Aug. 21, 1956 A. J. STOCK 2,759,614

ANTI-CLOGGING DEVICE

Filed May 3, 1951 4 Sheets-Sheet 1

Fig. 1.

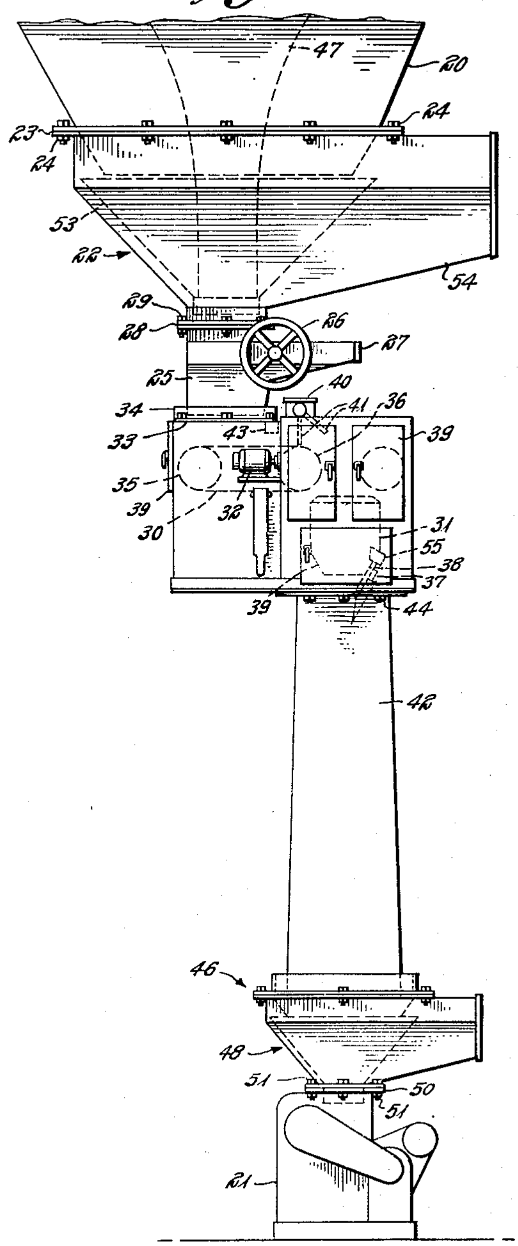
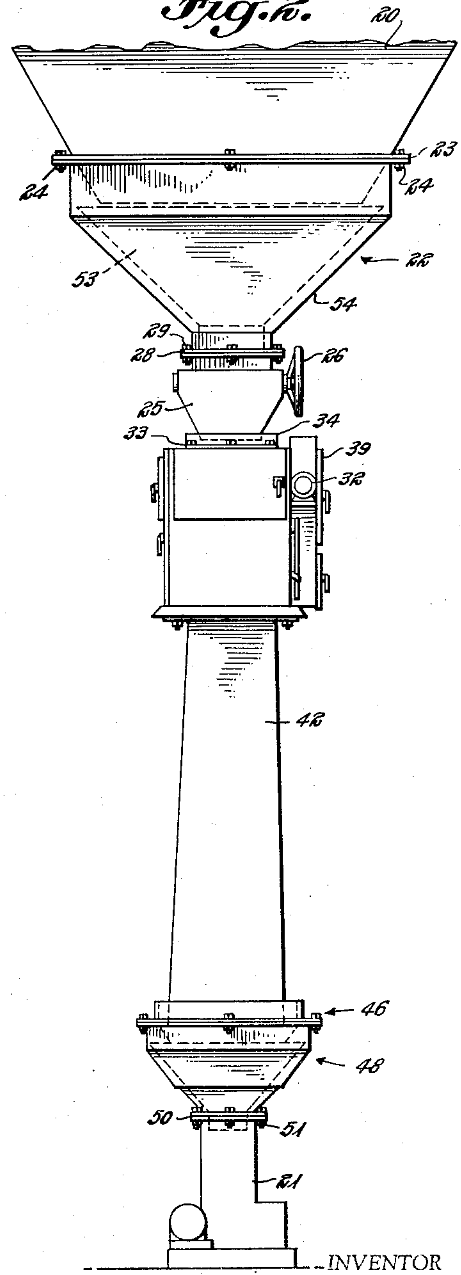


Fig. 2.



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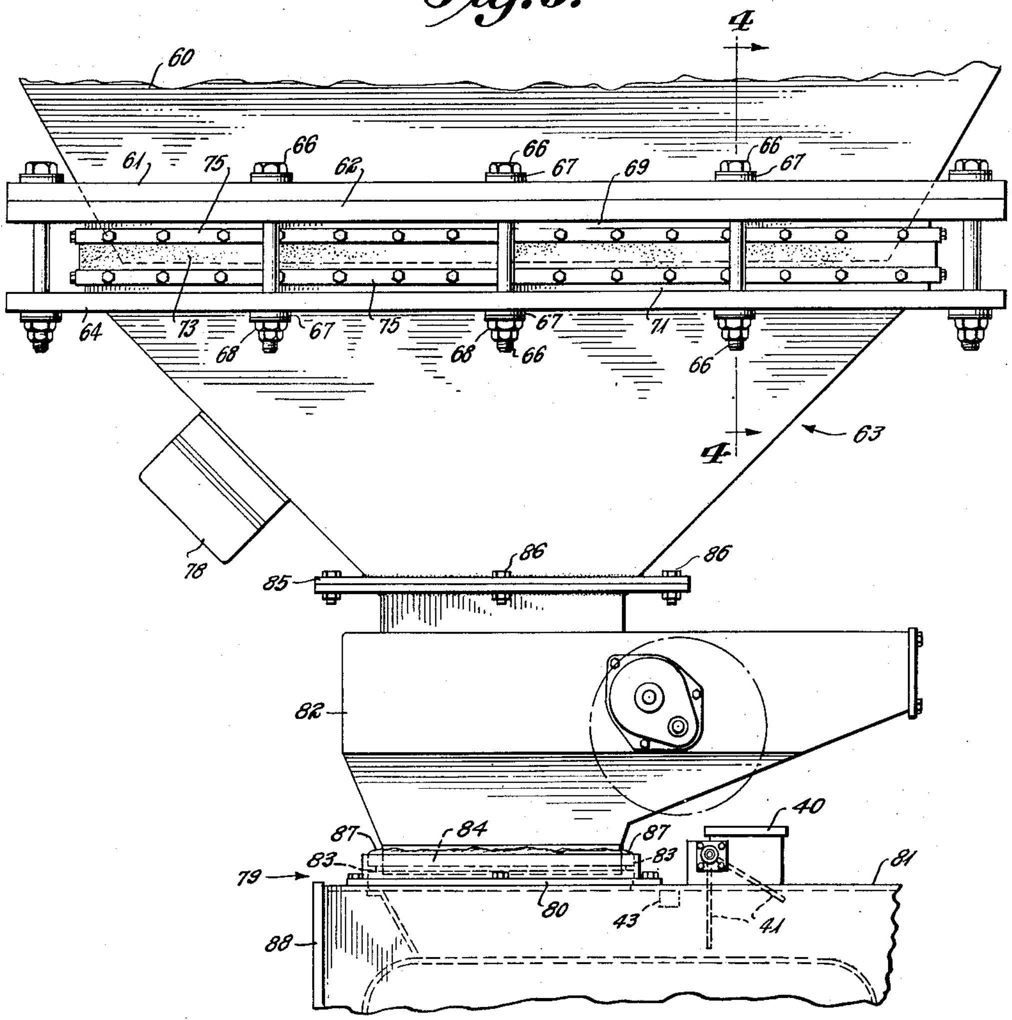
ATTORNEYS

Aug. 21, 1956 A. J. STOCK 2,759,614

ANTI-CLOGGING DEVICE

Filed May 3, 1951 4 Sheets-Sheet 2

Fig. 3.



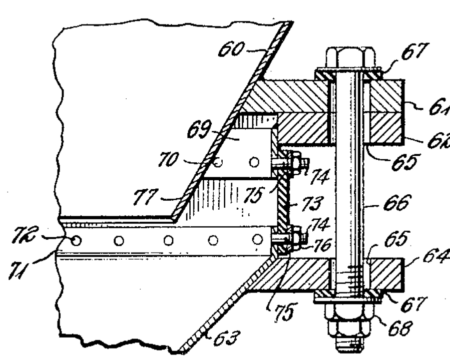


Fig. 4.

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Aug. 21, 1956 | A. J. STOCK | 2,759,614

ANTI-CLOGGING DEVICE

Filed May 3, 1951 | 4 Sheets-Sheet 3

Fig. 5.

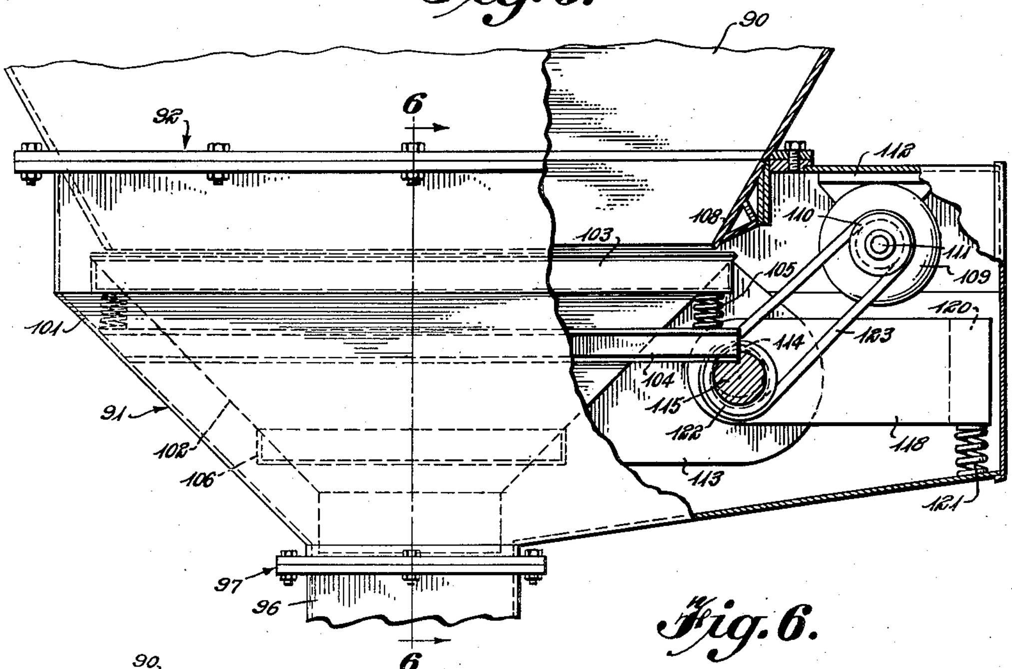
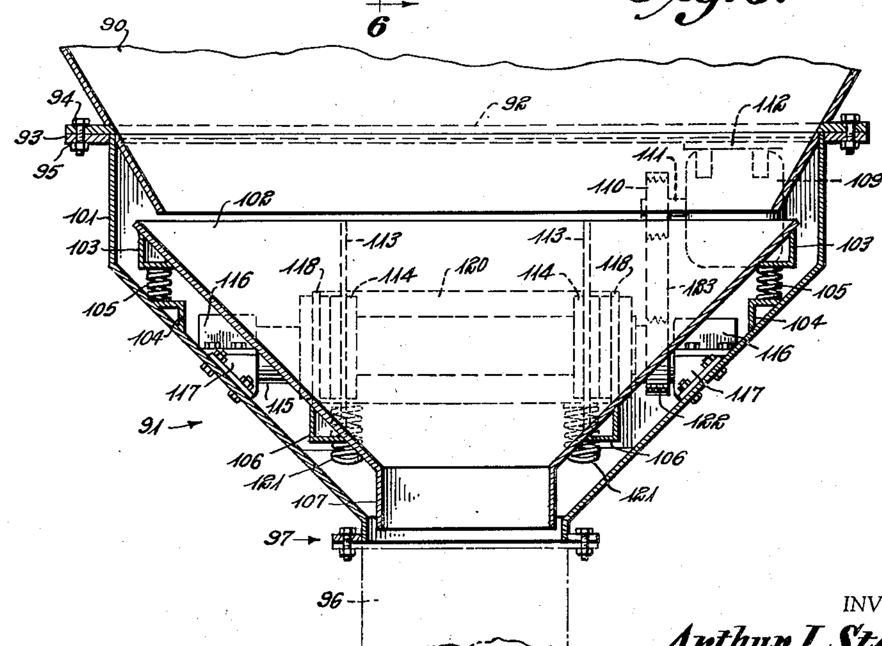


Fig. 6.



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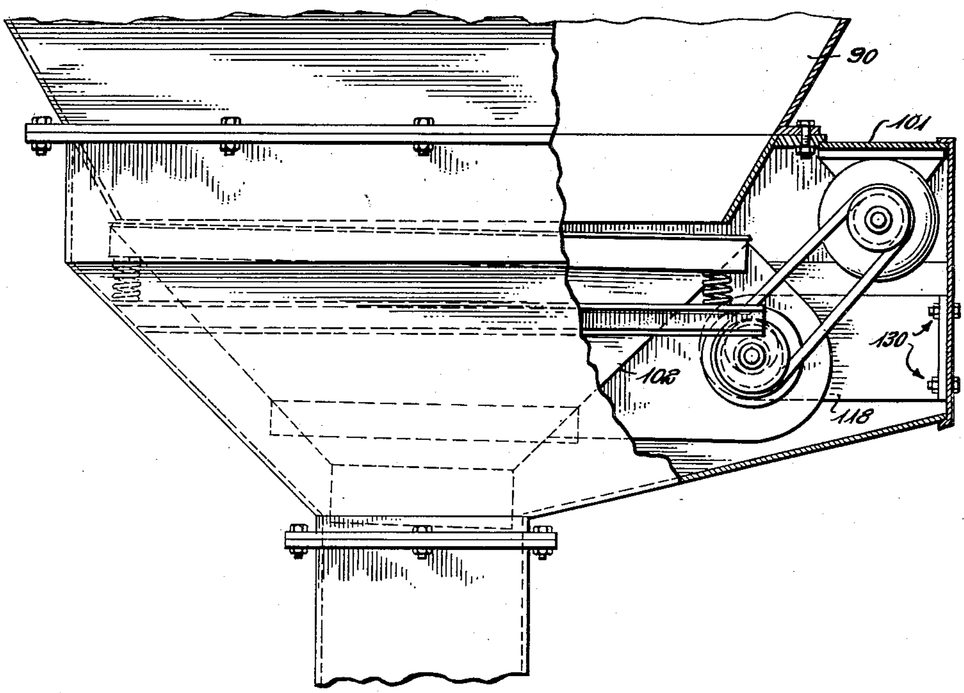
Aug. 21, 1956 A. J. STOCK 2,759,614

ANTI-CLOGGING DEVICE

Filed May 3, 1951 4 Sheets-Sheet 4

Fig. 7.



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United States Patent Office

2,759,614

Patented Aug. 21, 1956

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2,759,614

ANTI-CLOGGING DEVICE

Arthur J. Stock, Cleveland, Ohio

Application May 3, 1951, Serial No. 224,401

6 Claims. (Cl. 214—2)

This invention relates primarily to coal handling. However, its principles are equally applicable to the handling of other aggregate materials.

More particularly this invention relates to the gravity feeding of coal and to apparatus that will facilitate such feeding by the prevention of sticking, wedging, binding, bridging or the like in passages of the apparatus.

Depending upon various factors including fineness, amount of moisture, rate of flow, and size of orifices, coal and other aggregate materials tend to become compacted and to bind, stick, wedge or bridge in passages through which it is intended that they should flow by gravity.

The problems, insofar as coal is concerned, have become more acute in recent years because the coal to be handled has become finer and often wetter. Further, the coal has come to contain larger percentages of clay and other impurities that tend to make it compact more and hence result in greater clogging problems.

Similar problems to those discussed with coal are encountered in the handling of other like materials as for example fuller's earth, kaolin and titanium dioxide. Additionally it is to be understood that anything which prevents clogging will open gravity feed systems to use with a wider range of aggregate materials.

Recent advances in coal mining machinery and blasting techniques have increased the efficiency of coal production, but have also reduced particle size and increased the amount of impurities such as clay and shale. Naturally, industrial power plants utilize as cheap a coal as possible and therefore the finest and most impure coal. Hence serious feeding problems are encountered.

Attempts to overcome these feeding problems by the simple expedient of using passages of larger cross-sectional area throughout the system or by the use of vibrators located at certain points where clogging is most apt to occur have not proven very satisfactory. There is a practical limit to the size of passages that may be employed and vibration, if not properly applied is likely to cause more compacting and clogging, instead of preventing it.

In a previous patent application by the same inventor, Serial No. 662,802, filed April 17, 1946, and now abandoned, it has been proposed to operate a vibrator only during periods of coal stoppage. There are distinct advantages in this procedure which are: the vibrator is not nearly so likely to cause compacting of the coal, the power requirements for vibrator operation are lessened, and the attendant noise is not continuous. Furthermore, wear on the vibrator and other parts is lessened. However, even this arrangement is only partially satisfactory.

While this system is the one most nearly perfected thus far, it nevertheless possesses several disadvantages. For example, the weight of coal in a bunker for a large central station or large industrial boiler plant is such that considerable heavy gauge steel must be incorporated into it in order for it to carry the great weight. Inasmuch as the bunker outlet is usually located at the apex of an inverted pyramid, many of its structural members come together at the bunker outlet flange thereby producing a very rigid structure in the lower portion of the bunker. Consequently, a vibrator mounted on this portion of the bunker must be very powerful indeed to accomplish the desired result. Consequently, the vibrational requirements to effectively practice this system are economically unfeasible from a horse-power standpoint.

2

Another factor that has prevented successful solution to the problem of coal flow has been the size of the inlets to various apparatus which perform operations of one kind or another upon the coal. Examples are coal scale assemblies and pulverizer feeders. These apparatus generally have relatively small inlets. Thus, they limit the size of a spout or hopper leading to such apparatus.

While the problem of coal compacting exists in straight spouts (i. e., spouts of uniform cross-section), it is greatly increased by spouts or hoppers which taper in the direction of coal flow. It is possible to alleviate clogging by using a spout which increases in cross section in the direction of flow of material. However, the use of spouts of this type make it necessary eventually to reduce a large cross-section coal stream to a small cross-section to get it into the inlet to an apparatus such as a pulverizer feeder or coal scale.

While the difficulties of gravitational flow have been discussed in conjunction with coal, it is to be understood that the discussion is equally applicable to other like materials.

It is an object of this invention to provide a flexibly supported vibrating outlet for a hopper or spout which will more efficiently and more economically keep a material such as coal, titanium dioxide, fuller's earth, etc., uncompacted and able to flow from a relatively small outlet.

It is another object of this invention to provide a gravitational system for transporting coal and the like without stoppages more effectively than any system that has previously been available.

It is another object of this invention to provide a hopper or spout outlet that will be readily adaptable for mounting at the bottom of a standard hopper or spout in order that the material contained in the hopper or spout will discharge therefrom more freely and regularly.

It is a further object of this invention to provide a hopper or spout outlet which will enable larger outlets to be employed ahead of it in the system and which will enable the use, ahead of it in the system, of spouts which increase in size in the direction of flow of the material to be utilized.

Other objects and advantages of the present invention will become apparent from a detailed study of the following specification when considered in conjunction with the acompanying drawings in which:

Figure 1 is a view in front elevation showing a system for transporting coal from a bunker to a pulverizer through a coal scale;

Figure 2 is a view in side elevation similar to Figure 1;

Figure 3 is a view in front elevation showing a vibrating outlet for a hopper;

Figure 4 is a view in vertical section of Figure 3 taken along line **4—4**;

Figure 5 is a view in front elevation partly broken away showing a modified vibrating outlet for a hopper employing spring supports;

Figure 6 is a view in section of Figure 5 taken along line **6—6**; and

Figure 7 is a view in front elevation partly broken away showing a further modified vibrating outlet for a hopper.

Referring now to the drawings, Figures 1 and 2 show an improved system for transporting coal in boiler-plant operation from a coal bunker 20 to a pulverizer feeder 21. The bottom portion of the bunker 20 is provided with a vibrating outlet generally designated as 22 which includes an inner hopper 53 which is capable of being vibrated and an outer casing 54. The construction of this vibrating outlet will be considered fully in conjunction with Figures 5 and 6. This portion is detachably joined to the bunker by means of flanges 23 and bolts 24. Mounted beneath the outlet 22 is a standard Seco coal gate valve 25. The operating sheave for this valve is shown as 26. On the rear of the valve is a duct cover 27 which permits access to the valve and also removal of the gate. This gate (not shown) is U-shaped and rides on roller-bearing rollers. The top surface of the valve is provided with depending skirts which rest inside of the gate to prevent coal dust and moisture from deleteriously affecting the rollers. Flanges 28 and bolts 29 connect the valve to the bottom of casing 54 of outlet 22.

Beneath the valve is located a coal scale assembly having a feeder belt 30 and a weigh hopper 31 arranged in proper relation. A motor 32 is provided on the side of the assembly to drive the feed belt 30. The inlet 33 to this assembly is flexibly connected to the outlet of the coal valve. This flexible connection will be described in greater detail in conjunction with Figure 3. Immediately below the end of the feed belt 30 is weigh hopper 31 which is mounted with a suitable leverage assembly (not shown) to effect accurate measurements. The bottom 37 of the weigh hopper 31 is pivotally connected to the body of the hopper at 38 to permit discharge therefrom. This bottom 37 is held normally closed by means of a solenoid (not shown) which is operated responsive to the load contained in the hopper. When a desired weight of coal is held by the hopper, a switching means is actuated which causes the motor 32 driving feeder belt 30 to stop and the solenoid to release the bottom 37. When all coal is used off the bottom 37, the bottom closes itself by means of a counterweight 55 suitably arranged, and thus closes a second switching means which restarts the motor 32 which drives feeder belt 30. Doors 39 are also at various places on the assembly to allow the inside of the coal scale assembly to be readily accessible for examination or any other desirable purpose.

The coal scale assembly has mounted on its top a switching mechanism that includes a coal switch 40 and a pivotally mounted coal paddle 41. A leveling bar 43 is provided at the inlet to the coal scale assembly in order to establish a fixed level of coal on the coal scale feed belt. When this coal is flowing the switch assembly assumes the inclined position, and when the coal is not flowing the switch paddle assumes the vertical position. In the inclined position the switch is open and in the vertical position the switch is closed. When the switch is closed, the vibrator in 53 is energized electrically.

Depending from the outlet of the coal scale assembly is an expanding downspout 42. The top of the downspout 42 is joined to the coal scale assembly outlet by means of bolts 44 in a suitable manner. At the lower end, the downspout 42 is connected to a vibrating outlet 48. This connection designated as 46, is of the flexible type and is in the form of a slip joint. It is similar to flexible connection 34. The outlet 48 is similar to the outlet 22. The vibrating means in outlet 48 is operated responsive to a switching mechanism (not shown) located either in the pulverizer feeder 21 or below it. This switching mechanism may be any standard type. The operation of this outlet 48 is similar to that for outlet 22. The outlet 48 is joined to the inlet to pulverizer 21 in a usual manner as by flanges 50 and bolts 51.

The system above described will operate to transport coal contained in the bunker 20 to the pulverizer 21 as follows. Due to the nature of coal, it will tend to stick and wedge itself in the bunker 20 and will not gravitationally pass through the small bunker outlet 22. It will be found that occasionally during operation only the coal immediately above the outlet of 22 can be removed from the bunker and the remaining coal assumes a shape more or less as that indicated by 47 in Figure 1. When this condition occurs, paddle 41 assumes a vertical position, thus starting the vibrator of 22. Inner hopper 53 then vibrates. This action tends to shake loose and discharge most of the coal held therein. This enables some of the coal in the bunker 20 to pass down into the outlet 22 by reason of the fact that the connection between the bunker and outlet is of large enough cross section to prevent wedging and sticking of the coal at this point. Additionally, the vibrating of inner hopper 53 causes a shearing of the funnel-shaped body of coal in the plane between the bunker 20 and the inner hopper 53. Therefore, as long as the outlet 22 can force the coal through its narrow opening into the coal valve 25, the coal will have little tendency to stick or wedge in the bunker 20.

The coal stream issues from the bunker outlet 22 through the coal valve 25 and onto feed belt 30. While on the belt 30, the coal actuates the pivotal paddle arm 41 which in turn actuates coal switch 40. The vibrating means (not shown) on outlet 22 is operated responsive to switch 40 so that inner hopper 53 is vibrated only when there is a coal stoppage. The coal stream passes into the weigh hopper 31 from the feed belt 30 until a predetermined weight has been received by the hopper 31. When this condition occurs, the feed belt 30 is stopped in the manner previously mentioned. The coal in hopper 31 is weighed by a suitable scale mechanism (not shown) and then discharged from the weigh hopper 31 into the expanding downspout 42 and the cycle is repeated. The bottom outlet 48 of the downspout 42 is similar to outlet 22 and consequently the coal stream passes through this outlet in a similar manner into the inlet of pulverizer feeder 21.

A coal stream will not flow satisfactorily through a relatively small-sized opening or spout by reason of its tendency to stick and wedge therein. This condition is greatly exaggerated if the spout is tapered in the direction of flow, that is to say, the cross-sectional area is gradually or abruptly reduced, or the opening leads into a spout or like apparatus having a lesser cross-sectional area than that of the opening. The flow of the coal stream in the latter instances is extremely unsatisfactory. One way in which to have better flow of coal is to provide a breakway, that is, to provide adjacent sections which increase gradually or abruptly in cross-sectional area in the direction of flow of the coal stream. This construction relieves, to a large extent, the tendency of a flowing coal stream to stick. As indicated in Figures 1 and 2, several breakaways are provided in addition to the vibrating outlets 22 and 48 to assure a smooth and continuous flow of the coal stream between the bunker 20 and the pulverizer feeder 21. For example, there is a breakaway between the bottom of bunker 20 and the top of outlet 22, between the bottom of outlet 22 and the inlet to coal valve 25, between the outlet of coal valve 25 and the inlet to the coal scale assembly, between the bottom of scale hopper 31 and the downspout 42, between the bottom of the downspout 42 and the top of outlet 48, and between the bottom of outlet 48 and the inlet to the pulverizer feeder 21.

Additionally, the cross-sectional area of the expanding downspout 42 gradually increases in the direction of flow of the coal stream and consequently, an infinite number of breakaways are established between the coal scale outlet and the downspout outlet, or if desired the downspout 42 can be considered as one long breakaway.

However, the coal scale outlet is approximately four or five times larger than the inlet to the pulverizer feeder. Also, the outlet of the downspout 42 is approximately six or seven times larger than the inlet to the pulverizer feeder due to the increase in cross-sectional area. Consequently, while the difficulties which accompany the flow of the coal stream have been alleviated through the spout **42**, nevertheless, a new problem has been created, namely, reducing the coal stream from a cross-sectional area equal to the outlet of spout **42** to a cross-sectional area equivalent to the inlet to the pulverizer feeder. This is accomplished by the present invention by utilizing a vibrating outlet **48** similar to the outlet **22** which is employed with the bunker **20** and the breakaways above mentioned.

In Figures 3 and 4 is shown one form of a vibrating outlet suitable for use in conjunction with a hopper or tube. As can be seen, a hopper **60** is provided at its bottom with a flange **61**. To this flange **61** is joined an auxiliary flange **62** in a suitable manner. The hopper outlet generally designated as **63** is provided at its top with a flange **64**. The flanges **61** and **64** and the auxiliary flange **62** having holes **65** at spaced intervals, to permit the outlet **63** to be connected to the hopper **60** by bolts **66**, washers **67**, and nuts **68** in a conventional manner. Washers **67** are a resilient type of washer such as rubber. Depending from auxiliary flange **62** is a ring **69** having holes **70**. The top of the outlet **63** is deformed to also form a ring **71** having holes **72**. Interconnected between the two rings **69** and **71** is a resilient member **73** in the shape of a ring. This connection is effected by means of bolts **74** being passed through holes **70** and **72** and secured by nuts **76** in a conventional manner. Also strips **75** are interposed between nuts **76** and resilient member **73**. The holes **65** in the flanges **61** and **64** and auxiliary flange **62** are of greater diameter than the bolts **66**. The bottom of the hopper **60** lies within the interconnections between the hopper **60** and the outlet **63** to form a skirt **77** which protects the resilient member **73** from being injured by coal flow through the hopper and outlet. This construction also forms a breakaway between hopper **60** and outlet **63**. The outlet **63** is rigidly fixed to coal valve **82** by means of flanges **85** on the respective members and bolt and nut assemblies **86** utilized in a conventional way.

A vibrating means **78** of either the electrical, pneumatic, or any other mechanical type is mounted on the outlet **63** and serves to impart to it a vibratory motion. This is generally effected by means of the flexible connection between the hopper **60** and the outlet **63** and the flexible dust-tight connection designated as **79**. This connection consists of an angle flange **80** which is bolted to the top surface **81** of the coal scale housing **88**. A ring **83** is fixed to the inside surface of the flange **80**. The outlet **84** of the coal valve **82** lies within the flange **80**. The space between the flange **80** and outlet **84** and above the ring **83** is packed with a loose material such as cotton rope **89**. A resilient material such as a rubber cement or the like is used to cover the cotton rope and seal the connection as at **87**. This connection **79** is similar to connections **34** and **46** of Figures 1 and 2.

It is to be understood that the outlet construction above described can be either incorporated into any standard hopper structure initially or any standard hopper structure can be adapted at any time to include it.

To best illustrate the usefulness of the outlet shown in Figures 3 and 4, the following case should be considered. If bunker **60** were filled with coal it would be very difficult if not impossible to continuously maintain a gravitational flow of a coal stream through the bunker outlet. This condition would exist primarily due to the coal stream having a great resistance to flow and a tendency to wedge and stick. By means of the arrangement of the present invention, the hopper outlet **63** and the coal valve **82** are capable of being vibrated together generally in a horizontal plane. In so doing, the vibrating outlet **63** and coal valve **82** do not transport the coal or convey it directly, but rather merely maintain the lumps of coal in a continuous state of motion. This prevents the coal from clogging or binding together and permits it to naturally flow gravitationally. Additionally, a shearing action will be set up in the body of the coal in a plane between hopper **60** and the outlet **63** as mentioned in conjunction with Figures 1 and 2. Inasmuch as the cross-sectional area of the top of outlet **63** is larger than the cross-sectional area of the opening at the bottom of hopper **60**, a breakaway is formed, as previously described, and the coal will have a tendency to flow into the outlet **63** more easily. The cross-sectional area of the opening at the bottom of hopper **60** is preselected large enough so that coal will not stick therein. While the precise size of the opening at the bottom of hopper **60** would depend upon the physical characteristics of the material to be contained in the hopper **60**, it has been found that a cross-sectional area of approximately six feet square has proven satisfactory for some installations where coal is the material. Additionally, the vibrating of the coal valve **82** with the outlet **63** assures passage of the coal therethrough. Also, the coal valve **82** opens into the larger coal scale housing **88** thereby forming a breakaway since the housing **88** presents an increase in cross-sectional area over that of the coal valve. Mounted with the housing **88** is a coal switch **40** and a coal paddle **41** shown in two positions. Also a leveling bar **43** is located in housing **88**.

In Figures 5 and 6 is shown a hopper outlet which can be utilized with the apparatus of Figure 1 for use in conjunction with a pyramid-shaped hopper **90**. The outlet **91** is joined to the hopper **90** at its upper end by means of flanges, bolts, and nuts, generally indicated as **92**, in the usual way. At its lower end the outlet **91** is connected to a downspout **96** or other apparatus by means of flanges, bolts, and nuts, generally indicated as **97**, in a similar known manner. Enclosed within the dust-tight shell **101** of the outlet **91** is a vibrating hopper **102**. This hopper **102** is provided on each of its four sides along its upper portion with an angle **103**, the legs of which are welded to the side of the hopper **102**. Directly beneath the iron **103** is mounted another angle **104** with its legs welded to the outer shell **101**. Arranged in the space between the two angles **103** and **104** at each of the four corners of the hopper **102** is a heavy coil spring **105** or other suitable resilient mounting means. Along its lower portion, the hopper **102** is provided with an angle **106** along each of its sides for greater rigidity. Each angle **106** is mounted by welding its legs to a side of the hopper **102**. Thus the hopper **102** is flexibly supported. Depending from the bottom of the hopper **102** is a skirt **107** to effectively introduce material flowing therefrom into the downspout **96** without damage to the flanged connection between them. The hopper **90** also projects within hopper **102** by means of skirt **108** to prevent the material flowing into vibrating hopper from interfering with the vibrating apparatus. Since the cross-sectional area of hopper **102** at skirt **107** is less than that of downspout **96** a breakaway is formed. Similarly, a breakaway is formed between hopper **90** and hopper **102** as the bottom opening of hopper **90** is of lesser cross-sectional area than the mouth of hopper **102**.

The vibrating apparatus is mounted within the shell **101** and along one side of the hopper **102** and consists of the following. A motor **109** supplied by suitable power means is mounted on the top of shell **101** by means of a bracket **112**, and drives a pulley **110** through shaft **111**. Secured to the side of the vibrating hopper **102** at spaced intervals are two ear-like plates **113**. A shaft **115** which has two eccentric portions **114** is mounted by means of bearings **116** and angle plates **117** which are bolted to shell **101**. Each plate **113** is mounted on an eccentric portion **114**. Also an inertia weight plate **118** is mounted on each eccentric portion **114**. An inertia weight **120** which is flexibly supported on springs **121** is mounted across the ends of plates **118**. A pulley **122** is mounted on shaft **115** and is connected to pulley **110** by means of a V-belt **123**.

By this arrangement, operation of motor **109** through its V-belt drive causes the shaft **115** to turn. The eccentric portion **114** causes plates **113** to produce a vibrating motion imparted to the hopper **102** inasmuch as the hopper is spring-mounted and freely capable of such movement. The reaction to the hopper movement is counterbalanced by the inertia weight **120**.

Although the outlet **91** is shown in conjunction with a pyramid-shaped hopper **90**, nevertheless it is to be understood that it can be used with conical hoppers or bunkers, or other apparatus, if it is desired to produce an effective gravitational flow of material having a tendency to clog or wedge.

In Figure 7 is shown a modified hopper outlet which is similar in many respects to the hopper outlet of Figures 5 and 6. However, instead of employing a spring-mounted inertia weight, plates **113** are bolted to the shell **101** as indicated at **130**. In this manner the reaction to the vibrating of hopper **102** is transmitted to shell **101** which transmits a portion of the reaction to hopper **90** through the rigid connection between hopper **90** and shell **101**. Hence there is a small amount of vibration of hopper **90** which tends to assist the flow of coal from hopper **90** into hopper **102**.

It is to be understood that the several embodiments of my invention shown and described herewith can be modified or changed as to size, shape, and arrangement of parts by one skilled in the art without departing from the spirit of the invention or the scope of the subjoined claims.

What is claimed is:

1. An assembly for gravity discharge of an aggregate material that comprises a bunker having a discharge outlet, a funnel-shaped member, means mounting said member for bodily movement along an elongated axis with its mouth in registry with said outlet, means to vibrate said funnel-shaped member, and means to control the vibration of the funnel-shaped member, including an electrical switch responsive to the flow of aggregate material below said funnel-shaped member.

2. An assembly for gravity discharge of an aggregate material that comprises a bunker having a discharge outlet, a funnel-shaped member, means mounting said member for vertical bodily movement along an elongated axis with its mouth in registry with said outlet, means to vibrate said funnel-shaped member, and means to control the vibration of the funnel-shaped member, including an electrical switch responsive to the flow of aggregate material below said funnel-shaped member.

3. An assembly for gravity discharge of an aggregate material that comprises a bunker having a discharge outlet, a funnel-shaped member, resilient means mounting said member for bodily movement along an elongated axis with its mouth in registry with said outlet, means to vibrate said funnel-shaped member, and means to control the vibration of the funnel-shaped member, including an electrical switch responsive to the flow of aggregate material below said funnel-shaped member.

4. An assembly as defined in claim 1 wherein the mouth of said funnel-shaped member is larger in cross section than said discharge outlet, thereby providing a breakaway therebetween.

5. In a system for the gravity feeding of coal including a bunker, a coal scale, and a pulverizer feeder, the improvement that comprises a funnel-shaped member, means mounting said member for bodily movement along an elongated axis with its mouth in registry with the outlet of said bunker, means to vibrate said funnel-shaped member, and means to control the vibration of the funnel-shaped member, including an electrical switch responsive to the flow of aggregate material below said funnel-shaped member.

6. In a system for the gravity feeding of coal including a bunker, a coal scale, a pulvizer feeder, and a downspout connecting said coal scale and pulvizer feeder, the improvement that comprises a funnel-shaped member, means mounting said member for bodily movement along an elongated axis between said downspout and said pulverizer feeder with its mouth in registry with the outlet of said downspout, means to vibrate said funnel-shaped member, and means to control the vibration of the funnel-shaped member, including an electrical switch responsive to the flow of aggregate material below said funnel-shaped member.

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