June 28, 1966 R. P. FLAGG 3,257,778

IN-PLACE WASHING APPARATUS FOR AN ELECTROSTATIC PRECIPITATOR

Filed July 2, 1964 2 Sheets-Sheet 1

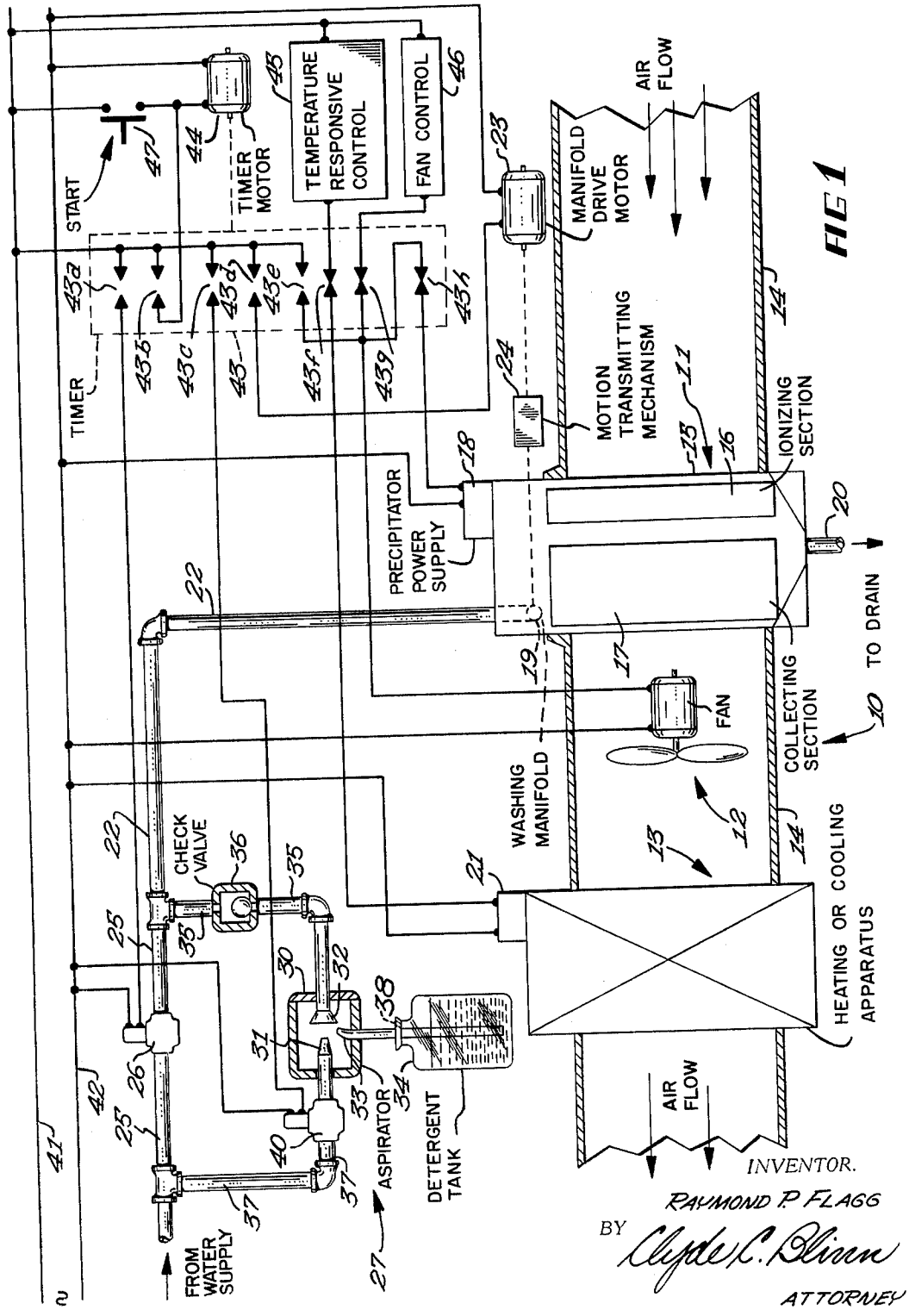


FIG 1

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IN-PLACE WASHING APPARATUS FOR AN ELECTROSTATIC PRECIPITATOR

Filed July 2, 1964 2 Sheets-Sheet 2

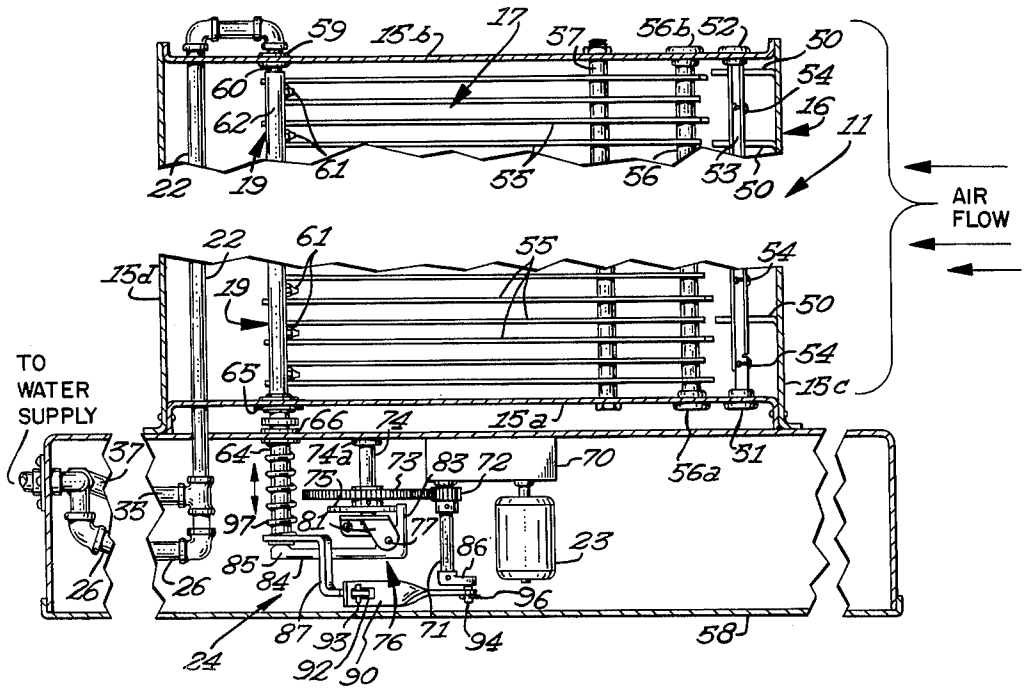


FIG 2

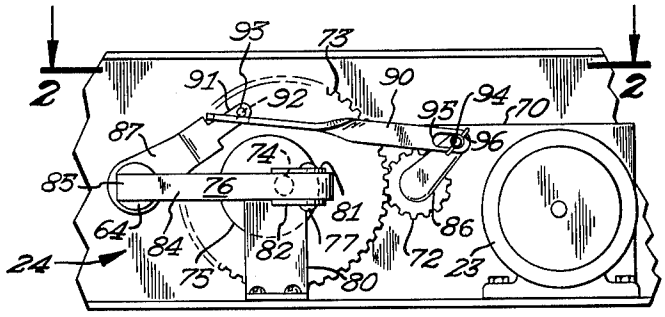


FIG 5

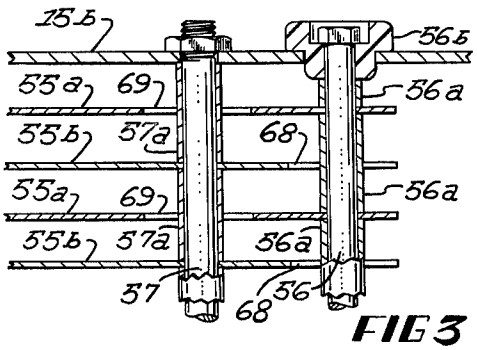


FIG 3

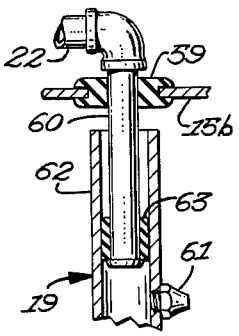


FIG 4

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3,257,778

IN-PLACE WASHING APPARATUS FOR AN ELECTROSTATIC PRECIPITATOR

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Filed July 2, 1964, Ser. No. 379,942
8 Claims. (Cl. 55—118)

The present invention relates to control apparatus and more specifically to an improved washing apparatus for a gas cleaner such as an electrostatic precipitator. Specifically the invention lies in an improved washing mechanism utilizing a washing manifold which is driven simultaneously in two modes of movement to provide improved washing of the gas cleaner and a simple mechanism driven by a unidirectional motor to impart this movement to the manifold. In addition the invention provides a simple and inexpensive means for providing detergent application to the gas cleaner as a part of the washing cycle to improve the cleaning thereof.

Electrostatic precipitators are presently available in a great variety of sizes ranging from the small portable units used in residences and offices and the slightly larger precipitators which are installed in the heating and cooling ducts in residences and small businesses, all the way up to the very large precipitators which may be many feet in heighth and width and used in large industrial or commercial installations. In between these extremes, in an area often termed "light commercial," an intermediate size precipitator is normally used. Regardless of the size of the precipitator it requires periodic cleaning if it is to operate efficiently. In the very small precipitators this is normally accomplished by simply removing the collecting section from the precipitator, manually washing it, and then replacing it in the precipitator. In the very large installations it is common to use a completely mechanized washing system which normally includes a chain-driven manifold which moves back and forth across the face of the precipitator and applies various cleaning fluids to the precipitator to remove the collected material therefrom. In these large precipitators, in addition to the application of hot water for removing the collected particles, it is customary to apply detergent by means of a motor driven pump which pumps detergent to the manifold and thereby to the collecting section of the precipitator during portions of the washing cycle. This type of washing mechanism is obviously expensive and occupies a great deal of space, but in very large installations these factors may not be prohibitive.

In the intermediate size of precipitator additional problems are often encountered. In many instances the precipitator is large enough so that the collecting section is difficult to handle and therefore removal of it from the precipitator for washing cannot be readily accomplished. Also, in some installations the precipitator is located in a place which is very hard to reach for frequent servicing. These problems could obviously be overcome by adding a large and elaborate washing mechanism such as is used with the very large precipitators but this is often prohibited by the expense involved and also by the amount of space necessary for such equipment. In precipitators of this type, washing is generally accomplished by utilizing a fixed manifold which has spray nozzles directed toward the collecting section and washing is accomplished simply by applying hot water to the manifold. Washing with hot water alone removes some of the collected material from the precipitator but has been found ineffective to accomplish complete and satisfactory washing. This is particularly true in the case of precipitators located where a great deal of smoke and tobacco tars are removed from the air by the precipitator.

In addition to the ineffectiveness of hot water alone to accomplish a satisfactory cleaning of the precipitator, the use of a fixed manifold, in most instances, has been found to result in certain portions of the collecting section being partially or completely uneffected by the washing operation due to the fact that the nozzles generally cannot cover the entire area of the collecting section.

While not limited thereto, my improved washing mechanism is particularly applicable to this intermediate size of gas cleaner where space and cost considerations prohibit the use of the elaborate washing equipment commonly used with larger precipitators and where size and inconvenient locations commonly make removal of the collecting section for cleaning inconvenient or substantially impossible.

My invention provides an elongated manifold which extends substantially across the air passage through the precipitator and in close proximity to the collecting section thereof, this manifold having disposed axially therealong a plurality of fluid dispensing openings or nozzles which are directed generally toward the collecting section. Rather than having the manifold completely fixed and relying only upon the dispersion by the spray nozzles for accomplishing cleaning of the entire collecting section, the manifold is mounted for limited axial movement within the air cleaner housing and also for angular oscillation with respect thereto. A unidirectional motor drives a transmission mechanism which is in turn connected to the manifold and which, upon rotation of the motor, imparts both axial reciprocation and angular oscillation to the manifold so that the fluid dispensing openings or nozzles thereon periodically scan substantially the entire surface area of the collecting section to assure that good cleaning is accomplished. In addition, my washing mechanism provides for the application of detergent to the collector by the use of a simple aspirator arrangement. This provides the improved cleaning which can be obtained only by using detergent along with the hot water applied to the collector but without requiring an expensive and elaborate pump arrangement for applying the detergent.

My washing mechanism is preferably controlled by a motor driven timer but, as will appear in the detailed description which follows, it may also be used with manual controls. In the description which follows, my improved washing mechanism has been described in conjunction with an electrostatic precipitator but it is to be understood that it is also applicable to any type of gas cleaner which utilizes a means for charging particles and then collecting them in a collecting section. Obviously electrostatic precipitation is the most common method of accomplishing such gas cleaning but other arrangements, such as the use of magnetic means for charging and collecting particles, have been proposed. These units will require periodic cleaning as do electrostatic precipitators and the washing apparatus described herein will be equally adaptable for use with them.

An object of my invention is to provide an improved washing apparatus for gas cleaners such as electrostatic precipitators and the like.

A further object of my invention is to provide a washing mechanism for gas cleaners having a washing manifold which is mounted for limited axial reciprocation and angular oscillation so that the fluid dispensing openings on the manifold periodically scan substantially the entire collecting section of the cleaner to insure that the entire area thereof is affected by the cleaning, and the provision of a unidirectional motor and transmission means for applying simultaneously such reciprocating and oscillating motion to the manifold.

Another object of my invention is to provide, in washing apparatus for a gas cleaner, an improved and simpli-

fied means for supplying a cleaning detergent to the washing manifold thereof.

Still another object of my invention is to provide a washing apparatus as described in the previous objects which is simple and relatively inexpensive and which is particularly adaptable for use in electrostatic precipitators which are to be located in remote and relatively inaccessible areas making frequent servicing thereof undesirable or substantially impossible.

These and other objects of the invention will become apparent upon reading the following description and claims taken in conjunction with the drawing wherein:

FIGURE 1 is a schematic representation of a forced air temperature conditioning system including an electrostatic precipitator having incorporated therewith the washing apparatus of the present invention.

FIGURE 2 is a top view, with portions broken away, of an electrostatic precipitator having incorporated therein one embodiment of my improved washing apparatus.

FIGURE 3 is a somewhat enlarged, fragmentary, cross-sectional view disclosing a preferred construction for the collecting section of the precipitator.

FIGURE 4 is a fragmentary view, partially in cross-section, of a connection between the washing manifold and a fluid conduit as utilized in one form of my invention.

FIGURE 5 is an enlarged front view of a unidirectional motor and transmission mechanism which forms a part of the present invention.

Referring first to FIGURE 1, the numeral **10** generally designates a forced air temperature conditioning system including an electrostatic precipitator **11**, a fan or blower **12** and a heating or cooling apparatus **13**. These members are connected by air flow ducts **14** which may be a part of the duct work system in a residence or a commercial installation. Precipitator **11** includes a housing **15** having mounted therein an ionizing section **16**, and a collecting section **17** mounted immediately downstream of the ionizing section. Precipitator **11** has a power supply **18** which is shown only schematically since it is conventional and forms no part of the present invention. Mounted somewhat above the collector section **17** of the precipitator is a washing manifold **19** which will be described in more detail, as will the precipitator itself, in connection with FIGURE 2. Manifold member **19** extends across housing **15** in close proximity to collecting section **17** and is adapted to apply cleaning fluids thereto during a washing operation. The precipitator housing **15** includes a port **20** at the bottom thereof which is adapted to be connected to a drain so that water which is applied during a washing operation may be effectively removed from the precipitator.

The heating or cooling apparatus **13** forms no part of the present invention and may be any conventional apparatus such as a furnace or air conditioning unit. The apparatus includes a control **21** which also is shown only schematically since it forms no part of the present invention.

As seen in FIGURE 1, air is drawn through the duct **14** from right to left by operation of the fan **12**. In an actual installation the right hand end of duct **14** may be connected to the return air duct of the system and the left hand end connected to the conditioned air supply duct. As air is drawn through the duct by fan **12**, it passes through a passage in the precipitator **11**, passing first through the ionizer **16**, and through the collector **17**, and then is moved on through the heating or cooling apparatus.

The manifold member **19** is connected, inside the air cleaner housing **15**, to a first fluid conduit member **22** as will be described in detail in connection with FIGURES 2 and 4. These two members are connected so that the manifold member **19** may be moved a limited distance in an axial direction with respect to the conduit

member **22** and also may be rotated with respect to conduit member **22**. A unidirectional electric motor **23** is operably connected to manifold member **19** through a transmission means **24**. As will be fully described hereinafter, motor **23**, when energized, operates transmission means **24** to import simultaneous axial reciprocation and angular oscillation to the manifold member **19**.

The conduit member **22** is connected to a further conduit **25** which is adapted to be connected to a source of hot water (not shown). Interposed in the conduit **25** is a valve **26** which may be any electrically operated valve and is preferably a normally closed solenoid valve. Connected in parallel with the valve **26** is a detergent injecting apparatus which preferably takes the form of an aspirator **27**. Aspirator **27** has a housing **30**, an inlet nozzle **31** and a flared outlet tube **32**. An injection tube **33** extends into the housing **30** and terminates in a space substantially between the inlet nozzle **31** and the outlet tube **32**. The other end of injection tube **33** extends into a detergent tank **34** which is adapted to contain a supply of liquid detergent and which has an air-inlet opening **38**. The aspirator is arranged so that when water is supplied under pressure through the inlet nozzle **31** to the outlet tube **32**, a suction is created adjacent the end of injector tube **33**. Hence air is drawn in through opening **38** and detergent is drawn from the tank **34** and injected into the stream of water which then passes out through the tube **32**.

Outlet tube **32** is connected to a joint intermediate conduits **22** and **25** by a further conduit **35**. Conduit **35** has interposed therein a check valve **36** which may, for example, be a gravity type check valve as illustrated which permits the flow of fluid from the aspirator toward the first conduit **22** but prevents backflow therethrough. A further conduit **37** connects the inlet nozzle **31** of the aspirator to a source of hot water, which, as illustrated, may be the same supply conduit which is connected to conduit **25**. Interposed in conduit **37** is a valve **40** which may also be any type of electrically operated valve but is preferably a normally closed solenoid valve. In practice, it has been found that it is quite essential that a substantially constant pressure be maintained across the aspirator **27** if it is to operate properly. Therefore I prefer to use a solenoid valve which also provides pressure regulation such as the valve disclosed, for example, in Patent Number 2,500,750 issued to D. H. Halenza on March 14, 1950. Valves of this general type are now readily available on the market.

The various components in the system described in connection with FIGURE 1 are supplied with power from a pair of conductors **41** and **42** which may, for example, be connected to a standard A.C. power source. Manual controls may be used for controlling the various components of the system, but they are preferably under the control of a timer **43**. Timer **43** is shown schematically in FIGURE 1 but preferably includes a plurality of sets of switch contacts which are operated by a like plurality of cams which in turn are driven by an electric motor **44**. In the example shown, timer **43** has five sets of contacts designated **43***a* through **43***e* which are normally open and which are closed by the motor driven cams at various times during the washing cycle. Similarly timer **43** includes normally closed sets of contacts **43***f* through **43***h* which are opened by the motor driven cams during certain portions of the time cycle. In FIGURE 1 the contacts are all shown in the position they assume when the timer is in a standby condition.

Normally closed contacts **43***f* in the timer **43** complete a circuit from conductor **41** through a temperature responsive control **45**, such as a thermostat, to one terminal of the control **21** for the heating or cooling apparatus **13**. The other terminal of control **21** is connected to conductor **42** and hence, when contacts **43***f* are closed, the heating or cooling apparatus **13** operates under the control of the temperature responsive control **45**. Normally

closed contacts 43*g* complete a circuit from conductor 41 through a fan control 46, which may include a manual switch and also may include a thermostatic control actually associated with the heating and cooling apparatus 13, to one terminal on the motor of fan 12. The other terminal of fan 12 is connected to conductor 42. In like manner, normally closed contact 43*h* normally completes a circuit from conductor 41, through fan control 46 and normally closed contact 43*g* to one terminal of the power supply 18 for the precipitator 11. The other terminal of the power supply is also connected to conductor 42.

Normally open contact 43*a* is adapted, when closed, to complete a circuit from conductor 41 to one terminal of the operator for valve 26 which has another terminal connected to the common conductor 42. Normally open contact 43*b*, when closed, completes a circuit from conductor 41 to one terminal of the timer motor 44 which has its other terminal connected to conductor 42. As seen in FIGURE 1, a shunt circuit is provided around normally open contact 43*b* and has interposed therein a start button 47 which, when depressed, completes a circuit from conductor 41 to the motor 44. The timer 43 is preferably constructed so that normally open contact 43*b* is closed shortly, i.e. several seconds or one minute, after motor 44 is energized and is then maintained closed until the time required for a complete washing cycle has elapsed. Thus by depressing the start button 47, the motor 44 is operated and it subsequently closes the contact 43*b* and establishes a holding circuit for the motor so that the start button may be released.

Normally open contact 43*c*, when closed, completes a circuit from conductor 41 to one terminal of the solenoid operator for valve 40. The other terminal of the solenoid operator is continuously connected to conductor 42. Contact 43*d*, when closed, completes a circuit from conductor 41 to the manifold driving motor 23 which has its other terminal connected to conductor 42. Normally open contact 43*e*, when closed, provides a shunt circuit around fan control 46 and normally closed contact 43*g* so that fan 12 may be energized by a circuit completed through contact 43*e* regardless of the condition of the fan control 46 or the contact 43*g*. FIGURES 2, 3, 4, and 5 disclose, in detail, a preferred embodiment of the washing apparatus of my invention in combination with an electrostatic precipitator. In FIGURE 2, the precipitator and the washing apparatus are seen as they would be viewed looking down from the top of the precipitator if the top portion of the housing thereof were removed. As seen there, the housing 15 of the precipitator 11 includes side walls or housing members 15*a* and 15*b* extending parallel to the direction of air flow and on opposite sides of the air flow passage through the precipitator. Housing 15 further includes end walls or housing members 15*c* and 15*d* extending transversely to the air flow passage at the inlet and outlet ends of the precipitator respectively. It is to be understood that in actual production devices a further housing (not shown) encloses the complete structure so that the housing members 15*a* through 15*d* actually appear as supporting members for the precipitator components rather than as an actual outside housing. The members 15*c* and 15*d*, which extend transversely of the gas flow passage which extends through the precipitator, obviously must have openings to allow the air to pass therethrough. In a preferred construction, member 15*c*, at the inlet end of the precipitator, has portions 50 cut and folded generally perpendicular thereto and extending into the housing to act as ionizer ground plates. Above these plates and mounted on the opposing side walls 15*a* and 15*b* by insulator members 51 and 52 respectively, is an ionizer mounting bar 53 which extends across the housing adjacent the top thereof. A similar bar (not shown) extends across the housing substantially adjacent the bottom thereof. Intermediate these two mounting bars are extended ionizing wires 54 which are connected to the high voltage terminal of the precipitator power supply. Since the precipitator power supply and the means for connecting it to these ionizing electrodes form no part of the invention they have not been shown in FIGURE 2.

Downstream of the ionizing section 16 is the collecting section 17 which is made up of spaced parallel plates 55 extending generally parallel to the direction of air flow through the passage of the precipitator. These plates actually form two sets of plates alternately disposed between each other with all of the plates of one set electrically and mechanically connected together and insulated from all of the plates of the other set. One set of plates (the charged plates 55*a*) is connected to a high D.C. voltage and the other set, consisting of plates 55*b*, is grounded. The means for connecting these plates to the power supply has been omitted in the drawing for simplicity. The plates may be supported and insulated in any known manner. The manner in which I have chosen to mount them can best be seen by referring to FIGURE 3.

Briefly stated the charged plates 55*a* are supported on one set of rods (of which only one, rod 56, is shown in FIGURE 2) with spacers 56*a* therebetween, and the grounded plates 55*b* are supported on another set of rods (of which rod 57 is exemplary in FIGURE 2) which also has spacers 57*a* between each of the plates. The rods 56 for the charged plates extend between housing members 15*a* and 15*b* and are insulatedly supported thereon by appropriate means such as insulators 56*a* and 56*b* respectively. The rods 57 for the grounded plates also extend between housing members 15*a* and 15*b* and may be supported thereon by any appropriate means since insulation between the housing and these rods is not necessary. The rods and spacers of the charged plates extend through clearance openings 68 in the grounded plates and hence are insulated therefrom. Similarly the rods and spacers of the grounded plates extend through like clearance openings 69 in the charged plates and are insulated therefrom.

For clarity in the drawing a portion at the center of the precipitator has been broken away, but it is to be understood that in actual practice a great number of collector plates may be used so that the precipitator is many times proportionately wider than it is shown in the drawing. Also it is to be understood that the precipitaor is connected, at the right and left hand ends, to the system duct work as illustrated in FIGURE 1.

Mounted on the outside of housing 15, adjacent housing member 15*a* and extending in the direction of gas flow, is a further housing member 58 which is attached to the housing 15 by appropriate means (not shown). The additional housing member 58 is mounted on housing 15 in such a manner that it is positioned outside of the area of gas flow and hence protrudes outside of the duct work. This housing 58 includes the operating mechanism for the washing apparatus (to be described hereinafter) and also may include various control elements for the precipitator which form no part of the invention and therefore have been omitted.

As seen in FIGURE 2, the various fluid conduits which are adapted to connect the washing apparatus to the source of hot water are contained in this housing 58 and it is to be understood that, while it is not shown in this figure, the detergent tank 34 may be located immediately below the housing. The first conduit member 22 extends from the housing 58, through wall 15*a*, across the entire width of the housing 15, and through wall 15*b* to a position where, by appropriate fittings, it makes a 180° turn and extends back into the housing 15 through a grommet or other holding means 59 which is mounted in the wall 15*b* of the housing 15. The portion of conduit 22 which extends through the housing is a cylindrical portion 60 which, as will be seen hereinafter, provides not only a fluid connection to the manifold member 19 but also acts as a support member therefor. It is to be understood that the conduit member 22, including the

cylindrical portion **60**, is fixed with respect to the housing.

As seen in FIGURE 2, the manifold member **19** is an elongated tubular member which extends from housing **58** through the wall thereof and through the wall **15***a* of housing **15** into the precipitator and extends substantially all the way across the housing **15** transversely to the collector plates. Preferably the manifold **19** is positioned slightly above the upper vertical limit of the collector plates. By so doing the fluids emitted from the manifold are aided in their travel to the collector plates by the force of gravity as well as the pressure supplied to the fluids. Spaced axially along the manifold member **19** are a plurality of fluid dispensing openings which may be fitted with fluid nozzles **61**. When the manifold is mounted in the precipitator, these nozzles are directed generally toward the collector plates **55**.

The tubular manifold member **19** has an open end **62** which is telescoped with the portion **60** of the conduit **22** and intermediate these two members is a cylindrical sealing member **63** which acts as a fluid seal between the two members and also may be rotated with respect thereto. The details of this connection can best be seen in the enlarged fragmentary cross sectional view disclosed in FIGURE 4. It should be noted that, while member **63** provides a substantially fluid-tight seal, a small leak at this connection makes little difference since the connection is inside the housing and leakage will occur only during a washing cycle.

The end **64** of manifold **19**, which is disposed in the additional housing **58**, is closed so that fluids cannot flow therethrough. Bearing members **65** and **66** in the walls of housings **15** and **58** respectively support this end of the manifold member **19** and allow both axial and rotational movement of the manifold member with respect to the housing.

Also mounted in the housing **58** is the manifold driving motor **23** which has a gear box **70** and an output shaft **71**. Motor **23** is preferably a unidirectional electric motor and the gear box **70** is sufficient to substantially reduce the rotational speed of the motor so that output shaft **71** rotates at a relatively slow rate when motor **23** is energized. Motor **23** and the output shaft **71** are operably connected to the manifold member **19** by a motion transmission means generally designated by the numeral **24**.

Actually this transmission means includes two motion transmission mechanisms. The first of these converts the unidirectional rotation of the output shaft **71** to linear reciprocating movement. This first mechanism includes a pinion **72** fixedly mounted on the shaft **71** and driving a gear **73** which is rotatably mounted on a shaft **74** which is in turn mounted on the housing as by a bearing member **74***a*. Gear **73** is connected to an eccentric cam **75** which acts upon a follower mechanism **76**. The follower member **76** is a generally L-shaped member which is pivotally mounted on a vertically extending pin **77** at a point adjacent the apex of the two legs of the L-shaped member. The pin **77** is supported by a bracket **80** which is mounted on the housing **58** and has an upstanding portion which forms a bearing for the forward end of the shaft **74**. This upstanding portion of the bracket **80** has a pair of spaced, horizontally extending fingers **81** and **82** which support the pin **77**. The L-shaped follower member **76** has one leg **83** which normally engages the surface of the eccentric cam **75**. The other leg **84** terminates in an operating portion **85** which normally abuts the closed end **64** of the manifold member **19**.

The second motion transmission mechanism includes a crank member **86** which is fixedly mounted on the output shaft **71** of the motor **23** and gear train **70**. A second crank member **87** is connected to the closed end **64** of manifold member **19** and extends generally radially outward therefrom. Actually this crank extends radially outward from the end of manifold **19** and then is bent so that it extends a short distance in an axial direction and then is again bent to extend radially. This provides for clearance around the mechanism of the first transmission mechanism and particularly around the leg **84** of the follower member **76**.

As best seen in FIGURE 5, crank **87** has a substantially greater throw than does crank **86**. This is desirable so that when crank **86** rotates continuously, the crank **87**, and consequently manifold member **19**, is merely angularly reciprocated rather than rotating through a complete circle. Operably connecting the two cranks **85** and **87** is a connecting rod member **90** which may be of any desired form. The only requirement is that this connecting member must provide a flexible connection between the two members since the cranks **86** and **87** do not always lie in the same plane due to the axial reciprocation of the manifold member **19** and consequently the crank member **87**. This flexible connection may be accomplished, for example, in the manner shown in FIGURES 2 and 5. Here crank member **87** has near its outer extremity a portion **91** of reduced width which projects into an enlarged opening **92** in one end of the connecting rod member **90**. These two members are held together by a pin **93** which extends through the end of the portion **91** of crank **87**.

A similar connection is made between the connecting rod **90** and crank **86**. A pin **94** extends outward from crank **85** and generally perpendicular thereto. This pin **94** extends through an enlarged opening **95** in the end of connecting rod **90** and the two members are held together by a further pin **96** which extends through the end of pin **94**. As seen in FIGURES 2 and 5 of the drawing, in order to accomplish this connection, the connecting rod member **90**, which has been disclosed as a flat metal strip, must have a 90° twist in it. Obviously various other arrangements may be used for connecting cranks **85** and **97**. However, this particular configuration has been found to provide a completely adequate and very inexpensive way of accomplishing the necessary connection.

When a cleaning fluid is applied to the manifold member, the pressure of the fluid will urge manifold member **19** axially away from portion **60** of the conduit member **22** with which it is telescoped and will also urge the end **64** into engagement with operator portion **85** of the follower member **76**. This in turn pivots member **76** about pin **77** and urges leg **83** into engagement with cam **75**. In some instances, for example where the water pressure is unusually low, it may be necessary to add a spring, such as spring **97**, to assist the water pressure in so biasing the manifold member.

Operation

The contacts of timer **43** are shown in FIGURE 1 in the condition in which they are normally found when the system is operating in a normal manner and the washing apparatus is in a stand-by condition. When precipitator **11** requires cleaning, the operator depresses the start button **47**. This completes the circuit to timer motor **44** which then begins to operate the timer and, as discussed above, within a short time closes the contacts **43***b* to complete a holding circuit for timer motor **44** so that the start button may be released. Thereafter the timer automatically sequences the operation of the switches therein to program the system through a washing cycle. A typical sequence of operations is as follows.

A short time after the energization of timer motor **44** and the closing of contacts **43***b*, contacts **43***h* are opened thereby de-energizing the power supply **18** for the precipitator **11**. At approximately this time contacts **43***f* are also opened to interrupt the circuit to the control **21** for the heating or cooling apparatus **13**. After a short delay, contacts **43***g* are also opened to interrupt the circuit to the fan **12**. At this point the precipitator

power supply, the fan and the heating or cooling apparatus have all been de-energized and the system is ready for the application of a washing operation to the precipitator.

This operation is begun by the closing of contacts 43*d* which complete the circuit to the manifold driving motor 23. When the motor 23 is energized it drives through the gear box 70 and imparts very slow unidirectional rotary motion to output shaft 71. Pinion 72 drives gear 73 which in turn drives eccentric cam 75. Cam 75 acts upon leg 83 of the follower member 76 and causes the member 76 to be pivoted about the pin 77 in accordance with the angular position of the cam member 75. Pivotal movement of the follower member 76 by cam 75 results in substantially linear movement of the operating portion 85 of leg 84 of member 76. This portion 85 acts upon the end 64 of manifold member 19 and imparts to the manifold member relatively slow axial reciprocating movement. The action of the spring 97 causes the end 64 of manifold member 19 to closely follow operation portion 85 of the follower member 86 and consequently causes portion 83 of the follower member 76 to remain in engagement with the surface of eccentric cam 85.

At the same time, rotation of output shaft 71 also causes unidirectional rotation of crank member 85. This rotation of crank member 85 is transmitted through the connecting rod member 90 to crank 87 and consequently to the manifold member 19 to which it is attached. Due to the substantially greater throw of crank member 87 than that of crank member 85, this rotation of crank member 85 results in angular oscillation of the crank member 87 and of manifold member 19. By this simultaneous axial reciprocation and angular oscillation of the manifold member 19, the fluid nozzles 61 are caused to periodically scan substantially the entire surface of the collector plates 55 whenever the motor 23 is operating. Thus when cleaning fluid is supplied to manifold 19, it is distributed over substantially the entire collector section to accomplish complete and uniform cleaning thereof.

At approximately the same time that contacts 43*d* are closed to energize motor 23, contacts 43*a* are also closed and hence valve 26 is opened to allow water to flow from the supply through the conduits 25 and 22 to the manifold 19. This water serves to wash a portion of the collected materials from the collector 17 and also to clear the conduits intermediate the hot water supply and the manifold of cold or warm water therein and to insure that the water being supplied to the manifold is then hot. After a period of time sufficient to accomplish this purpose, contacts 43*a* are again opened to de-energize the operator for valve 26. Contacts 43*c* are then closed completing a circuit to the operator for valve 40. Valve 40 is thus opened and hot water is supplied through the aspirator 27 which injects liquid detergent from the tank 34 into the water which then passes through the check valve 36 and is supplied through the conduit 22 to the manifold 19. Contacts 43*d* have remained closed so that motor 23 continues to drive the manifold. After a time sufficient to accomplish a complete soaking of the collector section with the detergent-containing hot water, contacts 43*c* are again opened and valve 40 closed. At this time the system preferably enters into a "soak" period to allow the detergent to loosen the material collected upon the collector plates.

After this soaking period, contacts 43*a* are again closed and valve 26 opened so that hot water is supplied to the manifold to rinse the precipitator components. After the rinsing period, contacts 43*a* and 43*d* are opened to de-energize valve 26 and motor 23 respectively.

At this point in the cycle all of the contacts of timer 43 are open and are maintained in that position for a period of time sufficient to allow the water accumulated on the precipitator components to substantially drip off and to pass through the port 20 to a suitable drain. After this drip period has been completed contacts 43*e* are closed to energize the fan 12. At the same time, contacts 43*f* are also closed so that if the temperature responsive control 45 is calling for operation of the heating or cooling apparatus 13, it may operate. During this period the fan 12 is continuously operated to draw air through the precipitator to accomplish drying of the components thereof.

It should be noted that at this time the contacts 43*h* are still open so that the precipitator powers supply is not energized. Obviously it is undesirable to energize the precipitator power supply before the internal components of the precipitator have dried. After a time sufficient to accomplish drying of the precipitator components, the contacts 43*h* and 43*g* are again closed and contacts 43*e* are opened. Thus the shunt circuit for fan 12 is opened and the fan and the precipitator power supply are placed under the control of the fan control 46. A short time later contact 43*b* is opened interrupting the circuit to motor 44 and thereby stopping the timer in its stand-by condition.

From the foregoing it can be seen that I have provided an improved washing mechanism for use with gas cleaners, such as electrostatic precipitators, which provides a simple, compact, and inexpensive means of injecting detergent into the washing water for the gas cleaner and further have provided an improved washing mechanism which is effective to provide substantially uniform washing over the entire surface of the collector section. In combination these features result in an improved washing apparatus which effectively cleans the collecting section of the precipitator to insure greater efficiency of operation of the precipitator and to prolong the periods of operation between washings.

While I have disclosed and described a specific embodiment of my invention, various modifications thereof may become apparent to those skilled in the art without departing from the spirit of the invention. Therefore it is to be understood that my invention is to be limited solely by the scope of the appended claims.

I claim:

1. In-place washing apparatus for an electrostatic precipitator of the type including a housing having a gas flow passage therethrough, an ionizing section and a collecting section mounted in the glas flow passage, and the collecting section including a plurality of spaced parallel collector plates each disposed in a plane substantially parallel to the direction of gas flow through the passage, the washing apparatus comprising: an elongated manifold member having an axially extending fluid passage therein and a plurality of fluid dispensing openings disposed axially therealong; means mounting said manifold member in said housing with said member extending generally transversely to the collector plates and in close proximity thereto, said mounting means facilitating limited axial movement and rotation of said manifold member with respect to the housing; fluid conduit means connected to the passage in said manifold member and adapted to connect said passage to a source of cleaning fluid; a unidirectional electrically energizable driving motor; transmission means operably connecting said driving motor to said manifold member and imparting limited axial reciprocatory movement and limited angular oscillatory movement to said manifold member upon energization of said motor means so that said fluid dispensing openings periodically scan substantially the entire surface area of the collector plates during operation of said driving means; and means for controlling the energization of said motor means.

2. In combination with an electrostatic gas cleaner including a housing having a gas flow passage therethrough, a particle ionizing section in said passage and a particle collecting section in said passage downstream of said ionizing section, said collecting section comprising a plu-

rality of spaced parallel collector plates vertically disposed in said passage and each lying in a plane generally parallel to the direction of gas flow through the passage, in-place cleaning apparatus for removing collected material from said collector plates comprising: an elongated manifold member having an axially extending fluid passage therethrough; a plurality of fluid dispensing openings axially disposed along and connected to the axially extending passage therein; means mounting said manifold member in said housing with said member extending generally horizontally across the passage and disposed in close proximity to the upper vertical extreme of said ionizer section and said collector plates, said mounting means mounting said manifold member for limited axial movement with respect to said housing and rendering said member angularly rotatable with respect to said housing; fluid conduit means connected to said manifold member and adapted to be connected to a source of cleaning fluid; a unidirectional driving motor; motion transmitting means operably connecting said motor and said manifold member and effective, upon unidirectonal rotation of said motor, to impart to said manifold member movement including simultaneous limited axial reciprocation within said housing and angular oscillation with respect thereto so that said nozzles periodically scan substantially the entire surface area of said collector plates during operation of said driving motor.

3. In-place washing apparatus for an electrostatic precipitator including a housing having a gas flow passage therethrough and an ionizing section and a collecting section mounted in the gas flow passage, the washing apparatus comprising: an elongated manifold member having an axial opening extending therethrough; a plurality of fluid dispensing openings axially spaced along said member and connected to said axial opening; means closing one end of said axial opening; means mounting said manifold member in the housing with said manifold member extending generally transversely to the gas flow passage and with said fluid dispensing openings directed toward said collecting section; first fluid conduit means; means connecting said first fluid conduit means to the other end of the axial opening in said manifold member; second fluid conduit means connected to said first fluid conduit means and adapted to be connected to a source of cleaning water; a fluid control valve interposed in said second conduit means; a storage tank for liquid detergent; an aspirator-type injector associated with said detergent storage tank, said injector having an inlet nozzle, an outlet tube and a suction feed tube, said feed tube extending into the detergent tank and adapted to draw detergent therefrom; third fluid conduit means connected to said inlet nozzle of said injector and adapted to be connected to a source of water under pressure; a fluid control valve interposed in said third conduit means; fourth fluid conduit means connecting the outlet tube of said injector to the axial opening in said manifold member; and check valve means interposed in said fourth conduit means and constructed and arranged to permit fluid flow therethrough in a direction from said injector to said manifold member and to effectively block flow in the reverse direction therethrough.

4. Washing apparatus for a gas cleaner of the type including a housing having a gas flow passage therethrough and a particle charging section and a particle collecting section mounted in the gas flow passage, the wahing apparatus comprising: a fluid conduit having a first portion external of the housing and a cylindrical second portion extending a relatively short distance into the housing in a position in close proximity to the collecting section and generally transversely to the gas flow passage; a tubular manifold member arranged co-axially with the second portion of said fluid conduit and having one end telescoped therewith inside of the housing; a cylindrical bearing and sealing member interposed intermediate the telescoped portions of said manifold member and said fluid conduit and of sufficient length to permit limited axial movement between said members; a plurality of fluid dispensing openings axially disposed along said manifold member and directed generally toward said collecting section; means sealing the other end of said tubular manifold member; bearing means intermediate the housing and said other end of said manifold member; a movable follower member mounted on the housing and having an operating portion adapted to be engaged by a portion of said manifold member and movable in a direction generally parallel with the axis of said manifold member, the construction of said manifold member being such that the pressure of cleaning fluids applied thereto will yieldably urge said manifold member axially away from said second portion of said fluid conduit and into engagement with the operating portion of said follower member; a unidirectional electric motor and gear train having an output shaft; a cam member operably connecting said output shaft to said follower member to impart reciprocating movement to the operating portion of said follower member and thereby to said manifold member upon rotation of said motor; a driving crank member having a relatively short throw and operably connected to said output shaft to be rotated thereby; a driven crank member connected to said manifold member and extending generally radially outward therefrom, said driven crank having a throw substantially greater than said driving crank; means operably connecting said driving crank and said driven crank so that rotation of said driving crank imparts angular oscillation to said driven crank and said manifold member; and means adapted to connect said fluid conduit to a source of cleaning water under pressure.

5. Washing apparatus for a gas cleaner of the type including a housing having a gas flow passage therethrough and a particle charging section and a particle collecting section mounted in the gas flow passage, the washing apparatus comprising: a first fluid conduit having a first portion external of the housing and a cylindrical second portion extending a relatively short distance into the housing in a position in close proximity to the collecting section and generally transversely to the gas flow passage; a tubular manifold member arranged co-axially with the second portion of said fluid conduit and extending across the gas flow passage in close proximity to the collecting section, said manifold member having a first end telescoped with the second portion of said first conduit inside of the housing; a cylindrical bearing and sealing member interposed intermediate the telescoped portions of said manifold member and said fluid conduit and of sufficient length to permit limited axial movement between said members; a plurality of fluid dispensing openings axially disposed along said manifold member and directed generally toward said collecting section; means closing the other end of said tubular manifold member so that said manifold member will be urged away from the second portion of said first conduit member by the pressure of fluids applied thereto; bearing means intermediate the housing and said other end of said manifold member; second fluid conduit means connected to said first fluid conduit means and adapted to be connected to a source of cleaning water; a fluid control valve interposed in said second conduit means; a storage tank for liquid detergent; an aspirator-type injector associated with said detergent storage tank, said injector having an inlet nozzle, an outlet tube and a suction feed tube, said feed tube extending into the detergent tank and adapted to draw detergent therefrom; third fluid conduit means connected to the inlet nozzle of said injector and adapted to be connected to a source of water under pressure; a fluid control valve interposed in said third conduit means; fourth fluid conduit means connecting the outlet tube of said injector to the axial opening in said manifold member; check valve means interposed in said fourth conduit

means and constructed and arranged to permit fluid flow therethrough in a direction from said injector to said manifold member and to effectively block flow in the reverse direction therethrough; a movable follower member mounted on the housing and having an operating portion adapted to be engaged by a portion of said manifold member and movable in a direction generally parallel with the axis of said manifold member, said manifold member being urged into engagement with the operating portion of said follower member by the pressure of cleaning water applied thereto; unidirectional rotary motor means having an output shaft; a cam member operably connecting said output shaft to said follower member to impart reciprocating movement to the operating portion of said follower member and thereby to said manifold member upon rotation of said motor means; a driving crank member having a relatively short throw and operably connected to said output shaft to be rotated thereby; a driven crank member connected to said manifold member and extending generally radially outward therefrom, said driven crank having a throw substantially greater than said driving crank; means operably connecting said driving crank and said driven crank so that rotation of said driving crank imparts angular oscillation to said driven crank and said manifold member simultaneously with the axial reciprocation thereof by said cam member.

6. In-place washing apparatus for an electrostatic precipitator of the type including a housing having a gas flow passage therethrough, an ionizing section and a collecting section mounted in the gas flow passage and the collecting section including a plurality of spaced parallel collector plates each disposed in a plane substantially parallel to the direction of gas flow through the passage, the washing apparatus comprising: an elongated tubular manifold member having a plurality of fluid dispensing openings disposed axially therealong; means mounting said manifold member in said housing with said member extending generally transversely to the collector plates and in close proximity thereto and with said fluid dispensing openings directed generally toward the collecting section; said mounting means facilitating limited axial movement and rotation of said manifold member with respect to the housing; fluid conduit means connected to the passage in said manifold member and adapted to connect said passage to a source of cleaning fluid; unidirectional electrically energizable motor means having an output shaft; first transmission means for converting unidirectional rotary motion to reciprocating linear motion; means including said first transmission means operably connecting the output shaft of said motor means to said manifold member; second transmission means for converting unidirectional rotary motion to oscillating angular motion; means including said second transmission means also operably connecting the output shaft of said motor means to said manifold member, said first and second transmission means together imparting simultaneous axial reciprocation and angular oscillation to said manifold member upon operation of said motor means so that said fluid dispensing openings periodically scan substantially the entire surface of the collector plates.

7. In combination with a gas cleaner including a housing having a gas flow passage therethrough, a particle charging section in said passage and a particle collecting section in said passage downstream of said charging section, said collecting section comprising a plurality of collector plates disposed in said passage and each lying in a plane generally parallel to the direction of gas flow through the passage, in-place cleaning apparatus for removing collected material from said collector plates comprising: a first fluid conduit having a first portion external of the housing and a cylindrical second portion extending a relatively short distance into the housing in a position in close proximity to the collecting section and generally transversely to the gas flow passage; a tubular manifold member having a closed end and an open end, said manifold member being disposed co-axially with the second portion of said fluid conduit and extending across the gas flow passage in close proximity to the collecting section, said manifold member having said open end telescoped with the second portion of said first conduit inside of the housing; a cylindrical bearing and sealing member interposed intermediate the telescoped portions of said manifold member and said first fluid conduit and of sufficient length to permit limited axial movement between said members; a plurality of fluid dispensing openings axially disposed along said manifold member and directed generally toward said collecting section; bearing means intermediate the housing and said other end of said manifold member; second fluid conduit means connected to said first fluid conduit means and adapted to be connected to a source of cleaning fluid; unidirectional rotary motor means; first transmission means including a movable follower member mounted on the housing and having an operating portion adapted to be engaged by a portion of said manifold member and movable in a direction generally parallel with the axis of said manifold member; and an eccentric cam member operably connecting said output shaft to said follower member to impart reciprocating movement to the operating portion of said follower member upon rotation of said motor means, the construction of said manifold member being such that the pressure of cleaning fluid applied thereto will yieldably urge said manifold member axially away from said second portion of said fluid conduit means and into engagement with the operating portion of said follower member; second transmission means including a driving crank member having a relatively short throw and operably connected to said output shaft to be rotated thereby, a driven crank member connected to said manifold member and extending generally radially outward therefrom, said driven crank having a throw substantially greater than said driving crank, and means operably connecting said driving crank and said driven crank so that rotation of said driving crank imparts angular oscillation to said driven crank and said manifold member simultaneously with the axial reciprocation of said manifold member by said cam member and said follower member.

8. In combination with a gas cleaner including a housing having a horizontal gas flow passage therethrough, a particle charging section in said passage and a particle collection section in said passage downstream of said charging section, in-place cleaning apparatus for removing collected material from said collector section comprising: an elongated manifold member having an axially extending fluid passage therethrough; a plurality of fluid dispensing openings axially spaced along said manifold member; means mounting said manifold member in said housing with said member extending generally horizontally across the passage and disposed in close proximity to said collector section, said mounting means mounting said manifold member for limited axial movement with respect to said housing and rendering said member angularly rotatable with respect to said housing; first fluid conduit means connected to said manifold member; second fluid conduit means connected to said first fluid conduit means and adapted to be connected to a source of cleaning water; a storage tank for liquid detergent; an aspirator-type injector associated with said detergent storage tank, said injector having an inlet nozzle, an outlet tube and a suction feed tube, said feed tube extending into the detergent tank and adapted to draw detergent therefrom; third fluid conduit means connected to the inlet nozzle of said injector and adapted to be connected to a source of water under pressure; fourth fluid conduit means connecting the outlet tube of said injector to the axial opening in said manifold member; check valve means interposed to said fourth conduit means and constructed and arranged to permit fluid flow therethrough

in a direction from said injector to said manifold member and to effectively block flow in the reverse direction therethrough; a unidirectional driving motor; motion transmitting means operably connecting said motor and said manifold member and effective, upon unidirectional rotation of said motor, to impart to said manifold member movement including simultaneous limited axial reciprocation with said housing and angular oscillation with respect thereto so that said nozzles periodically scan substantially the entire surface area of said collector plates during operation of said driving motor.

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