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Gmuer

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[54] **SILO DRAINING DEVICE**

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[51] **Int. Cl.** **B65g 3/12**
[58] **Field of Search** 222/196, 198, 199, 200, 222/201, 21; 259/23, 24, 7, 8

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[57] **ABSTRACT**

A silo draining or discharge device is shown including a vibration floor of generally frusto-conical shape, having a centrally located outlet or discharge opening, and a vibration generator fastened to the vibration floor. The vibration floor is supported so as to permit it to vibrate freely beneath the outlet opening of a silo. A funnel-like device is mounted on the vibration floor for vibration therewith, with the circular inlet and outlet openings thereof coaxially aligned above the circular discharge opening of the vibration floor. Metering means are provided to selectively control the respective flows of material through and around the funnel-like device in order to obtain an even descent of material in the silo.

16 Claims, 3 Drawing Figures

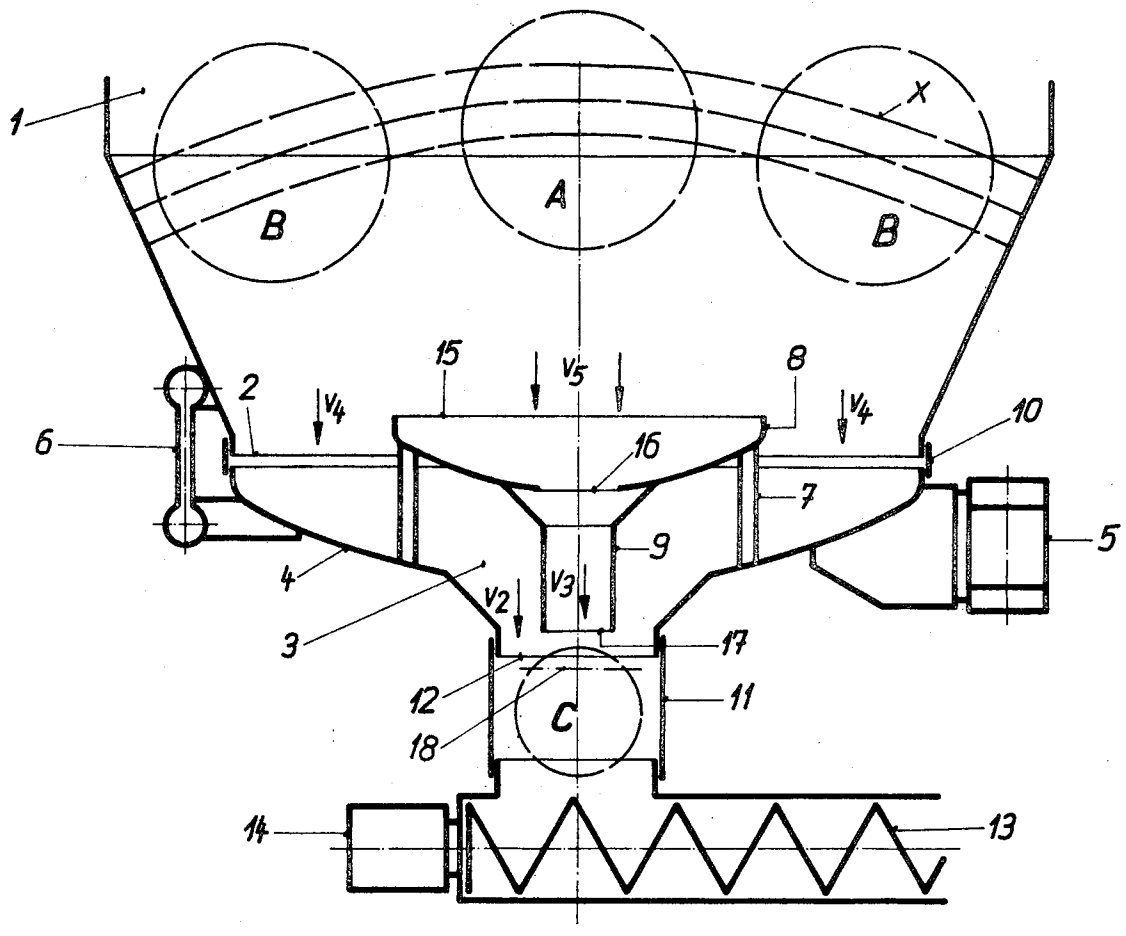

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Fig.1

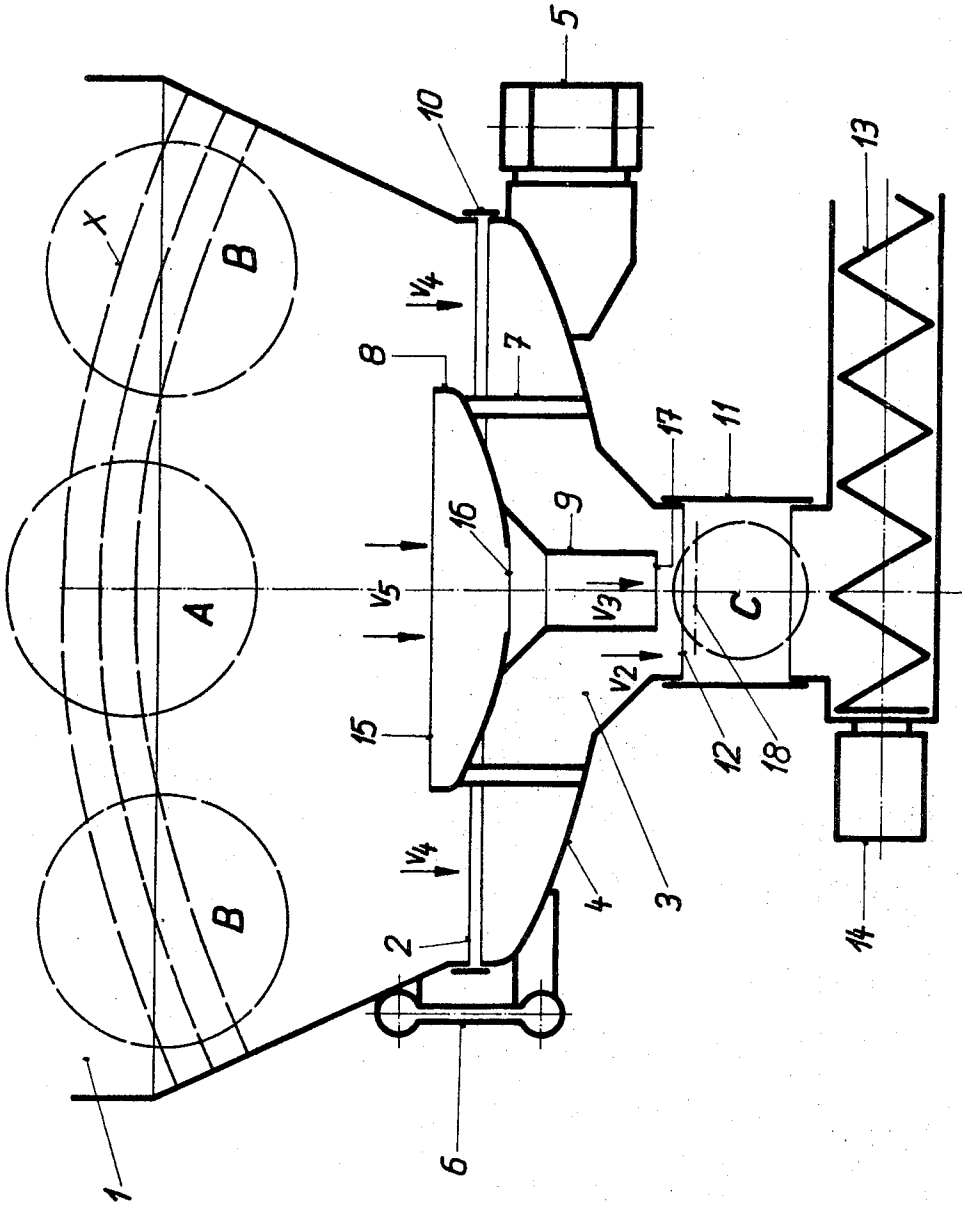
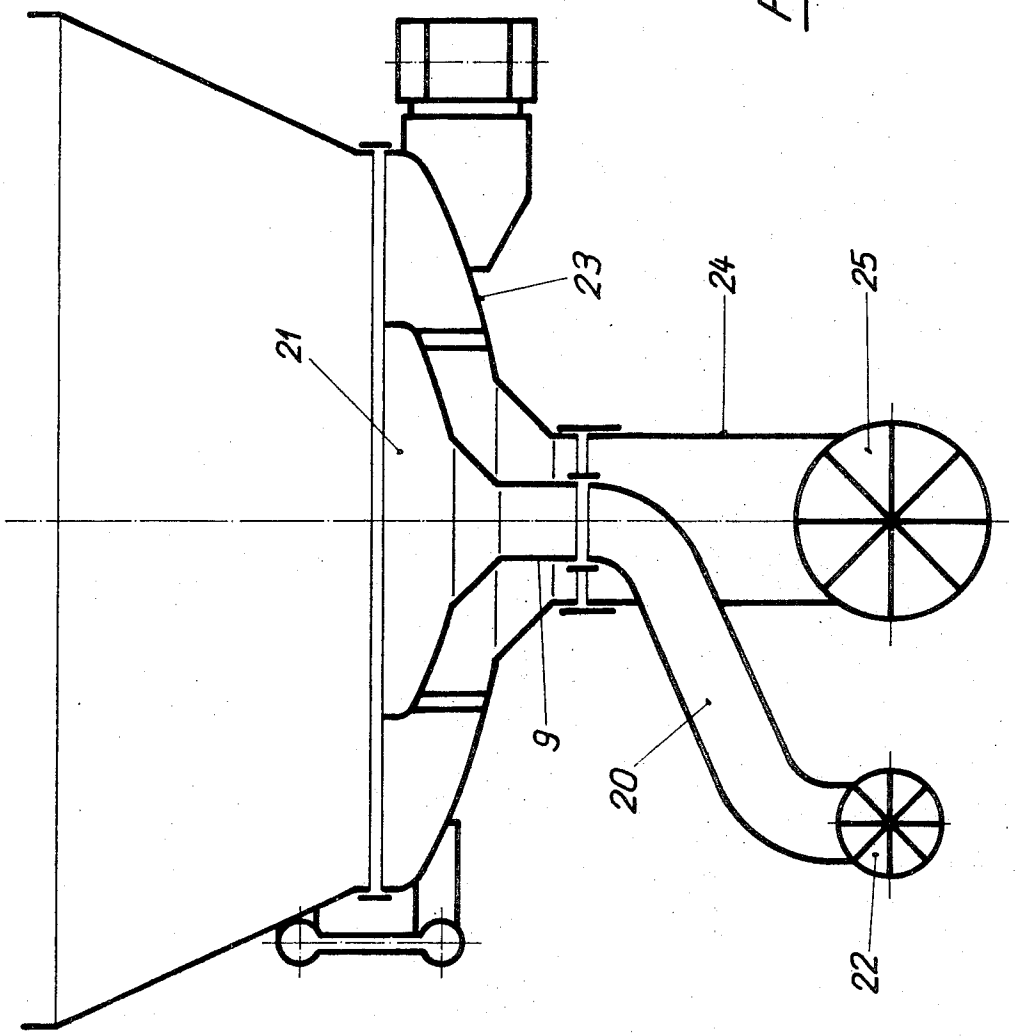


Fig. 2



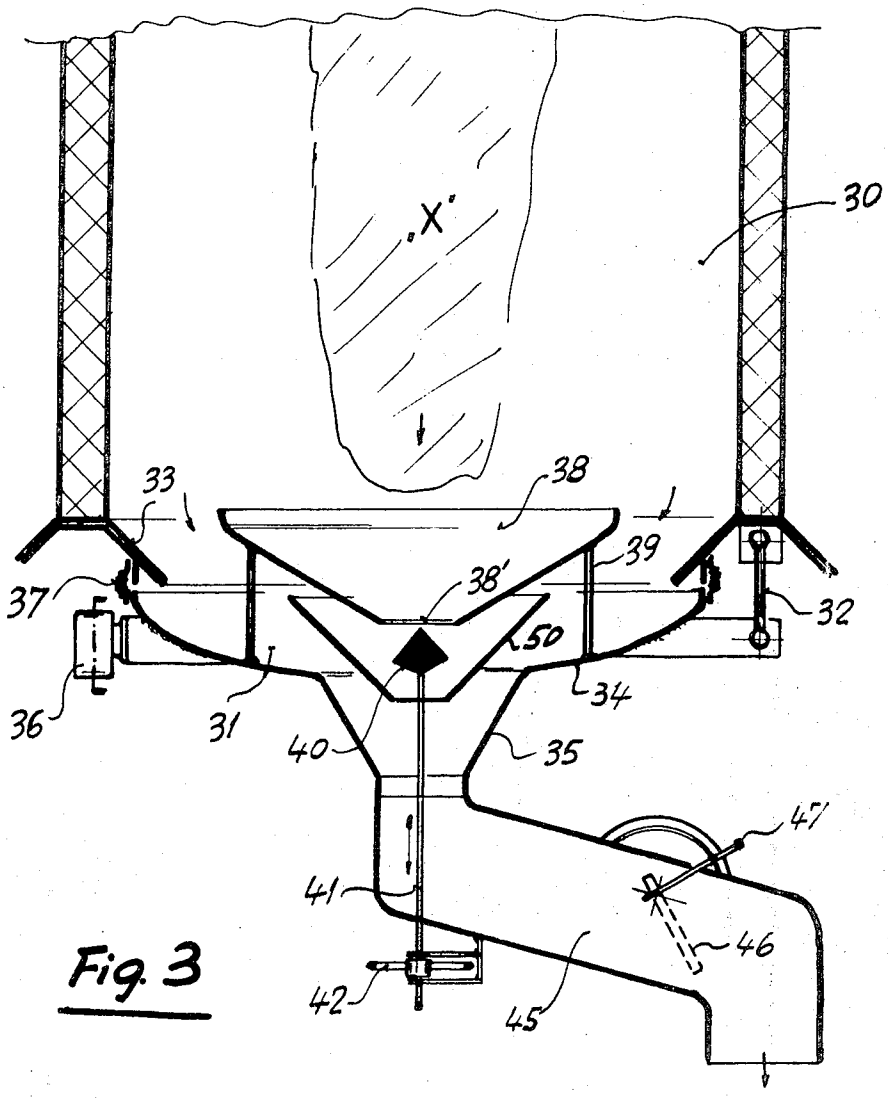


Fig. 3

SILO DRAINING DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention refers to a silo draining device consisting of a vibrating floor which is installed to vibrate freely under the outlet opening of a silo and exhibits a vibration generator attached to the vibration floor.

Description of the Prior Art

It is known that when silo-stored bulk goods are taken out of storage, the stored material may descend very irregularly.

All bulk goods support themselves against the silo walls, especially against the sloping portions located directly above the outlet opening. Because of the great pressure in the outlet area, areas of very strong compaction can occur with stored materials which do not flow easily. These compactions often cause extreme fluctuations in the volume of the output.

The use of vibrating floors can prevent such compactions, at least in the outlet area, thus making it possible to attain a certain regularity in the output volume on different occasions.

In normal storage units with a symmetrically installed outlet opening having no particular shape, it is regularly found that in the silo there is a tendency toward depression of the central section. In extreme cases, movement is detectable only in a central flue. The outer portions may remain statonary and, in the case of foodstuffs, spoil.

The practice has therefore been started of building in an obstruction above the vibrating floor to prevent an avalanche in the core section of the silo through the opening in the vibrating floor. However, complete or at least partial blocking of the central flow again interferes with the even descent of materials in the silo and the areas close to the walls are favored over the central area. If the vibrating floor is very small relative to the silo base, a central obstruction can not in all cases prevent the formation of bridges.

Vibration forces must be partially transmitted to areas at a significant distance above the collection floor. When the product is removed, strong pressure waves can develop which significantly exceed the normal static pressure. These greater forces must be taken into consideration in the arrangement of the obstruction elements, particularly if they extend into the space inside the silo. This can be done by making them oversized for strength.

SUMMARY OF THE INVENTION

The task set for the invention was to build a vibrating collecting floor which makes it possible with no significant additional cost for the contents of the silo to descend uniformly and with no hitches.

The solution according to the invention is characterized by the fact that a vibrating collection funnel is located above and connected with the vibrating floor and by the installation of a measuring element.

Using the solution to the problem according to the invention, the familiar vibrating floors can be improved with surprisingly simple means. What occurs is a very advantageous joint operation of the vibration floor, the collection funnel located above it, and the measuring element.

From the area located above it, the collection funnel removes an amount of th product which can be precisely determined in advance. In conjunction with the output of the vibration floor, this results in a controlled descent of the entire contents of the silo.

The collection funnel also proves very advantageous with respect to strength.

When familiar solutions to the problem are used, the obstruction wall must create an actual blockage to effectively stop the central flow and the resultant rotation forces must be absorbed. A form advantageous for flow dynamics would offer no significant resistance to the flow of material and thus have no effect on the central flow.

The collection funnel according to the invention, on the other hand, offers little resistance, can be built correspondingly lighter and affords an ideal uniform descent of the entire contents of the silo, especially if it is similar in shape to the vibrating floor.

One of the main ideas of the invention is that a limited but controlled removal of material from the lower core area above the outlet compels the entire cross-section of the silo to descent evenly. In addition, by removing a central archpiece, as it were, from any bridge of material likely to form, the inception and therefore also the formation of bridges is prevented.

In a very advantageous version, a collection funnel is installed above and connected with the vibrating floor and a measuring element is installed below the collection funnel.

In an especially advantageous version the lower opening of the collection funnel is situated to extend down by means of an outlet section at least to a point close to the narrowest point of the vibration floor.

In another advantageous version the ratio between the narrowest outlet area of the vibration floor and the narrowest outlet area of the collection funnel is equal to that between the effective drain area of the vibration floor and the corresponding area of the collection funnel.

In a very advantageous version the measuring element vibrates as well. In this solution the inner bracing effect of the bulk goods is utilized to regulate the volume of material emptied from the collection funnel and the vibrating floor.

In another version the measuring element is a disc situated between the vibration floor and the collection funnel.

In another version a measuring element is added to the outlet portion of the collection funnel.

In this solution the central flow normally present in a silo is utilized in such a way that only the output volume of the collection funnel is regulated.

In a very simple version a conical sliding valve is added to the outlet portion of the collection funnel to provide a measuring element.

In another version a measuring channel, which is connected with the vibrating floor and vibrates along with it, is installed below the collection funnel.

In another very advantageous version a vibrating guide element is situated below the outlet portion of the collection funnel and near the narrowest area of the vibrating floor.

In another version the guide element is developed as a tapered socket.

In another version the obstruction generator is a measuring element, particularly a sluice gate or a worm gear.

In another version the highest edge of the collection funnel is at the same elevation as the corresponding edge of the vibration floor.

To better explain the silo drain according to the invention reference is made to the versions presented by way of example.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a cross-section through a silo drain device with a measuring worm gear situated below.

FIG. 2 shows a silo drain device with separate drain conduits for the vibration floor or the collection funnel.

FIG. 3 shows another version of a silo draining device.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A silo drain device **3** is situated beneath round silo unit **1** with floor outlet **2.** Silo drain device **3** consists of a vibration floor **4,** to which is fastened a vibration generator **5** and several suspended pendulums **6** which are distributed about the circumference and cushioned by rubber elements, whereby both **5** and **6** are connected with the silo. In vibration floor **4** there is a collection funnel **8** which is firmly connected with vibration floor **4** by means of braces **7** and which has an outlet piece **9.** Vibration floor **4** is sealed by means of a rubber ring **10** at floor outlet **2** to prevent dust from escaping. A similar rubber element **11** to seal against dust connectes an outlet **12** of vibration floor **4** with a measuring worm gear **13** which operates as a measuring element. The worm gear is driven by a motor **14** and expels the material for further processing or transport. The collection funnel **8** has an upper opening **15** as well as a lower opening **16** which are connected with an opening **17** via the outlet piece **9.**

Referring to the sample silo drain device represented in FIG. **1,** the device functions as follows:

From potential bridges indicated by lines X, an area corresponding to a central arch-piece A is drained off through collection funnel **8.** The annular area B located around area A is drained off through vibration floor **4.** In this way a partial amount is drained off over an annular cross-section which lies relatively close to the silo walls, thus effectively preventing the material from remaining along the walls or in the corners. By removing the central arch-piece A, bridges made by the material are made to collapse immediately. The material descends uniformly over the entire cross-section of the silo. The rate with which the material in th peripheral area descends is accordingly indentical with the rate of descent in the interior of the silo, and the possibility of the material becoming unmixed is eliminated. When loose, bulk goods behave similar to liquids, the measuring worm gear **13** expels less material than vibration floor **4** and collection funnel **8** are able to remove. In this way, measuring worm gear **13** works as a very effective measuring (or metering) element, and because of this a compact column of material forms above worm gear **13.**

The great inner friction of the material in the compact column of material C causes a uniform rate of descent over the whole cross-section in the area which roughly coincides with rubber element **11.** As a result, the rates of descent through outlet opening **12** of vibration floor **4** (V4) as well as through opening **17** of outlet piece **9** of collection funnel **8** are equal. Since the ratio of the effective drain openings of vibration floor **4** to collection funnel **8** can be determined in advance, the corresponding rates of descent V4 and V5 can be controlled by simple means. They can, for example, coincide. In practice, the two rates of descent in the area A and/or in the area B are adjusted to the prevailing ratios of silo cross-section and the cross-section of the vibration floor. If the floor outlet **2** of silo **1** is small in proportion to the cross-section of the silo, the corresponding rate of descent V4 below area B must be greater.

FIG. **2** shows another version of the silo drain mechanism. A separate drain conduit **20** leads from collection funnel **21** to a separate obstruction element **22.** Vibration floor **23** leads into an obstruction generator **25** via a vertical connection conduit **24.** The two obstruction generators **22** and **25** are thus developed as rotation sluices. The rotation sluices operative volumetrically and can cause a back-up of the bulk material by draining off a limited amount of material. Especially in the case of very difficult or changing materials, the silo drain device shown in FIG. **2** makes it possible to achieve in the silo a rate of descent which is operationally controllable at least for two areas. The evacuation capacity of sluices **22** and/or **25** can be changed in a well-known way by means of variators which are not shown. In the case of materials which tend very stubbornly to form bridges, it can be advantageous to situate the collection funnel at an elevation significantly higher than the collection floor, for example at an elevation at which natural drainage in accordance with the dimensions of the silo still obtains. On the other hand, in the case of easily flowing materials it is advantageous to locate the upper edge of collection funnel **8, 21** at the same elevation as the corresponding upper edge of vibration floor **4, 23.** In the case of materials which tend to trickle easily, it is also possible to situate some obstruction plates below vibration floor **4, 23** and/or collection funnel **8, 21** in place of sluice **22, 25** and/or measuring worm gear **13** shown in FIGS. **1** and **2.** By utilizing the formation of cones in the bulk goods, it is thus possible, even without moving parts, to achieve a back-up on the silo drain device and consequently also a measuring function which requires only a single setting, both of which permit the rates of descent in silo **1** to be controlled with certainty. Of course, two or even several collection funnels can be used in conjunction in the vibration floor, e.g., for highly perishable materials. One or several collection funnels can also be situated considerably above the vibration floor in silo **1** and, by means of appropriately constructed braces **7,** be connected with the collection floor or even with the lower part of the silo as an independently vibrating system. The essential thing in all the solutions is that the potential evacuation capacity be reduced by an obstruction element. In this way the inner friction and the support forces in the area of the drain openings of the vibrating parts can be controlled. It is on this that the operation and the simplicity of the solution according to the invention is ultimately based.

In the case of certain products which trickle easily, an actual measuring element can be eliminated by re-

ducing the size of the free outlet openings **12, 16** of vibrating floor **4** and/or of collection funnel **8.**

As shown in FIG. **3,** a vibrating floor **31** is suspended beneath a silo **30** by a transition section **33** so that it can vibrate on rocker mountings **32.**

The vibrating floor has a gently sloping outer floor area **34** and a conical narrow portion **35.** The vibrating floor **31** is made to vibrate by means of a vibrator **36.**

An elastic cuff **37** is situated between vibration floor **31** and transition section **33** to permit the vibrating floor to vibrate freely and to prevent dust from escaping. A collection funnel **38** with an outlet **38'** is situated above vibrating floor **31,** with which it is rigidly connected by brace **39.** Accordingly, collection funnel **38** vibrates with approximately the same vibrating motion as vibrating floor **31.**

In FIG. **3,** the measuring element is shown as a conical slide valve **40** situated below the collection funnel. The conical slide valve is adjusted by a threaded rod **41** by means of a hand wheel **42** so that it can be moved up or down as indicated by the arrow.

Vibrating floor **31,** which is an actual aid to removing the material from the silo, passes the material on to a conveyance element **45** which is equipped with a flap **46.**

The illustrated version operates as follows:

The conveyance element **45** is set in motion simultaneously with vibrating floor **31,** for which purpose vibrator **36** is engaged. Through the vibrations the material is removed from conveyance element **45** and is followed by an equivalent amount which flows out of the silo under activation by vibrating floor **31.** Because of friction against the silo walls, there is a strong tendency in silo **30** for a central zone indicated by "X" to empty. If one looks into the silo from above, the central flow can be easily detected as a depression in the surface of the material. Now if a central flow, which may be termed the formation of a flue, predominates, the conical slide valve **40** is moved closer to outlet **38'** of collection funnel **38.** In this way, the central flow can be limited in a simple way to precisely the amount consistent with a uniform descent of the entire contents of the silo. This is accomplished by regulating only the naturally favored flow.

Of course, the size and shape of the collection funnel can be developed according to the properties of the material, whereby consideration can also be given economic exigencies.

It is advantageous if conical slide valve **40** vibrates together with collection funnel **38,** i.e., with vibrating floor **31.**

In the same FIG. **3** a very advantageous combination is provided by connecting conveyance element **45** as a vibrating channel directly with vibrating floor **31.** Conveyance element **45** thus undergoes the same vibrations as vibrating floor **31.** Flap **46** can be adjusted by a lever **47.** However, it is also possible for conveyance element **45** together with flap **46** to function as actual measuring elements if appropriate and per se familiar control devices are used.

In this way it is possible to operate either by checking only the central flow by means of conical slide valve **40** and collection funnel **38** or by using only conveyance element **45** which functions as a measuring element, whereby the above-described inner friction of the material is utilized. On the other hand, conical slide valve **40** and conveyance element **45** may function simultaneously as measuring elements.

A direct connection of conveyance channel **45** with vibrating floor **31** is of great advantage particularly in small plants, since with a small amount of vibrational energy it is possible to simultaneously remove material from the silo and to convey it for a short distance.

In the case of products which have a strong tendency to cake it may be very advantageous to install a co-vibrating guide element, e.g. in the form of a tapered socket **50,** below outlet **38'** of collection funnel **38** and near the narrowest part **35** of vibrating floor **31.** The dimensions of tapered socket **50** should be so determined that with respect to flow characteristics easy passage is provided for the bulk goods between vibrating floor **31** and collection funnel **38.** The reason for this arrangement is to prevent larger amounts of the material from accumulating or remaining stationary between collection funnel **38** and vibrating floor **31.** Tapered socket **50** can also bring great advantages in combination with conical slide valve **40,** whereby tapered socket **50** can at the same time be easily connected functionally with conical slide valve **40.** It is also conceivable that in place of conical slide valve **40** some other measuring element could be used, e.g., a vertical worm gear measuring device which can extend into the collection funnel if necessary.

What is claimed is:

1. In a silo drain device including a vibration floor having an axial outlet opening, and a vibration generator fastened to the vibration floor, the vibration floor being so situated so as to vibrate freely beneath the outlet opening of a silo, the improvement comprising a vibrating collection funnel situated above and in line with the axial outlet opening and connected with the vibrating floor to provide an outer material flow path around the funnel to the axial outlet opening, said vibrating collection funnel having an inlet of smaller diameter than the silo and a still smaller outlet positioned below the funnel inlet to provide an inner material flow path through which a portion of the material in the center of the silo passes, and metering means installed in a selected path of flow of material from the silo.

2. A silo drain device according to claim **1,** wherein the metering means is a measuring element positioned downstream from the axial outlet opening of the vibration floor to control the flow of material therethrough.

3. A silo drain device according to claim **2,** wherein the collection funnel has a tubular outlet piece which extends at least to a point close to the narrowest point of the vibration floor defined by the outlet opening thereof.

4. A silo drain device according to claim **2,** a tubular wherein outlet piece of the collection funnel and the outlet opening from the vibration floor are each connected to a separate measuring element.

5. A silo drain device according to claim **2,** wherein the measuring element is developed as a sluice.

6. A silo drain device according to claim **2,** wherein the measuring element is developed as a worm gear.

7. A silo drain device according to claim **2,** wherein the measuring element is an obstruction plate.

8. A silo drain device according to claim **1,** wherein the ratio between the narrowest outlet opening of the vibration floor and the narrowest outlet area of the collection funnel is equal to that between the effective en-

tering annular area of the vibration floor and the corresponding entering area of the collection funnel.

9. A silo drain device according to claim **1,** wherein the collection funnel is situated with its highest edge at the same elevation as the corresponding edge of the vibration floor.

10. A silo draining device according to claim **1,** wherein the collection funnel is situated above and connected with the vibrating floor, and wherein the metering means is a measuring element situated below the outlet of the collection funnel to control the flow therethrough.

11. A silo draining device according to claim **10,** wherein the measuring element is connected with the vibrating floor and vibrates together with the vibrating floor and with the collection funnel.

12. A silo draining device according to claim **10,** wherein the measuring element is developed as a conical slide valve which is movable to open and close the collection funnel outlet, and vibrates together with the collection funnel and the vibrating floor.

13. A silo draining device according to claim **1,** wherein the metering means flow is a measuring element mounted to vibrate together with the vibrating floor.

14. A silo draining device according to claim **1,** wherein a co-vibrating guide element in the form of a tapered socket is situated below the outlet of the collection funnel and near the narrowest point defined by the outlet opening of the vibrating floor.

15. A silo discharge device comprising:

a. a vibration floor having a sloping side wall and a centrally located discharge opening;

b. means for supporting said vibration floor beneath the outlet opening of a silo so as to permit free vibration thereof;

c. a vibration generator connected to said vibration floor;

d. a funnel-like device having an inlet opening and a smaller outlet opening;

e. means mounting said funnel-like device on said vibration floor so as to vibrate therewith, with the inlet and outlet openings of said funnel-like device disposed directly above said discharge opening of said vibration floor to provide paths of flow through said discharge opening from said silo both through and around said funnel-like device; and

f. means for selectively obstructing flow of material through at least one of said paths of flow.

16. A silo having a discharge device according to claim **15,** wherein the silo has a cylindrical storage portion of greater cross section than the cross section of the vibrating bottom floor, wherein the ratio between the narrowest part of the discharge opening of the vibrating bottom floor and the narrowest outlet opening of the funnel-like device is the same as the ratio between the cross section of the said cylindrical portion of the silo and the cross section of the inlet opening of the funnel-like device.

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