Dec. 27, 1955 E. G. PETERSON 2,728,470

HOPPER CONSTRUCTION

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Fig. 1.

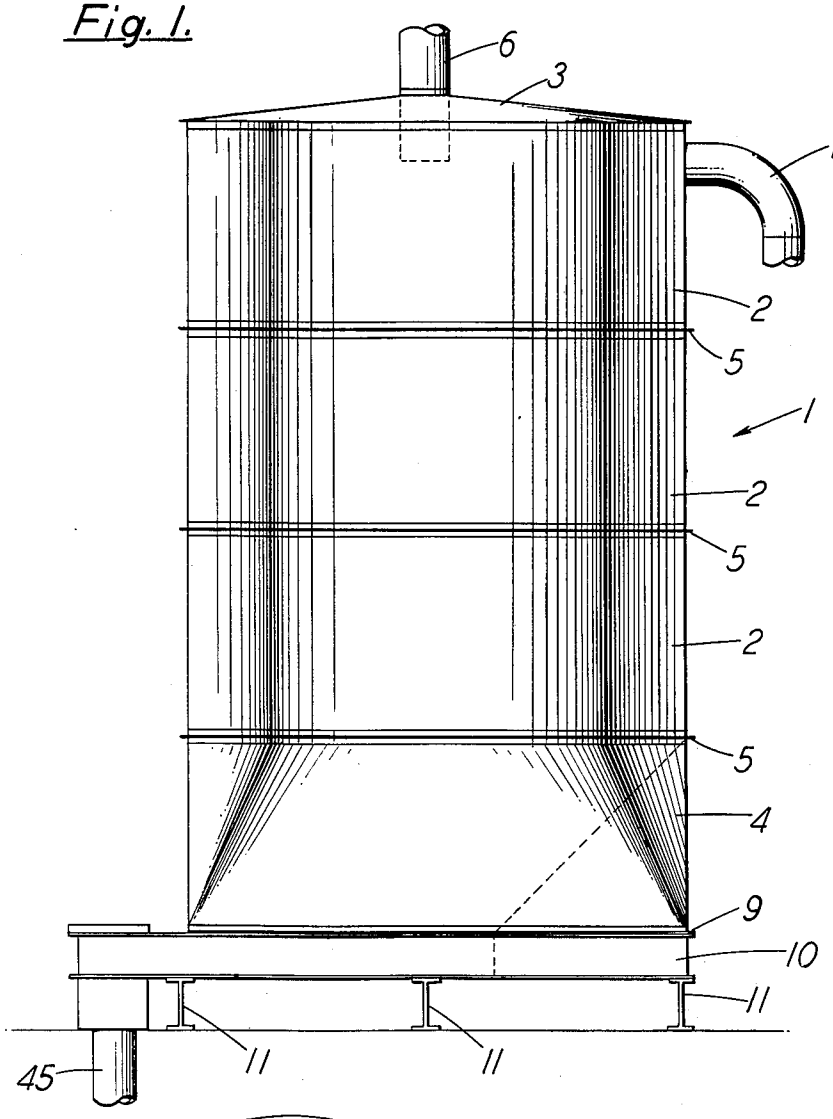
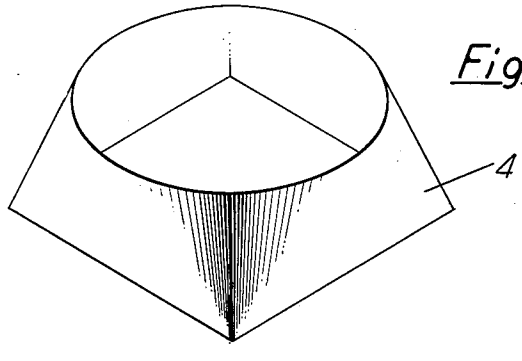


Fig. 2.



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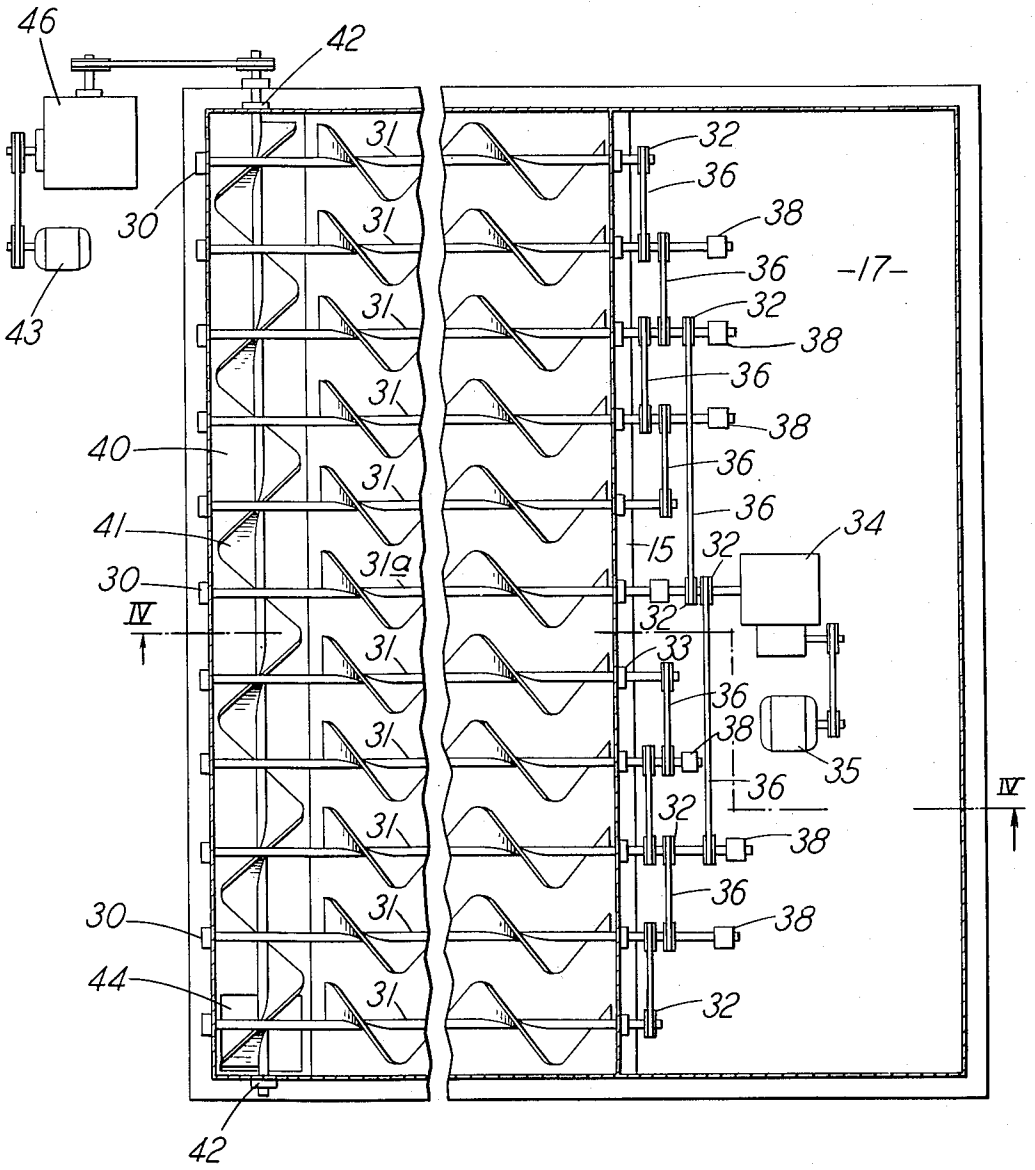


Fig. 3.

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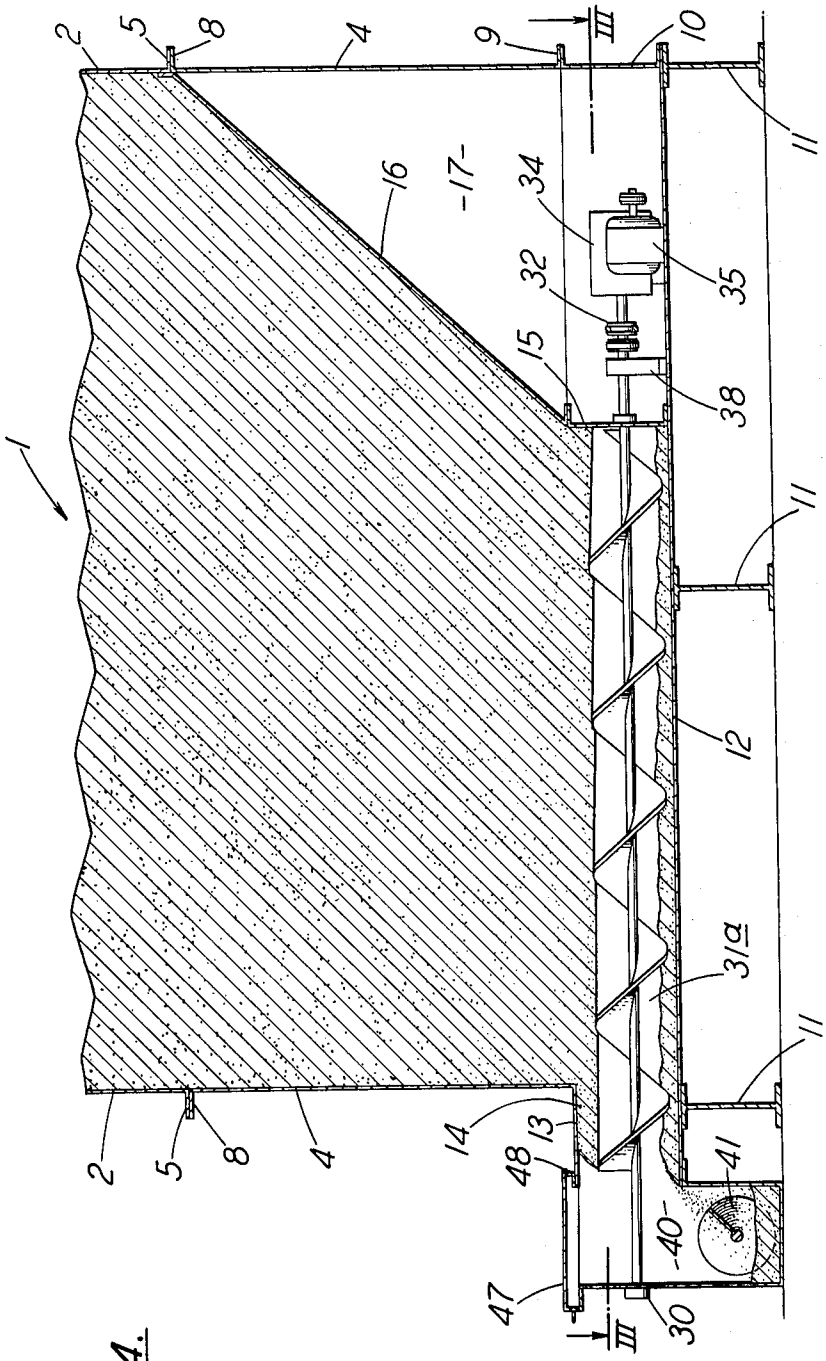


Fig. 4.

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HOPPER CONSTRUCTION

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Application June 4, 1951, Serial No. 229,687

3 Claims. (Cl. 214—17)

This invention relates to live floor hoppers and more particularly to the construction of that portion of the hopper immediately above the floor.

The constant, automatic removal of fine materials from the bottom of hoppers has heretofore always presented a problem to which no satisfactory solution has, prior to my invention, been developed. Although this problem occurs with all finely divided materials, to a greater or lesser degree, it is particularly serious with sawdust. The difficulty arises because of the tendency of the material to bridge above the floor of the hopper whereby the material will be suspended above the live floor and free of all contact with the material removing conveyors at the bottom of the hopper. The bridging effect occurs when the material wedges itself against the sides of the hopper and forms a stable arch.

Existing designs of hoppers intended to overcome this problem have not been successful. Such expedients as increasing the weight of the material in the hopper, increasing and decreasing the diameter of the hopper or employing special means such as agitators, have failed to provide the desired functional improvement.

It is, therefore, a primary object of my invention to provide a hopper design which will positively prevent the bridging of the material within the hopper. Other objects of my invention include the development of such a hopper design adaptable to hoppers having a wide range of sizes and usable for a large number of materials.

These and other objects and purposes of my invention will be immediately seen by those acquainted with the design and construction of material hoppers upon reading the following specification and the accompanying drawings.

In the drawings:

Figure 1 is a side elevation view of my improved hopper.

Figure 2 is an oblique view of the bottom section of my improved hopper, not showing the top and bottom mounting flanges.

Figure 3 is a sectional view taken along the plane III—III of Figure 4 and showing the live floor of my improved hopper in plan view.

Figure 4 is an enlarged, fragmentary, sectional view of my improved hopper taken along the plane IV—IV of Figure 3.

In executing the objects and purposes of my invention, I have provided a circular hopper, the upper portion of which is of conventional design. The floor of this hopper is equipped with a plurality of slowly rotating, parallel, helical members for removing the material from the bottom of the hopper. The section of the hopper immediately above the hopper floor is designed to effect a transition in shape of the hopper walls. Between its upper and lower ends, this piece passes through a gradual transition in shape from circular to square.

In the following description the terms "upper" and "lower" are frequently used and are to be taken to mean "upper" as the hopper is normally used and as it appears in Figure 1 and "lower" away therefrom. The terms "front" and "rear" are also freely used and are to be taken to mean "front" the side of the hopper through which the live floor discharges, that is, to the left as the hopper appears in Figure 1 and "rear" away therefrom.

Referring now to the drawings in greater detail, the numeral 1 refers to a cylindrical hopper consisting of three circular sections 2, a roof 3 and a lower transition section 4. It will be understood that the choice of three circular sections 2 is merely for convenience in describing my invention. A greater or lesser number of the circular sections 2 may be used, according to the amount of storage capacity desired for the hopper 1. Each of the circular sections 2 is provided with a radially, outwardly projecting flange 5 at its upper and lower ends whereby it may be anchored to each of the next adjoining sections. The sections 2 are joined, through the flanges 5 by means of rivets, bolts, welds or other suitable means.

The roof 3 is anchored to the flange 5 of the top, circular section 2 in the same manner as the circular sections 2 are joined to each other. A pipe 6 extends down through the roof 3 and terminates within the hopper just below the roof. Material is blown into the hopper 1 through the pipe 6. The air used to carry the material into the hopper is exhausted through the pipe 7. Where the material received through the pipe 6 originates and by what means the air exhausted through the pipe 7 is disposed of is immaterial to my invention. Therefore, this structure is neither shown nor described.

The transition section 4 is provided with a radial flange 8 (Figure 4) at its upper end whereby it may be readily joined to the adjacent circular section 2 immediately above it. The transition section 4 is circular at its upper end. The shape of the transition section gradually changes from that of a circle at its upper end to that of a square at its lower end (Figure 2). The size of the square, lower end is such that the circular, upper end, in plan view, appears tangent to the sides of the square. The purpose of the shape of the transition section 4 will be fully explained under "Operation." The lower end of the transition section 4 is provided with a peripheral flange 9 along its side and rear edges (Figure 1) whereby it may be seated upon and anchored to the base frame 10. The base frame 10 is, in turn, supported upon the I-beams 11.

Mounted on the I-beams 11 is a floor plate 12, extending under the entire hopper 1. The front portion of the floor plate 12 extends outwardly beyond the periphery of the transition section 4. A lip 13 extends outwardly from the lower end of the transition section 4, spaced from and parallel to the floor plate 12. Between the floor plate 12 and the lip 13 is a passageway 14, extending across the entire width of the front of the hopper 1. The sides of the passageway 14 are enclosed by the extended ends of the side beam members of the frame 10.

At a point spaced rearwardly approximately two-thirds of the distance across the hopper 1 from the passageway 14, a channel 15 (Figure 4), identical in height to the frame 10, is mounted on the floor plate 12 parallel to the passageway 14. Secured to the top of the channel 15 is an inclined baffle 16, extending rearwardly away from the passageway 14 and, at the midpoint of its rearward edge affixed to the bottom circular section 2 at the joint between the circular section 2 and the transition section 4. The upper edge of the baffle 16 is so shaped that it will seat tightly against the inward face of the transition section 4, along its entire edge except that edge affixed to the channel 15. The area defined between the floor plate 12, transition section 4, baffle 16, frame 10 and channel 15 constitutes the operation chamber 17.

Immediately above the floor plate 12 are the screw conveyors 31 and 31*a*. The material moving blades of the screw conveyors 31 and 31*a*, terminate in the passageway 14 but the central shaft of each of these conveyors extends forwardly across the hereinafter described trough 40 and is supported by a bearing 30, mounted on the outside face of the forward wall of the trough 40. The screw conveyors 31 and 31*a* are spaced apart to provide only a very small operating clearance between the blades. This clearance is so small that walls of unagitated material cannot build up between the blades of the screw conveyors. The rearward ends of the shafts of the screw conveyors extend through the channel 15 and, on their ends projecting into the operation chamber 17, mount one or more pulleys 32. Each of these shafts is supported by a bearing 33, mounted to the channel 15. The shaft of the screw conveyor 31*a*, midway between the sides of the hopper 1, is directly connected to a speed reducer 34 operated by the prime mover 35. By means of a plurality of belts 36 and pulleys 32 all the other screw conveyors 31 are driven from the screw conveyor 31*a*. The belts 36 and pulleys 32 are so arranged that all of the screw conveyors 31 and the screw conveyor 31*a* rotate in the same direction and at the same angular velocity. Those shafts of the screw conveyors 31 mounting more than one pulley 32 and the shaft of the screw conveyor 31*a* are each provided with additional bearing support in the form of the bearing and bearing supporting posts 38.

Along the forward side of the hopper 1, the passageway 14 discharges into the trough 40. The trough 40 is at a right angle to the screw conveyors 31 and extends across the entire width of the hopper 1. The trough 40 extends below the floor plate 12 whereby material removed from the hopper 1, by the screw conveyors 31 and 31*a*, may drop freely by gravity into the bottom of the trough 40. At the bottom of the trough 40 is a screw conveyor 41, extending the entire length of the trough. The shaft of the screw conveyor 41 is supported by bearings 42, mounted on the end walls of the trough. The screw conveyor 41, by means of the prime mover 43, is rotated to move the material discharged by the screw conveyors 31 and 31*a* to the discharge opening 4 (Figure 3) in the bottom of the trough 40. The discharge opening 44 connects with the offtake conduit 45 (Figure 1). The offtake conduit removes the material to the means for finally disposing of it. In the case of sawdust this is normally either a furnace or a machine for making sawdust fuel logs.

The prime mover 43 operates the screw conveyor 41 through the prime mover 46 in order that the screw conveyor may be operated at a low angular velocity. The top of the trough 40 is closed by a cover 47, mounted to the lip 13 by the hinge 48. It will be recognized that the screw conveyor 41 may be rotated in the opposite direction to discharge the material at the opposite end of the trough 40. It is also possible to use two short screw conveyors, rotated in opposite directions to discharge the material through an opening at the center of the trough. Each of these constructions are equivalents so far as my invention is concerned.

Operation

The hopper 1 serves as an accumulation and temporary storage area for the material. The material is fed into the hopper 1 through the pipe 6. In the case of most materials, air under pressure is used to carry the material into the hopper 1. This air, after the material originally entrained in it has been deposited in the hopper, is removed through the conduit 7. The hopper 1 may be operated with any amount of material in it but, normally, it is operated with a major portion of its storage capacity occupied by material.

The lower end of the material accumulated in the hopper 1 comes in contact with the screw conveyors 31 and 31*a*. These screw conveyors are rotated very slowly and by means of their blades urge the material at the bottom of the hopper toward the trough 40. Thus, the screw conveyors 31 and 31*a*, constituting the live floor of the conveyor, are constantly operating to remove the material from the bottom of the hopper, preferably at a rate somewhat similar to the rate of deposition of the material at the top of the hopper. In hoppers of conventional design these screw conveyors or their mechanical equivalent, are capable of removing material for a while. Then the material forms a bridge above the conveyors, which bridge is stable and supports the remainder of the material in the hopper above the conveyors whereby no material is removed from the bottom of the hopper. When this happens, it becomes necessary to break the bridge. This operation has to be repeated time and again as the bridge repeatedly reforms. By reason of the design of the transition section 4 of my hopper, this bridge of material cannot form. As the material moves down toward the screw conveyors 31 and 31*a*, the material, after it enters the transition section 4, spreads out because of the change in the shape of this section. Because the sides of the transition section slope outwardly away from the body of the material in the hopper 1, the material cannot frictionally wedge itself against the sides of the hopper and thereby provide a secure anchor to support a bridge. The outwardly sloping walls of the transition section also cause the span of any arch, which might become the basis of a bridge of material, to constantly increase as the material passes downwardly. This disrupts the stability of any such arch, collapsing it. The fact that the rearward portion of the hopper is provided with an inwardly sloping wall formed by the baffle 16, does not destroy this effect. The stable arch which forms in the conventional hopper is in the form of a convex segment of a sphere and, as such, must be stable in all directions. Since two sides of the arch are expanding, the arch is not stable and collapses. This insures constant operation of the hopper no matter how much material is stored in the hopper. It becomes unnecessary to periodically shift the material to cause it to come in contact with the live floor of the conveyor.

Since the conventional method of forcing the material into the hopper is by means of a stream of air, it is necessary to prevent this air from creating a channel through the material in the hopper and exhausting past the screw conveyors 31 and 31*a* into the trough 40. The passageway 14, being a narrow, restricted area, creates a plug of material extending from the inner wall of the hopper 1 to the end of the screw conveyors 31 and 31*a*. This slowly moving plug of material in the passageway 14 serves as a barrier to the escape of air from the inside of the hopper into the trough 40. Since the plug formed in the passageway 14 prevents the material from being forced from the hopper by air leaking into the trough 40, the rate of removal of the material from inside the hopper may be closely regulated by the speed at which the screw conveyors 31 and 31*a* are operated. The material removed by the screw conveyors 31 and 31*a* is dropped into the trough 40 where it is carried by the screw conveyor 41 toward the end of the trough 40 having the opening 44. The material drops through the opening 44 and is removed entirely from the hopper structure.

I have described a hopper structure in which constant, dependable removal of the material is assured and in which the material will not form an arch in the hopper whereby it cannot readily be removed. Various modifications of my invention may be made, each without departing from the principle of my invention. Each of these modifications is to be considered as included in the hereinafter appended claims unless these claims by their language expressly state otherwise.

I claim:

1. In a hopper for finely divided material having a material inlet at its upper end and a live floor conveyor means

at its lower end, the combination comprising: a cylindrical main body section above said conveyor; a transition section between said main body section and said conveyor; said transition section being circular at its upper end and square at its lower end, said change in shape being gradual, said square lower end being of such size that said cylindrical main body section may be inscribed therein.

2. In a hopper for finely divided material as described in claim 1 wherein the diameter of said cylindrical section is equal to the length of one of the sides of the square bottom of said transition section.

3. In a hopper for a finely divided material, said hopper having an inlet in its upper portion, the combination comprising: said hopper having a bottom discharge end and means at said end for forcibly removing material from said hopper; said hopper having a cylindrical main body section

and a transition section between said main body section and said means; said transition section being circular at its upper end and rectilinear at its lower end, said change in shape being gradual, said rectilinear lower end being of such size that said cylindrical main body section may be inscribed therein.

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