Jan. 22, 1952 T. W. CARRAWAY 2,583,252

AIR OR GAS CLEANING APPARATUS

Filed May 21, 1948 3 Sheets-Sheet 1

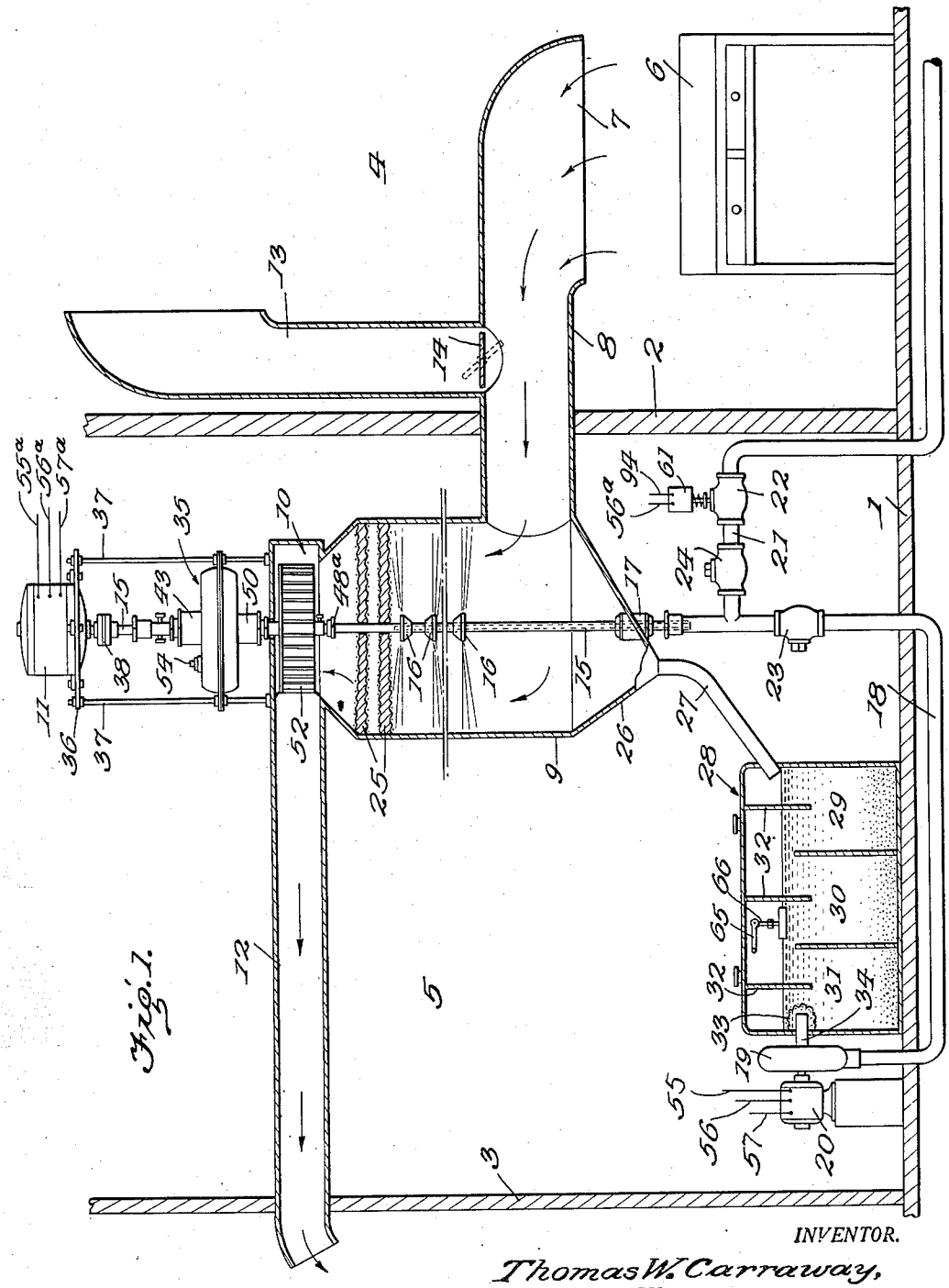


Fig. 1.

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Fig. 4.

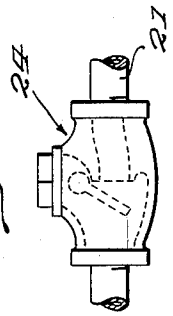


Fig. 5.

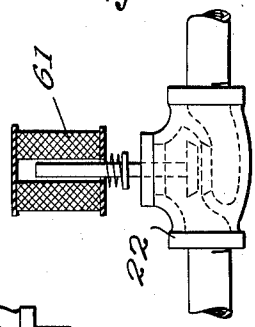


Fig. 6.

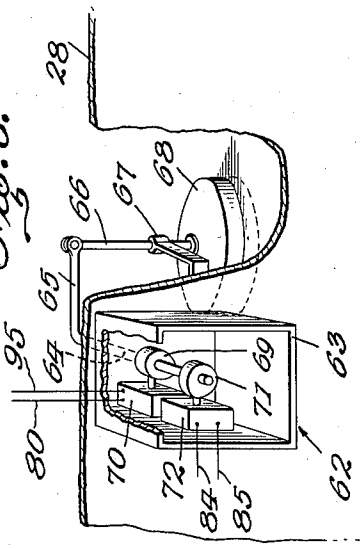


Fig. 3.

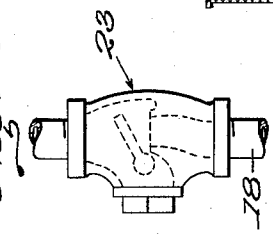
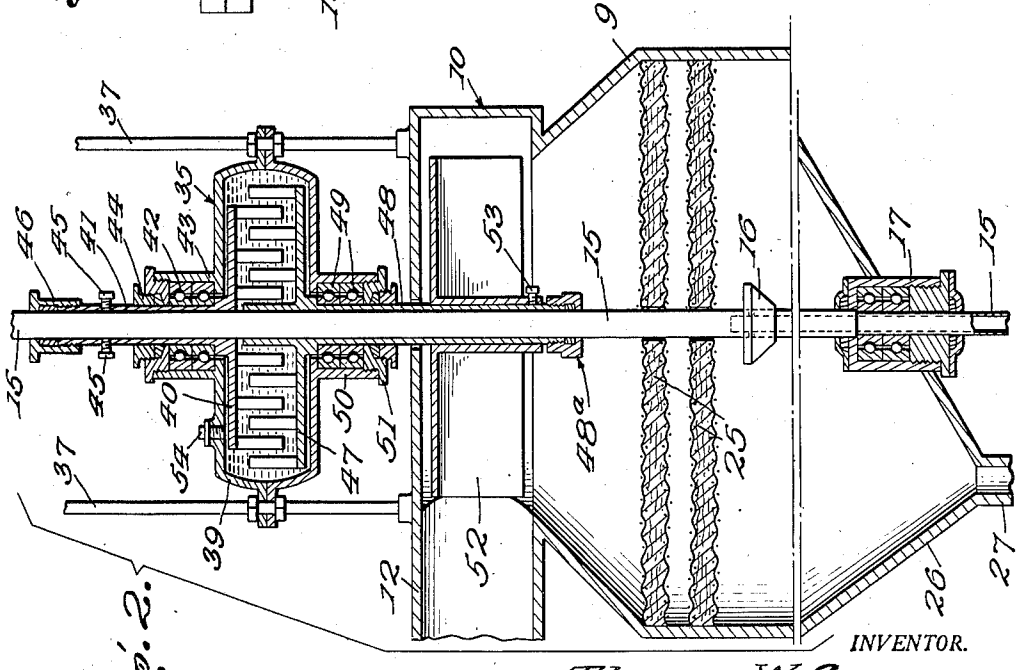


Fig. 2.



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AIR OR GAS CLEANING APPARATUS

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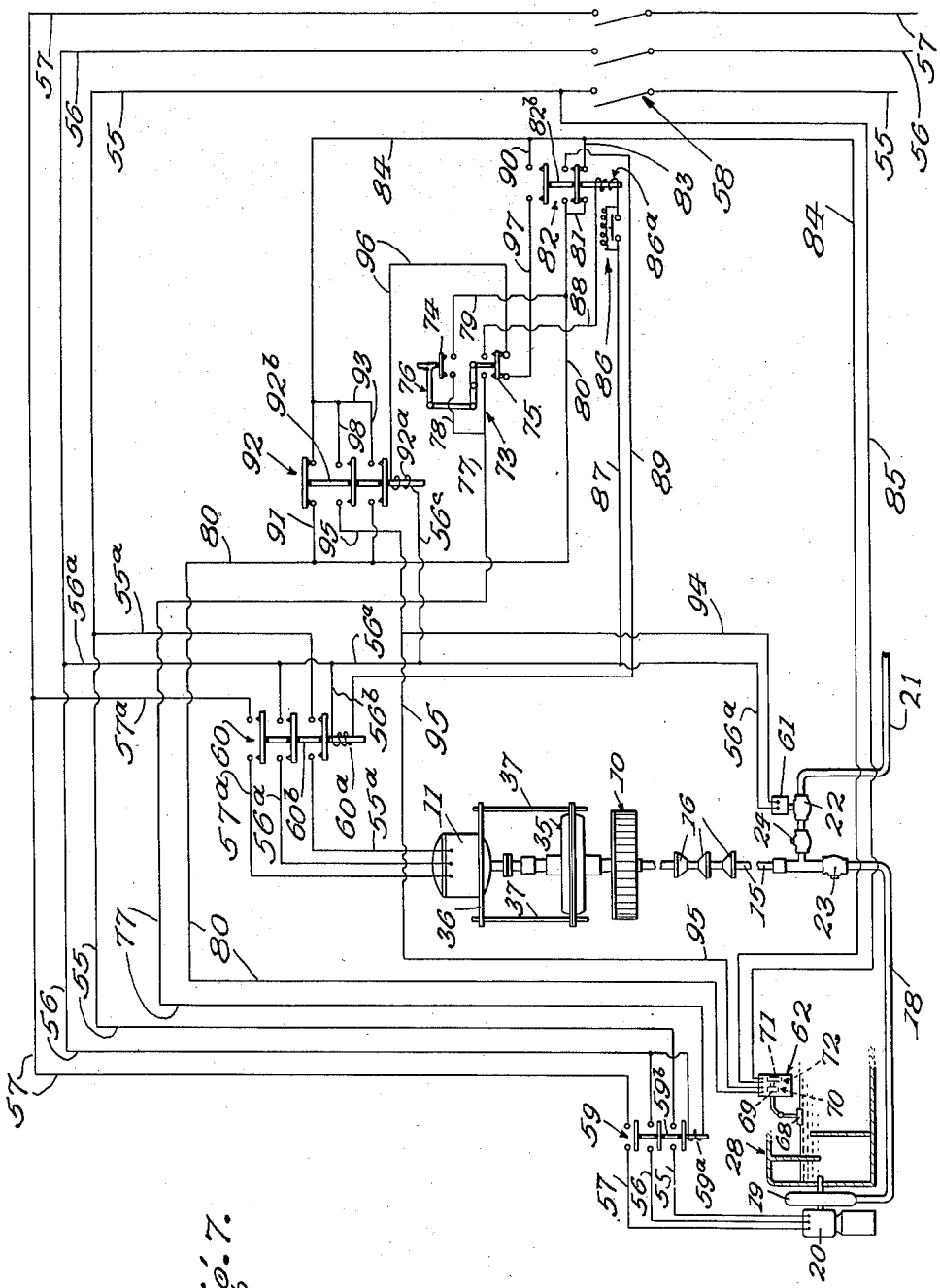


Fig. 7.

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UNITED STATES PATENT OFFICE

2,583,252

AIR OR GAS CLEANING APPARATUS

Thomas W. Carraway, Dallas, Tex.

Application May 21, 1948, Serial No. 28,432

14 Claims. (Cl. 261—26)

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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, e. g., by a blower or fan, 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 appartus 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.

In the copending application of Thomas W. Carraway, Serial No. 586,986, filed April 6, 1945, now Patent No. 2,539,344, issued Jan. 31, 1951, there is disclosed and claimed air or gas cleaning apparatus of the character referred to above, and which includes or is combined with mechanism for controlling the operation of the dust removing equipment so as to eliminate the danger of dust explosions occurring in the apparatus itself. The control equipment disclosed in the copending application operates so as automatically to effect thorough wetting of the inside of the wall of the cleaning chamber and all parts inside the chamber before the mechanically movable parts in the chamber begin to operate, and so as automatically to effect delivery of fresh, clean washing fluid to the impeller for a predetermined period following actuation of a manually operated switch, push button or the like for stopping the operation of the entire apparatus.

An object of the present invention is to provide air or gas cleaning apparatus of the kind generally referred to above, and which is automatically controlled or operated so that the starting of the blower or fan will be preceded to a predetermined extent by operation of a rotatable impeller which supplies the spray or diffusion of cleaning fluid in the cleaning chamber, thus assuring that the interior of the chamber and the parts contained in the chamber will be wetted and forcibly washed thoroughly before air or gas is moved through the chamber.

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Another object of the invention is to provide improved means for controlling or operating the several parts of the air or gas cleaning equipment in accordance with a predetermined plan, sequence, or timing.

Other objects of the invention will become apparent from a reading of the following 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 fragmentary view drawn on an enlarged scale, partly in section and partly in elevation, showing a fluid coupling and associated parts for transmitting drive to a blower;

Figures 3 and 4 respectively, are elevations of check valves;

Figure 5 is a view partly in elevation and partly in section of a solenoid-operated fresh fluid supply control valve;

Figure 6 is a detail, perspective view with parts broken away, showing a preferred form of float switch equipment; and

Figure 7 is a wiring diagram.

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 apparatus room 5. A table 6 located in the work room 4 may be used for doing 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.

Closely related to and preferably supported 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. The mechanism for delivering and diffusing the cleaning fluid within the chamber 9 comprises a hollow shaft 15 coupled to the blower 10 in a manner to be described later, and a plurality of vertically spaced impellers 16 rotatable with the shaft 15. The bottom shaft bearing 17 is constructed and sealed in any suitable manner to permit the flow of cleaning fluid up through the hollow shaft from a recirculation pipe 18 fed with fluid under pressure by a pump 19 driven by an operating motor 20. Fresh or non-recirculated washing fluid may be delivered from a pipe 21 to the pipe 18 and into the hollow shaft 15 under the control of a normally closed solenoid-operated valve 22 for a purpose to be described later.

A check valve 23 in the pipe line 18 permits the flow of recirculated fluid from the pump to the shaft 15 but not reversely, and a check valve 24 in the pipe 21 permits the flow of fresh cleaning fluid from the valve 22 to the shaft 15, but not reversely.

In order to prevent entrained droplets of water or cleaning liquid from entering the blower 10 and being carried out through the discharge duct 12, one or more filters 25 comprising matted minute glass or the like strands or fibres may be mounted in the upper end of the chamber 9.

The impellers 16 may vary as to their specific construction, but preferably are so arranged that they communicate with the interior of the shaft 15, so that fluid delivered under pressure within the shaft will be sprayed out into the chamber 9 when the shaft and impellers are stationary, and will be thrown centrifugally outwardly when the shaft and impellers are rotating. The impellers may be constructed, for example, as shown in Pat. No. 2,239,344, referred to above.

The larger particles of cleaning fluid will impinge upon the filters 25 and the walls of the chamber 9, and will drain into a collecting basin 26 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 26 flows downwardly through a return pipe 27 and is delivered to a suitable separating equipment such as a decanter 28 shown in Figure 1. The decanter equipment includes three chambers 29, 30 and 31 and downwardly extending baffles 32. 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 32 at the left hand chamber 31 encounters a screen 33 at the end of an intake pipe connection 34 leading to the pump 19.

In the normal operation of the equipment thus far described the pump 19 and blower 10 will run continuously. Recirculated fluid from which most of the dust and solid particles have been separated by the decanter 28 will be forced by the pump 19 through the pipe 18 and hollow shaft 15, and thence outwardly through the rotating impellers 16 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 filters 25 or the walls of the chamber 9 will drain to the collecting basin 26, and then be returned through the pipe 27 to the decanter 28 for re-cleaning.

Some moisture will evaporate in the chamber 9, and some few particles of unevaporated moisture may be carried past the filters 25 and discharged through the duct 12. In order to replenish the supply of cleaning fluid in the recirculation system the valve 22 is opened from time to time to permit fresh cleaning fluid to flow into the hollow shaft 15 and out through the impellers 16. The opening and closing of the valve 22 for maintaining a proper fluid level in the decanter or reservoir 28 is controlled automatically by means to be described hereinafter.

Means is provided for assuring the timing of the starting and stopping of the pump 19 and the blower 10 and the inflow of fresh uncirculated cleaning fluid, all at the proper times so as to avoid explosions in the air cleaning system itself. When the blower 10 and pump 19 are stopped after the system has been in operation for some time, the walls of the chamber 9, the filters 25, and the shaft 15 and impellers 16 will be covered with cleaning fluid. If the last cleaning fluid to flow into the chamber 9 was recirculated by the pump 19 it might contain some residuum of dust or solid particles, not separated from fluid in the decanter 28. If the system should remain out of operation for some time the moisture within the chamber 9 would evaporate, leaving a deposit of dust particles within the chamber 9, on the shaft 15 and the impellers 16. 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 impellers and the blower shaft start to run when the system is put in operation again. To eliminate this danger, means are provided for automatically and serially initiating operation of the shaft 15 and the blower 10 after the lapse of a predetermined period following delivery of cleaning fluid to the chamber 9. Although in normal operation the cleaning fluid is thrown from the impellers 16 centrifugally, the pump 19 delivers fluid at sufficient pressure to flow through the impellers 16 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 16 will be thoroughly wetted, and will be washed down into the basin 26 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 9 and for delivering fresh cleaning fluid to the cham-

ber for a predetermined period prior to stopping of the blower 10 and the impellers 16. 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 22 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 22 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.

The control mechanism preferably also includes means such as a float controlled valve responsive to lowering of the cleaning fluid to a predetermined level in the decanter reservoir 28, for automatically opening the fresh water valve 22 and maintaining it open until the desired level in the reservoir 28 is restored. The control mechanism also preferably includes a safety device which disables all of the equipment when the fluid level in the reservoir 28 falls to another predetermined level somewhat lower than that which causes opening of the make-up valve 22.

The general construction and arrangement of the parts described above is similar to the construction and arrangement disclosed in Patent No. 2,539,344, previously referred to. In accordance with the present invention, the blower 10 is so operated or controlled that it is delayed in starting, or has a retarded pick-up which follows only after the shaft 15 and impellers 16 have been in operation for a period sufficient to wet and wash the interior walls of the chamber 9 and the parts contained in the chamber. In the form shown in the drawings, the delayed or retarded starting of the blower is accomplished by providing an impositive drive such as a slip clutch or coupling in the connections transmitting drive from the motor 11 to the blower 10. Preferably, the clutch or coupling comprises a kinetic type fluid coupling 35 interposed between the impeller shaft 15 and the blower 10. The motor 11 is carried on a mounting platform 36 which is secured to the upper ends of vertical supports 37, anchored at their lower ends on the top of the chamber 9 or any other suitable fixed part. The impeller shaft 15 extends from the bottom bearing 17 upwardly through the blower structure and the coupling 35 for connection to the motor shaft by means of a flange coupling 38.

The fluid coupling 35 includes a casing 39 which is carried by the vertical supports 37 and is interposed between the blower 10 and motor 11. Mounted within the casing 39 is a vaned impeller rotor 40 formed with a sleeve 41 which extends upwardly through anti-friction bearings 42 carried in a hub 43 formed on the casing 39. A packing gland 44 at the upper end of the hub 43 prevents leakage of fluid from within the casing 39 between the hub 43 and sleeve 41. Set screws 45 secure the sleeve 41 of the coupling impeller 40 to the hollow impeller shaft 15 so as to cause the impeller 40 and impeller shaft 15 to rotate together. A packing gland 46 seals the upper end of the fit clearance space between the impeller shaft 15 and the sleeve 41.

A driven rotor 47, formed with vanes interspersed between vanes of the impeller rotor 40, is mounted within the casing 39, and is formed

with an outer shaft in the form of a sleeve 48 by which the rotor 47 is supported and journaled in bearings 49 housed within a downwardly extending hub 50 on the casing 39. A packing gland 51 at the lower end of the sleeve 50 prevents leakage of fluid from within the casing 39, and between the sleeve 48 and hub 50.

The outer shaft or sleeve 48 of the driven rotor 47 extends downwardly beyond the packing gland 51 and into the hub of the rotor 52 of the blower 10, being secured to the rotor 52 by a set screw 53. A packing gland 48a prevents leakage between the sleeve 48 and the shaft 15. The casing 39 is formed with a filler opening normally closed by a plug 54.

In operation, when the motor 11 is started, it will drive the impeller shaft immediately through the fixed flange coupling 38, and the impellers 16 will be rotated so as to throw cleaning fluid out centrifugally and forcibly against the walls of the chamber 9, thus removing the last trace of accumulated dust which may have remainded following the termination of the preceding period of operation. The impeller 40 of the fluid coupling 39, being positively connected to the shaft 15 by the set screws 45, will start to rotate and will be driven concurrently with the shaft 15 and the impellers 16. However, because of the impositive drive characteristics of the fluid coupling 39, the driven rotor 47 will not start to rotate immediately when the driving rotor 40 begins to run, but will be started and accelerated with a delayed or retarded pick-up action, causing the blower rotor 52 to lag behind the impellers 16. Consequently, no air will be moved through the chamber 9 until after the chamber walls and all parts contained in the chamber have been washed forcibly and thoroughly.

Figure 7 shows a preferred arrangement for controlling the operation of the pump 19, the impeller shaft 15, the blower 10, and the fresh water valve 22 in accordance with the desired sequence or timing. Power for operating the motors 11 and 20 and the various control elements to be described later is derived from a three-phase supply line constituted by line conductors 55, 56, and 57 controlled by a main three-pole service switch 58. The line conductors 55, 56, and 57 lead from the switch 58 through a triple contact relay switch 59 to the pump motor 20. Branch conductors 55a, 56a, and 57a lead through a triple contact relay switch 60 to the motor 11 which drives the impeller shaft 15 and the blower 10.

The fresh water valve 22 is adapted to be operated by a solenoid device 61, one side of which is connected to a branch line conductor 56a, and the other side of which is connected to the control circuit which is to be described later.

Means is provided for automatically effecting energization of the solenoid 61 to open the fresh water valve when the fluid in the reservoir 28 has fallen to a predetermined level requiring replenishment or replacement of fluid lost by evaporation. Other means is provided for responding to falling of the fluid in the reservoir 28 to a still lower level for stopping operation of the entire apparatus so as to prevent damage which might otherwise be caused by operating the pump when dry, or operating the blower 10 to draw air through the chamber 9 when no fluid is available for diffusion within the chamber. The equipment for controlling the adding of replacement fluid to the system or stopping of the system may include a float switch assembly 62

of the kind disclosed and claimed in the copending application of Thomas W. Carraway, Serial No. 793,713, filed December 24, 1947. As shown in Figure 6, this equipment includes a casing 63 which may conveniently be mounted on the reservoir 28. A shaft 64, journaled for rocking movements in the casing 63, is formed with a radial arm 65 connected to a depending link 66 extending through a fixed guide 67 for connection to a float 68. Fast on the shaft 64 is a cam 69 adapted, upon lowering of the fluid level in the reservoir 28, to close a normally open micro-switch 70 so as to energize the solenoid 61 and open the valve 22. Also fast on the shaft 64 is a cam 71 which normally maintains a micro-switch 72 closed. When the float 68 descends to a predetermined level, lower than that at which the switch 70 is closed, the cam 71 is moved to such a position as to open the switch 72, thereby stopping operation of the entire system in a manner to be described later.

In order to prepare the apparatus for service but not actually to start it, the line switch 58 is closed. Starting and stopping of the apparatus is controlled by a master switch, generally designated 73, including two contact bars 74 and 75 articulated by any suitable mechanism or linkage 76 so as to be movable to open and closed positions simultaneously. In order to start the apparatus, the contact bars 74 and 75 are moved respectively downwardly and upwardly to closed positions. Closing of the contact bar 74 immediately energizes the relay coil 59^a of the switch 59, lifting the contact bars 59^b, and closing the switch 59 to start the pump motor 20. The circuit for energizing the relay coil 59^a includes the conductor 56, the coil 59^a, conductors 77 and 78; the upper contact 74 of the switch 73; conductors 79, 80, and 81; the lower contact arm of a relay switch 82; conductors 83 and 84; the normally closed safety switch 72; a conductor 85; and the line conductor 55.

When the contactors 74 and 75 of the switch 73 are closed, starting the pump motor 20 immediately as described above, the motor 11 will not be started immediately, but a device, generally designated 86 for controlling the motor 11, will be enabled and will start a timing cycle. The device 86 may be of any of a number of known or commercially available constructions characterized by being capable of effecting a delayed closing of the switch 82 after the lapsing of a predetermined interval following enabling of the device 86, and preferably further characterized by being capable of effecting opening of the switch 82 only after the lapsing of a predetermined interval following disabling of the device 86. The circuit for enabling the control device 86 includes the conductors 56 and 56^a; a conductor 87; the control device including a relay coil 86^a; a conductor 88; the lower contact bar 75 of the switch 73; the conductors 77 and 78; the upper contact bar 74; conductors 79, 80, and 81; the lower bar of switch contactor 82^b; conductors 83 and 84; the normally closed safety switch 72; and the conductors 85 and 55. After the lapsing af a predetermined interval during which the pump 19 has been driven to deliver fluid to the hollow impeller shaft 15 but during which the blower and shaft 15 have not been running, the cycling of the control device 86 is completed and the relay coil 86^a is energized sufficiently to lift the contact unit 82^b. This will complete a circuit through the coil 60^a of the switch 60 so as to lift the triple contact unit 60^b and close the switch 60 to start the motor 11. The circuit for energizing the relay coil 60^a includes conductors 56 and 56^a, a branch conductor 56^b, the coil 60^a, a conductor 89, the lower bar of the contact unit 82^b of the switch 82, the conductor 80, a conductor 91, the upper bar of a contactor unit 92^b of a triple contact switch 92, the conductor 84 and safety switch 72, and the conductors 85 and 55.

Thus, closing of both contactors 74 and 75 of the switch 73 will, first, effect the starting of the pump motor 20, and thereafter, following the lapsing of a predetermined interval, start the motor 11 which drives the impeller shaft 15 and blower 10.

During normal operation, some of the washing fluid being supplied from the pump 19 to the chamber 9 and recirculated back through the reservoir 28 will be evaporated and carried out through the discharge duct 12, causing the fluid level to fall in the reservoir 28. When a predetermined liquid level has been reached and the float 68 has descended accordingly, the cams 69 and 71 will be rocked sufficiently to close the fluid make-up switch 70, but not to open the safety switch 72. Closing of the switch 70 will effect energizing of the solenoid 61 to open the valve 22 to deliver additional and fresh fluid to the pipe 18, and thus to restore the fluid in the reservoir 28 to its proper operating level. The circuit thus closed by the switch 70 includes the conductors 56 and 56^a, the solenoid 61, conductors 94 and 95, the make-up switch 70, the conductor 80, the conductor 91, the upper bar of the contactor unit 92^b, the conductor 84, the safety switch 72, and the conductors 85 and 55. When the fluid in the reservoir 28 has been restored to the desired operating level, the consequent raising of the float 68 will rock the cam 69 to open the switch 70, thereby breaking the circuit just described, deenergizing the solenoid 61, and closing the valve 22.

If the supply of washing fluid should fail during an operating period, the fluid in the reservoir 28 eventually would fall to a level somewhat below the level at which the switch 70 is closed in the manner described above. Descending of the float 68 to this lower level will rock the cam 71 sufficiently to open the normally closed safety switch 72, thereby breaking all of the circuits described above, and thus deenergizing the coils 59^a, 86^a, and 60^a, so that the motors 20 and 11 will be stopped. This prevents operation of the apparatus or any of its parts when no cleaning fluid is available.

If the level of fluid in the reservoir 28 should fall due to evaporation or leakage when the system is not in operation, closing of the float-operated switch 70 will effect energizing of the solenoid 61 to open the valve 22 and cause make-up liquid to be added. The circuit for energizing the solenoid when the system is not operating, with the contactors positioned as shown in Figure 7, includes conductors 56 and 56^a, the solenoid 61, conductors 94 and 95, the make-up switch 70, conductors 80 and 91, the upper bar of contactor 92^b, conductor 84, the safety switch 72, and conductors 85 and 55.

In order to stop the apparatus, the switch 73 is operated to lower its contact bar 75 and raise its contact bar 74, thus returning the contact bars to the positions shown in Figure 7. This will break the circuit through the relay coil 59^a immediately so as to open the switch 59 and stop the motor 20 and pump 19. Returning of the contact bars 74 and 75 of the switch 73 to their Figure 7 posi-

tions will break the circuit through the delayed action control device 86, but, because of the delayed action characteristics of this device previously referred to, the contact unit 82b of the switch 82 will not be lowered immediately. At the instant the switch 73 is restored to its Figure 7 position, and before the contact unit 82b is lowered, a circuit is completed through the relay coil 92a of the switch 92 to raise its triple bar contact assembly 92b. The circuit for energizing the relay coil 92a includes the conductors 56 and 56a, a branch conductor 56c, the coil 92a, a conductor 96, the lower contact bar 75 of the switch 73, a conductor 97, the upper bar of the contact unit 82b, conductors 90 and 84, the safety switch 72, and conductors 85 and 55.

When the contact bar 92b is raised by energizing the coil 92a, the control of the make-up switch 70 over the solenoid valve 61—22 is superseded, that is, the solenoid 61 is energized independently of the switch 70, and the fresh fluid valve 22 is opened so as to effect delivery of fresh, unused washing fluid to the hollow impeller shaft 15 following the stopping of the pump, and during continued operation of the impeller shaft 15 and blower 10. The circuit for independently energizing the solenoid 61 includes conductors 56 and 56a, the solenoid 61, conductors 94 and 95, the middle contact bar of the contact unit 92b, a conductor 98, the conductors 93 and 84, the safety switch 72, and conductors 85 and 55.

As previously explained, when the contactors 74 and 75 are returned to their Figure 7 positions, the circuit is broken through the time control device 86, but the contact unit 82b remains raised for a predetermined interval during which the impeller shaft 15 and blower continue to run while the valve 22 is maintained open for the delivery of fresh fluid. At the close of the predetermined time interval, the contactor unit 82b returns to its Figure 7 position, thus breaking the circuit through the relay coil 60a, and opening the switch 60 to stop the motor 11, the shaft 15, and the blower 10. Simultaneously, the circuit is broken through the relay coil 92a so as to open the switch 92 and deenergize the solenoid 61, thereby closing the valve 22 and terminating the delivery of fluid to the impeller shaft 15.

In some instances it is desirable that the flow of fresh washing fluid be continued for a short while after the switch 82 has opened to stop the motor 11. Accordingly, the switch unit 92 preferably has delayed opening characteristics such that the contactor unit 92b will remain raised for a predetermined period after the coil 92a has been deenergized. Any of a number of commercially known and available delayed opening switches may be used for this purpose.

It will be apparent that apparatus or systems embodying the invention are capable of efficiently removing dust and solid particles from air or gas during continued operation with a minimum danger of explosions occurring within the apparatus itself. The concept of timing the starting and stopping of the constituent parts of the apparatus and the provision of practical apparatus and controls for putting these concepts into operating effect results in important advantages and safeguards.

Although the apparatus disclosed embodies the invention in the form now preferred, it will be apparent that changes may be made in the arrangement of parts, and other physical forms of individual parts may be employed without departing from the invention. Thus it may be desirable in some installations to employ other than three-phase equipment, and in certain instances it may be to advantage to provide transformer equipment for placing the control circuits and relays under low voltage operation. It is intended that the scope of the invention be determined by the appended claims rather than by the specific disclosure of a preferred embodiment.

I claim:

1. In apparatus for removing dust or solid particles from gas, a removal chamber; a blower including a rotor for moving the gas through said chamber; a fluid diffusing impeller mounted to rotate in said chamber at a speed different from the speed of said blower rotor; a motor for driving said impeller; means for supplying fluid to said impeller for being thrown off centrifugally by said impeller to create a diffused spray of fluid contactible by the gas as it moves through the chamber; and means for automatically starting and impositively driving said blower rotor only after said impeller has been driven, whereby a diffused liquid spray will be created in said chamber before gas is moved therethrough.

2. In apparatus for removing dust or solid particles from gas, a removal chamber; a blower including a rotor for moving the gas through said chamber; a fluid diffusing impeller mounted to rotate in said chamber at a speed different from the speed of said blower rotor; a motor for driving said impeller; means for supplying fluid to said impeller for being thrown off centrifugally by said impeller to create a diffused spray of fluid contactible by the gas as it moves through the chamber; and a slip clutch coupling for transmitting impositive delayed starting drive from said motor to said blower so as automatically to start and drive said blower rotor only after said impeller has been driven, whereby a diffused liquid spray will be created in said chamber before gas is moved therethrough.

3. In apparatus for removing dust or solid particles from gas, a removal chamber; a blower including a rotor for moving the gas through said chamber; a fluid diffusing impeller mounted to rotate in said chamber at a speed different from the speed of said blower rotor; a motor for driving said impeller; means for supplying fluid to said impeller for being thrown off centrifugally by said impeller to create a diffused spray of fluid contactible by the gas as it moves through the chamber; and an impositive delayed action fluid clutch coupling for transmitting delayed starting drive impositively from said motor to said blower so as automatically to start and drive said blower rotor only after said impeller has been driven, whereby a diffused liquid spray will be created in said chamber before gas is moved therethrough.

4. In apparatus for removing dust or solid particles from gas, a removal chamber; a blower including a rotor for moving the gas through said chamber; a fluid diffusing impeller mounted to rotate in said chamber at a speed different from the speed of said blower rotor; a motor directly driving said impeller; means for supplying fluid to said impeller for being thrown off centrifugally by said impeller to create a diffused spray of fluid contactible by the gas as it moves through the chamber; and a kinetic type fluid coupling for transmitting impositive delayed starting drive from said motor to said blower so as automatically to start and drive said blower rotor only after said impeller has been driven, whereby a diffused liquid spray will be created in said chamber before gas is moved therethrough.

5. In apparatus for removing dust or solid particles from gas, a removal chamber; a motor; an inner shaft drivingly connected to said motor and extending into said chamber; means associated with said shaft for throwing fluid in a diffused spray in said chamber when said shaft is rotated; means for supplying fluid to said fluid throwing means; an outer shaft journaled for rotation about the axis of and relatively to said inner shaft; a blower including a rotor drivingly connected to said outer shaft; and means for automatically impositively starting and driving said outer shaft with respect to said inner shaft and thereby said blower rotor only after said inner shaft and said fluid throwing means have been driven, whereby a diffused liquid spray will be created in said chamber before gas is moved therethrough.

6. In apparatus for removing dust or solid particles from gas, a removal chamber; a motor; an inner shaft drivingly connected to said motor and extending into said chamber; means associated with said shaft for throwing fluid in a diffused spray in said chamber when said shaft is rotated; means for supplying fluid to said fluid throwing means; an outer shaft journaled for rotation about the axis of and relatively to said inner shaft; a blower including a rotor drivingly connected to said outer shaft; and a slip clutch coupling impositively connecting said shafts for automatically starting and driving said outer shaft with respect to said inner shaft and thereby said blower rotor only after said inner shaft and said fluid throwing means have been driven, whereby a diffused liquid spray will be created in said chamber before gas is moved therethrough.

7. In apparatus for removing dust or solid particles from gas, a removal chamber; a motor; an inner shaft directly drivingly connected to said motor and extending into said chamber; means associated with said shaft for throwing fluid in a diffused spray in said chamber when said shaft is rotated; means for supplying fluid to said fluid throwing means; an outer shaft journaled for rotation about the axis of and relatively to said inner shaft; a blower including a rotor drivingly connected to said outer shaft; and a delayed action fluid clutch impositively connecting said shafts for automatically starting and driving said outer shaft with respect to said inner shaft and thereby said blower rotor only after said inner shaft and said fluid throwing means have been driven, whereby a diffused liquid spray will be created in said chamber before gas is moved therethrough.

8. In apparatus for removing dust or solid particles from gas, a removal chamber; a motor; an inner shaft drivingly connected to said motor and extending into said chamber; means associated with said shaft for throwing fluid in a diffused spray in said chamber when said shaft is rotated; means for supplying fluid to said fluid throwing means; an outer shaft journaled for rotation about the axis of and relatively to said inner shaft; a blower including a rotor drivingly connected to said outer shaft; and a kinetic type fluid coupling impositively connecting said shafts for automatically starting and driving said outer shaft with respect to said inner shaft and thereby said blower rotor only after said inner shaft and said fluid throwing means have been driven, whereby a diffused liquid spray will be created in said chamber before gas is moved therethrough.

9. In apparatus for removing dust or solid particles from gas, a removal chamber; a motor; a hollow inner shaft directly drivingly connected to said motor and extending into said chamber; means for supplying fluid to the interior of said shaft; impeller means on said shaft and communicating with the interior thereof for receiving fluid and throwing it in a diffused spray when said shaft is rotated; an outer shaft journaled for rotation about the axis of and relatively to said inner shaft; a blower including a rotor drivingly connected to said outer shaft; and means for automatically starting and driving said outer shaft impositively with respect to said inner shaft and thereby said blower rotor only after said inner shaft and said impeller means have been driven, whereby a diffused liquid spray will be created in said chamber before gas is moved therethrough.

10. In apparatus for removing dust or solid particles from gas, a removal chamber; a motor; a hollow inner shaft drivingly connected to said motor and extending into said chamber; means for supplying fluid to the interior of said shaft; impeller means on said shaft and communicating with the interior thereof for receiving fluid and throwing it in a diffused spray when said shaft is rotated; an outer shaft journaled for rotation about the axis of and relatively to said inner shaft; a blower including a rotor drivingly connected to said outer shaft; and a kinetic type fluid coupling impositively connecting said shafts for automatically starting and driving said outer shaft and therefrom driving said blower rotor only after said inner shaft and said impeller means have been driven, whereby a diffused liquid spray will be created in said chamber before gas is moved therethrough.

11. In apparatus for removing dust or solid particles from gas, a removal chamber; a blower for moving the gas through said chamber; a fluid diffusing impeller mounted to rotate in said chamber; means for supplying fluid under pressure to said impeller for being sprayed into said chamber by the fluid pressure while said impeller is stationary and for being thrown off centrifugally by said impeller during rotation thereof to create a diffused spray of fluid contactible by the gas as it moves through the chamber; time delay controlled means for starting rotative driving of said impeller after lapsing of a predetermined appreciable time following the start of operation of said fluid supplying means, whereby fluid will be sprayed into said chamber before said impeller is rotated; and means for automatically starting and driving said blower only after said impeller has been driven, whereby a diffused liquid spray will be created in said chamber before gas is moved therethrough.

12. In apparatus for removing dust or solid particles from gas, a removal chamber; a blower for moving the gas through said chamber; a fluid diffusing impeller mounted to rotate in said chamber; means for supplying fluid under pressure to said impeller for being sprayed into said chamber by the fluid pressure while said impeller is stationary and for being thrown off centrifugally by said impeller during rotation thereof to create a diffused spray of fluid contactible by the gas as it moves through the chamber; time delay controlled means for starting rotative driving of said impeller after lapsing of a predetermined appreciable time following the start of operation of said fluid supplying means, whereby fluid will be sprayed into said cham-

ber before said impeller is rotated; and a delayed action fluid clutch for automatically starting and driving said blower only after said impeller has been driven, whereby a diffused liquid spray will be created in said chamber before gas is moved therethrough.

13. In apparatus for removing dust or solid particles from gas, a removal chamber; a blower for moving the gas through said chamber; a fluid diffusing impeller mounted to rotate in said chamber; a pump for supplying fluid under pressure to said impeller for being sprayed into said chamber by the fluid pressure while said impeller is stationary and for being thrown off centrifugally by said impeller during rotation thereof to create a diffused spray of fluid contactible by the gas as it moves through the chamber; means for conducting fluid from said chamber back to said pump for recirculation; a source of fresh fluid; a normally closed valve for controlling delivery of fresh fluid from said source to said impeller; means for driving said pump and said impeller; means for automatically starting and driving said blower only after said impeller has been driven, whereby a diffused liquid spray will be created in said chamber before gas is moved therethrough; cut-off means for stopping said pump; delayed action means operative in response to operation of said cut-off means for terminating driving of said impeller and said blower after the lapsing of a predetermined period following operation of said cut-off means; and means also responsive to operation of said cut-off means for opening said valve and maintaining it open during said period.

14. In apparatus for removing dust or solid particles from gas, a removal chamber; a blower for moving the gas through said chamber; a fluid diffusing impeller mounted to rotate in said chamber; a pump for supplying fluid under pressure to said impeller for being sprayed into said chamber by the fluid pressure while said impeller is stationary and for being thrown off centrifugally by said impeller during rotation thereof to create a diffused spray of fluid contactible by the gas as it moves through the chamber; means for conducting fluid from said chamber back to said pump for recirculation; a source of fresh fluid; a normally closed valve for controlling delivery of fresh fluid from said source to said impeller; means for driving said pump and said impeller; a delayed action fluid clutch for automatically starting and driving said blower only after said impeller has been driven, whereby a diffused liquid spray will be created in said chamber before gas is moved therethrough; cut-off means for stopping said pump; delayed action means operative in response to operation of said cut-off means for terminating driving of said impeller and said blower after the lapsing of a predetermined period following operation of said cut-off means; and means also responsive to operation of said cut-off means for opening said valve and maintaining it open during said period.

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