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

(11) **EP 4 230 802 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
23.08.2023 Bulletin 2023/34

(21) Application number: **23157316.3**

(22) Date of filing: **17.02.2023**

(51) International Patent Classification (IPC):
E02D 29/02 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E02D 29/0208; E02D 29/0241

(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 ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **18.02.2022 IT 202200003050**

(71) Applicant: **Officine Maccaferri S.p.A.**
40069 Zola Predosa (BO) (IT)

(72) Inventor: **BIANCHINI, Paolo**
40069 Zola Predosa (BO) (IT)

(74) Representative: **Provvisionato, Paolo**
Provvisionato & Co S.r.l.
Piazza di Porta Mascarella 7
40126 Bologna (IT)

(54) **GABION REINFORCEMENT ELEMENT**

(57) A reinforcement element for constructing earth covering, containment and reinforcement structures, in particular for constructing support walls, said reinforcement element comprising a reinforcement web(18) which is formed by a mesh, wherein said reinforcement web is adjacent and secured to a containment structure comprising at least one front face (13) made of double-torsion metal mesh, wherein a front panel (20) of electro-welded mesh is fixed to the front face (13), preferably by means of metal fasteners (20), such as clips or C-rings.

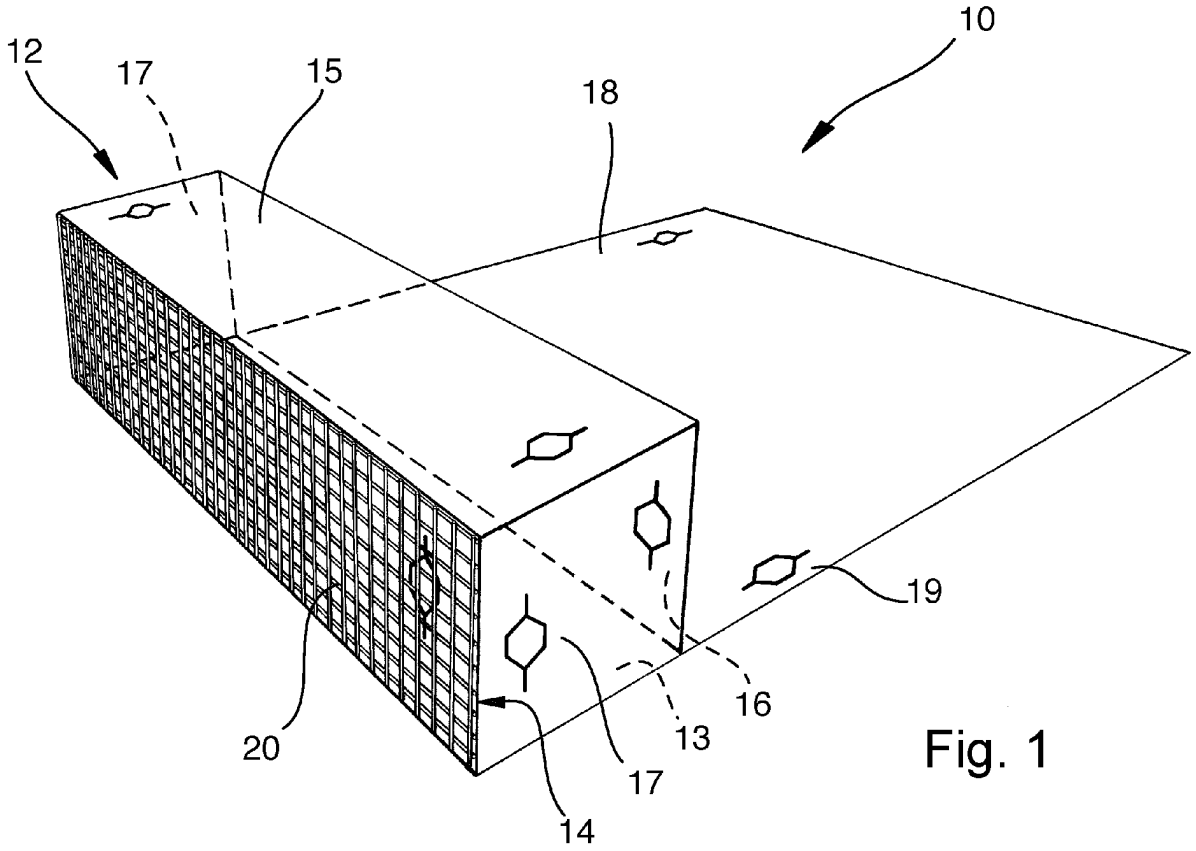

Fig. 1

EP 4 230 802 A1

Description

Field of the invention

[0001] The present invention relates to the field of earth covering, containment and reinforcement structures, for example, for stabilizing escarpments, embankments and the like.

[0002] The invention has been developed with regard to a reinforcement element for constructing such structures and particularly, even if not exclusively, for constructing support walls. The invention also relates to a method for constructing such a reinforcement element.

Technological background

[0003] There are known reinforcement elements of the above-indicated type which have been found to be particularly effective. US 5161917 in the name of Officine Maccaferri S.p.A. describes a reinforcement element for constructing elevated structures from shored-up and reinforced earth and walls, which is known by the commercial name Terramesh®. This reinforcement element comprises a web made of double-torsion metal mesh with a box made of mesh at one end thereof. The mesh box is formed at three sides by the folded web of mesh while a fourth side is formed by means of an additional transverse panel which is fixed to the web made of mesh. The mesh box defines the front wall, the front facing, of the support wall.

[0004] This reinforcement element is particularly economical and easy to put into operation. However, the front portion of the mesh box which defines the exposed facade of the support wall is subjected to the thrust of the filling material and the layers of earth which, with the passage of time, curve and deform it. Not only do the aesthetics of the support wall suffer as a result, but the deformation of the façade may indicate local deformations of the entire support structure which it is necessary to prevent with maintenance operations.

[0005] An improved solution of such a reinforcement element is described in EP 1012406, also from Officine Maccaferri S.p.A. This document describes a structure which is constituted by a web of metal mesh of the type with double torsion, which is folded so as to constitute a structure with a base wall, a front wall and an upper wall. The front wall made of metal mesh is supported at the rear by an additional panel made of electro-welded metal mesh which is supported by metal brackets. A layer of geosynthetic material on the front wall allows vegetation-supporting walls to be produced.

[0006] This reinforcement element allows the production of support walls with planar front walls which are maintained over time because the panel of electro-welded mesh which is positioned behind the web of double-torsion mesh contains the thrust of the filling material and the earth. However, this reinforcement element is rather complex to construct and to put into operation because it is necessary to provide and correctly mount the support brackets of the front wall before carrying out the filling of the structure with the earth.

[0007] In other reinforcement elements of the known type, it has been sought to overcome these disadvantages by constructing a support structure of the front wall which is constructed with bars or with a panel of electro-welded mesh which are folded substantially in an L-shape so as to provide a self-supporting structure which does not require brackets. However, these reinforcement elements, in addition to being complex to construct, are bulky to transport and to put into operation.

[0008] Another improved solution is described in EP 1579081 also from Officine Maccaferri S.p.A. This document describes a reinforcement element for constructing earth covering, containment and reinforcement structures comprising a web of metal mesh of the double-torsion type, to which a front panel of electro-welded metal mesh is connected in an articulated manner. An upper panel of double-torsion mesh is connected to the front panel. This reinforcement element is complex to construct. Furthermore, the articulation between the web of mesh and the front panel does not allow the front panel to be positioned in the desired configuration of the wall, for example, in a vertical or inclined position, without providing a number of supports in the rear portion thereof.

Statement of invention

[0009] An object of the present invention is to overcome the disadvantages of the prior art. An object of the invention is therefore to provide a reinforcement element for constructing earth covering, containment and reinforcement structures, the front wall of which is not subjected to deformations as a result of the thrust applied by the earth or the filling material. Another object of the invention is to provide a reinforcement element which is simple and economical to manufacture, to transport to the installation site and to install. Another object of the invention is to provide a reinforcement element which can also be rapidly installed by non-expert operators. Another object is to provide a reinforcement element which is reliable over time and which does not require particular maintenance.

[0010] These objects and other objects are achieved by a reinforcement element having the features indicated in the appended claims.

[0011] According to a first aspect, there is described a reinforcement element for constructing earth covering, containment and reinforcement structures, in particular for constructing support walls. The reinforcement element may comprise a reinforcement strip or web which is formed by a mesh. This reinforcement element is adjacent and secured to a containment structure for containing earth or facing material, such as stones, rocks and the like. The containment structure comprises at least one front face which forms the facing of the support wall. The front face may be vertical or inclined in such a

manner that the superimposition of a plurality of reinforcement elements defines a support wall or a portion thereof which is vertical or inclined, respectively. The front face of the containment structure may be made of double-torsion metal mesh. There can be fixed to the front face of the containment structure a front panel of electro-welded mesh. In the most advantageous form thereof, the front panel of electro-welded mesh is fixed to the external side of the containment structure, that is to say, at the side of the exposed face of the facing, opposite the earth. In any case, it is also possible to couple the panel of electro-welded mesh at the rear to the front face in such a manner that it acts as a support for the double-torsion metal mesh. In any case, the close positioning between the double-torsion metal mesh and the electro-welded mesh, which is preferably but not exclusively over the entire extent of the facing, stiffens the containment structure, preventing it from becoming deformed under the combined thrust of the earth, the stones or rocks at the rear, and the weight of the containment structures positioned thereabove. Another advantage is that of providing smaller and more compact containment structures with respect to the prior art. In the configuration in which the electro-welded mesh is positioned at the external side of the containment structure, that is to say, at the side of the exposed face of the facing, there is a substantial advantage from the production point of view because it is quite convenient to couple the two meshes and to fold the reinforcement element in such a manner that it is easy to transport it and to unfold it at the installation site. Naturally, this does not exclude coupling two mesh panels at both sides of the front face in order to obtain a particularly rigid and resistant containment structure.

[0012] In order to fix the front panel of electro-welded mesh to the front face of the containment structure made of double-torsion metal mesh, it is particularly advantageous to use metal fasteners, such as clips or C-rings. This method allows a high production capacity to be obtained with simple means which have been found to be advantageous.

[0013] According to another aspect, the reinforcement strip or web can be formed by a double-torsion metal mesh. The front face of the containment structure can be constructed integrally with the same double-torsion metal mesh of the reinforcement strip. The double-torsion metal mesh can be folded in the region of a common edge between the reinforcement strip and the front face of the containment structure. In this manner, the manufacture of the reinforcement element is further accelerated, ensuring the resistance and reliability thereof over time.

[0014] According to another aspect, the containment structure can be an actual gabion made of double-torsion metal mesh. Such a gabion may effectively contain stones and rocks which serve to form the containment wall structure. The front face of the gabion which will form the exposed face is reinforced, as mentioned above, with the front panel of electro-welded mesh. Advantageously, the gabion may comprise a lower face and an upper face which are formed, together with the front face, by the same web of metal mesh.

[0015] There is further described a method for manufacturing a reinforcement element according to any one of the preceding claims, which may comprise the step of providing a web of double-torsion metal mesh, for example, of the type with hexagonal mesh. There can be set down on this web of metal mesh a panel of electro-welded metal mesh which preferably has a length equal to the width of the web of metal mesh. Therefore, it is possible to fix the panel of electro-welded metal mesh to the web of metal mesh in a position which corresponds to a front face of a containment structure which has a height equal to the height of the electro-welded mesh panel. The front face of the containment structure can be formed by transversely folding the web of metal mesh in the region of at least one of the two edges of the panel of electro-welded metal mesh.

[0016] A support wall can be constructed by juxtaposing and superimposing reinforcement elements of the above-indicated type relative to each other. The gabions, which are filled, for example, with stones, serve to constitute the façade or facing of the support wall while the reinforcement strips extend in the rear embankment with respect to the gabions in order to form a reinforced earth section.

Brief description of the drawings

[0017] Additional features and advantages will be appreciated from the following detailed description of a preferred embodiment with reference to the appended drawings which are given by way of non-limiting example and in which:

- Figure 1 is a schematic perspective view of a reinforcement element for constructing earth covering, containment and reinforcement structures incorporating features of the present invention; and
- Figure 2 is a detailed view, drawn to an enlarged scale, of the front wall of the reinforcement element of Figure 1.

Detailed description

[0018] Now with reference to the Figures, there is illustrated a reinforcement element 10 for constructing earth covering, containment and reinforcement structures incorporating features of the present invention. The reinforcement element comprises a gabion 12 of metal mesh of the double-torsion type with hexagonal mesh. The gabion 12 comprises a lower face or wall 13, a front face or front wall 14, an upper face or wall 15, a rear face or wall 16 and two lateral faces or walls 17. There extends at the rear from the gabion 12 a reinforcement strip or web 18 which is also made of metal mesh. The lower wall 13, the front wall 13 and the upper wall 15 of the

gabion 12 are preferably formed by a single web of metal mesh 19 which is folded transversely. The rear wall 16 is constructed with a panel of metal mesh which is fixed to the web of metal mesh 19. Alternatively, the rear wall 16 can be constructed by folding the web of metal mesh 19 in two. The side walls are also formed by two panels of metal mesh which are fixed to the web of metal mesh 19. The metal mesh of the gabion 12 and the reinforcement strip 18 is preferably of the double-torsion type with hexagonal mesh. The metal mesh can be zinc-coated and/or plastic-coated.

[0019] A front panel 20 of electro-welded metal mesh, for example, with square mesh, is fixed to the front wall 14 of the gabion 12, externally with respect to the gabion itself. As can better be seen in detail in Figure 2, the front panel 20 is fixed to the front wall 14 of the gabion 12 by means of metal fastenings 21, for example, clips, also called "C-rings", or functionally equivalent systems.

[0020] Naturally, the gabion 12 is not limited to the parallelepipedal shape shown in Figure 1, but may assume different formations in section. Preferably, the rear wall 16 is always vertical while the front wall 14 and the associated front panel 20 can be both vertical and inclined in order to construct support walls which are vertical or inclined, respectively. Though the lower, front and upper walls of the gabion 12 are preferably constructed integrally with the same web of metal mesh as the one from which the reinforcement strip 18 is constructed, this does not exclude the possibility of constructing the various walls with panels of separate metal mesh and/or constructing the reinforcement strip 18 with a web of metal mesh which is separate from the one used for the gabion 12. Figure 1 illustrates the preferred direction which the hexagonal mesh take up at the various walls of the gabion 12.

[0021] In order to form a support wall, a plurality of reinforcement elements 10 are juxtaposed and superimposed in such a manner that the gabions 12 form the façade or facing of the support wall. The reinforcement strips 18 are encased in the earth behind the support wall in order to form a reinforced earth embankment.

[0022] The reinforcement element 10 is manufactured in a production facility where it is folded in order to be transported to the installation location. In particular, there are fixed to the web of metal mesh 19 the mesh panels which form the rear wall 16 and the side walls 17. These mesh panels are fixed with fastenings, for example, of the helical type, along the contact edges thereof with the web of metal mesh 19. The front panel 20 of electro-welded mesh is further placed and fixed on the web of metal mesh 19. The front panel 20 has a length equal to the width of the web of metal mesh 19. The height of the front panel 20 defines the height of the gabion 12 which, during installation, is formed by folding the web of metal mesh 19 along the edges of the front panel 20.

[0023] The web of metal mesh 19 is then folded, for example, by setting down the portions of mesh web 19 corresponding to the front wall 14 and upper wall 15 on the reinforcement strip 18. The side walls 17 can be folded inside. In a particularly compact formation, the reinforcement element 10 can be folded so as to have from above dimensions which substantially correspond to the dimensions of the front panel 20 of electro-welded mesh. In another particularly compact formation, the reinforcement element 10 can be folded so as to have from above dimensions which substantially correspond to those of the front panel 20 of electro-welded mesh adjacent to the upper wall 15 which serves to form the gabion 12.

[0024] At the installation site, after setting down the reinforcement element 10, and particularly the lower strip 12, on the section of earth to be reinforced, there is raised the rigid panel 30 which drags with it the front strip 14 in order to form the façade. The front strip 12 can be substantially vertical, as illustrated in Figure 1, in order to construct a vertical support wall or it may be inclined in order to construct a generally inclined wall structure. The rear wall 18 and the front wall 14 which is joined to the front panel 20 are raised and joined to the side walls 17 by known systems, for example, with fastenings or metal clips. The upper wall 15 is left open in order to allow the gabion 12 to be filled with the filling material provided, for example, stone. When filling is finished, the upper wall 15 is closed in the manner of a cover by fixing the end edge thereof to the upper edge of the rear wall 18 by known systems, for example, with fastenings or metal clips.

[0025] The front panel 20 has a function which is both aesthetic and functional, providing greater rigidity of the façade. The rigidity of the façade allows more rapid installation in addition to benefits in environmental terms as a result of the reduction of the filling stone.

[0026] Naturally, variants can be produced with respect to the solution illustrated and described above. The gabion can be replaced by an open containment structure which is, for example, L-shaped, that is to say, without the upper face and rear face with respect to what has been described above, or C-shaped, that is to say, without the single rear face with respect to what has been described above. The front panel 20 can be fixed alternately to one or the other side of the front wall 14. It is also possible to provide two front panels 20 of electro-welded mesh which are fixed to both sides of the face or front wall 14. The front panel(s) 20 do not necessarily have to involve the entire extent of the front wall 14 of the gabion or more generally the containment structure, but can have smaller dimensions, it being possible to involve only portions of the front wall 14 and therefore of the facing constructed with the reinforcement element.

[0027] Naturally, the principle of the invention remaining the same, the forms of embodiment and details of construction may be varied widely with respect to those described and illustrated without thereby departing from the scope of the present invention.

Claims

1. A reinforcement element for constructing earth covering, containment and reinforcement structures, in particular for constructing support walls, comprising a reinforcement web (18) which is formed by a mesh and which is arranged adjacent and secured to a containment structure comprising at least one front face (13) made of double-torsion metal mesh, to which a front panel (20) of electro-welded mesh is fixed.

2. A reinforcement element according to claim 1, wherein the front panel (20) is fixed to the front face (14) of the containment structure by metal fasteners (20), such as clips or C-rings.

3. A reinforcement element according to claim 1 or claim 2, wherein the reinforcement strip (18) is formed by a double-torsion metal mesh, the front face (13) being constructed integrally with the same double-torsion metal mesh of the reinforcement strip (18), which double-torsion metal mesh is folded in the region of a common edge between the reinforcement strip (18) and the front face (13).

4. A reinforcement element according to any one of the preceding claims, wherein the containment structure is a gabion (12) made of double-torsion metal mesh.

5. A reinforcement element according to claim 4, wherein the gabion (12) comprises a lower face (13) and an upper face (15) which are formed, together with the front face (14), by the same web of metal mesh (19).

6. A method for manufacturing a reinforcement element according to any one of the preceding claims, comprising the steps of:

   - providing a web of double-torsion metal mesh (19),
   - setting down on the web of metal mesh (19) a panel of electro-welded metal mesh (20) which has a length equal to the width of the web of metal mesh (19),
   - fixing the panel of electro-welded metal mesh (20) to the web of metal mesh (19) in a position which corresponds to a front face (14) of a containment structure which has a height equal to the height of the electro-welded mesh panel to be formed by transversely folding the web of metal mesh (19) in the region of at least one of the edges of the panel of electro-welded metal mesh (20).

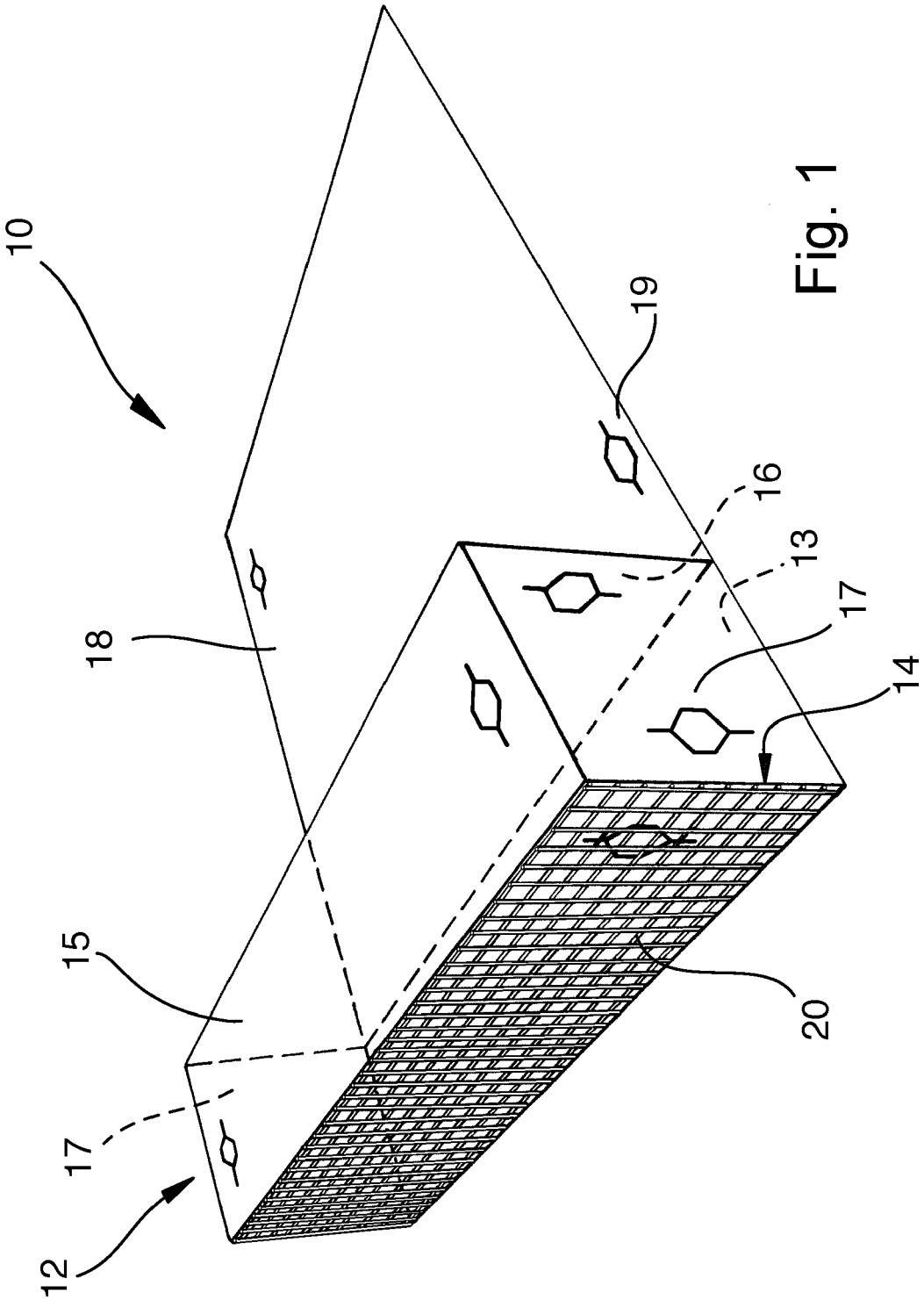

Fig. 1

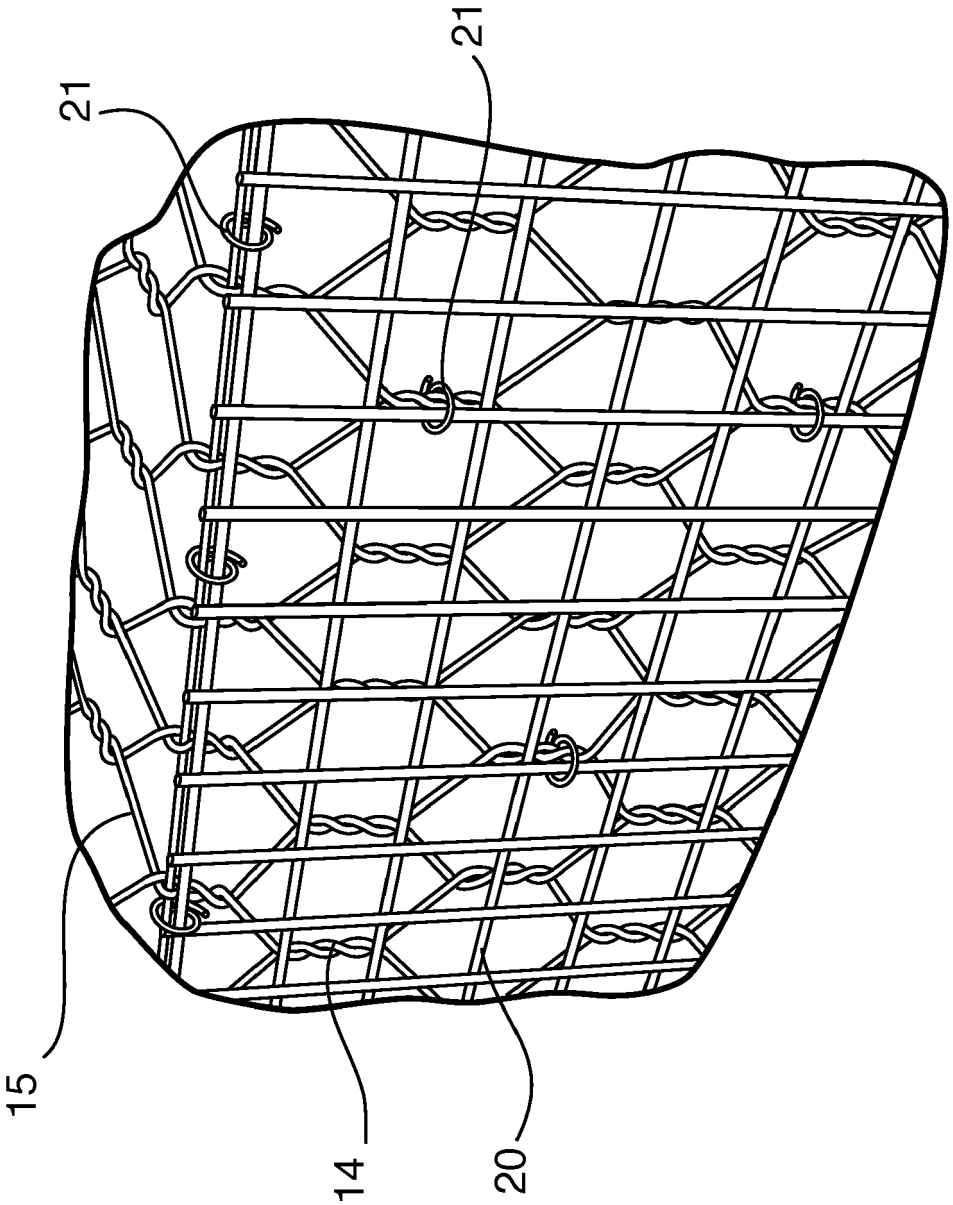

Fig. 2

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 23 15 7316

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,D	EP 1 012 406 A1 (MACCAFERRI SPA OFF [IT]) 28 June 2000 (2000-06-28)	1-3,6	INV. E02D29/02
A	* paragraphs [0019] - [0022]; claims 1,8; figures 1-7 *	4,5	
X	EP 1 711 661 A1 (MACCAFERRI SPA OFF [IT]) 18 October 2006 (2006-10-18)	1-6	
	* paragraphs [0025], [0029], [0030]; claims 1-5,9 *		
X	US 2020/248426 A1 (PALMA DONATELLA [IT]) 6 August 2020 (2020-08-06)	1-3,6	
A	* paragraphs [0001], [0014] - [0028]; figures 1,2 *	4,5	
A	GB 2 073 281 A (NETLON LTD) 14 October 1981 (1981-10-14)	1-6	
	* the whole document *		
			TECHNICAL FIELDS SEARCHED (IPC)
			E02D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	27 June 2023	Koulo, Anicet

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 23 15 7316

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.

27-06-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1012406 A1	28-06-2000	AR 011856 A1	13-09-2000
		AT 449885 T	15-12-2009
		AU 738525 B2	20-09-2001
		BR 9807756 A	22-02-2000
		CA 2281475 A1	03-09-1998
		CZ 9902939 A3	14-02-2001
		EP 1012406 A1	28-06-2000
		HR P980092 A2	31-12-1998
		HU 0001803 A2	28-09-2000
		ID 24608 A	27-07-2000
		IL 131276 A	12-09-2002
		IT BO970094 A1	25-08-1998
		JP 3830168 B2	04-10-2006
		JP H10331162 A	15-12-1998
		JP 2001513156 A	28-08-2001
		KR 20000075687 A	26-12-2000
		KR 20060091327 A	18-08-2006
		MY 119127 A	31-03-2005
		NO 320507 B1	12-12-2005
		PL 335351 A1	25-04-2000
		RU 2194823 C2	20-12-2002
		SI 1012406 T1	30-04-2010
		SK 114899 A3	12-09-2000
		TW 396233 B	01-07-2000
		US 6296422 B1	02-10-2001
		WO 9838391 A1	03-09-1998
EP 1711661 A1	18-10-2006	AR 047217 A1	11-01-2006
		AU 2004272814 A1	24-03-2005
		CA 2536114 A1	24-03-2005
		EG 24368 A	10-03-2009
		EP 1711661 A1	18-10-2006
		ES 2388922 T3	19-10-2012
		IL 174077 A	17-02-2010
		MX PA06002920 A	31-05-2006
		MY 136713 A	28-11-2008
		NZ 546555 A	30-04-2009
		PE 20050508 A1	09-09-2005
		PL 1711661 T3	29-03-2013
		RU 2361980 C2	20-07-2009
		SI 1711661 T1	30-11-2012
		US 2006291962 A1	28-12-2006
		WO 2005026451 A1	24-03-2005
		ZA 200601578 B	25-04-2007
US 2020248426 A1	06-08-2020	CN 110234813 A	13-09-2019

EPO FORM P0459

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

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 15 7316

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.

27-06-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		EP 3577280 A1	11-12-2019
		US 2020248426 A1	06-08-2020
		WO 2018142433 A1	09-08-2018
GB 2073281 A	14-10-1981	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

- US 5161917 A **[0003]**
- EP 1012406 A **[0005]**
- EP 1579081 A **[0008]**