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(54) **THROAT ARMOUR FOR A BLAST FURNACE**

SCHLAGPANZER FÜR HOCHOFEN

ARMURE DE GUEULARD DE HAUT FOURNEAU

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(56) References cited:
DE-C- 638 492 **DE-U- 8 804 067**

- **PATENT ABSTRACTS OF JAPAN vol. 10, no. 318 (C-381) [2374], 27 November 1984 (1984-11-27) & JP 61 127802 A (NITTETSU PLANT DESIGNING CORP), 16 June 1986 (1986-06-16)**

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Description

[0001] The present invention relates to throat armour for a blast furnace.

[0002] In a blast furnace, the use of throat armour to protect the outer shielding of the furnace above the charge against wear due to the raw materials loaded through the throat has long been known.

[0003] Originally, this throat armour was merely formed with refractory bricks. Such refractory bricks are, however, not very resistant to wear. Since then, many methods have been developed to increase the working life of the throat armour.

[0004] Thus, it is for example known how to form the throat armour with solid shielding plates. made of pig iron or cast steel suspended from the outer shielding of the blast furnace. However, even though these solid plates have quite good wear resistance because of their substantial thickness, they have a tendency to become deformed during a blast furnace campaign, which may upset the distribution of the charge. In addition, a plate may break or become detached and thus expose a considerable area of the outer shielding of the blast furnace to wear.

[0005] In order to avoid such problems with the shielding plates, throat armour is nowadays formed using pig iron or cast steel shielding bricks. These shielding bricks, which are much smaller in size than the shielding plates, are overlapped in large numbers over several rows and fixed to the outer shielding of the blast furnace. In an older type of execution, they form a smooth impact surface inside the furnace. In a more recent type of execution, each brick is dish-shaped. These dish-shaped bricks make it possible to form throat armour whose impact surface comprises material-retaining pockets. When such throat armour is new, its material-retaining pockets are filled with a concrete having a good wear resistance. This wear-resistant concrete then forms the majority of the impact surface and thus reduces the exposure of the metallic bricks to wear. As the concrete in the pockets becomes worn away, said pockets become filled with the charge material, which thus takes over the protective function of the initial wear-resistant concrete. Throat armour formed with dish-shaped bricks has an acceptable working life, but the fixing of the bricks to the outer shielding is complicated and the installation of the throat armour consequently takes a considerable time.

[0006] In order to make the installation of throat armour with metallic bricks less difficult, it is known that annular segments of the throat armour may be pre-assembled in the workshop. These pre-assembled segments comprise a metallic supporting plate on to which the metallic bricks are individually fixed. In order to install the throat armour in the furnace, it is then sufficient to fix the pre-assembled ring segments to the outer shielding of the furnace. However, even though the time taken for installation inside the furnace is thus greatly reduced, it should still be noted that the assembly of a segment of such throat armour in the workshop is far from simple. Another weakness of this type of throat armour originates from the large number of fixing elements required to fix the shielding bricks.

[0007] The objective of the present invention is to propose throat armour for a blast furnace which may be more easily installed, while having a working life that is comparable with, if not longer than, that of throat armour formed using pig iron or cast steel bricks.

[0008] In conformity with the invention, this objective is attained by throat armour according to Claim 1.

[0009] In throat armour according to the invention, the protective elements are no longer bricks but nodular graphite cast iron plates. The present invention has in effect the merit of having noticed that throat armour formed with nodular graphite cast iron plates may attain a working life comparable with, if not longer than, throat armour formed using pig iron or cast steel bricks, with two conditions: (1) the plates are provided with superimposed rows of material-retaining pockets; and (2) the plates are provided with an internal cooling circuit behind said rows of material-retaining pockets. Because of the existence of these pockets, the plates have an excellent wear resistance with a weight that is considerably less than that of solid plates. Thanks to its internal cooling circuit, the rear part of the plate forms, in spite of a reduced thickness, a support for the pockets which is distinguished by excellent stability in shape and high mechanical strength over time. In addition, the cooling of the plates also protects their fixing elements against overheating that could affect their mechanical strength.

[0010] In a preferred execution, approximately two thirds of the thickness of a plate are formed by material-retaining pockets, while the rest of the thickness of the plate forms a solid plate in which the internal cooling circuit is arranged.

[0011] In view of their reduced weight and their protection against overheating through their internal cooling circuit, the plates may be fixed to the outer shielding by means of threaded rods. Fixing elements, such as internally threaded bushes, are also advantageously anchored in the cooled rear part of the plate, which guarantees their strength over time.

[0012] The pockets are advantageously filled with a concrete having a good wear resistance. At least at the start of a blast furnace campaign, this wear-resistant concrete then forms the major part of the impact surface. As the wear-resistant concrete in the pockets wears away, said pockets are filled with charge material, which thus takes on the protective function of the initial wear-resistant concrete.

[0013] In order to guarantee good heat transfer, the internal cooling circuit is preferably cast in the plate. It may for example have a serpentine path or may comprise parallel vertical channels extending between two horizontal collectors.

[0014] In a preferred execution, the pockets have access openings in the impact surface of the throat ar-

mour, said openings penetrating the thickness of the plate obliquely, preferably making an angle between 30° and 50° with the vertical. Such an inclination of the pockets promotes the retention of the wear-resistant concrete or the charge material in the pockets. The lower edge of the opening of a pocket is advantageously formed by a vertical shoulder in order to promote still further the retention of the wear-resistant concrete or the charge material in the pockets.

[0015] In order to increase the stability of the plates, provision is advantageously made for vertical partitions that delimit the pockets in a given row.

[0016] The material-retaining pockets of an uppermost row preferably have access openings in the upper end surface of the plate. Although the throat armour then comprises two superimposed plates, the upper plate has its lower edge bevelled, so as to give access to the pockets of the uppermost row of the lower plate. In this way, an excellent protection of the two superimposed plates is achieved at the level of their common joint.

[0017] Other special features and characteristics of the invention will emerge from the detailed description of an advantageous mode of execution given below, as an illustrative example, in which reference is made to the appended drawings. These show:

Figure 1: a three-dimensional view showing the rear face of a segment of throat armour of a blast furnace;

Figure 2: a three-dimensional view showing the front face of the segment of Figure 1;

Figure 3: an elevation of the segment of Figure 1, showing the front face;

Figure 4: a side elevation of the segment of Figure 1.

[0018] In the appended figures, the same reference numbers denote identical or similar elements.

[0019] Figures 1 to 4 show an annular segment 10 of the throat armour of a blast furnace, which serves to protect the outer shielding of the furnace above the charge against wear by the raw materials loaded through the throat. These annular segments 10 are arranged side by side so as to form a continuous ring at the level of the blast furnace throat. To give an idea of size, it should be noted that, for a blast furnace with a diameter of about 10 m at the throat, such a segment 10 may have, for example, a height of about 5 m and a width of about 1.0 m, so that the throat armour will be formed by some thirty segments 10 as shown in the figures.

[0020] The segment 10 consists of two superimposed plates 12, 12'. Each plate 12, 12' comprises a rear surface 14, 14', which faces the outer shielding of the blast furnace, a front surface 16, 16', which is oriented towards the inside of the blast furnace and acts as the impact surface, two side surfaces 18, 20, 18', 20', an upper end 22, 22' and a lower end 24, 24'. The rear surface 14, 14' advantageously has a shape that matches the shape of the inner surface of the outer shielding at the place where it is fixed (see in particular the rear surface 14' of the lower plate 12' in Figure 4).

[0021] Each plate 12, 12' is individually fixed to the outer shielding of the blast furnace. It can be seen in Figures 1 to 4 that, in the back 14, 14' of each plate 12, 12', four bushes 26, 26' are anchored, each provided with an internal thread. Into these bushes 26, 26' are screwed threaded rods (not shown) which are used to fix the plates 12, 12' to the outer shielding (not shown). Sealing is achieved by sealing caps (not shown) welded to the outer shielding.

[0022] The plates 12, 12' are moulded plates made of nodular graphite cast iron. In order to guarantee their stability in shape and their mechanical strength over time, they are provided with an internal cooling circuit. It can be seen in Figure 3 that a plate 12, 12' comprises two serpentine channels whose path is shown by the broken lines 28, 30 or 28', 30'. It can be seen in Figure 4 that these channels are formed by pipes 32, 32', which are cast in the plate 12, 12' near the rear surface 14, 14'. The ends of these pipes 32, 32' emerge from the rear surface 14, 14' of the plate 12, 12' and form the connecting pipes 34, 36 and 34', 36'. Said connecting pipes emerge imperviously through the outer shielding where they enable the plates 12, 12' to be integrated into a cooling system of the blast furnace. The imperviousness of the passage of the connections 34, 34', 36, 36' into the outer shielding is achieved, for example, by means of sealing sleeves and/or expansion joints connected between each connector 34, 34', 36, 36' and the outer shielding.

[0023] Each plate 12, 12' comprises, on the side of its front surface 16, 16', several rows of material-retaining pockets 40, 40' (see for example Figure 2). These material-retaining pockets 40, 40' have access openings in the front surface 16, 16' of the plate 12, 12' and penetrate the thickness of said plate obliquely, making an angle of approximately 40° with the vertical (see Figure 4). Vertical partitions 42, 42' delimit the pockets 40, 40' of a given row. The lower edge of the opening of a material-retaining pocket 40, 40' is advantageously formed by a vertical shoulder 44, 44' (see for example Figure 2).

[0024] It should be noted that the material-retaining pockets 46, 46' of the uppermost row have their access openings in the surface of the upper end 22, 22' of the plate 12, 12'. It can be seen in Figure 4 that the upper plate 12 has its lower edge bevelled, so as to give access to the pockets 46' of the uppermost row of the lower plate 12'.

[0025] In Figure 4, the dotted areas in the pockets 40, 40', 46, 46' represent a concrete 50 with a good wear resistance, which fills the pockets 40, 40', 46, 46' at least at the beginning of a blast furnace campaign. This wear-resistant concrete 50 then forms more than three quarters of the impact surface 16, 16' of a plate 12, 12' and

thus reduces the exposure of said plate to wear. As the concrete 50 in the pockets 40, 40', 46, 46' wears away, said pockets become filled with charge material, which thus takes on the protective function of the initial wear-resistant concrete. It remains to point out that the inclination of the pockets 40, 40', 46, 46' and the vertical shoulders 44, 44' promote the retention of the wear-resistant concrete or the charge material in the pockets 40, 40', 46, 46'.

[0026] It should be appreciated that two thirds of the thickness of a plate 12, 12' are formed by the material-retaining pockets 40, 40', 46, 46', while the rest of the thickness of a plate 12, 12' forms a solid plate in which said internal cooling circuit is arranged. Because of the existence of the pockets 40, 40', 46, 46', the plates 12, 12' have a weight that is considerably less than that of solid plates with the same thickness. Thanks to its internal cooling circuit, the rear third of the plate 12, 12' has an excellent stability of shape and a high mechanical strength over time. The cooling of the plates 12, 12' also protects the plate-fixing elements against overheating which might affect their mechanical strength. In this context, it should be particularly pointed out that the bushes 26, 26' are anchored in the cool rear part of the plate. The cooling circuit also has a beneficial effect on the wear resistance of the concrete in the material-retaining pockets and it promotes the deposition of the charge materials replacing the wear-resistant concrete at the end of the campaign.

[0027] The working life of the throat armour as described above may be estimated as equivalent to at least one blast furnace campaign, i.e. as at least 15 years.

Claims

1. Throat armour for the protection of an outer shielding of a blast furnace against wear above the charge, said throat armour comprising protective elements, which are fixed to said outer shielding and which form an impact surface (16, 16') formed mainly by material-retaining pockets (40, 40', 46, 46')
   characterised
   in that said protective elements are plates (12, 12') made of nodular graphite cast iron, each plate (12, 12') comprising several rows of material-retaining pockets (40, 40', 46, 46'); and
   in that these plates (12, 12') are provided with an internal cooling circuit (32, 32') arranged behind said rows of material-retaining pockets (40, 40', 46, 46').

2. Throat armour according to Claim 1, **characterised in that** approximately two thirds of the thickness of a plate (12, 12') are formed by the material-retaining pockets (40, 40', 46, 46'), while the rest of the thickness of the plate (12, 12') forms a solid plate in which said internal cooling circuit (32, 32') is arranged.

3. Throat armour according to Claim 1 or 2, **characterised in that** said plates (12, 12') are fixed to said outer shielding by threaded rods.

4. Throat armour according to any one of Claims 1 to 3, **characterised in that** fixing elements (26, 26') are anchored in the cooled rear part of the plate (12, 12').

5. Throat armour according to any one of Claims 1 to 4, **characterised in that** said pockets (40, 40', 46, 46') are filled with a concrete (50) having a good wear resistance.

6. Throat armour according to any one of Claims 1 to 5, **characterised in that** said internal cooling circuit (32, 32') is cast in the plate (12, 12').

7. Throat armour according to Claim 6, **characterised in that** said internal cooling circuit (32, 32') has a serpentine path (28, 30).

8. Throat armour according to Claim 6, **characterised in that** said internal cooling circuit comprises parallel vertical channels extending between two horizontal collectors.

9. Throat armour according to any one of Claims 1 to 8, **characterised in that** said pockets (40, 40') have access openings in the impact surface (16, 16') of said throat armour and penetrate the thickness of the plate (12, 12') obliquely.

10. Throat armour according to Claim 9, **characterised in that** said pockets (40, 40', 46, 46') make an angle of between 30° and 50° with the vertical.

11. Throat armour according to Claim 9 or 10, **characterised in that** the lower edge of the opening of a material-retaining pocket (40, 40', 46, 46') is formed by a vertical shoulder (44, 44').

12. Throat armour according to any one of Claims 1 to 11, **characterised in that** vertical partitions (42, 42') delimit the pockets (40, 40', 46, 46') of a given row.

13. Throat armour according to any one of Claims 1 to 11, **characterised in that** the material-retaining pockets (46, 46') of an uppermost row have access openings in the surface of the upper end (22, 22') of the plate (12, 12').

14. Throat armour according to Claim 13, **characterised by** two superimposed plates (12, 12'), the up-

per plate (12) having a bevelled lower edge so as to give access to the pockets (46') of the uppermost row of the lower plate (12').

Patentansprüche

1. Schlagpanzer zum Schutz des äußeren Schutzpanzers eines Hochofens gegen Verschleiß oberhalb der Gicht, wobei der Schlagpanzer schützende Elemente umfasst, die am äußeren Schutzpanzer befestigt werden und eine Stossfläche (16, 16') bilden, die hauptsächlich aus Material zurückbehaltenden Taschen (40, 40', 46, 46') besteht,
dadurch gekennzeichnet, dass
die Schutzelemente aus Platten (12, 12') bestehen, die aus Kugelgraphitgusseisen hergestellt sind, wobei jede Platte (12, 12') mehrere Reihen von Material zurückbehaltenden Taschen (40, 40', 46, 46') umfasst und
in diesen Platten (12, 12') ein inneres Kühlsystem (32, 32') vorgesehen ist, welches hinter den Reihen Material zurückbehaltender Taschen (40, 40', 46, 46') angeordnet ist.

2. Schlagpanzer nach Anspruch 1 **dadurch gekennzeichnet, dass** etwa zwei Drittel der Dicke einer Platte (12, 12') aus den Material zurückbehaltenden Taschen (40, 40', 46, 46') bestehen, während die übrige Dicke der Platte (12, 12') eine feste Platte bildet, in welcher das genannte Kühlsystem (32, 32') angeordnet ist.

3. Schlagpanzer nach Anspruch 1 oder 2 **dadurch gekennzeichnet, dass** die Platten (12, 12') am äußeren Schutzpanzer durch Gewindestangen befestigt sind.

4. Schlagpanzer nach irgendeinem der Ansprüche 1 bis 3 **dadurch gekennzeichnet, dass** Befestigungselemente (26, 26') im gekühlten rückwärtigen Teil der Platte (12, 12') verankert sind.

5. Schlagpanzer nach irgendeinem der Ansprüche 1 bis 4 **dadurch gekennzeichnet, dass** die Taschen (40, 40', 46, 46') mit einem Beton (50) gefüllt werden, der eine gute Verschleißfestigkeit aufweist.

6. Schlagpanzer nach irgendeinem der Ansprüche 1 bis 5 **dadurch gekennzeichnet, dass** das innere Kühlsystem (32, 32') in die Platte (12, 12') eingegossen ist.

7. Schlagpanzer nach Anspruch 6 **dadurch gekennzeichnet, dass** das innere Kühlsystem (32, 32') einen serpentinenähnlichen Pfad aufweist (28, 30).

8. Schlagpanzer nach Anspruch 6 **dadurch gekennzeichnet, dass** das innere Kühlsystem parallele vertikale Kanäle umfasst, welche zwischen zwei horizontalen Kollektoren verlaufen.

9. Schlagpanzer nach irgendeinem der Ansprüche 1 bis 8 **dadurch gekennzeichnet, dass** die Taschen (40, 40') Einlassöffnungen in der Stossfläche (16, 16') des Schlagpanzers aufweisen und in die Dicke der Platte (12, 12') schräg eindringen.

10. Schlagpanzer nach Anspruch 9 **dadurch gekennzeichnet, dass** die Taschen (40, 40', 46, 46') einen Winkel von zwischen 30° und 50° zur vertikalen Ebene bilden.

11. Schlagpanzer nach Anspruch 9 oder 10 **dadurch gekennzeichnet, dass** die untere Kante der Öffnung einer Material zurückbehaltenden Tasche (40, 40', 46, 46') in Form einer vertikalen Schulter (44, 44') ausgeführt ist.

12. Schlagpanzer nach irgendeinem der Ansprüche 1 bis 11 **dadurch gekennzeichnet, dass** die vertikalen Unterteilungen (42, 42') die Taschen (40, 40', 46, 46') einer bestimmten Reihe abgrenzen.

13. Schlagpanzer nach irgendeinem der Ansprüche 1 bis 11 **dadurch gekennzeichnet, dass** die Material zurückbehaltenden Taschen (46, 46') einer obersten Reihe Einlassöffnungen in der Oberfläche des oberen Endes (22, 22') der Platte (12, 12') aufweisen.

14. Schlagpanzer nach Anspruch 13, der durch zwei übereinander liegende Platten (12, 12') gekennzeichnet ist, wobei die obere Platte (12) eine abgeschrägte untere Kante aufweist, sodass der Zugang zu den Taschen (46') der obersten Reihe der unteren Platte (12') möglich ist.

Revendications

1. Armure de gueulard pour la protection d'un blindage extérieur d'un haut fourneau contre l'usure au-dessus de la charge, ladite armure de gueulard comprenant des éléments protecteurs, lesquels sont fixés audit blindage extérieur et constituent une surface d'impact (16, 16') formée principalement par des poches de retenue de matières (40, 40', 46, 46'),
caractérisée
en ce que lesdits éléments protecteurs sont des plaques (12, 12') en fonte à graphite sphéroïdal, chaque plaque (12, 12') comprenant plusieurs rangées de poches de retenue de matières (40, 40', 46, 46') ; et
en ce que ces plaques (12, 12') sont munies d'un

circuit de refroidissement interne (32, 32') disposé derrière lesdites rangées de poches de retenue de matières (40, 40', 46, 46').

2. Armure de gueulard conformément à la revendication 1, **caractérisée en ce qu'**environ deux tiers de l'épaisseur d'une plaque (12, 12') sont formés par les poches de retenue de matières (40, 40', 46, 46'), tandis que le reste de l'épaisseur de la plaque (12, 12') forme une plaque massive dans laquelle est logé ledit circuit de refroidissement interne (32, 32').

3. Armure de gueulard conformément à la revendication 1 ou 2, **caractérisée en ce que** lesdites plaques (12, 12') sont fixées audit blindage extérieur par des tiges filetées.

4. Armure de gueulard conformément à n'importe laquelle des revendications 1 à 3, **caractérisée en ce que** des éléments de fixation (26, 26') sont ancrés dans la partie arrière refroidie de la plaque (12, 12').

5. Armure de gueulard conformément à l'une quelconque des revendications 1 à 4, **caractérisée en ce que** lesdites poches (40, 40', 46, 46') sont remplies d'un béton (50) présentant une bonne résistance à l'usure.

6. Armure de gueulard conformément à l'une quelconque des revendications 1 à 5, **caractérisée en ce que** ledit circuit de refroidissement interne (32, 32') est moulé dans la plaque (12, 12').

7. Armure de gueulard conformément à la revendication 6, **caractérisée en ce que** ledit circuit de refroidissement interne (32, 32') présente un tracé en serpentin (28, 30).

8. Armure de gueulard conformément à la revendication 6, **caractérisée en ce que** ledit circuit de refroidissement interne comprend des canaux verticaux parallèles s'étendant entre deux collecteurs horizontaux.

9. Armure de gueulard conformément à l'une quelconque des revendications 1 à 8, **caractérisée en ce que** lesdites poches (40, 40') sont munies d'ouvertures d'accès dans la surface d'impact (16, 16') de ladite armure de gueulard et s'engagent obliquement dans l'épaisseur de la plaque (12, 12').

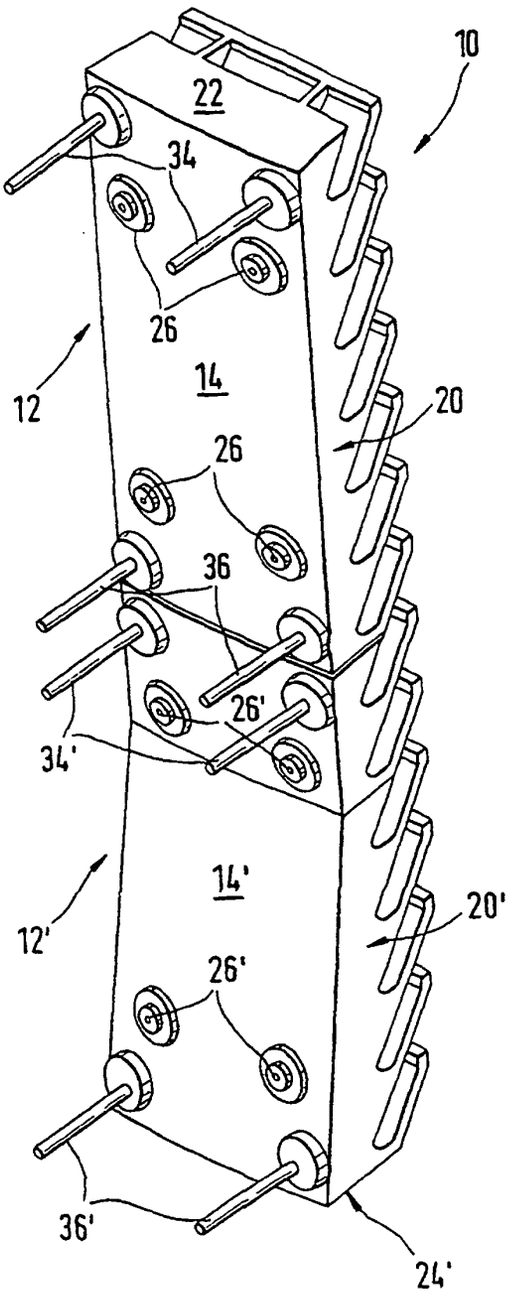
10. Armure de gueulard conformément à la revendication 9, **caractérisée en ce que** lesdites poches (40, 40', 46, 46') forment un angle entre 30° et 50° avec la verticale.

11. Armure de gueulard conformément à la revendication 9 ou 10, **caractérisée en ce que** le bord inférieur de l'ouverture d'une poche de retenue de matières (40, 40', 46, 46') est constitué d'un épaulement vertical (44, 44')

12. Armure de gueulard conformément à l'une quelconque des revendications 1 à 11, **caractérisée en ce que** des cloisons verticales (42, 42') délimitent les poches (40, 40', 46, 46') d'une rangée donnée.

13. Armure de gueulard conformément à l'une quelconque des revendications 1 à 11, **caractérisée en ce que** les poches de retenue de matières (46, 46') d'une rangée supérieure ont des ouvertures d'accès sur la face du bord supérieur (22, 22') de la plaque (12, 12').

14. Armure de gueulard conformément à la revendication 13, **caractérisée par** deux plaques superposées (12, 12'), la plaque supérieure (12) ayant un bord inférieur biseauté de manière à assurer l'accès aux poches (46') de la rangée supérieure de la plaque inférieure (12').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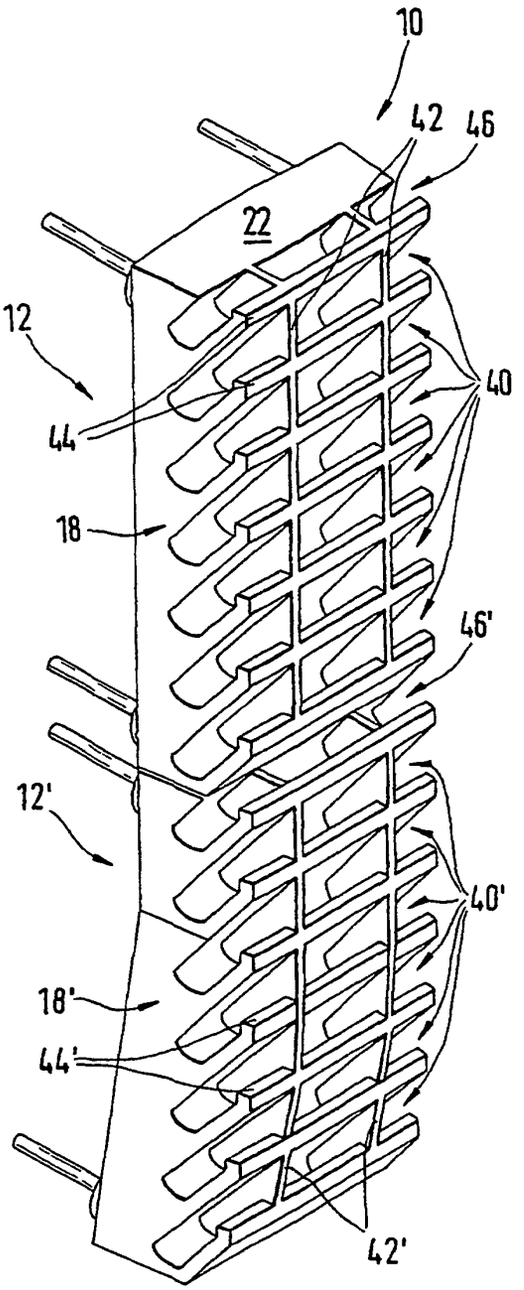
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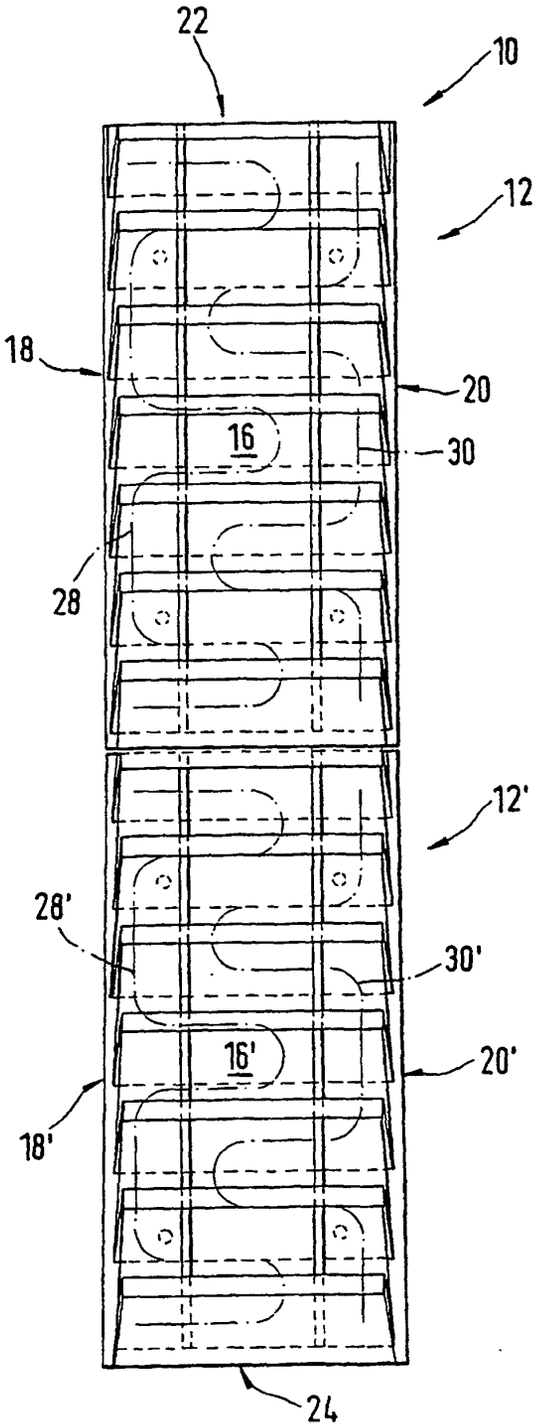
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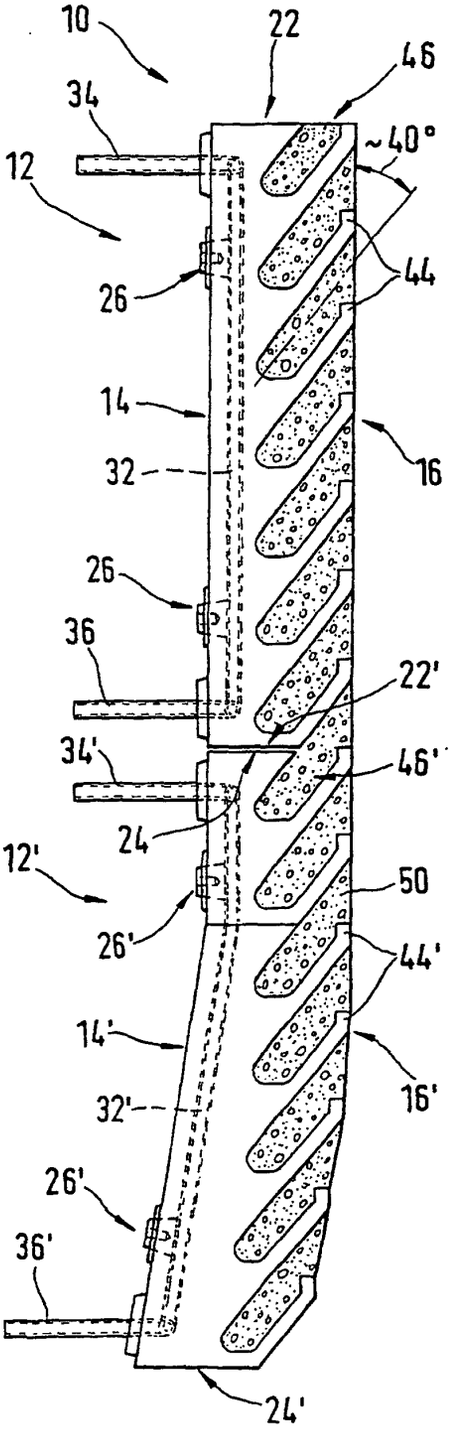
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