



(21) (A1) **2,236,645**
(22) 1998/05/05
(43) 1999/11/05

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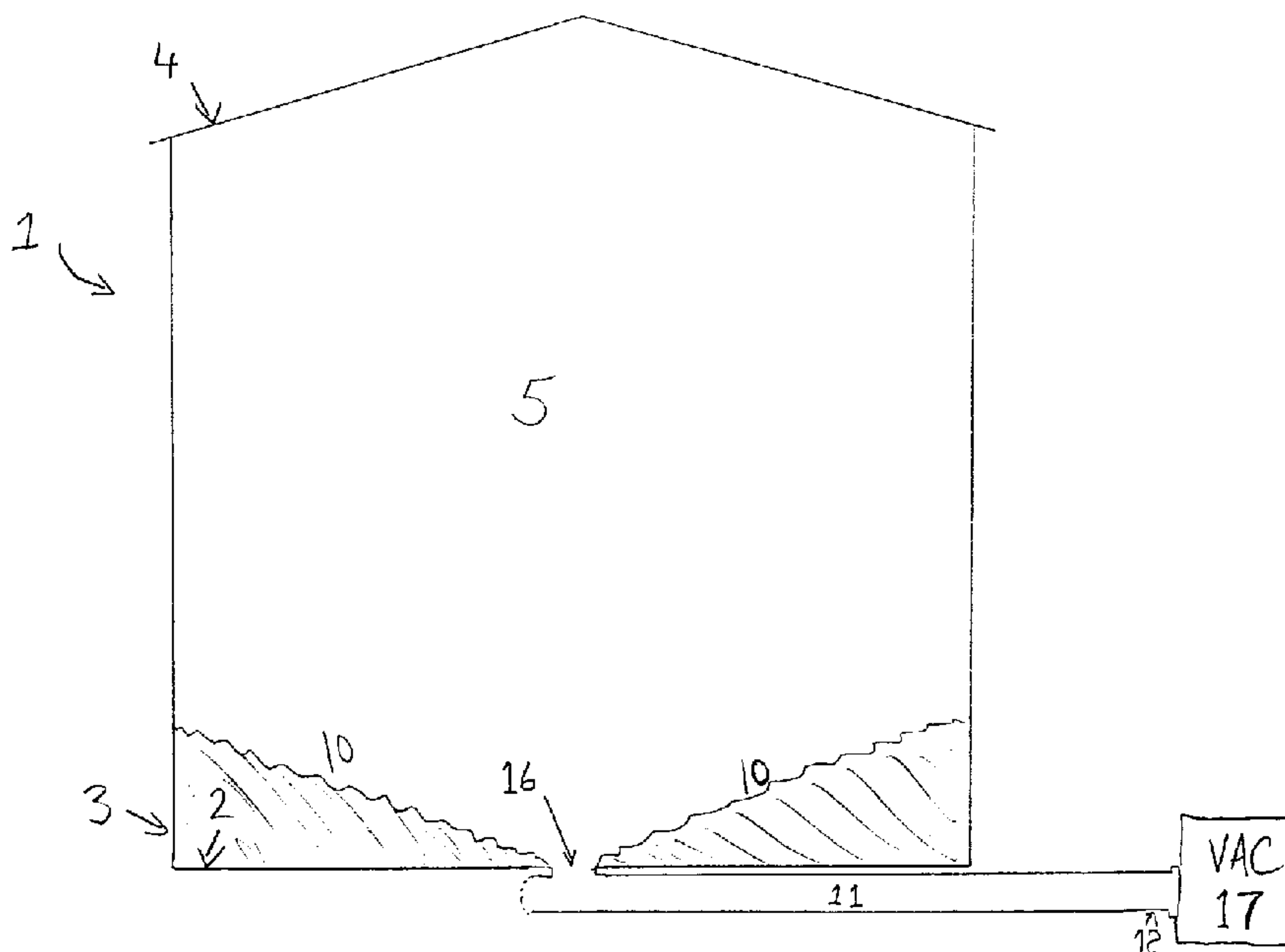
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(51) Int.Cl.⁶ B65G 65/40, B65G 53/24

(54) **CONDUIT D'ASPIRATION POUR LE VIDAGE PAR LE BAS DES
SILOS DE STOCKAGE**

(54) **VACUUM DUCT FOR BOTTOM UNLOADING OF STORAGE
BINS**



(57) The invention is a vacuum duct for bottom unloading of particulate material storage bins. The device consists of a duct running along the floor of the bin, either above or below the bin floor, with a number of unloading openings operatively connecting the duct and the storage cavity. A vacuum unit is attached to one end of the duct and there is a vacuum airstream inlet at or near the opposite end of the duct. By opening one or more of the unloading openings and allowing air to enter the duct through the vacuum airstream inlet, a conventional grain vacuum or other vacuum device can be used to evacuate the contents of the bin from the bottom. The vacuum airstream inlet might be adjustable, as might be the unloading openings. The device is simpler and less costly to manufacture and use than other prior art methods.

5 **ABSTRACT:**

The invention is a vacuum duct for bottom unloading of particulate material storage bins. The device consists of a duct running along the floor of the bin, either above or below the bin floor, with a number of unloading openings operatively connecting the duct and the storage cavity.

10 A vacuum unit is attached to one end of the duct and there is a vacuum airstream inlet at or near the opposite end of the duct. By opening one or more of the unloading openings and allowing air to enter the duct through the vacuum airstream inlet, a conventional grain vacuum or other vacuum device can be used to evacuate the contents of the bin from the bottom. The vacuum airstream inlet might be adjustable, as might be the unloading openings. The device is simpler
15 and less costly to manufacture and use than other prior art methods.

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VACUUM DUCT FOR BOTTOM UNLOADING OF STORAGE BINS

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This invention deals with storage bins for grain and other particulate materials, and more particularly with methods and apparatus for the bottom unloading of such storage bins.

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BACKGROUND:

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In agricultural and other operations, grain and other particulate materials are stored in storage bins - cylindrical bins are common. Bins of other shapes are also used as well. With the consolidation and increased efficiency of various agricultural operations and other operations requiring particulate material storage, the size of such storage bins continues to increase. In many cases there might be a cylindrical bin, for example, which has a storage capacity of several hundred thousand bushels. The diameter of the floor of such a bin might be as large as fifty or one hundred feet.

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Cylindrical bins of smaller sizes, and other miscellaneous storage bins, have conventionally been unloaded using augers. In some cases, a straight screw type auger would be put in through a side

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door of the bin and into the grain inside, and as the grain is augered out the auger itself is pushed further and further into the bin. However, use of an auger from a side door such as this results in lopsided unloading of the bin. The grain at the side of the bin closest to the auger is evacuated more quickly than that on the opposite side of the bin. Other methods, such as sweep augers or grain vacuums, need to then be used to evacuate the remnants which the auger cannot pick up.

Another problem with the conventional side unloading of cylindrical storage bins by an auger is that the newer bins have come to be of such a size that the structural integrity of the bin is compromised when the bin is unloaded from the side, because such a large quantity of grain or other material remains piled against the opposite wall of the bin once the portion of the bin closest to the auger has been evacuated. This results in the necessity for top or bottom unloading, and in any event unloading from the center of the bin. The structural breach caused by side unloading of a large capacity grain bin is demonstrated by Figure 1 - a conventional grain bin 1, having a floor 2, walls 3 and roof 4, has a door 6 which in turn is fitted inside with a hatch insert 7. The hatch insert serves to create a small space inside the door of the bin through which the auger 8 can be inserted at such time as it is desired to unload the bin. The auger 8 is inserted into the bin through the door and hatch insert 6,7 and the auger is engaged. The grain or other particulate material stored in the bin then begins to shift from the bin load position 9, and as more material is evacuated the load in the bin becomes severely lopsided. The bin load slope 10 demonstrates this effect.

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Grain vacuums are sometimes used in the place of sweep augers or other clean up methods to clean out the remnants of a storage bin once the side unloading method has been exhausted. The grain vacuum has many advantages over an auger, not the least of which is safety. Also, a grain vacuum does not have a lengthy or complex drive train or other extensible moving parts which can create safety, maintenance and manufacturing problems. It has not, however, to this point been known in the art to use a grain vacuum for anything more than bin clean up - a flexible hose or the like is attached to the grain vacuum and an operator takes it into the bin once the hatch insert can be removed from the bin door and then manually walks around inside the bin with the hose to clean up.

These vacuums have sufficient capacity to move large capacities of grain and as such it would be ideal to use the vacuum to actually unload the bulk of the bin, rather than just use it in the clean up. This is an object of the present invention.

SUMMARY OF THE INVENTION:

The problem, then, which the present invention seeks to address is two fold. Firstly, augers are costly to manufacture and maintain and represent a serious safety hazard to the farmer, and yet to date have seemed to be the only method of bottom unloading of a grain bin. It is the object of the present invention to provide a method of bottom unloading a grain bin using a

- Page 5 -

conventional grain vacuum apparatus. This will address both the safety and cost issues, while providing a method of bottom unloading which is particularly effective when employed in larger capacity storage bins which would otherwise be compromised by conventional side unloading techniques using a screw auger.

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The invention is a vacuum duct for the bottom unloading of particulate material storage bins. These bins each typically have a floor, walls and roof which define a bin storage cavity. The invention itself comprises substantially a tubular duct having two ends, a vacuum attachment end and an extreme end; one or more unloading inlets in the walls of the duct operatively connecting
10 the duct and the bin storage cavity; a vacuum airstream inlet operatively connected to the duct at a point between the extreme end of the duct and the first unloading inlet along the duct from its extreme end; and vacuum attachment means at the vacuum attachment end of the duct.

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The device is then intended to be attached to a vacuum device, and might itself further comprise such vacuum device. One type of a vacuum device which could be employed in the present invention is a conventional grain vacuum, known in the prior art.

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The tubular duct could run either above or below the bin floor. In the case of the tubular duct being installed in the bin above the floor the extreme end of the tubular duct could go into the
bin through a bin wall, and then lie on or near the bin floor. The unloading inlets could just be
installed in the walls of the tubular duct and would, upon the opening thereof, be operatively

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connected to the bin storage cavity and the material stored therein. In the alternative, the tubular duct could be installed beneath the bin floor, and the unloading inlets could be operatively connected to the bin storage cavity by passing through the bin floor.

5 A vacuum airstream inlet is necessary to allow air to enter the duct from a point past the furthest load entry point into the tubular duct, creating the vacuum. The size or capacity of the vacuum airstream inlet might be predetermined and set at the time of manufacture, or might be adjustable by the operator. One type of a vacuum airstream inlet which would be adjustable by the operator and which could be used in the present device is a manual or mechanically actuated valve. The
10 vacuum airstream inlet could be adjustable from a point outside of the perimeter of the bin to make it easiest to use.

One or more unloading inlets could be used along the length of the duct, dependent on the size of the bin to be unloaded and other factors.

15 The unloading inlet, or inlets in the case of a multiple inlet duct, could further comprise unloading inlet aperture control . The unloading inlet aperture control could preferably be actuated from a point outside of the bin. In one embodiment of the invention, the unloading inlet aperture control could comprise a slide in the unloading inlet which could be opened and closed
20 form outside of the bin. It might be opened and closed from outside of the bin by the use of a control rod or the like which could be manually pushed or pulled by the operator. In the case of

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a lengthier duct or a duct with corners or bends in it, which would make the use of a control rod impossible or unwieldy, the slide or slides could be mechanized.

5 The tubular duct could run under or along a portion of the bin floor depending on the number of unloading inlets and positioning of the unloading inlets which is preferred to be used. If the tubular duct extended beneath the entire bin floor such that it went under one side of the bin and came out the other side, the vacuum airstream inlet , if adjustable, could be easily accessible if disposed at the extreme end of the duct. An alternative means of getting the vacuum airstream inlet to a point where they could be easily controlled by the operator would be to double the
10 tubular duct back on itself underneath the bin at a point just past the last unloading inlet such that the extreme end would emerge on the same side of the bin as the vacuum attachment end. Alternatively, the tubular duct itself might be terminated with the vacuum airstream inlet attached to a smaller tube or pipe joined to the duct, the tube or pipe then extending to a control point outside of the perimeter of the bin.

15 While in the basic embodiment the tubular duct is straight, to follow along a flat bin floor, the invention would also work with bends or elbows placed in the duct to follow the contour of a non-flat bin floor. In the case of a very large bin floor, horizontal elbows or corners could also be put in the tubular duct to allow for the positioning of unloading inlets in more positions in the
20 bin, in a pattern other than a straight line.

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In operation of the device, the vacuum is turned on and the vacuum airstream inlet adjusted to provide for a vacuum within the duct. The unloading inlets would then allow for the vacuum flow of grain or other material down out of the bin through the duct to be loaded or handled in whatever conventional means by or past the vacuum. If the unloading inlets were controllable,
5 the flow could be further adjusted and certain portions of the bin could be unloaded more quickly than others if that were in fact desired.

The unloading inlets, where they enter the bin, could be outfitted with tool attachment means such that once the bin was emptied as far as could reasonably be done without operator
10 intervention, an operator could enter the bin and attach a flexible hose or other tool to the vacuum outside of the bin via the unloading inlet and could proceed then in the normal fashion to manually vacuum up the remainder of the material in the bin.

The duct could be cylindrical or rectangular in shape, or any other shape which provided for the
15 definition of a vacuum path therewithin.

DESCRIPTION OF THE DRAWINGS:

20 While the invention is claimed in the concluding portions hereof, preferred embodiments are provided in the accompanying detailed description which may be best understood in conjunction

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with the accompanying diagrams where like parts in each of the several diagrams are labeled with like numbers, and where:

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Figure 1 is a cutaway side view of a grain bin which has been unloaded using the conventional method of a screw auger inserted into the bin through a side door hatch;

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Figure 2 is a cutaway side view of a similar storage bin, partially loaded, using one embodiment of the present invention with a single unloading inlet, the tubular duct running beneath the bin floor and the extreme end doubled back towards the vacuum attachment end;

Figure 3 is a top view of the embodiment of Figure 2;

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Figure 4 is a cutaway side view of another embodiment of the present invention with a plurality of unloading inlets, and whereby the tubular duct extends across the full diameter of the bin floor, above the bin floor, with the extreme end of the tubular duct being on the opposite side of the bin from the vacuum attachment end;

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Figure 5 is a top view of the embodiment of Figure 4;

Figure 6 is a cutout view of a portion of the embodiment of Figure 4, demonstrating the

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use of an unloading inlet slide and control rod;

Figure 7 is a top view of another embodiment of the tubular duct, with horizontal bends placed in the tubular duct so as to displace the unloading inlets in a pattern other than a straight line; and

Figure 8 is a cutaway side view of another embodiment of the tubular duct demonstrating the use of contour-following vertical bends in the duct, to enable the tubular duct to follow a non-flat bin floor.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS:

Figures 2 and 3 demonstrate a basic embodiment of the present invention, which is a vacuum duct for use in the bottom unloading of particulate material storage bins. A grain bin itself is demonstrated - there is shown a bin 1, of which the relevant parts are the bin floor 2 and the walls 3. The roof 4 is also shown. The bin storage cavity is defined by the floors, walls and roof 3, 4, 5.

Looking at the device itself, there is shown in Figure 2 the tubular duct 11. The tubular duct 11 has two ends, being the vacuum attachment end 12 and the extreme end 13. The tubular duct 11

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runs underneath the bin floor 2 to a point at or near the centre of the bin floor 2, at which point there is disposed an unloading inlet 16, passing through the bin floor 2 to operatively connect the tubular duct 11 to the bin storage cavity 5. At a point past the unloading inlet 16, the tubular duct 11 is doubled back such that the extreme end 13, with the vacuum airstream inlet 15 disposed thereon, emerges back out from under the bin floor 2 at a point near the vacuum attachment end 12. This is so that the person who is operating the vacuum device 17 which is attached to the vacuum attachment end 12 of the duct via vacuum attachment means can also at the same time adjust the vacuum airstream inlet 15, which in this embodiment is adjustable, without having to run to the other side of the bin 1.

The vacuum attachment means could be one of any number of engaging mechanisms by which a vacuum device 17 could be detachably or fixedly coupled to the tubular duct 11.

The doubled back aspect of the duct is shown by figure 3, top view. What can also be seen in Figure 3 is the fact that the tubular duct 11 beyond the unloading inlet 16, the sole purpose of which is to allow for the placement of the vacuum airstream inlet 15 in an accessible position, can be reduced in size since the only flow through the tubular duct 11 in this section is air and the large volume of air which might be required to maintain the proper vacuum flow can pass through a channel of relatively small diameter. How far the diameter of the tubular duct 11 in this section could be reduced would be dependent only on this factor, namely that the diameter of the duct at this point be sufficient to allow for the necessary air flow. An alternative approach,

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having the same effect as reducing the diameter of the tubular duct past the last unloading inlet, would be to terminate the formal portion of the tubular duct 11 at a point just past the unloading inlet 16 and to use only a hose or tube or the like attached to the extreme end of the tubular duct to double back towards the vacuum attachment end. Again, similar to the concept of simply
5 narrowing the duct itself past the last unloading inlet, the only limiting factor in the use of such a tube or hose would be that it be large enough to ensure the necessary volume of air flow for the vacuum to function properly.

The tubular duct 11 demonstrated in Figures 2 and 3 runs beneath the bin floor 2. The tubular
10 duct 11 could also run above the bin floor 2, as shown in the embodiment illustrated in Figures 4 and 5. Figure 4 is a cutaway side view of another embodiment of the device installed above the bin floor, and used in a larger capacity storage bin employing a number of unloading inlets. Since some of the bins now being used have floor diameters of upwards of 100 feet, it would be preferable to use more than one unloading inlet to maximize the effectiveness of the unloading
15 device without human intervention within the bin storage cavity 5. The tubular duct 11 enters the bin storage cavity 5 through a bin wall 3, and in this embodiment extends all the way through the bin to the opposite wall, where it exits the bin 1 through that opposite bin wall 3. The tubular duct 11 rests on the floor 2 of the bin. The unloading inlets 16 are operatively connected to the bin storage cavity 5 by simply opening them, since they do not need to pass through the
20 floor 2. The vacuum airstream inlet 15 is demonstrated disposed at the extreme end 13 of tubular duct 11. Four unloading inlets 16 are shown.

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An alternative configuration of the tubular duct in the bin above the bin floor, rather than having the duct rest the bin floor would be to place the tubular duct slightly above the bin floor on a number of legs or the like. Leaving a small space between the tubular duct 11 and the bin floor 2 would make it easier to clean up the bin remainder once the bin had been unloaded to the point that the duct would no longer be useful, and conventional clean-out techniques needed to be employed to clean up the bin. The unloading inlet or inlets 16 in such a modified embodiment could also be disposed along the bottom surface of the tubular duct 11, so that they opened into the space between the tubular duct 11 and the bin floor 2. It will be understood that this variation, namely the placement of the duct inside the bin and above the bin floor, could be accomplished in various ways, all of which are contemplated within the scope of the present invention.

It is preferable that the vacuum airstream inlet 15 be adjustable so that the vacuum airstream can be optimized for the type of vacuum equipment 17 which is being used as well as the type of material which is being unloaded from the bin with the device. For example, heavier material might require more air. Obviously one of the easiest things to use as the vacuum airstream inlet to render it adjustable is a valve. The valve could be manually or mechanically adjustable. In the case of the embodiment of Figures 2 and 3, demonstrated above, a manual valve might easily be used because the valve could be placed at the extreme end 13 of the duct, or on the end of a tube or hose, such that it was easily accessible to the operator of the vacuum device 17. In the case of an embodiment such as that shown in Figures 4 and 5, where a fairly large diameter bin

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might be in use and that is preferable to have a longer tubular duct 11 with a number of unloading inlets 16 necessitating the extension of the tubular duct 11 through the majority of the bin 1, a mechanical valve of sorts could be used at the vacuum airstream inlet 15 so that the operator of the vacuum device 17 could still control such valve from a remote position.

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In operation of the device of Figures 2 to 5, the vacuum device 17 is turned on and the vacuum airstream inlet 15 is adjusted such that a proper vacuum is coming through the tubular duct 11, in the direction along the tubular duct 11 from its extreme end 13 towards the vacuum attachment end 12 and the vacuum 17. Particulate materials stored in the bin can then enter the vacuum stream within the tubular duct 11, by flowing downwards through one or more open unloading inlets 16. Gravity will continue to feed particulate material down into the vacuum stream until such point in time as the tensile force of the surface of the grain or other material remaining in the bin, or in other words the bin load slope 10, is such as to stop any further gravity flow into the tubular duct 11. At that point in time a conventional bin clean-up can be done.

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The unloading inlets could be adjustable also. Figure 6 demonstrates the addition of an unloading inlet opener, consisting of an unloading inlet slide in a race 18 and a control rod 19. In this fashion, the slide 18 could be actuated from outside of the bin 1 via the control rod 19, to open and close one or more unloading inlets during the process of unloading the bin. This could be used to selectively unload certain parts of the bin more quickly than others. It will be understood that mechanical openers could also be used, in situations where a straight control rod

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was not feasible, and that all such methods of opening, closing or adjusting the aperture of one or more unloading inlets are contemplated within the scope of the present invention.

As also mentioned above, horizontal bends could be employed in the duct, to achieve the result of displacing the unloading inlets in a pattern other than a straight line within the bin storage cavity. Figure 7 demonstrates this change from a top view. This would be of particular utility in larger bins, wherein a straight line of unloading inlets would simply not allow for the removal of enough of the particulate material stored in the bin, where the placement of the unloading inlets in a staggered pattern about the bin floor allows for the unloading of a significantly larger portion of the bin without human intervention inside the bin storage cavity. Horizontal bends might also be employed in tight-fitting situations, where the vacuum device 17 needed to be placed in a particular position outside of the bin which was not in line with the optimal positioning of the bin unloading inlets. It will be understood that any such placement of the duct or unloading inlets in a pattern within the bin other than in a straight line are contemplated within the scope of the present invention.

Figure 8 demonstrates a vertical bend in the tubular duct 11, which could be employed to follow the contour of a non-planar bin floor. This might be useful in either a bin manufactured with a non-flat floor, or might also be useful in retrofitting older bins with flaws or irregularities in the floor. Again it will be understood by any person skilled in the art that the concept of such vertical bends does and is intended to encompass any specific vertical bend in the duct, and as

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such any of those are contemplated within the scope of the present invention as well.

The device could be manufactured integrally with a vacuum device, or various vacuum attachment means could be used on the vacuum attachment end of the tubular duct to allow for the attachment and removal of equipment already available to the farmer. As well, by making the vacuum detachable via the vacuum attachment means, one vacuum 17 can be used on more than one bin and vacuum duct.

The bin unloading inlets 16 could be outfitted with tool attachment means to simplify the manual or conventional cleanup of the bin. For example, the tool attachment means might be a collar whereby a clean-up operator could enter the bin and attach a flexible vacuum clean-up hose to the unloading inlet, and then in effect use the duct as a vacuum extension of the clean-up hose to the vacuum 17 outside of the bin. One or more such attachments could be used at the same time, and the efficiency of such an attachment might be increased in conjunction with aperture control , where all of the unloading inlets in the bin other than the one to which the tool is attached could be closed.

Thus it can be seen that the invention accomplishes all of its stated objectives. The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous changes and modifications will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly, all

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such suitable changes or modifications in structure or operation which may be resorted to are intended to fall within the scope of the claimed invention.

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LISTING OF DIAGRAM REFERENCE NUMERALS:

5	1.	Grain bin;	11.	Tubular duct;
	2.	Bin floor;	12.	Vacuum attachment end;
	3.	Bin walls;	13.	Extreme end;
	4.	Bin roof;	14.	Vacuum airstream inlet;
	5.	Storage cavity;	15.	Unloading inlet;
10	6.	Bin door;	16.	Vacuum device;
	7.	Hatch insert;	17.	Slide; and
	8.	Auger;	18.	Control rod.
	9.	Bin loaded position;		
	10.	Bin load slope;		

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CLAIMS:

5 We claim:

1. A vacuum duct for the bottom unloading of particulate material storage bins, such bins each having a floor, roof and walls defining a bin storage cavity, said vacuum duct comprising:

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a tubular duct defining an air passageway, having two ends being a vacuum attachment end and an extreme end;

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one or more unloading inlets in the walls of the duct operatively connecting the air passageway and the bin storage cavity;

a vacuum airstream inlet operatively connected to the air passageway at a point between the extreme end of the duct and the first unloading inlet along the duct from the extreme end; and

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vacuum attachment means at the vacuum attachment end of the duct.

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2. The vacuum duct of Claim 1 wherein the vacuum duct is placed inside the bin storage cavity.
3. The vacuum duct of Claim 2 wherein the vacuum duct rests on the bin floor.
- 5 4. The vacuum duct of Claim 2 wherein the vacuum duct runs above the bin floor.
5. The vacuum duct of Claim 1 wherein the vacuum duct runs below the bin floor, and the unloading inlets operatively connect the bin storage cavity and the air passageway by
10 passing through the bin floor.
6. The vacuum duct of Claim 1 further comprising a vacuum device attached to the vacuum attachment means.
- 15 7. The vacuum duct of Claim 6 wherein the vacuum device is a conventional grain vacuum.
8. The vacuum duct of Claim 1 wherein the vacuum airstream inlet is adjustable.
9. The vacuum duct of Claim 8 wherein the vacuum airstream inlet is adjustable from a
20 point outside of the perimeter of the bin.

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10. The vacuum duct of Claim 9 wherein the vacuum airstream inlet is a valve.
11. The vacuum duct of Claim 1 wherein the number of unloading inlets is one.
- 5 12. The vacuum duct of Claim 11 further comprising an unloading inlet aperture control.
13. The vacuum duct of Claim 12 wherein the unloading inlet aperture control can be actuated from a point to the outside of the bin.
- 10 14. The vacuum duct of Claim 13 wherein the unloading inlet aperture control comprises a slide in the unloading inlet which can be opened and closed from outside of the bin by a control rod.
- 15 15. The vacuum duct of Claim 1 wherein the number of unloading inlets is more than one.
16. The vacuum duct of Claim 15 further comprising an unloading inlet aperture control on each unloading inlet.
- 20 17. The vacuum duct of Claim 16 wherein the unloading inlet aperture control can be actuated from a point to the outside of the bin.

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18. The vacuum duct of Claim 17 wherein the unloading inlet aperture control comprises a slide in the unloading inlet which can be opened and closed from outside of the bin by way of a control rod.

5 19. The vacuum duct of Claim 16 wherein the unloading aperture control can each be actuated independently from one another.

20. The vacuum duct of Claim 1 wherein the duct is straight.

10 21. The vacuum duct of Claim 1 wherein the duct is bent vertically to follow the contours of a non-flat bin floor.

22. The vacuum duct of Claim 1 wherein the duct is bent horizontally to position the unloading inlets in a pattern other than a straight line within the bin.

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23. The vacuum duct of Claim 1 further comprising tool attachment means on one or more of the unloading inlets.

FIGURE 1:

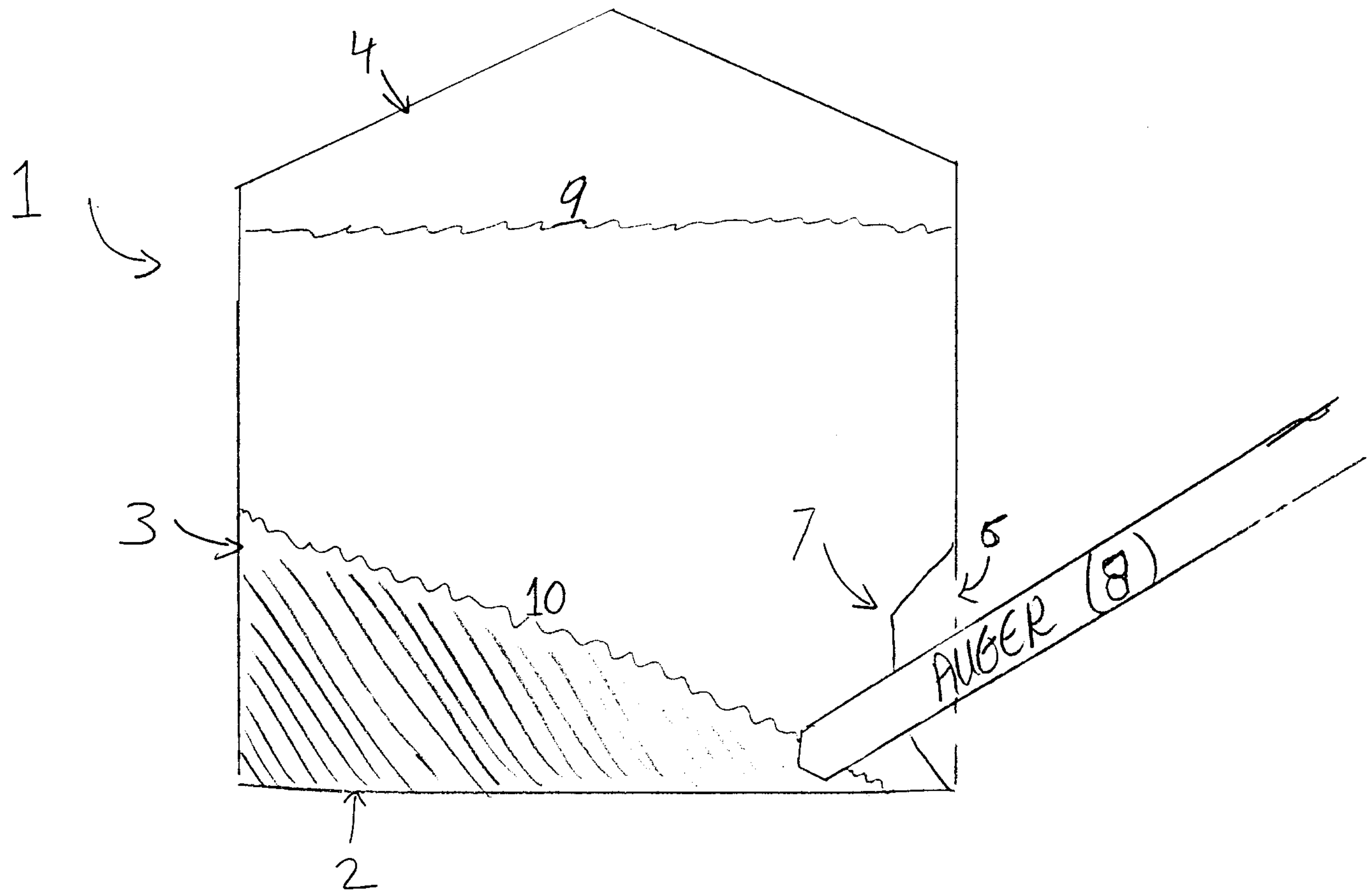


FIGURE 2:

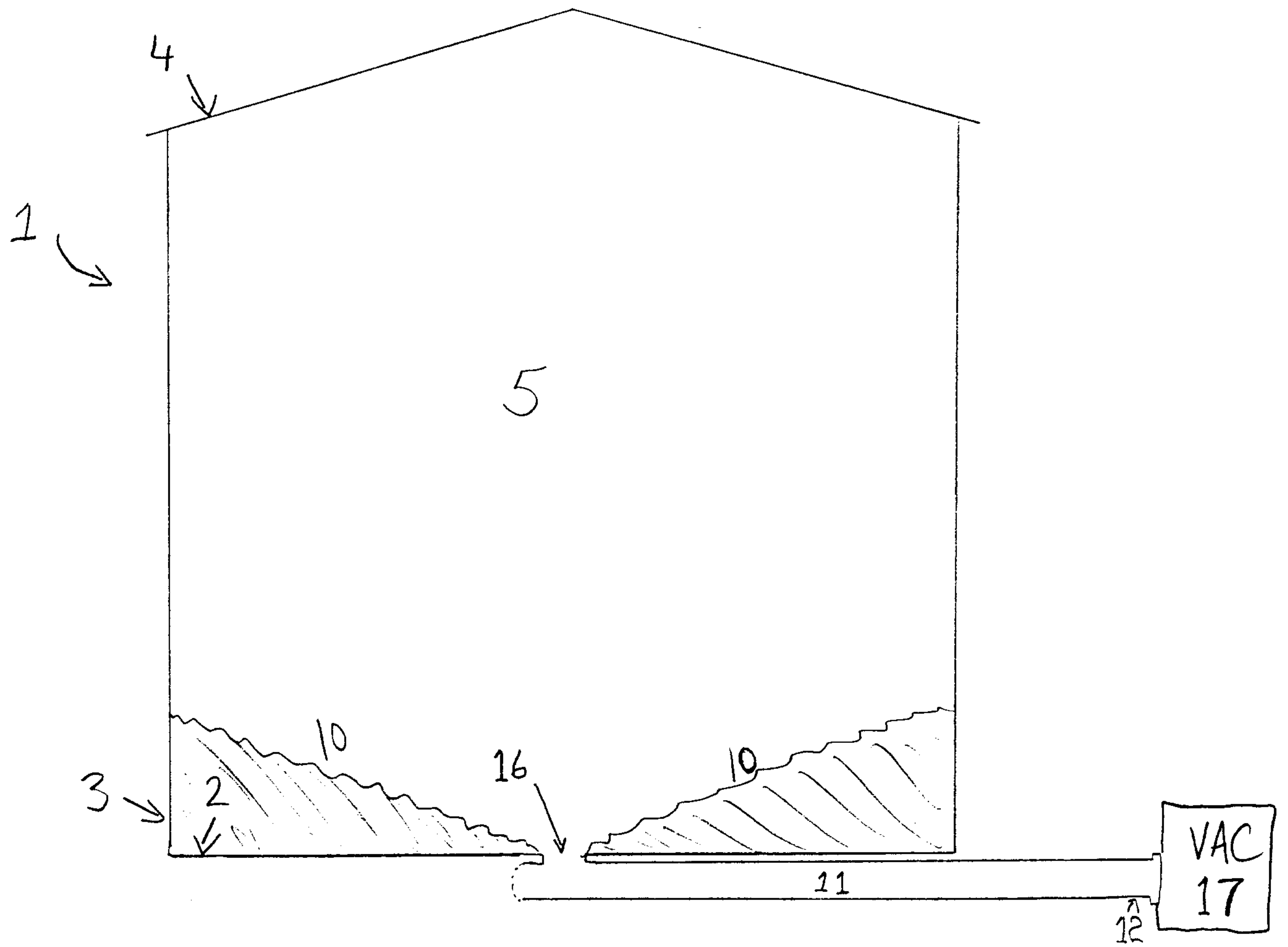


FIGURE 3:

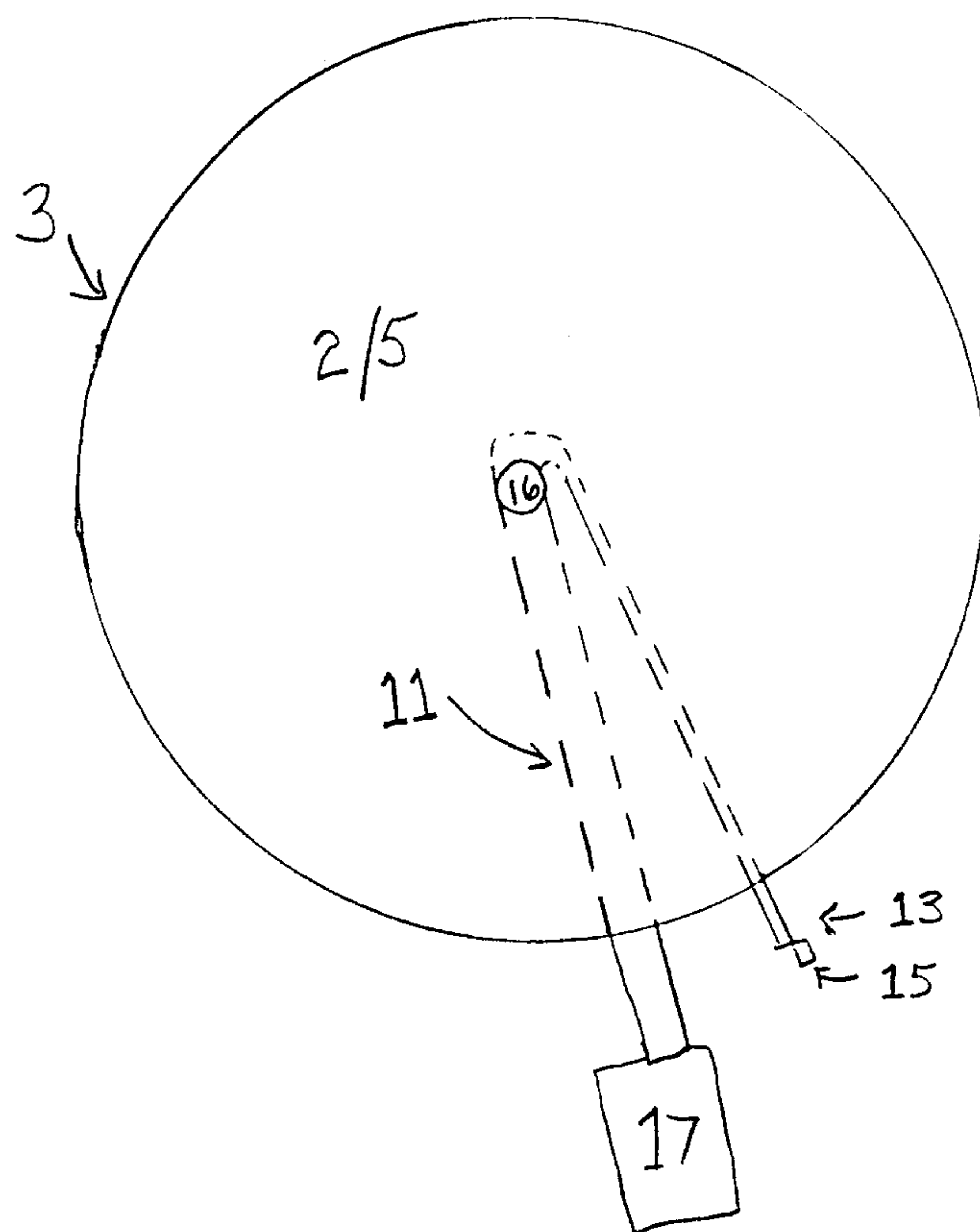


FIGURE 4:

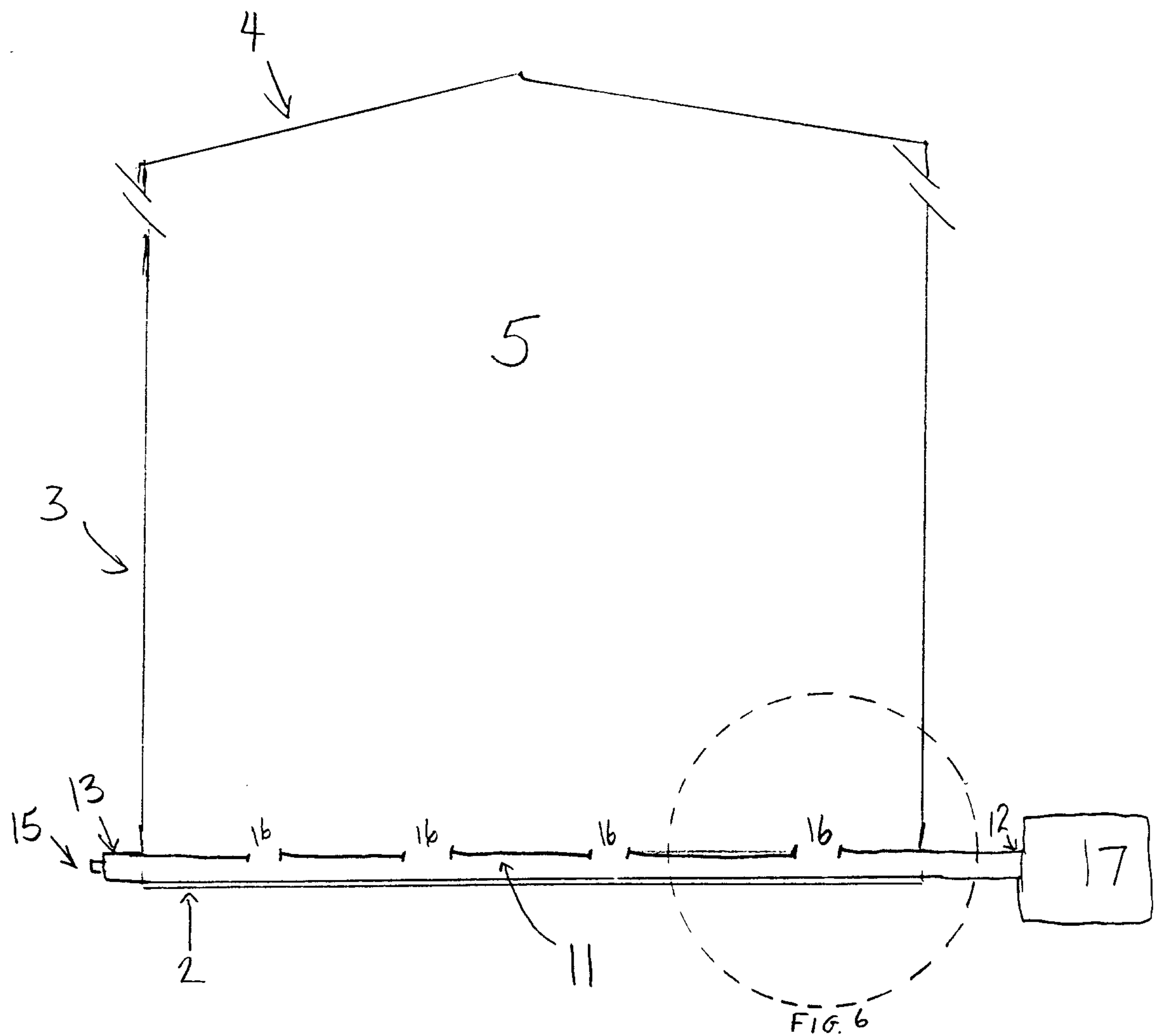


FIGURE 5:

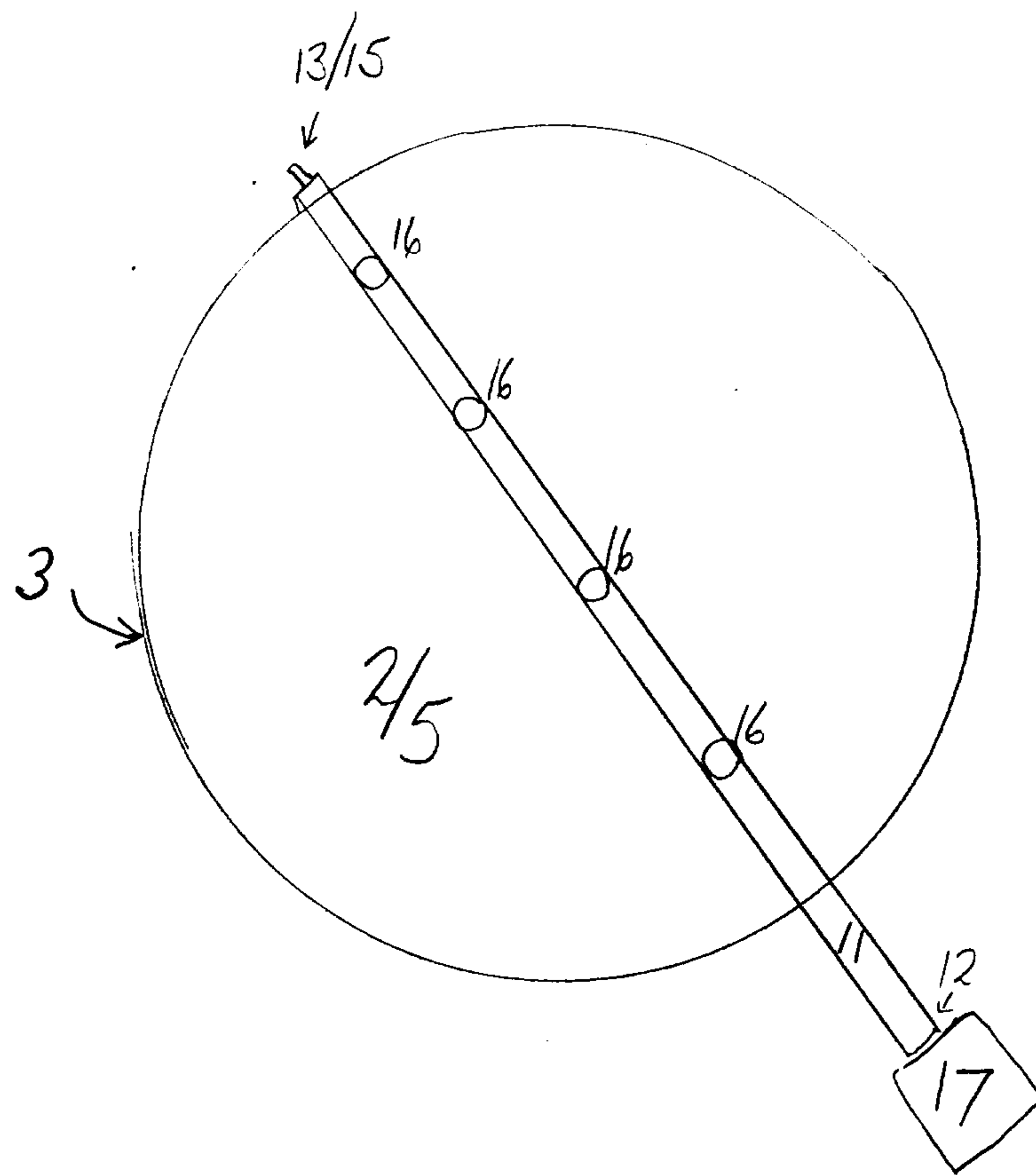


FIGURE 6:

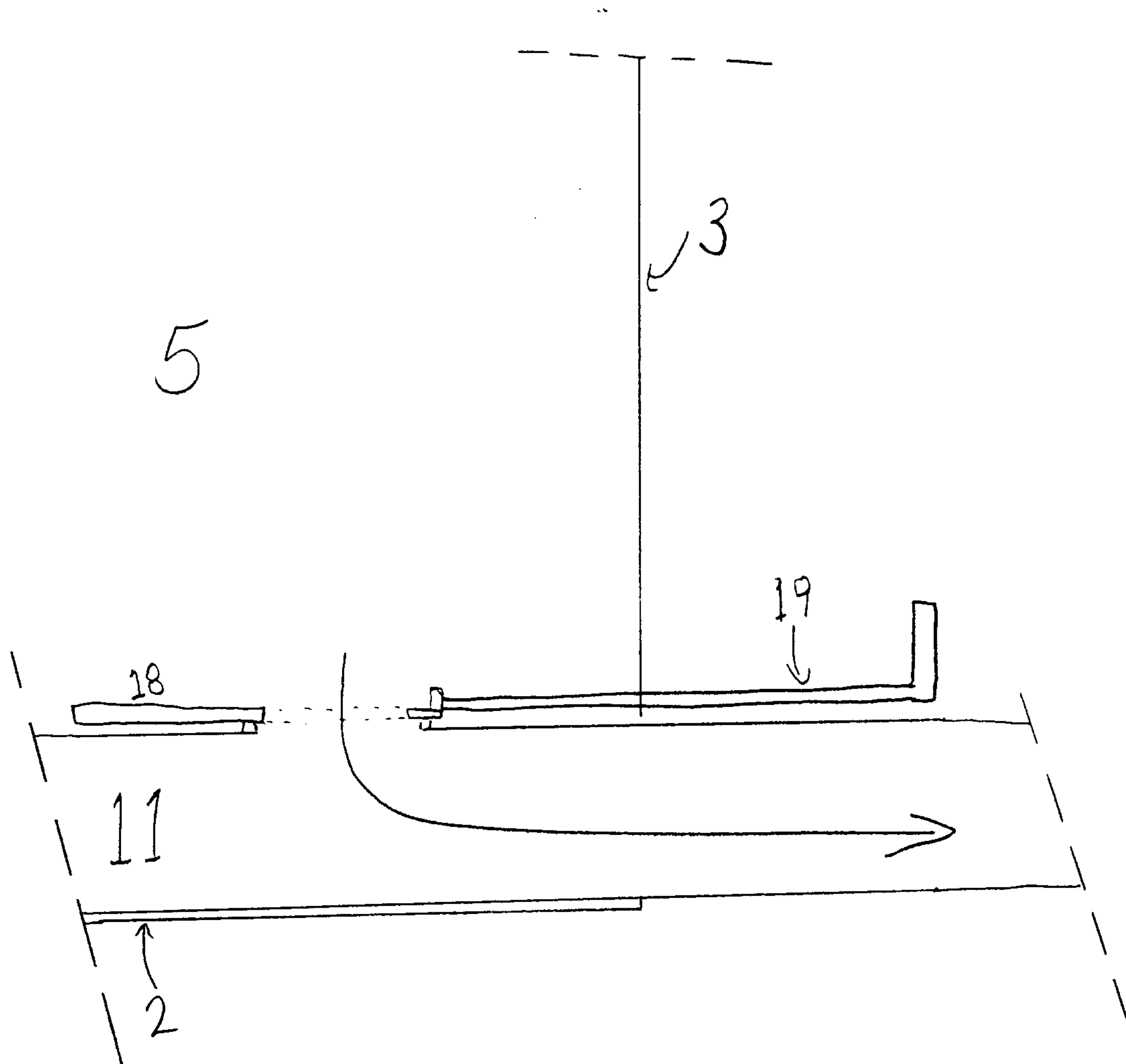


FIGURE 7:

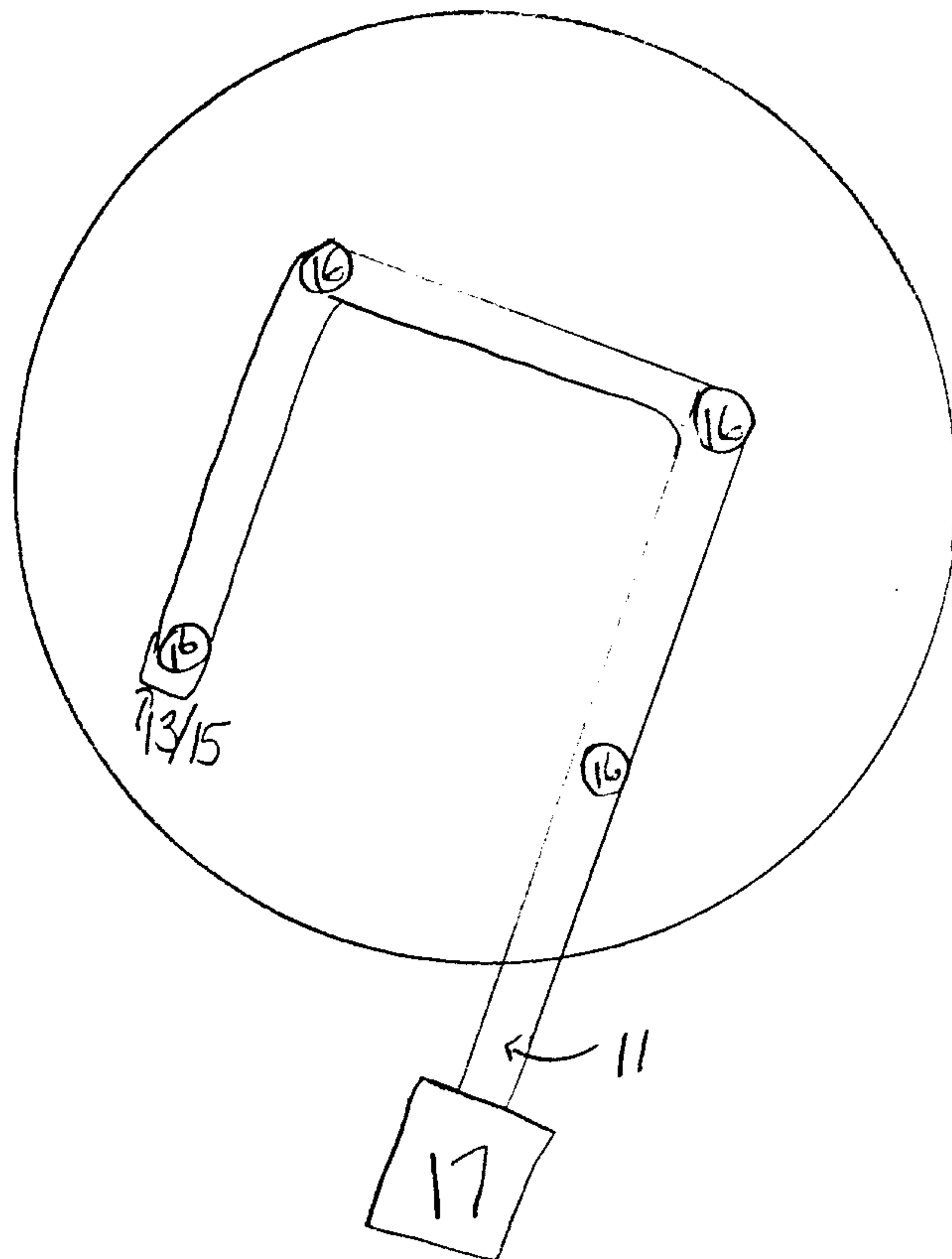


FIGURE 8:

