

Oct. 31, 1961

P. J. SULLIVAN, JR
BIN CONSTRUCTION

3,006,038

Filed April 6, 1959

2 Sheets-Sheet 1

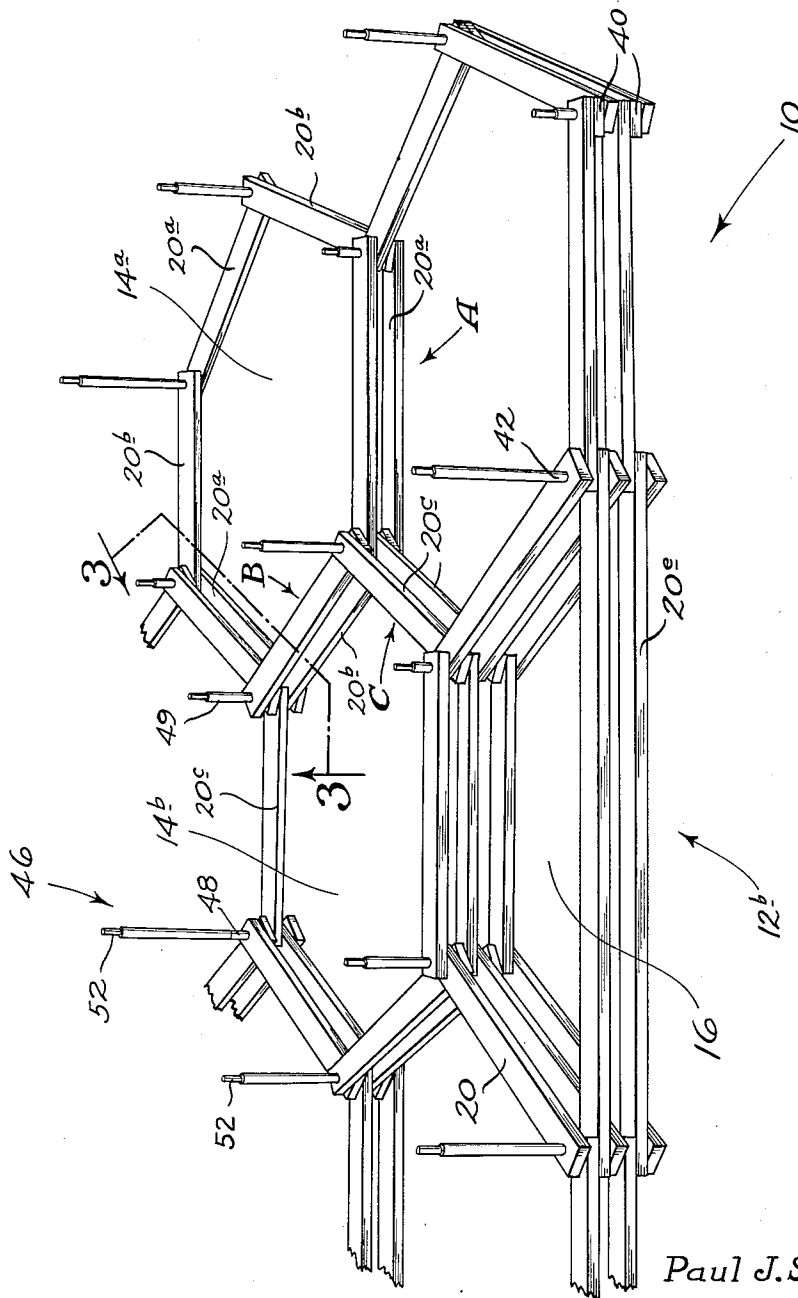


Fig. 1.

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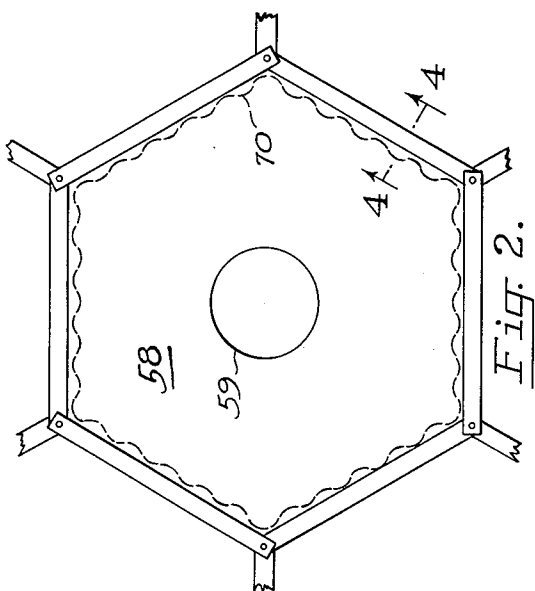
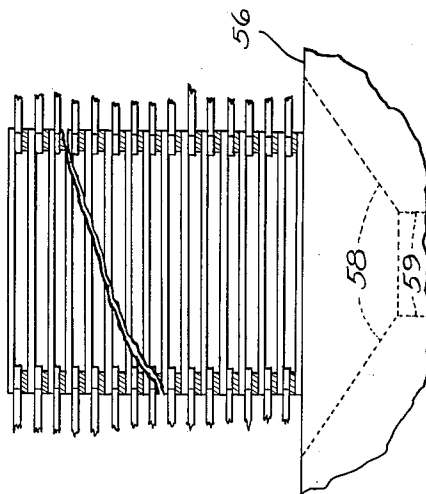


Fig. 3.

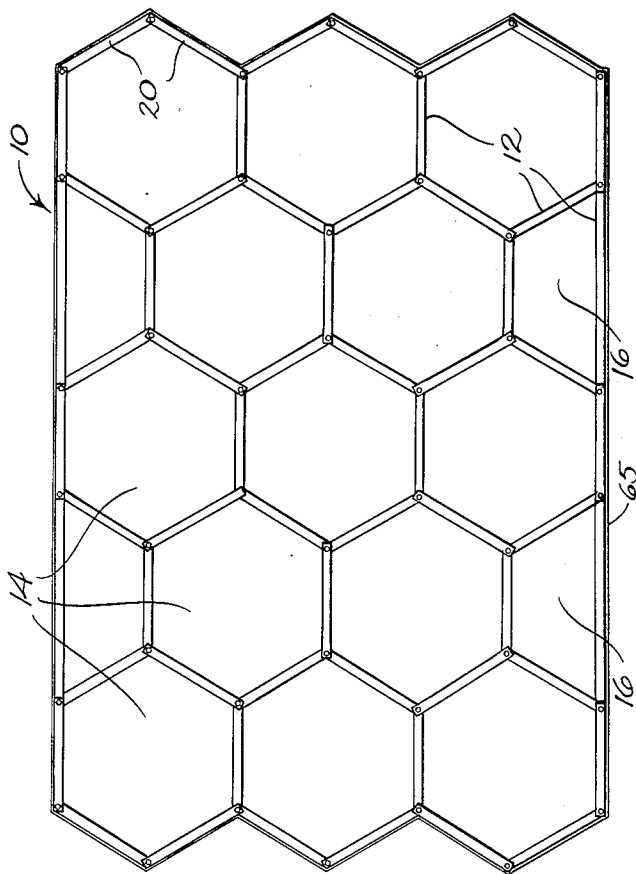
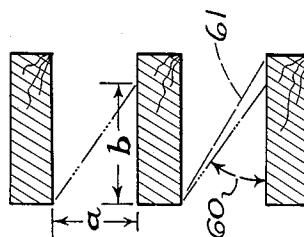


Fig. 5.

Fig. 4.

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BIN CONSTRUCTION

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Filed Apr. 6, 1959, Ser. No. 804,452

8 Claims. (Cl. 20—1.2)

This invention relates to open grain bin structures, and particularly those having a plurality of vertically disposed cells arranged therein. One of the principal objects of this invention is to provide a simple structure which may easily be erected and dismantled and may be used in the field or within a building.

This bin may be constructed of elongated, flat slats, preferably of lumber, which may be stacked and overlapped to produce a sturdy structure. The slats do not have to be nailed or otherwise secured together but may be threaded over vertical pins and yet be strong enough to contain a quantity of grain, without spillage, and without exerting lateral strains upon the walls which must be externally reinforced.

A further and more specific object of my invention is to provide a grain bin of this character, built of stacked slats spaced apart, to provide lateral apertures throughout the vertical height of the bin, and throughout the separate cells thereof so as to afford lateral ventilation for those grains which contain substantial quantities of humidity. Moist grain requires aeration to permit water vapor to be released to the atmosphere. One of the specific features of a grain bin of this character is that the slats are spaced apart to promote such ventilation but yet they are proportioned and arranged so that there is no lateral spillage of grain through the openings. This is because they have such width as to maintain the grain at its normal angle of repose.

A further object of my invention is to provide a bin of this character which, though laterally apertured to afford ventilation, may be enclosed by a covering of relatively fragile, moisture-proof material such as treated fabric, processed paper or film-type plastics. Inasmuch as the grain lying within the bin is at repose, there is no lateral spillage through said openings, and there are no rupturing strains developed upon said relatively fragile sheeting.

Another object of my invention is to provide a grain storage bin of this character with fastening devices for the several slats, which fastening devices comprise vertical pins made in sections easily joined together during erection and easily separated into separate joints when a bin is being dismantled.

Another object of this invention is to provide a multi-cell, honeycomb structure comprising walls made of spaced-apart stacks of spaced, elongated flat slats in which the slats are successively crossed at their ends with the slats making up the individual cells and also overlap with slats in adjacent cell walls so that the several cells are securely joined one with the other.

Proper storage of harvested grain such as wheat, rye, barley, corn and the like imposes a difficult problem during the harvesting season. Commercial storage facilities are usually filled at harvest time and thus it is common practice to make use of temporary structures to store grain until it can be taken to elevators or other more permanent storage facilities. During temporary storage, it is necessary that grain be kept dry and free from damage by rodents and other pests. When the need for said temporary storage facilities is ended, it is essential that temporary bins be easily dismantled for use next season, or that the materials be used in other construction. To this end, I have devised a bin made up of standard dimension lumber which needs no cutting to length or other milling. It is essential only that the

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separate boards or slats be drilled at fixed modules to accommodate vertical pins or rods to hold them in assembled position while the bins are being used for grain storage.

This invention is not limited to temporary facilities but is usable as well within warehouses and other buildings in which the walls are not sufficiently strong to hold bulk grain. Bins embodying this invention may be set up within such a building and occupy substantially the entire floor surface thereof. The grain may be dumped into the several cells of the bin, each of which is self-sustaining. By self-sustaining, I mean that each cell is capable of holding its capacity of grain without imposing structural strain upon the members making up the bin, and inhibits the discharge of grain therefrom. A grain bin embodying my invention when it is used in a multiple cell storage unit is firmed up and made more rigid by the depositing of grain therein, and the several cells thereof are individually made more rigid, because the lateral stresses produced by the grain tend to flex the members slightly (due to the fluidity of the grain) and thus tighten up the joints of the slats with each other and about the vertical pin connections.

Other and further details of this invention are herein-after described with relation to the accompanying drawings, in which:

FIG. 1 is a perspective view illustrating a grain storage bin of honeycomb structure as it looks when it is partially erected, and illustrates the manner in which the various boards or slats are laid one over another to define the separate cells joined with adjacent cells;

FIG. 2 is a plan view of a grain storage bin cell illustrating how it may be centered over a hopper for the discharge of the contents thereof;

FIG. 3 is a foreshortened vertical section taken through one of the cells on the line 3—3 in FIG. 1, said figure also illustrates the hopper arranged in underlying position for promoting the discharge of grain therefrom;

FIG. 4 is a diagrammatic view taken along the line 4—4 in FIG. 2 illustrating the construction and arrangement of spaced slats in the wall of a grain cell and illustrating how said slats may be spaced and proportioned with respect to the angle of repose of the grain in said cell to inhibit the grain from spilling laterally through the spaces between slats; and

FIG. 5 is a view on a reduced scale illustrating diagrammatically the plan of a complete and multi-celled bin.

A grain storage bin embodying my invention is shown in plan in FIG. 5. The bin preferably is a honeycomb structure defining a plurality of vertically disposed cells of hexagonal, horizontal section and said bin is indicated generally as 10 in said figure. Within the outline of the bin there are a plurality of vertically extending wall structures 12 which divide the bin into plural upright bin spaces 14. Said bin spaces preferably are hexagonal in cross section so that they may fit within the exterior outline. If it is desired that the bin have straight sides on the top and bottom of FIG. 5, it is necessary that some of the bins be only one half as large as the remainder. Said half size bin spaces 16 have only four sides.

The manner in which a bin embodying my invention is constructed is shown most clearly in FIG. 1. During the process of erection, the walls of the bin frame 10 are built up using a series of elongated boards or slats 20. It is not necessary that the boards be of uniform length because the degree of overlap is unimportant. It is essential, however, that each slat be provided with a hole 42 adjacent each end thereof. This is to receive pins 46 which pass through the ends of the several slats, as is indicated in FIG. 1. The pins preferably are dis-jointable and are made of relatively short sections. The

sections or joints are preferably of different lengths, such as 2, 3 and 4 foot lengths. It is preferable that in starting a bin, two, two-foot lengths 48 be arranged diametrically opposing each other and that three-foot lengths 49 and four-foot lengths 50 be similarly arranged. If the pins 46 are made of pipe or tube, one end may be closed by a plug or stud 52 which fits tightly within the bore of said pipe and extends axially therefrom to engage the joint arranged immediately adjacent thereto. Sections are added to those originally placed in the bin and form axial extensions of each other. It is desirable that when a bin has been constructed to its ultimate height, that matching sections be added so that the overall height of each pin 46 is more or less uniform. That is to say, if any given jointed pin 46 starts out with a four-foot section 48, it could be capped with a two-foot section 50. The three-foot sections 49 may be capped with other three-foot sections, and if a two-foot section 50 is used at the lower end of a pin it could be capped by a four-foot section 48. Other arrangements than this, of course, are possible.

I have determined that lengths of 2 x 6 or 2 x 8 lumber is particularly adapted for building said bins in commercial sizes, with the majority of the boards or slats being from 8 to 10 feet in length. Boards or slats of this size are susceptible of constructing a grain storage bin 20 to 30 feet high. These dimensions are given for purposes of illustration only and other slat sizes may be used in constructing said bins.

The boards or slats making up the bin walls are arranged in first, second, and third vertical stacks, these three stacks differing from each other in the levels of the slats contained therein. The boards or slats of each stack are spaced apart from each other, and between each of the slats in a given stack the ends of two other slats from two other stacks are arranged. Thus the slats of a given stack are vertically spaced apart in a wall at regular modules, the distance separating a pair of slats being a distance equal to twice the thickness of each of the slats. This is illustrated most clearly in FIG. 1 in which the three different stacks are indicated at A, B, and C, and in which the slats of these stacks are given numbers 20a, 20b, and 20c, respectively. The slats 20a appear as the first, fourth, seventh, etc. slat up from the ground in stacks A, the slats 20b appear as the second, fifth, eighth, etc. slat up from the ground in stacks B, and slats 20c appear as the third, sixth, ninth, etc. slat up from the ground in stacks C. Referring to storage cell 14a, it will be seen that slats 20a and 20b are alternately arranged in stacked relationship and mated with slats in adjacent cells. In cell 14b, slats 20b and 20c are stacked and mated with slats 20a in adjacent cells. Each type of slat is stacked with every other type of slat at each corner, and appears as every third slat. Thus, considering slats 20c, these overlap the ends of slats 20a and 20b at each corner. The slats subtend equal angles about their points of joinder.

Defining the peripheral margin of four-sided storage cells 16 are longer slats 20e which make up the longer wall structures 12b. Because of the longer span of these slats, lumber of greater width may sometimes be necessary for these slats, in order that the slats better withstand lateral pressure produced by the grain with a minimum outward bowing occurring by reason of this said lateral pressure.

As already indicated, each level of slats 20a occupies a common horizontal plane throughout the storage bin. This is likewise true of the levels of slats 20b and 20c. The slats themselves are horizontal, and in those marginal cells wherein only two types of slats join at a corner, it is necessary to provide spacers 40, as is illustrated in FIG. 1. These spacers take the place of the slats which are absent.

In construction of a bin of slats in accordance with my invention, alternate sides of hexagonal cells spaced

from each other by the width of the side of a cell are first laid, using slats 20a. Then slats 20b are used to fill in the gaps between the ends of slats 20a, and the ends of the slats are pinned by extending a pin 46 through the mated holes 42 therein. Slats 20c may then be used to interconnect the spaced cells, these slats defining new cells intermediate the first layed out cells.

If the cells are to be used for permanent storage, it is desirable that a hopper 56 be arranged below each cell so that the grain may be discharged from the bottom of each cell (see FIG. 3). The hopper should have a funnel-shaped mouth 58 which has a proper slope to permit the grain to slide freely thereover. I have discovered that a slope of 45 degrees with the horizon is sufficient to promote proper flow with many types of grain. Said funnel discharges into an opening 59 which is normally closed but may be opened to permit unloading from any given bin space.

Referring to FIG. 4, the relation of the spacing between adjacent slats of a wall and the angle of repose of a grain is illustrated. When a bin space is filled with a type of grain, the grain falls in the apertures between the slats, with the grain surfacing off to assume its natural angle of repose, as indicated by the dot and dash lines in FIG. 4, running from the lower inwardly disposed corner of a superimposed slat to a point within the breadth of an underlying slat. The angle of repose for the grain is designated at 60. Thus the grain spreads out a distance *b* along the top of each slat, with the spacing between the slats being the dimension *a* (which is twice the thickness of one slat). If the grain is to be prevented from discharging from the bin sides, a line extending from the lower inner edge of an overlying slat to the outer upper edge of an underlying slat should subtend a vertical angle less the angle of repose of grain. Thus in FIG. 4 such a line 61 subtends such an angle which is less than angle 60. With wheat I have discovered by trial and error that the angle of repose for the grain is 28 degrees with respect to the horizon. With wheat, therefor, the angle subtended by line 61 should be somewhat less than about 28 degrees, the slats preferably being somewhat wider than the minimum necessary for grain stability to afford some margin of safety. The width of the slats and the spacing between them may be adjusted for other grains or other commodities stored within the bins so as to prevent lateral spilling over the outer edges of the slats. A substantially smaller spacing than sufficient to prevent lateral spillage should be avoided because it will require more lumber to build such bins. Likewise the lumber should not be wider than necessary because that also leads to the same result.

When a bin is made in accordance with my invention and the sides are apertured, it provides lateral ventilation without inadvertent spillage loss by reason of the proportioning of the slots and their location with respect to each other. If a bin embodying my invention is housed within an enclosed storage room, it usually is not necessary to provide a protective covering for a multi-celled bin. In the field, however, it frequently is desirable to provide some shelter from the elements and to prevent rodents from entering the bin through the spaces between slats. It is necessary only to provide a fragile exterior covering (such as shown at 65 in FIG. 5) which will shed moisture and prevent the inadvertent entry of rodents because it is not necessary to withstand any lateral strain generated by reason of the fluidity of the grain within the bin. Thus, treated paper fabric or thin films of plastic may be utilized. In either event, whether there is an external sheeting or not, the proportioning and arrangement of the slats inhibits the lateral discharge of grain through the apertured walls of the bin.

If the bin is to be used for temporary storage it may be dismantled easily by taking off the uppermost slats first, threading them from the pins which secure their ends.

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If lumber is used for constructing the slats, it may be easily piled for later used or for other construction purposes. In any event, it occupies a very small bulk, may be stored conveniently under shelter and is substantially unaffected by the pierced holes 42 through which pins 46 are passed.

If it is ever necessary to provide an internal liner (such as liner 70 in FIG. 2) for the bin, this may be arranged in the usual manner by inserting it so as to lie flatwise against the inner edges of the slats defining a bin cell. I have found that if corrugated metal is used for the liners, it is best to have the corrugations run vertically so that grain in the bins will be discharged readily and the corrugations will give lateral stiffness to the liner. Interior liners are disadvantageous in most cases, however, because they do not permit the proportioning and arrangement of the slats to be utilized to inhibit lateral discharge of grain, and lateral ventilation is eliminated.

It is claimed and desired to secure by Letters Patent:

1. A grain storage bin comprising a honeycomb structure defining a plurality of vertically disposed cells of hexagonal horizontal section, said structure having walls comprising first, second, and third vertical stacks of spaced, elongated flat slats of equal width and thickness and lying flatwise in horizontal planes, the slats in each of said stacks overlapping and joining at their ends with slats of both of the other stacks to bound said hexagonal cells, each slat in a vertical stack being spaced vertically from adjacent slats in the same stack a distance equal to double the thickness of each slat by reason of the overlapping of slats of the other stacks and separated from such adjacent slats by a void.

2. A grain storage bin comprising a honeycomb structure defining a plurality of vertically disposed cells of hexagonal horizontal section, said structure having walls comprising first, second, and third vertical stacks of spaced, elongated flat slats of equal width and thickness and lying flatwise in horizontal planes, the slats in each of said stacks overlapping and joining at their ends with slats of both of the other stacks to bound said hexagonal cells, the stacked slats subtending equal angles in a horizontal plane progressing outwardly from their points of joinder, each slat in a vertical stack being spaced vertically from its adjacent slats in the same stack a distance equal to double the thickness of each slat by reason of the overlapping of slats of the other stacks and separated from such adjacent slats by a void.

3. A grain storage bin comprising a honeycomb structure defining a plurality of vertically disposed cells of hexagonal horizontal section, said structure having walls comprising first, second, and third vertical stacks of spaced, elongated flat slats of equal width and thickness and lying flatwise in horizontal planes, the slats in each of said stacks overlapping and joining at their ends with slats of both of the other stacks to bound said hexagonal cells, each slat in a vertical stack being spaced vertically from its adjacent slats in the same stack a distance equal to double the thickness of each slat and separated from such adjacent slats by a void, each slat having a predetermined width greater than its thickness and of such proportion that the vertical spacing of the slats in a stack defines horizontally disposed apertures between the slats in which a line extending from the lower inner edge of an overlying slat to the outer upper edge of an underlying slat subtends a vertical angle less than the angle of repose of grain held in said bin thus to prevent lateral spillage of grain through said walls.

4. A grain storage bin comprising a honeycomb structure defining a plurality of vertically disposed cells of hexagonal horizontal section, said structure having walls comprising first, second, and third vertical stacks of spaced, elongated flat slats of equal width and thickness and lying flatwise in horizontal planes, the slats in each of said stacks overlapping and joining at their ends with slats of both of the other stacks to bound said hexagonal cells,

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each slat in a vertical stack being spaced vertically from its adjacent slats in the same stack a distance equal to double the thickness of each slat and separated from such adjacent slats by a void, each slat having a predetermined width greater than its thickness and of such proportion that the vertical spacing of the slats in a stack defines horizontally disposed apertures between the slats in which a line extending from the lower inner edge of an overlying slat to the outer upper edge of an underlying slat subtends a vertical angle less than the angle of repose of grain held in said bin thus to prevent lateral spillage of grain through said walls, and elongated pins piercing the overlapping ends of the slats and securing them in a continuous stack.

5. A grain storage bin comprising a honeycomb structure defining a plurality of vertically disposed cells of hexagonal horizontal section, said structure having walls comprising first, second, and third vertical stacks of spaced, elongated flat slats of equal width and thickness and lying flatwise in horizontal planes, the slats in each of said stacks overlapping and joining at their ends with slats of both of the other stacks to bound said hexagonal cells, each slat in a vertical stack being spaced vertically from its adjacent slats in the same stack a distance equal to double the thickness of each slat and separated from such adjacent slats by a void, and elongated pins piercing the overlapping ends of the slats and securing them in a continuous stack, said elongated pins comprising easily separated segments joined end to end.

6. A grain storage bin comprising a honeycomb structure defining a plurality of vertically disposed cells of hexagonal horizontal section, said structure having walls comprising first, second, and third vertical stacks of spaced elongated flat slats of equal width and thickness and lying flatwise in horizontal planes, the slats in each of said stacks overlapping and joining at their ends with slats of both of the other stacks to bound said hexagonal cells, each slat in a vertical stack being spaced vertically from its adjacent slats in the same stack a distance equal to double the thickness of each slat and separated from such adjacent slats by a void, and elongated pins piercing the overlapping ends of the slats and securing them in a continuous stack, said elongated pins comprising easily separated tube segments having plugs fixed in one end only and interfitting with the unplugged end of an adjoining segment which is in axial alignment therewith.

7. A grain storage bin comprising a honeycomb structure defining a plurality of vertically disposed cells of hexagonal horizontal section, said structure having walls comprising first, second, and third vertical stacks of spaced, elongated flat slats of equal width and thickness and lying flatwise in horizontal planes, the slats in each of said stacks overlapping and joining at their ends with slats of both of the other stacks to bound said hexagonal cells, each slat in a vertical stack being spaced vertically from its adjacent slats in the same stack a distance equal to double the thickness of each slat and separated from such adjacent slats by a void, and elongated pins piercing the overlapping ends of the slats and securing them in a continuous stack, said elongated pins comprising easily separated segments, certain of the pins about each cell having separably joined pin segment ends lying at different horizontal level than the pin segment ends of other pins.

8. A grain storage bin comprising a honeycomb structure defining a plurality of vertically disposed cells of hexagonal horizontal section, said structure having walls comprising first, second, and third vertical stacks of spaced, elongated flat slats of equal width and thickness and lying flatwise in horizontal planes, the slats in each of said stacks overlapping and joining at their ends with slats of both of the other stacks to bound said hexagonal cells, each slat in a vertical stack being spaced vertically from its adjacent slats in the same stack a distance equal to double the thickness of each slat and separated from such

adjacent slats by a void, each slat having a predetermined width greater than its thickness, and proportioned so that the vertical spacing of the slats in a stack defines horizontally disposed apertures between the slats in which a line extending from the lower inner edge of an overlying 5 slat to the outer upper edge of an underlying slat subtends a vertical angle less than the angle of repose of grain held in said bin thus to prevent lateral spillage thereof through said walls, and a covering surrounding said bin free of rupturing strains due to said absence of spillage through 10 said walls.

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