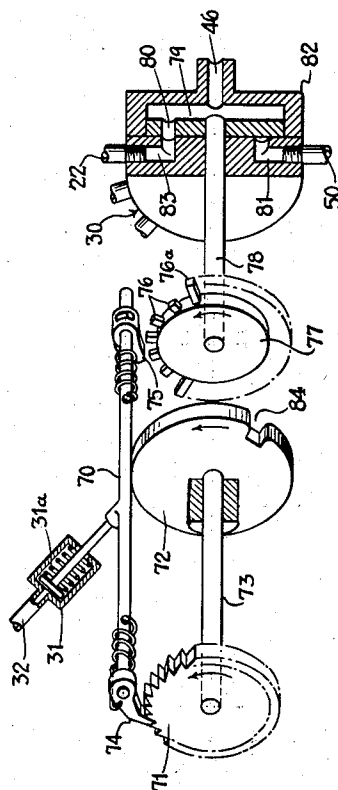


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## APPARATUS FOR CONTROLLING BOILER SOOT BLOWERS AND THE LIKE

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This invention relates to apparatus for automatically controlling soot blowers such as used in water tube boilers, periodically, to provide air puffs for blowing soot and ash from the boiler tubes, and more specifically the invention relates to equipment for controlling the timing of the cycles of operation of groups of such blowers. The invention is adapted for use in connection with water tube boilers, generally, and is particularly well adapted for use in connection with black liquor recovery boilers, such as are now used in the paper industry.

In such boilers, it is necessary to provide some method and means for removing soot and ash accumulations from the boiler tubes to assure continuous and efficient operation. It is a common practice to accomplish this by providing means known as soot blower heads at numerous places around and within the boiler for injecting puffs of air or steam. In a typical installation, as many as twenty-four of such soot blower head assemblies are provided, located at spaced points with perforated fluid discharge pipes projecting into the space between the boiler tubes, each of the nozzles being rotatable about its axis so as to direct successive puffs of air or steam in various different directions.

Since the continuous operation of such soot blowers would interfere with the proper operation of the boiler and require the use of excessive and expensive quantities of steam or air under pressure, it is common practice to operate such blowers periodically and to cause them to be actuated in groups with a predetermined sequence and with each group divided into sub-groups. But the necessary control equipment for the numerous groups and sub-groups becomes relatively complicated with numerous valves and other parts which may easily become inoperative. Also, while such heretofore-known equipment has provided for a complete cycle of operation of all the groups and sub-groups in proper succession, yet at the end of such cycle, such equipment has to be manually reset or started at a later time to cause it to operate through another cycle. These factors have resulted in excessive costs due to the almost constant requirements for maintaining and attending such equipment. The prior known apparatus for the purpose has also required the use of an expensive control panel positioned at a place convenient to an attendant and yet often quite remote from the boiler so that in the presence of corrosive atmospheric conditions in the plant, considerable expense is involved for maintaining and replacing, from time to time, long lengths of numerous pressure-control tubes.

The present invention provides a substantially simplified arrangement of apparatus, which is certain and dependable in operation and requires little expense for maintenance. Also, with the present invention, the equipment is entirely automatic in that it will operate continuously through successive cycles without requiring an attendant manually to initiate each cycle. Furthermore, no remotely located control panel board is required.

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Various further and more specific objects, features and advantages of the invention will appear from the detailed description given below, taken in connection with the accompanying drawings which form a part of this specification and illustrate merely by way of example a preferred form of the invention. The invention consists in such novel features, arrangements and combinations of parts as may be shown and described herein.

In the drawings:

10 Fig. 1 is a schematic diagram of a preferred embodiment of the control equipment of the present invention; and

Fig. 2 is a somewhat schematic diagram of certain of the principal operating parts of a known form of distributor valve mechanism used in the system of Fig. 1.

Referring now to Fig. 1 in further detail, one of the so-called soot blower head assemblies, which may be of a well-known construction, is somewhat schematically indicated at 10. Such assemblies include a perforated pipe as at 11, which projects through the wall of the boiler into the spaces between banks of boiler tubes. The perforated pipes as at 11 are arranged to be rotated about their axes, step by step, so that each time a puff of steam or air is projected from the perforations, the puff will be directed at a different angle with respect to the axis to insure blowing the soot and ash from all parts of the boiler tubes. Such step-by-step rotation of the tube 11, may be accomplished by ratchet means of known form such as schematically indicated at 12, suitably actuated by a cylinder and piston device at 13.

Since the various control devices for periodically causing admission of the pressure to the soot blower heads involve the use of numerous valves and other mechanisms, it is desirable that these parts be made relatively small and as inexpensive as possible, and for that reason it would be practically prohibitive to make such control valves and the conduits connecting same large enough to conduct the large volumes of blowing air or steam therethrough. Accordingly, as is common practice, each soot blower head assembly preferably includes suitable valve means located as at 14, which may be for example a piston type valve actuable by the control system hereinafter described, to admit periodically the large volumes of air under pressure through a main line 15 coming from a compressor and storage tank as at 16, 17.

The overall purpose of the control equipment now about to be described is to provide at proper intervals to each soot blower head, air or steam under pressure through a pipe as at 18 for simultaneously actuating the soot blower head valve 14, as well as to actuate the piston in the cylinder 13 for moving the ratchet 12 to rotate the blowing tube one step about its axis at the beginning of each puff.

The apparatus as schematically shown in the upper portion of Fig. 1 comprises equipment for controlling one sub-group of the soot blower heads. That is, for example, a sub-group actuating a total of eleven blower heads, each receiving air pressure from branches of pipe 15 as indicated by the arrows 20. The control pipe connections for these blower head assemblies respectively are indicated by the arrows 21. It will be understood that each sub-group may actuate a greater number, but usually a smaller number of blower heads. Also, in the example indicated, the group is divided into sub-sub-groups, each having control pipe connections as at 22-25, inclusive.

Certain of the devices schematically indicated along the lower portion of Fig. 1, as hereinafter explained, are common to all of three main groups of blower heads.

The control arrangement and equipment and its operation, as shown in the upper part of Fig. 1, will now be explained.

Pressure from the compressor and tank 16, 17 enters a diaphragm operated control valve 26 which will be considered as being held in open position at the start by pressure admitted through connection 27 to the diaphragm of the valve. The pressure in the tank 17, for example, may be normally maintained between 200 and 300 p. s. i. and such pressure subsequent to the control valve 26 is conducted through a connection 28 and through another diaphragm operated valve 29 into what will be termed a "ratchet operated distributor valve" 30 which acts at proper intervals sequentially to admit pressure to the control connections 22-25, inclusive. The device 30 may be of well-known type, an example of which is commercially available under the name "AMC Distributor," as put out by Diamond Power Specialty Corp. of Lancaster, Ohio, the principal operating parts of which are schematically shown and hereinafter described in connection with Fig. 2, although it will be understood that other forms of distributor valve means might be provided for the purpose.

The distributor valve means 30 may be actuated by a cylinder and piston device 31 which receives air pressure at intervals through connection 32 which in turn is under the control of a solenoid operated valve 33. The solenoid of this valve may be energized at predetermined intervals by using any of the numerous well-known types of timing switches commonly available, preferably of a form having all of its mechanism enclosed and protected against deterioration, so as to insure reliable operation. For example, a tiltable mercury switch as at 34 may be provided for the purpose, having suitable pivotal supporting means as at 35 adapted to be tilted at intervals by a rotating cam 36 driven by a motor 37. The speed of the motor is preferably adjustable as by a rheostat 38 in order to permit adjustment of the intervals of operation of the switch. For example, in a typical instance, this switch is arranged to close a circuit to the solenoid for periods of about 1½ seconds' duration, which periods may, for example, be spaced apart by 7 to 8 seconds.

In lieu of the mercury switch arrangement above described, other well-known types of electrical timing devices might, of course, be used if constructed for highly reliable operation over long periods of time without attention, for example a so-called scanning-oscillator type of unit may be used as put out by Minneapolis-Honeywell Regulator Company, and same have been found highly satisfactory and reliable for the purpose.

The pressure supply to the solenoid-operated valve 33 is derived from a connection 40 communicating with the conduit 28, the pressure supply passing through a reducing valve 41, thence through a connection 42 and through a pressure-actuated valve 43 and a connection 44 into the solenoid-operated valve 33. The pressure-reducing valve 41 is adapted, for example, to reduce the pressure running to the valves 43 and 33 from the range of 200-300 p. s. i. down to say, 110 p. s. i., so that lower pressure operating valves at lesser maintenance costs may be used subsequent to such reducing valve.

During the normal operation of the equipment, at the outset of each puff of air through the soot blower heads, the pressure available from the tank 17 will tend to be considerably greater than after a succession of pulses has occurred. For example, the pressure may fall from about 300 p. s. i. down to the neighborhood of 200 p. s. i. after a series of puffs, and it is accordingly desirable to stop the puffs at that point until full, normal air pressure can be restored, since it would be a waste of air pressure to provide same at the blower heads at a low and ineffective pressure. To accomplish this purpose, the pressure operated valve 43 is provided and is arranged to be actuated by a spring to closed position, when the pressure in pipe 28 falls to a predetermined level, such as 200 p. s. i. The valve 43 is normally held open by a pressure diaphragm subjected to pressure

through a connection 45 which communicates with pipe 28. The valve 43 should be one of the well-known suitable types which will be actuated to closed position at the predetermined lower pressure limit, say, of 225 p. s. i., but the construction being such that the valve will not open again until the pressure is restored to normal, for example 300 p. s. i.

The distributor valve 30 of types normally available is so constructed, that its ratchet stepping mechanism may not be readily actuatable to move a valve-piece when subjected to heavy pressure. For this reason, the pressure diaphragm operated valve 29 is provided in the line 28 in advance of the distributor valve 30. The valve 29 is normally closed, but when a pressure impulse is provided in connection 32, the same impulse transmitted through connection 32a will actuate the diaphragm of valve 29 to open this valve just as the ratchet stepping mechanism of valve 30 is actuated in one direction. Then when the pressure impulse is cut off, valve 29 will close, pressure in connection 46 will subside, and the ratchet mechanism at 31 will be free to actuate in the other direction.

Thus, with the arrangement above described, successive short puffs of pressure will be supplied to the actuating piston 31 of the valve 30 through connection 32, such puffs being occasionally interrupted by the action of the valve 43 when the pressure supply falls too low and until pressure is restored to normal. Actuation of the ratchet-like mechanism associated with valve 30 will cause the valve-piece to be turned to successive positions for distributing the pressure supply coming in through connection 46 in succession to the connections 22 to 25, respectively, running to the sub-sub-groups of soot blowers.

When the valve-piece in the valve 30 has stepped around to the last step of its cycle of revolution, pressure will be discharged through a connection 50 to actuate the diaphragm of a diaphragm-controlled valve 51. This valve is thereby opened to admit pressure, say at about 110 p. s. i. through a connection 52 running from connection 42 to the valve 51, the pressure at the outlet side of this valve being conveyed through a connection 53 to an actuating cylinder and piston means at 54, for another ratchet-operated distributor valve 55, which may be of a construction similar to the valve arrangement 30, 31 above referred to. The valve 55 is for the purpose of distributing pressure in succession through connections 27, 27a and 27b for respectively actuating valves 26, 26a and 26b, which act to put in operation when opened, the control equipment for each of three main groups of soot blowers. For the example of the invention here being described, it will be understood that the valves 26a and 26b are each connected to control systems like that schematically shown along the upper part of Fig. 1, but for controlling respectively each of the three main groups of soot blower heads. When the cycle of actuation of each of such controls is completed, its distributor valve, in its last position of rotation, will apply pressure through connections 50, 50a or 50b, for actuating, as the case may be, the corresponding valve 51, 51a or 51b, these valves in turn admitting pressure to actuate step-by-step the valve 55 and thereby causing the valves 26, 26a, 26b in turn to be opened to initiate the operation of each of the control arrangements for the three main groups of blowers.

Pressure is admitted to valve 55 in the following way. A connection 60 communicating with the main tank 17 runs to a reducing valve 61, thence through a connection 62 to a three-way valve 63 which is diaphragm-operated, and thence through a connection 64 to the distributor valve 55. Then when pressure is supplied through connection 53 and thence through connection 65 to actuate the diaphragm of valve 63, this valve will momentarily cut off the pressure through connection 64 and instead discharge pressure from connection 62 to an exhaust

outlet 66. Meanwhile, the pressure in connection 53 will actuate the valve 55 one step to transfer the control from the first main group of control apparatus, above described, to similar control apparatus for the second main group. Thereupon, control valve 26 for the controls for the first group will be closed and the pressure in connections 53 and 65 will subside, allowing three-way valve 63 to move back to normal position, shutting off exhaust 66 and placing the connections in condition for the next operation of distributor valve 55.

In order that the pressures on the downstream sides of the various control valves above described, will promptly subside when such valves are closed, it will be understood that such valves may be of the so-called "self-bleeding" type on the downstream side.

The operation of one particular type of distributor valve, such as the valve 30, will now be summarized in connection with the schematic diagram of Fig. 2. The essential parts of this mechanism may comprise cylinder and piston means 31, the piston having a restoring spring 31a and the piston rod being connected to a crossbar as at 70 which, upon actuation of the piston, is pushed in a forward direction along the teeth of a ratchet wheel 71 and along the periphery of a disc 72 mounted on a common shaft 73. When the pressure in connection 32 is released, the spring 31a will retract the bar 70 and cause pawl 74 thereon to engage one of the teeth on ratchet wheel 71 and at the same time a pawl 75 on the other end of cross-bar 70 may engage one of the pins 76 on a wheel 77. The pawls 74 and 75, as indicated, may be accompanied by springs normally to hold them in downwardly projecting position. The wheel 77 is rotatably mounted on another shaft 78 coaxial with shaft 73. Shaft 78 has secured thereon to rotate therewith a disc-like valve-piece 79 having an orifice 80. The disc 79 rotates in a space formed between two stationary valve housing members 81 and 82. The member 81 is formed with a plurality of radially extending port-like cavities as at 83, communicating respectively with the several pressure lines such as at 22-25 and 50, as indicated in Fig. 1. The disc-like valve-piece 79 rotates step by step, the port or opening 80 will come into register with one or another of the port cavities as at 83, and thus distribute the control pressure successively to the several sub-groups of soot blowers. The valve housing portion or member 82 is provided with an inlet connection with the line 46.

The pins 76 on wheel 77 are so mounted that they may be pulled out to extended positions when desired, as is shown in the case of pin 76a. One of such pins is provided corresponding to each of the valve outlet connections, and in case some of these outlet connections are not being used, then the corresponding pin is pulled out at 76a.

It will be noted that the disc 72 has a notch at 84, which, once during each revolution, will come into a position under the bar 70 and allow the bar to drop down slightly. Thus, when the bar 70 is held up on the periphery of the disc 72 in the position shown in Fig. 2, the pawl 75, when retracted, will be free to pass the normally positioned pins 76, but when one of the extended pins, as at 76a, comes opposite the pawl 75, then the pawl will angularly move the wheel 77 one step in the direction shown by the arrow thereon.

Assuming an air pressure impulse is applied to connection 32 and at the same time to connection 46, the bar 70 will be moved forwardly without moving the parts 71, 72 or 77, and meanwhile air pressure through connection 46 and valve aperture 80 will be transmitted to one or another of the distributing connections 22-25 or 50, which is then located with its port opposite opening 80. Then when the pressure impulse through connections 32 and 46 is terminated, the spring 31a will retract the bar 70 and cause the ratchet wheel 71 to be rotated in the direction indicated by the arrow thereon by an amount corre-

sponding to one tooth. And if at that moment one of the extended pins, as at 76a, is in position to be engaged by the pawl 75, then the valve-piece 79 will be rotated one step. Then when the next pressure impulse occurs, the same operations will be repeated, except that if the notch 84 is then in a position to receive the bar 70, the pawl 75 will be lowered far enough to engage one of the pins 76 which is in normal position and thus will cause the valve-piece to be rotated one step to allow air pressure to escape through the next distributor connection. But it will be noted that this can occur only once during each revolution of disc 72, that is at a time when the notch 84 is in a position to receive the bar 70. Thus, normally, if the ratchet wheel 71 has for example twenty-one teeth, then twenty-one puffs of air will be applied to each of the sub-groups of soot blowers before the valve means is moved to the next step corresponding to the next sub-group of blowers. Further, it will be noted, that in cases where one of the extended pins, as at 76a, which corresponds to an unused outlet port, comes into position, such outlet port will receive but one puff before the valve is stepped to the next position.

It is noted that the ratchet wheel 71 may appropriately have the same number of teeth as the ratchet wheels schematically indicated at 12 on the soot blowers. This will insure that for each revolution of the ratchet wheel 71 and disc 72, the soot blower pipes, as at 11, will be rotated through one complete revolution.

The ratchet-operated distributor valve indicated at 55 in Fig. 1, may be like the one schematically shown in Fig. 2, except as will now be explained. The valve 55 is shown in Fig. 1 as having three outlet connections 27, 27a and 27b, but if, say, the valve has twelve angularly spaced outlet ports, each of the three outlet connections, respectively, would have parallel connections to every third outlet port and twelve of the corresponding pins, all in extended position (as pin 76a) would be provided, so that upon each pressure impulse the valve would be turned one step.

Although a preferred embodiment of the invention is herein disclosed for purposes of explanation, various modifications thereof, after study of this specification, will be apparent to those skilled in the art to which the invention pertains. Reference should accordingly be had to the appended claims in determining the scope of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. Apparatus for controlling the operation of pluralities of main groups and sub-groups of boiler soot blowers of the type having a fluid pressure controlled inlet valve for admitting puffs of blowing fluid thereto and having fluid pressure operated means for turning the blower toward various directions, such control apparatus comprising in combination a first distributor valve common to the control apparatus for all the main groups and associated with fluid pressure operating means and connections including valves for admitting pressure to the control apparatus for each main group of blowers successively, other pressure control distributor valves for each of the main groups respectively and means associated with said other distributor valves including connections and pressure operated means therefor, for distributing pressure control puffs to the soot blowers of the sub-groups in succession for actuating the inlet valves and turning means thereof, timing devices associated with the operating means for each of said other distributor valves for causing actuation of the latter at predetermined timed intervals, said other distributor valves also each having connections and associated valve means for causing actuation of said first-named distributor valve following the distribution of pressure control puffs to each of said sub-groups, whereby said first-named distributor valve then admits pressure to the control apparatus for the next main group.

2. Apparatus for controlling the operation of pluralities of main groups and sub-groups of boiler soot blowers, comprising in combination a first distributor valve common to the control apparatus for all the main groups and

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associated with fluid pressure operating means and connections including valves for admitting pressure to the control apparatus for each main group of blowers successively, other pressure control distributor valves for each of the main groups respectively and means associated with said other distributor valves including connections and pressure operated means therefor, for distributing pressure control puffs to the soot blowers of the sub-groups in succession for actuating same, timing devices associated with the operating means for each of said other distributor valves for causing actuation of the latter at predetermined timed intervals, said other distributor valves also each having connections and associated valve means for causing actuation of said first-named distributor valve following the distribution of pressure control puffs to each of said sub-groups whereby said first-named distributor valve then admits pressure to the control apparatus for the next main group.

3. Apparatus for controlling the operation of pluralities of main groups and sub-groups of boiler soot blowers, comprising in combination a first distributor valve common to the control apparatus for all the main groups and associated with fluid pressure operating means and connections including valves for admitting pressure to the control apparatus for each main group of blowers successively, other pressure control distributor valves for each

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of the main groups respectively and means associated with said other distributor valves including connections and pressure operated means therefor, for distributing pressure control puffs to the soot blowers of the sub-groups in succession for actuating same, timing devices associated with the operating means for each of said other distributor valves for causing actuation of the latter at predetermined timed intervals, the operating means for said other distributors respectively also having associated therewith valves actuatable in response to abnormal reduction of the supply pressure to the soot blowers to interrupt the operation of said other distributor valves until the normal soot blower pressure is restored, said other distributor valves also each having connections and associated valve means for causing actuation of said first-named distributor valve following the distribution of pressure control puffs to each of said sub-groups, whereby said first-named distributor valve then admits pressure to the control apparatus for the next main group.

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