Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2599263 C 2016/08/09

(11)(21) **2 599 263**

(12) **BREVET CANADIEN**
CANADIAN PATENT

(13) **C**

(22) **Date de dépôt/Filing Date:** 2007/08/13

(41) **Mise à la disp. pub./Open to Public Insp.:** 2009/02/13

(45) **Date de délivrance/Issue Date:** 2016/08/09

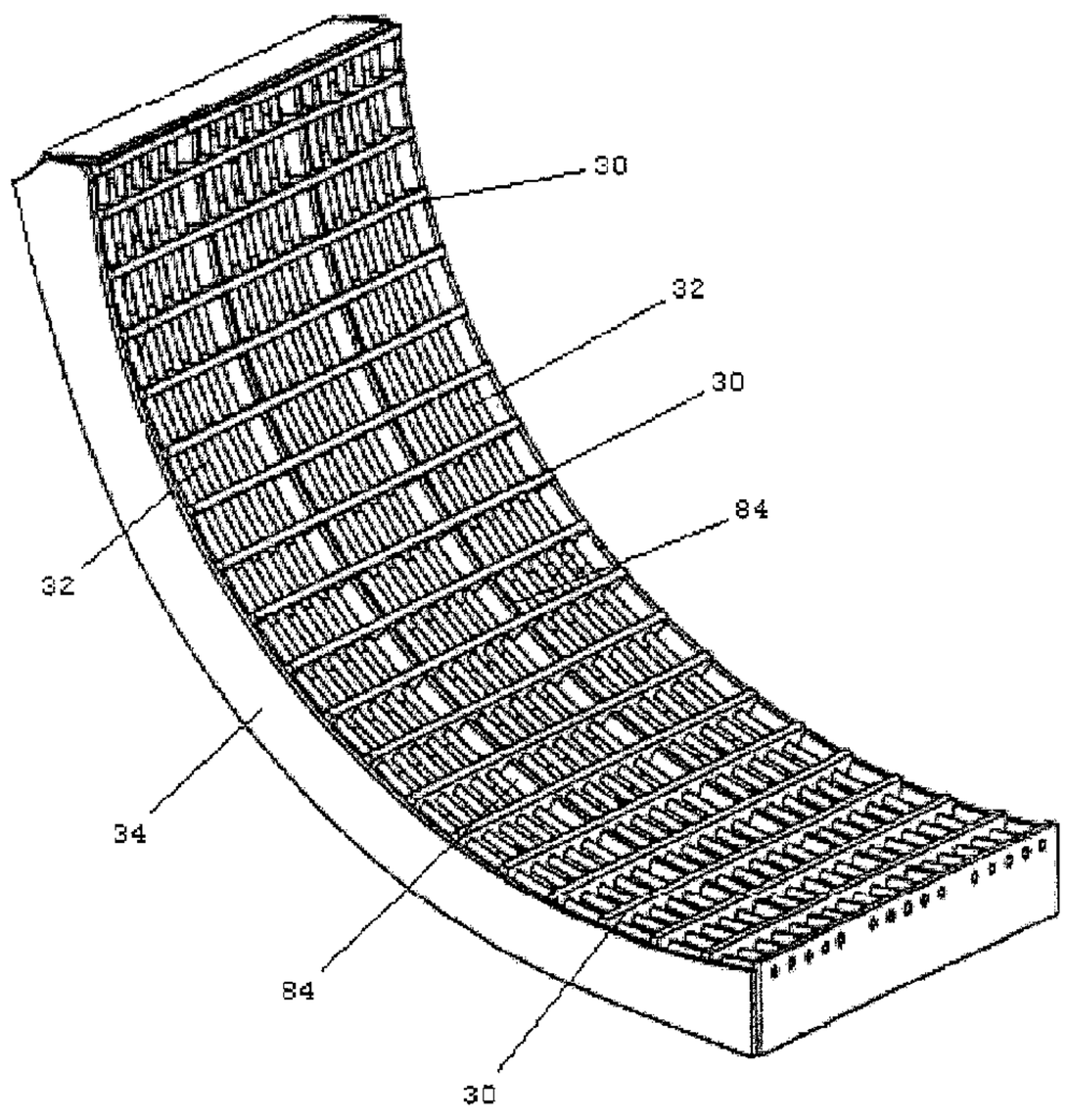
(51) **Cl.Int./Int.Cl.** ***A01F 12/26*** (2006.01), ***A01D 41/12*** (2006.01), ***A01F 12/44*** (2006.01)

(72) **Inventeur/Inventor:**
KUCHAR, GEORGE J., US

(73) **Propriétaire/Owner:**
KUCHAR, GEORGE J., US

(74) **Agent:** ADE & COMPANY INC.

(54) **Titre : CONTRE-BATTEUR EN ENTONNOIR**
(54) **Title: PROGRESSIVE CONCAVE**



(57) **Abrégé/Abstract:**
A concave which has axially extending members and circumferentially extending members. Each of these members has a flat interior surface presented toward the rotor. The flat surfaces of the axially extending members are in the same circular surface as the circumferentially extending members. This presents a smooth grid surface which faces the rotor. The axially extending members have a progressively larger spacing for the first portion of their section. Beginning with the greatest spacing toward the direction material enters the concave and an increasingly smaller spacing away from the opening until they reach a uniform spacing for the remainder of the concave unit.

ABSTRACT OF THE DISCLOSURE

A concave which has axially extending members and circumferentially extending members. Each of these members has a flat interior surface presented toward the rotor. The flat surfaces of the axially extending members are in the same circular surface as the circumferentially extending members. This presents a smooth grid surface which faces the rotor. The axially extending members have a progressively larger spacing for the first portion of their section. Beginning with the greatest spacing toward the direction material enters the concave and an increasingly smaller spacing away from the opening until they reach a uniform spacing for the remainder of the concave unit.

PROGRESSIVE CONCAVE

FIELD OF THE INVENTION

The present invention relates to grain harvesting machines and, more particularly, to the concave section of the harvesting machine where grain is separated from the stock.

BACKGROUND OF THE INVENTION

This invention relates to a combine in which one or more rotors or contacting concaves are mounted longitudinally of the axis of the combine. Combines of this type are relatively expensive and especially in order to justify a substantial investment in a combine, it is desirable that the same be capable of harvesting a relatively wide variety of crop products efficiently. Concaves employed in so-called universal type combines of the kind referred to comprise a series of bars which extend longitudinally in the threshing compartment of the combine and a series of longitudinally spaced curved rods extend transversely through said bars to provide openings through which threshed material passes and is received by a grain pan beneath the concave, said pan discharging onto a suitable sieve unit incident to completing the separation of the product material from chaff and other waste material.

Several downsides occur because of the present art forms of concaves. These faults are a slowing of the material especially in high moisture or other less than ideal conditions such as greater leaf material, higher crop yields and wear of the machine parts. These faults result in more grain damage, greater grain loss through

the waste material ejection system on the combine and greater fuel consumption. In addition down down is often incurred by the operator in attempts to unplug the harvesting machine when large material flows cause the separation system to plug up shutting down all harvesting processes until the situation can be remedied. Not only is economy adversely effected from a quantitative and qualitative point but fuel consumption is increased, possible damage from deteriorating weather conditions is increased as is the safety of the operator engaged in the unplugging of the machine.

Recently the advent of pharmaceutical harvesting of grains has increased the need for gentle harvesting techniques. Pharmaceutical harvesting refers to the growing or crops for removal of particular germs, cells or components for use in the pharmaceutical industry. However such harvested grain is held to higher standards of quality control than food or feed grains are held to, thus upping the requirement for less damage to the kernel during harvesting.

Manufacturers have sought to solve this issue since the first combine was manufactured and have used a variety of means to deal with the issue. One solution is to reverse the direction go the feeding mechanism, pulling the plugged material back from the direction it came in.

Another solution attempt is made by increasing the rotational speed of the rotor to force the material through the separation unit.

Twin rotors are yet another example in known art of a method to process large amounts of material through the separation system without increasing loss or damage to the grain.

Neihaus, U.S. Patent No. 4,499,908, developed an inwardly interior flat surfaced concave to eliminate the catching of crop materials.

Rowland-Hill, U.S. Patent No. 4,031,901 provides for rotatable sleeves that rotate over the arcuate rods of the concave in an attempt to facilitate the passage of threshed crop material through the openings in the concave to reduce crop damage. Other U.S. Patents by Rowland-Hill relating to combine harvesters include 3,742,686, 3,696,815 and 3,631,862.

Kuchar, U.S. Patent No. 4,909,772 provides for more bars in the concave to permit a reduced rotational speed of the cylinder thus reducing crop damage in the separation mechanism.

Peiler, U.S. Patent No. 4,330,000, received a patent for the ability to have adjusting linkage enabling the operator to change the distance relationship between the concave and the cylinder.

Williams, U.S. Patent No. 4,284,086 attempted to clean the cylinder concave area with air pressure to d=reduce clogging and build up of material.

Glaser, U.S. Patent No. 4,258,726 used vanes to direct the crop into various portions of the separation mechanism to reduce clogging and damage.

Johnston, U.S. Patent No. 4,222,395 used protruding fingers that were either mechanically adjusted or remotely adjusted to control the flow rate through the separation mechanism.

Ausherman, U.S. Patent No. 3,927,679 used an elevated sharpened raspbar fin to "cut' through the crop material forcing it though the separation mechanism.

Knap, U.S. Patent No. 3,568,682 describes a grate to be placed under the separation mechanism that crop material will pass over.

Gerhardt, U.S. Patent No. 3,552,396 uses a hydraulic cylinder to adjust the concave spacing relationship with the cylinder.

Johnson, U.S. Patent No. 2,457,680 used an inwardly zigzag configuration on his concave design to provide for a more efficient means of threshing grain.

Plugged material removal from a reversal of the direction of the mechanical components that created the plug don't always work and when they don't can damage parts of the machine increasing downtime and repair costs. They also do not then properly process the crop in a manner that provides with a quantitative or qualitative product.

In order to prevent foreign material from clogging the concave, some combine manufacturers have increased the rotational velocity of the cylinder in an attempt to force the foreign material through the apertures in the forward portion of the concave and to maintain these apertures open. However, increasing the rotational velocity of the cylinder increases the likelihood of damage to the harvested crop. This damage is caused by increased impact forces as the faster cylinder

contacts the separated grain and appears as cracking making the grain more susceptible to infestation and deterioration.

Increasing the rotational velocity of the cylinder also causes more of the crop residue, which is displaced along the concave, to be recirculated by the cylinder rather than being discharged from the aft, upper edge of the concave. Backfeeding of the crop residue, or its recirculation about the rotating cylinder, reduces the combine's capacity to separate the grain from the plant residue resulting in reduced recovered yields and greater likelihood of residue clogging of the concave. Finally, operating the cylinder at increased rotational velocities increases the combine's fuel consumption rate and is thus less fuel efficient. Forcing material through the separation unit of the machine only increased the damage done to the grain portion of the crop resulting in a lower or no value product such as for pharmaceutical harvesting where the grain must be held to a much higher quality than food quality grains are held.

Twin rotors increase the cost of manufacturing substantial as well as the cost of maintenance in parts and labor, now the operator has two separation systems to be concerned with and to clean and maintain.

Changing the distance relationship between the cylinder and the concave does not reduce damage. Decreasing the distance creates a plugging effect and increasing the distance results in unthrashed crop material passing through the separation mechanism.

Smooth surfaces further defeat the purpose by eliminating much of the frictional area that the concave proposes to provide as a means of removing the seed heads or grain from the stocks or leafy material.

It would be desirable to decrease damage caused to crops as the result of separation and thrashing.

It would also be desirable to reduce operator expense by reducing fuel consumption.

It would also be desirable to reduce operator maintenance and down time from machine damage by reducing plugged and damaged separation units.

It would also be desirable to reduce downtime from plugged separation units.

It would also be desirable to increase the price of the crop harvested through a reduction in damage.

It would also be desirable to provide for faster more economical harvesting.

It would also be desirable to reduce weather damaged crops by increasing the speed and reliability of the harvest.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention, there is provided a concave which has axially extending members and circumferentially extending members. Each of these members has a flat interior surface presented toward the rotor. The flat surfaces of the axially extending members are in the same

circular surface as the circumferentially extending members. This presents a smooth grid surface which faces the rotor. The axially extending members have a progressively larger spacing for the first portion of their section. Beginning with the greatest spacing toward the direction material enters the concave and an increasingly smaller spacing away from the opening until they reach a uniform spacing for the remainder of the concave unit. This results in better retainage of the vitamins, minerals and enzymes within the grain.

In accordance with another aspect of the invention, for use in a combine harvester with a rotating cylinder having a plurality of raspbars mounted in a spaced manner about the periphery of said cylinder for separating grain from the leafy portion of a plant, a concave comprising:

first and second end brackets each adapted for mounting to respective a respective inner wall of the combine and including a respective lower leading edge and a higher trailing edge, wherein each of said brackets forms a circular arc between the leading and trailing edges thereof;

a plurality of longitudinal crossbars coupled at respective ends thereof to said first and second end brackets and spaced apart from one another from the lower leading edge to the higher trailing edge of each of said end brackets, the longitudinal crossbars being progressively spaced apart such that spacing between said elongated crossbars decreases in a direction moving from the lower leading edge of each end bracket to the higher trailing edge thereof; and

arcuate rods that are longitudinally spaced apart from one another and coupled to the crossbars in positions lying transversely thereto between the end

brackets, and that are flush with upper edges of both the end brackets and the longitudinal crossbars.

In one embodiment, the spacing between the longitudinal cross-bars is approximately 1-5/16 inch at a leading area adjacent the lower leading edge.

In one embodiment, the spacing between the longitudinal cross-bars is approximately 1 inch at a trailing area adjacent the upper trailing edge.

In one embodiment, the spacing between the longitudinal cross-bars is approximately 1-1/8 inch at an intermediate area between the lower leading edge and the upper trailing edge.

BRIEF DESCRIPTION OF THE DRAWINGS

A complete understanding of the present invention may be obtained by reference to the accompanying drawings, when considered in conjunction with the subsequent, detailed description, in which:

Figure 1 is a partial cutaway view of an illustrating the manner in which the improved concave invention is intended for use in a combine;

Figure 2 is a prior art view of an is a perspective view of a prior art arrangement showing the general arrangement of a concave, a cylinder, a beater, and a conveyer arrangement such as employed in a typical prior art combine;

Figure 3 is a prior art view of a sectional view of a prior art arrangement of a concave, a cylinder, and a beater used for separating the grain-bearing portion of a plant from its leafy residue in a typical combine;

Figure 4 is a front perspective view of a concave in accordance with the principles of the present invention;

Figure 5 is a cross-sectional view of an is an enlarged, partial end view of the concave assembly illustrating the pinch point of a concave and a cylinder used for separating the grain-bearing portion of a plant from its leafy residue in a typical combine;

Figure 6 is a top perspective view of a concave of the present invention illustrating cut away detail; and

Figure 7 is a front & side view of a preferred embodiment of an improved progressive concave.

For purposes of clarity and brevity, like elements and components will bear the same designations and numbering throughout the Figures.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, there is shown a partially cutaway perspective view of a typical combine 10 which incorporates a prior art cylinder and concave 24 arrangement. The combine 10 is comprised primarily of an aft separation mechanism 12 / drive section and a forward header assembly 14 attached to a forward portion of the separation mechanism 12 / drive section. The combine 10 includes an operations platform 22 in which are positioned various operating controls for the combine 10.

The separation mechanism 12 / drive section effects separation of the grain from the crop residue and includes a plurality of wheels 20 as well as a means for propulsion (typically a diesel engine 28 which is not shown for simplicity) for propelling the combine 10 through a field in harvesting the crops. The separation mechanism 12 / drive section includes an aft exit end or discharge area 16 from which the crop residue, after the grain is separated therefrom, is exhausted from the combine 10 and deposited in the field being harvested.

The header assembly 14 mounted to a forward portion of the separation mechanism 12 / drive section is wider than the separation mechanism 12 / drive section and includes a plurality of head units extending along the length thereof. The header assembly 14 may also be provided with a plurality of spaced row crop heads along the length thereof for harvesting soybeans, wheat, milo, rice or various other grain and seed crops. The heads are adapted to separate and remove the seeds or grains from the plant stalk. The grain and the plant residue are then delivered to an aft portion of the header assembly 14 and are directed to the center thereof by means of a conveyance mechanism. From the center, aft portion of the header assembly 14, the grain and residue mixture is delivered to a feeder house 11 which transports the mixture via a conveyor to the combination of a rotating rotor 13 and a concave 24 screen. The rotor 13 includes a plurality of spaced raspbars 50 extending along the length and spaced around the periphery thereof. Rotation of the rotor 13 causes the raspbars 50 to engage the grain or seed heads and separate the grain from the leafy portion of the plant. A beater assembly, which is not shown in the figure, is typically

positioned immediately aft of the rotor 13 and concave 24 screen combination for further carrying out the separation process. The beater assembly deposits the reduced mixture upon an elongated chaffer sieves 15 which is comprised of a plurality of vibrating sieves. The separated grain is allowed to fall through the vibrating sieves of the chaffer sieves 15, while the unwanted plant residue is retained on an upper portion of the chaffer sieves 15 and displaced toward the rear of the combine 10. The thus separated grain which falls through the vibrating sieves of the chaffer sieves 15 is deposited upon a cleaning shoe 17 positioned below the chaffer sieves 15 and comprised of a grate structure for further separating the grain from any crop residue remaining in the mixture. As the grain and residue mixture falls upon the cleaning shoe 17, a blower 19 directs an air stream on the falling mixture to remove chaff therefrom. The chaff and other crop residue removed from the mixture in the earlier separation steps are discharged from the aft or exit end of the combine 10. The thus cleaned grain collects in a lower portion of the separator section of the combine 10 and is laterally displaced by means of a rotating clean grain auger to a center portion of the combine 10.

The clean grain auger is coupled to and continuous with a generally vertically oriented grain elevator. The grain elevator includes a housing within which is positioned a plurality of paddles attached to a moving endless chain. The grain elevator lifts individual portions of grain upward where the grain is then displaced by a loading auger into a storage bin or grain tank 18. One end of an off-loading grain

auger may be positioned within the storage grain tank 18 for removing the grain positioned therein from the combine 10.

Referring to FIG. 2, there is shown a perspective view illustrating greater details of a prior art arrangement of a feeder house 11, a concave 24, a rotating cylinder 52, a rotating beater 56, and an upper auger. The cylinder is positioned in closely spaced relation to the concave 24 which is disposed immediately below the cylinder and comprised of a pair of curved end brackets 54 (only one of which is shown in FIG. 2 for simplicity) and a plurality of spaced bars 30 extending along the length thereof connected by welding or other permanent secure means to arcuate rods 32. The concave 24 further includes a plurality of spaced, curved members disposed along its length which are also not shown in the view of FIG. 2. As previously described, the combination of the rotating cylinder 52 and the concave 24 effects separation of the grain from the leafy, or stock, portion of the plant. Disposed immediately forward of the cylinder is a conveyor-type feeder assembly which delivers the crop directly between the cylinder and the open-mouth concave 24 as the cylinder rotates in the direction of the arrow in FIG. 2. Disposed immediately aft of the cylinder is a rotating beater 56 assembly which displaces the crop material and un-separated grain from the cylinder/concave 24 combination for further separation processing. An upper auger disposed above and slightly forward of the cylinder returns un-threshed grain which reaches the back of the cleaning area to the cylinder area for another pass between the cylinder and the concave 24.

The cylinder shown in FIG. 2 is disclosed and claimed in Applicant's U.S. Pat. No. 4,796,645, issued Jan. 10, 1989. The present invention is not limited to use with this particular cylinder, but will operate with virtually any type of rotating cylinder 52 intended for use in a combine 10. The cylinder includes a plurality of hubs 60, or spiders, disposed in a spaced manner along the length thereof and coupled by means of an axle, or support shaft 58, inserted through a center of each of the hubs 60. Each of the hubs 60 includes a plurality of spaced, upraised peripheral portions upon which are mounted raspbars 50 which extend substantially the entire length of the cylinder. Each of the raspbars 50 is securely mounted to an upraised peripheral portion of each of the hubs 60 in a spaced manner by conventional means such as mounting bolts 64 or the combination of a mounting bracket and a bolt, which are not shown for simplicity.

Positioned immediately adjacent to and attached to each of the raspbars 50 along the length thereof is a respective spacer or filler plate 44. Each of the filler plates extends over a portion of the gap 62 or space between adjacent raspbars 50 and is disposed over substantially the entire length of the cylinder and has a curved cross section. The filler plates may be securely coupled to each of the hubs 60 by conventional means such as bolts 64.

Referring to FIG. 3, there is shown a sectional view of a portion of the prior art concave 24, rotating cylinder 52, and rotating beater 56 arrangement. As previously described, the rotating cylinder 52 includes a plurality of spaced raspbars 50 disposed about its periphery, although only four raspbars 50 through are shown in

the figure for simplicity. The rotating beater 56 similarly includes a plurality of spaced wings 68, or extensions, and disposed about its periphery and extending the length thereof. The cylinder as well as the beater each rotate in a clockwise direction as shown by the direction of the arrows in the figure. The harvested portion of the plant including the grain and leafy portion is directed onto the lower, leading edge of the concave 24 by the combination of the rotating cylinder 52 and the previously described feeder house 11 which is not shown in the figure. When engaged by the concave 24 as well as the raspbars 50 disposed about the rotating cylinder 52, the grain bearing portion of the plant, such as the corncob shown in the figure, is urged between the grate-like structure of the concave 24 in a downward direction. The leafy residue of the plant is displaced rearward and upward along the upper surface of the concave 24 by the rotating raspbars 50 of the cylinder. As the leafy residue arrives at the upper edge of the concave 24, it is positioned in the vicinity of the rotating beater 56 which then displaces the leafy residue rearwardly over a short flat finger grate 74. The finger grate is positioned adjacent to the upper, aft edge of the concave 24 for supporting the leafy residue and maintaining it in position for rearward displacement by the rotating beater 56. After exiting the concave 24, cylinder, and beater assembly, the leafy residue is then further processed for the removal of additional grain therefrom and discharge from the combine 10.

The concave 24 includes a pair of curved brackets on each end thereof. Each of the curved end brackets 54 is securely attached to a respective inner wall of the combine 10 by means of an upper mounting bolt 66 and a lower mounting bolt 70.

Extending between and mounted to each of the curved end brackets 54 are a plurality of linear, spaced crossbar. Each of the crossbars is further coupled to a plurality of spaced, curved intermediate bars 72 along the respective lengths thereof and to arcuate rods 32 welded into each of the cross bars 30 to secure the spacing. The combination of the crossbars and curved intermediate bars 72 forms a grate-like structure having a plurality of generally rectangular-shaped apertures therein.

As shown in the figure, the curved end brackets 54 and curved intermediate bars 72 are not formed in a true circular arc. Only portions of each of the curved end brackets 54 and intermediate barare formed in a circular arc. Thus, the concave 24 includes an upper generally linear portion, a lower generally linear portion, and an intermediate circular portion. Because only the intermediate portion of the concave 24 is formed in a circular arc about the rotating cylinder 52, the cylinder's raspbars 50 and are displaced in a closely spaced, generally parallel path only along this portion of the concave 24. The displacement between the cylinder's raspbars 50 and the upper end portion and lower end portion of the concave 24 is greater than the close spacing between the raspbars 50 and the intermediate portion of the concave 24. In addition, the cylinder's raspbars 50 travel in a path into, or toward, the concave 24 adjacent to the lower portion thereof. Because the spacing between the cylinder's raspbars 50 and the concave 24 is not fixed, but varies, along these portions of the concave 24, reduced separation of the grain and leafy residue of the plant occurs in these areas of the concave 24. In addition, the movement of the cylinder's raspbars 50 into, or toward, the concave 24 adjacent to the lower end

thereof causes compressive forces to be applied to the grain resulting in grain damage and clogging of the lower, leading edge of the concave 24 with foreign debris such as rocks and soil. Thus, the gaps between the three lowermost crossbars become clogged by foreign matter, preventing the passage of the separated grain-bearing portion of the plant therethrough. The uppermost crossbars are ineffective in the grain separation process because of their greater displacement from the rotating raspbars 50.

As shown in FIG. 3, a flat finger grate 74 is disposed adjacent to the upper end of the concave 24. The flat finger grate 74 includes a plurality of spaced, cell grate 76 extending rearward from the concave 24. The bars are disposed in a spaced manner along the length of the concave 24, with their proximal ends mounted to a filler plate 44 by conventional means such as weldments. A crossbar extends between each adjacent pair of bars to form the finger grate. Each end of the filler plate 44, which also extends along the length of the concave 24, is securely coupled to a respective mounting bracket. Each of the mounting brackets 78 is attached to an adjacent inner wall of the combine 10 by means of a respective mounting pin 80. As the leafy crop residue is displaced upward by the cylinder's rotating raspbars 50, the finger grate is intended to provide support for the crop residue as it is displaced rearward by the wings of the rotating beater 56. However, because the upper end of prior art concaves as well as the finger grate attached thereto are disposed directly beneath the rotating beater 56, the crop residue is displaced to a location directly below and slightly forward of the beater resulting in some of the residue being

displaced forward of the beater and continuing around the rotating cylinder 52. This is known as residue "backfeed" and results in the residue being recirculated around the rotating cylinder 52 so as to increase the likelihood of the residue clogging the concave 24 during its second pass, a reduction in the rate at which the harvested plants can be processed for grain separation within the concave 24-cylinder combination, and imposition of a greater load on the rotating cylinder 52. In an effort to compensate for this increased load, some prior art combines have increased the rotational velocity of the cylinder but this has led to increased impact damage to the grain.

Referring to FIG. 4. A perspective view of a concave 24 in accordance with the principles of the present invention. A side elevation view is shown in FIG 5 and partial front perspective view of the concave 24 is shown in FIG. 6. The concave 24 includes a pair of curved end brackets 54 and a plurality of linear, elongated crossbars extending therebetween. Coupled to and extending through the plurality of cross bars 30 are a plurality of arcuate rods 32 and a plurality of curved intermediate bars 72. The curved intermediate bars 72 are arranged in a spaced manner between the two curved end brackets 54 and along the crossbars. Each of the curved end brackets 54 and intermediate bars 84 is shaped in the form of a circular arc over the full length thereof. Thus, the concave 24 is disposed in closely spaced, parallel relation to the rotating raspbars 50 of the cylinder. The upper edges of each of the crossbars are similarly disposed in closely spaced relation and at the same distance from the displacement path of the rotating cylinder's raspbars 50. Also in accordance

with the present invention, the upper edges of each of the crossbars extends above the upper edges of the curved intermediate bars 72 as well as above the upper edges of each of the curved end brackets 54. The fixed separation distance between the upper edge of each of the crossbars and the rotating cylinder's raspbars 50 as they are rotationally displaced along the concave 24 can be seen in the sectional view of FIG. 5. This fixed, progressively, close spacing between the rotationally displaced raspbars 50 of the rotating cylinder 52 and the concave's crossbars extends over the entire width of the concave 24 from its leading to its trailing edge for separating the grain bearing portion of the plant from its leafy residue.

The circular arc cross section of the concave 24 and the close, fixed, progressive, spacing between the concave's crossbars and the rotationally displaced raspbars 50 allows the combine 10 to harvest at a faster rate and to reduce damage caused by friction and impact between the raspbars 50 and the crossbars.

While prior art concaves employ equally spaced crossbars, e.g., typically thirteen (13) crossbars spaced an equal distance apart. The progressively spaced concave 24 crossbars of the present invention provides improved threshing action and better grain separation. Entrance end -crossbar spacing in the present invention is on the order of 1 5/16" inch, progressing to 1 1/8" and then to 1" while a spacing of on the order of 1-1/4 inch is typically used in the prior art.

Upper and lower mounting bolts 64 securely attach respective ends of each of the curved end brackets 54 to an adjacent, inner wall of the combine 10 (not shown in the figures for simplicity). A lower plate extends between the two curved

end brackets 54 and along the length of the concave 24. The lower plate is positioned in contact with the first, or leading, crossbar. A trap is positioned adjacent to the forward edge of the concave 24 for removing foreign matter ingested by the combine 10 such as rocks, soil and trash. The close, fixed spacing between the rotationally displaced raspbars 50 and the forward portion of the concave 24 allows the raspbars 50 to force the grain bearing portion of the harvested crop through the spaces between adjacent crossbars and to maintain these spaces, or inter-crossbar gaps, unclogged.

Disposed adjacent to and in contact with the last, or uppermost, crossbar is a filler plate 44. The filler plate 44 extends the length of the concave 24 and is securely attached at respective ends thereof to the two curved end brackets 54 by conventional means such as weldments. The filler plate 44 extends upward from the last crossbar and is generally L-shaped. The filler plate 44 and the lower plate, as well as other components of the concave 24 and cylinder described herein are preferably comprised of high strength, corrosion resistant steel.

The orientation of the angled bars of the finger grate and their close proximity to the last crossbar facilitates upward and rearward displacement of the plant residue by the rotating raspbars 50. This is in contrast to the configuration and positioning of the prior art finger bars shown in FIG. 3, which do not guide the plant residue to a location below and aft of the rotating beater 56. In the prior art arrangement of FIG. 3, plant residue is displaced upward by the rotating raspbars 50 and into the rotating beater 56. Some of the plant residue is displaced by the rotating

raspbars 50 to a location forward of the rotating beater 56 which is then unable to rearwardly displace this plant residue, resulting in back feeding of the residue onto the rotating cylinder 52 and its displacement again between the cylinder and concave 24. The rearward and upward slope of the angled bars of the finger grate of the present invention allows these bars to guide the plant refuse to a location adjacent to a lower, aft portion of the rotating beater 56 which facilitates further aft displacement of the plant residue by the beater and away from the cylinder-concave 24 threshing combination.

There has thus been shown an improved cylinder and concave 24 arrangement for use in a combine 10 for separating the grain bearing and leafy portions of a plant. The progressively closer spacing of the cross bars 30 concave's crop engaging members relative to the rotationally displaced cylinder's raspbars 50 permits the full thrashing extent of the concave 24 to be used for grain separation, prevents impact damage of the grain by the moving raspbars 50, eliminates crop residue back feeding onto the cylinder, and allows the cylinder to rotate more slowly with increased grain recovery and improved fuel efficiency.

While particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects. Therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the scope of the invention. The matter set forth in the

foregoing description and accompanying drawings is offered by way of illustration only and not as a limitation

Referring to FIG.5, a preferred embodiment of the threshing or separation mechanism 12 illustrating the crop entrance 48 point, the crop pinch point 47 the crop exit 46 from a rear view. point. A corn cob 82 illustrates the means that various seeds and grains are positioned between the concave 24 and the rotating cylinder 52 as they travel through the combine's separation mechanism 12. Concaves can be adjustable at both the crop entrance 48 and crop exit 46 points as well as at the pinch point 47. Progressive spacing 88 of the bars 30 begins at the crop entrance 48 point and diminishes in spacing of the bars 30 as the direction of the crop exit 46 is obtained.

FIG. 6, each concave 24 includes opposite transversely extending side frame members or ribs 34, which terminate along one end. Two intermediate frame members 84 also extend transversely along the cicumferential span of the concave 24. A plurality of longitudinally extending frame members, configured as bars 30, extend between and are connected to the opposite side frame members and intersect the intermediate frame members 84. The concave 24 inserts also include a plurality of longitudinally spaced arcuate rods 32 that extend between the ends of the concave 24 insert through the plurality of bar members below a top edge thereof. The spaces or openings formed between the rods, bar members and frame members form apertures through which the grain passes as the crop materials are threshed between the concave 24 and the adjacent, cooperating rotor 13. In various suitable

embodiments, the openings have a range of widths from about 1 1/2 inch to about 1/4 inch and a length of from about 1 1/2 inch to about 3/4 inches, depending on the type of grain being threshed. The various concave 24 insert components, including the frames, rods, bearing plates and plates, are preferably made of a rigid durable material such as steel, although other materials would also work.

As best shown in FIG. 6, each concave 24 insert includes opposite transversely extending side frame members or ribs 34, which terminate along one end in a downwardly extending hook portion. Two intermediate frame members 84 also extend transversely along the cicumferential span of the concave 24 insert. A plurality of longitudinally extending frame members, configured as bar member, extend between and are connected to the opposite side frame members and intersect the intermediate frame members 84. The lowermost frame member, which defines an end of the concave 24 insert, includes at least a pair of openings formed in a lower portion thereof. The concave 24 inserts also include a plurality of longitudinally spaced arcuate rods 32 that extend between the ends of the concave 24 insert through the plurality of bar members below a top edge thereof. The spaces or openings formed between the arcuate rods 32, bar members and frame members form apertures through which the grain passes as the crop materials are threshed between the concave 24 insert and the adjacent, cooperating rotor 13. In various suitable embodiments, the openings have a range of widths from about 1/4 inch to about 1 1/2 inch and a length of from about 3/4 inch to about 1 1/2 inches, depending on the type of grain being threshed. The various concave 24 insert components,

including the frames, arcuate rods 32, bearing plates and plates, are preferably made of steel, although other materials would also work.

Referring to FIG. 7. A front inside and side view of a most preferred embodiment of a concave 24 in accordance with the principles of the present invention. The concave 24 includes a pair of curved end brackets 54 and a plurality of linear, elongated crossbars or bars 30 extending therebetween. Coupled to and extending through the plurality of cross bars 30 are a plurality of flush mounted arcuate rods 90. Each of the curved end brackets 54 and is shaped in the form of a circular arc over the full length thereof. Thus, the concave 24 is disposed in closely spaced, parallel relation to the rotating raspbars 50 of the cylinder. The upper edges of each of the crossbars are similarly disposed in closely spaced relation and at the same distance from the displacement path of the rotating cylinder's raspbars 50. Also in accordance with the present invention, the upper edges of each of the crossbars is flush with the upper edges of each of the curved end brackets 54 as are the arcuate rods 32. The fixed separation distance between the upper edge of each of the crossbars and the rotating cylinder's raspbars 50 as they are rotationally displaced along the concave 24 can be seen in the sectional view of FIG. 5. This fixed, progressively, close spacing between the rotationally displaced raspbars 50 of the rotating cylinder 52 and the concave's crossbars extends over the entire width of the concave 24 from its leading to its trailing edge for separating the grain bearing portion of the plant from its leafy residue.

The circular arc cross section of the concave 24 and the close, fixed, progressive, spacing between the concave's crossbars and the rotationally displaced raspbars 50 allows the combine 10 to harvest at a faster rate and to reduce damage caused by friction and impact between the raspbars 50 and the crossbars. This occurs in part, from the ability of the concave 24 to provide various spacings to better fit the separation characteristics presented by the toughness or ease of seed and grain separation characteristics offered by the crop.

While prior art concaves employ equally spaced crossbars, e.g., typically thirteen (13) crossbars spaced an equal distance apart. The progressively spaced concave 24 crossbars of the present invention provides improved threshing action and better grain separation. Entrance end -crossbar spacing in the present invention is on the order of 1 5/16" inch, progressing to 1 1/8" and then to 1" while a spacing of on the order of 1-1/4 inch is typically used in the prior art.

Upper concave hanger 92 brackets and lower mounting bolts 64 securely attach respective ends of each of the curved end brackets 54 to an adjacent, inner wall of the combine 10 (not shown in the figures for simplicity). A lower plate extends between the two curved end brackets 54 and along the length of the concave 24. The lower plate is positioned in contact with the first, or leading, crossbar.

The orientation of the angled bars of the finger grate and their close proximity to the last crossbar facilitates upward and rearward displacement of the plant residue by the rotating raspbars 50. This is in contrast to the configuration and positioning of the prior art finger bars shown in FIG. 3, which do not guide the plant

residue to a location below and aft of the rotating beater 56. In the prior art arrangement of FIG. 3, plant residue is displaced upward by the rotating raspbars 50 and into the rotating beater 56. Some of the plant residue is displaced by the rotating raspbars 50 to a location forward of the rotating beater 56 which is then unable to rearwardly displace this plant residue, resulting in back feeding of the residue onto the rotating cylinder 52 and its displacement again between the cylinder and concave 24 . The rearward and upward slope of the angled bars of the finger grate of the present invention allows these bars to guide the plant refuse to a location adjacent to a lower, aft portion of the rotating beater 56 which facilitates further aft displacement of the plant residue by the beater and away from the cylinder-concave 24 threshing combination.

There has thus been shown an improved concave 24 arrangement for use in a combine 10 for separating the grain bearing and leafy portions of a plant. The progressively closer spacing of the cross bars 30 concave's crop engaging members relative to the rotationally displaced cylinder's raspbars 50 permits the full thrashing extent of the concave 24 to be used for grain separation, prevents impact damage of the grain by the moving raspbars 50, eliminates crop residue back feeding onto the cylinder, and allows the cylinder to rotate more slowly with increased grain recovery and improved fuel efficiency.

While particular preferred embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader

aspects. Therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only and not as a limitation.

Since other modifications and changes varied to fit particular operating requirements and environments will be apparent to those skilled in the art, the invention is not considered limited to the example chosen for purposes of disclosure, and covers all changes and modifications which do not constitute departures from the scope of this invention.

Having thus described the invention, what is desired to be protected by Letters Patent is presented in the subsequently appended claims.

CLAIMS

1. For use in a combine harvester with a rotating cylinder having a plurality of raspbars mounted in a spaced manner about the periphery of said cylinder for separating grain from the leafy portion of a plant, a concave comprising:

first and second end brackets each adapted for mounting to respective a respective inner wall of the combine and including a respective lower leading edge and a higher trailing edge, wherein each of said brackets forms a circular arc between the leading and trailing edges thereof;

a plurality of longitudinal crossbars coupled at respective ends thereof to said first and second end brackets and spaced apart from one another from the lower leading edge to the higher trailing edge of each of said end brackets, the longitudinal crossbars being progressively spaced apart such that spacing between said elongated crossbars decreases in a direction moving from the lower leading edge of each end bracket to the higher trailing edge thereof; and

arcuate rods longitudinally spaced apart from one another and coupled to the crossbars in positions lying transversely thereto between the end brackets, the arcuate rods being flush with upper edges of both the end brackets and the crossbars.

2. The concave of claim 1 wherein the spacing between the longitudinal cross-bars is approximately 1-5/16 inch at a leading area adjacent the lower leading edge.

3. The concave of any one of claim 1 or 2 wherein the spacing between the longitudinal cross-bars is approximately 1 inch at a trailing area adjacent the upper trailing edge.

4. The concave of any one of claims 1 to 3 wherein the spacing between the longitudinal cross-bars is approximately 1-1/8 inch at an intermediate area between the lower leading edge and the upper trailing edge.

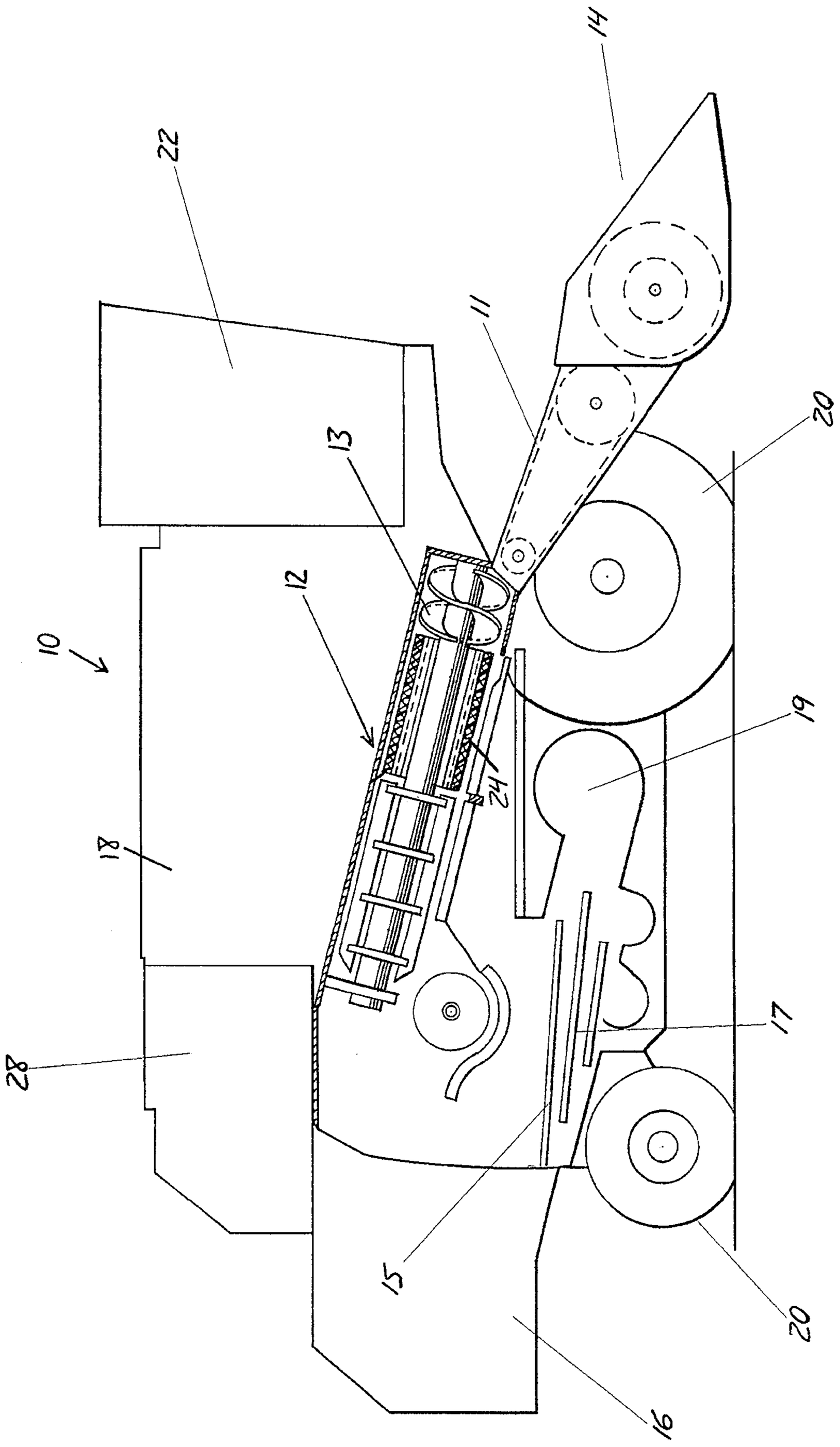
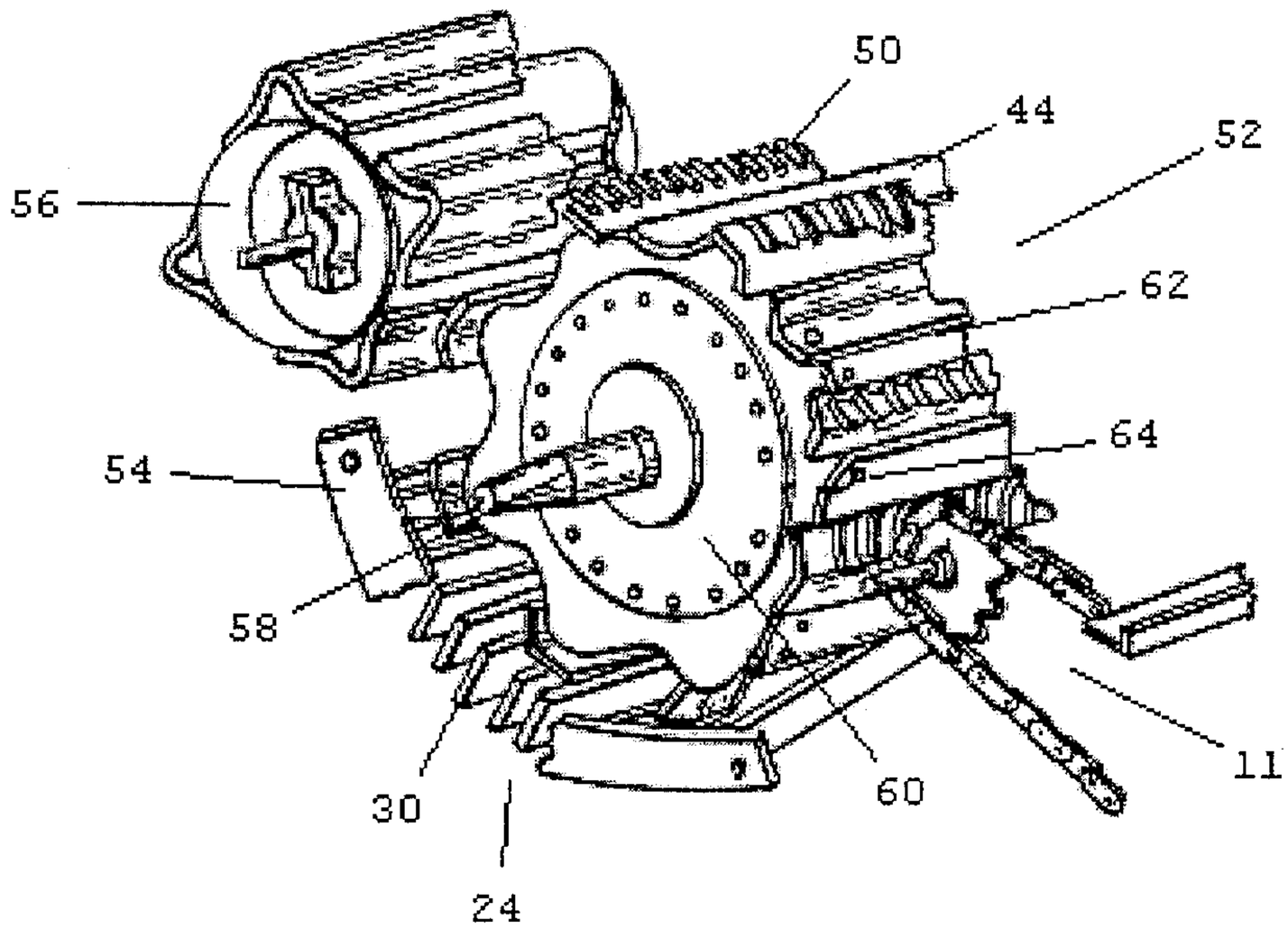


FIGURE 1

FIG. 2 (PRIOR ART)



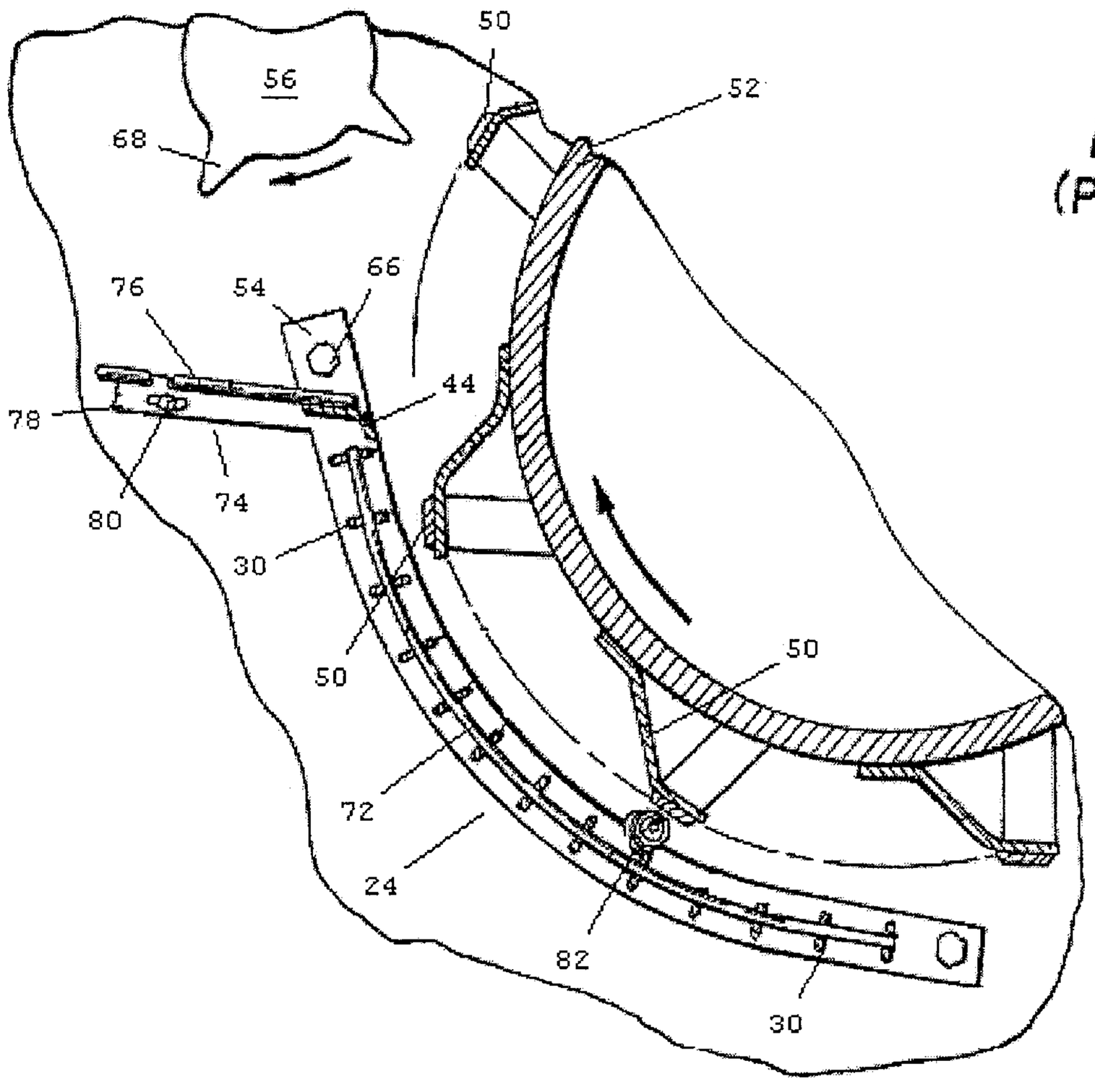


FIG. 3
(PRIOR ART)

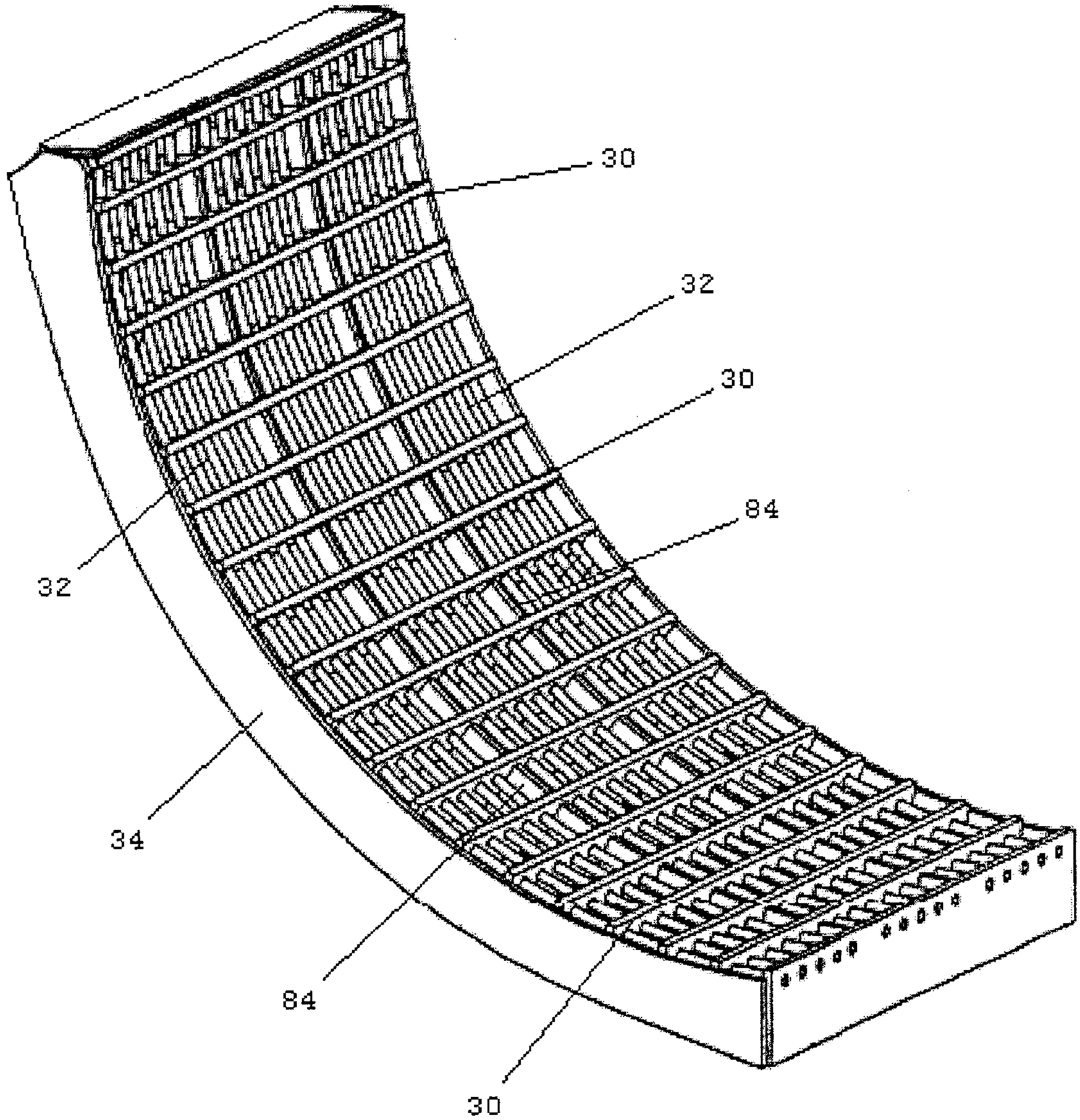


FIGURE 4

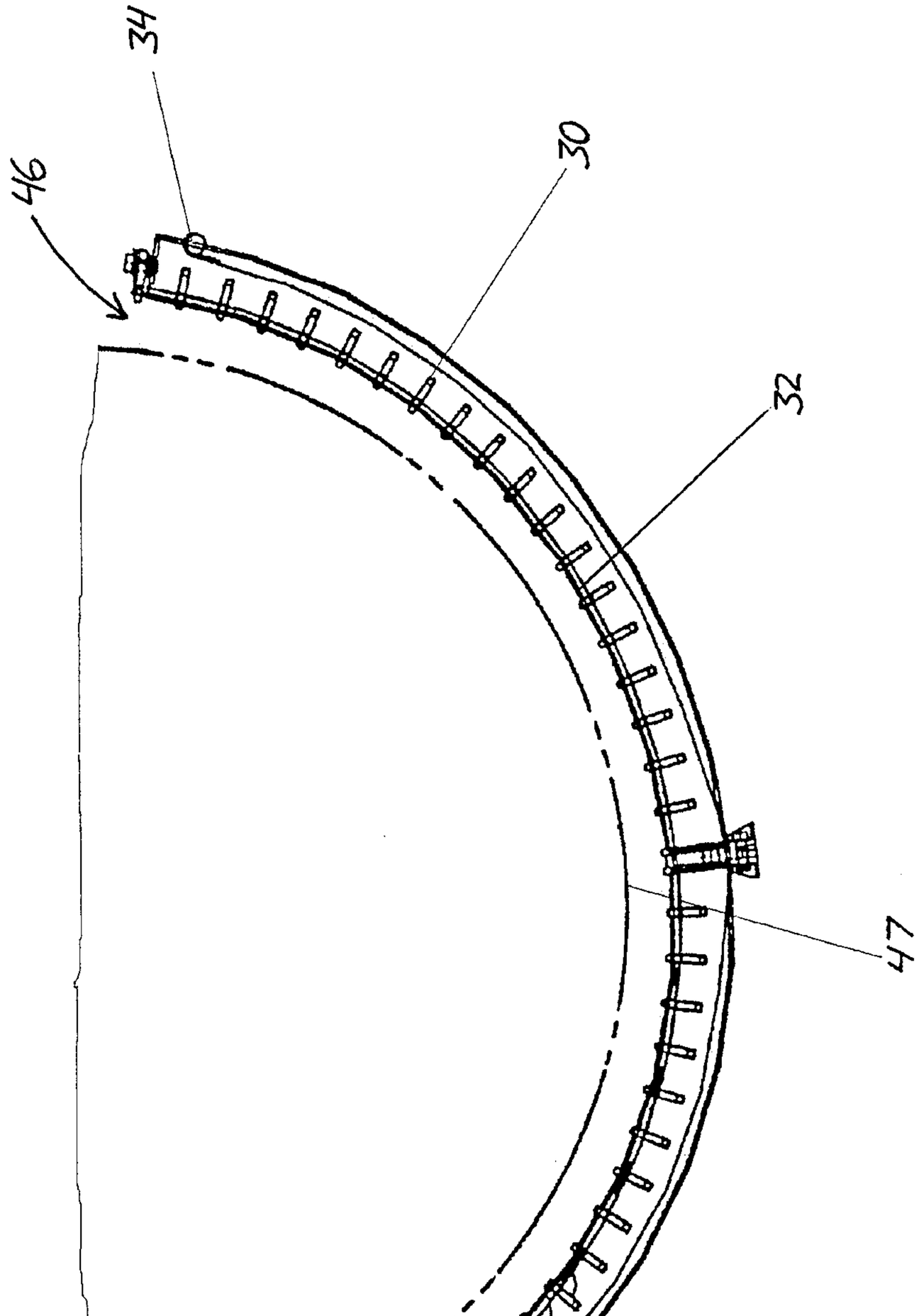


FIGURE 5

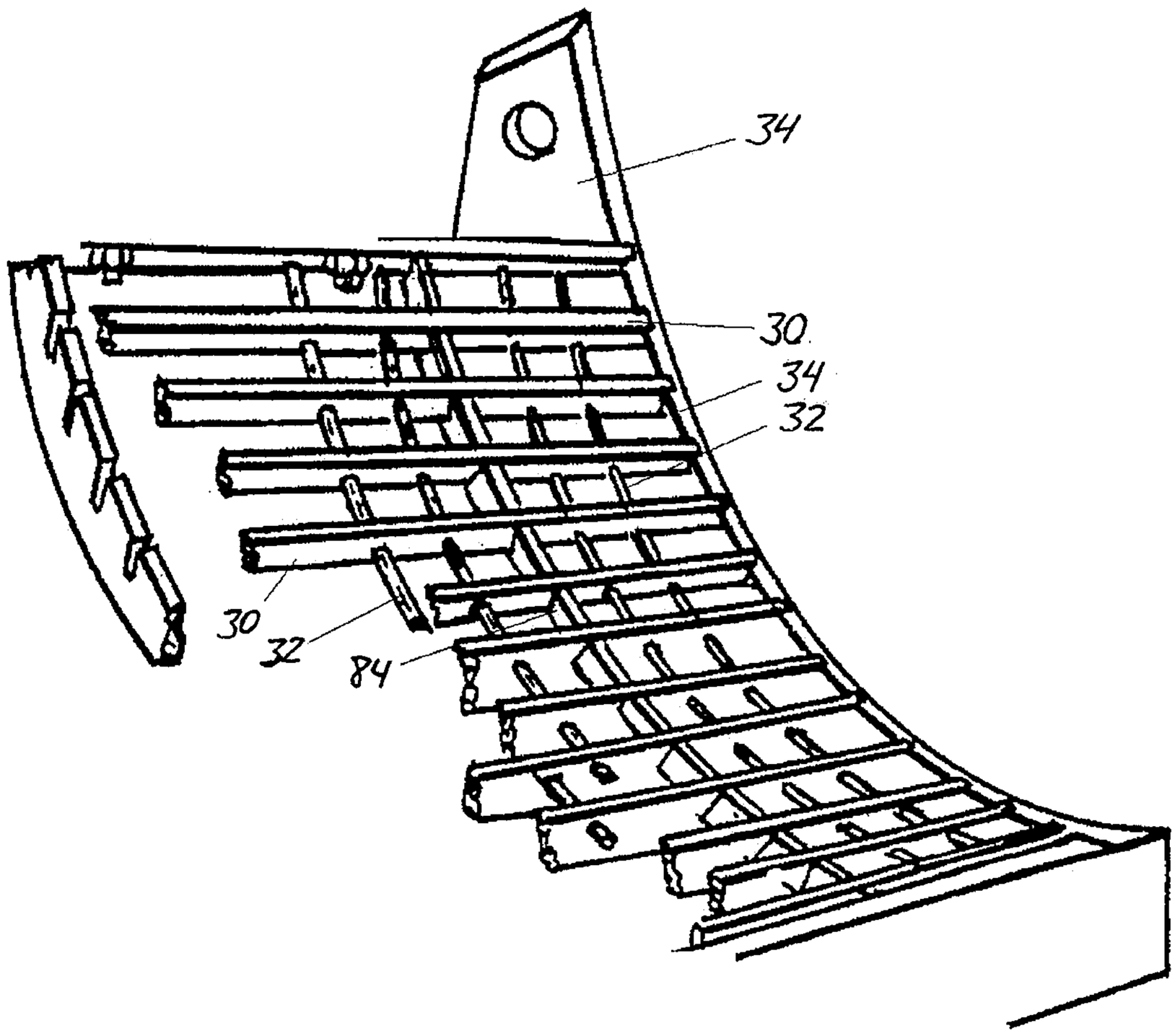


FIGURE 6

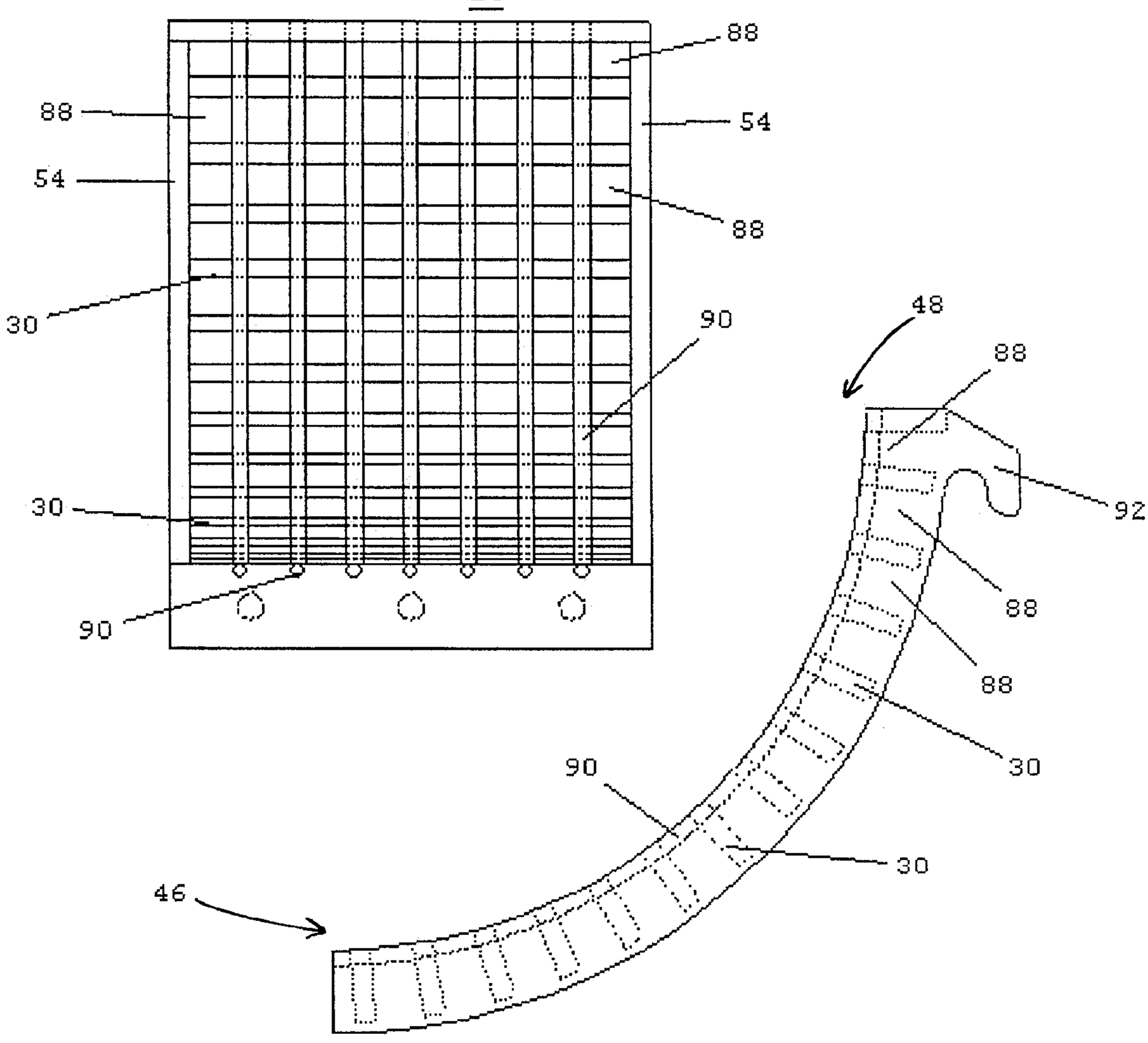
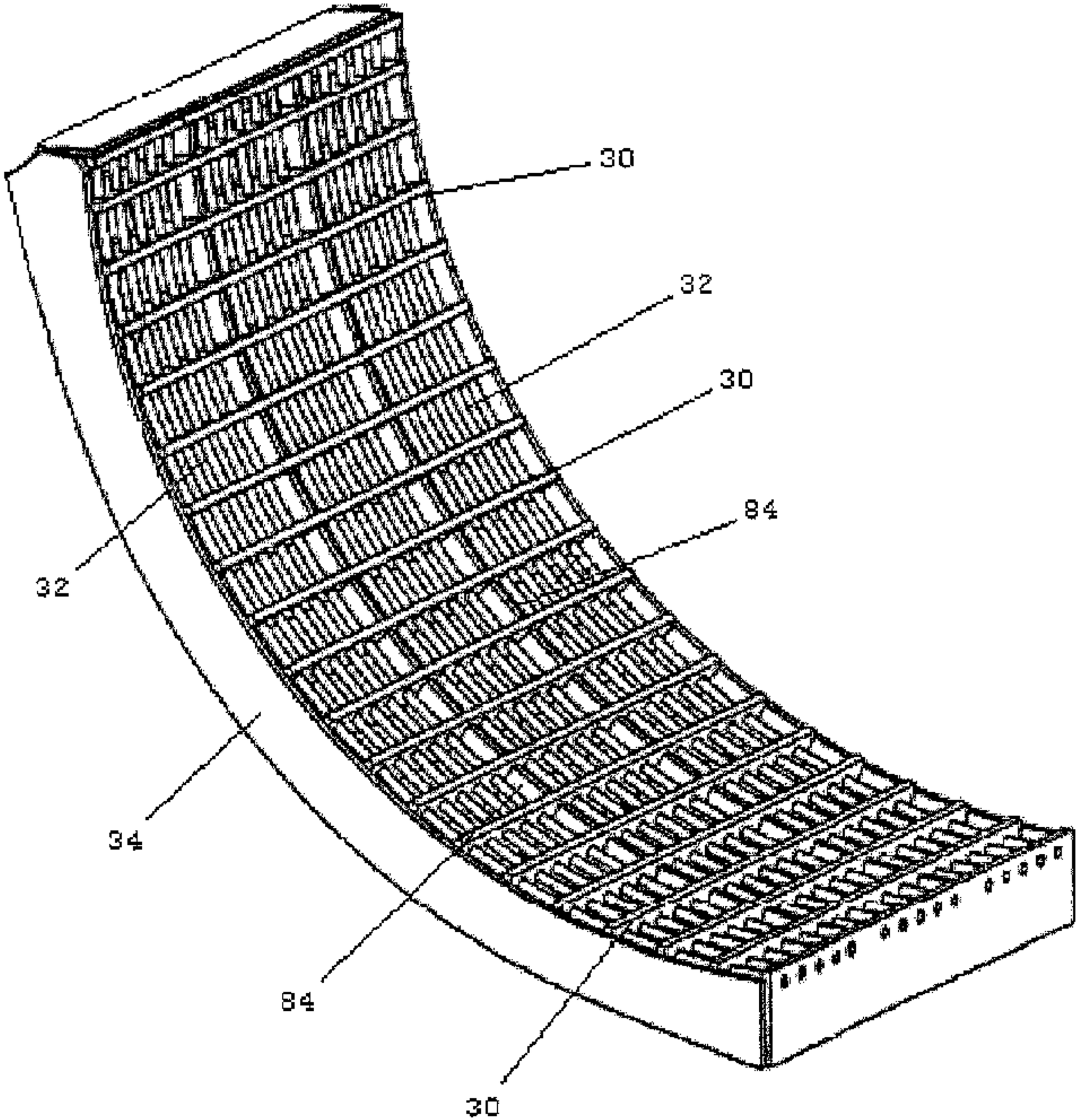


FIGURE 7


30
32
30
84
32
34
84
30