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(73) Patenthaver: **Linde AG, Klosterhofstrasse 1, 80331 München, Tyskland**

(72) Opfinder: **KRABBENDAM, Peter, Leeuwendalerstraat 41, NL-2046 AA Haarlem, Holland**
OUDSHOORN, Felix, Pieter, Galjoen 12, NL-1113 GS Diemen, Holland

(74) Fuldmægtig i Danmark: **RWS Group, Europa House, Chiltern Park, Chiltern Hill, Chalfont St Peter, Bucks SL9 9FG, Storbritannien**

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EP-A- 1 269 815
EP-A2- 0 561 193
F. A. BAZZAZ; R. W. CARLSON: "The response of plants to elevated CO2", OECOLOGIA, vol. 62, no. 2, 1 May 1984 (1984-05-01), pages 196-198, XP008140439, ISSN: 0029-8549, DOI: 10.1007/BF00379013

Description

The invention relates to a process to accelerate growth of turfs, in particular in football stadia and the like.

Whereas football stadia and sporting arenas, previously, still frequently possessed uncovered stands, which were arranged with a relatively gentle slope and at a certain distance to a turf games field, for example separated by running tracks and light athletics sporting facilities, there is a trend to build the stands right up to the edge of the playing field of football fields, to arrange the stands so as to be relatively steep, in order to allow the public a good view of the playing field and in addition to roof over such football stadia, at least in the region of the stands, but sometimes also completely.

In these modern football stadia, owing to the roofing firstly, and because only one region, if at all, is uncovered directly above the turf, the light incidence and the light intensity are extraordinarily restricted.

Especially in the winter months in which the turf, owing to the temperature, scarcely grows, since conventional grass varieties forming the turf scarcely still grow below 5°C air temperature, such sport turfs are extraordinarily highly stressed.

Since, in particular in the sector of professional football, the frequency of the games is increasing, in the winter, but sometimes also in summer, the regeneration capacity of the grass plants is no longer high enough so that damage due to play can be made up for.

It is therefore known to cultivate such turf-forming grass plants agriculturally and to condition them correspondingly as turf, to detach the turf when needed, and roll it up into rolls and lay in football stadia, after the corresponding worn turf layer has been removed.

It is disadvantageous in this case that the removal of a damaged turf surface and the installation of a new turf surface are extraordinarily expensive. Frequently, there is the problem that a new turf surface stops growth under the conditions prevailing in the stadium.

To increase the regeneration capacity of a turf, it is known to pull webs over the turf, in which webs light-emitting diodes are present. This system available on the market from Intravision under the trade name "Lumigren" essentially consists of a rail system on which the material webs containing integrated light-emitting diodes can be unrolled, and an aeration system which causes air circulation.

The company SGL, Waddinxveen, Netherlands, carries out turf management, in which the growth of the turf, the light acting on the turf, the temperature, the water supply, the fertilizer input and mowing are measured. The individual growth parameters are changed individually. Optionally, the turf is artificially illuminated.

Although this system improves the light supply to the grass plants, in winter, in particular, a badly damaged turf can no longer be regenerated hereby.

EP 0 561 193 A2 shows a process and a device for promoting plant growth. The grass is virtually completely covered by the device. The method provides, to promote the growth of grass under a closed covering, to illuminate the grass by means of artificial light sources for about 8 to 12 hours in the course of 24 hours. The atmosphere to which the grass is exposed is agitated in this case by two aerators constantly, or at intervals, and/or exchanged continuously or from time to time. The amount of carbon dioxide which is taken up by the grass is to be fed continuously or in time sections to the atmosphere of the space by an appliance for introducing carbon dioxide.

By this method and this device, it is said to be possible to have grass grow at any season in accordance with the natural conditions. The device can be integrated into flat baseplates for covering a turf surface.

EP 1 269 815 A describes a device for the gas treatment of turf surfaces. In this case, a gas stream is fed to the turf surface via a gas channel extending over a turf surface. The gas channel is connected at an open end to a pressure unit and is closed at the other end. This channel has outlet openings at a region facing the turf surface. In a development of the device, sensors are provided which detect one or more measured variables such as ambient temperature, ambient air humidity, turf temperature, turf moisture, gas intake temperature, gas outlet temperature, intake gas moisture, outlet gas moisture, carbon dioxide fraction and fertilizer fraction and transmit them to a control and measurement unit with which the pressure unit and/or the feed of water vapour and/or carbon dioxide and/or fertilizer and/or the heating device can be set.

In F.A. Bazzaz et al; "The response of plants to elevated CO_2", the effect of CO_2 on the growth of plants is studied. Therein, it is stated that individual plants behave very differently with respect to an increasing CO_2 fraction, in such a manner that competition of the plants can be considerably changed by a changed CO_2 content in the air. In addition, it is explained that certain plant types develop a stronger growth with increasing CO_2 content, whereas other plant types do not react to an increasing CO_2 content.

It is an object of the invention to provide a process to accelerate growth and regenerate a turf, with which high growth and regeneration phases are also possible in winter.

The object is achieved by a process having the features of Claim 1.

Advantageous developments are characterized in the subclaims dependent thereon.

The process according to the invention provides erecting, over a restricted turf surface, a closed space, wherein, in the closed space, lighting appliances are present which illuminate the turf situated under the lighting appliance. The lighting is carried out in this case preferably at a wavelength which promotes particularly well the photosynthesis of the grass plants forming the turf. Mercury vapour lamps are particularly suitable therefor, optionally with corresponding filters, or fluorescent tubes having the appropriate light spectrum.

Furthermore, CO_2 is introduced into the closed space wherein the CO_2 concentration in the closed space is under permanent monitoring, and the CO_2 feedline is correspondingly controlled. By this means, a CO_2 concentration of at least 500 ppm CO_2 that is markedly increased compared with the natural concentration (approximately 350 ppm CO_2) can be set, and preferably at least 800 ppm CO_2. In the process known from EP 0 561 193 A2, a natural CO_2 concentration is set. Used CO_2 is replaced in this case. Owing to the low mounting of the lamps, a regular air exchange is necessary in order not to exceed the desired temperature, for which reason it is also impossible to keep the CO_2 concentration markedly above the natural value in the long term.

Owing to the presence of CO_2, the heat introduced by means of the light is retained better ("greenhouse effect"), as a result of which the heating in the closed space is supported.

Since all modern football stadia and all modern sports places which possess a sports turf have corresponding turf heating, the size or volume of the closed space is chosen in such a manner that, in a sufficient time, the spatial volume is heated by the turf heating to a temperature such that growth of the turf-forming grass plants is possible. In addition, the heating can be accomplished solely or additionally by the waste heat of the lighting appliance.

In the case of presence of turf heating or waste heat of the lighting appliance, in addition, circulation means for circulating the carbon dioxide that is fed in can be dispensed with, since this circulation is achieved by convection.

Preferably, the illumination means are arranged at a height of 1.80 m to 2.80 m above the turf surface.

The CO_2 can be fed at the highest point, or in the highest region of the space, and descends owing to its higher weight in comparison with air.

Preferably, the enclosed space is a tent or a tent-like structure made of a substantially gas-tight tent wall which extends from an upper region or a tent roof or a tent roof wall down to the turf.

In order to prevent gas losses, and also keep temperature drops small, the tent wall is constructed, for example, from a film, optionally in combination with a tear-resistant fabric layer.

In a preferred embodiment, the tent wall has insulating properties, in that it comprises a foam material-film layer, or air chambers are arranged between an inner film wall and an outer film wall.

Preferably, the tent can be constructed in a reinforced manner on a lower edge standing on the turf, wherein downwards-extending, surrounding, blade-like elements grip the subsoil and thus make possible a safe stand and good sealing.

The process additionally provides erecting such an enclosed space or a plurality of said enclosed spaces on a turf surface, allowing the lighting and the CO_2 to act on the turf and after a sufficient time of action to relocate the tent. For this purpose, according to the invention, in addition to a manual relocation, an automated relocation having a rail system and/or cable system can also be used. In such an embodiment, instead of an anchoring of the space on the ground at the bottom, rolls can be present with which the enclosed space can be pulled over the turf. For this purpose, however, skids or rails are also conceivable.

The invention will be explained by way of example with reference to a drawing. In the drawings:

Figure 1: shows a device for carrying out a process according to the invention in a longitudinal section,
Figure 2: shows the abovementioned device highly schematized in a cross section,
Figure 3: shows a further embodiment of the above-mentioned device in a schematic perspective view without lighting means and without outflow device, and
Figure 4: shows the embodiment shown in Figure 3 in the folded-up state in a perspective view.

The device for carrying out a process according to the invention 1 is arranged on a turf 2 which is to be regenerated which grows on a subsoil 3.

The device 1 comprises an enclosed space 4 having a roofing wall 5 and side walls 6. The roofing wall 5 and the side walls 6 are preferably firmly connected to one another and optionally have a support structure which is not shown.

The surrounded space 4 is in particular a tent 4 which is open at the bottom and stands up with side wall edges 7 on the turf 2.

The enclosed space 4 or the tent 4 can be constructed so as to be cuboidal, or have a falling monopitch roof or have a peaked roof (Fig. 2).

In an upper region, or below a roof wall 5, an outflow device

8 for gas is present, wherein the outflow device 8 is, for example, a tube-like structure 8 which extends over a partial length or the entire length of the space 4. The tube 8 or tube-like structure 8 has outflow openings 9 from which a CO_2 gas can flow out.

The CO_2 gas originates from a gas store 10 which is connected by a corresponding feed line 11 to the tube-like structure 8.

In order, in addition, to monitor the CO_2 content in the enclosed space 4, or the tent 4, a CO_2 measuring instrument or a CO_2 sensor 12 is connected via a line 13 preferably to the gas store 10, wherein a corresponding control appliance (which is not shown) for controlling/measuring the gas content is present.

At a height h measured from the ground 2 or the turf 2, a lighting appliance 14 is present in the enclosed space 4 or in the tent 4, which lighting appliance consists, for example, of incandescent lamps or gas-discharge lamps. Preferably, photosynthesis lamps are used such as those produced by General Electric Comp. and marketed under the trade name Lucalox PSL.

In an embodiment of the lighting appliance 14, it consists, for example, of fluorescent tubes 15 which extend in the enclosed space 4.

Owing to a turf heating 17 present in the ground 3 below the turf 2, within the enclosed space 4, a circulation occurs of the CO_2 exiting from the tube-like structure 8 and flowing downwards or falling, wherein, by convection, in the case of a central introduction of the CO_2 from the roof, the CO_2 flows upwards into the edge regions (arrows 16 in Fig. 2).

It has been observed that the heat development of the lighting appliance 14 is also completely sufficient for the formation of such a convection, and so even in stadia where there is no turf heating 17, sufficient convection is ensured.

In the exemplary embodiment described above, a tube 8 is used to supply the CO_2 gas. However, it has also been found that in the context of the invention it is possible, instead of such a tube, to use an individual point-form nozzle, since even distribution of the CO_2 gas is ensured by the convection existing in the enclosed space.

The lighting means are provided at a height h of 1.80 m to 2.80 m, or 2.20 m to 2.50 m, wherein the CO_2 feedline 8 is provided about 20 to 80 cm and preferably 50 cm above the lighting means.

In the process according to the invention and in a corresponding device, it is advantageous that it is very simply constructed. The gas-tight encapsulation by means of an enclosed space 4 or tent 4 induces a significant temperature increase by the heat development of the illumination means, optionally also the heat development by turf heating, which is sufficient to permit growth for the grass plants forming the turf.

The heat development of the illumination means, firstly, and optionally of turf heating, secondly, achieves a uniform CO_2 concentration by convective distribution.

The CO_2 concentration is in the range from 500 to 1500 ppm and preferably in the range from 800 to 1200 ppm CO_2 or 800 to 2000 ppm CO_2. The natural CO_2 concentration is approximately 350 ppm. As a result of the increased CO_2 concentration, a considerably stronger growth of the turf 2 is achieved. Using the process according to the invention and a corresponding device, even in cold winter months, and with high stress of the turf surface, in a simple manner, by a higher light intensity than in daylight, and a high CO_2 concentration with sufficient high temperatures, optimum conditions for the turf is achieved.

The inventors, even in the winter months, have been able to observe a growth of about 0.5 mm per hour of the grass plants forming the turf. The outdoor temperatures in this case were about 5°C to 6°C. The temperatures measured in the turf were markedly higher. This was partly due to the fact that soil heating was used. However, the heat input due to the lamps and the heat-retention action by the tent and the CO_2 concentration also contributed to the temperature increase in the turf. Thus, a temperature of 21°C was achieved in the turf.

The tents 4 or surrounded spaces 4 have about a ground area of 10×30 m to 15×30 m, or 30 m^2 to 400 m^2. Smaller tents 4 are used in order to care for regions which are very stressed locally, such as, for example, the region around the goal.

In a further exemplary embodiment, the device 1 comprises a plurality of segments 18 (Fig. 3) that are connected to one another. The structure corresponds to that of the above-described exemplary embodiment.

Each of the segments 18 has a length of approximately 5 m and a width of approximately 6 m. Two to five of these segments 18 can form a tunnel which covers a surface of approximately 150 m^2. Using, e.g., four of these tunnels (approximately 600 m^2), the turf area of a stadium (approximately 7000 m^2) is regenerated by sections.

The individual segments 18 of this tunnel are provided in their bottom edge region with wheels 19, in order to be displaceable on the turf 2 that is to be regenerated.

The segments 18 of the device 1 are constructed so as to be foldable (Fig. 3). In the folded state they have a length of approximately 80 cm and can be relocated using a simple lifting machine, for example a fork lift. The roofing wall 5 and the side walls 6 are preferably constructed of a transparent film that is permeable to light in order to supply the turf 2 that is to be regenerated with sunlight. The lighting means 14 can be switched off in daylight hereby, as a result of which considerable energy is saved.

At a height h measured from the turf 2, in each segment 18, lighting appliances 14 are present in the form of, for example, six lamps. The lamps are assimilation lamps from Phillips that are specially developed for photosynthesis, at, for example, 600W, and a lighting level of 100 to 200 µmol/m^2s.

The lamps are arranged at a height h of 1.6 m to 2.0 m, and preferably 1.8 m.

The lamps increase the ambient temperature by approximately 10°C. This is frequently sufficient to reach a temperature of 3°C to 5°C, even in winter, which the turf requires for growth.

In the case of high outdoor temperatures, it can be expedient to separate the lamps spatially from the gas-treated space, since they generate the most heat. Excessive temperatures would be harmful for the growth of the turf 2. Therefore, the device 1 according to the invention, according to a further embodiment, has a lighting space 20 in which the lighting means 14 are arranged and a regeneration space 21 in which the outflow device 8 is arranged. The lighting space 20 and the regeneration space 21 are separated from one another by a second roofing wall 22 which is constructed so as to be transparent or permeable to light, in order to allow through the solar irradiation. The second roofing wall 22 seals the regeneration space 21 gas-tightly and is arranged approximately 50 cm above the ground.

The lamps are arranged in the lighting space 20 below the ridge. The side walls 6 are provided with ventilation means 23 which are constructed as ventilation openings 23 in order to remove the heat of the lamps. The spatial separation and/or the open ventilation openings 23 prevent(s) an additional heating of the regeneration space 21.

The embodiment shown in Figs. 3 and 4 can also be constructed without subdivision of the enclosed space 4 into a lighting space 20 and a regeneration space 21.

The CO_2 concentration is preferably between 800 ppm CO_2 and 2000 ppm CO_2.

According to the invention, it is provided that the process is deployed and operated at a certain site for four to twelve hours and preferably ten to twelve hours, and is then redeployed in order to be operated further at a next site.

List of reference signs:

1 Device according to the invention
2 Turf
3 Subsoil
4 Enclosed space/tent
5 Roofing wall
6 Side walls
7 Side wall edges
8 Outflow device
9 Outflow openings
10 Gas store
11 Feed line
12 CO_2 sensor
13 Line
14 Lighting appliance
15 Fluorescent tubes
16 Arrows
17 Turf heating
18 Segment
19 Wheels
20 Lighting space
21 Regeneration space
22 Second roofing wall
23 Ventilation means

Patentkrav

1. Fremgangsmåde til vækstacceleration og regeneration af plænearealer, idet plænearealet (2) i det mindste i delområder på oversiden er omsluttet af et nedad åbent på alle sider omsluttet rum (4), og idet der ledes CO_2 ind i rummet (4), og det af rummet (4) overdækkede plæneareal (2) påvirkes med en belysningsanordning (14) med lys,
kendetegnet ved,
at CO_2-indholdet i rummet (4) fordeles ved hjælp af konvektion ved hjælp af den afgivne varme fra belysningsanordningen (14) og/eller en plæneopvarmning (17).

2. Fremgangsmåde ifølge krav 1,
kendetegnet ved,
at gasindholdet i rummet (4) indstilles til 500 til 2.000 ppm CO_2.

3. Fremgangsmåde ifølge krav 1 eller 2,
kendetegnet ved,
at CO_2-koncentrationen indstilles til i det mindste 500 ppm CO_2 og fortrinsvis til i det mindste 800 ppm CO_2.

4. Fremgangsmåde ifølge et af de foregående krav,
kendetegnet ved,
at der ledes CO_2 ind i det højeste område i rummet (4).

5. Fremgangsmåde ifølge et af de foregående krav,
kendetegnet ved,
at gasindholdet i rummet (4) indstilles til 500 til 1.500 ppm CO_2.

6. Fremgangsmåde ifølge et af de foregående krav,
kendetegnet ved,
at den inden i det overbyggede rum (4) eksisterende luft endvidere opvarmes med varmeanordninger.

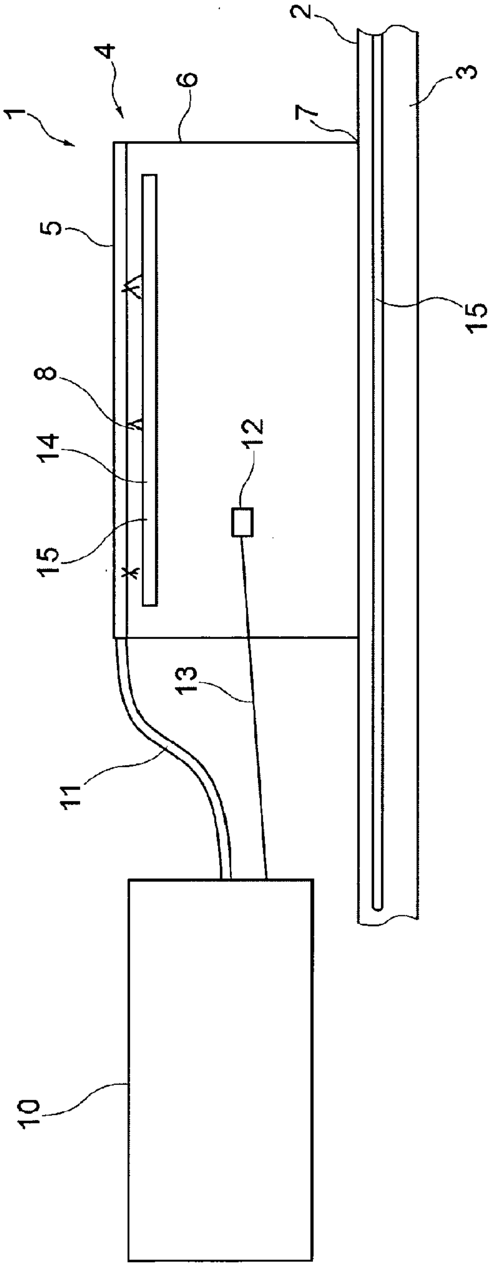

Fig. 1

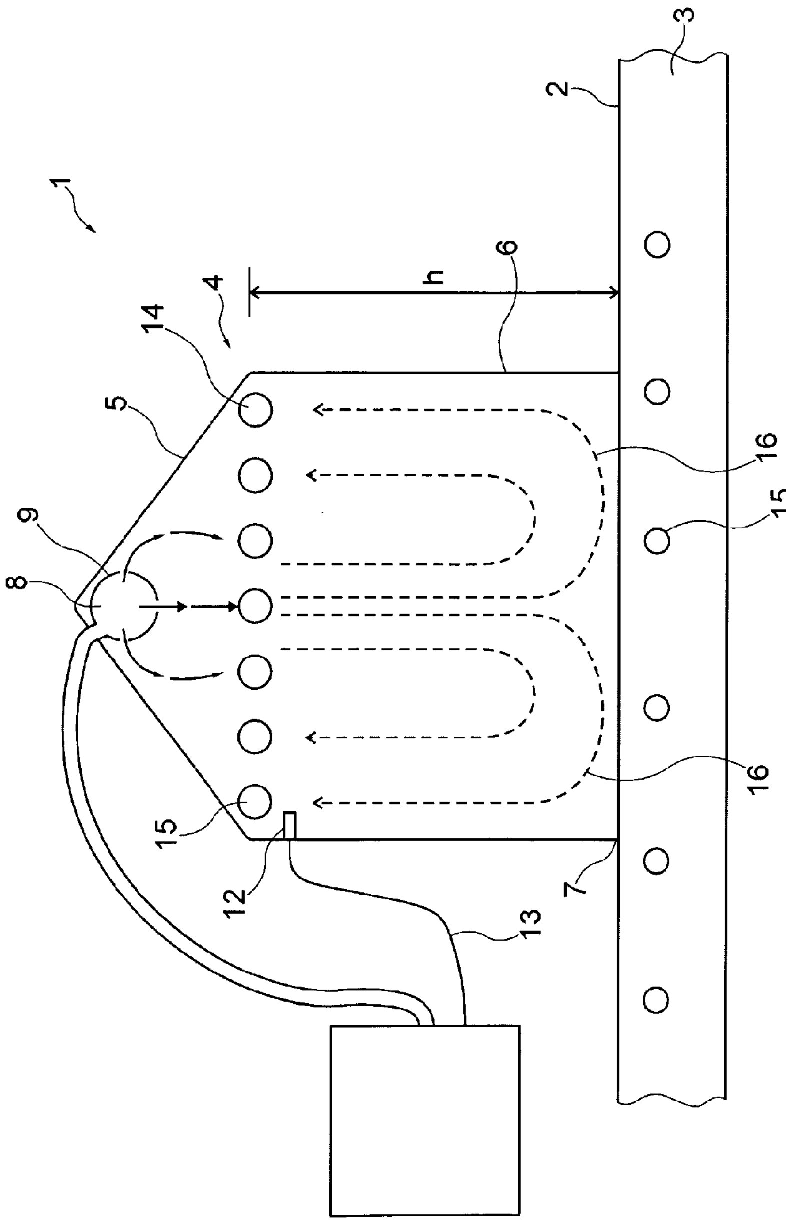

Fig. 2

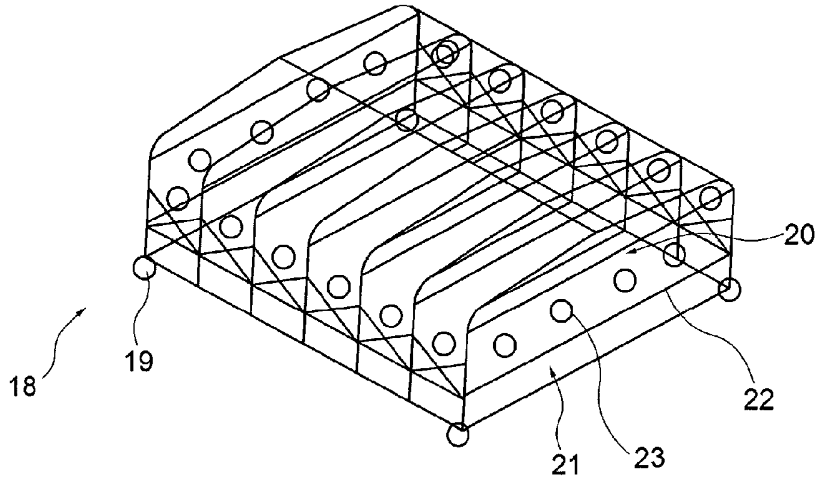

Fig. 3

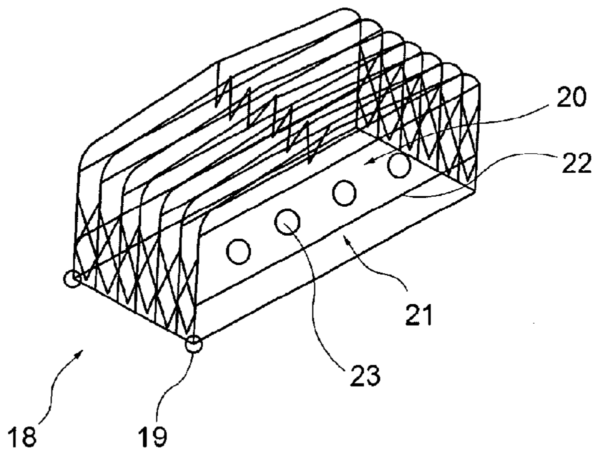

Fig. 4