The present invention relates to soot blowing apparatus for boilers, wherein the tubular blowing element normally lies outside of the intensely heated region in which it must be while performing a cleaning operation and enters that region only when it is called upon to discharge cleaning fluid against the surfaces to be cleaned; and it has for its object to produce an apparatus that is simple and rugged in construction, adjustable to meet a wide range of conditions, and instantly responsive to manual control at any point in a cycle of operations to cause a change in that cycle.

In the preferred embodiment of our invention the blowing element moves lengthwise through the wall of a boiler setting between an extended working position in which it lies mainly on the inner side of the wall and a retracted position in which it is disposed mainly on the outer side of the wall. Therefore the invention may be said to have as separate, specific objects: simple and novel manually controlled automatic operating means for the blowing element; means for easily adjusting the stroke of the element over a considerable range; means to cause the element quickly to return to its retracted position from any other position, when desired; simple means to halt the movement of the element at any point in its cycle of movement, when desired, and then, if desired, to cause it to complete the cycle which was under way at the time of stopping the element; and to provide simple, novel and efficient mechanisms and devices, such as improved bearings, reversing means and motors, forming part of the apparatus or system.

The various features of novelty whereby our invention is characterized will hereafter be pointed out with particularity in the claims; but, for a full understanding of the 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 side view of an apparatus embodying the present invention, a fragment of the wall of a boiler setting to which the apparatus is applied being shown in section; Figs. 2 and 3 are sections taken, respectively, on lines 2—2 and 3—3 of Fig. 1; Fig. 4 is a section on a plane containing the axis of the blowing or cleaning element, showing on a somewhat larger scale than Fig. 1, the aforesaid wall and an adjacent fragment of the apparatus; Fig. 5 is a section, on a still larger scale, on line 5—5 of Fig. 4; Fig. 6 is a view, on a larger scale than Fig. 4, of the outer end of the apparatus, the cover being removed and the side that is away from the observer in Fig. 1 being shown; Fig. 6a is a section taken approximately on line 6a—6a of Fig. 6, showing only a small fragment of the apparatus; Fig. 7 is a section through a control valve seen in Fig. 6; Fig. 8 is a view similar to Fig. 6, showing the side that is toward the observer in Fig. 1; Fig. 9 is a section on line 9—9 of Fig. 8; Fig. 10 is a vertical longitudinal section on a plane containing the axis of the shaft of the motor appearing in Fig. 8; Figs. 11 and 12 are sections taken, respectively, on lines 11—11 and 12—12 of Fig. 10; Fig. 13 is a section on line 13—13 of Fig. 8; Fig. 14 is a section on line 14—14 of Fig. 8; Fig. 15 is a section on line 15—15 of Fig. 14; Fig. 16 is a section through the reversing valve for the traversing motor and its immediate operating mechanism, the section being taken on line 16—16 of Fig. 17; Fig. 17 is a section through the reversing valve on a plane transverse to the long axis of the apparatus; Fig. 18 is a section on line 18—18 of Fig. 17; Fig. 19 is a section on line 19—19 of Fig. 16; Fig. 20 is a section on line 20—20 of Fig. 6, illustrating the main air valves for controlling the motors, and the scale being larger than that of Fig. 6; Fig. 21 is a view similar to Fig. 20, showing the latches in their holding positions and the motor-driven tripping means being omitted; Fig. 22 is a section through the pneumatic actuator for one of the latches in Figs. 20 and 21; Fig. 23 is a section on line 23—23 of Fig. 20, showing one valve open and the other closed; Fig. 24 is a section on line 24—24 of Fig. 21; Figs. 25 and 26 are sections taken, respectively, on lines 25—25 and 26—26 of Fig. 24; Fig. 27 is a front view of the control panel for the apparatus; Fig. 28 is a section on line 28—28 of Fig. 27; Fig. 29 is a section on line 29—29 of Fig. 28; Fig. 30 is a diagram illustrating the conditions in and those parts of the system affected by the pressing of the starting button; and Fig. 31 is a diagram similar to Fig. 30, but including the parts affected by pressing the "stop" and the "emergency retract" buttons.

The blower unit, as shown in Fig. 1, comprises a long horizontal, stationary pipe 1 connected at one end to a head 2 to which cleaning fluid, preferably steam, is supplied in any usual or suitable way; together with a long, tubular blowing element 3 telescoped upon the pipe and slideable along and rotatable about the same. The free end of the pipe is open and the free end of the blowing element, which, when retracted, projects somewhat beyond the corresponding end of the pipe, is closed. As best seen in Fig. 4, the nose or closed end of the blowing element contains little
nozzles 4 adapted to discharge jets of cleaning fluid radially. The other, open end of the blowing element extends into and is rotatable in a casing or housing 5 that is slidable along the pipe 1. This casing or housing is provided with a stuffing box 6 to provide a steam tight joint between the same and the said pipe. This unit, including also a bearing 7 in the vicinity of the free end of the pipe 1, is supported by a long beam 8. One end of this beam is supported by the wall A of a boiler setting and the beam extends away from and at right angles to the wall, and on the other end contains a large opening fitted with a heavy sleeve or bushing 9 in the outer end of which the nose of the blowing element lies, when the said element is in its retracted position.

Normally the blowing element occupies a retracted position, as in Fig. 1, the greater part thereof being in the cool region outside of the furnace or combustion chamber; and even the nose of the element being sheltered against the intense heat in said chamber because it is withdrawn from the chamber proper into the tunnel through the furnace wall. To effect a blowing or cleaning operation, the blowing element is extended or projected into the chamber and is rotated; steam or other cleaning fluid being supplied to the head and issuing from the nozzles in the form of jets.

Two motors, preferably air motors, are used, one for turning the blowing element and the other for extending and retracting it. These motors are mounted on opposite sides of the I beam 8 at the end remote from the furnace wall, as best shown in Figs. 6 and 8; 10 being the motor for turning the element and 11 being the motor for moving the element lengthwise.

The driving mechanism between the motor 10 and the blowing element is best shown in Fig. 15, it will be seen that above and parallel to the blowing element is a shaft 12 that is noncircular in cross section. A cylindrical portion 14 at one end of this shaft extends through a bearing 15 in the wall of a housing 16 fastened to the outer end edge of the I beam and forming with the latter a T. The shaft 12 carries a pinion 17, slidable thereon within the casing 5 and rotatable in the latter while interlocked therewith against axial movement relative thereto. The pinion meshing with a pinion 10 fixed to the outer end of the tubular blowing element at a point within the casing 5. As the shaft 12 revolves it produces similar turning movements on the part of the blowing element. In the arrangement shown, the pinions 17 and 18 are alike, so that the shaft 12 and the blowing element turn at the same speed. It will be noted that the gear casing 5 has at the top what may be termed a wheeled carriage 13 which rides on the lower flange of the I beam and thus relieves the shaft 12 and the tubular members 1 and 2 of the weight of the casing and pinions.

The motor 10 has a shaft 19 extending through a wall of the housing 16 to drive a train of gearing between it and the part 14 of shaft 12; whereby the high speed motor can cause the shaft 12 to rotate slowly. In the arrangement shown, a pinion 20 on the motor shaft meshes with a larger gear wheel 21 fixed on a shaft 22 that parallels the motor shaft. On the shaft 22 is a worm 23 that meshes with a worm wheel 25 on a shaft 26 that lies at right angles to shaft 22. On shaft 26 (see Fig. 14), is a second worm 27 that meshes with a worm wheel 28 on a shaft 29 parallel to the motor shaft. On shaft 21 is a gear wheel 30 meshing with a gear wheel 31 on the shaft member 14. The shaft 22 extends through the wall of the housing 16 farthest from the motor and is adapted to receive a crank, not shown, for turning the motor and shafts by hand. The free end of the shaft 22 is shown as having a slot or kerf 32 cut into the end face to form an interlock with the manually operable actuator.

The blowing element is reciprocated lengthwise by an endless chain 34 driven by the motor 11 through speed reducing gearing. As will be seen in Figs. 1, 2, and 1, loop of the chain extends around a sprocket wheel on a short, vertical shaft 35 at the furnace end of the apparatus; the other loop being engaged with a sprocket wheel on the lower end of a vertical shaft 36 mounted in the housing 16 so as to project from the latter at the top and at the bottom, as best shown in Figs. 10 and 14. As in the case of the other motor, the shaft 37 of motor 11, paralleling that of motor 10, extends into the housing 16 where it is provided with a pinion 33 meshing with a gear wheel 38 on a shaft 39 that parallels the motor shafts.

The shaft 40 may be turned by hand by applying a crank to the outer free end thereof which contains a slot or kerf 32, as does the shaft 22. On shaft 40 is a worm 41 meshing with a worm wheel 42 on a shaft 43. Shaft 44 has thereon a worm 45 meshing with a worm wheel 46 on shaft 36 that drives the chain. The chain is connected in any suitable way to the casing 5 so that the latter and the blowing element to which it is attached must travel with the chain. In the arrangement shown, the casing forms a link in the chain, the ends of the chain, between which the casing is located, being connected thereto by eye bolts 34a of which one is shown in Fig. 6.

While the motor 10 may always turn in the same direction, because the blowing element need only turn in one direction, the traversing motor 11 must be reversed to impart reciprocatory movements to the blowing element. Such reversal should usually be automatic, as should other steps forming part of a complete blowing cycle; so that, after a cycle has been properly started, it will be automatically completed.

The automatic control depends primarily on the operation of the traversing motor, each cycle being carried out during the time that it takes that motor to complete a variable, predetermined number of revolutions. To this end we have provided a control shaft 47 arranged transversely above a depressed portion of the housing 16; this shaft being driven by a worm 48 fixed on the upper end of shaft 36 and meshing with a worm wheel 49 on the shaft 47. Mounted on opposite sides of the housing 16, near the ends of the shaft 47, are two large cam wheels 50 and 51. Gear wheels 52 on shaft 47 mesh with gear wheels 53 on the cam wheels. Thus the cam wheels revolve in the same direction and at the same speed when the motor 11 is running; the direction being reversed when the motor is reversed.

As will hereinafter be seen, the cam wheels exercise control over the supply of air to the motors and over the direction in which the traversing motor turns.

Air is supplied to both motors through two main air valves disposed in a valve casing 55 located just below the cam wheel, as best seen in Fig. 6. The details of these valves are illustrated in Figs. 21-26. The main part of the valve casing contains two like, vertical, non-communicating chambers 56 and 57 arranged side by side, together with a separate channel 58 undergoing
both of the other chambers but divided therefrom by a horizontal wall. A pair of like sleeves 59 are arranged in the valve casing, one extending from top to bottom through chamber 58 and chamber 56, while the other goes through chambers 58 and 57. These sleeves are stationary and each contains ports 60 and 61, respectively, that place the interior thereof in communication with both of the chambers through which it passes. In the sleeves are spring-actuated piston-like valve devices which are alike but are numbered differently, 62 and 63, to distinguish them from each other. Each valve comprises a spool-like valve proper 65 which, in the down position, shuts off communication between the ports 60 and 61 in the surrounding sleeve; whereas, in the up position, communication is established between those ports. In other words, when a valve is down, no air can pass from the lower chamber 58 to the corresponding upper chamber; whereas, when a valve is up, such a flow of air can occur. Each valve has a stem 66 that extends out through the top of the casing and there terminates in a button or head 67. Surrounding each stem within the casing is a spring 68 tending constantly to hold the valve down. Below the body member of the valve casing is a thick cover plate 69 provided with an interior chamber 70 of irregular shape in communication with the bores in the two sleeves.

When air under pressure is admitted into the chamber 70 it passes into the sleeves below the valves 65 and forces both valves up. If the valves are latched in their raised positions they will remain there until they are unlatched; but, otherwise, they will drop into their closed positions as soon as the air pressure in chamber 70 is reduced.

On top of the casing 55 are mounted two latches, 72 and 73, each adapted to rock about a vertical pivot pin 74 from a position in which its nose underlies the head on the projecting end of the stem of one of the valves 62 and 63, as in Fig. 21, and a position in which the nose is clear of such head, as in Fig. 20; the first being the latching position and the other the releasing position. Each latch has associated therewith a spring 75 tending constantly to hold it in the latching position. These latches are controlled by the cam wheel 50 which has thereon a cam 76 in the form of a curved finger adapted to engage a pin 77 on the tail of latch 73 in one angular position of said wheel. There is also on the cam wheel a pin 78 for engagement with the tail of latch 72 when the cam wheel is in said predetermined position. The cam finger and the pin 78 move the latches far enough to unlatch the air valve and permit them to close.

Air for energizing both motors enters chamber 58 in valve casing 55 through a pipe 79 when air is admitted to the pipe from a suitable source of supply. Assuming the valves 62 and 63 to be closed, no air can enter the chambers 56 and 57 until these valves are opened. When that occurs, air can enter chambers 56 and 57, flowing from chamber 56 through a pipe 81 to motor 10 and from chamber 57 through a pipe 82 which leads to a reversing valve 83 for the traversing motor, located near the motor, as shown in Fig. 8. From the reversing valve two pipes 84 and 85 lead to the traversing motor through a suitable governor 86.

The cam wheel 51 actuates the reversing valve whenever the blowing element reaches its retracting position and again when it has been extended to a predetermined, selected point. This wheel is located directly above the reversing valve which has a controlling arm 87 supported at its lower end for rocking movements about an axis parallel to and directly below the axis of the wheel. The upper end of this arm extends into the vicinity of the cam wheel which has thereon a pair of peripheral lugs 88 and 89 that are adjustable circumferentially of the wheel. In both Figs. 6 and 7 the parts are in the positions which they occupy when the blowing element is fully retracted, the latches for the motor valves being held in idle positions and the lug 88 remaining where it was after having shifted the reversing valve to "extend" position. In order to cause the motors to start, the valves 62 and 63 must be opened by air from a manually controlled control system and must be held open long enough to cause the cam wheel, as viewed in Fig. 6, to turn in the clockwise direction the distance needed to release the latches and cause them to lock the valves open. Thereafter the motors will continue to run, under normal conditions, until the blowing element has returned to its retracted position. The time that elapses in making one complete cycle depends, among other things, upon the angular distance between the lugs 88 and 89. In other words, the cam wheels must turn far enough to bring the lug into engagement with the arm 87 of the reversing valve, before the blowing element can begin its return movement. The greater the distance between the two lugs, the longer will be the stroke of the blowing element.

As is customary, steam should be allowed to flow into the blowing element at the start of each cycle and should be shut off when the cycle is ended. The head 2, which contains the valve to control the delivery of steam to the blower element, is indicated as being of a well known type such as shown, for example, in our prior Patent No. 2,357,529. In that head there is a pilot valve controlling the main valve and operated, in turn, by a pneumatic actuator in the form of a piston in a cylindrical casing. In the present instance 90 represents the pneumatic actuator for the pilot valve in a similar head; and in Fig. 8, 81 is the stem of the pilot valve, whereas 82 is a pipe to deliver air under pressure to the actuator. The pipe 82 is connected with a chamber 94 in a valve casing 55 located near the cam wheel 50. In the bottom of this casing is another chamber 95 communicating with the chamber 94 through a port 87. A normally closed valve 89, controlling this port, has a stem 93 protruding from the top of the valve casing not far from the cam wheel. The chamber 96 receives air under pressure through a pipe 100 that is connected to chamber 98 in the casing 55 of the main air valve. Therefore, whenever air under pressure enters chamber 58, some of it flows into chamber 96 so as to be ready to flow to the actuator 90 for the pilot valve in the blower head as soon as the valve 66 opens.

The valve 89 is adapted to be opened and to be locked in its open position by a flat, plate-like cam 101 pinned to an ear 102 on the valve casing for swinging movements in a plane parallel to the adjacent cam wheel. The peripheral edge face 103 of the cam is so curved that when the cam is in the angular position shown in Figs. 6 and 7 the valve 98 is unrestrained and closed. When the cam is turned counterclockwise, the edge face 104 presses the valve stem down and opens the valve. The valve stem is radial to the axis of the cam so that the cam serves as a positive lock.
are a pair of ears 105 and 106 that extend up behind the cam wheel in the form of a V. This permits a rearwardly projecting pin 107 on the cam wheel (see Fig. 14) to engage first one ear and then the other when the wheel oscillates; thereby rocking the cam back and forth between its idle and working positions. The pin 107 is preferably carried by a lug 108 detachably and adjustably secured to the rim of the cam wheel. The parts are so designed that, as the cam wheel turns in the counterclockwise direction during the return movement of the blowing element to its retracted position, the pin 107 passes ear 105 and strikes ear 106 shortly before the wheel stops. The cam is thus rocked into the idle position illustrated, allowing the valve 88 to close and the supply of steam to the tubular blowing element to be shut off. Then, when the cam wheel begins to turn in the clockwise direction at the start of a new cycle, the pin passes ear 105 and strikes ear 106. This causes the cam to rock in the direction to open valve 88, whereupon steam begins to flow into the blowing element.

In order that the blowing element may be protected from the furnace or combustion chamber quickly and be arrested slowly, there is provided a governor for throttling the flow of air to the traversing motor during the retreating movements of the blowing element but not during movements in the other direction. The pipe 85 from the reversing valve to the traversing motor 11 is connected to the lower part of the governor 86 which, in this instance, serves simply as a continuation of the pipe to the motor. In other words, the bulging part of the casing, indicated at 109 in Fig. 9, contains a bore 110 into one end of which the pipe 85 leads while the other end opens into a bore or passage 111, appearing in Fig. 12, in the motor block. The pipe 84, on the other hand, as best seen in Fig. 9 and Fig. 10, leads to a bore 112 near the top of the governor casing; from which bore there are two paths to the passage 114 that leads directly to the second bore or port 115 in the motor block. The first of these paths contains a check valve 116 while the second path goes through a throttle valve 117. Air entering through pipe 84 closes the check valve and must therefore follow the second path, containing the throttle valve. When air comes to the motor through pipe 84 and exhausts through pipe 85, the motor is revolving in the direction to retract the blowing element and is therefore running at its slower, regulated speed. When the direction of air flow is reversed so as to extend or project the blowing element, the incoming air flows through pipe 85 and is not subject to the control of the governor. The exhaust air which now flows back from the passage 114 is not required to go through the throttle valve, but simply lifts the check valve and flows on past the same. The motor now runs at a much higher speed than before, permitting the blowing element to be extended quickly.

The throttle valve 117 operates with ports 118 to reduce or completely stop air flow through the same. The speed of the motor determines the position of the valve. In the arrangement shown, the motor shaft has a crank on the end of which is a pin that rotates a ball governor 120 which, through a lever 121, moves the throttle valve in the direction to close the ports 118 when the motor speed exceeds a predetermined value. A spring 122, bearing against one end of the valve, acts in opposition to the governor so that, when the motor is not running, the valve is wide open. Consequently, whenever the motor is started, the energizing air is flowing freely and under full pressure, the throttling occurring only after it has reached a predetermined speed, and then only while the motor is driving the blowing element in the direction to retract it.

Previously the reversing valve has been described only in general terms. Since it includes novel and useful features, the detailed construction must be understood. The preferred form is illustrated in Figs. 16 to 19. The valve casing contains three independent, high, narrow chambers, 125, 126 and 127, arranged side by side. The pipe 82 is connected to the middle chamber, 125; pipe 84 is connected to chamber 126; and pipe 85 is connected to chamber 127. These chambers surround a partition or wall in the form of a cylindrical, open-ended sleeve or shell 128 which is perforated at each chamber to provide one or more ports 129 for communication with the same. Slidable back and forth within and lengthwise of the cylinder 128 is a spoon-shaped valve 130, movable between two positions in one of which it connects chamber 125 to atmosphere and chamber 127 to pipe 82, through chamber 126; whereas, in the other position, it connects chamber 127 to atmosphere and chamber 125 to pipe 85. Thus air for the traverse motor can flow to the same through either pipe 84 or pipe 85 and exhaust through the other of these pipes, depending on the position of the valve 130. The valve proper has stem-like axial extensions 131 at its ends, these extensions passing through and being secured to the arms of a yoke 132 in the form of a wide, flat U. The cross member of the yoke fits slidably in a groove 134 in the front face of the valve casing. At the center of the cross piece of the yoke is a pin 135 which projects from the same at the front and at the back. The rearwardly projecting portion of the pin is inserted in a recess 136 in the face of the casing to define the distance through which the yoke and valve can travel.

The immediate operating means for the reversing valve is an arm 137 mounted at its upper end for swinging movements on a horizontal stub shaft 138 fixed to the valve casing at some distance above the pin 135 and projecting forwardly over the latter; the lower end of the arm being connected to the pin. In a broad sense the arm 137 is a downward continuation of the actuating arm 87, heretofore described and which is also journalled on the stub shaft. The movements imparted to the actuator 87 by the cam wheel 51 are comparatively slow, whereas it is desirable that the reversing valve move quickly from one working position to the other, preferably by a snap action. To this end we have mounted the arms 87 and 137 so that they may swing relatively to each other and have provided means to lock the arm 137 against movement until the arm 87 has almost completed each shifting movement from one spoon-shaped positions to the other; energy being stored as the arm 87 swings in either direction and being released to drive the arm 137 sharply to a new position just about the time that the arm 87 stops.

Associated with the arm 87 is a spring holder 133 that is preferably separate from the arm and free to rock relatively thereto on the stub shaft. A strong spring 140 is interposed between the members 87 and 133 to cause them to act as a unit in normal service, but permitting either to move
while the other is being prevented from moving due to some abnormal condition that may arise. As best shown in Fig. 8, the arm 137 is T-shaped, the cross piece of the T being at the top. The spring holder lies in the plane of this arm and contains two vertical compression springs 141, one above each end of the cross piece. Thus the arms 87 and 137 are yieldingly connected for movements in unison with each other and if the arm 137 is held fast while the other is moved, one spring or the other will be further compressed, to supply the power subsequently to shift the valve very rapidly. Cooperating with the arm 137 are a pair of latches 144 standing upright at opposite ends of the cross arm or piece and provided with shoulders adapted to underlie the ends of said cross piece and lock the arm against rocking movements in one direction or the other, depending which of the latches is in action. A tension spring 145, connecting the latches together, holds them in their latching positions but allows them to be rocked into release positions. The latches project up on opposite sides of the spring holder and close to the latter. Consequently, when the actuating arm and its spring holder are rocked in either direction, the spring on the side which is swinging downward is compressed until, finally, the holder strikes the latch on that side and trips it. Upon the tripping of the latch the arm 137 is shifted and the other latch snaps into locking position to prevent a return movement of the arm 137 until the actuating arm 87 is again swung in the opposite direction and has almost completed that stroke.

The reversing valve is also provided with pneumatic actuating means. This means consists of a pair of aligned cylinders 146 and 147, disposed behind the actuating arm 87 with their common axis parallel to that of the valve. A plunger or connected-piston device 148 is engaged with both cylinders and is interlocked with the actuating arm to rock the same in one direction or the other, depending on which of the cylinders is energized. In the arrangement shown, the device 148 is a plunger provided at the middle with a circumferential groove 149, and there is a pin 150 projecting rearwardly from the actuating arm into the groove. When air under pressure is let into cylinder 145, the reversing switch is shifted to the "extend" position, as shown in Figs. 8 and 17. This is always done at the time of starting a cycle, in order to insure that the reversing valve is properly set; air being delivered to cylinder 146 directly from chamber 70 in the bottom cover plate 89 for the valve casing 55 through a pipe 151. Therefore, when air is admitted to chamber 70, through pipe 152, to open the main air valves, the reversing valve is automatically shifted to the "extend" position if it be not already there.

There are certain additional devices or features whose functions have not yet been explained. One of these is a device for unlatching the air valve 93, at will, to stop the traverse motor 11 at any time, regardless of the position of the blow-

ing element. This device consists of a little cylinder 154. 65

provided with a piston 155 having a stem 156 that protrudes from the cylinder. The device is mounted on the valve casing 55 in such position that when air is admitted into the cylinder, behind the piston, the stem is driven against the tail of latch 70 to force the latch into the release position which it occupies in Fig. 20. There is preferably a small vent 157 in the closed end of the cylinder. Air is delivered into the cylinder, when desired, through a pipe 158.

Another feature has to do with emergency retraction of the blowing element. This comprises means to shift the reversing switch if it is not already in the "retract" position and means to eliminate the influence of the governor on the speed of the traverse motor during retracting movements of the blowing element. To accomplish the first of these aims, air is delivered to the cylinder 147 of the pneumatic actuator for the reversing valve through a pipe 159. As shown in Fig. 8, a branch pipe 160 from pipe 159 leads into a cap-like closure 161 for one end of the cylindrical chamber in which the throttle valve 117 moves. Thus, when air is admitted into pipe 160 to cause the reversing valve to be shifted, some of this air enters the said chamber for the throttle valve, at a point to act in opposition to the force applied to the throttle valve by the ball governor, as can be seen in Fig. 10, and hold the valve wide open regardless of the speed of the motor. In other words, the blowing element can be withdrawn from the furnace just as fast as it can be projected into the same.

The starting of a cycle of operations and the altering of the same before its completion can conveniently be achieved by the operation of a few simple devices as, for example, push buttons. In Figs. 27-29 there is shown a simple control panel in which the manually-operable means are push buttons. Referring to these figures, 162 represents a casing open at the back and having on the front side, at the top, an air gauge and a steam gauge. Below the region of the gauges is a vertical row of three push buttons 164, 165 and 166. Within the casing, behind the push buttons, is a casting 157 that forms a housing for three valves. In the rear portion of the casing is an internal chamber 168, sufficiently long, in the vertical direction, to be intersected by the extended axes of all the push buttons and receiving air under pressure through a pipe 163. In the wall closing the rear side of said chamber are three bores 169, coaxial with the push buttons. Each button has a stem 170 extending rearwardly therefrom through the corresponding bore. A forwardly seating valve 171 on the rear end of each stem controls communication between the corresponding bore and the chamber 168. A spring 172 tends constantly to hold each valve seated. An intermediate portion of each bore is enlarged to form a little chamber 174 to which a little pipe is connected; these pipes, corresponding to the push buttons 164, 165 and 166, being respectively, 182, 183 and 189 to which reference has already been made. The push button devices are all alike except that the valves corresponding to the push buttons 164 and 165 close immediately when the operator's finger is withdrawn, the third push button is provided with means whereby its valve may be locked in the open position. It will be seen that push button 166 has a little radial handle 175 by means of which it may be turned. This push button also has a radial finger 176 that rides on an inclined surface 177 extending in an angular line along the axis of the push button on the back side of the front wall of the panel. Therefore, by turning the push button 166, the corresponding valve is not only opened, but is locked in the open position due to the small angle of inclination of the cam surface 177. With this arrangement, no separate vent ports are required, air leaking out of chambers 174 past the corresponding push buttons to reduce the pressure in such chambers to that of
the atmosphere when the corresponding push buttons are in positions to close their valves.

In Fig. 30 there is shown the control panel and, more or less diagrammatically, so much of the apparatus hereinafter described, at least in general terms, that is used to start a blowing cycle and permit it to be automatically completed in the normal or usual way. Referring to this figure, a pipe 178 from a main air line 190 to the air gauge enables the operator to see whether there is sufficient air pressure for proper operation of the system. If there is, he simply presses the push button 164; whereupon air flows from pipe 163 into pipe 152 and thence into chamber 70 in the bottom of the casing 95 for the main air valve. This causes the valve 82 and 83 to open and air to be delivered to motor 10 through pipe 81 and to the reversing valve 83 through pipe 82. A branch 151 of pipe 152 delivers air to cylinder 146 of the reversing valve to move that valve into “extend” position if it be not already there. Consequently, air from the valve 82 will pass through the reversing valve and pipe 85 to traversing motor 11 and from there through pipe 84 back to the reversing valve and be there exhausted into the atmosphere.

Although air entering the casing 98 in the casing for the main air valves from pipe 78 cannot pass on to the motors until the air valves are opened, some of this air immediately flows through pipe 100 to chamber 94 in control valve casing 95. Both motors having been supplied with air, the blowing element begins to rotate and move lengthwise into the furnace chamber. As herefore explained, the operator must keep the push button 164 depressed until the cam wheel 50 has released the latches 72 and 73 to permit them to latch the main air valves in their open positions. By the time that this has occurred the cam 101 will have been actuated to open the valve 68 in the valve casing 55 and lock it against closing; air now being permitted to flow through the pipe 62 to the pneumatic actuator 90 for the pilot valve in the scot blower head. A pipe 178, extending from the scot blower head 2 to the steam gauge on the control panel indicates what the pressure is in the blowing element.

A safety factor, so that the cycle will not continue if no or not sufficient steam is being supplied to the blowing element, there may be a secondary cam or lug 180 on the cam wheel 50 for tripping the latch 73 and allowing the air valve 63 to close shortly after the wheel 51 has turned far enough to release the latches. This causes the traversing motor to stop, although the blowing element continues to rotate. Then, if the operator sees that the gauge shows sufficient steam pressure, he may press the starting button again and cause the cycle to continue. The cycle having finally been started, either by the first pressing of the push button or by the second, (when the auxiliary cam 180 is used), the cycle completes itself automatically, as herefore explained; the blowing element rotating continuously, moving quickly into an extended position in the furnace chamber determined by the spacing between the lugs 88 and 89 on the cam wheel 51, and returning slowly under the control of the governor to its retracted position.

Because it may at times be desirable, or even necessary, to stop the lengthwise movement of the blowing element, or to retract it quickly, means to accomplish these ends are associated with the push buttons 165 and 166, respectively. As shown in Fig. 31, the depression of push button 165 caused air to be delivered from supply pipe 163 to pipe 156 and by the latter to the pneumatic tripping device 154 for the latch 73. When this valve 63 is down, the main valve 63 for the traversing motor 11 automatically closes and that motor stops. Upon again pressing the starting button 164, the valve 63 is again opened and is locked open by the latch 73, so that the cycle that was interrupted starts where it left off and continues until the blowing element is fully retracted.

When it is desired not merely to stop the traversing motor but to cause a quick withdrawal of the blowing element from the furnace chamber, the operator presses button 166. This causes air from pipe 163 to flow through pipe 156 to cylinder 141 of the reversing valve. If the blowing element is not already on its return stroke toward its retracted position, the reversing valve will be shifted so as to cause the return movement to begin at once. As previously explained, pipe 165, branching from pipe 156, carries a supply of chamber air to the bottle valve in the governor and causes this valve to be held wide open; the influence of the governor over the return speed of the blowing element being temporarily destroyed. It is to ensure against the assumption of control by the governor, during the retracting movement of the blowing element, that means have been provided to lock the button 166 in position to hold its valve open; since, otherwise, the operator would be required to keep his finger on the button until the blowing element reached its fully retracted position.

Herefore we have referred to the motors in general terms only. In the particular type of motor illustrated there are three radial cylinders 181, 182 and 183, containing pistons 186 on connecting rods that are attached to a crank pin 119. Shoes 186 on the connecting rods form with each other a sleeve held on the crank pin by a cap nut 197 that surrounds one end thereof while the other end extends into a groove 188 in the crank arm. The engine shaft, with a thick walled sleeve valve 190 surrounding it, extends through a hub 189 on the cylinder block. In the periphery of the valve 190 are similar, oppositely disposed, and concentric receding elements 191 and 192 spaced apart by a rib composed of two oppositely disposed sections 194, displaced axially relative to each other and joined together at their ends by diametrically opposed rib elements 195; the latter elements being of small angular length and wider than the combined widths of said rib sections.

A passage 196 extends through the cylinder block from the outer end of each cylinder to the bore in the hub 189, the hub ends of these passages constituting both inlet and exhaust ports for the cylinders. These ports are midway about the axis of the motor shaft, spaced at equal distances from one another, and lie with their centers in a plane parallel to and midway between the planes of the ribs 184. There are two other ports, 197 and 199, in the bore in the hub. These, as best seen in Fig. 13, are spaced approximately on the axis of the motor, at right angles to the axis of the shaft and at opposite ends of the recessed area of the valve. These ports are the ends of the passages 111 and 115, previously described. The function of the valve is to connect each port or passage 196 alternately to the passages 111 and 115 to admit escape and then exhaust is from each cylinder in proper time relation to the same cycle for the other cylinders.

There is another feature of the apparatus that has not been described in detail, namely, the bearing indicated as a whole by the numeral 71 in...
Fig. 1 and the construction of which is illustrated in Figs. 4 and 5. As there shown the blowing element extends through a spider 159 carrying three distributed rollers 200, rotatable about axes in a plane at right angles to the axis of the blowing element, and shaped to the curvature of the surface of the latter. The spider has at each end a hub 201 mounted in annular ball bearings the stationary races of which are supported by the casing; the planes of these ball bearings being at right angles to the axis of the blowing element.

As shown in Fig. 4, the discharge end of the stationary pipe 1 terminates in a nozzle setting on the ejection principle on fluids in the narrow nular space between the pipe and the surrounding tubular blowing element. Beginning a short distance inwardly from the end of the pipe, the core is first gradually contracted, as indicated at 203, and then expands again, as indicated at 204, as the end of the pipe is approached. In the region of minimum diameter there are holes or ports 205 bored through the wall of the pipe. As the steam flows past these holes or ports it creates a partial vacuum in the same to take care of any back pressure which might otherwise be built up in the free space surrounding the stationary pipe within the tubular blowing element.

For the sake of economy it is desirable to use ordinary commercial I beams to support the blow er units. However, these I beams have the dis advantage of not being made as accurately as possible in the case of similar members that have been machined surfaces. To compensate for this deficiency we provide means to make adjustments in the carriage I over a range equal to the variations likely to occur in ordinary I beams. The compensating means illustrated, as best shown in Fig. 6A, comprises an eccentric axle or journal 206 for each supporting wheel 207 for the carri age. Each of the members 206 is carried by one end of a short stub shaft 208 rotatably mounted in an arm 209 that projects upward from the body of the carriage. Each stub shaft may be clamped in any position angularity of its axis by simply tightening the nut 210 on the outer end thereof; further security against accidental displacement being afforded by a set screw 211 extending down through the top edge of the corresponding arm 209 and into a groove 212 in the shaft. By turning the stub shaft carrying the same, each supporting wheel may be raised or lowered as may be necessary for achieving smooth working of the tubular blowing element in its various movements. In other words, the rollers 213 on the carriage can be made to contact the under side of the flanges while the wheels run on top of the flanges, regardless of the thickness of the flanges, within limits.

We claim:

1. The combination with a blowing element and power means to move it back and forth between a retracted position and an extended position of a governor for the power means to cause the said element to travel more slowly toward its retracted position than it does toward the extended position, and manually controlled means to cause a reverse in the movement of said element toward the extended position and to render the governor inoperative to control the speed of movement of the element toward the retracted position.

2. The combination with a blowing element and power means to move it back and forth between a retracted position and an extended position, and a controller for said power means of an actuator for the controlling means including a member tending constantly to move from a working position to an idle position, a manually operable device to move said member to a working position, a latch for holding said member in its working position, mechanism coordinated in movement with movements of said element to trip the latch, and means including a second manually operable device for tripping the latch at will.

3. The combination with a blowing element and power means to move it lengthwise between a retracted position and an extended position, and a controller for said power means including a reversing device of an actuator for the controller including a member tending constantly to move from a working position to an idle position, a manually operable device to move said member to a working position, a latch for holding said member in its working position, mechanism coordinated in movement with movements of said element to operate the reversing device and to trip the latch, means including a second manually operable device for tripping the latch, and means including a third manually operable device cooperating with the last mentioned means to operate the reversing device.

4. The combination with a blowing element, means including an air motor to move back and forth from a retracted position to an extended position, and a valve for admitting steam to said element: of air operated means for controlling the steam valve, a main air valve for admitting air to the motor, means to admit air to said main air valve and to said air operated control means, the said main air valve tending constantly to close, means including a pneumatic actuator and a manually operable device for admitting air there to for opening the main air valve, a latch for holding the main air valve open, and means coordinated in movements with said element for tripping the latch.

5. The combination with a blowing element and an air motor for moving it back and forth from a retracted position to an extended position: of pneumatically actuated apparatus to reverse the direction in which said motor is moving, a governor for controlling the flow of air through the motor to cause the movement of said element toward the retracted position to be slower than movement in the opposite direction, and a manually operable member and means associated therewith to admit air to and means for actuating the reversing apparatus and simultaneously cause air to be supplied to the motor independently of governor control.

6. A soot blower apparatus comprising a stationary pipe for supplying cleaning fluid and a tubular blowing element surrounding and movable lengthwise of the pipe between a retracted idle position and an extended working position, wherein the end of the pipe within said element terminates in a nozzle wherein the bore is restricted at an intermediate point and wherein there are ports through the wall of the nozzle at such point.

7. The combination with a blowing element adapted to be reciprocated between an extended position and a retracted position and to rotate about its own axis, of an air motor to reciprocate said element and a second air motor to turn the latter, a reversing valve for the first motor, a valve device to control the delivery of air to the first motor through its reversing valve and directly to the second motor, separate pneumatic actuators for the reversing valve and said valve device, and means, including a manually operable
member simultaneously to energize or deenergize said actuators.

8. The combination as set forth in claim 7, wherein there is a device driven by the first motor, and means controlled by that device to cause the reversing valve to be shifted at each end of a reciprocatory movement of the blowing element and to cause the said valve device to shut off the air controlled thereby whenever the blowing element is in its retracted position.

9. The combination with a blowing element adapted to be reciprocated between an extended position and a retracted position and to rotate about its own axis, of an air motor to reciprocate said element and a second air motor to turn the latter, a reversing valve for the first motor, a valve device to control the delivery of air to the first motor through its reversing valve and directly to the second motor, separate actuators for the reversing valve and said valve device, and means, including a push button at a remote point, to energize said actuators as long as said push button is being pressed, latch means for said valve device, and means driven by the first motor to control said latch means.

10. The combination with a blowing element adapted to be reciprocated between an extended position and a retracted position and to rotate about its own axis, of an air motor to reciprocate said element and a second air motor to turn the latter, a reversing valve for the first motor, self-closing valves to control the delivery of air to the reversing valve and directly to the second motor, respectively, pneumatic actuating means for opening said valves, means including a manually operable device to energize said actuators so as to open the self-closing valves and shift the reversing valve into position for causing the blowing element to be extended, latches to hold the self-closing valves open, means driven by the first motor to cause the reversing valve to be shifted to its retracted position whenever the blowing element reaches its extended position, and other means driven by the first motor to trip the latches when said element reaches its retracted position.

11. The combination as set forth in claim 10, wherein there is a second manually operable device and means controlled thereby to make it possible at any time to energize the actuator for the reversing valve and cause it to enter its retracting position if it is not already there.

12. The combination as set forth in claim 10, wherein there is an additional manually operable device to trip the latch that holds open the valve through which air passes to the first motor by way of the reversing valve.

13. The combination with a blowing element adapted to be reciprocated between an extended position and a retracted position and to rotate about its own axis, of an air motor to reciprocate said element and a second air motor to turn the latter, a reversing valve for the first motor, self-closing valves to control the delivery of air to the reversing valve and directly to the second motor, respectively, pneumatic actuating means, for opening said valves, means including a manually operable device to energize said actuators so as to open the self-closing valves and shift the reversing valve into position for causing the blowing element to be extended, latches to hold the self-closing valves open, a shaft driven by the first motor and extending to points near said valves, means on said shaft to shift the reversing valve whenever the blowing element reaches the vicinity of either of its extreme positions, and other means on said shaft to trip the latches when said element reaches the vicinity of its retracted position.

14. The combination with a blowing element, means including an air motor to move it back and forth from a retracted position to an extended position, and a valve for admitting steam to said element: of air operated means for controlling the steam valve, a main air valve, piping connecting the main air valve to the motor and having therein a two-position reversing device for the motor, means driven by the motor in timed relation to the blowing element acting on the reversing device to operate the same, the main air valve tending constantly to close, piping connected to both the main air valve and said air operated means to supply air thereto, a valve in the latter piping controlling admission of air to said air operated means, means driven by the motor in timed relation to the blowing element to operate the last-mentioned valve: an additional, pneumatic operating means for said reversing device; means, including a pneumatic actuator that is connected to the main air valve, and a manually operable device for admitting air thereto, to open the main air valve; said manually operable device also admitting air to said pneumatic operating means for the reversing device to set the latter in one of its two positions, if it is not already there; a latch for holding the main air valve open: and means coordinated in movement with said blowing element for tripping the latch.

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