May 15, 1951 C. L. HOWSE 2,553,044

CONTROL SYSTEM FOR SOOT BLOWERS

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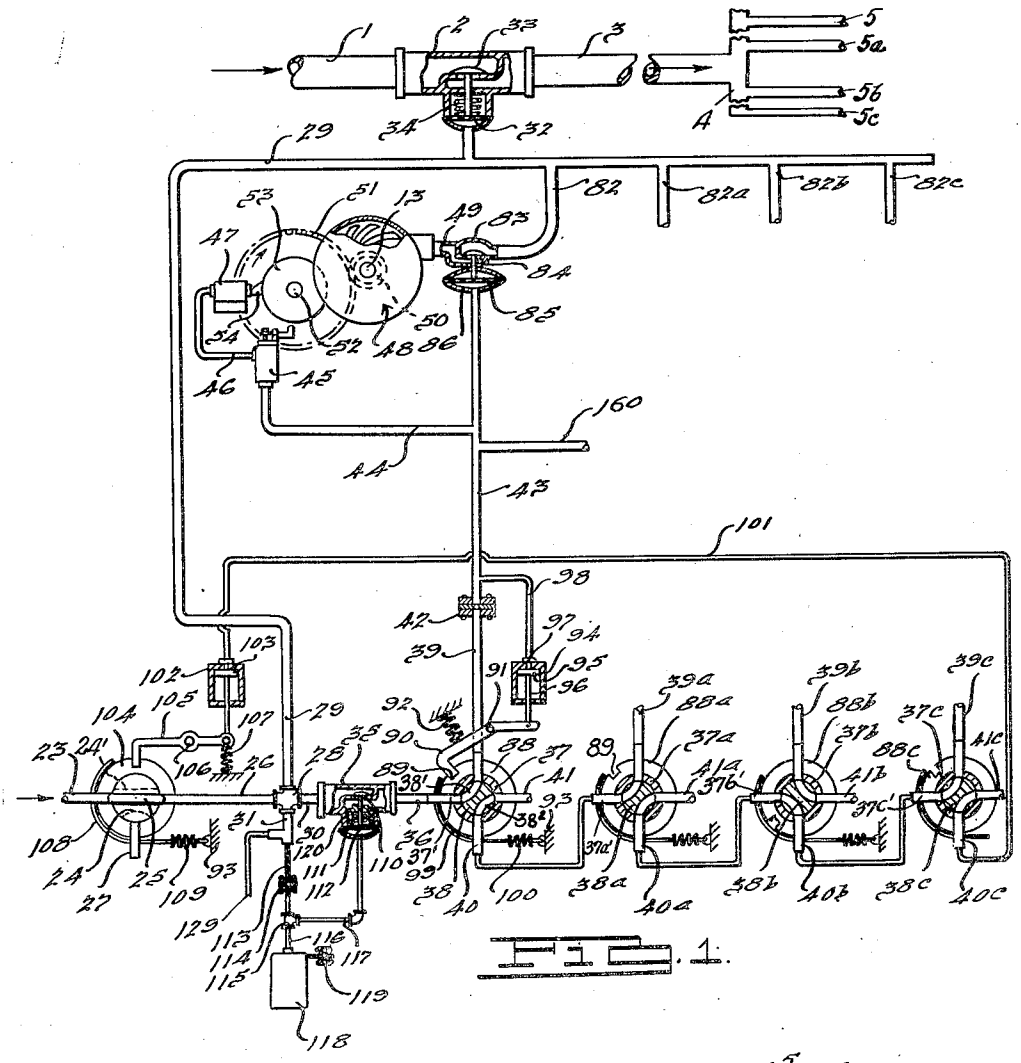


FIG. 1.

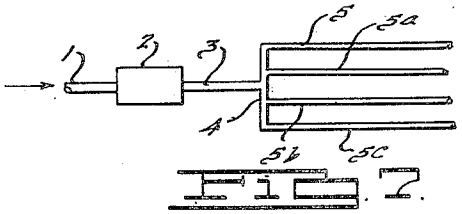


FIG. 2.

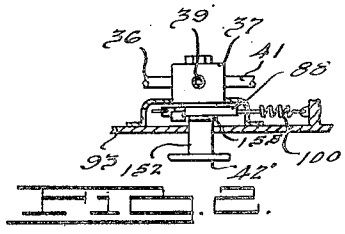


FIG. 3.

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FIG. 3.

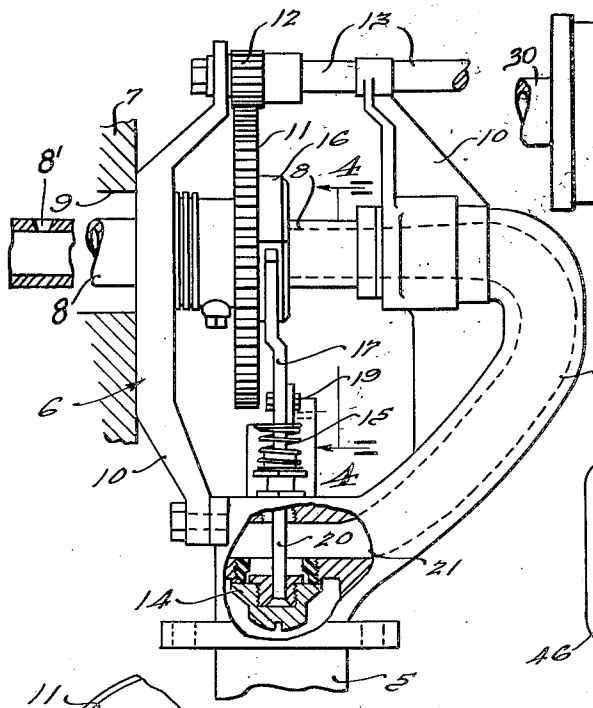
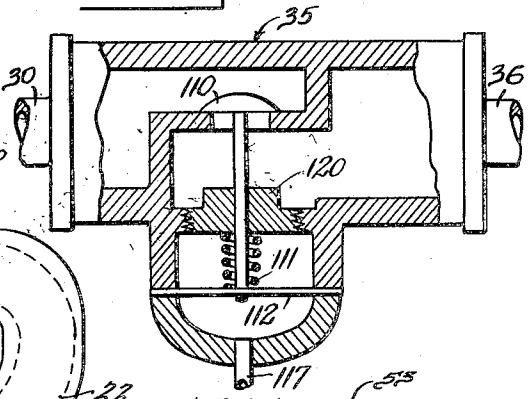


FIG. 13.



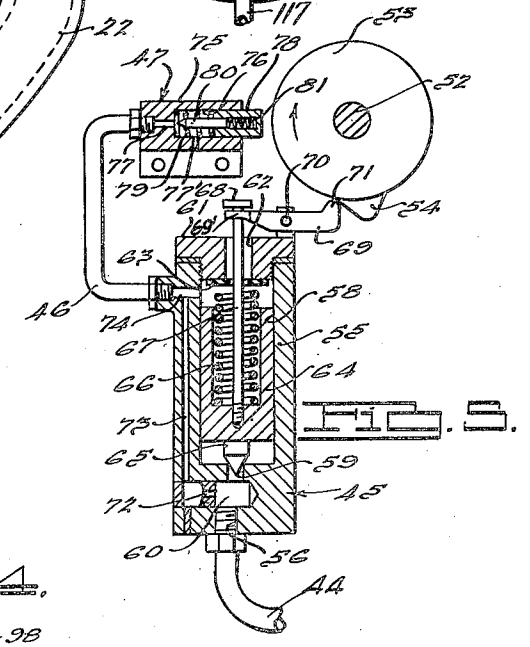


FIG. 5.

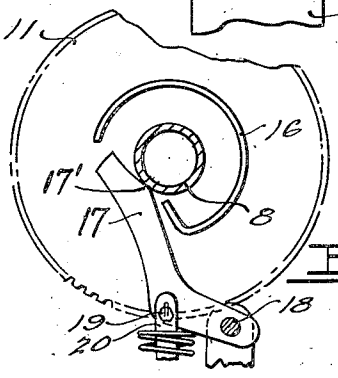


FIG. 4.

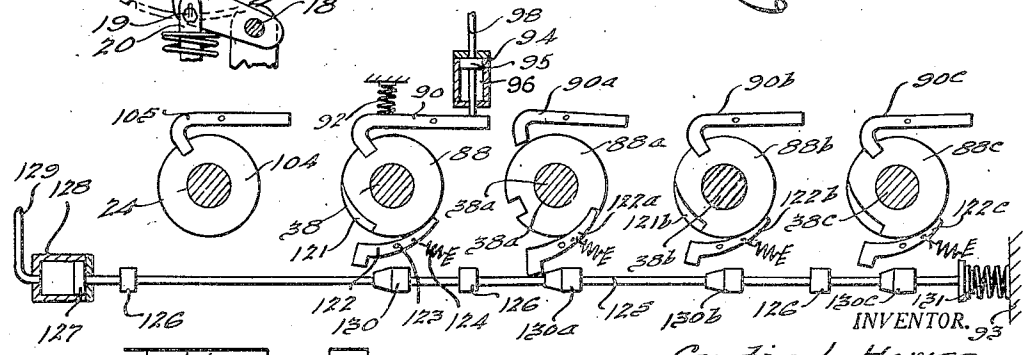


FIG. 6.

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CONTROL SYSTEM FOR SOOT BLOWERS

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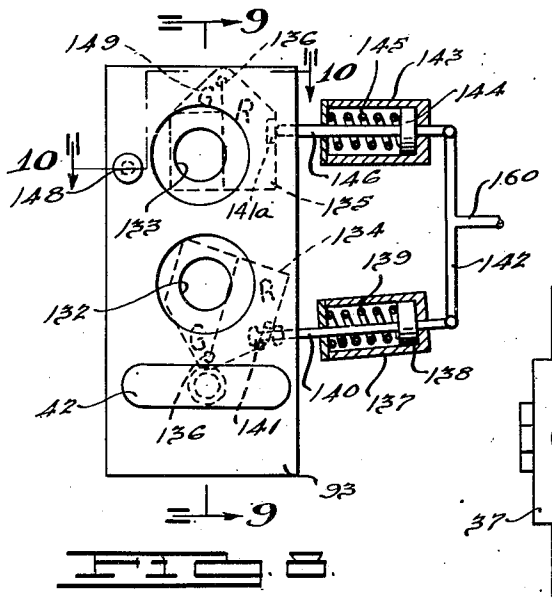


Fig. 8.

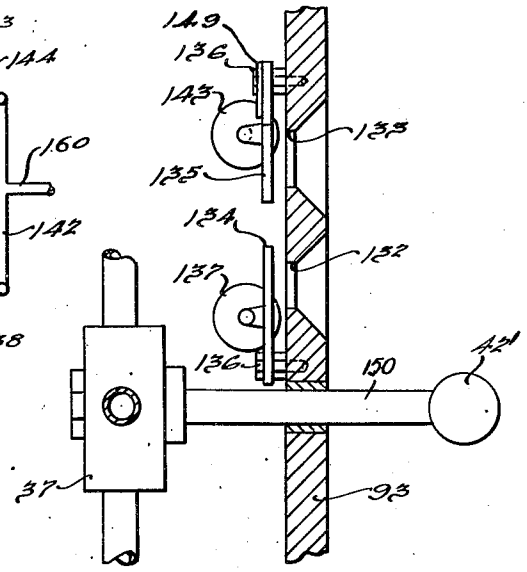
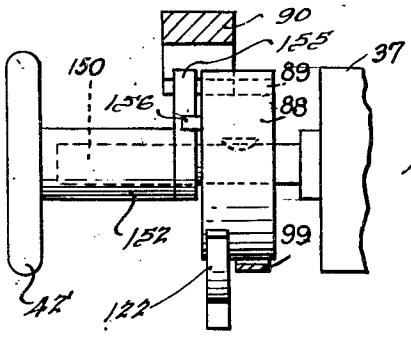


Fig. 9.

Fig. 12.



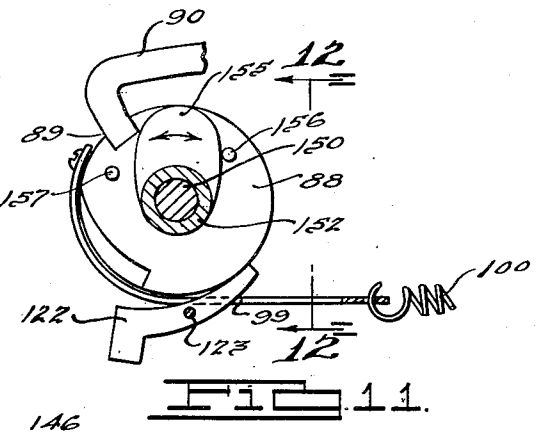


Fig. 11.

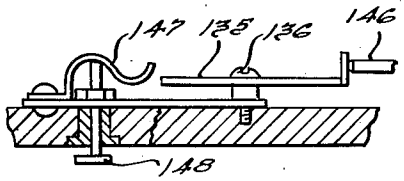


Fig. 10.

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Patented May 15, 1951 2,553,044

UNITED STATES PATENT OFFICE

2,553,044

CONTROL SYSTEM FOR SOOT BLOWERS

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Application January 10, 1945, Serial No. 572,153

32 Claims. (Cl. 15—318)

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The present invention relates to systems for selectively and progressively controlling the operation of soot blowers.

One of the primary objects of the present invention is to provide a novel system for selectively and progressively controlling the operation of a plurality of soot blowers.

Another object of the invention is to provide an automatic system of the type mentioned which may be mechanically set to selectively and automatically control the operation of a plurality of soot blowers according to a predetermined setting, and which, when once set, will run through the complete predetermined cycle. That is, after the predetermined cycle has begun it must be completed.

Another object of the invention is to provide a visual signaling or indicating means in combination with the system above mentioned which will indicate the status of the cycle at all times.

A further object of the invention is to provide a system of the type mentioned with a controllable delay in the system to delay the start of the soot blowers and thereby to permit heating up of the piping system and removal of condensate before blowing of the soot blower starts.

Other objects of the invention will become apparent from the following specification, the drawings relating thereto, and from the claims hereinafter set forth.

In the drawings, in which like numerals are used to designate like parts in the several views throughout:

Fig. 1 is a diagrammatic view of a system, according to the present invention, for selectively and progressively controlling the operation of a plurality of soot blowers;

Fig. 2 is a top plan view of one of the control valves of the system shown in Fig. 1 and showing such valve mounted on the panel of a housing within which the controls are mounted;

Fig. 3 is an elevation, with parts in cross section, of a portion of a blower head with which the control system of the present invention is associated;

Fig. 4 is a fragmentary elevational view taken substantially along the line 4—4 of Fig. 3;

Fig. 5 is a cross sectional view of certain control or relay valves employed in the present invention and showing the valves in their operative association with other of the control elements;

Fig. 6 is an elevational view of a locking system employed in conjunction with the control valves of the present invention, to insure completion of a predetermined cycle once the cycle has begun;

Fig. 7 is a diagrammatic view illustrating the connections of the control system with a plurality of pipes or conduits leading to the individual blower heads;

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Fig. 8 is a partial front elevational view of the control panel showing the control handle for one of the valves and illustrating the visual signaling or indicating means associated therewith;

Fig. 9 is a cross-sectional view taken substantially on the line 9—9 of Fig. 8 and looking in the direction of the arrows, showing the valve and control handle in elevation;

Fig. 10 is a cross-sectional view taken substantially along the line 10—10 of Fig. 8;

Fig. 11 is an elevational view showing modified manual actuating means for one of the valves and related parts; and

Fig. 12 is a cross-sectional view taken substantially along the line 12—12 of Fig. 11.

Fig. 13 is a sectional, elevational detail view of one of the controlling valves.

In cleaning the heated surfaces of boilers or other heat exchangers, it is frequently desirable that the cleaning be done in successive steps, to reduce the necessary rate of delivery of cleaning fluid and hence the required volumetric capacity of the cleaning fluid supply system. In cleaning boilers it is also desirable to start nearest the furnace and progressively clean portions nearer the stack, so that the matter discharged from the heating surface will be carried on through the boiler; and, as it invariably further encumbers successive passage in the boiler in the path of the gases, this matter will be cleaned in time, if the system is of the progressive nature, so that when the last surface is cleaned, the entire boiler will be cleaned. These operations are performed during the operation of the boiler, and it is further necessary to perform these operations in steps so as not to interfere with the operation of the boiler.

In order to perform the cleaning it is desirable that the succession of steps be automatically controlled so that they do not require constant attention of an operator, who may be busy on other duties in connection with the operation of the boiler.

It is desirable in a progressive system that the operator be able to predetermine whether all blower units will be operated in succession or one or more blower units omitted from the normal cycle. It is frequently desirable to omit one or more of the units, inasmuch as all portions of the boiler do not become fouled at the same rate so that certain portions of the boiler may not need to be cleaned each time. The system of the present invention incorporates convenient means for omitting cleaning of those surfaces which do not need to be cleaned, thereby effecting economies in operation. It is also possible that one or more units might be mechanically defective for some reason and so impossible to operate; and such units may be omitted by proper selection in the operation of the present system.

By way of example, the system of the present invention may be employed with the type of boiler cleaner or soot blower disclosed in Snow Patent No. 1,966,190.

The blowing medium, that is, the medium which is blown through the soot blowers onto the tubes, may be steam or air or a combination of steam on some soot-blower heads and air on others. The system of the present invention is designed for any of these blowing mediums, alone or combined. With the use of air as a blowing medium, the piping need not be heated up to prevent condensation, as the piping is essentially the same temperature as the air; but when steam is used, the steam being hot and the piping being relatively cold, there will be a very considerable quantity of condensation. It is undesirable to have this condensation enter the soot-blowing element, as would be the case if the steam were controlled identically with the way the air is controlled. In a combination system where both steam and air are used, it would invariably be the practice to use the steam first, to clean the initial stages or portions of the boiler, that is, those first engaged by the gases of combustion; and air, if used at all, would be employed to clean the final portions, such as the economizer or air preheater. So that the system of the present invention will have universal application, it is therefore necessary to introduce a time factor between the opening of the main steam supply valve to the blowing head and actual initiation of operation of the first blower head. Use of this delay period permits steam from the main steam supply valve, which is opened initially, to enter the piping system and heat it up and allows all condensate to be drawn off by a suitable trap, which keeps the piping system free of accumulated moisture, so that only relatively moisture-free steam has access to the various blowing heads.

Referring to the drawings, a main blowing fluid supply conduit 1 is provided which leads from a source (not shown) of high-pressure air or steam to one side of a master control valve 2 of the diaphragm-actuated type. The opposite side of the valve 2 is connected to a conduit 3 which communicates with a header 4 (Fig. 7). A plurality of conduits as 5, 5*a*, 5*b*, and 5*c* communicate with the header 4, and each conduit leads to the inlet of a soot blower unit. There are four of such conduits shown in the embodiment illustrated, but it will be appreciated that the particular number may be varied to suit the installation.

In Fig. 3 the conduit 5 is shown communicating with the inlet of a soot blower head assembly generally indicated at 6. It will be appreciated that the other conduits 5*a*, 5*b*, and 5*c* lead to other similar blower heads. The blower head 6 may be of the type disclosed in the above-mentioned Snow patent. For a complete detailed study of such soot blower head and its relation to the boiler and boiler tubes, reference may be had to such Snow patent. A part of the boiler wall is shown at 7, and it will be understood that boiler tubes (not shown) may be disposed therein in the usual or any suitable way, a plurality of the soot blower heads 6 ordinarily being mounted on the wall 7 at desired points. Although only one blower head is depicted, each of the conduits 5, 5*a*, 5*b*, and 5*c* leads to one of such blower heads.

Each blower head 6 feeds, and serves to rotate, a rotary blower tube element 8, which extends through an opening 9 in the wall 7 and projects into the boiler where it is provided with a plurality of openings or nozzles through which it may discharge the cleaning medium against the portions to be cleaned.

The blower tube 8 projects outwardly through the opening 9 and is rotatably mounted in spaced bearings on a supporting bracket assembly 10. The blower tube element is rotated by means of a gear 11 keyed thereupon within the bracket assembly. A pinion 12 is keyed to a shaft 13 also journaled in the bracket 10, the pinion 12 meshing with the gear 11 to rotate the same upon rotation of shaft 13. Shaft 13 is driven by motor means presently to be described.

The blower tube element 8 is supplied with cleaning medium through the supply pipes 5 and through a valve 14 which is normally held closed by spring 15 to prevent flow of the cleaning medium to the blower tube elements. The valve 14 is adapted to be opened during a desired part of each revolution of the blower tube element. In order to accomplish this, a cam 16 is fixed to the gear 11 for rotation therewith. A valve-actuating cam follower or "trigger" 17 is pivotally mounted at 18 in the bracket assembly 10 and is actuatable by the cam 16 as shown in Fig. 4. The trigger 17 is connected at 19 with the stem 20 of the valve 14 to actuate the latter, and the length of the cam is such that the valve is thereby held open only during a portion of the rotation of the blower tube 8, that is, that portion during which the cam 16 engages the following surface 17' of the trigger 17. During such engagement, the trigger 17 is rocked about its fixed pivot 18 to depress the valve stem 20 and open the valve 14.

When the valve 14 is open the conduit 5 communicates with a passageway 21 formed in a conduit 22 which may also form a structural element of the supporting bracket assembly 10. The upper end of the conduit 22 communicates directly with the adjacent open end of the blower tube element 8.

The above description relates to the construction of one of the blower heads, and it will be understood that the other heads are of the same construction. It is to the control for predetermined, sequential and selective operation of such heads that the present invention is directed.

The control for the system is preferably air-operated and comprises a main control fluid supply pipe 23 (Fig. 1) which leads from a suitable source (not shown) of air under pressure. One end of the pipe communicates with the inlet of a master control valve 24. The control valve 24 may be a conventional three-way plug valve having an operating handle 25, so that when the valve is in the "on" position, in which it is shown in Fig. 1 the pipe 23 is in communication with another pipe or conduit 26; and when the handle is in the "off" position (rotated 90° counterclockwise from the position in which it is shown in Fig. 1), the conduit 29 communicates with the atmosphere through conduit 27.

The conduit 26 communicates through a coupling 28 with conduits 29, 30, and 31. With the valve 24 set so that air under pressure is passing from conduit 23 into conduit 26, the air in conduit 29 acts on a diaphragm 32 in valve 2 to unseat valve 33 against the action of spring 34 and thus to provide communication between conduits 1 and 3. When the valve 33 is open, the cleaning medium is thus permitted to pass to the conduit 5 and to valve 14 of blower head 6. Thus, when the valve 14 is open, the cleaning medium may pass to the blower element 8.

Conduit 30 communicates with one side of a diaphragm-operated valve 35, and the opposite side of the valve 35 communicates through a conduit 36 with the inlet 37' of a control valve 37 for one of the blower heads as 6. The control valve 35 is only needed when the delay above referred to is desired, that is, when steam is employed as the cleaning medium, and the means for effecting the delay by controlling the actuation of valve 35 will be described in detail hereinafter. The system will first be described regardless of the particular cleaning medium being used and with the assumption that the valve 35 is open.

In the embodiment illustrated there are four of the main control valves, generally designated 37, 37*a*, 37*b*, and 37*c*, one of such valves being provided for each of the blower head units, and the description here illustratively showing a system for the control of four blower heads. As mentioned above, this number may be varied for particular installations, but the principles here disclosed and claimed are applicable regardless of the particular number.

The valves 37, 37*a*, 37*b*, and 37*c* are all the same and are four-way plug valves with rotatable plugs or valve elements, 38, 38*a*, 38*b*, and 38*c*, respectively. A description of one of the valves will suffice for an understanding of all.

One of the outlets of valve 37 communicates with conduit 39, another with conduit 40, and another with conduit 41. The valve element 38 has the usual pair of passageways 38^1, 38^2 therein, so that when it is rotated by means of handle 42', conduit 36 may be placed in communication with conduit 39, at which time conduit 40 is in communication through conduit 41 with the atmosphere. When the valve body 38 is rotated to its other position, conduit 36 is in communication with conduit 40, and conduit 39 is in communication with atmosphere through conduit 41. Conduit 40 communicates with the inlet 37*a*' of valve 37*a*. Parts associated with valves 37*a*, 37*b*, and 37*c* corresponding to parts associated with valve 37 are designated by like reference characters distinguished by the inclusion of the letters *a*, *b*, and *c* respectively.

Handle 42' may be rigidly connected to the plug, as indicated in Figs. 2 and 9 or may have a lost motion connection therewith as shown in Figs. 11 and 12. When it has a rigid connection and the locking mechanism is employed, the valve cannot be turned once the cycle has been started. However, in certain instances it may be desirable to permit an operator to close one of the valves after the cycle has started, and the lost-motion connection and associated mechanism is then employed. This will be described hereinafter.

Conduit 40 communicates with the inlet 37*a*' to valve 37*a*; conduit 40*a* communicates with the inlet 37*b*' to valve 37*b*; and conduit 40*b* communicates with the inlet 37*c*' to valve 37*c*. Valve 37*c* is the last valve in the control, and its outlet conduit 40*c* communicates with a control for the master control valve 24. At the completion of the cycle, this control is effective to operate the valve 24 and close it. Its details will be described hereinafter.

Each valve 37, 37*a*, 37*b*, and 37*c* is connected through its corresponding conduit 39, 39*a*, 39*b*, or 39*c* with a similar, separate control circuit. A description of the control circuit for one will be sufficient for an understanding of all. Conduit 39 communicates through a restricting orifice contained in a plate 42 with a conduit 43. A

branch conduit 44 connects conduit 43 with the inlet of valve 45 which communicates through a conduit 46 with valve 47. The details of valves 45 and 47 and their operation will be described hereinafter.

An air motor 48 is provided, which may be of the vane type, and having an inlet 49 for admitting air under pressure to the interior thereof for the purpose of driving the same. The driven shaft 13 of motor 48 carries and serves to drive the pinion 12 and so turns gear 11 and the blower tube element 8, as described above in connection with the showing in Fig. 3.

A pinion 50 is also keyed to motor shaft 13 and meshes with a gear 51. Pinion 50 and gear 51 have the same ratio as pinion 12 and gear 11. Gear 51 is keyed to a shaft 52 carrying a disc 53 having a cam or actuating projection 54 integral therewith. The ratio of pinion 50 to gear 51 is such that in one cycle of operation of the soot blower the cam 53 makes one revolution, finishing up in the position shown in Fig. 1.

Referring to Fig. 5, the details of valves 45 and 47 and their operating relationship to each other are shown in detail.

Valve 45 comprises a valve housing 55 having an inlet 56 at the lower end thereof which communicates with the conduit 44. The housing 55 is formed with a central bore 58 therein and with a valve opening 59 of relatively small diameter which communicates with a passageway 60. The passageway 60 is in open communication with the inlet 56. The upper end of the valve housing is closed by a cap 61 which has an axial opening 62 therethrough. The inner face of the cap has a valve seat or valve pad 63 fixed thereto and such valve seat 63 is formed of a suitable resilient material, such as rubber, and is in the form of a ring having a central opening therethrough which will permit, in certain instances, communication of the upper end of bore 58 with the atmosphere through opening 62.

A plunger 64 is slidably disposed within bore 58 and has an integral tapered valve 65 fixed to the closed end thereof which is adapted to seat upon the valve seat formed by the upper end of opening 59 to close communication between passageway 60 and the bore 58 under the adjacent face of plunger 64. A helical compression spring 66 normally urges the plunger 64 downwardly so that the valve 65 closes the valve opening 59. A valve stem 67 is connected to the plunger 64 and projects upwardly through opening 62. Valve stem 67 has a head 68 formed on the outer end thereof.

To urge the plunger 64 upwardly so that the upper edge thereof bears against the valve pad 63 and closes communication between the bore and the atmosphere through opening 62, a rocker arm 69 is pivotally mounted on the cap 61 and has an inwardly directed forked arm 69' which embraces the valve stem 67 under the head 68. The opposite end of the arm 69 is formed with a projection 71 which is disposed within the path of the cam lobe 54 on disc 53. Thus, when the lobe 54 reaches the position shown in Fig. 5, continued rotation of the disc 53 in the direction of the arrow will depress the outer end of rocker arm 69 and cause the plunger 64 to move upwardly. When the plunger 64 moves upwardly, valve 65 opens so that air under pressure enters under the plunger and moves the plunger upwardly against the valve pad 63 to close communication with the atmosphere.

One of the most important elements of the

control is a restricting orifice 72 which is disposed within the passageway 69 and connects the inlet side of passageway 60 with a passageway 73. The upper end of passageway 73 communicates with another passageway 74 which is also connected with the upper end of bore 58 and with conduit 46.

Conduit 46 communicates with valve 47 and such valve 47 includes a valve housing 75 formed with an axial bore 76 therein opening through one end thereof. An inlet passageway 77 of reduced diameter is formed in the opposite end of the housing 75 and communicates with conduit 46. The bore 76 is open to atmosphere through port 77'. A plunger 78 is disposed within the bore 76 and the closed end of the plunger projects outwardly beyond the housing 75 in the path of lobe 54. A helical compression spring 79 urges the plunger 78 to its outer position. A needle valve 80 is slidably disposed within the hollow plunger 78 and is adapted to close the inner end of passageway 77. It is urged toward such passageway by means of a helical compression spring 81.

Air to the air motor 48, to operate the same, is supplied from conduit 29 through a conduit 82 (Fig. 1) which communicates with the inlet 49 of the air motor through a pressure-actuated diaphragm valve 83. The valve element 83 has a valve 84 disposed therein, the stem of which is connected to a diaphragm 85 for movement therewith. The diaphragm 85 is positioned within a housing 86 with which the conduit 43 communicates on the underside of the diaphragm 85. An increase of pressure within the housing 86 below the diaphragm 85 causes the diaphragm to move upwardly, thus unseating valve 84 and connecting conduit 82 with inlet 49. With this communication established, the air motor is operated to rotate shaft 13, pinion 50, gear 51, and disc 53.

Operation of valves 45 and 47 is accomplished as follows. With the valve 24 set so that air under pressure is present in conduit 29 and conduit 82, and with the valve 37 set so that conduits 36 and 39 are in communication; and with valve 35 open, air under pressure passes through orifice plate 42 into conduits 43 and 44. The pressure in conduits 43 and 44 is controlled by the relationship between the rate of admission of air through orifice plate 42 and the rate of escape thereof through orifice 72. This pressure in conduits 43 and 44 is sufficient to open valve 84 by reason of the action on diaphragm 85 and thus admit air to the air motor 48. The air motor will then operate the soot blower head through the shaft 13, which is connected with the blower nozzle tube element 8 as described above in connection with Fig. 3, and will also rotate gear 51 through pinion 50. The cam lobe 54 starts at the position of Fig. 1 where it was stopped when it contacted plunger 78 at the end of the previous cycle. The lobe 54, when it reaches the position shown in Fig. 5, actuates the lever 69 to raise valve 65 from its seat against the action of spring 66. As soon as valve 59 is opened, air pressure is applied to the underside of piston 64 with the result that the piston is forced upwardly and its top seats against the valve pad 63. As soon as this happens, air can no longer pass to the atmosphere through opening 62, but will have to pass through conduit 46 into the inlet 77 of valve 47. This valve passageway 77 is normally open to the atmosphere through port 77', since the plunger 78 and valve 80 are moved outwardly unless plunger 78 is engaged by lobe 54. Continued rotation of the disc 53 causes the lobe 54 to engage the plunger 78 and move it and valve 80 inwardly to close valve passage 77. When passage 77 is closed, opening to the atmosphere is shut off, and the orifice 72 can no longer control the pressure in the conduits 43 and 44, with the result that this pressure builds up to the same value as the supply pressure entering the inlet of valve 37.

Fixed to each of the valve plugs 38, 38*a*, 38*b*, and 38*c* is a disc 88, 88*a*, 88*b*, and 88*c* respectively. Each of these discs contains a notch as 89 into which a pawl 90 which is pivoted upon a fixed axis at 91 is adapted to be forced by means of a spring 92.

It will be understood that the valves 37, 37*a*, 37*b*, and 37*c*, together with the actuating means for each of the valves above described, may be mounted upon a suitable panel such as that indicated at 93 in Figs. 1, 2, and 9, although the invention is not concerned with the precise structural details of such mechanical supporting means.

The notch 89 is arranged so that when the valve plug 38 is rotated so as to connect conduit 36 with conduit 39, the valve is held in this position and cannot be rotated until the pawl 90 releases it.

The pawl is releasable by means of a cylinder and piston, the cylinder being indicated at 94 with the piston 95 disposed therein. A piston rod 96 projects through one end of the cylinder 94 and is pivotally connected to one end of the pawl 90, so that as the piston moves downwardly within the cylinder, the pawl is rotated about pivot 91 to release disc 88. The side of the piston opposite to that of the piston rod is connected through an inlet 97 in the cylinder 94 with a conduit 98. Conduit 98 communicates with conduit 43. Thus, when pressure builds up within conduit 43, with valves 45 and 47 closed to atmosphere, the piston rod 96 is moved downwardly to release the pawl. The resistance of spring 92 is such that when the pressure in conduits 43 and 44 is normal, that is, when they are exhausted to the atmosphere through valves 45 and 47, and the blower head is operating, the piston 95 does not have sufficient force to disengage the pawl 90 from notch 89 against spring 92. However, as soon as valves 45 and 47 are closed, the pressure in conduit 43, and therefore in conduit 98, rises to full supply pressure, there is sufficient force exerted by the piston to disengage the pawl.

A band 99 is fixed to the periphery of the disc 88 at one end, and the opposite end is connected to the spring 100. The opposite end of the spring 100 may be connected to a fixed part of the housing or panel 93, and when the pawl is released the spring 100 will cause rotation of the disc 88 and the valve body 38 so as to close off communication between conduits 36 and 39 and provide communication between conduits 36 and 40. Conduit 39 is then vented to atmosphere through conduit 41.

If the handle of valve 37*a* has been turned to its operating position, that is, its position which will permit communication between conduits 40 and 39*a*, the air motor and relay valves associated with the blower head for valve 37*a* will then be operated to follow the same cycle as that above described in connection with valve 37, valve 37*a* having a similar control system associated with it.

In Fig. 1 valve 37*a* is shown in its operating position so that upon completion of the operation in connection with valve 37 and the turning of valve 37 by spring 100 as above mentioned, the

blower head and nozzle tube associated with valve 37a will function in succession to the operation of the blower head and nozzle tube associated with valve 37.

Valve 37b has been shown in Fig. 1 as turned to its non-operating position so that upon completion of the cycle with respect to valve 37a conduit 40a communicates directly with conduit 40b and air passes to the inlet of valve 37c, thereby cutting out operation of the blower associated with valve 37b. For the valve setting illustrated in Fig. 1 the blowers associated with valves 37 and 37a operate in sequence, then the blower associated with valve 37b is by-passed and the blower associated with 37c then functions immediately following that controlled by valve 37a.

Valve 37c, in the embodiment illustrated, is the last valve in the cycle and upon completion of the operation of the unit controlled by that valve the valve body 38c is shifted to connect conduit 40b with outlet conduit 40c. Outlet conduit 40c communicates with conduit 101 which leads to the inlet of a cylinder 102 having a piston 103 therein connected to a pawl 105 having an end engageable in a peripheral notch of a disc 104, which is connected to the valve body or plug of the master control valve 24. The operation of the notched disc 104 is similar to the notched disc 88 in that a pawl 105 is disposed adjacent thereto and is pivotally mounted upon a pivot pin 106. One end of the pawl 105 is connected to the piston rod of piston 103 and the pawl is urged to its notching position by means of a spring 107 the function of which is similar to that of spring 92. A band 108 is connected to the disc 104 and is also connected to a spring 109 the other end of which is anchored, as to the panel 93. The action of the band 108 is similar to the action of band 99 to turn the disc 104 and rotate the plug of valve 24 to its closed position when the pawl is released from its notch. Thus communication between the conduits 23 and 26 is shut off at the completion of the entire cycle for all of the blowers.

In order that the piston 64 may be ready to operate on a subsequent blowing period, it is necessary that orifice 72 be again in control of the pressure in conduits 43 and 44, which means that valve 45 or valve 47 must be opened to the atmosphere. Valve 45 cannot open until the cam lobe 54 passes beyond the operating arm 69 and allows it to open. Therefore, valve 45 does not release air to the atmosphere and restore orifice 72 to control, but this is accomplished by valve 47. As stated previously, piston 64 which controls valve 65 and valve opening 59 is forced upwardly toward the seat 63 by action of the cam projection on the operating lever 69 and is held in that position by air pressure against the underside of piston 64.

The piston 64 will continue to stay in its upper position closing off the opening to the atmosphere through opening 62 until air pressure under piston 64 is reduced to below the operating pressure, or to atmosphere. That point at which valve opening 59 closes then is determined by the spring pressure of spring 66 and the air pressure under piston 64. It is noted that, as previously stated, when valve 47 is closed by lobe 54, it causes pressure in conduits 43 and 44 to rise to maximum, which causes pawl 90 to release the control valve which, therefore, returns it to its off position and the pressure in conduits 43 and 44 drops to atmosphere, being vented to atmosphere through conduit 41, as in that position of the valve conduits 39 and 41 are in communication. This decreases the pressure to atmosphere under piston 64 and the spring 66 returns it to its lower position closing valve passage 59. This opens passage 62 to the atmosphere so that it is immaterial whether valve 47 is open to atmosphere at the start of the next operation or not. It is pointed out that valve 45 acts as a relay valve, which in one case transfers control of the leak-off air from orifice 72 to valve 47 and in the second case takes control away from valve 47 and opens an auxiliary passage (62) for leak-off of air from orifice 72.

In the operation of the system above described, the delaying function of valve 35 has not been considered as it is not necessary when the controlling medium is air. In the operation of the system above described, the handles as 42' associated with control valves 37, 37a, 37b, and 37c may be turned to their operating or nonoperating positions to effect the desired cycle. Unless one or more of the valves is turned to its nonoperating position, the valves will operate in sequence; and, if one of the valves is turned to its nonoperating position, those valves turned to their operating positions will operate in sequence. After the control valves are set as desired, the master control valve 24 may be turned to its operating position. The master valve 24 is held in its operating position by the pawl 105 until the last head has completed its blowing according to the predetermined setting of the control valves 37, etc., associated therewith have run through their predetermined cycle. As soon as the last blowhead completes its blowing cycle and its valve is returned to its nonoperating position, the pawl 105 is actuated and valve 24 automatically turned to its nonoperating position as above described. The passages, generally designated 24', in the master control valve 24 are so arranged that when this valve is returned to its nonoperative position, all of the air contained in the piping system is discharged to atmosphere which vents conduit 29 and permits closing of valve 33 by spring 34.

When the blowing medium is steam, instead of air, or a combination of steam and air, then the initiation of blowing involves further refinements than those above described. As previously mentioned, a delay in the initiation of the cycle is desirable to remove the condensate first. This involves the introduction of a time factor between the opening of the main steam supply valve to the blowing head and actual initiation of operation of the first blowing head. This delay is accomplished by control of the opening of valve 35. The previous discussion involved the operation of the system in a manner in which it could be considered that valve 35 was always opened or dispensed with.

The valve 35 is a diaphragm pressure operated valve having a valve element 110 which controls the passage of air from conduit 30 to conduit 36. The valve element 110 is urged to a closed position by means of an adjustable spring 111 and the valve stem is connected to a diaphragm 112 for movement therewith. Conduit 31 is in open communication with a conduit 113 which has a restricting orifice plate 114 therein. The conduit 113 then communicates through a T-connection 115 with conduits 116 and 117. Conduit 117 leads to the underside of the diaphragm 112 and conduit 116 leads to a reservoir 118. Communicating with the reservoir 118 is a restricting orifice formed in a plate 119 and venting to atmosphere. The metering orifice in plate 119 is

considerably smaller than the orifice in 114 so that when air is admitted to conduit 113, the air in reservoir 118 will slowly build up in pressure to somewhat near the value of pressure in conduit 23 or 26. The diaphragm operated valve 35 may be adjusted by adjusting the spring 111 by means of an internal nut 120 which keeps the valve seated until the pressure in conduit 117 and on the diaphragm 112 reaches a value where it will open valve 110 and let the air pass into conduit 36. By predetermining the size of the reservoir 118 and the relative sizes of orifices in 114 and 119, the desired time interval may be interposed between the opening of the master control valve 24 and the opening of valve 35. This interval of time is arranged to provide the necessary delay so that the steam piping and other equipment may heat up and drain prior to the soot-blowing action taking place.

Referring to Fig. 6, the means are shown for insuring the completion of a predetermined cycle once it has started. This means includes the provision of a notch 121 in disc 88 and in each of the other discs 88*a*, 88*b*, 88*c*, and 104. A pawl 122 is pivotally mounted under the disc 88 on a fixed pivot 123 and is adapted to engage in the notch 121 when the disc rotates in a counterclockwise direction to a position in which the notch is adjacent the nose (upper) end of the pawl, which is resiliently urged toward the notch by means of a compression spring 124. The pawl is engaged in the notch when the valve 37 associated with that disc 88 is in its non-operating or by-passing position. The disc associated with valve 38*a* is shown in this position in Fig. 6.

A slidable rod 125 is disposed under the valves and discs and is slidably mounted in spaced bearings 126 which may be carried by the panel.

One end of the rod 125 (the left end, viewing Fig. 6) is connected to a piston 127 which is disposed within a cylinder 128. The left end of the cylinder 128 is in communication with a conduit 129 which communicates with conduit 31 as shown in Fig. 1. A cam in the form of a tapered collar as 130 is disposed on the shaft adjacent the lower end of each of the pawls 122, 122*a*, 122*b*, 122*c*. The shaft, together with the tapered collars, is urged to the left by means of a compression spring 131.

When the shaft and collars are in the left position, the tapered collars will engage their respective pawls to disengage the pawls from their corresponding notches 121 etc. so that the control valves can be manually turned at will to reset them. The control shaft 125 normally occupies the left-hand position in which pawls 122 etc. are prevented from entering the notches 121, etc., so that prior to operating the control system, the operator can freely turn each control valve that he desires in the direction of the arrows in Fig. 6 to its operating position where it is latched by pawl 90, or its corresponding pawl. Any control valve not so turned to its operating position will have its notch 121, or its corresponding notch, still in position so that its pawl 122, etc. can re-engage it as the operating shaft 125 is moved to the right as air enters cylinder 128. With this arrangement, therefore, prior to operating the master control valve 24 the operator rotates the control valves 38, 38*a*, 38*b*, and 38*c* to the operating position that he desires where those so turned are locked by their respective pawls 90, etc. The predetermined cycle is thereby set up so that any control valves not so rotated remain at their rest positions.

Rotation of the master control valve 24 to its operating position thus admits air to conduit 129 and cylinder 128 which shifts the operating shaft 125 to the right against the resistance of spring 131. This frees all of the pawls 122, etc. to re-enter the notch 121, etc. of any disc in position to permit it (which has not been shifted by turning its control valve to operating position). It is then impossible for the operator to rotate a control valve from the off position to the operating position, after he has opened the master control valve to supply air to the control system. The operator accordingly cannot confuse the operation of the system by changing his mind after the system has been put into operation. Without such provision of the pawls 122, etc., the injudicious or accidental turning of either the master control valve 104 or one of the individual control valves before completion of the cycle could cause one or more of the blowers to be stopped while in a dangerous position, as for example in the case of projectable-type soot blowers, before the full retraction of a blower to the protected, inoperative position. After the completion of the operation of any particular valve, its disc is engaged by its pawl corresponding to 122 so that it can not again be reset until the completion of the entire cycle.

As mentioned above, it may be desirable to provide a construction in which the operator is permitted to turn off a valve once the cycle has started, or during the operation of the cycle. The structure to permit this is shown in Figs. 11 and 12. The handle 42', instead of being rigidly attached to the shaft 150 of the valve, as previously considered, is mounted on shaft 150 for limited relative rotation with respect thereto and the shaft in turn is rigidly connected to the valve plug 37 and has the disc 88 rigidly connected thereto for rotation therewith. This is accomplished by a sleeve 152 which is connected to the handle 42' and which telescopically receives the shaft 150 therein. When the valve has been set for operation, the latch 90 is engaged in slot 89, and the valve cannot be turned to its off position until this latch is released from the slot. The sleeve 152 has a cam 155 fast thereupon and having a curved opposite edge. The latch 90 projects laterally to overlie the cam 155 as well as the disc 88, as shown in Fig. 12. Thus, by turning the handle 42' counterclockwise, as viewed in Fig. 11, when pawl 90 is in slot 89, cam 155 will raise the latch out of the notch so that the valve will then be turned to its off position by the spring 100 acting through the strap 99. Limit pins 156 and 157 are fixed to and project outwardly from the disc in the path of movement of the cam 155 to limit relative movement between the disc and handle and permit manual turning of the disc. The cam 155 is shaped to lift the pawl 90 when the handle is turned in either direction, as will be apparent.

The present invention also contemplates the provision of a signaling system by which the operator may be visually informed of the condition of the system at any time. This involves the provision of visual signaling means for each of the control valves. Referring to Figs. 8 and 9, the signaling system is shown in its association with valve 37, and it will be understood that similar means is provided for each of the other valves. The panel 93 adjacent one of the valves is formed with a pair of vertically spaced windows 132 and 133 therethrough. These are disposed above the operating handle 42'. A pivot-

ed screen is disposed behind each of the windows, such screen being indicated at 134 for window 132 and 135 for window 133. Each screen is formed of two colors, the left-hand of each screen being green and the right-hand red. The lower screen 134 is pivotally mounted on the back of the panels 93 by means of a pivot pin 136 at the bottom thereof; and the screen 135 is pivotally connected at its upper edge to the back of the panel by pivot 136.

A cylinder 137 is disposed adjacent screen 134 and has a piston 138 therein which is urged to the right, viewing Fig. 8, by a spring 139. The piston rod 140 is pivotally connected to the screen 134 by suitable articulating means as 141. Air is admitted to the right-hand end of cylinder 137 through a conduit 142.

A similar cylinder 143 is disposed adjacent screen 135 and has a piston 144 therein which is urged toward the right by spring 145. The piston rod 146 bears against a tab 141a carried by one edge of the screen 135 so that when the piston moves to the left the screen is pushed about its pivot 136 to shift the red half in front of the window 133. When it is pushed to this position, it is caught by a spring latch 147 (Fig. 10) and is held in this position until it is released by a push button 148. The screen 135 is then free to drop down to a position so that the green is again visible through the opening 133. The screen 135 may be weighted if desired, as indicated at 149.

Spring 145 in the top cylinder 143 is stronger than spring 139 in the bottom cylinder 137 so that the upper screen is not operated until a higher pressure is obtained.

The conduit 142 conducts air to the ends of each of the cylinders 137 and 143 to operate their respective pistons and such conduit 142 is in communication with a conduit 160 which communicates with conduit 43 to receive its supply of air under pressure as shown in Fig. 1 and which, therefore, has the same pressure conditions prevailing therein as prevail in conduit 43 at any time.

When fluid (air in the illustrative system under consideration) is delivered to the control line as 39—43 for the blower to which the indicator assembly is connected (the indicator assembly for the blower operable by the first air motor 48 being shown in Fig. 3), reduced pressure exists in the control conduit 43 during the period prior to the closing of vent valve 47, as previously explained, and this pressure, which is delivered to cylinders 137, 143 by the branch conduits 160, 142 while the blower is rotating, is sufficient to compress the bottom spring 139 to throw the lower screen 134 to the red position. The bottom screen accordingly shows red through the window 32 as soon as the corresponding blower commences to operate, and this screen remains in the red position during the time that the blower in question is operating. The reduced pressure which exists in the control conduit and connected system during operation of the blower is not sufficient, however, to move the piston 144 against the resistance of spring 145, so that the top screen remains in the green position, while the blower is in operation. Of course both screens are also in the green position before the blower commences to operate.

When the blower completes its operation, the pressure builds up to a higher value in the control conduit due to the closing of the vent valve 47 and the increased pressure developed in conduit 160 and the cylinder 143 connected thereto overcomes the resistance of spring 145. Screen 135 then moves to the red position, imparting a red appearance to the window 133 and indicating that the blowing cycle for that blower has been completed. Screen 135 is latched in the red position, so that although the lower screen 134 returns to the green position after the pressure in the control line system is dissipated, to indicate that the blower is not in operation, the upper screen remains in the red position to indicate that the blower has operated. A push button 48 is provided serving as the latching member for the screen 135 and arranged so that when the button is pushed, the screen 135 is released to allow it to fall to the green position.

The indication of red in window 133 and green through opening 132 will then indicate to the operator that its particular head has completed its cycle and he can, therefore, tell at a glance at each indicating target on the panel whether or not a head has completed its cycle or is then operating. After the complete blowing operation has taken place on all of the heads and the operating handles all returned to the off position, the operator can restore conditions for the next operation by merely pushing button 148, and the corresponding buttons for the other valves.

The springs 139 and 145 are of such strength that the lower window 132 will show red shortly after the fluid under pressure has been introduced into the lines, thus indicating that the system is operating, but the upper window will continue to show green until nearly full pressure has been established in the lines, and then will show red. With this arrangement, the operator is fully advised at all times of the status of the system. In the embodiment illustrated the button 148 is shown as individually operated for each valve.

Formal changes may be made in the specific embodiments of the invention disclosed without departing from the spirit and substance of the invention, the scope of which is commensurate with the appended claims.

What is claimed is:

1. Controlling means for a heater cleaner of the type incorporating a plurality of blower units, conduit means for conducting a cleaning fluid to said blower units, a pressure responsive valve for controlling the flow of said fluid through said conduit means, means associated with each of said blower units for operating each of said units, and mechanical means operably connected to each of said last-named means for effecting operation of said last-named means, said control means including pressure responsive control means for actuating each of said mechanical means, a valve associated with each of said control means to control the flow of fluid thereto, means interconnecting the valves for all of the control means for operating said control means in succession according to a preset cycle for said valves, and a master fluid pressure control means operably connected to said pressure responsive valve and with the valves associated with the control means for controlling the opening and closing of the pressure responsive valve and for controlling the supply of fluid to said pressure responsive control means through the valves associated with the control means.

2. Controlling means for a heater cleaner of the type incorporating a plurality of blower units,

conduit means for conducting a cleaning fluid to said blower units, means associated with each of said blower units for operating each of said units, mechanical means operably connected to each of said last-named means for effecting operation of said last-named means, said controlling means including pressure responsive control means for actuating each of said mechanical means, a four-way valve associated with each of said control means to control the flow of fluid thereto, means interconnecting an outlet port of one of the valves with the inlet port of the next succeeding valve for operating said control means in succession according to a preset cycle for said valves, and a master fluid pressure control means for controlling the supply of fluid to said pressure responsive control means through said valves.

3. Controlling means for a heater cleaner of the type incorporating a plurality of blower units, conduit means for conducting a cleaning fluid to said blower units, means associated with each of said blower units for operating each of said units, mechanical means operably connected to each of said last-named means for effecting operation of said last-named means, said controlling means including pressure responsive control means for actuating each of said mechanical means, a valve associated with each of said control means to control the flow of fluid thereto, means interconnecting the valves for all of the control means for operating said control means in succession according to a preset cycle for said valves, a master fluid pressure control means for controlling the supply of fluid to said pressure responsive control means through said valves, and means responsive to the pressure in the first-named control means for one of the blowers to move the valve associated with that first-named control means to thereby shut off the flow of fluid to said that control means and vent said that control means to atmosphere.

4. Controlling means for a heater cleaner of the type incorporating a plurality of blower units, conduit means for conducting a cleaning fluid to said blower units, means associated with each of said blower units for operating each of said units, mechanical means operably connected to each of said last-named means for effecting operation of said last-named means, said controlling means including pressure responsive control means for actuating each of said mechanical means, a four-way valve associated with each of said control means to control the flow of fluid thereto, means interconnecting one of the outlets of one of the valves with the inlet of the next succeeding valve, a master fluid pressure control means having a conduit connected to the inlet of said one of the valves, and means responsive to the pressure in the control means for one of the blowers to move the valve associated with that control means to thereby shut off the flow of fluid to that control means and to communicate the master control means with the next succeeding valve.

5. Means for controlling the operation of a blower unit incorporated in a heat exchanger-cleaner of the variety having conduit means for conducting a cleaning fluid to such blower unit, means including a movable element associated with said blower unit for movably operating said unit, and fluid actuated means operably connected to said element for moving said element, said controlling means including fluid pressure operated control means for controlling the actuation of said fluid actuated means, means to conduct fluid under pressure to said control means and to said fluid actuated means, said control means including means operably connected to said fluid actuated means and responsive to the operation of said fluid actuating means to control the operation of said control means, and a pair of valves in series in the control means and operated by said last-named means to change the pressure conditions in the control means to effect operation of said fluid actuated means.

6. Means for controlling the operation of a blower unit of the variety having conduit means for conducting a cleaning fluid to such blower unit, means including a movable element associated with said blower unit for operating said unit, and fluid actuated means operably connected to said element for moving said element, said control means including fluid pressure operated control means for controlling the actuation of said fluid actuated means, a valve associated with the control means to control the flow of fluid thereto, means to conduct fluid under pressure to said control means through said valve and to said fluid actuated means, said control means including means operably connected to said fluid actuated means and responsive to the operation of said fluid actuating means to control the operation of said control means, a pair of valves in series in the control means and operated by the last-named means to change the pressure conditions in the control means to effect operation of said fluid actuated means, and means responsive to the pressure conditions in the control means to shift the first-named valve.

7. Means for controlling the operation of a plurality of blower units incorporated in a heat exchanger-cleaner of the variety having conduit means for conducting a cleaning fluid to such blower units, means including a movable element associated with each of said blower units for operating each of said units, and fluid actuated means for each of said units operably connected to said movable elements for moving said elements, said controlling means including fluid pressure operated control means for each of said units for controlling the actuation of said fluid actuated means, a valve associated with each of the control means to control the flow of fluid thereto, means interconnecting the valves for all of the control means for operating the control means in succession according to a preset cycle for said valves, master fluid pressure control means to conduct fluid under pressure to said control means through said valves and to said fluid actuated means, each of said control means including means operably connected to said fluid actuated means and responsive to the operation of said fluid actuating means to control the operation of said control means, a pair of valves in series in the control means and operated by the last-named means to change the pressure conditions in the control means to effect operation of said fluid actuated means, and means responsive to the pressure conditions in the control means to shift the first-named valves.

8. Controlling means for a heater cleaner of the type incorporating a plurality of blower units, conduit means for conducting a cleaning fluid to said blower units, a valve for controlling the flow of said fluid through said conduit means, means associated with each of said blower units for operating each of said units, and mechanical means operably connected to each of said last named means for effecting operation of said last named means, said control means including fluid pres-

sure operated control means for actuating the mechanical means for the blower units according to a pre-set cycle, said control means being operably connected to said valve for controlling the opening and closing of said valve, and said control means including means to delay the operating of said mechanical means until after the opening of said valve.

9. Controlling means for a heater cleaner of the type incorporating a plurality of blower units, conduit means for conducting a cleaning fluid to said blower units, a valve for controlling the flow of said fluid through said conduit means, means associated with each of said blower units for operating each of said units, and mechanical means operably connected to each of said last named means for effecting operation of said last named means, said control means including pressure responsive control means for actuating each of said mechanical means, a valve associated with each of said control means to control the flow of fluid thereto, means interconnecting the valves for all of the control means for operating said control means in succession according to a pre-set cycle, and a master fluid pressure control means operably connected to said first named valve for controlling the opening and closing of said valve, and operably connected with the valves for the pressure responsive control means, and said control means including means to delay the flow of fluid to the second named valves until after the opening of said first named valve.

10. Controlling means for a heater cleaner of the type incorporating a plurality of blower units, conduit means for conducting a cleaning fluid to said blower units, means associated with each of said blower units for operating each of said units, mechanical means operably connected to each of said last-named means for effecting operation of said last-named means, said controlling means including pressure responsive control means for actuating each of said mechanical means, a valve associated with each of said control means to control the flow of fluid thereto, each of said valves having a manually shiftable portion, means interconnecting the valves for all of the control means for operating said control means in succession according to a preset cycle for said valves, a master fluid pressure control means for controlling the supply of fluid to said pressure responsive control means through said valves, and means including a pressure-actuatable blocking element to prevent a change in the valve settings from the predetermined setting for the cycle after the cycle has begun and before the cycle is completed.

11. Controlling means for a heater cleaner of the type incorporating a plurality of blower units, conduit means for conducting a cleaning fluid to said blower units, means associated with each of said blower units for operating each of said units, mechanical means operably connected to each of said last-named means for effecting operation of said last-named means, said controlling means including pressure responsive control means for actuating each of said mechanical means, a valve associated with each of said control means to control the flow of fluid thereto, and means interconnecting the valves for all of the control means for operating said control means in succession according to a preset cycle for said valves, a master fluid pressure control means for controlling the supply of fluid to said pressure responsive control means through said valves, and means operably connected to each of the valves to prevent a change in the valve setting from the predetermined setting for the cycle for all of the valves after the cycle has begun and before the cycle is completed.

12. Controlling means for a heater cleaner of the type incorporating a plurality of blower units, conduit means for conducting a cleaning fluid to said blower units, means associated with each of said blower units for operating each of said units, mechanical means operably connected to each of said last-named means for effecting operation of said last-named means, said controlling means including pressure responsive control means for actuating each of said mechanical means, a valve associated with each of said control means to control the flow of fluid thereto, and means interconnecting the valves for all of the control means for operating said control means in succession according to a preset cycle for said valves, a master fluid pressure control means for controlling the supply of fluid to said pressure responsive control means through said valves, locking means to prevent a change in the valve settings from the predetermined setting for the cycle after the cycle has begun and before the cycle is completed, and pressure responsive means to release said last-named means after completion of the cycle so that the valves may be reset.

13. In a control system for a blower-type cleaning system incorporating a plurality of cleaning blower heads of the movable type, in combination with a source of blowing fluid and blow-valve means for regulating admission of such fluid to each of said heads, motor means for moving each of said heads, a head control unit appurtenant each of said heads, each head control unit incorporating means for supervising the actuation of the motor means and of the blow valve means for the head to which said unit is appurtenant, master controlling means for activating said head control units in desired sequence, means including tripping mechanism responsive to the positions of said heads for influencing the action of said master controlling means, said master controlling means comprising a plurality of activating means one of which is operably connected to each of said head control units, said activating means being connected in series whereby they may be effectively operated only in a predetermined sequence, and each being effective when so operated to activate or disable the head control unit connected thereto.

14. Means for controlling the action of a plurality of movable soot-blower heads or the like comprising, in combination with a motor incorporated in each head, a motor control valve adapted to control the connection of each such motor to a source of energizing fluid therefor, pressure-responsive actuating means for each of said motor control valves, a control-fluid supply system, a plurality of master control valves connectable to said supply system, a control line connecting each master control valve to the pressure-responsive actuating means for a correlated one of said motor-control valves, the motor-control valves being actuatable by fluid pressure in the control line leading thereto, means responsive to a change in pressure in each control line for actuating the master control valve connected thereto, and means also connected to each control line and responsive to the position of one of said blower heads for chang-

ing the pressure in the control line to actuate a correlated one of said master control valves.

15. Means as set forth in claim 14 in which said master control valves have portions connected in series with one another and only an initial one of said master control valves is connected to said supply system whereby control fluid is delivered to succeeding ones of said control lines and actuating means after the fluid has been diverted from a preceding control line and actuating means by the preceding master control valve.

16. A sequence controlling and activating and deactivating system for a plurality of motor driven soot blowers, said system including a control station and a plurality of controlled stations, each controlled station including a driving motor and a soot blower drivable thereby, means for connecting power lines to the motors, individual control lines, one such control line connecting the control station to each controlled station, force varying means at each controlled station operatively connected to the control line and to the motor for that station, means responsive to actuation of the motor for actuating said force varying means to change the force derivable from the control line, master controller means at the control station for selectively connecting the control lines to a power source, and force responsive means also located at the control station and operatively connected to each control line and actuatable by such change of force in the control line to actuate the master controller means.

17. A sequence controlling and activating and deactivating system for a plurality of motor driven soot blowers, said system including a control station and a plurality of controlled stations, each controlled station including a driving motor and a soot blower drivable thereby, means for connecting power lines to the motors, individual control lines, one such control line connecting the control station to each controlled station, force varying means at each controlled station operatively connected to the control line and to the motor for that station, means responsive to actuation of the motor for actuating said force varying means to increase the force derivable from the control line, master controller means at the control station for selectively connecting the control lines to a power source, and force responsive means also located at the control station and operatively connected to each control line and actuatable by such increase of force in the control line to actuate the master controller means.

18. A system as defined in claim 16 wherein said power source comprises a source of fluid under pressure, said means for connecting power lines to the motors including a pressure-operable motor controller for each motor, each such controller having a pressure-actuatable part connected to the control line for the control station at which such motor is located, said force-varying means including a pressure-modifying valve connected to the control line and operable by the motor to change the pressure in the control line.

19. A system as defined in claim 16 including a regulating element connected to each of said control lines for restricting the force developed therein and the rate of change of force therein which results from actuation of said force varying means.

20. A system as defined in claim 17 wherein said power source comprises a source of fluid under pressure, said means for connecting power lines to the motors including a pressure-operable motor controller for each motor, each such controller having a pressure-actuatable part connected to the control line for the control station at which such motor is located, said force-varying means including a pressure-modifying valve connected to the control line to change the pressure in the control line, and a pressure regulating element connected to each of said control lines for restricting the force developed therein and the rate of change of force therein which results from actuation of said force varying means.

21. A system as defined in claim 20 wherein said pressure regulating element comprises a restricting member through which connection may be made from the power source to the control line.

22. A system as defined in claim 20 wherein said pressure regulating element comprises a restricting member through which connection may be made from the power source to the control line, said pressure-modifying valve comprising a vent valve.

23. A system as defined in claim 17 wherein said power source comprises a source of fluid under pressure, said means for connecting power lines to the motors including a pressure-operable motor controller for each motor, each such controller having a pressure-actuatable part connected to the control line for the control station at which such motor is located, said force-varying means including a pressure-modifying valve connected to the control line and operable by the motor to change the pressure in the control line, the motor controller being actuatable to start the motor in response to the lower pressure in the control line, and the force responsive means including a member operative only in response to such increased pressure in the control line to interrupt communication between the power source and the control line, the controller being biased to a position to stop the motor, whereby the motor stops when the pressure in the control line falls below a predetermined minimum after such interruption of communication.

24. A system as defined in claim 16 wherein said master controller means includes a plurality of shiftable diverting devices connected in series with one another and the first of which is connected with the power source, said devices being individually shiftable between a position in which the corresponding control line is by-passed and a diverting position in which it provides potential connection between one of the control lines and the power source.

25. In a system as defined in claim 24, individual biasing means tending to shift each of said diverting devices to by-passing position.

26. In a system as defined in claim 24, individual biasing means tending to shift each of said diverting devices to by-passing position, said force-responsive means including a latch for holding each diverting device in the diverting position, and a release for such latch responsive to change of pressure in the control line to release the latch and permit the diverting device to move to by-passing position under the influence of the biasing means.

27. In a system as defined in claim 24, individual biasing means tending to shift each of said diverting devices to by-passing position, said

force-responsive means including a latch for holding each diverting device in the diverting position, a release for such latch responsive to change of pressure in the control line to release the latch and permit the diverting device to move to by-passing position under the influence of the biasing means, and a supplemental latch for holding each diverting device in by-passing position.

28. In a system as defined in claim 24, individual biasing means tending to shift each of said diverting devices to by-passing position, said force-responsive means including a latch for holding each diverting device in the diverting position, a release for such latch responsive to change of pressure in the control line to release the latch and permit the diverting device to move to by-passing position under the influence of the biasing means, a supplemental latch for holding each diverting device in by-passing position, and means for simultaneously releasing all of said supplemental latches.

29. In a system as defined in claim 24, individual biasing means tending to shift each of said diverting devices to by-passing position, said force-responsive means including a latch for holding each diverting device in the diverting position, a release for such latch responsive to change of pressure in the control line to release the latch and permit the diverting device to move to by-passing position under the influence of the biasing means, a supplemental latch for holding each diverting device in by-passing position, means for simultaneously releasing all of said supplemental latches, a start-stop device in series with said master controller and power source, and means for actuating the start-stop device to a stop position in response to shifting of the last of said series-connected diverting devices to by-passing position.

30. A control system for a plurality of motor driven soot blowers, said system including a control station and a plurality of controlled stations, each controlled station including a driving motor and a soot blower drivable thereby, means to actuate the motor, and means for regulating the action of each soot blower including a single control conduit connecting the control station to the controlled station, means at the control station for delivering fluid under pressure to the control conduit, means at the controlled station responsive to actuation of the soot blower for changing the pressure in the control conduit, means responsive to the pressure in the control conduit to start and stop the motor, and means at the control station responsive to pressure change in the control conduit for interrupting the delivery of fluid through said fluid delivering means.

31. In a sequence controlling and activating and deactivating system for a plurality of motor driven soot blowers, including a control station and a plurality of controlled stations and a dual pressure control conduit connecting the control station to each of said controlled stations, said system incorporating means for varying the pressure in the control conduit to regulate the action of a soot blower connected thereto, indicating means for visually denoting the operation of the blower during such operation and for denoting the completion of an intended cycle of operation of the blower after such completion, comprising a pair of pressure-operable indicators both connected to the control conduit, one of said indicators being operable at a reduced pressure which obtains in the control conduit during a portion of the operating cycle and the other indicator being inoperable by such reduced pressure but operable by an increased pressure obtaining in the control conduit at a later phase of the operating cycle of the blower.

32. Means as set forth in claim 31 including releasable latch means for holding the last-mentioned indicator in the operated position.

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