Aug. 24, 1943. DE LOS E. HIBNER ET AL 2,327,524

AUTOMATIC SOOT BLOWER SYSTEM

Filed April 17, 1940 9 Sheets-Sheet 1

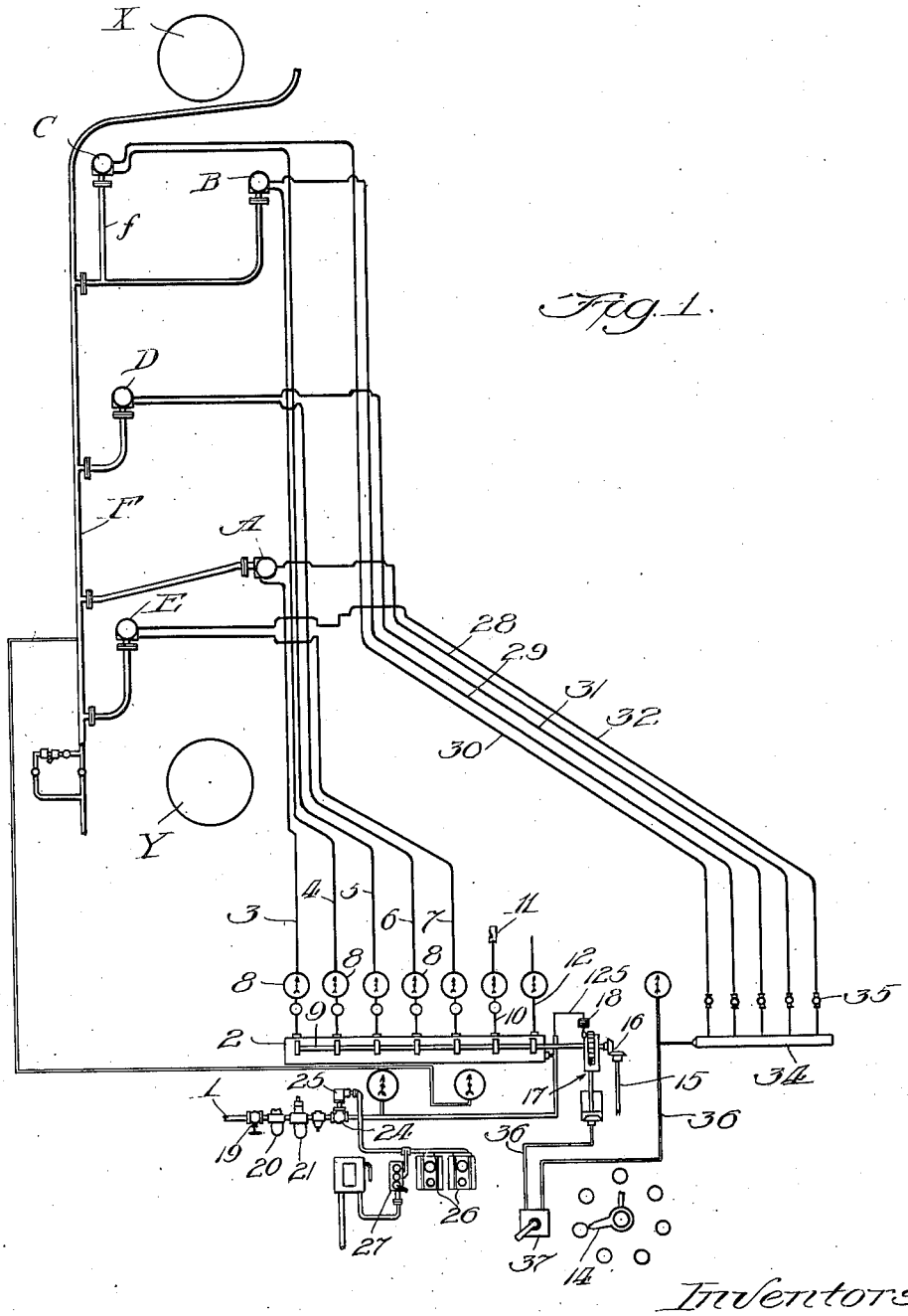


Fig. 1.

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Aug. 24, 1943. DE LOS E. HIBNER ET AL 2,327,524

AUTOMATIC SOOT BLOWER SYSTEM

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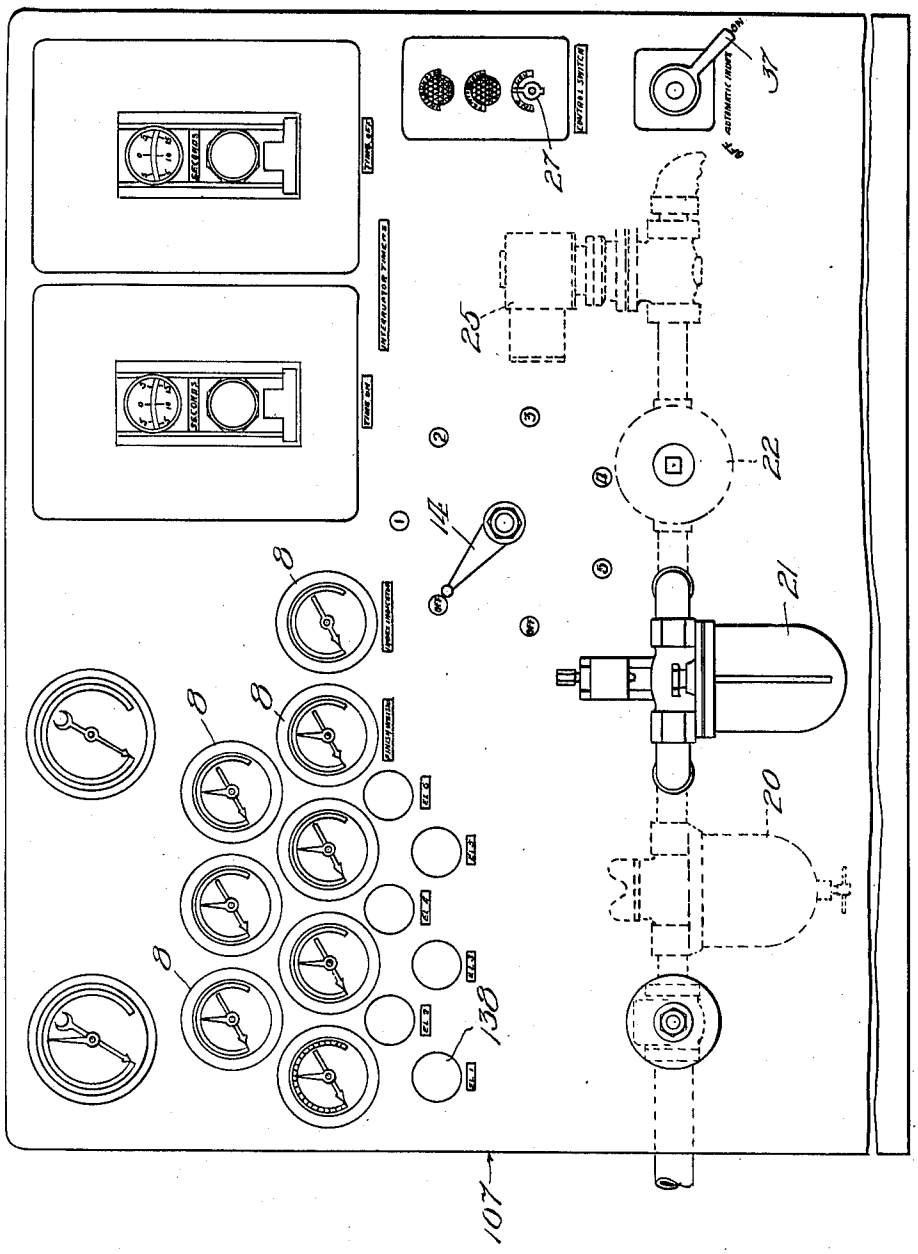


Fig. 2.

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Aug. 24, 1943. DE LOS E. HIBNER ET AL 2,327,524

AUTOMATIC SOOT BLOWER SYSTEM

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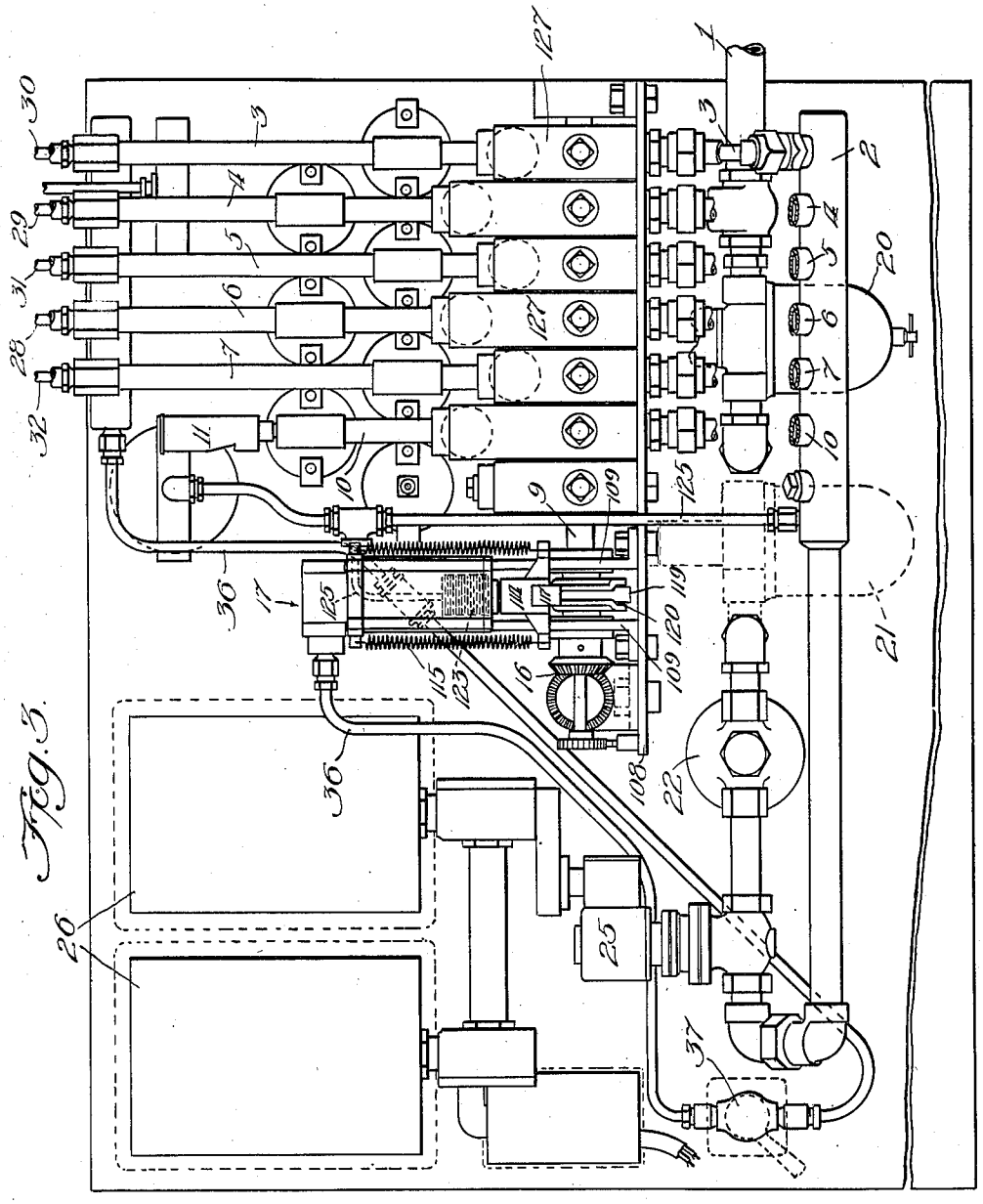


Fig. 3.

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Aug. 24, 1943. DE LOS E. HIBNER ET AL 2,327,524

AUTOMATIC SOOT BLOWER SYSTEM

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Fig. 4.

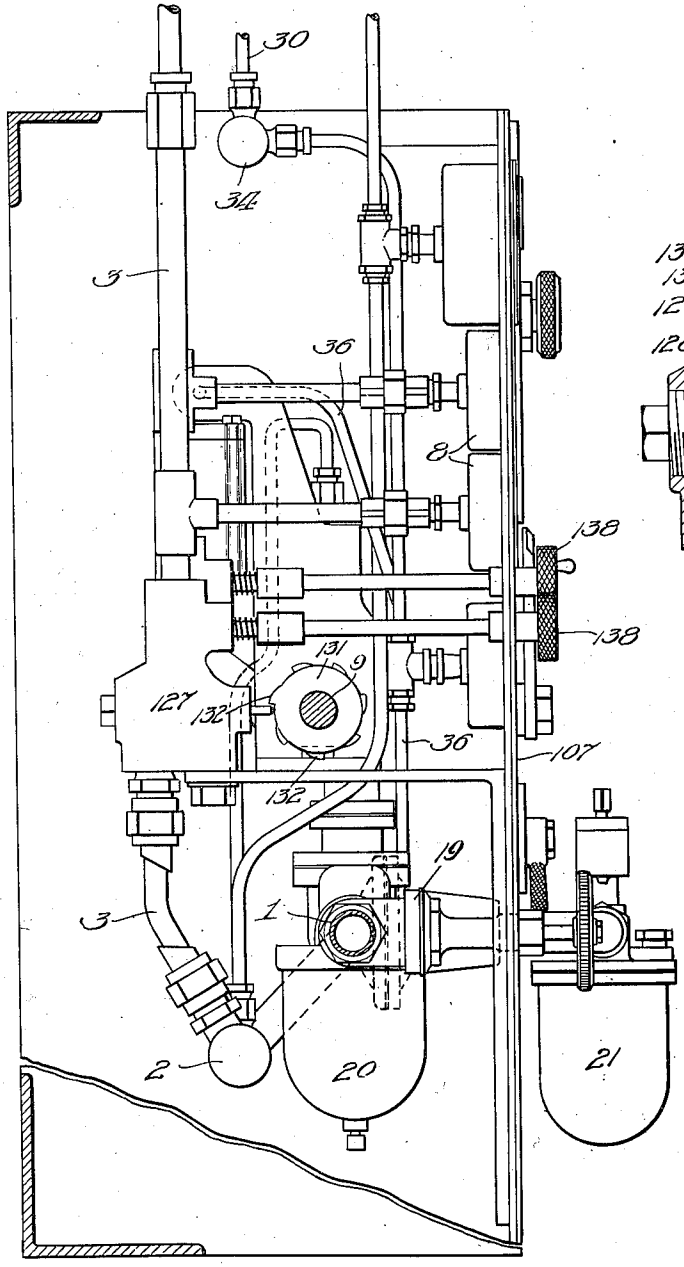
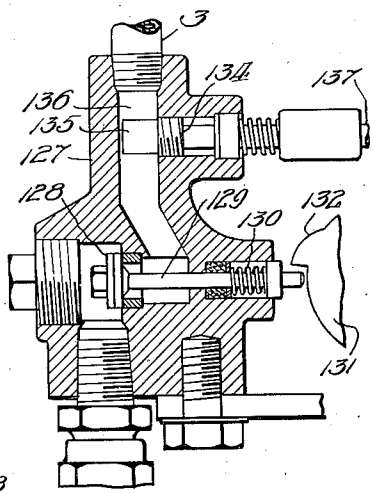


Fig. 5.

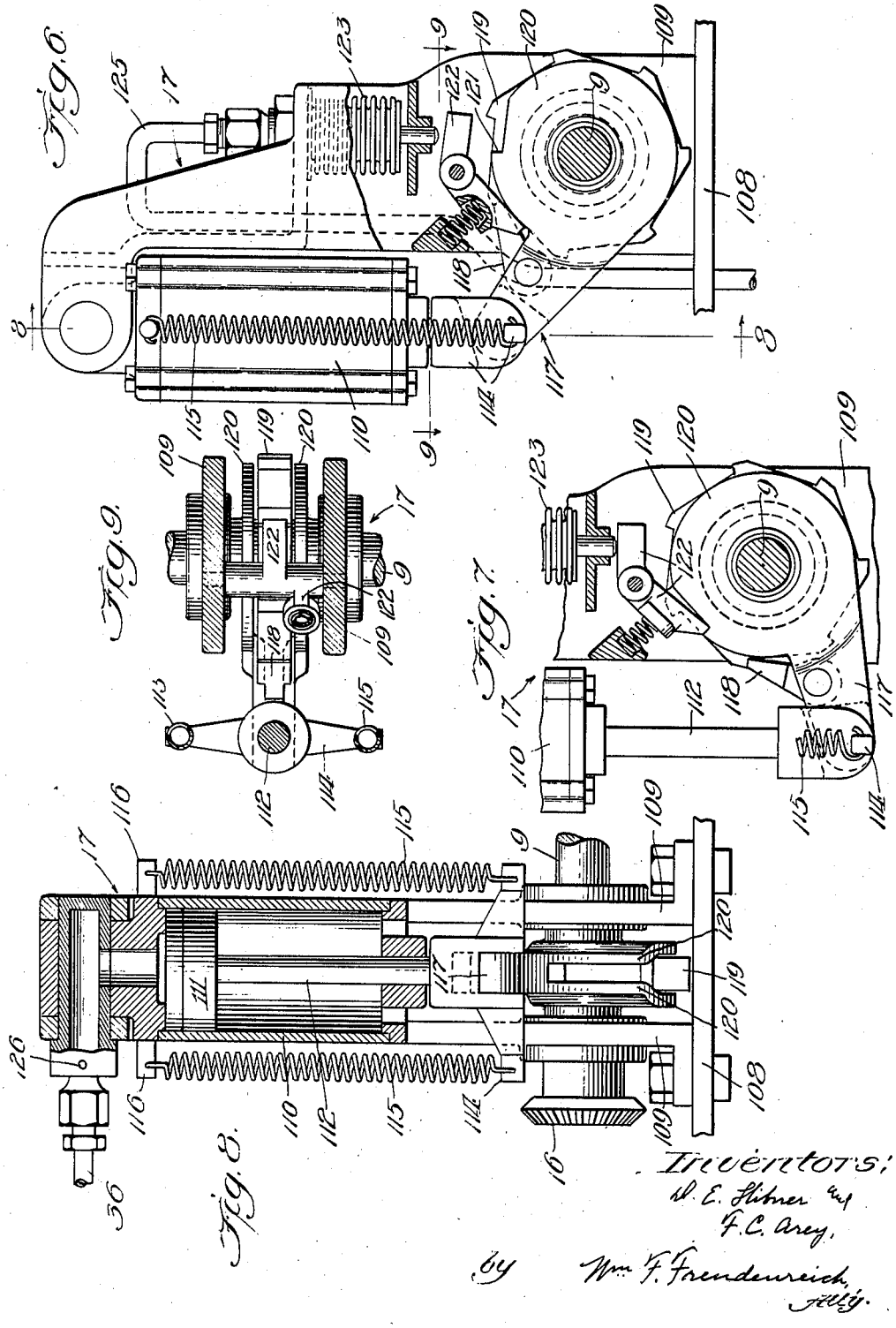


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AUTOMATIC SOOT BLOWER SYSTEM

Filed April 17, 1940 9 Sheets-Sheet 5



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AUTOMATIC SOOT BLOWER SYSTEM

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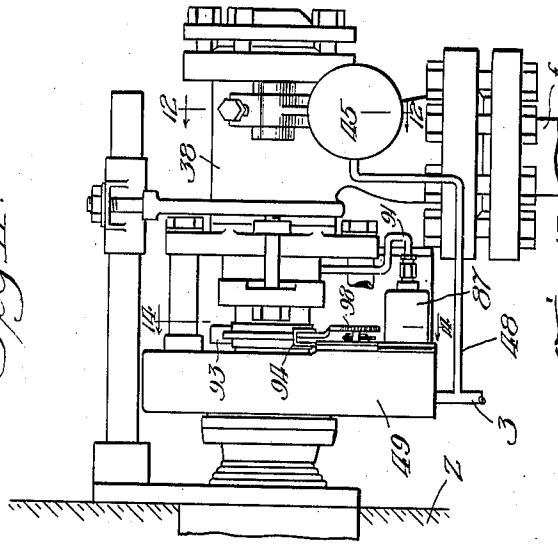


Fig. 11.

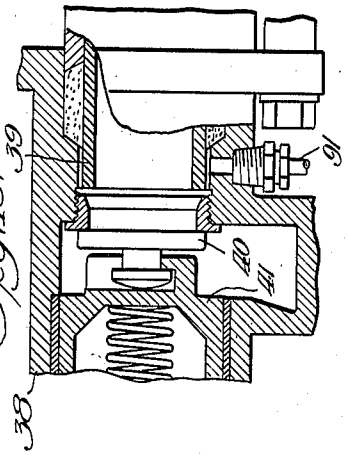


Fig. 13.

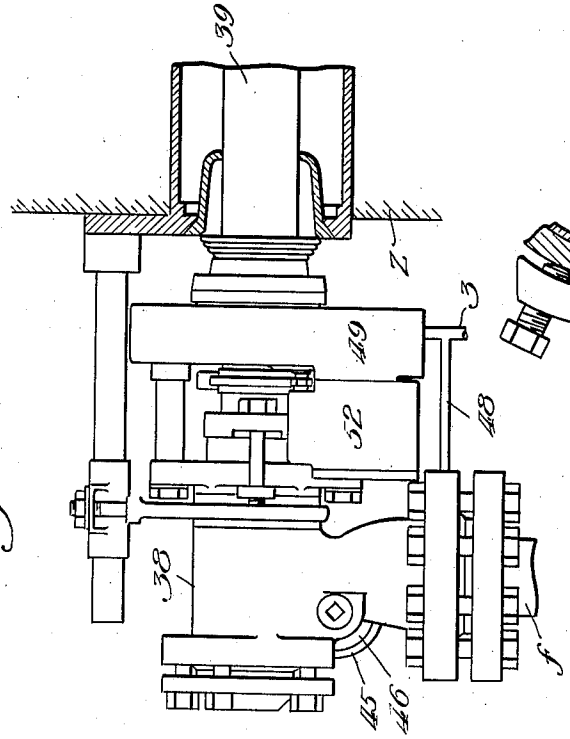


Fig. 10.

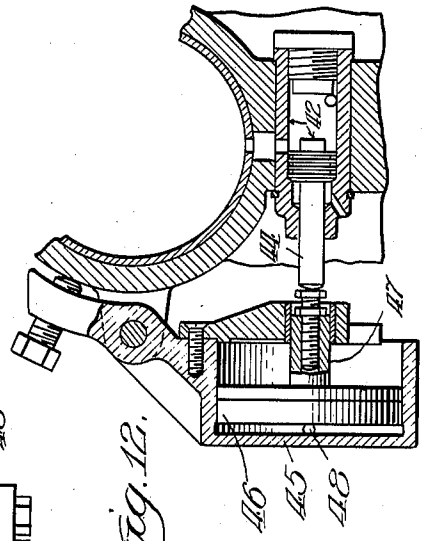


Fig. 12.

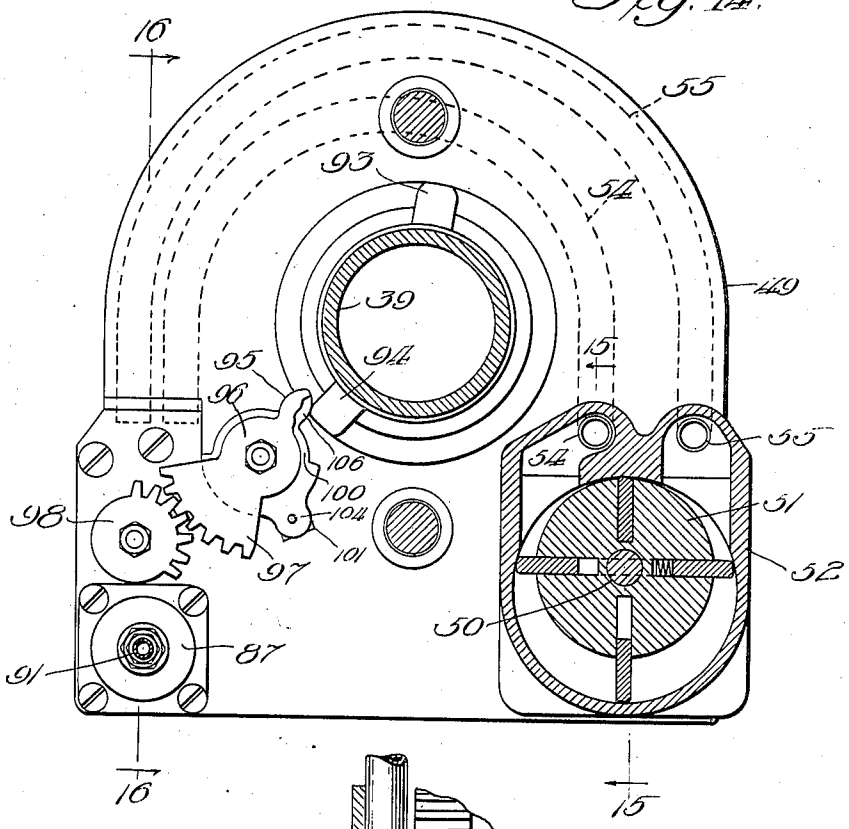
Inventors:
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Aug. 24, 1943. DE LOS E. HIBNER ET AL 2,327,524

AUTOMATIC SOOT BLOWER SYSTEM

Filed April 17, 1940 9 Sheets-Sheet 7

Fig. 14.



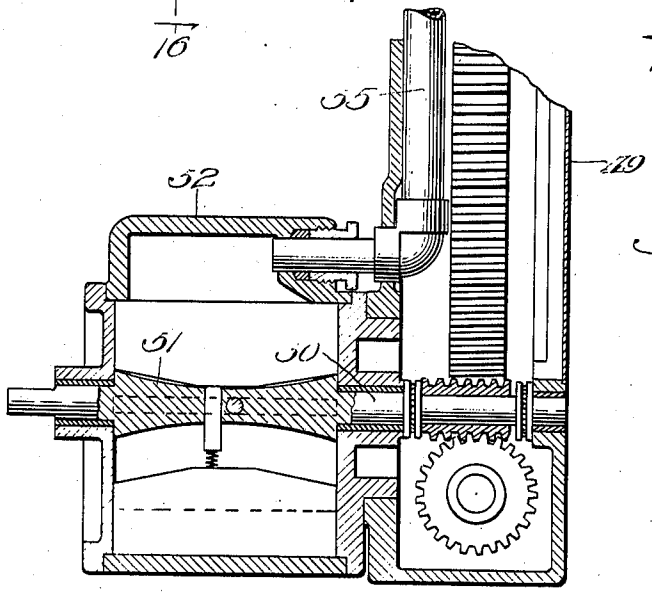


Fig. 15.

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Aug. 24, 1943. DE LOS E. HIBNER ET AL 2,327,524

AUTOMATIC SOOT BLOWER SYSTEM

Filed April 17, 1940 9 Sheets-Sheet 8

Fig. 16.

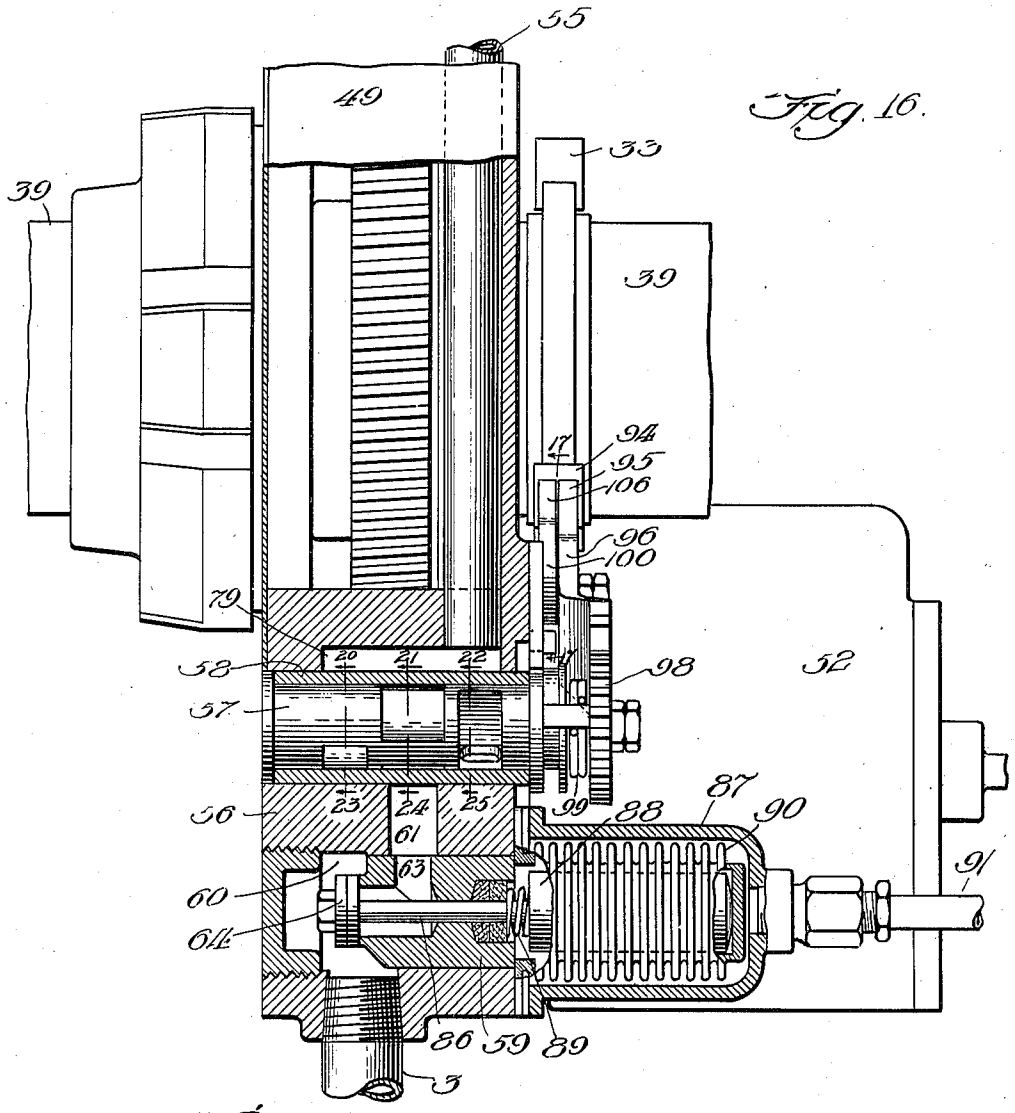
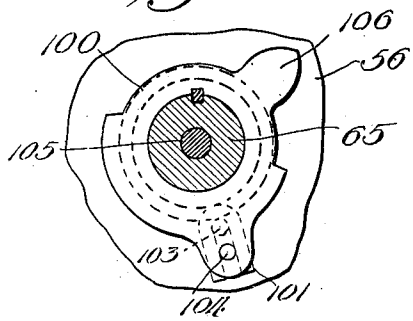


Fig. 17.



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AUTOMATIC SOOT BLOWER SYSTEM

Filed April 17, 1940 9 Sheets-Sheet 9

Fig. 18.

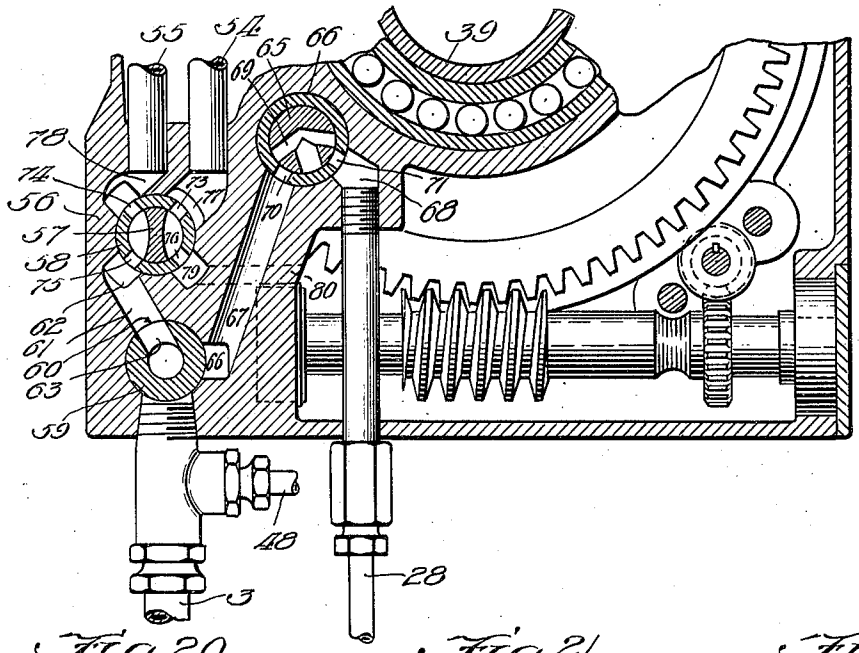


Fig. 20.

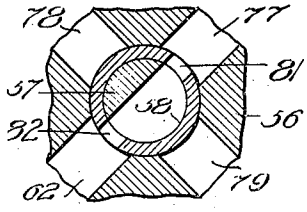


Fig. 21.

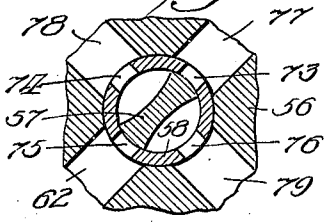


Fig. 22.

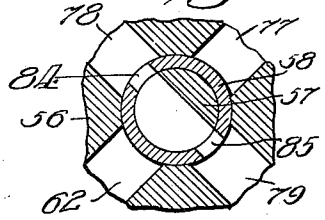


Fig. 23.

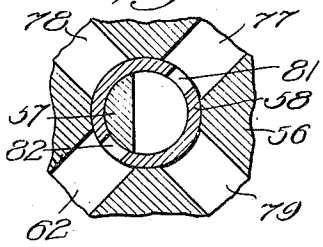


Fig. 24.

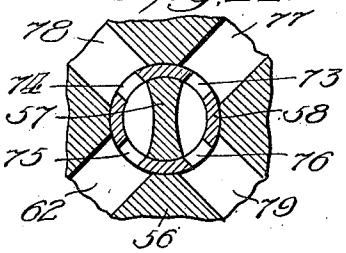


Fig. 25.

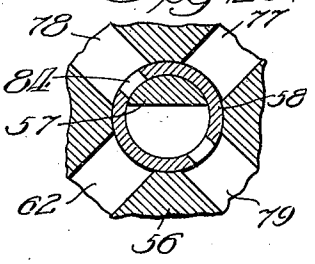
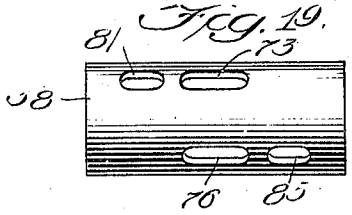


Fig. 19.



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Patented Aug. 24, 1943

2,327,524

UNITED STATES PATENT OFFICE

2,327,524

AUTOMATIC SOOT BLOWER SYSTEM

De los E. Hibner, Du Bois, and Fred C. Arey, Freeport, Pa., assignors to Vulcan Soot Blower Corporation, a corporation of Pennsylvania

Application April 17, 1940, Serial No. 330,124

4 Claims. (Cl. 122—392)

It is common practice to employ a number of soot blowing units in connection with large steam generating boilers, each unit being operated, when desired, by hand or by power. The object of the present invention is to produce a simple and novel system for automatically operating a number of such boiler units in succession.

Soot blowing units commonly include jetting elements extending transversely of the tubes in the boilers, the jets in some types of apparatus operating continuously in each unit throughout the operating cycle thereof, whereas, in other instances, the jetting is intermittent. One of the objects of the present invention is to make it possible easily and conveniently to convert the operation of a blowing unit from the continuous jetting type to the intermittent type and back again, through the mere act of manipulating a suitable controlling handle or other element.

Viewed in one of its aspects, the present invention may be said to have for its object to produce a simple and novel pneumatic controlling and operating system for a series of soot blower units.

The various features of novelty whereby our invention is characterized will hereinafter be pointed out with particularity in the claims; but, for a full understanding of our invention and of its objects and advantages, reference may be had to the following detailed description taken in connection with the accompanying drawings, wherein:

Figure 1 is a diagrammatic illustration of a system embodying the present invention; Fig. 2 is a front view of the panel from which the system is controlled; Fig. 3 is a rear view of the panel shown in Fig. 2; Fig. 4 is a side view of the panel; Fig. 5 is a section, on a larger scale than Fig. 4, through one of the controlling valve devices at the main air manifold; Fig. 6 is a side view of the actuator for the cam shaft which controls the opening and closing of the air valves of which one is illustrated in Fig. 5; Fig. 7 is a view similar to Fig. 6, showing only the lower end of the device, with the parts in different positions than those which they occupy in Fig. 6; Fig. 8 is a section on line 8—8 of Fig. 6; Fig. 9 is a section on line 9—9 of Fig. 6; Fig. 10 is a side elevation of an old form of blower unit applied to a boiler, a fragment of the fitting of which is shown in section, and the unit being equipped in accordance with the present invention; Fig. 11 is a view similar to Fig. 10, showing the opposite side of the unit from that which appears in Fig. 10; Fig. 12 is a section on an enlarged scale on line 12—12 of Fig. 11; Fig. 13 is an axial section through the head of a blower unit, showing the main steam valve which is of any usual or suitable type; Fig. 14 is a section, on a larger scale, on line 14—14 of Fig. 11; Fig. 15 is a section on a still larger scale, on line 15—15 of Fig. 14; Fig. 16 is a view on a still larger scale showing a fragment of the head partly in side elevation and partly in section; Fig. 17 is a section on line 17—17 of Fig. 16; Fig. 18 is a section at right angles to the plane of the section in Fig. 16, on a smaller scale than the latter; Fig. 19 is an elevation of the stationary sleeve or bushing for the reversing valve shown in Figs. 16 and 18; Figs. 20, 21 and 22 are views taken respectively on lines 20—23, 21—24, 22—25, with the valve in one working position; and Figs. 23, 24 and 25 are views similar to Figs. 20, 21, and 22, respectively, showing the valve in the second of its working positions.

In the drawings the invention is illustrated as applied to a group of five blowing units, the controlling system being shown large enough to accommodate an additional unit; and, for the sake of brevity, the detailed description will be confined to this particular disclosure.

In the diagram constituting Figure 1, X and Y represent upper and lower drums of a water tube boiler, while A, B, C, D, and E indicate separate blower units of the type in which the head portion is outside of the boiler setting and a tubular jetting element extends into the interior of the boiler; these five units being distributed so as to cooperate with each other to clean the boiler tubes.

The cleaning units are supplied with steam through a header F and suitable branches leading from the latter, whereas the power for operating the units is derived from compressed air obtained from a suitable source of supply through a pipe 1. From the pipe 1, the air enters a manifold 2 from which small pipes 3, 4, 5, 6, and 7 lead to the units A, B, C, D, and E, respectively. Each of these pipes is provided with an individual pressure gauge 8. There is a valve, not shown in the diagram, between the manifold 2 and each of the air delivery pipes, these valves being operated by cams on a cam shaft 9 extending lengthwise of the manifold. In addition to the pipes 3 to 7, there is a sixth air pipe 10 that leads to a whistle 11; air being admitted to the pipe 10 in the same way as to the other five. The parts are so proportioned that the valves open, one after the other, no two valves being open at the same time. Therefore, if the cycle begins with the opening of the valve leading to

the pipe 3, all five of the blower units will be brought into service, one after the other and, after the last one has done its work, air will be admitted to the whistle to notify the attendants that a blowing cycle has been completed. An additional air pipe 12 is shown, simply because the manifold has been made long enough to take care of an additional blowing unit.

The cam shaft may be operated in any suitable way. In the arrangement shown, there is a pointer 14 which, when shifted, turns a little shaft 15 which serves to drive the cam shaft through bevel gears 16. The cam shaft may therefore be operated manually, if desired, to open one air valve after the other, or it may be set at the desired starting point for automatic operation. Automatic operation of the cam shaft may be brought about by a pressure responsive pawl and ratchet device indicated as a whole at 17; this device being provided with a pneumatic lock 18 which prevents actuation thereof unless there is pressure in the manifold 2.

The air supply pipe is shown as being provided with a shut off valve 19, a strainer 20, a lubricator 21, a regulator 22 and a valve 24 controlled by a solenoid 25. Upon energizing the solenoid, assuming that the shut off valve 19 is open, air is admitted to the manifold 2 and to the pneumatic lock 18. If it is desired that the jetting be continuous throughout the cycle of operations of each blowing unit, the solenoid should remain energized until the system as a whole has completed its cycle. On the other hand, if intermittent jetting for each unit is desired, the solenoid should be periodically energized and de-energized. Accordingly, there is provided an interrupter and timer apparatus 26 of any usual or suitable type, together with a control switch 27 to permit either constant or intermittent energization of the solenoid, depending upon the position of the switch.

As will hereinafter be explained, each blowing unit is provided with a valve that is opened at the end of the cycle for that unit. From these valves extend pipes 28, 29, 30, 31 and 32 to an indexing manifold 34. Consequently, whenever a blowing unit has done its work, air is admitted from the airline leading thereto into the corresponding pipe which, in turn, leads to the indexing manifold. Each of the pipes 28 to 32 has therein, adjacent to the manifold 34, a check valve 35 to prevent air from flowing back through these pipes from the indexing manifold.

A pipe 36 extends from the manifold 34 to the pressure chamber in the pawl and ratchet actuator 17. This pipe contains a two-positioned valve 37 which, in one position, prevents air from reaching the pawl and ratchet actuating device while, in the other position, such flow is permitted and the cam shaft 9 is caused to make a step ahead whenever any one of the blower units completes its cycle.

As heretofore explained, there is nothing new in the blower units themselves. As shown in Figs. 10 to 13, each unit comprises a hollow head 38 from one end of which protrudes an oscillatory, tubular jetting element 39 that extends into the combustion chamber of a boiler through a wall Z of a boiler setting; steam being admitted into the lower end of the head through a pipe *f* that constitutes one of the branches of the main steam pipe F. Steam enters the head freely from the steam pipe, but is normally prevented from entering the jetting element by a valve 40 which is closed by steam pressure and is open by the pressure of steam within the head against a piston 41. In order to permit the valve 40 to open, the space behind the piston must be open to atmosphere; this being done in the well known way by means of a pilot valve device 42 such as is illustrated in Fig. 12. Heretofore, in manually-operated apparatuses, the pilot valve has been shifted toward the right from its normal position, indicated in Fig. 12, by pressing against the outer end of the valve stem 44. In the arrangement shown, there is mounted on the side of the head, in registration with the stem of the pilot valve, a short cylinder 45 of large diameter containing a piston 46 having a short piston rod 47 aligned with the valve stem 44 and normally in contact therewith. In order to operate the pilot valve so as to admit steam into the jetting element, pressure must be introduced into the cylinder 45 behind the piston 46. Assuming that the unit which has been illustrated in detail is the one marked A in the diagram, then the pipe 3 leading to this head is the one that supplies air to this unit when the proper valve at the manifold 2 is opened; a branch 48 extending between the cylinder 45 and the pipe 3, as shown in Figs. 10 and 11. Consequently, whenever the valve corresponding to this unit is opened, the pilot valve in the head is moved into position to cause the main steam valve of that unit to open and steam to flow into the jetting element.

The jetting element is adapted, as is commonly done, to be turned while jetting, so that the jets sweep through a substantial angle. In the particular type of unit under consideration, the jetting element oscillates instead of turning continuously in one direction, and a working cycle may therefore comprise a turning movement in one direction or a stroke in that direction and a return stroke, or a plurality of strokes in each direction, depending upon the type of control.

Since the details of the turning means for the turning elements are not in themselves novel, it is sufficient to say that the jetting element extends through a suitable gear casing 49 within which is arranged a train of driving gears terminating in a shaft 50 that extends to the exterior of the casing. In accordance with the present invention, this shaft is driven by or forms part of an air motor which is best shown in Figs. 14 and 15. This motor consists of a suitable rotor 51 arranged within a casing 52 and adapted to revolve in one direction or the other, depending upon whether air under pressure enters the casing through a pipe 54 or through a pipe 55. The pipes 54 and 55 are curved so as to extend through the gear casing, above the jetting element and to the opposite side or edge of the casing from that at which the air motor is located, and there the ends of these pipes are engaged in a casting 56 which contains several valves. One of these valves is the reversing valve and comprises a rotatable body member 57 and a stationary sleeve or bushing 58 surrounding the rotatable member and having suitable ports which control the admission to and exhaust of air from the pipes 54 and 55. The second valve is a shut off valve between the air pipe 3 and the reversing valve. This shut off valve comprises a cylindrical plug 59 which, as best shown in Fig. 16, is fitted within a bore in the casting 56 a short distance below the reversing valve, this being the bore with which the air pipe 3 communicates. From this bore, which is indicated at 60, leads a port 61 the far end of which connects with a chamber 62 ad-

jacent to the stationary sleeve member 58 of the reversing valve. The inner end of the plug 59 contains an L-shaped passage 63 through which air may flow from the chamber or bore 60 into the port 61. A valve 64 cooperates with that end of the passage 63 that opens out through the end face of the plug to shut off communication between the passage 63 and the bore 60. The third valve in the casting 56 is what may be termed an indexing valve, comprising a short plug member 65 rotatable in a suitable sleeve or bushing 66 fitted into a bore in the casting above and inwardly from the reversing valve. A passage 67, as best shown in Fig. 18, leads from the bore 60 to a point adjacent to the sleeve or bushing 66. There is another passage 68 leading from the exterior of the casting 56 to the periphery of the sleeve or bushing 66 and, fixed to the casting and communicating with this passage is a pipe which corresponds to the indexing pipe 28 of the diagram. The plug member 65 contains a chamber 69 which opens out through the periphery of the plug at three points separated angularly with respect to each other. The sleeve member 66 of the indexing valve contains ports 70 and 71 communicating with the passages 67 and 68, respectively. The parts are so proportioned that the passage in the plug may connect the pipe 28 to the passage 67 in either of two positions while interrupting such communication in an intermediate or neutral position. This, as will hereafter be understood, is for the purpose of permitting air to enter the pipe 28 whenever the indexing valve is rocked to either limit of its movement and to shut off such supply when the valve occupies a central neutral position such as illustrated in Fig. 18.

The reversing valve, as heretofore stated, must permit air to enter and be exhausted from either of the two pipes 54 and 55. Accordingly, the sleeve member 58 is provided with four ports 73, 74, 75 and 76. The port 73 communicates with a chamber 77 in the casting, with which chamber the pipe 54 communicates. The port 74 opens into a chamber 78 in the casting, which chamber is in communication with the pipe 55. The port 75 opens into the chamber 62. The port 76 opens into a chamber 79 which, in turn, opens into the interior of the crank case through a passage 80; this being the exhaust passage. It will be seen that when the valve member 57 occupies the position illustrated in Fig. 18, air may flow through the reversing valve and into the pipe 55 whereas the pipe 54 may exhaust through the reversing valve and the chamber or passage 79; and, consequently, if the shut off valve 64 is open, air can flow into the motor for the purpose of turning it in one direction. The rection of the reversing valve in Fig. 18 is taken at about the middle of the valve device, namely on about lines 21—24 of Fig. 16, so that there is correspondence between Fig. 18 and Fig. 24. It will be seen that the sleeve or bushing 58 has four additional ports, namely diametrically opposed ports 81 and 82 toward the lefthand end as it appears in Fig. 16 and registering with the chamber 77 and 62, respectively, together with a second set of diametrically opposed ports 84 and 85 toward the righthand end of the valve device as it appears in Fig. 16 and registering respectively with the chambers 78 and 79. The movable member of the valve is, in effect, a cylindrical block the ends of which are left intact and which is divided into three non-communicating or separate sections each of which is adapted to cooperate with one of the groups of ports in the surrounding sleeve.

In Figs. 23, 24, 25 are illustrated the conditions at the three different sections of the reversing valve when the movable member of the valve is in the position shown in Fig. 18. It will be seen that at this time solid portions of the movable member of the valve close the port 82 and the port 84, so that only the central group of ports, 73 to 76, is effective. When the valve is shifted through a fairly small angle, to bring about the conditions illustrated in Figs. 20, 21 and 22, it will be seen that the pipe 55 exhausts through the chamber 78, the ports 84 and 85 and the chamber 79, while the pipe 54 is receiving air from the chamber 62 through the ports 82 and 81 and the chamber 77; the two end sections of the valve being now active and the central section being idle because the central section of the movable member of the valve, as indicated in Fig. 21, closes both the ports 75 and 73 and forms an imperforate barrier between the ports 74 and 76.

The purpose of the shut off valve 64 in the blowing unit head is to insure that there will be steam in the jetting element before the motor begins to operate; thereby insuring that the jetting element will be effective throughout its entire sweep. We therefore provide means for normally holding this valve closed, but causing it to open whenever there is sufficient pressure within the tubular jetting element for that purpose. To this end the stem 86 associated with the valve 64 extends out through a face of the casting and into a casing 87 fastened to the casting. The stem terminates in a long cylindrical part 88 of much larger diameter than the stem. A spring 89 between the inner end of the enlarged portion 88 and the plug tends constantly to draw the valve against its seat. Extending over the member 88 is a bellows-like sheathing 90 which constitutes a flexible inner casing. Upon admitting steam into the casing 87 on the outside of the flexible inner casing, the latter collapses sufficiently to cause the plunger-like part 88 to be forced in a valve-opening direction against the resistance of the spring 89. Steam is supplied for this purpose through a pipe 91 which, as best shown in Figs. 11 and 13, connects with that part of the blowing unit head which surrounds the inner end of the tubular jetting element 39 and the space within which receives steam only when the valve 40 is open. It will therefore be seen that since the valve 40 opens almost immediately upon turning air into the pipe 3, there need be no delay in the starting of the motor after the pressure in the jetting element has been built up sufficiently to insure adequate jets will be discharged.

It will now be understood that suitable means being provided to shift the reversing valve, the admission of air into the airline leading to the unit causes the steam to be turned into the tubular jetting element and, thereafter, air to be delivered to the motor to cause the jetting element to be turned in one direction until the reversing valve is again operated; and, if the indexing valve is opened at the end of a swinging movement of the jetting element, air is admitted to the indexing manifold. The indexing manifold then supplies air to the cam shaft actuator whereupon automatic operation of the cam shaft occurs, the air is cut off from the blowing unit which has just completed its cycle, and air is then delivered to the next unit in

the group or series. Whenever the cycle of any unit is completed, the air leaks out of the cylinder forming part of the device for opening the pilot valve in the head, and thereupon the main steam valve in that head closes and no more steam is delivered to the jetting element in that unit until the cam shaft is again caused to open the corresponding air valve.

As shown in Figs. 14 and 16, the reversing valve and the indexing valve are both operated by the jetting element; this element having thereon and adjustable angularly thereof relatively to each other and to the element a pair of little blocks or lugs 93 and 94. In the path of these lugs is a finger 95 projecting radially from a member 96 pivotally mounted on the gear casing and having thereon diametrically opposite the finger a gear segment 97. This segment meshes with complementary teeth on a mutilated pinion 98 mounted on the gear casing outwardly from one end of the reversing valve and coaxial with the latter. Between the part 93 and the movable member of the reversing valve is a suitable snap action device including a connecting spring 99 whereby the rocking of the member 96 through a small angle causes the reversing valve to snap quickly from one extreme position to the other. Assuming that the tubular jetting element has been turning in the clockwise direction, as viewed in Fig. 14, it will be seen that the lug 94 is just coming into engagement with the finger 95, so that the parts 96 and 98 will be turned. Since the shifting of the reversing valve is substantially instantaneous, the motor will promptly be reversed and the jetting element will begin to turn in the counter-clockwise direction, provided that the motor is receiving a supply of air. If no means were provided to shut off the air, the motor would simply run in the reverse direction until the lug 93 reached the finger 95, whereupon the reversing valve would be turned back to its starting position and the cycle would then be repeated indefinitely. The length of the cycle of an individual unit is controlled by the indexing valve in the head.

As shown in Fig. 17, the rotatable member 65 of the indexing valve projects beyond the front of the casing 58, where it is surrounded by a shallow cup-shaped member 100 fixed thereto in any suitable manner. Within the chamber of the cup-shaped member is a torsion spring 101, the ends of which are crossed. Between the crossed ends are two pins 103 and 104; the first being stationary and projecting from the casting while the other is carried by the member 100. This spring tends constantly to hold the member 65 in the angular position illustrated in Fig. 18, namely the neutral position, while permitting it to be turned in either direction so as to bring it into either of its two working positions. The member 96 that actuates the reversing valve is carried by the valve member 65 outwardly from the member 100, being held from dropping off by means of a bolt or screw 105 extending through the part 96 and into the valve member 65 at the axis of the latter. However, the member 96 is loose on this valve which acts simply as a support and does not interfere with the independent rotary movements of the member 96. On the member 100 is a projecting radial finger 106 that lies behind the finger 95 so as to be engaged simultaneously with the latter by either the lug 93 or the lug 94 mounted on the tubular jetting element. It therefore follows that when the jetting element has reached one end of its sweep, as indicated in Fig. 14, it engages both of the fingers 95 and 106, causing the reversing valve to be shifted and thus enable the motor to drive the jetting element through a return stroke provided the air is not shut off, and turning the movable member 65 of the indexing valve out of its neutral position so as to admit air into the indexing line 28. As will hereinafter be explained, the cam shaft for controlling the admission of air to the individual units is operated so quickly after the admission of air into the indexing manifold, that the jetting element, which was forced to come to rest and then must start from that position on a return stroke, can move only a short distance on its return stroke before the supply of air to the motor is shut off and further operation of that unit ceases. By permitting the jetting element to travel even a very short distance on a return stroke after the reversing valve has been shifted at one limit of the sweep of the jetting element, the lug which brought about the shifting of the reversing valve and the indexing valve moves far enough away from the fingers 95 and 106 to permit the indexing valve member 65 to be returned to its neutral or idle position by its spring 101. Therefore, in the system as illustrated, a cycle of operations of a single unit consists simply of a total angular movement of its jetting element equal to a full sweep of the latter between its two extreme positions. It will also be seen that after the cycle has been completed, the series of operations with respect to that particular head, heretofore described, will be repeated the next time that the corresponding air valve at the main air manifold is opened.

All of the controlling devices, except those in or upon the heads of the blowing units, are preferably brought together in a single panel assembly; the panel itself being conveniently a casing or housing 107 on the front of which appear the various gauges and manually-operable elements, while the two manifolds are arranged within the casing, one at the top and the other at the bottom; the cam shaft 9 also extending across the interior of the casing above and parallel to the main manifold 2.

It will be seen from Fig. 3, that the actuator 17 for the cam shaft is mounted on a stationary shelf-like member 108 from which rise tall brackets 109 in which one end of the cam shaft has bearings. The details of this actuating device are best shown in Figs. 7 to 9, inclusive. Referring to these figures, it will be seen that there is mounted on top of the brackets 109, well above the cam shaft, a stationary vertical cylinder 110. In this cylinder is a piston 111 provided with a rod 112 that extends down through the lower end of the cylinder and is there provided with a cross arm 114. Two long tension springs 115 are connected at their lower ends to the ends of the cross arm 114 and at their upper ends to lateral projections 116 on the upper cylinder head. Pinned to the middle of the cross arm 114 is one end of a lever 117 which carries a pawl 118 adapted to cooperate with a ratchet wheel 119 fixed to the cam shaft, for the purpose of turning the latter step by step. In the arrangement shown, the member 117 comprises two disk-like parts 120 both connected to a single, more or less radial arm; the ratchet wheel lying between the two disk-like parts. One of the members 120 has a peripheral notch 121 which, when the piston 111 is at the lower end of its stroke, is engaged by a pawl 122, as shown in Fig. 7. The pawl 122 is adapted to be tripped by an expansible, bellows-

like shell 123 when air under pressure is admitted into the latter. Normally the member 123 is contracted, as indicated in Figs. 6 and 7, so that after the piston rod has been brought into the position indicated in Fig. 7, it cannot move up again until the pneumatic lock is released. In the diagram, Fig. 1, the pneumatic lock 18 corresponds to the pawl 122 and the pawl actuator 123, and it is seen that air is supplied to the bellows-like element through a small pipe 125 connected to the main airline near the inlet end of the main manifold 2.

When air is admitted into the main manifold, the air lock for the cam shaft, just described, is released so that, after the first blowing unit has completed its cycle, and air is admitted into the cylinder 110 from the indexing manifold, the piston in this cylinder is driven downward, stretching the springs 115. As soon as the pressure above the piston 111 is reduced sufficiently, the springs 115 return the piston to its starting point, thereby swinging the cam shaft actuating lever 117 through a working stroke and bringing the cam shaft into the proper position to energize the next blowing unit in the series. The air in the indexing portion of the system leaks out rapidly enough to permit the springs 115 to raise the piston 111 without any considerable delay. In order to insure prompt turning of the cam shaft after the indexing valve in a unit has been opened, I provide the connection between the pipe 36 and the cylinder 110 with a small vent 126, as shown in Fig. 8. This vent is small enough not to interfere with the building up of the necessary pressure to force the piston down and stretch the springs 115, while insuring direct escape of air from the cylinder as soon as the inflow has stopped.

The cam shaft and the valves actuated thereby are best shown in Figs. 3 to 5. It will be seen that in each of the pipes 3 to 5 and 10 there is a valve casing 127. Within each of these casings is a poppet valve 128 provided with a horizontal stem 129 that extends forwardly through the front side of the casing toward the cam shaft. Surrounding each of the valve stems, within a socket extending inwardly through the front face of the valve casing is a compression spring 130 that tends constantly to hold the valve closed. On the cam shaft are fixed a series of disks 131, one disk directly in front of each valve stem. Each disk has thereon a peripheral cam lug 132 which, in a given angular position of the cam shaft, when the latter is turned in the clockwise direction, as viewed in Figs. 4 and 5, forces the valve stem inwardly and causes the valve to open. The cam lugs are distributed spirally around the shaft so that only one valve at a time can be open.

It may be that the construction of the various heads in a series of blower units makes it inadvisable to supply the energizing air thereto at the same pressure and in the same volume. Accordingly, means are provided to regulate the flow of air through each of the airlines leading to the blowing units, in addition to the valves that simply serve as shut off valves. In the arrangement shown, there is screwed through the front wall of each of the casings 127, above the shut off valve in the latter, a stem 134 having at its inner end a plug 135 which may be caused to obstruct the passage 136 in the casing to any desired extent. A rod 137 is connected to each of these devices, and it extends to the front of the panel where it is provided with a finger piece or button 138 by means of which it may be turned.

The pressure gauges 8, as well as the other gauges showing the pressure of the air supply and the steam supply may also be located on the front of the panel as are the indexing pointer 14 and the handle for the automatic indexing valve 37. The timing devices 26 and the controlling switch 27, for energizing the valve actuating solenoid 25 and determining whether it shall remain continuously energized or be alternately energized and de-energized, are also preferably placed on the front of the panel.

It will thus be seen that we make it possible for an attendant to operate any one of a series of blowing units with which a boiler is equipped, and permit it to run for any desired length of time; or operate the entire group, one after another, with each tubular blowing element moving through any desired angular distance; or bring about the operation in automatic succession of the entire series, each unit performing according to a predetermined cycle. In the latter instance, a warning will be given through the blowing of a whistle, so that the attendant may shut off the supply of air and steam or other fluids which may be employed. It will further be seen that the jetting performed during a single operating cycle of each unit may be continuous or intermittent, without requiring the attendant to do anything more than simply to shift the controlling switch for the solenoid valve in the airline into its "continuous" or its "intermittent" position. It will also be seen that the tubular jetting elements cannot be moved until they have been supplied with cleaning fluid, thereby insuring that the entire zone corresponding to the angular distance through which a cleaning element has turned will have been properly cleaned. Should the supply of air fail, the controlling cam shaft will be locked from being automatically turned from one position to the next until air pressure is again restored, for the reason that the air lock acts immediately upon failure in the air pressure of the system. Since it is not likely that all of the blowing units will be exactly alike, and, since it may be desirable to operate some units more rapidly than others, even though they should be alike, the means for regulating the flow of air to each unit, after it has past the shut off valves, is an important feature, as it permits each blowing unit to be operated in a manner that will enable it best to perform its intended functions.

While we have illustrated and described with particularity only a single preferred form of our invention, we do not desire to be limited to the exact structural details thus illustrated and described; but intend to cover all forms and arrangements which come within the definitions of our invention constituting the appended claims.

We claim:

1. The combination with a plurality of soot blowers each having an oscillatory blowing element and a fluid pressure motor for moving the element, of a system for supplying fluid under pressure to the motors including a motor-reversing valve adjacent to each motor and individual shut-off valves, a cam shaft for operating said shut-off valves in succession during each revolution of the shaft, and means for causing each reversing valve to be shifted and the cam shaft to be turned through a predetermined step at each limit of movement of the blowing element corresponding to that reversing valve.

2. The combination with a plurality of soot blowers each having an oscillatory blowing element, a fluid pressure motor, a valve to admit cleaning fluid to said element, and a controller for the aforesaid valve, of a system for supplying fluid under pressure to the motors and to said controllers including a shut-off valve and a motor-reversing valve for each blower, a master controller for operating said shut-off valves in succession, and means for causing the corresponding reversing valve to be shifted and the master controller to be moved far enough to operate the shut-off valve associated with the next succeeding blower element at each limit of movement of each blower element.

3. The combination with a plurality of soot blowers each having a movable blowing element, a fluid pressure motor, a valve for controlling the admission of cleaning fluid to the blowing element, and a fluid pressure actuator for said valve; of a shut-off valve at each motor, fluid pressure actuators for the aforesaid shut-off valves, means to admit fluid from said blowing elements to the last-mentioned actuators from the corresponding blowing elements; together with a system, including a second shut-off valve for each blower, for supplying fluid under pressure to each of the first-mentioned shut-off valves, a master controller movable step by step for operating said second shut-off valves in succession; and means to shift the master controller through one step whenever any one of the blowing elements reaches a predetermined position.

4. The combination with a plurality of soot blowers each having a movable blowing element, a fluid pressure motor, a valve for controlling the admission of cleaning fluid to the blowing element, and a fluid pressure actuator for said valve; of a fluid pressure distributing system including a pipe leading to each motor and to the corresponding actuator, a shut-off valve in each of said pipes, a controller movable step by step to operate said shut-off valves in succession, a fluid pressure actuator for moving said controller through one step whenever that actuator is energized, an indexing valve adjacent to each soot blower to admit fluid to the last mentioned actuator, and a part movable with each blower element to engage the adjacent indexing valve and open the same when that element reaches a predetermined position.

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