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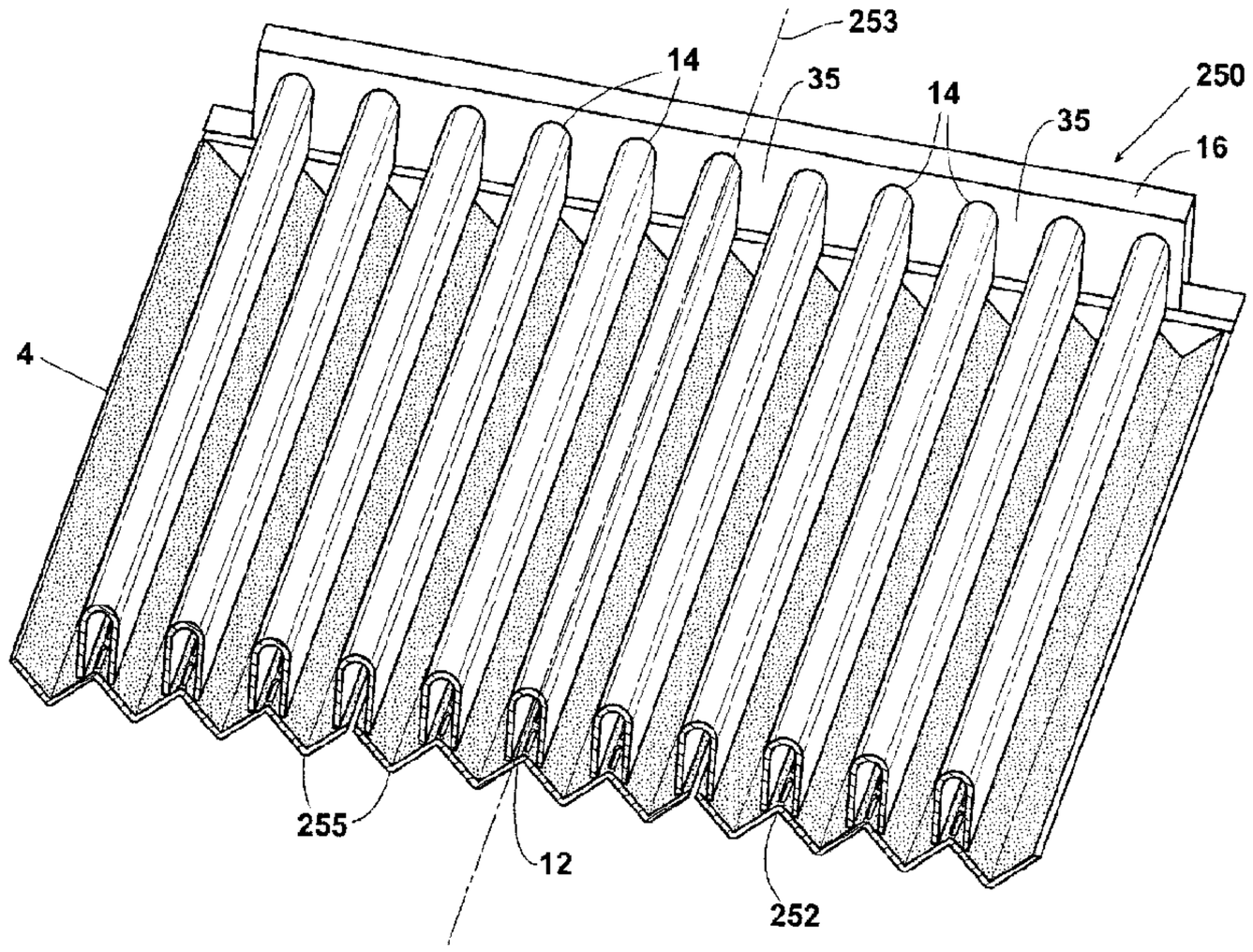

(57) **Abrégé/Abstract:**
A cooking grate and a grill assembly having one or more of the cooking grates therein wherein the cooking grate reduces or eliminates flare-ups, reduces preheating time, provides attractive grill marks, provides increased thermal efficiency, and produces a higher percentage of infrared cooking energy. The cooking grate can be a one-piece structure but is preferably a two- piece structure wherein the upper piece comprises longitudinally extending food support ribs having hollow interiors. The ribs will be positioned over and cover open areas in the lower structure in such close proximity that combustion gases flowing through the open areas of the lower structure will be directed into and will flow through the hollow interiors of the food support ribs.

Abstract

A cooking grate and a grill assembly having one or more of the cooking grates therein wherein the cooking grate reduces or eliminates flare-ups, reduces preheating time, provides attractive grill marks, provides increased thermal efficiency, and produces a higher percentage of infrared cooking energy. The cooking grate can be a one-piece structure but is preferably a two-piece structure wherein the upper piece comprises longitudinally extending food support ribs having hollow interiors. The ribs will be positioned over and cover open areas in the lower structure in such close proximity that combustion gases flowing through the open areas of the lower structure will be directed into and will flow through the hollow interiors of the food support ribs.

COOKING GRATE AND COOKING APPARATUS

FIELD OF THE INVENTION

The present invention relates to cooking grates and grate assemblies which support food items for cooking in outdoor grills and in other cooking systems. The invention also relates to cooking systems which utilize such grates or grate assemblies

BACKGROUND OF THE INVENTION

Outdoor grilling systems which primarily utilize infrared radiant energy for cooking food items are known in the art. The beneficial results which these systems are capable of providing over conventional convective grills are also well known. However, there are various shortcomings which are often associated with the current infrared systems. The following are examples of such shortcomings and deficiencies commonly encountered in existing infrared grilling systems:

- existing infrared grilling systems typically require the use of expensive infrared burners or other high cost burner systems in order to provide the degree of performance and results desired;
- many existing systems also require the use of a separate infrared emitter plate or other emitting structure positioned intermediate the burner and the food support grate;
- many existing infrared systems, including, but not limited to, those having open grates positioned above an intermediate infrared emitting plate or other structure, are commonly prone to flare-up problems caused by the ignition of fat which drips from the food product; and
- cooking grate structures heretofore developed in the art to reduce flare-ups have also had significant shortcomings or deficiencies in that, for example: (a) they

can require extended preheat times; (b) the food contacting portions of the grate do not heat quickly enough and/or do not reach a sufficient temperature for adequately searing the food product and/or for providing attractive grill marks on the product; and/or (c) the grate structures can be difficult and expensive to make due to the need to hold tight tolerances and the difficulty of applying porcelain coatings to small openings.

Consequently, a need currently exists for improved cooking grate structures or assemblies for infrared grills which will: (a) allow lower cost burners or other heating elements to be used for providing excellent infrared cooking results, (b) eliminate the need for a separate emitter plate or other emitting structure intermediate the burner and the grate structure or grate assembly, (c) greatly reduce or eliminate flare-ups, (d) greatly reduce the preheating time required to reach cooking temperature, and (e) rapidly provide high contacting temperatures for searing the food product and producing attractive grill marks. In addition, a continuing need exists for improved infrared cooking systems which will (1) provide increased thermal efficiency and/or (2) provide and transmit a greater percentage of infrared cooking energy to the food product.

SUMMARY OF THE INVENTION

The present invention provides an improved cooking grate or grate assembly and an improved cooking system which satisfy the needs and alleviate the problems discussed above. In one embodiment, the cooking grate assembly preferably comprises: (a) a lower radiating structure and (b) a food support rib structure which is positionable on top of the lower radiating structure.

The food support rib structure preferably comprises a series of parallel food support ribs which have hollow interiors and are each open at the lower end thereof. The lateral cross-section of each rib element will preferably have an inverted U-shape but can alternatively have an inverted V-shape, a rectangular shape, a combination of such shapes, or any other desired geometry.

The lower radiating structure preferably includes apertures, slots, or other openings which will be positioned beneath or inside the lower ends of the food support

ribs so that hot combustion gas or other hot flue gas will flow into the rib elements. The lower radiating structure preferably has no openings therethrough which will be positioned in the gaps between the adjacent rib elements.

In addition, although the lower radiating structure can be flat, the lower radiating structure can alternatively comprise a series of parallel ridge structures which will project upwardly in the gaps between the parallel ribs. The ridges can have an inverted V-shape, a wide inverted U-shape, or any other geometry desired, preferably with downwardly sloping or downwardly curving lateral sides.

Moreover, as another alternative, the lower radiating plate can provide downwardly extending valleys between the parallel ribs. By way of example, such valleys can have shapes similar to the ridges just mentioned, but in inverted form.

Further, one or more types of outlet openings are also preferably provided for the rib elements so that hot gas generated by the burner or other heating element does not simply remain stagnant in the interior of the rib elements but continuously flows through and out of the rib elements. This increases and accelerates the heat transfer to the rib elements which greatly reduces the required preheating time and increases the contacting temperature of the rib elements to provide beneficial searing and to produce attractive grill marks. It also increases thermal efficiency and increases the infrared percentage of total cooking energy.

Examples of gas outlet flow openings for the rib elements include, but are not limited to: (a) gas discharge openings provided in one or both of the longitudinal ends of the rib elements, (b) slots, holes, or other apertures provided through one or both of the sidewalls of the rib element, preferably near the top thereof, and/or (c) gaps between the lower radiating structure and the lower ends of the sidewalls of the rib elements, such gaps preferably being formed by spacing the rib elements above the lower radiating structure.

Thus, by way of example, the present invention provides a cooking grate assembly which can comprise: (a) a lower structure comprising a side-by-side series of parallel, longitudinally extending solid sections having substantially no openings therethrough; (b) a series of parallel, longitudinally extending open sections provided in

the lower structure, the open sections being located between the solid sections, each of the open sections having an open area lateral width; and (c) an upper structure comprising a side-by-side series of parallel, spaced apart, longitudinally extending food support ribs, each having a hollow interior and a longitudinally extending bottom opening, the bottom opening having a lateral width that is not less than the open area lateral width of the open sections of lower structure.

The upper structure is preferably removably positionable over the lower structure such that the food support ribs will be positioned over and substantially parallel to the open sections of the lower structure. Consequently, as viewed from above the cooking grate assembly, the food support ribs will substantially entirely cover the open sections of the lower structure. When the upper structure is positioned over the lower structure, the open sections of the lower structure will be located within, at, or below the bottom openings of the food support ribs in a manner such that combustion gases flowing upwardly through the open sections of the lower structure will flow into the hollow interiors of the food support ribs.

In another aspect concerning this example, the longitudinally extending solid sections of the lower structure can each have a downwardly extending cross-sectional shape such that the solid sections of the lower structure will form longitudinally extending valleys between the food support ribs. The downwardly extending cross-sectional shape of the solid sections will most preferably be a V-shape.

As another alternative, the longitudinally extending solid sections of the lower structure can have an upwardly extending cross-sectional shape. The upwardly extending cross-sectional shape of the solid sections will most preferably be an inverted V cross-sectional shape such that the solid sections will form longitudinally extending ridges between the food support ribs.

As another example, the present invention provides a cooking grate assembly comprising: (a) a lower structure comprising a side-by-side series of parallel, longitudinally extending solid sections having substantially no openings therethrough; (b) a series of parallel, longitudinally extending open sections provided in the lower structure, the open sections being located between the solid sections, each of the open

sections of the lower structure having an open area lateral width; and (c) an upper structure comprising a side-by-side series of parallel, spaced-apart, longitudinally extending food support ribs, each having a hollow interior and a longitudinally extending bottom opening having a lateral width which is greater than the open area lateral width of the open sections of the lower structure.

The upper structure is preferably removably positionable over the lower structure such that the food support ribs will be positioned over and substantially parallel to the open sections of the lower structure. Consequently, as viewed from above the cooking grate assembly, the food support ribs will substantially entirely cover the open sections of the lower structure. The solid sections of the lower structure have a downwardly extending lateral cross-sectional shape such that the solid sections of the lower structure will form longitudinally extending valleys between the food support ribs. When the upper structure is positioned over the lower structure, the open sections of the lower structure will be received in the bottom openings of the food support ribs such that combustion gases flowing upwardly through the open sections of the lower structure will flow into the hollow interiors of the food support ribs.

As another example, the present invention provides an infrared cooking grate comprising alternating side-by-side series of substantially parallel solid sections and food support ribs wherein: (a) the food support ribs have hollow interiors; (b) the food support ribs have open bottoms for receiving combustion gases; and (c) the food support ribs have one or more discharge openings for flow of the combustion gases out of the hollow interiors of the food support ribs.

As yet another example, the present invention provides a grill assembly comprising a housing having therein at least one cooking grate or cooking grate assembly of any type mentioned above or otherwise disclosed herein, or any combination of such cooking grates and/or cooking grate assemblies.

Further aspects, features, and advantages of the inventive cooking grate and cooking system will be apparent to those of ordinary skill in the art upon examining the accompanying drawings and upon reading the following detailed description of the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an embodiment **2** of the inventive cooking grate assembly.

FIG. 2 is a perspective view of an alternative embodiment **50** of the inventive cooking grate assembly.

FIG. 3 schematically illustrates an elevational cutaway end view of cooking grate assembly **2** and grate assembly **50**.

FIG. 4 schematically illustrates an elevational cutaway end view of an alternative embodiment **100** of the inventive cooking grate assembly.

FIG. 5 schematically illustrates an elevational cutaway end view of an alternative embodiment **150** of the inventive cooking grate assembly.

FIG. 6 schematically illustrates a cutaway elevational end view of an alternative embodiment **200** of the inventive cooking grate assembly.

FIG. 7 is a perspective view of an alternative embodiment **250** of the inventive cooking grate assembly.

FIG. 8 is a perspective end view of the inventive cooking grate assembly **250**.

FIG. 9 is a perspective view of an alternative embodiment **300** of the inventive cooking grate assembly.

FIG. 10 schematically illustrates a cutaway elevational end view of the inventive cooking grate assembly **250** and the inventive cooking grate assembly **300**.

FIG. 11 schematically illustrates a cutaway elevational end view of an alternative embodiment **400** of the inventive cooking grate assembly.

FIG. 12 schematically illustrates a cutaway elevational end view of an alternative embodiment **450** of the inventive cooking grate assembly.

FIG. 13 schematically illustrates a cutaway elevational end view of an alternative embodiment **500** of the inventive cooking grate assembly.

FIG. 14 is a perspective view of an alternative embodiment **550** of the inventive cooking grate assembly.

FIG. 15 schematically illustrates a cutaway elevational end view of the inventive cooking grate **550**.

FIG. 16 schematically illustrates a cutaway elevational end view of an alternative embodiment **600** of the inventive cooking grate assembly.

FIG. 17 schematically illustrates a cutaway elevational end view of an alternative embodiment **650** of the inventive cooking grate assembly.

FIG. 18 schematically illustrates a cutaway elevational end view of an alternative embodiment **700** of the inventive cooking grate assembly.

FIGS. 19A and 19B are perspective and end views of an alternative embodiment **800** of the inventive cooking grate assembly.

FIG. 20 schematically illustrates a cutaway elevational end view of inventive grate assembly **800**.

FIG. 21 schematically illustrates a cutaway elevational end view of an alternative embodiment **850** of the inventive cooking grate assembly.

FIG. 22 schematically illustrates a cutaway elevational end view of an alternative embodiment **900** of the inventive cooking grate assembly.

FIG. 23 schematically illustrates a cutaway elevational end view of an alternative embodiment **950** of the inventive cooking grate assembly.

FIG. 24 schematically illustrates a cutaway elevational end view of an alternative embodiment **730** of the inventive cooking grate.

FIG. 25 schematically illustrates a cutaway elevation end view of an alternative embodiment **740** of the inventive cooking grate.

FIG. 26 is a cutaway elevational view of an embodiment **750** of the inventive grilling apparatus which utilizes the inventive cooking grate assembly **2** and/or any of the other inventive cooking grate assemblies illustrated in FIGS. 1-25.

FIG. 27 is a perspective view of an alternative embodiment **760** of the inventive cooking grate.

FIG. 28 is a perspective view of an alternative embodiment **770** of the inventive cooking grate.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments **2** and **50** of the inventive cooking grate apparatus are illustrated in FIGS. 1-3. Each of the inventive cooking grate assemblies **2** and **50** comprises a lower radiating plate **4** and a food support structure **6** which is positioned on top of the

radiating plate **4**. Although the inventive grate **2** or **50** could be a unitary structure as discussed below, it is preferred, for reasons of ease of manufacture, lower cost, and cleaning, that the lower radiating plate **4** and the food support structure **6** be manufactured and used together as separate pieces such that the food support structure **6** is removably placeable on top of the lower radiating plate **4**.

The lower radiating plate **4** comprises a series of parallel ridge structures **8** which preferably have an inverted V-shape. As seen in FIG. 1, the ridge structures **8** extend longitudinally and therefore are substantially parallel to the longitudinal center line **15** of the grate assembly **2** or **50.** Elongate slots **10** or a series of shorter slots **12,** or other gas flow apertures, are provided along the bottoms of the valleys formed between each adjacent pair of ridges **8**.

Given the ability of the inventive cooking grate assemblies **2** and **50** to heat the food support ribs **14** of the food support structure **16** to higher temperatures, and in view of the exponential increase in infrared emission levels which these higher temperatures will provide, the lower radiating plate **4** can be formed of generally any material which will withstand these operating temperatures and which preferably (a) is at least minimally corrosion resistant and (b) has an emissivity of at least 0.25 (more preferably at least 0.3, more preferably at least 0.4, more preferably at least 0.5, more preferably at least 0.6, more preferably at least 0.7 and more preferably at least 0.8). Examples of suitable materials include, but are not limited to: coated steel (e.g., porcelain-coated steel), treated cast iron, or titanium. The emissivity of stainless steel having an ordinary finish will also increase to a more desirable level during operation as a result of oxidation and the deposition of food debris which operate to darken the surface.

More preferred materials having desirably high emissivities include, but are not limited to: porcelain-coated steel (most preferably steel with a black porcelain coating providing an emissivity of more than 0.9); shot blasted stainless steel; and oxidized stainless steel. It will also be understood that numerous other materials having excellent emissivities which are more expensive to purchase and/or use in manufacturing can also be employed, but are not necessary.

The food support structure **6** preferably comprises a side-by-side series of parallel food support ribs **14** which are connected to and extend from a lateral cross support **16,** or extend between a pair of opposing lateral cross supports **16**. As seen in FIG. 1, the food support ribs **14** extend longitudinally and are therefore substantially parallel to the longitudinal center line **15** of the grate assembly **2** or **50.** The food support ribs **14** preferably have an inverted U-shape with a rounded top **18** but can alternatively be of a rectangular or square shape, an inverted V-shape, a combination of such shapes, or any other desired geometry. The food support ribs **14** have lower ends **25** which rest on top of the lower radiating plate **4** in the ridge valleys such that the openings **20** in the lower ends of the ribs **14** straddle the slots **10**, **12** or other gas openings provided in the ridge valleys of the lower plate **4**.

The food support ribs **14** preferably also include either (a) flue exhaust slots or other openings **22** (as illustrated in grate assembly **50**) which extend along one side **24** or both sides **24** and **26** (preferably both of sides **24** and **26**) of the ribs **14** near the tops thereof; (b) flue exhaust openings, as used in grate assembly **2**, provided through one or both of the longitudinal ends **28** of each rib with corresponding exhaust **40** openings provided through the lateral cross-support(s) **16** (not shown in FIGS. 1-3 but see the example of such openings **40** shown in FIG. 8); or (c) a combination thereof. Because of the exhaust openings provided near the tops and/or through the longitudinal end(s) of the food support ribs **14**, the hot gas received through the lower plate openings **10** or **12** does not remain stagnant but instead continuously flows through and accelerates the heating of the support ribs **14**.

In the inventive grate assembly **50**, as well as all of the other embodiments of the inventive grate assembly discussed herein when manufactured to have upper flue gas slots **22** (or a single elongate slot **22**) extending along each side **24** and **26** of the food support ribs **14**, the number and/or size of the slots will preferably be effective such that, at an operating temperature of 600° F, the flow of flue gas into the ribs **14** and out of the slots **22** will (a) reduce the warm-up time of the grate assembly by at least 10% (more preferably at least 15% and most preferably at least 20%) and/or (b) increase the thermal efficiency of the grate assembly by at least 8% (more preferably at least 10% and most preferably at least 13%) versus a high performance prior art

infrared grate assembly of the type shown in FIG. 1 of U.S. Patent Application Publication No. US2007/0125357 A1 (discussed below). The single elongate slot **22** or plurality of slots **22** in each side wall **24** and **26** of the food support rib **14** will preferably have a width in the range of from about 0.03 to about 0.1 inch. The width of the slot(s) **22** will more preferably be in the range of from about 0.035 to about 0.085 inch and will most preferably be in the range of from about 0.05 to about 0.06 inch.

In the inventive grate assembly **2**, as well as all of the other embodiments of the inventive grate assembly discussed herein when manufactured to have flue gas flow out of one or both longitudinal ends of each food support rib **14**, the size (and thus the resulting surface area) of the ribs **14**, along with the flue gas flow through the ribs, will preferably be effective such that, at an operating temperature of 600° F, the flow of flue gas into the ribs **14** and out of the end(s) thereof will (a) increase the infrared energy output percentage of the grate assembly by at least 10% (more preferably at least 15% and most preferably at least 20%) and/or (b) reduce the warm-up time of the grate assembly by at least 10% (more preferably at least 15% and most preferably at least 20%) versus a high performance prior art infrared grate assembly of the type shown in FIG. 1 of U.S. Patent Application Publication No. US 2007/0125357 A1.

By way of example, but not by way of limitation, the food support ribs **14** can be formed of any of the same suitable and preferred materials discussed above for the lower radiating plate **4**. In addition, the ribs **14** can also be treated with a corrosion-resistant and/or nonstick coating such as porcelain, PTFE, silicone oxide ceramic, tantalum, or other known coating technologies.

The food support ribs **14** of the inventive grate assemblies **2** and **50** will preferably have a height **30** in the range of from about 0.2 to about 1.25 inches and will more preferably have a height in the range of from about 1/4 to about 1 inch. The lateral width **32** of the bottom openings **20** of the food support ribs **14** must be sufficient such that the hot flue gas can flow into and out of the ribs **14** without creating sufficient back pressure to cause a combustion failure in the grilling system. The lateral width **32** of the lower end openings **20** of the support ribs **14** will preferably be at least 1/8 inch. The lateral width **32** of the bottom openings **20** of the ribs **14** will more

preferably be at least 1/4 inch and will most preferably be in the range of from about 0.28 to about 0.32 inch.

In order to be sufficiently wide for easy cleaning without being so wide as to permit a large enough inflow of fresh atmospheric air to cause flare-up problems, the lateral width **35** of the gaps between adjacent support ribs **14** will preferably be in the range of from about 1/4 to about 1 inch and will more preferably be in the range of from about 1/2 to about 3/4 inch.

In one alternative embodiment, the slots **10** or **12** or other openings provided in the ridge valleys of the lower radiating plate **4** can be of substantially the same width **32** as the bottom openings **20** of the support ribs **14**. When large plate openings of this size are employed, the user will have the option of simply removing the food support structure **6**, if desired, and using the lower plate **4** essentially in the same manner as a conventional convection cooking grate.

However, for better manufacturing control which will ensure that no gaps will exist outside of the ribs **14** and cause flare-ups, the width **34** of the slots **10** or **12** or other openings provided in the ridge valleys of the lower radiating plate **4** will preferably be narrower than the lateral width **32** of the bottom openings **20** of the support ribs **14**. Moreover, I have discovered that, although the use of narrower plate openings **10**, **12** allows a lesser amount of direct infrared emission from the burner into the rib bottom openings, the narrower plate openings unexpectedly create a surprising jet flow effect whereby the velocity of the flue gas flowing into the support ribs **14** is increased and creates more turbulent flow conditions within the food support ribs **14.** This beneficial turbulence significantly increases the rate and degree to which the hot gas heats the food support ribs and effectively cancels out (i.e., compensates for) any reduction in radiant heat transfer to the rib interior.

To allow sufficient flow to prevent combustion failure, the width **34** of the plate slots or other openings **10**, **12**, will preferably be at least 0.02 inch, more preferably at least 0.04 inch. The width **34** of the plate slots or other openings **10**, **12**, will more preferably be in the range of from about 0.8 to about 0.05 (more preferably from about 0.5 to about 0.08 and most preferably from about 0.3 to about 0.1) times the lateral width **32** of the rib bottom openings **20**.

The inventive grate assemblies **2** and **50** provide surprisingly significant increases in energy efficiency and/or infrared energy output as compared to even the best cooking grates and cooking grate assemblies heretofore known in the art. Tests were conducted, for example, to compare the inventive grate assemblies **2** and **50** with the high performance prior art infrared grate assembly shown in FIG. 1 of U.S. Patent Application Publication No. US2007/0125357 A1. In the prior art grate assembly, flue gas either does not enter the food support ribs or is stagnant. These tests were conducted using an otherwise conventional grill with a single wall fire box and simple large tube burners which ran from front to back. The results were as follows:

- The prior art high performance infrared grate required 7.38 minutes to heat to an operating temperature of 600° F. The thermal efficiency of the prior art grate was 29.1% and 62.2% of the total energy output to the food product was in the form of infrared energy.
- The inventive grate assembly **2** required only 5 minutes to heat to an operating temperature of 600° F (i.e., a 32.2% reduction in the time required by the prior art grate assembly). The thermal efficiency of the inventive grate assembly **2** was substantially the same as the prior art grate but the infrared energy output percentage was 76.4% (i.e., a 22.8% improvement over the prior art grate assembly).
- The inventive gate assembly **50** also provided a 32.2% reduction in preheating time. The infrared energy output percentage of the inventive grate **50** was somewhat higher than that of the prior art grate and the thermal efficiency of the inventive grate assembly **50** was 34.1% (i.e., a 17.2% improvement over the prior art grate assembly).

Moreover, in addition to the improvement in thermal efficiency provided by inventive grate assembly as measured by flux testing after reaching the specified cooking temperature (i.e., 600° F), each of the inventive grate assemblies **2** and **50** also provides a further significant improvement in thermal efficiency by greatly reducing the necessary preheating time and thereby reducing the total time and amount of fuel/energy required to cook a food product. Also, the performance advantages of the inventive cooking grates and assemblies over the prior art high performance grates can

be even further enhanced when used with burner systems such as those described in U.S. Patent Application Publication Nos. US2009/0202688 and US2010/0095951 which can provide high heat output while allowing an increase in the back pressure produced by the cooking grate.

The bottom edges **25** of the food support ribs **14** of grate assemblies **2** and **50** rest on the lower radiating plate **4**. The contact between the ribs **14** and the plate **4** is not sealed so that hot fat which drips into the gaps between the support ribs **14** will flow beneath the lower ends **25** of the ribs **14** and out of the slots or other openings **10, 12** formed in the ridge valleys of the lower radiating plate **4**. Because of the drainage occurring through the slots or other openings **10**, **12** formed in the lower radiating plate **4**, a grill assembly utilizing the inventive grate **2** or the inventive grate **50** will also preferably utilize a grease drip pan installed beneath the grill burner or other heating element.

Although the parallel ridges **8** of the radiating plates **4** shown in FIGS. 1 and 3 have an inverted V-shape, it will be understood that the ridges **8** could be of any other shape, a few examples of which are illustrated below, and of any angle, slope, and/or curvature which will preferably promote drainage toward the plate openings **10**, **12**. The inventive grates **2** and **50** require less frequent cleaning than other grate systems and are also easily cleaned because (a) the very hot, low viscosity fat which flows beneath the rib side edges will not readily clog the radiating plate slot openings **10, 12** and (b) any debris which accumulates in the gaps between the ribs **14** can be readily removed by lifting the food support structure **6** and brushing the lower radiating plate **4**. Moreover, a further advantage of the inventive grate assemblies **2** and **50** is that the inventive assembly **50** is highly resistant to flare-ups and the inventive assembly **2** substantially eliminates the possibility of flare-ups entirely.

An alternative embodiment **100** of the inventive grate assembly is illustrated in FIG. 4. Except for the differences discussed below, the construction, features, materials, and other particulars of the inventive grate assembly **100** will preferably be the same as inventive assembly **2** and/or inventive assembly **50** and these features will provide all of the same benefits and advantages discussed above.

The inventive grate assembly **100** will preferably be identical to either the inventive grate assembly **2** or the inventive grate assembly **50,** or a combination thereof, except that the parallel structures **102** of the lower radiating plate **4** of the assembly **100** have an upwardly curved rather than an inverted V cross-sectional shape.

An alternative embodiment **150** of the inventive grate assembly is illustrated in FIG. 5. Except for the differences discussed below, the construction, features, materials, and other particulars of the inventive assembly **150** will preferably be the same as those of the inventive assembly **2** and/or the inventive assembly **50** and these features will therefore provide all of the same benefits and advantages discussed above.

The inventive grate assembly **150** will preferably be identical to inventive grate assembly **2** or inventive grate assembly **50**, or a combination thereof, except that the parallel structures **152** of the lower radiating plate **4** of the grate assembly **150** are flat rather than having an inverted V cross-sectional shape. Consequently, although easier to manufacturer, the rate of fat drainage from the inventive grate assembly **150** will be slower than is provided by inventive assemblies **2** and **50**.

An alternative embodiment **200** of the inventive grate assembly is illustrated in FIG. 6. Except for the differences discussed below, the construction, features, materials, and other particulars of the inventive assembly **200** will preferably be the same as those of the inventive assembly **2** and/or the inventive assembly **50** and these features will therefore provide all of the same benefits and advantages discussed above.

The inventive grate assembly **200** will preferably be identical to inventive grate assembly **2** or inventive grate assembly **50**, or a combination thereof, except that the parallel structures **202** of the lower radiating plate **4** of the grate assembly **200** have flat top surfaces **204** with downwardly sloping sides **206** which facilitate fat drainage.

An alternative embodiment **250** of the inventive grate assembly is illustrated in FIGS. 7, 8, and 10. Except for the differences discussed below, the construction, features, materials, and other parameters of the inventive grate assembly **250** will preferably be the same as those of the inventive grate assembly **2** and/or the inventive assembly **50** and these features will therefore provide all of the same benefits and advantages discussed above.

Inventive grate assembly **250** is identical to the inventive grate assembly **2** except that (a) the food support ribs **14** of assembly **250** rest on top of the inverted V-shaped ridges **252** of the lower radiating plate **4** and (b) the flue slots or other apertures **10**, **12** of the lower radiating plate **4** of assembly **250** are therefore provided along the ridge peaks rather than in the valleys between the ridges **252**. FIG. 8 illustrates the flue gas exhaust openings **40** provided in the lateral rib holding member **16** which can be used in either of embodiments **2** or **250,** and in other embodiments discussed herein, to allow gas flow out of the longitudinal ends of the ribs **14**.

Because the lower radiating plate **4** of inventive grate assembly **250** forms downwardly extending V-shaped valleys **255** in the gaps between the food support ribs **14**, fat and water which drips into the valleys **255** between the support ribs **14** will collect therein rather than draining from the radiating plate flue openings **10** or **12**. Consequently, the inventive grate assembly **250** requires more frequent cleaning than the inventive assembly **2** but will not require the installation of a drip pan below the grill burner or heating element. The fat and water which collect in the gaps between the food support ribs **14** vaporizes during the cooking process and is infused back into the food product to make the product even more tender, moist, and flavorful.

An alternative embodiment **300** of the inventive grate assembly is illustrated in FIGS. 9 and 10. Except for the differences discussed below, the construction, features, materials, and other particulars of the inventive grate assembly 3**00** will preferably be the same as those of the inventive assembly **50** and these features will therefore provide all of the same benefits and advantages discussed above.

The inventive grate assembly **300** is identical to the inventive grate assembly **250** except that the food support ribs **14** of the inventive assembly **300** utilize flue exhaust slots or other openings **22** identical to those used in assembly **50** which extend along either or both sides **24** and **26** of the ribs **14** near the upper ends thereof.

It will also be understood that inventive grate assembly **300** could, if desired, be further adapted to also allow flue exhaust flow through the longitudinal ends of the food support ribs **14** as illustrated in FIG. 8.

An alternative embodiment 4**00** of the inventive grate assembly is illustrated in FIG. 11. Except for the differences discussed below, the construction, features,

materials, and other particulars of the inventive grate assembly 4**00** will preferably be the same as those of the inventive assembly **2** and/or the inventive assembly **50** and these features will therefore provide all of the same benefits and advantages discussed above.

The inventive grate assembly **400** is identical to the inventive assembly **250** or the inventive assembly **300**, or a combination thereof, except that the parallel structures **402** of the lower radiating plate **4** form a downwardly dipping U-shape **405**, rather than a downwardly dipping V-shape, in the gaps between the food support members **14**.

An alternative embodiment **450** of the inventive grate assembly is illustrated in FIG. 12. Except for the differences discussed below, the construction, features, materials, and other particulars of the inventive grate assembly **450** will preferably be the same as those of the inventive assembly **2** and/or inventive assembly **50** and these features will therefore provide all of the same benefits and advantages.

The inventive grate assembly **450** will preferably be identical to inventive assembly **250** or inventive assembly **300**, or a combination thereof, except that the parallel structures **452** of the lower radiating plate **4** will have a wide U cross-sectional shape for collecting water and grease with a flat bottom surface **454** which extends between the adjacent food support ribs **14**.

An alternative embodiment **500** of the inventive grate assembly is illustrated in FIG. 13. Except for the differences discussed below, the construction, features, materials, and other particulars of the inventive grate assembly 5**00** will preferably be the same as those of the inventive assembly **2** and/or the inventive assembly **50** and these features will therefore provide all of the same benefits and advantages discussed above.

The inventive grate assembly **500** will preferably be identical to the inventive assembly **250** or the inventive assembly **300**, or a combination thereof, except that the parallel structures **502** of the lower radiating plate **4** have flat bottom surfaces **504** with upwardly sloping sides **506**.

Further alternative embodiments **550**, **600**, **650**, and **700** of the inventive grate assembly are illustrated in FIGS. 14-18. Except for the differences discussed below, the construction, features, materials, and other particulars of the inventive grate assembles

550, **600**, **650**, and **700** will preferably be the same as those of the inventive assembly **2** and/or the inventive assembly **50** and these features will therefore provide all of the same benefits and advantages discussed above.

The inventive assemblies **550**, **600**, **650**, and **700** are identical, respectively, to the inventive grate assemblies **250**, **400**, **450**, and **500** discussed above except that the gas flow into the bottoms of the food support ribs **14** of assemblies **550**, **600**, **650**, and **700** does not flow out of exhaust openings provided through the sides, or through the longitudinal ends, of the support ribs **14**. Rather, the lower ends **25** of the food support ribs **14** are spaced above the lower radiating plate **4** (i.e., are not in contact with the lower radiating plate **4**) so that gas exhaust flow is provided through the longitudinal gaps **552** thus created between the lower ends **25** of the food support ribs **14** and the upper surfaces of the lower radiating plate **4**. The height of the gaps **552** will preferably be in the range of from about 0.01 to about 0.2 inch. The height of the gaps 552 will more preferably be from about 0.015 to about 0.15 inch and will most preferably be from about 0.05 to about 0.1 inch.

Thus, the inventive grate assemblies **550**, **600**, **650**, and **700** also operate such that the flue gas is not stagnant within the support ribs **14** but continuously flows into and out of the support ribs **14** to promote heat transfer to the ribs. In addition, the abrupt change in flow direction and velocity which occurs as the hot gas escapes beneath the lower ends **25** of the food support ribs **14** creates a significant amount of turbulence which promotes further heat transfer to the base of the rib **14** and to the lower radiating plate **4**. Also, the flow pattern of the hot gas through the gaps **552** beneath the side edges **25** of the food support ribs **14** also beneficially operates to block fresh air entry into the gaps between the ribs **14**, thus providing additional resistance to the flare-ups. Further, the resulting low velocity flow of the hot gas out of the gaps between the support ribs **14** adds an amount of convective heat transfer to the cooking process without drying the food product.

Further alternative embodiments **800**, **850**, **900**, **950** of the inventive grate assembly are illustrated in FIGS. 19-23. Except for the differences discussed below, the construction, features, materials, and other particulars of these inventive grate assemblies will preferably be the same as those of the inventive assembly **2** and/or the

inventive assembly **50** and these features will therefore provide all of the same benefits and advantages discussed above.

The inventive grate assemblies **800**, **850**, **900**, **950** will preferably be identical or close to identical to the inventive assemblies **550**, **600**, **650**, **700** except that (a) the radiating plate openings **10, 12** of assemblies **800**, **850**, **900**, **950** are located in the valleys between parallel plate structures **8**, **102, 152**, or **202** (as is the case with inventive assemblies **2, 50, 100, 150**, and **200)** and (b) the food support ribs **14** are also positioned in the valleys over the openings **10, 12** but are spaced above the lower radiating plate **4**.

The inventive grate assemblies **800**, **850**, **900**, **950** thus provide gas flow gaps **552** beneath the lower edges **25** of the food support ribs **14**, similar to the inventive assemblies **550, 600, 650, 700**. However, due to the location of the gas flow gaps **552** and the plate openings **10, 12** in the valleys between plate ridges **8**, **102**, or **202** of the type seen in assemblies **2, 50**, **100, 200** (or above flat parallel plate structures **152** of the type seen in assembly **150**), fat and water which drip into the gaps between the parallel support ribs **14** of the inventive assemblies **800**, **850**, **900**, **950** will drain through the gas flow openings **10, 12** of the lower radiating plate **4**. Thus, a drip pan will preferably be installed beneath the grill burner whenever these inventive grate assemblies are used. Moreover, because of the size of the gaps **552** between the support ribs **14** and the top of the lower radiating plate **4**, inventive assemblies **800**, **850**, **900**, **950** will permit debris to flow beneath the ribs **14** and into the plate openings **10, 12** and will thus require more frequent cleaning than the inventive grate assemblies **2** and **50**.

Further alternative embodiments **730** and **740** of the inventive grate are illustrated in FIGS. 24 and 25. The inventive grates **730** and **740** are respectively identical to inventive grate assembly **2** (or **50**) shown in FIGS. 1-3 and inventive grate assembly **250** (or **300**) shown in FIGS. 7-10, except that the inventive grates **730** and **740** are each of single piece rather than two piece construction.

For manufacturing purposes, it may be desirable to form grate **730** or **740** using a plurality of elongate food support rib pieces **732** or **742** which are placed in side-by-side contacting relationship. If so, unsealed contracting edges may exist in grate **730** at points **734** or **736** and may exist in grate **740** at points **744** or **746**. Such unsealed

contacting points will not allow sufficient gas flow to appreciably increase the possibility of flare-ups. However, if any unsealed gaps are present at low points **734** or **744**, a drip pan will preferably be installed below the grill burner to catch the very hot, low viscosity fat which will run through these unsealed cracks.

Another alternative grate **760** is illustrated in FIG. 27. Grate **760** is substantially the same as grate **730** except that grate **760** includes one or a series of narrow apertures **762** for gas flow extending longitudinally along the base on one side or on each side of each food support rib **764** (i.e., along the lines where the bottoms of the ribs and the solid intermediate sections meet).

Another alternative grate **770** is illustrated in FIG. 28. Grate **770** is substantially the same as grate **740** except that grate **770** includes one or a series of apertures **772** for gas flow extending longitudinally along one side wall or both side walls of each food support rib **774**.

An example of a grill assembly **750** provided by the present invention is illustrated in FIG. 26. The inventive grill assembly **750** comprises: a housing **752** which can optionally include a cover (not shown); a burner or other heating element **754** provided in the housing **752**; and a pair of inventive grate assemblies **756** and **758** installed in the housing **752** above the heating element **754**. The inventive grate assemblies **756** and **758** used in the grill assembly **750** can be any one or a combination of any of the various inventive grate assemblies which are discussed above and are illustrated in any of FIGS. 1-25. The heating element **752** can be any type of burner or electric heating element or charcoal bed known in the art, including even an expensive multi-tube burner or infrared burner. However, the inventive grate assemblies and grill assembly **750** provided by the present invention are also capable of providing excellent results with the heating element **754** being, for example, a gas tube burner, a pancake burner, or other common, inexpensive gas burner known in the art.

* * * * *

Thus, the present invention is well adapted to carry out the objectives and attain the ends and advantages mentioned above as well as those inherent therein. While presently preferred embodiments have been described for purposes of this disclosure, numerous changes and modifications will be apparent to those of ordinary skill in the

art. Such changes and modifications are encompassed within the invention as defined by the claims.

CLAIMS:

1. A cooking grate assembly comprising:

a lower structure comprising a side-by-side series of parallel, longitudinally extending solid sections having substantially no openings therethrough;

a series of parallel, longitudinally extending open sections provided in said lower structure, said open sections being located between said solid sections, each of said open sections having an open area lateral width; and

an upper structure comprising a side-by-side series of parallel, spaced apart, longitudinally extending food support ribs, each having a hollow interior and a longitudinally extending bottom opening, said bottom opening having a lateral width that is not less than said open area lateral width of said open sections of said lower structure,

said upper structure having gaps between said longitudinally extending food support ribs and said upper structure being removably positionable on said lower structure,

when said upper structure is positioned on said lower structure, said longitudinally extending food support ribs are positioned over and substantially parallel to said longitudinally extending open sections of said lower structure so that, as viewed from above said cooking grate assembly, said longitudinally extending food support ribs straddle and entirely cover said longitudinally extending open sections of said lower structure and said longitudinally extending solid sections of said lower structure are positioned in said gaps between said longitudinally extending food support ribs;

when said upper structure is positioned on said lower structure, said open sections of said lower structure are located within, at, or below said bottom openings of said food support ribs such that combustion gases flowing upwardly through said open sections of said lower structure will flow into said hollow interiors of said food support ribs;

said food support ribs each have two opposing rib side walls;

said two opposing rib side walls have longitudinally extending bottom edges;

when said upper structure is positioned on said lower structure, said bottom edges of said rib side walls contact an upper surface of said lower structure; and

wherein said food support ribs each have at least one longitudinal end which is open for flow of said combustion gases such that said combustion gases which flow into said hollow interiors of said food support ribs from said open sections of said lower structure will flow out of said open longitudinal ends of said food support ribs.

2. The cooking grate assembly of claim 1 wherein said solid sections of said lower structure each have a downwardly extending cross-sectional shape such that said solid sections of said lower structure will form longitudinally extending valleys between said food support ribs.

3. The cooking grate assembly of claim 2 wherein said solid sections of said lower structure have a downwardly extending cross-sectional V-shape.

4. The cooking grate assembly of claim 1 wherein said solid sections of said lower structure have an upwardly extending cross-sectional shape.

5. The cooking grate assembly of claim 4 wherein said solid sections of said lower structure have an upwardly extending inverted V cross-sectional shape such that said solid sections will form longitudinally extending ridges between said food support ribs.

6. The cooking grate assembly of claim 1 wherein said food support ribs have an inverted U cross-sectional shape.

7. The cooking grate assembly of claim 1 wherein said open sections of said lower structure are each formed by a longitudinally extending slot or by a plurality of slots or other apertures.

8. The cooking grate assembly of claim 1 wherein said solid sections of said lower structure have an upper surface with an emissivity of at least 0.25.

9. The cooking grate assembly of claim 1 wherein:

said solid sections of said lower structure have an upwardly extending cross-sectional shape and

said bottom edges of said rib side walls contact said upper surface of said lower structure in a non-sealed manner such that, during cooking, hot fat which falls between said food support ribs can drain beneath said bottom edges of said rib side walls and through said open sections of said lower structure.

10. The cooking grate assembly of claim 1 wherein:

said food support ribs have a vertical height of from about 1/4 to about 1 inch;

said lateral width of said bottom openings of said food support ribs is at least 1/4 inch; and

said food support ribs are spaced from about 1/4 to about 1 inch apart.

11. The cooking grate assembly of claim 10 wherein said open area lateral width of said open sections of said lower structure is less than said lateral width of said bottom openings of said food support ribs.

12. The cooking grate assembly of claim 10 wherein said open area lateral width of said open sections of said lower structure is in a range of from about 0.08 to about 0.5 times said lateral width of said bottom openings of said food support ribs.

13. A cooking grate assembly comprising:

a lower structure comprising a side-by-side series of parallel, longitudinally extending solid sections having substantially no openings there through;

a series of parallel, longitudinally extending open sections provided in said lower structure, said open sections being located between said solid sections, each of said open sections of said lower structure having an open area lateral width; and

an upper structure comprising a side-by-side series of parallel, spaced part, longitudinally extending food support ribs, each having a hollow interior and a longitudinally extending bottom opening having a lateral width which is greater than said open area lateral width of said open sections of said lower structure,

said upper structure having gaps between said longitudinally extending food support ribs, and said upper structure being removably positionable on said lower structure,

when said upper structure is positioned on said lower structure, said longitudinally extending food support ribs are positioned over and substantially parallel to said longitudinally extending open sections of said lower structure so that, as viewed from above said cooking grate assembly, said longitudinally extending food support ribs straddle and entirely cover said longitudinally extending open sections of said lower structure and said longitudinally extending solid sections of said lower structure are positioned in said gaps between said longitudinally extending food support ribs;

said solid sections of said lower structure have a downwardly extending lateral cross-sectional shape such that said solid sections of said lower structure will form longitudinally extending valleys between said food support ribs; and

when said upper structure is positioned on said lower structure, said open sections of said lower structure are received in said bottom openings of said food support ribs such that combustion gases flowing upwardly through said open sections of said lower structure will flow into said hollow interiors of said food support ribs;

said food support ribs each have two opposing rib side walls;

said two opposing rib side walls have longitudinally extending bottom edges;

when said upper structure is positioned on said lower structure, said bottom edges of said rib side walls contact an upper surface of said lower structure; and

wherein said food support ribs each have at least one open longitudinal end which is open for flow of said combustion gases out of said hollow interiors of said food support ribs such that said combustion gases which flow into said hollow interiors of said food support ribs from said open sections of said lower structure will flow out of said open longitudinal ends of said food support ribs.

14. The cooking grate assembly of claim 13 wherein said lateral cross-sectional shape of said solid sections of said lower structure is a V-shape.

15. The cooking grate assembly of claim 13 wherein said food support ribs have an inverted U cross-sectional shape.

16. The cooking grate assembly of claim 13 wherein:

said food support ribs have a vertical height of from about 1/4 to about 1 inch;

said lateral width of said bottom openings of said food support ribs is at least 1/4 inch; and

said food support ribs are spaced from about 1/4 to about 1 inch apart.

17. The cooking grate assembly of claim 16 wherein said open area lateral width of said open sections of said lower structure is in a range of from about 0.08 to about 0.5 times said lateral width of said bottom openings of said food support ribs.

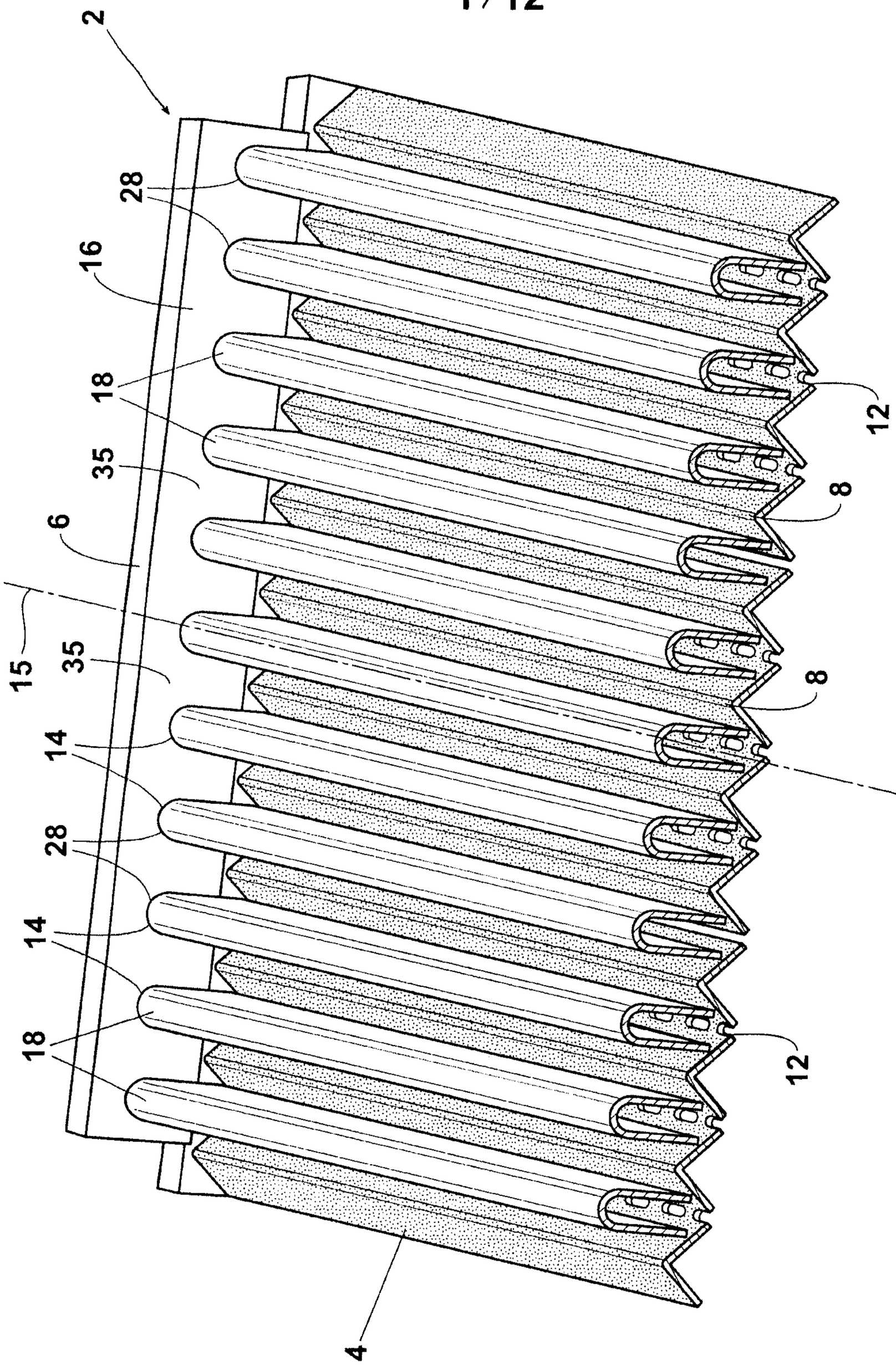

Fig. 1

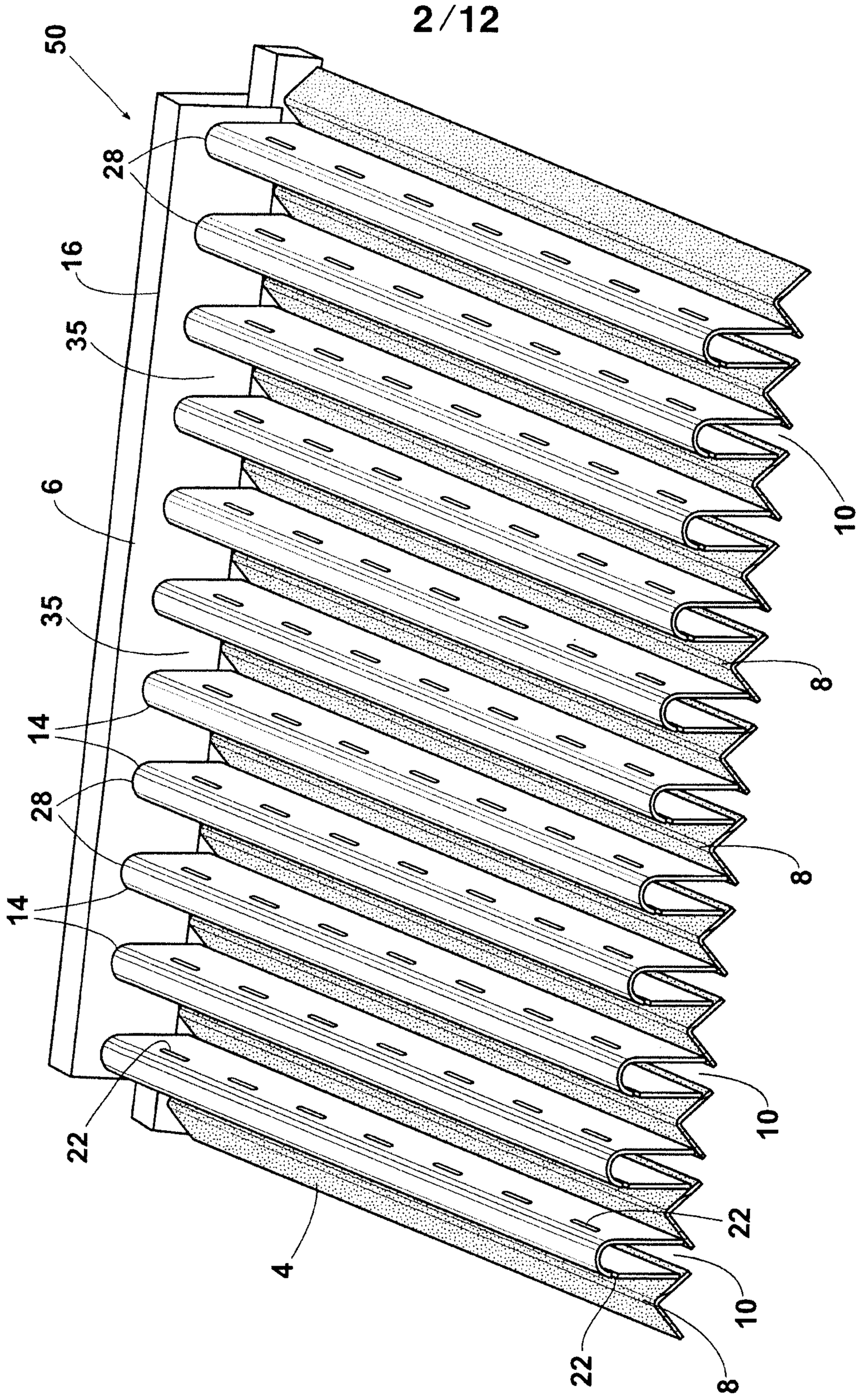

Fig. 2

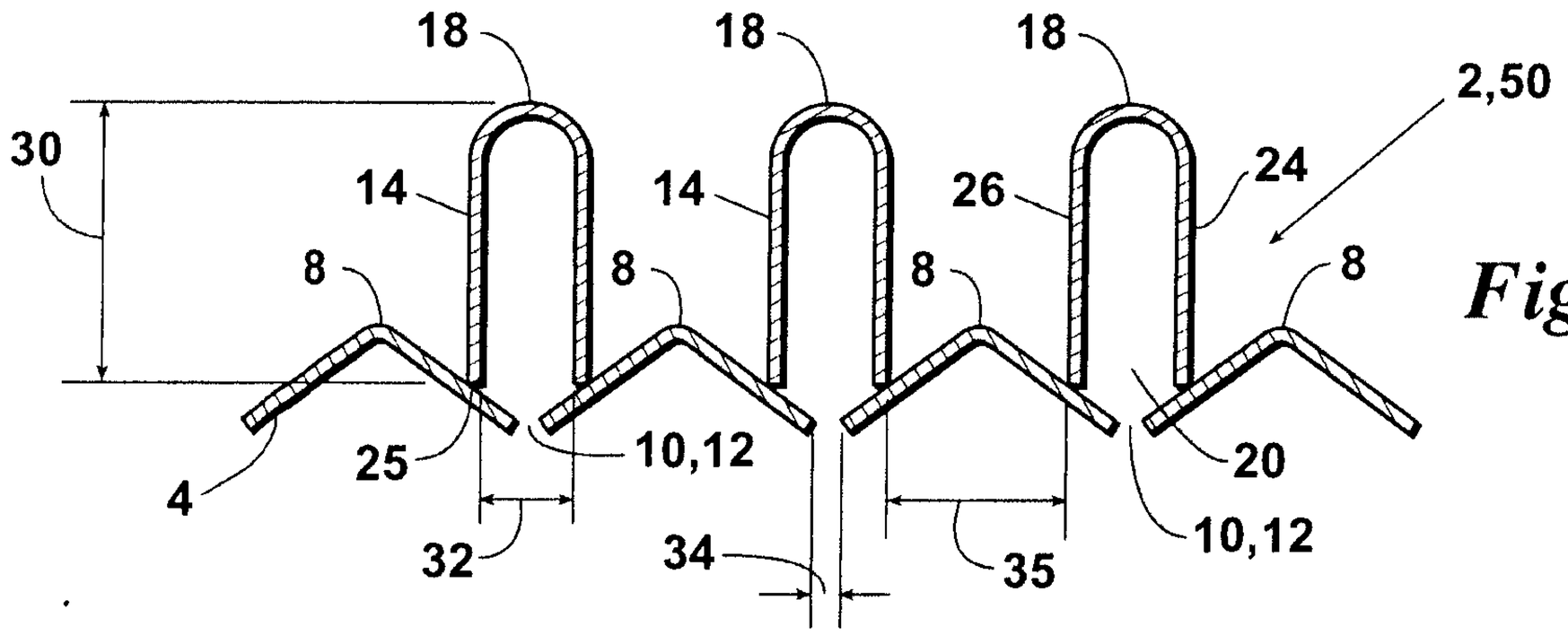

Fig. 3

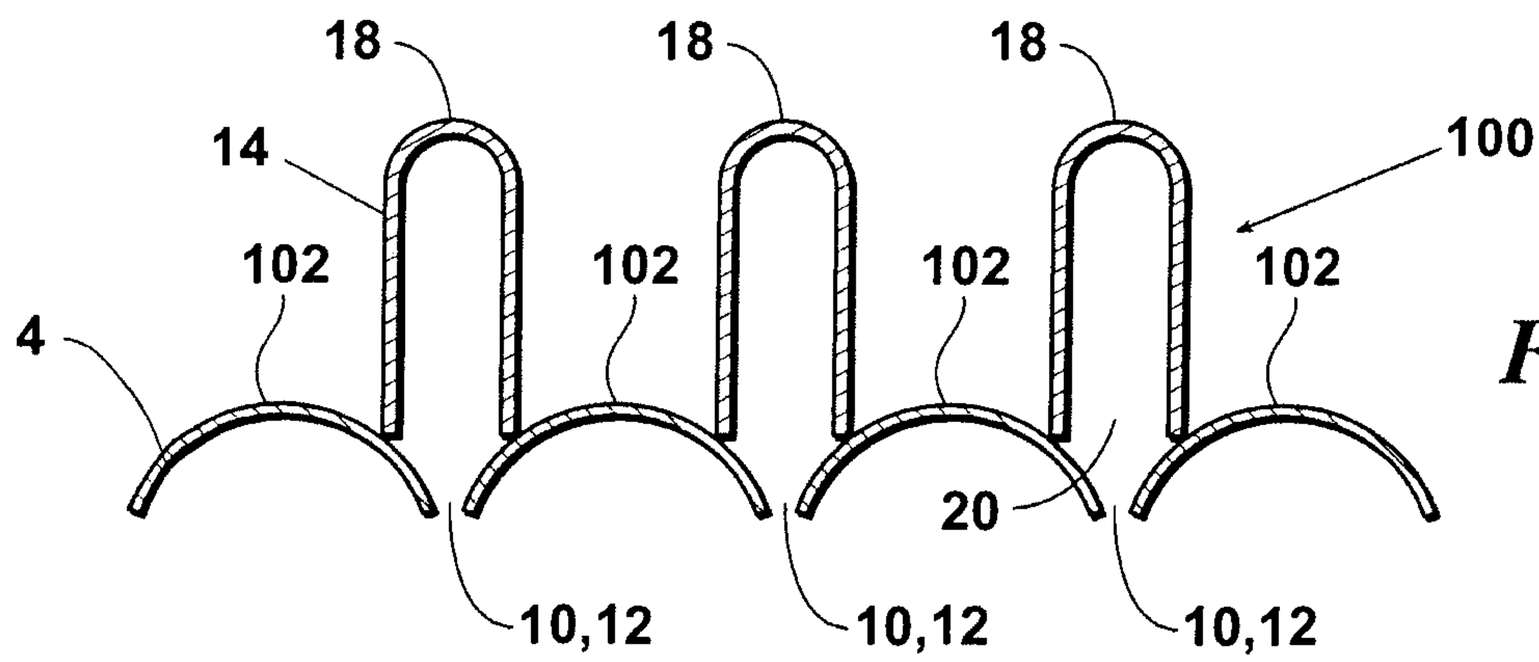

Fig. 4

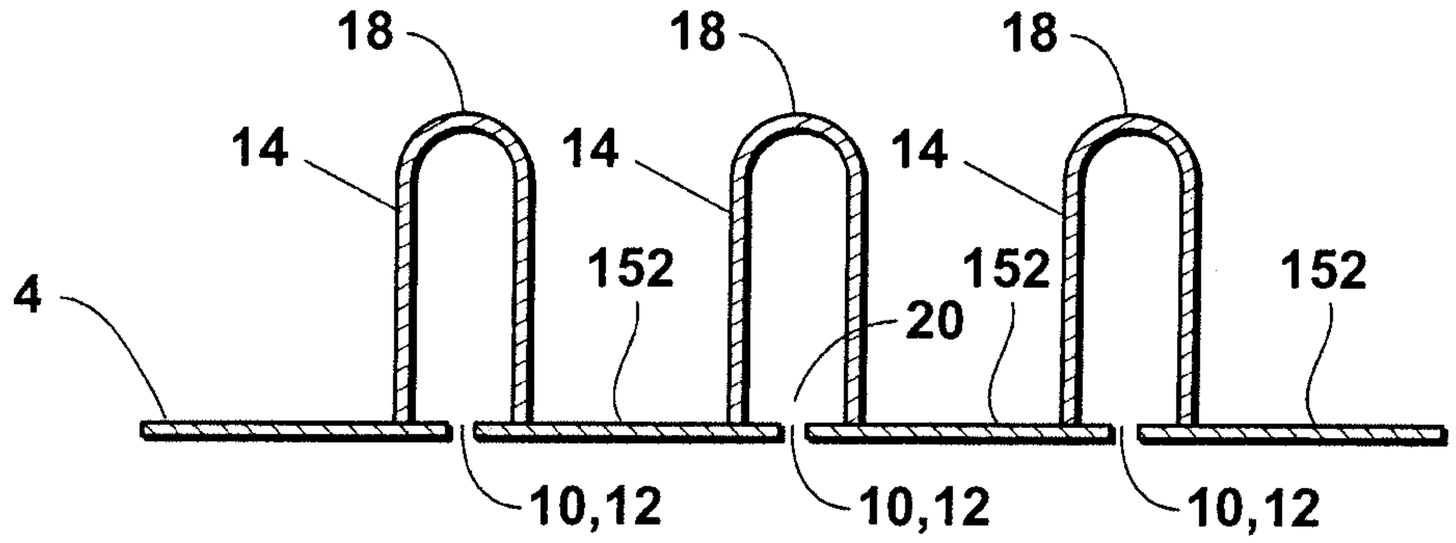

Fig. 5

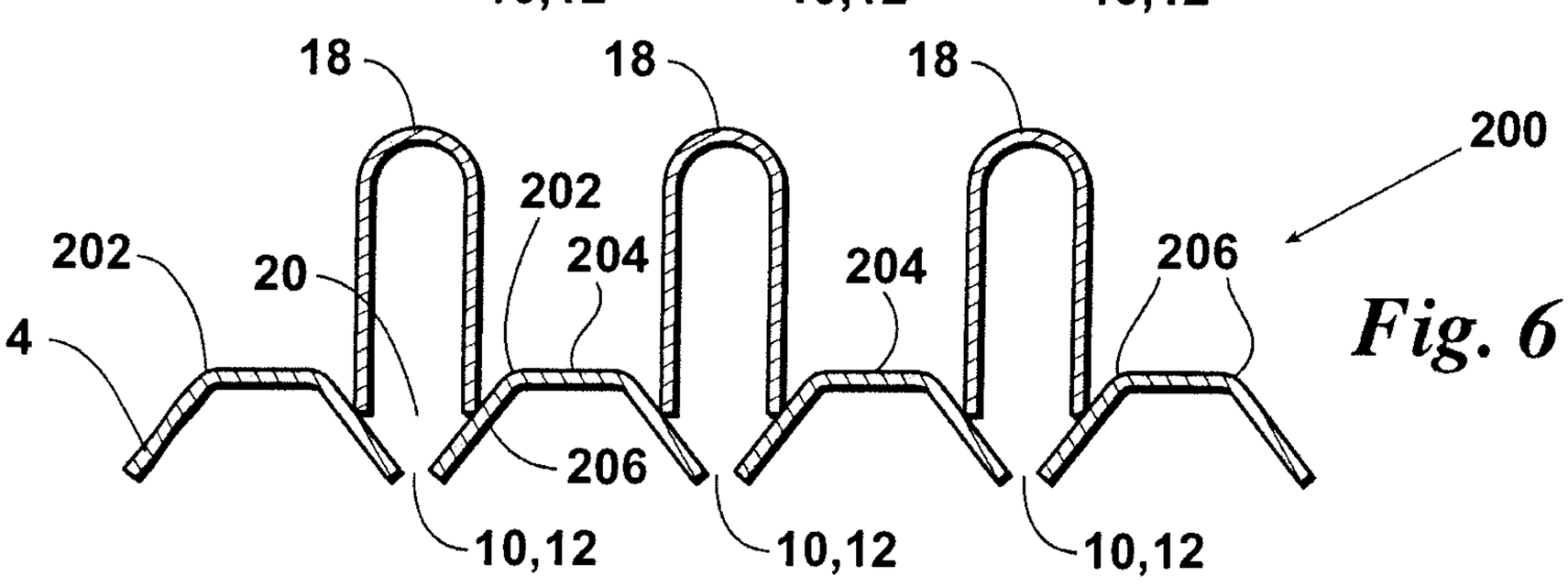

Fig. 6

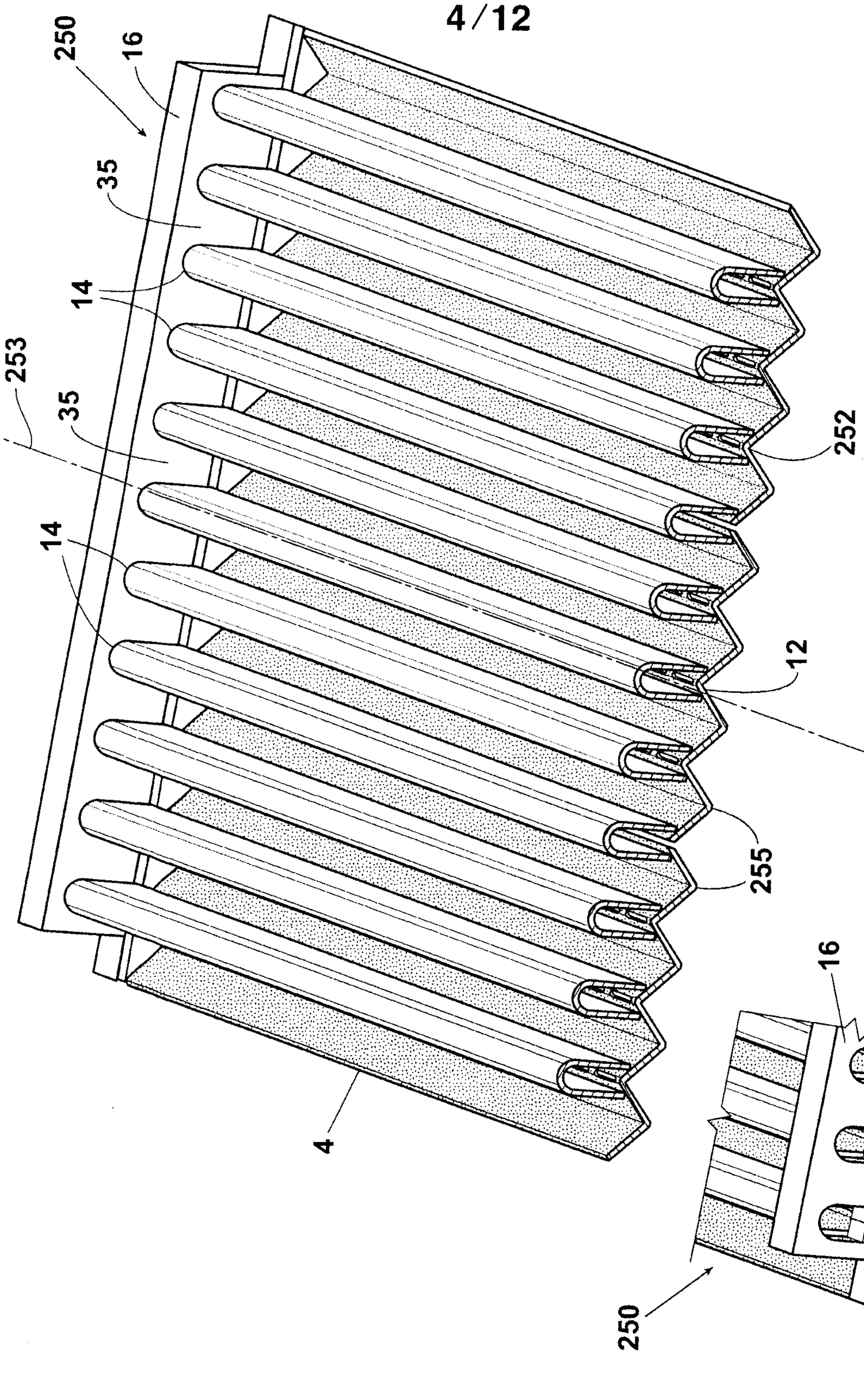

Fig. 7

Fig. 8

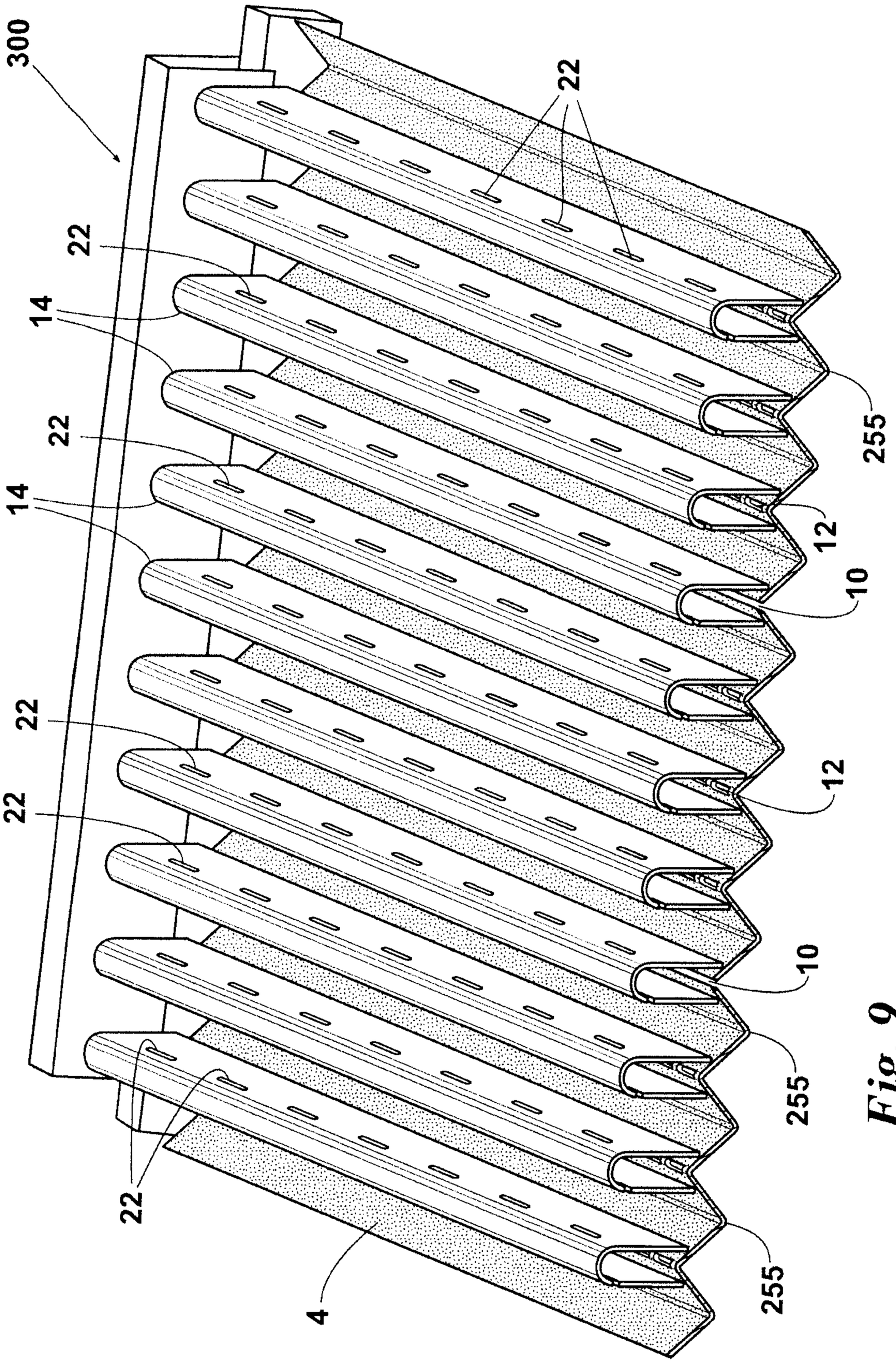

Fig. 9

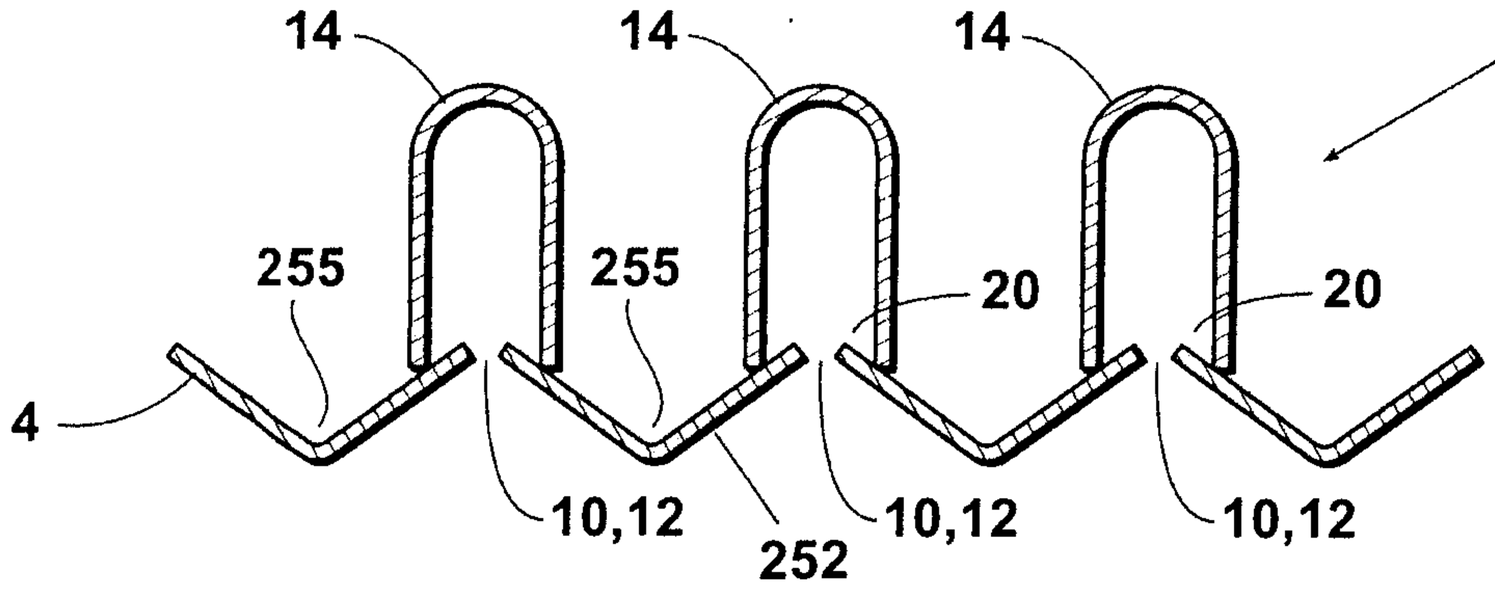

Fig. 10

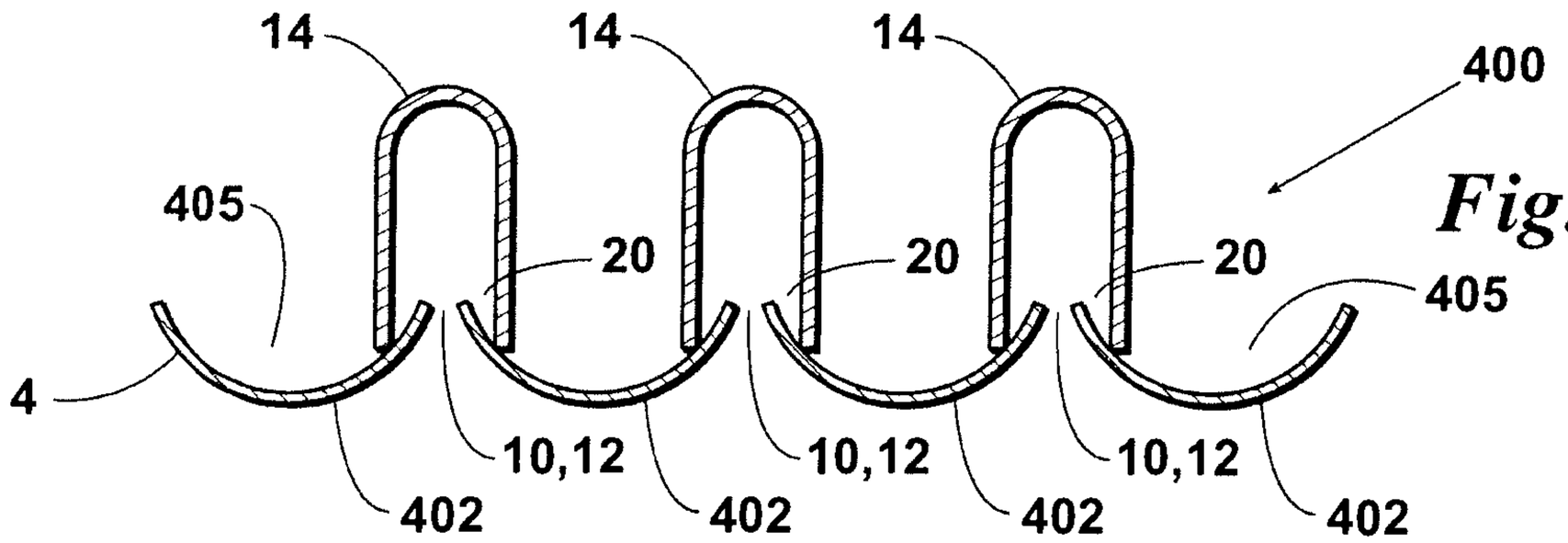

Fig. 11

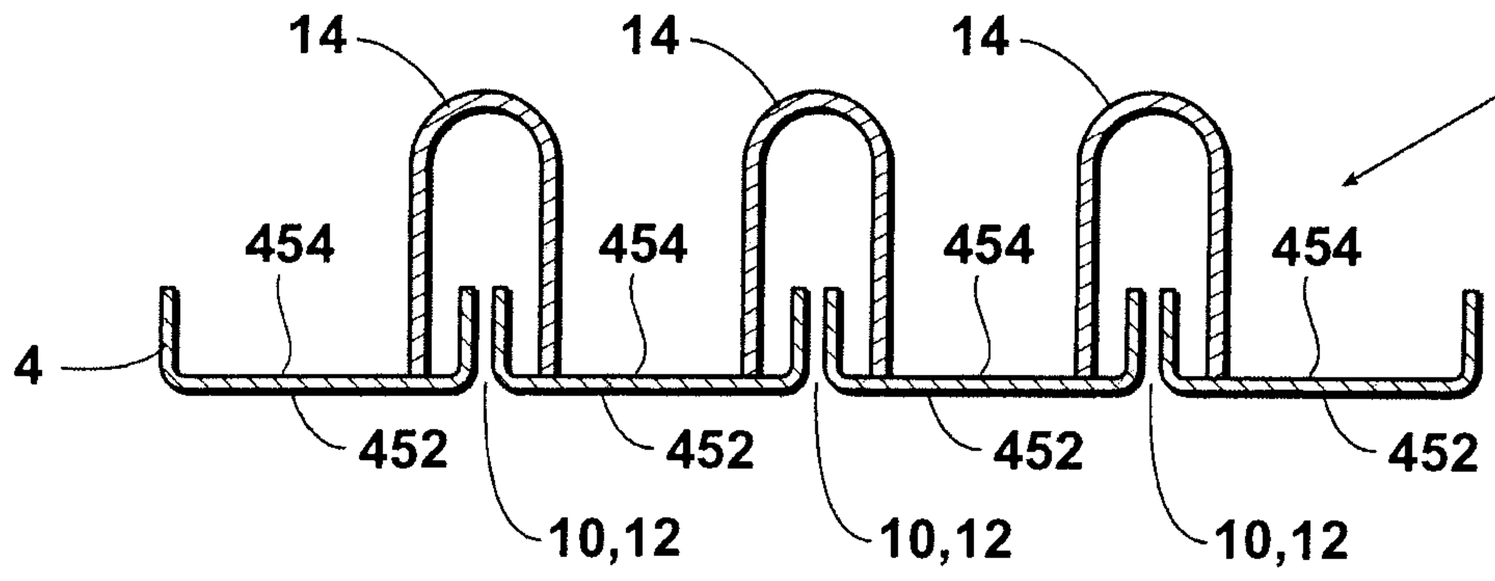

Fig. 12

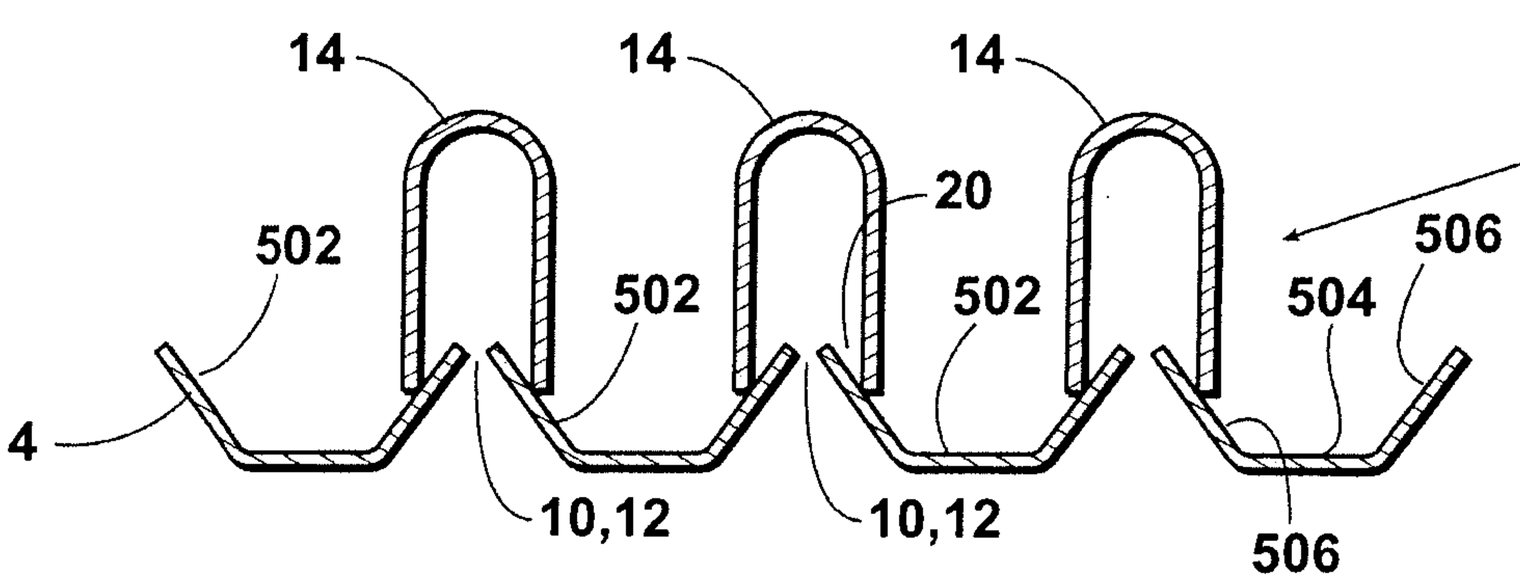

Fig. 13

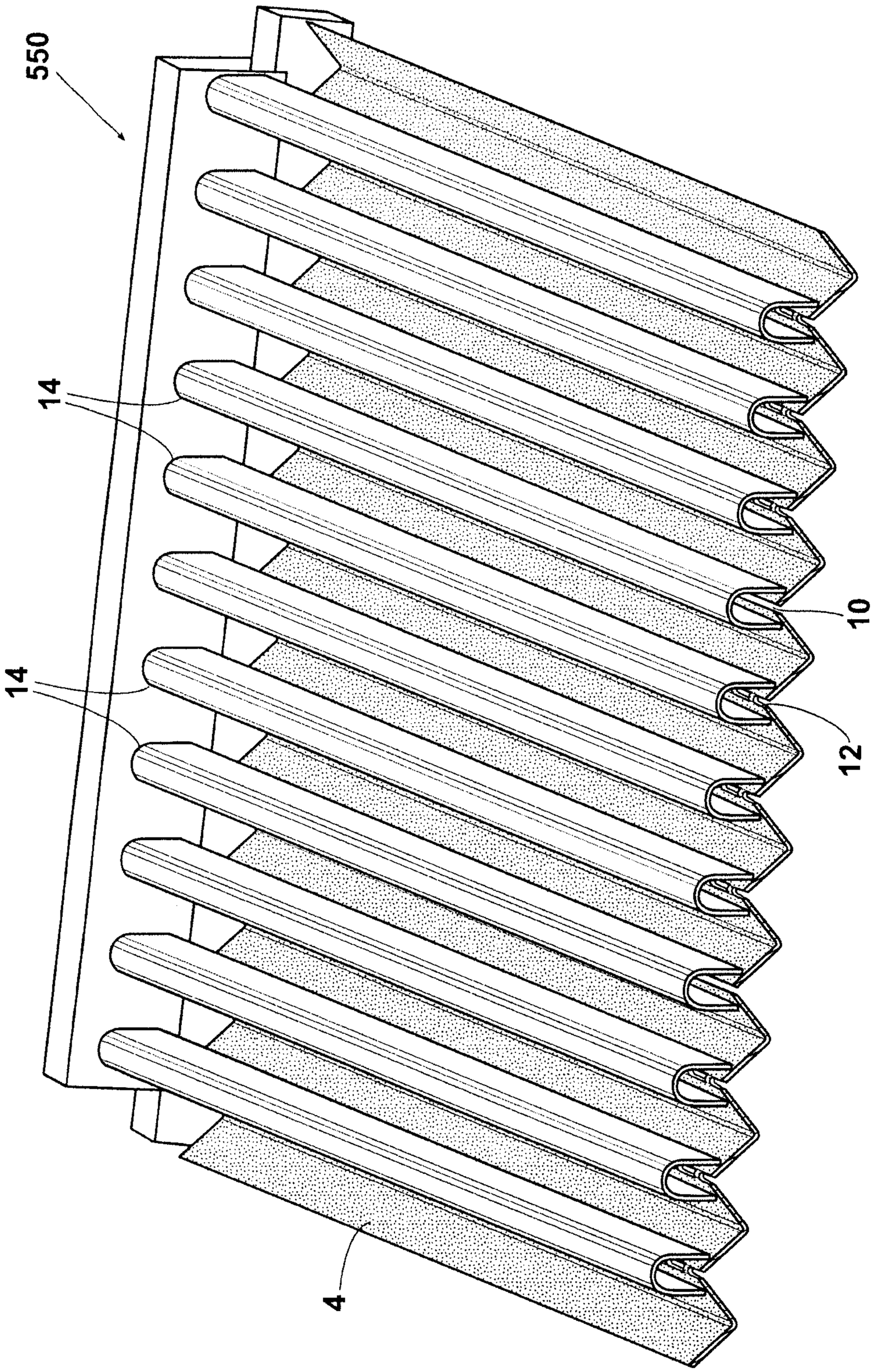

Fig. 14

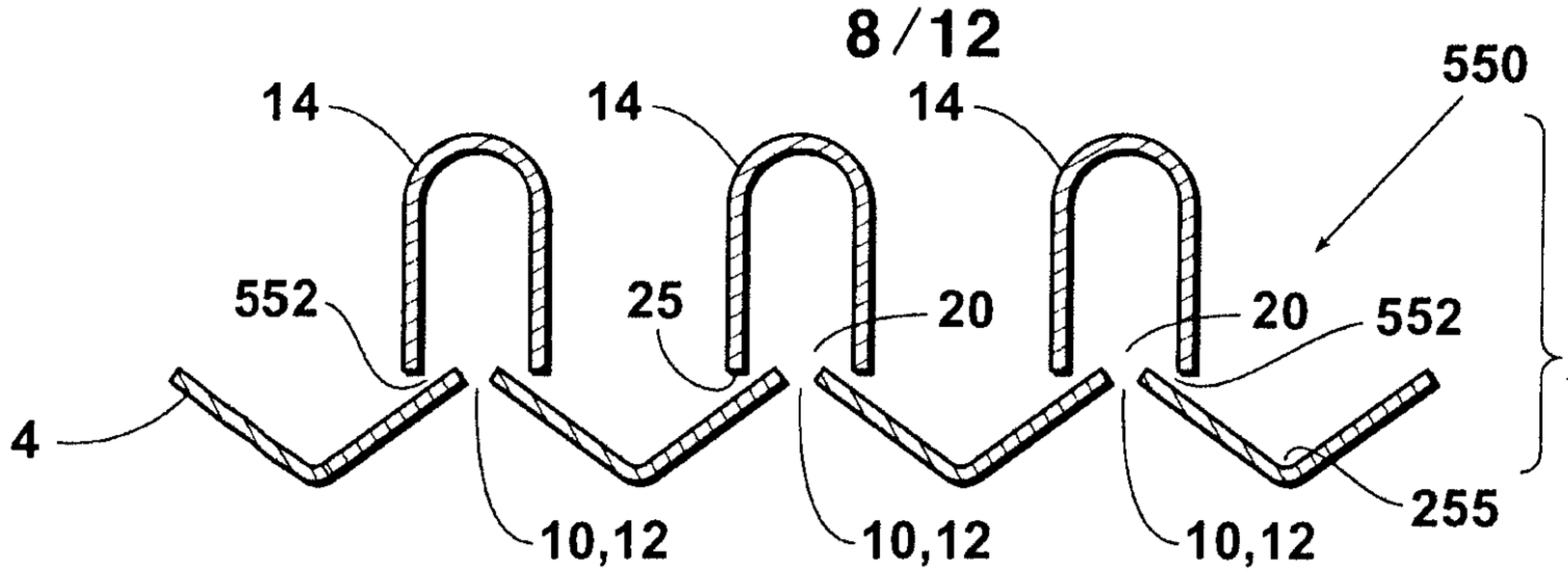

Fig. 15

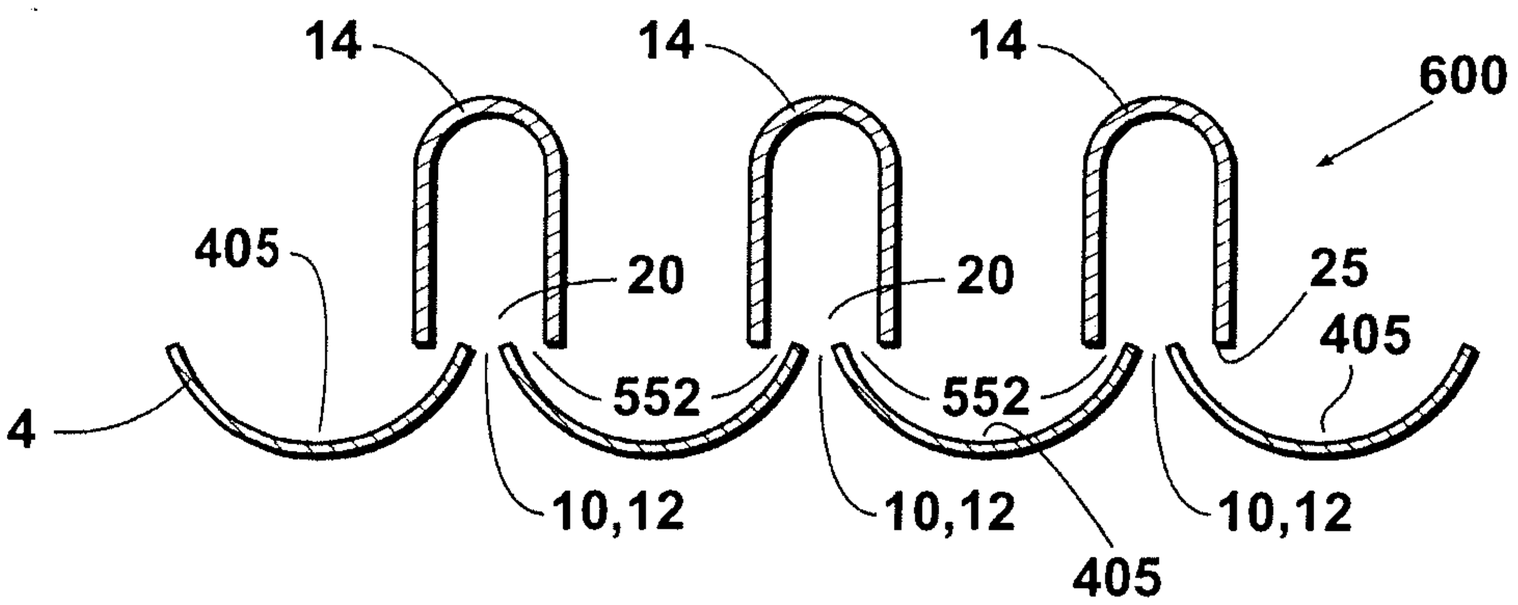

Fig. 16

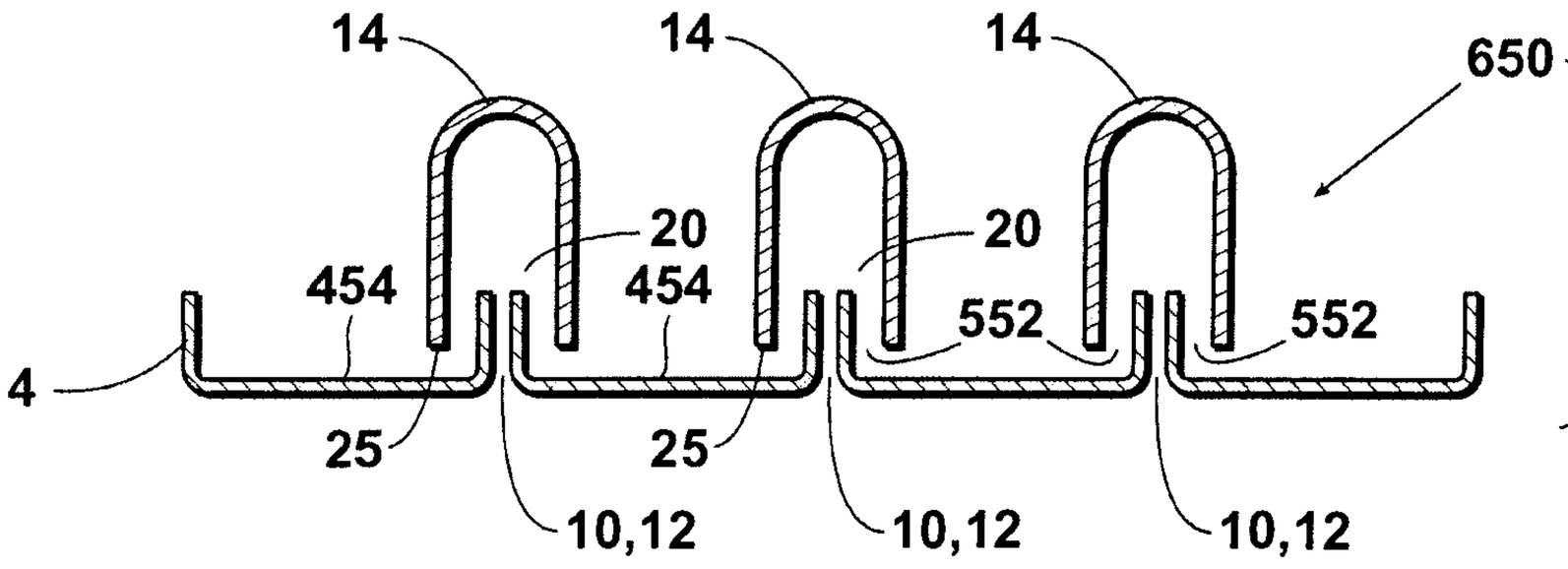

Fig. 17

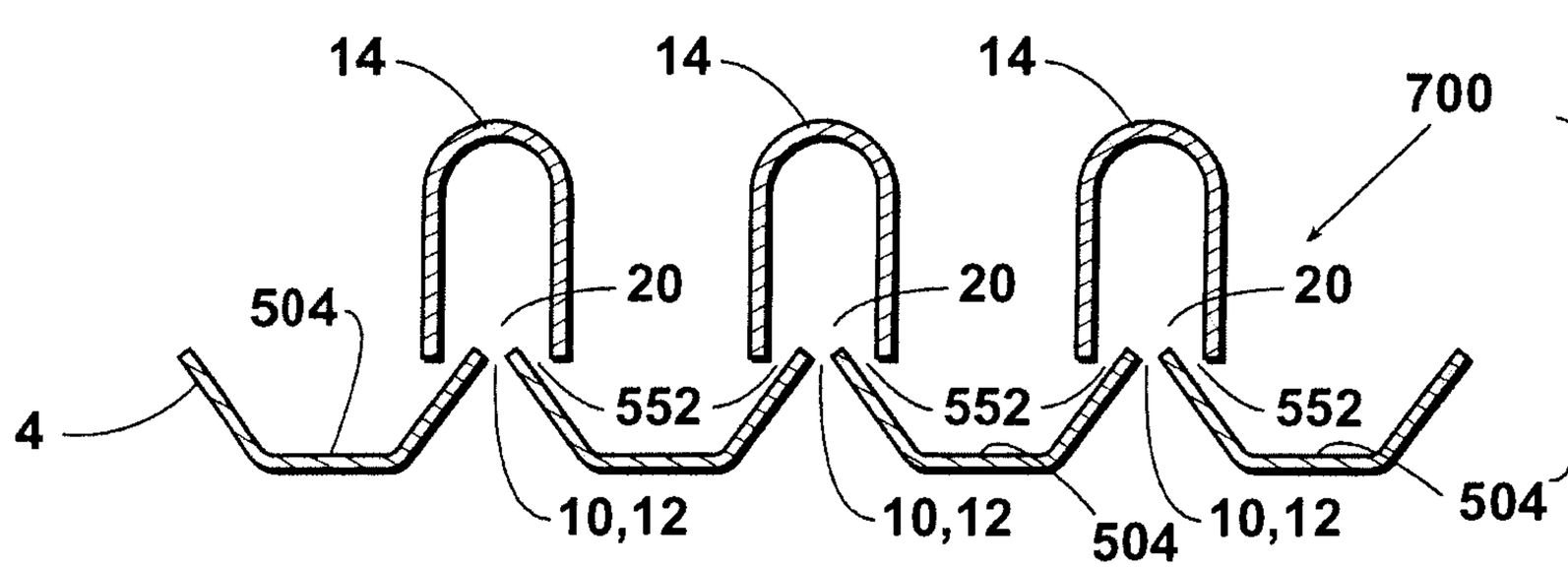

Fig. 18

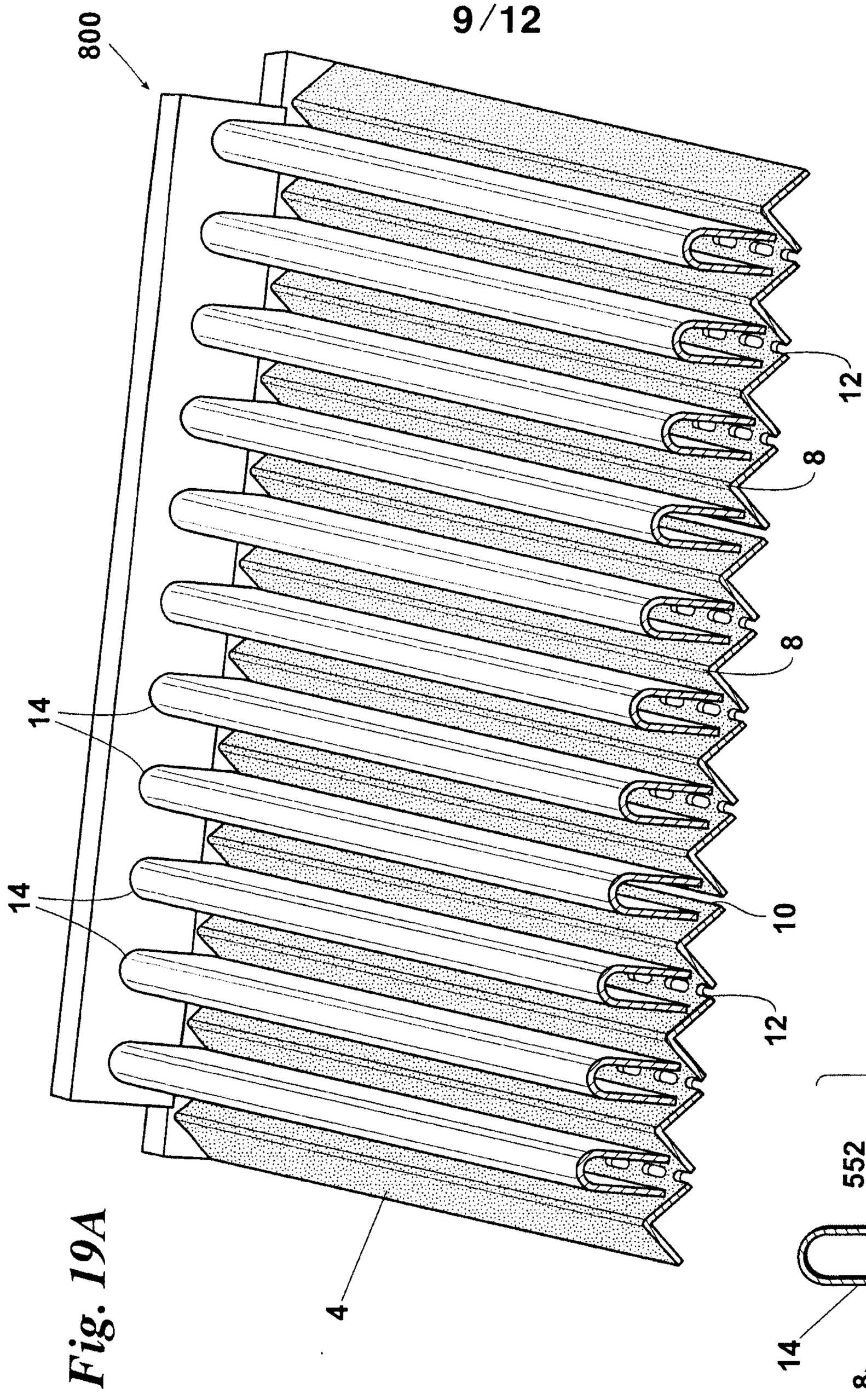

Fig. 19A

Fig. 19B

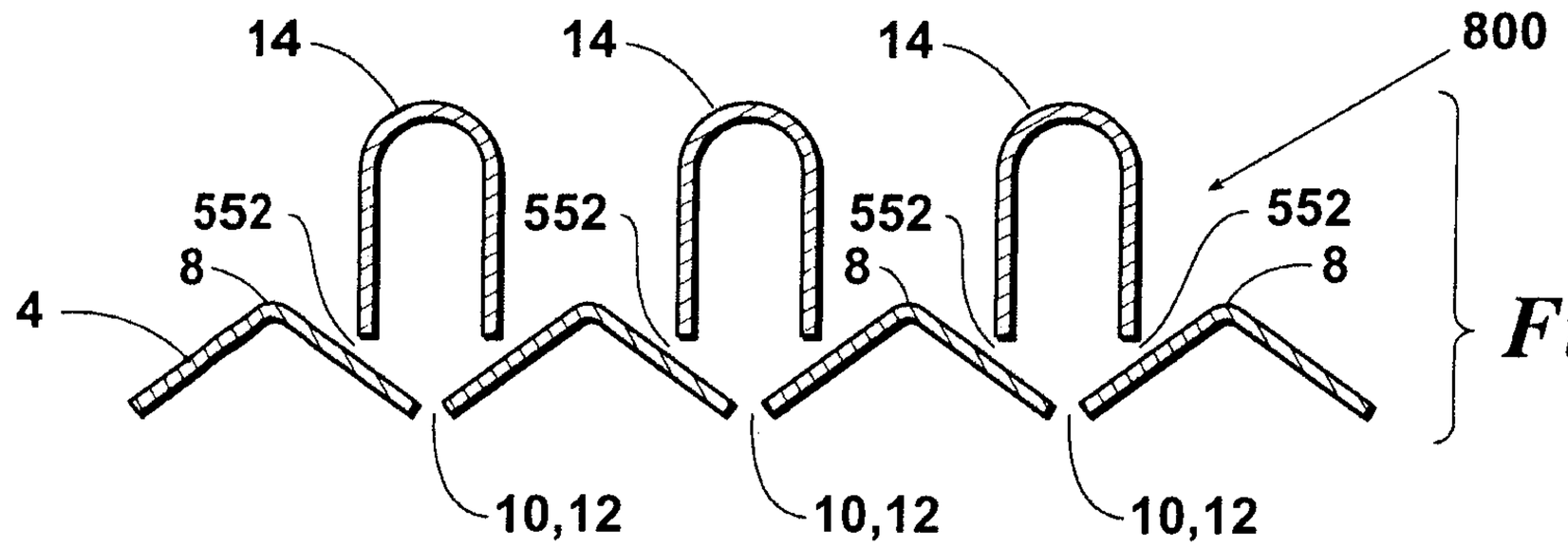

Fig. 20

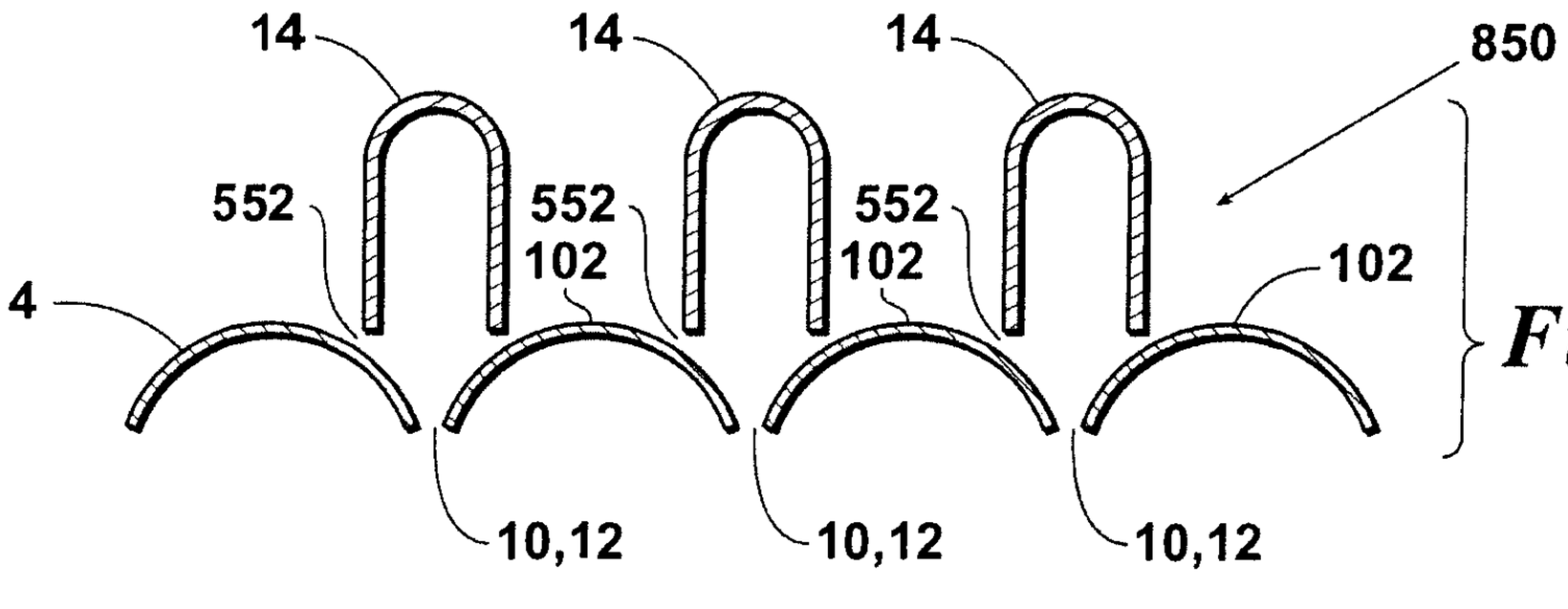

Fig. 21

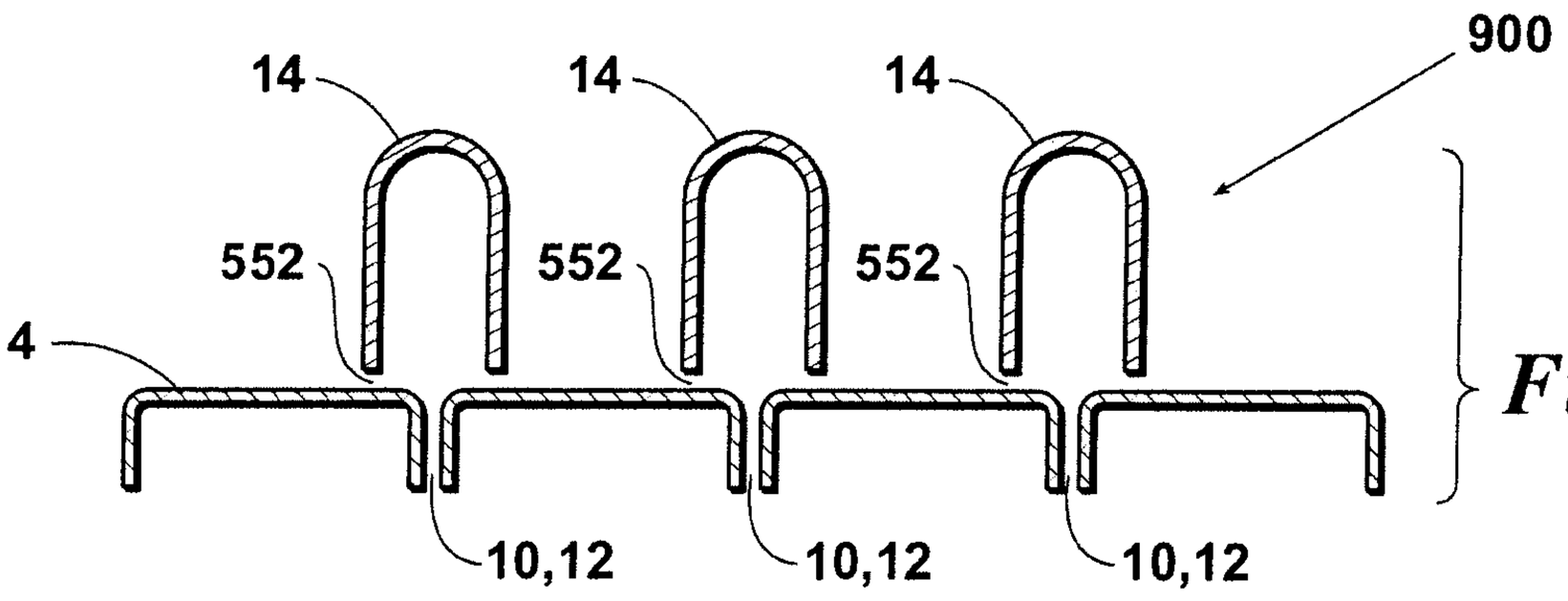

Fig. 22

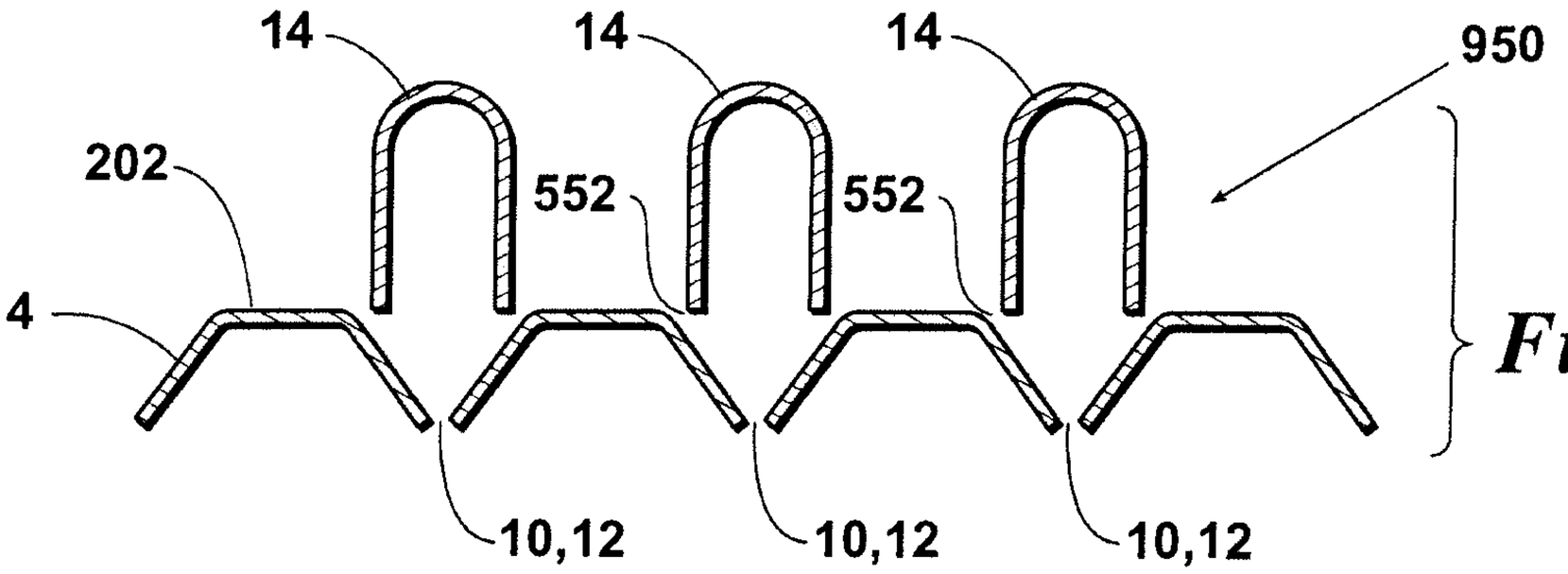

Fig. 23

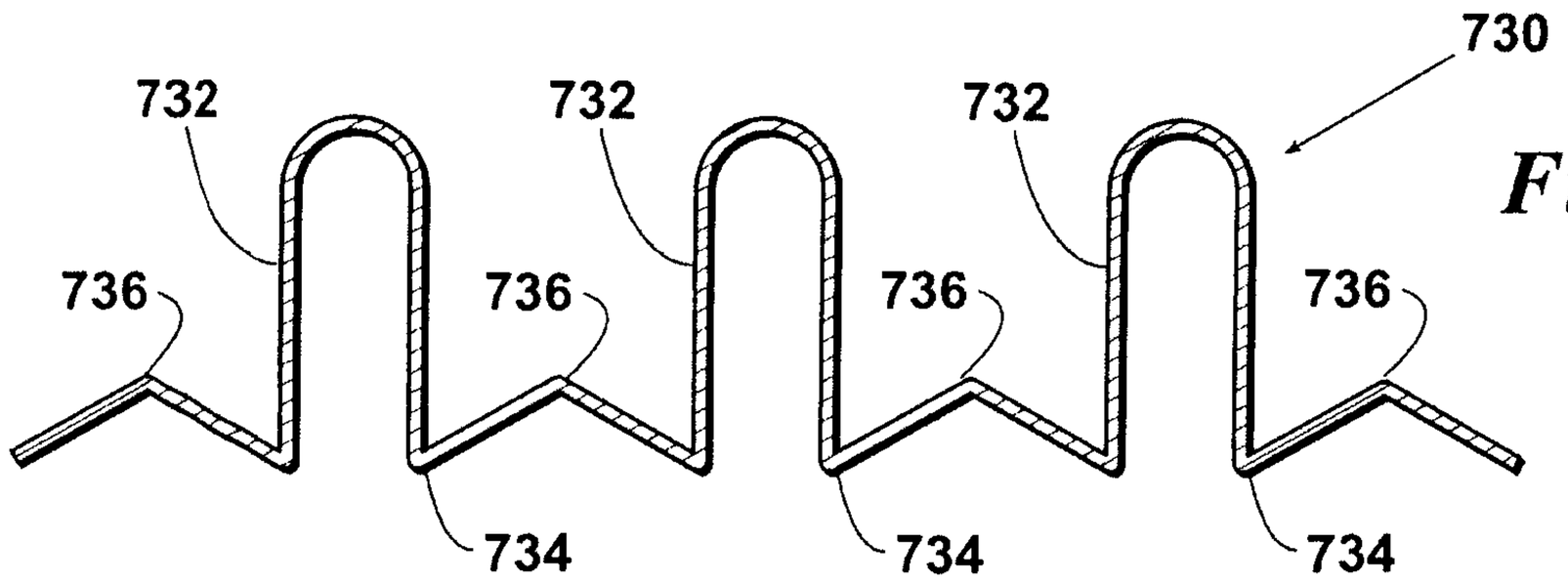

Fig. 24

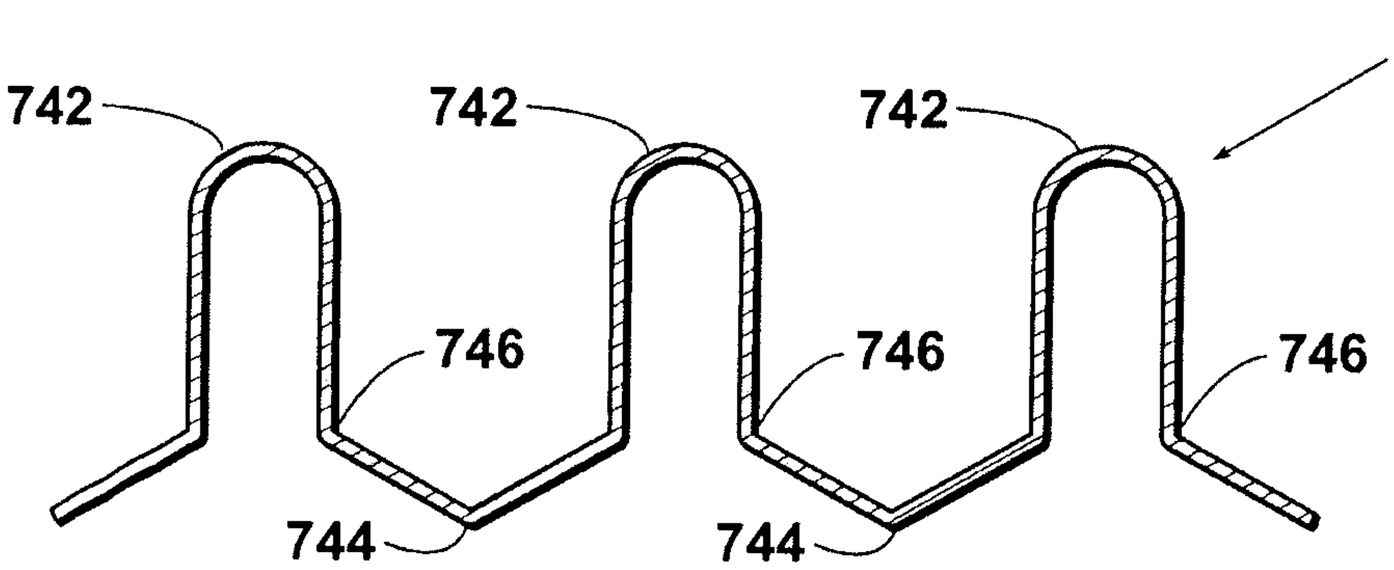

Fig. 25

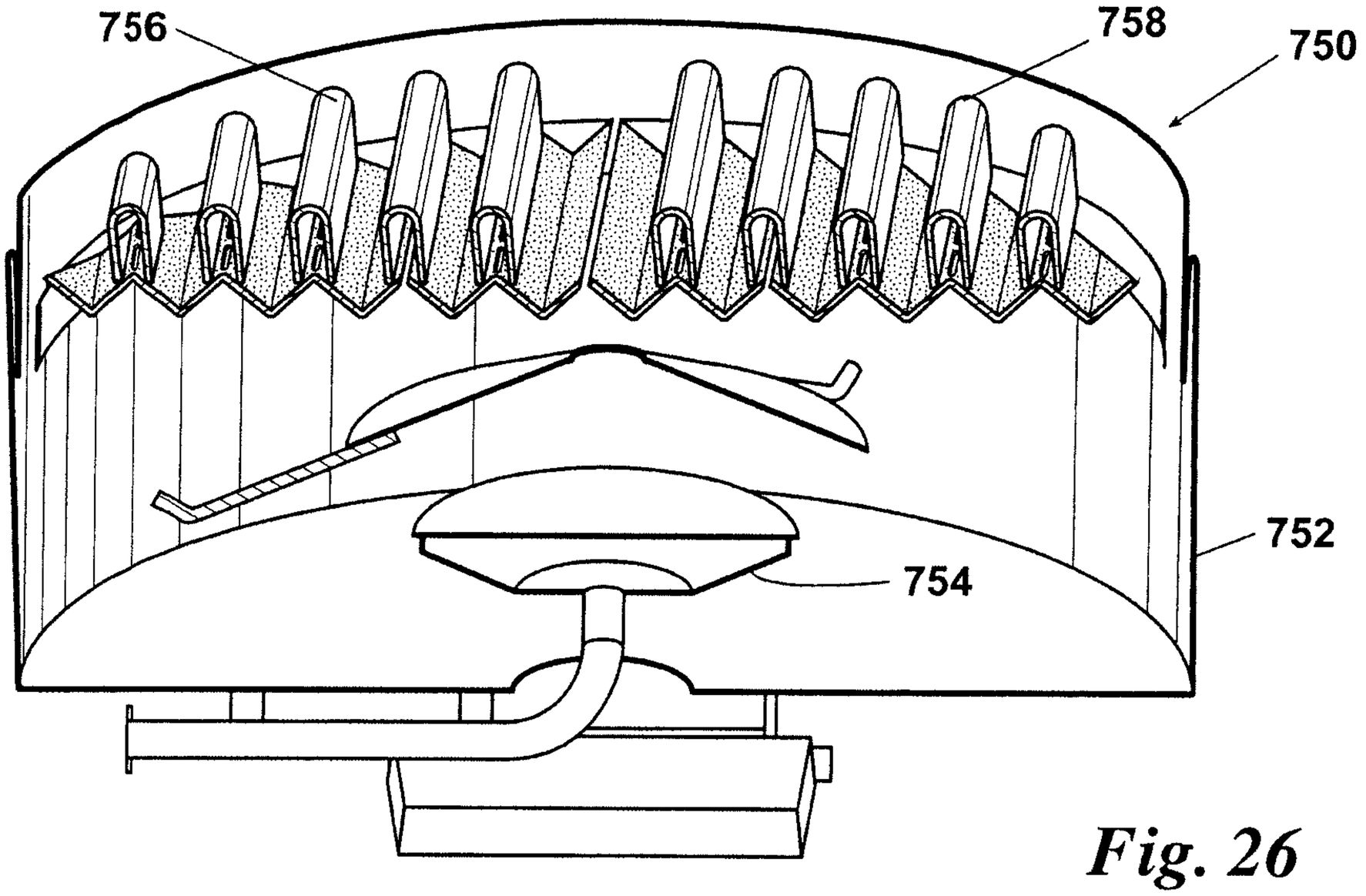

Fig. 26

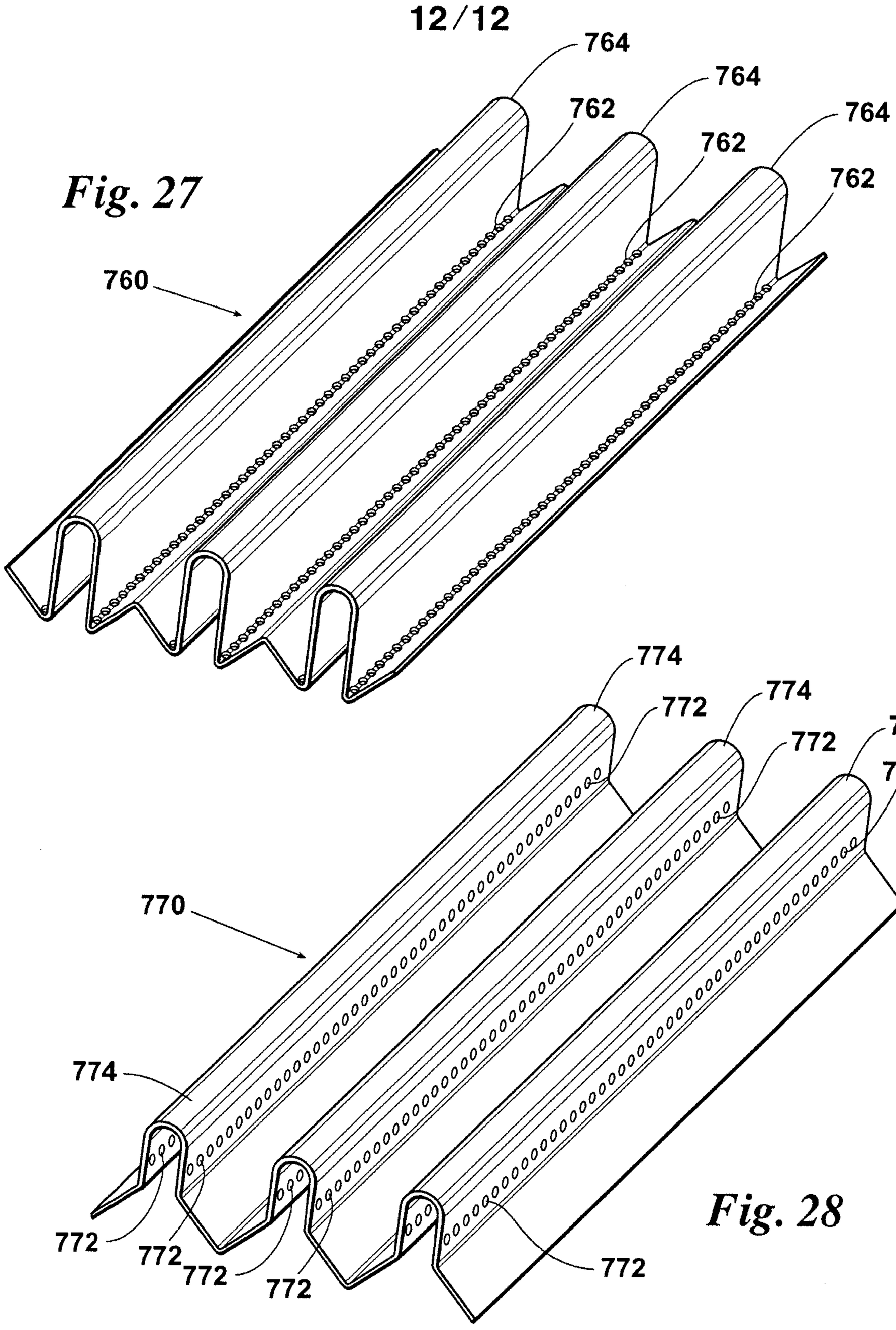
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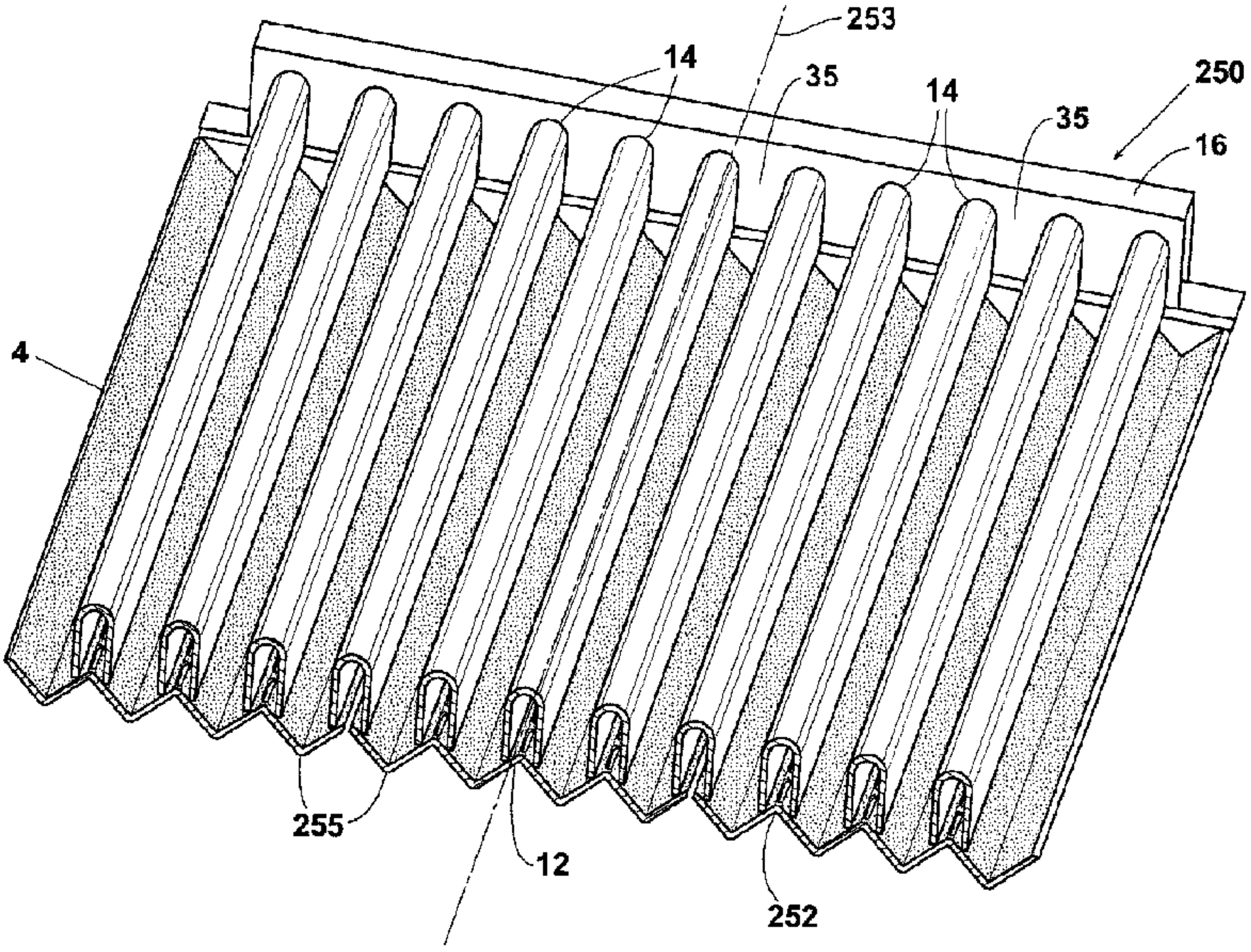
Fig. 27

Fig. 28


253
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