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(54) **System of floor elements and method for manufacturing the floor elements, and a method for manufacturing a floor construction using the floor elements**

(57) The invention relates to a system of floor elements (2) which comprise thermally insulating material and are intended for placing on a substantially solid bottom as formwork for a ribbed floor to be arranged thereon. Each floor element is provided with a lower leg (12) for supporting on the bottom and with an upper leg (11) for supporting on a lower leg of a floor element (2) to be laid adjacently. The upper leg is provided on the underside thereof, and the lower leg on the upper side thereof, with co-acting profiles (13-16), this such that between adjacently placed floor elements there remains a free space (19) for the purpose of ventilation and a free space (18) for a rib.

The invention also relates to a method for manufacturing the floor elements and to a method for manufacturing a floor construction using the system of floor elements according to the invention.

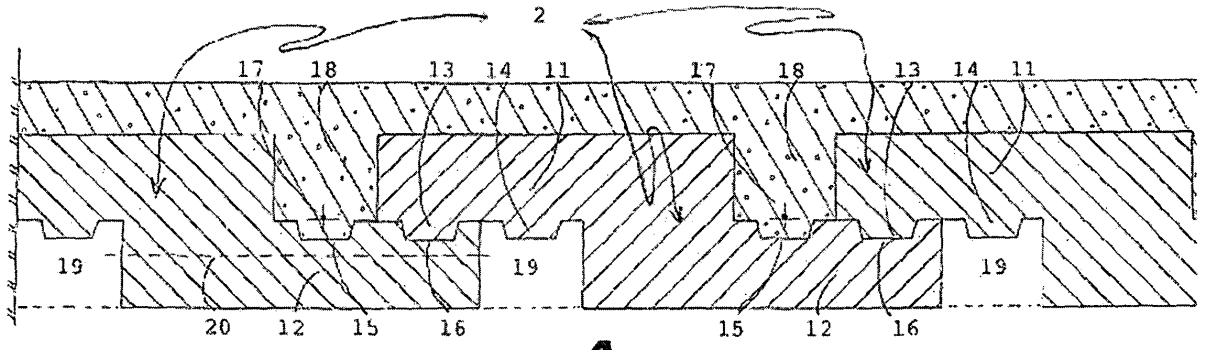

FIG. 1

EP 1 972 735 A1

Description

[0001] The invention relates to a system of floor elements, which floor elements comprise thermally insulating material and are intended for placing on a substantially solid bottom as formwork for a ribbed floor to be arranged thereon.

[0002] Concrete floors consisting of concrete slabs are generally known which are provided on the underside with concrete ribs and the undersides are provided with thermal insulation material of diverse shapes and profiles. Such floors are factory-made in parts and disposed in the building structure as cantilever floor from support point to support point, also above so-called crawl spaces or conduit spaces of small height, after which they are filled with a quantity of concrete, depending on the floor type. Such floor systems are known for instance from the Netherlands patent applications 7904326 - 7907756 - 8002014 and 8006287, in addition to the European patent 0558826.

[0003] Because these floors, and also other types of larger-scale floor parts, are not intended to rest on a solid surface, but as cantilever floors spanning crawl spaces, they have concrete ribs of considerable height as seen in cross-section, this resulting in profiled lower surfaces of the insulation material.

[0004] The forming of crawl or conduit spaces under the ground floors in building structures has in recent years met with the disapproval of government agencies, including water regulatory authorities, and research organizations such as TNO (Organization for Applied Scientific Research) and RIVM (Institute for Public Health and Environment) for reasons of water management as well as on health grounds. Because of crawl spaces, water regulatory authorities must keep the groundwater level unnecessarily low in built-up areas, while it has now been realised that rainwater must infiltrate into the ground, on the one hand to store as much excess water as possible and on the other to prevent dessication.

[0005] Health aspects form a second important reason for abandoning crawl spaces. Some years ago a nationwide study by TNO showed that crawl spaces in the Netherlands are generally so damp that per dwelling, due to diverse imperfections in the ground floors, such as poorly closing hatches, recesses for conduits through the floors, joints and the like, an average of a litre of moisture in the form of vapour enters the living areas every 24 hours, with all the consequences this entails, such as house mites, chronic respiratory disorders and so on. Scientists have frequently pointed out that it is crawl spaces where harmful radon from the ground concentrates and penetrates living spaces together with moist vapours. The stricter norm for permissible radon levels in buildings announced by the government underlines these concerns.

[0006] Building without crawl spaces, wherein conduits are laid in cable protection pipes so that the ground floors can be completely closed, is therefore on the increase. This can be seen particularly in the large-scale new residential areas in the Netherlands, the so-called 'VINEX' sites.

[0007] Already long known is the making of a concrete slab on a solid bottom. The required thermal insulation can be arranged under the concrete slab as well as on the concrete slab. There are however a number of drawbacks to such a simple construction. First of all in respect of moisture and radon radiation. Because good ventilation is lacking, moisture and radon can move in only one direction, i.e. penetrate into and through the floor construction. A second significant drawback is of structural and economic nature. In the case of a concrete floor on a solid bottom account must be taken of smaller or larger subsidence and settlements, even if the bottom or the sand has been compacted beforehand. This requires a reasonable thickness of the concrete slab, since double reinforcement meshes must absorb both positive and negative compression and tensile stresses. The economic advantages of ribbed floors, such as less use of concrete and steel, are absent here.

[0008] The present invention has for its object to provide a system of floor elements of the type stated in the preamble which obviates these drawbacks.

[0009] In the system according to the invention each floor element is provided for this purpose with a lower leg for supporting on the bottom and with an upper leg for supporting on a lower leg of a floor element to be laid adjacently, wherein the upper leg is provided on the underside thereof, and the lower leg on the upper side thereof, with co-acting profiles, this such that between adjacently placed floor elements there remains a free space for the purpose of ventilation and a free space for a rib.

[0010] The lower free spaces between adjacent floor elements form main ventilation channels for the discharge of moisture vapours, affected by and mixed with the harmful radon, to and via the outer sides of the floor construction. The co-acting profiles guarantee a fixed position and preclude as far as possible undesirable loss of cement slurry from pouring material to be poured thereon, such as concrete. The co-acting profiles also enable compact packaging of the floor elements, this being economically advantageous in transport and storage up to the moment of processing.

[0011] According to the first practical embodiment of the system according to the invention, the profiles comprise per element at least one protrusion with a corresponding recess. This results in a simple design so that the floor elements can be laid and manufactured in relatively simple manner, for instance by being pressed by means of the moulding method known in the field. According to a further development of this first practical embodiment, the upper leg comprises on the underside thereof at least two protrusions, and the lower leg comprises on the upper side thereof at least two recesses. Adjacent floor elements can now be readily placed apart at a fixed mutual distance, wherein between adjacent floor elements there is created on the underside a space for a ventilation channel and on the upper side a space

for a rib of pouring material of the same width as the ventilation channel. According to another development of the system according to the invention, the width of a co-acting recess and protrusion differs. This guarantees a dimensionally stable connection.

[0012] In a further preferred embodiment of the system according to the invention channels are arranged running in substantially transverse direction in the bottom of the floor elements for the purpose of obtaining transverse ventilation channels. These transverse ventilation channels form together with the main ventilation channels a grid of ventilation channels. A circuit is thus formed with the purpose of ventilation to one or more sides of the floor construction.

[0013] According to yet another preferred embodiment of the system according to the invention, recesses running substantially in transverse direction are arranged in the top of the floor elements for the purpose of receiving transverse ribs of pouring material.

[0014] The floor elements can likewise be provided with incisions for the channels and/or recesses.

[0015] The invention also relates to a method for manufacturing floor elements according to the invention, the method comprising the following steps of:

- selecting preferably large-scale forms of a suitable thermal insulation material;
- wholly or substantially wholly separating floor elements using hot wire, wire saw or in other manner such that the upper leg of a first floor element is cut free of the lower leg of a second floor element; and
- arranging the co-acting profiles in the underside of the upper leg of the first floor element and in the upper side of the lower leg of the second floor element during separation of the floor elements. Using the method cutting takes place such that the legs of the floor elements connect against each other in nested manner, so that no cutting loss occurs.

[0016] The invention also relates to a method for manufacturing a floor construction on a substantially flat bottom using the system of floor elements according to the invention, the method comprising the following steps of:

- laying the floor elements adjacently, wherein the lower leg of each floor element supports on the bottom and wherein the upper leg of each floor element supports on the lower leg of the adjacently laid floor element such that between adjacently laid floor elements there remains a free space for the purpose of ventilation and a free space for a rib;
- forming a floor construction on the adjacently laid floor elements by pouring a suitable pouring material such as concrete over the adjacently laid floor elements; and
- allowing the pouring material to cure.

[0017] Using the method according to the invention a thermally insulating and horizontally ventilating bottom-sealing floor construction resting on a substantially flat surface can be manufactured in rapid, simple and economic manner, which floor is provided on the downward directed side with thermally insulating material as formwork for a floor construction of pouring material such as concrete, and which floor is provided with ventilation channels on the underside, wherein the floor construction consists of a slab which is provided on the underside with ribs at regular mutual distances.

[0018] The invention will be further elucidated with reference to the drawing. In the drawing:

Figure 1 shows a cross-section of a preferred embodiment of the system of floor elements according to the invention as part of an insulated concrete ribbed floor;
Figure 2 shows a cross-section of a number of floor elements of figure 1 in nested position by way of illustrating the method according to the invention for manufacturing the floor elements;
Figure 3 shows a top view of a part of the insulated concrete ribbed floor of figure 1;
Figure 4 shows a cross-section of a side connection of the concrete ribbed floor of figure 1 against for instance brickwork;
Figure 5 shows a cross-section, parallel to the running direction of the floor elements of figure 1, of an end surface connection of the floor against for instance brickwork; and
Figure 6 shows a cross-section, parallel to the running direction of the floor elements, of a transverse ventilation channel formed in the lower leg of a floor element.

[0019] Figure 1 shows a cross-section of a part of a concrete ribbed floor 1 intended for use on a flat solid bottom, wherein the concrete construction is poured onto a formwork of floor elements 2 of thermally insulating material with a generally Z-shaped profile.

[0020] Each floor element 2 is provided with a lower leg 12 for supporting on the bottom and with an upper leg 11 for supporting on a lower leg 12 of a floor element 2 to be laid adjacently. Upper leg 11 and lower leg 12 are provided with co-acting profiles 13, 14, 15, 16 located respectively on the underside and the upper side thereof.

[0021] By placing the floor elements apart relative to each other space is created for a rib filling and concrete compression layer which together give a T-shaped concrete construction 18. Through placing apart of the floor elements space 19 is created on the underside between the floor elements as ventilation channels running parallel to the concrete ribs. Because the thicknesses of legs 11 and 12 of the floor elements are the same, but may also differ, it is possible during production of the floor elements to opt for a variety of heights for the concrete ribs and ventilation channels.

[0022] The profiling on the underside of upper legs 11

comprises at least two protrusions 13 and 14. The profiling on the upper side of lower legs 12 comprises at least two recesses 15 and 16.

[0023] The combination 13-15 here takes a slightly heavier form as seen in cross-section than the combination 14-16. Pressing the wider protrusion 13 into the narrower recess 16 during mutual displacement of the floor elements results not only in an ensured width for concrete ribs and ventilation channels but also in a mutual sealed lateral closure between the floor elements, thereby preventing loss of moisture from the fresh concrete. The empty recess 15 remaining in the bottom formwork for the concrete ribs results in the usually single reinforcing bar 17 at the bottom of the ribs in concrete ribbed floors obtaining a lowered position compared to a flat bottom formwork, thereby achieving a stronger concrete construction. The central location in the width of the rib is also ensured because spacer rings or other spacers obtain a fixed position in the groove.

[0024] Ventilation channels 19 can be mutually connected by forming transverse ventilation channels 20 at the bottom of the floor elements. These can be of differing form and also be made internally transversely through the lower leg. This can be done most simply, depending on the size of a floor field and the ventilating direction to one or more sides of the relevant building structure, by forming these transverse channels through rebates in lower legs 12. If during the production of the floor elements an incision or saw cut is made at the position of an outer end, use can be made hereof as required on the building structure by means of a second incision, either for the purpose of realizing a grid of ventilation channels or for the purpose of an annual structure along the outer sides of the floor field or for a single transverse channel in the case of a small floor field. Harmful vapours from the ground, including radon gas, are thus discharged in horizontal manner.

[0025] Figure 2 illustrates in cross-section the method according to the invention for manufacturing floor elements 2.

[0026] In a first step large-scale forms of a suitable thermal insulation material, for instance polystyrene foam, are selected.

[0027] In a second step the floor elements are separated therefrom such that upper leg 11 of a first floor element is separated from lower leg 12 of a second floor element. For separating purposes use can be made of hot wire, wire saw or other suitable techniques known in the field. The floor elements can be completely separated or almost completely, for instance up to point 26. In the latter case the floor elements can remain attached to each other until the moment of processing, at which they can be separated from each other in simple manner.

[0028] In a third step the co-acting profiles are arranged during separating of the floor elements. The underside of upper leg 11 of the floor element is provided with protrusions 13 and 14 and the upper side of lower leg 12 is provided with recesses 15 and 16.

[0029] In the method the horizontal legs 11 and 12 connect in nested manner against each other so that no cutting loss occurs. Portions of both lower leg and upper leg remain unused at the beginning and end of the slab, although this small quantity will certainly be usable in side connections and the like in the floor field, as shown in figure 4. Broken line 25 indicates that rebates can be made for transverse concrete ribs, but also that floor elements with lowered upper leg 21 can be made, for instance in order to obtain weighted concrete strips or to obtain locally lowered portions, for instance for bathing areas and the like.

[0030] Figure 3 shows a top view of a part of a floor field between enclosing boundaries of for instance brickwork. The transverse direction D and longitudinal direction L are indicated. For details of connections reference is made to other figures. The transverse ventilation channel as according to figure 6 (69) does not have to lie in one line but can be offset when floor elements have unequal lengths.

[0031] Figure 4 shows in cross-section an ending of the floor connecting against brickwork which is opposite the ending in figure 1. Lower leg 12 is here kept clear of the wall, thereby creating ventilation channel 49. Auxiliary part 44, which is the same as the profile of upper leg 11, becomes available during the production of the floor elements and finds application here. Channel 49 can be vented through the brickwork. A ventilation circuit is created together with channels along the other sides of the floor field.

[0032] Figure 5 shows a head end of the floor field in a cross-section parallel to the length direction of the floor elements and concrete ribs. Owing to a transverse rebate in lower leg 12 ventilation of channel 59 can here also take place through the brickwork. If an unreliable bottom, or any other reason, makes it necessary for the floor to be placed with the outer ends of the concrete ribs on the brickwork or the like, weighting of the concrete cross-section close to the support may be desirable. Locally lowered upper legs as indicated with broken line 25 in figure 2 and some shortening of the upper legs, thereby creating wider concrete ribs above and close to the support, provide a solution herefor.

[0033] Figure 6 shows in a cross-section parallel to the length direction of the floor elements and concrete ribs how transverse rebates in lower legs 12 connect main ventilation channels through 69. Depending on the size of the floor field and the desire to achieve a grid pattern of ventilation channels, transverse channels can be formed at any desired location in the floor. This is done most simply at one of the outer ends of the floor elements by means of two incisions, a number of which are already precut, so that a second incision will suffice as required.

[0034] The concrete ribbed floor shown in the figures, which is described as preferred embodiment of the invention, is manufactured according to the method below. In a first step floor elements 2 are laid adjacently, wherein lower leg 12 of each floor element 2 supports on the bot-

tom and wherein upper leg 11 of each floor element 2 supports on the lower leg of the adjacently laid floor element such that between adjacently laid floor elements there remains a free space 19 for the purpose of ventilation and a free space 18 for a rib.

[0035] In a following step a floor construction is formed on the adjacently laid floor elements 2 by pouring a suitable pouring material, such as concrete, over the adjacently laid floor elements. Finally, the pouring material must cure.

[0036] Using the system of floor elements and the method according to the invention a thermally insulating and horizontally ventilating bottom-sealing floor construction is provided resting on a flat bottom, which floor is provided on the downward directed side with thermally insulating material as formwork for a concrete construction, and which floor is provided with ventilation channels on the underside, wherein the concrete construction consists of a concrete slab which is provided on the underside with concrete ribs at regular mutual distances.

[0037] The invention is of course not limited to the described and shown preferred embodiment. It is noted that, in order to obtain only bottom-sealing ventilating floor constructions in which the rib fillings only fulfil a sealing ballast function, no concrete compression layer need be arranged over the upper surfaces and rib fillings, and the concrete can be replaced by other material. Examples hereof are formed by floor constructions in which accessibility is of only little importance while a sealing from moisture and ground vapours is all the more important. Particularly envisaged here are existing crawl spaces which are nearly always damp, not insulated and filled with accumulations of moisture vapour and radon gas. Compared to the concrete ribbed floor, the concrete compression layer over the floor elements here serves little purpose, although an inexpensive plastic film or the like does so.

[0038] If on the other hand weighted concrete strips and the like are necessary in a floor field, for instance for linear loads to be absorbed, floor elements with thinner upper leg can be applied at these locations. It may also be deemed structurally desirable to make a semi-supported floor if the bottom, although stabilized, is not considered trustworthy. Weighting close to the support can then be achieved in simple manner by a heavier concrete compression layer at that position and by widening and/or deepening the outer ends of the concrete ribs.

[0039] In addition to having a stiffening function for the whole construction, the concrete filling in the ribs also has a ballast function against lifting of the floor when the water level under the floor rises. The concrete can also be replaced here by another material of sufficient weight. If the floor elements are made of polystyrene foam, a material which substantially takes up no water when immersed, the thermally insulating capacity of such a bottom-sealing floor will also remain substantially intact in the case of a small rise in the water level.

[0040] The present invention therefore extends to any embodiment falling within the scope of protection as defined in the claims, as seen in the light of the foregoing description and associated drawings.

Claims

1. System of floor elements, which floor elements comprise thermally insulating material and are intended for placing on a substantially solid bottom as formwork for a ribbed floor to be arranged thereon, wherein each floor element is provided with a lower leg for supporting on the bottom and with an upper leg for supporting on a lower leg of a floor element to be laid adjacently, wherein the upper leg is provided on the underside thereof, and the lower leg on the upper side thereof, with co-acting profiles, this such that between adjacently placed floor elements there remains a free space for the purpose of ventilation and a free space for a rib.

2. System as claimed in claim 1, wherein the profiles comprise per element at least one protrusion with a corresponding recess.

3. System as claimed in claim 1, wherein the upper leg comprises on the underside thereof at least two protrusions, and wherein the lower leg comprises on the upper side thereof at least two recesses.

4. System as claimed in claim 2 or 3, wherein the width of a co-acting recess and protrusion differs.

5. System as claimed in any of the foregoing claims, wherein ventilation channels are arranged running in substantially transverse direction in the bottom of the floor elements.

6. System as claimed in any of the foregoing claims, wherein recesses for transverse ribs running substantially in transverse direction are arranged in the top of the floor elements.

7. System as claimed in claim 5 or 6, wherein the floor elements are provided with incisions for the channels and/or recesses.

8. Method for manufacturing floor elements as described in one or more of the foregoing claims, the method comprising the following steps of:

    a) selecting preferably large-scale forms of a suitable thermal insulation material;
    b) wholly or substantially wholly separating floor elements using hot wire, wire saw or in other manner such that the upper leg of a first floor element is cut free of the lower leg of a second floor element;

c) arranging the co-acting profiles in the underside of the upper leg of the first floor element and in the upper side of the lower leg of the second floor element during separation of the floor elements.

9. Method for manufacturing a floor construction on a substantially flat bottom using the system of floor elements as described in claims 1-7, the method comprising the following steps of:

a) laying the floor elements adjacently, wherein the lower leg of each floor element supports on the bottom and wherein the upper leg of each floor element supports on the lower leg of the adjacently laid floor element such that between adjacently laid floor elements there remains a free space for the purpose of ventilation and a free space for a rib;
b) forming a floor construction on the adjacently laid floor elements by pouring a suitable pouring material such as concrete over the adjacently laid floor elements; and
c) allowing the pouring material to cure.

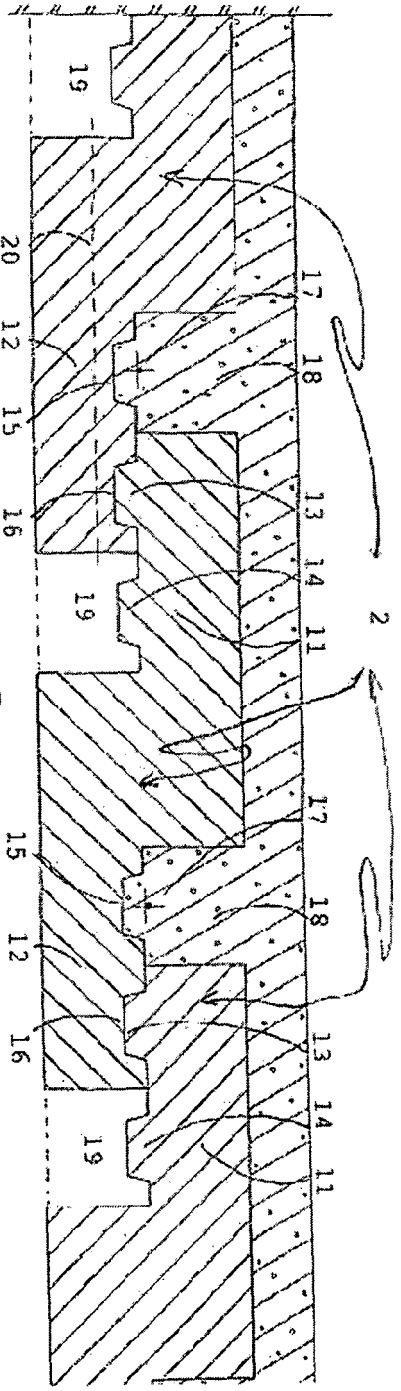

FIG. 1

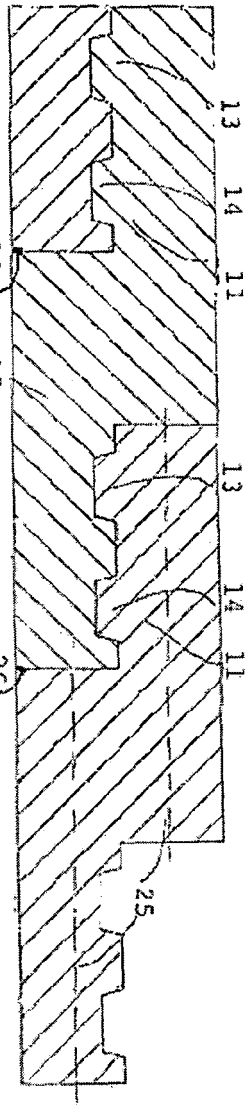

FIG. 2

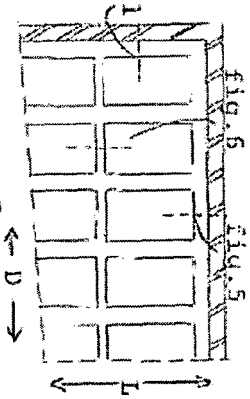

FIG. 3

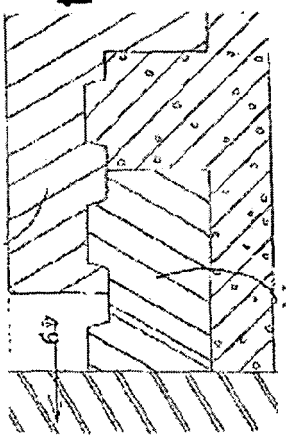

FIG. 4

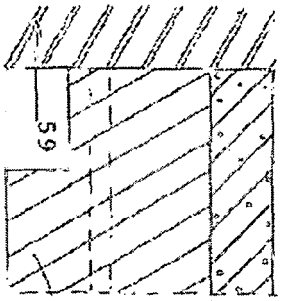

FIG. 5

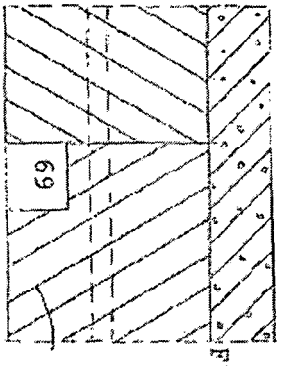

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 08 10 2432

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	NL 7 806 703 A (BREDERO NV) 28 December 1979 (1979-12-28) * figure 1 *	1-9	
A	WO 01/57329 A (GYLLING HANS [FI]) 9 August 2001 (2001-08-09) * abstract; figures 1,2 *	1-9	

TECHNICAL FIELDS SEARCHED (IPC)

E04B
E02D
E04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	28 May 2008	Leroux, Corentine

CATEGORY OF CITED DOCUMENTS

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28-05-2008

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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