(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 950 025 A1

# (12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**02.12.2015 Bulletin 2015/49**

(21) Application number: **15169357.9**

(22) Date of filing: **27.05.2015**

(51) Int Cl.:
***F27D 11/12*** *(2006.01)* ***B05D 7/14*** *(2006.01)*
***B05D 1/18*** *(2006.01)* ***E04C 5/01*** *(2006.01)*
***F27D 3/12*** *(2006.01)*

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
Designated Extension States:
**BA ME**
Designated Validation States:
**MA**

(30) Priority: **27.05.2014 IT CT20140010**

(71) Applicant: **Santonocito, Antonino**
**95040 Motta S. Anastasia (CT) (IT)**

(72) Inventor: **Santonocito, Antonino**
**95040 Motta S. Anastasia (CT) (IT)**

(74) Representative: **Sarpi, Maurizio et al**
**Studio Ferrario S.r.l.**
**Via Collina, 36**
**00187 Roma (IT)**

## (54) Electromagnetic heating transferring means for steel bars between working stations comprising two dip tanks containing bituminous solutions

(57) The plant comprises a metal cage or tunnel that develops longitudinally over the entire path from exit of the steel bars from the furnace or from where they are stored, up to the final station, covering two consecutive dip tanks, contained in which is bituminous solution at different temperatures. Said cage carries within it a bell-shaped thermo-electromagnetic device, closed at the bottom by an electromagnetic plate, which is slidingly guided in a suspended way along said cage. The electromagnetic plate defines within the bell a closed top compartment, which is used as chamber for containing equipment designed for heating, and a compartment open at the bottom, which serves as heating chamber for the bars, which are attracted by the electromagnetic plate and are carried by the bell to the various operating stations.

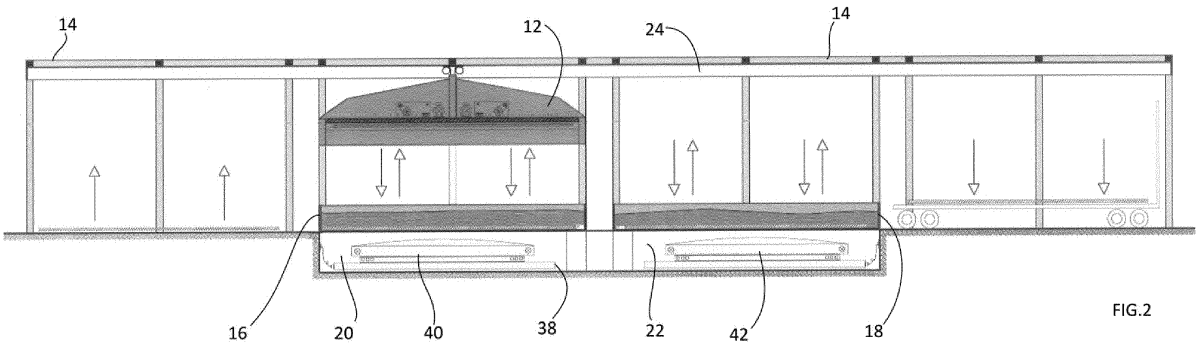



FIG.2

EP 2 950 025 A1

## Description

**[0001]** The present disclosure relates to the building sector and more in particular to an innovative method, and the corresponding means, for coating the steel bars used in the building sector with a layer of bituminous material in order to guarantee conservation thereof over time.

**[0002]** Right from the very first forms, up to the present day, reinforced-concrete structures have been subject to limited duration because the steel bars are inevitably attacked by rust (iron oxide), which jeopardizes the strength and integrity of the structures and which in the majority of cases leads to the need for demolition thereof.

**[0003]** A large number of scientific researchers (engineers, architects, scientists, experts on building materials, etc.) throughout the world have devoted their energy over the years to seeking a solution for improving the strength and conservation over time of steel bars for reinforced-concrete structures, above all in the United States of America, where there is a prevalence of skyscrapers, and for which huge amounts of capital have been invested but without any altogether satisfactory results since steel bars resist only for a limited time, with the result that after approximately 60-100 years such buildings undergo corrosion of the steel and have to be demolished.

**[0004]** The limit of researchers has been to concentrate their attention and experiments exclusively on cold-dipping of the bars in one and only one first tank, thus making just one first pass for treatment of the bars.

**[0005]** In the Italian patent No. 1403867 filed in the name of the present applicant, a process has been described for anti-oxidizing treatment with protective baths of bituminous material of the steel bars that are used in the building sector both in load-bearing structures made of steel structural work and as skeletons resistant to bending and shear stresses of reinforced concrete.

**[0006]** The above process envisages a series of production steps, respectively of impregnation, where the individual bar, at ambient temperature, first comes into contact with a bath of bituminous solution at a temperature of between 6°C and 10°C, then passes to a step of first drying in air at ambient temperature, followed by a second dipping in a second tank containing a hot bituminous emulsion kept at a temperature of between 350°C and 450°C for a certain time, and eventually passes to a final drying step, where it is left to cool at ambient temperature for a time interval that varies as a function of the ambient temperature in order to obtain a metal bar that cannot be attacked by corrosion.

**[0007]** A task of the present invention is to rationalize the above method, rendering the process of treatment of the bars no longer dependent upon the environmental conditions and hence upon the geographical area, the season, the natural temperature gradients, etc.

**[0008]** Another task of the invention is to guarantee industrial reproducibility of the method, enabling control of the temperatures throughout the treatment path from the point where the steel bars are picked up to the point where they are loaded onto the conveying trolley.

**[0009]** The above has been obtained, according to the invention, by resorting to a thermo-electromagnetic plant, which is able to measure, adapt, and balance the various temperatures of the steel bars that are to undergo treatment with the temperatures of the antioxidant bituminous solutions contained in the dip tanks described in the aforementioned Italian patent filed in the name of the present applicant, in addition to carrying out movement of the bars through the various operating stations.

**[0010]** In greater detail, with the present invention:

- the first step of the treatment has been improved in so far as it has been found that it is of fundamental importance to dip the bars in a tank, appropriately built, containing a bituminous solution that is cold but at an adequate constant temperature; and
- a second step has been devised, tested, and developed, which consists in providing a second tank immediately downstream of the first, without envisaging any intermediate steps, for dipping the bars into a special hot bituminous emulsion at an adequate constant temperature.

**[0011]** In the course of testing, the inventors have surprisingly found that the aforesaid constant temperature is of fundamental importance, since a higher or lower temperature would not prove suitable and would nullify the result thereof.

**[0012]** Consequently, forming a further object of the invention is a method that envisages:

measuring the temperature of the environment in which the steel bars are deposited, the temperature of the bituminous liquid contained in the two tanks, and the temperature of the loading environment;

adapting in succession the temperature of the environment where the steel bars are located to the temperature of the bituminous liquid of the first tank, to the temperature of the bituminous liquid of the second tank, and finally to the temperature of the loading environment;

balancing the various temperatures of the steel bars and of the dipping liquid throughout the treatment path; and

articulating the steps of treatment of the steel bars from the point where they are picked up from the ground or from the furnace to the point where they are loaded onto the trolley.

**[0013]** Yet a further object of the invention is to provide a plant equipped with a thermo-electromagnetic device designed to carry out in succession the various treatment steps starting from measurement of the temperature of the environment in which the steel bars are deposited.

**[0014]** According to the invention, the above plant ba-

sically comprises a metal cage or tunnel that develops longitudinally over the entire path from outlet of the steel bars from the furnace or from where they are stored up to the final station, covering two dip tanks, contained in which is bituminous solution at different temperatures. Provided inside said cage or tunnel is a thermo-electromagnetic device constituted by a bell, closed at the bottom by an electromagnetic plate, which is slidingly guided in a suspended way along a fixed horizontal guide, via a vertical load-bearing arm. In a preferred embodiment, said electromagnetic plate defines within the bell a closed top compartment, which is used as chamber for containing equipment, and a compartment open at the bottom, which serves as chamber for heating the bars since it is able to contain the steel bars, which that, once they have been attracted by the electromagnetic plate, are carried by the bell to the various operating stations.

**[0015]** The temperature of the steel bars, picked up from the environment where they are deposited, must first be adapted to that of the dipping liquid of the first tank, which consists of a cold bituminous solution (6°-10°C).

**[0016]** Once the steel bars have come out of the first tank, their temperature must be adapted to that of the dipping liquid of the second tank, which consists of a hot bituminous emulsion (390°-410°C).

**[0017]** Finally, the temperature of the bars that have come out of the second tank must be adapted to that of the loading environment so that they can be loaded onto the conveying trolley.

**[0018]** The bell has an electromagnetic field that has the basic function of binding the two elements, namely bitumen and iron (steel bars for reinforced-concrete structures), into just one element, which becomes a single body that is compact and resistant to corrosion over time.

**[0019]** Further characteristics and advantages of the invention will emerge clearly from the ensuing description, with reference to the attached plates of drawings, which illustrate, purely by way of nonlimiting example, a preferred embodiment thereof.

**[0020]** In the plates of drawings:

Figure 1 is a top plan view of the plant;

Figure 2 is a vertical cross-sectional view according to the plane of trace A-A of Figure 1, which shows the thermo-electromagnetic bell set in a position corresponding to the first tank containing the cold bituminous solution;

Figure 3 is a vertical cross-sectional view according to the plane of trace B-B of Figure 1 of the bell in the position of Figure 2;

Figure 4 is a vertical cross-sectional view according to the plane of trace A-A of Figure 2, at a larger scale, of just the bell; and

Figure 5 is a schematic perspective view of the longitudinal cage and of the thermo-electromagnetic bell.

**[0021]** With reference to the figures, the plant that is described is constituted by an electromagnetic bell 12 designed to slide within a metal cage 14, which extends throughout the path for treatment of the bars 15 from the point of exit of said bars from the furnace or the point where they are picked up from the ground where they have been accumulated up to the point where they are loaded onto the trolley that conveys the treated bars, covering also two dip tanks 16, 18 that contain the bituminous solution, which are kept at a differentiated temperature by two mutually independent combustion chambers 20 and 21, respectively, set underneath said tanks.

**[0022]** The electromagnetic bell 12 is guided so as to slide in the cage along a horizontal load-bearing shaft or beam 24 fixed on the roof of the cage itself thanks to a vertical supporting arm 26, the bottom end of which is anchored to a magnetic plate 28, which slides downwards along two guides 30 welded to the iron pillars distributed throughout the length of the cage.

**[0023]** The above magnetic plate 28 separates the inside of the bell 12 into two chambers: a top chamber 32, contained in which is the equipment 34 that has the function of gradually heating the steel bars (which are located in the underlying heating chamber) to the temperature established both for the first tank and for the second tank; and a bottom or heating chamber 36, which receives the heat from the equipment of the overlying chamber and located underneath which is the magnetic plate 28, which magnetically attracts the steel bars.

**[0024]** The magnetic plate 28 is, in fact, subject to magnetization and demagnetization for attraction and repulsion, respectively, of the steel bars 15.

**[0025]** The two metal tanks 16, 18, each measuring 2.00 m x 1.00 m, are located at the base of the cage. The first contains the cold bituminous solution and the second contains the hot bituminous solution in which the steel bars are to be dipped.

**[0026]** The two combustion chambers 42, 44 are equipped, respectively, with means 42 for heating the cold bituminous solution to the temperature of 6°-10°C, and with means 44 for heating the hot bituminous emulsion to the temperature of 390°-410°C.

**[0027]** The plant just described enables the operations outlined in what follows to be carried out.

Measurement of temperatures

**[0028]** With an appropriate distribution of temperature sensors, the temperature of the environment in which the steel bars are deposited is first measured. Then, the temperature of the bituminous dipping liquid in the first tank is measured. This is followed by measurement of the temperature of the bars after first dipping in the first tank and then measurement of the temperature of the bituminous dipping liquid in the second tank. Finally, the temperature of the loading environment is measured.

**[0029]** The temperature of the liquid both in the first tank and in the second tank (which is practically standard

for each of the tanks) is fixed at the start of each treatment cycle (within the limits established).

Adaptation of the temperatures

a) Adaptation of the ambient temperature of the steel bars to that of the (antioxidizing) bituminous liquid in the first tank

**[0030]** The temperature of the environment in which the steel bars are deposited may vary considerably in so far as it depends upon the geographical area (in northern areas, it is approximately 15°C below zero; in southern areas, it is approximately 40°C above zero), the season, the place, the natural temperature gradients, etc. Hence, before the steel bars are dipped into the cold bituminous solution of the first tank, they must be adapted to the temperature thereof, which should be 6°-10°C.

**[0031]** A difference of a few degrees centigrade (more or less, for at most 2°C) is insignificant in so far as the temperature of the bars will be regulated by the temperature of the bituminous dipping liquid.

b) Adaptation of the temperature of the bars after dipping in the liquid of the first tank (6°-10°C) to that of the (antioxidizing) bituminous liquid of the second tank (390°-410°C)

**[0032]** After the steel bars have been dipped in the bituminous liquid of the first tank, they have a mean temperature of 8°C, and this temperature will have to be adapted to the mean temperature of 400°C of the liquid, i.e., the hot bituminous emulsion, of the second tank.

**[0033]** A difference of several degrees centigrade (more or less, for at most 10°C) is insignificant in so far as the temperature of the bars will be regulated by the temperature of the bituminous dipping liquid in the second tank.

**[0034]** Adaptation of the temperatures as described above is obtained via appropriate heating devices located within the so-called "equipment chamber", which gradually bring the temperature of the bars to higher values to enable dipping in the bituminous liquid of the two tanks.

**[0035]** When the bars are to be dipped in the bituminous liquid of the second tank, they will never have a mean temperature of 400°C but will gradually adapt to the temperature of the dipping liquid, given that iron is a conductor that immediately absorbs heat, reaching high temperatures.

**[0036]** Careful control of the temperatures and consequent adaptation both of the steel bars and of the bituminous dipping liquid enables the bars to blend with the hot bituminous liquid in an optimal way as compared to a simple or normal dipping.

**[0037]** Considering the dimensions of a tank with a width of 1.00 m and a length of 2.00 m, this will be able to contain twenty-four steel bars with a total weight of 120 kg.

Balancing of the temperature variations

**[0038]** The electromagnetic field produced by the bell has the function of:

a) balancing the variations of temperature throughout the treatment path from the point where the steel bars are picked up from the ground or from the furnace to the point where they are loaded onto the trolley so that they will not undergo alterations such as scaling, air bubbles, or pitting in which a gap is created that does not enable the bituminous liquid to adhere, and consequently the bars will be subject to deterioration and hence be unusable;
b) binding the hot bituminous emulsion at the mean temperature of 400°C to the steel bars at the same temperature at the moment of dipping using the magnetic plate in such a way that the two elements, namely, bitumen and iron (steel bars), combine to form just one element, thus constituting a single body that is compact and resistant to corrosion over time; the electromagnetic field of the bell does not act on the hot bituminous liquid, but acts directly and specifically on the steel bars in so far as it causes an increase in the attractive energy of the steel bars so as to get the bitumen to penetrate therein or, rather, to get the element iron to bind with the element bitumen, it being at the same time important to bear in mind that bitumen does not penetrate in depth or, rather, into the central care of the steel bar; and
c) magnetizing and demagnetizing the magnetic plate to enable attraction and repulsion, respectively, of the steel bars and passage thereof through the four process steps.

**[0039]** In conclusion, the electromagnetic bell hence has the function of measuring, adapting, and balancing the variations of the temperatures of the steel bars throughout the processing cycle and of the bituminous liquid of the two tanks, which constitutes the basic premise for creating a protection for the bars such as to render them corrosion-resistant; i.e., they cannot be attacked by rust and are indestructible over time.

**[0040]** The bell, with all its articulated passes, is basically the device that enables blending of the two elements, bitumen and iron, into just one.

Steps of treatment of the steel bars

**[0041]** Control of the temperatures must be carried out throughout the treatment path from the point where the steel bars are picked up from the ground or from the furnace to the point where they are loaded onto the trolley and follows the four steps below.

Step I

**[0042]** Once the steel bars have been raised from the level of the furnace or the ground to the level of the first tank, they undergo adaptation in temperature from the value of ambient temperature to the value of the mean temperature of the dipping liquid, which is 8°C.

Step II

**[0043]** The steel bars are lowered right down to the bottom of the first tank so as to be entirely dipped in the cold bituminous solution (6°-10°C).

**[0044]** They are then raised from the bottom of the first tank to the level of the second tank.

Step III

**[0045]** The steel bars are lowered right down to the bottom of the second tank. As they are lowered, they gradually undergo adaptation to the temperature of the hot bituminous emulsion (390°-410°C).

Step IV

**[0046]** As the steel bars are raised from the bottom of the second tank, they gradually undergo adaptation to the ambient temperature of the loading environment, and are pushed out so as to be loaded onto the trolley and conveyed into the various workplaces, now ready to confront any temperature.

**[0047]** Once a first cycle of treatment of the steel bars has been completed, a subsequent new cycle automatically starts, and so forth.

**[0048]** The thermo-electromagnetometer may be installed in a structure additional with respect to the steel-production complex or in another place prepared for treatment of steel bars.

**[0049]** With the present invention, the major drawback of iron (namely, rust, i.e., iron oxide) is overcome, so that large structures, such as large public buildings, skyscrapers, bridges, viaducts, and so forth, that will be built with these new criteria will no longer have to undergo demolition within a short stretch of time (60-100 years, as occurs today) but will even last for centuries.

**[0050]** Rusting, in fact, in addition to jeopardizing the compressive strength of steel, causes increase in the volume thereof, which can thus cause cracking of the concrete that coats it.

**[0051]** It should be emphasized that, without adaptation of the temperatures of the steel bars to those of the liquid of the two tanks, the steel would undergo alterations, namely, scaling, such as to render it unusable and inefficient.

Control of the structure of steel and concrete

**[0052]** It is indispensible for the heating and dipping steps to be carried out as accurately as possible, since they are determining factors in so far as they affect the structure of iron (steel bars).

**[0053]** Of primary importance is adaptation of the temperatures, both during the first pass and during the second pass, so that it is necessary to:

- check the structure of the steel bars to verify that that they are homogeneous and are impregnated uniformly, thus preventing any sharp jumps in temperature from start to end of the treatment process;
- observe the rules regarding reinforced concrete (right dosage, water-to-cement ratio, perfect packaging and compaction of the mixture); and
- ensure perfect adherence of the concrete to the steel bars.

**[0054]** In this connection, it is to be emphasized that in a preferred embodiment the operating rules outlined below are to be followed.

**[0055]** The steel bars with improved adherence that come out of the furnace are made to cool naturally down to the ambient temperature Ta.

**[0056]** Only when the bars have reached said temperature is treatment started, i.e., dipping of the bars in the first tank, which contains the cold bituminous solution at a temperature of from 6°C to 10°C (preferably a mean temperature of 8°C) for a maximum duration of 2 minutes.

**[0057]** Once the temperature of the bituminous liquid to be maintained has been established, e.g. 8°C, this must remain constant throughout the treament cycle of dipping of the bars in order for them to be homogeneous.

**[0058]** Constant temperature is of fundamental importance from the structural standpoint of iron (steel bars) since a temperature different from the one established at the start and different during the course of treatment produces bars with different degrees of absorption, and hence not homogeneous.

**[0059]** Of considerable importance are also the modalities of impregnation of the bars in the liquid. Impregnation must take place in a uniform manner over all the bars: a small variation of temperature and impregnation are sufficient for there to be produced bars that are not homogeneous and uniform.

**[0060]** It is important to guarantee that the constancy in temperature and the uniformity of impregnation are maintained during dipping of the bars also in the second tank, which contains the hot bituminous emulsion at the temperature of 390-410°C (preferably the intermediate temperature of 400°C).

**[0061]** Once the temperature to be maintained for the liquid has been set (e.g. 400°C), this must remain constant during dipping of the bars for a maximum duration of 2 minutes, to prevent bars with different degrees of absorption from being obtained, as has already been said as regards the first tank.

**[0062]** Likewise, as in the first pass within the first tank, also in the second pass within the tank at 400°C, impreg-

nation must take place in a uniform way.

## Claims

1. A thermo-electromagnetic plant for antioxidizing treatment of steel bars used in the building sector by means of protective baths with bituminous materials, **characterized in that** it comprises:

   a metal cage or tunnel that develops longitudinally over the entire path that the steel bars follow from their exit from the furnace or from where they are stored, there being provided in said path various operating stations that comprise two consecutive dip tanks containing bituminous solution at different temperatures; and
   within said cage or tunnel, a thermo-electromagnetic device constituted by a bell, closed at the bottom by an electromagnetic plate, which is slidingly guided along a fixed horizontal guide,
   said electromagnetic plate defining within the bell a closed top compartment, which is used as chamber containing equipment that also has the function of gradually heating the steel bars, which, once attracted by the electromagnetic plate, are received in the open underlying compartment, which serves as heating chamber, and are then carried, having been magnetized by said bell, to the various operating stations.

2. The thermo-electromagnetic plant as per the preceding claim, **characterized in that** within said cage or tunnel the electromagnetic device is slidingly guided suspended along a horizontal guide fixed at the top to said cage via a vertical load-bearing arm.

3. The thermo-electromagnetic plant as per the preceding claims, **characterized in that** of the two metal tanks located at the base of the cage, the first one reached by the steel bars along their path within the cage or tunnel contains the cold bituminous solution and the second tank contains the hot bituminous emulsion,
   underneath the two metal tanks there being provided two combustion chambers, the first of which is equipped with means for heating the cold bituminous solution to the temperature of 6°-10°C, and the second is equipped with means for heating the hot bituminous emulsion to the temperature of 390°-410°C.

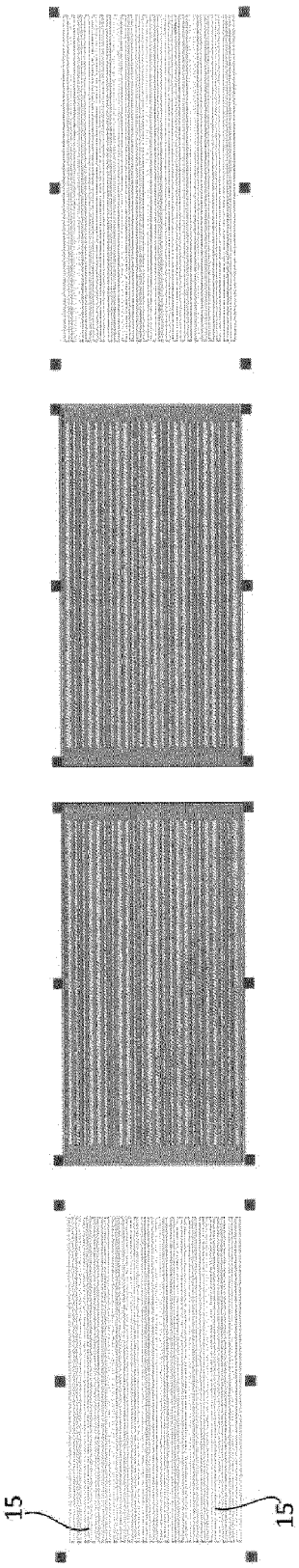



FIG.1

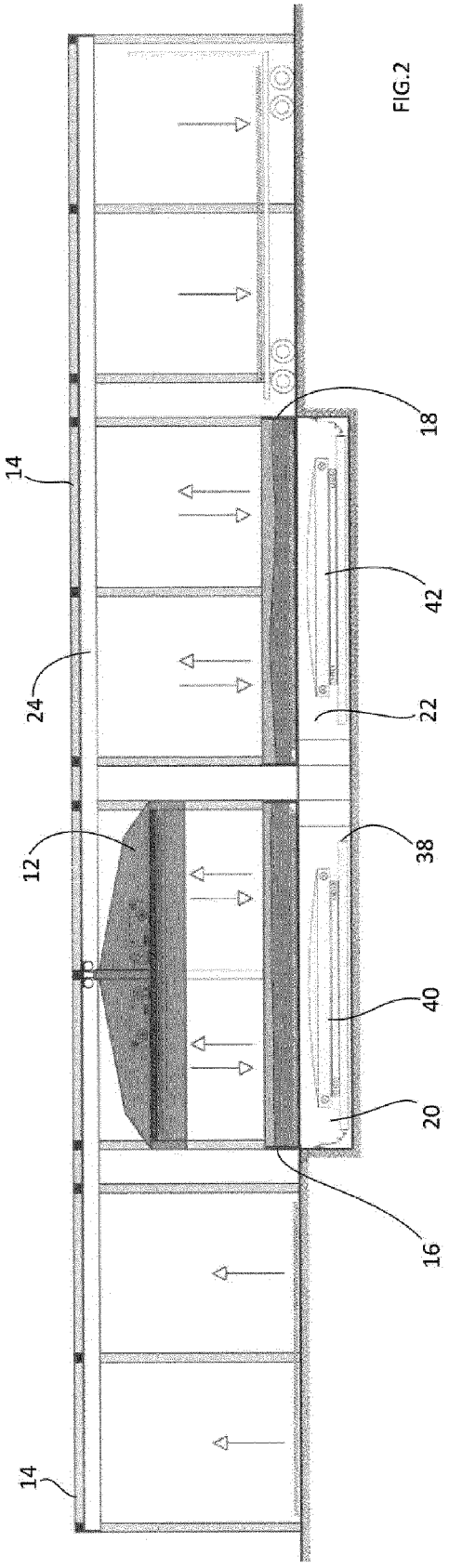
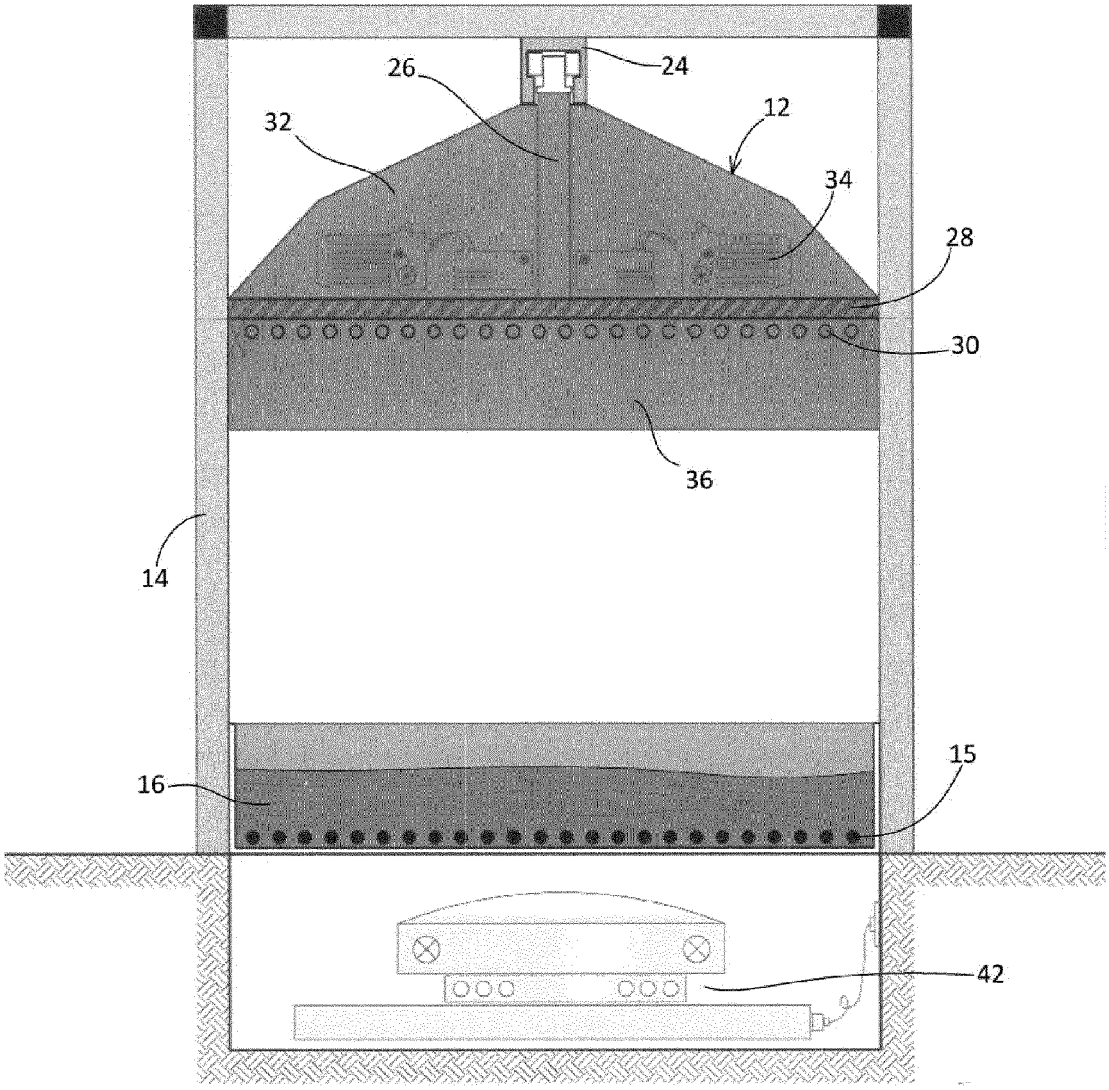



FIG.2

FIG.3



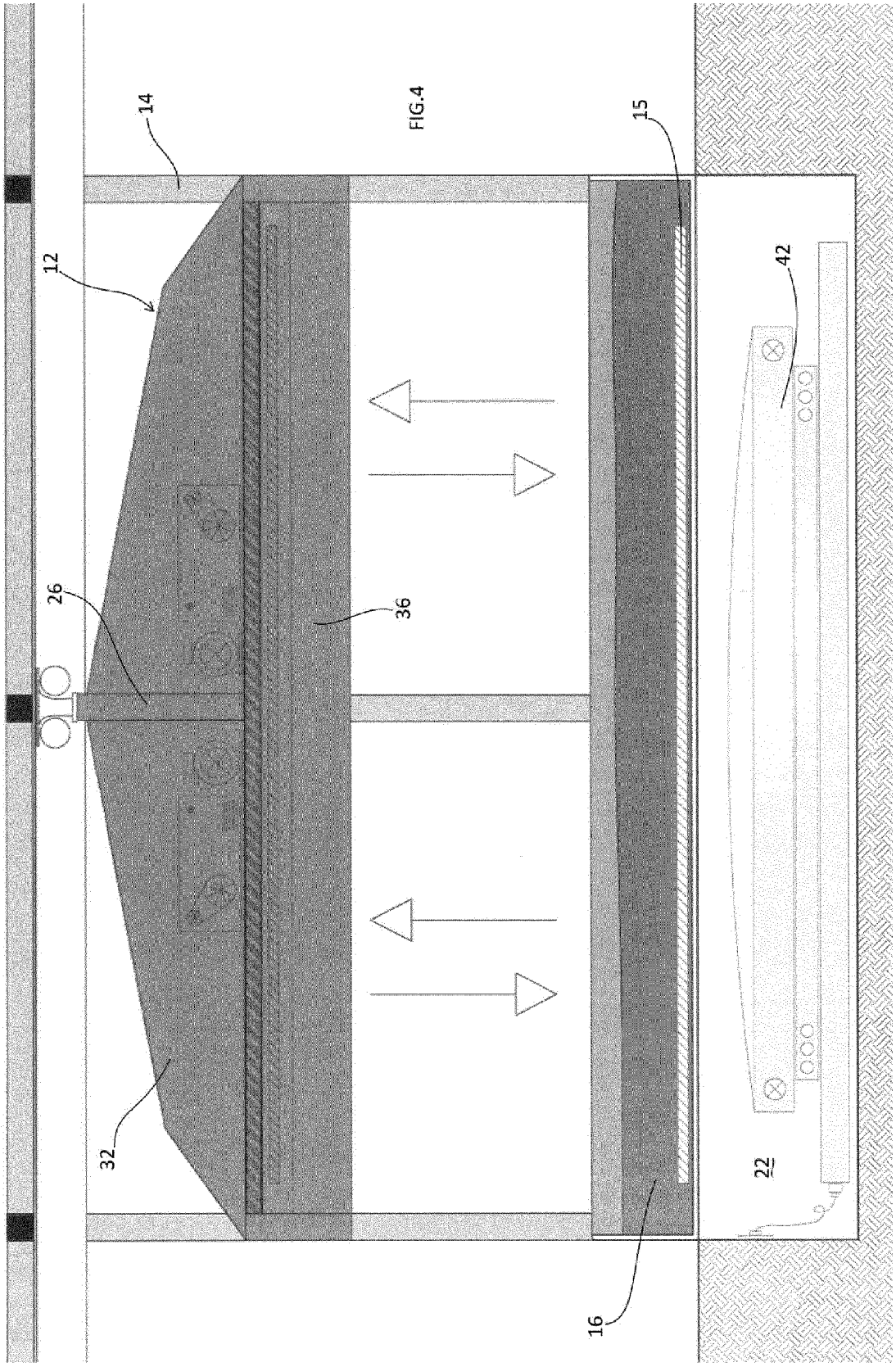



FIG.4

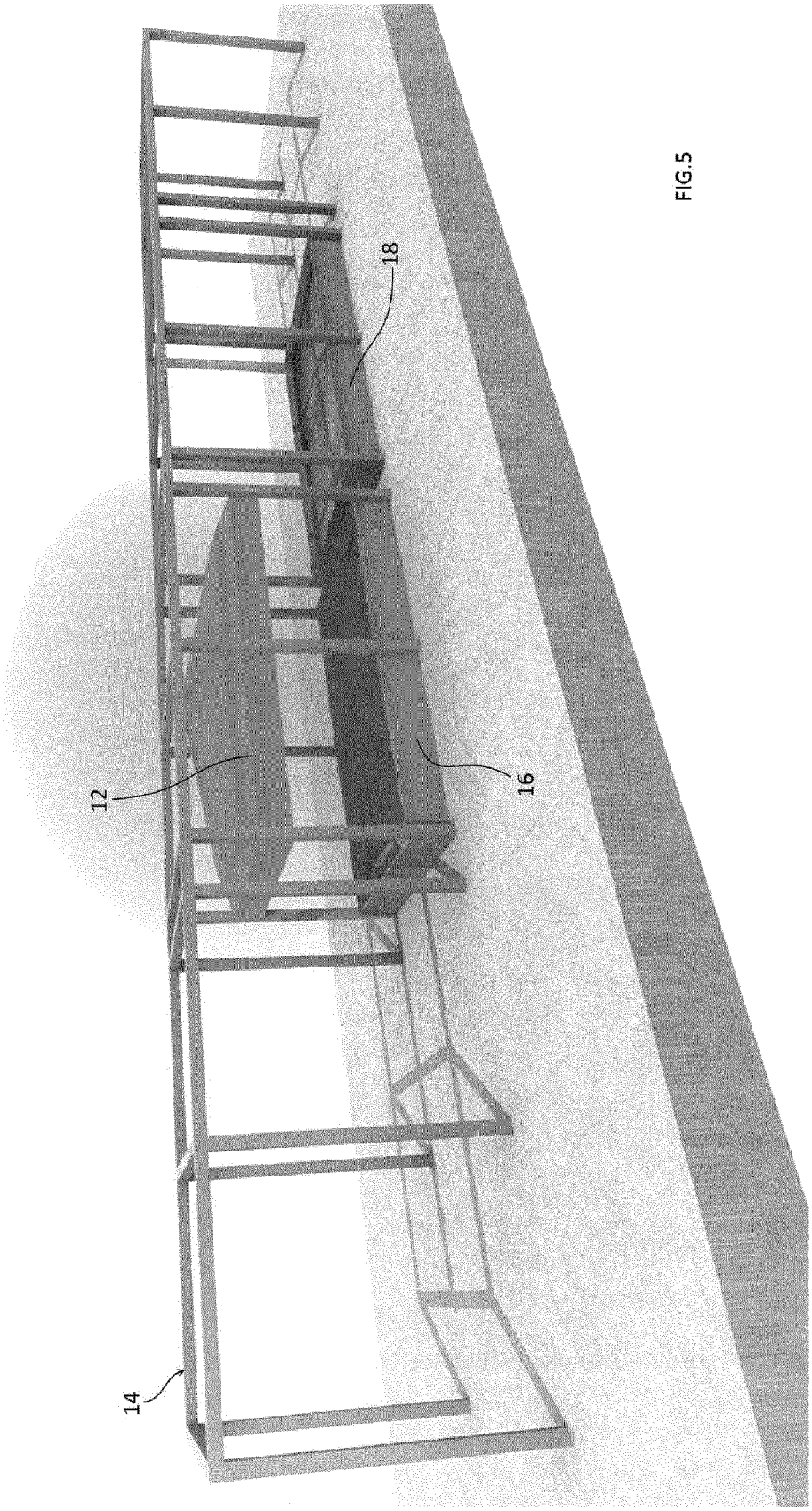



FIG.5

Europäisches Patentamt
European Patent Office
Office européen des brevets

# EUROPEAN SEARCH REPORT

Application Number
EP 15 16 9357

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| A | EP 2 484 841 A1 (SANTONOCITO ANTONINO [IT]) 8 August 2012 (2012-08-08)<br>* the whole document * | 1-3 | INV.<br>F27D11/12<br>B05D7/14<br>B05D1/18 |
| A | JP 2005 231796 A (SUMITOMO CONSTR MACHINERY MFG)<br>2 September 2005 (2005-09-02)<br>* abstract; figures 1-4 * | 1-3 | E04C5/01<br>F27D3/12 |
| A | US 3 871 533 A (MULCAHY JOSEPH ALOYSIUS ET AL) 18 March 1975 (1975-03-18)<br>* the whole document * | 1-3 | |
| A | RU 2 181 174 C2 (INST TRANSPORTA EHNERGORESURSO) 10 April 2002 (2002-04-10)<br>* abstract; figures 1-5 * | 1-3 | |

TECHNICAL FIELDS SEARCHED (IPC)

F27D
B05D
E04C

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 21 September 2015 | Gavriliu, Alexandru |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 15 16 9357

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

21-09-2015

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| EP 2484841 A1 | 08-08-2012 | DK 2484841 T3 | 27-01-2014 |
| | | EP 2484841 A1 | 08-08-2012 |
| | | ES 2443586 T3 | 19-02-2014 |
| JP 2005231796 A | 02-09-2005 | NONE | |
| US 3871533 A | 18-03-1975 | NONE | |
| RU 2181174 C2 | 10-04-2002 | NONE | |

EPO FORM P0459

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

## REFERENCES CITED IN THE DESCRIPTION

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

### Patent documents cited in the description


- IT 1403867 **[0005]**