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Outer Crushing Shell Support Ring

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Field of invention

The present invention relates to a support ring to positionally support an outer crushing
20 shell (concave) within a gyratory crusher and in particular, although not exclusively, to a support ring capable of moving dynamically with the crushing shell.

Background art

25 Gyratory crushers are used for crushing ore, mineral and rock material to smaller sizes. Typically, the crusher comprises a crushing head mounted upon an elongate main shaft. A first crushing shell (typically referred to as a mantle) is mounted on the crushing head and a second crushing shell (typically referred to as a concave) is mounted on a frame such that the first and second crushing shells define together a crushing chamber through which the
30 material to be crushed is passed. A driving device positioned at a lower region of the main shaft is configured to rotate an eccentric assembly positioned about the shaft to cause the crushing head to perform a gyratory pendulum movement and crush the material

introduced in the crushing chamber. Example gyratory crushers are described in WO 2004/110626 and WO 2010/123431.

Typically, both the inner and outer crushing shells wear and distort due to the significant pressures and impact loading forces they transmit. In particular, it is common to use backing compounds to structurally reinforce the shells and their mounting position at the topshell and head centre respectively. Conventionally, a backing compound (typically an epoxy or polyurethane material) is cured between the shell and the corresponding frame and head centre to provide structural support during crushing particularly in tough high-pressures applications involving extremely hard materials. However, the majority of widely used backing compounds are disadvantageous for health and environmental reasons and require long curing times that extends the downtime of the crusher. Accordingly, there is a general preference to avoid their use. However, in high pressure and tough applications the use of backing compounds is often unavoidable in order to add structural support and this is typically difficult to predict beforehand. CN 1970154 disclosures of epoxy secured and/or reinforced crushing shell.

The use of epoxy based backing materials that are cured in situ is disadvantageous for a number of reasons. Firstly, long curing times are generally required which increases crusher downtime. A further problem is that it is not always easy to introduce the highly viscous epoxy into the region between the concave and the topshell frame (or a filler ring) where an uneven distribution can provide high stress regions in the concave and reduce its service lifetime. Additionally, hardened epoxy resins are often difficult to remove from the topshell which again leads to extended crusher downtime. Accordingly, what is required is a means of supporting the concave in position at the topshell frame that addresses these problems.

Summary of the Invention

It is an objective of the present invention to provide an outer crushing shell (concave) support ring that may be assembled and mounted in position conveniently with regard to both time and labour. In particular, it is an objective to avoid mounting delays associated

with conventional epoxy based mounting techniques that typically require appreciable curing times.

It is an additional objective to provide a means of supporting a concave within a topshell frame that is both time and labour efficient to remove with regard to conventional epoxy support methods where the cured resin is often very difficult to break away from the topshell.

The objectives are achieved by providing a concave support ring mountable in contact with the concave to sit radially between the concave and the topshell or a filler ring. The present support ring may be mounted and dismounted conveniently by personnel simply fitting the ring in position around the concave and subsequently raising and/or lowering the support ring and concave via auxiliary lifting apparatus. Accordingly, there is no requirement to crack or chisel a cured resin based support material from the topshell. The present support ring may be provided as a single piece component or may be formed as a multi-segment modular assembly as desired. Such a configuration provides a number of options for mounting and dismounting techniques and procedures. The ring may be formed from a polymer based material to be environmentally friendly. In particular, the ring may be formed from recycled materials and may be itself recycled following use. The material may be environmentally benign and in some implementations may be biodegradable and/or bio-compostable to reduce environmental impacts.

According to a first aspect of the present invention there is provided a crushing shell support ring mountable in contact with and around an outer crusher shell of a gyratory crusher, the ring comprising: a plurality of segments connected or connectable together in a circumferential direction to form the ring; each segment having a length extending in a circumferential direction around a central longitudinal axis, a width extending generally in an axial direction and a thickness extending in a radial direction, the thickness defined by a radially inward facing region for positioning against the outer crusher shell and a radially outward facing region for positioning towards a topshell frame of the gyratory crusher; the radially inward facing region being generally convex in the axial direction and/or aligned to extend transverse to the axis such that an axially upper end of the ring is positioned

radially closer to the axis than an axially lower end of the ring; a plurality of articulation joints coupling the segments in the circumferential direction to enable the ring to expand and contract radially when mounted radially between the outer crushing shell and the topshell frame.

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Optionally, the radially inward facing region (i.e., surface) may be continuously convex from an axially upper end to an axially lower end or the convex curvature may extend over only a part of the axial length of the support ring between the upper and lower ends.

Optionally, the radially inward facing region or the support ring generally may be frusto-conical. Optionally, the support ring may comprise a radially inward facing region that comprises a frusto-conical portion and a convex portion provided at different respective axial positions. Optionally, the frusto-conical portion may be positioned at an axially upper region and the convex portion may be provided at an axially lower region.

Advantageously, the radially inward facing region is so shaped to match (and to mate in close fitting contact with) the shape profile of a radially outward facing region (i.e., surface) of the outer crushing shell that may be generally convex and/or may comprise a frusto-conical shape profile. Such an arrangement maximises the support function of the ring to minimise stress concentrations in the crushing shell during use.

The articulation joints are particularly advantageous to provide a ring that is flexible in a radial and a circumferential direction. The joints allow the ring position at the concave to adjust dynamically in use and in particular to be capable of moving axially with the movement (axial elongation) of the concave. That is, the present support ring, via its articulation joints and the choice of component materials, is capable of being ‘squeezed’ between the concave and topshell. Accordingly, the present ring positionally supports the concave in a manner that avoids undesirable concave deformation that may otherwise change the dimensions of the crushing zone and affect crushing capacity and reduction.

Preferably, the ring comprises a polymer or polymer based material. Optionally, the material comprises any one of a polyamide, a polyalkylene or a polyalkylene glycol. The ring is pre-moulded and is not polymerised or cured in situ between the crushing shell and the topshell according to conventional epoxy resin systems. Optionally, the material may

comprise a metal having the required ductility to withstand the tensile stresses and compressive stress and to deform when in use between the topshell frame and the concave. Further example materials include ductile steel alloys or aluminium. The choice of material may be considered to represent a compromise between its capability to deform (so
5 as to be compressible radially and to elongate axially) and a required stiffness to withstand the impact crushing forces. This capability of the ring to positionally adjust (in response to changes in the position and the dimensions of the concave) whilst structurally supporting the concave, may be considered to be achieved, by a combination of the choice of constituent material and the articulation joints that allow for radial expansion and
10 contraction.

Each segment may comprise an upper lengthwise extending edge and a lower lengthwise extending edge, a length of the upper edge being less than a length of the lower edge. Preferably, a mount tab is provided at the upper edge and is configured to be engagable by
15 a lifting device. Optionally, the mount tab is formed integrally with the body of the segment that may be formed from a casting or moulding manufacturing process. Preferably, the tab comprises an eyelet attachable to a chain or cable of a lifting device. Optionally, the mount tab may be formed as a hook or one half of mechanical attachment mechanism.

20 Preferably, each articulation joint comprises a first part provided at a first segment of the ring and a second part provided at a second segment of the ring, the first and second parts are configured to inhibit the segments from being decoupled in a circumferential direction. Preferably, the first and second parts comprise radially extending members configured to
25 overlap and abut one another. The fingers may be configured to overlap in a circumferential, radial and axial directions. Preferably, the fingers comprise barbed ends such that the barbs of each respective finger of respective segments are configured to engage one another to releasably lock the segments side-by-side in a circumferential direction. Preferably, the fingers are formed integrally with the segment and due to the
30 material of the segment, comprise a degree of flexibility. In particular, the fingers may be configured to be resiliently biased towards one another in engaging contact so as to inhibit undesirable separation of the segments in a circumferential direction. Optionally, the

segments may comprise components to releasably interlock the segments axially so as to prevent a first segment moving independently of a second segment in the axial direction. Such a configuration may comprise additional overlapping or inter-engaging locking members or the same locking fingers that provide the coupling in the circumferential direction. Accordingly, such fingers may comprise members and barbs extending in the axial direction. Optionally, axial locking of the segments may be provided by circumferentially overlapping arms and/or shoulders provided at neighbouring segments in a circumferential direction. In particular, each segment may comprise an arm or lip projecting outward from the segment at or towards one lengthwise end and a corresponding shoulder, recess or edge section at an opposite lengthwise end such that adjacent segments via the engaging member are capable of overlapping axially (and circumferentially) to provide a part-tessellated assembly. Optionally, the widthwise extending edges may be aligned transverse to the longitudinal axis of the head centre such that the widthwise extending edges of circumferentially neighbouring segments are capable of abutting one another to axially couple the segments and prevent independent axial movement. Preferably, each segment comprises a first inter-engaging part at or towards a first lengthwise end and a second inter-engaging part at or towards a second opposite lengthwise end. Such first and second parts may provide coupling in both the circumferential and axial directions.

Optionally, the segments are separate segments that may be coupled and decoupled from one another. Optionally, the segments may be coupled to one another so as to be formed integrally during the moulding or casting process. Optionally, the segments may be connected with one another via webbing, ribs, tendrils or the like. Preferably, such ribs are configured to be flexible relative to the segments so as to allow the segments to move relative to one another and to compress and expend radially as a unitary body. Optionally, such ribs may extend in a circumferential direction from the lengthwise ends of each segment and may be provided at different regions along the length of the widthwise extending edges so as to span the junction between segments. Such an arrangement may be advantageous to provide a unitary body for convenient mounting and dismounting at the head centre. Preferably, the segments are configured to provide respective gaps between

the widthwise extending edges (lengthwise ends) to enable the ring to expand and contract radially.

Optionally, the radially outward facing region comprises lengthwise extending and

5 widthwise extending ribs that together define a web, the web having pockets that extend radially into the ring from the outward facing region towards the inward facing region.

The lengthwise and widthwise extending ribs increase the stiffness of each segment and the support ring generally by, in part, increasing the radial thickness of the segments.

Preferably, a thickness of the ribs (that extend axially and in a circumferential direction)

10 increase from the lower lengthwise extending edge to the upper lengthwise extending edge.

Preferably, a thickness of the ribs or webbing at the radially outward facing region tapers according to a curved and in particular a concave shape profile from the axially lower to

upper edge. Such an arrangement is advantageous to structurally support the concave at

and around its mid-axial length region. The increased tapered thickness of the support ring

15 at and towards its upper axial end (relative to the lower end) is further beneficial to fill the annular region between the concave and the topshell (or intermediate filler ring) where this

region is generally non-uniform in the axial direction and generally decreases from the

axially upper to axially lower ends of the concave. The radially outward facing support

ribs may be formed as webbing that extends over discrete regions of the support ring (at its

20 radially outward facing region). Optionally, the webbing may extend over 50 to 100% of

each segment at the radially facing region. The webbing increases the stiffness of each

segment such that the ring is configured to withstand the compressive forces resultant from

the topshell being forced radially outward due to the crushing action in a direction towards the topshell or filler ring.

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Preferably, the inward facing region or surface of the support ring is smooth relative to the outward facing region. That is, the inward facing region is devoid of ribs or webbing.

Such an arrangement is advantageous to increase the frictional contact with the concave and help maintain the position of the support ring at the concave.

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Optionally, a radial thickness of each segment may be substantially uniform over all or the majority of the axial length of the segment from an axial upper to axial lower ends.

Preferably the ring is mounted at the crushing shell exclusively via the non-bonded mating contact between the outward facing region (surface) of the crushing shell and the inward facing region (surface) of the support ring. That is, the support ring, as a free standing
5 component or assembly, is configured to rest or sit on the crushing shell under gravity and is not otherwise mechanically or chemically attached the shell.

According to a second aspect of the present invention there is provided an assembly for a gyratory crusher comprising: a topshell frame to house a head for oscillating gyroscopic
10 motion with a crusher; an outer crushing shell mounted within the topshell frame; and a crushing shell support ring as claimed in any preceding claim mounted radially between the crushing shell and the topshell frame.

Preferably, the assembly further comprises a filler ring positioned radially between the
15 support ring and the topshell frame and a filler ring support collar positioned radially between the filler ring and the topshell frame wherein the filler ring support collar comprises a plurality of segments, each segment having a radially inward facing region for positioning against the filler ring and the radially outward facing region for positioning towards the topshell frame.

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Optionally, the filler ring support collar may comprise a pre-moulded polymer or polymer based material. Optionally, the material of the support collar may be the same as the material of the support ring.

25 Preferably, the outer crushing shell comprises at least one shoulder projecting radially outward towards the topshell frame and configured to abut a part of the support ring. Optionally, the shoulder may extend continuously or discontinuously in a circumferential direction around a central axis of the crushing shell. The shoulder being continuous or segmented at the radially outward facing region of the crushing shell is configured to abut
30 a lower lengthwise extending edge of the support ring so as to prevent the ring moving axially downward independently of the crushing shell. The shoulder may contact all or only some of the segments of the ring. Where the shoulder is discontinuous around the

crushing shell, any segments not in contact with a shoulder section are prevented from moving axially independently by axially overlapping members or regions of each segment. That is, the segments when positioned side-by-side form a tessellated assembly such that any one segment cannot be forced axially upward relative to any of the remaining
5 segments due to this axial overlap between regions of the segments.

Importantly, the shoulder that projects radially outward from the crushing shell does not extend sufficiently that would otherwise bridge the gap between the outer crushing shell and the topshell (or filler ring). That is, the shoulder at the topshell projects radially
10 outward by a distance less than the distance by which an axially lower skirt of the crushing shell projects radially outward. Optionally, the topshell comprises 2 to 6, 2 to 5, 2 to 4 or optionally 3 or 4 radially outward projecting shoulder segments. Preferably, the shoulder segments are distributed so as to be separated in a circumferential direction by a substantially equal angular separation. Optionally, the shoulder segments comprise a
15 radial thickness that increases from an axially lower region of the segment to an axially upper region of the segment. Optionally, the shoulder segments comprise a wedge shaped profile and configuration with a thicker end of the wedge positioned axially uppermost relative to a thinner end. Preferably, the wedge segments are positioned immediately axially above and as a part-continuation of an annular skirt positioned at or towards the
20 axially lower end edge of the outer crushing shell. However, a radially outward facing surface of each shoulder segment is recessed relative to a radially outward facing surface of the lower annular skirt. Optionally, the shoulder segments comprise an axial height being less than a corresponding axial height of the lower annular skirt.

25 According to a further aspect of the present invention there is provided a gyratory crusher outer crushing shell comprising: a main body mountable within a region of a topshell frame of a gyratory crusher, the main body extending around a central longitudinal axis; the main body having a mount surface being outward facing relative to the axis for positioning opposed to at least a part of the topshell frame and a crushing surface being
30 inward facing relative to the axis to contact material to be crushed, at least one wall defined by and extending radially between the mount surface and the crushing surface, the wall having an upper axial end and a lower axial end; an annular skirt positioned axially at

or towards the lower axial end and projecting radially outward from the wall, the skirt having a radially outward facing raised contact surface for positioning opposed to a radially inward facing surface of the topshell frame, the contact surface extending continuously around the axis; and at least one shoulder section projecting radially outward from the wall at an axial position above the skirt, a radially outward facing shoulder surface at the shoulder section being recessed radially relative to the contact surface of the skirt; and wherein the shoulder section is positioned axially closer to the lower end than the upper end of the main body.

- 10 Optionally, the skirt is terminated at an axial upper end by an annular transition surface projecting radially and transverse to the outward facing shoulder surface. Preferably, the shoulder section is terminated at an axial upper end by an abutment face aligned to project radially and transverse to the outward facing shoulder surface, the abutment face being configured to abut an axially lower end of a segment of the support ring so as to support the ring axially above the skirt.

- 20 Preferably, and axially lower end of the shoulder section is positioned generally at the same axial position as the transition surface (representing an axially uppermost end of the skirt) such that the shoulder section extends axially upward from the upper end of the skirt (and the transition surface). Preferably, the abutment face of the shoulder section is aligned transverse including perpendicular to the axis. Optionally, a radial length of the abutment face is generally equal to a radial length of the transition surface.

- 25 Optionally, the contact surface of the skirt is aligned transverse to the radially outward facing shoulder surface by an angle in a range 1 to 15°, 1 to 12°, 1 to 10°, 1 to 8°, 1 to 7°, 1 to 5°, or 1 to 3°.

- 30 Preferably, the contact surface of the skirt and the outward facing shoulder surface are orientated to be inclined inwardly towards the axis such that their respective axial upper ends are positioned radially closer to the axis than their respective lower axial ends. Optionally, the shoulder surface and the contact surface are inclined relative to the central axis by an angle in a range 10 to 30°. Optionally, an axial length of the shoulder section is

less than an axial length of the skirt. Optionally, an axial length of the shoulder section is in a range 50 to 100% of an axial length of the skirt. Optionally, a radial thickness of the wall at the shoulder section is less than a radial thickness of the wall at the skirt.

- 5 According to a further aspect of the present invention there is provided a gyratory crusher outer crushing shell assembly comprising: i) an outer crushing shell having a main body mountable at a topshell of a gyratory crusher and/or an intermediate filler ring, the main body extending around a central longitudinal axis, the main body having a mount surface being radially outward facing relative to the axis for positioning opposed to at least a part
10 of the topshell and a crushing surface being radially inward facing relative to the axis to contact material to be crushed, at least one wall defined by and extending radially between the mount surface and the crushing surface, the wall having an upper axial end and a lower axial end; and ii) a support ring mounted at the mount surface of the crushing shell to contact the topshell and/or an intermediate filler ring and support the mounting of the
15 crushing shell at the topshell and/or an intermediate filler ring.

Optionally the ring is a single piece ring extending continuously around the central axis and in contact with the crushing shell. Optionally, the ring comprises a generally uniform shape and configuration in a direction around the axis. Preferably, the ring is pre-formed
20 and may be a free standing unitary body. Preferably the ring does not comprise and is devoid of an epoxy material. Optionally, the ring is bonded to the crushing shell via an adhesive such as an epoxy based material. Preferably the ring is formed from a polymer material such as any one of a polyamide, a polyalkylene or a polyalkylene glycol as described herein.

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- According to a further aspect of the present invention there is provided a gyratory crusher outer crushing shell assembly comprising: i) an outer crushing shell having a main body mountable at a topshell of a gyratory crusher and/or an intermediate filler ring, the main body extending around a central longitudinal axis, the main body having a mount surface
30 being radially outward facing relative to the axis for positioning opposed to at least a part of the topshell and a crushing surface being radially inward facing relative to the axis to contact material to be crushed, at least one wall defined by and extending radially between

the mount surface and the crushing surface, the wall having an upper axial end and a lower axial end; and ii) support segments mounted at the mount surface of the crushing shell to contact the topshell and/or an intermediate filler ring and support the mounting of the crushing shell at the topshell and/or an intermediate filler ring.

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Optionally the support segments are pre-formed. Preferably the support segments do not comprise and are devoid of an epoxy material. Optionally, the support segments are bonded to the crushing shell via an adhesive such as an epoxy based material. Preferably the support segments are formed from a polymer material such as any one of a polyamide, a polyalkylene or a polyalkylene glycol as described herein. Preferably, the support segments are arranged at the mount surface of the crushing shell in non-touching contact with one another and extend in a circumferential direction around the axis substantially at a common axial position.

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15 Brief description of drawings

A specific implementation of the present invention will now be described, by way of example only, and with reference to the accompanying drawings in which:

20 Figure 1 is a perspective view of a gyratory crusher shell support ring mountable in contact with and around an outer crushing shell according to a specific implementation of the present invention;

25 Figure 2 is an external perspective view of the support ring of figure 1 mounted in position within a topshell frame of a gyratory crusher;

Figure 3 is an external perspective view of the support ring of figure 1 mounted in position around an outer crushing shell (concave);

30 Figure 4 is a cross sectional perspective view through A-A of the support ring of figure 1;

Figure 5 is a lower perspective view of an articulation joint formed between the segments of the support ring of figure 1 according to the specific implementation;

Figure 6 is a perspective view of the ring segment of figure 4 from a region of a radially outward facing surface;

Figure 7 is a perspective view of the segment of figure 4 from a region of an internal facing surface;

Figure 8 is a plan view of the concave and support ring of figure 3;

Figure 9 is an external perspective view of the concave of figure 8 with the support ring removed for illustrative purposes;

Figure 10 is a magnified perspective view of a lower region of the concave of figure 9 having a ring support shoulder;

Figure 11 is an external perspective view of the ring and concave of figure 8 mounted in position and surrounded by a filler ring and a filler ring support collar according to a specific implementation of the present invention;

Figure 12 is a cross sectional perspective view through B-B of figure 11;

Figure 13 is an external perspective view of an outer crushing shell support ring mounted in position around an outer crushing shell according to a further specific implementation of the present invention;

Figure 14 is a cross sectional perspective view of a segment through C-C of figure 13 illustrating a radially outward facing surface;

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Figure 15 is a further cross sectional perspective view through C-C of figure 13 illustrating a radially inward facing surface.

Detailed description of preferred embodiment of the invention

Referring to figure 1, an outer crushing shell (concave) support ring 10 comprises a
5 plurality of segments 11 arranged to extend in a circumferential direction around a central
longitudinal axis 12 such that when arranged side-by-side the segments 11 form an annular
collar capable of mounting onto an outer crushing shell within a gyratory crusher. Each
segment 11 is formed from a polymer based material such as a polyamide and comprises a
hardness and a stiffness configured to withstand compressive and tensile stress when in
10 use. Each segment 11 comprises a curved general trapezoidal shape profile such that when
arranged side-by-side around axis 12, ring 10 comprises a part funnel shaped profile. In
particular, each segment 11 comprises an axially upper edge 14 that is shorter than an
axially lower edge 15. Such edges 14, 15 may define respective planar end faces or may
be rounded or curved in the axial direction. Each segment 11 further comprises respective
15 lengthwise end edges 13 by which the segments 11 are interconnected circumferentially.
Accordingly, upper and lower edges 14 and 15 extend lengthwise perpendicular to axis 12
and end edges 13 represent widthwise extending edges aligned in the axial plane. When the
ring 10 is assembled around axis 12, widthwise extending edges 13 curve radially outward
so as to extend transverse to axis 12. Each segment 11 comprises a radially outward facing
20 surface 24 and an opposite radially inward surface 25 with each surface 24, 25 defined by
the perimeter edges 13, 14, 15. Each surface 24 and 25 is aligned transverse to axis 12. In
particular, each surface 24 and 25 curves radially outward in the axially downward
direction away from axis 12 such that upper edge 14 is positioned axially closer to axis 12
than axially lower edge 15. Additionally, the general shape profile of each ring segment
25 11 is curved in a plane perpendicular to axis 12 so as to extend in a circumferential
direction around crushing shell 20.

According to the specific implementation, ring 10 is formed from eight separate segments
11 that are releasably coupled together around axis 12 via a set of articulation joints
30 indicated generally by reference 18. Each joint 18 is formed, in part, by the lengthwise
ends of each segment 11 (at the region of widthwise extending edges 13). Joints 18 enable
each segment 11 to move radially relative to axis 12 such that ring 10 is configured to

expand and contract relative to axis 12 with each joint 18 expanding or contracting in a circumferential direction.

According to further specific implementations, segments 11 may be interconnected so as to
5 be formed integrally via webbing, ribs or other circumferentially extending members to provide a unified fully integral single body. In such implementations, such webbing, ribs or members are flexible to provide the articulation joints 18 as described herein.

Referring to figures 2 to 4, ring 10 is conveniently mountable and demountable at an outer
10 crushing shell (concave) 20 by mating contact between ring inward facing surface 25 and a radially outward facing surface 30 of concave 20. According to the specific implementation, ring 10 comprises a height in the axial direction being in the range 60 to 90% of an axial height of concave 20. In particular, ring 10 comprises a radius to enable mounting over a mid-length region of concave 20 (in the axial direction) such that only
15 relatively short axially upper and lower annular end sections of concave 20 are exposed to extend axially beyond ring 10. Ring 10 may be raised and lowered as a unitary body relative to concave 20 via a set of mounting tabs 16 provided about each respective segment 11, with each tab 16 comprising an eyelet 17 engagable by a chain or cable of an auxiliary lifting device. Ring 10 comprises a radial thickness that may be considered to be
20 generally consistent (i.e. at certain axial positions, approximately equal to) a radial thickness of concave 20. The radial thickness of ring 10 is intended to be similar to a thickness of an epoxy resin which is otherwise applied to the region around concave 20 according to conventional support and reinforcement practices. Having the appropriate dimensions, the present ring 10 is capable of positioning between concave 20 and a
25 topshell frame 19 and in particular an annular wall 26 of topshell 19. Ring 10 is, according to the specific implementation, compatible for use with a crusher having topshell 19 and a conventional filler ring 22. According to the specific implementation, shell support ring 10 is positioned radially between concave 20 and filler ring 22. Additionally, a filler ring support collar 23 is positioned radially between filler ring 22 and topshell wall 26.
30 According to the specific implementation, filler ring support collar 23 comprises the same material as that of crushing shell support ring 10 and is similarly formed from individual segments arranged side-by-side to extend in a circumferential direction around axis 12 and

in contact against a radially outward facing surface of filler ring 22 and a radially inward facing surface of topshell wall 26. Filler ring 22 is described in further detail below with reference to figures 11 to 12 according to a further embodiment. However, the features described with reference to figures 11 to 12 apply equally to the embodiment illustrated
5 and described with reference to figures 2 to 10.

Referring specifically to figures 3 and 4, support ring 10 (and accordingly each individual segment 11) is mounted in contact with and around concave 20. In particular, concave 20 comprises a radially inward facing (crushing) surface 29 that defines part of the crushing
10 zone and is configured for positioning in opposed relationship to an inner crushing shell (mantle) not shown. Concave 20 also comprises a radially outward facing surface 30 that is generally concave and extends between an axially upper annular end 27 and an axially lower annular skirt 30 that is positioned at and extends from an axially lower end 28 of concave 20. The inward facing surface 25 of each segment 11 is generally convex in an
15 axial plane having a curvature that mirrors the concave curvature of crushing shell surface 30 so as to allow ring 10 to mate in close touching contact around crushing shell 20. Similarly, the outward facing region 24 of each segment 11 is concave substantially the full axial length of each segment 11 between the upper and lower edges 14, 15. A radial wall thickness of each segment 11 is tapered to increase generally from lower end edge 15
20 to upper end edge 14.

Ring 10 is positionally supported at concave 20 by seating upon three shoulder sections 32 that project radially outward from concave 20 at a region immediately above skirt 31. Each shoulder section 32 is configured to abut against ring lower edge 15 so as to prevent
25 ring 10 moving axially downward over concave surface 30. Accordingly, ring 10 is maintained in a fixed axial height position at concave 20 via shoulder sections 32. With segments 11 positioned end-to-end, ring 10 comprises a generally curved, funnel shaped profile in which the lower annular end comprises a radius being greater than a corresponding upper annular end. Due to the convex inward facing surface 25, the radius
30 increases progressively in a downward direction from the upper annular end to the lower annular end of ring 10.

Referring to figures 5 to 7, each segment 11 is connected at its lengthwise ends (in a circumferential direction) to two neighbouring segments 11 via two corresponding articulation joints 18. Each joint 18 according to the specific implementation is divided axially into an upper part 18a and a lower part 18b. Each part 18a, 18b comprises the same inter-engaging formations to releasably couple the segments 11 to form the curved funnel shaped ring 10. In particular, each part 18a, 18b comprises respective fingers 70 having barbed ends 33. The fingers 70 and barbs 33 are formed integrally with segment 11 and are positioned in a circumferential direction in-board of lengthwise end edges 13. That is, each segment 11 comprises a first lengthwise end edge 13a and an opposite second lengthwise end edge 13b, with each end region having a respective upper and lower joint part 18a, 18b. Fingers 70 are formed by a relatively thinner wall section of each segment 11 such that fingers 70 comprise a degree of flex in a radial direction. However, fingers 70 also comprise sufficient stiffness to achieve and maintain the interconnection between segments 11 in the circumferential direction. Each finger 70 is terminated at its end by a radially extending bard 33. Each joint 18 comprises an upper and lower pair of fingers 70 and barbs 33 in opposed and overlapping position. That is, the fingers 70 of a first segment 11 extend radially over the corresponding fingers 70 of a second segment 11 such that the fingers 70 of the first and second segments 11 overlap in a circumferential direction with the fingers of the first segment 11 being respectively radially external relative to the fingers 70 of the second segment 11. The respective barbs 33 of the first and second segments overlap radially such that the first and second segments are inhibited from being circumferentially separated by abutment contact between the opposed bards 33.

The capability of ring 10 to compress and expand radially is provided by respective gap regions 21, 34 as illustrated in figures 5 to 7. That is, with the barbs 33 of the neighbouring first and second segments 11a, 11b slightly spaced apart circumferentially by a small gap 21, a corresponding gap 34 is provided between the respective lengthwise end edges 13a, 13b and a corresponding shoulder 36 from which the fingers 70 extend circumferentially. Accordingly, joint parts 18a, 18b of the first segment 11a are capable of sliding or passing over the corresponding and underlying parts 18a, 18b of the second segment 11b by a circumferential distance (or width) of the gap regions 21, 34. As illustrated, each joint part 18a, 18b is separated in the axial direction by a mid-section that effectively is a

continuation of the main body of each segment 11. Segments 11 are maintained in axial position relative to one another via an upper region of each joint 18. In particular, finger 70 at joint upper part 18a is terminated at its uppermost end by a radially and circumferentially extending lip or shoulder 35 that is a continuation of the lengthwise
5 extending upper edge 14. Accordingly, with the first and second segments 11a, 11b mounted in side-by-side relationship as shown in figures 5 to 7, shoulder 35 is dimensioned to sit axially immediately above an uppermost lengthwise end edge 37 of finger 70 of the second segment 11b. Accordingly, the segments 11a, 11b are coupled axially and prevented from independent axial movement relative to one another via axial
10 abutment contact between shoulder 35 and finger end edge 37.

Each segment 11 comprises ribs (or webbing) provided at the radially outward facing region so as to reinforce the segment 11 by increasing the radial thickness from the lower to upper ends 15, 14. The webbing comprises axially extending ribs 38a (extending
15 between the upper and lower ends 15, 14) and perpendicular, circumferentially extending ribs 38b (extending in the direction around axis 12 between segment ends 13a, 13b) that cross the axial ribs 38a. The ribs 38a, 38b define pockets 39 having a depth (in a radial direction) that increase from the segment lower to upper ends 15, 14. The increased thickness of the webbing 38a, 38b at the axially upper region of each segment 11
20 structurally reinforces ring 10 at its axially upper region at and above the mid-axial length of concave 20.

Referring to figures 8 to 10, shoulder sections 32 extend radially outward at the lower region of concave 20 and are spaced apart in a circumferential direction around axis 12 via
25 a uniform angular separation. According to the specific implementation, each shoulder section 32 extends over an angular distance of 25 to 30° and accordingly are separated from one another by 90 to 95° (angular separation). As such, the shoulder sections 32 comprise an angular length being less than half the length of each segment 11 (in a circumferential direction). In particular, each shoulder section 32 comprises an angular
30 length being 25 to 75% of the corresponding angular length of each segment 11 (in a circumferential direction) between the connected end edges 13a, 13b. Such an arrangement is advantageous to allow ring 10 to seat correctly onto the outward facing

surface 30 of concave 20. Such a configuration also reduces the material of the concave 20 to maximise weight saving and optimise the use of material. As will be noted, any segments 11 not supported directly by shoulder section 32 are supported axially by the abutment contact between each shoulder 35 and finger edge 37 of adjacent neighbouring segments 11.

Referring specifically to figures 9 and 10, each shoulder section 32 comprises a generally wedge-shaped configuration having an axially lower end 41 and an axially upper end 40 in which the upper end 40 comprises a greater radial thickness than lower end 41. Each wedge section 32 protrudes radially outward at the concave external facing surface 30 so as to define an axially upward facing abutment face 42 for mating against segment lower edge 15. The radial thickness of surface 42 is sufficient to engage segment end edge 15. The radial thickness of each section 32 is configured such that a shoulder radially outward facing surface 43 is recessed radially relative to a corresponding radially outward facing surface 44 at the lower annular skirt 31. Accordingly, a lip or ledge transition 46 extends between shoulder section lower end 41 and an annular upper end 45 of skirt 31.

Referring to figures 11 and 12 the present concave support ring 10 is compatible for use with or without an additional filler ring 22 being dependent upon the shape and configuration of the concave 20 and to some extent topshell 19. Figures 2, 11 and 12 illustrate ring 10 used in combination with filler ring 22 and the additional filler ring support collar 23. Filler ring 22 comprises an annular axial upper end 56 and a corresponding lower annular end 57 with a radially outward facing surface 58 and a radially inward facing surface 59 extending axially between the respective ends 56, 57 and in a circumferential direction around axis 12. Concave support ring 10 is positioned radially intermediate filler ring 22 and concave 20 by mating contact between the respective radially inward facing surface 59 of filler ring 22 and the radially outward facing ring surface 24; and by mating contact between the radially inward facing ring surface 25 and the radially outward facing shell surface 30.

Filler ring support collar 23 comprises a modular segmented configuration formed from segments 54, each having an axially upper end 47 and an axially lower end 48. Each

segment 54 is further defined by a pair of lengthwise ends 55a, 55b that are positioned adjacent respective ends 55a, 55b of neighbouring segments 54 to define the collar 23. Each segment 54 may be considered to comprise a generally 'T' shaped profile such that when the edges 55a, 55b are positioned side-by-side to define the collar 23, sections 53 of the filler ring 22 are exposed between the segments 54. That is, collar 23 when assembled as a ring does not surround completely filler ring 22 and covers only a majority of filler ring 22. Each segment 54 comprises a radially inward facing surface 60 and a radially outward facing surface or region 62. Inward facing surface 60 is generally smooth or non-profiled relative to outward facing region 62 that comprises ribs 50, 51 extending in the axial and circumferential direction to define pockets 49 being consistent with the webbing 38a, 38b and pockets 39 of the support ring segments 11.

According to the specific implementation, a radial thickness of each collar segment 54 decreases in the axial direction from upper end 47 to lower end 48 with the shape profile of the inward facing surface 60 corresponding to that of the outward facing surface 58 of filler ring 22. A groove 52 is recessed into collar inward facing surface 60 at each segment 54 and extends axially from upper end 47 towards lower end 48. Each groove 52 is configured to receive a mounting bolt to secure the concave 20 and filler ring 22 in position within topshell 19 and in particular to rotationally lock filler ring 22 and support collar 23 relative to topshell 19. According to the specific implementation, support collar 23 comprises six segments 54. The segments 54 are supported axially upon a lower annular skirt 61 projecting radially outward and formed at an axially lower region of filler ring 22.

A further specific implementation of the crushing shell support ring 10 is illustrated in figures 13 and 15. As will be noted, the general shape profile of each ring segment 11 is curved in a plane perpendicular to axis 12 so as to extend in a circumferential direction around crushing shell 20 that is not curved in an axial plane. That is, the radially inward facing surface 25 of each segment 11 is generally planar in the axial direction. Each segment 11 is shaped and dimensioned so as to tessellate together to form the ring that is inclined to comprise a frusto-conical shape profile. That is, inward facing surface 25 of each segment 11 extends transverse to axis 12 by a shallow angle of 2 to 7°. As will be

noted, the features described with reference to the embodiment of figures 1 to 12 are also common to the further embodiment of figures 13 to 15 including in particular webbing 38a, 38b, pockets 39, articulation joints 18 and associated fingers 70 and barbs 33.

Claims

1. A crushing shell support ring (10) mountable in contact with and around an outer crusher shell (20) of a gyratory crusher, the ring (10) comprising:
 - 5 a plurality of segments (11) connected or connectable together in a circumferential direction to form the ring (10);
each segment (11) having a length extending in a circumferential direction around a central longitudinal axis (12), a width extending generally in an axial direction and a thickness extending in a radial direction, the thickness defined by a radially inward facing
10 region (25) for positioning against the outer crusher shell (20) and a radially outward facing region (24) for positioning towards a topshell frame (19) of the gyratory crusher;
the radially inward facing region (25) being generally convex in the axial direction and/or aligned to extend transverse to the axis (12) such that an axially upper end of the ring (10) is positioned radially closer to the axis (12) than an axially lower end of the
15 ring (10);
a plurality of articulation joints (18) coupling the segments (11) in the circumferential direction to enable the ring (10) to expand and contract radially when mounted radially between the outer crushing shell (20) and the topshell frame (19).
- 20 2. The ring as claimed in claim 1 wherein the ring (10) comprises a polymer or polymer based material.
3. The ring as claimed in claim 2 wherein the material comprises any one of a polyamide, a polyalkylene or a polyalkylene glycol.
25
4. The ring as claimed in any preceding claim wherein each segment (11) comprises an upper lengthwise extending edge (14) and a lower lengthwise extending edge (15), a length of the upper edge (14) being less than a length of the lower edge (15).
- 30 5. The ring as claimed in claim 4 comprising a mount tab (16) provided at the upper edge (14) configured to be engagable by a lifting device.

6. The ring as claimed in any preceding claim wherein each articulation joint (18) comprises a first part provided at a first segment (11a) of the ring (10) and a second part provided at a second segment (11b) of the ring (10), the first and second parts movable relative to one another in a circumferential direction and configured to inhibit the segments
5 (11a, 11b) from being decoupled in a circumferential direction.

7. The ring as claimed in claim 6 wherein the first and second parts comprise radially extending fingers (70) configured to overlap and abut one another.

10 8. The ring as claimed in claim 6 or 7 wherein each segment (11) comprises the first part positioned at or toward a first lengthwise end (13a) and the second part positioned at or towards a second opposite lengthwise end (13b).

9. The ring as claimed in any preceding claim wherein the radially outward facing
15 region (24) comprises lengthwise extending and widthwise extending ribs (38a, 38b) that together define a web, the web having pockets (39) that extend radially into the ring (10) from the outward facing region (24) towards the inward facing region (25).

10. The ring as claimed in any preceding claim when dependent on claim 4 wherein a
20 radial thickness of each segment (11) decreases from the upper edge (14) to the lower edge (15).

11. An assembly for a gyratory crusher comprising:
a topshell frame (19) to house a head for oscillating gyroscopic motion with a
25 crusher;
an outer crushing shell (20) mounted within the topshell frame (19); and
a crushing shell support ring (10) as claimed in any preceding claim mounted radially between the crushing shell (20) and the topshell frame (19).

30 12. The assembly as claimed in claim 11 wherein the outer crushing shell (20) comprises at least one shoulder (32) projecting radially outwardly towards the topshell frame (19) and configured to abut a part of the support ring (10).

13. The assembly as claimed in claim 12 wherein the shoulder (32) extends continuously or discontinuously in a circumferential direction around a central axis (12) of the crushing shell (20).

5

14. The assembly as claimed in any one of claims 11 to 13 further comprising a filler ring (22) positioned radially between the support ring (10) and the topshell frame (19) and a filler ring support collar (23) positioned radially between the filler ring (22) and the topshell frame (19) wherein the filler ring support collar (23) comprises a plurality of segments (54), each segment (54) having a radially inward facing region (60) for positioning against the filler ring (22) and a radially outward facing region (62) for positioning towards the topshell frame (19).

15. The crusher as claimed in claim 14 wherein the filler ring support collar (23) comprises a pre-moulded polymer or polymer based material.

15

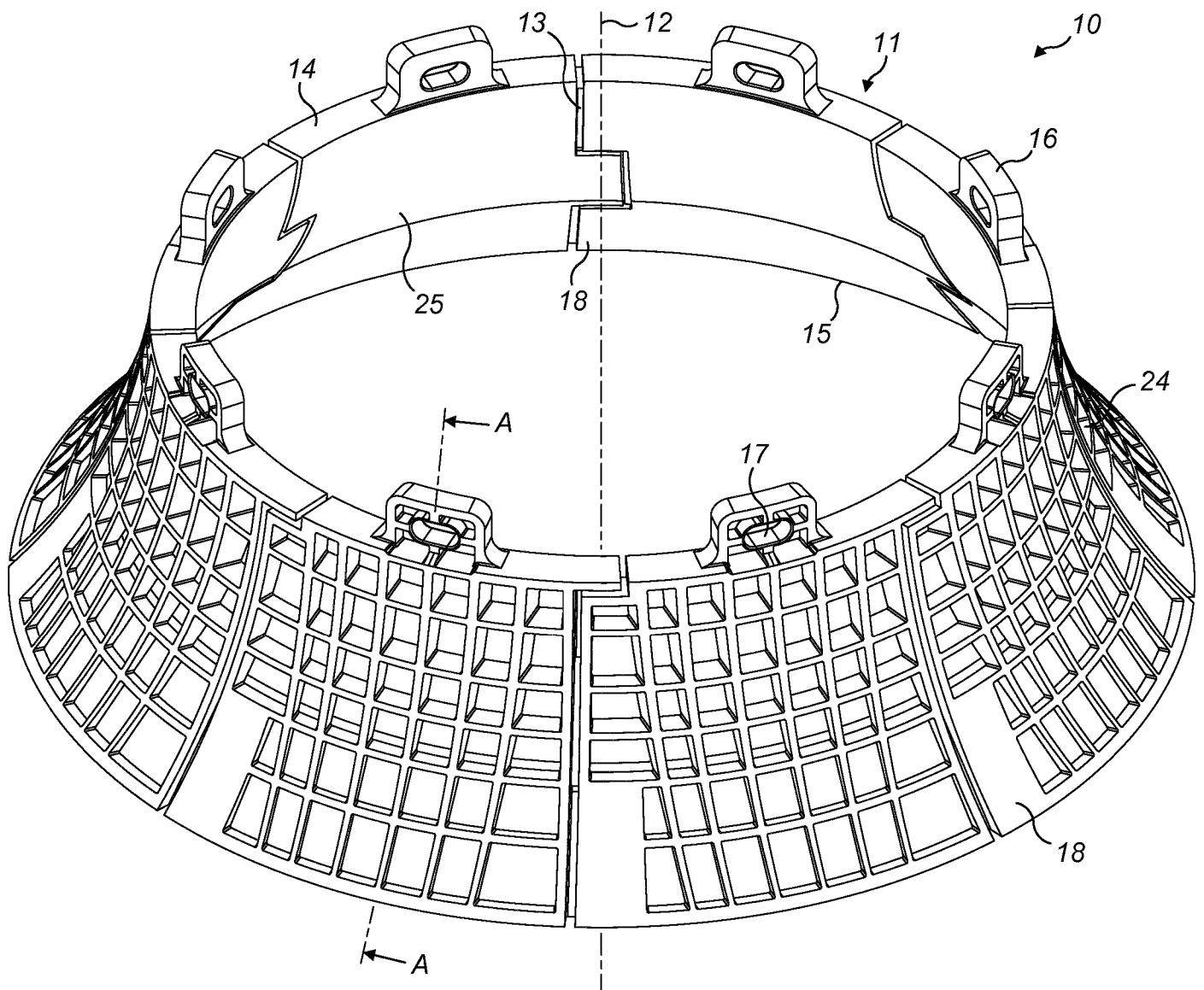


FIG. 1

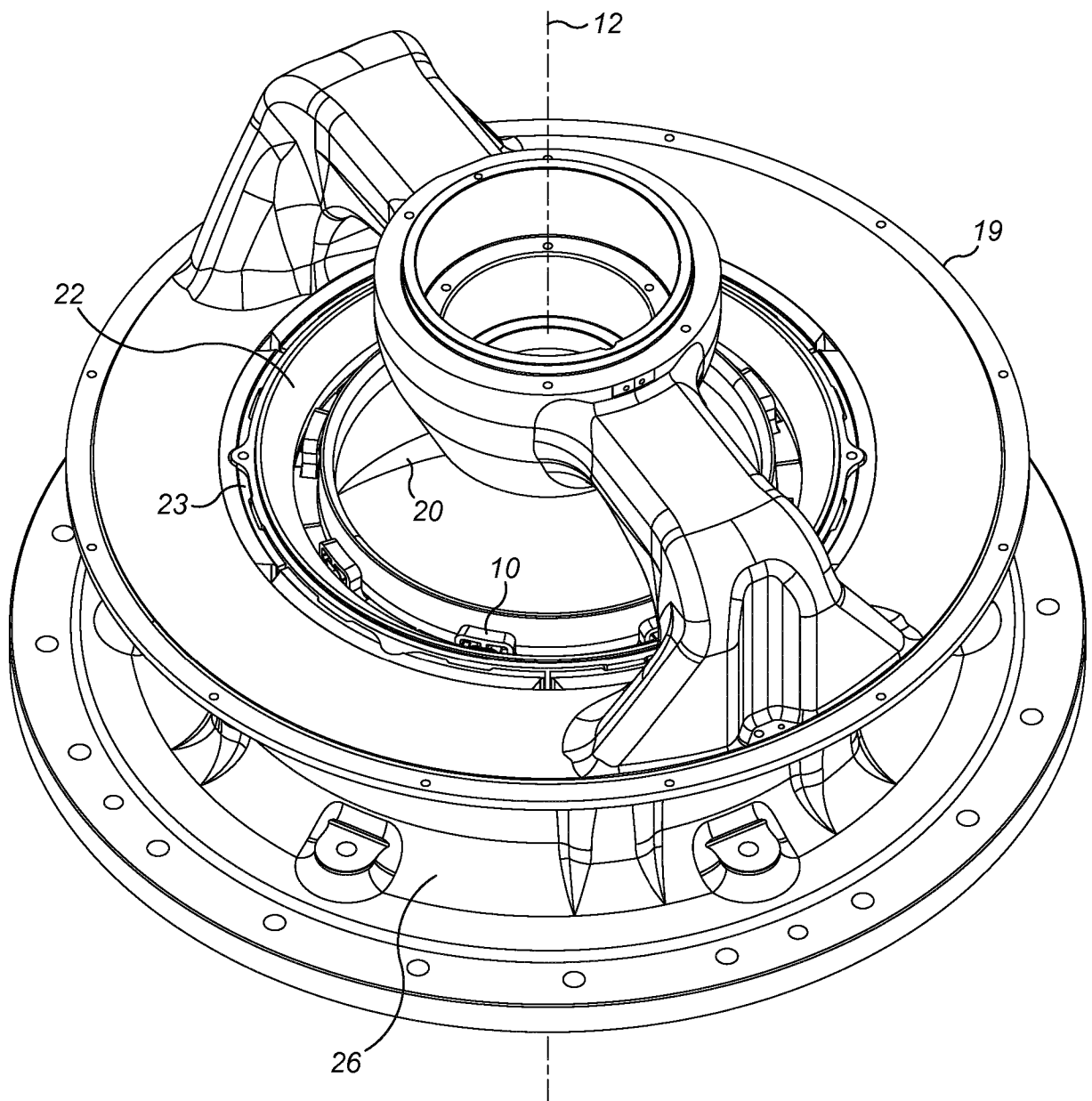


FIG. 2

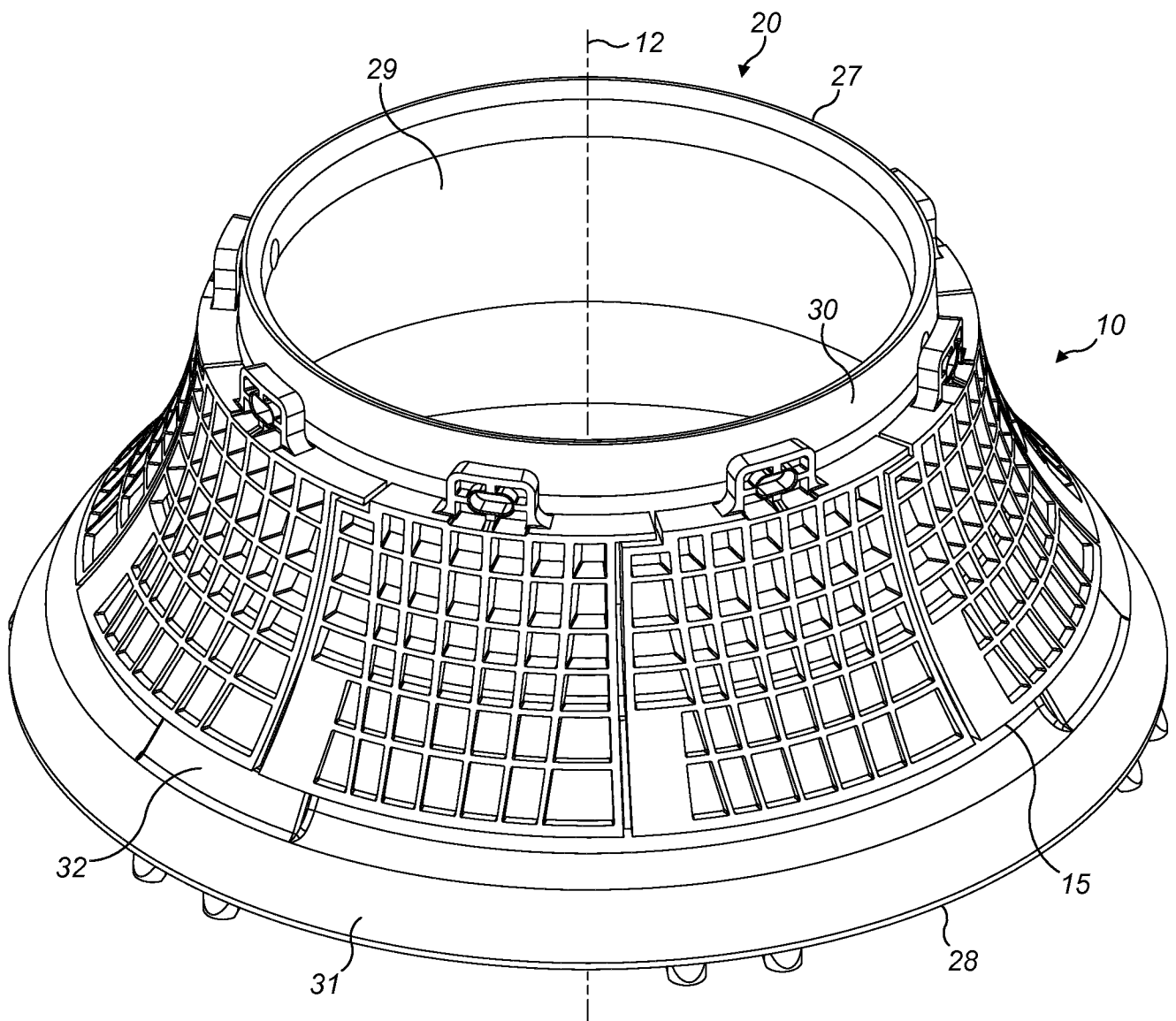
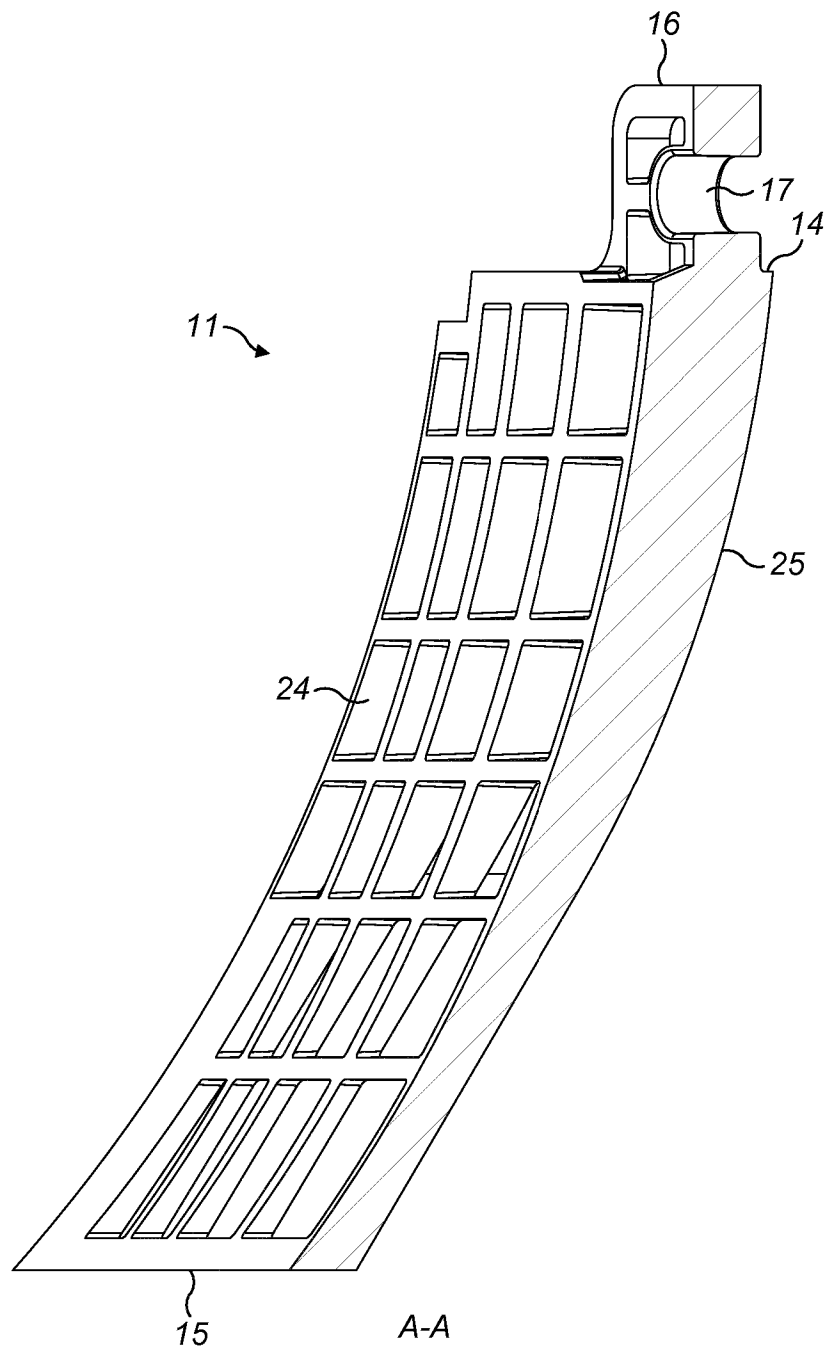


FIG. 3

**FIG. 4**

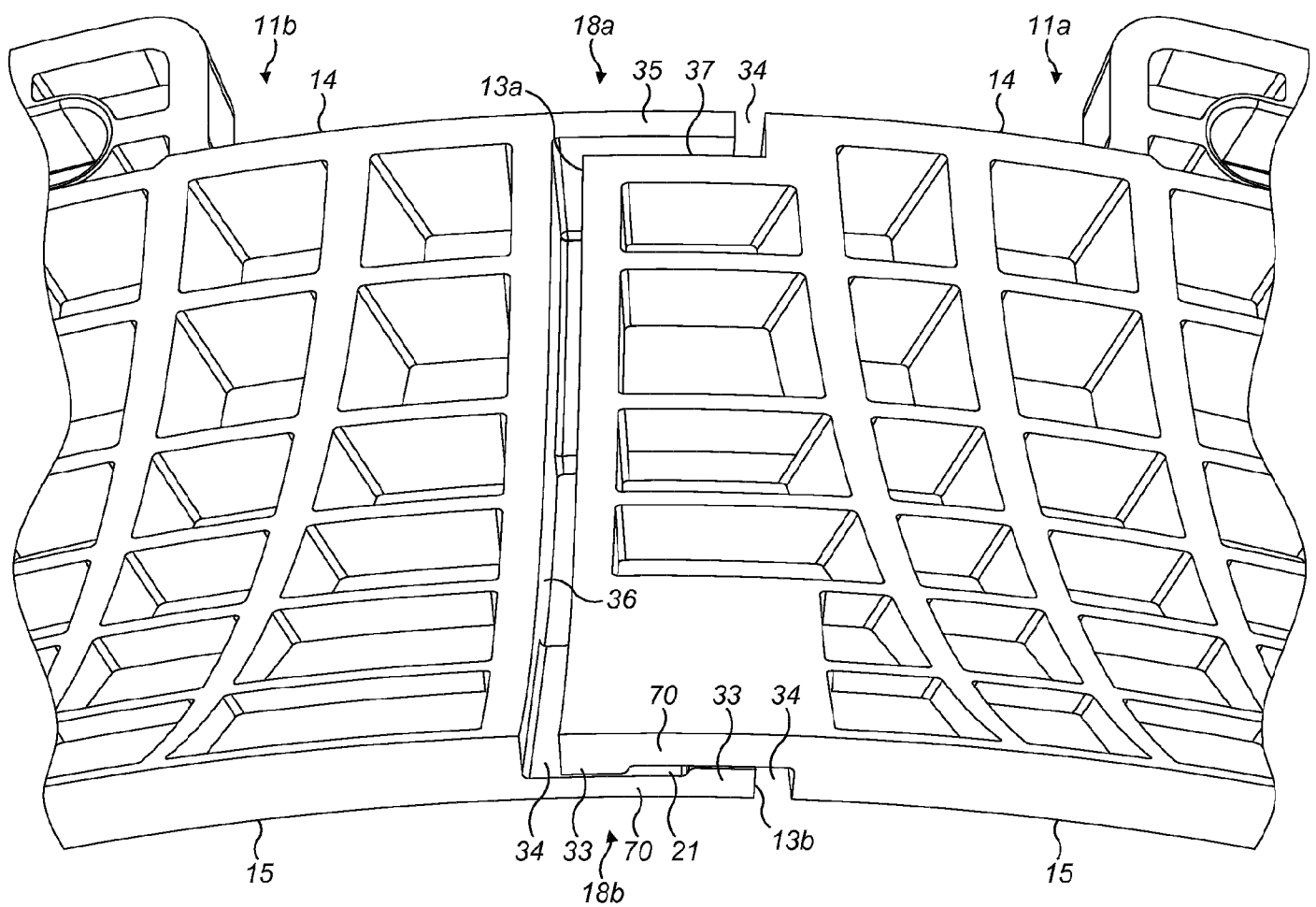


FIG. 5

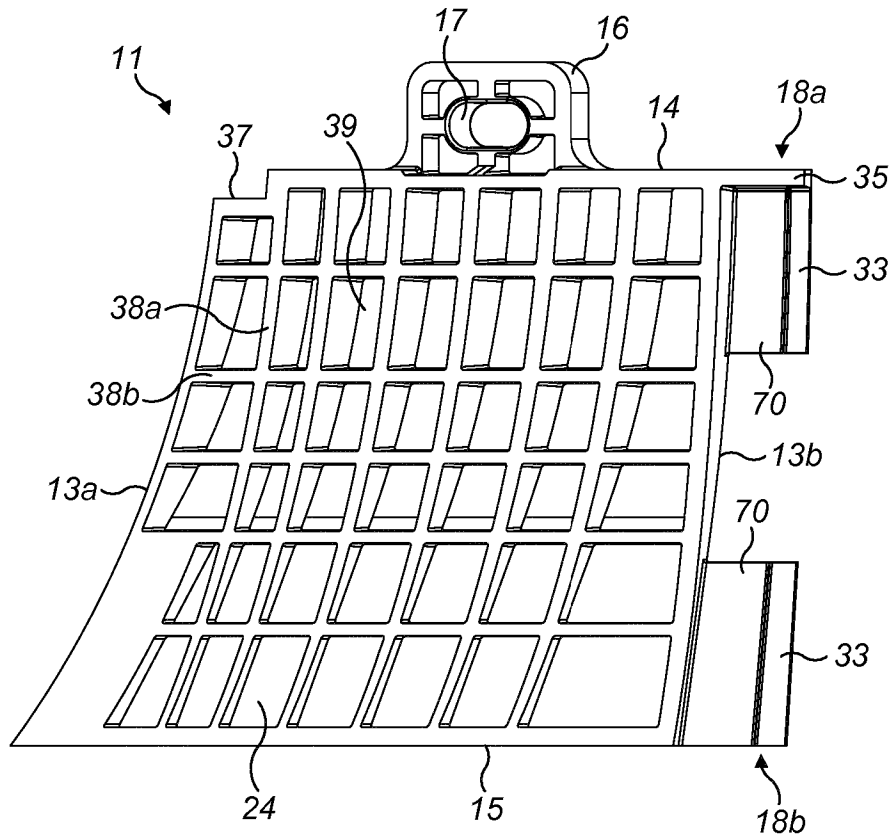


FIG. 6

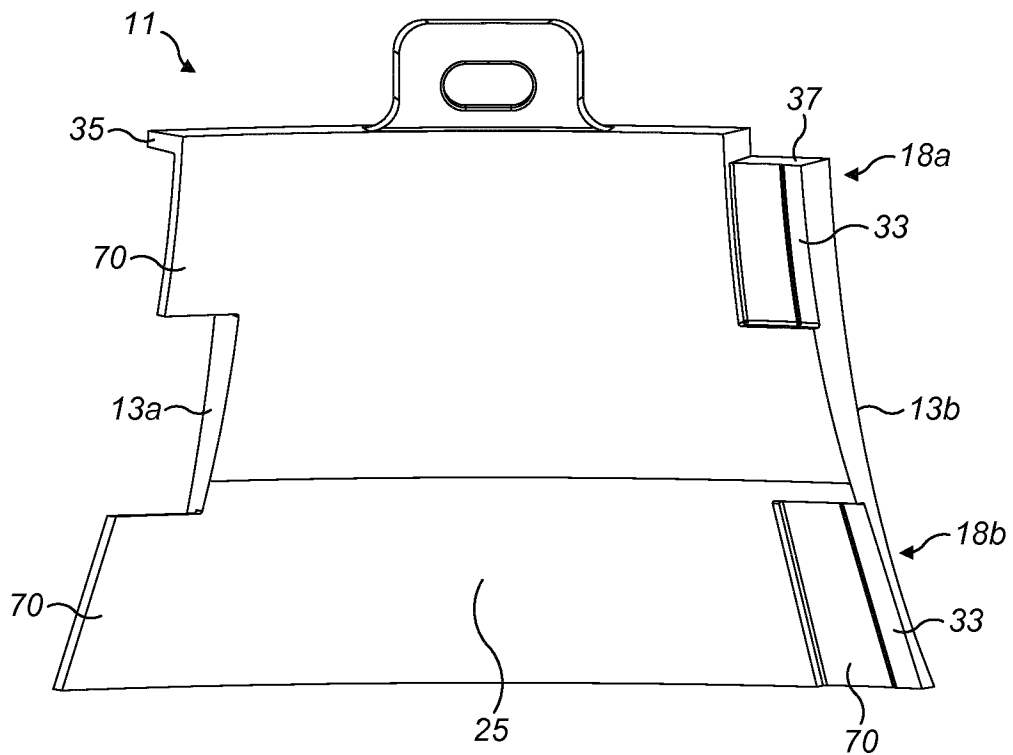
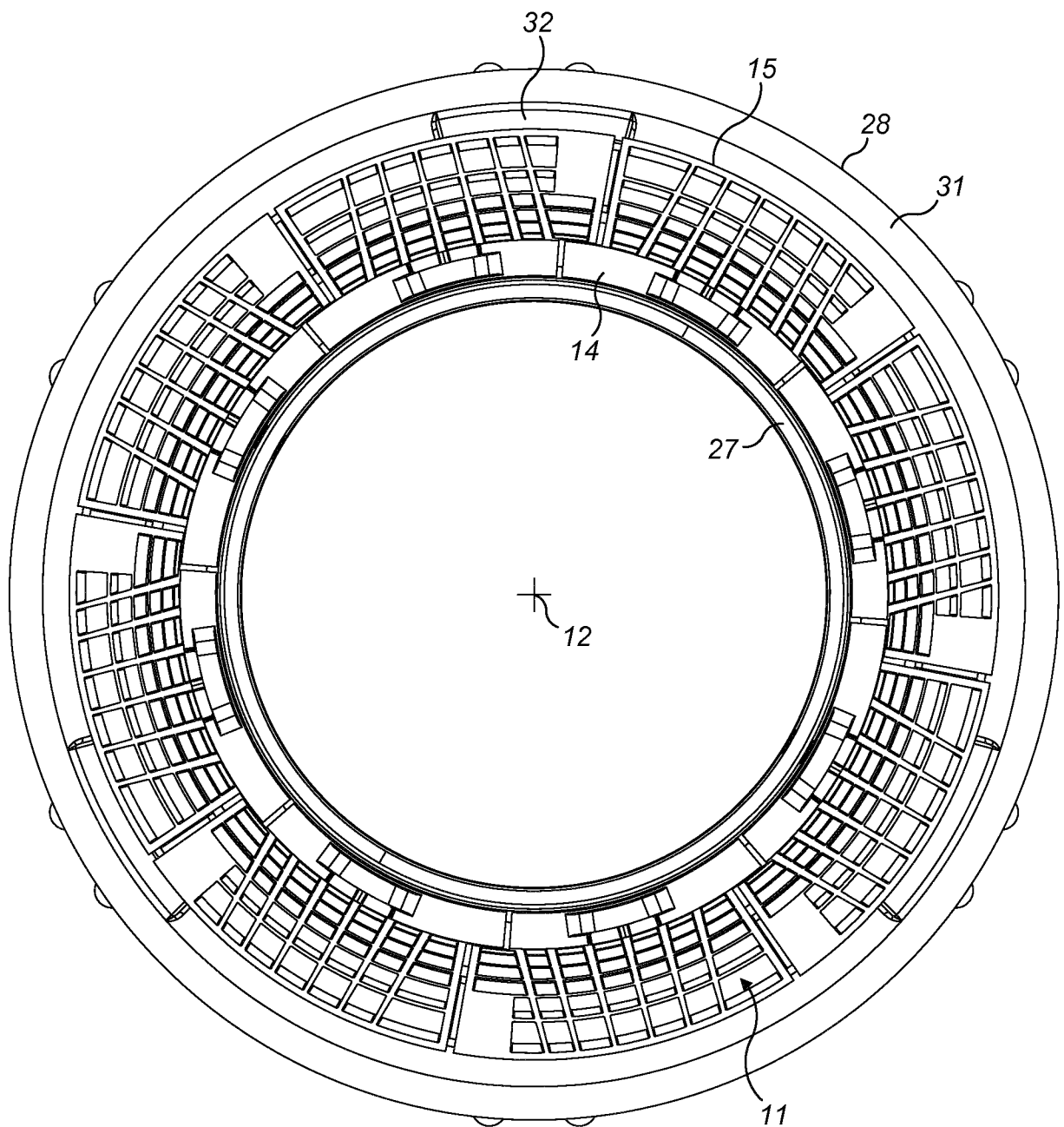


FIG. 7

**FIG. 8**

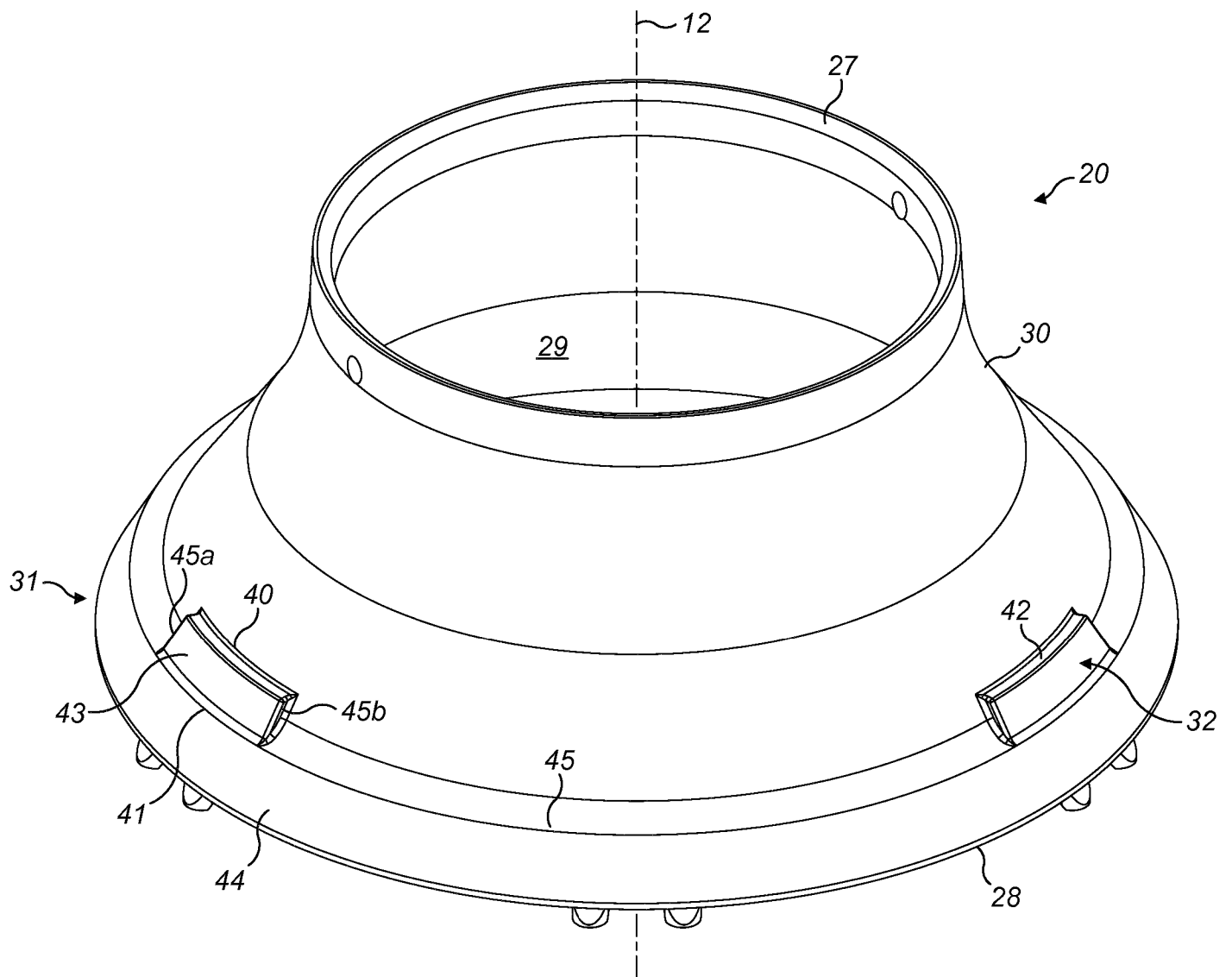


FIG. 9

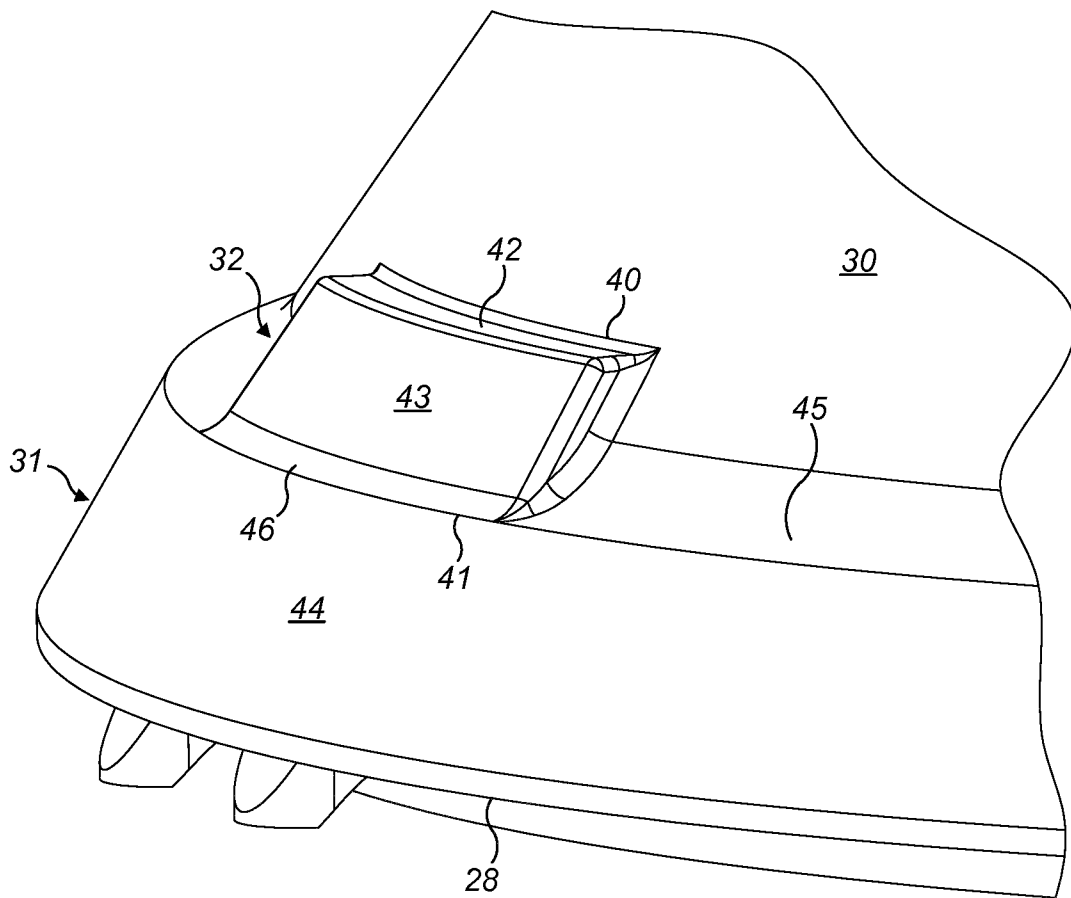


FIG. 10

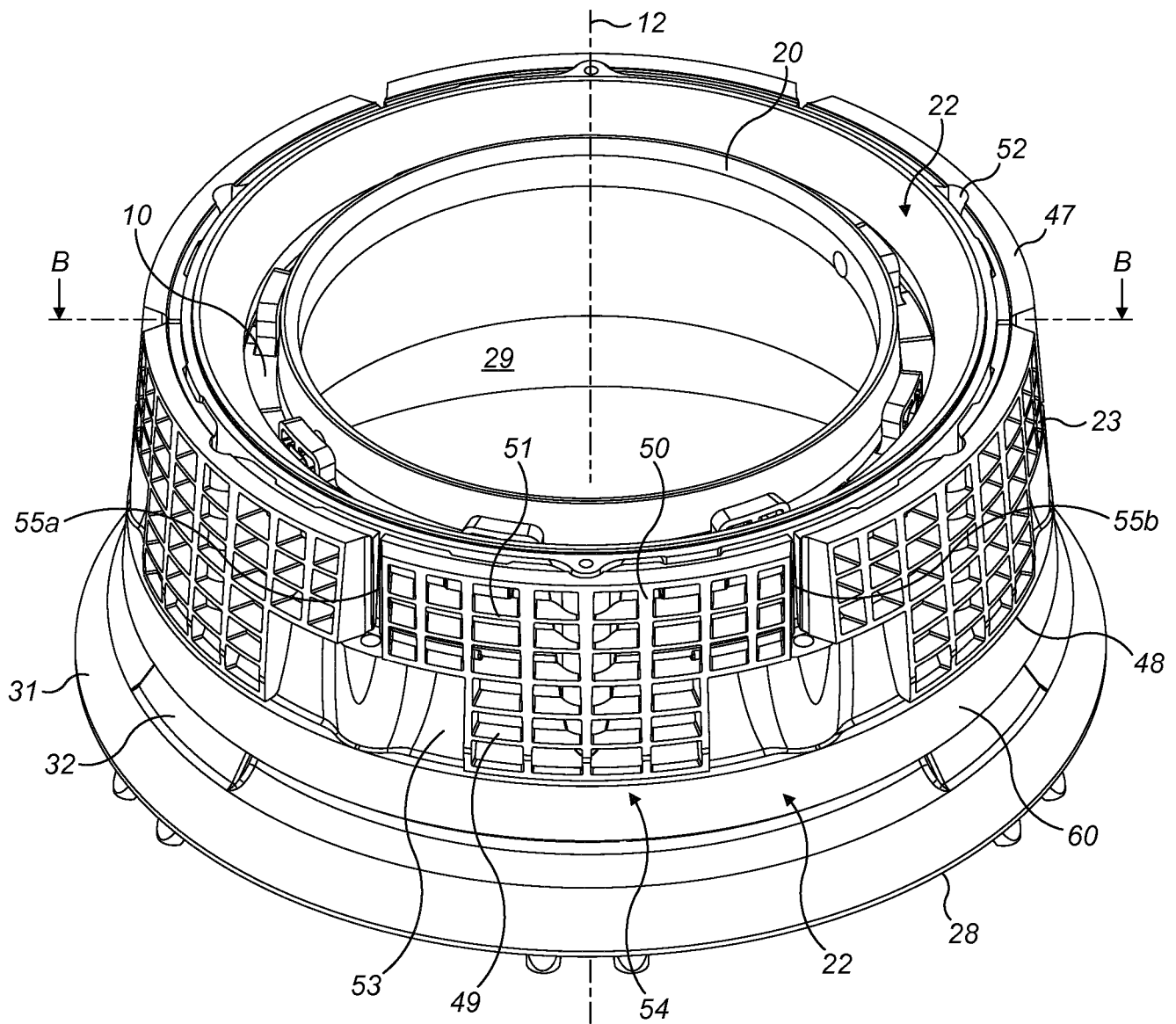


FIG. 11

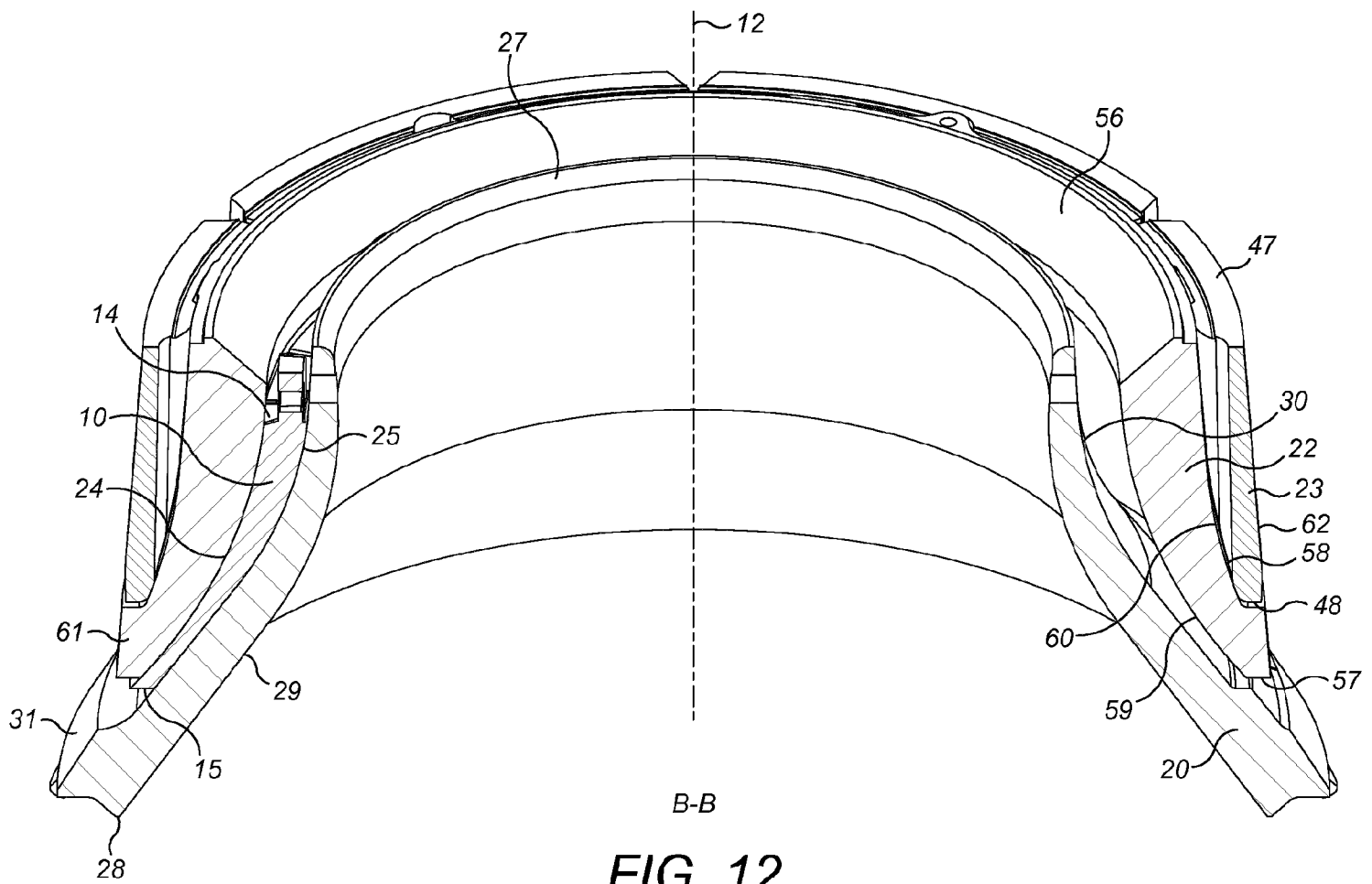
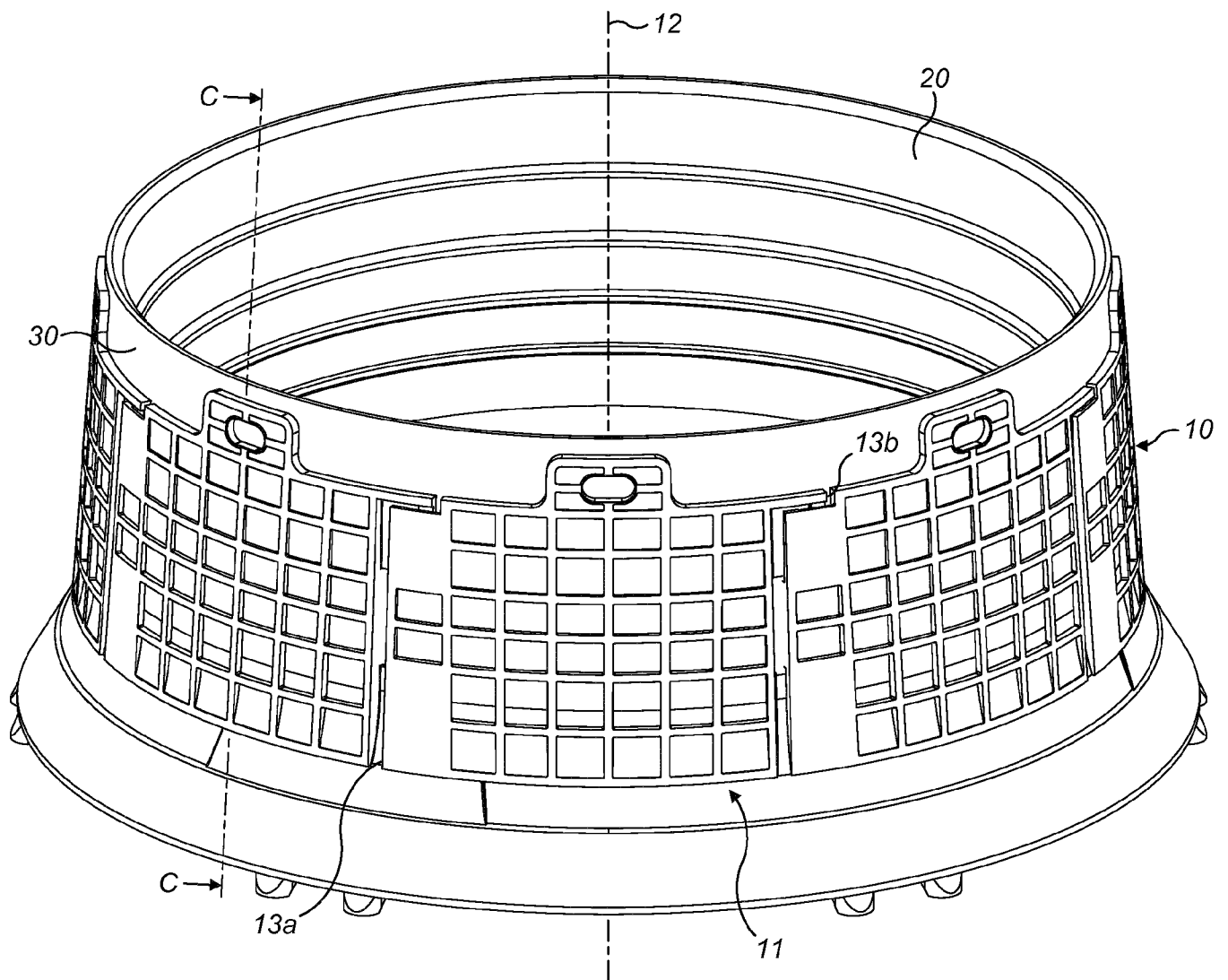


FIG. 12

*FIG. 13*

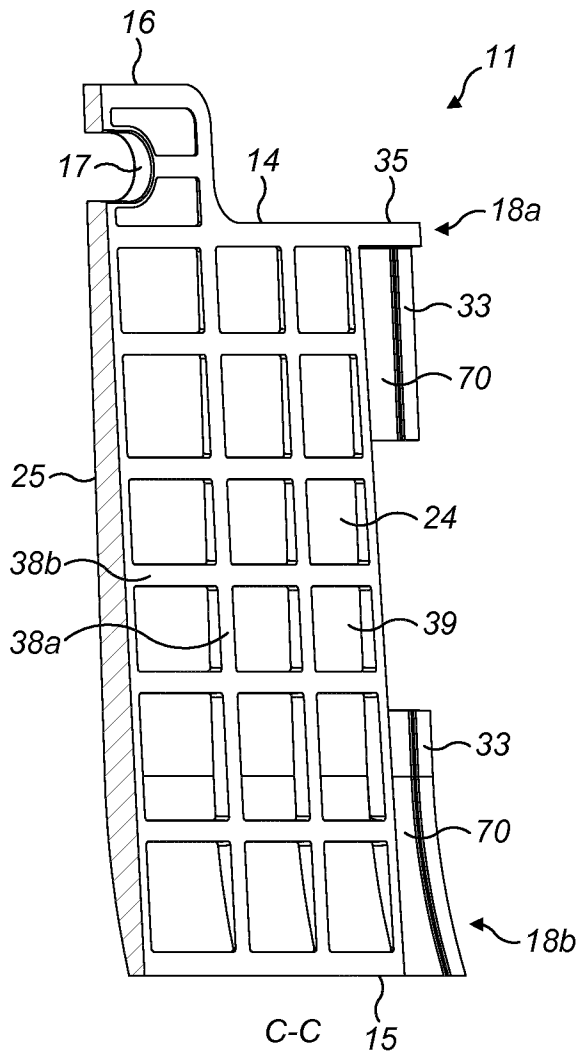


FIG. 14

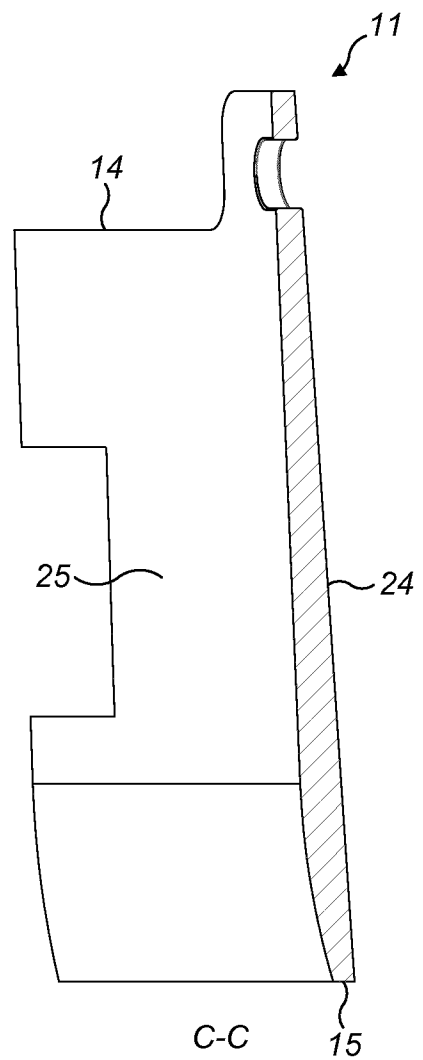


FIG. 15

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2016/061429

A. CLASSIFICATION OF SUBJECT MATTER

INV. B02C2/00 B02C2/04
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B02C

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2004/110626 A1 (SANDVIK AB [SE]; OLSSON GERT-AAKE [SE]; SILFVER ROLF [SE]; NILSSON TOR) 23 December 2004 (2004-12-23) cited in the application page 4, line 36 - page 5, line 2 page 11, lines 4-13; figures -----	1-15
A	GB 643 081 A (SAMUEL WILLIAM TRAYLOR JR) 15 September 1950 (1950-09-15) page 2, lines 23-55; figures -----	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

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

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

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

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Date of the actual completion of the international search

10 January 2017

Date of mailing of the international search report

26/01/2017

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Authorized officer

Flodström, Benny

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/061429

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