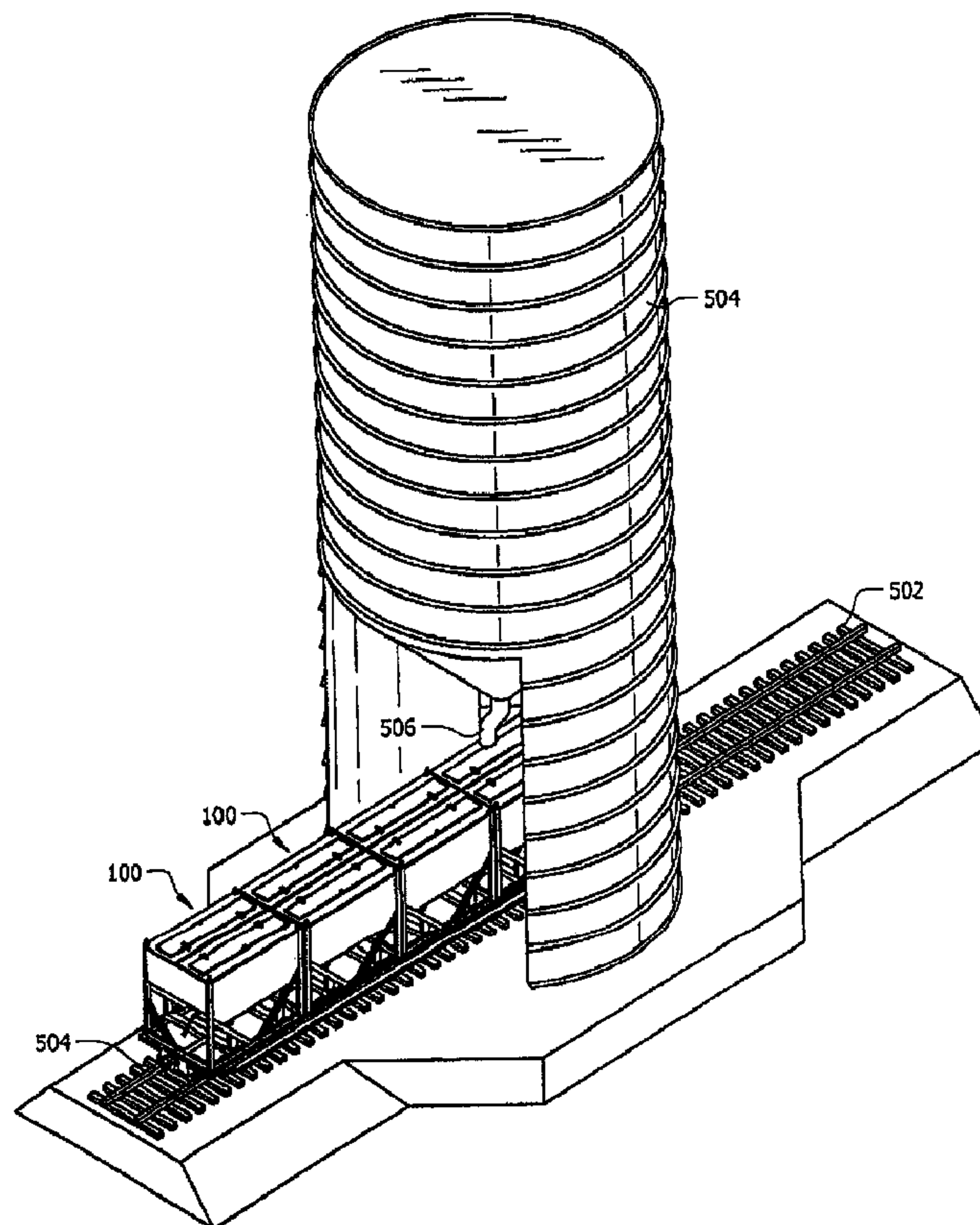




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(54) **Titre : SYSTEMES ET METHODES POUR LE STOCKAGE ET LE TRANSPORT DE MATERIAU EN VRAC**
(54) **Title: SYSTEMS AND METHODS FOR BULK MATERIAL STORAGE AND/OR TRANSPORT**



(57) **Abrégé/Abstract:**

Bulk material storage units that can be placed on flatbeds that can be hauled in various manners, including rail cars or trucks, to the destination and removed from the flatbed for temporary storage at the destination, freeing the transportation mode, e.g., rail cars or

(57) **Abrégé(suite)/Abstract(continued):**

trucks, to be used elsewhere. Embodiments of the bulk material storage unit of the present invention replace rail hopper cars or truck trailers to hold the bulk material during transportation as well as provide temporary storage at the desired location, e.g., the origin or destination, without tying up transportation resources.

ABSTRACT

Bulk material storage units that can be placed on flatbeds that can be hauled in various manners, including rail cars or trucks, to the destination and removed from the flatbed for temporary storage at the destination, freeing the transportation mode, *e.g.*, rail cars or trucks, to be used elsewhere. Embodiments of the bulk material storage unit of the present invention replace rail hopper cars or truck trailers to hold the bulk material during transportation as well as provide temporary storage at the desired location, *e.g.*, the origin or destination, without tying up transportation resources.

SYSTEMS AND METHODS FOR BULK MATERIAL STORAGE AND/OR TRANSPORT

[0001] Blank.

TECHNICAL FIELD

[0002] Exemplary embodiments of the present invention relate generally to the handling of bulk materials, and more particularly, to a bulk material container for storage and/or transporting of particulate materials therein.

BACKGROUND OF THE INVENTION

[0003] This section is intended to introduce various aspects of the art, which may be associated with exemplary embodiments of the present invention. This discussion is believed to assist in providing a framework to facilitate a better understanding of particular aspects of the present invention. Accordingly, it should be understood that this section should be read in this light, and not necessarily as any admission of prior art.

[0004] Bulk materials, such as sand, coal, ores, or grains, are typically collected (*e.g.*, mined or harvested) at the source, stored, then transported and delivered to end users. The flow of materials between the origin and destination, *i.e.*, logistics, significantly affects the profitability of such materials. Profitability increases with improved logistics.

[0005] A frequent problem with shipping bulk materials is bottle necks in the logistics chain. Bottle necks are often caused by transportation delays. Transportation delays can be isolated at the point of the delay by providing excess storage capacity to accommodate any accumulation of material due to the delay. For example, if trucks are

not available to transport materials as they arrive by train, the materials collect at the train yard. As long as the train yard has available storage capacity, material continues to be shipped. However, once all excess storage capacity has been used, no further materials can be moved (logistical gridlock).

[0006] A significant aspect of shipping bulk materials is the ability to ship and efficiently store the material along the logistics chain. Storage containers for bulk materials are typically large permanently fixed storage vessels often referred to as silos. These are costly and do not facilitate in the transportation process of materials from one site to another. Accordingly, the need exists for a method and apparatus that provide storage solutions that also facilitate the transportation process to expedite the logistics of delivering bulk materials from an origin to the end users.

SUMMARY OF THE INVENTION

[0007] In one embodiment, a bulk material storage container unit is described. The container unit includes a storage component that includes a generally rectangular portion and a tapered portion, and a frame component attached to said storage component, where the frame component includes a plurality of support members configured to allow said storage component to sit on a surface. The container unit further includes a dispenser component attached to the storage component, and a top surface attached to the storage component, where the top surface includes at least one opening and a lid member corresponding to the lid member. The bulk material storage container unit also comprises a width that corresponds to the width of at least one of a rail cart trailer and a truck trailer. In one embodiment, the tapered portion includes a plurality of walls disposed at an angle with respect to a horizontal surface, said angle is in the range between about 25 degrees and about 60 degrees. In particular, the angle is about 45 degrees.

[0008] The container unit can further include a diverter component attached to the storage component, where the diverter component is configured to reduce the angle of repose of particulates entering the storage component through the at least one opening of the top surface. In one embodiment, the number of diverter components corresponds

to the number of opening of the top surface. In another embodiment, each diverter component is placed in said storage component below the respective opening. In one embodiment, the component includes a diverter plate with a plurality of apertures, where the diverter plate being positioned to disperse bulk material entering the bulk material storage container. In one embodiment, the diverter component comprises two surfaces at an angle with respect to said top surface and a plurality of apertures. Some of the plurality of apertures can have a diameter of about 1.5 inches. The angle of said two surfaces with respect to the top surface can be in the range of about 27 degrees to about 89 degrees. In one particular embodiment, the angle is about 30 degrees.

[0009] In one embodiment, the bulk material storage container unit has a length of less than about 12 feet, a width of less than about 8 feet 6 inches, and a height of less than about 10 feet. In particular, the length is preferably about 12 feet, said width is about 8 feet 4 inches, and said height is about 9 feet 9 1/16 inches. In one embodiment, the lid member has a width that ranges between about 12 inches and about 48 inches and a length of about 10 feet.

[0010] In one embodiment, the plurality of support members include at least one of a plurality of vertical support members, a plurality of horizontal support members, and a plurality of angled support members. In one embodiment, the frame component, storage component, and diverter component comprise at least one of the following material: aluminum, steel, plastic, or fiberglass. The container unit can include a transfer component, which can enable a forklift to engage and move the bulk material storage container unit. Alternatively or in addition to, the transfer component can also be a lift ring.

[0011] In one embodiment, the dispenser component is configured allow for adjustment of the flow rate of particulates from the storage component. In particular, the dispenser component is a butterfly valve.

[0012] According to another aspect of the invention, a method for filling a container with particulates is described. In one embodiment, the method comprises the

step of pouring a plurality of particulates into a container through at least one opening of the container, where the pouring step forms a flow of particulates into the container. The method further includes the step of reducing the angle of repose of the particulates in the container by diverting at least a portion of the particulates from the flow of particulates. The diverting step comprises providing the container with a diverter component configured to change the direction of at least a portion of flowing particulates that strike a surface of the diverter component. In one embodiment, the particulates comprise sand.

[0013] The foregoing has outlined rather broadly the features and technical advantages of the present disclosure in order that the detailed description of the disclosure that follows may be better understood. Additional features and advantages of the disclosure will be described hereinafter which form the subject of the claims of the disclosure. It should be appreciated by those skilled in the art that the conception and specific embodiment disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present disclosure. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the disclosure as set forth in the appended claims. The novel features which are believed to be characteristic of the disclosure, both as to its organization and method of operation, together with further objects and advantages will be better understood from the following description when considered in connection with the accompanying figures. It is to be expressly understood, however, that each of the figures is provided for the purpose of illustration and description only and is not intended as a definition of the limits of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] For a more complete understanding of the embodiments of the present invention, reference is now made to the following descriptions taken in conjunction with the accompanying drawing, in which:

[0015] FIG. 1A is a perspective view of a first embodiment of a bulk material storage unit according to certain aspects of the present invention;

[0016] FIG. 1B is a front view of the bulk material storage unit of FIG. 1A;

[0017] FIG. 1C is a side view of the bulk material storage unit of FIG. 1A;

[0018] FIG. 1D is a cross-section view of the bulk material storage unit of FIG. 1C along line A-A;

[0019] FIG. 1E is a top view of the bulk material storage unit of FIG. 1A;

[0020] FIG. 1F is a cross section view of the bulk material storage unit of FIG. 1D along line B-B;

[0021] FIGS. 2A and 2B illustrate exemplary angles of repose for certain deposited bulk material and corresponding volumes;

[0022] FIG. 3A is a perspective view of an exemplary embodiment of a diverter component of a bulk material storage according to certain aspects of the present invention.

[0023] FIG. 3B is an end view of the diverter component of FIG. 3A;

[0024] FIG. 4 is a perspective view of an exemplary embodiment to unload the bulk storage units shown in FIG. 1A from a flatbed according to certain aspects of the present invention;

[0025] FIG. 5 is a perspective view of the bulk storage units shown in FIG. 1A transported on a flatbed rail car and being loaded with bulk material according to certain aspects of the present invention;

[0026] FIG. 6 is a perspective view of exemplary bulk storage units of the present invention transported on a flatbed rail car;

[0027] FIG. 7 is a perspective view of the bulk storage units of FIG. 1A transported on a flatbed trailer;

[0028] FIG. 8 is a perspective view of a second embodiment of a material storage unit according to certain aspects of the present invention;

[0029] FIG. 9 is a side view of an exemplary embodiment to load the bulk material storage unit of FIG. 8; and

[0030] FIG. 10 is a side view of another exemplary embodiment to load the bulk material storage unit of FIG. 8.

[0031] It should be understood that the drawings are not necessarily to scale and that the disclosed embodiments are sometimes illustrated diagrammatically and in partial views. In certain instances, details which are not necessary for an understanding of the disclosed methods and apparatuses or which render other details difficult to perceive may have been omitted. Also, for simplification purposes, there may be only one exemplary instance, rather than all, is labeled. It should be understood, of course, that this disclosure is not limited to the particular embodiments illustrated herein.

DETAILED DESCRIPTION OF THE INVENTION

[0032] While embodiments of the present invention have a broad range of applications, they are particularly applicable for transportation of bulk materials using the railway or roadway systems. In railway transportation, the bulk material is typically loaded from silos at the source location into rail hopper cars for transport to the destination for use by the end users. If needs for the material is not immediate at the destination and storage is not available at that moment, these hopper cars usually end up sitting on the railway serving as temporary storage while taking up room on the rails that can lead to scheduling delays, thereby triggering a negative domino effect on the logistics. In roadway transportation, the bulk material is loaded from silos at the source location into truck trailers designed to hold bulk materials for transportation. Similar to

railway transportation, if storage at the destination is lacking, the trucks need to remain there to serve as storage until the materials can be unloaded, thereby tying up resources in the logistical system.

[0033] Embodiments of the present invention provide bulk material storage units that can be placed on flatbed rail cars or flatbed trailers for transportation. The bulk material storage units of the present invention provide efficient storage of bulk material during transportations and upon arrival at the final destination.

[0034] Referring to FIGS. 1A-1F, one embodiment of the bulk material storage unit of the present invention is shown, storage component 100, which comprises frame component 102, storage component 104, and dispenser component 106. Frame component 102 provides support to storage component 104, which is attached to frame component 102. As shown in FIGS. 1A, 1C, 1D, and 1E, frame component 102 comprises vertical support members 108 preferably attached to the corners of storage component 104. In certain embodiments, frame component 102 also includes horizontal support members 110 extending between vertical support members 108. In the preferred embodiment, horizontal support members 110 are attached to vertical support members 108 near the end of vertical support members 108 toward the bottom of bulk material storage unit 100. In other embodiments, however, horizontal support members 110 can be placed at a higher position toward the top of bulk material storage unit 100 as appropriate. If additional support is needed or desired, frame component 102 can also include angled support members 112 extending between vertical support members 108 and horizontal support members 110. The angle of angled support members 112 can be varied as desired or required.

[0035] In the preferred embodiment, bulk material storage unit 100 further comprises transfer component 114 attached to frame component 102 that allow bulk material storage unit 100 to be placed onto or unloaded from the transport equipment, *e.g.* flatbed, and placed at a convenient location to provide temporary and portable storage of the bulk material. In one embodiment, transfer component 114 allows bulk material storage unit 100 to be moved by a forklift, such as forklift 402 as shown in FIG.

4. As shown in FIGS. 1A-1D, transfer component 114 comprises bars 116 extending across opposite horizontal support members 110 and spaced apart the appropriate distance to accommodate the forklift forks from one another. Referring to FIGS. 1A-1B and 1D, bars 116 also include openings 118 to allow insertion of the forklift forks. Alternatively or in addition to transfer component 114, bulk material storage unit 100 can further include another transfer component, such as lift ring 134, attached to the top of vertical support members 108. Lift ring 134 preferably comprises standard commercially available products that can be bolted in or welded in place. The capacity for lift ring 134 preferably meet the applicable ASME and OSHA standards.

[0036] Referring to FIGS. 1A-1D, storage component 104 comprises rectangular portion 120 and tapered portion 122. Rectangular portion 120 comprises four side walls 124a and 124b and top surface 126. Side walls 124a extend between two vertical support members 108 along the length of bulk material storage unit 100. Side walls 124b extend between two vertical support members 108 along the width of bulk material storage unit 100. As shown, the height of side walls 124a is longer than the height of side walls 124b. In embodiments where angled support members 112 are used, the corners of side walls 124a can be removed to accommodate certain angled support members 112, as shown in FIGS. 1A-1B and 1D. Other embodiments can have different arrangements of side walls 124a and 124b.

[0037] Top surface 126 has openings (not shown) that allow the bulk material to be loaded into storage component 104 from above, such as shown in FIG. 5. Referring to FIGS. 1A and 1C, top surface 126 comprises lid members 128 to regulate access to storage component 104 through these openings. Referring to FIG. 1A, lid members 128 lay on top surface 126 and is attached to top surface 126 via hinges 140. In this configuration, lid members 128 open away from top surface 126. However, in other embodiments, lid members 128 can have other known arrangements, such as opening into top surface 126. Referring to FIGS. 1A and 1E, lid members 128 have dimensions that are slightly larger than the corresponding openings of top surface 126 so they can sufficiently cover the openings and protect the bulk material within when closed. In the preferred embodiment, the openings of top surface 126 and corresponding lid members

128 have a length that extend substantially along the length of top surface 126. The openings of top surface 126 and corresponding lid members 128 have a width that is sufficient to allow bulk material to be efficiently loaded into storage component 104. Thus, in certain embodiments, the width can vary depending on the particular bulk material and/or equipment, but it is preferable that the width is designed to be compatible with as many equipment and/or bulk material as possible. The dimensions of lid members 128 can vary. For example, lid member 128 can have a width of about 12 inches, about 18 inches, about 24 inches, about 36 inches, or about 48 inches. For applications involving fine particles such as sand, the preferred width is about 36 inches. If two lid members 128 are used, both can have the same or different width as desired. In one embodiment, the width of lid member 128 is at least dependent on the size of the down spout used to fill bulk material container unit 100. In the preferred embodiment, the length of lid member 128 is about 10 feet. In one embodiment, lid member 128 can be made out of any suitable light weight and durable material such as formed plastic, or fiberglass. In an embodiment for use with finer particles such as sand, the preferred material for lid member 128 is steel or aluminum.

[0038] Referring to FIGS. 1A-1D, tapered portion 122 includes four tapered walls 130 extending from each side wall 124 in a narrowing manner toward the bottom of bulk material storage unit 100. To maximize the volume of storage component 104, tapered portion 122 preferably ends near the bottom of bulk material storage unit 100. In the preferred embodiment, the angle at which walls 130 taper is about 45 degrees; however, tapered walls 130 can have any other angles, such as about 60 degrees, about 55 degrees, about 50 degrees, about 40 degrees, about 35 degrees, about 30 degrees, or about 25 degrees. An angle of about 45 degrees is a minimum angle at which the full effect of gravity acts on the particulate material inside storage component 104. While angles less than about 45 degrees gradually reduce the vertical force of gravity as the angle approaches 0 degrees, certain embodiments can employ such angles to sacrifice the gravity effect for additional volume where rapid dispensing of the bulk material may not be critical. Likewise, angles greater than about 45 degrees may be beneficial in certain applications.

[0039] Referring to FIGS. 1A-1F, tapered portion 122 ends with an opening (not shown) near the bottom bulk material storage unit 100 to allow unloading of the bulk material from storage component 104. Dispensing component 106 is attached to the end of tapered portion 122 to regulate the flow of the bulk material from storage component 104. In the preferred embodiment, dispensing component 106 retains the bulk material in storage component 104 and prevent leakage of the bulk material in the closed position. Referring to FIGS. 1A-1E, dispensing component 106 preferably also allows for adjustment of the rate of flow of the bulk material within the range from the closed position to fully open using actuator member 132. In one embodiment, dispensing component 106 comprises a valve, preferably a butterfly valve according to ASME standards.

[0040] Referring to FIGS. 1B-1F, in the preferred embodiment, to maximize the volume of bulk or particulate material that can be loaded into storage component 104, bulk material storage unit 100 further comprises diverter components 136 positioned below lid members 128. Diverter components 136 divert the bulk material pouring in from the top toward side walls 124 to minimize the angle of repose or the conical pile that typically forms when bulk or particulate material is poured through openings of top surface 126. FIGS. 2A and 2B demonstrate the angle of repose of bulk material 202 when poured through top surface 126 having one opening/one lid member 128 or two openings/two lid members 128, respectively, into storage component without any diverter component 136 installed. As shown in FIG. 2B, using top surface 126 with two openings can increase the volume of material that can be poured into storage component 104 as compared to only using one opening as shown in FIG. 2A. The two openings allow bulk material to be introduced to the sides of storage component 104, taking advantage of space near the top of storage component 104 that would be unavailable if only one opening was used. There are many factors that affect the angle of repose, or the internal angle between the surface of the pile and the horizontal surface, such as density, surface area and shapes of the particles, and the coefficient of friction of the material. Material with a low angle of repose forms flatter piles than material with a high angle of repose. As such, the decision to employ one or two openings, as well as corresponding diverter components 136, may be more critical in maximizing the volume of bulk

materials with higher angle of repose that can be loaded as compared to bulk materials with lower angle of repose.

[0041] Referring to FIGS. 1B-1F and 3A-3B, each diverter component 136 preferably includes two ends attached to the inner surface of side walls 124b. A body extend between the two attached ends. The length of diverter component 136 preferably generally match the length of the respective opening of top surface 126 covered by lid member 128. The width of diverter component 136 (the maximum distance across diverter component 136) can be larger or smaller than the width of the respective opening of top surface 126. In one embodiment, the width of diverter component 136 is between about 12 inches and 48 inches, and more particularly, about 12 inches, about 18 inches, about 24 inches, about 36 inches, or about 48. In an exemplary embodiment, when used with down spouts having a width of about 24 inches, divert component 136 preferably has a width of about 24 inches, and for down spouts of about 36 inches, the width of diverter component 136 is about 36 inches.

[0042] In another embodiment, the body of diverter component 136 has two surfaces 138 angled away from each other that reduce the conical piling below the loading point of the bulk material. The incoming particulates hit angled surfaces 138 and get deflected toward the sides of storage component 104. Thus, the incoming bulk material fills up storage component 104 more evenly, thereby making more volume near the top of storage component 104 available for use as storage. In addition, diverter component 136 preferably comprises a plurality of apertures 142 to allow bulk material particulates to pass through. Referring to FIGS. 3A and 3B, diverter component 136 has three rows of apertures 142, and surfaces 138 are at an angle of about 30 degrees from the horizontal, as indicated by line 302. This can vary with different industries and particulate materials, ranging from about 27 degrees to about 89 degrees. For fine particles like sand and other particles with properties similar to sand, the preferred angle is about 30 degrees. In one embodiment, particularly for sand, the surface area provided by apertures 142 is about half of the total surface area of surfaces 138. As shown, apertures 142 has a diameter of about 1.5 inches, which is particularly suitable to sand and other similar fine particles. The diameter and surface area of apertures 142 can vary

with other industries and materials, where at least the density and permeability of the particulate material being loaded. It is understood that the location, size, and/or shape of apertures 142 can vary to optimally reduce of the angle of repose of the material being loaded, thereby maximizing the use of space within storage component 104. In particular, each of the position, size, and shape of apertures 142 can each be varied. For instance, an exemplary diverter component can have apertures 142 of various sizes and/or shapes that are positioned in uniform or nonuniform arrangement.

[0043] Further, it should be understood that the illustrated diverter component 136 with angled surfaces 138 is merely illustrative and not intended to limit the present invention. Diverter component 136 deflects particulates toward the walls of storage component 104, thereby disrupting the flow of particulates into storage component 104 that can form a conical pile if left undisturbed. The deflection of particulates can be implemented in other forms within the skill of one of ordinary skill in the art. For example, instead of or in addition to apertures 142, angled surfaces 138 can comprise a plurality of fingers where certain particulates would be deflected when they hit the surface of these fingers while others fall through the gaps between the fingers. Another example includes a cylinder with a plurality of protrusions that is configured to spin as particulates are flowing in and hitting the surfaces of the cylinder.

[0044] In the preferred embodiment, for every opening of top surface 126 and lid member 128, there is provided a divert component 136 placed below the respective opening of the top surface 126 to direct incoming bulk material to the side and minimize the angle of repose. Also, in other embodiments, such as that shown in FIG. 4, top surface 126 can comprise one opening (not shown) and one lid member 128. Storage component 104 of bulk material storage unit of FIG. 4 preferably includes one corresponding diverter component 136 placed below the single lid member 128.

[0045] In the preferred embodiment, bulk material storage unit 100 is sized to be compatible with equipment at the source location, the transport equipment, and equipment at the destination. Bulk material storage unit 100 is preferably adapted to fit flatbed rail cars for rail transportation or flatbed trailers for roadway transportation. The

preferred bulk material storage unit has dimensions that are compatible with both railway and roadway transportation equipment for versatility. Based on dimensions of flatbeds currently used for both railway and roadway transport and roadway regulations governing the height of trailers, the preferred bulk material storage unit 100 has a length of less than about 12 feet, a width of less than about 8 feet 6 inches, and a height of less than about 10 feet. In particular, bulk material storage unit 100 more preferably has a length of about 12 feet, a width of about 8 feet 4 inches, a height of about 9 feet 9 1/16 inches, not including any lift ring 134. In one embodiment, diverter component 136 is attached to the interior of side walls 124b through welding or it can be bolted to side walls 124b. In certain embodiments, angular supports can be used to reinforce the anchoring at the location of attachment. Diverter component 136 is preferably attached to side walls 124b so that the distance between the peak angle of diverter component 136 and top surface 126 is about 1 to 18 inches. The specific distance can vary depending on the density and angle of deflection of the product being loaded into bulk material storage unit 100. For applications involving fine particles such as sand, the preferred distance from top surface 126 is about 3 inches determined based at least on the density of sand. Sand products can vary from about 8-16 mesh to about 100 mesh in size. Storage component 104 preferably is configured with dimensions to provide it with the capacity to hold up to 675 cubic feet of volume. Components of bulk material storage unit 100 can be made of durable materials such as steel, aluminum, fiberglass, plastic, or a combination thereof.

[0046] Referring to FIGS. 4-7, four bulk material storage units 100 can fit on a flatbed that is about 48 feet long, whether for a rail car, e.g., rail car 404 as shown in FIGS. 4-6, or a trailer, e.g., trailer 704, as shown in FIG. 7. Referring to FIG. 4, bulk material storage units 100 can be transferred to and from flatbed 406, whether transported by rail or road, using forklift 402. Alternatively or in addition, bulk material storage units 100 can be transferred to and from flatbed 406 using a crane or similar lifting device through transfer component 114. While four bulk material storage units 100 can be placed on a flatbed of about 48 feet long, certain transportation regulations governing weight, particularly for roadways, may restrict the actual number of full bulk material storage units 100 that can be hauled by a particular at any one time. If bulk material storage units 100 are empty or not fully filled. This can expedite the logistics

process and cut transport costs by enabling multiple empty bulk material storage units 100 to be returned by one truck for every one full bulk material storage unit 100 delivered, where conventional trailers cannot provide this increased capability.

[0047] Referring to FIG. 8, according to another aspect, there is provided a second embodiment of the bulk material storage unit of the present invention, bulk material storage unit 800, which is similar to bulk material storage unit 100 of FIGS. 1A-1F. Certain descriptions of bulk material storage unit 100 are also applicable to bulk material storage unit 800, such as dimensions, composition materials, and manners of transfer or transportation. Bulk material storage unit 800 also comprises frame component 802, storage component 804, and dispenser component 806. Frame component 802, however, does not include any angled support members. Further, the arrangements of the components of bulk material storage units 800 are modified to allow bulk material storage to stack on top of one another. As shown, storage component 804 and horizontal support members 810 are respectively attached to frame component 802 such that a portion of the top and bottom of each vertical support member 808 are available so the top of vertical support members 808 of one storage unit 800 can engage and attach to the bottom of vertical support members 808 of another storage unit 800. As shown, bulk material storage unit 800 also includes lid member 828 placed generally in the center of top surface 826 that is round instead of rectangular like lid members 128 of bulk material storage unit 100. The shape and location of lid member 828 can allow for transferring of bulk material from a higher stacked storage unit 800 to a lower stacked storage unit 800. It is understood that any one or more of these modifications can be made to bulk material storage unit 100. Other known modifications can also be made to bulk material storage unit 100 to make it stackable.

[0048] According to another aspect of the present invention, there is provided a method of transporting bulk material using embodiments of the bulk material storage unit disclosed herein. The transport of bulk material begins with loading of bulk material into the bulk material storage units at the origin, whether it is the source location where the bulk material is collected, an off-site storage location, an intermediate transport point, etc. FIG. 5 shows one way of loading of bulk material storage units 100 with two lid

members 128 hauled by rail car 404. Railway 502 runs through silo 504 allowing successive bulk material storage units 100 to be pulled to the proper position underneath dispenser 506 of silo 504 to receive the bulk material. FIGS. 9 and 10 show exemplary ways of filling bulk material storage unit 800.

[0049] Once the bulk material storage units are filled, they are transported to the destination via the particular transportation mode, e.g., rail cars or trucks. The destination can be the final delivery point for the end-user, an intermediate transport point, etc. If storage of the bulk material, whether permanent or temporary, is needed at the destination, the bulk material storage units can be unloaded from the rail cars or trucks and transferred to the desired location. Referring to FIG. 4, unloading of bulk material storage units 100 can be achieved with forklift 402. Embodiments of the present invention allow for storage to be stored immediately without requiring existing storage infrastructures at the destination, thereby freeing the transportation equipment to be utilized elsewhere, preventing obstruction of the logistics flow, and reducing costs associated with constructing storage structures. Embodiments of the present invention also eliminate any costs or material loss associated with the transfer of bulk material from conventional shipping containers to a storage container by providing bulk material storage units that can serve as both. If the stored bulk material needs to be moved to another location or transported again via rail way or road way, the bulk material storage units can be moved via the transfer components as described above. Embodiments of the present invention also allow for straightforward transfer of only a portion of the stored bulk material by transferring only the desired number of bulk material storage units. Further, the portability of embodiments of the present invention provides storage flexibilities to adapt to the changing market where stored bulk material and/or storage space can be moved cost effectively to other regions.

[0050] As mentioned, embodiments of the present invention are applicable to meet needs of industries that involve storage and transport of particulate materials, such as sand, grains, ores, gravel, stone, etc. Certain embodiments, however, are particularly applicable for storing and transporting sand or similar fine particles. A specific industry that requires a large amount of sand to be delivered from the mines is the oil and gas

industry, which uses the sand as proppants in hydraulic fracturing at well sites. While the following descriptions specifically mention sand, it is understood they can be similarly applicable to other industries and particulate materials. Current rail transportation of sand uses rail hopper cars which are not designed to retain fine particles like sand, which often lead to product loss during transportation. This loss is typically referred to as variance. Variance in the oil and gas industry today ranges approximately 3% to 10%. Embodiments of the present invention can reduce or eliminate this variance because they are configured to prevent leakage.

[0051] When sand is delivered to the well site, it is typically injected into the well using pneumatic trailers. Embodiments of the present invention can reduce the number of pneumatic trailers used by allowing the sand to be stored closer to the well, thereby making the sand more accessible. Embodiments of the present invention can also facilitate in eliminating use of the pneumatic trailers through the use of an alternative sand injector that can take advantage of the It is designed to use gravity as one energy source to introduce the sand into the well.

[0052] Sand has different angles of repose depending on its properties. Dry sand has an angle of repose of about 34 degrees, moist sand has an angle of repose of about 15 degrees and 30 degrees, and wet sand has an angle of repose of about 45 degrees. As discussed above, more volume of moist sand can be filled as compared to dry and wet sand because moist sand has the lowest angle of repose. Specifically, for a bulk material storage unit with dimensions of about 12 feet in length, about 8 feet 4 inches in width, and about 9 feet and 9 1/16 inches in height, the volume for a 45 degrees angle of repose for a single opening surface, as shown in FIG. 2A, is about 360 cubic feet, and the volume for a 34 degrees angle of repose is 425 cubic feet. For a two-opening surface, as shown in FIG. 2B, the volume for a 45 degree angle of repose is 460 cubic feet compared to the volume for a 34 degree angle of repose is 493 cubic feet.

[0053] As described, the volume of sand that can be loaded is increased by using two openings. This volume can further be increased by using diverter components 136, as described above. In one embodiment, under normal conditions, an increase of about

2,000 to 6,000 lbs. can be achieved for sand products. Referring to FIGS. 3A and 3B, as described above, diverter component 136 has three rows of apertures 142, and surfaces 138 are at an angle of about 30 degrees from the horizontal, as indicated by line 302. The surface area provided by apertures 142 is about half of the total surface area of surfaces 138. As shown, apertures 142 has a diameter of about 1.5 inches, which is particularly suitable to sand and other similar fine particles. For other industries and particulate materials, diverter components 136 are reconfigured to suit the conditions of such industries and materials, including but not limited to modifications to the dimensions, angle of surfaces 138, surface area of apertures 142, number and arrangement of apertures 142, and diameter of apertures 142.

[0054] Although the present disclosure and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the disclosure as defined by the appended claims. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods and steps described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure of the present disclosure, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed that perform substantially the same function or achieve substantially the same result as the corresponding embodiments described herein may be utilized according to the present disclosure. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps.

CLAIMS

What is claimed is:

1. A method for filling a container with proppant, the method comprising the steps of:
positioning a plurality of containers proximate a proppant storage facility when proppant is stored therein to enable transfer of the stored proppant into each of the plurality of containers, each of the plurality of containers being moveable via a transportation mode;
pouring the stored proppant into each of the plurality of containers through one or more openings positioned within a top of the container to obtain a filled container, the pouring step includes forming a flow of proppant into each of the plurality of containers and along an interior tapered portion thereof positioned along a bottom portion of the container;
transporting each of the plurality of filled containers to a desired destination via the transportation mode;
unloading the filled container from the transportation mode at the desired destination, the filled container being lifted by a forklift via engagement of one or more transfer components when located at the desired destination; and
stacking the plurality of filled containers at the desired destination.
2. The method as defined in Claim 1, further comprising temporarily storing the filled container at the desired destination until the stored proppant positioned therein is needed at the desired destination.
3. The method as defined in Claim 2, wherein each filled container of the plurality of filled containers has a frame component that enables a first filled container of the plurality of filled containers to stack on top of a second filled container of the plurality of filled

containers, the first filled container of the plurality of filled containers being supported by the frame component of the second filled container of the plurality of filled containers.

4. The method as defined in Claim 1, wherein the transportation mode is a rail car, and the method further comprises:

positioning one or more of the plurality of containers prior to being filled with proppant below a silo when the one or more of the plurality of containers is on the rail car, the rail car being directed toward the silo via a rail; and

wherein the pouring step further includes emptying at least a portion of the proppant from the silo into the one or more of the plurality of containers through the one or more openings in the top of the one or more of the plurality of containers.

5. A method for filling a container with proppant, the method comprising the steps of:

positioning a plurality of containers proximate a proppant storage facility when proppant is stored therein to enable transfer of the stored proppant into each of the plurality of containers, each of the plurality of containers being moveable via a transportation mode;

pouring the stored proppant into each of the plurality of containers through one or more openings positioned within a top of the container to obtain a filled container, the pouring step includes forming a flow of proppant into each of the plurality of containers and along an interior tapered portion thereof positioned along a bottom portion of the container;

transporting each of the plurality of filled containers to a desired destination via the transportation mode;

unloading the filled container from the transportation mode at the desired destination, the filled container being lifted by a forklift via engagement of one or more transfer

components when located at the desired destination; and

temporarily storing each of the plurality of filled containers at the desired destination until the stored proppant positioned therein is needed at the desired destination

6. The method as defined in Claim 5, further comprising stacking the plurality of filled containers at the desired destination.

7. The method as defined in Claim 5, wherein each filled container of the plurality of filled containers has a frame component that enables a first filled container of the plurality of filled containers to stack on top of a second filled container of the plurality of filled containers, the first filled container of the plurality of filled containers being supported by the frame component of the second filled container of the plurality of filled containers.

8. The method as defined in Claim 5, wherein the transportation mode is a rail car, and the method further comprises:

positioning one or more of the plurality of containers prior to being filled with proppant below a silo when the one or more of the plurality of containers is on the rail car, the rail car being directed toward the silo via a rail; and

wherein the pouring step further includes emptying at least a portion of the proppant from the silo into the one or more of the plurality of containers through the one or more openings in the top of the one or more of the plurality of containers.

9. A method of transporting a plurality of proppant containers on a rail car, the method comprising:

positioning a plurality of proppant containers on a rail car when proppant is stored therein to enable transfer of the stored proppant into each of the plurality of containers, each of the plurality of containers being fillable with proppant through one or more openings positioned within a top of the container to obtain a filled container;

transporting each of the plurality of filled containers to a desired destination via the rail car;

unloading the filled container from the rail car at the desired destination, the filled container being lifted by engagement of one or more transfer components when located at the desired destination; and

stacking the plurality of filled containers at the desired destination.

10. The method as defined in Claim 9, further comprising temporarily storing the filled container at the desired destination until the stored proppant positioned therein is needed at the desired destination.

11. The method as defined in Claim 10, wherein each filled container of the plurality of filled containers has a frame component that enables a first filled container of the plurality of filled containers to stack on top of a second filled container of the plurality of filled containers, the first filled container of the plurality of filled containers being supported by the frame component of the second filled container of the plurality of filled containers.

12. The method as defined in Claim 9, further comprising:

positioning one or more of the plurality of containers prior to being filled with proppant below a silo when the one or more of the plurality of containers is on the rail car, the rail car being directed toward the silo via a rail; and

emptying at least a portion of the proppant from the silo into the one or more of the plurality of containers through the one or more openings in the top of the one or more of the plurality of containers.

13. The method as defined in Claim 10, wherein the lifting includes engagement by a forklift of the one or more transport components.

14. A method of transporting a plurality of proppant containers on a rail car, the method comprising:

positioning a plurality of proppant containers on a rail car when proppant is stored therein to enable transfer of the stored proppant into each of the plurality of containers, each of the plurality of containers being fillable with proppant through one or more openings positioned within a top of the container to obtain a filled container, and each filled container of the plurality of filled containers has a frame component that enables a first filled container of the plurality of filled containers to stack on top of a second filled container of the plurality of filled containers;

transporting each of the plurality of filled containers to a desired destination via the rail car; unloading the filled container from the rail car at the desired destination, the filled container being lifted by a forklift via engagement of one or more transfer components when located at the desired destination; and

stacking the plurality of filled containers at the desired destination, the first filled container of the plurality of filled containers being supported by the frame component of the second filled container of the plurality of filled containers when in a stacked position.

15. The method as defined in Claim 14, further comprising temporarily storing each of the plurality of filled containers at the desired destination until the stored proppant positioned therein is needed at the desired destination

16. The method as defined in Claim 14, further comprising:

positioning one or more of the plurality of containers prior to being filled with proppant below a silo when the one or more of the plurality of containers is on the rail car, the rail car being directed toward the silo via a rail; and

emptying at least a portion of the proppant from the silo into the one or more of the plurality of containers through the one or more openings in the top of the one or more of the plurality of containers.

17. The method as defined in Claim 15, wherein the lifting includes engagement by a forklift of the one or more transport components.

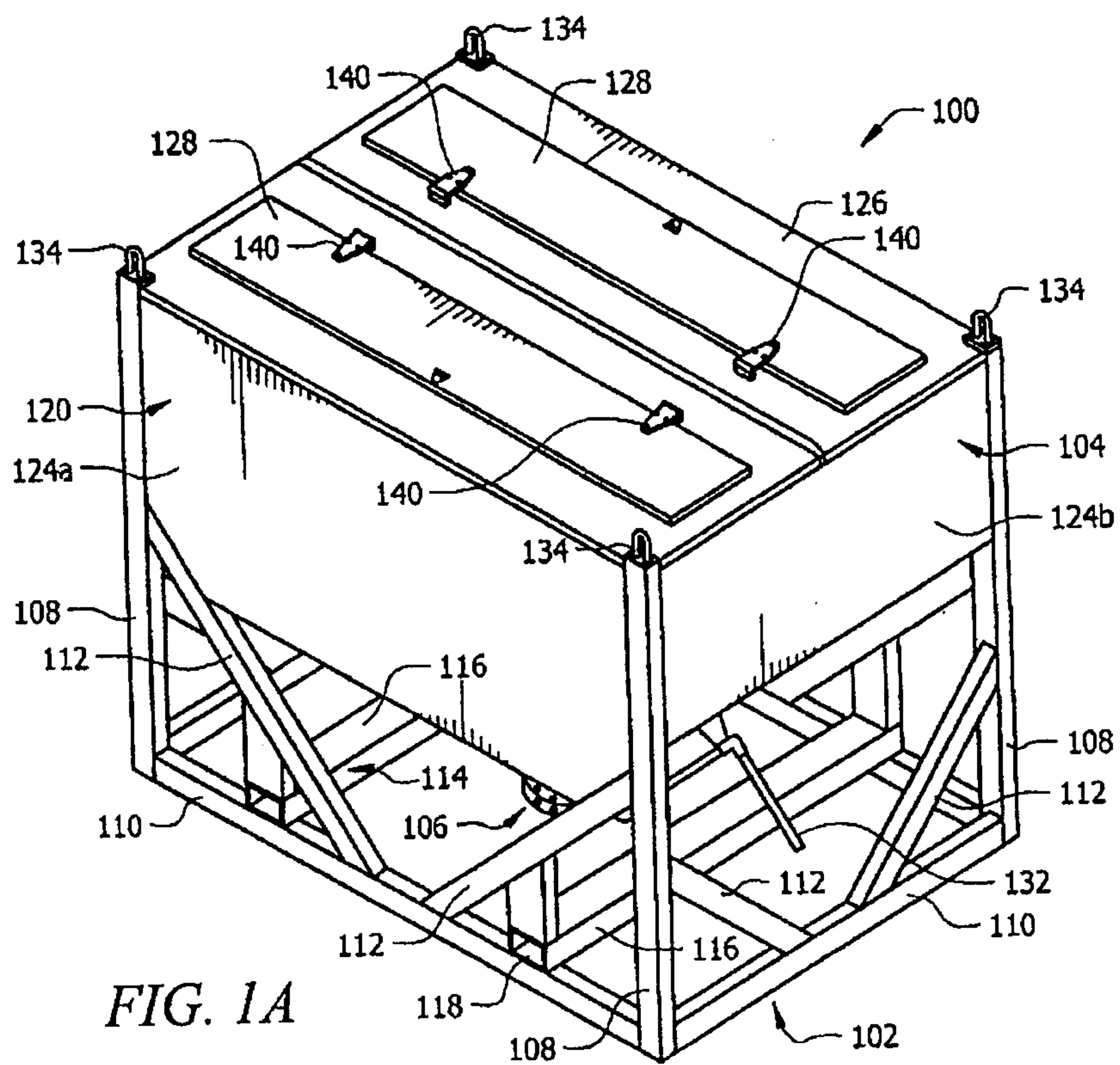


FIG. 1A

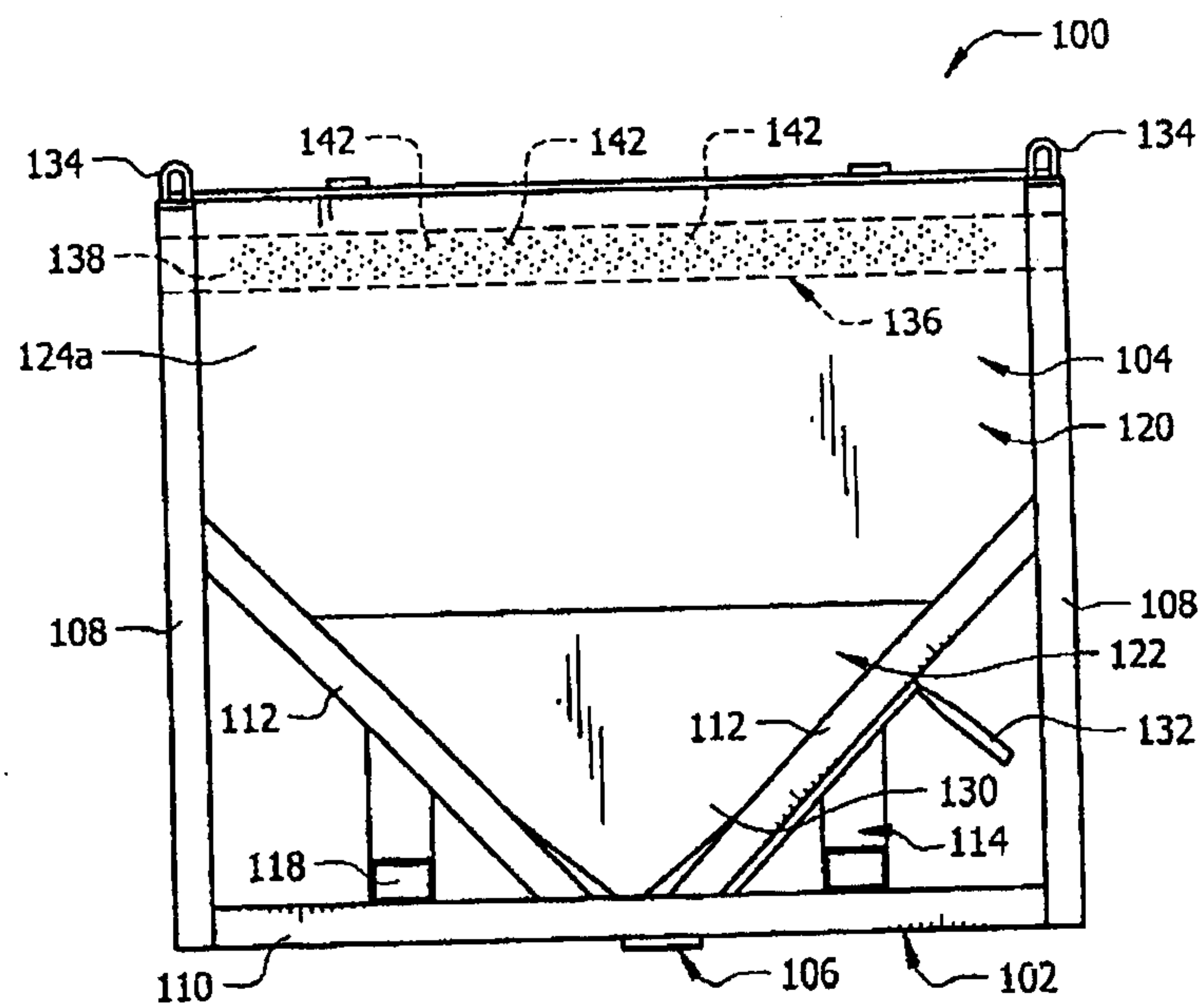


FIG. 1B

120

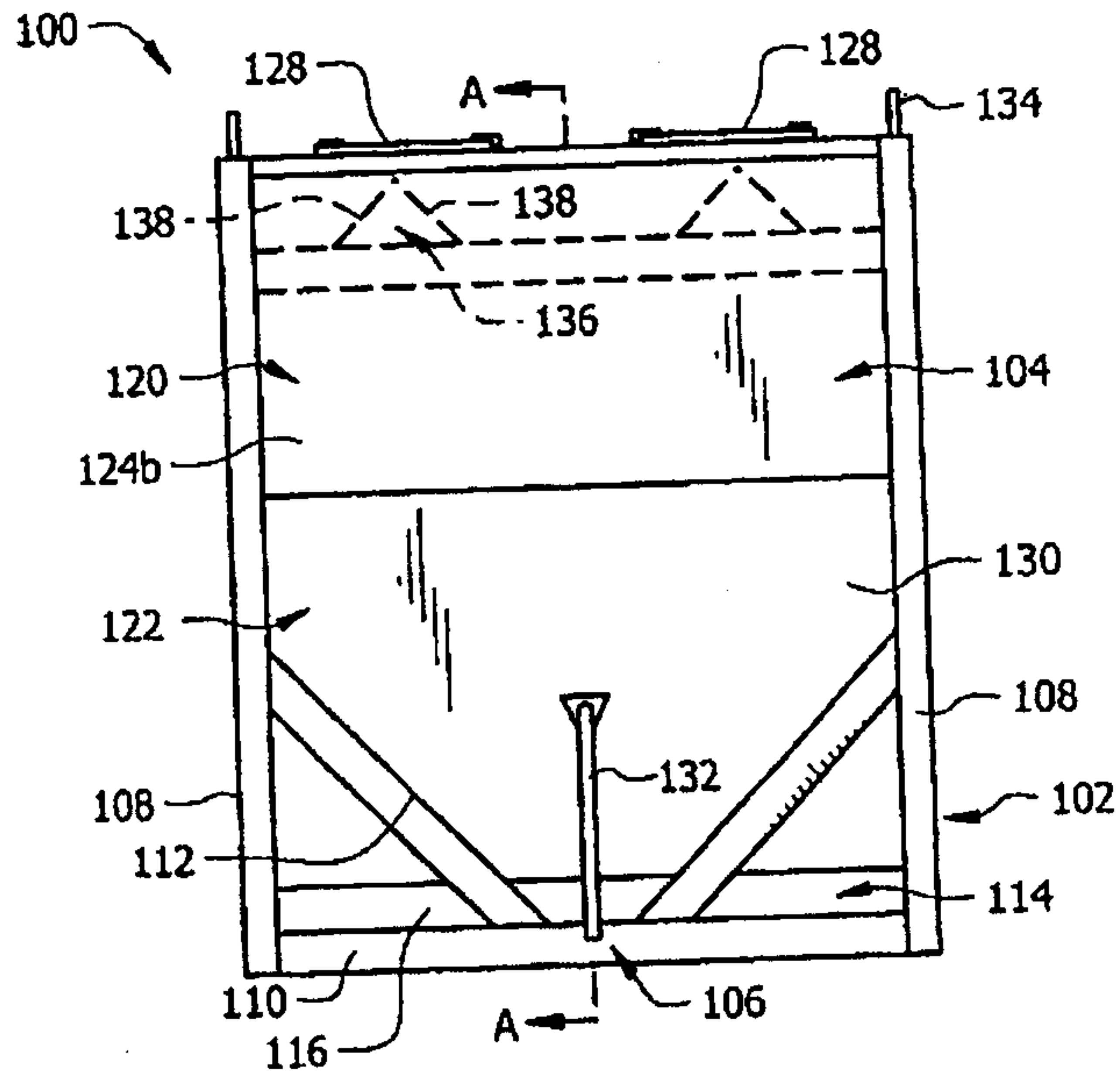


FIG. 1C

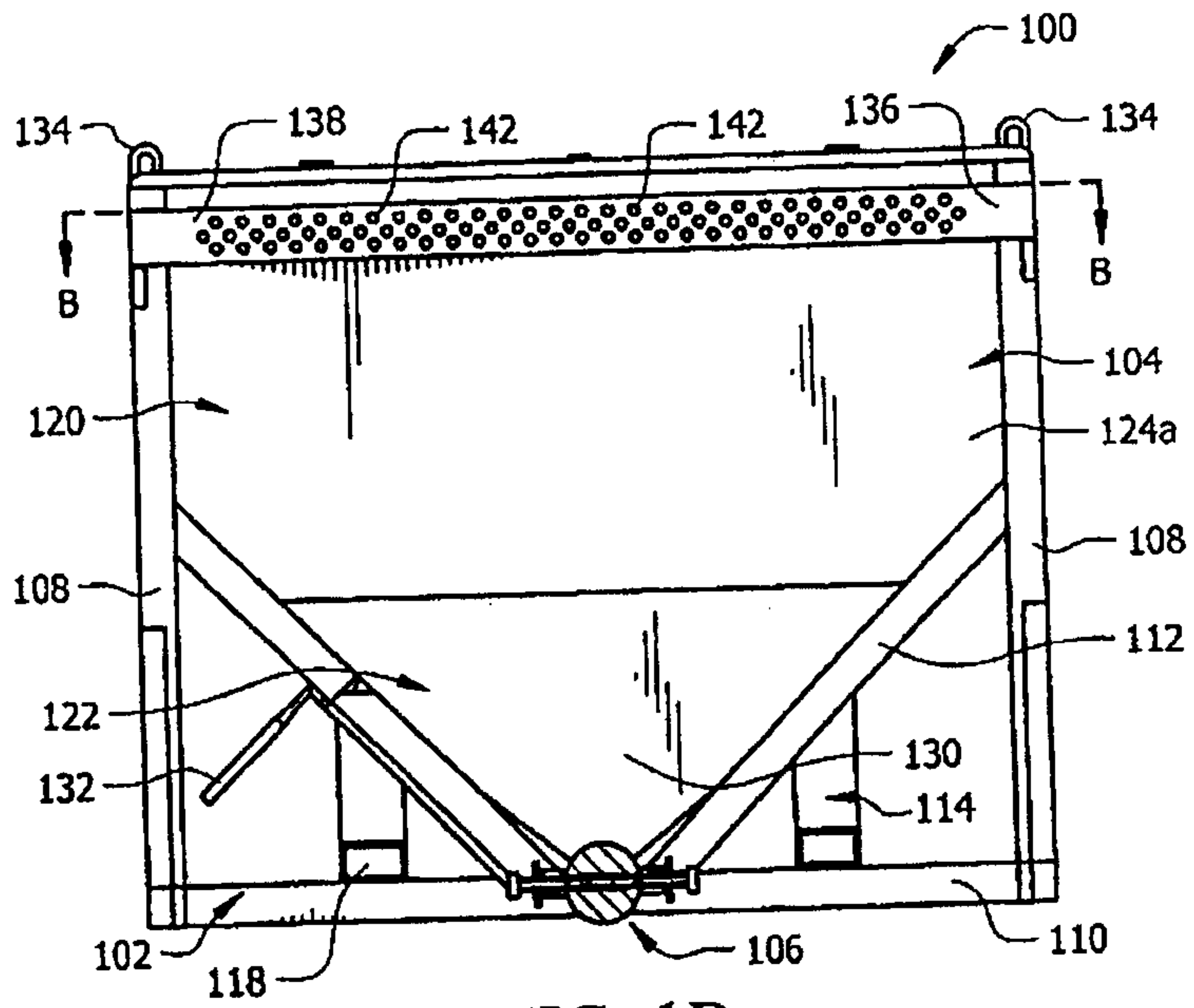


FIG. 1D

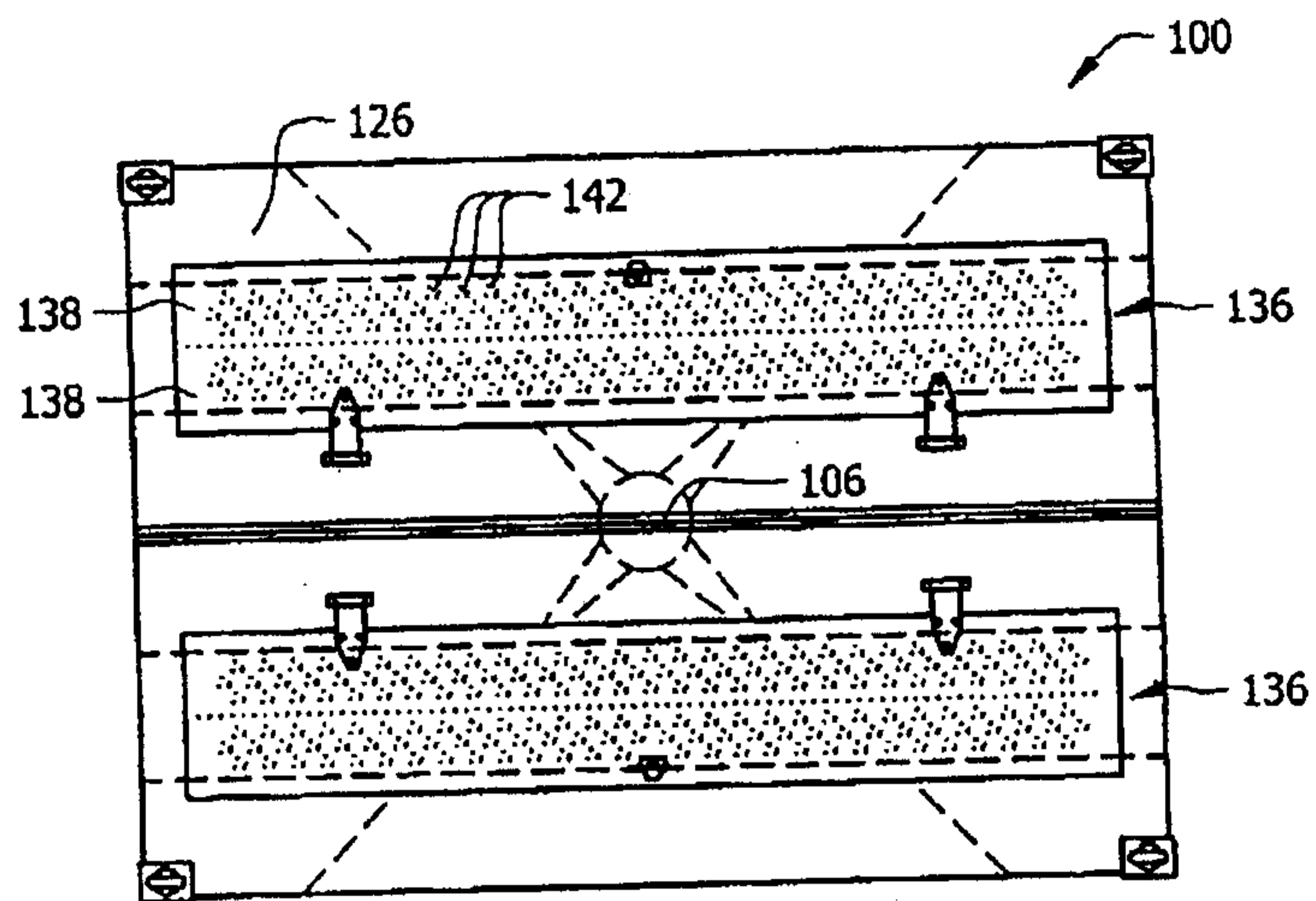


FIG. 1E

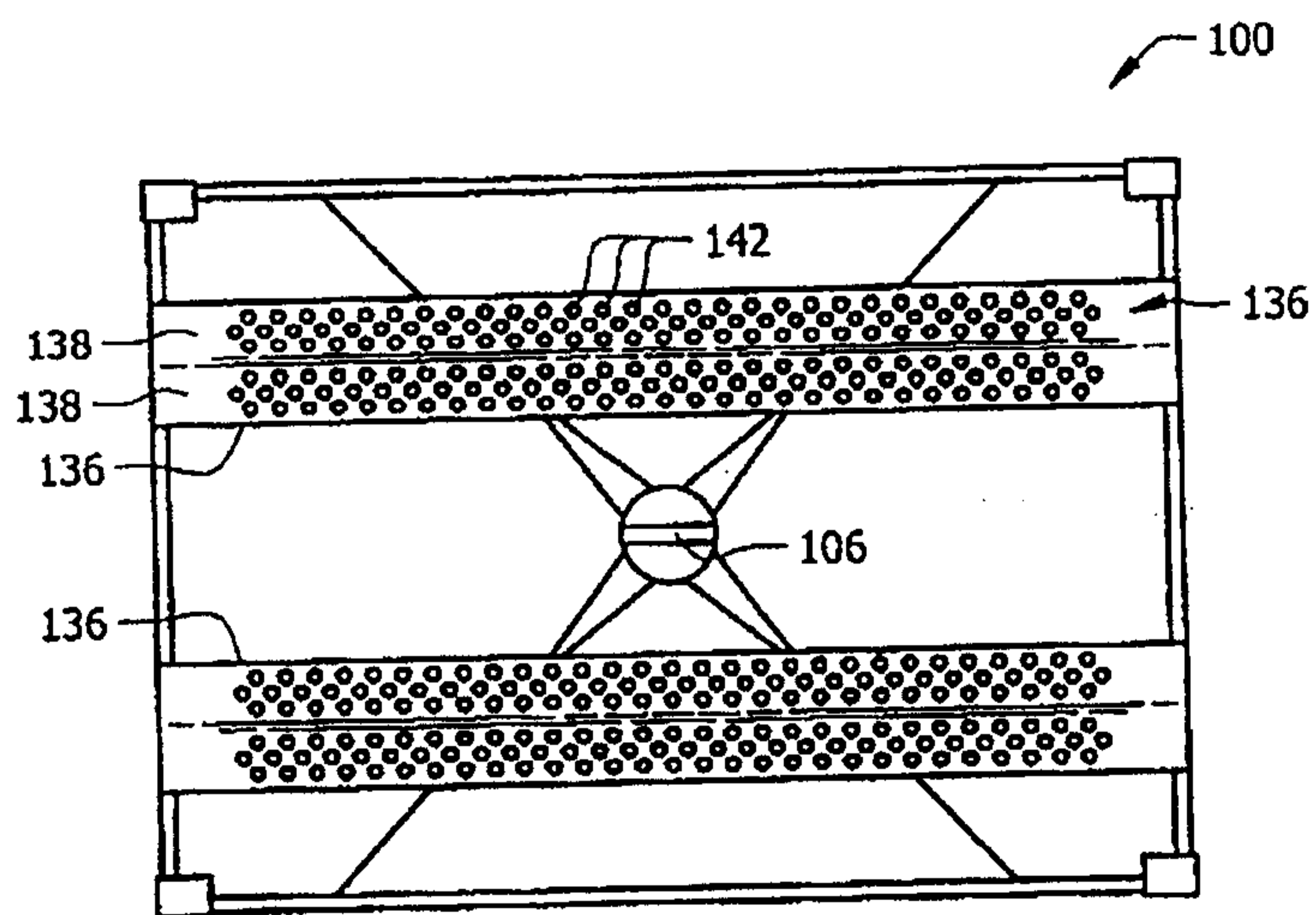


FIG. 1F

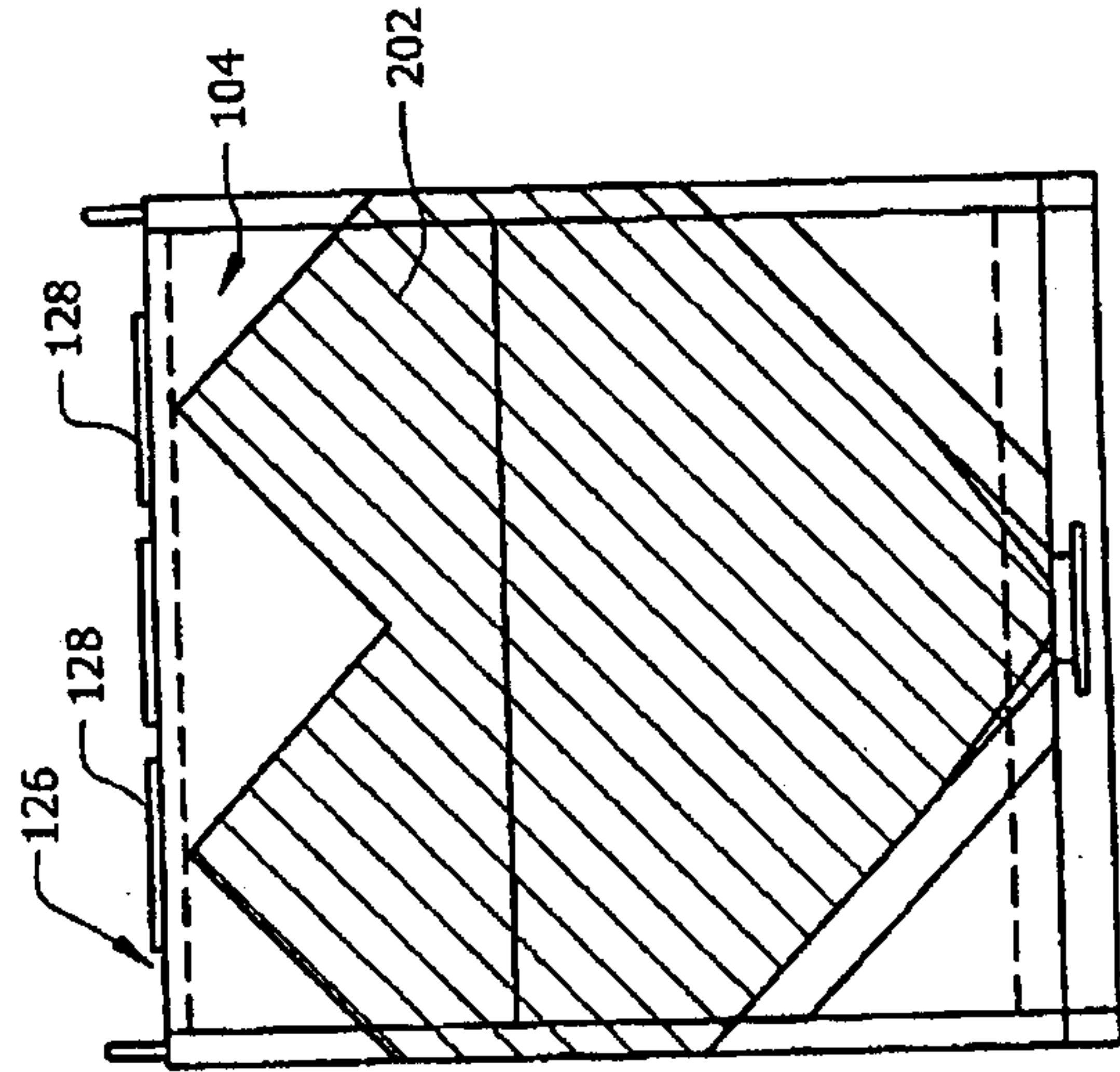


FIG. 2B

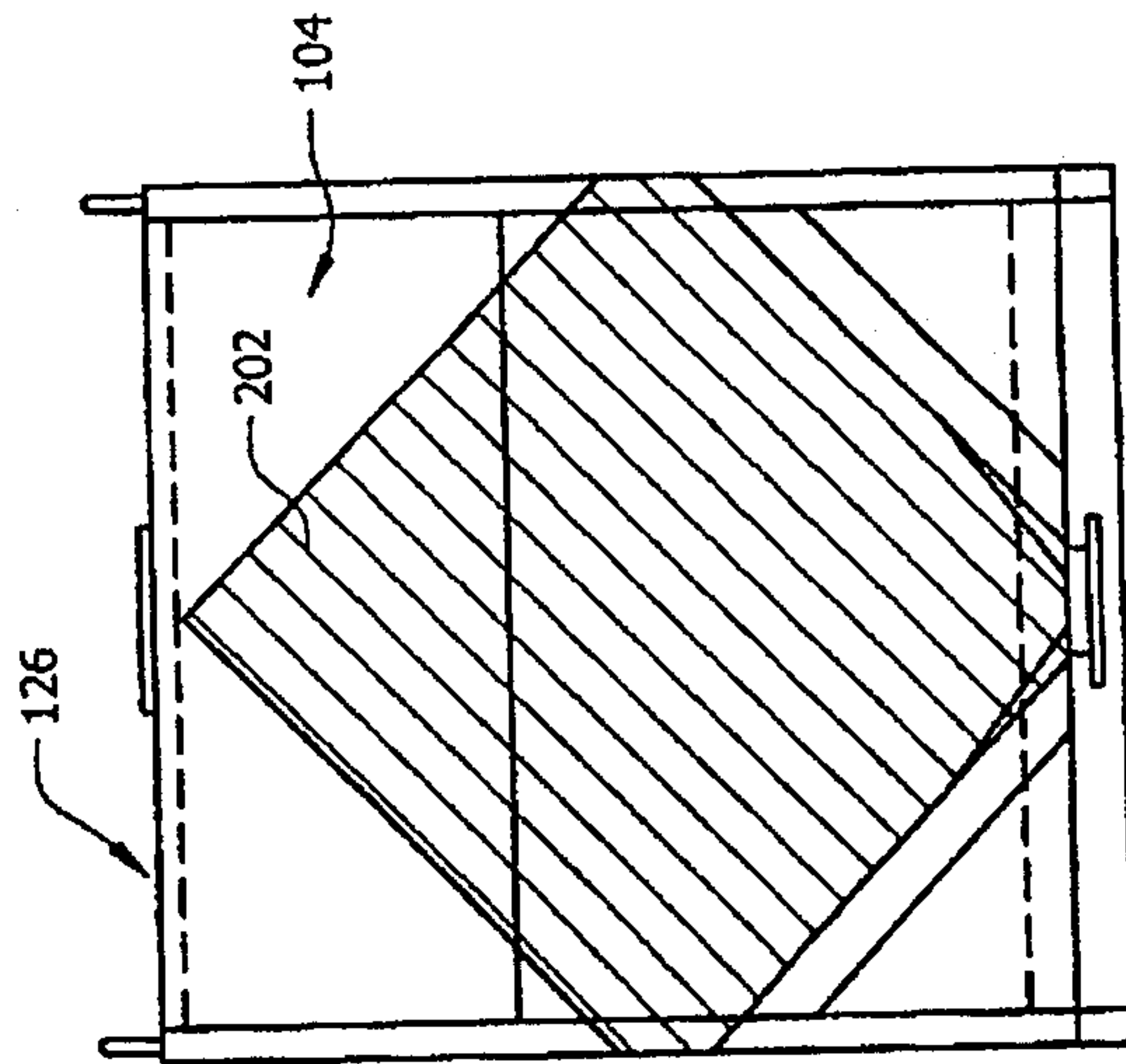


FIG. 2A

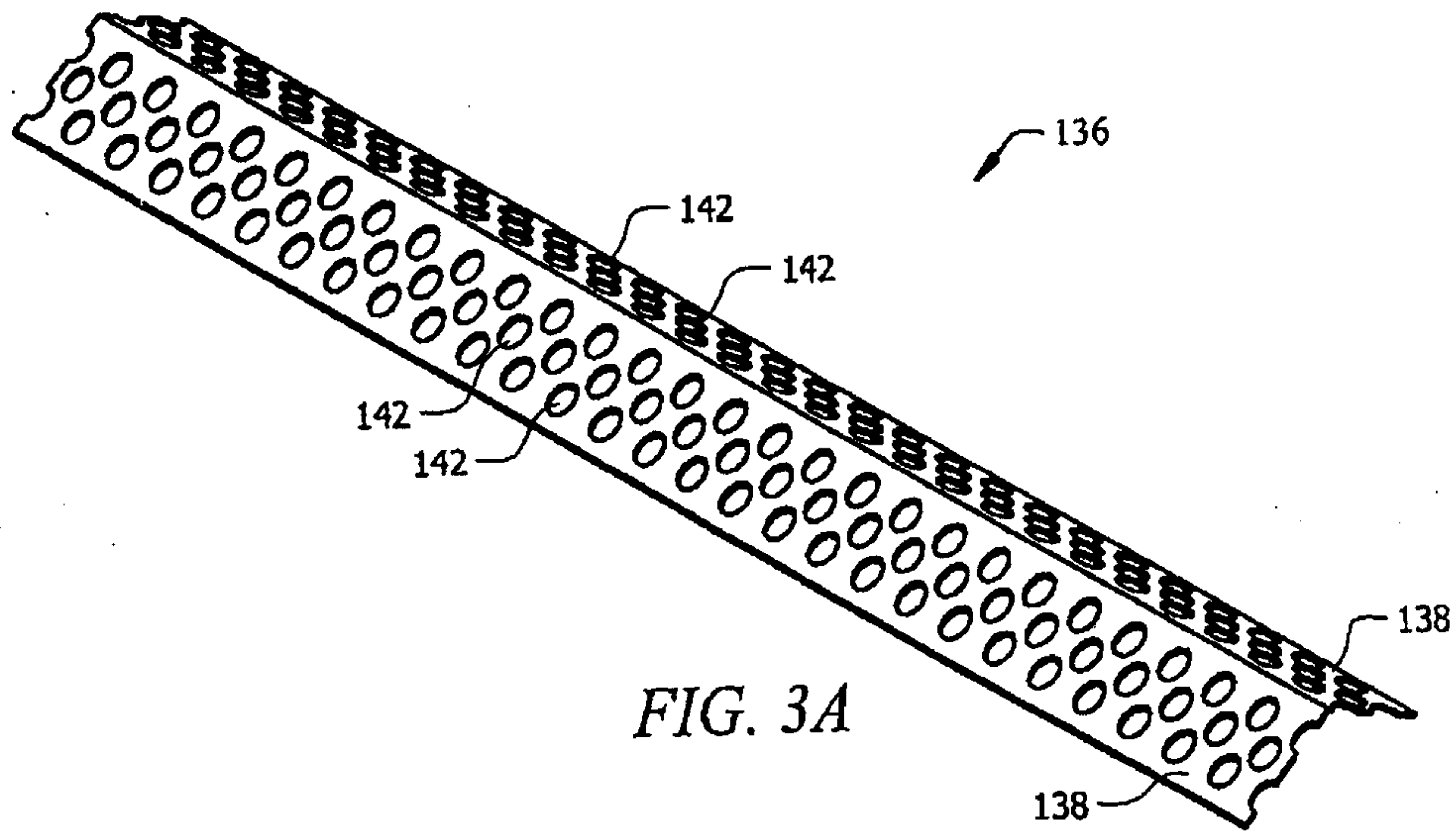


FIG. 3A

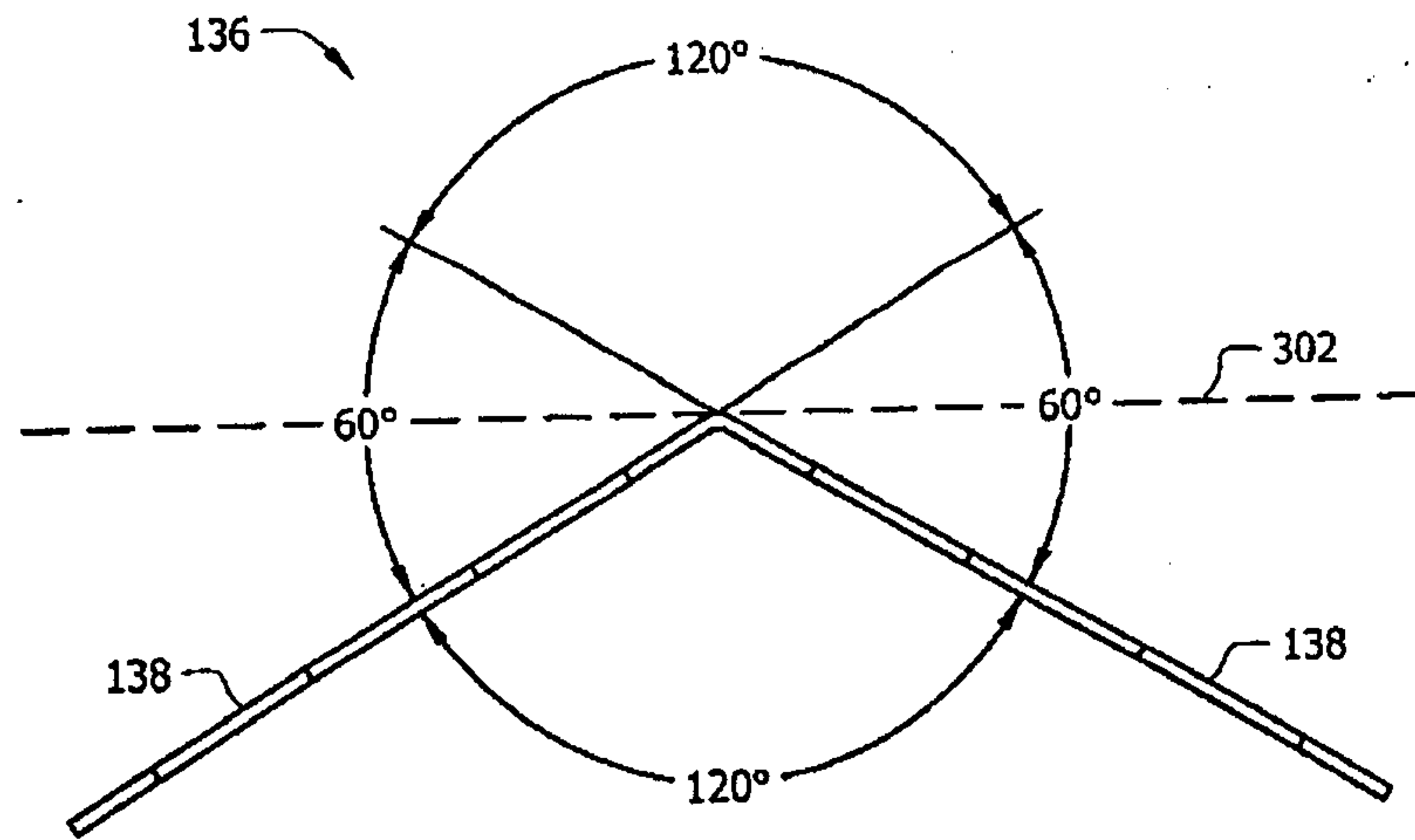


FIG. 3B

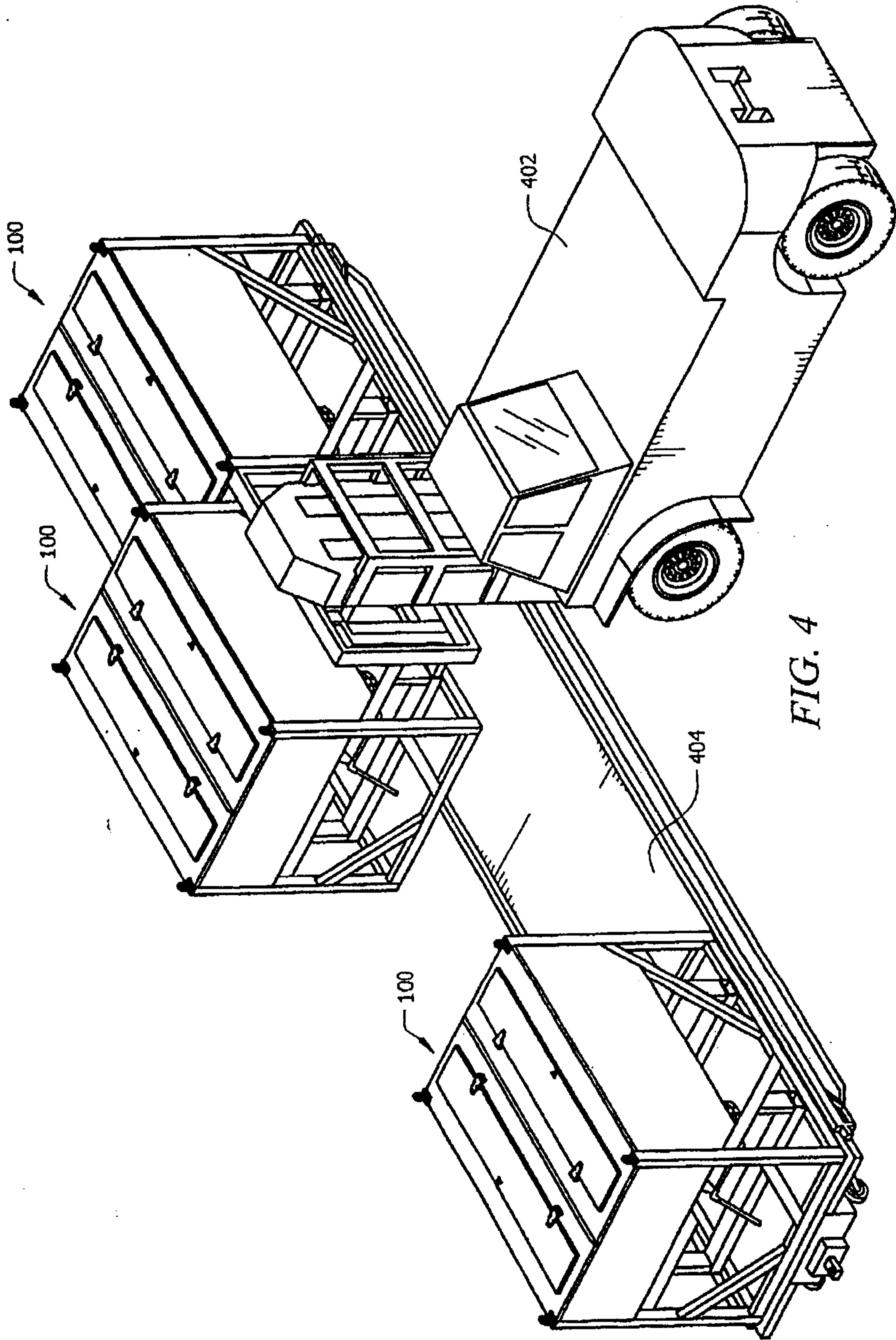


FIG. 4

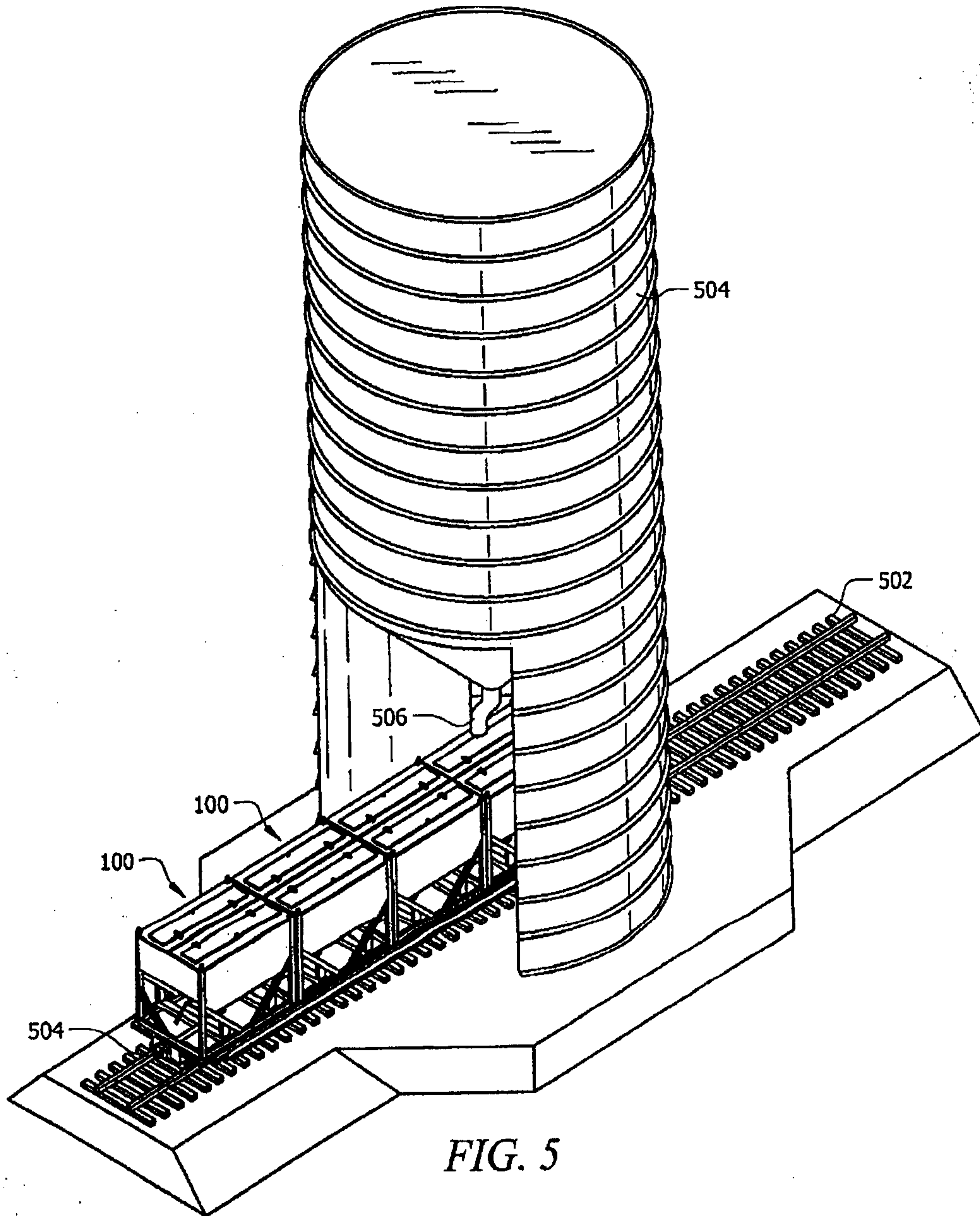


FIG. 5

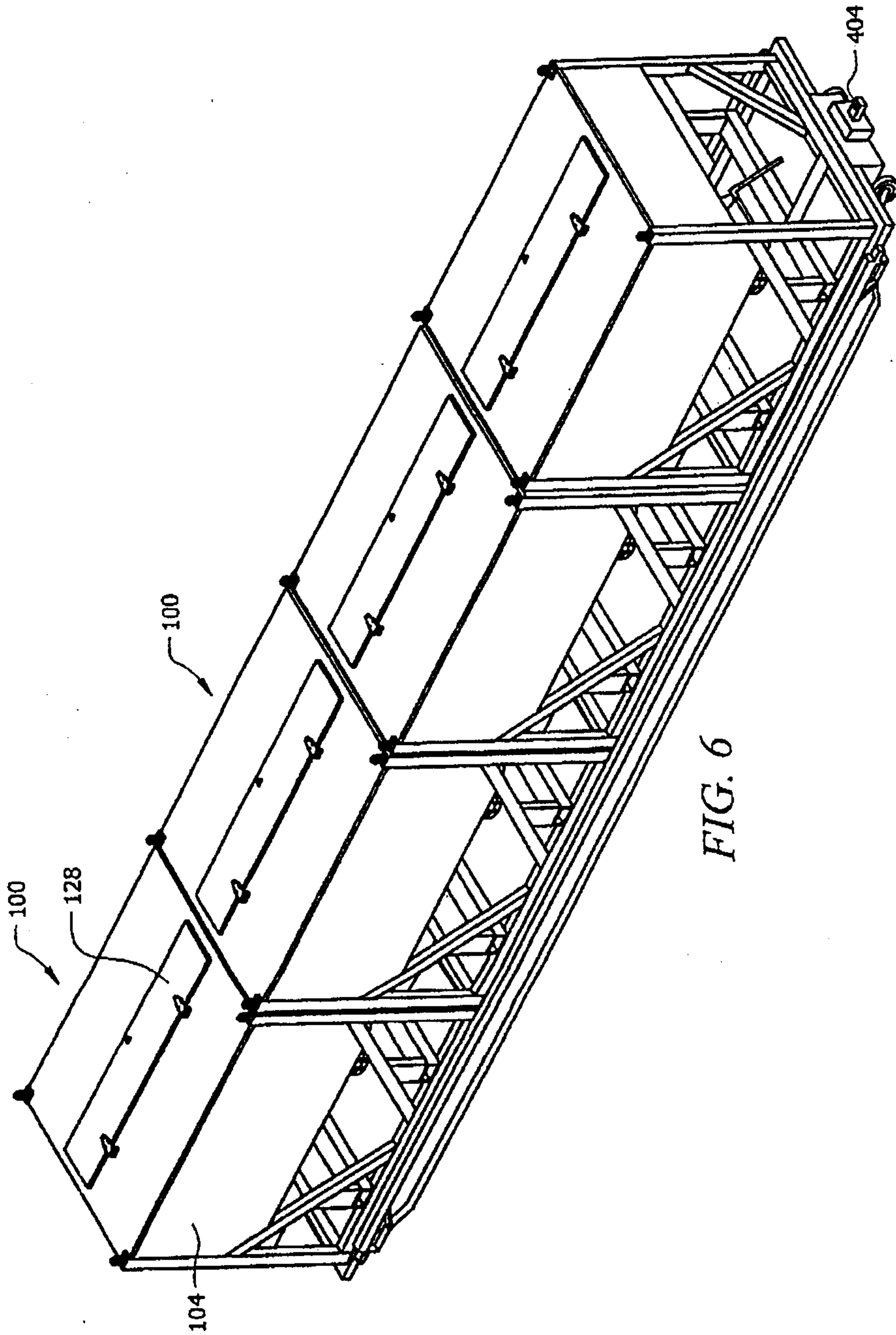


FIG. 6

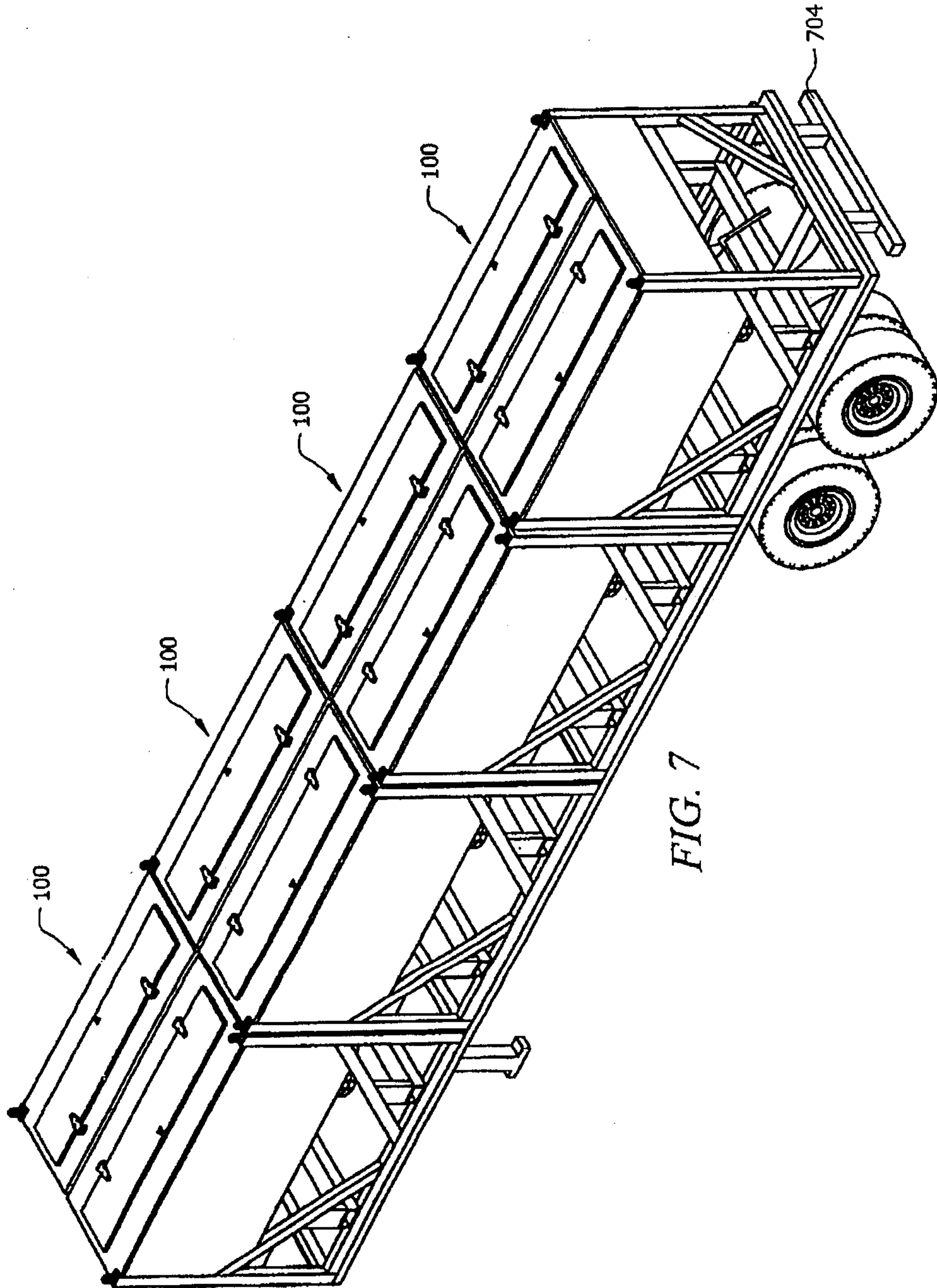


FIG. 7

11/11

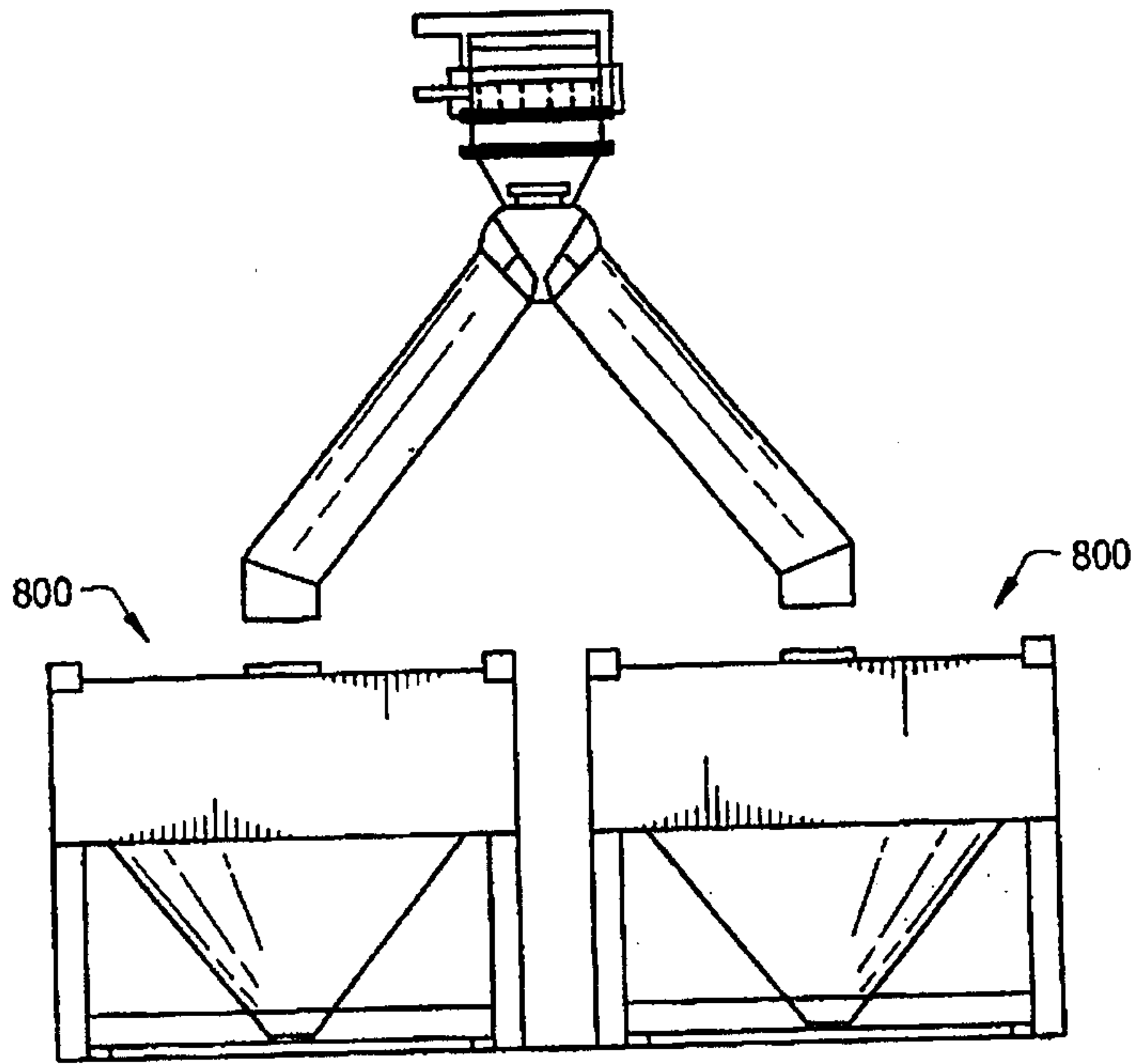


FIG. 9

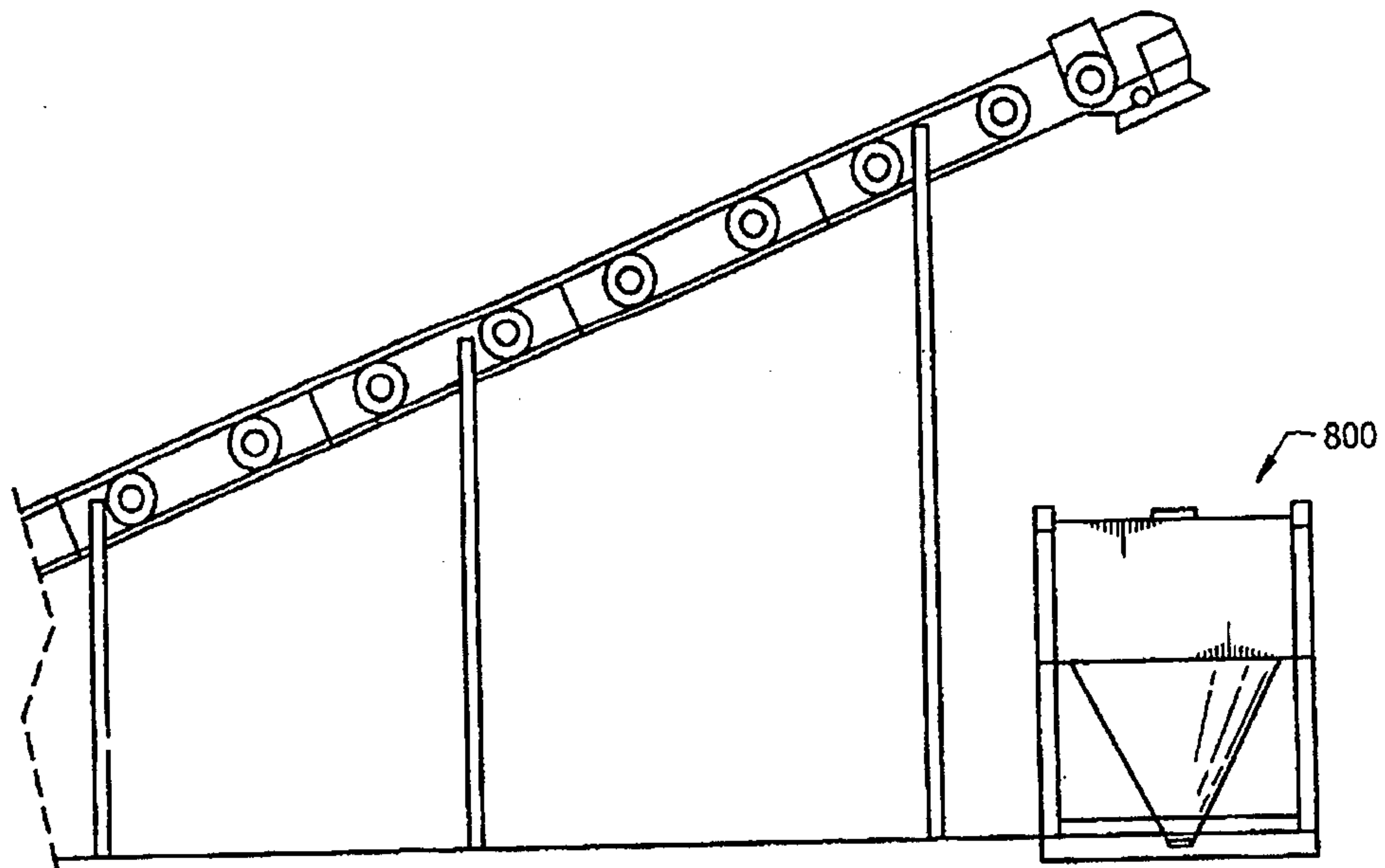


FIG. 10

