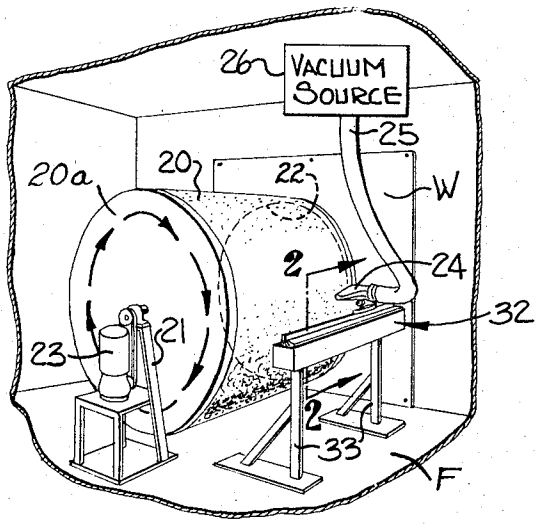
Oct. 10, 1967 J. W. SHERRILL 3,345,805

APPARATUS FOR CLEANING FILTERS

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Fig-1



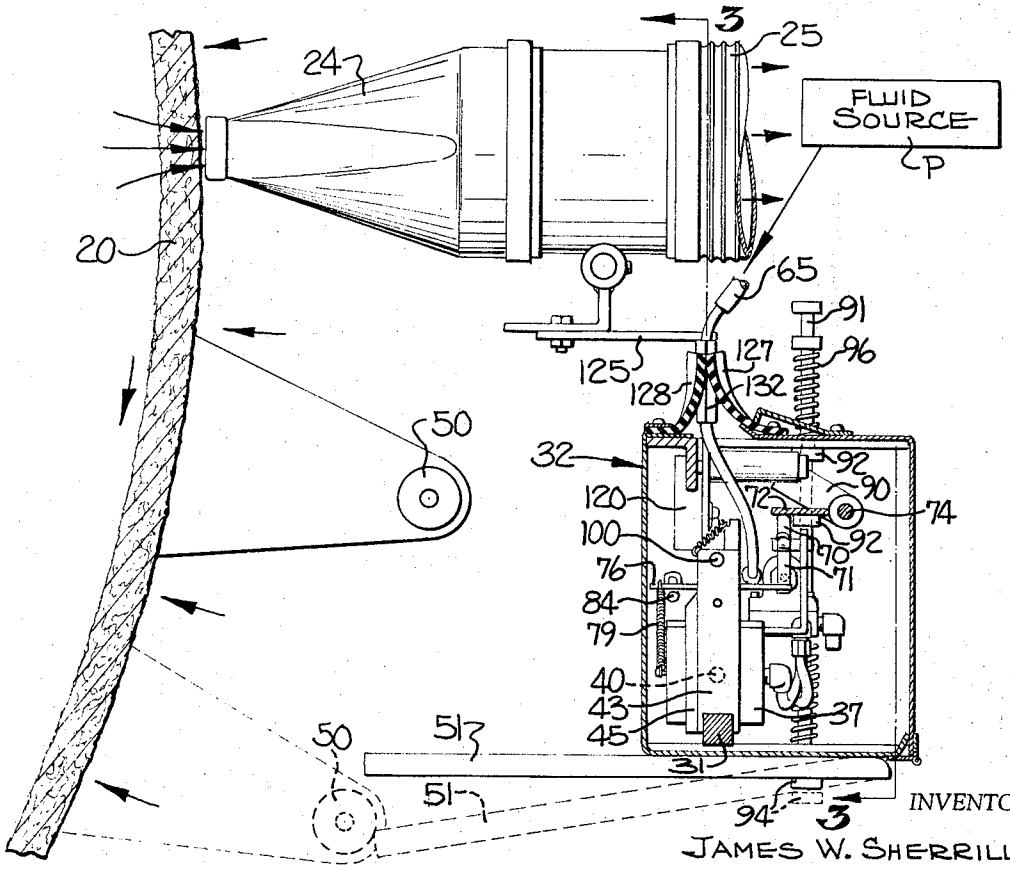


Fig-2

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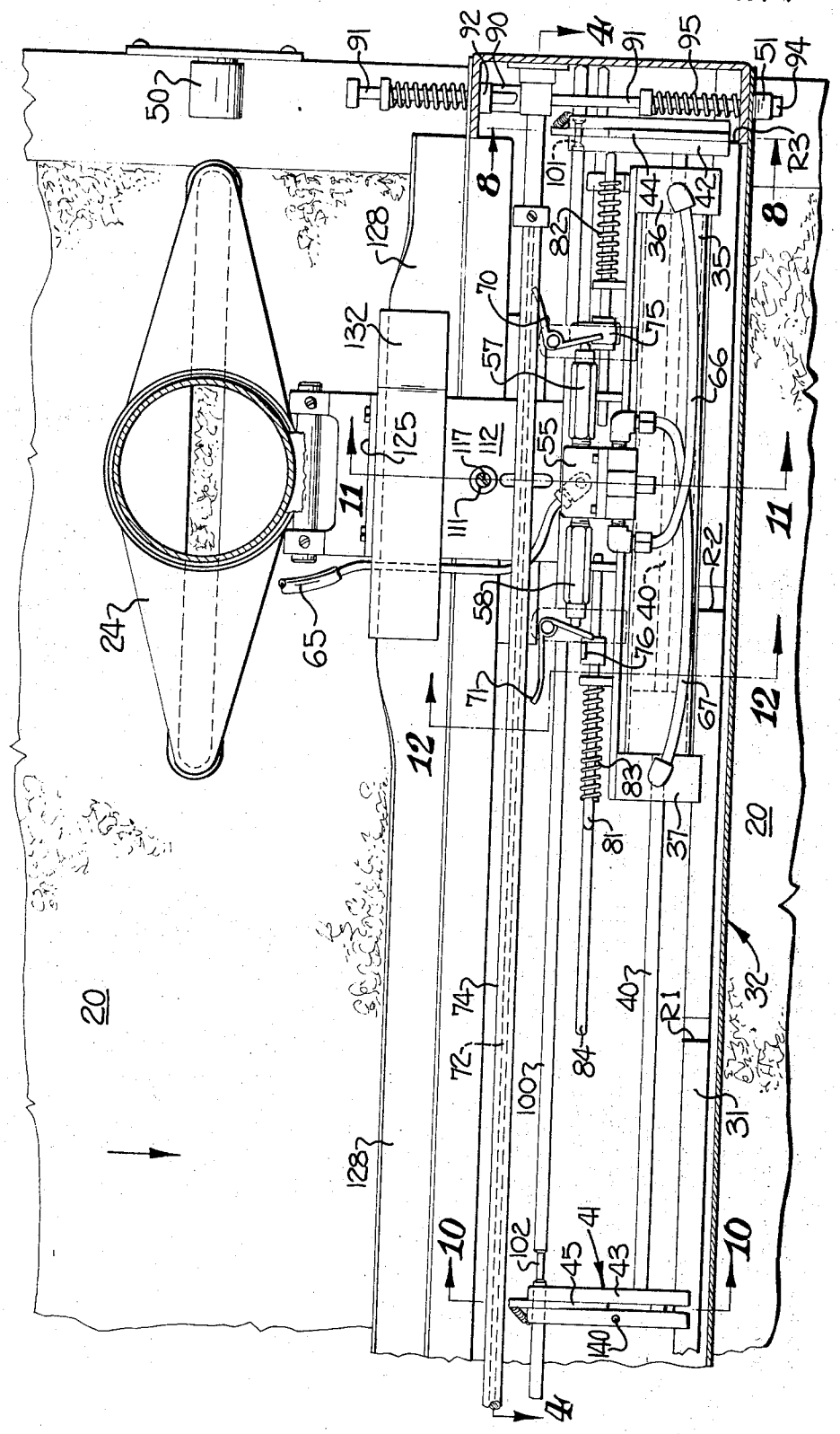


Fig. 3

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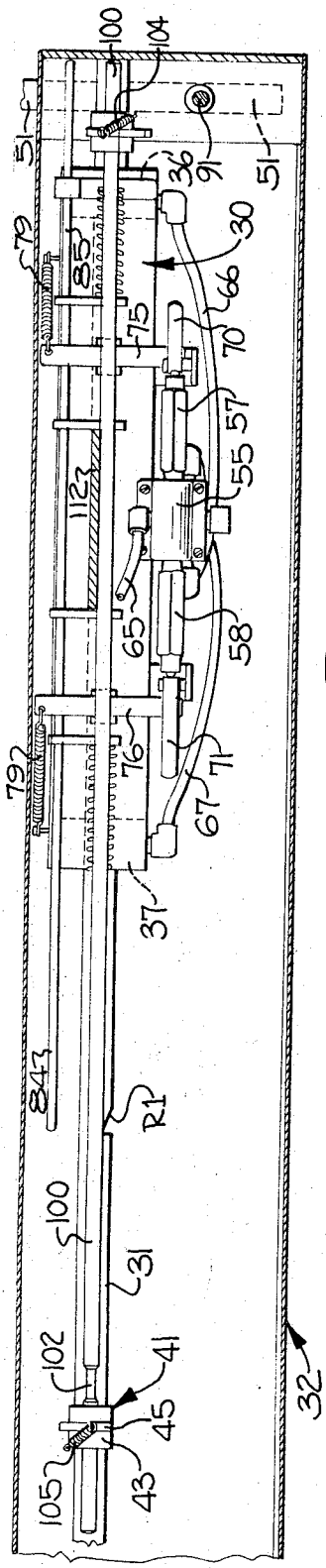


Fig. 4

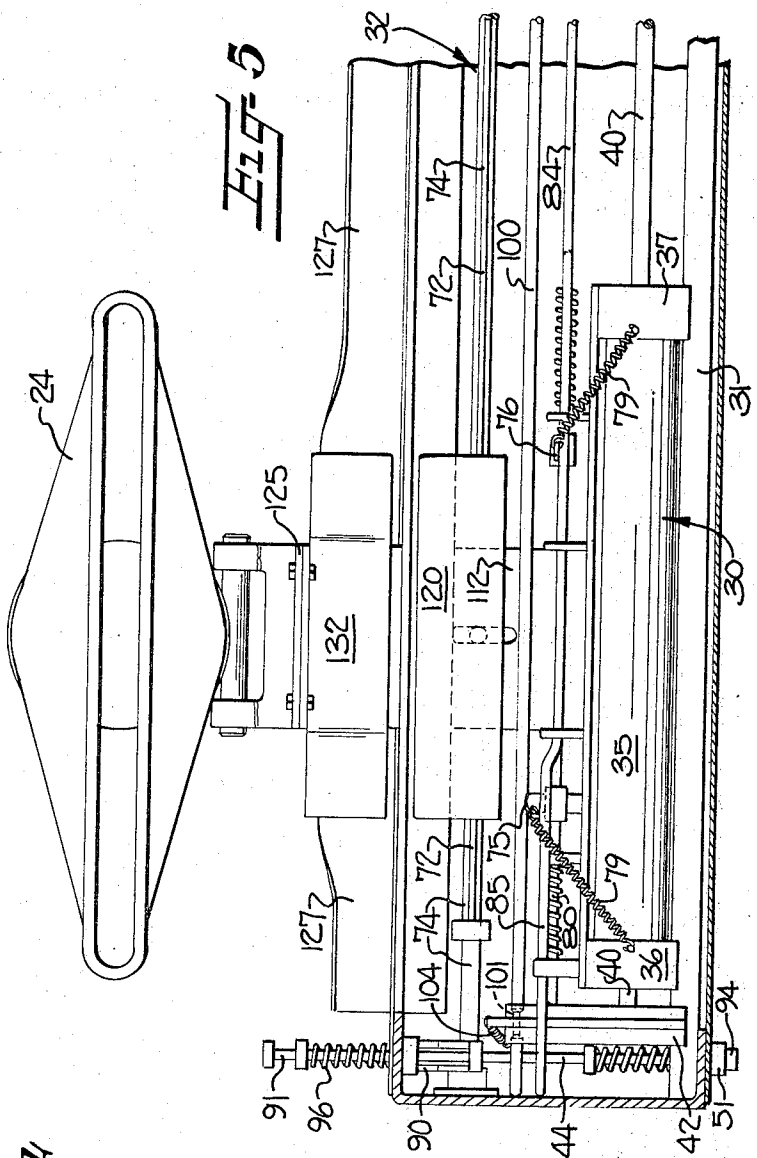


Fig. 5

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Oct. 10, 1967 J. W. SHERRILL 3,345,805

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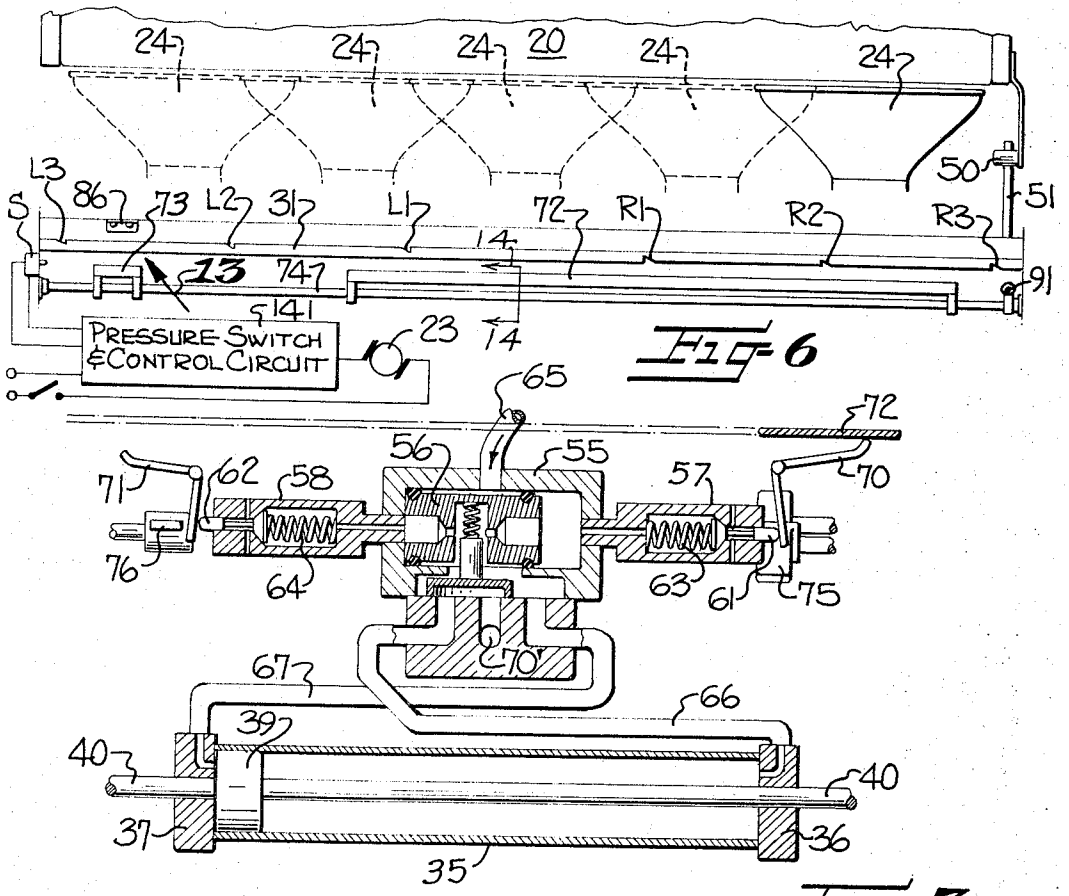


Fig-6

Fig-7

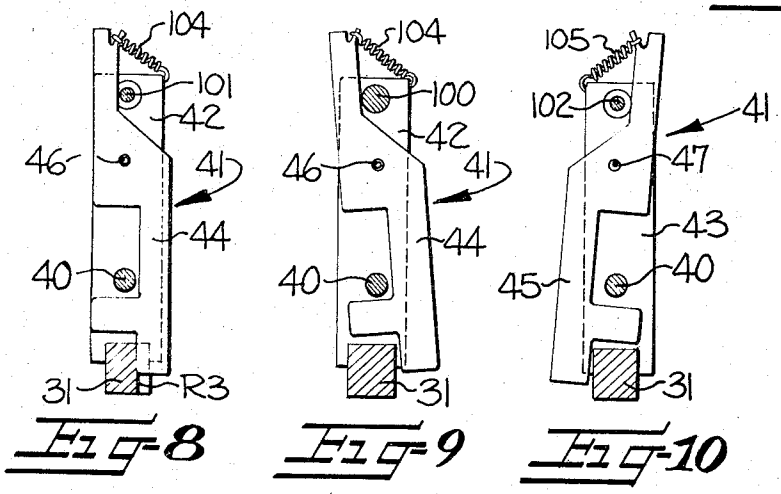


Fig-8 Fig-9 Fig-10

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Oct. 10, 1967 J. W. SHERRILL 3,345,805

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Filed Sept. 1, 1966

5 Sheets-Sheet 5

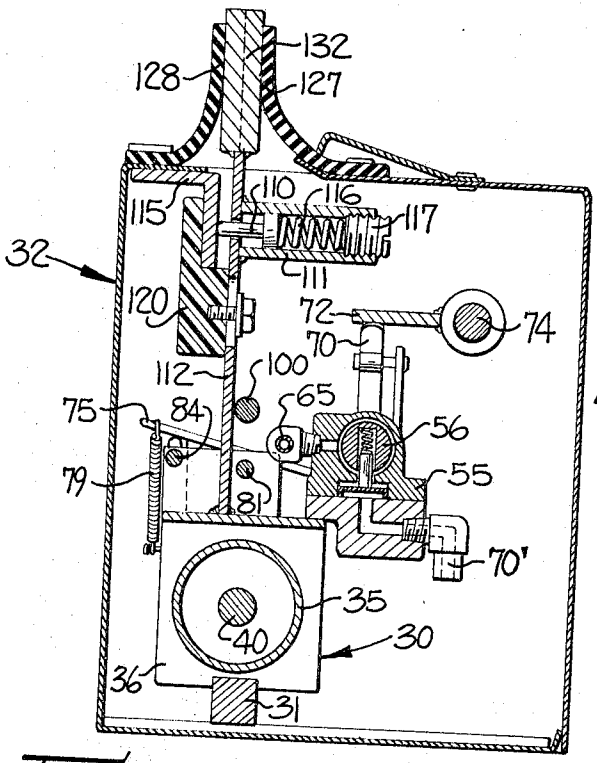


Fig-11

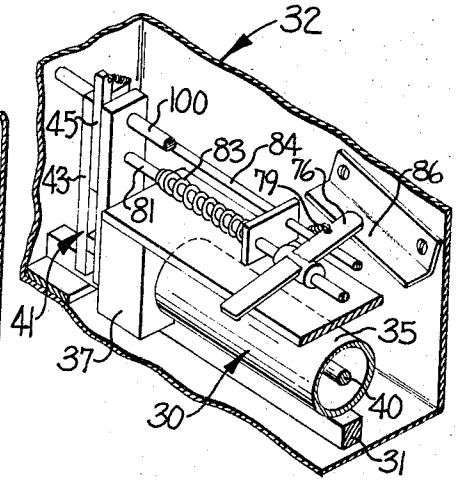


Fig-13

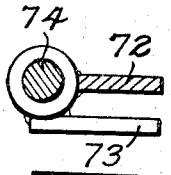


Fig-14

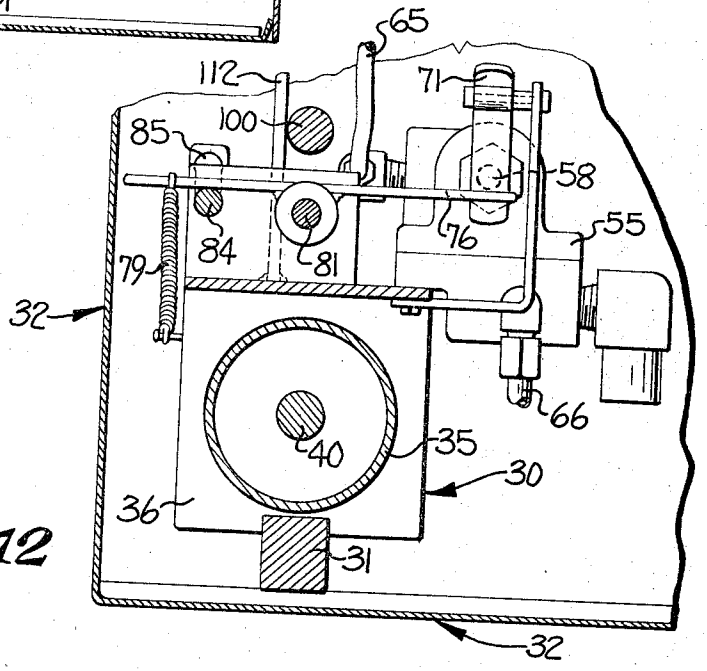


Fig-12

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ATTORNEYS

United States Patent Office 3,345,805 Patented Oct. 10, 1967

3,345,805

APPARATUS FOR CLEANING FILTERS

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Filed Sept. 1, 1966, Ser. No. 576,640
12 Claims. (Cl. 55—271)

ABSTRACT OF THE DISCLOSURE

Apparatus for cleaning the filter of an air circulating system wherein a suction nozzle is reciprocated along guide means across the filter by means of two relatively movable interconnected members supporting the nozzle. The members are subjected to directionally controlled force alternately effective with respect to the two members to impart movement thereto in alternation relative to each other along the guide means.

This application is a continuation-in-part of my copending application for Filter Cleaning System, Ser. No. 387,898, filed Aug. 6, 1964 and now Patent No. 3,303,635.

This invention relates to an improved apparatus for effecting relative traversing movement between a filter and a suction cleaning nozzle for removing lint, dust and other particles of waste material from the filter. The invention is particularly concerned with the cleaning of filters of the type employed in the air circulatory systems of buildings such as textile mills.

The filter cleaning system of said copending application includes method and apparatus for repeatedly effecting relative longitudinal movement between a filter and a suction cleaning head in strokes of a length corresponding substantially with the full length of the filter while imparting a plurality of transverse stepwise movements to the suction cleaning head in one direction, with each transverse stepwise movement corresponding to a stroke in relative longitudinal movement between the filter and the cleaning head. When the cleaning head has moved transversely substantially across the filter, the cleaning head is returned substantially to the point from which it started its transverse stepwise movements within an interval of time not exceeding that required for completion of one of said strokes in relative longitudinal movement between the filter and the suction cleaning head, instead of returning a step at a time corresponding to each successive relative longitudinal movement between the filter and the cleaning head, so the side portion of the filter from which the head started its stepwise movements will not become as heavily laden with waste material by the time it is reached by the suction cleaning head.

The primary object of this invention is to provide an efficient, economically and simply constructed, and relatively trouble-free apparatus for supporting and traversing the carriage of a suction cleaning nozzle across a filter and which is so constructed as to move the carriage in a stepwise manner from a starting position adjacent one side edge of the filter to the other as relative movement is effected between the filter and an elongate frame which supports the carriage and, upon reaching a point adjacent the other side edge of the filter, the carriage is automatically returned substantially to the starting position.

Another object is to provide, in combination with a substantially cylindrical rotary filter, means for imparting a stepwise movement to a suction cleaning nozzle positioned closely adjacent to and applying a suction cleaning force to the filter, which means is responsive to each of a plurality of predetermined rotational movements or revolutions of the filter, and wherein, upon the nozzle having traveled across the filter from adjacent one side edge thereof to the other, rotation of the filter is stopped and the nozzle may be returned to said one side edge before rotation of the filter is automatically restarted.

It is another more specific object of this invention to provide apparatus for cleaning an air filter comprising a frame positioned adjacent and extending across one face of the filter, with means for effecting relative longitudinal movement between the filter and the frame in a direction transversely of the frame, such as by rotating a cylindrical filter about an axis substantially parallel to the frame, or as by vertically reciprocating the frame past a stationary, upright, flat filter. Further, a carriage is mounted for movement on said frame across said face of the filter and comprises first and second interconnected relatively movable members, preferably a fluid-operated cylinder and a piston, mounted for movement longitudinally of said frame. A suction cleaning nozzle is mounted on one of said members for movement therewith and is connected to a source of suction for applying a suction cleaning force to said one face of the filter. Power means is provided for applying simultaneously directionally opposite relative force to the respective members in a direction substantially parallel to said guide means such that each member tends to move in the opposite direction from the other member, with control means for controlling said power means so said force acts against said first member in one longitudinal direction, restraining means spaced longitudinally of said guide means for successively restraining said second member against movement in a direction opposite from said one direction relative to said guide means so that said first member is advanced a step in said one direction along said guide means and relative to said second member under impetus of the applied directionally opposite relative force, means applying a yieldable restraining force to said first member relative to said guide means and independently of said second member, means responsive to predetermined advancing movement of said first member relative to said second member for operating said control means to reverse the direction in which the force applied by said power means is acting against said first member so as to advance said second member along said guide means in said one direction and relative to said first member under the impetus of the applied directionally opposite relative force, and said first-named restraining means being arranged so as to again restrain said second member upon predetermined advancing movement of said second member along said guide means.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds when taken in connection with the accompanying drawings in which—

FIGURE 1 is a perspective view of an installation of a drum filter assembly showing the improved filter cleaning apparatus in association therewith;

FIGURE 2 is an enlarged fragmentary vertical sectional view taken substantially along line 2—2 in FIGURE 1;

FIGURE 3 is a longitudinal vertical sectional view, mostly in elevation, taken substantially along line 3—3 in FIGURE 2, but showing only the right-hand portion of the filter cleaning apparatus with the suction cleaning nozzle occupying the position shown of FIGURE 1 and the solid line position of FIGURE 6;

FIGURE 4 is a plan view, partially in section, taken substantially along line 4—4 in FIGURE 3;

FIGURE 5 is a fragmentary rear elevation looking at the opposite side of the filter cleaning apparatus from

that shown in FIGURE 3, with parts being omitted for purposes of clarity;

FIGURE 6 is a schematic plan view of the filter cleaning apparatus, particularly illustrating a pair of valve tripper actuators, the track along which the suction head carriage is propelled, and the associated electrical circuit;

FIGURE 7 is a schematic vertical sectional view through the carriage cylinder, the control valve therefor, associated pilot valves, and valve trippers;

FIGURE 8 is an enlarged detail of the right-hand latch means taken substantially along line 8—8 in FIGURE 3 and showing the latch in latched position;

FIGURE 9 is a view similar to FIGURE 8 showing the latch beng held out of latched position by the latch shifter 100;

FIGURE 10 is an enlarged vertical sectional view through the left-hand latch means taken substantially along line 10—10 in FIGURE 3, but wherein the latch is held in unlatched position by engagement with the carriage track;

FIGURE 11 is an enlarged view similar to the lower right-hand portion of FIGURE 2 taken substantially along line 11—11 in FIGURE 3;

FIGURE 12 is a transverse vertical sectional view taken substantially along line 12—12 in FIGURE 3;

FIGURE 13 is a fragmentary perspective view taken looking substantially in the direction of the arrow 13 in FIGURE 6; and

FIGURE 14 is an enlarged fragmentary vertical sectional view showing the relative positions of a pair of valve tripper actuators and being taken substantially along line 14—14 in FIGURE 6.

Referring more specifically to the drawings, the numeral 20 generally designates an endless rotary air filter shown in the form of a drum type filter in FIGURE 1. The frame 20*a* of filter 20 is journaled on standards 21 resting upon a floor F. Either or both ends of filter 20 may be open and communicate through an opening 22 in a wall W with a room into which filtered air is to be directed after flowing through filter 20. The air may be circulated through filter 20 and thence through opening 22 by a suitable blower, not shown.

Filter 20 may be driven by an electric motor 23 and normally rotates continuously past a suction nozzle 24. Nozzle 24 is connected by a flexible conduit 25 to a suitable source of suction 26. Nozzle 24 is positioned in close proximity to the peripheral outer surface of filter 20 and is of a horizontal dimension substantially parallel to the axis of filter 20 which is considerably less than the axial length of filter 20.

In accordance with the invention, nozzle 24 is mounted on a carriage broadly designated at 30 and which is movable along an elongate guide means or track 31 suitably secured to the bottom wall of an elongate frame or housing broadly designated at 32. In this instance, housing 32 is shown mounted in a horizontal position upon standards 33 resting on the floor F. The length of track 31 should be about the same as or substantially longer than the axial length of filter 20.

Nozzle carriage 30 is in the form of a fluid-operated double-acting ram having relatively movable first and second members. The first member comprises an elongate creeping cylinder 35 whose opposite ends are closed by cylinder heads 36, 37 suitably grooved at their lower portions to guide cylinder 35 along track 31. The second member of said ram comprises an elongate element or piston rod 40, preferably about twice the length of cylinder 35, and whose medial portion has a piston 39 fixed thereon and positioned within cylinder 35.

Means are provided for successively restraining piston rod 40 at spaced points along track 31 in accordance with the direction the nozzle is to be propelled along track 31. To this end, a creeping latch unit or assembly 41 is operatively associated with carriage 30 and comprises two longitudinally spaced pairs of latch posts 42, 43 to which respective opposite ends of piston rod 40 are fixedly connected. Track gripping members, in the form of laterally movable latches 44, 45 (FIGURES 3, 9 and 10), are pivotally mounted at 46, 47 between the respective pairs of latch posts 42, 43. The bottoms of latch posts 42, 43 are suitably recessed to fit over and be guided by track 31.

Before proceeding further with the detailed description of the apparatus, a general description of the operation of the apparatus will be given. With the carriage 30 and nozzle 24 occupying the starting position shown in FIGURES 1, 3, 4 and 5, in which nozzle 24 is disposed closely adjacent the right-hand side edge of filter 20, an abutment or roller 50 carried by and projecting outwardly from the right-hand side portion of the frame 20*a* of filter 20 moves into engagement with and actuates a carriage trigger 51 which, through means to be later described, causes fluid pressure to enter the left-hand end of cylinder 35 (FIGURE 3). Such fluid pressure serves as power means applying simultaneously directionally opposite force to piston rod 40 and cylinder 35 and, thus, causes cylinder 35, piston rod 40, piston 39 and latches 44, 45 to move to the right until one of the posts 42 engages and is restrained from further movement by the right-hand end wall of housing 32, whereupon cylinder 35 moves to the left in FIGURE 3 until left-hand cylinder head 37 occupies a position closely adjacent latch 45. Thus, with movement of the cylinder 35 in the manner last described, suction nozzle 24 will have moved to the left a distance not over the horizontal length of nozzle 24 and preferably a distance such that the right-hand portion of nozzle 24 overlaps that portion of the periphery of filter 20 which was previously cleaned by nozzle 24.

The fluid flow is then reversed so fluid enters the right-hand end of cylinder 35, thereby reversing the direction at which directionally opposite force is applied to piston rod 40 and cylinder 35. Cylinder 35 is yieldably restrained against longitudinal movement, either by its own weight and the parts carried thereby acting upon track 31, or by a braking member to be later described. Therefore, upon the fluid flow being reversed in the manner last described, cylinder 35 remains at a standstill and latch unit 41 then moves to the left (FIGURE 3) until the relative positions of carriage 30 and latch unit 41 are substantially as shown in FIGURE 3, but located a substantial distance to the left of the starting position.

The operation as thus far described is then repeated with each predetermined rotational movement or revolution of filter 20, so that stepwise movement is imparted to the nozzle 24 across the outer face of the filter 20, as represented by the successive broken line positions of nozzle 24 in FIGURE 6, until nozzle 24 occupies the terminal position closely adjacent the left-hand side edge of filter 20 as shown in the left-hand portion of FIGURE 6. Thereafter, the next succeeding actuation of the carriage trigger 51 by abutment 50 initiates stepwise reverse movement of carriage 30 and suction nozzle 24, and motor 23 is deenergized automatically so that filter 20 remains at a standstill during the return movement of carriage 30 and nozzle 24. Upon the return of nozzle 24 to the starting position shown in FIGURES 1 and 3, motor 23 again is energized automatically, preferably by means of a device responsive to a drop in velocity or pressure of the forced air flow through filter 20 and the opening 22 in wall W. Of course, upon rotation of filter 20 being resumed, a succeeding cycle in the operation of suction nozzle 24 and carriage 30 is repeated.

A detailed description will now be given of the mechanisms for effecting the operation of carriage 30 and nozzle 24 as described briefly above.

Fixedly mounted on a medial portion of cylinder 35 is a four-way main or control valve 55 having a movable

core 56 (FIGURE 7) therein and whose body communicates with a pair of opposed check or pilot valves 57, 58 whose cores or plungers 61, 62 (FIGURE 7) are normally biased outwardly to closed position by respective springs 63, 64. A fluid feed conduit or pipe 65 extends from a suitable source of fluid pressure P (FIGURE 2), such as compressed air, to the central portion of the body of control valve 55. When core 56 occupies the left-hand position shown in FIGURE 7, fluid flows from conduit 65 through a branch conduit 66 to the right-hand cylinder head 36. When core 56 (FIGURE 7) is shifted to the right, fluid pressure flows from feed conduit 65 through a branch conduit 67 to the left-hand cylinder head 37.

The lower portion of control valve 55 has an exhaust passage 70' therein which may communicate with the atmosphere and through which fluid is exhausted from one end of cylinder 35 whenever fluid is being directed into the other end of cylinder 35. It is apparent, by referring to FIGURE 7 that, whenever right-hand pilot valve 57 is open and left-hand pilot valve 58 is closed, this permits fluid to exhaust from adjacent the right-hand side of core 56 so the pressure from feed conduit 65 will cause core 56 to move to the right-hand position. Conversely, when right-hand pilot valve 57 is closed and left-hand pilot valve 58 is open, pressure from feed conduit 65 causes core 56 to move to and occupy the position shown in FIGURE 7. Since valve structures of the type shown in detail in FIGURE 7 are readily commercially available and are well known in the art, a further detailed description thereof is deemed unnecessary.

A pair of substantially L-shaped valve trippers 70, 71 are pivotally supported on carriage cylinder 35 at points above the level of pilot valve cores 61, 62. The lower arms of valve trippers 70, 71 rest against the free ends of the respective pilot valve cores 61, 62. The upper substantially horizontal arms of valve trippers 70, 71 are adapted to be independently engaged and depressed or lowered by respective right-hand and left-hand tripper actuators 72, 73 in the form of elongated plates, as best shown in FIGURE 6. Tripper actuators 72, 73 are eccentrically fixed on a rocker shaft 74 journaled in opposed end walls of housing 32. It should be noted in FIGURE 6 that right-hand tripper actuator 72 is of substantially greater length than left-hand tripper actuator 73. Further, right-hand tripper actuator 72 is normally disposed on a higher level than actuator 73 (FIGURE 14). This is also the case with respect to the upper substantially horizontal arms of the respective right-hand and left-hand valve trippers 70, 71, (FIGURE 7) for purposes to be later described.

Valve trippers 70, 71 extend downwardly beyond the respective pilot valves 57, 58 and are normally substantially horizontally aligned with a pair of strikers 75, 76 shown in the form of levers extending transversely of and spaced above cylinder 35. Medial portions of strikers 75, 76 are fixedly mounted on respective striker plungers 80, 81 suitably journaled upon cylinder 35 and whose distal ends are biased outwardly beyond the vertical planes of the respective cylinder heads 36, 37 by respective springs 82, 83. Striker plungers 80, 81 are aligned with latch posts 42, 43.

The rear portion of each striker (remote from valve trippers 70, 71) is urged downwardly, by a corresponding spring 79 (FIGURE 5), against the upper surface of an elongate reversing rod or bar 84 which is carried by and suitably journaled upon cylinder 35. It will be observed that the left-hand or normally trailing portion of reversing rod 84 in FIGURE 5 is bent upwardly and then horizontally to provide a raised cam surface 85 thereon which is engaged by the rear portion of striker 75 during that portion of each cycle of carriage 30 in which the nozzle 24 is being moved in a stepwise manner from the starting position adjacent one side edge of the filter toward the terminal position adjacent the other side edge of the filter. However, when reversing rod 84 is shifted to the left in FIGURE 5 relative to cylinder 35 and strikers 75, 76, the rear portions of both strikers 75, 76 rest upon the lower surface portion of reversing rod 84 so that the front portions of both strikers are aligned with the lower portions of valve trippers 70, 71.

When the rear portion of striker 75 is raised by the cam surface 85 on reversing rod 84, the front portion of striker 75 then occupies a position below the level of the lower end of right-hand valve tripper 70 as shown in the right-hand portion of FIGURE 3. The rear portion of left-hand striker 76 is never engaged by the cam surface 85 of reversing rod 84. However, during the final stepwise movement of carriage 30 from right to left in FIGURES 3 and 6, the rear portion of left-hand striker 76 engages and rides up an inclined stationary reversing cam 86 suitably secured to the rear wall of housing 32 (FIGURES 6 and 13), thus tilting the front portion of left-hand striker 76 to a position below the level of the lower end of left-hand valve tripper 71 so that subsequent movement of striker 76 from left to right relative to cylinder 35 will not result in left-hand pilot valve 58 being opened.

Right-hand tripper actuator 72 is shown occupying its normal, raised and inactive position in FIGURES 2, 3, 5 and 11. In order to lower and raise tripper actuators 72, 73 at the end of each revolution of filter 20, the right-hand end portion of rocker shaft 74 (FIGURE 3) has a bifurcated crank 90 fixed thereon and projecting rearwardly therefrom. An upright shaft or trigger plunger 91 loosely penetrates bifurcated crank 90 and the upper and lower walls of housing 32. A pair of vertically spaced abutments or collars 92 (FIGURE 2) straddles bifurcated crank 90 and is fixed on plunger 91. The lower end of trigger plunger 91 also loosely penetrates the front portion of carriage trigger 51 and has a head portion 94 engaging the lower surface of trigger 51. Head portion 94 of plunger 91 is urged upwardly against the lower surface of carriage trigger 51 by suitable compression springs 95, 96 encircling lower and upper portions, respectively, of trigger plunger 91. It is apparent that head portion 94 of lunger 91 and trigger 51 may limit the extent of upward movement of plunger 91 and thus limit the extent of upward movement of tripper actuators 72, 73 (FIGURES 6 and 14).

Each time follower 50 on filter frame 20*a* moves downwardly from the position of FIGURE 2 and engages and imparts downward movement to the rear portion of carriage trigger 51 as shown in dotted lines in FIGURE 2, plunger 91 is moved downwardly to impart corresponding downward movement to trigger actuators 72, 73. Also, upon abutment 50 moving downwardly beyond the rear end of carriage trigger 51, it is apparent that springs 95, 96 will return trigger actuators 72, 73 to the substantially horizontal or inactive position in which they are shown in FIGURES 2, 3, 5, 11 and 14.

As heretofore stated, the upper portion of left-hand valve tripper 71 is positioned on a substantially lower level than the upper portion of right-hand valve tripper 70 when the lower portions of valve trippers 70, 71 are in engagement with the distal ends of the respective pilot valves 57, 58. Thus, each time right-hand tripper actuator 72 is activated or moved downwardly, it engages and imparts movement to the right-hand valve tripper 70 only to momentarily open right-hand pilot valve 57, unless of course, the right-hand valve tripper 70 then happens to be positioned to the left of the left-hand end of the right-hand tripper actuator 72 (FIGURE 6).

When suction nozzle 24 occupies its extreme left-hand or terminal position shown in the left-hand portion of FIGURE 6, neither of the tripper actuators 72 or 73 is then positioned above right-hand valve tripper 70, but the auxiliary or left-hand valve tripper actuator 73 is then positioned above left-hand valve tripper 71. The left-hand tripper actuator 73 occupies a lower position on rocker shaft 74 than that of the right-hand tripper actuator 72 (FIGURE 14) so that, with the next succeeding downward stroke of trigger plunger 91, as effected by engagement of abutment 50 with carriage trigger 51,

left-hand tripper actuator 73 moves downwardly sufficiently to engage and impart movement to left-hand valve tripper 71 so as to open left-hand pilot valve 58 while right-hand pilot valve 57 remains closed.

In the particular illustrated embodiment of the invention, it will be observed in FIGURE 6 that suction nozzle 24 occupies five different static positions during the course of the successive stepwise movements thereof from adjacent one side edge portion of filter 20 to a position adjacent the other side edge portion of filter 20. In other words, four separate stepwise movements are imparted to suction nozzle 24 in the course of its movement from one side edge portion to the other side edge portion of filter 20. Accordingly, track 31 is provided with three longitudinally spaced left-hand latch-receiving notches L1, L2, L3 (FIGURE 6) on the rear surface thereof and three right-hand latch-receiving notches R1, R2, R3 on the front surface thereof which cooperate with hte respective latches 45, 44 in effecting right to left stepwise movement and left to right stepwise movement, respectively, to carriage 30 and suction nozzle 24.

In each instance, it will be noted that the trailing edges of the notches in track 31 extend at substantially right angles with respect to the direction of movement of the suction nozzle 24. The leading edges of the notches are beveled so that the corresponding latches 44, 45 may readily ride out of the notches following each stepwise movement of the cylinder 35 and upon the initiation of the subsequent corresponding movement of latch unit 41. In this regard, it will be observed in FIGURE 9 that the lower portion of latch 44 is positioned to overlap the front surface of track 31 while, in FIGURE 10, the lower portion of the left-hand latch 45 is positioned to overlap the rear surface of track 31 in FIGURE 10.

In order to hold latches 44, 45 out of engagement with the respective notches R1, R2, R3 and L1, L2, L3 in alteration and according to the direction of movement of suction nozzle 24, an elongate latch shifter or latch control rod 100 is provided which is spaced above cylinder 35, bridges the distance between latch posts 42, 43 and is slidably mounted for longitudinal movement in the upper portions of latch posts 42, 43. Latch shifter 100 is provided with a pair of spaced cam recesses 101, 102 therein which are out of phase with latches 44, 45; i.e., when one of the cam recesses is in registration with one of the latches 44 or 45, the other of the cam recesses is disposed out of registration with the other latch.

For example, in FIGURES 3 and 8, cam recess 101 is shown in registration with the upper portion of latch 44 while, in FIGURE 1, cam recess 102 is located inwardly of and out of registration with the upper portion of latch 45. On the other hand, when latches 44, 45 are caused to move from left to right in FIGURE 3 with latch shifter 100 positioned against the right-hand wall of housing 32, in a manner to be later described, the right-hand end portion of latch shifter 100 is moved into engagement with the upper portion of latch 44, as shown in FIGURE 9, to prevent the lower portion of latch 44 from being urged back into any of the notches R1, R2, R3 by the corresponding spring 104 during subsequent right to left movement of latch unit 41 in FIGURE 3. Also, at the time cam recess 101 was moved out of registration with latch 44, cam recess 102 was moved into registration with the upper portion of left-hand latch 45, as shown in FIGURE 10.

The lower portion of latch 45 in FIGURE 10 is not in registration with a notch L1–L3 in the rear surface of track 31 so that the upper portion of latch 45 in FIGURE 10 is not shown positioned in the cam recess 102 under influence of the corresponding spring 105. However, recess 102 will then permit the lower portion of left-hand latch 45 to drop into the succeeding notches L1, L2, L3 (FIGURE 6) to restrain latch unit 41 against left to right movement during each corresponding right to left movement of cylinder 35 and suction nozzle 24.

Although carriage 30 and associated parts are of greater weight than latch unit 41, the frictional resistance to movement of carriage 30, resulting from the interengagement of cylinder heads 36, 37 with track 31 may, at times, be insufficient to cause the cylinder 35 to remain stationary during those periods in which it is desired that latch unit 41 moves along track 31. Therefore, means are provided for frictionally resisting or restraining movement of carriage 30 to a limited extent. As best shown in FIGURE 11, such frictional restraining means may take the form of a spring-loaded braking member or friction plunger 110 slidably mounted in a housing 111 carried by an upstanding plate or support 112 mounted on cylinder 35. Friction plunger 110 loosely penetrates plate 112 and is urged against the front surface of an elongate friction bar 115 by a suitable spring 116 positioned within housing or casing 111 and being adjustable by a set screw 117 (FIGURE 11). In order to stabilize plate 112 and thus assist in stabilizing cylinder 35 as it moves along track 31, a suitable slide bearing 120 is fixed to the rear surface of plate 112 and moves in sliding engagement with the rear surface of friction bar 115.

Friction bar 115 may extend substantially throughout the length of the upper portion of housing 32. Plate 112 extends upwardly through a slot suitably formed in the upper wall of and extending substantially throughout the length of housing 32 and has a bracket 125 mounted thereon to which nozzle 24 is adjustably secured. Suitable resilient strips 127, 128 may be secured to the upper wall of housing 32 and straddle the slot therein so as to prevent dust, lint and the like from entering housing 32. Accordingly, the upper portion of plate 112 has a slide member 132 fixed thereon which is sharpened at both ends so that it may move freely between and spread apart the resilient strips 127, 128 during movement of carriage 30 and its nozzle 24 along housing 32.

As stated earlier, when the return movement of suction nozzle 24 from the terminal position to the starting position is initiated, it is desirable to stop rotation of cylindrical filter 20 and to restart rotation of the filter 20 at some time after the nozzle 24 has returned to the starting position and preferably following a predetermined drop in pressure downstream of the air flow through filter 20. Accordingly, it will be observed in FIGURE 6 that a normally inactive switch S is suitably secured to the left-hand end wall of housing 32 and has its plunger biased through said end wall to be engaged by a switch actuator or abutment 140 (FIGURE 3) on the outermost of the left-hand latch posts 43. Switch S of FIGURE 6 is electrically connected to a pressure differential switch and control circuit 141 represented by an identifying block in FIGURE 6, and whose components may be arranged in a well known manner so as to complete the circuit to electric motor 23 whenever the air flow downstream of filter 20 drops below a predetermined pressure or velocity, provided that switch S is not then being actuated. If desired, the pressure switch and control circuit 141 also may control the motor, not shown, for the suction source in the same manner in which the filter driving motor 23 is controlled.

Upon actuation of switch S by engagement of the abutment 140 (FIGURE 3) therewith, the pressure differential switch and control circuit 141 operate in a well known manner to break the circuit to electric motor 23 and thus stop rotation of cylindrical filter 20 until a predetermined drop in pressure downstream of the filter 20 is again detected by the pressure switch. Since pressure differential switches and control circuits therefor are well known, an illustration and description thereof is deemed unnecessary. However, to my knowledge, such a pressure switch and control circuit has never been used heretofore for controlling the operation of a filter cleaning suction nozzle in the manner according to the instant invention. The differential pressure switch may be of a type disclosed

in a Bulletin No. E–51, copyrighted in 1965 by F. W. Dwyer Manufacturing Company, Michigan City, Ind., for example.

Although the illustrated embodiment of the suction nozzle propelling apparatus of the invention is of relatively simple construction, there are many successive steps involved in each cycle of operation of the apparatus. Therefore, the steps of the detailed method of operation will now be given in abridged form and in numerical sequence. The terms "R.H." and "L.H." are used in the following method of operation to indicate "right-hand" and "left-hand," respectively, as viewed looking toward FIGURES 1, 3, 4, 6, 7 and 13.

METHOD OF OPERATION

At start of each cleaning cycle, carriage **30** occupies the position shown in FIGURES 1–5, valve core **56** occupies the L.H. position shown in FIGURE 7, R.H. latch **44** is in engagement with R.H. track notch **R3**, and abutment **50** (FIGURE 2) occupies a position beyond (below) carriage trigger **51**. The sequence of operational steps then is as follows:

(1) Motor **23** is energized, as hereinafter described in Step 21, to initiate a cycle by starting the first revolution of filter **20** past nozzle **24**

(2) Adjacent the terminal end of said first revolution, carriage trigger **51** is engaged and momentarily lowered by abutment **50** on filter frame **20***a*, while:
- (a) R.H. tripper actuator **72** engages and moves R.H. valve tripper **70** to open R.H. pilot valve **57**, so
- (b) valve core **56** moves to the right in FIGURE 7, and
- (c) fluid enters L.H. end of carriage cylinder **35** through conduit **67** as fluid is exhausted from R.H. end of cylinder **35** through conduit **66** so directionally opposite relative force is applied between cylinder head **37** and piston **39**

(3) Piston **39**, piston rod **40** and latch unit **41** move from left to right in FIGURE 3 until outer R.H. latch post **42** engages R.H. end wall of housing **32**, during which latch shifter **100** is against R.H. end wall of housing **32**, so that:
- (a) R.H. latch **44** moves to the right of track notch **R3** and also to the right of R.H. latch shifter cam recess **101** in FIGURE 3 (see also FIGURE 9), while
- (b) L.H. latch **45** moves into registration with L.H. latch shifter cam recess **102** in FIGURE 3 (see also FIGURE 10).

(4) Since latch unit **41** thus is restrained from movement from left to right, carriage **30** and its nozzle **24** move from right to left in FIGURE 3 until striker plunger **81** engages and is actuated by inner L.H. latch post **43**, while:
- (a) L.H. striker **76** moves L.H. valve tripper **71** to open L.H. pilot valve **58**, so that
- (b) valve core **56** (FIGURE 7) moves from right to left to position shown and fluid enters R.H. end of cylinder **35** and is exhausted from L.H. end of cylinder **35**, thereby reversing the direction in which the directionally opposite relative force is acting on cylinder **35**

(5) Since frictional resistance to movement of carriage **30** then is greater than that of latch unit **41**, cylinder **35** remains stationary and latches **44**, **45** move from right to left until piston **39** engages L.H. cylinder head **37**
- (a) This moves L.H. latch **45** into engagement with, or to a position to the left of, the first rear track notch **L1** (FIGURE 6).

(6) Carriage cylinder **35**, piston **39** and parts carried thereby remain stationary with nozzle **24** occupying the second position from the right shown in FIGURE 6 until a second revolution of filter **20** is completed

(7) Step No. 2 (including 2a, 2b, 2c then is repeated substantially as described

(8) Since latch **45** then is restrained from left to right movement by engagement with track notch **L1**, carriage cylinder **35** moves from right to left a second time so nozzle **24** occupies the third position from the right in FIGURE 6, whereupon steps Nos. 4 and 5 are repeated substantially as described, except L.H. latch **45** slides out of track notch **L1** and moves into engagement with or slightly beyond rear track notch **L2**

(9) Carriage **30** and latch unit **41** then remain stationary, with nozzle **24** occupying the third position until a third revolution of filter **20** is completed

(10) Steps Nos. 2 and 8 then are repeated substantially as described, but nozzle **24** moves to fourth position (FIGURE 6), and L.H. latch **45** slides out of track notch **L2** and moves into engagement with terminal L.H. track notch **L3**

(11) Carriage **30** and latch unit **41** then remain stationary until a fourth revolution of filter **20** is completed

(12) Step No. 2 is repeated substantially as described

(13) Carriage **30** and nozzle **24** move to fifth or terminal position, during which:
- (a) reversing rod **84** strikes L.H. end wall of housing **32** to move raised cam surface **85** (FIGURE 4) out of engagement with striker **75**, and
- (b) L.H. striker **76** engages and is inactivated by stationary reversing cam **86** (FIGURES 6 and 13)
- (c) Although L.H. striker **76** moves to left in FIGURE 3 relative to cylinder **35**, it passes beneath L.H. tripper **71**

(14) Carriage **30** and latch unit **41** then remain stationary until a fifth revolution of filter **20** is completed

(15) Carriage trigger **51** is actuated by abutment **50** and abutment **50** passes beyond trigger **51**, while:
- (a) L.H. tripper actuator **73** (FIGURE 6) momentarily moves L.H. valve tripper **71** (FIGURE 3) to open L.H. pilot valve, and
- (b) fluid enters R.H. end of cylinder **35**

(16) Piston **39**, piston rod **40** and latch unit **41** move to the left with latch shifter **100** against L.H. end wall of housing **32** until outer L.H. latch post **43** engages L.H. end wall of housing **32**, during which:
- (a) L.H. latch **45** moves to the left of the last L.H. track notch **L3** and to the left of cam recess **102** in latch shifter **100**
- (b) R.H. latch **44** moves into registration with cam recess **101** (see FIGURE 8), and
- (c) abutment **140** (FIGURE 3) engages and activates limit switch S (FIGURE 6) to stop rotation of filter **20**

(17) Since latch unit **41** thus is restrained from further right-to-left movement, carriage **30** and nozzle **24** move in reverse or return direction (left-to-right), during which:
- (a) L.H. striker **76** leaves stationary reversing cam **86**, and
- (b) abutment **140** leaves limit switch S

(18) Since both strikers **75**, **76** are then registering with respective valve trippers **70**, **71**, and R.H. latch **44** is free to drop into successive R.H. track notches **R1–R3**, carriage **30** and nozzle **24** return to the starting position of FIGURE 3 in a stepwise manner, during which strikers **75**, **76** cooperate with latch posts **42**, **43** to operate pilot valves **57**, **58** in alternation

(19) However, as cylinder **35** approaches the R.H. or starting position, reversing rod **84** engages and is stopped by the R.H. end wall of housing **32** so as to move R.H. striker **75** below R.H. valve tripper **70** before R.H. striker plunger **80** engages the inner R.H. latch post **42**

(20) Thus, latch unit **41** and carriage **30** successively stop their left-to-right movement when they occupy the position shown in FIGURES 1, 3 and 4

(21) At a predetermined time after carriage **30** has come to rest at the starting position; e.g., upon a predetermined pressure drop downstream of filter **20** being detected by the pressure differential switch and control circuit **141**, motor **23** is restarted to initiate rotation of filter **20** and, thus, to initiate a succeeding cycle

If so desired, a suitable conventional timing device, not shown, may be used in place of the pressure differential switch and control circuit **141** of FIGURE 6 and which will automatically restart filter driving motor **23** at a predetermined time after actuation of switch S by the latch unit **41** and after suction nozzle **24** has completed a cycle and returned to the starting position. Such a timing device may be arranged to restart motor **23** immediately upon, or at any desired interval following, the return of nozzle **24** to the starting position.

As best shown in FIGURE 3, trigger plunger **91** projects upwardly from housing **32** for ready accessibility so an operator may manually cycle the crosswise stepwise movements of carriage **30** and its suction nozzle **24**, if desired, by momentarily depressing plunger **91**. Also, this arrangement of plunger **91** facilitates ease in installing the nozzle propelling apparatus, including housing **32** and the parts carried thereby, for use with a flat filter. For example, housing **32** and the parts carried thereby may replace the nozzle propelling mechanism of said copending application so as to be reciprocated vertically past the said flat filter and so the trigger plunger **91** is actuated at the end of each stroke in vertical reciprocation of housing **32**, without departing from the spirit of the invention. When used with a flat filter, the crosswise stepwise movements of carriage **30** and latch unit **41** would be effected relative to one face of the flat filter in substantially the same manner as heretofore described with respect to the cylindrical or endless filter **20**. Accordingly, an illustration and detailed description of the filter cleaning apparatus in association with a flat filter is deemed unnecessary.

In the drawings and specification, there has been set forth a preferred embodiment of the invention, and although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being defined in the claims.

I claim:

1. The combination with an air filter of an apparatus for cleaning the filter comprising

a suction cleaning nozzle positioned closely adjacent one face of the filter and connected to a source of suction for applying a suction cleaning force to the filter,

means for propelling said nozzle across the filter comprising elongate guide means extending across the filter,

first and second interconnected relatively movable members guided for movement along said guide means,

means mounting said nozzle on one of said members,

power means for applying simultaneously directionally opposite relative force to the respective members in a direction substantially parallel to said guide means such that each member tends to move in the opposite direction from the other member,

control means for controlling said power means so said force acts against said first member in one longitudinal direction,

restraining means spaced longitudinally of said guide means for successively restraining said second member against movement in a direction opposite from said one direction relative to said guide means so that said first member is advanced a step in said one direction along said guide means and relative to said second member under impetus of the applied directionally opposite relative force,

means applying a yieldable restraining force to said first member relative to said guide means and independently of said second member,

means responsive to predetermined advancing movement of said first member relative to said second member for operating said control means to reverse the direction in which the force applied by said power means is acting against said first member so as to advance said second member along said guide means in said one direction and relative to said first member under the impetus of the applied directionally opposite relative force, and

said first-named restraining means being located so as to again restrain said second member upon predetermind advancing movement of said second member along said guide means.

2. A structure according to claim **1**, in which said first member is a fluid-operated cylinder and said second member is a piston rod provided with a piston longitudinally movable in said cylinder, said power means for applying directionally opposite relative forces to the respective members including conduit means connecting opposite ends of said cylinder to a source of fluid, and said control means includes valve means interposed in said conduit means.

3. A structure according to claim **1**, including means for effecting relative movement between said filter and said guide means in a direction transversely of said guide means.

4. A structure according to claim **1**, wherein said filter is cylindrical, said guide means extending substantially parallel with the axis of said filter, means for rotating said filter, and means responsive to completion of each successive predetermined rotational movement of said filter for operating said control means to cause said relative force to act against said first member in said one longitudinal direction.

5. Apparatus according to claim **4**, wherein said first member normally occupies a starting position adjacent one side edge of said filter at the start of a cycle thereof and wherein said first member occupies a terminal position adjacent the other, opposite, side edge of said filter upon completion of a plurality of successive advancements of each of said members in said one direction, additional means responsive to completion of a rotational movement of said filter for operating said control means to cause said relative force to act against said first member in said reverse direction whenever said first member occupies said terminal position so said first member moves in said reverse direction relative to said guide means and said second member.

6. Apparatus according to claim **5**, including additional restraining means spaced longitudinally of said guide means for successively restraining said second member against movement in said one direction whenever said members are in the course of movement from the terminal position to the starting position, and means responsive to each of a plurality of movements of said first member in said reverse direction for operating said control means to cause said relative force to act against said first member in said one dierction so as to move said second member in said reverse direction relative to said first member under the impetus of the applied directionally opposite relative force.

7. Apparatus according to claim **6**, including stopping means for stopping rotation of said filter upon initiation of reverse movement of said first member at said terminal position, and means operatively connected to said last-named means for restarting rotation of said filter following reverse movement of said first member to said starting position.

8. Apparatus according to claim **7**, in which said means operatively connected to said stopping means comprises means responsive to a predetermined pressure drop in the forced air downstream of said filter for restarting rotation of said filter.

9. The combination with an air filter of apparatus for cleaning the filter comprising

a suction cleaning nozzle positioned closely adjacent one face of the filter and connected to a source of suction for applying a suction cleaning force to the filter,

means for propelling the nozzle across the filter comprising a double-acting fluid-operated ram supporting said nozzle and including a piston rod and a cylinder, means for introducing fluid into opposite ends of said cylinder in alternation,

guide means extending across the filter and guiding said cylinder for movement thereon,

a movable gripping device operatively associated with said piston rod and guided by said guide means,

means responsive to introduction of fluid to one end of said cylinder for advancing said piston rod and its gripping device in one direction relative to said guide means and said cylinder, and

means on said gripping device for restraining movement thereof relative to said guide means when fluid is introduced to the other end of said cylinder whereby said cylinder is advanced in said one direction relative to said guide means and said piston rod.

10. Apparatus for cleaning a substantially cylindrical rotary air filter through which forced air flows comprising

means for driving said filter,

an elongate frame positioned adjacent the outer face of the filter and substantially parallel with the axis of the filter, said frame being of a length at least about as long as the axial length of the filter,

a suction cleaning nozzle connected to a source of suction for applying a suction cleaning force through said nozzle to the filter, said nozzle being of a length parallel with said axis substantially less than the axial length of the filter and guided for movement longitudinally of said frame, said nozzle also being

arranged to occupy normally a position adjacent one side edge of the filter,

means responsive to each of a plurality of predetermined rotational movements of the filter for imparting a stepwise movement to said nozzle in one direction longitudinally of said frame with each such stepwise movement being substantially less than the axial length of the filter, and

said responsive means also being operable to reverse the direction of movement of said nozzle longitudinally of said frame upon said nozzle reaching a terminal position adjacent the other side edge of the filter so as to return said nozzle to said normal position.

11. Apparatus according to claim 10, including means responsive to movement of said nozzle to said terminal position for stopping rotation of said filter, and means operatively connected to said last-named responsive means for restarting rotation of said filter following an interval after said filter has been stopped.

12. Apparatus according to claim 11, in which said means operatively connected to said last-named means comprises means responsive to a predetermined drop in pressure of the forced air downstream of said filter for restarting rotation of said filter.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,345,805 Dated October 10, 1967

Inventor(s) James W. Sherrill

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the drawings, Sheet 2, Fig. 3: Sheet 3, Fig. 4; and Sheet 4, Fig. 7 (each instance), where the conduits 66, 67 are shown connected to the left-hand and right-hand sides, respectively, of the valve 55, these views should be read as having the conduits 66, 67 connected to the right-hand and left-hand sides, respectively, of the valve 55. Sheet 5, Fig. 12, reference numeral "66" should be read as --67--.

SIGNED AND
SEALED
MAY 26 1970

(SEAL)
Attest:

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