

July 17, 1951

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FLEXIBLE ROTARY AGITATOR FOR HOPPERS WITH VARIABLE
ECCENTRIC MOUNTINGS AND SPACED WEIGHTS
Filed March 22, 1946

2,561,258

FIG. 1.

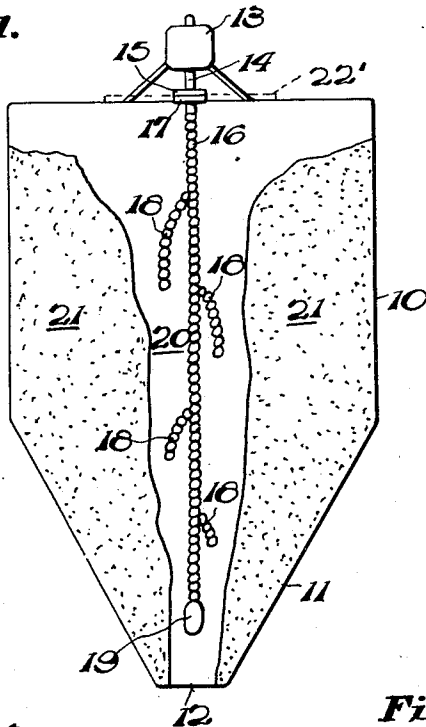


FIG. 2.

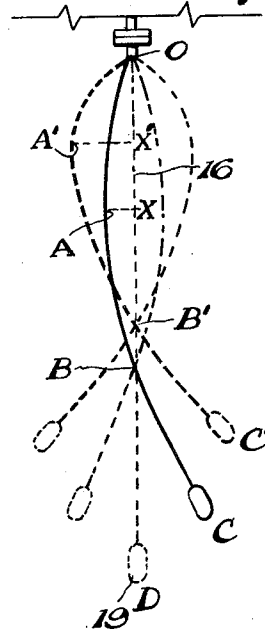


FIG. 3.

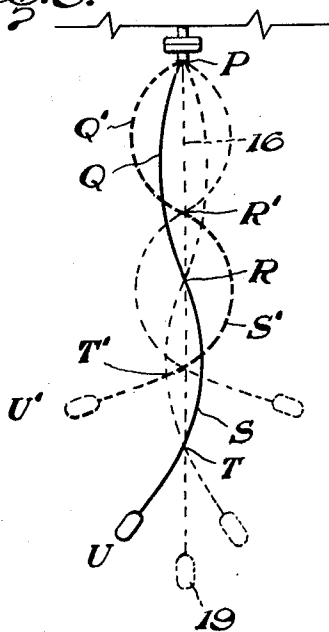


FIG. 4.

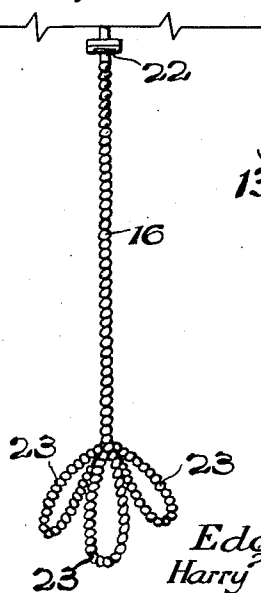
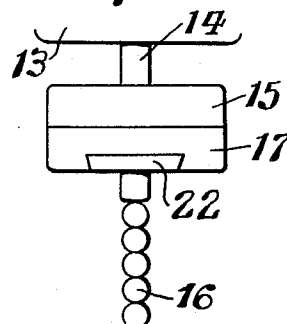


FIG. 5.



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UNITED STATES PATENT OFFICE

2,561,258

FLEXIBLE ROTARY AGITATOR FOR HOPPERS WITH VARIABLE ECCENTRIC MOUNTINGS AND SPACED WEIGHTS

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Application March 22, 1946, Serial No. 656,491

9 Claims. (Cl. 222-406)

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This invention relates to improved means for effecting the removal of material from bunkers, hoppers, bins and like containers, and more particularly to means for effecting removal of material in a relatively finely divided state, especially where the moisture content of such material may be relatively high. The invention has particular application to means for effecting the removal of finely divided coal from storage bunkers, hoppers, bins and the like, but as will be apparent to those skilled in the art the invention can be applied to many other comparable uses.

In bunkers, hoppers, bins and the like for the storage of such materials as coal, and which will hereinafter be generically referred to as bunkers, it is usual for the outlet therefrom to be of smaller area than the main cross sectional area of the bunker. With such constructions difficulty is frequently experienced in causing the material to flow through the outlet, particularly where the material is in a finely divided state, and especially if the moisture content of the material may be relatively high. Under such conditions operation may result in the formation of a tunnel through the material that starts at the outlet and extends upwardly through the mass. Such a tunnel is usually referred to as a "rat hole," and once a rat hole is formed little material will thereafter flow out of the bunker.

Various means have heretofore been proposed to eliminate the condition above referred to, such means including the use of electromagnetic vibrating devices adjacent the outlet of the bunker for vibrating the side walls thereof and the use of solid probing rods, or hollow probing rods through which a blast of compressed air may be delivered, which are manually operated for freeing the material.

It is an object of this invention to provide improved means for freeing the material in a bunker under the conditions above referred to that provides wide flexibility of application and use.

Another object of this invention is to provide a device of the type referred to which may be readily adapted to the configuration of a wide variety of bunkers.

Another object of this invention is to provide a device of the type referred to which by operation at different speeds can be used to meet the exigencies of a wide variety of situations.

Another object of this invention is to provide a device of the type referred to which is so constructed that injury will not occur if overload conditions are encountered.

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Another object of this invention is to provide a device of the type referred to which is simple in construction, easily repaired, readily adjustable and highly efficient in use.

Other objects will appear as the description of the invention proceeds.

The present invention, which may be applied to any type of bunker, hopper, bin or the like, includes a rotatable chain, cable, rope or similar means suspended from the top of the bunker and herein referred to generically as a freely hanging flexible element which extends into the void in the coal or other material afforded by the "rat hole," and which may be so constructed and operated as to meet the varying requirements of different bunkers, different materials, different conditions encountered, etc.

The invention is capable of receiving a variety of mechanical expressions only two of which have been illustrated diagrammatically on the accompanying drawings, but it is to be expressly understood that the drawings are for purposes of illustration only and are intended merely to exemplify some of the many possible expressions of the invention, reference being had to the appended claims for a definition of the invention.

Referring in detail to the accompanying drawings wherein the same reference characters are used in the different figures to designate corresponding parts,

Fig. 1 is a diagrammatic sectional elevation of a bunker provided with one embodiment of the present invention;

Fig. 2 is a diagram to illustrate the operation of an embodiment of the invention using a weight at the end of the suspended rotatable flexible element;

Fig. 3 is a comparable diagram to illustrate another mode of operation;

Fig. 4 is a partial diagrammatic elevation to illustrate an alternative way of providing a weight on the suspended rotatable flexible element; and

Fig. 5 is an enlarged detail of one form of coupling.

Referring first to Fig. 1, a bunker of any suitable size, configuration and construction is diagrammatically indicated as having an upper portion 10 from which extends a lower converging portion 11 terminating in an outlet 12 through which the material, such as coal, must flow. In conformity with the present invention any suitable driving means, such as an electric motor 13, preferably a variable speed motor, is mounted at or adjacent to the top or inlet por-

tion of the bunker in such a way that its shaft 14 lies approximately along the vertical axis of the bunker outlet 12. Any appropriate means (not shown) known to the art may be used for varying the speed of said driving means.

Suitably suspended from said shaft 14 through a suitable driving connection 15 is a flexible member 16 in the form of a freely hanging chain that preferably extends approximately the full height of the bunker, i. e., into the neighborhood of the outlet 12. Connection 15 may be of any suitable construction but is preferably such that if an excessive load is imposed on the element 16 said motor may rotate relatively to and independently of said element. A preferred construction is an overload clutch of any suitable construction such that the clutch maintains its driving relationship with the element 16 for all mechanical loads below a certain limiting value, but when the load exceeds this value, the clutch will slip or disengage to prevent overloading of the motor 13. Element 16 is connected to the output member 17 of said overload clutch in any suitable way, and may be swivelled thereto or merely hung therefrom. Under some conditions it is desirable that the element 16 be so mounted that it may be shifted laterally with respect to the shaft 14, as for example by providing a slidable connection between the upper end of the element 16 and the output member 17 of the clutch as diagrammatically indicated at 22 in Figs. 4 and 5; and it may be desirable to make the entire unit including the motor, coupling, etc., slidable transversely of the axis of the bunker in one or more directions, as by mounting the unit on an adjustable base indicated in dotted lines at 22' in Fig. 1; so that by adjustment the element 16 may have different degrees of eccentricity with respect to the driving shaft 14 and/or different positioning with respect to the axis of the bunker.

Element 16 may be unweighted, but preferably it is terminated at its lower end by any suitable weight 19 which may be a mass attached to the end of the element as indicated in Fig. 1 or, alternatively, the weight may be composed of one or more loops of chain, as shown at 23 in Fig. 4, to increase the cutting action at the free end of the flexible element. Element 16 may have only a single weight at the end thereof as shown in Fig. 4, or as shown in Fig. 1 it may have one or more intermediate weights which may take the form of masses strung on or attached to the flexible element or be short flexible members 18 attached to the element 16 at one or more points along its length to increase the cutting action. Such lateral elements may be similar one to another as regards length, unit or total weight, etc., or they may be of different lengths, different unit or total weights, etc. Similarly the lateral elements may be supported from the main element 16 at equal distances or they may have different spacings. The lateral elements may also be weighted if preferred, or they may take the form of one or more loops as shown at 23 in Fig. 4. Flexible element 16 when composed of a chain may be of any suitable construction, preferably being composed of ordinary link members so that replacement or repair may be simple and inexpensive. However, if preferred, the flexible element may be constructed in any other suitable way, have links of different lengths, construction, etc., or it may be a cable, rope or the like.

Fig. 1 shows the conditions within the coal

bunker after a rat hole 20 has formed in the coal 21. In this figure the flexible element 16 with its lateral elements 18 is shown as hanging in the rat hole 20 prior to initiating operation of the motor 13. If motor 13 be now started to initiate rotation of element 16 centrifugal force will cause element 16 to bow outwardly intermediate of its extremities and cut away the coal where the element contacts the sides of the rat hole, causing the displaced coal to flow out of the bunker by gravity.

Element 16 may be caused to assume different configurations during rotation by varying the speed of rotation and by varying the disposition of the masses along the element. This is illustrated by the diagrams of Figs. 2 and 3. One configuration of the flexible element when provided with one weight at the end thereof is indicated in full line in Fig. 2 at O, A, B, C, the volume of revolution swept out by the element being indicated by said full line and the symmetrically disposed dotted line corresponding thereto. If the speed of rotation is now increased the positions of node B and peak A of the configuration changes to the path indicated at O, A', B', C'. Thus Fig. 2 illustrates that, as the speed of rotation is progressively increased from zero through certain successive values, the weight 19 on element 16 describes a path from its center position D at the axis through C, C', etc., the nodal point moving upwardly from B to B' and the maximum amplitude of the loop above the axis increasing from AX to A'X', the transverse plane of said maximum amplitude also moving upwardly. Thus by selecting the speed of rotation of the flexible element the configuration of the volume defined by the displacement thereof can be controlled and adapted to the geometry of the particular bunker with which it is associated.

Attachment of side elements 18 to said main element 16 also results in an increase in the volume through which the rotating element is effective, as it is apparent that the side elements will move outwardly under centrifugal force to varying degrees, depending upon the speed of rotation of the element 16, the free ends of the lateral elements cutting through the coal to break up its formation.

Another mode of rotation of element 16 is indicated in Fig. 3 in which two complete loops are obtained as compared to the one complete loop shown in Fig. 2. Here at relatively low speed the configuration of element 16 is represented by the full line, P, Q, R, S, T, U and the volume cut out thereby is indicated by said full line and the symmetrical dotted line conforming thereto. On increasing the speed of rotation a new path is described represented by solid line P', Q', R', S', T, U' and the volume of revolution is correspondingly changed. It will be noted that the volume swept by the element in Fig. 3 differs in shape from that swept by the element in Fig. 2, and thus by use of the mode of rotation indicated in Fig. 3 the invention may be adapted to bunker configurations for which the mode of rotation indicated in Fig. 2 would be unsuitable.

Other configurations and their corresponding volumes of revolution than shown in Figs. 2 and 3 are possible as will be apparent to those skilled in the art and employment thereof in the present invention is contemplated, it being expressly understood that the configurations shown in Figs. 2 and 3 are for purposes of illustration only to show the result of selecting dif-

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ferent modes and speeds of rotation suitable to the particular bunker to which the flexible element is applied. The preferred mode of rotation may be stabilized by placing weights or side elements along the main element 16 at selected points where peak amplitudes and nodes are desired.

Whereas proper placement of weights along the length of the element 16, as represented by the lateral elements or weights 18, tends to stabilize the operation of the flexible element to effect given configurations and volumes at different speeds of rotation thereof, under some conditions it may be desirable to avoid a stabilized mode of rotation and provide for random motion of the element 16. Such may be obtained by placing weights or side elements 18 along the main element 16 at non-uniform spacings or by using weights of unequal value or both. In place of using side elements, weights may be used along the length of the main element 16, but suitably proportioned side elements are preferred because they not only operate as weights in determining the location of the nodes and points of maximum amplitude under different speeds of rotation but also increase the cutting action of the device and the volume embraced therein because of their swinging outwardly into cutting contact with the material at the sides of the rat hole depending on the speed of rotation. When unequal weights are desired as above referred to the side elements may be of unequal length or unequal unit or total weights or as previously referred to the side elements may be variously weighted or take the form of one or more loops.

If as a result of the operation of the flexible element as before explained the material should fall as an avalanche and engulf the lower portion of the flexible element preventing rotation thereof, in the absence of an overload clutch or its equivalent as before explained, continued rotation of the element would damage either the element or the motor 13. With an overload clutch, however, the stoppage of the element 16 does not prevent the motor 13 from continuing to drive the shaft 14 but the output member 17 of the clutch 15 will slip or release with respect to the input member thereof.

While in the drawing the main element 16 has been shown as suspended coaxially with the shaft 14 the suspension may be eccentric with respect to the shaft 14 to introduce other modes of rotation. To increase the effective range and adaptability of the device the entire unit may be mounted, as heretofore pointed out, so that its position may be adjusted with respect to the bunker. Any suitable provisions for such adjustments may be employed. The eccentricity adjustment may be accomplished by a radially slidable connection between the clutch output member 17 and the upper extremity of the chain 16, as shown in enlarged detail in Fig. 5, and the increase in effective operative range may be accomplished as by making the unit as a whole adjustable laterally as shown in Fig. 1.

While the present invention has been illustrated as breaking loose the material being delivered after a rat hole has formed, it can be used if desired to prevent the formation of a rat hole, and furthermore it may be used in aiding the removal of material from bunkers and the like where unaided gravity discharge normally results in large dead storage volumes.

It will therefore be perceived that the present invention provides a bunker emptying means of

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wide utility which by reason of its construction and operation can be adapted to a great variety of bunkers and conditions, and by variations in the speed of operation and in the disposition of weights the volume and configuration defined by the rotating flexible element, with or without lateral elements, can be modified to meet a wide variety of exigencies. The construction is simple and strong and readily and inexpensively repaired in event of breakage. The construction furthermore assures that in the event the material imposes a heavy load on the rotating element the driving motor shall not be injured.

While the embodiments of the invention illustrated on the drawings have been described with considerable particularity, it is to be expressly understood that the invention is not limited thereto, as will now be apparent to those skilled in the art. While a flexible element with a weight or loops at the end is preferred, such may be omitted within the broader aspects of the invention to obtain some of the benefits thereof. Through use of the principles hereinabove explained, by suitably locating the weights lengthwise of the element 16 to predetermine the nodes and planes of maximum displacement the device can be constructed to meet the requirements of a wide variety of conditions, and by use of suitable side elements, with or without weights thereon, and either singly or in the form of one or more loops, the total volume defined by the rotating element can be predetermined to meet the requirements of a wide variety of bunkers. Changes may also be made in the details of construction, arrangement and proportion of parts, other provisions than above described may be employed for driving the flexible element, for providing overload slippage or release, for providing lateral adjustment of the flexible element, etc., without departing from the spirit of this invention. Reference is therefore to be had to the appended claims for a definition of said invention.

What is claimed is:

1. In a bunker emptying means, in combination with a bunker having an outlet at the lower portion thereof, a motor mounted adjacent the top of the bunker and having a vertical shaft driven thereby and terminating adjacent the top of the bunker, a freely hanging flexible element extending throughout its entire length downwardly below said shaft from near the top of the bunker to near the outlet thereof approximately at the vertical axis of the bunker, at least one weight disposed intermediate the ends of said flexible element, and connecting means between said shaft and the upper end of said element for rotating said element around a vertical axis to flex said element and generate a geometrical surface of revolution as it rotates.

2. In a bunker emptying means, in combination with a bunker having an outlet at the lower portion thereof, a motor mounted adjacent the top of the bunker and having a vertical shaft driven thereby and terminating adjacent the top of the bunker, a freely hanging flexible element extending throughout its entire length downwardly below said shaft from near the top of the bunker to near the outlet thereof approximately at the vertical axis of the bunker, at least one short flexible element attached to said freely hanging element intermediate the ends thereof, and connecting means between said shaft and the upper end of said element for rotating said element around a vertical axis to flex said element

and generate a geometrical surface of revolution as it rotates.

3. In a bunker emptying means, in combination with a bunker having an outlet at the lower portion thereof, a motor mounted adjacent the top of the bunker and having a vertical shaft driven thereby and terminating adjacent the top of the bunker, a freely hanging flexible element extending throughout its entire length downwardly below said shaft from near the top of the bunker to near the outlet thereof approximately at the vertical axis of the bunker, a weight attached to said flexible element including a plurality of loops, and connecting means between said shaft and the upper end of said element for rotating said element around a vertical axis to flex said element and generate a geometrical surface of revolution as it rotates.

4. In a bunker emptying means, in combination with a bunker having an outlet at the lower portion thereof, a motor mounted adjacent the top of the bunker, a freely hanging flexible element extending downwardly from near the top of the bunker to near the outlet thereof, at least one weight attached to said element, connecting means between said motor and element for rotating said element around a vertical axis to flex said element and generate a geometrical surface of revolution as it rotates, and means for laterally adjusting the position of said flexible element with respect to the vertical axis of the bunker.

5. A bunker emptying means including, in combination with a bunker having an outlet below the top thereof, a variable speed motor adapted to be mounted at the top of the bunker and having a vertical shaft driven thereby and adapted to terminate adjacent the top of the bunker, a freely hanging flexible element depending throughout its entire length vertically below said shaft and operatively connected thereto only at the upper end of said element for rotation by said motor around an axis defined at least approximately by said hanging element when at rest, and means on said flexible element for predetermining the geometrical figure of revolution generated by said flexible element as it is rotated around said vertical axis by said motor, said last named means including at least one weight carried by said flexible element intermediate the length thereof.

6. A bunker emptying means including, in combination with a bunker having an outlet below the top thereof, a variable speed motor adapted to be mounted at the top of the bunker and having a vertical shaft driven thereby and adapted to terminate adjacent the top of the bunker, a freely hanging flexible element depending throughout its entire length vertically below said shaft and operatively connected thereto only at the upper end of said element for rotation by said motor around an axis defined at least approximately by said vertical element when at rest, and means on said flexible element for predetermining the geometrical figure of revolution generated by said flexible element as it is rotated around said vertical axis by said motor, said last named means including at least a group of loops at the end of said flexible element.

7. A bunker emptying means including, in combination with a bunker having an outlet below the top thereof, a variable speed motor adapted to be mounted at the top of the bunker and hav-

ing a vertical shaft driven thereby and adapted to terminate adjacent the top of the bunker, a freely hanging flexible element depending throughout its entire length vertically below said shaft and operatively connected thereto only at the upper end of said element for rotation by said motor around an axis defined at least approximately by said vertical element when at rest, and means on said flexible element for predetermining the geometrical figure of revolution generated by said flexible element as it is rotated around said vertical axis by said motor, said last named means including at least one laterally extending flexible element disposed at a point intermediate the length of said freely hanging flexible element.

8. A bunker emptying means including, in combination with a bunker having an outlet below the top thereof, a variable speed motor adapted to be mounted at the top of the bunker and having a vertical shaft driven thereby and adapted to terminate adjacent the top of the bunker, a freely hanging flexible element depending throughout its entire length vertically below said shaft and operatively connected thereto only at the upper end of said element for rotation by said motor around an axis defined at least approximately by said vertical element, and means on said flexible element when at rest for predetermining the geometrical figure of revolution generated by said flexible element as it is rotated around said vertical axis by said motor, said last named means including weights at the end and at least one intermediate portion of said flexible element.

9. A bunker emptying means including, in combination with a bunker having an outlet below the top thereof, a variable speed motor having a vertical shaft adapted to be mounted at the top of the bunker, a freely hanging flexible element depending vertically below said shaft and operatively connected thereto at the upper end of said element for rotation by said motor around an approximately vertical axis, means on said flexible element for predetermining the geometrical figure of revolution generated by said flexible element as it is rotated around said vertical axis by said motor, and means for laterally adjusting the position of said flexible element relative to the axis of said shaft whereby said element may be rendered eccentric with respect to the axis about which it is rotated.

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