

Dec. 1, 1964

A. E. REVELL

3,159,472

ELECTROSTATIC GAS CLEANING APPARATUS

Filed Jan. 27, 1961

2 Sheets-Sheet 1

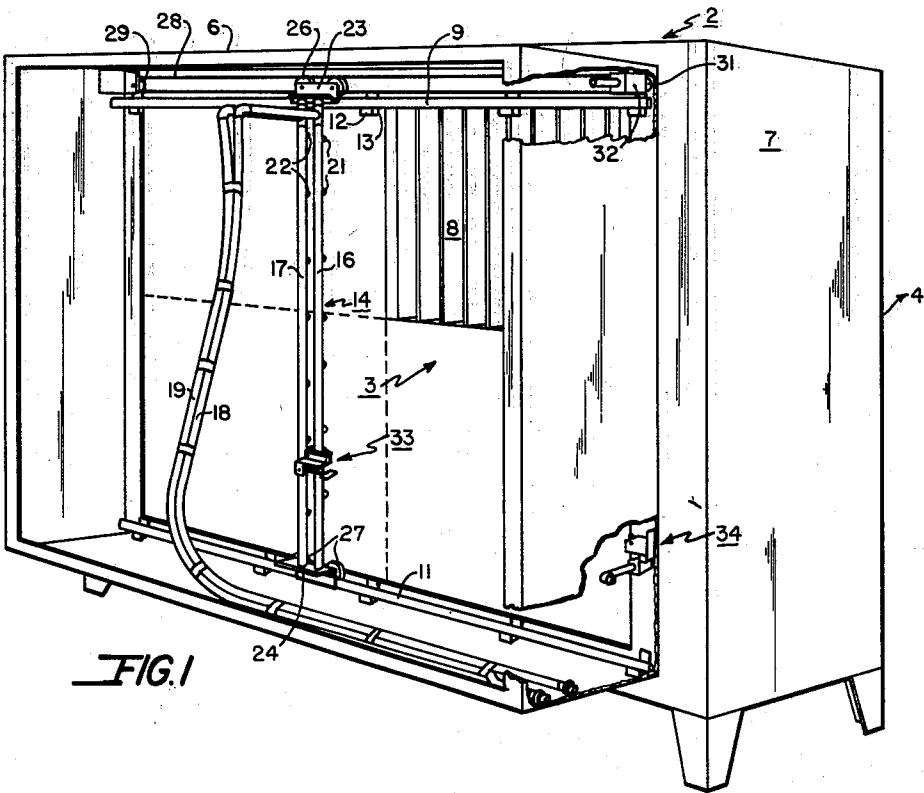


FIG. 1

FIG. 2

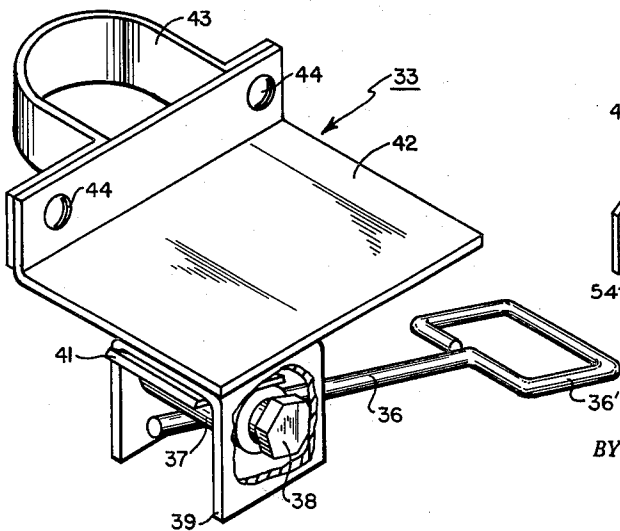
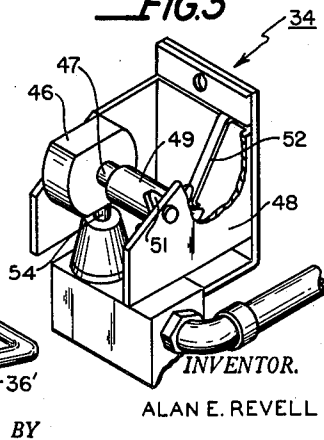


FIG. 3



INVENTOR.
ALAN E. REVELL

Ralph B. Grieb
ATTORNEY

Dec. 1, 1964

A. E. REVELL

3,159,472

ELECTROSTATIC GAS CLEANING APPARATUS

Filed Jan. 27, 1961

2 Sheets-Sheet 2

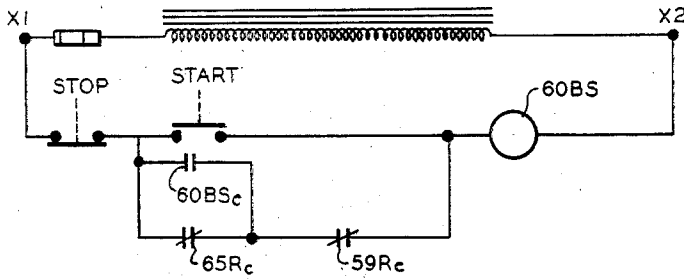


FIG. 4A

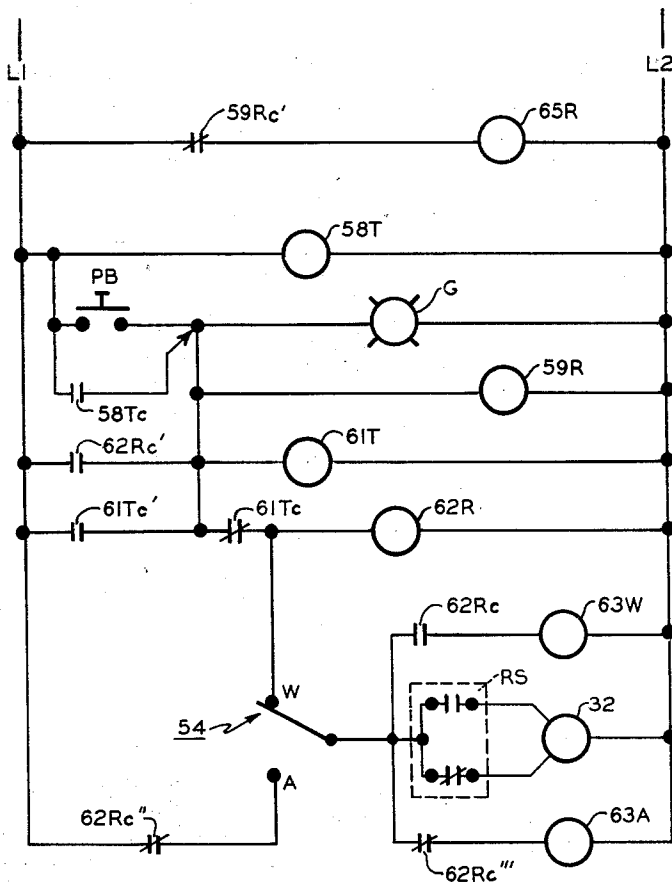


FIG. 4

INVENTOR.
ALAN E. REVELL

BY

Ralph B. Brick
ATTORNEY

1

3,159,472

ELECTROSTATIC GAS CLEANING APPARATUS
 Alan E. Revell, Louisville, Ky., assignor to American Air
 Filter Company, Inc., Louisville, Ky., a corporation of
 Delaware

Filed Jan. 27, 1961, Ser. No. 85,237
 7 Claims. (Cl. 55-118)

The present invention relates to electrostatic gas cleaning apparatus and more particularly to improved structure utilized for cleaning the plates of electrostatic gas cleaning apparatus.

It long has been known in the art of electrostatic precipitation to wash and adhesively treat gas cleaning plates disposed within the housing of an electrostatic precipitator by reciprocating a fluid header across a face of such plates and spraying appropriate wash or adhesive fluid on the plate surfaces. In the past, in order to control the length of wash, adhesive and intermittent drain periods through which the reciprocating fluid header cycled, a timer arrangement has been utilized to determine each period of the cycle, the timer being set in accordance with the number of passes desired for each period. Because of functional inaccuracies of the timer mechanisms and because of problems of friction involved in reciprocating a comparatively heavy fluid header mechanism, it has not always been possible to terminate movement of a header at an end of its path of travel so that such header would be removed from the path of flow of a dirty gas stream to be treated during gas cleaning operations. As a result, supplementary, complex and expensive actuating mechanisms have been incorporated with header moving structure in order to move a header to a desired end of path of travel. In still another type of known fluid treating mechanism for electrostatic precipitators, header actuated limit switches have been utilized at both ends of the path of travel of a header, such limit switches serving to stop wash and adhesive cycles of a header and the movement thereof. Although this arrangement permits removal of a header from the path of the gas stream during precipitating operations, the limit switches which have been utilized have restricted the number of passes which can be made by a header during wash and adhesive cycles and have further required a supplementary expensive and complex mechanism for restarting header movement for additional passes.

The present invention which provides an improved structural arrangement for fluid headers of electrostatic precipitators avoids the abovementioned disadvantages, presenting a simple, economical and straightforward construction which is efficient in operation and readily maintainable. In accordance with the present invention, previously required jog switches and complex circuitry associated therewith to insure header removal from a treated gas stream are eliminated. Further, multiple settings previously required for changes in sizes of electrostatic precipitator arrangements no longer are needed and; in addition, it is only necessary to make a simple substitution of a few parts in the present invention to provide for a change in the number of passes in a fluid header operating system.

Various other features of the present invention will become obvious to one skilled in the art upon reading the disclosure set forth hereinafter.

More particularly, the present invention provides an electrostatic precipitator for treating a dirty gas stream comprising a housing having spaced opposed gas inlet and gas outlet openings, gas cleaning means disposed within the housing intermediate the spaced openings, fluid header means to provide fluid treatment for the gas cleaning means, power means to reciprocate the fluid header means in a predetermined path of movement across the face of

2

the gas cleaning means, actuating means on the header means, and control means including a sequencing switch to control the "on-off" flow of fluid to the header means, the sequencing switch having programming means co-operable therewith and positioned in the path of movement of the actuating means on the header to be moved a preselected increment with each pass of the header to thereby program the sequencing switch and control the "on-off" flow of fluid to the header means.

It is to be understood that various changes can be made by one skilled in the art in the arrangement, form and scope of the apparatus described herein without departing from the scope or spirit of the present invention.

Referring to the drawings which disclose an advantageous embodiment of the present invention:

FIGURE 1 is a partially broken, perspective view of an electrostatic precipitator incorporating the inventive fluid treating structure;

FIGURE 2 is an enlarged perspective view of the actuating arrangement associated with the header assembly of FIGURE 1;

FIGURE 3 is an enlarged perspective view of a portion of the sequencing switch, including the programming means, which is mounted to the housing of the precipitator arrangement of FIGURE 1;

FIGURE 4 is a schematic, electrical diagram for operating the header assembly arrangement of FIGURES 1-3; and,

FIGURE 4A is a schematic, electrical diagram for operating a blower mechanism (not shown) associated with the precipitator of FIGURES 1-3, the circuitry of FIGURE 4A being linked to the circuitry of FIGURE 4 through a relay connection.

Referring to FIGURE 1 of the drawings, open-ended electrical precipitating housing 2 is disclosed having spaced opposed, upstream gas inlet 3 and downstream gas outlet 4. Housing 2 includes an upstream, open-ended housing section 6 which incorporates the fluid treating structure and a downstream open-ended housing section 7, communicating with housing section 6 and serving to house gas cleaning means indicated broadly by reference numeral 8. Gas cleaning means 8, which includes an ionizing section and a collector section, can be arranged in any one of several manners known in the art. Since the gas cleaning means, itself, does not constitute a critical part of the present invention, it is not described in detail herein.

Extending horizontally across housing section 6, in spaced parallel relationship on either side of gas inlet opening 3 are upper and lower track members 9, 11, respectively. Advantageously, track members 9, 11 can be U-shaped in cross section and are supported in position by engaging in interlocking fashion with vertically extending tongue portions 12 of spacer support brackets 13. Support brackets 13 are fastened to a side wall of housing section 6 on either side of gas inlet opening 3 by some suitable means such as welding or riveting. Mounted to ride along spaced track members 9, 11, in vertically extending position therebetween is fluid header assembly 14. Assembly 14 includes spaced vertically extending washing and adhesive conduits 16, 17, respectively, which are connected to suitable fluid supply sources (not shown) through hose connecting arrangements 18, 19, respectively. It is to be noted that conduit 16, 17 each have sets of spaced nozzles 21, 22, respectively, disposed thereon, these nozzles serving to distribute fluid from the conduits to gas cleaning means 8.

Fastened to the upper extremities of conduit 16, 17 is an upper carriage plate 23 of right angle cross-section and fastened to the lower extremities of conduit 16, 17 is a lower carriage plate 24 which can also be of right angle cross-section. The vertically extending leg of upper carriage plate 23 is arranged to carry a set

of track followers in the form of spaced and rotatably mounted rollers 26 which are slotted to ride securely on upper track member 9. In like fashion, lower carriage plate 24 is arranged to carry a set of track followers in the form of spaced rollers 27 slotted to ride securely on lower track member 11.

To move spaced upper and lower carriages 23 and 24 of header assembly 14 along tracks 9, 11, respectively, an endless belt 28 is provided. Belt 28, which is in the form of an endless ladder-chain, is mounted in horizontally extending position in housing section 6 to engage with idler sprocket 29 and horizontally spaced and aligned drive sprocket 31. These spaced sprockets are mounted in housing section 6 above and adjacent track members 9. A suitable gear motor 32, electrically connected to a power source to be described hereinafter (FIGURE 4) serves to drive sprocket 31 and move endless belt 28 through its flights, causing the fluid header assembly 14 to travel in reciprocating fashion back and forth across gas inlet 3 during washing and adhesive treating operations of gas cleaning means 8.

It is to be understood that any one of a number of arrangements can be used to accomplish the reciprocating movement of the header assembly 14. In the disclosed embodiment of the invention, a reversing switch such as indicated at RS in the circuit diagram of FIGURE 4 can be utilized to reverse the direction of rotation of gear motor 32, the reversing switch being actuated by assembly 14 as it moves to an end of its path of travel. If desired, a drive arrangement such as disclosed in applicant's co-pending application entitled, "Fluid Treating Structure for Electrostatic Precipitators," Serial No. 78,357, filed December 27, 1960, can also be used.

In accordance with the present invention, a unique arrangement is provided to insure efficient cycling of both washing and adhesive fluid to conduits 16, 17, such cycling being efficiently co-ordinated with movement of header assembly 14 and the operation of a blower circuit (FIGURE 4A) for a blower (not shown), which blower is utilized to induce a dirty gas stream to be treated through housing 2. Mechanically, the arrangement advantageously includes an actuating assembly 33 mounted on one of the conduits of reciprocable header assembly 14 and a sequencing switch assembly 34 mounted on housing 2 at inlet 3 to be engageable by actuating assembly 33 in a manner described hereinafter. The actuating assembly 33 (FIGURE 2) includes actuating arm 36 integrally mounted at one end thereof to sleeve 37. Sleeve 37, in turn, is rotatably mounted on pin 38 which extends in fixed position between the opposed legs of U-shaped bracket 39. A suitable stop member 41, engageable against the base of U-shaped bracket 39, is provided on sleeve 37 to limit rotational movement of such sleeve about pin 38 and thus limit pivotal movement of arm 36 connected to the sleeve. The U-shaped bracket which supports pivotally mounted arm 36 is supported from one leg of right angle plate member 42. The other leg of plate member 42 has a saddle-clamp 43 fastened thereto which can be arranged to engage around wash conduit 16. By tightening screws 44, associated with clamp 43, the actuating assembly 33 can be maintained in a selected position on conduit 16.

The sequencing switch assembly 34 (FIGURE 3) which is mounted to housing 2, includes cam member 46 fixed to pin 47 rotatably supported between the legs of U-shaped bracket 48. Bracket 48, in turn, is mounted to housing 2. Also fixed to pin 47, by means of an integral bushing 49, is a programming member 51 in the form of a star wheel. It is to be noted that the pin 47 and the star wheel 51 of switch assembly 34 are so mounted in bracket 48 that one tooth of the star wheel projects beyond an inclined side of a leg of U-shaped bracket 48. Thus, when assembly 14 is moved to a position where actuating arm 36 engages with sequencing

switch 34, a free end 36' of actuating arm 36 rides along the inclined side of the leg of U-shaped bracket 48 to engage against one of the teeth of programming member 51 and rotate the programming member a preselected increment. A flexible arresting member 52 in the form of a leaf spring mounted at one end to the base of U-shaped bracket 48 is adapted to engage in nesting arrangement with the teeth of star wheel 51 to insure that movement of the star wheel is made in appropriate increments as arm 36 engages therewith in its movement in one direction, the member 52 holding wheel 51 in fixed position to allow arm 36 to pass thereover in its movement in the other direction. With each rotation of star wheel 51, cam 46 is also rotated, being programmed in accordance with the position of the star wheel. The cam, which is contoured to engage against sequencing switch 54 at select positions, operates the switch to affect control in the circuit disclosed in FIGURE 4 of the drawing, bringing about appropriate washer, adhesive and blower control as described hereinafter.

To accomplish the wash and adhesive treatment of an electrostatic precipitator in automatic sequence with the blower operation for the precipitator, an electrical arrangement such as disclosed in FIGURES 4 and 4A can be provided. Referring to FIGURE 4, calendar timer 58T (which advantageously can be a seven day type) is disclosed as connected across 115 volt primary supply line L₁-L₂. On a preselected day at a preselected time, timer 58T operates to close normally open contact 58T_c for a preselected length of time, for example 30 minutes. This serves to complete the circuit across control relay 59R to energize the same. It is to be noted that normally open contact 58T_c also is shunted by push button PB. If PB is pressed, the same result could be reached as when 58T_c is closed by timer 58T. With control relay 59R energized, the blower (not shown) and power pack turn off. In this connection, attention is directed to the blower circuit of FIGURE 4A, wherein it is to be noted that normally closed contact 59R_c, operated by control relay 59R is caused to open and interrupt the circuit across blower starter coil 60BS. At the same time that control relay 59R is energized, a recycling timer 61T of known design, which includes a cam control mechanism to reverse in delayed timed relationship the normally closed contact 61T_c and normally open contact 61T_c', starts to run for the delayed time period and a control relay 62R is energized through normally closed contact 61T_c. With control relay 62R energized, normally open relay contacts 62R_c and 62R_c' are closed and normally closed relay contact 62R_c'' and 62R_c''' are open. With contacts 62R_c and 62R_c' closed and the sequencing switch 54 in the 54W position, the wash solenoid 63W is energized and water is turned on to flow to washing conduit 16. At the same time, gear motor 32 is energized through reversing switch RS and light G is lit. After header assembly 14 makes a preselected number of washing passes (for example, four), sequencing switch 54 is operated through programming member 51 and cam 46 to be moved to position 54A, shutting off the water and gear motor 32. After a selected drain time, the cam control mechanism in timer 61T aforescribed causes contacts 61T_c and 61T_c' to reverse so that normally closed contact 61T_c opens and normally open contact 61T_c' closes. Relay 62R is thus de-energized and, through its normally closed contact 62R_c'' and 62R_c'''—which were opened when relay 62R was energized and which are closed with the de-energization of relay 62R—the adhesive pump motor 63A is energized and adhesive is turned on to flow through conduit 17. It is to be noted that gear motor 32 also again operates to move header assembly 14 in its reciprocating path. After assembly 14 has made a further preselected number of passes, determined by the predetermined contour of cam 46, sequencing switch 54 is returned to 54W position, shutting off valve 63A and gear motor 32.

5

After a preselected drain time period (advantageously 2 hours), timer 61T times out and normally closed contact 61T_c returns to its normally closed position and normally opened contact 61T_c' to its open position. Light G goes off and relay 59R is de-energized. When this occurs, normally closed contact 59R_c (FIGURE 4A), which has been held open with energization of relay 59R (FIGURE 4), returns to closed position. It is to be noted that not only does relay 59R control the normally closed contact 59R_c in FIGURE 4A, but, in addition, it also controls normally closed contact 59R_c' across line L₁-L₂ to open such contact and prevent a time delay relay 65R from being energized when 59R is energized. When relay 59R is de-energized, 59R_c' also closes so that time delay relay 65R is energized. Since 65R is a time delay coil its contacts 65R_c are not open until the blower starter 60BS functions to close its contact 60BS_c and to allow the blower to run on its own.

Thus, in a straightforward and economical electro-mechanical arrangement, it is possible to automatically control the washing and adhesive cycle, the header movement cycle, and the gas "on-off" cycle of an electrostatic precipitator, avoiding past problems of header assembly dwelling in the path of a gas stream during gas cycle "on" operations, as well as the various other problems abovenoted.

The invention claimed is:

1. An electrostatic precipitator for treating a dirty gas stream comprising a housing having spaced opposed gas inlet and gas outlet openings, gas cleaning means disposed within said housing intermediate said spaced openings, fluid header means including fluid distributing nozzles to distribute fluid to said gas cleaning means to provide fluid treatment for said gas cleaning means, power means connected to said fluid header means to reciprocate said fluid header means in a predetermined path of movement across a face of said gas cleaning means, actuating means on said header means, and control means including a sequencing switch assembly to control the "on-off" flow of fluid to said header means, said sequencing switch assembly including a switch, a switch operating member and a movable programming member connected to said switch operating member, said programming member being positioned in the path of movement of said actuating means on said header to be moved a preselected increment with each pass of said header to thereby program said switch operating member to selectively operate said switch and control the "on-off" flow of fluid to said header means in accordance with a preselected number of passes of said fluid header means across the frame of said gas cleaning means.

2. An electrostatic precipitator for treating a dirty gas stream comprising a housing having spaced opposed gas inlet and gas outlet openings, gas cleaning means disposed within said housing intermediate said spaced openings, fluid header means including fluid distributing nozzles to distribute fluid to said gas cleaning means to provide fluid treatment for said gas cleaning means including a first header for washing fluid treatment and a second header for adhesive fluid treatment, power means connected to said fluid header means to reciprocate said fluid header means in a predetermined path of movement across a face of said gas cleaning means, actuating means on said header means, and control means including a sequencing switch assembly to control "on-off" flow of washing fluid to said first header and "on-off" flow of adhesive fluid to said second header, said sequencing switch assembly including a switch, a switch operating member and a movable programming member connected to said switch operating member, said programming member being positioned in the path of movement of said actuating means on said header to be moved a preselected increment with each pass of

6

said header to thereby program said switch operating member to selectively operate said switch and control the "on-off" flow of fluid to said first and second headers in accordance with a preselected number of passes of said fluid header means across the frame of said gas cleaning means.

3. The apparatus of claim 2, said control means including header movement control means to control said power means for reciprocating said header, said header movement control means including a switching circuit connected to said power means for said fluid header means, said switching circuit being responsive to the operation of said switch of said sequencing switch assembly whereby said power means is actuated and said first and second headers are moved only during the fluid flow "on" cycles.

4. The apparatus of claim 3, said control means further including a timer means to provide a time delay period between fluid operations of said first and second headers to permit fluid draining.

5. An electrostatic precipitator for treating a dirty gas stream comprising a housing having spaced opposed gas inlet and gas outlet openings, gas cleaning means disposed within said housing intermediate said spaced openings, fluid header means including fluid distributing nozzles to distribute fluid to said gas cleaning means to provide fluid treatment for said gas cleaning means, power means connected to said fluid header means to reciprocate said fluid header means in a predetermined path of movement across a face of said gas cleaning means, actuating means on said header means, and control means including a blower timer means to control dirty gas stream flow through said gas cleaning means, a header movement control means including a switching circuit connected to said power means to control said power means for reciprocating said header, and a sequencing switch assembly to control the "on-off" flow of fluid to said header means, said sequencing switch assembly and said header movement control means being operative during the "off" cycle of said blower timer means, said sequencing switch assembly including a switch, a switch operating member and a movable programming member connected to said switch operating member said programming member being positioned in the path of movement of said actuating means on said header to be moved in a preselected increment with each pass of said header to thereby program said switch operating member to selectively operate said switch and control the "on-off" flow of fluid to said header means in accordance with a preselected number of passes of said fluid header means across the frame of said gas cleaning means, said header movement control means including a switching circuit connected to said power means for said fluid header means, said switching circuit being responsive to the operation of said switch of said sequencing switch assembly whereby said power means is actuated and said header is moved only during the fluid flow "on" cycle.

6. An electrostatic precipitator for treating a dirty gas stream comprising a housing having spaced opposed gas inlet and gas outlet openings, gas cleaning means disposed within said housing intermediate said spaced openings, fluid header means including fluid distributing nozzles to distribute fluid to said gas cleaning means to provide fluid treatment for said gas cleaning means, power means connected to said fluid header means to reciprocate said fluid header means in a predetermined path of movement across a face of said gas cleaning means, an actuating arm pivotally mounted, at one end to said header, and control means including a sequencing switch assembly to control the "on-off" flow of fluid to said header means, said sequencing switch assembly including a switch, a rotatable switch operating cam engageable with said switch and a rotatable star wheel parallel to and connected with said cam, said star wheel

being positioned in the path of movement of said actuating arm on said header to be moved a preselected increment with each pass of said header to thereby program said switch operating cam to selectively operate said switch and control the "on-off" flow of fluid to said header means in accordance with a preselected number of passes of said fluid header means across the frame of said gas cleaning means.

7. The apparatus of claim 6, a flexible arresting member positioned so that one end thereof engages between the teeth of said star wheel to maintain movement of said star wheel in appropriate increments.

References Cited in the file of this patent

UNITED STATES PATENTS

2,333,551	Pegg	Nov. 2, 1943
2,448,045	Pegg	Aug. 31, 1948
2,448,046	Penney et al.	Aug. 31, 1948
2,591,404	Carlson	Apr. 1, 1952
2,604,184	Warburton et al.	July 22, 1952
2,615,529	Lincoln	Oct. 28, 1952
2,737,257	Warburton	Mar. 6, 1956
2,777,419	Paasche	Jan. 15, 1957
3,012,564	Dick	Dec. 12, 1961