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Espeel

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[54] **PNEUMATIC CONTROL SYSTEM FOR AIR FILTER CLEANING APPARATUS**

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Related U.S. Application Data

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[30] **Foreign Application Priority Data**

July 20, 1971 Switzerland 10639/71

[52] **U.S. Cl.** **55/284,** 55/283, 55/302

[51] **Int. Cl.** **B01d 46/04**

[58] **Field of Search** 55/283, 284, 302, 341

[56] **References Cited**

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Primary Examiner—Bernard Nozick

Attorney, Agent, or Firm—Merchant, Gould, Smith & Edell

[57] **ABSTRACT**

Control system for pneumatic control of a cleaning arrangement for dust filters wherein a plurality of tubular filter elements are cleaned by a blast of air forced through the filter elements successively and in the direction reverse to that of filtering air flow. A plurality of quick-opening valves are operatively connected to outlet ports in a housing defining a pressure chamber. An arm is movably mounted in the chamber and has an air passage therethrough from its inner end to its outer end, the outer end being movable over the outlet ports in succession. The arm is moved intermittently by pneumatically operated means including an actuator movable alternately in opposite directions. The inner end of the air passage communicates with a pneumatically operated control valve that is disposed in a pneumatic control circuit including other valve mechanisms operated responsive to movement of the actuator in opposite directions to open and close the pneumatically operated valve, to respectively permit a corresponding quick-opening valve to open, and to seal off the chamber from atmosphere during movement of the arm from one outlet port to the next succeeding outlet port.

5 Claims, 8 Drawing Figures

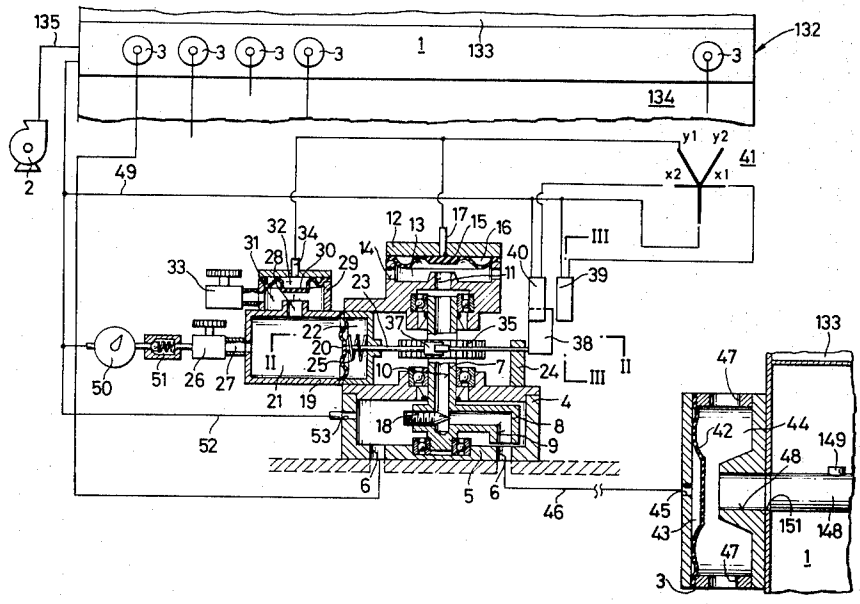


Fig. 1

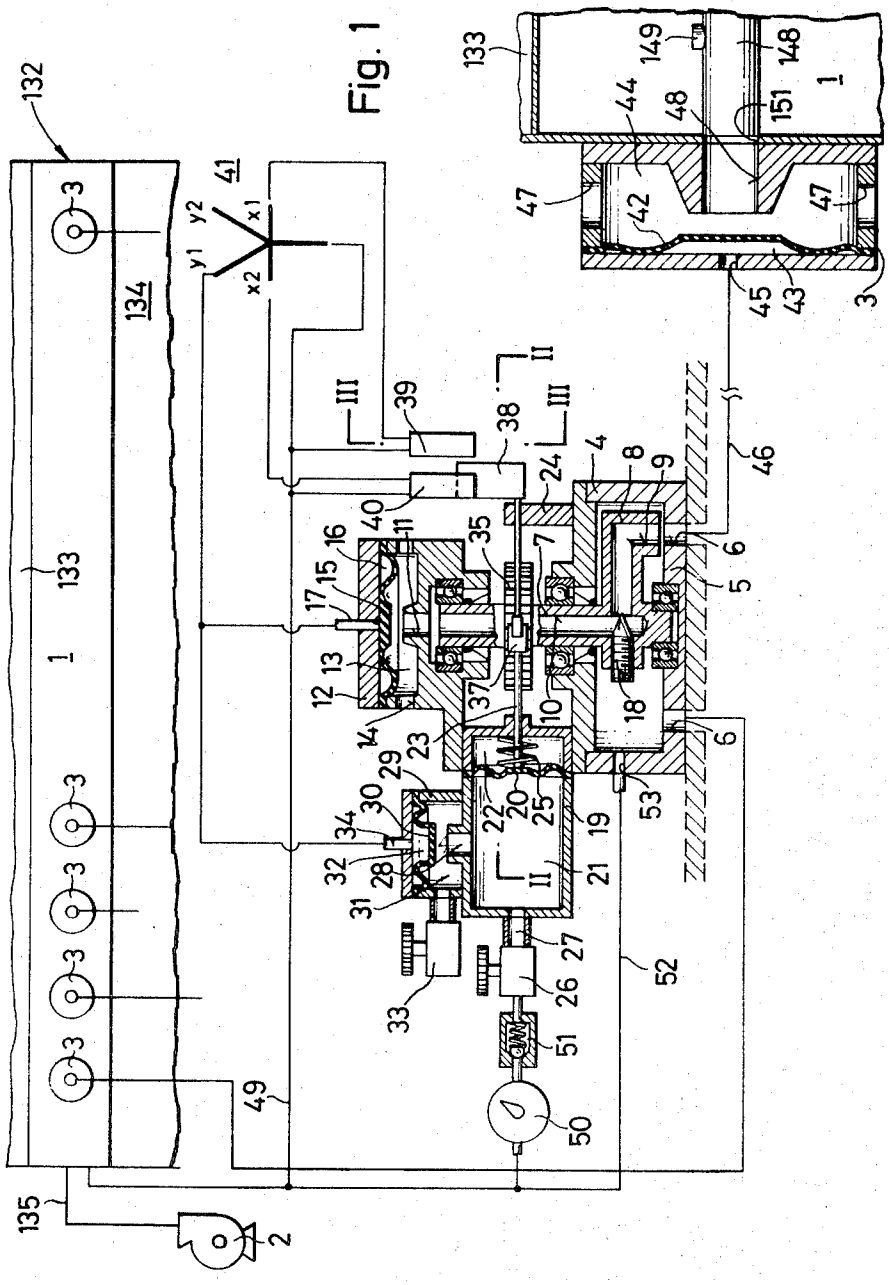
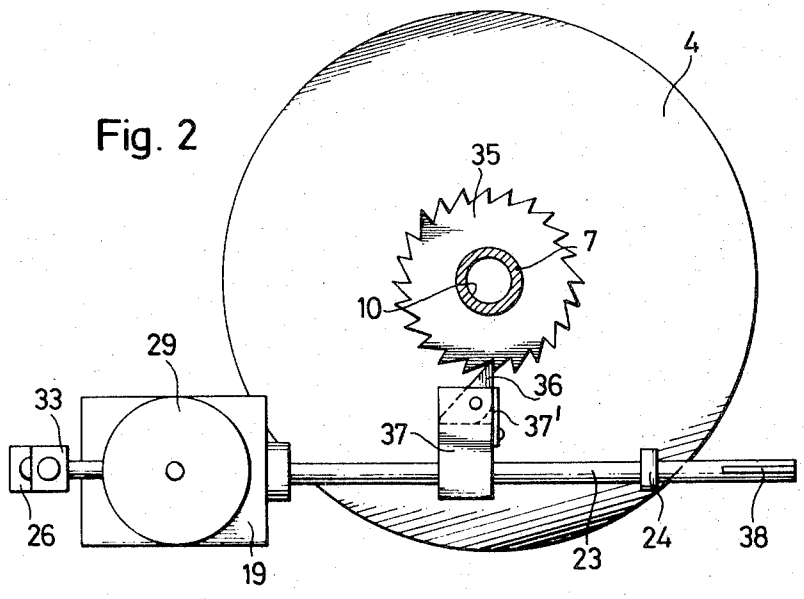

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Fig. 2



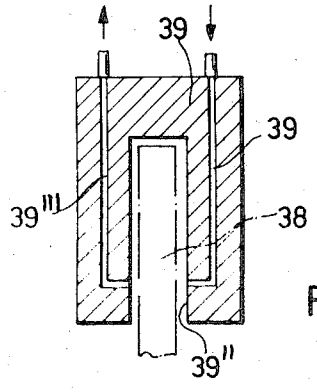


Fig. 3

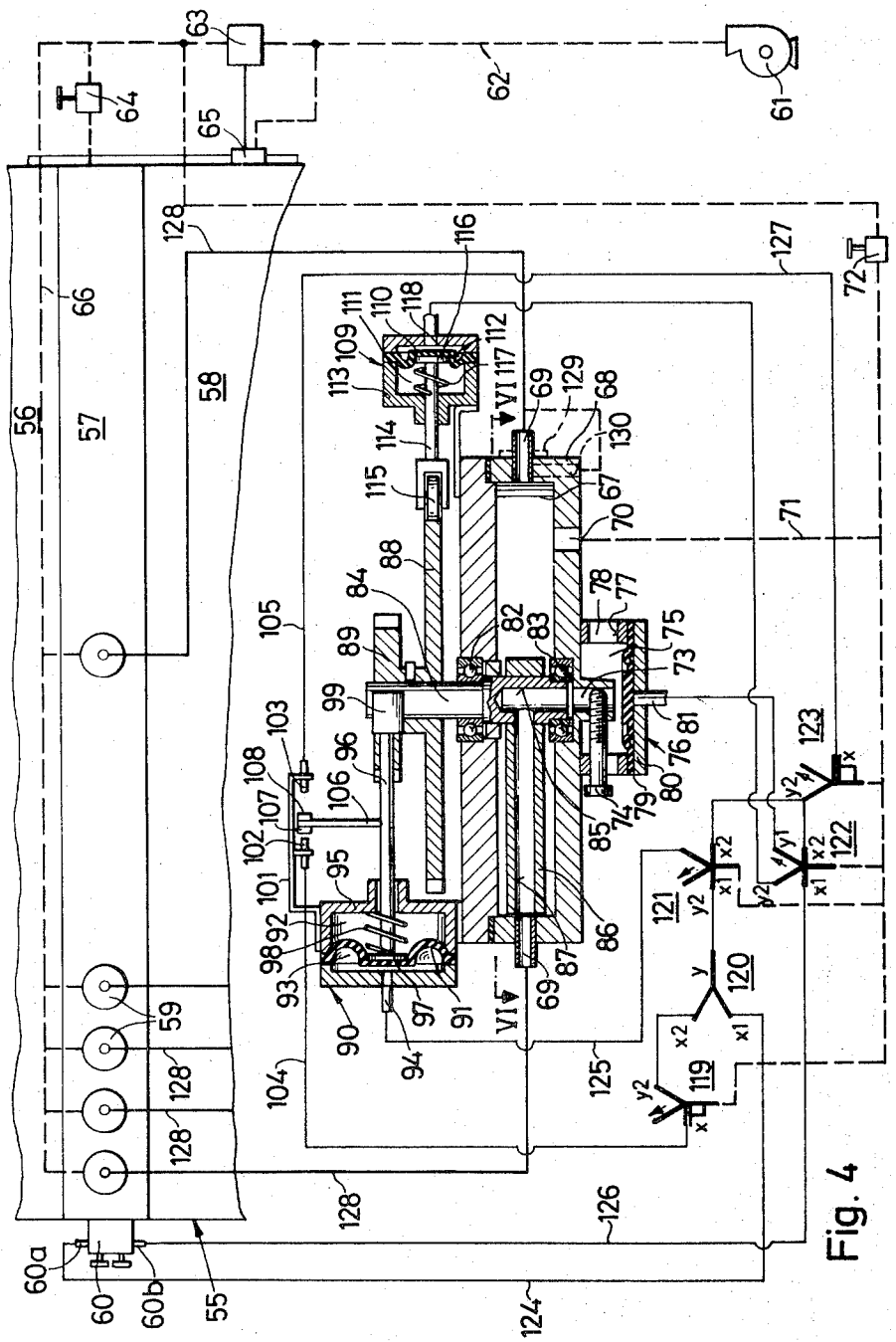


Fig. 4

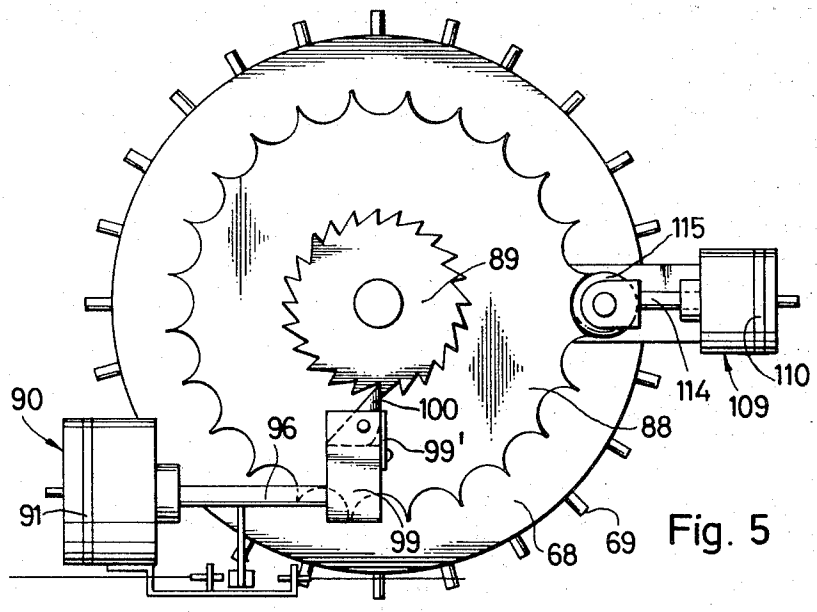


Fig. 5

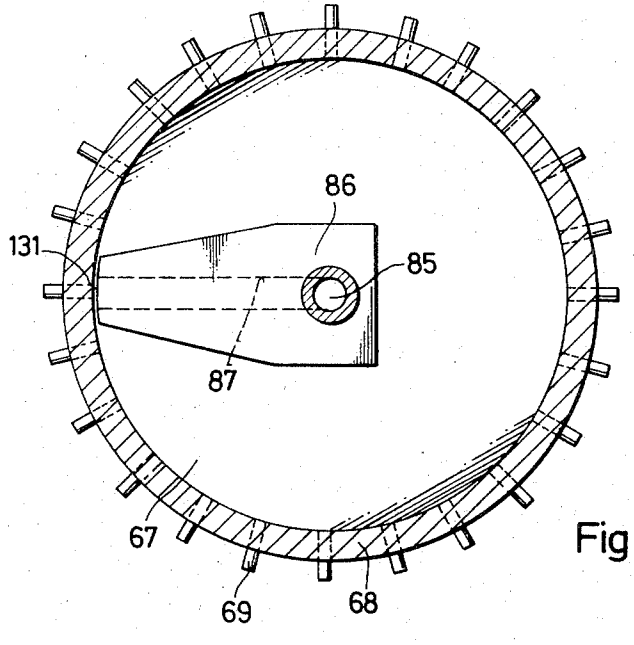


Fig. 6

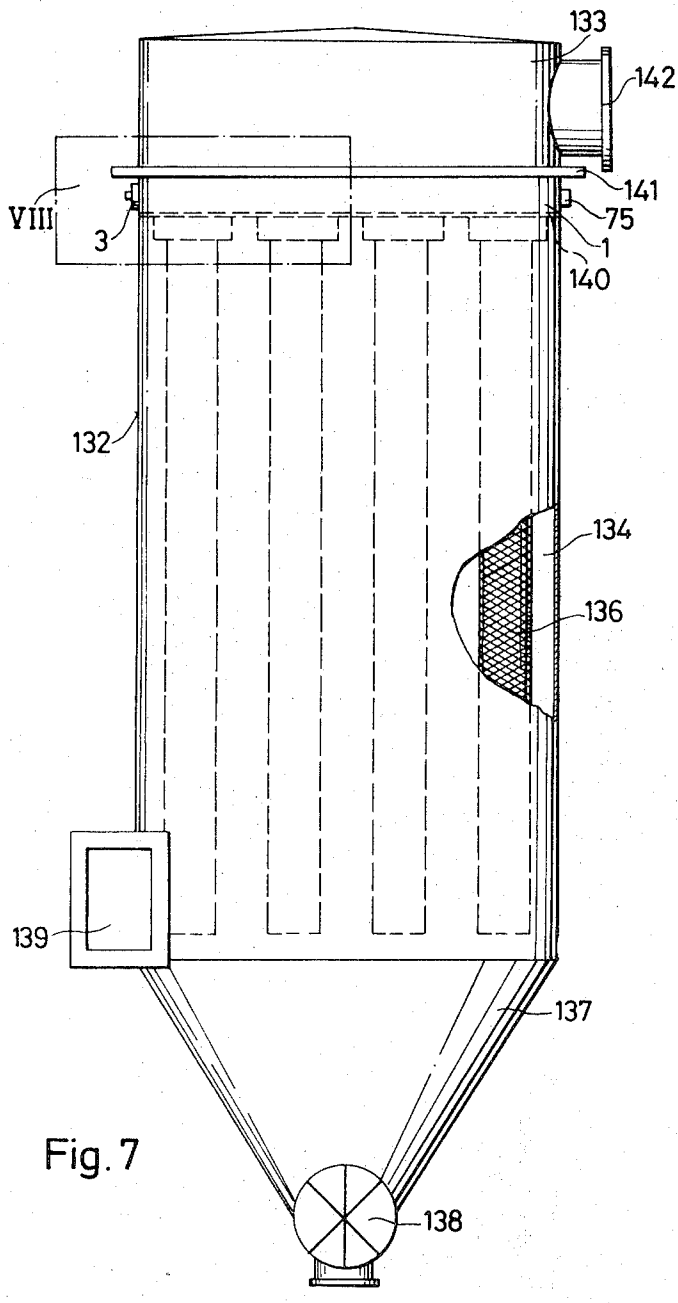


Fig. 7

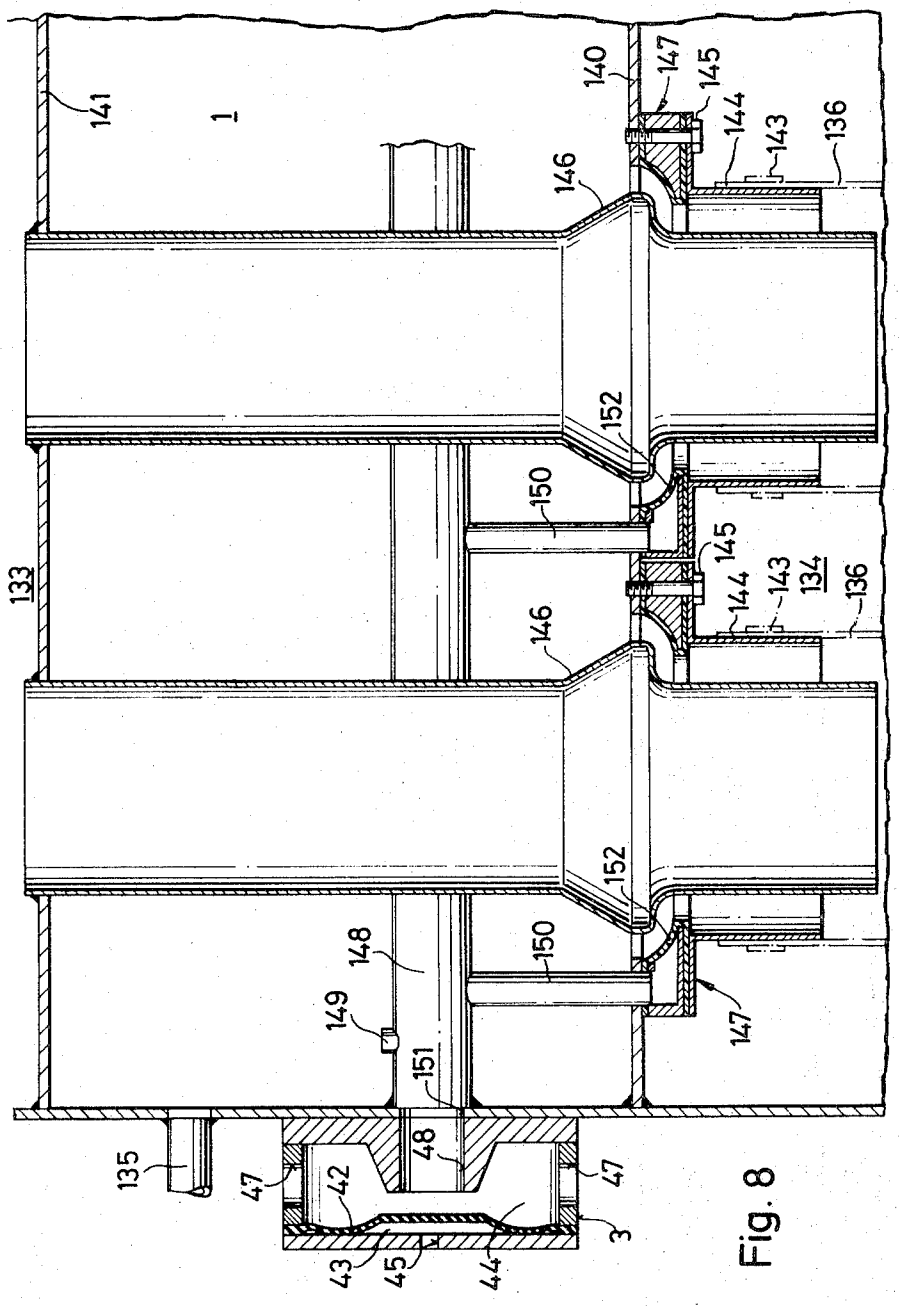

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Fig. 8

PNEUMATIC CONTROL SYSTEM FOR AIR FILTER CLEANING APPARATUS

This is a division of U.S. Pat. application Ser. No. 272,194, filed July 17, 1972.

The object of the present invention is a pneumatic dust removal plant with pneumatic clean air valves that are operated by a pneumatic-mechanical sequence control having at least one signal output or fluid outlet port operatively connected to a clean air valve or a group thereof for intake and exhaust ventilation.

Pneumatic dust removal plants with clean air valves are known. These clean air valves close or open the connecting dust running from the clean air container to the inside of the filter tubes. The filter tubes are cleaned by a reverse blast of clean air therethrough once in the course of periodically repeated cleaning cycles. The individual filter tubes or groups of tubes are cleaned in succession during a cleaning cycle. Hence, a sequence control for the consecutive activation is necessary. Electric, mechanical and pneumatic sequence controls are known. A disadvantage of the former is the need for an explosion shield, while the disadvantage of the latter two is their expensive construction and troublesome maintenance.

The present invention undertakes the task of making a pneumatic-mechanical sequence control which is structurally simple, compact in format, explosion-proof and maintenance-free.

According to the invention, the objectives are achieved as follows: The signal outputs or outlet ports open through the wall of a housing, the inner wall surface of the housing engaging the radially outwardly projecting arm of a rotary shaft disposed in a pressure chamber defined by the housing. The arrangement is such that at any point the radial arm closes one of the output ports from the inside of the housing. The arm is provided with a passage that extends longitudinally from end to end thereof, the outer end of the passage moving into registration with the outlet ports in succession, the arm including a shaft portion that is journaled in the housing, the inner end portion of the passage extending axially through the end of the shaft portion remote from said arm. Pneumatically operated devices are provided to periodically close the inner end of the passage and to rotate the arm from one outlet port to the next successive one thereof. The chamber defined by the housing is supplied with compressed air from a suitable source thereof.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view partly in section and partly diagrammatic, showing a preferred embodiment of the invention;

FIG. 2 is an enlarged view partly in top plan and partly in section, taken generally on the line II—II of FIG. 1;

FIG. 3 is an enlarged fragmentary section taken generally on the line III—III of FIG. 1;

FIG. 4 is a view corresponding to FIG. 1 but showing a modified arrangement;

FIG. 5 is a view partly in top plan and partly diagrammatic of a portion of FIG. 4;

FIG. 6 is a fragmentary section taken generally on the line VI—VI of FIG. 4;

FIG. 7 is a view in side elevation of a dust removal apparatus having clean air valves adapted to be operated by the control system of this invention; and

FIG. 8 is an enlarged fragmentary view in axial section of the portion of FIG. 7 bounded by the broken rectangular line VIII.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT OF FIGS. 1–3

In FIG. 1, the reference numeral 1 indicates the clean air container of a pneumatic dust removal plant, the container 1 being supplied with air under pressure by a fan 2. To exhaust the clean air valves of the individual filter tubes not shown, several clean air valves, not shown, may be assumed to be connected to one of a plurality of quick-opening valves 3, one of which is shown in FIG. 1.

A sequence control for opening the valves 3 in succession, comprises a generally cylindrical houong 4 having an end wall 5 which defines a plurality of circumferentially spaced axial air outlet ports or signal outputs 6 each of which is adapted to be connected to a different one of the quick-opening valves 3, such as by means of a conduit indicated diagrammatically at 46. A rotatable shaft 7 is journaled axially of the housing 4 and comprises the inner end portion of a radial arm 8 having an air passage 9 extending longitudinally therethrough. A continuation of the passage 9 is in the nature of an axial passage portion 10 that extends outwardly through the end of the shaft 7 remote from the radial arm 8. The passage portion 10 communicates with an exhaust chamber 13 through an opening 11 in a cylindrical housing 12 which defines the exhaust chamber 13. The exhaust chamber 13 communicates with outside atmosphere through ventilation holes 14. A diaphragm or membrane 15 seals the exhaust chamber 13 from a pressure chamber 16 defined by the housing 12, one wall of the housing 12 having a port 17 communicating with the pressure chamber 16. The arm 8 is provided with a metering valve 18 for regulating the flow of air through the passage 9 and passage portion 10.

Firmly connected to the housings 4 and 12 is a cylindrical housing 19 the inside of which is divided by a diaphragm or membrane 20 into a pressure chamber 21 and a spring chamber 22. A rod or stem 23 has one end fixed to the membrane 20 and projects axially outwardly of the end of the housing 19 adjacent the spring chamber 22, the outer end portion of the stem 23 being slidably supported in a bearing 24. A coil compression spring 25 loosely encompasses the stem 23 within the spring chamber 22 and yieldingly urges the membrane 20 and stem 23 in one direction of reciprocatory movement axially of the cylindrical housing 19. By means of a throttle valve 26 and a connecting branch pipe 27, compressed air can be metered into the pressure chamber 21 to move the membrane 20 and stem 23 axially of the housing 19 against yielding bias of the spring 25. The pressure chamber 21 can be evacuated by means of an exhaust branch pipe 28 which opens into an exhaust ventilation housing 29 the inside of which is divided by a diaphragm or membrane 30 into an exhaust chamber 31 and a pressure chamber 32. The exhaust chamber 21 is connected with outside atmosphere or any other low pressure source by a throttle valve 33 that is adapted to regulate the rate of exhaust ventilation from the pressure chamber 21 and exhaust cham-

ber **31.** The pressure chamber **32** is provided with a fluid port **34.** If the pressure in the pressure chamber **32** is greater than in the exhaust chamber **31,** the membrane **30** presses against the exhaust ventilation branch pipe **28** and seals off the pressure chamber **21.**

A ratchet wheel **35** is rigidly secured on the shaft **7** for common rotation therewith, the ratchet wheel **35** cooperating with a pawl **36** that is swivel mounted in a bearing component **37** and fastened to the stem **23** and held in a normally operative position shown in FIG. **2** by a leaf spring **37'.** The number of teeth on the ratchet wheel **35** corresponds to the number of signal outputs or outlet ports **6,** so that with each movement of the stem **23** in a direction against bias of the spring **25,** the pawl **36** turns the ratchet wheel **35** ahead one tooth, and the arm **8** is swung to the next successive signal output **6** in the cleaning cycle.

Secured to the stem **23** is an interrupter plate **38** which interrupts a fluid interrupter valve **39** when the stem **23** is at one limit of its reciprocatory movement, and another fluid interrupter valve **40** when the stem **23** is at its other limit of reciprocatory movement. FIG. **3** shows the interrupter valve **39** in cross section. The air current flows in the direction shown by the arrows through the intake duct **39',** crosses over the groove **39''** and enters an outlet duct **39'''.** If the interrupter plate **38** is moved between the opposed openings of the ducts **39'** and **39'''**, the air current is interrupted. The outlet passages or ducts of the interrupter valves **39** and **40** are connected with the control inputs *x***1** and *x***2** respectively of a bistable valve **41.**

Preferably, the quick-opening valve **3** is generally cylindrical in form, and has its interior space hermetically divided by a diaphragm or membrane **42** into a pressure chamber **43** and an exhaust chamber **44.** The pressure chamber **43** communicates with one of the signal outputs **6** by means of a port **45** in the valve **3** and the conduit **46.** The pressure chamber **43** can thus be evacuated via the port **45,** tube or conduit **46,** signal output **6,** the passage **9,** passage portion **10** and ventilation holes **14.** The exhaust ventilation chamber **44** is evacuated through exhaust holes **47.** The exhaust chamber **44** is adapted to be connected by means of a connecting passage **48** with the exhaust duct which leads to the clean air valve, not shown. If there is high pressure in the pressure chamber **43,** the membrane **42** will close off the passage **48.**

The control output or port *y***1** of the bistable element **41** is connected to the ports **17** and **34,** and supplies air to and evacuates air from the pressure chambers **16** and **32.** A tube **49** connects the clean air container **1** withthe intake ducts of the interrupter valves **39** and **40,** and with the air input of the bistable valve **41.** In addition, the clean air container **1** is connected with the throttle valve **26** by means of a shut-off valve **50** and a check valve **51,** so that compressed air can flow from the clean air container **1** into the pressure chamber **21.** Also, clean air container **1** is connected by means of a tube **52** to a connecting inlet port **53** in the housing **4** to supply the signal outputs or outlet ports **6** with compressed air.

OPERATION — EMBODIMENT OF FIGS. 1–3

The above-described mechanism operates as follows:

With fan **2** generating air pressure, and valve **50** closed, compressed air flows through the tube **49** to the interrupter valves **39** and **40** and to the bistable valve **41.** Simultaneously, compressed air flows through the tube **52** to the signal outputs **6** which close the corresponding quick-opening valves **3.** Since the interrupter plate **38** interrputs the interrupter valve **40,** an air current frm the latter reaches the control input of the bistable valve **41** which passes a signal through its output *y***1** into pressure chambers **16** and **32,** so that the membrane **15** closes the opening **11** and membrane **30** closes the exhaust ventilation branch pipe **28.**

When the valve **50** is opened, the compressed air flows through the check valve **51** and throttle valve **26** into the pressure chamber **21.** The pressure mounting in pressure chamber **21** moves the membrane **20** with its stem **23** toward one limit of movement thereof against bias of the spring **25,** whereby the pawl **36** turns the ratchet wheel **35** forward one tooth, whereupon the arm **8** is moved to the next successive signal output or outlet port **6.** At the same time, the interrupter plate **38** moves away from the interrupter valve **40** and interrupts the interrupter valve **39,** so that the signal lapses at the control input *x***1** of the bistable valve **41** which now receives a signal at the control input *x***2** and emits a signal at control output *y***2.** Thereupon the pressure drops in pressure chambers **16** and **32.** In this way, the pressure chamber **43** of the next successive quick-opening valve **3** is evacuated, whereby the pressure chamber **21** is simultenaously evacuated by means of exhaust chamber **31** and the throttle valve **33.** As a result of the pressure drop in pressure chamber **21,** the spring **25** moves the membrane **20** and stem **23** to its limit of movement in the opposite direction, at which time the interrupter plate **30** again closes the interrupter valve **40** and releases the interrupter valve **39,** whereupon the above-described operation is repeated. The time interval between the evacuation of two consecutive quick-opening valves **23,** which interval corresponds to that between two clean air blasts, is determined by the time required for the pressure chamber **21** to fill with compressed air. This time can be varied by adjusting the throttle valve **26.** The throttle valve **26** thus serves to set the time interval between two successive clean air blasts. The time during which pressure chamber **43** of the quick-opening valve **3** remains evacuated and which corresponds in duration to a clean air blast, depends on the rate at which the pressure chamber **21** is evacuated. This time is adjustable by means of the throttle valve **33** which thereby controls the duration of a clean air blast. The amount of residual dust adhering to a filter tube following a clean air blast in a reverse direction therethrough, depends on the impulse force of the clean air blast. This impulses force, and hence the amount of residual dust, can be regulated by means of the metering valve **18.** A small transition section from the passage portion **9** to this passage portion **10,** determined by the setting of the metering valve **18,** results in a reduced impulse force, and hence in an increased amount of residual dust, while a large transistion section results in an increased impulse force and a reduced amount of residual dust. During a clean air blast, there is a pressure drop in the clean air chamber. The check valve **51** is provided to prevent any effect which this pressure drop might have on the chamber **21.** The check valve **51** closes as soon as the pressure in the clean air chamber **1** falls below the pressure in the pressure chamber **21.**

MODIFIED ARRANGEMENT OF FIGS. 4–6

In the embodiment illustrated in FIGS. 4–6, the numeral 55 designates a pneumatic dust removal plant with a pure air chamber 56, a clean air chamber 57, and a dust air chamber 58. In the area of the clean air chamber 57, quick-opening valves 59 and a manostat 60 are mounted on the outer wall. The quick-opening valves 59 may be assumed to be identical to the quick-opening valve 3 of FIG. 1. The clean air chamber 57 is supplied from a clean air source, such as a fan 61, by a conduit or tube 62 in which a conduit valve 63 and a throttle valve 64 are mounted. The conduit valve 63 is opened and closed by a pressure differential switch 65 depending on the differential between the pressures in the clean air hamber 56 and dust air chamber 58. The clean valves, not shown, are supplied by means of a conduit 66 which is connected with the compressed air source 61.

The manostat 60 has two control outputs or ports 60*a* and 60*b*. When an upper pressure limit is reached in the clean air chamber 57, the control output 60*a* conveys a signal to the sequence control, while control output 60*b* imparts a signal to the sequence control when a lower pressure limit is reached in clean air chamber 57. The sequence control comprises a closed cylindrical chamber 67 in the walls 68 of which are disposed radial output ports or signal outputs 69 in circumferentially spaced relationship. These outputs 69 extend radially outwardly of the wall 68 and permit compressed air present in the chamber 67 to escape to the outside. In the chamber wall 68, there is also provided a connection opening 70 to which an air blast conduit 71 is connected which links the chamber 67 with the compressed air source 61 by means of a reduction valve 72. Further, the chamber wall 68 is provided with an axial exhaust opening 73 having a throttle valve screw 74, the exhaust opening 73 communicating with an exhaust chamber 75 of a housing 76, the exhaust chamber 75 communicating with the outer atmosphere through openings 77. The housing 76 is connected with the wall 68 and has a cylindrical wall 78 in which the openings 77 are arranged, and which forms the exhaust chamber 75. The exhaust chamber 75 is closed off on one side by a diaphragm or membrane 79 disposed between the cylindrical wall 78 and a cover 80. In the cover 80, a ventilation intake port 81 is provided which opens into a pressure chamber between the cover 80 and membrane 79. If forced air is introduced through the intake opening 81 into the space between the cover 80 and membrane 79, the membrane 79 presses against the mouth of the exhaust opening 73 to close off said opening. In the wall 68 are mounted bearings 82 and 83 which journal a rotatable axle 84. The axle 84 is provided with a downwardly opening axial passage 85, axially aligned with the exhaust opening 73. An arm 86 has an inner end rigidly secured to the axle 84 and extends radially outwardly therefrom, the arm 86 being provided with a radial passage 87 that communicates at its inner end with the axial passage 85 in the axle 84. The radial arm 86 and outer end of the radial passage 87 are so disposed that the passage 87 is successively moved into alignment with the several outlet ports or signal outputs 69.

A centering gear 88 and a ratchet wheel 89 are rigidly mounted on the axle 84 outwardly of the chamber 67. The number of teeth on the ratchet wheel 89 and on the centering gear 88 corresponds to the number of signal outputs or outlet ports 69. Further, the angular displacment between the teeth of the centering gear 88, the ratchet wheel 89 and the signal outputs 69 is equal.

Firmly attached to the wall 68 is a generally cylindrical housing 90 the inside of which is divided by a membrane 91 into a spring chamber 92 and a pressure chamber 93. Mounted in the wall 95 of the housing 90 is an axially movable stem 96 having a flange 97 at one end. Between the flange 97 and the wall 95, a coil compression spring 98 is mounted which presses the stem 96 against the membrane 91. At its other end, the stem 96 is provided with a bearing 99 which supports swivel mounted pawl 100 for operation of the ratchet wheel 89 and held in a normally operative position by a leaf spring 99′. Fastened to the housing 90 is a bracket 101 which supports the mouths 102 and 103 of two control ducts 104 and 105 respectively. Secured to the stem 96 is a laterally projecting pin 106 which carries two seals 107 and 108, the seal 107 closing the mouth 102 at one end of movement of the stem or rod 96, the seal 108 closing the mouth 102 responsive to movement of the stem 96 to its opposite limit of movement.

A housing 109 is rigidly mounted on the chamber wall 68, the interior of the housing 109 being divided into a spring chamber 111 and a pressure chamber 112 by means of a diaphragm or membrane 110. A rod or stem 114 is mounted in a wall 113 of the housing 109 for movements axially of the housing 109, the stem 114 being disposed radially of the centering gear 88. At its radially inner end, the stem 114 is provided with means journaling a wheel element 115, and at its radially outer end, the stem 114 is provided with a flange 116. A coil compression spring 117 is mounted in the spring chamber 111 and yieldingly urges the stem 114 and membrane 110 in a direction radially outwardly with respect to the centering gear 88. The housing 109 is further provided with a fluid port 118 communicating with the pressure chamber 112. Air pressure, introduced to the pressure chamber 112, moves the membrane 110 and stem 114 radially inwardly toward meshing engagement of the wheel element 115 with the centering gear 88, against bias of the spring 117. When pressure of air within the pressure chamber 112 is reduced, the spring 117 moves the wheel element 115 out of meshing engagement with the centering gear 88, as will hereinafter appear.

The control device of FIGS. 4–6 incorporates an or-nor gate or valve 119, an and-gate 120, a bistable element 121, a bistable element 122, and an or-nor gate 123. The control input *x* of or-nor gate 119 is connected with the mouth 102 by means of the duct or tube 104. The control output *y*2 of or-nor gate 119 is connected with the control input *x*2 of and-element or gate 120. The control input *x*1 of and-element 120 is connected with the control output 60*a* of the manostate 60 by means of a tube 124. The output *y* of and-element 120 is connected with the control input *x*1 of the bistable element or valve 121 the control output *y*1 of which is connected with the port 94 by means of a tube 125. The control input *x*2 of the bistable element or valve 121 is connected with the control output *y*2 of the or-nor gate 123 which is simultaneously connected with the control input *x*2 of the bistable element or valve 122. The control input *x*1 of the bistable element 122 is connected with the output 60*b* of the manostat

60 by means of a tube 126. The control outputs $y1$ and $y2$ of the bistable element 122 are connected with the intake opening 81 and the port 118 respectively. The control input x of or-nor gate 123 is connected by means of a tube 127 with the mouth 103.

OPERATION — MODIFICATION OF FIGS. 4–6

Air entering the chamber 67 from the tube 21 flows through the signal outputs or outlet port 69 through the tubes 128 to the quick-opening valve 59 which then close the connected valve not shown. If the pressure differential between pure air chamber 56 and the dust air chamber exceeds a certain valve, the pressure differential valve 65 will open the conduit valve 63 so that compressed air will enter the clean air chamber 57 through the throttle valve 64. If the pressure in the clean air chamber 57 reaches an upper limit, the manostat 60 generates a signal at its output 60*a* which is then conveyed to the input $x1$ of the and-gate 120. The bistable element 121 emits a signal at its output $y2$ thus supervening the signal at its output $y1$ and evacuating the pressure chamber 93. The stem 96 is moved to the left with respect to FIG. 4 by the spring 98, and the seal 107 covers the mouth 102, sealing the same. In this way, control input x of or-nor gate or key 119 is closed off, whereupon the latter imparts a signal at the output $y2$ for input $x2$ of the and-element 120. The signals from the output 60*a* of the manostat 60, on the one hand, and from and or-nor gate 119 on the other, generate a signal at the output y of the and-element 120, which is conveyed to the input $x1$ of the bistable valve or element 121 which then emits a signal at output $y1$ thereof and introduces forced air into the pressure chamber 93. In this way, the stem 96 is pushed to the right with respect to FIG. 4 until the seal 108 closes the mouth 103 and hence the input x of the or-nor key 123 which then emits a signal at the output y thereof which is conveyed to the control inputs $x2$ of the bistable elements 121 and 122. The sliding motion of the stem 96 causes the pawl 100 to advance the ratchet wheel 89 by one tooth in a counterclockwise direction with respect to FIG. 5. The bistable element 121 now evacutates the chamber 93, so that the stem 96 slides to the left with respect to FIG. 4 while the bistable element 122 introduces air to the pressure chamber 112 via the output $y2$ of the bistable element 122, and pushes the stem 114 out of the housing 109 to cause meshing engagement between the wheel element 115 and centering gear 88. When the bistable element 122 shifts to output $y2$ thereof, the pressure chamber between the membrane 19 and cover 80 is simultaneously evacuated, so that the membrane 79 releases the mouth of the exhaust opening 73 and the corresponding quick-opening valve 59 is opened. By means of the throttle screw 74, the rate of opening of the quick-opening valve 59 can be regulated. While the stem 96 is displaced from the left to the right with respect to FIG. 4, the pressure chamber 112 receives forced air from the bistable element or valve 122 and the wheel element 115 is in mesh with the centering gear 88.

When the wheel element 115 is in mesh with the centering gear 88, the radial passage 87 in the arm 86 is axially aligned with a given signal output or outlet port 69. While the pressure chamber 112 receives forced air from the bistable element 122 from its control output $y2$, the membrane 79 is evacuated via the other control output $y1$, so that the quick-opening valve 59 coorresponding to the position of the arm 86 is evacuated or opened through the passage 85, exhaust opening 73, exhaust chamber 75 and openings 77. In this way, the opened quick-opening valve 59 opens the connected valves, not shown, and there is a blast of clean air forced through the respective filter until the pressure in the clean air chamber 57 reaches a lower limit. At this point, the manostat 60 generates a signal at its output 60*b* which is conveyed to the control input $x1$ of the bistable element 122, which once again sends forced air to the membrane 79 via the control output $y1$ of the bistable element 122, and closes off the exhaust opening 73. At the same time, evacuation of the pressure chamber 112 causes disengagement of the wheel element 115 from the centering gear 88. As this happens, the stem 96 is positioned at the left-hand end of its movement with respect to FIG. 4, and the seal 107 closes the mouth 102 and the output x of the or-nor key 119, so that a signal is created at the control input $x2$ of the and-gate 120. As long as the pressure differential switch 65 maintains the conduit valve 63 in an open condition, the pressure in the clean air chamber 57 will again rise to an upper limit, at which time a signal is sent by the manostat 60 to the input $x1$ of the and-element 120, after which the above-described cycle is repeated.

FIGS. 7 and 8 show a pneumatic removal device 132 equipped with the sequence control system of FIGS. 1–3. This device 132 can be equipped in the same way with a sequence control according to FIGS. 4–6. The pneumatic dust removal device according to FIGS. 7 and 8 includes a dust-air chamber 134 in which a plurality of vertical filter hoses 136 are arranged. At the bottom of the device 132, a conical dust collection area 137 connects to the dust-air chamber 134. This collection area can be closed by a port 138. Tangentially opening into the dust-air chamber is a dust-air line 139. The dust-air chamber 134 is divided from the clean air chamber 1 by means of a separator wall 140 which, in turn, is separated from a clean air chamber 133 by a dividing wall 141. The clean air chamber has an exhaust branch pipe 142 for the clean air. A plurality of the quick-opening valves 3 are shown in FIG. 1 attached to the wall of the ventilating air chamber 1, one of the quick-opening valves 3 being shown in FIG. 7.

Each filter hose 136 is fastened by means of a clamping band 143 to a flanged tubular mounting bracket 144 which serves as a suspension means for its respective filter hose 136. Each mounting bracket 144 is secured to the dividing or separator wall 140 by means of screws 145. From the clean air chamber 133 and axial to each tubular bracket is a different one of a plurality of connecting tubes 146 each having a diametrically enlarged portion in upwardly spaced relation to a respective one of the mounting brackets 144 and forming the valve seat of a respective one of a plurality of pneumatic valves 147. Each pneumatic valve 147 is operated by a quick-opening valve 3 through a control line 148 to which several valves 147 are connected for simultaneous operation. The control line 148 is connected by means of an opening 149 with the clean air chamber 1, which is supplied with compressed air through the feeder line 135. From the control line 148, a branch line 150 leads to each valve 147. The control line 148 opens through an opening 151 into a quick-opening valve 3, as shown in FIG. 8.

The valve 147 includes an annular membrane 152. The interior of each ring membrane 152 is connected with the control line 148 by a respective one of the branch lines 150. When the membrane 42 of the quick-opening valve 3 closes off the connecting air passage 48, the annular membrane 152 is supplied with air taken from the cleaning air in the clean air container 1 through the opening 149, the control line 148, and the branch line 150. Thus, the annular or ring membrane 152 is inflated against the diametrically enlarged portion of the respective tube 146 and closes off the connecting channel between the cleaning air chamber 1 and the interior of the filter hose 136. When the membrane 42 of the quick-opening valve 3 is moved away from the passage 48, air is removed from the annular membranes 152 connected therewith, thus opening the connecting channel between the cleaning air chamber 1 and the inside of the respective filter hoses 136, and a cleaning air pulse results.

While I have shown and described a preferred embodiment of my control system, and a single modified arrangement, it will be understood that the same is capable of further modification, and that modification may be made without departure from the spirit and scope of the invention, as defined in the claims.

What is claimed is:

1. Dust removal means comprising:

a. casing means defining, a dust laden air chamber having an inlet, a clean air pressure chamber, and a clear air discharge chamber having an outlet;

b. a dust removal outlet from said dust laden air chamber;

c. a plurality of hollow filter elements in said dust laden air chamber having their interiors in communication with said clean air pressure and discharge chambers;

d. individual normally closed valve means between the interior of each of said filter elements and said clean air pressure chamber;

e. filter cleaning means for cleaning said filter, comprising an inlet to said clean air pressure chamber adapted to be connected to a pressure source of clean air;

f. and control means for said filter cleaning means, comprising:

1. a plurality of quick opening valves connected to said valve means and operative to open selected ones of said valve means,

2. a housing defining a pressure chamber having a plurality of outlet ports each adapted to be connected to a different one of said quick opening valves, and an inlet port for connection to a source of air under pressure,

3. a control arm in said chamber, said control arm having an outer end and an inner end portion, and an air passage extending longitudinally therethrough, said outer end being disposed to engage said housing adjacent said outlet ports,

4. means mounting said control arm in said housing for intermittent movements of said arm in a direction whereby said air passage registers at the outer end of the arm successively with each of said outlet ports,

5. a pneumatically operated valve communicating with said valve passage at the inner end portion of said control arm,

6. control arm operating means for imparting said intermittent movement to said arm and including an actuator movable alternately in opposite direction.

7. and a pneumatic circuit including said pressure source and other valve means for opening said pneumatically operated valve to permit air to escape therethrough from each of said quick opening valves in succession responsive to movements of said actuator in one direction and to close said pneumatically operated valve responsive to movements of said actuator in an opposite direction and during movement of said arm from each outlet port to the next succeeding outlet port.

2. The control system according to claim 1 in which said fluid pressure device comprises a cylindrical housing, a diaphragm in said cylindrical housing and dividing the interior of said cylindrical housing into a spring chamber and a pressure chamber, a stem having one end connected to said diaphragm and projecting axially outwardly of said housing through said spring chamber, said pawl being mounted on on said stem outwardly of said cylindrical housing, said pressure chamber being operatively connected to said pressure source.

3. The dust removal means defined in claim 1 in which each of said quick opening valves is operatively connected to a plurality of said first mentioned valve means for simultaneously opening said plurality thereof.

4. The control system according to claim 1 in which said actuator includes a reciprocatory pawl and a fluid pressure operated device for imparting movements to said pawl in one direction, characterized by a ratchet driven by said pawl and operatively connected to said arm.

5. The control system according to claim 4, characterized by pneumatically operated centering means for releasably holding said ratchet against movement independently of said pawl and operative to release said ratchet upon movement of said pawl in one direction of said reciprocatory movement thereof.

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