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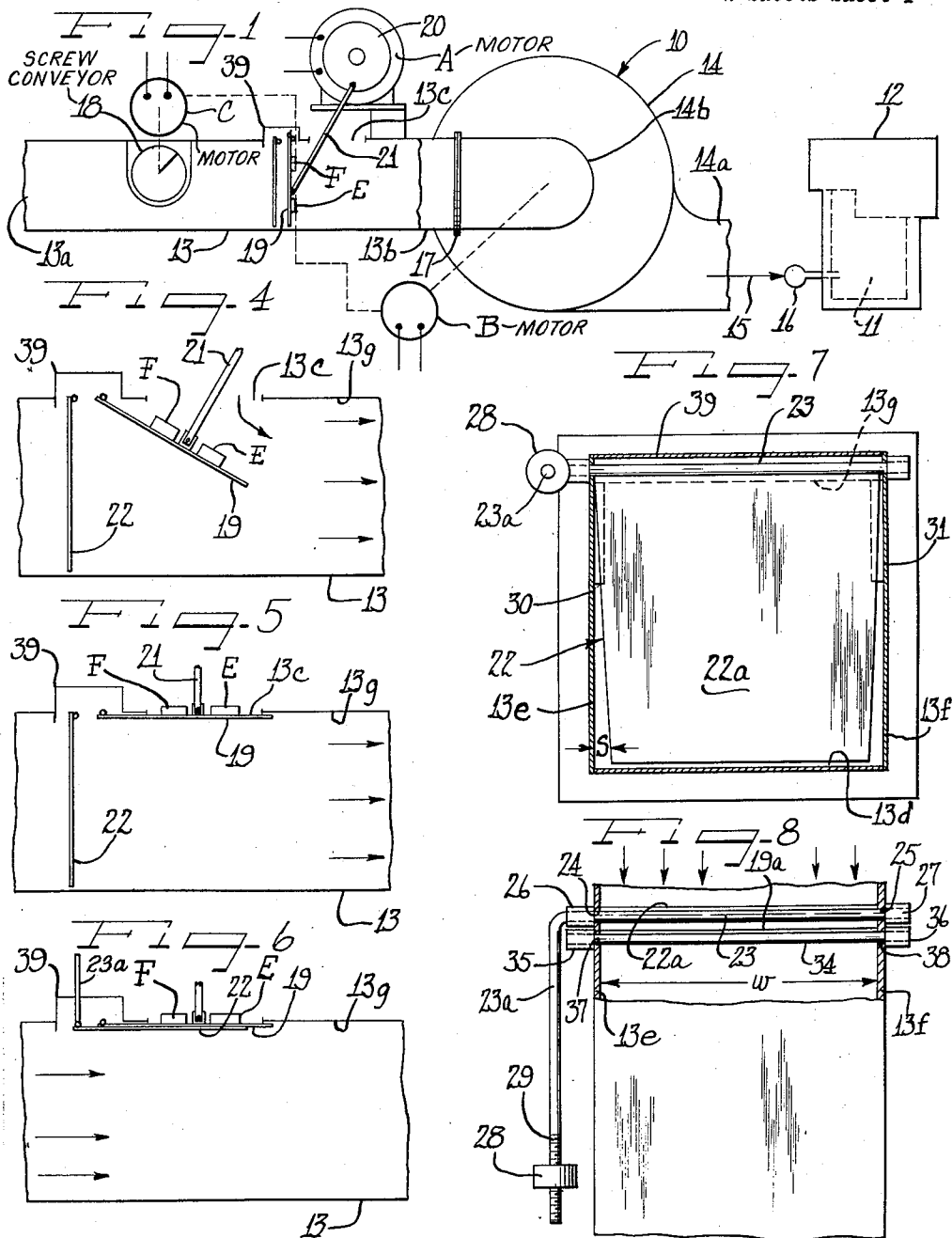
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2,912,943

MACHINE FOR HANDLING GAS-BORNE PARTICULATE MATERIAL

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2 Sheets-Sheet 1



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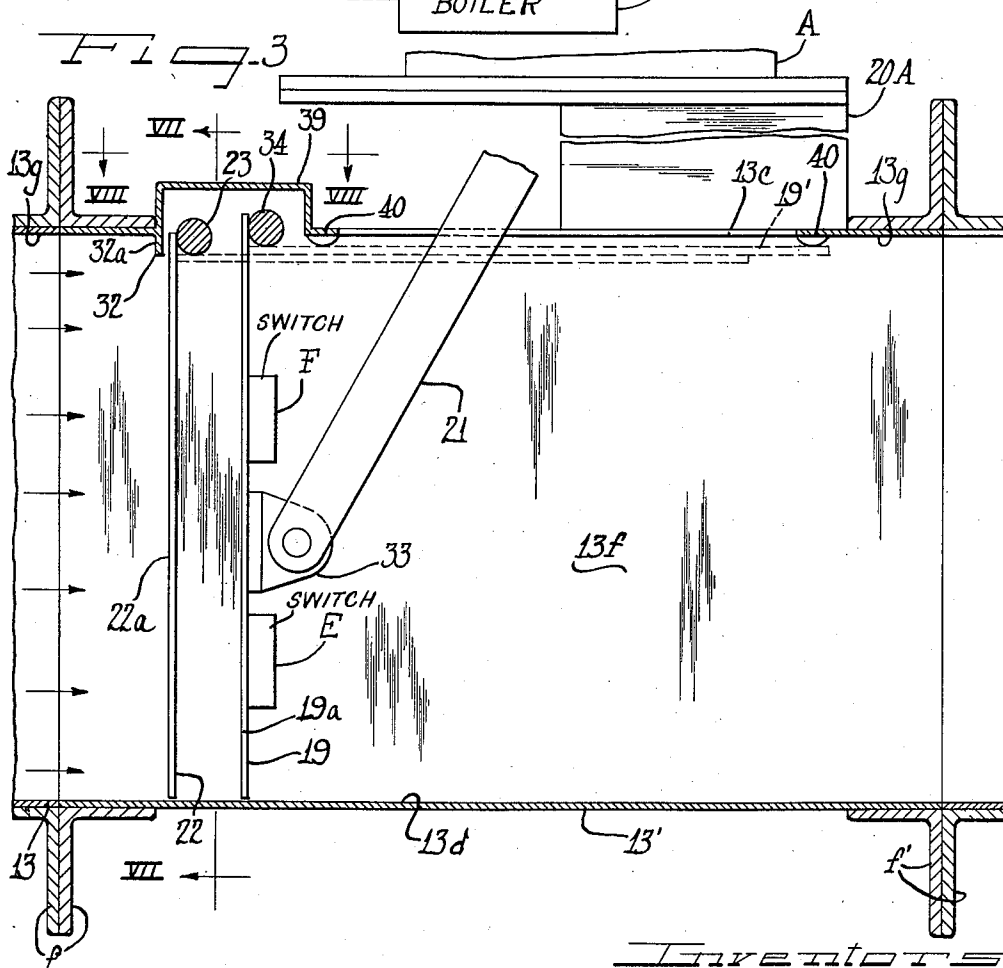
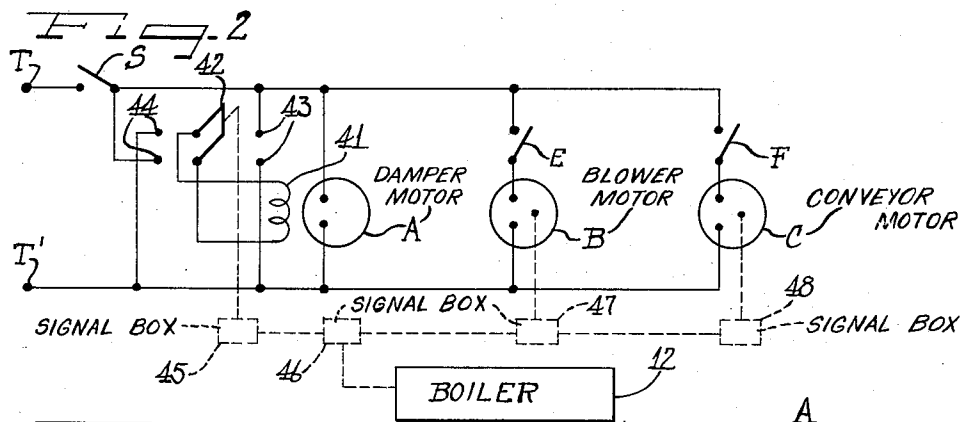
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MACHINE FOR HANDLING GAS-BORNE PARTICULATE MATERIAL

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5 Claims. (Cl. 110—104)

The instant invention relates to a machine for handling a gas-borne stream of particulate material, and more particularly, to a sawdust burning machine.

Although the machine of the instant invention may be used generally in the handling of particulate material in a fast flowing gas stream, and particularly in the handling of particulate combustible material in a combustion supporting gas stream, the instant machine is particularly suitable for use in the handling of air-borne sawdust in a sawdust burning machine, and for the most part the instant machine will be described in connection with this use. It should be pointed out, however, that the instant machine may also be used in the handling of other particulate material, combustible and non-combustible, such as asbestos fibers in insulating processes, powdered coal and various other particulate waste products. Because of certain unique safety features provided by the instant device in connection with machines involving combustion, the instant device is uniquely suitable for sawdust burning.

The burning of sawdust presents a number of difficult problems which have heretofore not been solved to the satisfaction of the workers in the art. In general, these problems spring from certain difficulties in the handling of sawdust per se, certain peculiarities in the flow of sawdust in streams of air, and a comparatively low combustion temperature for the burning sawdust, which requires rather close control of the air-sawdust ratio. Also, because the sawdust is conveyed to the combustion chamber in a stream of air, there is always a fire hazard present not only in connection with the operation of the combustion chamber per se but also in the operation of the air stream producing means and in the various ducts employed. Shutdown and startup of machines of this character afford further complications because of the possible fire hazard. Also, the collection of sawdust in "hidden" as well as openly exposed portions of the duct work surrounding the combustion chamber must be substantially avoided in order to minimize the fire hazard.

In spite of all these difficulties, a number of industries (and particularly the woodworking industries) produce such substantial quantities of particulate combustible waste material, particularly the vegetable waste materials, that it becomes an economic necessity to dispose of such waste material at the plant location whereat it is created. Costs of removing the waste material are generally prohibitive. Accordingly, there has developed in recent times a very great demand in industry for suitable disposal equipment, notwithstanding certain operational difficulties and hazards. It is because of such difficulties, however, that those skilled in the art have continuously sought to improve devices of this type. Prior to the instant invention, the operation of these devices left much to be desired in certain safety respects particularly.

One of the most difficult features of devices of this type are the flow control structures. Careful control of

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the flow of the air-borne sawdust is necessary; and this involves continuous flow of sawdust and air in the specified ratios. Also, valve devices and the like tend to clog up with sawdust particles so as to hamper the operation of the valves and also to upset the air-sawdust ratio. In particular, the instant invention provides an improved valving arrangement which not only avoids these difficulties but also is interconnected with the other operating features of the device so as to provide safe and automatic control during startup, shutdown and continuous operation. Also, the instant valving arrangement affords the unique method for purging or cleaning out the system during shutdown to remove all sawdust particles from the duct work.

It is, therefore, an important object of the instant invention to provide an improved device for the handling of gas-borne particulate material.

Another object of the instant invention is to provide a sawdust burning machine comprising a burning chamber, a duct having an air inlet, a discharge and a by-pass aperture intermediate the intake and discharge, a blower having its exhaust connected to the burning chamber and its intake connected to the duct discharge for normally forcing a fast flowing stream of air from the duct inlet to the burning chamber, a conveyor feeding sawdust into the air stream in the duct adjacent the duct inlet, and valve means in the duct intermediate the blower and the conveyor, said valve means being selectively movable from a first position of closed-aperture-and-open-duct to a second position of closed-duct-and-open-aperture and vice versa.

Other objects, features and advantages of the present invention will become apparent to those skilled in the art from the following detailed disclosure of a preferred embodiment thereof and the attached drawings which are made a part hereof.

On the drawings:

Figure 1 is an elevational view of the device embodying the instant invention with parts shown diagrammatically and parts broken away.

Figure 2 is a wiring diagram showing the wiring arrangement for the actuating means or motors shown in Figure 1;

Figure 3 is a detailed sectional elevational view of the valve structure shown in Figure 1 in the instant device;

Figure 4 is essentially a diagrammatical view of the valve structure of Figure 3 shown in a "first position" in the movement of the valve during startup;

Figure 5 is a diagrammatical view similar to Figure 4, showing the valve in the "second position" during startup operation.

Figure 6 is a view similar to Figure 4 and 5 showing the valve in the "final position" for the startup operation;

Figure 7 is a view taken substantially along the line VII—VII of Figure 3; and

Figure 8 is a top plan view taken substantially along the line VIII—VIII of Figure 3, with parts removed for the purpose of simplification.

As shown on the drawings:

In Figure 1, a sawdust burning machine, indicated generally by the reference numeral 10 is shown comprising a burning chamber 11 in the form of a boiler firebox with an overhead boiler 12, here shown diagrammatically. The sawdust burning machine 10 comprises a duct 13, which is a sheet metal conduit of generally rectangular cross-section, provided with an air intake or inlet at 13a, an air discharge at 13b and a by-pass aperture at 13c intermediate the intake 13a and the discharge 13b. A blower 14 actuated by an electric motor, indicated diagrammatically at B, which is controlled by the switch at E, has its exhaust 14a connected to the

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burning chamber 11, as indicated diagrammatically by the arrow 15 leading to the manifold 16 feeding into the burning chamber 11; and the blower 14 has its intake 14b connected to the duct discharge 13b at the flange 17. The blower draws air into the duct 13 normally through the inlet 13a and maintains a fast flowing stream of air in the duct 13 at sub-atmospheric pressure up to the blower intake 14b. In the blower, the fast flowing stream of air plus the sawdust or other particulate material is intimately mixed and the pressure in the stream is increased to super-atmospheric pressure and the stream is forced out the blower discharge 14a. A screw conveyor shown diagrammatically at 18 feeds sawdust into the air stream in the duct 13 adjacent the duct inlet 13a, and the sawdust fed into the air stream in the duct 13 is borne in the stream through the rest of the device 10. The conveyor 18 is actuated by an electric motor shown diagrammatically at C which in turn is controlled by a switch shown at F. The details of the operation involving the switches E and F will be described hereinafter.

The machine 10 is also provided with valve means 19, in the form of a damper, in the duct 13 intermediate the blower 14 and the conveyor 18. The damper valve 19 in the duct 13 is selectively movable from a first position, shown in dotted lines at 19' in Figure 3, which is a closed-aperture 13c and open-duct 13 position to a second position, shown in the full view of the valve 19 in Figure 3, which is a closed-duct 13 and open-aperture 13c position. The damper 19 is moved from the first position to the second position, and vice versa, by the electric motor shown at A in Figure 1, which has a selectively rotatable member 20 pivotally connected to an arm 21 which in turn is pivotally connected to the central portion of the damper 19. The rotatable member 20 is rotated and in carrying the arm 21 therewith it effectively moves the damper 19 from the second to the first position, and vice versa.

It will be appreciated that one of the functions of the damper 19 is to selectively close off the duct 13 and bypass air to the blower inlet 14b through the by-pass aperture 13c. It will be seen that a second damper valve 22 is also mounted in the duct 13. The damper valve 22 is swingably hung from the top of the duct 13 in much the same manner that the first damper valve 19 is mounted. Referring to the second damper valve 22 in detail, it will be noted that the valve 22 comprises a generally flat member 22a (Figures 3, 7 and 8) of substantially the width w of the duct 13 near the top of the flat member 22a and tapering slightly inwardly toward the bottom of the flat member 22a so as to effect a slight but uniform increase toward the duct bottom 13d in the space s (Figure 7) between the duct side walls 13e and 13f and the outer edges of the flat member 22a. There is, of course, at least some clearance between the flat member 22a and the duct walls at all points, but the clearance increases slightly as the flat member 22a is tapered downwardly. The taper is exaggerated in Figure 7. Actually, the clearance between the flat member 22a and the side walls 13e and 13f of the duct 13 is increased from minimum clearance at the top to a maximum clearance s at the bottom, s being about 0.5% to about 2% of the width w , and preferably about 1%. The reason for the uniformly increased clearance between the member 22a and the side walls 13e and 13f is that it has been found that sawdust particles will tend to collect between the duct walls and a damper member if the clearance is maintained at a minimum throughout the length of the damper, or if substantially the same (relatively small) clearance is maintained throughout the length of the damper member. The tapering of the damper member 22a is thus important to facilitate free movement thereof and the slightly increased clearance near the bottom does not actually hamper the operation of the damper, since only a small amount of air can slip by. The valve 19 is

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also provided with a flat member 19a which is formed in substantially the same manner as the flat member 22a with respect to clearance. The flat member 22a of the second damper 22 is secured at its top to a pivot rod 23 by means of a weld or any other suitable means and the pivot rod 23 extends through apertures 24 and 25 in the side walls 13e and 13f, respectively, of the duct 13. Axial movement of the rod 23 is prevented by lock nuts 26 and 27, respectively, which are secured to the rod 23 just outside the apertures 24 and 25, respectively. The rod 23 with the lock nuts 26 and 27 thereon may rotate freely in the apertures 24 and 25 which serve to define a "dry" bearing structure. No oil or similar lubrication is used in the apertures 24 and 25, because any accumulation of oil along the walls of the duct will serve to collect sawdust and substantially defeat the operation of the instant device. The rod 23 has an arm extension 23a which forms substantially a right angle with the rod proper 23 and which extends substantially normal to the plane of the flat member 22a. The extension 23a is adjustably weighted, for example, by a threaded weight 28 which may move axially of the extension 23a on the threads indicated at 29.

As is apparent from Figures 7 and 8, the weighted arm 23a for the damper 22 urges the damper member 22a in a clockwise direction opposite to the direction of stream flow indicated by the arrows in Figure 8. Suitable stop means in the form of side flange members 30 and 31 welded or otherwise secured to the inside surfaces of the side walls 13e and 13f of the duct serve to stop the clockwise movement of the flat member 22a at substantially a vertical position for the flat member 22a, which is the position in which it closes the duct 13. A top stop member 32 (Figure 3) may also be provided in lieu of the side members 30 and 31 or to operate in conjunction therewith. In any case, the stop members 30, 31 and 32 project only slight distances inwardly from the duct walls to which they are secured and the stop members 30, 31 and 32 extend outwardly from the duct walls on which they are mounted so as to avoid forming a sawdust particle trap on the upstream side (32a in Figure 3) of such stop members.

As will be appreciated, no stop members are provided for the first damper valve 19, because the movement of this valve is controlled by the motor A which is directly connected to the flat damper member 19a via the bracket 33 secured to the back central portion of the flat member 19a and pivotally connected to the arm 21 which in turn is pivotally connected to the rotary member 20 mounted by the motor A. The flat damper member 19a, however, has substantially the same cross-section as the duct 13 (and the flat member 22a) and in like manner, it is secured to a pivot rod 34 also provided with lock nuts 35 and 36 at opposite ends thereof to prevent axial movement and also mounted in "dry" bearings provided by the apertures 37 and 38 in the side walls 13e and 13f, respectively. An important feature of the mounting of the dampers 19 and 22 resides in the particular mounting of the pivot rods 23 and 34. The duct 13 is provided with a generally level flat top 13g (continued as 13g' in the center portion 13' secured by flanges ff and f'f' in Figure 3) which is broken by a slightly recessed portion 39 extending upwardly from the top 13g. The recessed portion 39 is in the form of an elevated housing which extends upwardly from the top 13g a distance substantially equal to the diameters of the pivot rods 23 and 34 the full width w of the duct 13. The recessed housing 39 carries the pivot rods 23 and 34 so that the pivot rods 23 and 34 and the top portions of the damper members 22a and 19a will not be exposed to the stream of airborne sawdust flowing in the duct 13. The pivot rods 23 and 34 are thus raised slightly above the effective top level of the airborne stream of sawdust and the collection of sawdust particles thereon is thus substantially avoided.

Referring now to the operation of the instant valve

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means 19 and 22, Figures 1 and 3 show the valve arrangement 19-22 in "shut down" position. At startup, the motor A (mounted on a rack 20A on the center duct portion 13') is actuated and movement of the rotary member 20 (which is geared down for extremely slow movement) carrying the linking arm 21 causes the damper 19 to start swinging upwardly, into the position shown in Figure 4. In the intermediate position shown in Figure 4, the amount of air being by-passed to the blower intake 14b through the by-pass aperture 13c is such that the draft in the duct 13 is insufficient to counteract the effect of the weighted arm 23a upon the damper 22. The first damper 19 continues to move upwardly until it reaches the position indicated in Figure 5, whereat the damper member 19 effectively closes the by-pass aperture 13c. In the detailed view of Figure 3, it will be noted that the aperture 13c is provided with a ridge of rubber or other resilient material 40 which engages the damper 19 and effectively seals off the aperture 13c. Once the aperture 13c is closed off the vacuum drawn by the blower 14 in the duct 13 is sufficient to lift the weighted damper 22, as shown in Figure 6. The position of the weight 28 on the arm 23a may be adjusted so as to permit the damper 22 to be lifted completely up against the damper 19, as shown in Figure 6, or the weight may be adjusted so as to cause the damper 22 to be lifted only partially during operation. The damper 22 thus weighted serves as an additional flow control member, if such is desired.

In its function as a safety valve, the damper 22 will, of course, close immediately if the blower fails. In contrast, the slowly geared rotary member 20 moves the damper valve 19 rather slowly. If the blower 14 shuts down completely during operation, it will be appreciated that substantially all movement of sawdust in the duct 13 will stop; but if the blower 14 fails only partially for one reason or another, to the extent that the blower only slows down, the operator might be unable to detect this failure and the air sawdust ratio would be distinctly altered. The damper 22, however, would serve to substantially cut off the sawdust intake into the blower 14 and thus avoid a possible fire hazard.

Another important function of the damper 22 is in the initial phases of the shut down of the device. When the device is to be shut down, the motor A is again actuated, this time in the reverse direction, so as to start the valve 19 downwardly and to reopen the by-pass aperture 13c. As quickly as the by-pass aperture 13c opens, the force of the draft holding the damper 22 up is lost and the damper 22 slams shut very quickly, thus permitting the purging air to enter the aperture 13c and flush the remaining sawdust particles out of the system without having additional sawdust particles entering the system past the damper 22.

Another feature of the instant invention resides in the "automatic" startup which is provided by certain actuating means associated with the damper 19. Referring briefly to the wiring diagram of Figure 2, it will be noted that the motor A which operates the damper 19 is connected to terminals T and T' arranged for connection to a suitable source of electricity such as 60 cycle, 110-120 volt single phase supply line, and the switch S will control the supply of electricity to the motor A. Since the motor A has two distinct movements or functions, namely, that of moving the damper 19 from the first position to the second position (hereinbefore described) and that of moving the valve 19 from the second position to the first position, suitable control means are provided for selectively actuating the motor A in the manner desired. Such control means may be in a number of forms, all of which may be readily constructed by those skilled in the art. One form, as here shown, involves the use of a reversible field 41 which permits actuation of the motor A in a "forward" direction when the switch 42 is closed across the terminals 43, 43 and which permits

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"reverse" actuation of the motor A when the switch 42 is closed across the terminals 44, 44. The movement of the switch 42 may, of course, be manual, but preferably this is automatically controlled by timing mechanism or the like (not shown) which will reverse the switch 42 as soon as the motor A has completed the movement of the damper 19 from the first position to the second position or vice versa. When the motor A is put on automatic operation, the switch S is closed and the switch 42 is actuated automatically so as to selectively move from "forward" to "off" or to "reverse" as desired. The details of the mechanism required for this operation are well within the skill of the art and need not be further described herein; but it will be noted that Figure 2 shows diagrammatically a control box 45 which effects the selective movement of the switch 42 and which is actuated in response to signals from a control box 46 connected to the boiler 12 (or some other operating device associated with the combustion chamber) which may serve to shut down the machine if the boiler temperature goes above a certain maximum. The signal box 45 is also connected to a signal unit 47 which serves to shut the unit down if the blower actuating motor B fails; and the control box 45 is also connected to a signal box 48 which will serve to shut the unit down if the conveyor actuating motor C fails. The various devices 45, 46, 47 and 48 are shown only diagrammatically to indicate the nature of the control of the operation of the damper 19.

It will be noted from the wiring diagram of Figure 2 that the switch E controls the actuation of the motor B and the switch F controls the actuation of the motor C. In order to take maximum advantage of the automatic operation of the instant device, the switches E and F are mercoird switches which are mounted on the damper 19 and are responsive to movement of the damper 19. As is well known, the mercoird switch is adapted to open and close the circuit in response to tilting movement of the switch itself (which comprises electrical leads and a pool of mercury which is movable in and out of contact with the leads). In the instant device, the switches E and F are secured to the back of the damper 19 and moved therewith. During startup, the damper 19 is moved from the position shown in Figures 1 and 3 to an initial position shown in Figure 4. At approximately the position shown in Figure 4, the switch E is actuated and the blower actuating motor B starts the blower 14. As the damper 19 continues to move upwardly almost to the point of completely closing the aperture 13c the switch F is closed and the conveyor motor C starts. At almost this same instant, the blower effectively lifts the check damper 22 and pickup of the sawdust fed by the conveyor 18 is commenced. It will thus be seen that the entire startup of the system is made automatically once the motor A is started, for example, by closing the switch S. The control box 45 may then be put in service and using a suitable thermo-responsive device to control the signal box 46, the unit may automatically start up and shut down in response to, for example, the boiler temperature. During shutdown, the initial movement involves opening the by-pass aperture 13c by movement of the damper 19. This results in an immediate shutdown of the conveyor 18 and an effective closing-off of the sawdust intake by closing the damper 22. During the remaining timed movement of the damper 19 downwardly to approximately the position shown in Fig. 4, the blower 14 purges the system and removes substantially all sawdust particles therein. Then the blower is shut down through opening of the switch E on the damper 19 and the entire unit is shut down.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

We claim as our invention:

1. In a machine for handling a gas-borne stream of particulate material, in combination, a duct, feed means

introducing particulate material into said duct, blower means drawing a gas-borne stream of particulate material through said duct downstream of said feed means, means defining an aperture to ambient atmosphere in said duct intermediate said blower means and said feed means, damper valve means swingably hung at the top of the duct adjacent the aperture, first switch means carried by the damper in control of actuation of the blower means and responsive to movement of the damper, second switch means carried by the damper in control of actuation of the feed means and responsive to movement of the damper, and valve actuating means selectively moving the damper from a first position of closed-aperture-and-open-duct to a second position of closed-duct-and-open aperture and vice versa, said first switch means functioning to start said blower when said damper has been moved to an intermediate position part way toward the first position and functioning to stop said blower when the damper has been moved from said intermediate position toward said second position, and said second switch means functioning to actuate the feed means when said damper has been moved toward said first position to a near closed position and functioning to deactivate said feed means when said damper has been moved from said last recited position toward said second position.

2. In a sawdust burning machine, in combination, a burning chamber, a duct having an air inlet, a discharge and a by-pass aperture intermediate the intake and discharge, a blower having its exhaust connected to the burning chamber and its intake connected to the duct discharge for normally forcing a fast flowing stream of air from the duct inlet to the burning chamber, a conveyor feeding sawdust into the air stream in the duct adjacent the duct inlet, valve means in the duct intermediate the blower and the conveyor, said valve means being selectively movable from a first position of closed-aperture-and-open-duct to a second position of closed duct-and-open-aperture and vice versa, blower actuating means responsive to the movement of said valve means, whereby movement of said valve means to an intermediate position part way toward said first position starts the blower and movement of said valve means from said intermediate position toward said second position stops the blower, conveyor actuating means responsive to the movement of said valve means, whereby movement of said valve means toward said first position to a near closed position starts the conveyor and movement of said valve means from said last recited position toward said second position stops the conveyor and valve actuating means responsive to the temperature in the burning chamber whereby a predetermined increase in said temperature may move said valve means away from said first position and a predetermined decrease in the temperature may move said valve means toward said first position.

3. In a sawdust burning machine, in combination, a burning chamber, a duct having an air inlet, a discharge and a by-pass aperture intermediate the intake and discharge, a blower having its exhaust connected to the burning chamber and its intake connected to the duct discharge for normally forcing a fast flowing stream of air from the duct inlet to the burning chamber, a conveyor feeding sawdust into the air stream in the duct adjacent the duct inlet, valve means in the duct intermediate the blower and the conveyor, said valve means being selectively movable from a first position of closed-aperture-and-open-duct to a second position of closed-duct-and-open-aper-

ture and vice versa, conveyor actuating means responsive to the movement of said valve means, whereby movement of said valve means to an intermediate position part way toward said first position starts said conveyor and movement of said valve means from said intermediate position toward said second position stops said conveyor and valve actuating means responsive to the temperature in the burning chamber, whereby a predetermined increase in the temperature may result in movement of said valve means away from said first position and a predetermined decrease in temperature may result in movement of said valve means toward said first position.

4. In a sawdust burning machine, in combination, a burning chamber, a duct having an air inlet, a discharge and a by-pass aperture intermediate the intake and discharge, a blower having its exhaust connected to the burning chamber and its intake connected to the duct discharge for normally forcing a fast flowing stream of air from the duct inlet to the burning chamber, a conveyor feeding sawdust into the air stream in the duct adjacent the duct inlet, valve means in the duct intermediate the blower and the conveyor, said valve means being selectively movable from a first position of closed-aperture-and-open-duct to a second position of closed-duct-and-open-aperture and vice versa, and valve actuating means responsive to the temperature in the burning chamber, whereby a predetermined increase in the temperature may result in movement of said valve means to an intermediate position part way away from said first position and a predetermined decrease in the temperature may result in movement of said valve means from said intermediate position toward said first position.

5. In a sawdust burning machine, in combination, a burning chamber, a duct having an air inlet, a discharge and a by-pass aperture intermediate the intake and discharge, a blower having its exhaust connected to the burning chamber and its intake connected to the duct discharge for normally forcing a fast flowing stream of air from the duct inlet to the burning chamber, a conveyor feeding sawdust into the air stream in the duct adjacent the duct inlet, valve means in the duct intermediate the blower and the conveyor, said valve means being selectively movable from a first position of closed-aperture-and-open-duct to a second position of closed-duct-and-open-aperture and vice versa, blower actuating means responsive to the movement of said valve means, whereby movement of said valve means to an intermediate position part way toward said first position starts the blower and movement of said valve means from said intermediate position toward said second position stops the blower and valve actuating means responsive to the temperature in the burning chamber, whereby a predetermined increase in the temperature may result in movement of said valve means away from said first position and a predetermined decrease in the temperature may result in movement of said valve means toward said first position.

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