Jan. 3, 1956 A. E. SWANSON 2,729,304

CLEANING DEVICE FOR AIR FILTERS

Filed Dec. 28, 1953

3 Sheets-Sheet 1

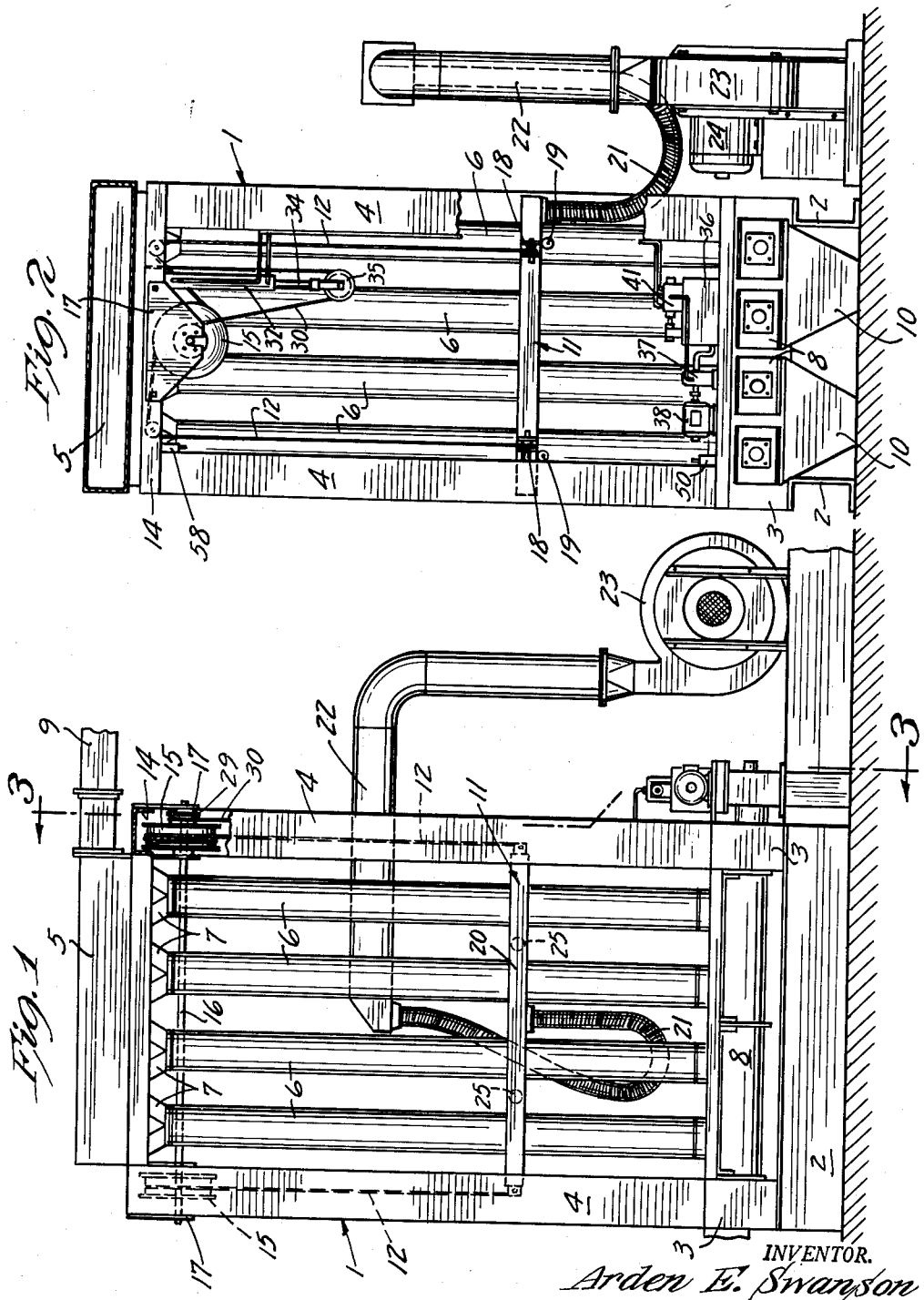


Fig. 2

Fig. 1

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Fig. 3

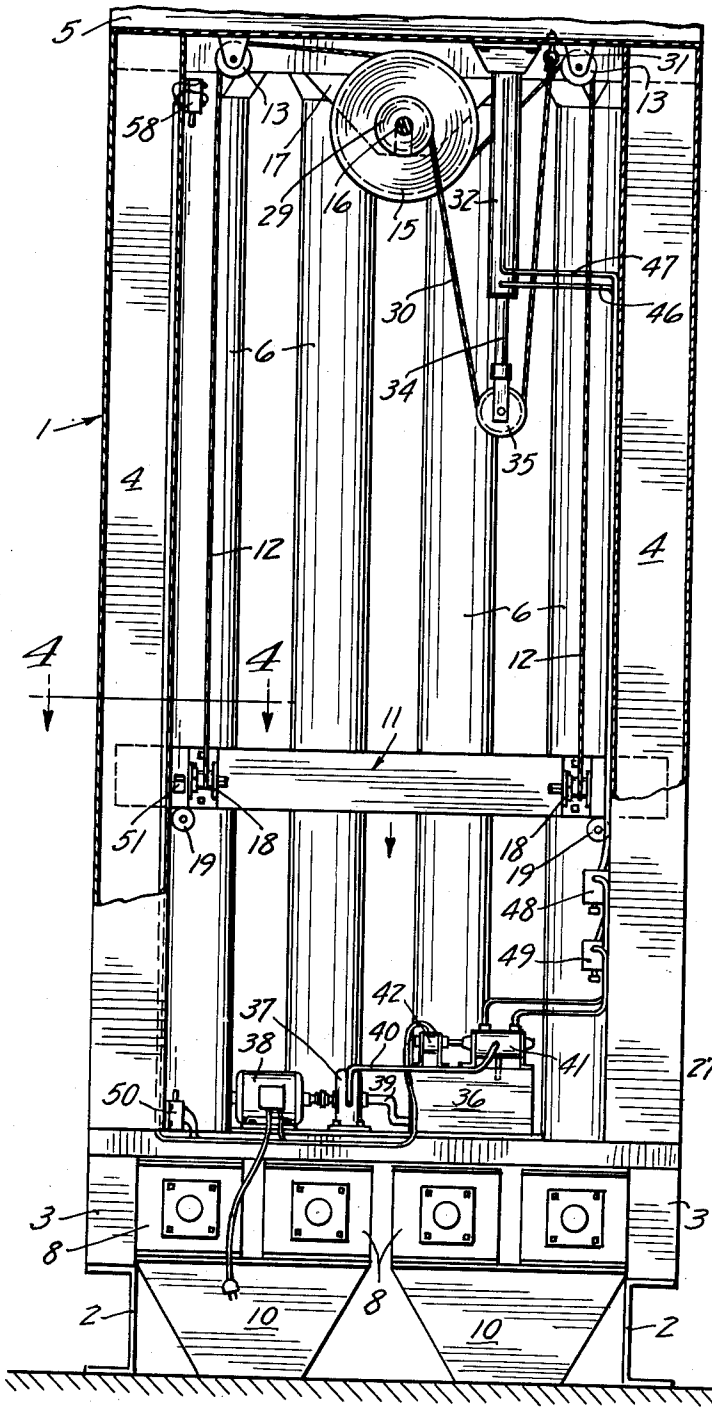
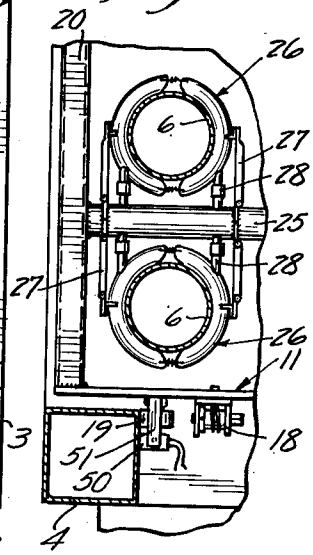


Fig. 4



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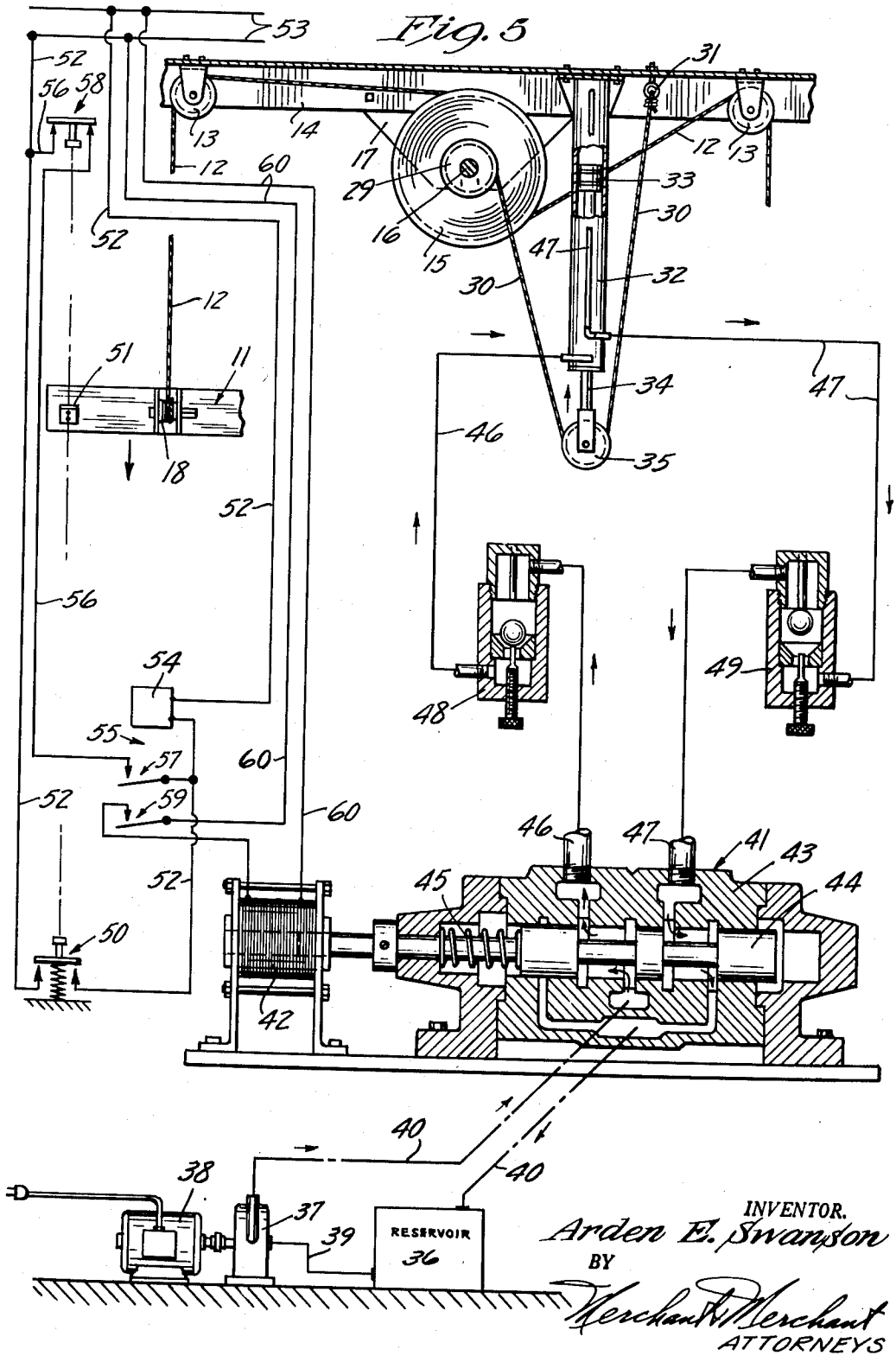
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Fig. 5



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2,729,304

CLEANING DEVICE FOR AIR FILTERS

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Application December 28, 1953, Serial No. 400,455

8 Claims. (Cl. 183—61)

My invention relates generally to dust collecting and air cleaning equipment and more particularly to improvements in apparatus for cleaning dust collectors, such apparatus being of the type disclosed in the Osgood et al. Patent 2,661,079, granted December 1, 1953, and entitled "Air Cleaner Construction."

More specifically, my invention relates to a novel method of, and apparatus for cleaning or removing the dust from the interior walls of the porous cleaning tubes in devices of the class above described.

As set forth in Patent 2,661,079, cleaning of the porous tubes has heretofore been accomplished by means of cleaning rings which encompass the filter tubes and which have radially inwardly opening air discharge passages therein, said cleaning rings being constantly moved between the delivery and the discharge ends of the vertical tubes and at constant speeds. Air delivered to said cleaning rings under considerably higher pressure than the dust laden air within the tubes, is caused to flow in a reverse direction through the porous walls of said tubes and in this manner the dust adhering to the interior walls is freed or loosened therefrom and is thus caused to pass downwardly therefrom under the action of gravity, and into the dust-collecting chamber. I have found that such method and apparatus is highly inefficient for the reason that in excess of 80% of the dust is removed from the interior walls of the tubes on the down stroke of the cleaning heads, whereas less than 20% of the dust is removed therefrom on the up stroke. This is due to the fact that the dust is redeposited on the cleaned areas of the walls of the tubes on the up stroke.

The primary object of my invention is the provision of a method and apparatus for cleaning the porous tubular air filters, which is considerably more efficient than any method or apparatus heretofore provided for said purpose.

A still further and highly important object of my invention is the provision of a method and apparatus of the class above described, which will greatly increase the capacity and efficiency of the filters, whereby devices of considerably smaller size and cost, and using fewer square feet of filtering material may be caused to do the work which formerly could be done only by considerably larger devices—with a consequent saving of money and room space to the ultimate purchaser.

A still further object of my invention is the provision of a device of the class described in which the effective cleaning time of the cleaning rings, in all positions thereof from opposite ends of said cleaning tubes, is substantially equalized whereby all areas of said tubes are rendered substantially equally effective.

To the above end, I provide a method and apparatus whereby the speed of travel of the cleaning rings during the highly inefficient up strokes thereof is increased to a maximum, whereas the speed of said cleaning rings during the down strokes thereof is adjusted to a most efficient, considerably slower speed.

Another object of my invention is the provision of novel means for automatically reversing the direction of movement of the cleaning device when the same reaches its limit of travel in one direction.

A still further object of my invention is the provision of operating and control means for a cleaning device as set forth which is relatively simple and inexpensive to manufacture and install, which is efficient in operation, and which is rugged in construction and durable in use.

Another object of my invention is the provision of means for selectively varying the speed of movement of the cleaning device in either direction of its reciprocatory movement with respect to the filter device.

The above and still further highly important objects and advantages of my invention will become apparent from the following detailed specification, appended claims and attached drawings.

Referring to the drawings, which illustrate the invention, and in which like characters indicate like parts throughout the several views:

Fig. 1 is a view in side elevation of an air filtering device and cleaner therefor incorporating my invention, some parts being broken away and some parts shown in section;

Fig. 2 is a view in end elevation as seen from the right with respect to Fig. 1, some parts being broken away and some parts shown in section;

Fig. 3 is an enlarged view partly in end elevation and partly in section taken substantially on the irregular line 3—3 of Fig. 1, some parts being broken away;

Fig. 4 is a fragmentary horizontal section taken substantially on the line 4—4 of Fig. 3; and

Fig. 5 is a diagram of the operating mechanism and control means of my invention.

Referring with greater detail to the drawings, a frame structure illustrated in its entirety by the numeral **1** is shown as comprising spaced supporting base members **2**, horizontally disposed bottom frame members **3**, a plurality of laterally spaced vertically extending legs **4** and a plenum chamber or the like **5** supported at the upper ends of the legs **4**. A plurality of rows of laterally spaced filter tubes **6** are secured at their upper ends to fittings **7** of the plenum chamber **5**, and at their lower ends to feeder outlet hoppers **8** mounted in and between the frame members **3**. The filter tubes **6** are preferably made from fine mesh textile fabric adapted to permit air under pressure to pass through the interstices or pores thereof and to prevent dust from escaping outwardly therethrough. Dust laden air is delivered under relatively low pressure to the plenum chamber **5** from a room or rooms, not shown, where the dust accumulates, such as certain chambers in a flour mill, grain elevator, or any other manufacturing or processing plant where the generation and accumulation of dust might constitute a hazard. The dust laden air is fed to the plenum chamber **5** through a duct **9**, shown fragmentarily in Fig. 1, by means of a conventional fan or blower, not shown.

As the dust is separated from the air passing outwardly through the walls of the filter tubes **6** it is ultimately deposited in the hoppers **8** from whence it is removed by conventional means, not shown but contained within the hoppers **8**, to a place of disposal through suitable conduit means **10**. The mechanism within the hoppers are adapted to gather and convey the settled out dust and other foreign matter without permitting passage of more than a minimum of air therethrough and the conduit means **10**. The above described mechanism is known to be old in the art, and, in itself, does not comprise the invention. Hence, for the sake of brevity it is not deemed necessary to disclose the same in greater detail.

In filters of the type above described, dust separated from the air passing outwardly through the walls of the tubes **6** tends to adhere to the tube walls, the particles of dust closing the interstices in the tube walls and restricting the air flow therethrough so that greater power is needed to maintain the proper flow of air through the

filter. For this reason, the tubes 6 must be constantly cleaned during the operation thereof for maximum efficiency. Hence I provide a cleaning device utilizing clean air at a relatively high pressure directed inwardly through the walls of the filter tubes 6. The cleaning device comprises a generally rectangular carriage 11 mounted for reciprocatory movements in the supporting structure 1 and longitudinally of the tube 6, between the opposite ends thereof. The carriage 11 is carried by a plurality, as shown 4, of flexible cables or the like 12 each connected at one end to the carriage 11 adjacent one of the corners thereof and running over one of a plurality of pulley wheels 13 suitably journalled in cross frame members 14 at the upper ends of the legs 4. The upper ends of the cables 12 are wound upon winding drums or spools 15 that are mounted fast on a shaft 16 which extends transversely between adjacent rows of filter tubes 6 adjacent their upper ends, and which is journalled in bearing brackets or the like 17 welded or otherwise secured to the upper cross members 14. As shown in Figs. 2, 3 and 5, the cables 12 are wound upon their respective drums or spools 15 in like directions, so that rotation of the drums in one direction causes the carriage 11 to move in a downward direction axially of the filter tubes 6 whereas rotation of the pulleys in the reverse direction will raise the carriage. The lower ends of the cables 12 are each wound around one of a plurality of take-up spools 18 adjustment of which is effected to level the carriage 11. The spools 18, when adjusted, may be assumed to be locked by any conventional means not shown. Guide rollers 19, mounted on the carriage 11, engage adjacent surfaces of the legs 4 to confine the carriage 11 against accidental lateral movement.

The carriage 11 defines a header 20 to which is connected one end of a flexible conduit 21, the other end of which is coupled to a rigid conduit 22 leading from the discharge portion of a conventional blower or fan 23 and shown as being powered by an electric motor or the like 24. The blower 23 is adapted to deliver clean air to the header 20 at relatively high pressure. A rigid conduit 25 is connected at one end to the header 20 and extends between adjacent rows of filter tubes 6. A plurality of cleaning rings 26 is connected to the conduit 25 by supporting arms 27, each of said cleaning rings encompassing a different one of the filter tubes 6. Air is delivered to the cleaning rings 26 from the conduit 25 through flexible tubular connections 28, see Fig. 4. The construction of the cleaning device including the cleaning rings 26 is fully disclosed in the Osgood et al. patent above identified. As therein shown, the cleaning rings 26 are provided with discharge openings through which air under relatively high pressure is moved radially inwardly through the ring-encompassed portion of each of the filter tubes 6 whereby to dislodge dust particles adhering to the inner wall surfaces of the filter tubes 6. Inasmuch as the cleaning rings in themselves do not comprise the instant invention further detailed showing and description thereof is omitted.

I provide novel means for raising and lowering the cleaning device 11 whereby air under relatively high pressure will be blown inwardly through the filter walls progressively from one end of the filter tubes to the other thereof as the carriage moves axially with respect to said tubes. Rigidly mounted on the shaft 16 is a relatively small winding drum or spool 29 on which is wound one end portion of a cable 30, the other end of which is anchored to one of the supporting frame members 14 as indicated at 31, see Figs. 2, 3 and 5. A vertically disposed fluid pressure cylinder 32 has its upper end rigidly secured to said one of the frame members 14 in closely spaced relationship to the cable anchoring element 31, and has mounted for axial movement therein a piston 33 and a cooperating piston rod 34 which projects axially outwardly from the piston and which is axially movable with respect thereto under differential in pressure within

the cylinder 32 at opposite sides of the piston 33 therein. A pulley 35 is mounted on the outer end of the piston rod 34 and engages the cable 30 whereby to rotate the shaft 16 and the drums 15 carried thereby in a direction to raise the cleaning device or carriage 11 upon axially outward movement of the piston rod 34 with respect to the cylinder 33, it being noted that the cable 30 is wound upon its drum or spool 29 in the reverse direction to that of the cables 12 on their respective drums or spools 15.

Fluid under pressure is admitted selectively or alternately to the opposite ends of the cylinder 32 from a reservoir 36 and a pump 37 operated by a suitable motor 38. The pump receives liquid from the reservoir through a conduit 39 and delivers the liquid under pressure through a conduit 40 to a reversing valve 41 preferably controlled by a solenoid 42. The reversing valve 41 is of the conventional type comprising a casing 43 and a spool element 44 axially movable in one direction therein responsive to energization of the solenoid 42, and being yieldingly urged in the opposite direction by a coil compression spring 45, see Fig. 5. A fluid conduit 46 extends from the reversing valve 41 to the lower end of the cylinder 32 and a second fluid conduit 47 extends from the reversing valve 41 to the upper end of the cylinder 32. A pair of conventional metering valves 48 and 49 are interposed in the conduits 46 and 47 respectively and are operative to control the rate of flow of fluid in one direction through their respective conduits to opposite ends of the cylinder 32. As shown in Fig. 5, the metering valve 48 is set to deliver fluid to the cylinder 32 at relatively slow speed. Thus, the cleaning device 11 will be permitted to descend under the action of gravity at a relatively slow rate of speed. Movement of the spool 44 of the valve 41 from its extreme position shown in Fig. 5 to its other extreme position in the direction of the solenoid 42 causes fluid to be delivered from the pump 37 to the upper end of the cylinder 32 through the conduits 40 and 47 and the check valve 49 at a relatively high rate thereby causing the piston 33 and cable 30 to rotate the shaft 16 in a direction to raise the cleaning device 11 at a very rapid rate of speed. With this arrangement, substantially all of the cleaning effort of the air blown inwardly through the filter tubes from the cleaning rings is expended during the downward travel of the cleaning device or carriage 11.

For the purpose of controlling the reversing valve 41 to cause automatic reversal in the direction of travel of the cleaning device 11, I provide a control circuit for the solenoid 42 and reversing switch means therefore now to be described. A normally open momentary contact switch 50 is mounted on the supporting structure in the path of travel of an actuating lug 51 on the carriage 11, and is adapted to be closed by the actuating lug 51 when the cleaning device or carriage 11 reaches its lower limit of movement axially of the filter tubes 6. The switch 50 is interposed in a lead 52 which extends from one side of a two-wire power line 53 to the other side thereof, and has also interposed therein in series with the switch 50 the coil 54 of a relay 55. A holding circuit for the relay coil 54 comprises a shunt lead 56 having interposed therein a normally open relay switch 57 and a normally closed switch 58 that is mounted on the frame structure adjacent the upper ends of the filter tubes 6 and in the path of travel of the actuating lug 51 whereby to be opened when the cleaning device 11 reaches its upper limit of travel axially of the filter tubes 6. The relay 55 includes a second switch 59 that is connected in series with the winding of the solenoid 42 through a lead 60 which has its opposite ends connected to opposite sides of the power line 53.

With reference to Fig. 5 it will be seen that the reversing valve 41 is positioned to permit downward movement of the cleaning element 11 at relatively slow speed. When the cleaning element 11 reaches its limit of downward travel, the actuating lug 51 closes the switch 50 causing

energization of the relay **55** whereby to close the holding circuit therefore through the normally closed switch **58** and the holding switch **57**. Simultaneously, the switch **59** is closed to energize the solenoid **42** and cause reversing of the flow of fluid in the fluid pressure system whereby to initiate upward travel of the cleaning device **11** at a relatively high rate of speed. Then, when the cleaning device reaches its upper limit of travel, the actuating lug **51** engages the switch **58** to open the same thereby causing de-energization of the relay **55** and the solenoid **42**, permitting the spring **45** to reverse the flow of fluid through the valve **41** and initiating upward travel of the piston rod **34** and consequent downward travel of the cleaning device **11** at a slow rate of speed.

My invention has been thoroughly tested and found to be completely satisfactory for the accomplishment of the objectives set forth; and while I have shown and described a preferred embodiment of my novel structure and arrangement, it will be understood that the same is capable of modification without departure from the spirit and scope of the invention as defined in the claims.

What I claim is:

1. A cleaning device for tubular air filters of the type comprising a tube of flexible porous material, an inlet at one end of said tube for dust laden air, an outlet at the other end of said tube for discharge of material filtered out of the air escaping outwardly through the interstices of the wall of said tube, and means for delivering dust laden air under relatively low pressure to the inlet; said cleaning device including a cleaning head having a discharge opening adapted to engage said tube, means mounting said cleaning head for reciprocatory movements axially of the tube, power operated mechanism for imparting said reciprocatory movement to the cleaning head, said power operated mechanism including a motor, and control means operative to cause said motor to move the cleaning head at relatively high speed in the direction of its reciprocatory movement toward said inlet and at relatively low speed in the opposite direction, said control means including motor reversing control elements adjacent opposite ends of said tube and alternately engaging said cleaning device at its limit of movement in one direction to cause movement of the cleaning device in the opposite direction, and speed control elements governing the speed of said motor in opposite directions.

2. A cleaning device for tubular air filters of the type comprising a vertically extended tube of flexible porous material, an inlet at the upper end of said tube for dust laden air, an outlet at the lower end of said tube for discharge of material filtered out of the air escaping outwardly through the interstices of the wall of said tube, and means for delivering the dust laden air under relatively low pressure to the inlet; said cleaning device including a cleaning head having a discharge opening adapted to engage said tube, means mounting said cleaning head for reciprocatory movements axially of the tube, power operated mechanism for imparting said reciprocatory movement to the cleaning head, said power operated mechanism including a motor, and control means operative to cause said motor to move the cleaning head at relatively high speed in an upward direction of its reciprocatory movement and at relatively low speed in a downward direction, said control means including motor reversing control elements adjacent opposite ends of said tube and alternately engaging said cleaning device at its limit of movement in one direction to cause movement of the cleaning device in the opposite direction, and speed control elements governing the speed of said motor in opposite directions.

3. The structure defined in claim 2 in which the means mounting said cleaning device includes a winding drum and a cable attached to said cleaning device and wound on said drum, and in which said power operated mechanism includes a fluid pressure operated motor and connections therebetween and said drum to cause rotation of said drum in a cable winding direction.

4. A cleaning device for tubular air filters of the type comprising a plurality of vertically extended tubes of flexible porous material connected at their upper ends by a plenum chamber having an inlet for dust laden air at relatively low pressure, and outlet means at the lower ends of said tubes for discharge of material filtered out of the air escaping through the interstices in the walls of said tubes; said cleaning device including a rigid delivery conduit, a plurality of cleaning rings one each associated with said tubes and connected to said conduit, means mounting said cleaning device for reciprocatory movements axially of said tubes, power operated mechanism for imparting said reciprocating movements to the cleaning device and control means including reversing devices adjacent opposite ends of said tubes and speed control elements for causing said power operated mechanism to move the cleaning device at relatively high speed in an upward direction of its reciprocatory movement and at a relatively slow speed in a downward direction.

5. The structure defined in claim 4 in which said cleaning device is gravity biased in a downward direction and in which said mounting means for the cleaning device includes a winding drum and a cable wound thereon, the free end of said cable being anchored to said cleaning device; said power operated mechanism comprising a fluid pressure operated motor operative to rotate the drum in a cable winding direction and to permit unwinding thereof responsive to actuation of one of said reversing devices.

6. A cleaning device for tubular air filters of the type comprising a plurality of vertically extended tubes of flexible porous material connected at their upper ends by a plenum chamber having an inlet for dust laden air at a relatively low pressure, and outlet means at the lower end of said tubes for discharge of material filtered out of the air escaping through the interstices in the walls of said tubes, said cleaning device including a rigid delivery conduit, a plurality of cleaning rings one each associated with one of said tubes and connected to said conduit, a supporting structure, a shaft journalled on said supporting structure, a winding drum fast on the shaft, a cable wound on said drum and having its free end connected to the cleaning device whereby to support the same, a second drum on the shaft, a second cable wound on the second drum, power operated mechanism including a fluid pressure cylinder, and a cooperating piston plunger movable axially with respect to the cylinder, said piston plunger being operatively coupled to the second cable to cause rotation of the shaft in a direction to move the cleaning device in one direction.

7. The structure defined in claim 6 in further combination with control means for said power operated mechanism, said control means including reversing valve means mounted on said frame structure and alternately engaging said cleaning device upon movement thereof to a predetermined distance in opposite directions axially of said cleaning tubes to cause reversal of movement of said cleaning device.

8. The structure defined in claim 7 in which said control means further includes valve means for controlling the speed of movement of said cleaning device whereby said cleaning device will be caused to move at a relatively rapid rate of speed in an upward direction and at a relatively low rate of speed in its downward direction of movement.

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