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(71) Demandeur/Applicant:
PIONEER HI-BRED INTERNATIONAL, INC., US

(72) Inventeurs/Inventors:
JOHNSON, DAVID, US;
RIZZO, MATTHEW JOHN, US;
SCHMIDT, JAMES REUBEN, US;
STOTT, BARRY, US;
UNRAU, ZANE WESLEY, US

(74) Agent: TORYS LLP

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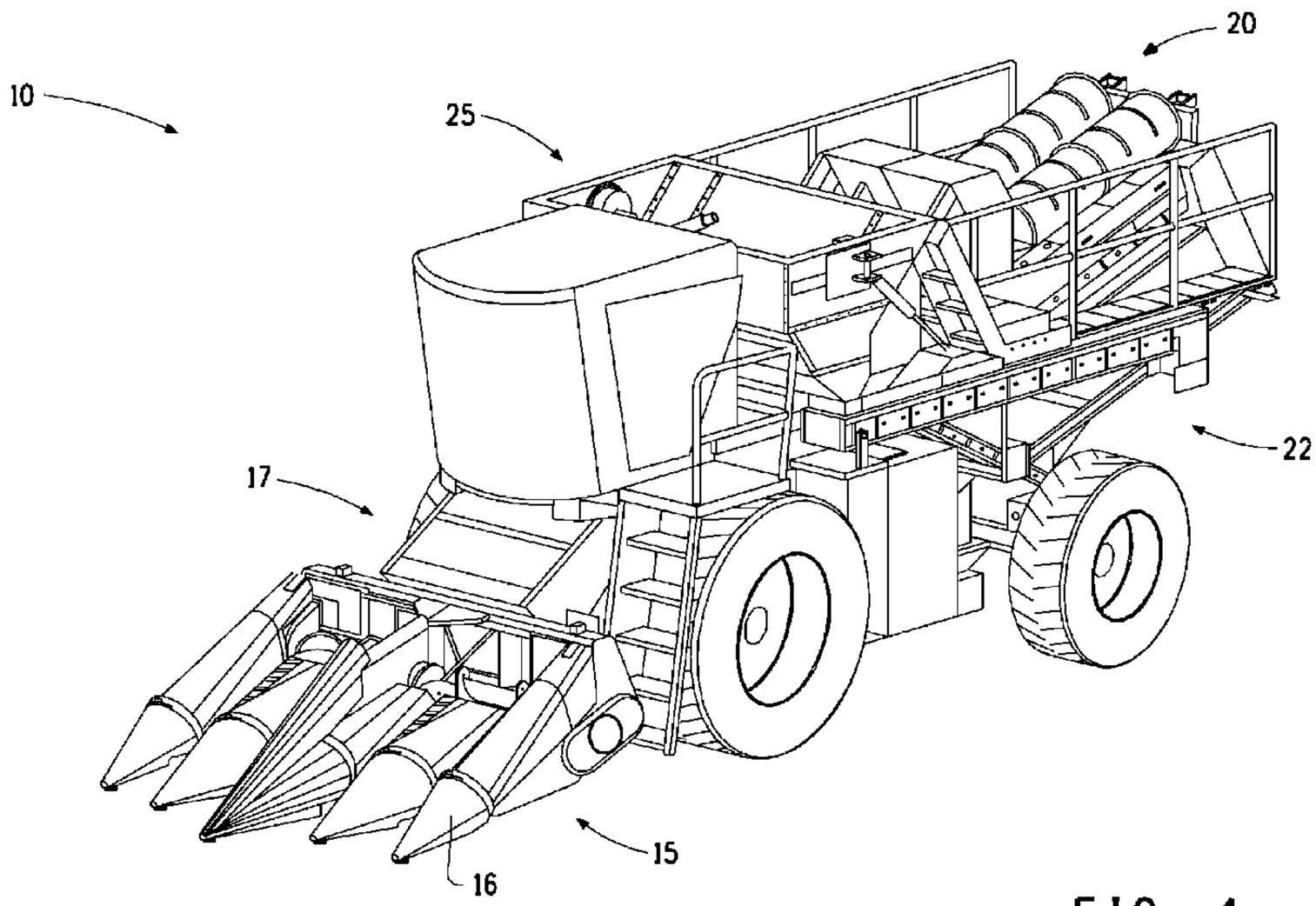

FIG. 1

(57) Abrégé/Abstract:
A combine harvester (10) is provided that separates grain material from material other than grain using multiple processing areas, including a harvesting area (15), a feederhouse area (17), a threshing area (20), a cleaning area (22), and a grain delivery area (25). In a location at or prior to entering one of the processing areas (15, 17, 20, 22, 25), the material may be collected and held until a collection threshold is reached. Once it is determined that the collection threshold is reached, the material forming a first group of material may be transported from the location to the processing area or a subsequent processing area. The first group of material is transported from the location to the processing area or the subsequent processing area substantially simultaneously and thus simulates the gathering of a large amount of crop material even when small plots are involved. In this way, reduced cycle times may be achieved, and the efficiency benefits of large-plot harvesting may be extended to small-plot applications.

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(71) **Applicant**: **PIONEER HI-BRED INTERNATIONAL, INC.** [US/US]; 7100 N.W. 62nd Avenue, Johnston, Iowa 50131-1014 (US).

(72) **Inventors**: **JOHNSON, David**; c/o Pioneer Hi-Bred International, Inc., 7250 N.W. 62nd Avenue, Johnston, Iowa 50131-0552 (US). **RIZZO, Matthew John**; c/o Pioneer Hi-Bred International, Inc., 7250 N.W. 62nd Avenue, Johnston, Iowa 50131-0552 (US). **SCHMIDT, James Reuben**; c/o Pioneer Hi-Bred International, Inc., 7250 N.W. 62nd Avenue, Johnston, Iowa 50131-0552 (US). **STOTT, Barry**; c/o Pioneer Hi-Bred International, Inc., 7250 N.W. 62nd Avenue, Johnston, Iowa 50131-0552 (US). **UNRAU, Zane Wesley**; c/o Pioneer Hi-Bred International, Inc., 7250 N.W. 62nd Avenue, Johnston, Iowa 50131-0552 (US).

(74) **Agent**: **VANDER VELDEN, Melinda S.**; Pioneer Hi-Bred International, Inc., 7250 N.W. 62nd Avenue, Johnston, Iowa 50131-0552 (US).

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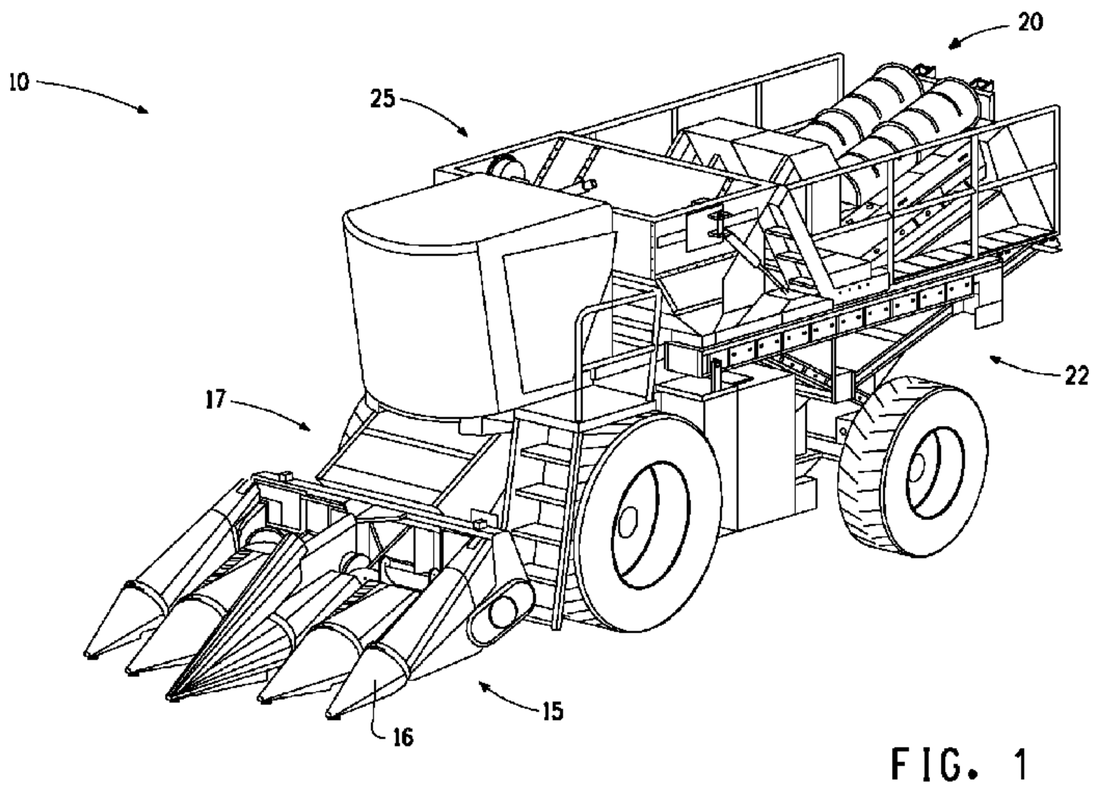

FIG. 1

(57) Abstract: A combine harvester (10) is provided that separates grain material from material other than grain using multiple processing areas, including a harvesting area (15), a feederhouse area (17), a threshing area (20), a cleaning area (22), and a grain delivery area (25). In a location at or prior to entering one of the processing areas (15, 17, 20, 22, 25), the material may be collected and held until a collection threshold is reached. Once it is determined that the collection threshold is reached, the material forming a first group of material may be transported from the location to the processing area or a subsequent processing area. The first group of material is transported from the location to the processing area or the subsequent processing area substantially simultaneously and thus simulates the gathering of a large amount of crop material even when small plots are involved. In this way, reduced cycle times may be achieved, and the efficiency benefits of large-plot harvesting may be extended to small-plot applications.

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COMBINE HARVESTER AND ASSOCIATED METHOD FOR GATHERING GRAIN

FIELD OF THE INVENTION

[0001] The present invention relates generally to combine harvesters and methods for gathering grain. More specifically, the present invention provides a combine harvester configured for gathering grain from multiple small-area research plots using one or more staging operations in the collection process, thereby increasing the efficiency of the collection process and reducing any idle periods as the combine harvester is moved between plots.

BACKGROUND

[0002] A combine harvester (also known simply as a "combine") is a well-known machine used in agricultural applications. In general, combines are designed to travel through crop fields to harvest crop materials. Although combines may have various configurations, most are designed to separate grain from material-other-than-grain ("MOG"). Harvested grain is typically stored on the combine, and MOG is ejected back onto the crop field.

[0003] In general, a typical combine is designed to move through large crop fields, and the operations performed by the combine (e.g., cutting, threshing, and cleaning the grain) are most efficient when large amounts of grain are being processed. The combine is operated, for the most part, continuously, and the speed of the movement of the grain through the combine is generally fixed. In some cases, for example, the ground speed of the combine may be adjusted to control the volume of material through the combine. A commercial combine is typically designed to be continuously operated in a fully-loaded condition to optimize performance. Combine performance may include material throughput, harvesting efficiency, and harvested grain quality.

[0004] Combines, however, are not only used to harvest crops in a commercial setting, but are also used in research settings involving smaller plots of crops. In a research setting, the same type of combine (e.g., a commercial combine) may be used under intermittently-loaded conditions.

[0005] As a result, there is a need in the art for a combine harvester and method configured for gathering crop material efficiently from small research plots rather than

continuously from large commercial fields. In addition, there is a need for a combine harvester and method that allows crop material to be gathered from multiple plots while keeping the grain gathered from each plot substantially separate and while minimizing the wait time between plots.

BRIEF SUMMARY OF VARIOUS EMBODIMENTS

[0006] The present invention addresses the above needs and achieves other advantages by providing a combine harvester and method for harvesting grain using multiple processing areas. In general, the combine harvester is moved through harvest material comprising grain material and material other than grain ("MOG"). The grain material is separated from the MOG by transporting the harvest material through the combine harvester using the multiple processing areas. In a location at or prior to entering one of the processing areas, the material is collected and held until a collection threshold is reached. After the collection threshold is reached, the material (which now forms a first group of material) is transported from the location to the processing area or a subsequent processing area. Transportation of the first group of material from the location to the processing area or the subsequent processing area substantially simultaneously thus simulates the gathering of a large amount of crop material even when small plots are involved, thereby providing the benefits of large-plot harvesting to small-plot applications, as described in greater detail below.

[0007] Accordingly, in one embodiment, a method for harvesting grain is provided that uses a combine harvester having a plurality of processing areas. The combine harvester is initially moved through harvest material comprising grain material and material other than grain. The grain material is separated from the material other than grain by transporting the harvest material through the combine harvester using the plurality of processing areas. In a location at or prior to entering one of the processing areas, material is collected in the location, a determination is made regarding whether a collection threshold is reached, and a first group of material is transported from the location to the processing area or a subsequent processing area after the collection threshold is reached. The first group of material may then be transported from the location to the processing area or the subsequent processing area substantially simultaneously. In some cases, at least one of the plurality of processing areas may be controlled independently of the other processing areas.

[0008] The plurality of processing areas may include at least a harvesting area, a feederhouse area, and a threshing area, and harvest material may be collected at the feederhouse area. Thus, the first group of material may comprise a first group of harvest material, and transporting the first group of material from the location to the processing area or a subsequent processing area after the collection threshold is reached may comprise transporting the first group of harvest material to the threshing area. In this regard, the feederhouse area may comprise a conveyance device, and collecting the harvest material at the feederhouse area may comprise moving the harvest material away from the harvesting area using the conveyance device.

[0009] In some cases, a speed of the combine harvester is greater than or equal to a speed at which the conveyance device moves the harvest material away from the harvesting area when collecting the harvest material. The conveyance device may, for example, be configured to move the harvest material away from the harvesting area when collecting the harvest material at a first speed, and the feederhouse area may be configured to transport the first group of harvest material to the threshing area at a second speed. The first speed may be less than the second speed. In addition, the conveyance device may comprise a lower member and an upper member, and at least one of the lower member and the upper member may comprise a conveyor. Both the lower member and the upper member may be configured to contact the harvest material in some cases.

[0010] In some embodiments, additional harvest material is removed using the harvesting area. The additional harvest material may be transported to the feederhouse area after transporting the first group of harvest material using the feederhouse area to the threshing area, and the additional harvest material may be collected at the feederhouse area to form an additional group of harvest material.

[0011] The determination of whether a collection threshold is reached may be made in a variety of ways. For example, the determination may include determining whether the combine has reached an end of a plot and/or whether a time period beginning at the start of collecting the harvest material is greater than or equal to a threshold time period. Determining whether a collection threshold is reached may comprise determining whether a mass of the first group of material is greater than or equal to a threshold mass. In other cases, determining whether a collection threshold is reached may comprise determining whether a volume of the

first group of material is greater than or equal to a threshold volume.

[0012] In some embodiments, the plurality of processing areas may include at least one of a threshing area, a grain conveying area, a cleaning area, a grain material delivery area, and a grain testing area, and collecting material in the location, may comprise collecting grain material in a location at or prior to entering one or more of the threshing area, the grain conveying area, the cleaning area, the grain material delivery area, and the grain testing area. Collecting material in the location may comprise collecting material prior to entering the threshing area, and transporting a first group of material from the location to the processing area or a subsequent processing area after the collection threshold is reached may comprise transporting a first group of material from the location to the threshing area after the collection threshold is reached.

[0013] In still other cases, collecting material in the location may comprise collecting grain material at the grain conveying area, and transporting a first group of material from the location to the processing area or a subsequent processing area after the collection threshold is reached may comprise transporting a first group of grain material from the grain conveying area to the cleaning area after the collection threshold is reached. Furthermore, material may be collected at the cleaning area, and a first group of grain material may be transported from the cleaning area to the grain material delivery area after the collection threshold is reached.

[0014] In some embodiments, grain material may be collected prior to entering the grain material delivery area, and a first group of grain material may be transported from the location to the grain material delivery area after the collection threshold is reached. Similarly, grain material may be collected at the grain material delivery area, and a first group of grain material may be transported from the grain material delivery area to the grain testing area after the collection threshold is reached. Furthermore, grain material may be collected prior to entering the grain testing area, and transporting a first group of material from the location to the processing area or a subsequent processing area after the collection threshold is reached may comprise transporting a first group of grain material from the location to the grain testing area after the collection threshold is reached.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

[0016] FIG. 1 shows a perspective view of various portions of a combine harvester configured to execute a method of harvesting grain using a plurality of processing areas in accordance with an exemplary embodiment of the present invention;

[0017] FIG. 2 shows a side view of the portions of the combine harvester of Fig. 1 in accordance with an exemplary embodiment of the present invention;

[0018] FIG. 3 illustrates a header configured in accordance with an exemplary embodiment of the present invention;

[0019] FIG. 4 shows a side view of a feederhouse area in accordance with an exemplary embodiment of the present invention;

[0020] FIG. 5 shows a perspective view of the feederhouse area of Fig. 4;

[0021] FIG. 6 shows a perspective view of a combined feederhouse area and thresher area in accordance with an exemplary embodiment of the present invention;

[0022] FIG. 7 shows a side view of a thresher area and conveyor in accordance with an exemplary embodiment of the present invention;

[0023] FIG. 8 shows a perspective view of a rotor of the thresher area illustrated in Fig. 7 in accordance with an exemplary embodiment of the present invention;

[0024] FIG. 9 shows a side view of a cleaning area in accordance with an exemplary embodiment of the present invention;

[0025] FIG. 10 shows a top view of a sieve assembly of the cleaning area of Fig. 9 in accordance with an exemplary embodiment of the present invention; and

[0026] FIG. 11 shows a perspective view of the sieve assembly of Fig. 10.

DETAILED DESCRIPTION

[0027] Some embodiments of the present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all, embodiments of the invention are shown. Indeed, various embodiments of the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure

will satisfy applicable legal requirements. Like reference numerals refer to like elements throughout. Some components of the combine harvester are not shown in one or more of the figures for clarity and to facilitate explanation of embodiments of the present invention.

[0028] As used herein, the terms "material," "crop," "plants," "crop material," and similar terms may be used interchangeably to refer generally to the plants being harvested and processed through the combine harvester, including grain and MOG. Thus, use of any such terms should not be taken to limit the spirit and scope of embodiments of the present invention. The crop material may include various types of grains such as, for example, corn, soybeans, canola, wheat, oat, rye, alfalfa, barley, rice, and sunflowers, among other crops, and/or the MOG associated therewith.

[0029] With reference to Figs. 1 and 2, in general, a typical combine **10** includes a crop harvesting area **15**, a feederhouse area **17**, a threshing area **20**, a cleaning area **22**, and a grain delivery area **25**. The crop harvesting area **15** may include a header **16** for gathering the grain from the planted crop. Although some headers **16** may be used for multiple different crops, a typical header is designed for use with a specific type of crop. As such, the header **16** may be removable from the combine so that other headers configured for use with other crops or crop row spacings may be attached in its place. In Fig. 1, for example, the depicted header **16** is configured for gathering corn.

[0030] Once the header **16** has gathered the grain at the harvesting area **15**, the crop material may proceed to the feederhouse area **17**, which may convey the crop material from the harvesting area **15** to the threshing area **20** via the conveyor **40**. In other words, the crop material cut by the header **16** at the harvesting area **15** (which at this point includes both grain and MOG) may be fed rearwardly toward the threshing area **20** via the feederhouse area **17** and the conveyor **40**, which may be a belt, auger, or other mechanism for moving material between locations.

[0031] Although the threshing area **20** may have different components and configurations, Figs. 1 and 2 show two threshing rotors **30** that are mounted axially within the combine **10**. The threshing rotors **30** may be substantially surrounded by rotor concaves **35** that have an arrangement of relatively small openings. Thus, as the crop material travels rearwardly through the threshing area **20**, the threshing rotor threshes the crop material against the inside surface of the rotor concaves **35**, separating the grain from the MOG.

[0032] The MOG typically continues to move through the rotor concaves **35** due to the rotation of the rotor **30** and is ultimately released out of the tail end of the rotor and is disposed onto the crop field, in some cases aided by a supplemental spreading device (not shown). The smaller crop material, composed substantially of grain, falls through the openings of the rotor concaves **35**. The threshing area **20** leads to the cleaning area **22**, where the grain is placed onto a series of sieves **45** that move back and forth. The sieves **45** may include an arrangement of smaller openings that further separate the heavier grain from any other non-grain crop material.

[0033] In some embodiments, a fan **41** may be included that is configured to blow air across the grain so as to separate lighter non-grain crop material from the grain before the grain is collected in an auger tube **53** or, in some embodiments, a grain pan **52**. In some embodiments, the lighter non-grain material may be mixed with the larger non-grain crop material and may be disposed onto the crop field. Once the grain falls through the moving sieves **45**, it reaches a grain handling system positioned below the moving sieves **45**.

[0034] In a typical harvesting application, the combine is configured to send all of the harvested grain directly to a grain tank **60**. In some instances, however, at least a portion of the harvested grain is tested and/or sampled for various characteristics at a testing area **50**. The testing area may include one or more testing stations configured to gather grain test data. The testing area may include, for example, a moisture test station, a bulk density station, and a plot weight station.

[0035] Alternatively or additionally, after the grain has been cleaned, it is conveyed from the auger tube **53** to a grain tank **60** as part of the delivery area **25**. Thus, in some embodiments, a clean grain auger **55** (shown in Fig. 9) may be disposed within the auger tube **53**. The clean grain auger **55** may be configured to move the grain collected in the tube **53** transversely to one side of the combine **10**, where it may travel to a grain tank **60** via a transport system **65**, such as a clean grain elevator. In other embodiments, the transportation system 65 may be a conveyor, auger, or pneumatic transport system.

[0036] In conventional combines, various parts of the combine such as the moving sieves, the clean grain auger, and the grain transport system are mechanically actuated via a belt and pulley system, a hydraulic system, an electrical system, or other known means, driven by the combine engine so as to associate the speed of the sieves, auger, and grain elevator (for

example) with the speed of the combine engine. In other words, in conventional systems, the ground speed of the combine may be adjusted to control the volume of material moving through the combine from the header **16** to the grain tank **60**. A commercial combine is designed to be continuously operated in a fully loaded condition to optimize performance (e.g., material throughput, harvesting efficiency, and harvested grain quality).

[0037] As will be described below, the present invention is generally directed to a combine harvester **10** and method for gathering grain and processing grain in a staged manner. In general, the combine harvester **10** is moved through crop material comprising grain material and material other than grain ("MOG"). The grain material is separated from the MOG using multiple processing areas as the harvest material is transported through the combine harvester, including, for example, a harvesting area **15**, a feederhouse area **17**, a threshing area **20**, a cleaning area **22**, and a grain delivery area **25**, depicted in Fig. 1 and generally described above. In a location at or prior to entering one of the processing areas, however, the material may be collected and held until a collection threshold is reached.

[0038] Once it is determined that the collection threshold is reached, the material (which now forms a first group of material) may be transported from the location to the processing area or a subsequent processing area. The first group of material is transported from the location to the processing area or the subsequent processing area substantially simultaneously and thus simulates the gathering of a large amount of crop material even when small plots are involved. In this way, the benefits of large-plot harvesting may be extended to small-plot applications, as described in greater detail below.

[0039] *Staging at the Harvesting Area*

[0040] Staging of the material may occur at various locations of the combine **10**, such as at the harvesting area **15**. Referring to Fig. 3, for example, the header **16** may be configured to include first and second transverse conveyors **68**, **69**. The first and second transverse conveyors **68**, **69** may be configured to move harvest material from the sides of the header **16** toward one or more openings **70**, through which the material may pass from the harvesting area **15** to the feederhouse area **17**. By adjusting the speed of movement of the first and second transverse conveyors **68**, **69**, each conveyor may serve as a staging location for the harvest material. For example, the first and second transverse conveyors **68**, **69** may be slowed down when the quantity of grain being harvested is relatively small until a collection

threshold is reached. Once the threshold is reached, the speed of the first and second transverse conveyors **68**, **69** may be increased to move the harvest material as a group to the openings **70** so that the material may be moved, as a batch, from the harvesting area to the feederhouse area **17**. The first and second transverse conveyors **68**, **69** may be a belt, as shown in Fig. 3, or an auger.

[0041] *Staging at the Feederhouse Area*

[0042] Staging of the material may additionally or alternatively occur at the feederhouse area **17**. In this case, the material may be harvest material that is collected at the feederhouse area **17** and is transported, as the first group of material, from the feederhouse area **17** to the threshing area **20**. With reference to Figs. 4 and 5, the feederhouse area **17** may include a conveyance device **72**. Collecting the harvest material at the feederhouse area **17** may thus comprise moving the harvest material away from the harvesting area **15** using the conveyance device **72**. The speed of the combine harvester **10** through the plot may be greater than or equal to a speed at which the conveyance device **72** moves the harvest material away from the harvesting area **15** when collecting the harvest material. Thus, although the combine may be moving rapidly through a plot, the conveyance device **72** may be configured to move the harvest material from the harvesting area **15** to the threshing area **20** at a relatively slower rate. In addition, in order to effect the staging of the material, the conveyance device **72** may be configured to move the harvest material away from the harvesting area **15** (in the direction of the arrow **75** in Fig. 5) at a first speed, while the feederhouse area **17** is configured to transport the first group of harvest material to the threshing area **20** at a second speed, the first speed being less than the second speed.

[0043] With reference to Fig. 5, for example, the conveyance device **72** may comprise a lower member **80** and/or an upper member **82**. One or both of the members **80**, **82** may comprise a conveyor, which may include a continuous belt **84**, **86** that is driven by one or more axles **88**, such that the lower and upper members may cooperate to move harvest material in direction of the arrow **75**, toward the threshing area **20**. In some cases, both the lower and the upper members **80**, **82** may be configured to contact the grain (e.g., within a chamber **90** of the conveyance device **72**).

[0044] Thus, the first group of material may, upon entering the feederhouse area **17** from the harvesting area **15**, be collected (e.g., between two or more extensions **92**) until the

collection threshold is reached. By decreasing the first speed at which the conveyance device **72** moves the harvest material away from the harvesting area **15**, more harvest material may be received from the harvesting area and may be deposited to form the first group. Then, once the collection threshold is reached, the conveyance device **72** may be operated at a faster, second speed. Thus, the feederhouse area **17** may convey the collected first group of material to the threshing area **20** at the faster, second speed, thereby providing a relatively large slug of material to the threshing area **20** to promote processing efficiency at the threshing area **20**.

[0045] Referring to Fig. 4, in other embodiments, a holding area **100** may be provided between the conveyance device **72** of the feederhouse area **17** and the conveyor **40**. Thus, harvest material may be deposited by the conveyance device **72** into the holding area **100** to form the first group of material. The harvest material may remain stationary in the holding area **100** until the collection threshold is achieved, at which point the collected harvest material, which now constitutes the first group of material, is conveyed substantially simultaneously to the threshing area **20**. The holding area **100** may be used to collect the crop material in lieu of or in addition to the feederhouse staging. In some embodiments, the conveyor **40** itself may serve as the holding area **100**.

[0046] By staging the harvest material at or near the feederhouse area **17** as described above, additional harvest material may be removed from the plot using the header **16** at the harvesting area **15** and transported to the feederhouse area **17**. The additional harvest material may be transported to the feederhouse area **17** after the first group of harvest material has been transported from the feederhouse area **17** to the threshing area **20**. The additional harvest material may be collected at or near the feederhouse area **17** to form an additional group of harvest material (e.g., a second group of harvest material), which may be the same as or different from the first group of harvest material. For example, the first group may be harvest material collected from one plot, whereas the second group may be harvest material collected from a second, different plot. Thus, the speed of the conveyance device **72** may be continually adjusted, independently from the movement of the combine harvester **10** to allow for the collection of material at the first speed, and subsequent conveyance of the material to the threshing area **20** in one or more batches (e.g., via a first group of material, a second group of material, a third group of material, etc.).

[0047] Turning to Fig. 6, in some cases the feederhouse area **17** may be combined with or

replaced by a threshing area **20**, such that material discharged from the opening **70** of the header **16** at the harvesting area **15** enters directly into a feederhouse thresher **105** (e.g., via an inlet **34**). The feederhouse thresher **105** may be an axial-flow threshing apparatus including a threshing rotor **30** that is substantially surrounded by rotor concaves **35**, as described above. Once crop material has been threshed, it may be conveyed to the cleaning area **22** via a conveyor **107** disposed below the feederhouse thresher **105**. Combining the feederhouse area with the threshing area may thus eliminate one step of the process and improve the overall efficiency of the combine harvester. Furthermore, as described above with respect to the feederhouse area **17**, the conveyor **107** of the feederhouse thresher **105** may be configured to have adjustable speeds, similar to the conveyance device **72**. In this way, the conveyor **107** may serve as a location for staging of the threshed material prior to conveyance to the cleaning area **22**.

[0048] *Staging at the Threshing Area*

[0049] Referring to Figs. 6, 7, and 8, staging may additionally or alternatively occur at or near the threshing area **20**.

[0050] In some embodiments, the efficiency of the threshing area is further enhanced by positioning the inlet **34** of the threshing area **20** at an upper location with respect to the threshing rotor **30**, as shown in Fig. 6. By positioning the inlet **34** at the upper location, the force of gravity may be used to facilitate the movement of the material from the inlet into the threshing area **20** (e.g., toward the auger **31**). In addition, such positioning of the inlet **34** may in some cases avoid the backward movement of material (e.g., movement toward the harvesting area **15**) that may result from the motion of the auger **31** at a lower location, as the auger rotates about the axis of the rotor **30**.

[0051] *Staging at the Cleaning Area*

[0052] Referring now to Figs. 9–11, staging may additionally or alternatively take place at or near the grain cleaning area **22**. In particular, material that has been passed through the threshing area **20** may be conveyed to the cleaning area **22** or, in some embodiments, the conveyor **107** (shown in Fig. 6), where it may be passed through series of moving sieves **45** to separate the heavier grain from any other non-grain crop material, as described above.

[0053] As noted above, the sieve assembly **45** may be configured to move, e.g., from front to back, with respect to the movement of material through the combine. As a result of this

movement, conventional sieve assemblies **45** may be unbalanced and may vibrate or shake within the combine.

[0054] Thus, in some embodiments, the sieve assembly **45** may be configured such that a first sieve **46** is provided on one side and a second sieve **47** is provided on the other side of the sieve assembly **45**, as shown in Figs. 10 and 11. The first and second sieves **46**, **47** may be separated by a partition **48**, and each sieve may be configured to move in a direction opposite that of the other sieve. For example, the first sieve **46** may be configured to move from front to back, whereas the second sieve **47** may be configured to move from back to front. By using an opposite pattern of movement, the net movement of the sieve assembly **45** may approach zero as the movement of the two sieves **46**, **47** will balance each other, reducing the amount of vibration. In some cases, where the combine is used to harvest material from two plots, the first sieve **46** may be used for material from one plot, and the second sieve **47** may be used for material from another, different plot. In this way, material from each plot may be processed concurrently, but separately.

[0055] Once the grain has fallen through the sieve assembly **45**, it may be moved via a conveyor **110** to a staging location **120** (shown in Fig. 9), where it is held until the collection threshold is reached. As noted above with respect to the conveyor **40**, the conveyor **110** may be a belt, an auger, or any other mechanism for conveying material between two locations. Upon reaching the collection threshold (thereby forming the first group of material), in some embodiments a door **125** may be displaced to allow the collected first group of material to drop, as a batch, into a pan **52**. In other embodiments, the collected first group of material may drop into the auger tube **53**. From the pan **52** or auger tube **53**, the first group of material may be moved by the clean grain auger **55** transversely to one side of the combine **10**, where it may travel to the grain tank **60** via the transport system **65** as described above (shown in Figs. 1 and 2). Because, in some embodiments, the grain is collected at the staging location **120** and is only passed to the clean grain auger **55** as a group via the movement of the door **125**, the clean grain auger **55** may be more efficient in moving the grain, as a group, to the area of the combine **10** to be moved to subsequent processing areas, even when relatively small quantities of grain are being harvested by the combine **10**. At the same time, once a first group of grain has been passed through the door **125** to the clean grain auger **55** and the door is returned to the collecting (e.g., closed) position, a subsequent batch of material (e.g., a

second group) may be cleaned and collected at the staging location **120**. In some embodiments, however, instead of a door **125**, the grain may be collected directly onto a conveyor, which may move a first group of the grain to the next location only once the collection threshold is achieved. In still other embodiments, the grain may be placed into an airlock that is part of a pneumatic conveyance system. The pneumatic conveyance system may only be activated to move the grain to the next location once the collection threshold is reached.

[0056] *Staging at Other Processing Areas*

[0057] As noted above, staging may occur at one or more of a number of processing areas, such as the harvesting area, the feederhouse area, the threshing area, and the cleaning area. In addition, depending on the configuration of the combine harvester **10**, additional processing areas may be provided. For example, the combine may include a grain conveying area, a grain material delivery area, and/or a grain testing area, as described above. The grain conveying area may include a conveyor that is configured to move grain from the threshing area **20** to the cleaning area **22**. The grain material delivery area may follow the grain cleaning area **22** and, as noted above, may include an elevator, an air lock, or a similar method of moving the clean grain to a location on the combine harvester where the grain may be ground, tested, and/or held for removal from the combine and/or further processing. At the grain testing area, which may follow the grain material delivery area, the clean grain may be collected and analyzed to determine certain properties of the grain. For example, the moisture level, weight, oil content, protein content, starch content and/or the bulk density of the grain may be measured at the grain testing area. In some cases, the grain testing area may be directly below the cleaning area, in which case the grain would not need to be conveyed from the cleaning area to the grain testing area. Furthermore, the analysis of the grain may take place simultaneously with (e.g., as part of) the staging of the material at the testing area. In other words, the grain may be analyzed at the testing area while being held for a period of time to reach the collection threshold.

[0058] Thus, collection of the material in the location may include collecting grain material in a location at or prior to entering one or more of the grain conveying area, the grain material delivery area, and/or the grain testing area, in addition to or instead of at or prior to the harvesting area, the feederhouse area, the threshing area, and the cleaning area described

above.

[0059] For example, collecting material in the location may comprise collecting grain material prior to entering the grain conveying area, and transporting the first group of material from the location to the processing area or a subsequent processing area after the collection threshold is reached may comprise transporting a first group of grain material from the grain conveying area to the cleaning area after the collection threshold is reached. For example, the conveyor **40** may be configured to slow down or stop to allow staging to occur before delivering the grain to the threshing area. Similarly, grain material may be collected at the cleaning area and a first group of grain material may be transported from the cleaning area to the grain material delivery area after the collection threshold is reached.

[0060] As another example, grain material may be collected prior to entering the grain material delivery area, and a first group of grain material may be transported from the location to the grain material delivery area after the collection threshold is reached. As yet another example, grain material may be collected at the grain material delivery area, and a first group of grain material may be transported from the grain material delivery area to the grain testing area after the collection threshold is reached. In other cases, grain material may be collected prior to entering the grain testing area, and a first group of grain material may be transported from the location to the grain testing area after the collection threshold is reached. Furthermore, one or more of the processing areas may be controlled independently of the other processing areas, such that a given group of material may be processed in an efficient manner with respect to the particular processing area.

[0061] Regardless of where the staging occurs or in how many locations, staging in this manner may facilitate the processing of multiple research plots through the combine harvester more efficiently without increasing the risk of cross-contamination between grain from different plots, as the staging is intended to keep grain harvested from a particular plot together and separated from grain harvested from other plots. For example, staging prior to the grain testing area may allow testing of grain from a particular plot, only, minimizing the risk that grain from other plots may inadvertently be analyzed and cause inaccuracies in the test results.

[0062] In addition, as a result of staging, the combine harvester may be able to move between different plots with minimal wait times. For example, although a conventional

research combine harvester may need to wait anywhere from 12 seconds to 24 seconds prior to moving from one plot of grain to the next, a combine harvester configured in accordance with embodiments of the present invention may be able to move between plots with only approximately 6–8 seconds or less of wait time required.

[0063] *Determining the Collection Threshold*

[0064] Regardless of where the staging occurs, in a location at or prior to entering one of the processing areas a determination is made regarding whether the collection threshold has been reached. In some cases, the collection threshold is determined by determining whether the combine has reached an end of a plot. For example, when the end of a plot has been reached (e.g., when an entire row of plants in the plot or all of the plants in the plot have been cut), the collected group of material may be moved to a subsequent processing area as no additional material would be expected to be introduced to the group.

[0065] In other embodiments, the collection threshold may be determined temporally. For example, determining whether a collection threshold is reached may include determining whether a time period beginning at the start of collecting the harvest material is greater than or equal to a threshold time period. In some cases, the collection threshold may be determined based on the mass or volume of the group of material collected. For example, the determination may be based on whether a mass of the first group of material is greater than or equal to a threshold mass. Similarly, the determination may be based on whether a volume of the first group of material is greater than or equal to a threshold volume. In other cases, the operator of the combine may determine that the collection threshold has been reached (such as through a visual inspection). In other cases, the determination may be made using a location-based trigger. For example, the location-based trigger may comprise determining whether a predetermined distance has been travelled by the combine or whether a predetermined time has elapsed. Alternatively, the location-based trigger may be based on a position of the combine in an area to be harvested, e.g., via a global positioning system (GPS) location or sensor input, such as a vision sensor. Any combination of methods may be used to determine whether a collection threshold is reached.

[0066] Many modifications and other embodiments of the invention will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be

understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

WHAT IS CLAIMED IS:

1. A method for harvesting grain using a combine harvester having a plurality of processing areas, the method comprising:

moving the combine harvester through harvest material comprising grain material and material other than grain; and

separating the grain material from the material other than grain using the plurality of processing areas as the harvest material is transported through the combine harvester,

wherein in a location at or prior to entering one of the processing areas the method further comprises:

collecting material in the location;

determining whether a collection threshold is reached; and

transporting a first group of material from the location to the processing area or a subsequent processing area after the collection threshold is reached,

wherein the first group of material is transported from the location to the processing area or the subsequent processing area substantially simultaneously.

2. The method of Claim 1, wherein at least one of the plurality of processing areas is controlled independently of the other processing areas.

3. The method of Claim 1, wherein the plurality of processing areas includes at least a harvesting area, a feederhouse area, and a threshing area, wherein collecting material in the location comprises collecting harvest material at the feederhouse area, wherein the first group of material comprises a first group of harvest material, and wherein transporting the first group of material from the location to the processing area or a subsequent processing area after the collection threshold is reached comprises transporting the first group of harvest material to the threshing area.

4. The method of Claim 3, wherein the feederhouse area comprises a conveyance device, and

wherein collecting the harvest material at the feederhouse area comprises moving the harvest material away from the harvesting area using the conveyance device.

5. The method of Claim 4, wherein a speed of the combine harvester is independent of a speed at which the conveyance device moves the harvest material away from the harvesting area when collecting the harvest material.

6. The method of Claim 4, wherein the conveyance device comprises a lower member, and wherein the lower member comprises a conveyor.

7. The method of Claim 2, further comprising removing additional harvest material using the harvesting area;

transporting the additional harvest material to the feederhouse area after transporting the first group of harvest material using the feederhouse area to the threshing area;

collecting the additional harvest material at the feederhouse area to form an additional group of harvest material.

8. The method of Claim 1, wherein determining whether a collection threshold is reached comprises determining whether the combine has reached an end of a plot.

9. The method of Claim 1, wherein determining whether a collection threshold is reached comprises determining whether a predetermined distance has been travelled by the combine harvester.

10. The method of Claim 1, wherein determining whether a collection threshold is reached comprises determining a position of the combine harvester.

11. The method of Claim 1, wherein determining whether a collection threshold is reached comprises determining whether a time period beginning at the start of collecting the harvest material is greater than or equal to a threshold time period.

12. The method of Claim 1, wherein determining whether a collection threshold is reached comprises determining whether a mass of the first group of material is greater than or equal to a threshold mass.

13. The method of Claim 1, wherein determining whether a collection threshold is reached comprises determining whether a volume of the first group of material is greater than or equal to a threshold volume.

14. The method of Claim 1, wherein the plurality of processing areas includes at least one of a threshing area, a grain conveying area, a cleaning area, a grain material delivery area, and a grain testing area, wherein collecting material in the location comprises collecting grain material in a location at or prior to entering one or more of the threshing area, the grain conveying area, the cleaning area, the grain material delivery area, and the grain testing area.

15. The method of Claim 14, wherein collecting material in the location comprises collecting material prior to entering the threshing area, and wherein transporting a first group of material from the location to the processing area or a subsequent processing area after the collection threshold is reached comprises transporting a first group of material from the location to the threshing area after the collection threshold is reached.

16. The method of Claim 14, wherein collecting material in the location comprises collecting grain material at the grain conveying area, and wherein transporting a first group of material from the location to the processing area or a subsequent processing area after the collection threshold is reached comprises transporting a first group of grain material from the grain conveying area to the cleaning area after the collection threshold is reached.

17. The method of Claim 14, wherein collecting material in the location comprises collecting grain material at the cleaning area, and wherein transporting a first group of material from the location to the processing area or a subsequent processing area after the collection threshold is reached comprises transporting a first group of grain material from the cleaning area to the grain material delivery area after the collection threshold is reached.

18. The method of Claim 14, wherein collecting material in the location comprises collecting grain material prior to entering the grain material delivery area, and wherein transporting a first group of material from the location to the processing area or a subsequent processing area after the collection threshold is reached comprises transporting a first group of grain material from the location to the grain material delivery area after the collection threshold is reached.

19. The method of Claim 14, wherein collecting material in the location comprises collecting grain material at the grain material delivery area, and wherein the step of transporting a first group of material from the location to the processing area or a subsequent processing area after the collection threshold is reached comprises transporting a first group of grain material from the grain material delivery area to the grain testing area after the collection threshold is reached.

20. The method of Claim 14, wherein collecting material in the location comprises collecting grain material prior to entering the grain testing area, and wherein transporting a first group of material from the location to the processing area or a subsequent processing area after the collection threshold is reached comprises transporting a first group of grain material from the location to the grain testing area after the collection threshold is reached.

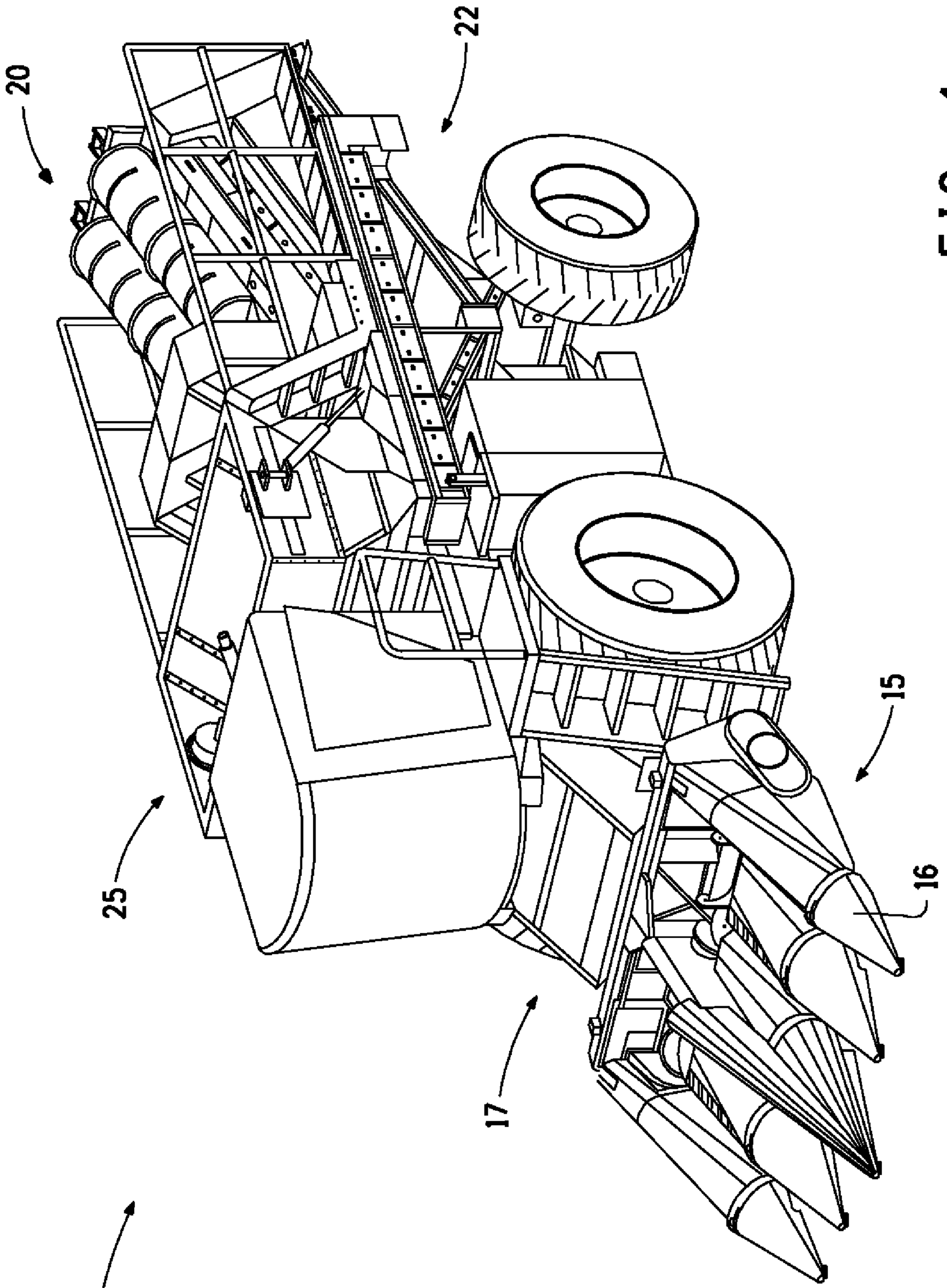

FIG. 1

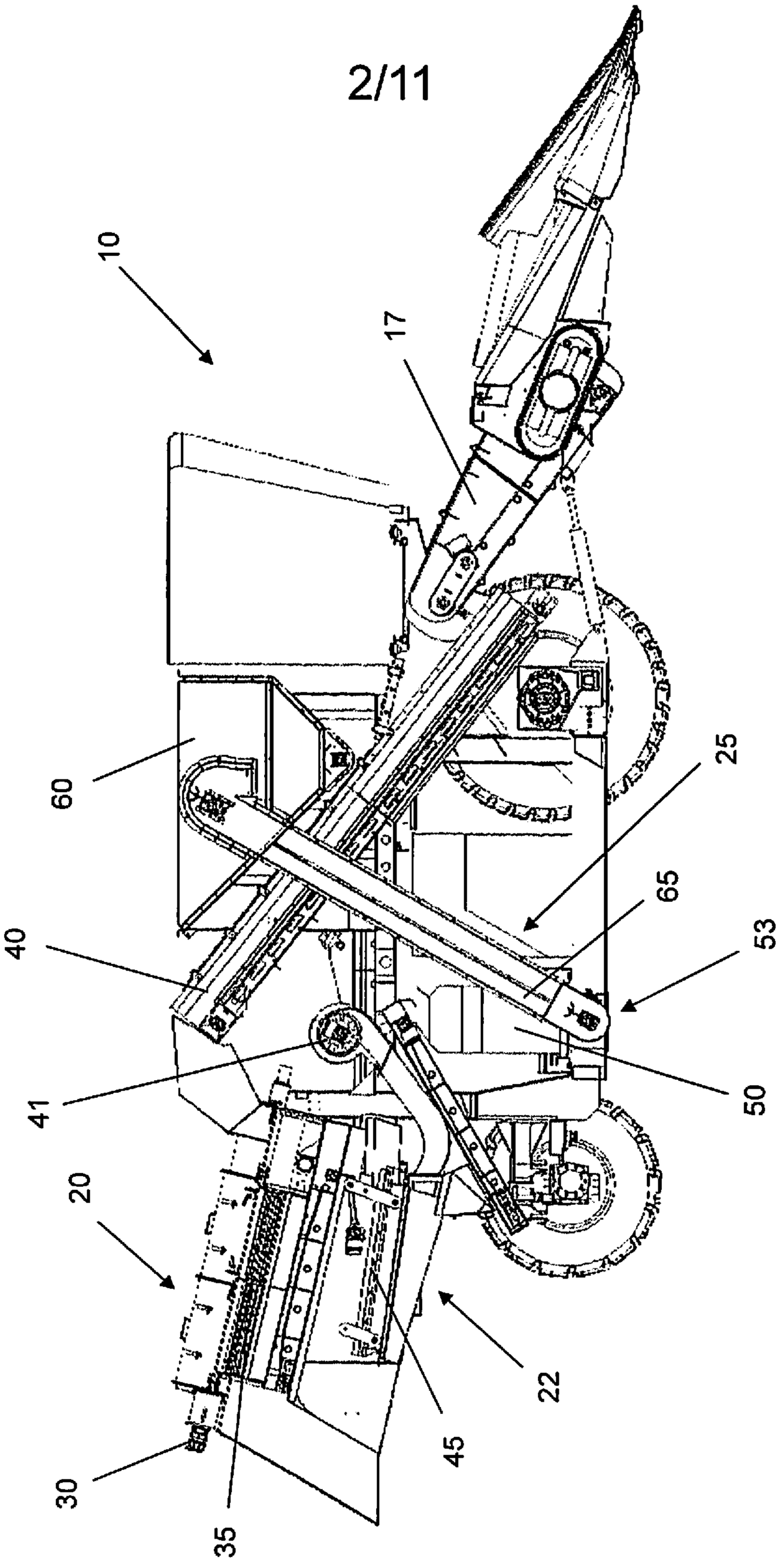

FIG. 2

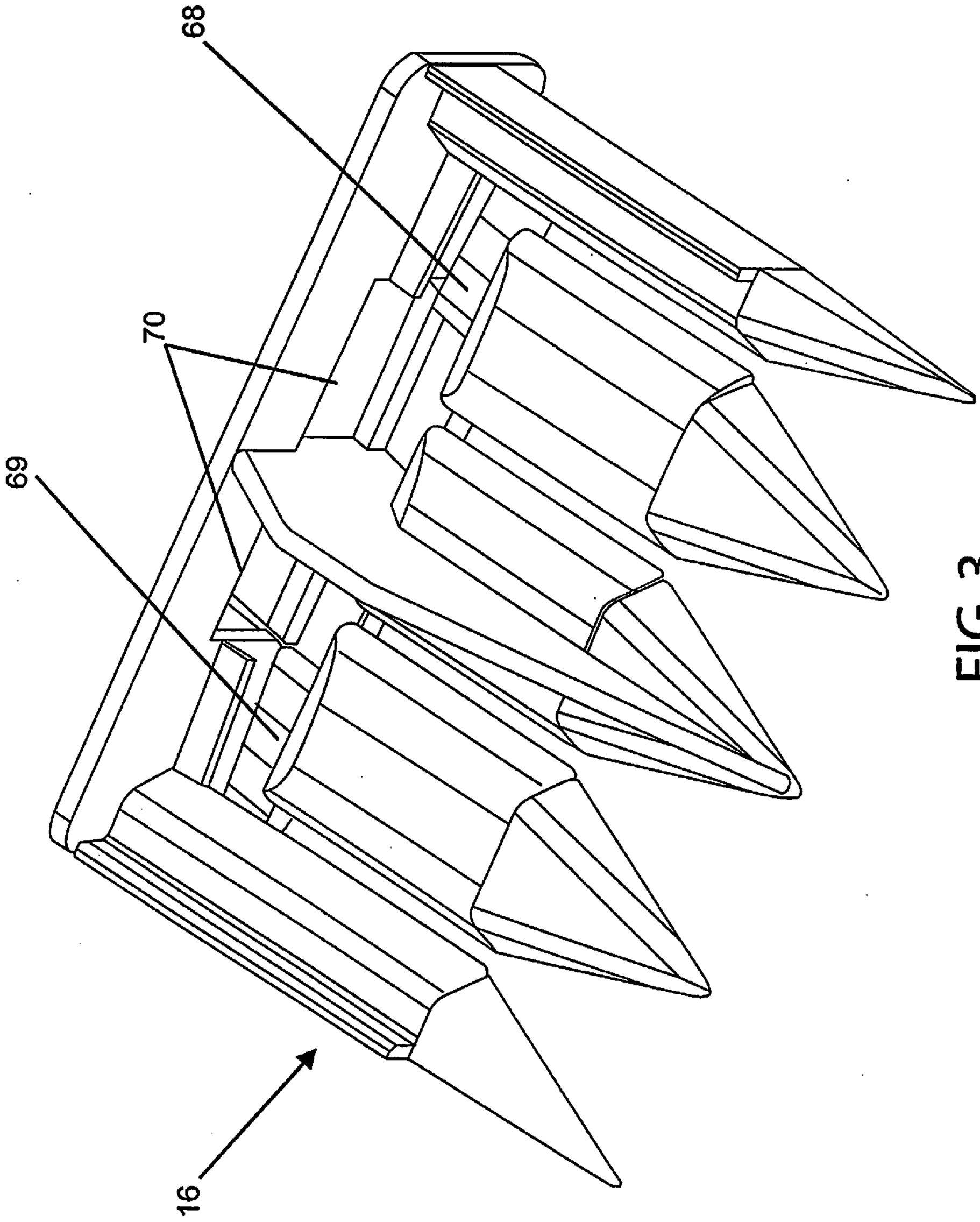

FIG. 3

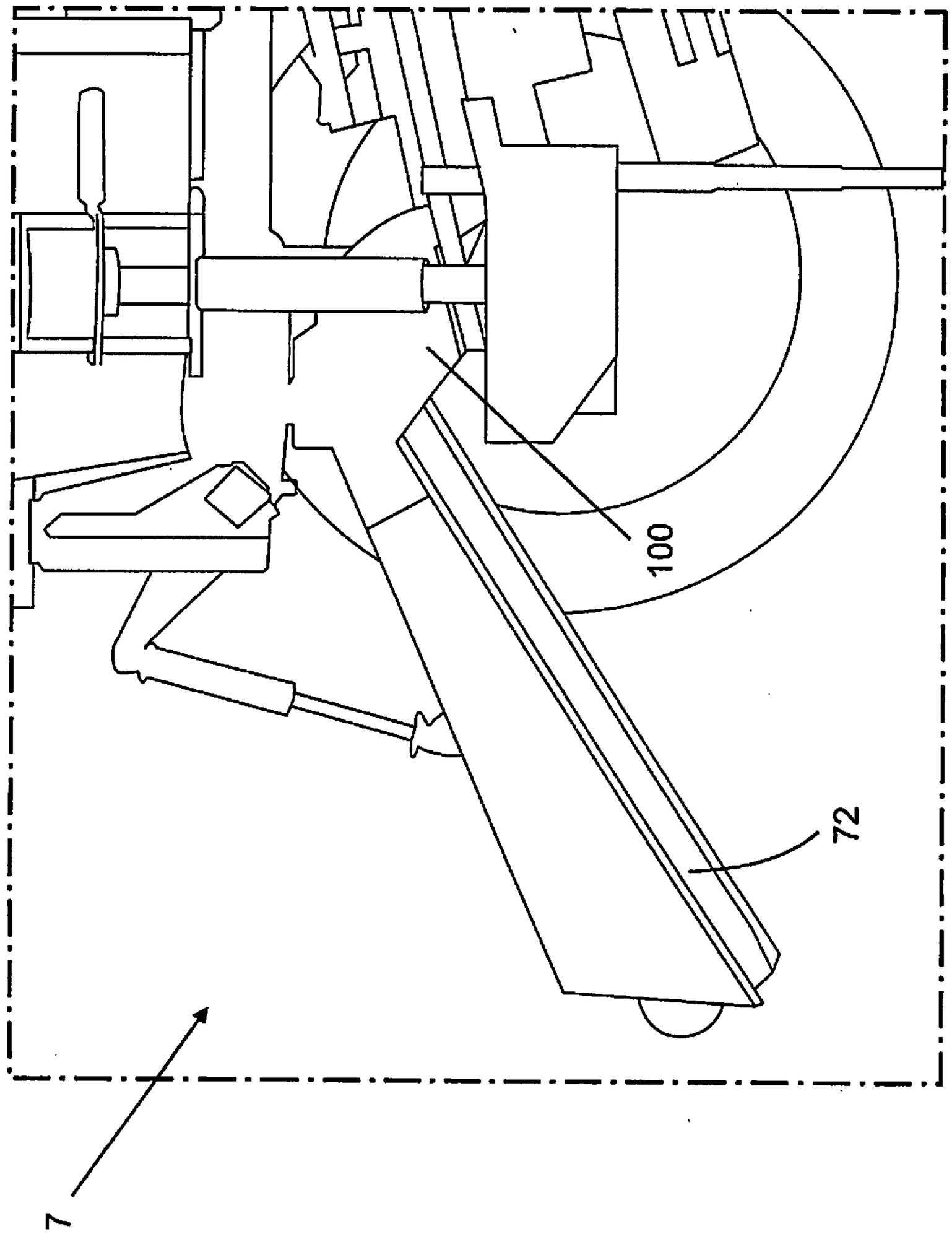

FIG. 4

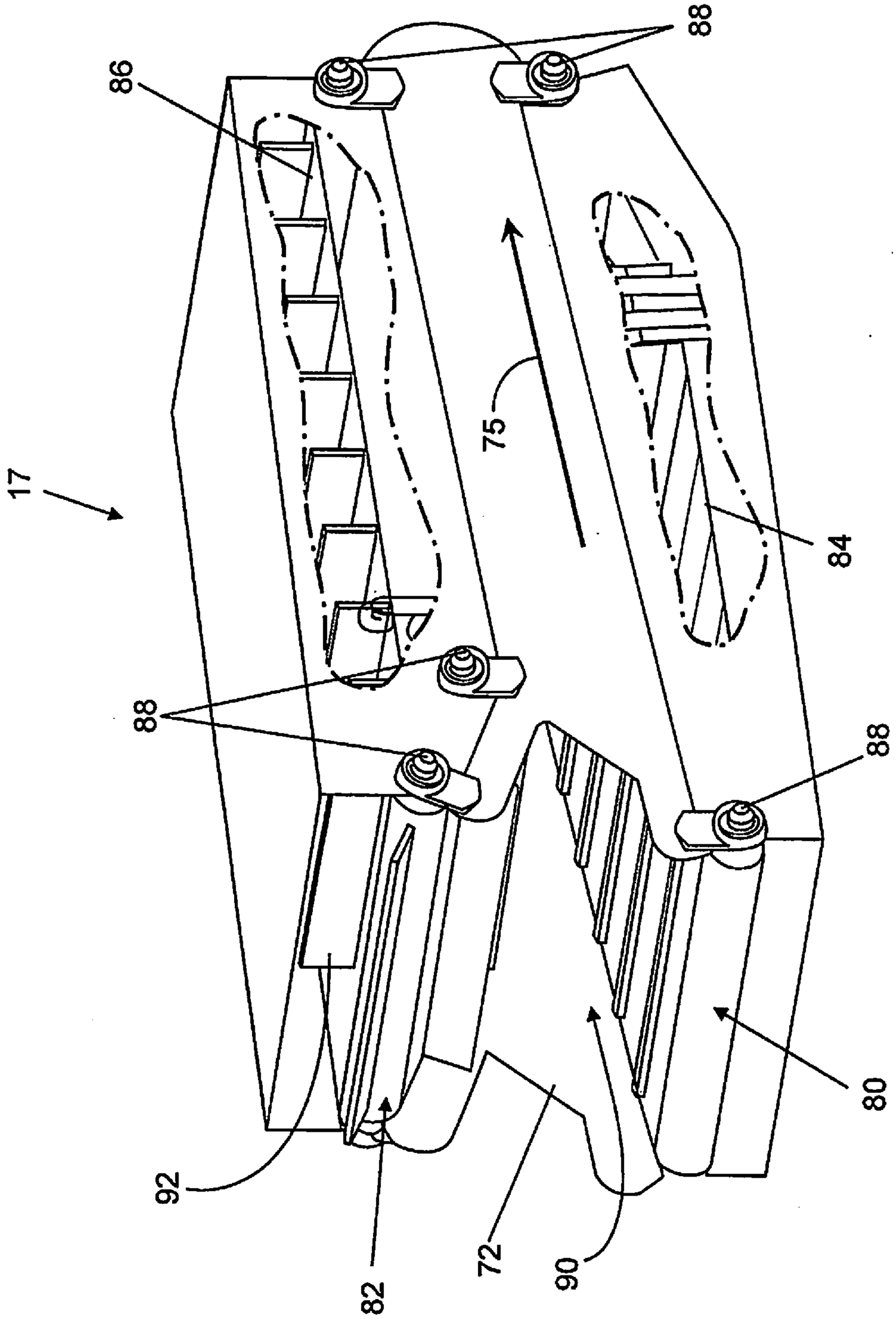

FIG. 5

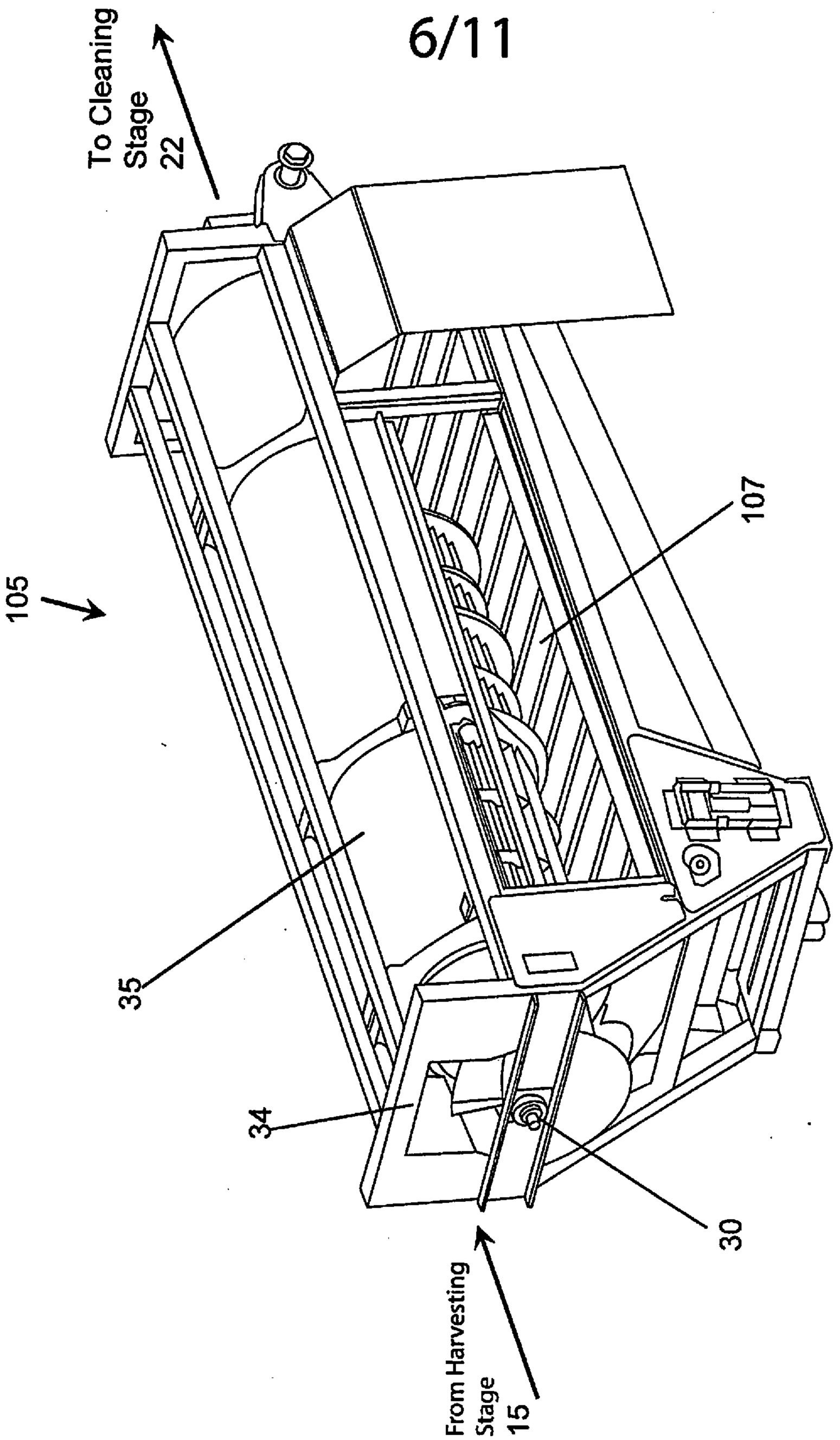
To Cleaning Stage 22
105
107
35
34
30
From Harvesting Stage 15

FIG.6

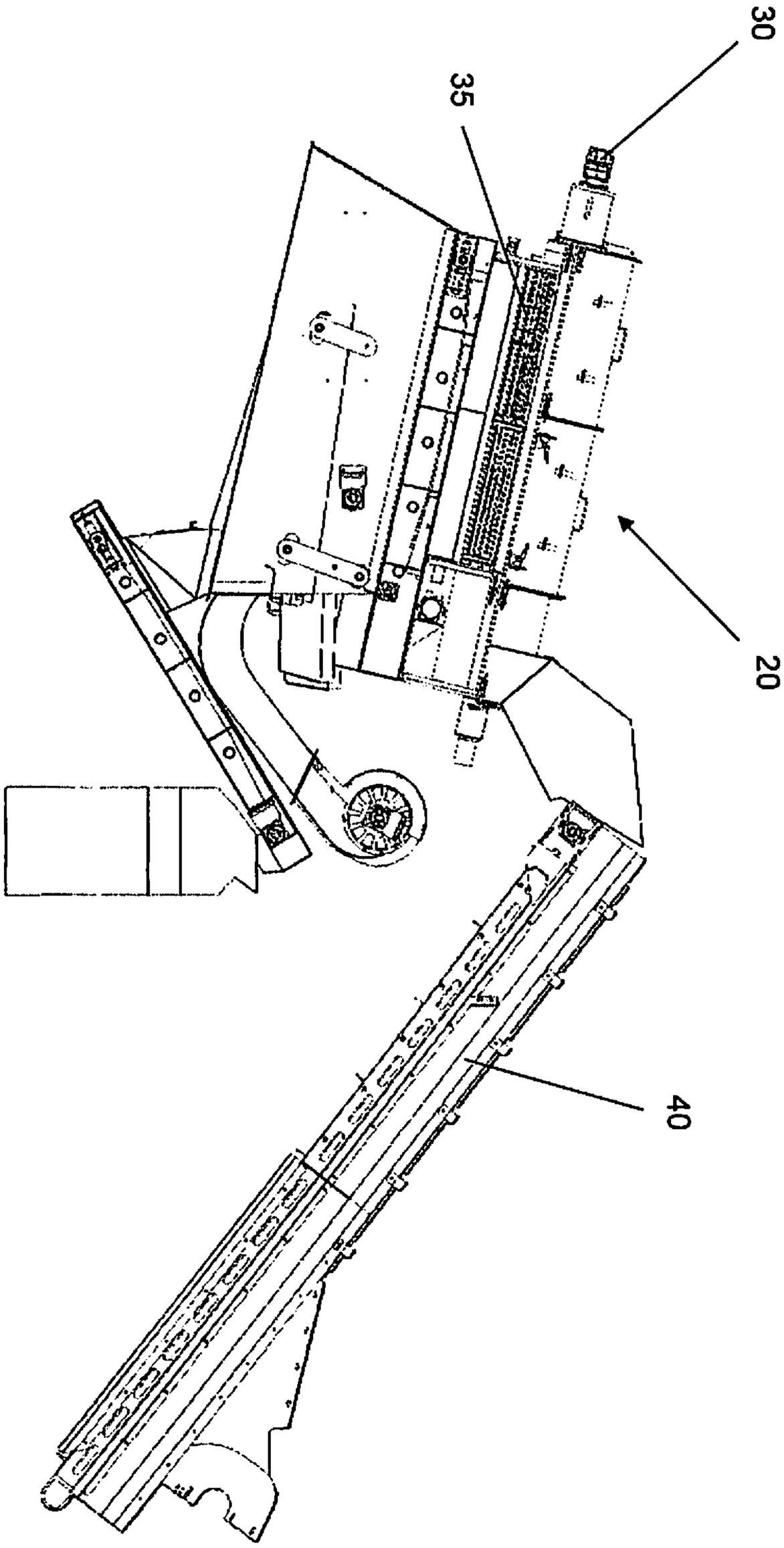

FIG. 7

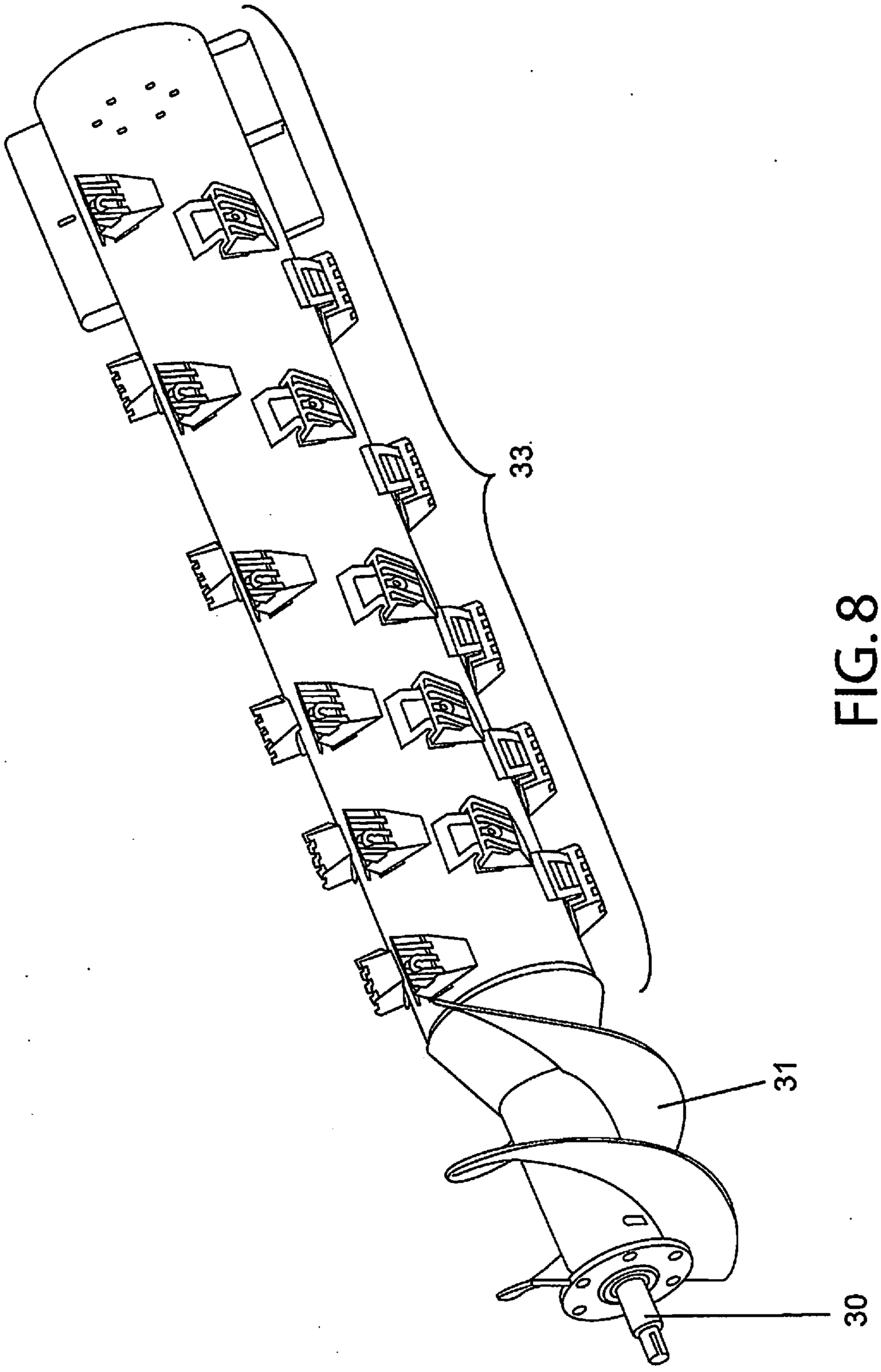

FIG. 8

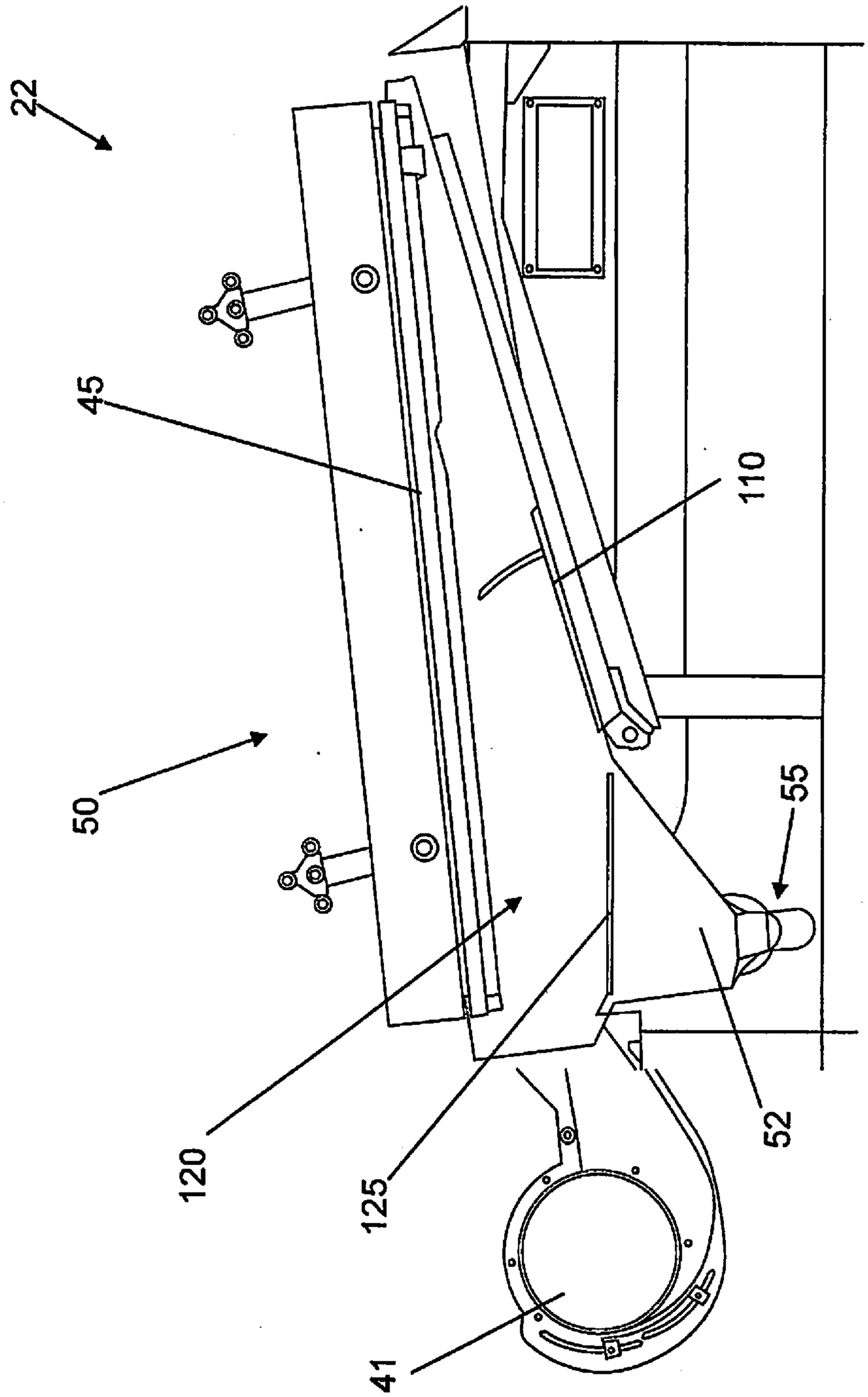

FIG. 9

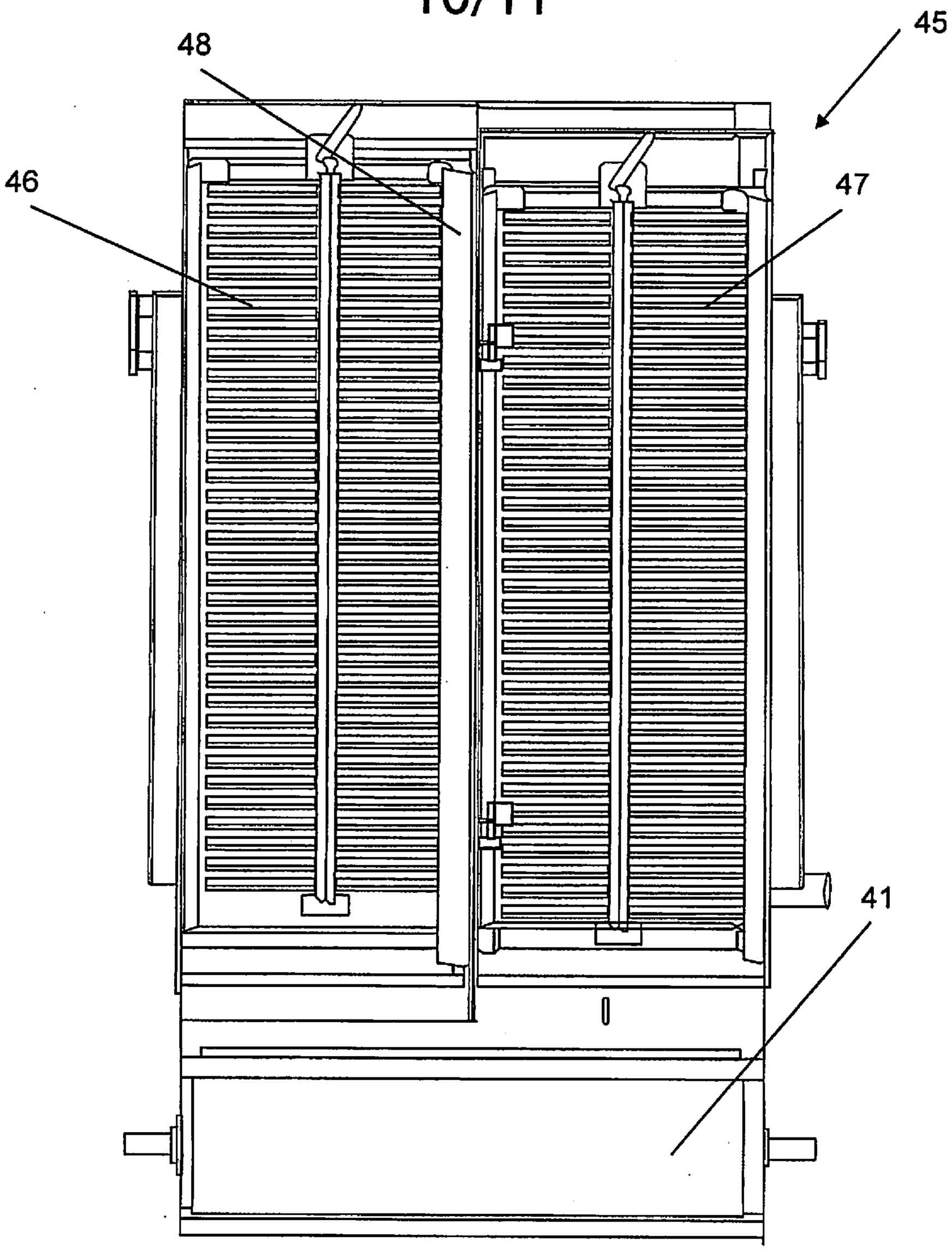

FIG. 10

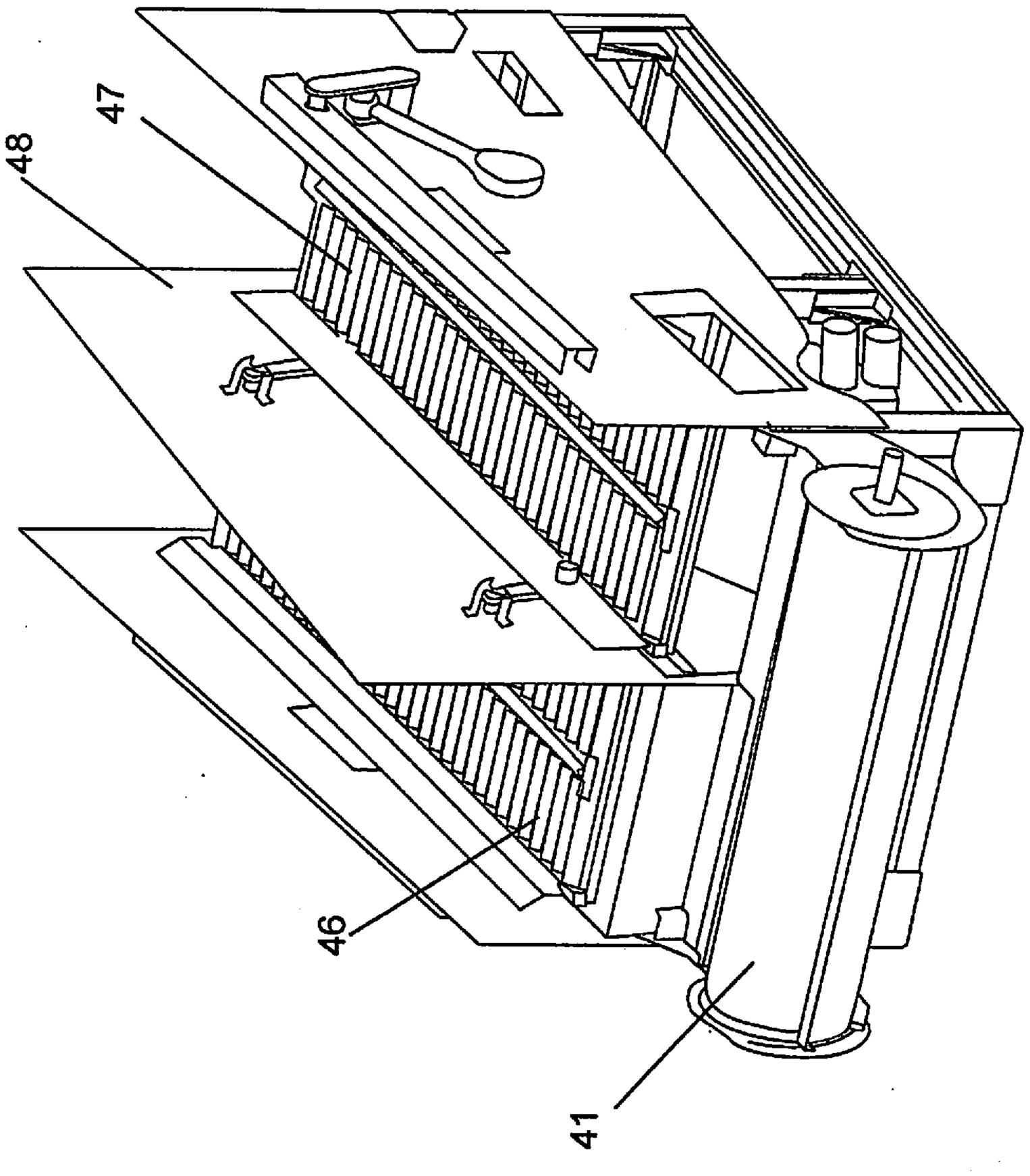

FIG. 11

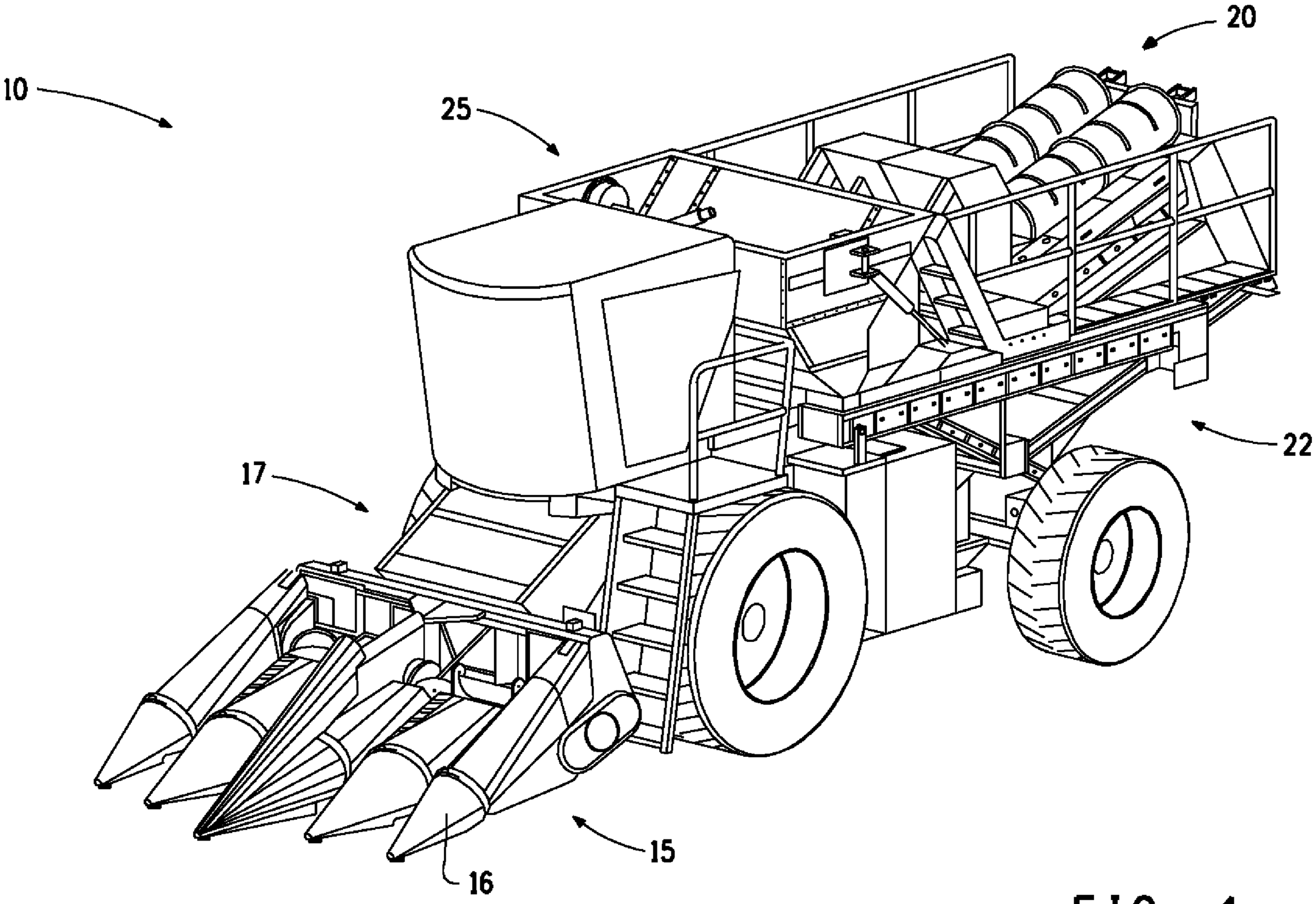

FIG. 1