US 20100206158A1

(19) **United States**

(12) **Patent Application Publication**

Neethling

(10) **Pub. No.: US 2010/0206158 A1**

(43) **Pub. Date: Aug. 19, 2010**

(54) **ARMOUR ARRANGEMENT**

(76) Inventor: **Rufus Stephanus Neethling**, Gemiston (ZA)

Correspondence Address:
NIXON & VANDERHYE, PC
901 NORTH GLEBE ROAD, 11TH FLOOR
ARLINGTON, VA 22203 (US)

(21) Appl. No.: **12/452,476**

(22) PCT Filed: **Jul. 4, 2008**

(86) PCT No.: **PCT/IB2008/052700**

§ 371 (c)(1),
(2), (4) Date: **Apr. 21, 2010**

(30) **Foreign Application Priority Data**

Jul. 5, 2007 (ZA) 2007/05496

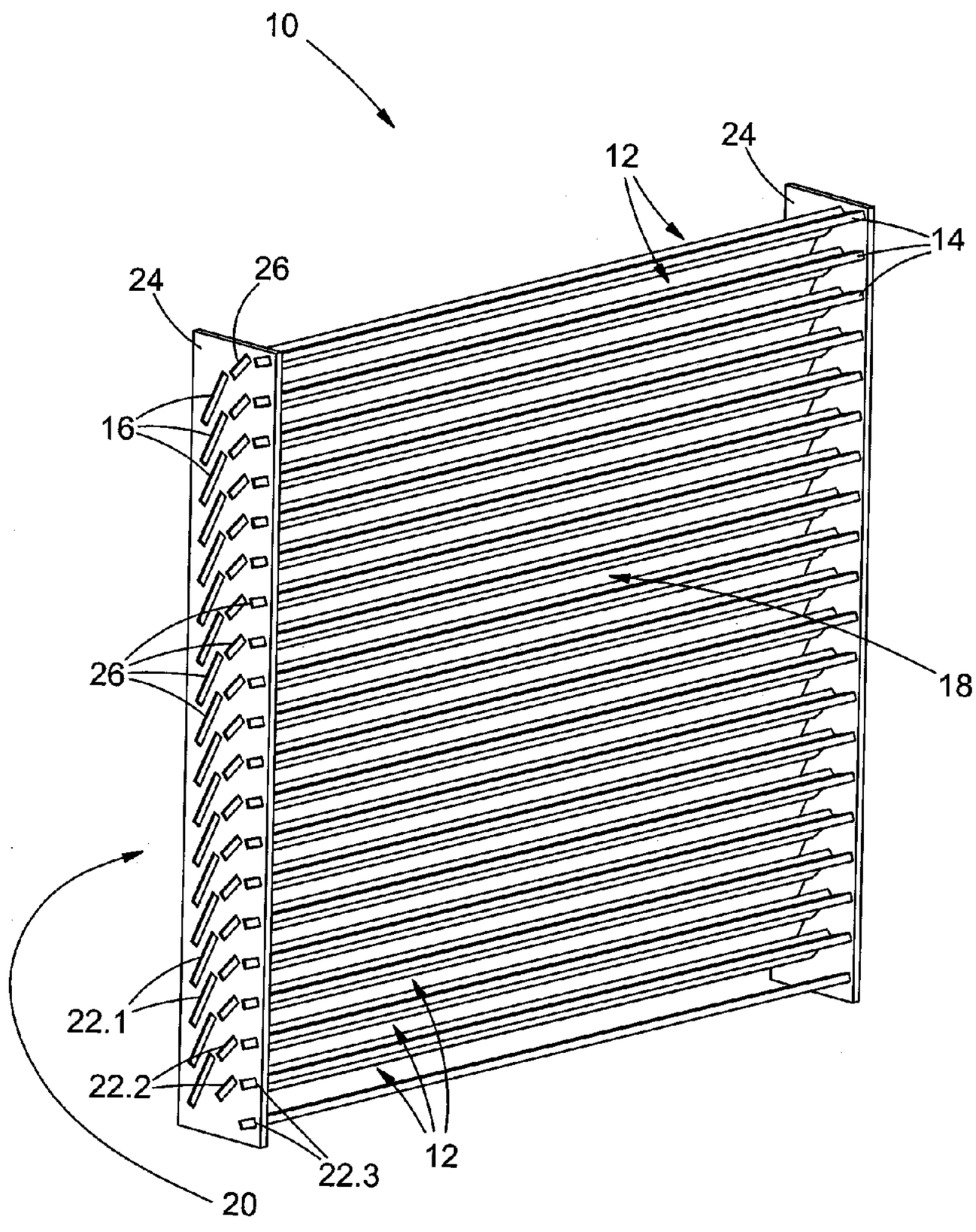
Publication Classification

(51) **Int. Cl.**
F41H 5/02 (2006.01)
F41H 7/00 (2006.01)

(52) **U.S. Cl.** **89/36.02**; 89/36.08; 89/904; 89/918

(57) **ABSTRACT**

This invention relates to an armour arrangement (**10**). The armour arrangement (**10**) comprises a plurality of disruption members (**12**) located adjacent one another, being at least partially spaced apart from one another and being angularly displaced relative to the surface. Each disruption member is arcuate in cross-section and includes three disruption bodies (**14**), positioned side-by-side to, such that the disruption member is in the shape of a half-parabolic curve.



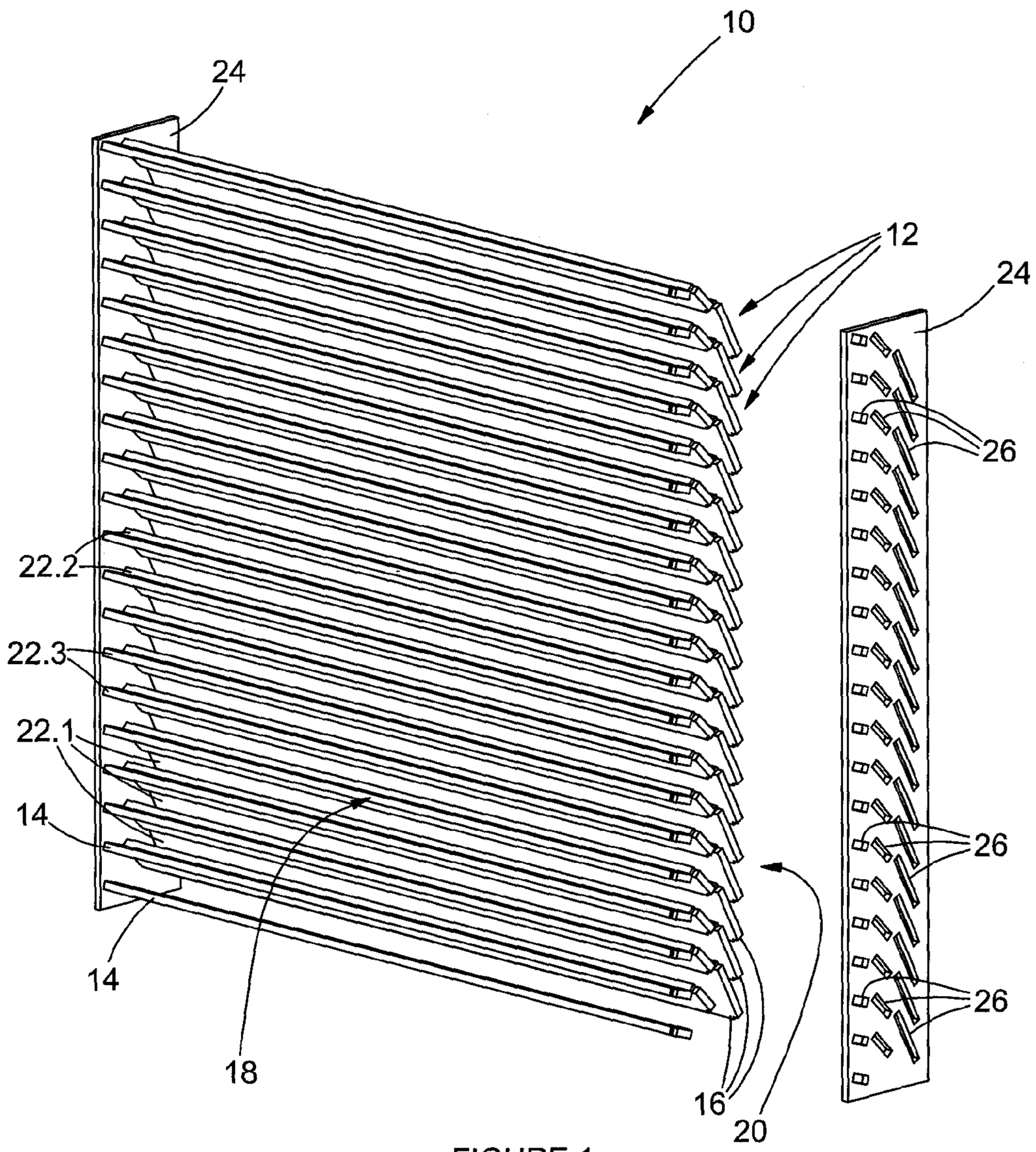


FIGURE 1

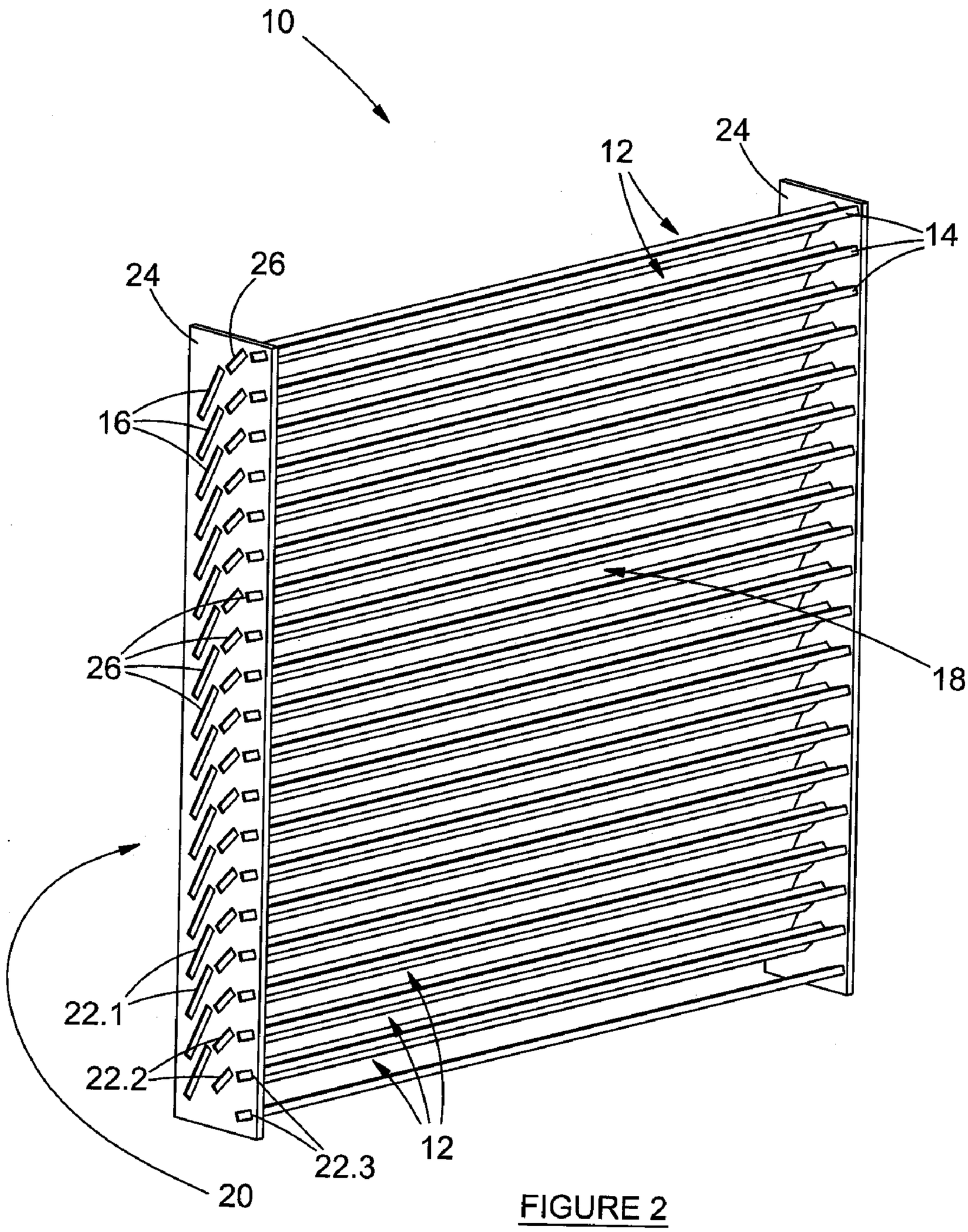


FIGURE 2

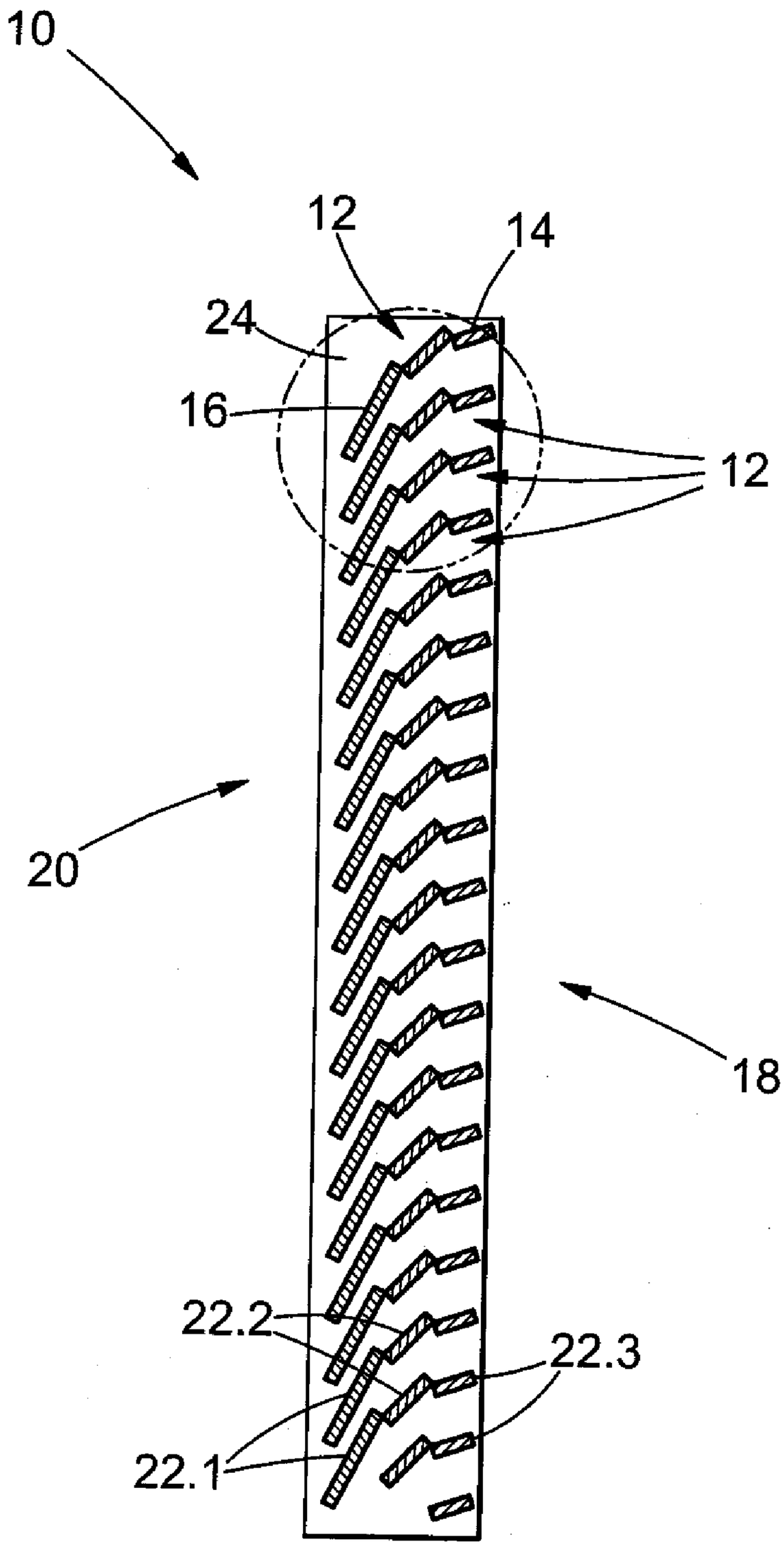


FIGURE 3

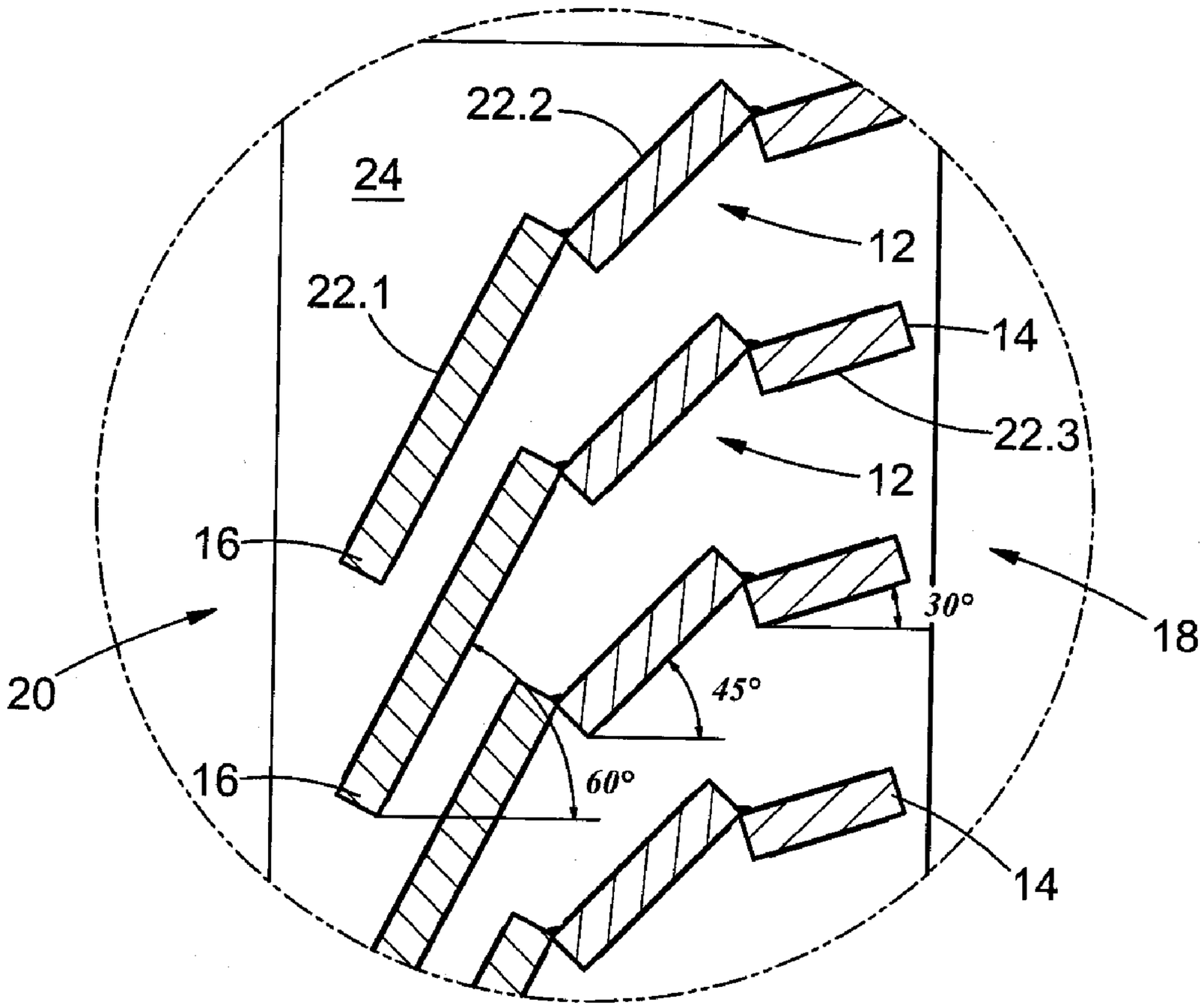


FIGURE 4

ARMOUR ARRANGEMENT

FIELD OF THE INVENTION

[0001] The invention relates to an armour arrangement, and more particularly, but not exclusively, to an armour arrangement suitable for use with armoured vehicles to protect a surface of the vehicle from shaped charges.

BACKGROUND TO THE INVENTION

[0002] A shaped charge is an explosive charge shaped to focus the effect of the explosive's energy. Various types of shaped charges are used to cut and form metal, initiate nuclear weapons, and penetrate armour. A typical device consists of a solid cylinder of explosive with a metal-lined conical hollow in one end and a central detonator, array of detonators, or detonation wave guide at the other end. The enormous pressure generated by the detonation of the explosive drives the liner contained within the hollow cavity inward to collapse upon its central axis. The resulting collision forms and projects a high-velocity jet of metal forward along the axis. Most of the jet material originates from the innermost layer of the liner, about 10% to 20% of its thickness. The remaining liner material forms a slower-moving slug of material.

[0003] A typical modern lined shaped charge can penetrate armour steel to a depth of 7 or more times the diameter of the charge's cone.

[0004] A shaped charge is also know as an Explosively Formed Penetrator or Explosively Formed Projectile (or "EFP" for short), Explosively-Forged Projectile, Explosively-Forged Penetrator, Self-Forging Warhead (SFW), and Self-Forging Fragment (SFF).

[0005] Shaped-charges and explosively formed projectiles are of major concern in modern day warfare, since they are relatively easy to produce and highly effective in penetrating armour plating of a light armour vehicle.

[0006] Composite armour, where sheets of different materials are located and secured atop one another, have been used with limited success heretofore, but do not prove to be sufficiently effective against the new threats of shaped charges and EFP's.

[0007] An example of known composite armour is laminate glass armour, which comprises silica/polycarbonate plastic layers sandwiched between glass layers. Disadvantages of laminate glass armour are that it is relatively very expensive to produce and relatively very heavy, since a sheet of laminate glass is approximately 3 inches thick and weights approximately 30 Lb/Ft^2.

OBJECT OF THE INVENTION

[0008] It is accordingly an object of the invention to provide an armour arrangement that will, at least partially, alleviate the disadvantages of existing solutions.

[0009] It is a further object of the invention to provide an armour arrangement that will be a useful alternative to existing armour arrangements.

SUMMARY OF THE INVENTION

[0010] According to a first aspect of the invention there is provided an armour arrangement for covering a surface to be protected, comprising a plurality of disruption members being located adjacent one another and being at least partially spaced apart from one another, wherein the disruption members are angularly displaced relative to the surface to be protected.

[0011] The disruption members may be arranged substantially parallel relative to one another.

[0012] Each disruption member may have a first impact side, being the side distal from the protected surface, and a second exit side, being the side proximate the protected surface, the arrangement being such that the armour arrangement includes a first impact face, being the face formed by the impact sides of the disruption members, and a second exit face, being the face formed by the exit sides of the disruption members.

[0013] The exit side of one disruption member may at the least partially overlap an adjacently positioned disruption member.

[0014] The disruption members may be planar.

[0015] Alternatively, the disruption members may be arcuate.

[0016] The disruption members may be of a non-linear configuration, wherein an angle between the impact side of the member and the protected surface is different to an angle between the exit side of the member and the protected surface.

[0017] Each disruption member may be formed from a single sheet of material.

[0018] Alternatively, each disruption member may include a plurality of disruption bodies.

[0019] Each disruption body may be planar.

[0020] Alternatively, each disruption body may be arcuate.

[0021] The disruption bodies may be positioned adjacent one another in a side-by-side arrangement and in an angularly offset configuration, to form the disruption member.

[0022] The disruption bodies may be arranged relative to one another, such that the disruption member is in the shape of a half-parabola.

[0023] The disruption bodies may be connected to one another to form the disruption member by a retaining frame, which may define a plurality of openings for receiving opposite outer ends of the bodies.

[0024] Alternatively, the disruption bodies may be connected to one another by being bonded to one another.

[0025] The armour arrangement may be positioned in front of the surface to be protected by being attached thereto by attachment means.

[0026] The surface may be an external surface of a hull section of an armoured vehicle.

[0027] According to a second aspect of the invention, there is provided an armoured vehicle including the armour arrangement according to the first aspect of the invention.

[0028] The armour arrangement may be attached to the armoured vehicle in order to protect the outer surface of the vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The invention will now be described further by way of a non-limiting example with reference to the accompanying drawings wherein:

[0030] FIG. **1** is a perspective view of an armour arrangement according to a preferred embodiment of the invention, being partially assembled;

[0031] FIG. **2** is a perspective view of the armour arrangement of FIG. **1**, being assembled;

[0032] FIG. **3** is a cross sectional side view of the armour arrangement of FIGS. **1** and **2**; and

[0033] FIG. **4** is a schematic illustration of the armour arrangement of FIGS. **1** to **3**, used in examples 1 and 2.

DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

[0034] Referring to the drawings, an armour arrangement according to a preferred embodiment of the invention is generally designated by reference numeral **10**.

[0035] The armour arrangement **10** is used to cover a surface (not shown) to be protected, such as an outer surface of a hull of an armoured vehicle (all not shown). The armour arrangement **10** is positioned in front of and is secured to the surface, by attachment means (also not shown).

[0036] The armour arrangement **10** comprises a plurality of disruption members **12** located adjacent one another, being at least partially spaced apart from one another and being angularly displaced relative to the surface.

[0037] Each disruption member **12** has a first impact side **14** and a second exit side **16**. The first impact side **14** is the side distal from the protected surface and the second exit side **16** is the side proximate the protected surface. The arrangement is therefore such that the armour arrangement **10** has a first impact face **18**, which is formed by the first impact sides **14** of the disruption members **12**, and a second exit face **20**, which is formed by the second exit sides **16** of the disruption members **12**.

[0038] The disruption members **12** are arranged substantially parallel relative to one another with the exit side **16** of one disruption member **12** at the least partially overlapping the disruption member **12** positioned adjacent it. The disruption members **12** are of a non-linear configuration, wherein an angle between the impact side **14** of the member **12** and the protected surface is different to an angle between the exit side **16** of the member **12** and the protected surface.

[0039] Each disruption member **12** is arcuate in cross-section and includes three disruption bodies (jointly referred to as **22**), a first body **22.1**, a second body **22.2** and a third body **22.3**. The disruption bodies **22** are planar and positioned side-by-side to form the arcuate disruption member **12**. The bodies **22** are further arranged in an angularly offset configuration, such that each disruption member **12** is in the shape of a half-parabolic curve. Specifically, the angle of the first body **22.1**, relative to the horizontal, is approximately 60°, the angle of the second body **22.2**, relative to the horizontal, is approximately 45°, and the angle of the third body **22.3**, relative to the horizontal, is approximately 30°.

[0040] The disruption bodies **22** are all made of 5 mm thick armour plate steel, with a Brinell hardness of between 500 and 600, such as Armox500™. The first body **22.1** is 30 mm wide and the second and third bodies **22.2** and **22.3** are both 25 mm wide each.

[0041] The disruption bodies **22** are connected to one another to form the disruption member **12** by a retaining frame **24**, as shown in FIGS. **1** and **2**. The retaining frame **24** defines a plurality of openings **26** for receiving opposite outer ends of the bodies **22**. However, the disruption bodies **22** could also be bonded to one another by, for example, having their adjacent ends welded together.

[0042] Below, as two examples, are the set up and results of trials that have been conducted to test the functionality of the armour arrangement **10**, as described above.

Example 1

[0043] Referring to FIG. **4**, the armour arrangement **10** in this example comprises three disruption bodies **22.1**, **22.1** and **22.3**, each being 5 mm thick and made from RAMOR500™ armour plate, having a Brinell hardness of 500. The first body **22.1** is 42.5 mm wide, the second body **22.2** is 23.5 mm wide and the third body **22.3** is 17 mm wide. The angle of the first body **22.1**, relative to the horizontal, is 63°, the angle of the second body **22.2**, relative to the horizontal, is 46°, and the angle of the third body **22.3**, relative to the horizontal, is 18°.

[0044] The armour arrangement **10** was positioned in front of the hull section of an armoured vehicle, with the exit face **20** of the armour arrangement **10** facing the surface of the hull and being approximately 435 mm from the surface.

[0045] An EFP was fired at the armour arrangement **10** from 2 m perpendicularly in front of the armour arrangement **10**.

[0046] It was found that the combination of the armour arrangement **10** and the hull of the armoured vehicle warded off the EFP. There were only minor splatter markings on the outer surface of the hull. The EFP thus had no effect on the inside of the hull.

Example 2

[0047] Using the same armour arrangement **10** described in example 1 above, the armour arrangement **10** was positioned approximately 321 mm from the surface of the hull. The EFP was again fired 2 m from the armour arrangement **10**. In this trial, the outer surface of the hull was relatively more damaged, but the EFP still did not penetrate the hull.

[0048] It has been shown that the damage sustained by armour plates during physical shaped-charge impact is based on the capability of the shaped charge to melt the material, which it is impacting. Further confirmation of this observation is the presence of splatter-patterns, consistent with molten metal droplets. It can therefore be concluded that a shaped-charge (or EFP) is most accurately modelled or approximated by the assumption that it is a phenomenon with:

[0049] i) High-speed (momentum/kinetic energy)

[0050] ii) High temperature (thermal energy)

[0051] iii) High pressure

[0052] iv) High viscosity (molten metal)

[0053] v) A spearhead-shape

[0054] vi) A molten/fluid metal slug or "jet" consistency

[0055] It is therefore submitted that in order to avoid death or serious injury due to a blast, one either needs to avoid the blast or the blast should be absorbed or deflected.

[0056] In the same vein, it is submitted that one can generalise and apply this philosophy to shaped charges too. Unfortunately, avoidance is quite improbable, thus the only two remaining options are absorption (dissipation through momentum redistribution) or deflection (redirection of the jet to avoid impact.

[0057] The basic concept of the present invention is to (i) deflect the molten metal jet as much as possible or, partially failing that, to (ii) dissipate the concentrated linear momentum of the single slug or jet by spreading it over a larger area (henceforth called splattering or scattering) by forcing it to break into smaller parts and changing its direction of motion through collision phenomena.

[0058] The former objective (deflection) would ideally be best facilitated by having a deflector-channel-shaped arrangement of plates which present a surface with a very high NATO (North Atlantic Treaty Organisation) impact angle at the point of first impact, gradually transitioning to

one having an impact angle parallel to or smaller than the surface tangent vector of the main armour behind it.

[0059] The latter objective (dissipation or disruption) would ideally be achieved by placing as many as possible thin (ca. 1 mm thick) plates at a slant to "disrupt" the flow (i.e. redirect, redistribute and convert the linear momentum) as many times as possible.

[0060] It has been found that thicker disruption bodies **22** provide more protection and deflection capability per body **22**, whilst the thinner bodies **22** provide more disruptive capability.

[0061] It has further been found that the multi-layered slanted body layout of the armour arrangement **10** proves to be effective in disrupting and diverting the jet originating from an EFP. There is a trade-off between structural strength and mass per unit area (which is attempted to be kept under 100 kg/m^2).

[0062] It will be appreciated that variations in detail are possible with an armour arrangement according to the invention without departing from the scope of the appended claims.

[0063] For example, the disruption members could each be formed from a single sheet of material, instead of a plurality of disruption bodies connected to one another. The disruption members could further be planar or arcuate formed by bending a single plate of material, to form a continuous smooth shape.

[0064] Further, the number of disruption bodies making up the disruption member may vary and the shape of the disruption bodies could be arcuate instead of planar.

1. An armour arrangement for covering a surface to be protected, comprising a plurality of disruption members being located adjacent one another, at least partially spaced apart from one another and being angularly displaced relative to the surface to be protected, wherein each disruption member is in the shape of a half-parabola.

2. An armour arrangement according to claim **1** wherein the disruption members are arranged substantially parallel relative to one another.

3. An armour arrangement according to claim **1** wherein each disruption member has a first impact side, being the side distal from the protected surface, and a second exit side, being the side proximate the protected surface, the arrangement being such that the armour arrangement includes a first impact face, being the face formed by the impact sides of the disruption members, and a second exit face, being the face formed by the exit sides of the disruption members.

4. An armour arrangement according to claim **3** wherein the exit side of one disruption member at the least partially overlaps an adjacently positioned disruption member.

5. An armour arrangement according to claim **1** wherein the disruption members are planar.

6. An armour arrangement according to claim **1** wherein the disruption members are arcuate.

7. An armour arrangement according to claim **3** wherein the disruption members are of a non-linear configuration and wherein an angle between the impact side of the member and the protected surface is different to an angle between the exit side of the member and the protected surface.

8. An armour arrangement according to claim **1** wherein each disruption member is formed from a single sheet of material.

9. An armour arrangement according to claim **1** wherein each disruption member includes a plurality of disruption bodies.

10. An armour arrangement according to claim **9** wherein each disruption body is planar.

11. An armour arrangement according to claim **9** wherein each disruption body is arcuate.

12. An armour arrangement according to claim **9** wherein the disruption bodies are positioned adjacent one another in a side-by-side arrangement and in an angularly offset configuration, to form the disruption member.

13. An armour arrangement according to claim **12** wherein the disruption bodies are arranged relative to one another, such that the disruption member is in the shape of a half-parabola.

14. An armour arrangement according to claim **12** wherein the disruption bodies are connected to one another, to form the disruption member, by a retaining frame, which defines a plurality of openings for receiving opposite outer ends of the bodies.

15. An armour arrangement according to claim **12** wherein the disruption bodies are connected to one another by being bonded to one another.

16. An armour arrangement according to claim **1** which is positioned in front of the surface to be protected by being attached thereto by attachment means.

17. An armour arrangement according to claim **16** wherein the surface is an external surface of a hull section of an armoured vehicle.

18. An armoured vehicle including the armour arrangement according to claim **1**.

19. An armoured vehicle according to claim **18** wherein the armour arrangement is attached to the vehicle in order to protect the outer surface of the vehicle.

20.-**21**. (canceled)

* * * * *