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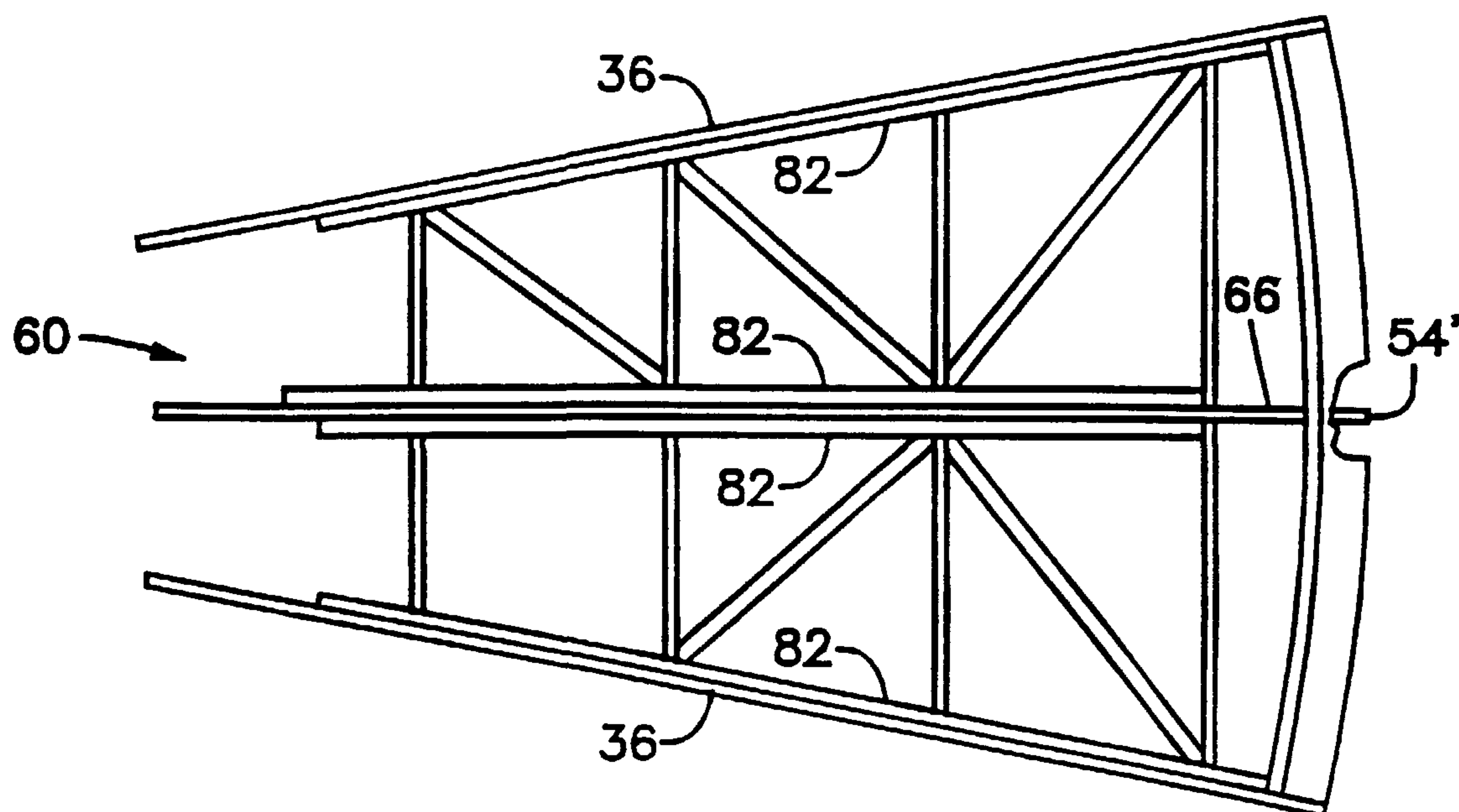
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(54) Title: ROTOR DESIGN WITH DOUBLE SEALS FOR HORIZONTAL AIR PREHEATERS



(57) Abrégé/Abstract:

An improvement for an existing horizontal air preheater (10) having a rotor housing (12) including a plurality of axial seal plates (27), sector plates (18, 20), and a rotor (14) located in said rotor housing having a plurality of radially extending original diaphragms (36) forming compartments (34) in said rotor, an original radial seal (48) extending from each axial edge of each of said original diaphragms, and an original axial seal (58) extending from an outboard radial edge of each of said original diaphragms, said improvement comprising an intermediate diaphragm mounted between each said original diaphragms (60), an additional axial seal (58), and an additional radial (48) seal.

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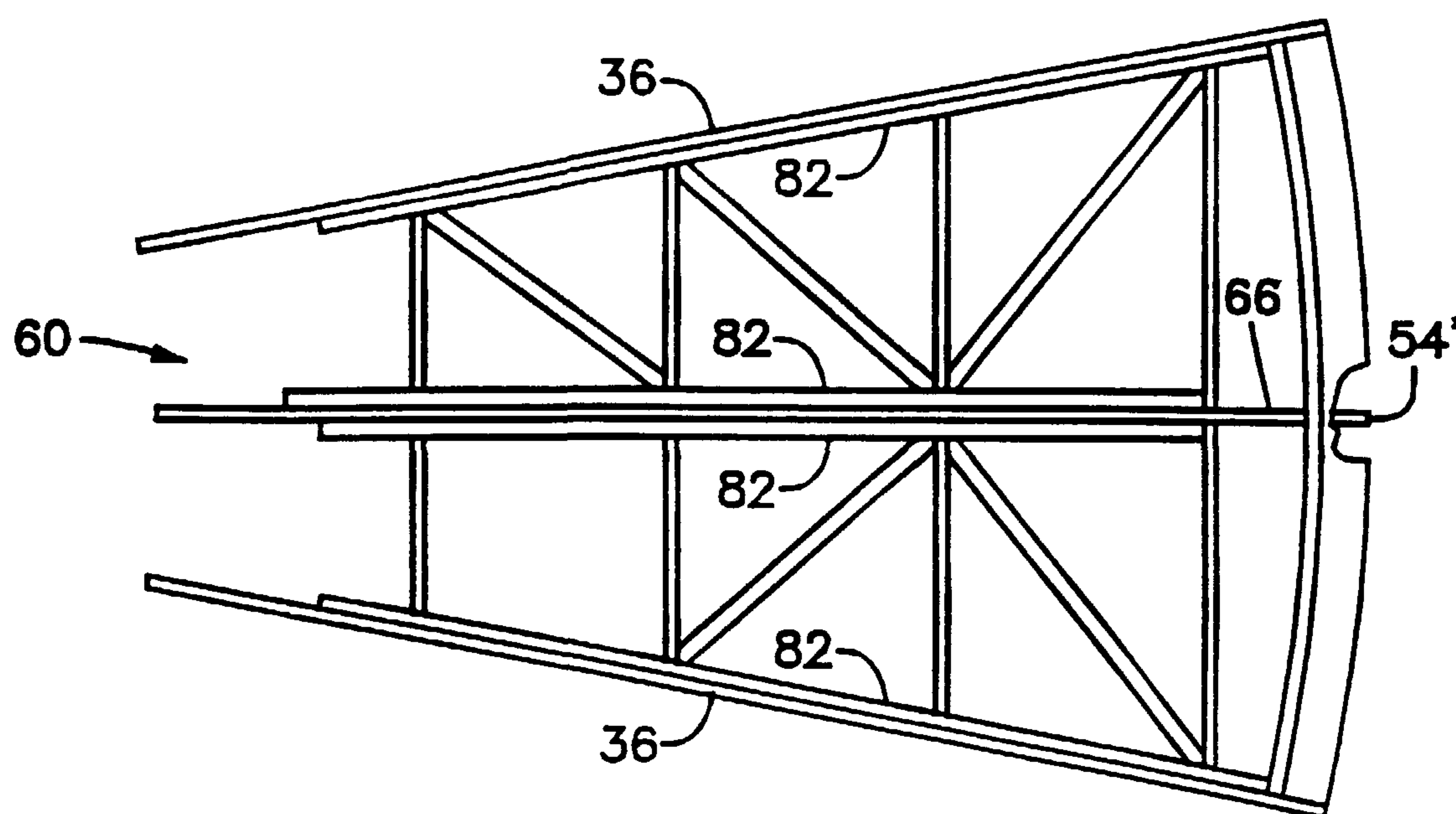
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(54) Title: ROTOR DESIGN WITH DOUBLE SEALS FOR HORIZONTAL AIR PREHEATERS



(57) **Abstract:** An improvement for an existing horizontal air preheater (10) having a rotor housing (12) including a plurality of axial seal plates (27), sector plates (18, 20), and a rotor (14) located in said rotor housing having a plurality of radially extending original diaphragms (36) forming compartments (34) in said rotor, an original radial seal (48) extending from each axial edge of each of said original diaphragms, and an original axial seal (58) extending from an outboard radial edge of each of said original diaphragms, said improvement comprising an intermediate diaphragm mounted between each said original diaphragms (60), an additional axial seal (58), and an additional radial (48) seal.



WO 01/86209 A1

Rotor Design With Double Seals For Horizontal Air Preheaters

Background of the Invention

5 The present invention relates to the axial seals and radial seals of a rotary regenerative air preheater for controlling leakage within the air preheater. More particularly, the invention relates methods and apparatus for adding additional axial seals and radial seals within installed air preheaters.

10 A rotary regenerative air preheater transfers sensible heat from the flue gas leaving a boiler to the entering combustion air through regenerative heat transfer surface in a rotor which turns continuously through the gas and air streams. The rotor, which is packed with the heat transfer surface, is divided into compartments by a number of radially extending plates referred to as diaphragms. These
15 compartments are adapted to hold modular baskets in which the heat transfer surface is contained.

The air preheater is divided into a flue gas side or sector and one or more combustion air sides or sectors by sector plates. In a typical installed rotary regenerative heat exchanger, rigid or flexible radial seals
20 mounted on the axial edges of the diaphragms are in close proximity to these sector plates and minimize leakage of air and/or gas between sectors. Similarly, rigid or flexible axial seals mounted on the outboard edge of the diaphragms are in close proximity to axial seal plates mounted on the inner surface of the housing and minimize leakage
25 therebetween. In typical installed air preheaters, the number of diaphragms and the width of the sector plates and the seal plates are such that only one radial seal and one axial seal is disposed proximate to the respective plate at any one time. These seals are proximity seals and are not designed to contact the sealing surface of the sector plates
30 or seal plates. Consequently, there is leakage past the seals where the



amount of leakage is dependent on the pressure differential between the air and gas streams across the seals. Leakage can degrade thermal performance, and require increased energy use resulting in higher costs for powering the fans. The leakage flow carries ash which produces erosion of the seals and sealing surfaces.

Summary of the Invention

The present invention relates to a method for adding additional axial seals and radial seals within existing air preheaters. To retrofit the additional seals, the original heat transfer baskets, the original radial seals, the original axial seals, and the original gratings are all removed from the air preheater. If stay plates are installed, they are either removed or modified to accept an intermediate diaphragm plate. A diaphragm inner support plate is mounted within each of the original compartments. Hot and cold end plates are mounted to the post and to an inboard portion of the original diaphragm plates. At this point an intermediate diaphragm plate is positioned within each original compartment by mounting it to the inner support plate and the rotor shell. New gratings and/or stay plates are mounted to the original diaphragm plates and the intermediate diaphragm plate. Additional hot and cold end axial seal support bars are mounted to the rotor shell and intermediate diaphragm plate. Axial seals are installed on the original axial seal support bars and on the additional axial seal support bars and radial seals are installed on the axial edges of the original diaphragm plates and the intermediate diaphragm plates. Finally, new heat transfer baskets are inserted into each of the compartments formed by the original diaphragm plates, the intermediate diaphragm plates, and the rotor shell.



Brief Description of the Drawings

Figure 1 is a general perspective view of a conventional bisector rotary regenerative air preheater which is cut-away to show the upper sector plates.

5 Figure 2 is a simplified top view of a conventional trisector air preheater showing the rotor in the housing and showing the sector plates.

10 Figure 3 is a simplified perspective view of a portion of the rotor assembly of an air preheater which has been modified in accordance with the present invention.

Figure 4 is a cross section view of an axial seal plate and a portion of a rotor which has been modified in accordance with the present invention illustrating the double seal arrangement.

15 Figure 5 is a cross section view of a sector plate and a portion of a rotor which has been modified in accordance with the present invention illustrating the double seal arrangement.

Figure 6 is a side view of the inboard portion of the rotor of Figures 3 and 4 illustrating the post, a diaphragm plate, gratings, and stay plates.

20 Figure 7 is a cross section view, taken along line VII-VII of Figure 6.

Figure 8 is a top view of the outboard portion of the rotor of Figures 3 and 4, partly in phantom, illustrating a compartment after the addition of the intermediate diaphragm plate, stay plates, and additional
25 axial seal support bar.

Figure 9 is a top view of the outboard portion of Figure 8, partly in phantom, illustrating the same compartment after the addition of gratings,

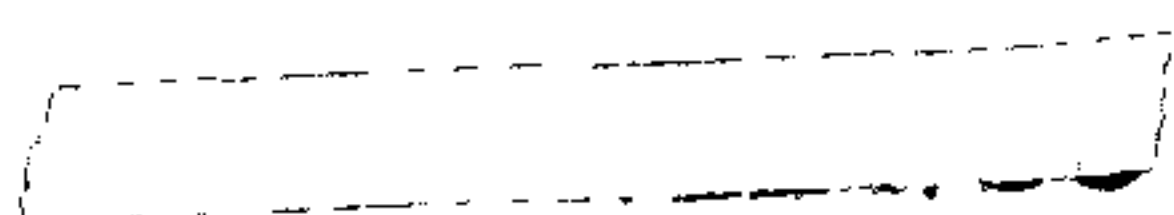


Figure 10 is a cross section view, taken along line X-X of Figure 8.

Figure 11 is a cross section view of a second embodiment of the outboard portion of Figure 8 illustrating an all grating construction.

5 Figure 12 is a cross section view of a third embodiment of the outboard portion of Figure 8 illustrating an all stay plate construction.

Description of the Preferred Embodiment

Figure 1 of the drawings is a partially cut-away perspective view of a typical bi-sector horizontal air preheater 10 rotated 90 degrees showing a housing 12 in which the rotor 14 is mounted on a drive shaft or post 16. The housing is divided by means of the flow impervious sector plates 18 and 20 into a flue gas sector 24 and an air sector 26. Corresponding sector plates are also located on the bottom of the unit. Mounted on the inside of the housing 12 are axial seal plates 27 which extend the full height of the rotor (Figure 4).

The hot flue gases enter the air preheater 10 as indicated by the arrow 28, flow through the flue gas sector 24 where heat is transferred to the heat transfer surface in the rotor 14. As this hot heat transfer surface then rotates through the air sector 26, the heat is transferred to the air flowing through the rotor as indicated by the arrow 30. Consequently, the cold air inlet and the cooled gas outlet define a cold end and the hot gas inlet and the heated air outlet define a hot end. The rotor 14 has a shell 32 and is divided into a plurality of pie-shaped compartments 34 by the diaphragm plates 36 with each compartment containing a plurality of heat exchange basket modules 38.

Figure 2 is a plan view representation of a conventional trisector air preheater comprising the rotor housing 12 and the rotor 14. The housing is divided in this case into three sectors by the sector plates 18,



20 and 22. The sectors are the flue gas sector 24 and the air sector 26 which is divided into the primary air sector 40 and the secondary air sector 42. This figure illustrates the sector plates in cross-section for purposes of clarity. The rotor 14 is composed of the shell 32 and the diaphragm plates 36 dividing the rotor into compartments 34. Each diaphragm plate 36 is composed of a relatively thick stub diaphragm portion 44, which extends from and is mounted to the rotor post, and a relatively thin main diaphragm portion 46 (Figures 6 and 7).

The primary concern with the leakage is between the air and the flue gas sides 26, 24 of the air preheater 10. In a trisector air preheater, leakage between the primary and secondary air sectors 40, 42 is not as critical as leakage between the air sectors 26 and the flue gas sector 24. However, it is still desirable to keep this leakage to a minimum. In conventional air preheaters, radial seals 48 are attached to the axial edges 50, 52 of each diaphragm plates 36 and engage the sector plates 18, 20, 22 as the rotor 14 revolves to control leakage past the hot and cold ends of the diaphragm plates 36. Hot and cold end axial seal support bars 54, 56 are mounted on the rotor shell 32 in line and the outboard radial edge of each diaphragm plate (Figures 10, 11, 12). Axial seals 58 attached to the hot and cold end axial seal support bars 54, 56 engage the seal plates 27 as the rotor 14 revolves to control leakage past the outboard periphery of the rotor 14. The size of the sector plates 18, 20, 22 and seal plates 27 and the number of diaphragm plates 36 to which seals 48, 58 may be attached are limited in conventional air preheaters such that only one radial seal 48 and one axial seal 58 are positioned adjacent the respective plate at any one time. These seals 48, 58 are proximity seals and are not designed to contact the sealing surface of the sector plates 18, 20, 22 or seal plates 27. Consequently, there is leakage past the seals 48, 58 where the



amount of leakage is dependent on the pressure differential between the air and gas streams across the seals 48, 58. The flow between the air and gas streams carries ash which produces erosion of the seals 48, 58 and sealing surfaces 18, 20, 22, 27, degrades thermal performance, and increases energy use of the fans.

The rotor 14 of a conventional horizontal air preheater which has been modified in accordance with the subject invention has an additional radial seal 48' and an additional axial seal 58' mounted intermediate each pair of the original or existing diaphragm plates 36, such that two radial seals 48, 48' and two axial seals 58, 58' are in engagement with the sector plates 18, 20, 22 and seal plates 27, respectively, at the same time. This is illustrated in Figures 4 and 5. Since the pressure differential between the air and gas streams now drops across two sets of radial and axial seals 48, 48', 58, 58', the volume of leakage flow is reduced by approximately fifty percent (50%) compared to the leakage flow rate for a single set of radial and axial seals 48, 58. Since the leakage flow is reduced, the flow of ash carried in the leakage flow is reduced proportionally, reducing erosion, and thermal performance and energy use are improved.

Conventional air preheaters do not have the structure required to support the additional radial and axial seals 48', 58' since these new seals are installed intermediate the existing diaphragm plates 36. Therefore, an additional support structure 60 positioned intermediate the existing diaphragm plates 36 (Figure 9) is required to provide mechanical support to the new seals 48', 58'. The nature of the additional support structure 60 is in part determined by the heat transfer basket/heat transfer basket support structure design which is incorporated in the preexisting air preheater. Conventional air preheats utilize three different heat transfer basket/heat transfer basket support structure

designs. If the same type of heat transfer baskets are to be used in the air preheater after modification in accordance with the invention, the additional support structure 60 must include the same elements as the original existing support structure. Consequently, the subject invention includes three different additional support structures to accommodate these different conventional heat transfer basket/heat transfer basket support structure designs.

The most common conventional heat transfer basket/heat transfer basket support structure design provides almost full use of the available rotor space. In this design, two layers of baskets are commonly used, with the cold end layer composed of full sector baskets and the hot end layer composed of individual type baskets. The support structure for this design comprises a combination of stay plates and gratings. This heat transfer basket/heat transfer basket support structure design requires, for example, a 67 inch deep rotor for 54 inches of heat transfer baskets. The conventional heat transfer basket/heat transfer basket support structure design that makes it easiest to change the heat transfer baskets utilizes a support structure composed of all gratings and two layers of full sector heat transfer baskets. The drawback of this design is the amount of rotor depth that is required to accommodate it. For example 54 inches of heat transfer baskets would require an 86 inch deep rotor. This is due to the fact that the heat transfer baskets take up more space and there is an unused area behind the pin rack. The conventional heat transfer basket/heat transfer basket support structure design which requires the least rotor depth utilizes a support structure composed of all stay plates and two layers of individual heat transfer baskets. This design requires only a 62 inch deep rotor for 54 inches of heat transfer basket. However, this combination of baskets is the hardest to change.

To modify a conventional air preheater in accordance with the invention, the rotor assembly 14 is first emptied of all heat transfer baskets 38. Next, the original, existing radial seals 48, axial seals 58, and grating(s) are removed. For a conventional air preheater containing
5 a combination of individual heat exchange baskets and full sector heat exchange baskets, or all individual heat exchange baskets, the original stay plates 64 may be re-used by forming a slot large enough to accommodate the thickness of the new intermediate diaphragm 66 plate in the middle portion of the stay plate 64 after any existing gratings are
10 removed. If the original stay plates 64 are not going to be re-used they are removed at this time. For a conventional air preheater which contains or will contain all full sector heat exchange baskets, any original stay plates 64 or gratings should be removed.

The end portions 68 of a diaphragm inner support plate 70 are
15 welded to the inner surface of each of the existing diaphragm plates 36 such that the inner support plate 70 extends across the original compartment 34 (Figure 7). Hot and cold end plates 72, 74 are mounted over and below an inboard portion of each compartment, preferably by welding the end plates 72, 74 to the post 16, the stub
20 diaphragm portion 44 and the inboard portion 76 of the main diaphragm portion 46. The intermediate diaphragm plate 66 is installed by welding the inboard end 78 to the inner support plate 70 and the outboard end 80 (Figure 10) to the rotor shell 32.

For a conventional air preheater containing a combination of
25 individual heat exchange baskets and full sector heat exchange baskets, the modified stay plates 64 and/or new stay plates 64' and new gratings 82 are welded to the original diaphragm plates 36 and the intermediate diaphragm plate 66. For a conventional air preheater containing all individual heat exchange baskets, the modified stay plates



64 and/or new stay plates 64' are welded to the original diaphragm plates 36 and the intermediate diaphragm plate 66. For a conventional air preheater containing all full sector heat exchange baskets, new gratings 82 are welded to the original diaphragm plates 36 and the intermediate diaphragm plate 66.

The additional hot and cold end axial seal support bars 54, 56 are welded to the rotor shell 32 and intermediate diaphragm plate 66, in line with the intermediate diaphragm plate 66. Once these modifications are complete on the entire rotor, axial seals 58, 58' are installed on the original axial seal support bars 54, 56 and on the additional axial seal support bars 54', 56' radial seals 48, 48' are installed on the axial edges of the original diaphragm plates 36 and the intermediate diaphragm plates 66, and new heat transfer baskets are installed. New heat transfer baskets are required since the intermediate diaphragm plate divides each of the original compartments into two compartment, each of which is substantially half the width of the original compartment.



New Claims:

1. An air preheater (10) having upper and lower axial ends, a rotor housing (12), a plurality of sector plates (18, 20) disposed on the axial ends, and a rotor (14) disposed within the rotor housing (12), the rotor (14) having a post (16),
5 a rotor shell (32), and a plurality of original diaphragm plates (36) extending radially from the post (16) to the rotor shell (32), the original diaphragm plates (36) each having an outboard radial edge and upper and lower axial edges (50, 52), the rotor shell (32) and the original diaphragm plates (36) defining a plurality of original compartments (34), the rotor (14) further having a plurality of original
10 heat exchange baskets (38) stored in the original compartments (34), a plurality of original gratings and/or original inner and outer stay plates (64) mounted within the original compartments (34) for mounting the original baskets (38), an original radial seal (48) extending from each axial edge (50, 52) of each of the original diaphragm plates (36), the air preheater (10) being characterized in that:
15 an intermediate diaphragm plate (66) is mounted in the center of each original compartment (34) between the two respective original diaphragm plates (36) forming the original compartment (34), an additional seal (48') extends from an outboard radial edge of each of the intermediate diaphragm plates (66), and an additional axial seal (58') extends from each axial edge of each of the intermediate
20 diaphragm plates (66).
2. An air preheater (10) according to claim 1, characterized in that the rotor (14) further includes an original axial seal support bar (54, 56) mounted to each of the outboard radial edges of the original diaphragm plates (36), an original axial seal (58) extending from each of the original support bars (54, 56), an
25 additional axial seal support bar (54', 56') mounted to the outboard radial edge of each of the intermediate diaphragms plates (66), and an additional radial seal (58') extending from each of the additional axial seal support bars (54', 56').
3. An air preheater (10) according to claim 1, characterized in that the air preheater (10) includes additional gratings or stay plates.

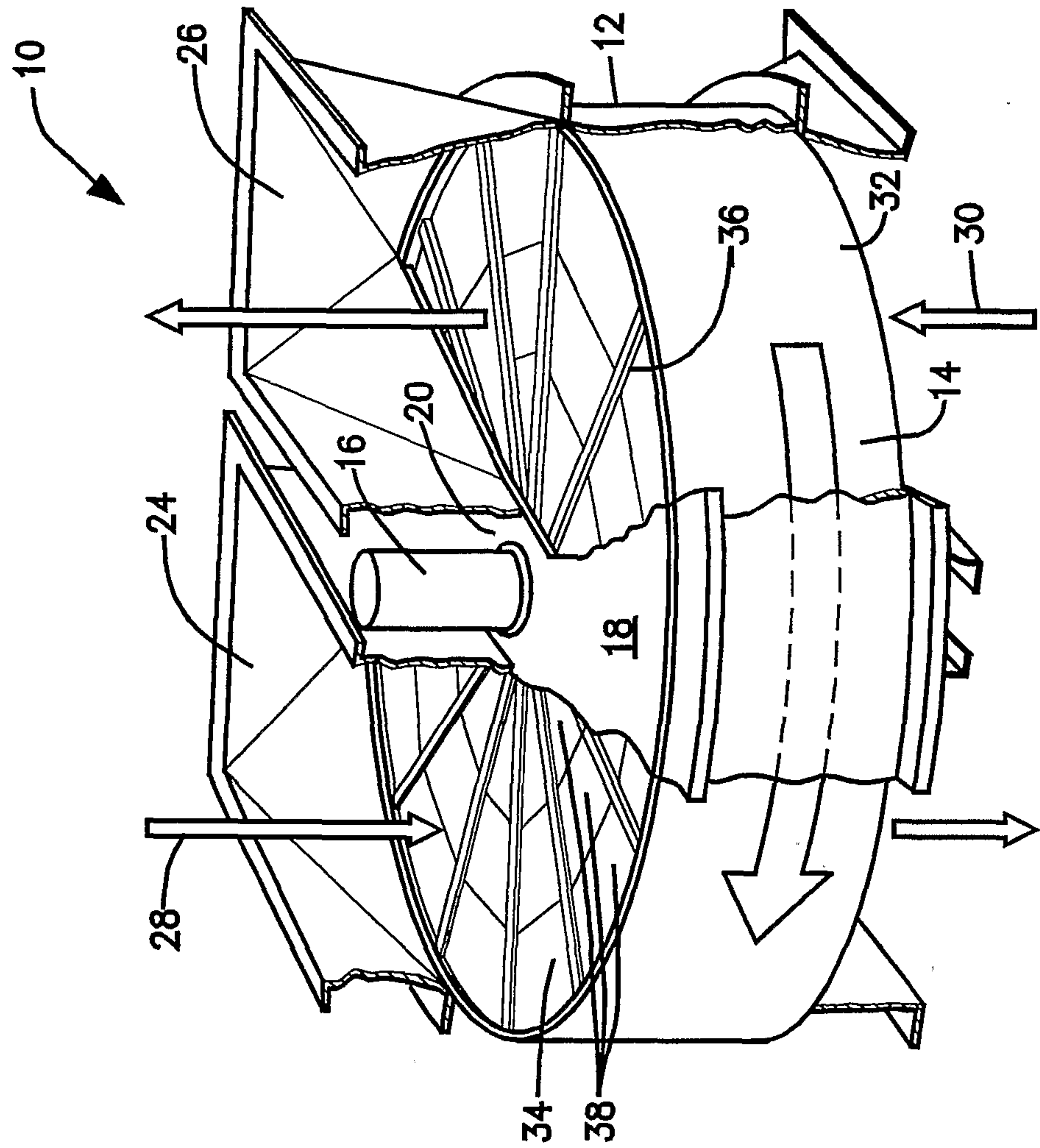
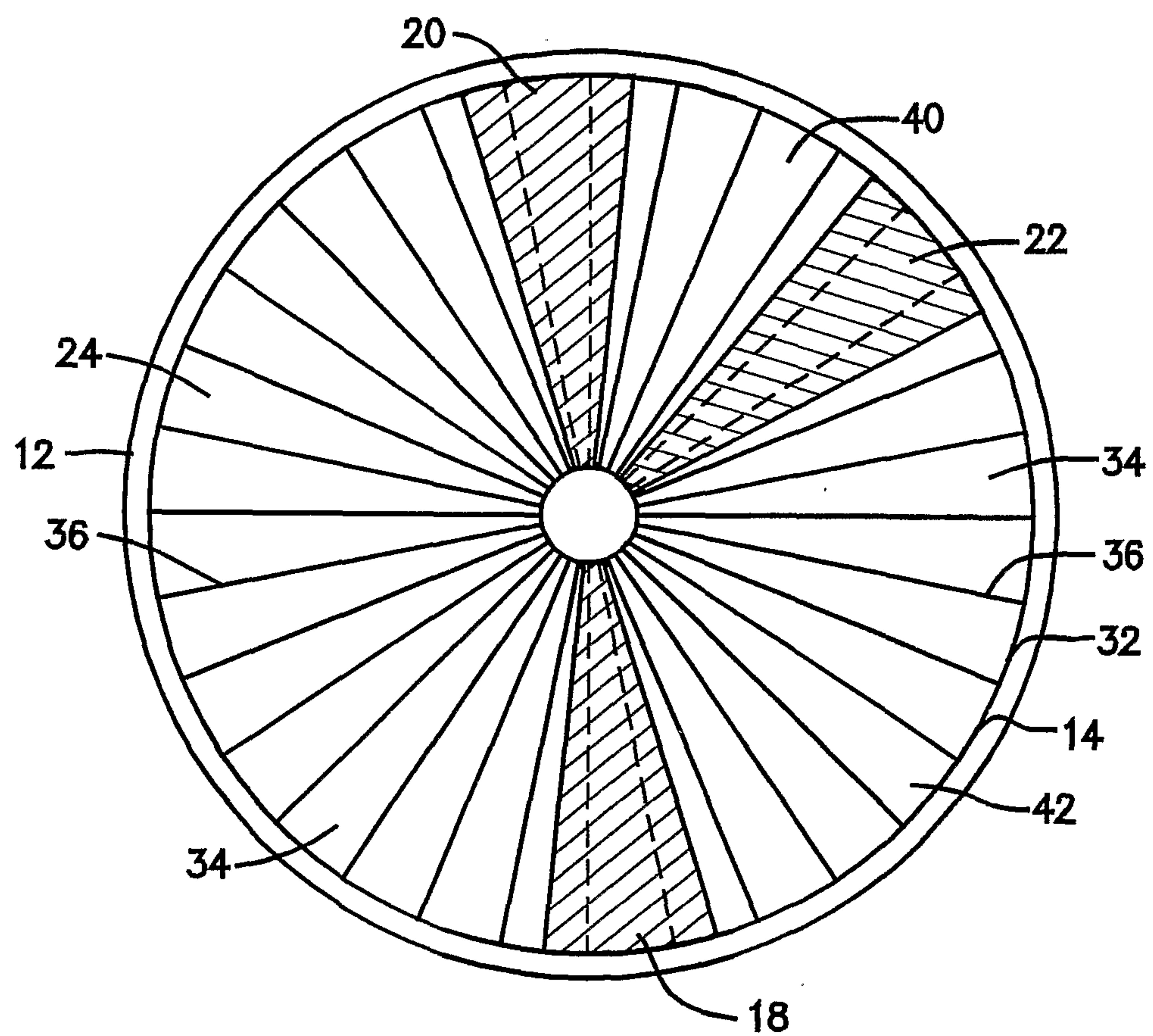


Figure 1

**Figure 2**

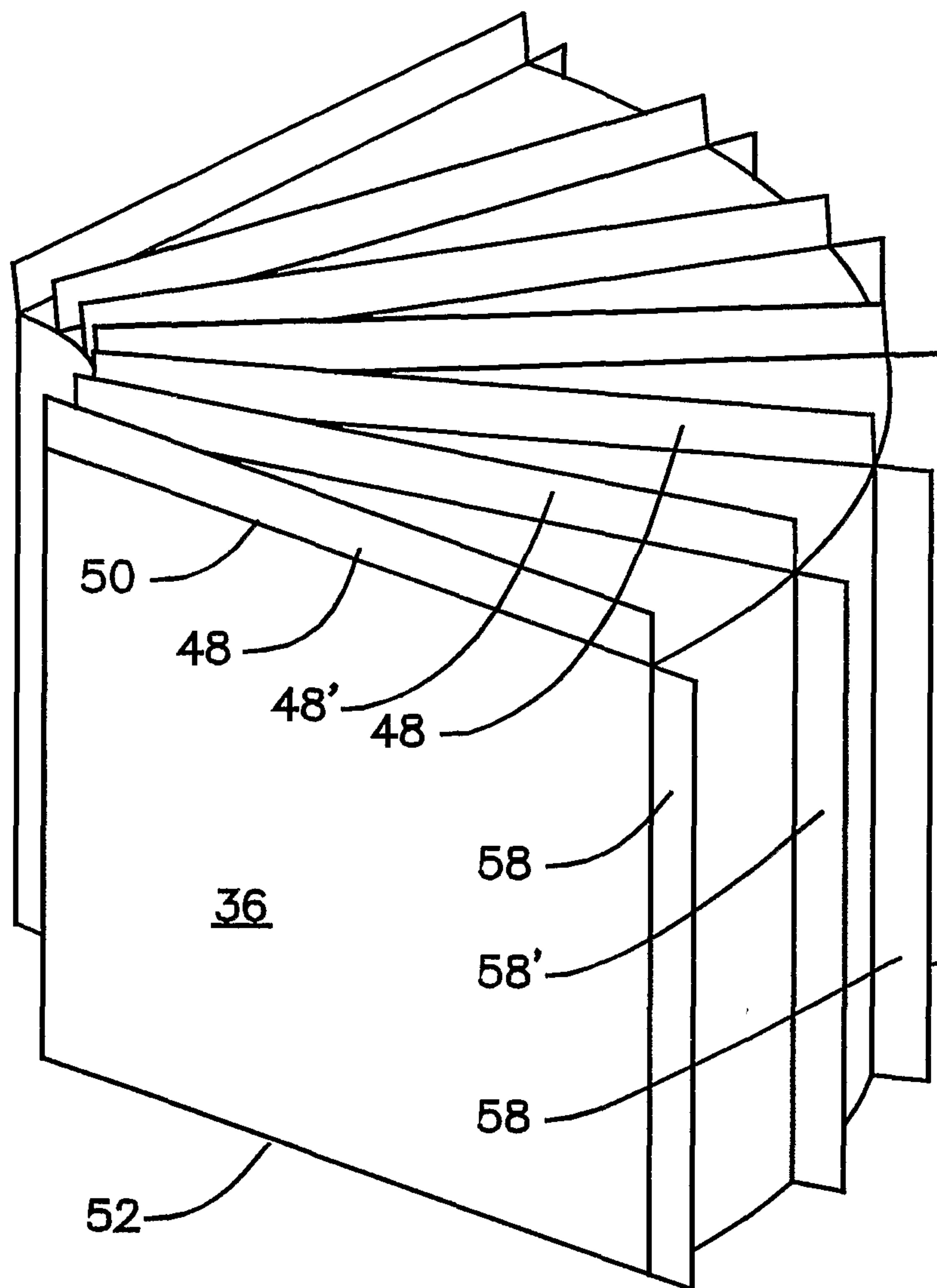


Figure 3

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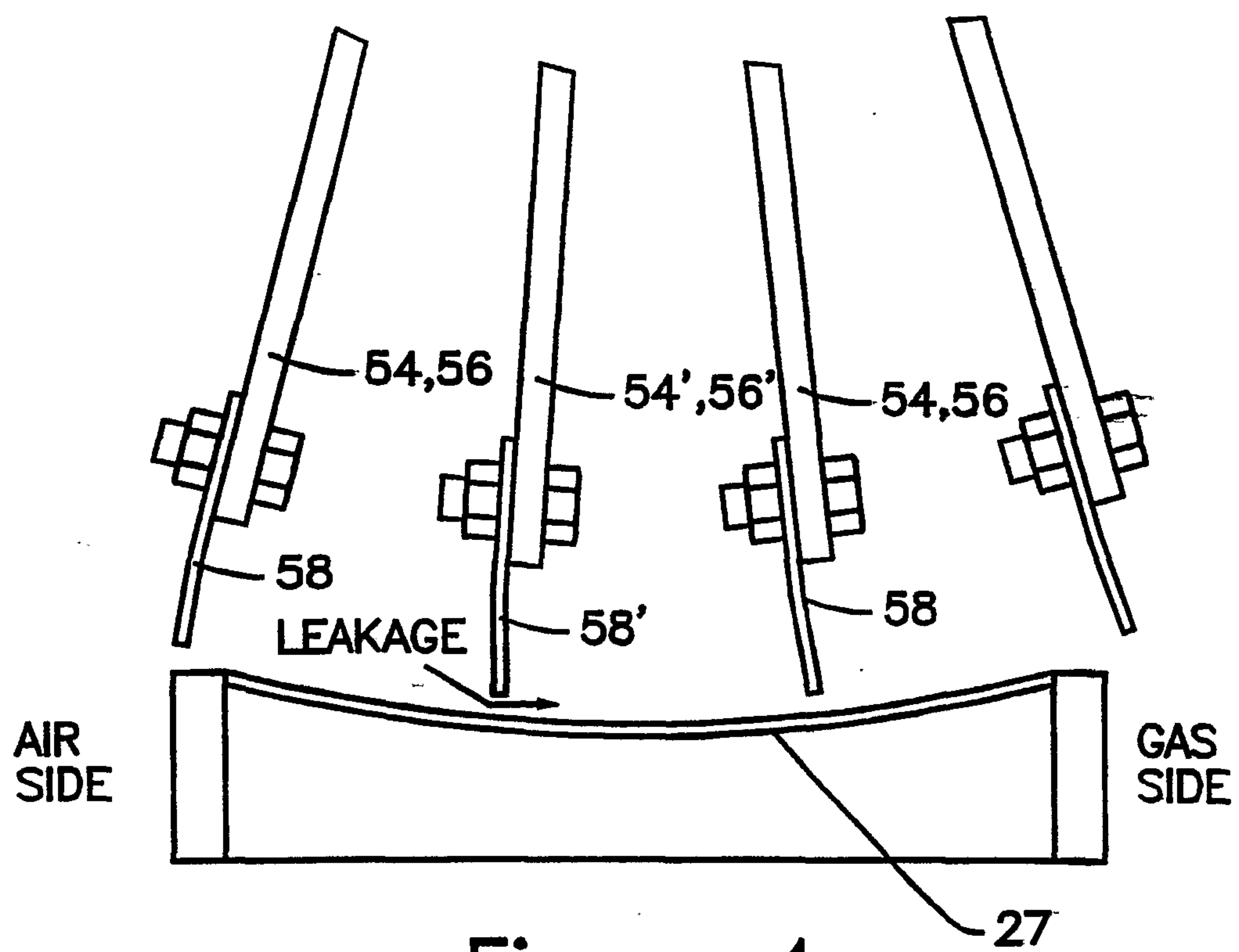


Figure 4

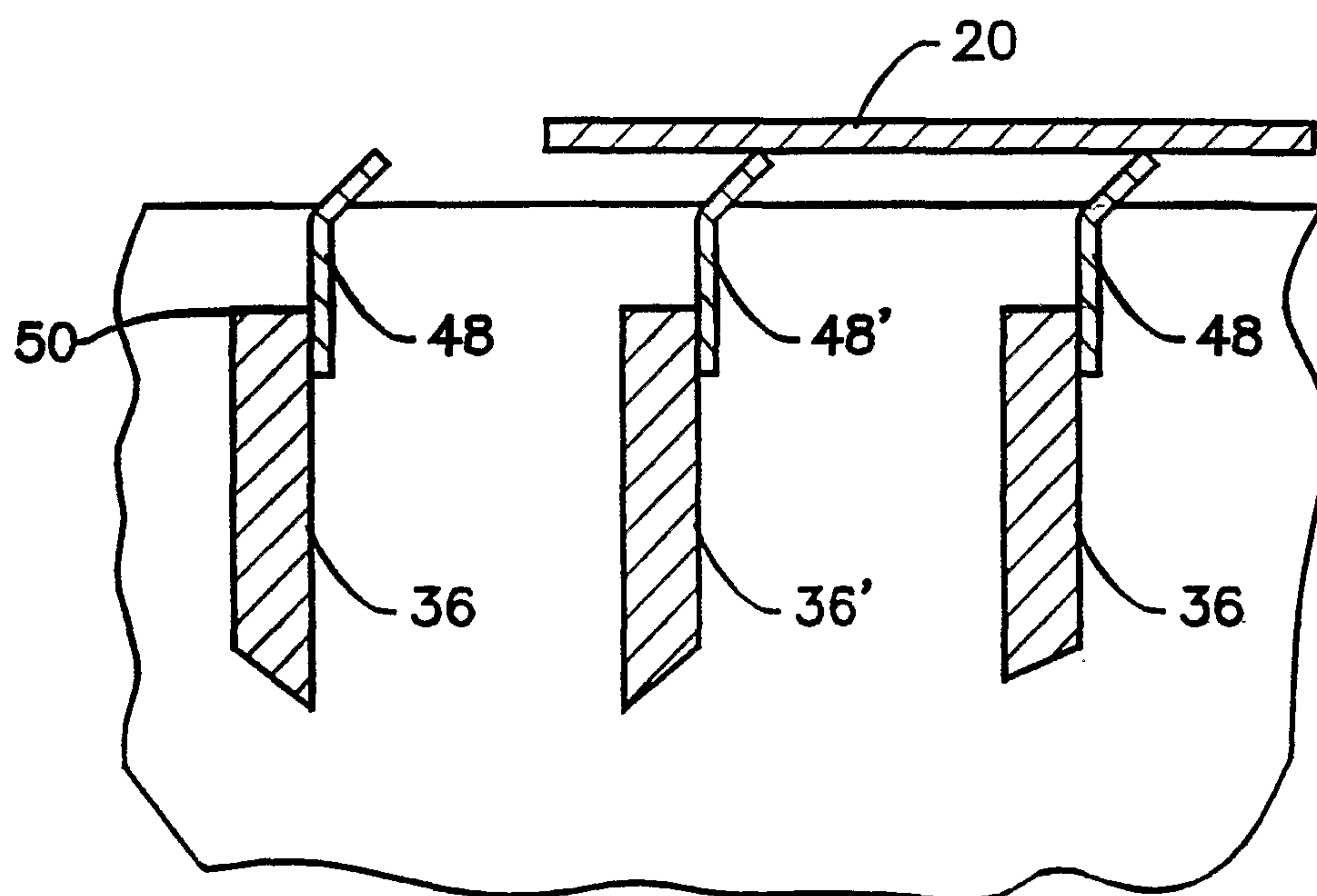


Figure 5

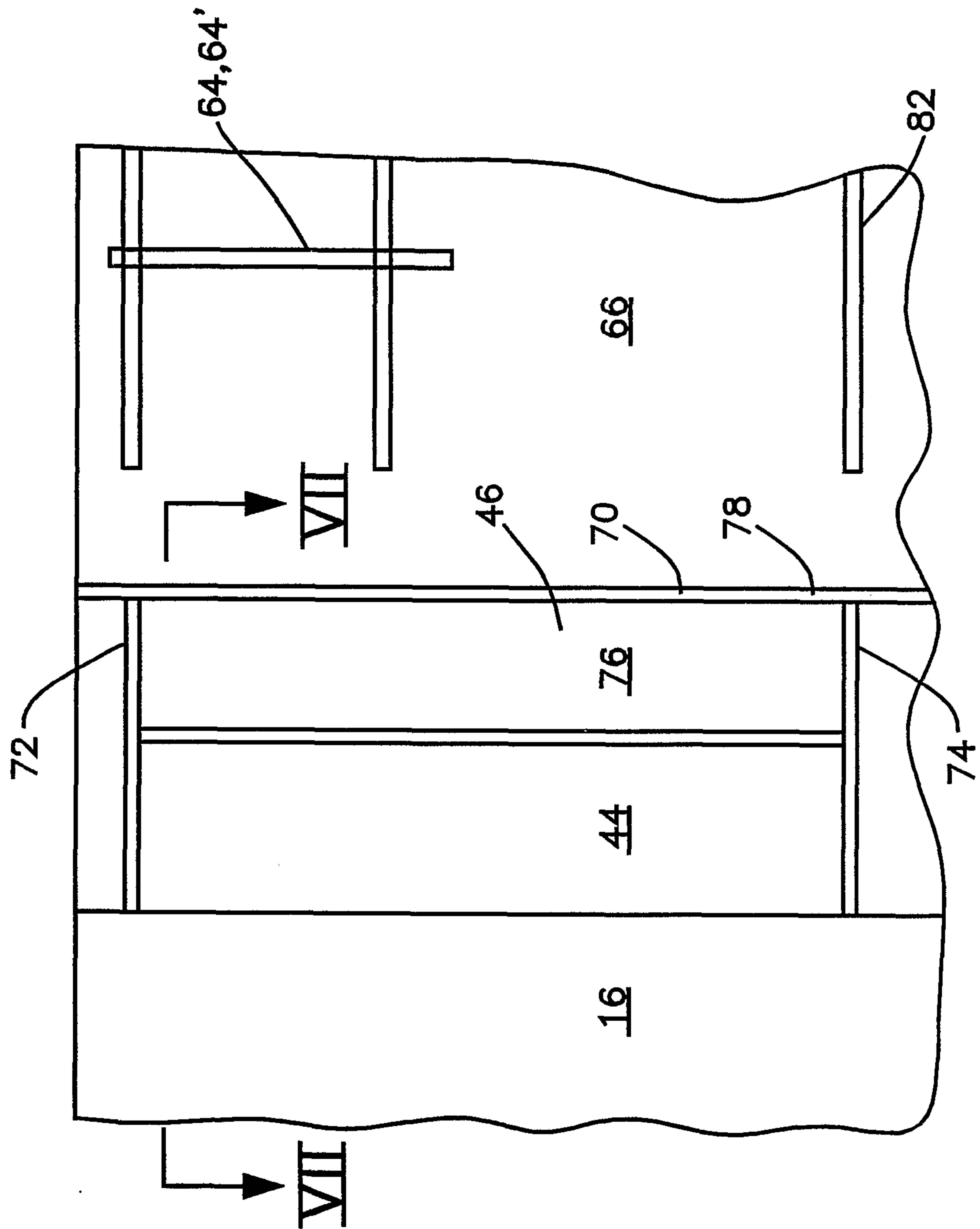


Figure 6

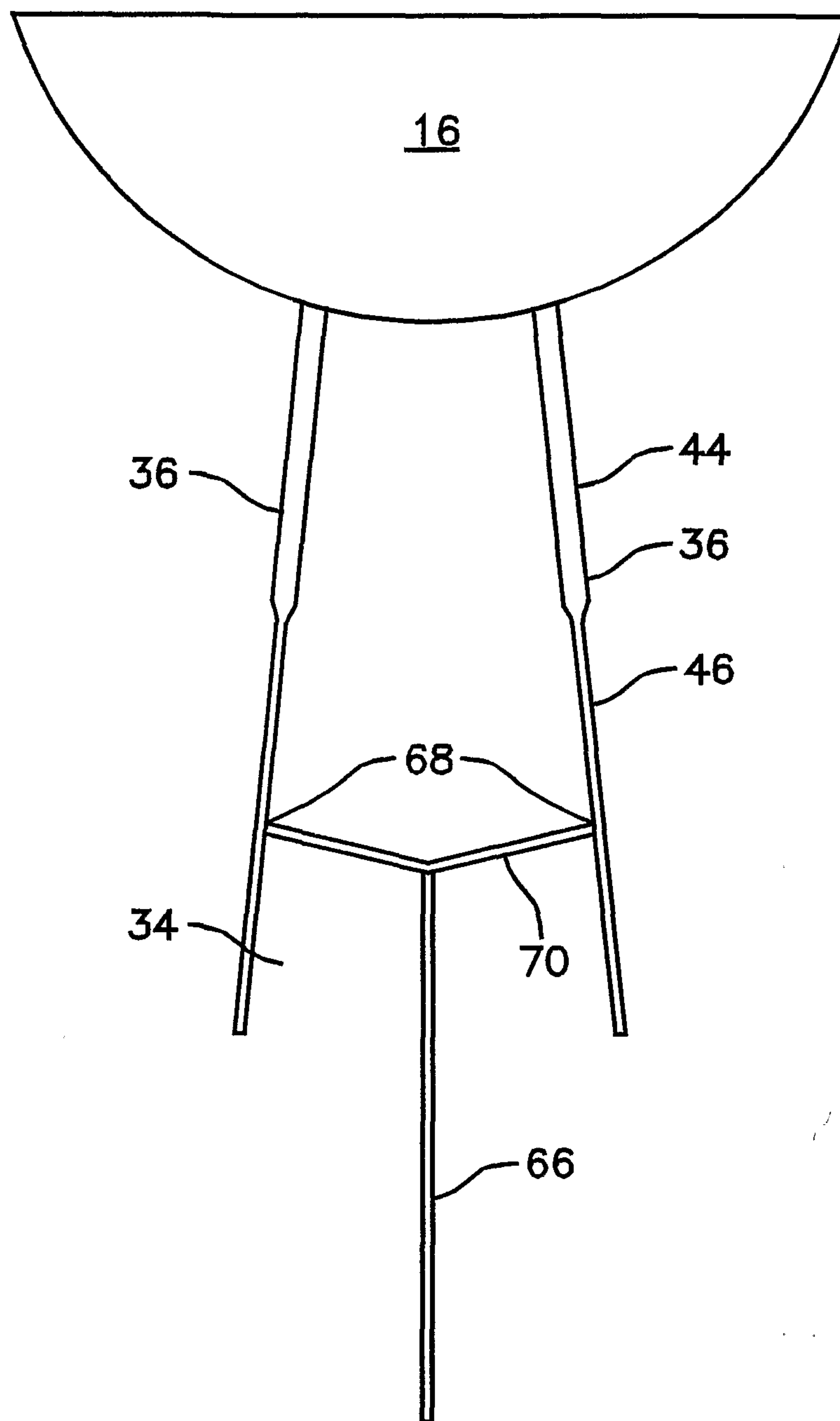


Figure 7

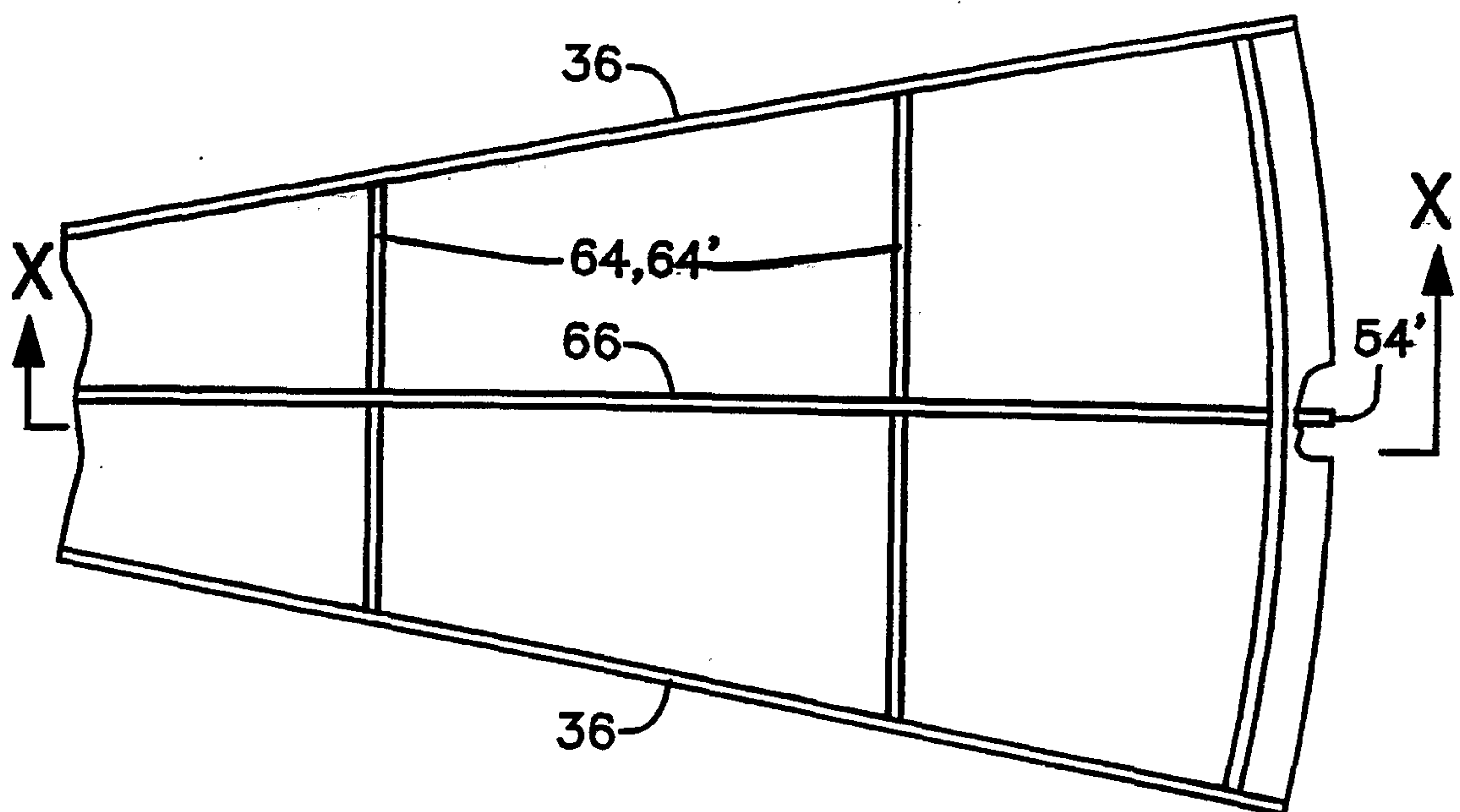


Figure 8

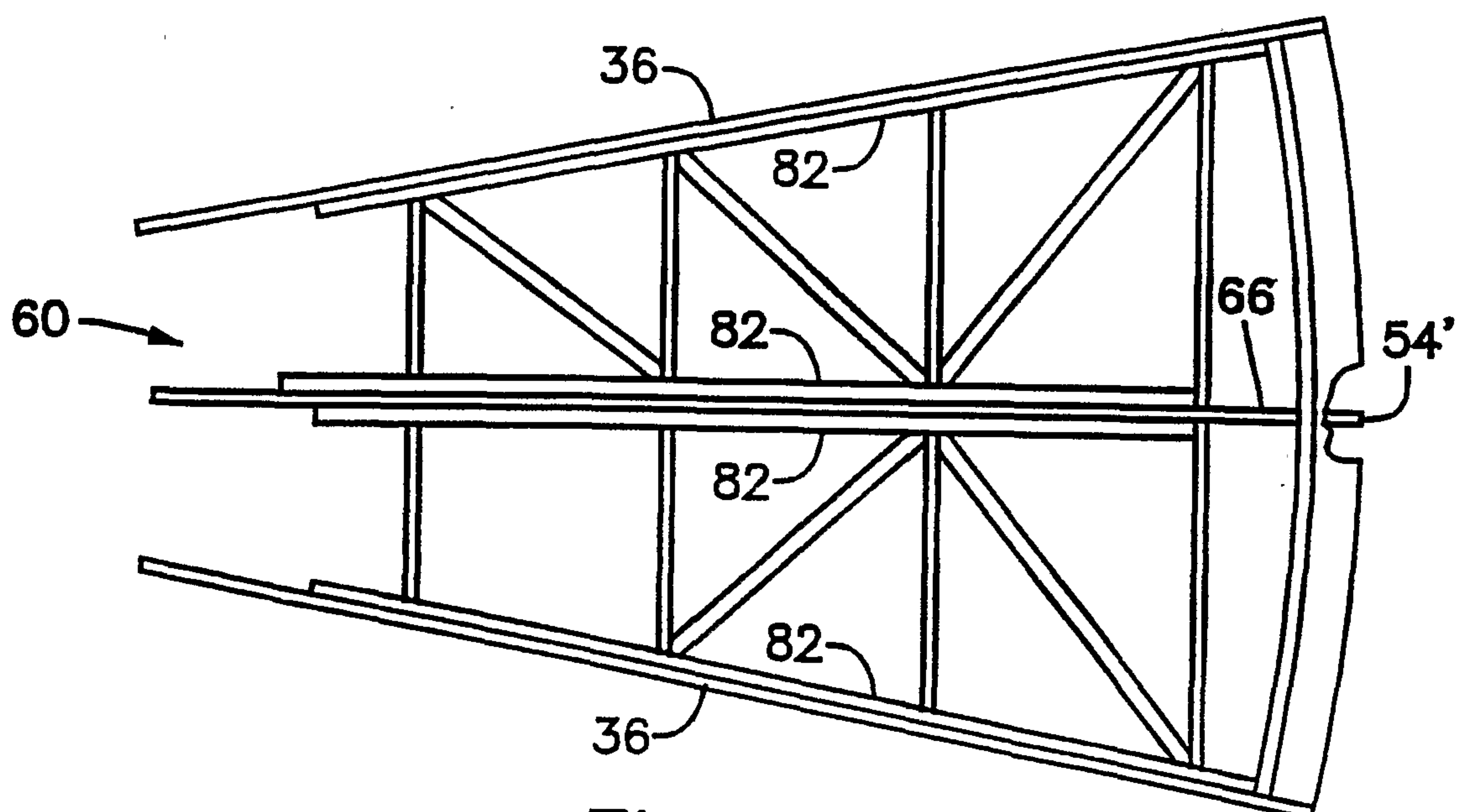


Figure 9

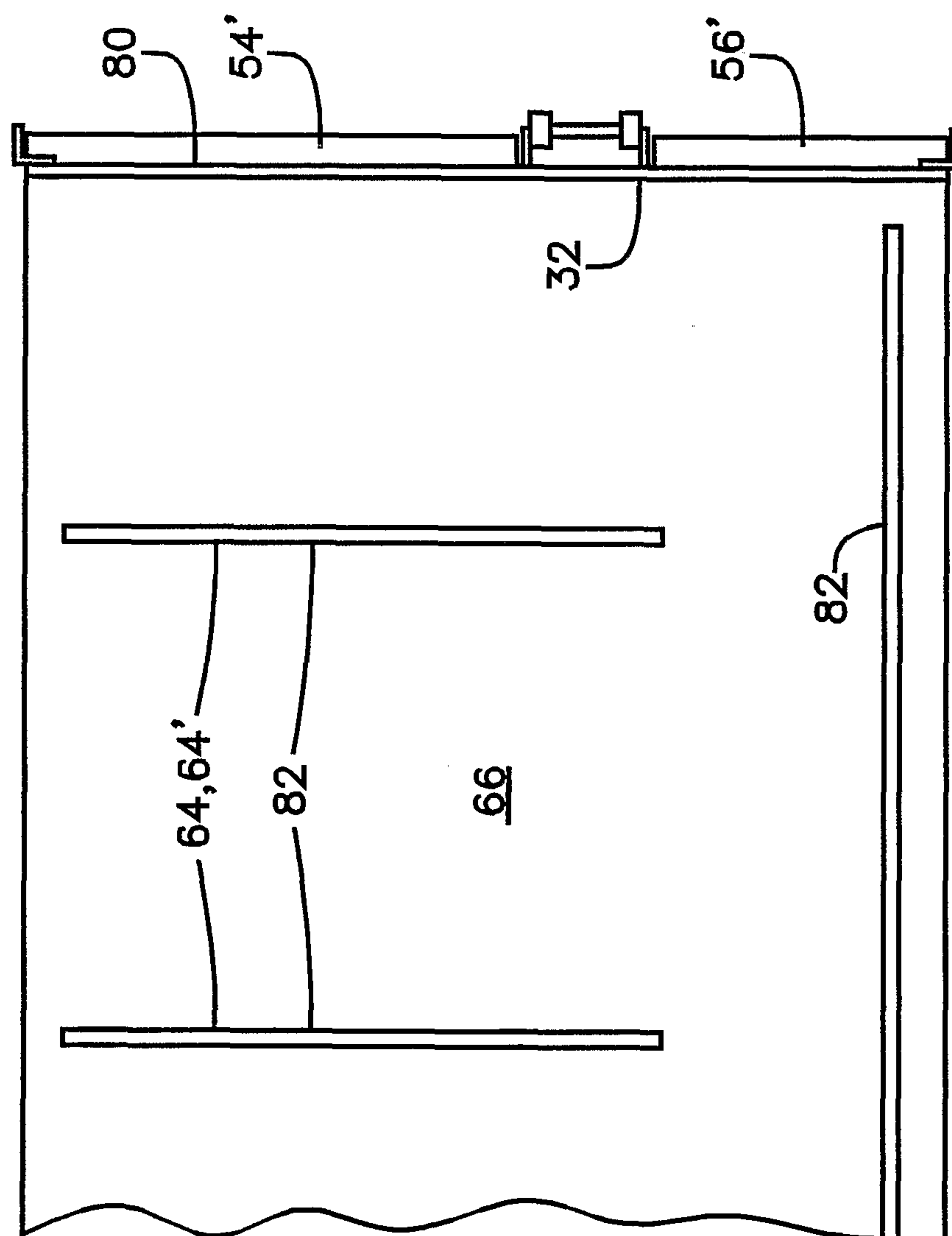


Figure 10

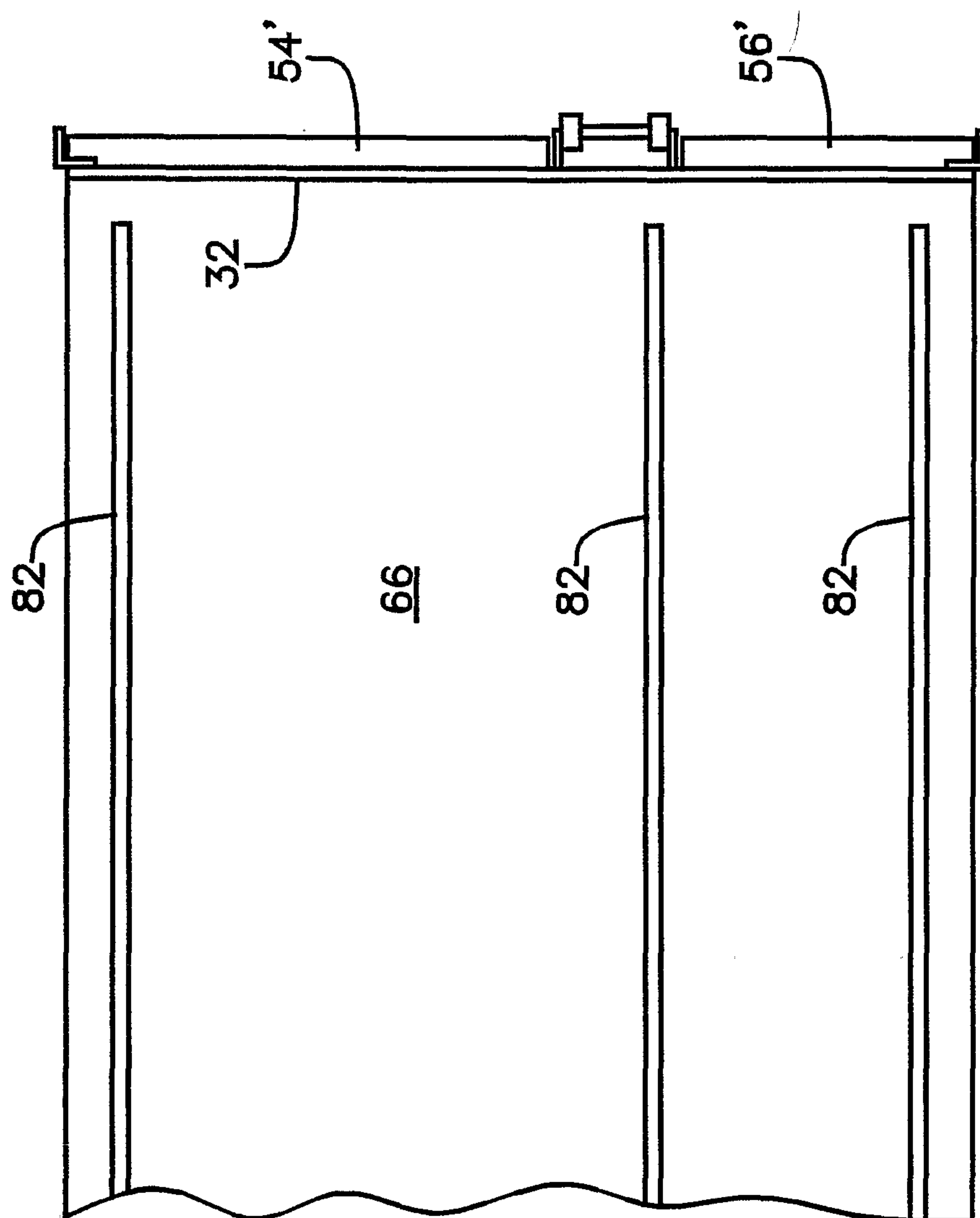


Figure 11

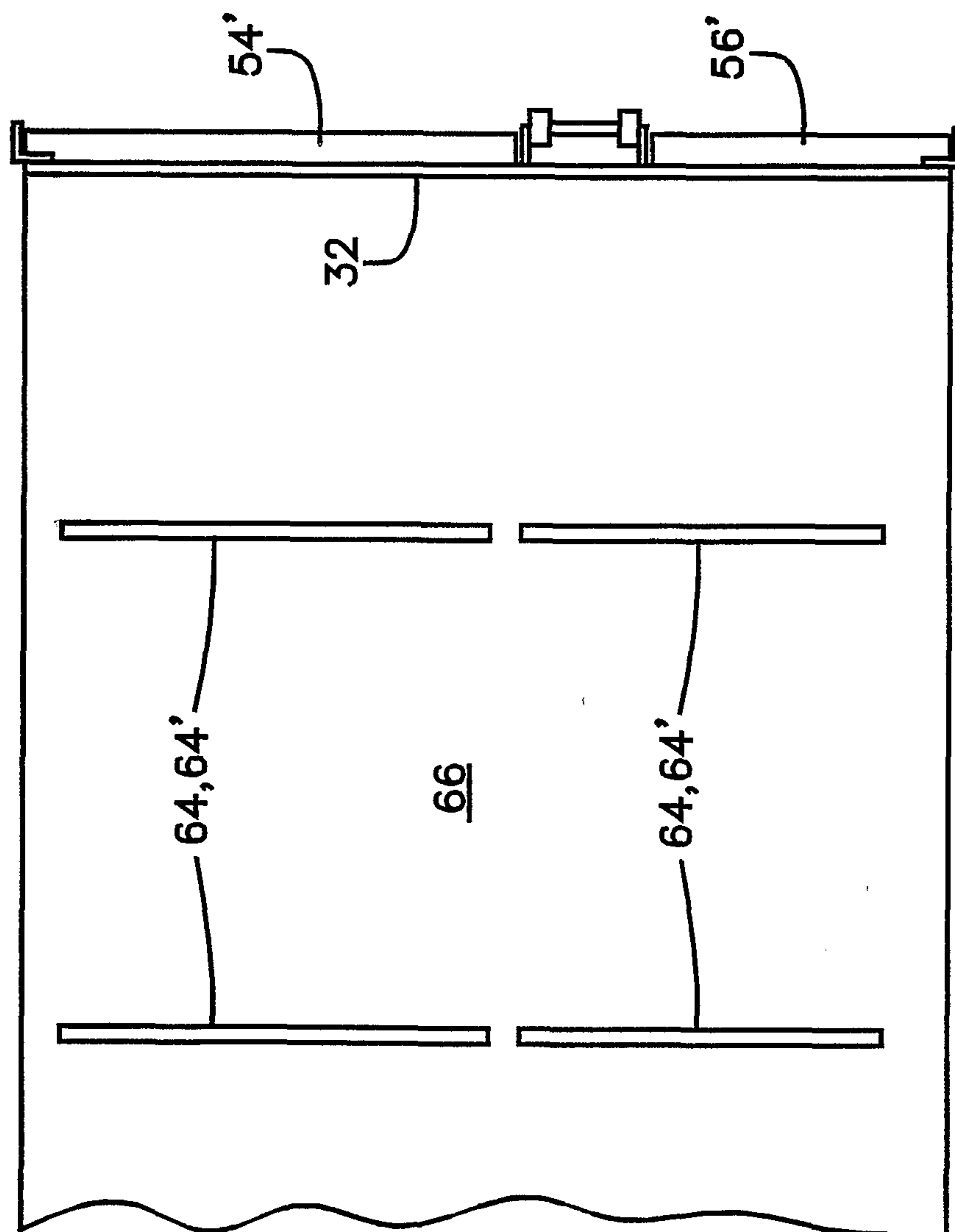


Figure 12

