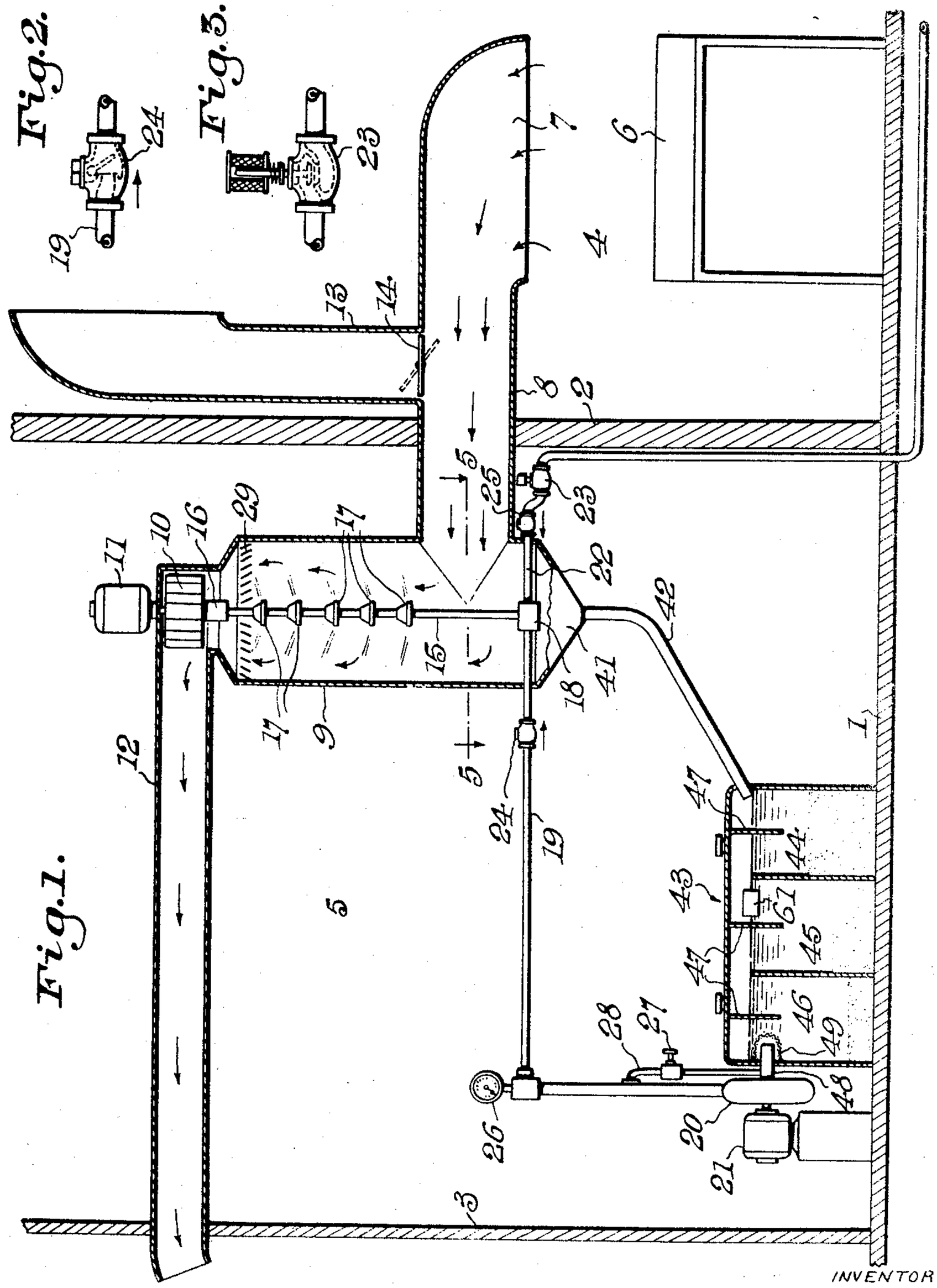
Jan. 23, 1951 T. W. CARRAWAY 2,539,344

AIR OR GAS CLEANING APPARATUS

Filed April 6, 1945 3 Sheets-Sheet 1



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Filed April 6, 1945 3 Sheets-Sheet 2

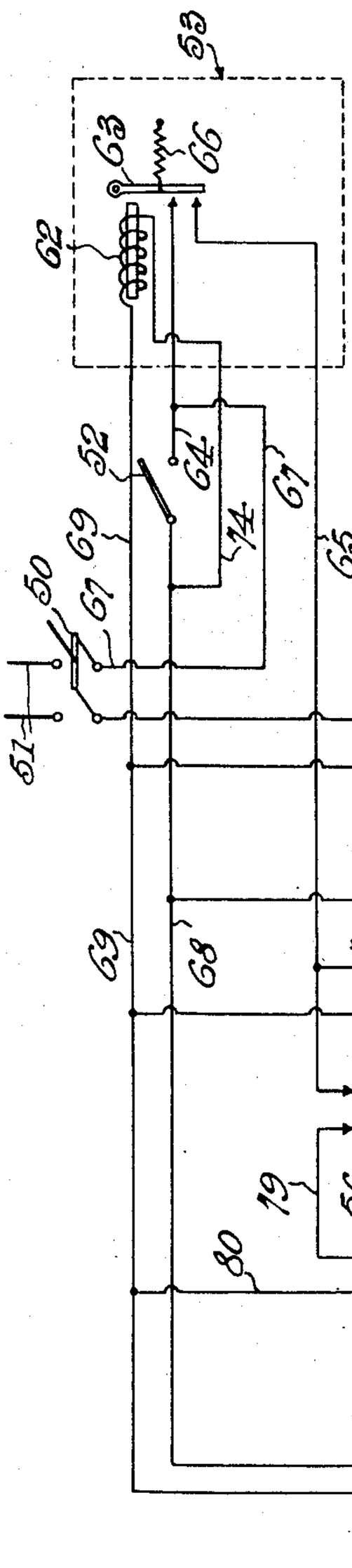

Fig. 4.

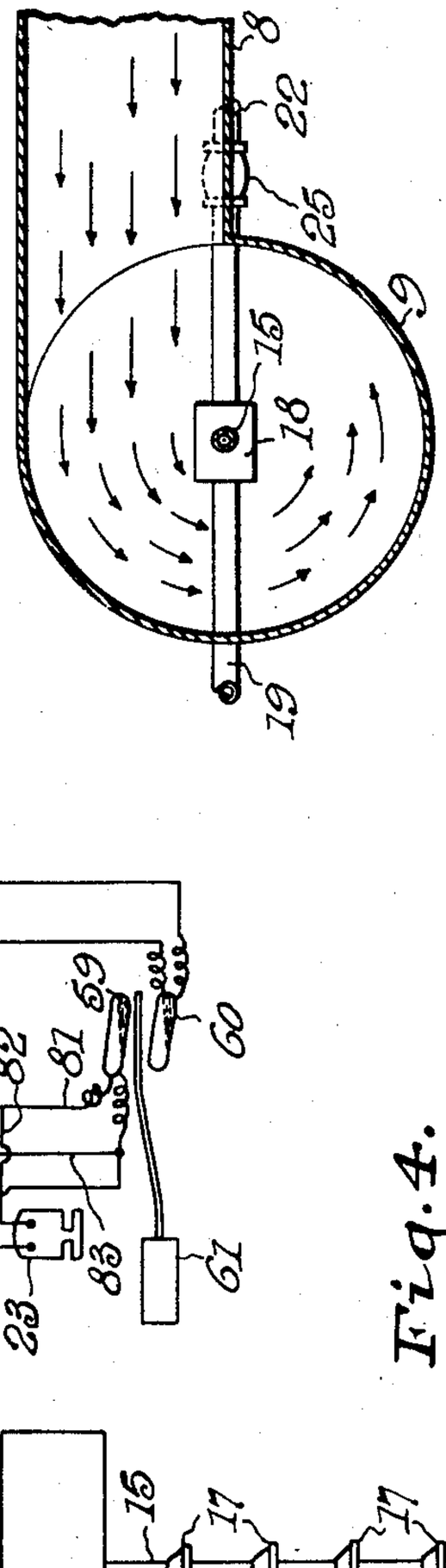

Fig. 5.

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Filed April 6, 1945 3 Sheets-Sheet 3

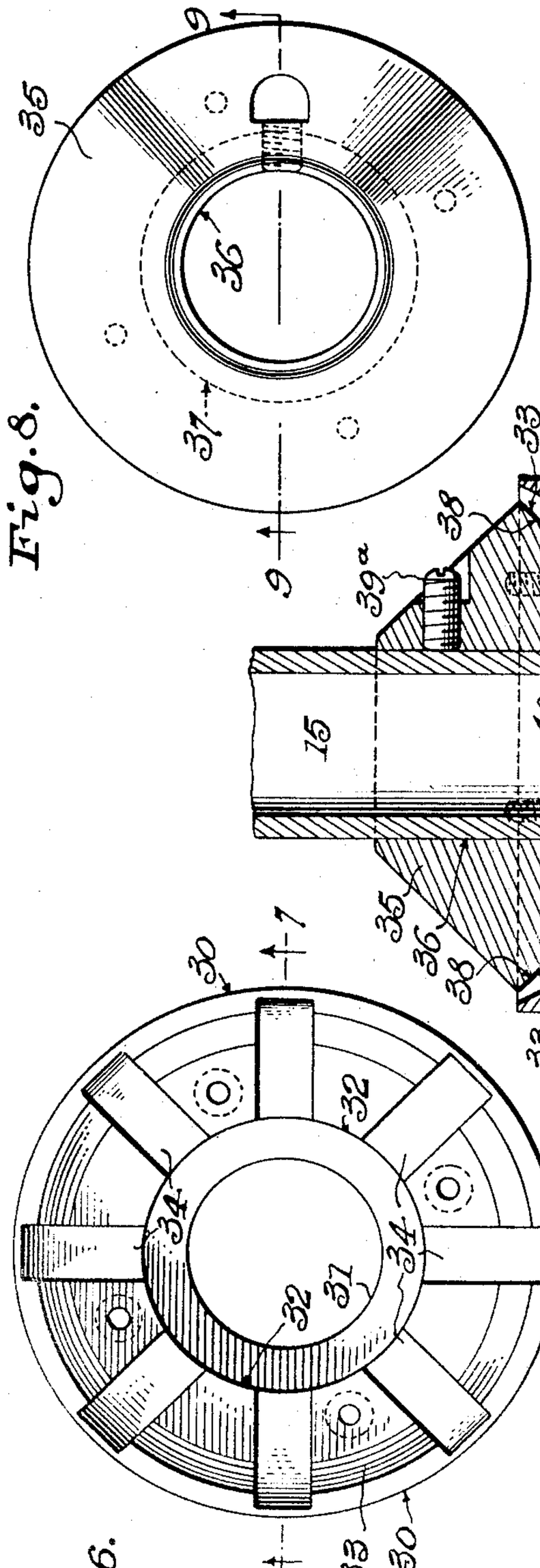

Fig. 8.

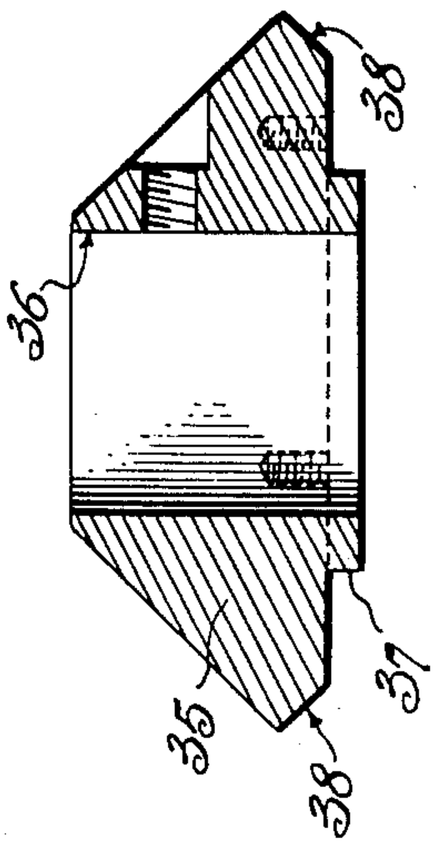

Fig. 9.

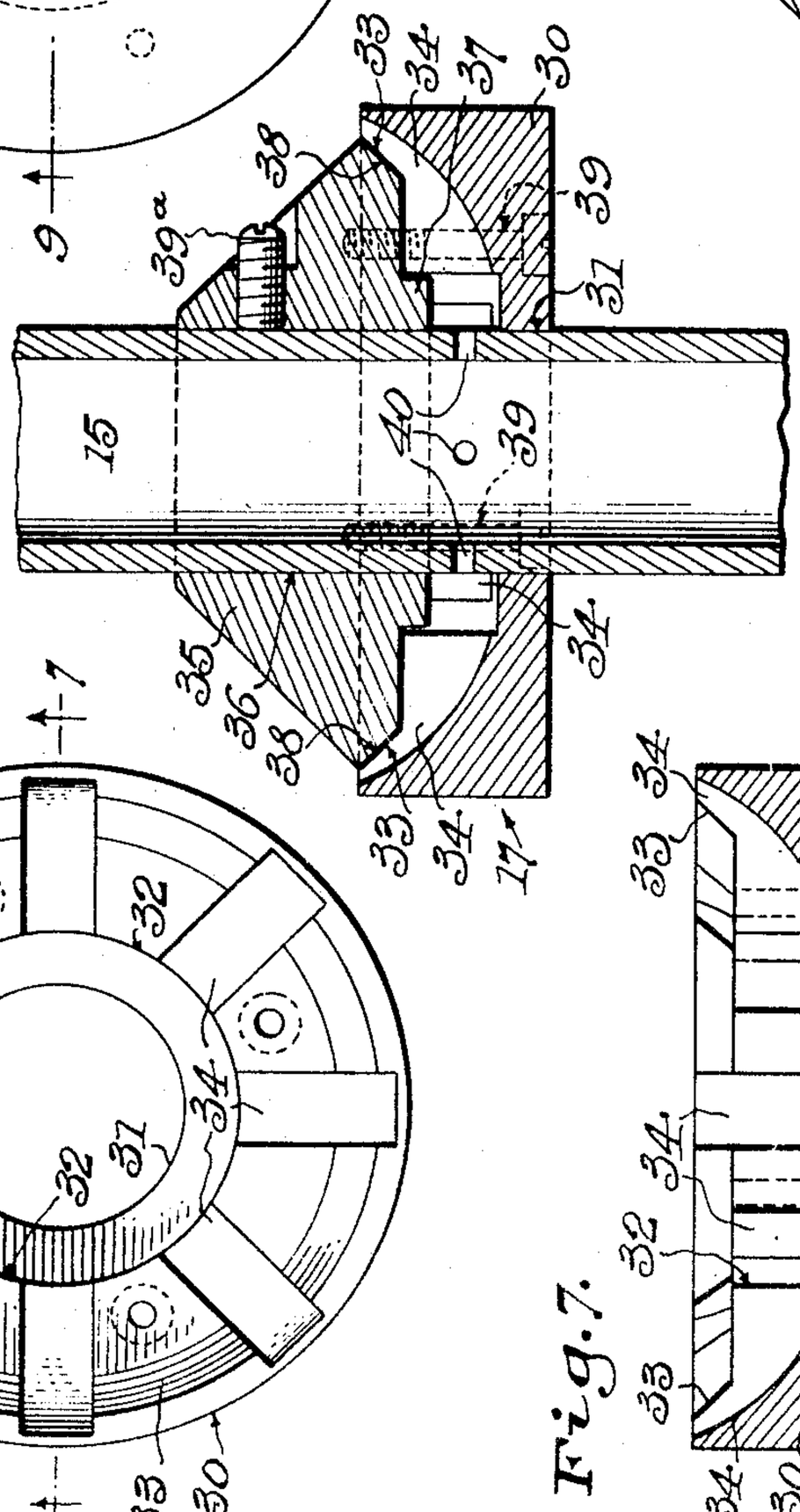

Fig. 10.

Fig. 6.

Fig. 7.

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2,539,344

UNITED STATES PATENT OFFICE

2,539,344

AIR OR GAS CLEANING APPARATUS

Thomas W. Carraway, Dallas, Tex.

Application April 6, 1945, Serial No. 586,986

11 Claims. (Cl. 261—7)

1

This invention relates to air or gas cleaning apparatus and more particularly to air or gas cleaning apparatus of the kind in which air or gas is moved through a cleaning chamber in which it is contacted by diffused water or other cleaning fluid which removes the dust or solid particles. In apparatus of this class, the air or gas may enter the cleaning or dust removal chamber tangentially so as to proceed over a spiral path with a swirling action while passing through the chamber. The cleaning fluid may be thrown centrifugally from a rotating impeller into the chamber in diffused form for intimate contact with the air or gas. The unevaporated cleaning fluid may be drained from the chamber and conducted to equipment for separating the entrained dust from the fluid, after which the fluid may be pumped back to the impeller and reused.

If such an apparatus remains out of operation for some time—long enough for the moisture in the cleaning chamber to drain off or evaporate—a residual deposit of dry dust particles may be left on the impeller. If the particles are of a highly explosive nature, such as particles of TNT removed from the air in a munitions factory, and if the impeller is again placed in operation before the residual particles are thoroughly washed away or wetted, dry explosive particles may be thrown off the impeller and against the chamber walls, resulting in an explosion.

An object of the present invention is to provide air or gas cleaning apparatus including or combined with mechanism for controlling operation of the dust removing equipment in such a way as to eliminate the danger of dust explosions occurring in the apparatus itself.

Another object of the invention is to provide apparatus of the kind referred to which is so controlled as to minimize the residuum of dust or solid particles left in the cleaning chamber when the apparatus is stopped.

Another object of the invention is to provide control equipment for automatically effecting thorough wetting of the inside of the chamber and all parts therein before the mechanically movable parts within the chamber can begin to operate.

Another object of the invention is to provide apparatus of the character stated including or combined with equipment for automatically washing the interior of the cleaning chamber and the mechanically movable parts therein with clean, fresh washing fluid at the close of an operative period.

Another object of the invention is to provide

2

control means for automatically effecting the addition of make-up fluid to a reservoir which supplies the cleaning fluid to the cleaning chamber.

Another object of the invention is to provide automatically controlled means for disabling the entire apparatus in response to failure of the supply of cleaning fluid.

A further object of the invention is to provide equipment for automatically timing the operation of the air or gas cleaning apparatus so that when a master control device is set for "starting," cleaning fluid will be delivered to the cleaning chamber for a predetermined time, after the expiration of which the impeller will begin to run, and when the master control device is set for "stopping" the impeller will continue to run for a predetermined period during which fresh, clean washing fluid will be delivered to the cleaning chamber.

Other objects will become apparent from a reading of the following more detailed description, the appended claims, and the accompanying drawings, in which:

Figure 1 is a vertical section through part of a building equipped with apparatus embodying the invention, parts of the apparatus being shown in section and other parts in elevation;

Figure 2 is a detail view showing a check valve in elevation and drawn on an enlarged scale;

Figure 3 is a detail view of a solenoid-operated valve, partly in elevation and partly in section, drawn on an enlarged scale;

Figure 4 is a wiring diagram;

Figure 5 is a fragmentary horizontal section on the line 5—5 of Figure 1 drawn on an enlarged scale;

Figure 6 is a plan view of the lower half of a fluid impeller;

Figure 7 is a section on the line 7—7 of Figure 6;

Figure 8 is a plan view of the upper half of a fluid impeller;

Figure 9 is a section on the line 9—9 of Figure 8; and

Figure 10 is a sectional view showing the two impeller halves assembled on a hollow shaft.

An illustrative embodiment of the invention is shown as being installed in a building including a floor 1 and walls 2 and 3 which define a work room 4 and aparatus room 5. A table 6 located in the work room 4 may be used by workers for loading shells with explosive charges or doing other work which may result in dust or solid particles becoming entrained in the atmosphere and which, in order to eliminate danger

of explosion, should be removed from the atmosphere.

The form of apparatus shown includes an air intake hood 7 located at a suitable level above the work table 6 and communicating with an air intake duct 8 which leads to the bottom of a cleaning or dust removal chamber 9. Preferably, the duct 8 is so connected to the chamber 9 that the air or gas enters the chamber 9 tangentially as best shown in Figure 5.

Closely related to and preferably suported on the top of the chamber 9 is a blower 10 driven by an operating motor 11 for moving air through the chamber 9 and discharging it through a duct 12. If desired, another intake duct 13 may be arranged to draw in air from an upper level in the room 4 and deliver it to the cleaning chamber 9 by way of the main intake duct 8 in proportion determined by setting of a damper 14.

Because the air or gas enters the bottom of the cleaning chamber 9 tangentially, it will swirl spirally as it is moved upwardly by the blower 10. During its swirling ascent the air or gas is subjected to the action of a cleaning fluid, for example, water, which is delivered to the interior of the chamber 9 in diffused condition for contact with the air or gas and the entrained dust or solid particles. In accordance with the invention the mechanism for delivering and diffusing the cleaning fluid within the chamber 9 comprises a hollow shaft 15 coupled as at 16 to the blower 10 and a plurality of vertically spaced impellers 17 rotatable with the shaft 15. The bottom shaft bearing 18 is constructed in any suitable manner to permit the flow of cleaning fluid up through the hollow shaft from a recirculation pipe 19 fed with fluid under pressure by a pump 20 driven by an operating motor 21. Fresh or non-recirculated washing fluid may be delivered from a pipe 22 through the bearing 18 into the hollow shaft 15 under the control of a normally closed solenoid-operated valve 23 for a purpose to be described later.

A check valve 24 in the pipe line 19 permits the flow of recirculated fluid from the pump to the shaft 15 but not reversely and a check valve 25 in the pipe 22 permits the flow of fresh cleaning fluid from the valve 23 to the shaft 15 but not reversely. A pressure gauge 26 connected to the pump outlet is provided for indicating the working pressure of the recirculated fluid and this pressure may be regulated by adjusting a valve 27 in a by-pass pipe 28 connected between the intake and the discharge sides of the pump 20.

In order to prevent entrained droplets of water or cleaning fluid from being carried past the blower 10 and out through the discharge duct 12, an assembly of moisture eliminators 29 which may be of conventional construction is mounted in the upper end of the chamber 9. In some instances, depending upon the nature of the dust or solid particles to be removed, the action of the eliminators 29 may be supplemented by a filter or the like comprising a pack of closely matted minute glass strands or fibers.

The impellers 17 may vary as to their specific construction. The preferred form of impleller is shown in Figures 6 to 10, inclusive, as comprising upper and lower halves which, when assembled together on the shaft 15, provide a plurality of radial circumferentially spaced passages from which the cleaning fluid is flung circumferentially.

The lower impeller half is shown in Figures 6 and 7 as comprising a disc 30 formed with an axial opening 31 of a size to fit the shaft 15. The disc 30 also is formed with counterbores 32 and 33 and with a plurality of fluid flow grooves or passages 34 which are inclined or curved outwardly and upwardly from the bottom of the counterbore 32 toward the opposite face of the disc.

The impeller upper half shown in Figures 8 and 9 comprises a disc 35 formed with an axial bore 36 of a diameter to fit the shaft 15. The disc 35 has a boss 37 of a diameter to fit within the counterbore 32 of the lower half disc 30 as shown in Figure 10. A tapered circumferential edge 38 on the upper half disc 35 is adapted to fit the similarly tapered counterbore 33 in the lower half disc 30 so as to cover but not fill up the fluid passages 34.

The impeller halves 30 and 35 may be held together by any suitable means as by screws 39 and a set screw 39a holds the assembled impeller halves fixed on the shaft 15.

The shaft 15 is formed with apertures 40 extending from its hollow center into the space within the counterbore 32 of the disc 30 between the bottom of the counterbore 32 and the bottom of the boss 37 on the disc 35. Fluid under pressure in the hollow shaft 15 will flow into the counterbore space and thence will be thrown centrifugally through and from the passages 34 in an upwardly and outwardly inclined direction so as to be diffused in the chamber 9 for contact with the air and entrained dust.

The larger particles of cleaning fluid will impinge upon the eliminators 29 and the walls of the chamber 9 and will drain into a collecting basin 41 at the bottom of the chamber. For economical reasons it is desirable to reuse the cleaning fluid but before reuse the collected dust and solid particles should be removed from the fluid. In the illustrative embodiment of the invention the used cleaning fluid collected in the basin 41 flows downwardly through a return pipe 42 and is delivered to a suitable separating equipment such as a decanter 43 shown in Figure 1. The decanter equipment includes three chambers 44, 45 and 46 and downwardly extending baffles 47. The fluid moves quietly from right to left from one chamber into the next permitting the dust or solid particles to precipitate and collect in the bottoms of the chambers in a well known manner. Fluid which has passed the baffle 47 at the left hand chamber 46 encounters a screen 49 at the end of an intake pipe connection 48 leading to the pump 20.

In the normal operation of the equipment thus far described the pump 20 and blower 10 will run continuously. Recirculated fluid from which most of the dust and solid particles have been separated by the decanter 43 will be forced by the pump 20 through the pipe 19 and hollow shaft 15 and thence outwardly through the rotating impellers for intimate contact with the air or gas swirling upwardly through the chamber 9. The dust and solid particles in the air or gas will adhere to the moisture particles which, upon impinging on the eliminators 29 or the walls of the chamber 9 will drain to the collecting basin 41 and then be returned through the pipe 42 to the decanter 43 for re-cleaning.

Some moisture will evaporate in the chamber 9 and some few particles of unevaporated moisture

will be carried past the eliminators 29 and discharged through the duct 12. In order to replenish the supply of cleaning fluid in the recirculation system the valve 23 is opened from time to time to permit fresh cleaning fluid to flow into the hollow shaft and out through the impellers 17. The opening and closing of the valve 23 for maintaining a proper fluid level in the decanter or reservoir 43 is controlled automatically by means to be described hereinafter.

An important feature of the present invention is the provision of a system of controls for assuring the timing of the starting and stopping of the pump 20 and the blower 10 and the inflow of fresh un-circulated cleaning fluid all at the proper times so as to avoid explosions in the air cleaning system itself. When the blower and pump are stopped after the system has been in operation for sometime, the walls of the chamber 9, the eliminators 29, and the shaft 15 and impeller 17 will be covered with cleaning fluid. If the last cleaning fluid to flow into the chamber 9 was recirculated by the pump 20 it might contain some residuum of dust or solid particles which were not separated from fluid in the decanter 43. If the system remains out of operation for sometime the moisture within the chamber 9 will evaporate, leaving a deposit of dust particles within the chamber 9 and on the shaft 15 and the impellers. Certain kinds of dust, for example, that including TNT particles, have such tremendously explosive potentialities that there would be danger of an explosion occurring if the chamber 9 and the shaft and impellers were not thoroughly wetted before the blower shaft and impellers start to run when the system is put in operation again. In accordance with the invention means are provided for automatically initiating operation of the blower and shaft 15 after the lapse of a predetermined period following delivery of cleaning fluid to the chamber 9, which in the form shown is effected by starting of the pump 20. Although in normal operation the cleaning fluid is thrown from the impellers 17 centrifugally, the pump 20 delivers fluid at sufficient pressure to flow through the impeller passages 34 and into the chamber 9 before the shaft 15 begins to rotate. In this way any particles which have remained on the chamber walls or on the shaft 15 and impellers 17 will be thoroughly wetted and will be washed down into the basin 41 before the shaft 15 begins to turn. Consequently the centrifugal throwing off of dry particles of dust against the walls of the chamber with danger of explosion is prevented.

As a further precaution against explosions within the chamber 9 itself means are provided for automatically discontinuing the flow of recirculated cleaning fluid to the chamber and for delivering fresh cleaning fluid to the chamber for a predetermined period prior to stopping of the blower and the impellers. Thus, when the system is to be put out of operation the pump stops, thereby discontinuing the delivery of recirculated cleaning fluid, and simultaneously the fresh water control valve 23 opens automatically causing fresh water to be delivered by the impellers to all parts within the chamber 9. The blower and impeller shaft continue to run and fresh water is delivered for a predetermined period at the close of which the blower stops and the valve 23 closes. The use of the fresh water exclusively, without any recirculated water, during the last part of the blower operation reduces to an absolute minimum the amount of dust

which may remain in the chamber 9 after the fluid evaporates.

In accordance with a further feature of the control mechanism forming part of the invention, means, such as a float controlled valve, is responsive to lowering of the cleaning fluid to a predetermined level in the decanter reservoir 43 for automatically opening the fresh water valve 23 and maintaining it open until the desired level in the reservoir 43 is restored. Control mechanism embodying the invention also preferably includes a safety device which disables all of the equipment when the fluid level in the reservoir 43 falls to another predetermined level somewhat lower than that which causes opening of the make-up valve 23.

Any suitable devices may be provided for controlling the several parts of the equipment so as to operate in the manner indicated generally above. The control means shown by way of illustration in Figure 4 are electrically operated and it will be understood that control devices may be connected in specifically different control circuits for accomplishing the same timing and control of the equipment shown in Figure 1.

The entire control circuit shown in Figure 4 is adapted to be connected through a cutout switch 50 to a source of power 51. Normally the starting and stopping of operation of the equipment is controlled by closing and opening a master control cutoff device or switch 52. When the switch 52 is closed, a circuit is immediately completed through the pump motor 21, the circuit including a conductor 67, a conductor 64, the closed master switch 52, a conductor 68, the pump motor 21, a conductor 69, a conductor 70, a normally closed mercury switch 60, and a conductor 71. The switch 60 is adapted to be tipped by lowering of a float 61 resting on the surface of the cleaning fluid in the decanter 43. If the level of the fluid falls below a predetermined height within the decanter 43, the float 61 is lowered to tip the mercury switch 60 so as to break the circuit leading to the pump motor 21.

Closing of the master switch 52 also energizes a relay coil 55 of a shunt switch 54. The relay coil circuit includes the conductors 67 and 64, the master switch 52, the conductor 68, another conductor 72, the relay coil 55 itself, a conductor 73, the conductor 70, the mercury switch 60, and the conductor 71. When the relay coil 55 is energized the switch 54 is opened so as to remove the shunt from a second float controlled mercury switch 59, thereby making the switch 59 effective for controlling operation of the solenoid 23 in a manner to be described later.

Closing of the master switch 52 also energizes the relay coil 62 of a switch generally designated 53 which is adapted to be closed immediately upon energizing of the relay coil 62 but which does not open until after the expiration of a predetermined time lag following deenergizing of the relay coil 62. The circuit for energizing the relay coil 62 comprises the conductors 67 and 64, the master switch 52, a conductor 74, the relay coil 62, the conductors 69 and 70, the safety switch 60, and the conductor 71. When the relay coil 62 is energized it immediately swings a pivoted switch arm 63 to closed position against the urge or bias of a spring 66. As thus far described, the circuits energized by closing the switch 52 produce no operation of the apparatus other than the running of the pump motor 21 and pump 20.

Closing of the switch 52, however, is effective

to place the blower 10 in operation after the expiration or lapsing of a predetermined time following the starting of the pump motor 21. The blower motor 11 is controlled by a time delay device including a switch 56 adapted to be closed by energizing of a relay coil 57, the closing of the switch 56 being retarded by a dash pot 58. The relay coil 57 for closing the delayed action switch 56 is energized by completion of a circuit including the conductors 67 and 64, the time delay switch 53 (closed as previously described), conductors 65, 75, and 76, the relay coil 57, conductors 77 78, 69, and 70, the safety switch 60, and the conductor 71.

When the switch 56 has been closed by energizing of the relay coil 57, a circuit through the blower motor 11 is completed and the blower 10 begins to run. The blower motor circuit includes the conductors 67 and 64, the delayed operation switch 53, the conductor 65, the switch 56, a conductor 79, the blower motor 11, conductors 80, 69, and 70, the safety switch 60, and the conductor 71. The delayed closing of the switch 56 starts the blower 10 only after the pump 20 has been running and delivering cleaning fluid to the impellers 17 for a predetermined time, the length of which depends upon the setting or characteristics of the dash pot 58. It will be observed that if the fluid in the decanter 43 falls to a predetermined unsafe level, the switch 60 is thereby opened, the circuit to the relay coil 57 is broken, and the switch 56 is thereby opened by gravity or any suitable restoring device. Consequently the blower 10 will stop operating whenever the supply of cleaning fluid in the decanter or reservoir 43 is insufficient for safe continuous operation.

The delayed starting of the blower 10 assures that the cleaning chamber 9, impellers 17 and moisture eliminators 29 will be thoroughly washed to remove any residual particles of dust before the shaft 15 and impellers 17 begin to rotate. Consequently there is no danger that the shaft or impellers will hurl off any explosive dry dust particles.

The solenoid valve 23 is controlled automatically by the devices shown in Figure 4 so as to open and admit make-up water or cleaning fluid whenever the liquid in the reservoir 43 falls below a desirable working level, which is somewhat higher than the level previously referred to as being unsafely low. When the fluid falls to the "make-up" level in the reservoir 43, lowering of the float 61 tips a mercury switch 59 so as to complete a circuit for energizing the solenoid which opens the valve 23. The energizing circuit includes the conductors 67 and 64, the time delay switch 53, the conductors 65 and 75, the switch 59, conductors 81 and 82, the valve solenoid 23, the conductors 78, 69, and 70, the safety switch 60, and the conductor 71. When the valve 23 is opened by energizing of its solenoid, fresh or non-recirculated water or cleaning fluid flows past the check valve 25 into the hollow shaft 15 and out through the impellers 17, and is then collected in the bottom of the casing 9 and returned through the pipe 42 to the decanter 43 so as to become part of the supply of recirculation fluid, thereby restoring the supply of fluid to the desired working level.

Inasmuch as the circuit for energizing the solenoid of the valve 23 includes the safety switch 60, the valve 23 cannot be opened if the safety switch 60 has been opened in response to falling of the liquid in the reservoir 43 to an unsafe level. Thus switch 60 is responsive to falling of the fluid to a predetermined level in the reservoir 43 for disabling the entire apparatus, making it impossible for the pump, the blower, and the valve 23 to be operated. If this occurs, the attendant knows that something is wrong and remedial steps can be taken either by introducing fluid directly to the reservoir 43 or by manually raising the float 61 to a position in which both the switches 59 and 60 are closed.

In order to stop the entire apparatus the master switch 52 is opened. Inasmuch as the switch 52 is included directly in the circuit to the pump motor 21, the pump motor and pump 20 will stop immediately.

Opening of the switch 52 also breaks the circuit for the relay coil 55 of the shunt switch 54, permitting the latter to be closed by gravity or by any suitable biasing means. The closed switch 54 then supersedes the control of the float switch 59 and energizes the solenoid 23 to open the valve irrespective of the level of the fluid in the reservoir 43. The shunt circuit for energizing the solenoid 23 includes the conductors 67 and 64, the time delay switch 53, the conductors 65, 75, and 83, the shunt switch 54, the conductor 82, the solenoid 23, the conductors 78, 69, and 70, the safety switch 60, and the conductor 71.

The blower motor 11 continues to operate and the fresh fluid control valve 23 remains open for a predetermined period following the opening of the switch 52 and the stopping of the pump 20. The blower motor circuit and the shunt circuit for maintaining the valve 23 open both include the time delay switch 53 and do not include the manually operable master switch 52. Thus the blower will continue to operate and the valve 23 will remain open until the switch 53 opens. The switch 53 may be of any suitable or standard construction designed to close immediately upon energizing of the coil 62 and designed to open for the expiration of a predetermined time following deenergizing of the relay coil 62. The switch 53 may, for example, be of the magnetic flux decay interval type with instantaneous pick-up and time delay drop out. An example of a switch operating with a time delay based on the flux decay principle is shown in the patent to Sterie No. 1,919,991. The device illustrated in the Sterie patent is adapted to close a circuit with a time delay and to open immediately, but it is apparent that a rearrangement of the contacts and switch arm as shown diagrammatically in Figure 4 makes the prior art device capable of closing immediately upon energizing of the coil 62 and opening following expiration of a predetermined period after deenergizing of the coil 62. If desired other types of time delay switches may be employed, for example, a switch including a synchronous motor driven device as disclosed in the patent to Goff 2,071,202. A switch of the synchronous motor type may be preferred where a wider range of adjustment of the time delay period is desired, although the flux decay type of switch also is capable of adjustment.

When the switch 53 does open, the circuits including the blower motor 11 and the solenoid valve 23 are finally opened and the blower stops and the fresh fluid valve is closed. Thus, after the switch 52 is opened, the blower 11 continues to operate for a predetermined period during which fresh non-recirculated water or cleaning fluid is delivered to the impellers 17 for thoroughly cleansing the impellers and the inside of the chamber 9 of any dust particles which may have

been carried in by the fluid which was recirculated by the pump 20.

It will be apparent from a consideration of the foregoing description in connection with the accompanying drawings that apparatus or systems embodying the invention are capable of efficiently removing dust and solid particles from air or gas during continuous operation. Moreover, the concept of timing the starting and stopping of the constituent parts so as to eliminate the danger of explosions occurring within the apparatus itself, the concept of disabling the entire apparatus when the supply of cleaning fluid is insufficient or unsafe, and the provision of practical apparatus and controls for putting these concepts into operative effect results in important advantages and safety features.

The apparatus disclosed embodies the invention in the form now preferred but, as already indicated, various changes may be made and other physical forms may be resorted to for carrying out the invention without departing from the invention as defined in the claims.

I claim:

1. In apparatus for removing dust or solid particles from gas; a removal chamber; a blower closely related to said chamber for moving the gas through the chamber; impelling means rotatable in said chamber for throwing fluid centrifugally to diffuse the fluid for contact with said gas; means for rotating said blower and said impelling means; means for supplying fluid to said impelling means under sufficient pressure to flow from said impelling means when the latter is stationary; means for operating said blower, said impelling means, and said fluid supplying means; and means for controlling said operating means including a master control device, means responsive to actuation of said master control device for initiating operation of said fluid supplying means, and a time delay device responsive to actuation of said master control device for automatically initiating operation of said blower and said impelling means after lapsing of a predetermined appreciable time following the start of operation of said fluid supplying means, said time lapse being of such extent that fluid is supplied to said chamber through said impelling means while the latter is stationary for a period sufficient to ensure thorough wetting of the interior of the chamber before said blower begins to operate.

2. In apparatus for removing dust or solid particles from gas; a removal chamber; a blower for moving gas through said chamber; a hollow shaft mounted to rotate in said chamber and being coupled to said blower; a plurality of impellers mounted in spaced relation on said shaft and being adapted to receive fluid from within said shaft and to discharge the fluid in diffused form in said chamber for contact with the gas and against the chamber walls; means for separating dust or solid particles from the fluid; means for conducting fluid with dust or solid particles entrained therein from said chamber to said separating means; a pump; an intake connection between said pump and a part of said separating means in which fluid from which the dust or solid particles have been removed is available; an outlet connection between said pump and the interior of said hollow shaft; means for operating said shaft; means for operating said pump; and means for controlling said operating means including a master control device, means responsive to actuation of said master control device for initiating operation of said pump, and a time delay device responsive to actuation of said master control device for automatically initiating operation of said shaft after lapsing of a predetermined appreciable time following the start of operation of said pump, said time lapse being of such extent that said pump is operated while said shaft is stationary for a period sufficient to ensure thorough wetting of the interior of the chamber before said shaft begins to operate.

3. In apparatus for removing dust or solid particles from gas, a removal chamber; means for moving the gas through the chamber; an electric motor for driving said gas moving means; means for supplying fluid to the chamber for contact with the gas; control means for effecting operation of said electric motor and said fluid supplying means including a switch in circuit with said motor, a master control device for starting operation of said fluid supplying means, and starting closing of said switch, and a dashpot for delaying closing of said switch and operation of said motor until after said fluid supplying means has supplied fluid to said chamber.

4. In apparatus for removing dust or solid particles from gas, a removal chamber; means for moving the gas through the chamber; a reservoir for fluid; means for supplying fluid from said reservoir to the chamber for contact with said gas; means for operating said gas moving means and said fluid supplying means; means for controlling said operating means including a master control device, means responsive to actuation of said master control device for initiating operation of said fluid supplying means, and a time delay device responsive to actuation of said master control device for automatically initiating operation of said gas moving means after lapsing of a predetermined appreciable time following the start of operation of said fluid supplying means, said time lapse being of such extent that fluid is supplied to said chamber for a period sufficient to ensure thorough wetting of the interior thereof before said gas moving means begins to operate; means responsive to falling of the fluid in the reservoir below a predetermined level for adding make-up fluid to the reservoir; and means responsive to falling of the fluid in the reservoir to another and lower predetermined level for disabling said operating means.

5. In apparatus for removing dust or solid particles from gas, a removal chamber; means for moving the gas through the chamber; an electric motor for driving said gas moving means; electrically operated means for supplying fluid to the chamber for contact with the gas; and control means for effecting operation first of said electrically operated means and then of both said electrically operated means and said motor including a switch in circuit with said motor, a relay for closing said switch, means for delaying closing of said switch when said relay is energized, and control switch means for simultaneously closing the circuits through said motor and said relay.

6. In apparatus for removing dust or solid particles from gas, a removal chamber; means for moving the gas through the chamber for therein separating the dust or solid particles from the gas; normally inoperative means for supplying washing fluid to said chamber; means for operating said gas moving means; and means for controlling operation of said gas moving means and said washing fluid supplying means including a cut-off device, delayed action means responsive to

operation of said cut-off device for automatically effecting continuing of operation of said gas moving means for a predetermined period after operation of said cut-off device, and means responsive to operation of said cut-off device and said delayed action means for rendering said washing fluid supplying means operative during said predetermined period.

7. In apparatus for removing dust or solid particles from gas, a removal chamber; means for moving the gas through the chamber for therein separating the dust or solid particles from the gas; normally inoperative means for supplying washing fluid to said chamber; an electric motor for operating said gas moving means; an electrically operated device for rendering said washing fluid supplying means operative; and control means including a first switch in circuit with said motor, a first relay energized during operation of said apparatus for maintaining said switch closed, a second switch in circuit with said electrically operated device and being biased to closed position, a second relay energized during operation of said apparatus for maintaining said second switch open, a delayed action switch in circuit with said relays, and a cut-off device for rendering said delayed action switch operative to open after lapse of a predetermined period following actuation of said cut-off device.

8. In apparatus for removing dust or solid particles from gas, a removal chamber; a blower for moving gas through said chamber; means for driving said blower; a pump; means for delivering fluid from said pump to said chamber for contact with the gas and for returning the fluid to the pump to be recirculated; a reservoir in the fluid circuit; means for driving said pump; means for supplying fresh fluid to said chamber; for contact with the gas means responsive to lowering of the fluid level in said reservoir for effecting operation of said fresh fluid supplying means; and control means including a cut-off device for stopping operation of said pump operating means and said blower driving means, and means responsive to operation of said cut-off device for superceding the control of said fluid level responsive means and effecting operation of said fluid supplying means for a predetermined period after stopping of said pump.

9. In apparatus for removing dust or solid particles from gas, a removal chamber; a blower for moving gas through said chamber; means for driving said blower; a pump; means for delivering fluid from said pump to said chamber for contact with the gas and for returning the fluid to the pump to be recirculated; a reservoir in the fluid circuit; means for driving said pump; means for supplying fresh fluid to said chamber; for contact with the gas means responsive to lowering of the fluid to a predetermined level in said reservoir for effecting operation of said fresh fluid supplying means; control means including a cut-off device for stopping operation of said pump operating means and said blower driving means, and means responsive to operation of said cut-off device for superceding the control of said fluid level responsive means and effecting operation of said fluid supplying means for a predetermined

period after stopping of said pump; and means responsive to lowering of the fluid in said reservoir to a level lower than said predetermined level for disabling said pump and blower driving means.

10. In apparatus for removing dust or solid particles from gas; a removal chamber; a blower for moving gas through said chamber; means for driving said blower; a pump; means for driving said pump; means for delivering fluid from said pump to said chamber for contact with the gas and for returning the fluid to the pump to be recirculated; means for separating dust or solid particles from the fluid returned from said chamber; means for supplying fresh non-recirculated fluid to said chamber; for contact with the gas and control means including a master device movable to starting position for effecting operation of said pump driving means and to stopping position for stopping said pump driving means, delayed action means responsive to movement of said master device to starting position for starting said blower driving means after said pump is in operation, and means responsive to movement of said master device to stopping position for effecting operation of said fresh fluid supplying means for a predetermined period.

11. In apparatus for removing dust or solid particles from gas; a removal chamber; a blower for moving gas through said chamber; means for driving said blower; a pump; means for driving said pump; means for delivering fluid from said pump to said chamber for contact with the gas and for returning the fluid to the pump to be recirculated; means for separating dust or solid particles from the fluid returned from said chamber; means for supplying fresh non-recirculated fluid to said chamber; for contact with the gas and control means including a master device movable to starting position for effecting operation of said pump driving means and to stopping position for stopping said pump driving means, delayed action means responsive to movement of said master device to starting position for starting said blower driving means after said pump is in operation, and means responsive to movement of said master device to stopping position for maintaining said blower driving means in operation and for effecting operation of said fresh fluid supplying means for a predetermined period.

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