PARTICULATE WASTE PRODUCT FIRING SYSTEM

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ABSTRACT

A waste product firing system which includes controlled bottom unloading of particulate material, such as sawdust, from a storage container and the metered feeding thereof to the preparatory means which compacts the particulate material to a desired density, selectively mixes the compacted particulate material with a determinable volume of air and feeds the resulting mixture into a combustion chamber, for example, of a boiler, for burning. The system including a control circuit system which cooperatively integrates the functions of the entire system so that an optimum amount of particulate material is fed into the combustion chamber for substantially complete combustion and minimization of pollutants.

11 Claims, 4 Drawing Figures
PARTICULATE WASTE PRODUCT FIRING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a particulate waste product unloading and firing system and somewhat more particularly, to a sawdust burning machine having an integrated control system.

2. Description of the Prior Art

The safe, pollution-free, orderly disposal of waste particulate material, such as sawdust, wood chips, hogged bark, tan bark, flour, etc., presents a difficult and complicated problem in many industries. Great quantities of waste particulate materials, such as sawdust, are produced in many industries, such as in furniture manufacture, and are generally stored in large cylindrical containers which are equipped to discharge the waste material via various unloading mechanisms.

A particularly suitable mechanism for the bottom unloading of particulate material, such as sawdust, is disclosed and claimed in U.S. letters Patent No. 3,414,142 granted to M. W. Kolze (which is incorporated herein by reference).

Some known bottom unloaders are comprised of a rotating screw-type conveyor having various means for positively driving the conveyor screw around the bottom of the container in a radially sweeping fashion. These prior art positively driven devices forced the conveyor screw through the particulate material regardless of whether or not the capacity of the conveyor screw had been satisfied, thus resulting in a less efficient operation. In addition, these prior art conveyor screws tended to arch upwardly into the particulate material as a result of the natural tendency of the rotating screw to "climb," ultimately causing the bending or breaking of the conveyor screw.

A preferred bottom unloader, as disclosed and claimed by M. W. Kolze in the above-mentioned letters Patent, operated as a separate entity wherein the rate of unloading was controlled simply by means of a mechanical paddle wheel having blades rotating either about a vertical or a horizontal axis extending downwardly into the discharge chute or bin in which the sawdust collected. By adjusting the length of the paddle wheel blades, various levels of accumulated sawdust could be maintained beneath the storage container, i.e., when the discharged sawdust dropped below a desired level of accumulation, the paddle wheel was free to rotate, wherein a signal was communicated to the screw unloading conveyor to begin unloading. Because of the characteristics of sawdust, the paddle wheel would periodically require the removal of sawdust which had accumulated on the paddle wheel. Further, any adjustment in a desired level of accumulation could only be effected by changing the position of the paddle wheel and/or changing the length of the blades thereof. Since the paddle wheel had to be located within the discharge chute or bin for operation, modification of the paddle wheel blades required an operator to enter the confines of the bin, which required the uneconomical shutting down of the entire system. Further, the entry into the bin created a substantial danger to an operator since he may become buried in the particulate material falling from the storage container or be caught in a spontaneous "dust explosion" of the particulate material.

The maintenance of a constant level of sawdust in the discharge chute or bin is important to insure, for example, that a constant volume of material is unloaded as to a truck in the case of a self-unloading or to a second conveyor screw operating with and controlled by a sawdust burning machine. For example, in the case of a second conveyor screw operating below a discharge bin, if too much sawdust is unloaded above such a screw, because of the peculiarities of sawdust, it will tend to be compacted from its own weight resulting in a compact self-supporting mass of material which can be tunneled through by the lower conveyor screw and leave a supporting arch of sawdust above the screw.

After the conveyor screw "tunnels" out the sawdust beneath the supporting arch, it will be unable to transport sawdust to a further point even though the paddle wheel sensor will continue to signal that sufficient material is present. The manual intervention of an operator will then be required to dislodge the compacted sawdust. The detection of the above problem is noticeable only after, for example, a sawdust burning machine fed by the "dry" conveyor screw cycles down for lack of sawdust. When too much sawdust is supplied into a combustion chamber, incomplete combustion will result and cause extensive smoke, ash and other pollution. On the other hand, when insufficient sawdust is fed into a combustion chamber, an inefficient combustion and/or disposal of sawdust results. Thus, it can be seen that due to the peculiarities of sawdust being unloaded or transported in a stream of air, and the comparatively low combustion temperature for the burning of sawdust, such a sawdust burning machine requires a constant and relatively consistently packed sawdust, as well as rather close control of the air/sawdust ratio. While some controlled sawdust burning machines are available, for example, as disclosed in U.S. letters Patent 2,912,943 and 2,723,021, both granted to H. Nicolai and H. F. Kolze, (which are incorporated herein by reference), they are generally limited to the control of a sawdust feeding and compacting screw conveyor and a sawdust/air mixing apparatus. However, the prior art has failed to integrate the control of an unloader operating in response to an optimum predetermined level of discharged sawdust or other particulate material, along with an optimum mixing of air therewith so as to provide an optimum combustion mixture.

SUMMARY OF THE INVENTION

The invention provides an integrated control system for the burning of particulate combustible waste products.

It is an object of the instant invention to provide an improved combustible particulate waste product burning machine having a fully integrated control system of the entire process from a storage container to a combustion chamber.

A still further object of the instant invention is to provide a sawdust burning system which includes a sonically controlled storage bin unloader, a controlled conveying and compacting screw, communicating first with the discharge from the bin unloader and second with a sawdust burning machine which includes a combustion chamber and a mixing duct wherein a relatively constant amount of compacted sawdust is mixed with a controllable volume of air and this mixture is fed into the combustion chamber, and control circuitry inte-
grating the functions of the bin unloader, screw conveyor, sawdust burning machine, as well as temperature, pollution and safety sensors.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Other objects, features and advantages of the invention, together with its organization, construction and operation will be best understood from the following detailed description of the preferred embodiments of the invention, taken in conjunction with the accompanying drawings, on which:

FIG. 1 is a schematic diagram illustrating the system flow and working relationship between the various elements of an exemplary embodiment of a particulate waste product firing system constructed in accordance with the present invention;

FIG. 2 is an electro-mechanical diagram illustrating the control system for a particulate waste product firing system constructed in accordance with the present invention;

FIG. 3 is a schematic illustration of another embodiment of the system shown at FIG. 1; and

FIG. 4 is an electro-mechanical diagram illustrating the control system for the device of FIG. 3.

**DESCRIPTION OF THE PREFERRED EMBODIMENTS**

FIG. 1 schematically illustrates a particulate waste product firing system with an integrating control means constructed in accordance with the present invention. While the present invention is discussed for illustrative purposes in the context of a sawdust bottom unloader and/or bottom unloading and burning operation, the present invention is useful for any other particulate material similarly involved. The system, indicated generally by reference numeral 10, includes a particulate material storage container 11, preferably having at least a cylindrical lower inner wall 6 and a bottom wall 9 with a central opening 5. An amount L of a particulate material, such as sawdust, is stored within the container 11. The particulate material is transported by a suitable means, for example, a forced air stream, from a source thereof, for example, a wood working machine or the like. A bottom unloading free-sweeping, non-arching conveyor screw 12 is mounted within the container 11 along the bottom wall 9 thereof and in operational relation to the central opening 5.

The conveyor screw 12 has a rotatable wheel 8, having a diameter greater than that of the individual flights of the conveyor screw 12, attached to the end thereof adjacent inner wall 6 of the container 11, and operable to maintain the conveyor screw 12 a determined distance above the bottom wall 9. An annular restraining band 7 is attached to the side wall 6 of container 11 in an operable relationship to the wheel 8 to prevent the natural tendency of the rotating free-sweeping conveyor screw 12 from “arching” upward into the particulate material and eventually bending or breaking.

The bottom unloading conveyor screw 12 is driven by an electrical motor 13 through a pair of mechanical transfer means 14 and 15. Transfer means 15 has a deflector means 4 positioned above and in operating relation with the opening 5 to prevent the particulate material from freely falling through the central opening 5. A weight-sensitive means 3 may be positioned between the deflector means 4 and transfer means 15 to monitor whether or not a preselected amount of particulate material is present within the bin 11.

A screw-compactor-conveyor 16, driven by the electrical motor 17, is arranged below the central opening 5 of the container 11 and transfers unloaded particulate material, for example, sawdust, from a trough-like unloading bin or discharge area 18, located beneath the container 11, to a duct 19. The flights of the compactor-conveyor screw 16 terminate at the point 83 where the screw 16 enters the duct 19. The compactor-conveyor screw 16 has a center shaft 84 which extends to a side 85 of the duct 19 and is rotatably attached to a support means 86. The compactor-conveyor 16 is mounted within an open top transport chute 81. At the distal end 82 of the chute 81, an enclosed tube 65 is provided for enclosing a shortened length of the compactor-conveyor 16 so that the cooperation between the flights of the compactor-conveyor screw 16 and the peripheral wall of the tube 65 compacts the sawdust or other particulate material located within the compactor flights encompassed by the tube 65.

The duct 19 is of a generally rectangular cross section having an air intake or inlet at 19a, an air discharge at 19b and a bypass aperture at 19c, positioned between the inlet 19a and the discharge 19b. A first damper valve means 20 is located within the duct 19 between the discharge end 16b of the compactor-conveyor 16 and the bypass aperture 19c. A second damper valve means 21 is also mounted in the duct 19 alongside the first damper valve means 20 adjacent the inlet 19a. The first and second valve means 20 and 21 operate in a cooperative relationship, which will be explained in greater detail hereinafter, to redirect the air intake flow within the duct 19 from either the intake 19a or 19c. Since the openings 19a and 19c are of a predetermined size in relation to the duct 19, a predetermined volume of air can pass through the duct 19.

A blower 22, driven by an electrical motor 23, has an intake 22a connected to the duct discharge 19b; and an exhaust 22b connected to a burning chamber 24. The burning chamber 24 may, for example, be combined with an overhead boiler 25 so that the exhaust flow at 22b, indicated diagrammatically by the arrow 26, leads to a manifold 27 and into the burning chamber 24. An alternate fuel source, indicated diagrammatically by the arrow 100, may be provided for feeding another fuel, such as coal, oil, natural gas, etc. to the manifold 27 during periods when insufficient sawdust or the like is available.

It will be appreciated that once the system is initiated, as will be discussed later, unloaded sawdust in the bin 18 will be compacted and transported to the duct 19 by the compactor-conveyor screw 16, wherein a rapidly flowing stream of air from 19a to 19b, created by the blower 22, will pick up a relatively constant amount of sawdust particles delivered per unit of time to the duct 19 and direct the resulting air/sawdust stream to the burning chamber 24 for combustion.

The first damper valve means 20 is hingedly attached to the side of the duct 19 for select movement from a first position, shown in dotted lines as 20a which is a closed-aperture 19c and open-duct 19 position, to a second position, shown in full view of the valve 20, which is a closed-duct 19 and open-aperture 19c position. The damper 20 is moved between its first and second positions by an electric motor 28, which has a selectively rotatable member 29 which is pivotally and
eccentrically connected to an arm 30 which in turn is pivotally connected to the center portion of the damper means 26. The selectively actuating motor 28, as will be discussed later, will cause the rotatable member 29 to controllably rotate, causing the arm 30 to move the damper means 20 from the first position to its second position and vice versa. Mounted on the first damper valve 20 are two mercoid switch means 32 and 33 which are responsive to the movement of the damper valve 20. As is well known, mercoid switches open and close electrical circuits in response to tilting movement of the switch itself. These mercoid switch means 32 and 33 are used to sense the movement of the first damper valve means 20 during the start-up and shut-down cycles of the system and will be discussed at a later point.

The second damper valve 21 is also hingedly attached to the side of the duct 19 in much the same manner as the first damper valve 20. The valve 21 is held in position against a tapered stop member 40 closing the duct 19 by a weighted arm 31 attached to the valve 21 in a counter-balancing relationship. The valve 21 is shown in dotted lines 31a in an open position. The stop member 40 has a tapered side toward the direction of air flow within the duct 19 to prevent the build-up of sawdust which would otherwise create a potential fire hazard.

During initial start-up of the system, the damper valves 21 and 20 are in the closed positions, as shown in full lines, blocking the duct 19. Thus, the blower 22 will initially draw a stream of air through the aperture 19c. Subsequently, the motor 28 is actuated to slowly bring the first damper 20 to its position 20a so that the aperture 19c is totally closed. Until the aperture 19c is totally closed by the damper 20, the second damper valve 21 will remain in a closed position blocking the duct 19 and being held in place against the stop member 40 by the counter-balancing weighted arm 31. Once the aperture 19c is closed off, the vacuum created by the blower 22 within the duct 19 is sufficient to overcome the weighted force of the arm 31 holding the valve 21 closed and quickly move the damper 21 to its open position 21a whereby an air stream is now drawn from the inlet 19a. Any sawdust particles discharged into the duct 19 by the compactor-conveyor 16 at the end 18 of the system is picked up and borne in the air stream for ultimate delivery to the burning chamber 24.

The reverse procedure is undertaken during shut-down of the system. The motor 28 is actuated to return the damper 20 to a position closing the duct 19. As soon as the damper 20 is slightly opened, air is once again drawn from the aperture 19c resulting in the loss of the necessary vacuum required to hold the damper 21 in an open position. Thus, the damper 21 will immediately close shut, causing the blower 22 to draw air entirely from the aperture 19c, permitting the purging of the system of any remaining sawdust particles without having additional sawdust particles entering the system past the damper valve 21.

It will be appreciated that in order to achieve a complete combustion of sawdust particles, an optimum mixture of sawdust particles and air is required. However, sawdust particles by their very nature do not lend themselves to delivery of a constant amount since they tend to entrap varying amounts of air therein so that substantially identical volumes of loose sawdust particles may in fact contain different amounts of sawdust. The enclosed tube 65 in cooperation with the compactor-conveyor 16 removes air entrapped within the sawdust and ensures that a constant amount of sawdust is delivered into the duct 19. Of course, a constant but controlled supply of sawdust must be available to the compactor-conveyor screw 16. In the present system, a constant and consistently compacted amount of sawdust is delivered to the duct 19 at the discharge point 83 of the conveyor screw 16 by first insuring that a relatively constant supply of sawdust is available within the bin 18 and secondly, by compacting the sawdust immediately prior to being discharged into the duct.

A sonic means, comprised of a sonic sender unit 34 and a sonic receiver unit 35, is used to continually monitor the level of accumulated sawdust in the bin or discharge area 18 and ultimately control the activity of the unloading conveyor screw 12 in response to a selected level 36 of accumulated sawdust within the bin 18. By externally mounting the sonic sensing means on the peripheral walls of the bin 18, a desired level of accumulated sawdust within the bin 18 can easily be adjusted from outside the bin for optimum levels of discharge. Further, by its very nature, a sonic means provides a sensing means which will operate effectively in a particulate environment and free from sawdust contamination. The strength of the sonic signal sent from the sonic sender unit 34 can be adjusted to accommodate the peculiar density characteristics of any particulate material, including sawdust, to insure that an accurate indication of a selected level of accumulation within the bin 18 is received.

As discussed earlier, the level of accumulated sawdust is important to the functioning of the system because of the peculiarities of sawdust to compact itself from its own weight. Thus, if the discharged sawdust is permitted to accumulate to a level sufficient to cause an undesired compacting effect, the conveyor screw 16 located at the bottom of the bin 18 would run "dry" after tunnelling out the lower portion of a compacted sawdust discharge. By providing a sonic sensing means, which is mechanically adjustable for a desired level of accumulation by selectively mounting units 34 and 35 in horizontal alignment with one another at a select pair of a plurality of mounting means 76 located on peripheral walls of the bin 18. Accordingly, the sensing means can be positioned at a desired level to prevent the sawdust or any other particulate material from compacting itself from its own weight. Thus, it can be seen that if for any reason an insufficient supply of sawdust is present within the bin 18, the conveyor screw 16 would not deliver the required amount of sawdust to the compacting portion 65 to achieve the desired consistency of sawdust for optimum operation of the system. However, by proper positioning of the sonic means within the discharge area 18, a sufficient supply of sawdust is virtually guaranteed.

The operation of the sonically controlled discharge operation of the container 11 can also be used in any particulate material bottom unloading operation apart from the present waste product firing system, such as shown in FIG. 3. In the embodiment illustrated at FIG. 3, a bottom unloading sonically controlled system is shown controlling the level 36 of discharge into a container, for example a truck 70. A storage container 11 having a central opening 71 is provided with a free-sweeping, non-arching conveyor 12, which is driven by an electrical motor 13 through a transfer means 14 and 15. Once the system is initiated by a main
power and control panel 72, it will discharge a stored particulate material indicated as 73 into the truck 70. A sonic sending means 34 is moveably attached beneath the container 11 on a member 74 to send a signal to a sonic receiving unit 35 which is selectively attached beneath the container 11 and in horizontal alignment within the sending unit 34 on a member 75. The signal will be received until the level of accumulated discharge achieves a desired level 36 blocking the signal, at which point the control panel 72 will terminate the unloading by shutting off the motor 13. At this point, the system is shut off by the panel 72 and the truck 70 is driven away. Located on members 74 and 75, respectively, are a plurality of mounting means 76 whereby the sonic sending and receiving means 34 and 35 can be mechanically relocated by an operator located outside the discharge area to provide for various desired levels of accumulated discharge. A weight-sensitive electrical control means 3 may be positioned between the deflector means 4 and transfer means 15 to signal the control panel 72 as to the presence of a sufficient amount of sawdust. Thus, the control panel 72 will shut off the unloading operation when insufficient sawdust is available.

FIG. 4 represents an electro-mechanical diagram of a basic unloading sonic control system constructed in accordance with the principles of this invention. Once the system is activated, a main power and control panel 72 operates the electrical motor 13 until the monitoring sonic signal from the sonic sending means 34 is no longer received at the sonic receiving means 35, at which point the control panel stops the motor 13. A weight-sensitive control means 3 is also operationally connected with the panel 72 so that when the means 3 is actuated, as by insufficient sawdust within a storage bin, a signal is generated which stops the motor 13. Thus, it will be appreciated that the sonically controlled bottom unloading system, as shown in FIG. 3, can be utilized ideally anywhere an unattended unloading activity is required.

Returning to FIG. 1, it is necessary after providing for a constant level of sawdust above the conveyor screw 16 by the sonically controlled unloading of the container 11, to controllably compact the sawdust carried by the conveyor screw 16, so as to eliminate any voids or air pockets within the sawdust. The sawdust is compacted to the desired consistency by "choke feeding" the sawdust into a tube or restricted zone 65. The conveyor screw 16 is preferably mounted in an askew or eccentric fashion within the restricted zone 65 (not shown in FIG. 1). By mounting the conveyor screw 16 within the zone 65 such that the distance between the conveyor flights' edges and the peripheral walls of the restricted zone 65 and varies about the periphery of the zone 65, any irregularities contained within the sawdust, such as nails or particles of wood, will be able to pass, since the conveyor-compact screw 16 can flex, and/or a sufficiently large space between the flight edges and the walls of the restricted zone is moved past the irregularity, thus preventing the irregularity from jamming the compactor-conveyor screw 16.

Referring to the electro-mechanical diagram of FIG. 2, which illustrates a circuit whereat the various elements of the particulate waste product firing system 10 in FIG. 1 are integrated together as well as coordinated with various safety features to provide a fully automatic operation by a main control center 50. The system is provided with a source of electricity connected to terminals T and T' such as a 60 cycle, 110-120 volt single-phase supply line. The main control center 50 is provided with a means to either manually or automatically initiate the sawdust burning process. Once the system is activated, a switch 51 is closed by the main control center 50 providing electrical power to the system. The weight-sensing means 3 continually monitors the supply of sawdust within the storage container 11 and communicates the status of stored sawdust to the main control panel 50. The main control panel 50 will, depending upon the signal received from the sensing means 3, either refuse to start the sawdust burning process, activate or deactivate the process, all of which reflects the availability of sawdust within the storage container 11. Once power is provided to the system, and the presence of sawdust is detected within the storage container 11 by the weight-sensitive means 3, the ultrasonic sensor analyzer 52 begins monitoring an ultrasonic signal between the units 34 and 35. The ultrasonic signal received by the unit 35 is analyzed to determine if the desired level of accumulated sawdust is present within the unloading bin 18, as shown in FIG. 1. If an insufficient level of sawdust is detected, a signal is sent to the control center 50 which in turn closes the switch 53, resulting in the activation of the bin unloader motor 13. The ultra-sensor analyzer 52 continually monitors the level of accumulated sawdust discharge within the bin 18 and allows the main control panel 50 to control the activity of the screw unloading conveyor 12 and provide a desired level of accumulated discharge.

Once having received the required signal from the sonic analyzer unit 52, the main control center 50 then actuates the damper motor 28 by closing the switch 54. Since the motor 28 has two distinct movements, namely, that of moving the damper 20 alternately open and closed, suitable control means are provided for selectively actuating the motor 28 in the desired manner. Such control means may be in a number of forms, all of which may be readily constructed by those skilled in the art. As shown in FIG. 2, one form involves the use of a reversible field 55 which permits actuation of the motor 28 in a "forward" direction when the switch 54 is closed across the terminals 56 and which permits "reverse" actuation of the motor 28 when the switch 54 is closed across the terminals 57.

After the system is initiated and the damper motor 28 is in the process of opening the damper 20, the mercoid switches 32 and 33, secured to the back of the damper 20, progressively make contact, causing first the blower motor 23 to actuate, creating the required air flow within the duct 19, and secondly, to actuate the electrical motor 17, causing the sawdust to be metered into the duct 19 for mixing with the air flow therein. In response to either an automatic shut-down as a result of an automatic timing means contained within the control center 50 or a manual shut-down, the above start-up procedure is reversed by the control center 50 whereby the system is stopped in the reverse progressive manner, as described above.

In addition to the automatic start-up and shut-down capabilities of the main control center 50, one may also provide it with a range of safety and monitoring features. A signal box 58 connected to the blower motor 23 will signal the control center 50 in the event of a failure in the blower motor 23, whereby the system will
be automatically "shut-down." The same result will occur if the electric motor 17 signals failure through a signal box 59 which is shown connected to the motor 17 and the main control center 50. A similar signal box 90 is provided for the bin unloader motor 13. A boiler signal box 60 communicates various data to the main control center 50 to permit the constant monitoring of safety and/or critical parameters within the boiler, such as boiler temperature, water supply, smoke and pollution levels, etc. If any one of these parameters falls outside of pre-established safety limits, the main control center 50 will automatically shut down the system, thus permitting the system to run safely with a minimum amount of operator surveillance.

The boiler may also be provided with an alternate fuel source means so that the particulate waste system 10 is utilized as an auxiliary fuel system. An alternate fuel source control means 61 may be incorporated for mixing both fuel systems and/or using one system in preference to the other, such as, for example, when a larger amount of sawdust or other combustible waste product has been accumulated.

Although the present invention has been described by reference to particular illustrative embodiments thereof, the illustrations and descriptions have only been provided to show preferred embodiments of the invention and the principles thereof and what is now considered to be the best mode contemplated for applying these principles. Many changes and modifications of the invention may become apparent to those skilled in the art without departing from the spirit and scope of the invention. It is, therefore, intended that the patent warranted hereon cover all such changes and modifications as may reasonably and properly be included within the scope of the contribution to the art.

We claim as our invention:

1. A bottom unloading system for particulate material comprising:
   a particulate material cylindrical storage container including a bottom wall with a central opening therein, a cylindrical side wall having an annular restraining means attached thereto and above said bottom wall and a deflector means axially aligned with and in working relationship to said central opening,
   a radially free-sweeping, non-arching conveyor screw means extending along said bottom wall from said central opening to said side wall of the storage container,
   a wheel means attached to an outer end of said conveyor screw means adjacent to said side wall of the container in working relationship thereto for contacting said bottom wall and said restraining means, operable to maintain said conveying means at a substantially parallel distance above said bottom wall of the container and prevent said conveyor screw means from ascending above said restraining means of said container,
   an electromotive means connected to the conveyor screw means operable to rotate said conveying means about its longitudinal axis,
   a sonic control means positioned below said central opening within a discharge area in operable relationship to a discharge from said storage container and communicating with said electromotive means to control the energy input thereto in response to a desired accumulation level of discharged particulate material, whereby the sonic control means generates a signal to said electromotive drive means in response to the level of discharge from said container and the drive means rotates said conveying screw means about its longitudinal axis causing frictional engagement of said wheel means with said bottom wall, resulting in the radially free-sweeping movement of said conveying screw means about the bottom wall of said container and uniform unloading of said particulate material from said container at a rate sufficient to maintain a constant desired level of discharge below said container.

2. A bottom unloading system for particulate material in accordance with claim 1, wherein said sonic control means comprises:
   a transmitting means operable to generate and transmit an ultra-sonic wave, said transmitting means being positioned at one side of the discharged particulate material below said central opening,
   a receiving means operable to receive said ultra-sonic wave, positioned on an opposite side of said discharged particulate material below said central opening of said container in alignment with said transmitting means, and
   a control means in working relationship with said transmitting means, receiving means and said electromotive drive means, to monitor the signal between said transmitting and receiving means and in response to said signal, control energy input to said drive means, resulting in a controlled rate of unloading by said conveying screw means in response to a selected level of discharge below said central opening in said bottom of the storage container.

3. A bottom unloading system for particulate material in accordance with claim 2, wherein said ultrasonic wave is selectively adjustable to various density characteristics of different particulate materials.

4. A bottom unloading system for particulate material in accordance with claim 2, wherein said transmitting and receiving means are mounted onto a support means located beneath said central opening on opposite sides of said discharge area, said support means includes a plurality of spaced-apart mounting means whereby a selected level of discharged particulate material within said discharge area is attained by relocating said transmitting and receiving means along said mounting means to correspond to said selected level.

5. A bottom unloading system for particulate material in accordance with claim 1, including a weight-sensitive means located below said deflector means in operable relationship thereto to monitor the presence of particulate material within said cylindrical storage container and in communication with said control means to signal the amount of particulate material within said storage container, whereby said control means will initiate unloading of particulate material only when a sufficient amount of said particulate material is present within said container.

6. In a waste product firing system which includes: a combination of a storage container bottom unloader for particulate material having a central opening in the bottom of said container; a free-sweeping, non-arching conveying screw located within said container operable to unload stored particulate material through said opening; a screw transporting and compacting means
3,865,053

located beneath said central opening of said storage container positioned to receive the particulate material discharged through said opening in the container bottom; said transporting and compacting means being operable to compact and convey a constant amount of said particulate material to a particulate material burning machine; a blower means in working relation with said burning machine to establish a directed flow of air within said particulate material burning machine from one of at least two air intakes to an inlet of a combustion chamber; a valve means within said particulate material burning machine to selectively redirect the intake of air from one of said two air intakes, wherein only the first of said air intakes results in a flow of air over the particulate material discharged into said burning machine by said transporting and compacting means; whereby said particulate material is combined with the flow of air to form a desired/particulate material mixture and is controllably fed to the inlet of said combustion chamber within said particulate material burning machine, the improvement comprising:

an integrating control system means operable to coordinate the particulate material burning process, which includes a sonic sensor unit generating a signal to said control system in response to a selected level of discharged particulate material beneath said central opening whereby said integrating control system selectively operates said free-swinging, non-arching conveying screw to maintain said selected level of discharged particulate material beneath said central opening;

a first sensing means located within said burning machine to generate a signal to said integrating control system in response to a selected position of said valve means, whereby said integrating control system operates said screw transporting and compacting means;

a second sensing means located within said burning machine to generate a signal to said integrating control system in response to a second selected position of said valve means, whereby said integrating control system operates said blower means;

a system initiator-terminator means operable to selectively start and stop the particulate material burning process in a predetermined sequence in response to select parameters in accordance with the availability of particulate material; and

a combustion safety and pollution sensing means within said combustion chamber operable to monitor selected parameters relating to said combustion chamber and communicate abnormal conditions to said integrating control system, whereby said integrating control system will terminate the particulate material burning process.

7. In a waste product firing system as defined in claim 6, including an alternate fuel source means in communication with said combustion chamber and said integrating control system so that when a signal is received by said source from said system, a fuel will be directed to said combustion chamber to burn separately and in cooperation with the burning of said particulate material.

8. In a waste product firing system as defined in claim 6, including a weight-sensitive means located above said central opening in operable relationship thereto to monitor the presence of particulate material within said cylindrical storage container and communicate with said control system a signal representing the amount of particulate material within said storage container whereby said control system will initiate unloading of particulate material only when a sufficient amount of said particulate material is present within said storage container.

9. In a waste product firing system which includes: a particulate material storage container including a bottom wall with a central opening therein, a cylindrical side wall having annular restraining means attached thereto above said bottom wall, and a deflector means axially aligned with and in working relationship to said central opening, a radically free-sweeping, non-arching conveying screw means extending along said bottom wall from said central opening to said side wall of the storage container, a wheel means attached to an outer end of said conveying screw means adjacent to said side wall of the container in working relationship thereto for contacting said bottom wall and said restraining means, operable to maintain said conveying means at a substantially parallel distance above said bottom wall of the container and prevent said conveying screw means from ascending above said bottom wall of the container, an electromotive means connected to the conveying screw means operable to rotate said conveying means about its longitudinal axis, a discharge bin located beneath said central opening, a flexible compactor conveyor screw located along the bottom of said discharge bin mounted off-center within a partially opened-top cylindrical tube having a closed discharge portion wherein said particulate material is compacted, a particulate material burning machine comprised of a duct having an intake and discharge opening, said duct communicating with the discharge portion of said compactor conveyor screw at a point adjacent to said intake opening of said duct, a by-pass aperture located within said duct intermediate said discharge portion of said compactor conveyor screw and said discharge opening of said duct, a blower means having an intake connected to said duct discharge opening for selectively establishing a fast-flowing continuous stream of air through said duct via said intake opening and by-pass aperture to an exhaust of said blower, valve means positioned in the duct in operable relation to said by-pass aperture and intermediate said blower and said compactor conveyor discharge portion, said valve means being selectively movable from a first position of closed by-pass aperture and open-duct to a second position of closed-duct and open by-pass aperture and vice versa, and a combustion chamber attached to said blower means for receiving the exhaust of said blower, the improvement comprising:

an integrating control system means operable to coordinate the particulate material burning process, which includes a sonic sensor unit generating a signal to said control system in response to a selected level of discharged particulate material beneath said central opening whereby said integrating control system selectively operates said free-sweeping, non-arching conveying screw to maintain a selected level of discharged particulate material beneath said central opening;

a first sensing means located within said burning machine to generate a signal to said integrating control system in response to a selected position of said valve means, whereby said integrating control system operates said compactor conveyor screw;
a second sensing means located within said burning machine to generate a signal to said integrating control system in response to a second selected position of said valve means, whereby said integrating control system operates said blower means; a system initiator-terminator means operable to selectively start and stop the particulate material burning process in a predetermined sequence in response to select parameters in accordance with the availability of particulate material; and a combustion safety and pollution sensing means within said combustion chamber operable to monitor selected parameters relating to said combustion chamber and communicate abnormal conditions to said integrating control system, whereby said integrating control system will terminate the particulate material burning process.

10. In a waste product firing system as defined in claim 9, including an alternate fuel source controlled by said integrating control system and selectively directed to said combustion chamber to burn therein.

11. In a waste product firing system as defined in claim 9, including a weight-sensitive means located below said deflector means in operable relationship thereto to monitor the presence of particulate material within said cylindrical storage container and communicate with said control system a signal representing the amount of particulate material within said storage container whereby said control system will initiate unloading of particulate material only when a sufficient amount of said particulate material is present within said storage container.

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