of which there may be bonded a layer corresponding to the layer **8** of FIG. **1**. The unit **9** may be separate from or may be of one part with the layer **1** so that they together can constitute a unitary element. It is essential that the unit **9** have good thermally and acoustically insulating properties, as well as being pressure resistant and providing the necessary vapor barrier.

A further difference of the embodiment of FIG. **2** over that of FIG. **1** is the provision of an additional reinforcing mesh **3** which may be identical in construction with the reinforcing mesh **2** shown in FIG. **3**, but which can also be provided without the distancing portions **2'**. In any case, the mesh **3** is placed on top of the conduit means **4** to which it may be again secured in suitable manner. It is completely embedded in the material of the layer **1**, together with the conduit means **4** and the mesh **2** and further increases the structural strength of the building component.

In addition, the upper or exposed surface of the layer **1** is provided, in the FIG. **2** embodiment, with a plurality of here parallel grooves **1'** (only one shown) which may be formed with a suitable tool such as a trowel before the material of the layer **1** hardens. This further increases the surface strength of the layer **1**, as well as reducing the possibility of the formation of fissures due to shrinkage.

Coming, finally, to FIG. **4** it will be seen that here I have illustrated that the upper surface of the layer **1** can be provided for surface strengthening reasons, and to reduce the possibility of the formation of fissures, with the grooves **1'** of FIG. **2** which extend in parallelism with one another, and which advantageously extend transversely of the elongation of the conduit portions **4', 4''**. I have additionally illustrated in FIG. **4** that instead of forming the grooves **1'** strictly in parallelism with one another, it is also possible to form grooves **1''** which extend crosswise of one another or to form grooves which are of non-linear configuration, such as the meandering grooves **1'''** illustrated. Naturally, the grooves **1'''** could also be of sinuous configuration or of other suitable configuration. Any of the grooves **1', 1''** and **1'''** can be utilized by themselves but, as shown in FIG. **4**, they can also all be provided on one and the same layer **1**. The grooves **1'''** may be provided particularly advantageously if the building component is to be used in an exterior application and if it is desired to provide an ornamental appearance in addition to the stiffening or strengthening which is afforded by the grooves.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of constructions differing from the types described above.

While the invention has been illustrated and described as embodied in a structural building component with heat-exchange means, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

1. An arrangement of the character described, comprising layer means including a structural layer section of hardenable material and a base layer section, said structural layer section and said base layer section having abutting surfaces; conduit means completely embedded in said structural layer section and spaced from said abutting surfaces, said conduit means being adapted for circulation therethrough of a heat-exchange medium; and a reinforcing mesh in said structural layer section intermediate said conduit means and said abutting surfaces, said reinforcing mesh having a substantially planar portion spaced from said abutting surfaces and being located at least closely adjacent to said conduit means, said reinforcing mesh further including distancing portions extending from said planar portion in a direction towards said abutting surfaces and to locations at least closely adjacent thereto.

2. An arrangement as defined in claim **1**, said conduit means comprising a conduit including a plurality of pairs of parallel conduit portions which are in abutment over at least substantially their entire length, with incoming heat-exchange medium flowing in one direction through one conduit portion and returning heat-exchange medium flowing in the opposite direction through the other conduit portion of each pair.

3. An arrangement as defined in claim **2**, wherein said conduit is of synthetic plastic material.

4. An arrangement as defined in claim **2**, said distancing portions being sections of said reinforcing mesh which project out of the general plane of the same.

5. An arrangement as defined in claim **4**, said distancing portions having free ends, and including contact plates provided on said free ends for contacting said base layer section.

6. An arrangement as defined in claim **1**; and further comprising an additional steel reinforcing mesh overlying said conduit means and embedded in said structural layer section of hardenable material.

7. An arrangement as defined in claim **1**, wherein said hardenable material is selected from a group composed of concrete and hardenable synthetic plastics.

8. An arrangement as defined in claim **1**, said structural layer section having an exposed surface; and futher comprising a plurality of grooves formed in said exposed surface.

9. An arrangement as defined in claim **8**, wherein said grooves extend transversely of said conduit means.

10. An arrangement as defined in claim **1**, said structural layer section having an exposed surface; and fur-

ther comprising a plurality of embossed non-linear grooves formed in said exposed surface.

11. An arrangement as defined in claim **1,** said base layer section including a plurality of layers of thermally insulating material and of fluid-impermeable material, respectively.

12. An arrangement as defined in claim **1,** said base layer section including a unitary layer composed of thermally insulating and fluid-impermeable components, respectively.

13. An arrangement as defined in claim **1,** wherein said base layer section has a thermal conductivity which is lower than that of said structural layer section.

14. An arrangement as defined in claim **1,** wherein said reinforcing mesh comprises a steel mesh.

15. An arrangement as defined in claim **1,** said structural layer section having an exposed surface on a side of said conduit means and said reinforcing mesh remote from said abutting surfaces; and wherein said structural layer section has a thickness intermediate said abutting surfaces and said exposed surface of at most about 65 mm, said conduit means comprising at least one conduit having an outer diameter between substantially 20 and 22 mm, and said reinforcing mesh including a plurality of rods having a diameter between substantially 2 and 4 mm.

16. An arrangement as defined in claim **1,** wherein said planar portion of said reinforcing mesh is spaced from said abutting surfaces by at least about 3 mm.

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