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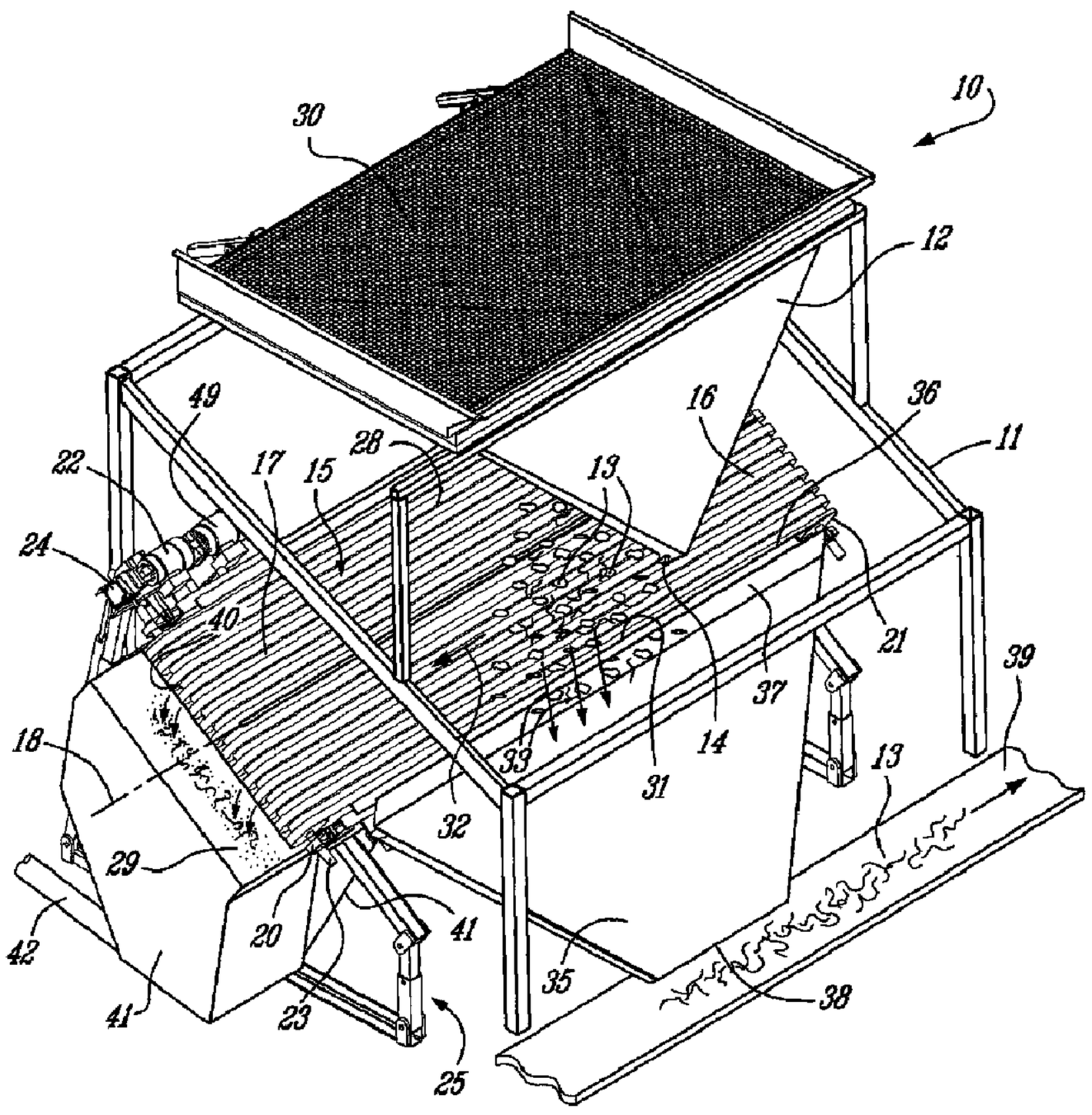
(71) Demandeur/Applicant:
AGRO-100 LTEE, CA

(72) Inventeur/Inventor:
HARNOIS, JEAN-MARC, CA

(74) Agent: OGILVY RENAULT LLP/S.E.N.C.R.L.,S.R.L.

(54) Titre : SEPARATEUR DE PARTICULES ET INSTALLATION DE TRI PARTICULAIRE DE MATIERES D'UN MELANGE

(54) Title: PARTICLE SEPARATOR AND SYSTEM FOR SORTING PARTICLES OF MATTER FROM A MIXTURE



(57) Abrégé/Abstract:
A particle separator and a method for sorting particles or matter from a particulate mixture discharged thereon is described. It comprises an endless belt conveyor having an outer surface provided with a plurality of longitudinally extending parallel endless

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(57) Abrégé(suite)/Abstract(continued):
sorting channels formed therein. The endless belt is driven and displaced in a longitudinal direction under a supply bin which discharges the particulate mixture in an upper region thereof. The channels have a predetermined width/depth ratio and are configured to receive and retain therein unwanted matter of a size capable of being received in the channels. An adjustable support frame adjustably positions the endless belt conveyor at a desired inclined transverse angle above a support surface. The particulate matter is discharged in an upper region thereof at a receiving end and gravitates transversely of the longitudinal direction of displacement of the endless belt towards a lowermost part of the endless belt where it is discharged and conveyed. A substantial portion of the unwanted matter is trapped in the channels during this gravitational displacement of the particulate mixture, and discharged at a discharge end of the conveyor whereby to remove a substantial part of this unwanted matter from the particulate mixture.

ABSTRACT

A particle separator and a method for sorting particles or matter from a particulate mixture discharged thereon is described. It comprises an endless belt conveyor having an outer surface provided with a plurality of longitudinally extending parallel endless sorting channels formed therein. The endless belt is driven and displaced in a longitudinal direction under a supply bin which discharges the particulate mixture in an upper region thereof. The channels have a predetermined width/depth ratio and are configured to receive and retain therein unwanted matter of a size capable of being received in the channels. An adjustable support frame adjustably positions the endless belt conveyor at a desired inclined transverse angle above a support surface. The particulate matter is discharged in an upper region thereof at a receiving end and gravitates transversely of the longitudinal direction of displacement of the endless belt towards a lowermost part of the endless belt where it is discharged and conveyed. A substantial portion of the unwanted matter is trapped in the channels during this gravitational displacement of the particulate mixture, and discharged at a discharge end of the conveyor whereby to remove a substantial part of this unwanted matter from the particulate mixture.

PARTICLE SEPARATOR AND SYSTEM FOR SORTING PARTICLES OF MATTER FROM A MIXTURE

TECHNICAL FIELD

The present invention relates to a particle separator and method for sorting particles or matter from a particulate mixture and particularly a particle separator formed by an endless belt having a plurality of longitudinally extending endless particle receiving channels formed therein and wherein the endless belt is oriented at an inclined transverse angle with respect to the longitudinal direction of displacement of the endless belt.

BACKGROUND ART

Numerous types of sorting apparatus are known for sorting particles by size and an example of these is described in U.S. Patent 4,140,630 wherein particles are released on a screen having passages of different sizes whereby to separate particles by size. The majority of such apparatuses use wire cloth screen surfaces or panels and they are commonly used for sorting sand, gravel and other fragmented materials. Also, these screens and panels are usually supported inclined in their longitudinal direction of displacement when the screen is formed as an endless belt. Collecting conveyors are positioned under the screens to receive and transport the particles classified by size range.

It is also known to support screens on vibrating frames with the screens having the larger openings being positioned at an uppermost end and the screens and fine openings positioned therebelow. In this fashion one can separate the size of the granular particles at each level of the machine.

Known particle separating apparatuses have various inherent problems such as being affected by the temperature

of the product as compared to the temperature of the screening device and the adherent effect of the product, particularly when operating in a humid, ambient environment. A further disadvantage of known screening devices is that the passages in the screen also can become blocked by the adherence of the product when in a humid state or simply by dust in the environment of the screen which adheres to the screen when in a wet condition. All of these problems influence the effectiveness of such screening apparatus.

Furthermore, these known screening apparatuses employ many mechanical parts in their construction and thus are susceptible to breakage and necessitating constant maintenance. Because many of these screening devices are fabricated from metal parts they produce excessive noise during operation and create excess dust due to the friction imparted to the particulate material being screened. When the screens also become clogged it is necessary to shut down the machine to effect the cleaning thereof and this increases the cost of its use. Further, if the screens are not washed before use with a different product, the material which is adhered to the screen can contaminate the different material. Many of these known devices can only be used to effect a specific screening function and cannot be constructed of different sizes to adapt the system to different screening materials. Furthermore, these machines are usually expensive to fabricate and consume excessive energy to operate.

SUMMARY OF INVENTION

It is a feature of the present invention to provide a particle separator and method which substantially overcome all of the above-mentioned disadvantages of the prior art.

Another feature of the present invention is to provide a particle separator and method comprised of an endless belt having a flat outer surface with a plurality of

longitudinally extending endless sorting channels formed therein and wherein the endless belt and its sorting channels are automatically cleaned during operation of the particle separator.

Another feature of the present invention is t provide a particle separator and method capable of removing unwanted matter from a particulate mixture, such as fertilizers.

Another feature of the present invention is to provide a particle separator and method which is more environmentally friendly than those of the prior art and capable of operating at different speeds and at lower energy cost and which is capable of being fabricated on different scales, depending on a variety of applications.

According to the above features, from a broad aspect, the present invention provides a particle separator for separating unwanted matter from a particulate mixture. The particle separator comprises an endless belt conveyor having an outer surface provided with a plurality of longitudinally extending endless sorting channels formed therein. Drive means is provided for displacing the endless belt in a longitudinal direction between support means. The channels have a predetermined width/depth ratio and configured to receive and retain therein the unwanted matter of a size capable of being received in the channels. Support means is provided for adjustably supporting the endless belt conveyor at an inclined transverse angle above a support surface of the particles separator whereby the particulate mixture can be controllably discharged on the inclined conveyor and caused to gravitate transversely of the longitudinal direction of displacement of the endless belt towards a lowermost part of the endless belt wherein unwanted matter is trapped and conveyed by the sorting channels and the remaining particulate mixture is gravity discharged at

the said lowermost part. The unwanted matter which is conveyed by the channels is discharged at a discharge end of the endless belt conveyor thereby separating the at least a substantial part of the unwanted matter from the particulate mixture.

According to a further broad aspect of the present invention there is provided a method of separating unwanted matter from a particulate mixture. The method comprises the steps of providing an endless belt conveyor having an outer surface provided with a plurality of longitudinally extending endless sorting channels formed therein in a spaced-part manner. The method further comprises adjusting the support means to position the endless belt conveyor at a desired inclined transverse angle above a support surface of the support means. The endless belt conveyor is operated at a predetermined adjustable speed for displacement in a longitudinal direction. The particulate mixture is controllably discharged on the inclined endless belt conveyor wherein the particulate mixture is caused to gravitated transversely of the longitudinal direction, as it is conveyed by the endless belt conveyor, towards a lowermost part of the endless belt. The unwanted matter is received and trapped in the sorting channels. Unwanted matter is received at a discharge end of the inclined endless belt conveyor and the remaining particulate mixture, which is gravity discharged at a lowermost part of the endless belt conveyor, is conveyed for further use.

BRIEF DESCRIPTION OF DRAWINGS

A preferred embodiment of the present invention will now be described with reference to the accompanying drawings in which:

FIG. 1 is a perspective view of the particle separator of the present invention;

FIG. 2 is a top view of Figure 1;

FIG. 3 is an end view of Figure 1;

FIG. 4 is a simplified side view of the conveyor belt showing its construction and its attachment to the adjustable supports as well as the cleansing brush to clean the surface and channels; and

FIG. 5 is an enlarged fragmented cross-section view of the upper surface of the endless belt conveyor.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the drawings and more particularly to Figures 1 to 3, there is shown generally at 10 the particle separator of the present invention. It has a stationary frame 11 for supporting an elevated supply bin 12 in which a particulate mixture of particles and matter 13 is contained and discharged at a lower discharge end 14 thereof onto an endless belt conveyor 15.

As shown in Figure 5, the endless belt conveyor has an outer surface 16 provided with a plurality of longitudinally extending endless sorting channels 17 formed therein and extending in spaced apart parallel relationship along the longitudinal axis 18 of the endless belt conveyor 15. Accordingly, the sorting channels extend in a longitudinal direction. Also, the channels are of substantially square cross-section and the width 18, herein the base of the channel, is of like dimension as the depth 19, herein the opposed side walls of the channel. Accordingly, the channels 17 have a width/depth ratio of 1:1. The endless belt conveyor 15 is made of reinforced rubber and it is supported taut between a drive roll 20 and an idler roll 21.

The drive roll 20 is driven by a variable drive motor 22 which is coupled to the drive shaft 23 of the drive roll 20 by a gear box or gear coupling 24. Accordingly, the

drive roll 20 can be driven at a desired speed by controlling the variable drive motor 22 whereby to impart rotation to the drive roll and hence displacement of the endless belt conveyor 15.

As better illustrated in Figure 3, the endless belt conveyor 15 is supported by an adjustable support frame 25 whereby the endless belt conveyor 15 can be adjustably supported at an inclined transverse angle 26 relative to the support surface 27 of the adjustable support frame 25. This transverse angle 26 is selected dependent on the type of particulate mixture which is to be released onto the conveyor at the discharge end 14 of the supply bin 12 and the temperature of the particulate mixture. The speed of operation of the endless belt conveyor is also dependent on these characteristics of the particulate mixture.

The discharge end 14 of the supply bin 12 may have an adjustable opening, not shown but obvious to a person skilled in the art, which is adjustable also dependent on the nature of the particulate mixture. Also, the supply bin 12 may be mounted on a vibrating mechanism, herein not shown but obvious to a person skilled in the art, whereby to impart vibration thereof to facilitate the precipitation of the particulate mixture loaded therein towards the discharge end 14. A screen 30 may also be secured on top of the collection housing whereby to prevent the loading of large unwanted matter, such as stones, into the supply bin together with the particulate mixture, such as fertilizers. Because the fertilizer contains unwanted matter such as fines which form a powdery matter and filament type matter 29, as shown in Figure 5, it is necessary to separate these fines from the fertilizer particles. Therefore, by discharging the particulate matter onto the inclined endless belt and preferably in an upper portion 28 of the endless belt 15, this particulate matter 13 will be caused to gravitate and

tumble transversely to the longitudinal direction of displacement of the endless belt towards the lowermost part 31 of the endless belt as the particles are transported in the direction of arrow 32. They gravitate transversely in the direction of arrows 33, as illustrated in Figure 1. During the gravitational displacement of this particulate mixture 13, many unwanted matter, herein the fines 29, become trapped and are conveyed in the sorting channels 17, as illustrated in Figure 5, while the larger particles 34 of the particulate mixture 13 gravitate and are discharged from the endless belt conveyor 15 at its lowermost part 31 thereof. This particulate mixture 13 discharged at the lowermost part 31 is collected in an open-ended trough 35 having an open top end 36 with a flange wall 37 and extending along substantially the entire length of the endless belt conveyor 15 whereby the particulate mixture 13 is gathered in a funnel-type collecting trough 35 to be discharged at a lower end 38 onto a transport conveyor belt 39 where the particulate matter 13 can be stock-piled or released in containers, etc.

The unwanted matter or fines 29 which is trapped and conveyed in the sorting channels 17, or stuck to the belt, are discharged at a discharge end 40 of the endless belt conveyor 15 into a collection housing 41 where the fine particles are then transported by a conveyor, such as a suction pipe 42, for disposal or packaging.

In order to maintain the outer surface 16 and the sorting channel 17 clean when the conveyor belt returns to its position under the supply housing 12 there is provided cleansing brushes 50 which are rotating brushes supported underneath the endless belt 15 under the discharge end 40 and above the collection housing 41 whereby to dislodge the fine particles and other matter from the outer surface 16 and the sorting channel 17. The rotating brush 50 is supported on a

driven shaft 51 which is coupled to a drive motor 49 to impart rotation thereof. The rotating brush 50 is provided with bristles 52 and is adjustably supported by an adjustable coupling 48 whereby the bristles will enter into the sorting channels to remove any foreign matter therefrom. This foreign matter is projected into the collection housing 41 in the direction of arrows 47. Accordingly, the outer surface 16 and sorting channels are cleansed and ready to receive further matter as it returns under the discharge end 14 of the supply bin 12.

As previously described, the endless belt conveyor 15 is adjustably mounted on an adjustable support frame 25 for adjusting the inclined transverse angle 26 thereof. One of these frames is secured to the endless belt at opposed ends thereof. Only one of these will be described as they are identical to one another. The adjustable support frame 25 comprises a horizontal ground surface engaging member 60 having opposed telescopic support arms 61 and 62. These arms 61 and 62 are hingedly connected on hinge connections 61′ and 62′, respectively at opposed ends of the ground surface engaging member 60. They are also hingedly secured by hinge pins 61″ and 62″ at a top end thereof to a belt support frame 63. Each telescopic support arm has an outer cylindrical member 64 and an inner cylindrical member 65 displaceable thereinto. The extension of the inner cylindrical member 65 can be adjusted and fixed mechanically or else can be caused to be displaced by a cylinder 66 secured to the support arm 62 only to position the belt support frame 63 at a desired angle.

As shown in Figure 3, a controller 70 is provided and coupled to the belt drive motor and the hydraulics of the piston 66 whereby to automatically position the endless belt conveyor 15 at a desired angle and to impart a predetermined speed of rotation to the conveyor belt. It can also control

the transport conveyor belt 39 as well as the blower (not shown) associated with the suction pipe 42 of the collection housing 41. As previously mentioned, the drive speed of the endless belt conveyor is selected depending on the nature of the particulate mixture as well as the discharge rate of the particulate matter by the support housing onto the conveyor belt to ensure that there is sufficient residual time for the particulate material to propagate from the uppermost area of the belt where it is discharged from the supply housing 12 to the lowermost part 31 thereof.

It is also pointed out that the endless belt is also interchangeable whereby to provide belts having sorting channels of different sizes depending on the matter to be separated. The belt can also be used simply to separate particle sizes from a particle mixture and not only fine particles that are undesirable in a fertilizer mixture. These fines which are removed from fertilizers form a dust cloud when discharged onto an agricultural field and do not add any beneficial nutrients to the fertilized ground. Further, it is obvious to a person skilled in the art that the particle separator of the present invention may be secured onto a transportable frame for use at different locations.

It is within the ambit of the present invention to cover any other obvious modifications provided such modifications fall within the scope of the appended claims.

CLAIMS,

1. A particle separator for separating unwanted matter from a particulate mixture, said particle separator comprising an endless belt conveyor having an outer surface provided with a plurality of longitudinally extending parallel endless sorting channels formed therein, drive means for displacing said endless belt in a longitudinal direction between support means, said channels having a predetermined width/depth ratio and configured to receive and retain therein said unwanted matter of a size capable of being received in said channels, adjustable support means for adjustably supporting said endless belt conveyor at an inclined transverse angle above a support surface of said particle separator whereby said particulate mixture can be controllably discharged on said inclined conveyor and caused to gravitate transversely of said longitudinal direction of displacement of said endless belt towards a lowermost part of said endless belt wherein at least a substantial portion of said unwanted matter is trapped and conveyed by said sorting channels and the remaining particulate mixture is gravity discharged at said lowermost part; said unwanted matter conveyed by said sorting channels being discharged at a discharge end of said endless belt conveyor thereby separating at least said substantial portion of said unwanted matter from said particulate mixture.

2. A particle separator as claimed in claim 1 wherein said sorting channels are endless channels disposed in side-by-side parallel relationship along said endless belt, said channels being of substantially square cross-section and wherein said width/depth ratio is 1:1.

3. A particle separator as claimed in claim 2 wherein said support means is an adjustable support frame for adjusting said inclined transverse angle.

4. A particle separator as claimed in claim 2 wherein there is further provided cleaning means to clean said sorting channels and said outer surface of residue material after said unwanted matter transported in said sorting channels have been discharged at said discharge end of said endless belt.

5. A particle separator as claimed in claim 4 wherein a collection housing is secured at said discharge end of said endless belt to receive said unwanted matter discharged by said conveyor and said cleaning means, and conveyor means to transport said unwanted matter from said collection housing.

6. A particle separator as claimed in claim 5 wherein said cleaning means is a rotating brush supported underneath said endless belt above said collection housing under said discharge end, said brush being in brushing contact with said outer surface of said endless belt and having bristles adapted to penetrate into said sorting channels to remove any residual unwanted matter therein.

7. A particle separator as claimed in claim 2 wherein said endless belt is a reinforced rubber belt supported taut between a drive roll and an idler roll, said drive means being constituted by a gear coupling interconnecting a variable speed motor to a drive shaft of said drive roll to impart rotation thereto.

8. A particle separator as claimed in claim 2 wherein there is further provided collection means and transporting means under said lowermost part of said endless belt to

transport said particulate mixture discharged at said lowermost part.

9. A particle separator as claimed in claim 1 wherein there is further provided controllable supply means secured spaced above said endless belt at a feed end thereof for discharging said particulate mixture on said inclined conveyor.

10. A particle separator as claimed in claim 1 wherein there is further provided a controller means to control the speed of said drive means and thereby said endless belt conveyor dependent on the nature of said particulate mixture and said inclined transverse angle of said endless belt.

11. A particle separator as claimed in claim 3 wherein said adjustable support frame is provided, at least in part, with telescopic support members; and piston means to displaceably adjust said telescopic support members, and controller means to control the operation of said piston means to adjust the transverse angular position of said endless belt conveyor.

12. A method of separating unwanted matter from a particulate mixture, said method comprising the steps of:

i) providing an endless belt conveyor having an outer surface provided with a plurality of longitudinally extending endless sorting channels formed therein in a spaced-part manner;

ii) adjusting support means to position said endless belt conveyor at a desired inclined transverse angle above a support surface of said support means;

iii) operating said inclined endless belt conveyor at a predetermined speed for displacement in a longitudinal direction;

iv) controllably discharging said particulate mixture on said inclined endless belt conveyor wherein said particulate mixture is caused to gravitate transversely of said longitudinal direction towards a lowermost part of said endless belt as it is conveyed by said endless belt conveyor, said unwanted matter being received and trapped in said sorting channels; and

v) collecting said unwanted matter at a discharge end of said inclined endless belt conveyor, and conveying the remaining particulate mixture gravity discharged at a lowermost part of said endless belt conveyor.

13. A method as claimed in claim 12 wherein there is further provided the step of cleaning said sorting channels after said unwanted matter is collected at said discharge end.

14. A method as claimed in claim 12 wherein there is further provided control means, said control means controlling the speed of a variable drive speed motor of said endless belt conveyor, and adjusting the inclined angle of said endless belt conveyor dependent on the type of material contained in said particulate mixture and the temperature thereof.

15. A method as claimed in claim 12 wherein said step (v) further comprises conveying said collected unwanted matter for further handling.

16. A method as claimed in claim 12 wherein said step (i) comprises selecting an endless belt conveyor having endless sorting channels of a desired size dependent on said unwanted matter, said sorting channels being of substantially square cross-section and having a width/depth ratio of 1:1.

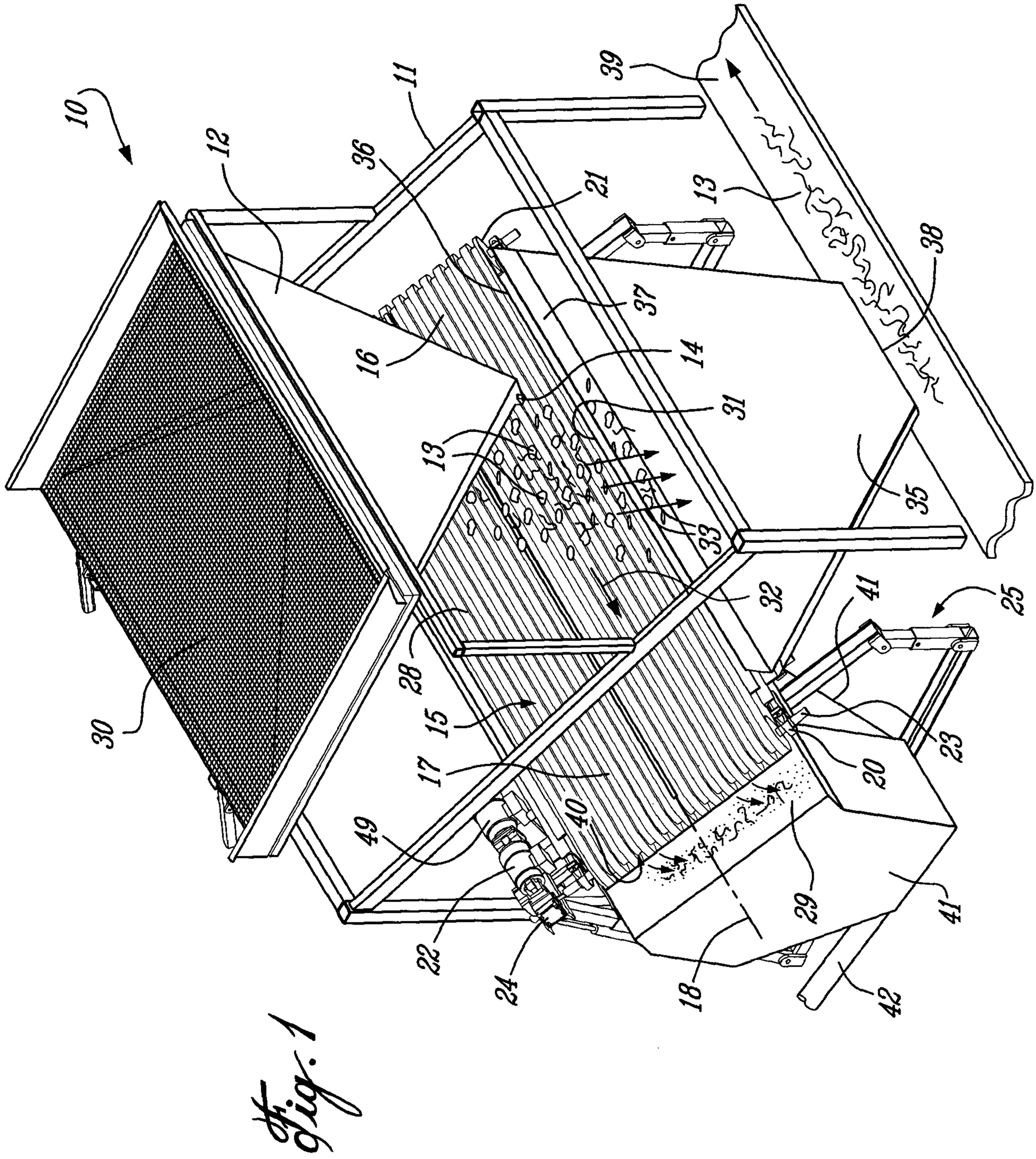
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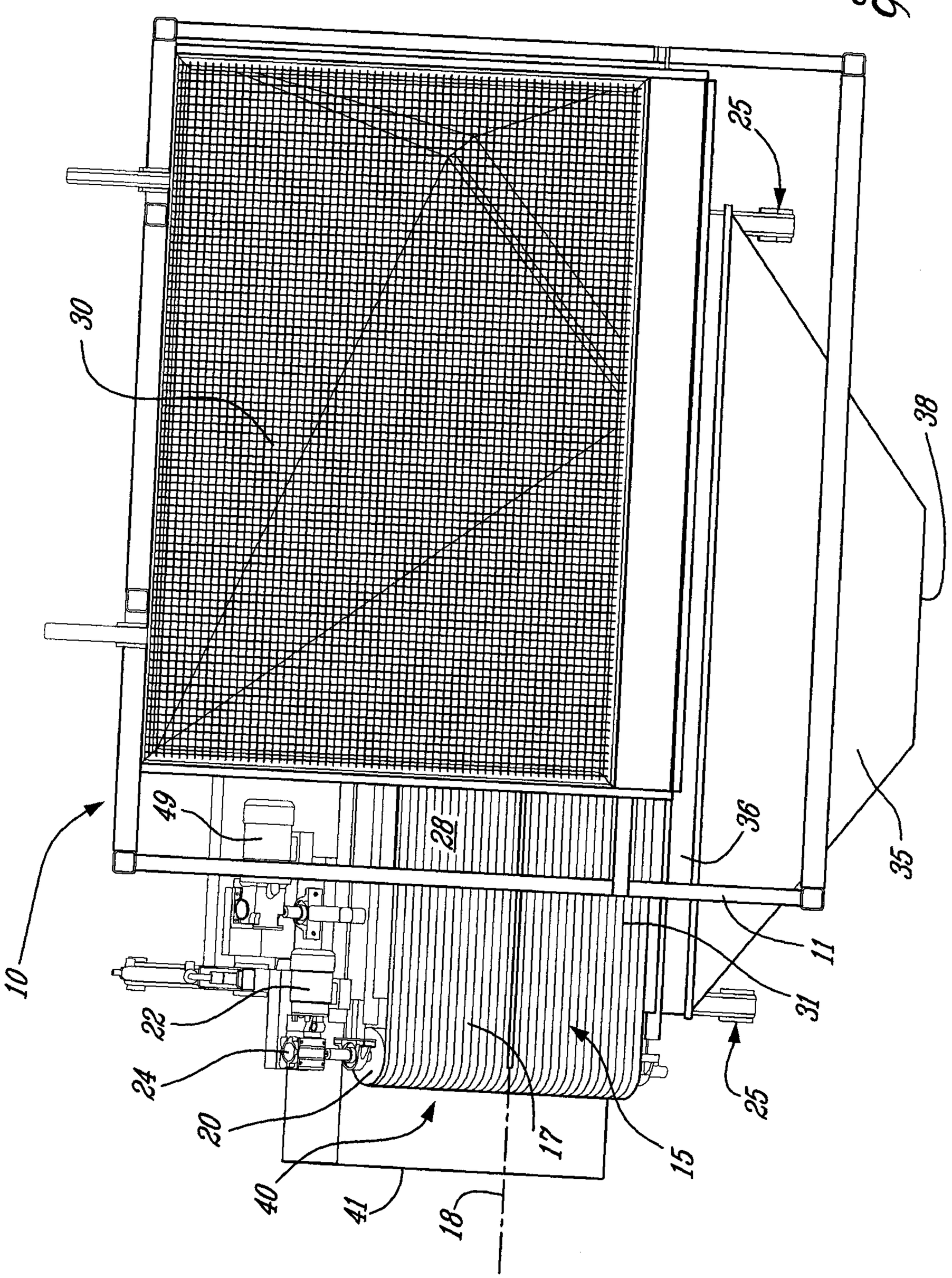
Fig. 1

Fig. 2



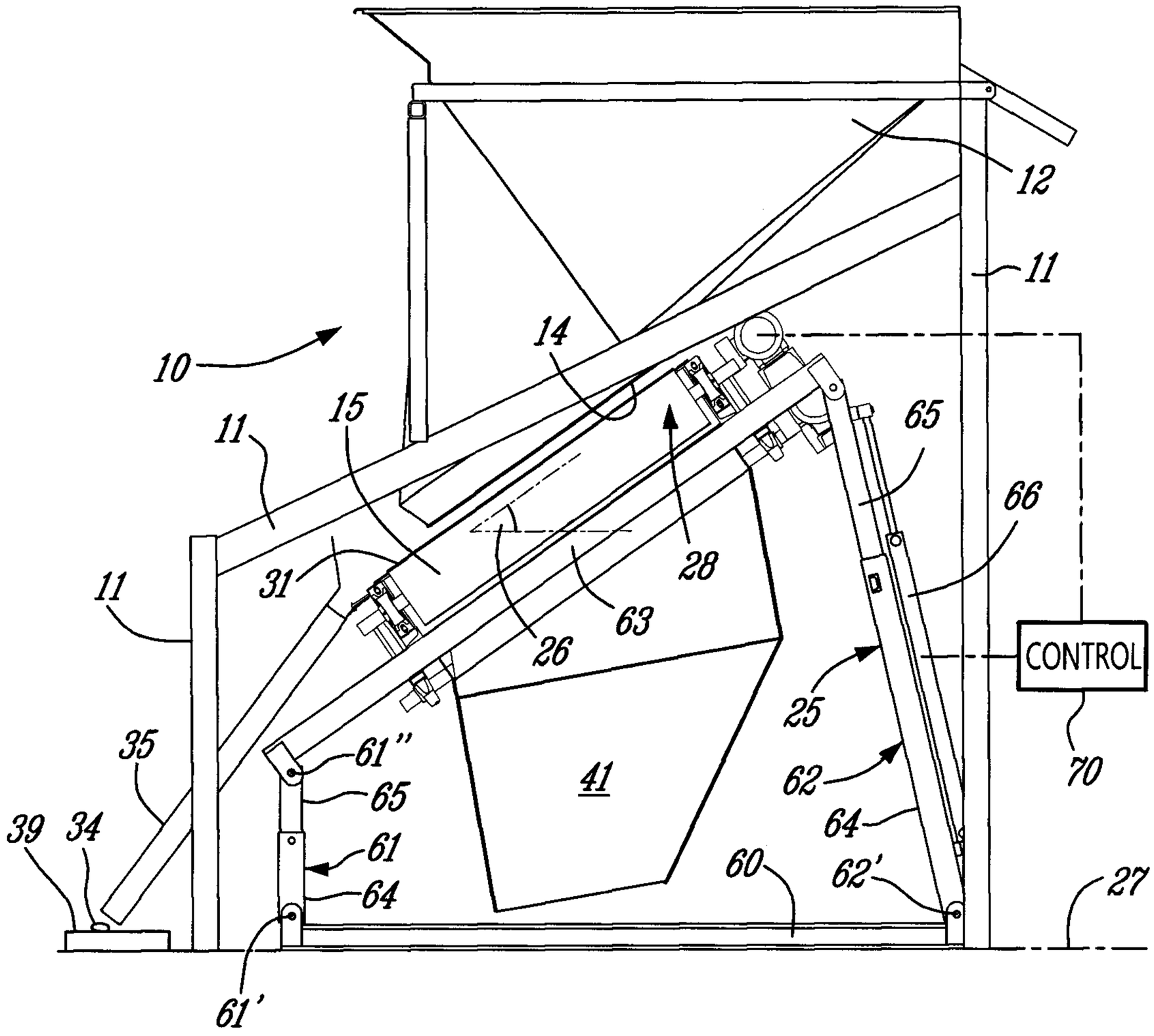

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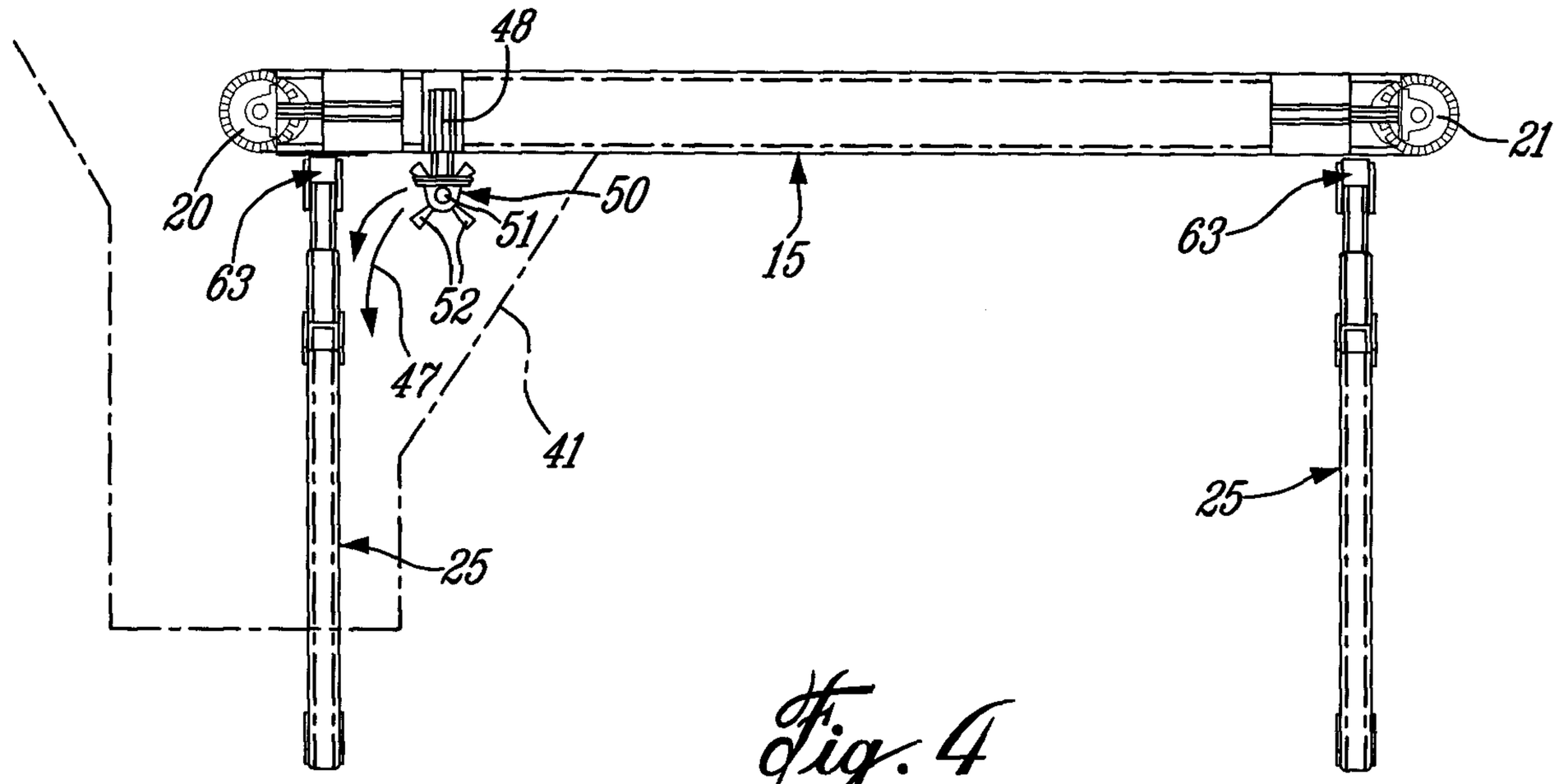
Fig. 3



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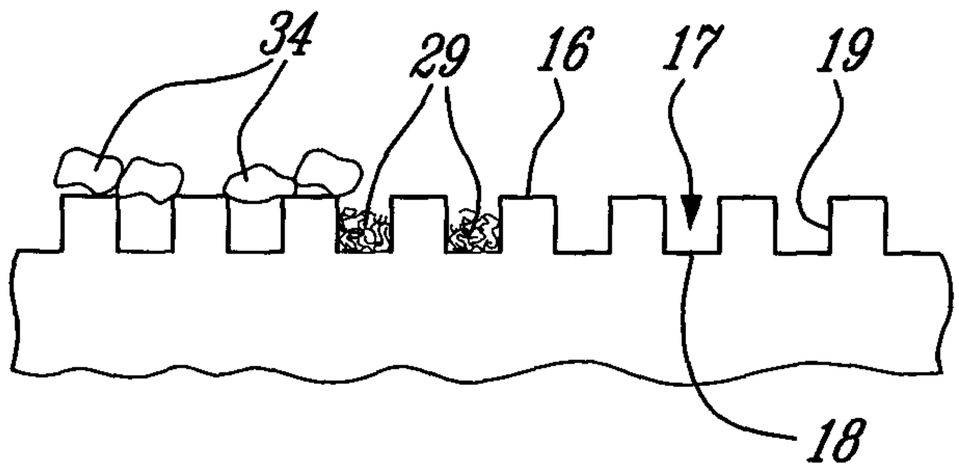
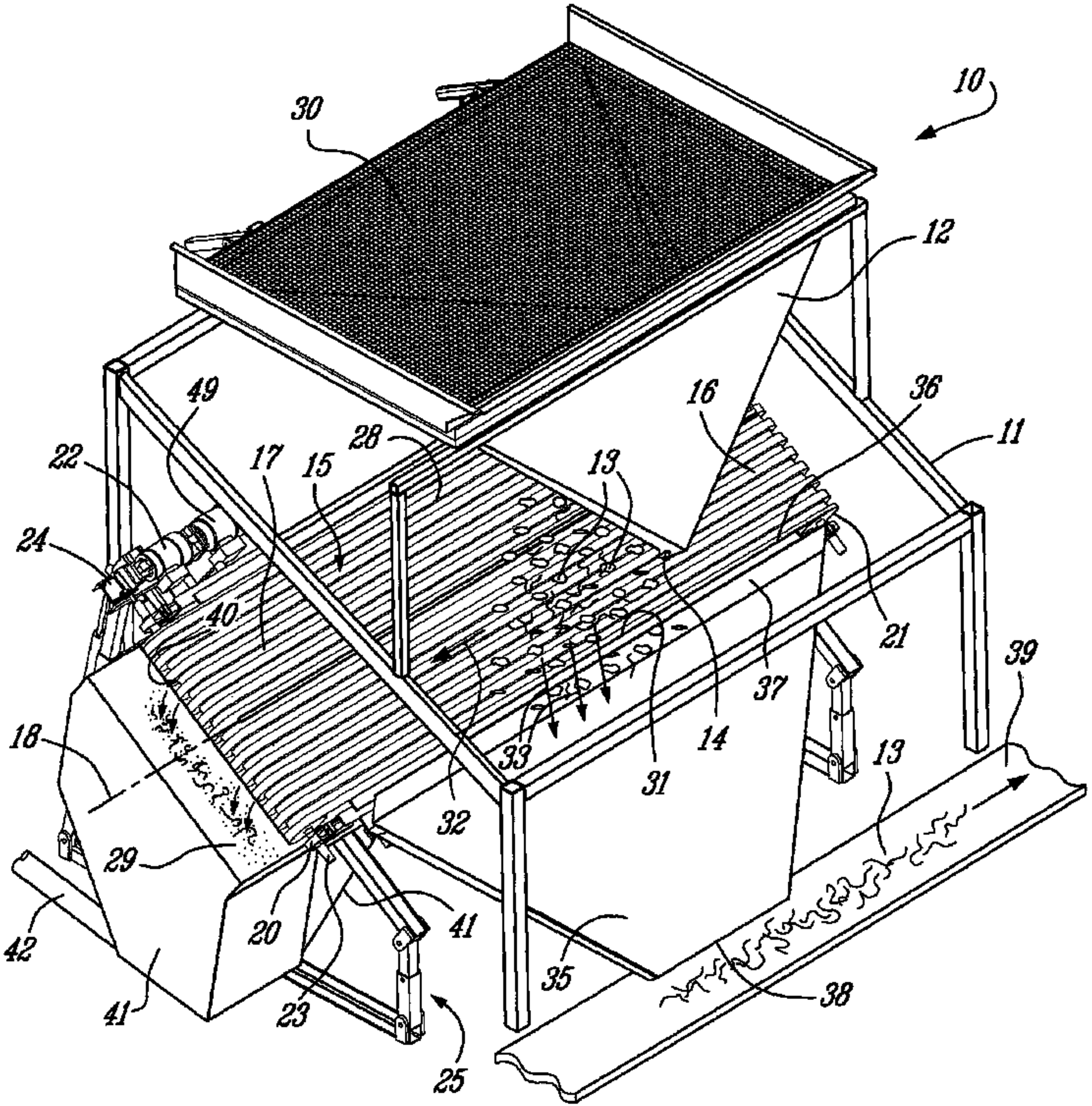


Fig. 5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