United States Patent [19]

Fannon, Jr.

[11] **3,715,774**

[45] **Feb. 13, 1973**

[54] AUTOMATIC WINDOW WASHER

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[73] Assignee: **Harsco Corporation**, Harrisburg, Pa.

[22] Filed: **Jan. 20, 1971**

[21] Appl. No.: **107,957**

[52] **U.S. Cl.** ..... **15/302**, 15/312 R

[51] **Int. Cl.** **A47l 5/38**

[58] **Field of Search** .....15/302, 312 R, 50 C, 98, 103

[56] **References Cited**

UNITED STATES PATENTS

3,218,663	11/1965	Battista	15/98 X
3,344,454	10/1967	Mikalson	15/50 C
3,497,902	3/1970	Hartigan	15/302

FOREIGN PATENTS OR APPLICATIONS

1,165,082	9/1969	Great Britain	15/302

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Assistant Examiner—C. K. Moore
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[57] **ABSTRACT**

An automatic window washer has a module riding in tracks on the face of the building and is controlled from a unit mounted on the roof of the building. As the module moves down the face of the building the presence of areas to be washed is automatically sensed and the washing operations then automatically begun and terminated by equipment in the module. The module or modules may be mounted in a span frame for lateral movement therein for washing more than one vertical column of windows when the tracks on the face of the building are spaced apart by a plurality of columns of windows. The washing equipment in the module may take various forms for washing windows of curtain front buildings and for washing recessed windows.

17 Claims, 10 Drawing Figures

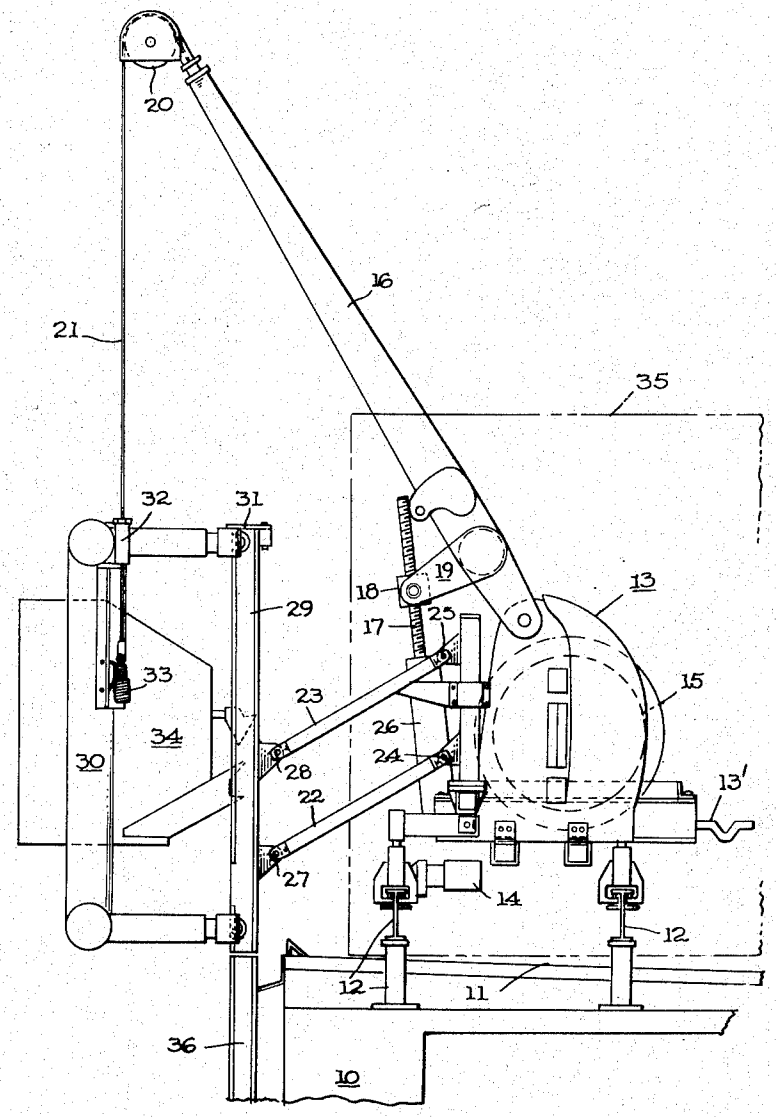
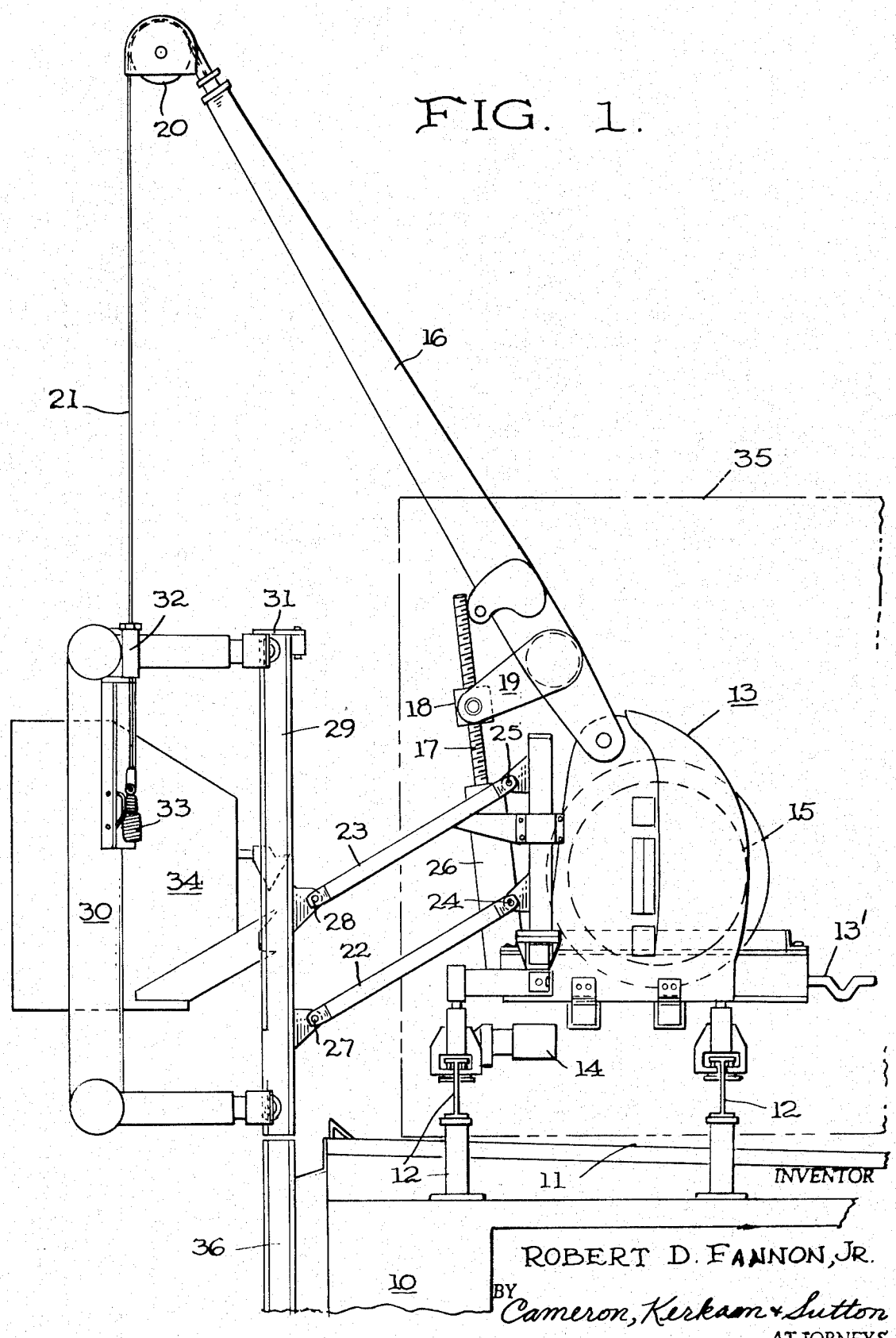


FIG. 1.



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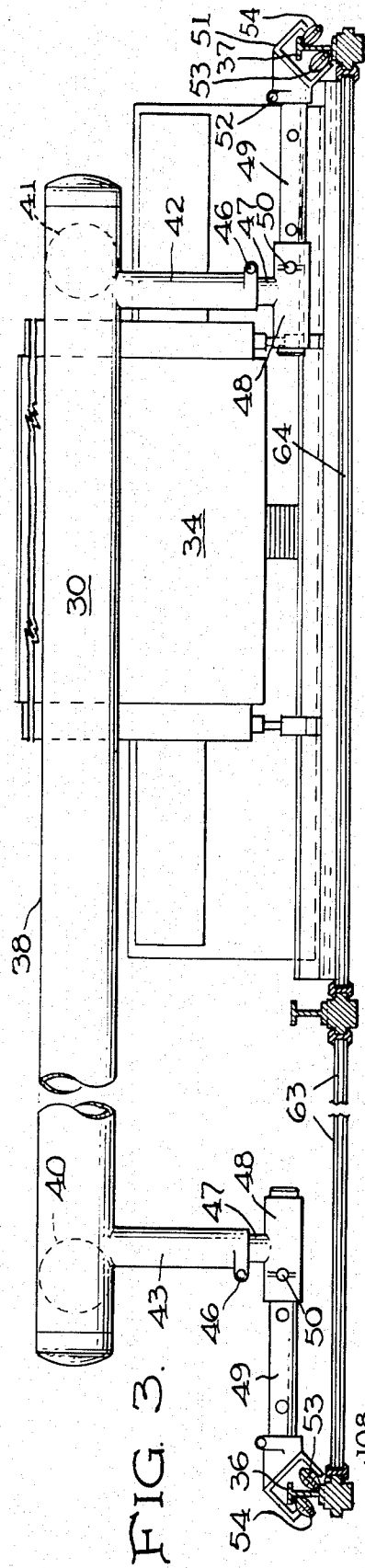

FIG. 3.

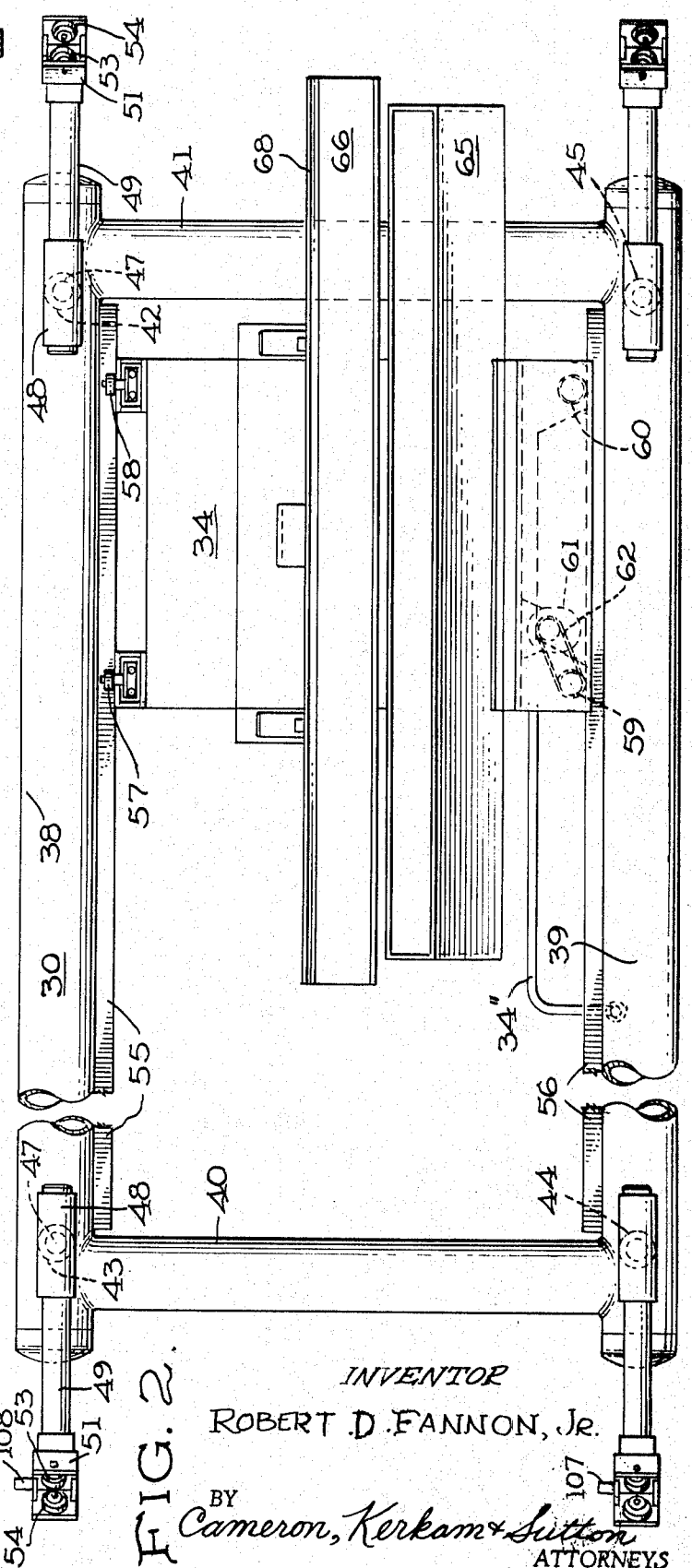

FIG. 2.

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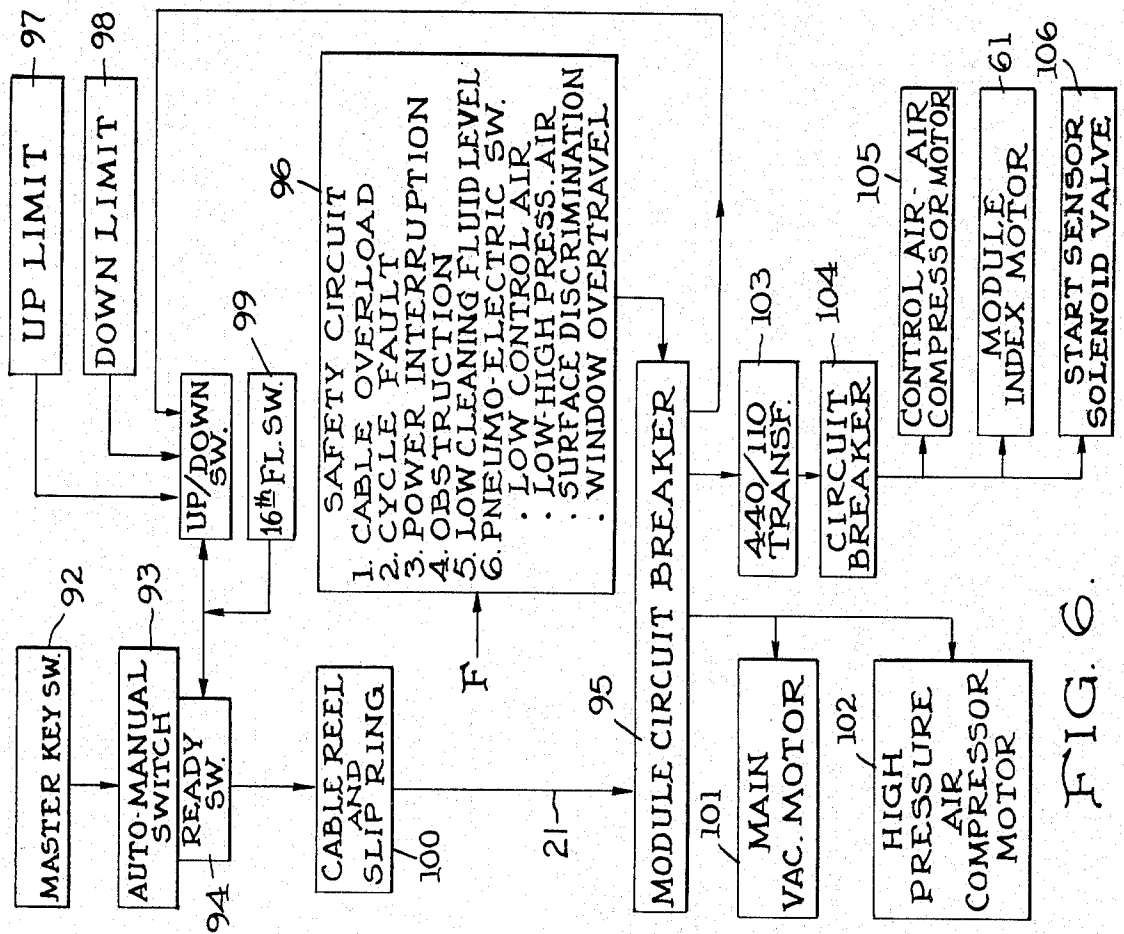

FIG. 6.

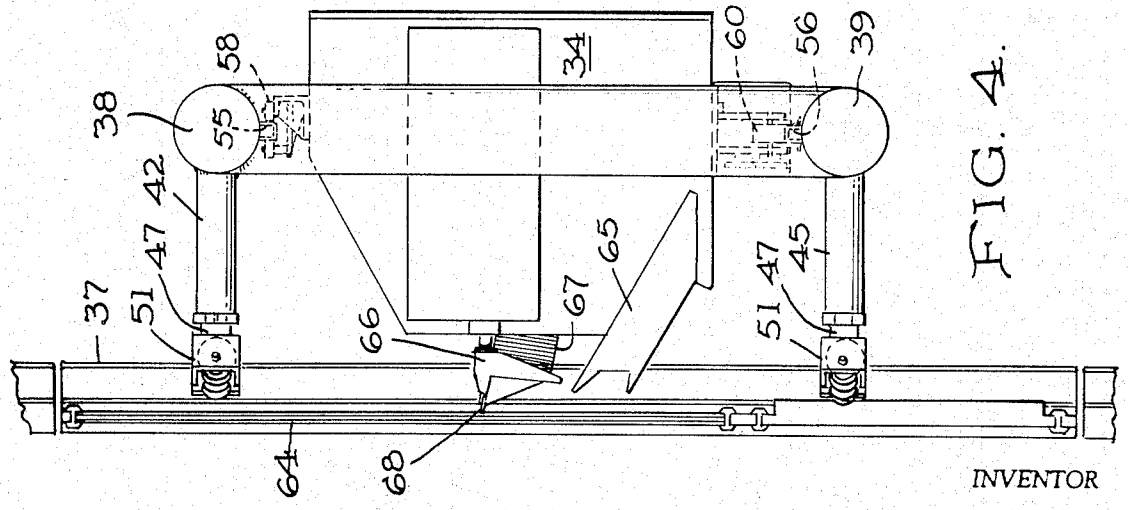

FIG. 4.

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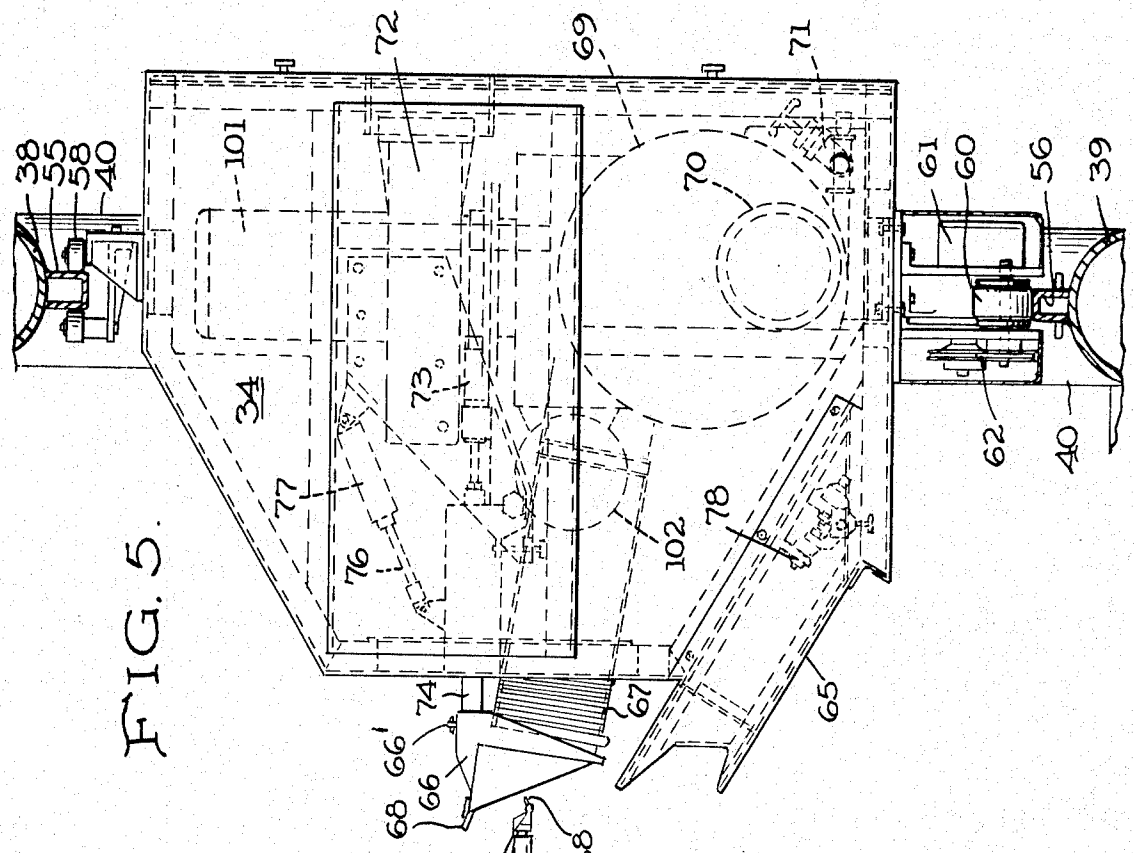

FIG. 5.

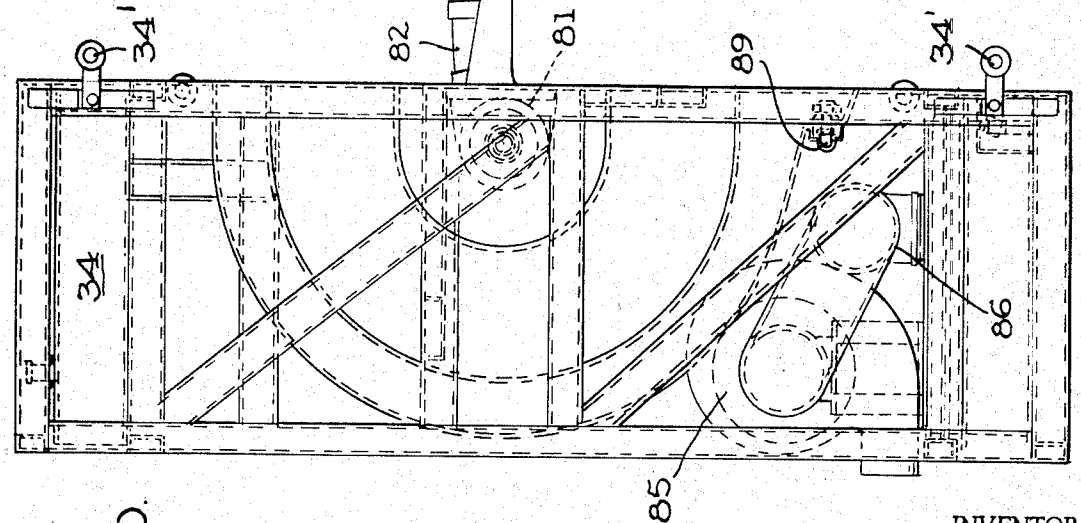

FIG. 10.

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FIG. 7.

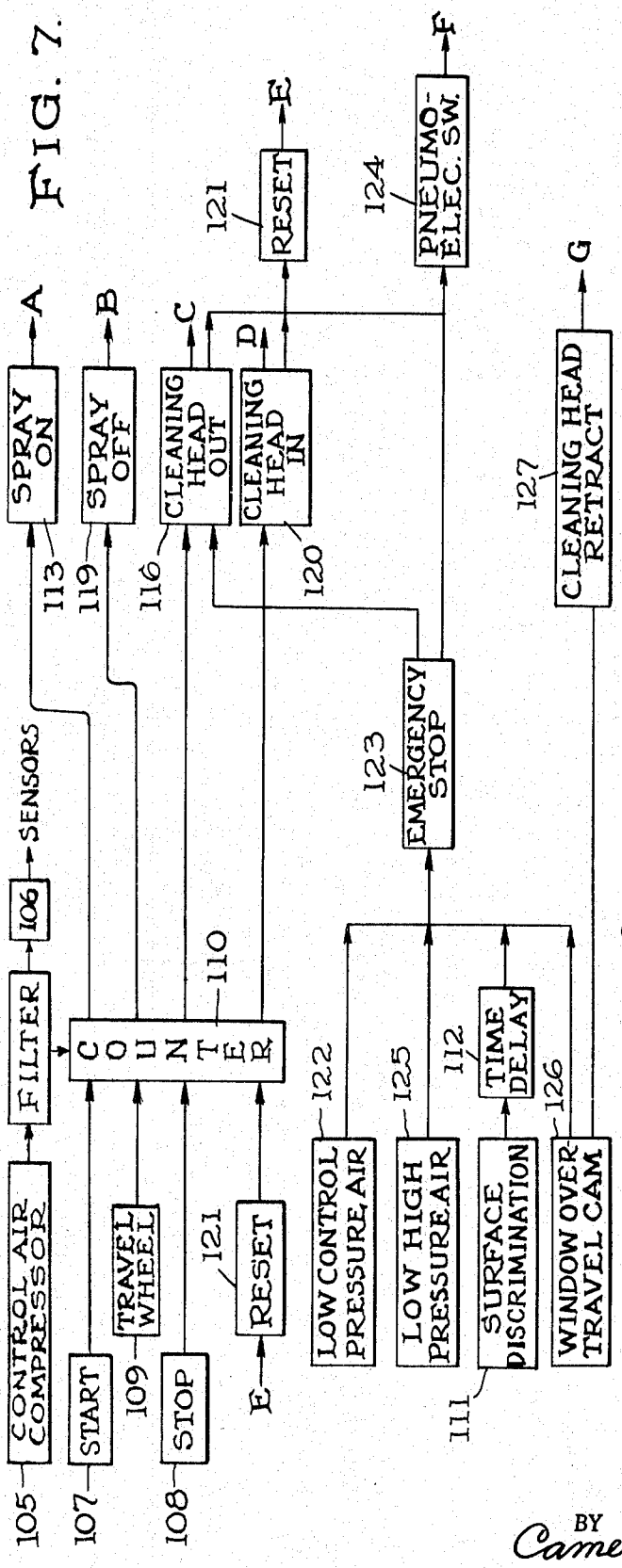

FIG. 8.

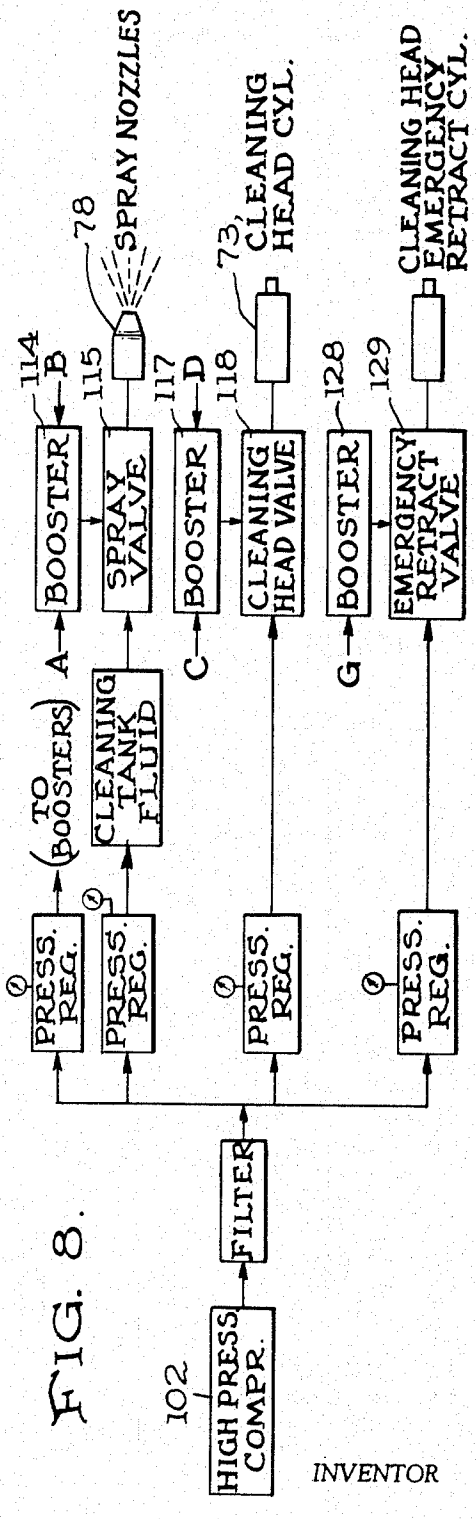

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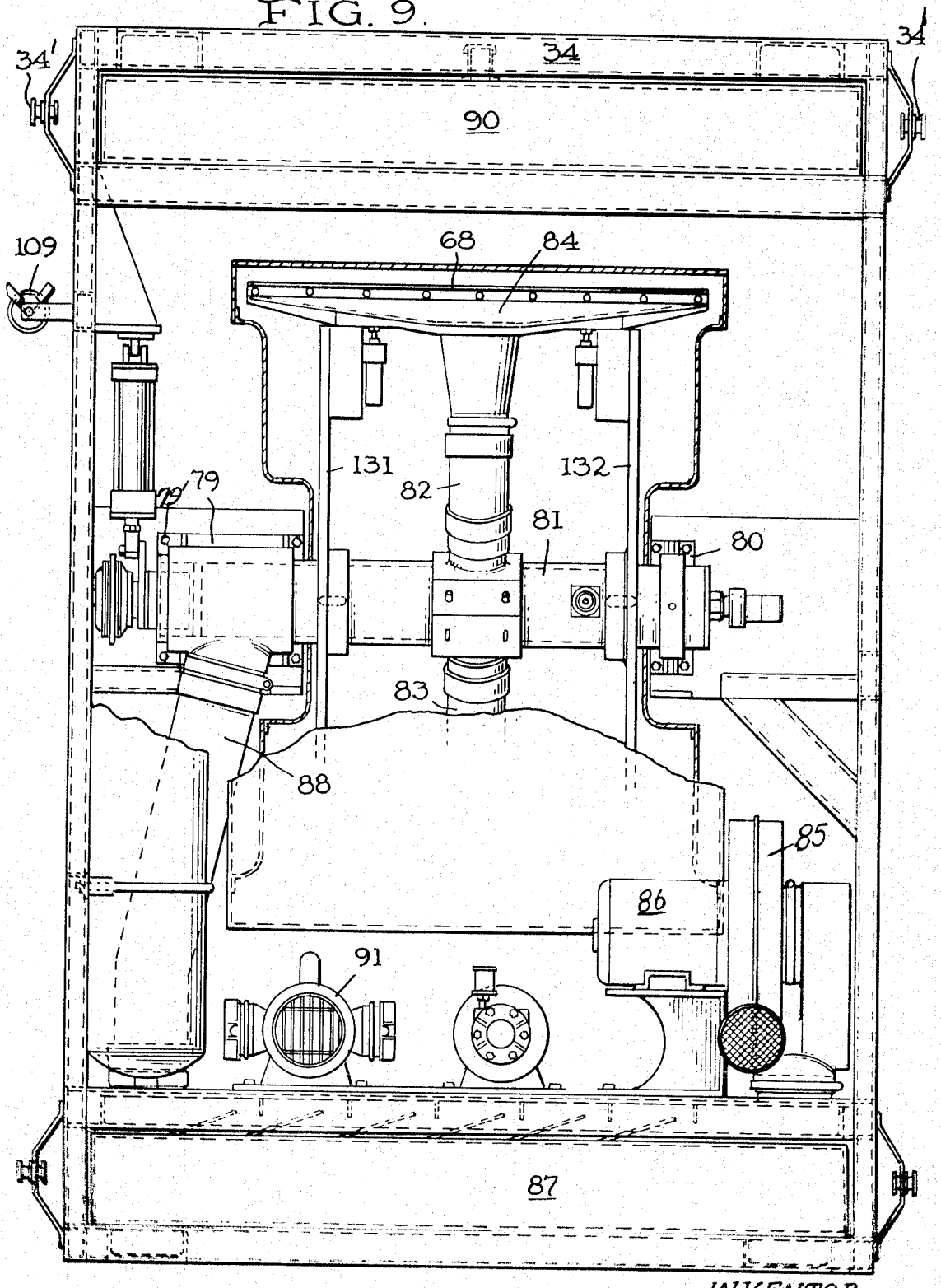
FIG. 9.



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AUTOMATIC WINDOW WASHER

BACKGROUND OF THE INVENTION

Heretofore automatic window washers have been proposed for cleaning the exterior of fixed windows of multistory buildings where the use of window washing personnel on scaffolds was impractical for reasons of height, poor weather or economy. Such a washer is disclosed in U. S. Pat. No. 3,298,052 granted to M. G. Wolfe on Jan. 17, 1967 for Automatic Window Washer and Dryer for Modern Skyscrapers.

In this patent a module suspended from the roof of the building rides in tracks on each side of a vertical column of windows and has a washing brush, a drying roller and a squeegee in washing engagement with a curtain wall and windows. A sensor actuates the squeegee at appropriate time and the brush and roller may be moved into and out of engagement with the windows.

U. S. Pat. No. 3,497,902 also relates to this same subject matter.

Various prior art patents such as U. S. Pat. Nos. 1,691,164; 1,982,345; and 2,293,115 show hand tools for window washing including a squeegee and vacuum means for removing moisture collected by and on the squeegee.

The present invention may be classified as a machine for brushing, scrubbing and general cleaning with suction and with liquid cleaning material application to work and includes a roof unit running on tracks which may support a span frame moving in tracks on the face of the building with a cleaning module mounted for lateral movement in the span frame. The cleaning module contains nozzles for spraying the surfaces to be cleaned with a cleaning fluid supplied from a reservoir in the module or in the span frame; a squeegee moved into and out of engagement with the surface to be cleaned; a vacuum head adjacent the squeegee removing collected residue to a sump in the module; means in the module for pressurizing the cleaning fluid; means in the module for supplying a vacuum to the head; means in the module for moving the squeegee into and out of operative position; and electric, pneumatic and hydraulic systems for sensing and for sequential operation of the cleaning cycle. Motor means are provided for moving the module in the span frame and various electrically actuated safety features are provided in and from the roof unit. The roof unit, the span frame and the module are so arranged that they may be stored as a unit in any suitable storage area on the building roof.

SUMMARY OF THE INVENTION

It is therefore the object of the present invention to provide an automatic window washer controlled from a movable roof unit in which the washing cycle for each window in a vertical series of windows is automatically started and stopped for each window as a cleaning module descends in tracks disposed at the sides of the windows which may include a span frame for the module or modules engaging the tracks when the tracks are spaced by a plurality of columns of windows, the washing cycle for each window first spraying the window with a cleaning solution which is then removed from the window by a squeegee, residue collected by the squeegee being removed by a vacuum to a sump, it being understood that all surfaces of the building including windows may be cleaned by the washer.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the present invention, which may selectively employ two constructions for actuating the squeegee, is shown in the accompanying drawings, in which like reference characters indicate like parts, and in which

FIG. 1 is a side elevation of the roof unit, span frame and cleaning module in position to engage the tracks in the face of the building at the beginning of a cleaning run;

FIG. 2 is a view from the building of the span frame and cleaning module of FIG. 1;

FIG. 3 is a view from above of the span frame and cleaning module of FIG. 1 in window washing position;

FIG. 4 is a side view of the structure of FIG. 3;

FIG. 5 is an enlarged side view of the cleaning module and span frame showing certain of the components of the module;

FIG. 6 is a block diagram of a suitable electric central circuit for the embodiment of FIG. 1;

FIG. 7 is a block diagram of a suitable fluidic control system for the cleaning cycle;

FIG. 8 is a block diagram of a suitable pneumatic control system used in association with the control system of FIG. 7;

FIG. 9 is an elevational view with the housing of the module partly removed of a double rotatable squeegee suitable for use in the present invention for recessed windows; and

FIG. 10 is a side view of the modification of FIG. 9.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1–4, a building **10** has roof **11** supporting spaced tracks **12** for a wheeled roof unit **13** driven along a track **12** by electric motor **14**. Roof unit **13** is of known type and includes a suitably and electrically driven cable drum **15**; a boom arm **16** and a driven screw **17** and nut **18** for raising and lowering the boom through link **19**. Boom **16** has end sheave **20** rotatably mounted thereon over which cable **21** passes to drum **15**. A rack **13'** may be provided on unit **13** to receive and support the cleaning module when not in use.

Parallel links **22** and **23** are pivoted at **24** and **25**, respectively, to upright **26** of roof unit **13** and at their outer ends are pivoted at **27** and **28**, respectively to track extensions **29** for span frame **30**. Track extensions **29** have removable stops **31** at the top thereof and cable **21** passes through guide **32** on span frame **30** and is secured to span frame **30** at compression spring **33**.

Span frame **30** carries cleaning module **34**. One or more such modules may be used. When span frame **30** and module **34** are in the raised position shown in FIG. **1**, stops **31** stop further upward movement of the span frame and track extensions **29** then lift on links **22** and **23** and roof unit **13** may then be moved to the next column of windows and tracks or the entire unit may be supported on rack **13'** and moved to storage as in roof garage **35**.

When the span frame and module are in the position shown in FIG. **1**, drum **15** may be actuated to unwind cable **21** and span frame **30** and module **34** then move downwardly and span frame **30** engages tracks **36** and **37** spaced horizontally by a plurality of columns of win-

dows and extending vertically up the face of the building, shown in these figures as a curtain front building.

Referring now more particularly to FIGS. 2, 3 and 4, span frame 30 has parallel spaced hollow horizontal members 38 and 39 closed at their ends and connected by spaced hollow vertical frame members, the hollow span frame or portion thereof thus formed being ideally suited as a reservoir for the cleaning fluid supplied to module 34 through hose 34''. Tubular extensions 42, 43, 44 and 45 extend inwardly toward the building, respectively, from each corner of the span frame 30 and each ends in a clamp 46. An extension 47 is slidably mounted in each of extensions 42–45 and is held in desired position by clamp 46. Each tube 47 ends in hollow T extension slidably receiving support tube 49 which is adjustably mounted therein by through bolts 50. A wheel frame 51 is clamped at 52 to support tube 49. Frame 51 mounts opposed rollers 53 and 54 oppositely engaging the adjacent track 36 or 37. Span frame 30 is therefore mounted at each of its corners on rollers engaging the tracks on the face of the building with adjustments provided to compensate for various horizontal spacings of the tracks and to provide suitable spacing of the span frame from the face of the building.

A track 55 is secured beneath and extends the length of member 38 and track 56 is secured above and extends the length of member 39. Cleaning module 34 has oppositely disposed and horizontally spaced pairs of rollers 57 and 58 engaging track 55 and has horizontally spaced wheels 59 and 60 engaging track 56 to support module 34 for horizontal movement in span frame 30. An electric motor 61 drives wheel 59 through belt or chain 62 to provide this movement. Thus, cleaning module 34 may be moved in span frame 30 to clean adjacent vertically disposed columns of windows when the span frame spans a plurality of such columns of windows, adjacent windows 63 and 64 being seen in FIG. 3. It is to be understood that any other building surfaces may be cleaned and reference to windows herein is to be construed as including such other surfaces.

Cleaning module 34 has, extending therefrom toward the window, a spray hood 65 and a squeegee assembly 66 including an extensible vacuum duct 67 and a squeegee 68. Squeegee assembly 66 and spray hood 65 with its nozzles may be of desired length to suit the widths of the windows being cleaned. Cleaning hood 66 is readily removable from the unit at clamp nut 66' for replacement with a head of suitable size.

Referring now to FIG. 5, vacuum duct 67 is connected to sump 69 which receives the residue from squeegee 68. Sump 69 has a removable cover 70 and is drained through valve 71. Vacuum is supplied to duct 67 by blower 72 as will be described more fully hereinafter in connection with the several control systems.

The horizontal position of squeegee 68 is adjusted by cylinder 73 and piston 74 and has emergency return piston 76 and cylinder 77. The operation of these cylinders and pistons will be further discussed hereinafter.

A plurality of spaced nozzles 78 are disposed at the bottom of spray hood 65 and extend across module 34 to cover the width of the window with cleaning fluid when actuated. Cleaning fluid is supplied to nozzles 78 under suitable pressure from a reservoir either carried in module 34 or formed by the hollow members of span frame 30 by air pressure supplied by the high pressure compressor 102 to be described hereinafter. In the structure discussed above, squeegee 68 is capable of limited adjusting movements necessary for the cleaning of windows of a curtain wall building.

When recessed windows are to be cleaned a rotary squeegee has been found to be more efficient as constructed and as shown in FIGS. 9 and 10. In these figures module 34 supports bearings 79' and 80 mounting hollow shaft 81 for rotation. Two identical parallel support arms 131 and 132 support squeegee heads 84 at the outer ends thereof and heads 84 carry squeegees 68 as in the first embodiment, squeegees 68 may be removable for insertion of squeegees of desired length. Vacuum is supplied to heads 84 beneath squeegees 68 through extensible ducts 82 and 83 by blower 85 driven by motor 86 and connected to sump 87 for the used residue. Sump 87 is connected by pipe 88 through rotary joint 79 to hollow shaft 81 and thus to heads 84.

Shaft 81 is suitably rotated in counter-clockwise direction as seen in FIG. 10 when the presence of a window is sensed by the control system and squeegee 68 engages the upper edge of the window beneath the overhang and travels downwardly over the window with the downward movement of the module removing the residue from the windows. Cleaning fluid supplied by nozzles 89 is supplied from tank 90 by air pressure supplied by high pressure compressor 91. When squeegee 68 reaches the lower edge of the window the control system causes rotation of shaft 81 through 90° in counter-clockwise direction lifting the squeegee off the window and bringing the opposed squeegee assembly into position for subsequent 90° rotation into cleaning position for the next lower window. Module 34 of FIGS. 9 and 10 need not be mounted in a span frame and may have suitable means 34' to engage tracks 36 and 37.

As noted above, the automatic operation of the components of module 34 for window cleaning is controlled by three systems, electric, fluidic and pneumatic. The control of the electric system is from the roof unit 13 through suitable electric cables, which may be incorporated in cable 21, to the module to energize the various motors and circuitry there as indicated in FIG. 6. Low pressure air from a compressor in the module energizes the fluidic control system of FIG. 7 for sensing the position of the module and then sequentially operating valves in the pneumatic control system of FIG. 8 for energizing in proper sequence the cleaning components in the module.

Referring now to FIG. 6, the electrical control system is energized through the roof unit master key switch 92 which provides electric current to automatic or manual switch 93, usually set in position for automatic operation. The cleaning cycle is then started by moving a rotary switch 94 to ready position until the module circuit breaker 95 holds. Safety circuit 96 controls the holding of circuit breaker 95. When all conditions imposed by circuit 96 are met such as no overload; proper air pressures; satisfactory vacuum; clean fluid in spray system; and the remaining conditions 1–6 identified by the schematic of circuit 96, rotary switch 94 is moved to down position and the window cleaning

cycle is started. Conventional up and down limit switches **97** and **98** associated with cable **21** limit the travel of module **34** in each direction and a control **99** is provided for any portion of the building facade not to be cleaned, here assumed to be the **16th** floor where louvres and panels are present. A safety switch is provided in the roof unit circuitry to stop operations in the event of slack in cables **21**. An overload switch may be mounted in conjunction with compression springs **33**. In the event of overload during upward travel the springs compress abnormally activating the overload switch.

When circuit breaker **95** is energized, current is supplied to motors **101** or **86** powering blowers **72** or **85**, respectively, to provide vacuum to squeegee head **66** or **84** through duct **67** or **82**, driving a high pressure air compressor **101** or **91** in the module supplying the pneumatic system of FIG. **8**. Electric current is also supplied to transformer **103** and reduced voltage is then supplied through circuit breaker **104** to compressor and motor **105** supplying low pressure air to the fluidic control system of FIG. **7**. Current from transformer **103** is also used for driving motor **61** for indexing module **34** in span frame **30** and to actuate solenoid valve **106** which controls the fluidic signal from the start sensor **107**.

There are numerous ways to sense when and/or where cleaning operations are to be started and stopped. In one system involving the curtain wall module and span frame, the start sensor **107** of FIG. **7** is of the opposed jet type and is located on the lower wheel frame **51** and on the same side as the similar stop sensor **108** is located on the upper wheel frame **51**.

The start and stop sensors **107** and **108** of FIG. **2** are of the opposed jet type and are located on the wheel frame of span frame. **30**. A counting or travel wheel **109** is driven over the face of the building as the module descends and actuates counter **110** to which start and stop sensors **107** and **108** are connected. Compressor **105** is connected to and supplies low pressure air to counter **110** and the other fluidic components. Wheel **109** measures movement in one-quarter inch or other desired intervals and furnishes impulses to counter **110** for start sequence counter, stop sequence counter and emergency reset. As the cleaning mechanism starts its operation, start sensor **107** will determine the beginning of a window and will indicate when the cleaning operation is to start, as by sensing a mullion slot, by sending an impulse to the start sequence of counter **110**. Counting wheel **109** is also providing specific counts to sequence counter **110** but before cleaning can start surface discriminator **111** must also provide an impulse through a suitable delay **112** to prevent operation from false indications such as a crack in the building face. Discriminator **111** is an air operated fluidic ear type sensor located beneath the spray nozzles **78** to sense a continuous smooth surface such as a window. If the sensor indicates no window then counter **110** automatically resets or will not start counting.

When a window is present, counter **110** then provides a signal properly setting the **113/119** flip-flop circuit to furnish low pressure air through line A to pressure booster **114** in the pneumatic control system of FIG. **8** to open valve **115** and to supply cleaning fluid under pressure to nozzle **78**. Nozzles **78** then cover the window with cleaning fluid as the module **34** descends.

Counter **110** continues to count and at preset time supplies a signal to properly set **116/120** flip-flop circuit to furnish low pressure air through line C and booster **117** (FIG. **8**) opens cleaning head valve and energizes cylinder **73** to move squeegee **68** into window cleaning and engaging position just beneath the upper window seal, vacuum in head **67** removing residue collected by the squeegee.

Counter **110** stops counting and cleaning continues. When stop sensor **108** detects the starting mullion slot counting again begins and at a preset time provides a signal to reset the **113/119** flip-flop circuit thereby withdrawing the signal to spray booster **114** allowing the spring-loaded valve **115** to close stopping the spray. Also at a later preset time the counter provides a signal to reset the **116/120** flip-flop circuit thereby stopping the low pressure air to the cleaning head booster **117** allowing the spring-loaded valve **118** to return to its off position which furnishes high pressure air to the opposite side of piston **74** in cylinder **73** which retracts the cleaning head **66**. Resetting of the **116/120** flip-flop circuit automatically activates the reset circuit **121** which resets the counter **110** for cleaning of the next window.

All boosters are provided with high pressure air from compressor **102** as shown at left center of FIG. **8**.

If, during a window washing cycle, the low pressure air for the fluidic control system fails, low pressure responsive device of safety circuit **96** energizes emergency stop **123** and outward movement of cleaning head **66** is stopped. Pneumatic electric switch **124** is also actuated and through suitable electric cables either separate or incorporated in cables **21**, line **15** opens circuit breaker **95**. If the high pressure air for the pneumatic control system fails this failure is determined by pressure responsive device **125** which acts through emergency stop **123** to prevent outward movement of the cleaning head and through switch **124** to open circuit breaker **95**.

A lever or cam actuated window over travel valve **126** may also be provided in case cleaning head **66** is not withdrawn at appropriate time from the window. Valve **126** then supplies low pressure air to valve **127** and through line G and booster **128** (FIG. **8**) to emergency retract valve **129** which actuates cleaning head emergency retract cylinder **77** to retract cleaning head **66**.

Suitable pressure regulators and air filters may be provided in the systems of FIGS. **7** and **8** as required.

The components per se of the systems of FIGS. **6–8** are standard items known to the art but the inter-relationship of the electric, fluidic and pneumatic control systems for accurate and automatic cleaning of windows in vertical sequence is critical to and novel in the present invention.

What I claim is:

1. An automatic window washer for buildings having a mobile supporting unit on the roof of the building, at least one cleaning module, nozzles in said module for spraying cleaning fluid on the windows, means in said module for supplying cleaning fluid under pressure to said nozzles, a squeegee in said module above said nozzles, means in said module for moving said squeegee

into and out of engagement with a window being cleaned, vacuum means in said module cooperating with said squeegee for removing residue therefrom, means in said module for supplying high pressure air, means in said module for supplying low pressure air, a span frame, means for moving said module laterally in said span frame, means on said span frame engaging vertical tracks on the building disposed adjacent the windows to be washed, resilient non-extensible means extending from said span frame to the roof unit for positioning said module adjacent a window to be washed, electric control means energized from the roof unit for energizing said means for supplying cleaning fluid, said vacuum means, said means for moving said module laterally in said span frame and for energizing said means for supplying high and low pressure air, fluidic control means mounted in said module energized by said means for supplying low pressure air, a start fluidic sensor for said fluidic control means sensing the top of a window to be cleaned, a stop fluidic sensor for said fluidic control means sensing the bottom of a cleaned window, pneumatic control means energized by said means for supplying high pressure air sequentially actuated by said fluid control means for first connecting said means for supplying cleaning fluid to said nozzles and then for actuating said means for moving said squeegee, said start sensor starting window cleaning and said stop sensor stopping window cleaning.

2. An automatic window washer as described in claim 1, said fluidic control means including a counter having a start position connected to said means for supplying low pressure air, said start sensor starting said counter and connecting said means for supplying cleaning fluid to said nozzles, said counter after a predetermined interval actuating said pneumatic control means and moving said squeegee into engagement with a window.

3. An automatic window washer as described in claim 2, said counter actuated by said stop sensor after a predetermined interval disconnecting said means for supplying cleaning fluid to said nozzles and thereafter after a predetermined interval said stop sensor actuating said pneumatic control means and moving said squeegee out of engagement with the window.

4. An automatic window washer as described in claim 3, including means for resetting said counter to its start position at the end of each window cleaning cycle.

5. An automatic window washer as described in claim 2, said counter including a wheel travelling on the face of the building and actuating said counter a predetermined linear distances on the face of the building.

6. An automatic window washer as described in claim 2, said fluidic control means including a surface discriminator and a delay associated therewith, said surface discriminator preventing actuation of said fluidic control means should said start sensor erroneously start said counter.

7. An automatic window washer as described in claim 2, said fluidic control means including a cam actuated window over travel valve actuating said means for moving said squeegee out of window engagement when said squeegee at appropriate time is not otherwise moved out of window engagement.

8. An automatic window washer as described in claim 1, including a reservoir for cleaning fluid and a reservoir for compressed air in said span frame.

9. An automatic window washer as described in claim 1, including parallel links pivoted on and extending from the roof unit and spaced parallel track extensions pivotally mounted on said links away from the roof unit, said track extensions forming extensions of the vertical tracks on the building and receiving said span frame and said module when said span frame is raised above the tracks on the building.

10. An automatic window washer as described in claim 1, said start fluidic sensor and said stop fluidic sensor being mounted on said span frame.

11. An automatic window washer as described in claim 1, said electric control means including overload responsive means inactivating said electric control means upon overload of said resilient non-extensible means.

12. An automatic window cleaner for buildings having a mobile supporting unit on the roof of the building, at least one cleaning module, at least one means in said cleaning module for window cleaning, an open rectangular span frame, said module being capable of lateral movement in the opening of said span frame, means on said span frame engaging vertical tracks on the building disposed adjacent the windows to be cleaned, resilient non-extensible means extending from said span frame to the roof unit for positioning said span frame adjacent to at least one window to be cleaned and means for energizing said window cleaning means.

13. An automatic window cleaner for buildings having a mobile supporting unit on the roof of the building, at least one cleaning module, means in said cleaning module for window cleaning, an open rectangular span frame, said module being mounted in the opening of said span frame, means on said span frame engaging vertical tracks on the building disposed adjacent the windows to be cleaned, resilient non-extensible means extending from said span frame to the roof unit for positioning said span frame adjacent to at least one window to be cleaned and means energized from the roof unit for energizing said window cleaning means.

14. An automatic window cleaner for buildings having a mobile supporting unit on the roof of the building, at least one cleaning module, at least one means in said cleaning module for window cleaning, an open rectangular span frame, means for moving said module laterally in the opening of said span frame, means on said span frame engaging vertical tracks on the building disposed adjacent to the windows to be washed, resilient non-extensible means extending from said span frame to the roof unit for positioning said span frame and said module adjacent to at least one window to be cleaned and means for energizing said window cleaning means and said means for moving said module laterally in said span frame.

15. An automatic window cleaner as described in claim 14, said means for energizing said window cleaning means and said means for moving said module laterally in said span frame being mounted in said roof unit.

16. An automatic window cleaner as described in claim 12, said means on said span frame engaging vertical tracks on the building including at least one corner of said span frame an adjustable support and guiding

means on said support positively engaging the adjacent vertical track on the building.

17. An automatic window cleaner as described in claim 12, said span frame including spaced hollow horizontal members and spaced hollow vertical members connecting said horizontal members.

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