



(51) International Patent Classification:
B65G 25/06 (2006.01)

(21) International Application Number:

PCT/EP2023/083313

(22) International Filing Date:

28 November 2023 (28.11.2023)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

LU503128

02 December 2022 (02.12.2022) LU

(71) Applicant: **PAUL WURTH S.A.** [LU/LU]; 32, rue d'Alsace, 1122 Luxembourg (LU).

(72) Inventors: **ARÁUJO, José Geraldo**; Rua Cabo Verde 391/501, Cruzeiro, 30310-260 Belo Horizonte - Minas Gerais (BR). **DE OLIVEIRA EVANGELISTA, Emerson Luis**; Rua Castelo de Tordesilhas, 155, Bairro Castelo,

31330-230 Belo Horizonte - Minas Gerais (BR). **DUTRA DA SILVA, Renato**; Rua Marilda 284, Bairro Flávio Marques Lisboa, Belo Horizonte - Minas Gerais (BR).

(74) Agent: **OFFICE FREYLINGER**; B.P. 48, 234, route d'Ar-lon, 8001 Strassen (LU).

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(54) Title: RECIPROCATING FLOOR

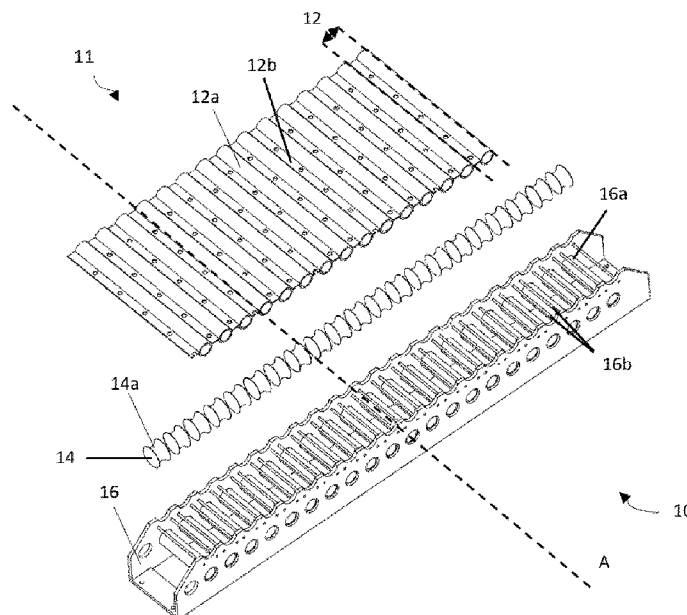


Fig. 1.

(57) Abstract: A moving floor for transport of a load along a transport direction comprises a deck composed of a plurality of elongate elements extending parallel to the transport direction, a base, and a plurality of rollers mounted between the base and the deck. At least one elongate element has an elongate tubular portion extending parallel to the transport direction and at least one roller of the plurality of rollers is a concave roller, the outer circumferential rolling surface of which having an annular recess extending in circumferential direction, said at least one elongate tubular portion being supported by the least one concave roller such that the tubular portion is at least partially fitted inside the annular recess of said concave roller.



(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

Reciprocating Floor

Technical field

[0001] The present invention generally relates to moving floors, also commonly known as walking floors or reciprocating floors. More specifically, the invention relates to a robust moving floor able to withstand high temperatures.

Background of the Invention

[0002] Moving floors are commonly used in warehouses, loading docks and trucks to automate the transport of a load charged on the moving floor.

[0003] Moving floors usually comprise a deck composed of a plurality of parallel elongate slats, a base supporting the slats in a slidable way, three transverse rulers connecting the slats alternately and forming three sets of slats, and three driving means to drive each set of slats in a back and forth movement.

[0004] The sets of slats are able to be powered by the driving means and the rulers to move either in unison or one at a time. When all three sets move in unison, friction drives the load in the same direction as the slats. Conversely, when only one set moves at a given time, the load remains static on the deck. Hence, in order to move a load in a specific transport direction, the moving floor will first move the sets of slats in unison in the transport direction to drive the load in the transport direction, before retracting them one at a time in the opposite direction, keeping the load static. Once all the sets of slats are retracted this operation can be repeated indefinitely to continuously move the load in the transport direction.

[0005] To reduce friction between the slats and the base, a polymeric tape or coating is typically applied on a surface of the base. This solution is however not practical in applications requiring temperature above 100°C due to the low resistance of the polymeric tape or coating. Traditional moving floor are thus not suited for such applications, which include drying systems and cooling systems.

Object of the invention

[0006] It is an object of the present invention to provide a moving floor able to withstand high temperatures, that is also durable and easily maintainable.

[0007] This object is achieved by a moving floor according to claim 1.

[0008] It is a further object of the invention to provide a moving floor able to improve the ventilation of the load charged on its deck, which can be particularly useful in applications requiring high thermal transfer between a load and surrounding gases.

General Description of the Invention

The present invention provides a moving floor for transport of a load along a transport direction, comprising a deck composed of a plurality of elongate elements extending parallelly to the transport direction, a base, and a plurality of rollers mounted between the base and the deck. Each roller of said plurality of rollers has an outer circumferential rolling surface, said plurality of rollers being configured for supporting the elongate elements by the respective outer circumferential rolling surface and for enabling rolling movements of the elongate elements parallelly to the transport direction.

The moving floor further comprises at least three connecting means to connect the elongate elements alternately, forming at least three sets of alternating elongate elements, and at least three driving means to drive back and forth movements of each set of elongate elements.

In use, the load is charged on top of the deck and is supported by the elongate elements, each supported by one or more of a plurality of rollers so as to enable rolling movements of the elongate elements parallelly to the transport direction, the rollers being mounted on the base.

Hence, when a driving means is actuated to drive a movement of a set of elongate elements, the driven elongate elements are able to roll on the plurality of rollers supporting them. The plurality of rollers thus enables motion of the elongate elements with little friction, and hence little wear.

[0009] According to the invention, at least one elongate element has an elongate tubular portion extending parallelly to the transport direction and at least one roller of the plurality of rollers is a concave roller, the outer circumferential rolling surface of which having an annular recess extending in circumferential direction, said at least one elongate tubular portion being supported by the least one concave roller such that the tubular portion is at least partially fitted inside the annular recess of said concave roller.

[0010] Tubular geometries have been found to be particularly effective in resisting deformation, even when exposed to high temperatures. Hence by supporting the load with a tubular portion, the durability of the elongate element is drastically improved. Furthermore, the manufacture of tubes suited for hot work is a simple and economical process, thereby facilitating replacement of the elongate element and the maintenance of the deck.

[0011] By using a concave roller having an annular recess in which the tubular portion can be fitted, the drawbacks of using tubular geometry can be avoided. Indeed, an element of tubular geometry would normally be susceptible of moving sideways by rolling or vertical rotation. In the context of the invention, this could potentially lead to contact between an elongate element and the base or between two adjacent elongate elements, thereby increasing frictional wear. Moreover, transversal displacement of elongate elements could lead to gaps in the deck, through which some of the load could fall. However, the geometry of concave rollers according to the invention locks tubular portions to the plane of rotation of their respective rollers, such that motion in any other direction is prevented, with little to no increase in friction. The elongate elements are thus stabilized, only able to move in the plane of rotation of their respective rollers, and do so with little friction.

[0012] In embodiments, a plurality of, preferably most of, ideally all, of the rollers are concave rollers, the outer circumferential rolling surface of which having an annular recess extending in circumferential direction, and a plurality of, preferably most of, ideally all of, the elongate elements have an elongate tubular portion extending parallelly to the transport direction, each being supported by at least one concave roller, such that the tubular portions are at least partially fitted inside the annular recess of concave rollers.

[0013] In embodiments, an elongate element having a tubular portion further comprises an elongate plate portion, the tubular portion and the plate portion of said elongate element being connected along their length, preferably by welding.

[0014] The plate portion serves to narrow the gaps between adjacent elongate elements, allowing a given number of tubular portions to cover a wider area or a given area to be covered by fewer tubular portions. As elongate plates suitable for hot works can also be cheaply manufactured and are easily attachable to the tubular portion, the maintenance costs of the deck further decrease.

[0015] Tubular portions and/or plate portions may be perforated so as to allow vertical flow of air through the deck. Ventilation through the deck is particularly relevant in applications a high degree of thermal transfer, such as driers or coolers.

[0016] Preferably, the rollers are mounted within the base so as to be free for rotation and/or linear movement parallel to the transport direction . The rollers being free for linear movement further decreases friction at the tubular portion.

[0017] In particular, the base has at least one tubular support parallel to the transport direction for supporting at least one concave roller, the tubular support being able to fit at least partially inside the annular recess of the concave roller. Hence each concave roller is simply lodged between a tubular support of the base and the tubular portion of an elongate element. Replacement of the rollers is simple and does not require heavy machinery. Most importantly, vertical rotation of a concave roller is restricted by the tubular support, which guarantees that the plane of rotation of the concave rollers is always parallel to the tubular support and thus to the transport direction, further stabilizing the linear motion of the elongate elements.

[0018] Preferably, the base comprises lateral supports configured to limit rotation of each roller about the tubular support supporting it.

[0019] The connecting means may comprise transversal rulers. The at least three driving means may comprise at least one of hydraulic, pneumatic and/or electric cylinders.

[0020] Preferably only materials able to withstand high temperatures are used in the moving floor, thereby increasing its durability at high temperatures. Hence, the elongate elements, the base and/or the rollers may be made of metal, preferably of an alloy such as bronze and/or cast steel.

[0021] Preferably, the diameter of tubular portions (12a) is comprised between 30 et 100mm and/or their length between 6 and 25m, and the diameter of rollers (14) is comprised between 50 and 150 mm.

[0022] Preferably, the width of plate portions (12b) is comprised between 25 and 75mm, their thickness between 6 and 20mm and/or their length between 6 and 25m.

[0023] In embodiments, a hot air blower is configured to blow hot air underneath the deck, at temperatures preferably comprised between 100 and 400°C.

[0024] A moving floor as described above may be used in a thermal transfer system such as a drying system or a cooling system.

Brief Description of the Drawings

[0025] Further details and advantages of the present invention will be apparent from the following detailed description of not limiting embodiments with reference to the attached drawing, wherein:

Fig.1 shows an exploded view of a segment of the moving floor supporting the load according to an embodiment of the invention.

Fig.2 shows an assembled view and a side view of an identical segment.

Fig.3 shows a top view of the moving floor according to an embodiment of the invention at different stages in the process of transporting a load.

Description of Preferred Embodiments

[0026] Figure 1 illustrates a segment of the moving floor 10 supporting the load according to an embodiment of the invention. As it can be seen, this segment of the moving floor 10 comprises a deck 11 composed of a plurality of elongate elements 12, which extend parallelly to a transport direction A. Each elongate element 12 comprises an elongate tubular portion 12a and an elongate perforated plate portion 12b. The tubular portions 12a and the plate portions 12b extend parallelly to the transport direction A. Each plate portion 12b is connected to a single tubular portion 12a.

[0027] This segment of the moving floor 10 further comprises concave rollers 14 having an annular recess 14a, and a base 16 having a plurality of tubular supports 16a and lateral supports 16b. The annular recess 14a of each concave roller 14 extends circumferentially along its outer circumferential rolling surface, and the tubular and lateral supports 16a, 16b extend parallelly to the transport direction A.

[0028] Figure 2 illustrates an identical segment. For the sake of clarity, only part of the supporting structure of the moving floor 10 is shown on Figures 1 and 2. In reality, the elongate elements 12 extend further along the transport direction A and

cover the entire width of base 16. Furthermore, a plurality of bases identical to base 16 are parallelly placed at regular intervals along the transport direction A, each having an identical plurality of concave rollers 14. Each elongate element 12 is thus associated to a plurality of aligned concave rollers 14.

[0029] In use, the load is charged on top of a deck 11. The tubular portion 12a of each elongate element 12 is vertically supported by a plurality of concave rollers 14 having an annular recess 14a. The tubular portions 12a are mounted on the concave rollers 14 and are partially fitted inside the concavity formed by the annular recess 14a. Movement of the elongate elements 12 is thus restricted to the plane of rotation of the concave rollers 14. Each concave roller 14 is itself vertically supported by a tubular support 16a of the base 16, with the tubular support 16a being partially fitted inside the concavity formed by the annular recess 14a. Hence, the plane of rotation of each concave roller 14 is locked to the axis of elongation of its tubular support 16a. Each concave roller 14 is supported on its sides by a pair of bars 16b, ensuring the concave roller 14 remains directly above its tubular support 16a.

[0030] Hence movement of each elongate element 12 is restricted to the plane of rotation of its concave rollers 14, which is itself locked to the axis of elongation of their tubular support 16a, which is itself parallel to the transport direction A. Therefore, when elongate elements 12 are mounted on their plurality of aligned concave rollers 14, linear motion of the elongate elements 12 may only occur parallelly to the transport direction A. As the concave rollers 14 are free for rotation on a plane parallel to the transport direction A and free for linear movement on axes parallel to the transport direction A, linear motion of the elongate elements 12 occurs with minimal friction and thus minimal wear.

[0031] Figure 3 illustrates the moving floor 10 according to an embodiment of the invention at different stages in the process of transporting a load. As top views are illustrated on figure 3, the concave rollers 14 and the bases 16 are located 'behind' the deck 11 and thus not visible.

[0032] As it can be seen, rulers 18a, 18b, 18c connect the elongate elements 12 of the deck 11 alternatively. If the elongate elements 12 were to be numbered from left to right, ruler 18a would connect the elongate elements satisfying the equation $N=3k+1$, ruler 18b would connect the elongate elements satisfying the equation $N=3k+2$, and ruler 18c would connect the elongate elements satisfying the equation

$N=3k$, where N is the number of each ruler and k an integer. Rulers 18a, 18 b and 18c are respectively coupled to hydraulic cylinders 20a, 20b and 20c, and are configured to transfer the motion from their respective hydraulic cylinders 20a, 20b, 20c to their associated elongate elements 12. Hydraulic cylinders 20a, 20b, 20c are configured to extend and retract in the transport direction A.

[0033] The process of transportation of a load charged on top of deck 11 is as follows:

- In Step 1, all the cylinders 20a, 20b, 20c are extended at the same time, all the elongate elements 12 move forward (towards the top of figure 3), and the load is moved forward by friction with the elongate elements 12.
- In Step 2, only cylinder 20a is retracted, only elongate elements satisfying the equation $N=3k+1$ move backward, and the load remains static.
- In Step 3, only cylinder 20b is retracted, only elongate elements satisfying the equation $N=3k+2$ move backward, and the load remains static.
- In Step 4, only cylinder 20c is retracted, only elongate elements satisfying the equation $N=3k$ move backward, and the load remains static.

[0034] After Step 4, all the cylinders 20a, 20b, 20c are retracted, and the process can be repeated indefinitely from Step 1 until all of the load has reached the desired location.

Claims

1. A moving floor (10) for transport of a load along a transport direction comprising:
- a deck composed of a plurality of elongate elements (12) configured for supporting the load, the elongate elements (12) extending parallelly to the transport direction;
 - a plurality of rollers (14) mounted underneath the deck, each roller of said plurality of rollers (14) having an outer circumferential rolling surface, said plurality of rollers configured for supporting the elongate elements (12) by the respective outer circumferential rolling surface and for enabling rolling movements of the elongate elements (12) parallelly to the transport direction;
 - a base (16) on which the rollers (14) are mounted;
 - at least three connecting means (20a, 20b, 20c) connecting the elongate elements (12) alternately, forming at least three sets of connected elongate elements (12);
 - at least three driving means (18a, 18b, 18c) configured for driving back and forth movements of each set of connected elongate elements (12);
- characterized in that** at least one elongate element (12) has an elongate tubular portion (12a) extending parallelly to the transport direction and at least one roller of the plurality of rollers (14) is a concave roller, the outer circumferential rolling surface of which having an annular recess (14a) extending in circumferential direction, said at least one elongate tubular portion (12a) being supported by the least one concave roller (14) such that the tubular portion (12a) is at least partially fitted inside the annular recess (14a) of said concave roller (14).
2. The moving floor (10) according to claim 1, wherein a plurality of, preferably most of, ideally all, of the rollers (14) are concave rollers, the outer circumferential rolling surface of which having an annular recess (14a) extending in circumferential direction, and
- wherein a plurality of, preferably most of, ideally all of, the elongate elements (12) have an elongate tubular portion (12a) extending parallelly to the transport direction, each being supported by at least one concave roller (14), such that

the tubular portions (12a) are at least partially fitted inside the annular recess (14a) of concave rollers (14).

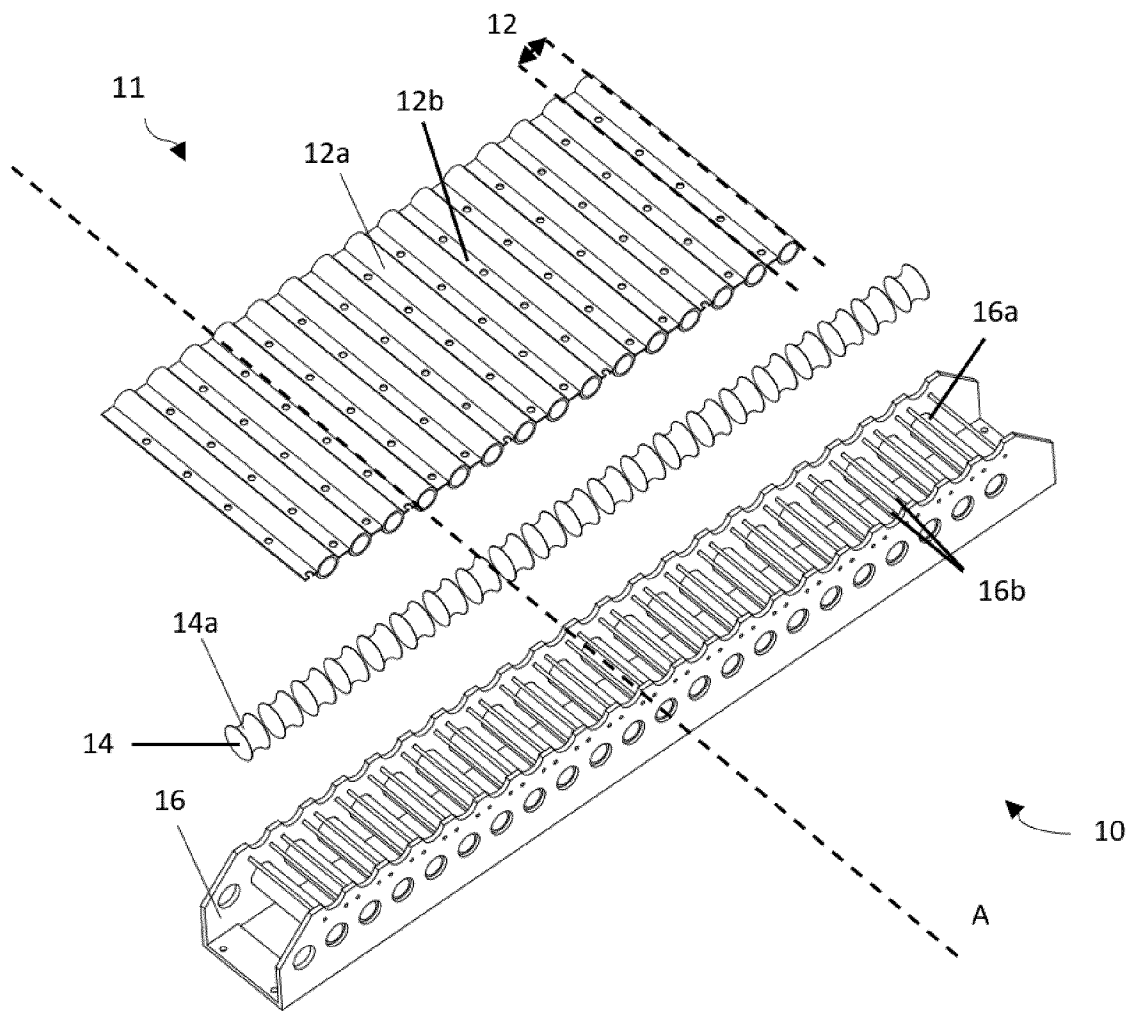
3. The moving floor (10) according to any of the preceding claims, wherein an elongate element (12) having a tubular portion (12a) further comprises an elongate plate portion (12b), the tubular portion (12a) and the plate portion (12b) of said elongate element (12) being connected along their length, preferably by welding.
4. The moving floor (10) according to any of the preceding claims, wherein tubular portions (12a) and/or plate portions (12b) are perforated so as to allow vertical flow of air through the deck.
5. The moving floor (10) according to any of the preceding claims, wherein the rollers (14) are mounted within the base (16) so as to be free for rotation and/or linear movement parallel to the transport direction.
6. The moving floor (10) according to any of the preceding claims, wherein the base (16) has at least one tubular support (16a) parallel to the transport direction for supporting at least one concave roller (14), the tubular support (16a) being able to fit at least partially inside the annular recess (14a) of the concave roller (14).
7. The moving floor (10) according to claim 6, wherein the base (16) further comprises lateral supports (16b) configured to limit rotation of each roller (14) about the tubular support (16a) supporting it.
8. The moving floor (10) according to any of the preceding claims, wherein the connecting means (20a, 20b, 20c) comprise transversal rulers.
9. The moving floor (10) according to any of the preceding claims, wherein the at least three driving means (18a, 18b, 18c) comprise at least one of hydraulic, pneumatic and/or electric cylinders.
10. The moving floor (10) according to any of the preceding claims, wherein the elongate elements (12), the base (16) and/or the rollers (14) are made of metal, preferably of an alloy such as bronze and/or cast steel.
11. The moving floor (10) according to claims according to any of the preceding claims, wherein the diameter of tubular portions (12a) is comprised between 30

et 100mm and/or their length between 6 and 25m, and wherein the diameter of the rollers (14) is comprised between 50 and 150 mm.

12. The moving floor (10) according to any of the preceding claims, wherein the width of plate portions (12b) is comprised between 25 and 75mm, their thickness
5 between 6 and 20mm and/or their length between 6 and 25m.

13. The moving floor (10) according to any of the preceding claims, wherein a hot air blower is configured to blow hot air underneath the deck (11), at temperatures preferably comprised between 100 and 400°C.

14. Use of a moving floor (10) according to any of the preceding claims in a thermal
10 transfer system such as a drying system or a cooling system.

**Fig. 1.**

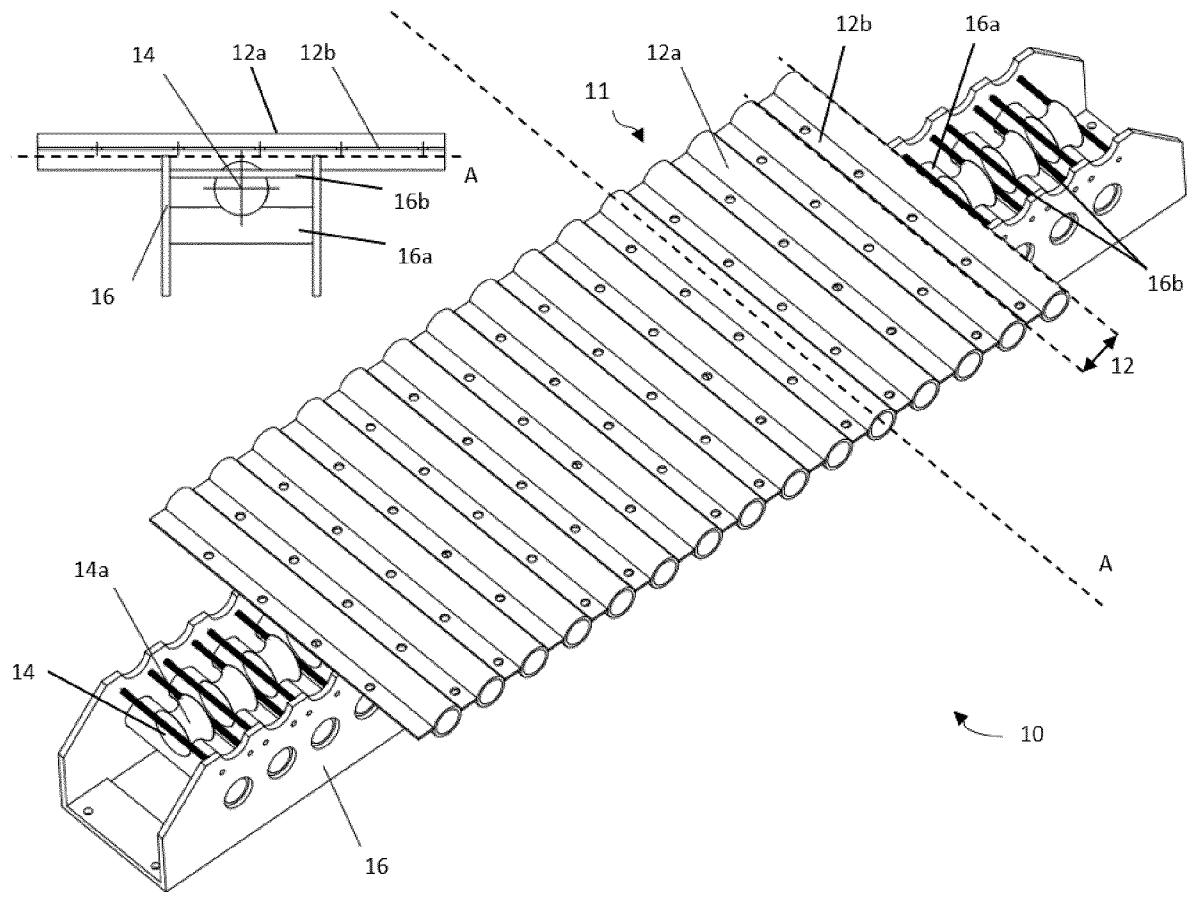


Fig. 2.

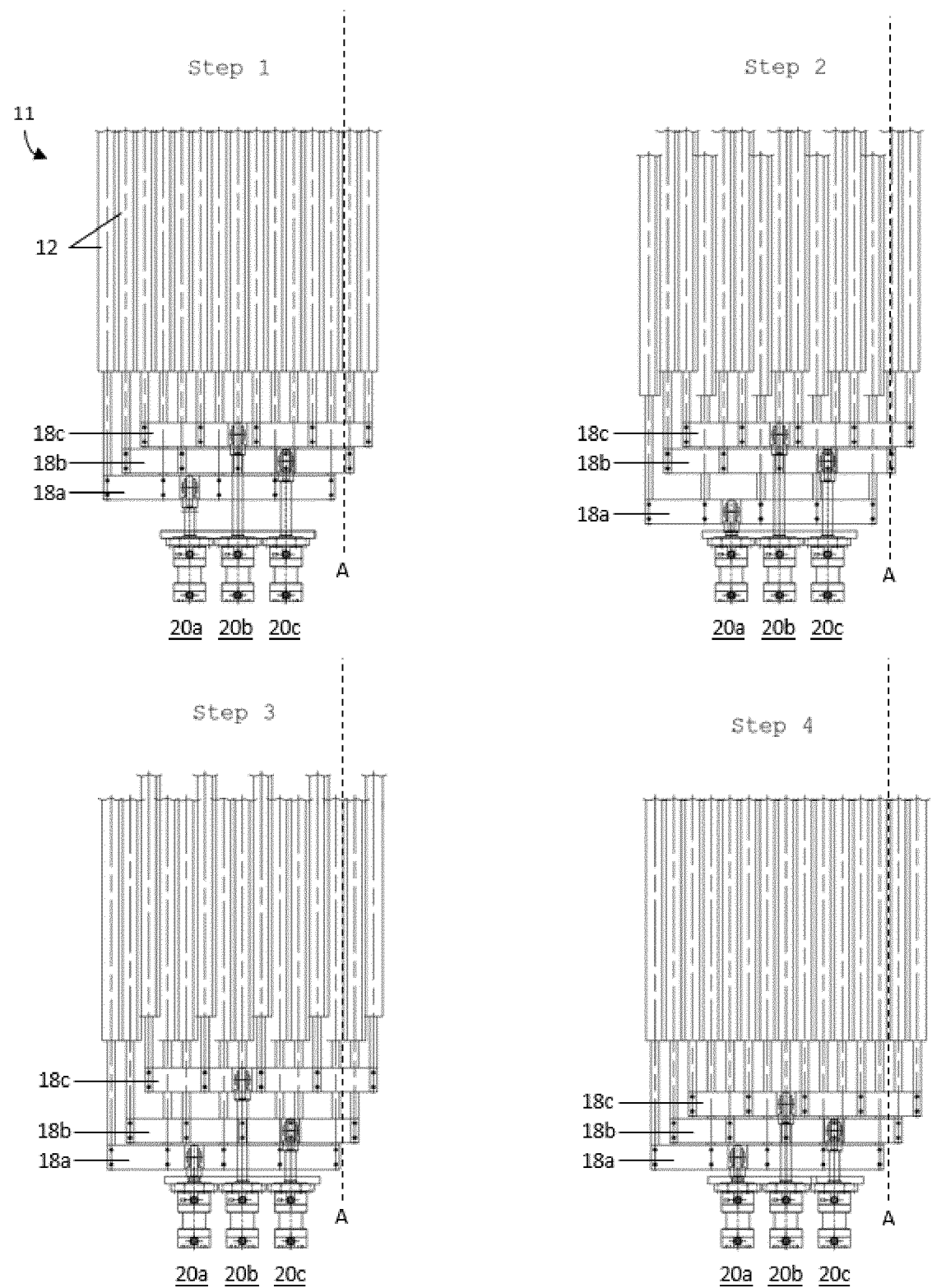


Fig. 3.

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2023/083313

A. CLASSIFICATION OF SUBJECT MATTER**INV. B65G25/06****ADD.**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B65G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 056 113 A (FOSTER RAYMOND KEITH [US]) 2 May 2000 (2000-05-02) column 1, line 59 - line 60; figure 1 -----	1-14
A	EP 0 334 460 A2 (RUTTE HOEKSTRA JETSKE) 27 September 1989 (1989-09-27) figure 2 -----	1-14
A	EP 2 072 425 A1 (OHG BOVESANE S R L [IT]) 24 June 2009 (2009-06-24) figure 1 -----	1-14



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

19 February 2024

Date of mailing of the international search report

23/02/2024

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2

NL - 2280 HV Rijswijk

Tel. (+31-70) 340-2040,

Fax: (+31-70) 340-3016

Authorized officer

Torrell Cantero, A

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2023/083313

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6056113	A	02-05-2000	NONE	

EP 0334460	A2	27-09-1989	AT E108408 T1	15-07-1994
			DE 68916672 T2	03-11-1994
			EP 0334460 A2	27-09-1989
			ES 2055781 T3	01-09-1994
			NL 8800728 A	16-10-1989

EP 2072425	A1	24-06-2009	AT E476383 T1	15-08-2010
			EP 2072425 A1	24-06-2009
			ES 2349482 T3	04-01-2011
			PL 2072425 T3	31-01-2011
