March 3, 1970 J. HARTIGAN 3,497,902

BUILDING CLEANING APPARATUS

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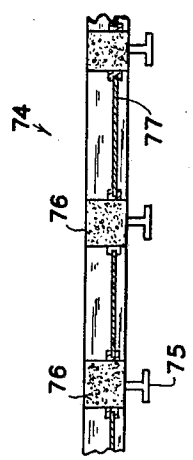

Fig. 2

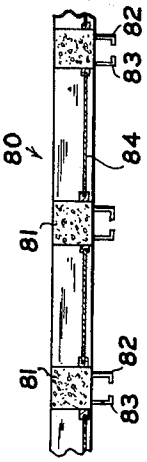

Fig. 3

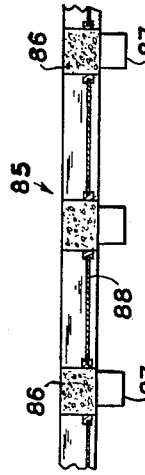

Fig. 4

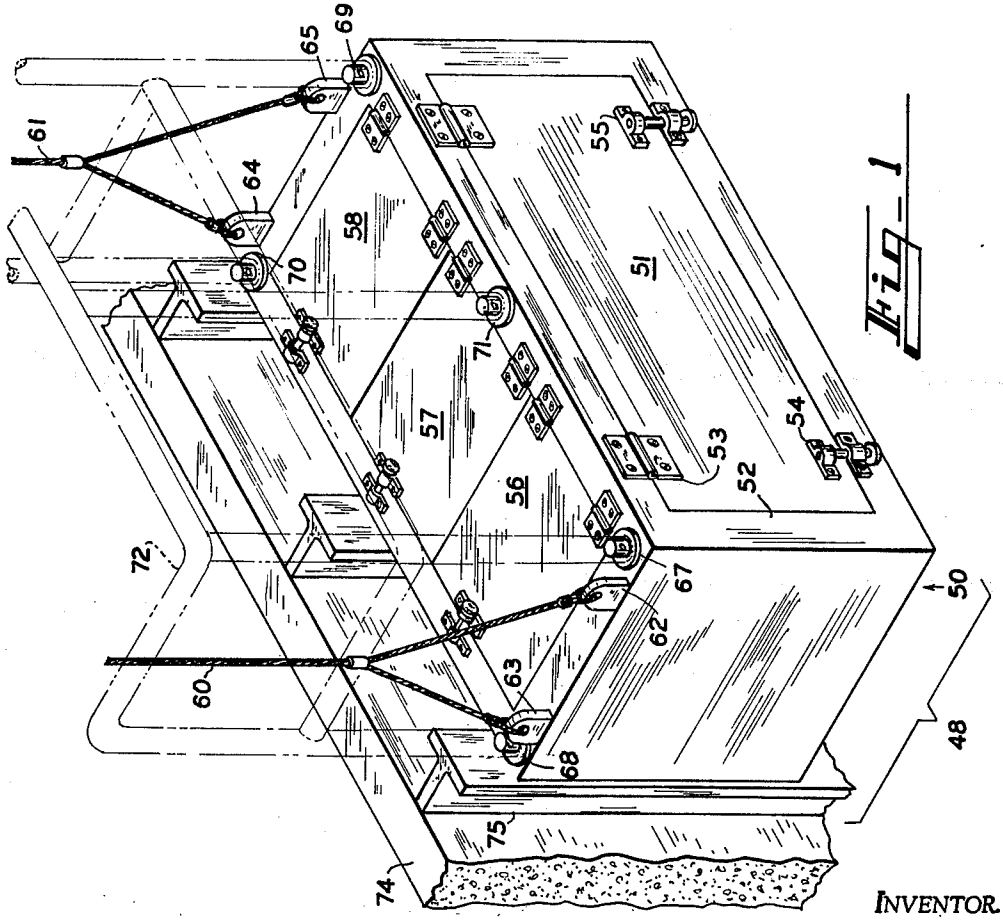

Fig. 1

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BUILDING CLEANING APPARATUS

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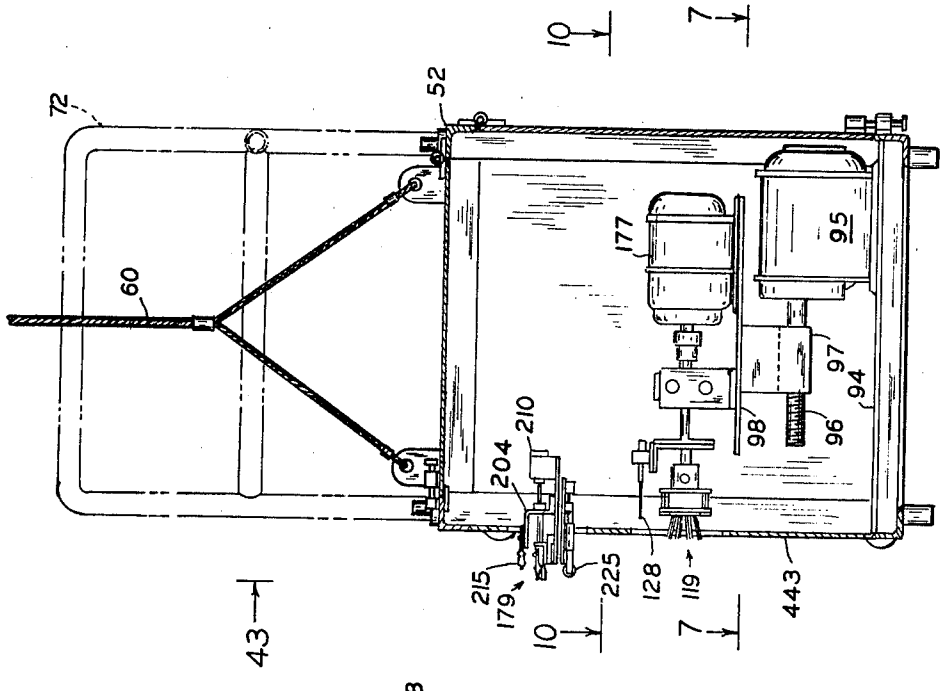

Fig. 6

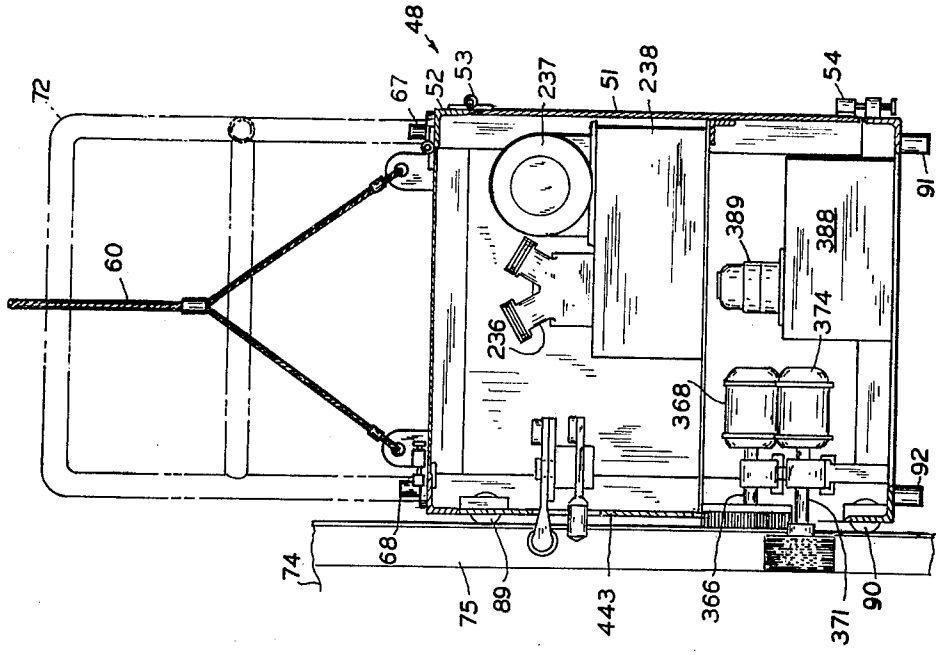

Fig. 5

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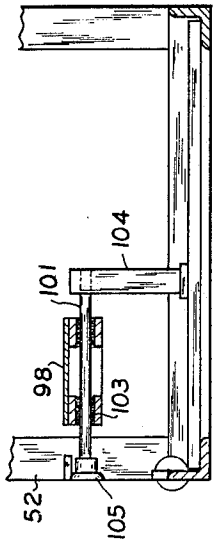

Fig. 9

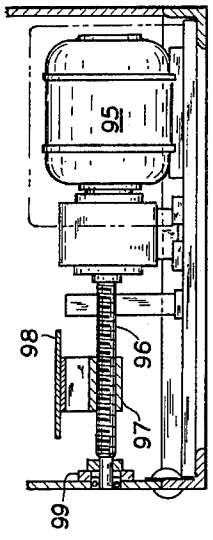

Fig. 8

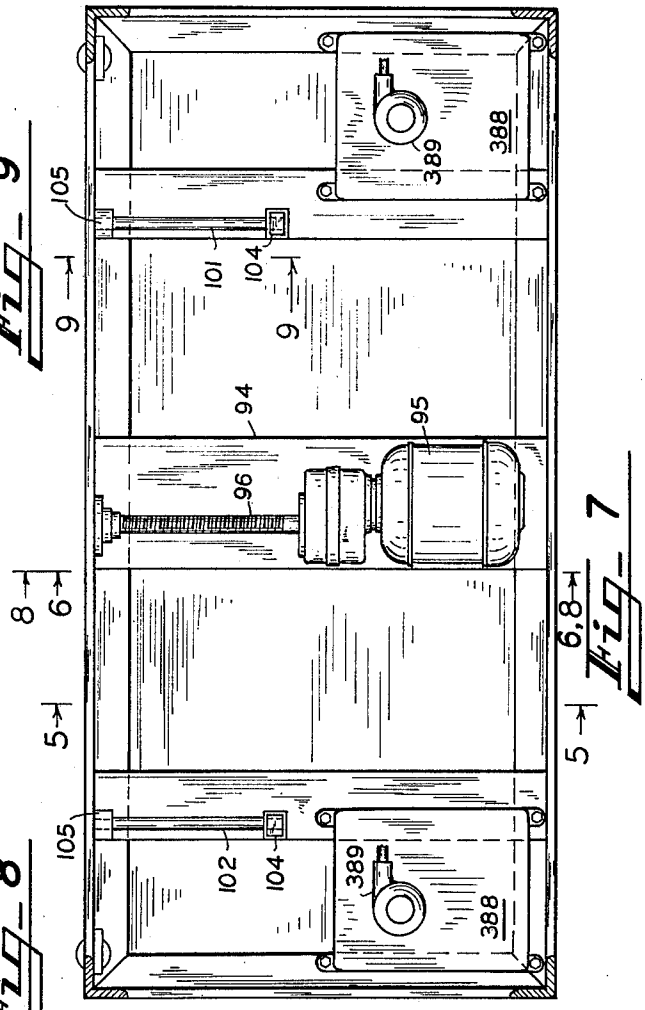

Fig. 7

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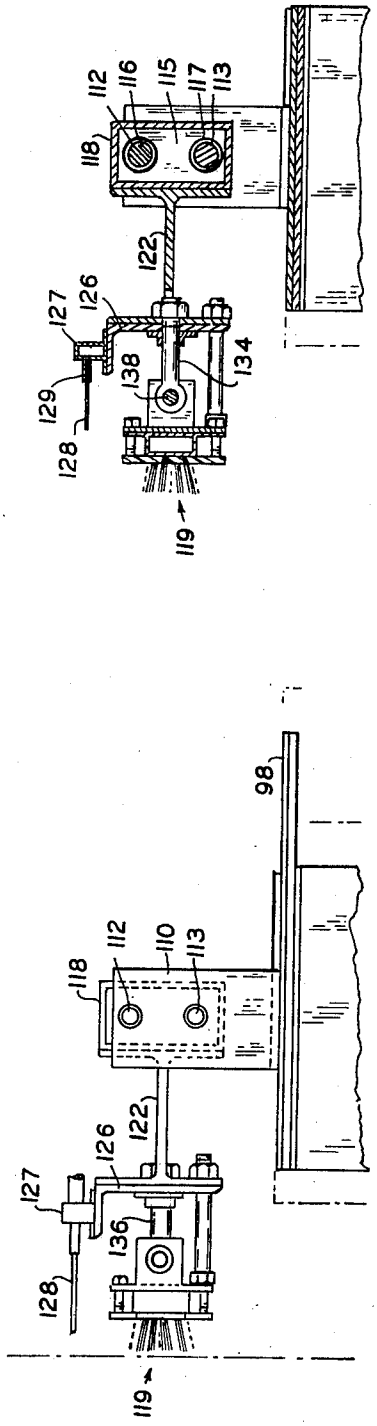

Fig-12

Fig-11

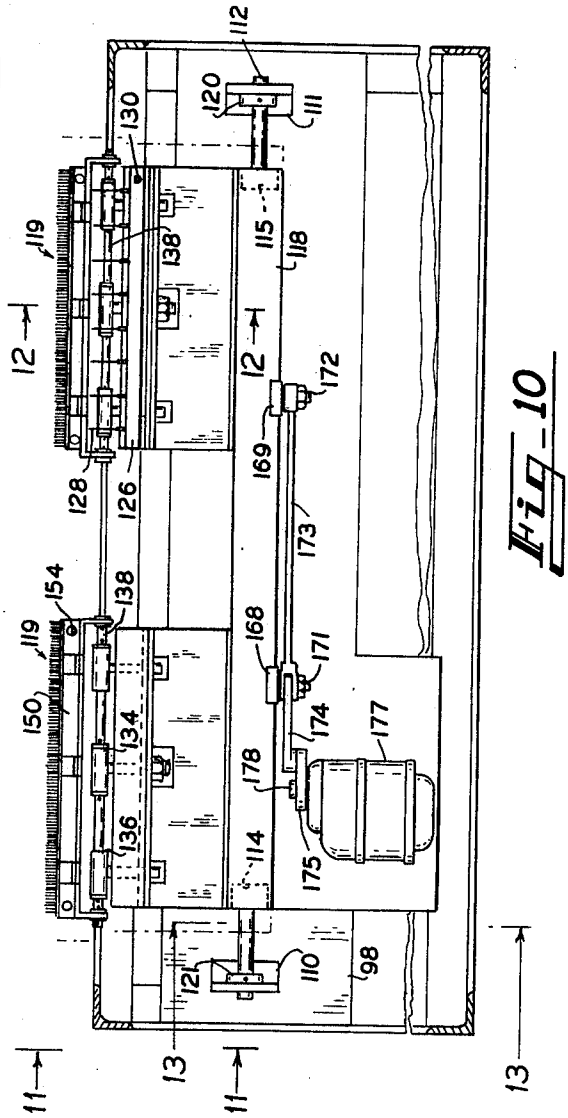

Fig-10

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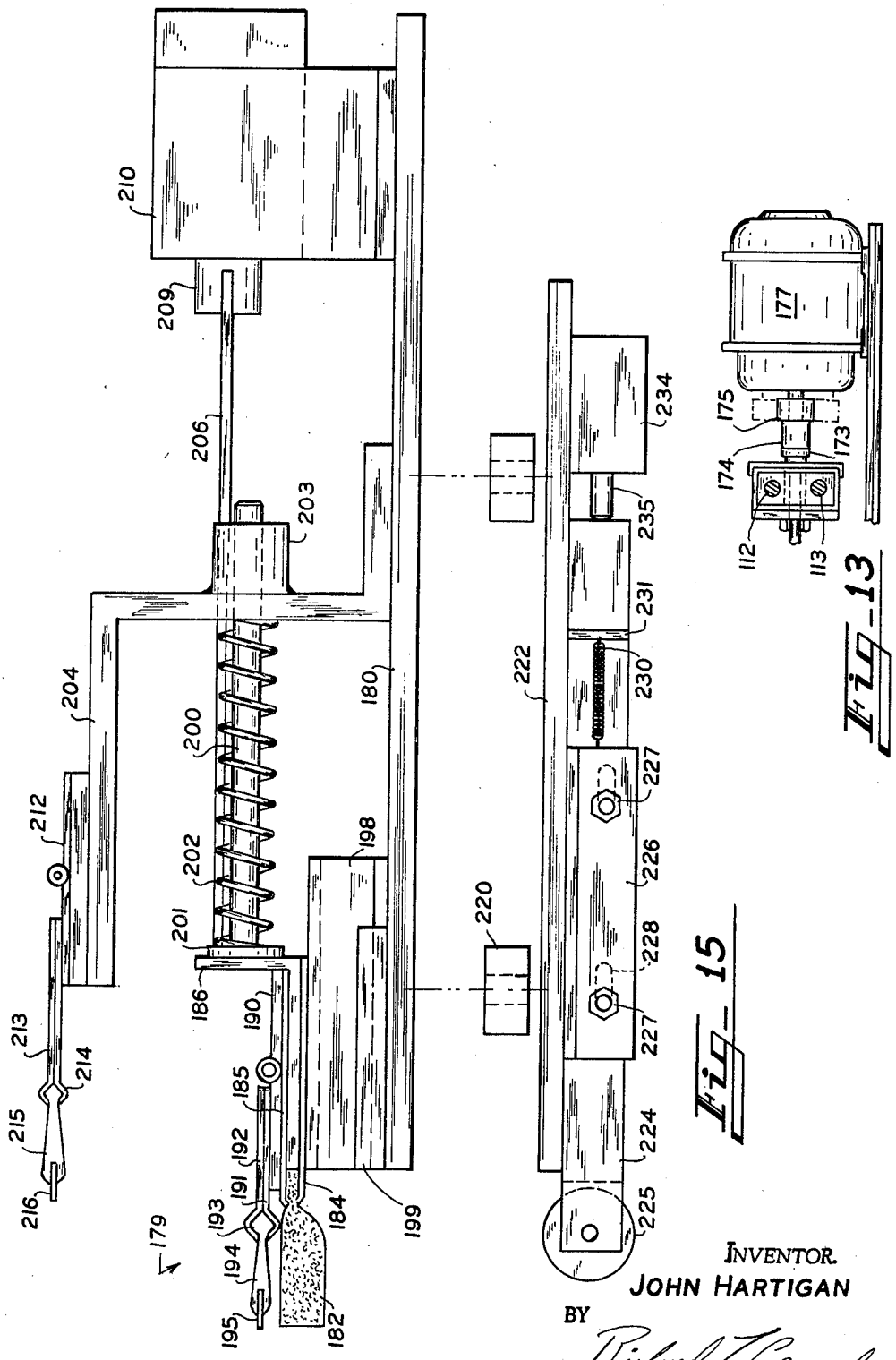

Fig-13

Fig-15

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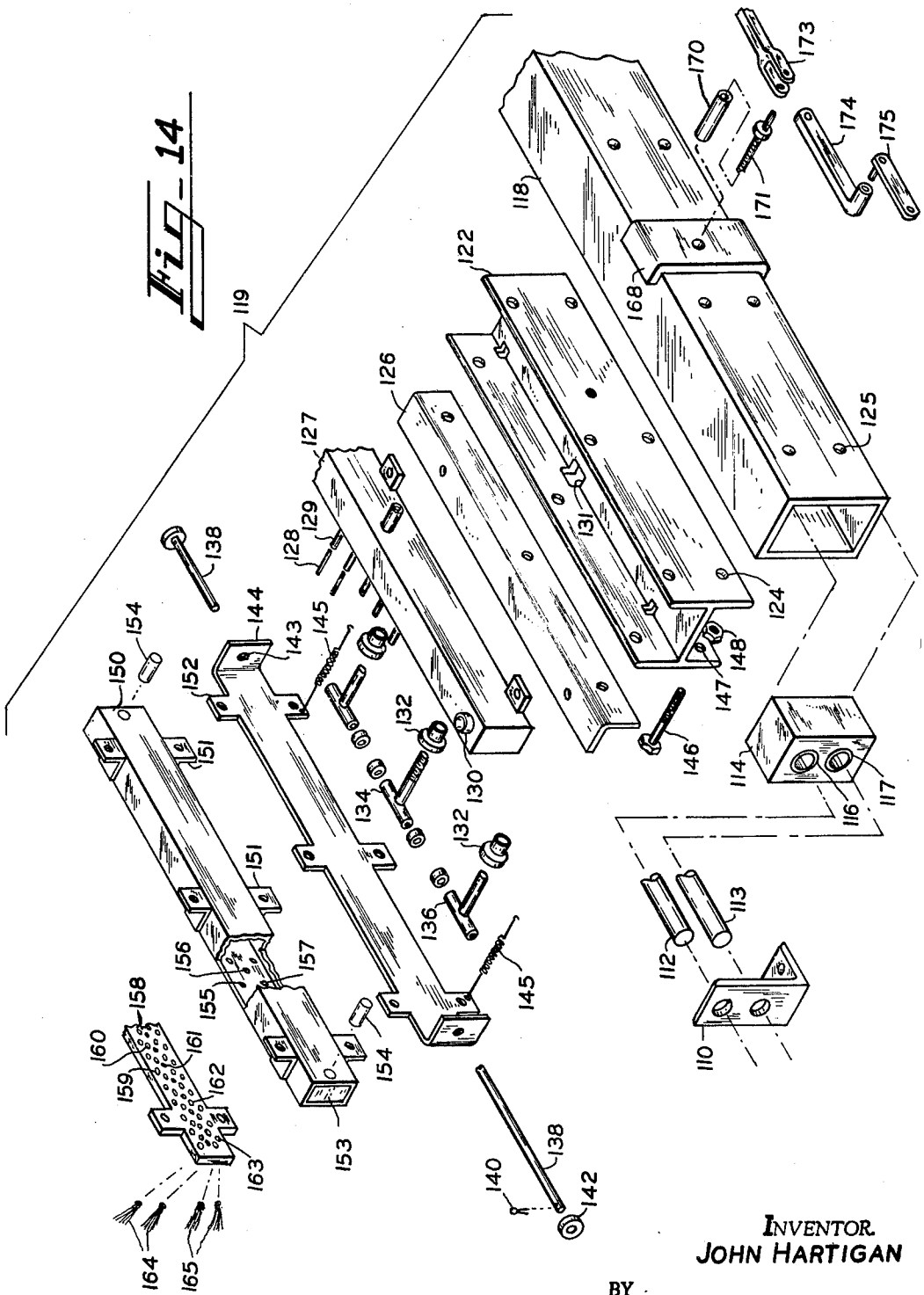
Fig. 14



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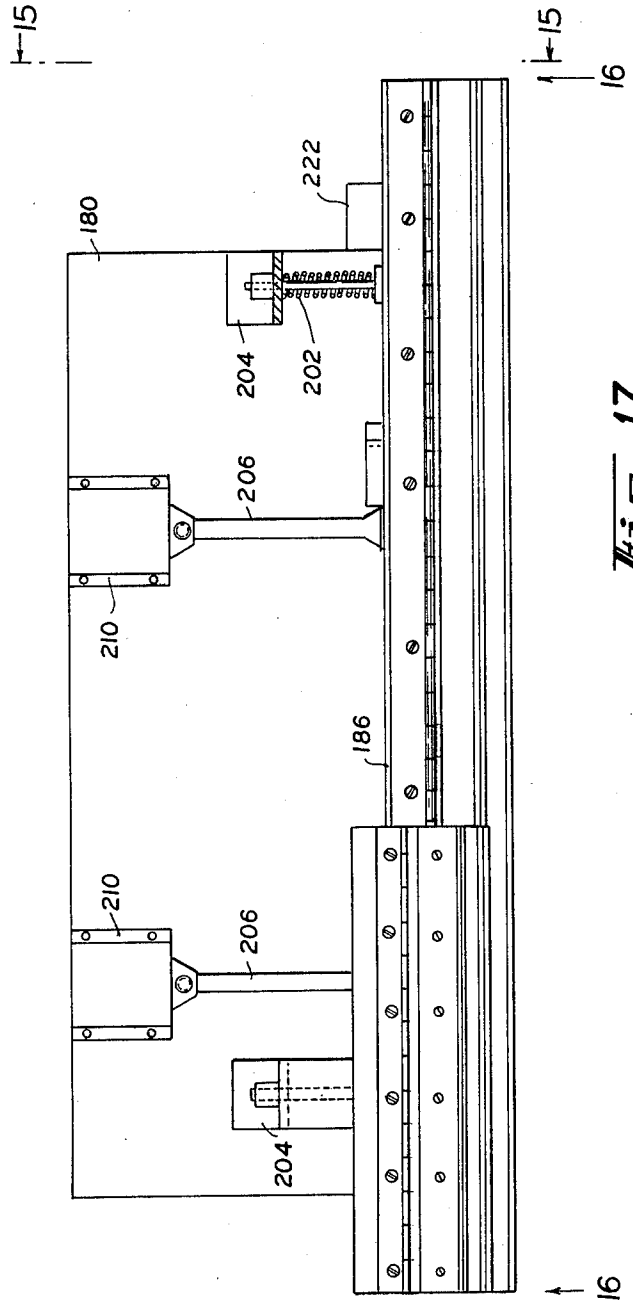

Fig. 17

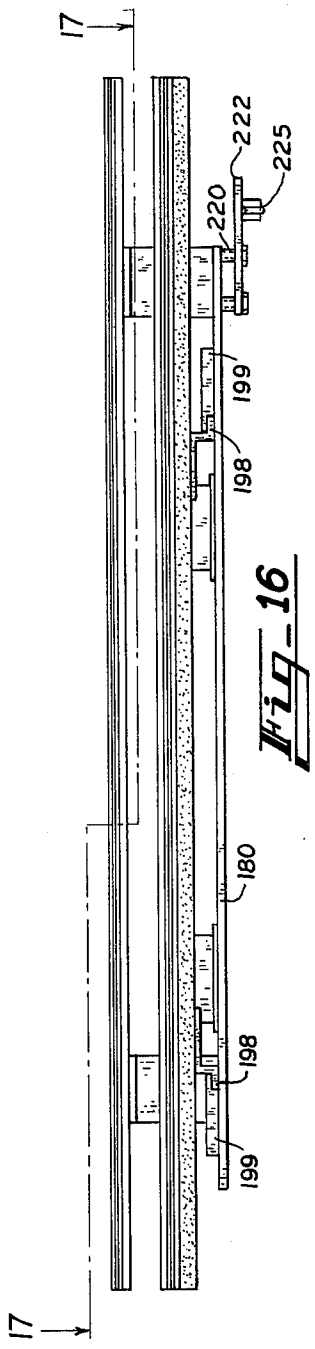

Fig. 16

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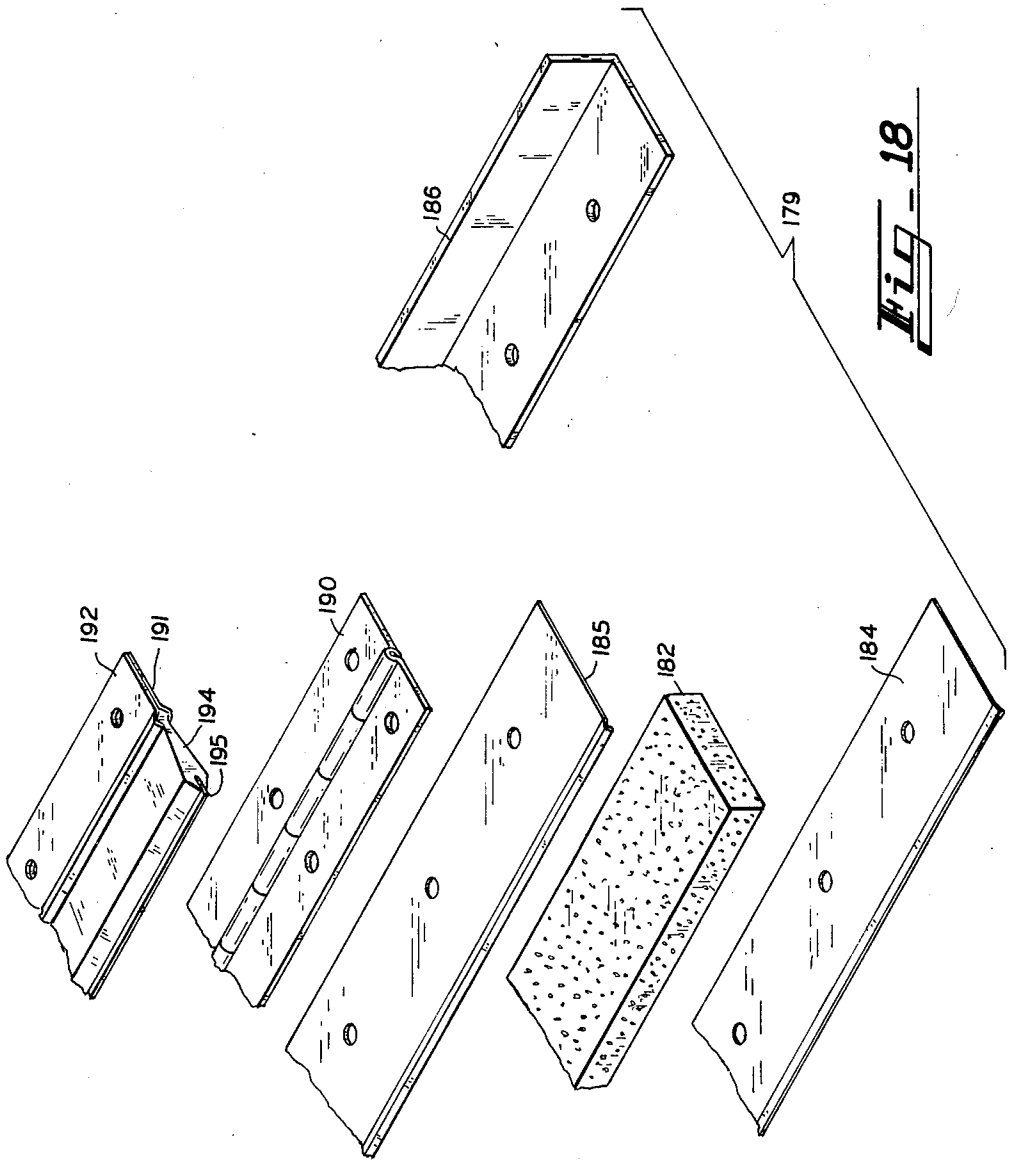

Fig - 18

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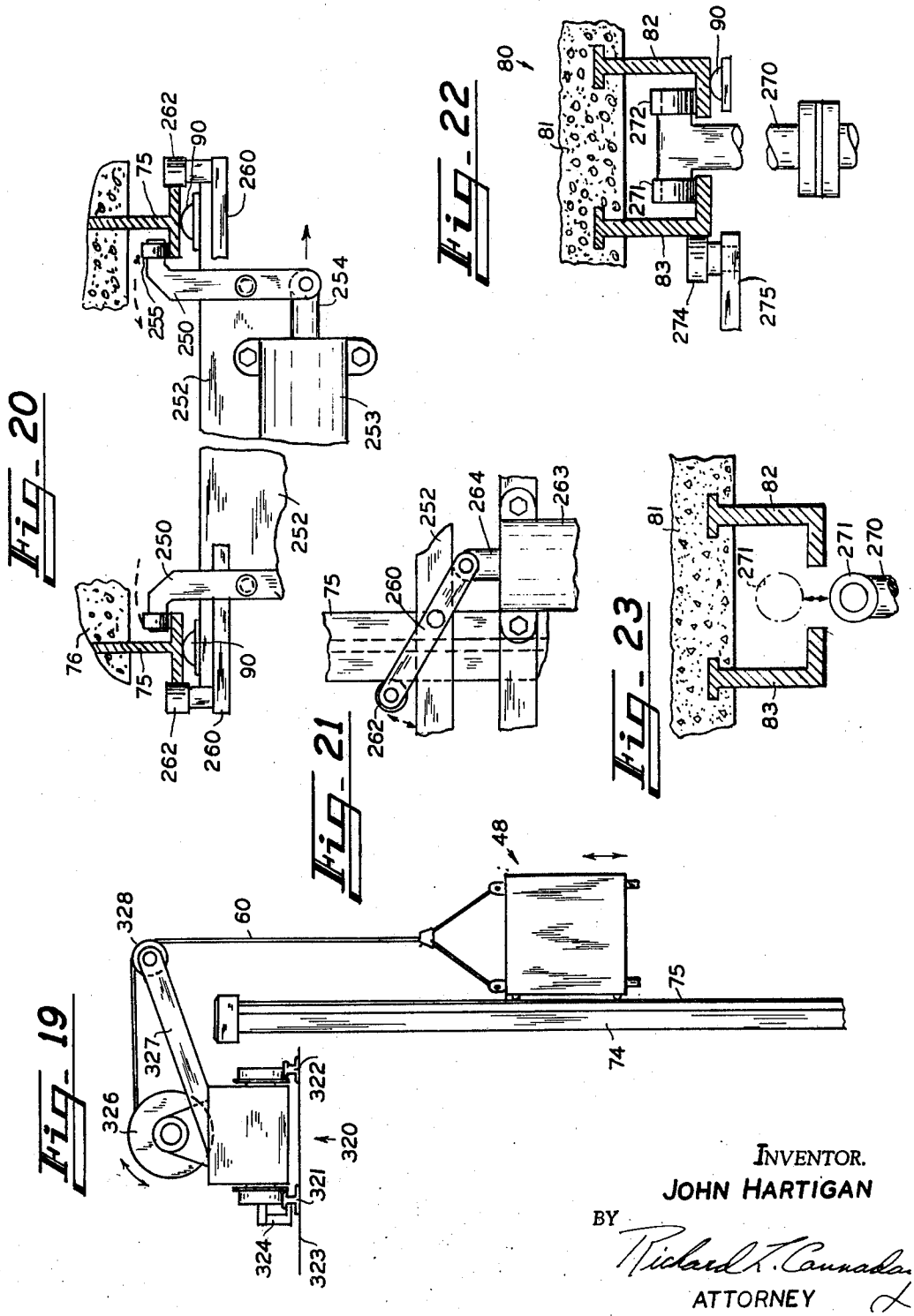

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BUILDING CLEANING APPARATUS

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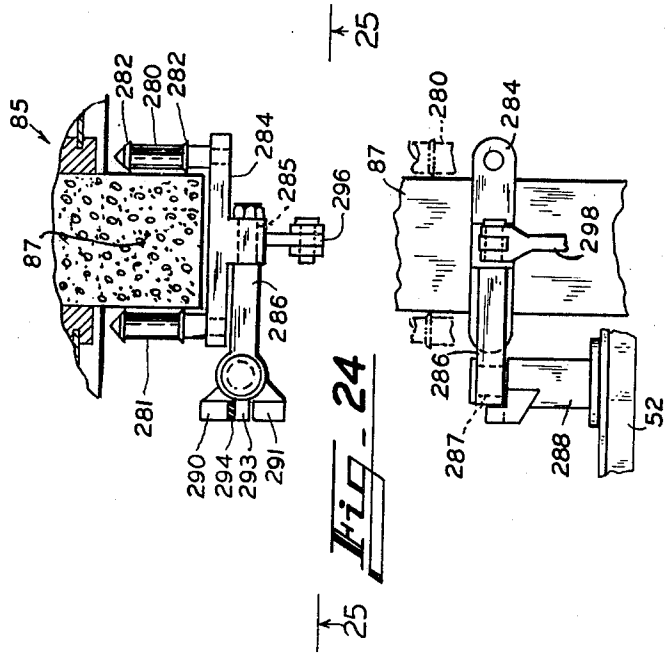

Fig - 24

Fig - 25

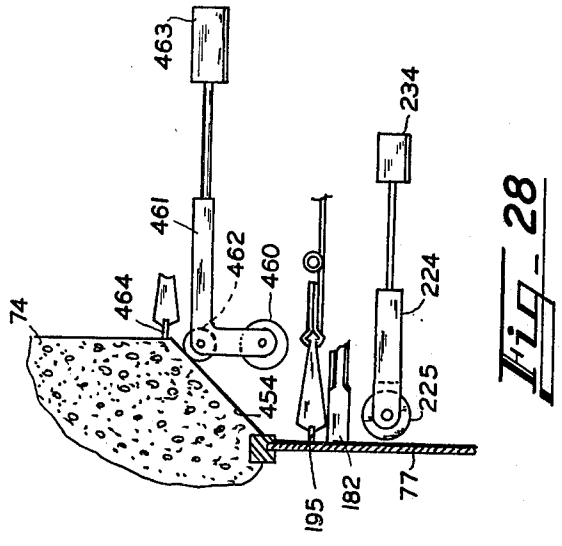

Fig - 28

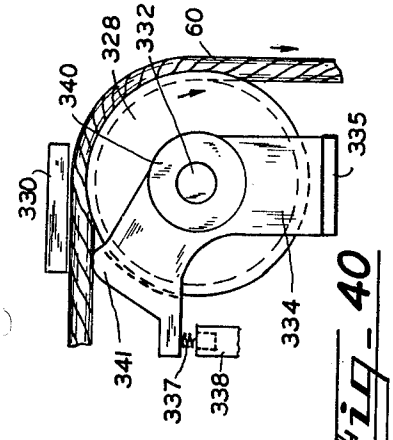

Fig - 40

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BUILDING CLEANING APPARATUS

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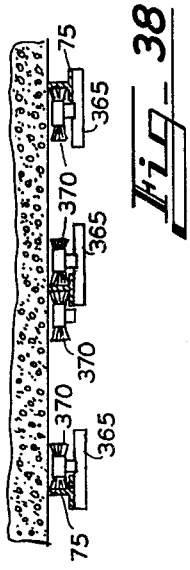

Fig. 38

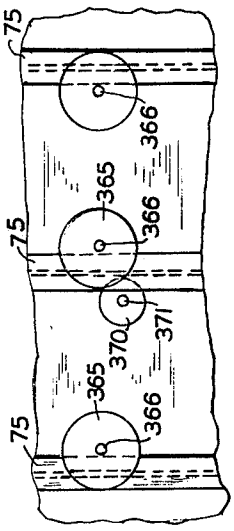

Fig. 39

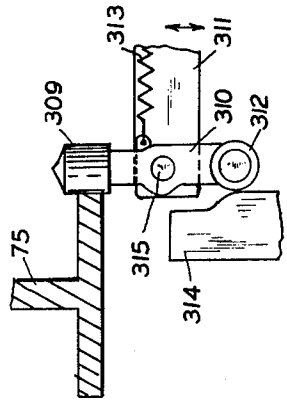

Fig. 27

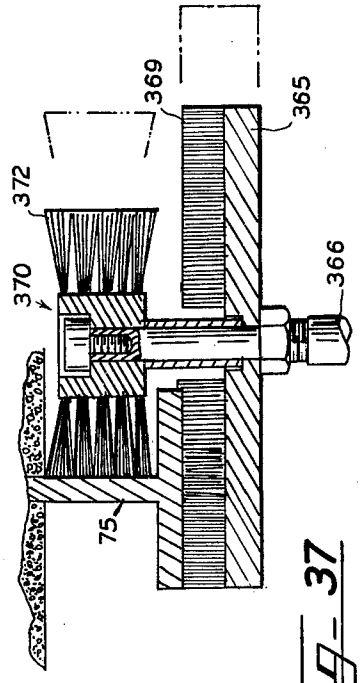

Fig. 37

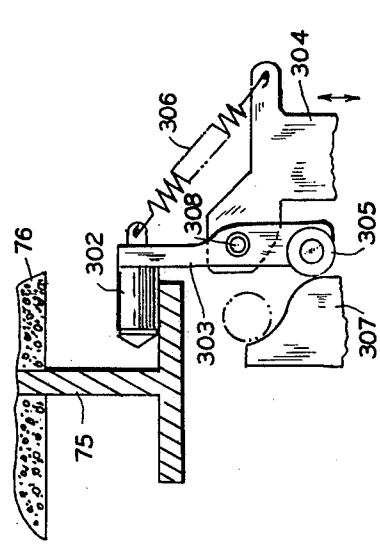

Fig. 26

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BUILDING CLEANING APPARATUS

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Fig_32

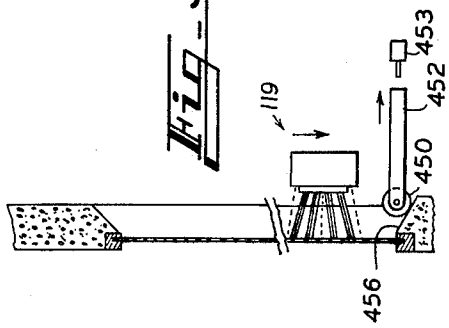


Fig_31

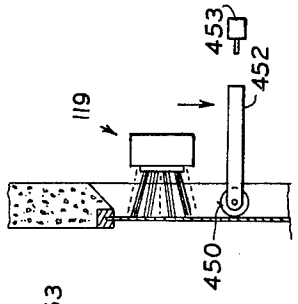


Fig_30

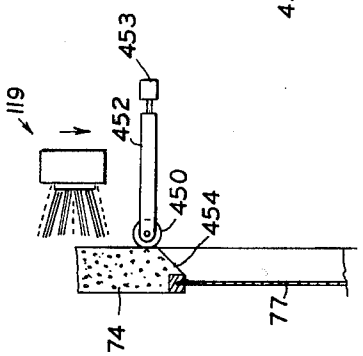


Fig_29

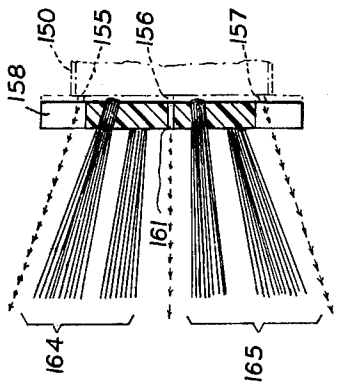


Fig_36

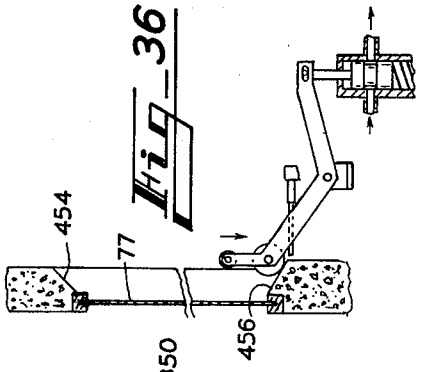


Fig_35

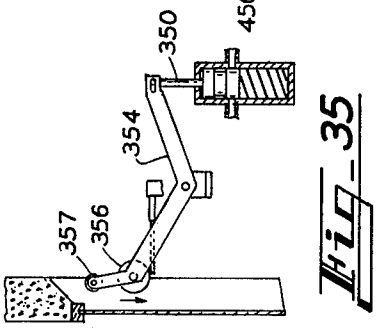


Fig_34

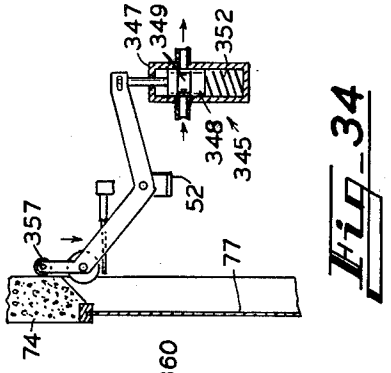
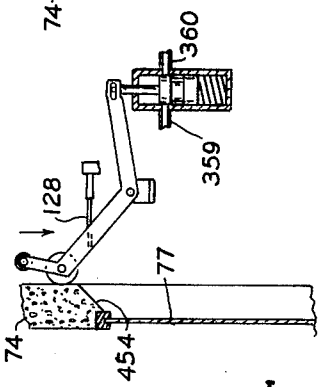


Fig_33



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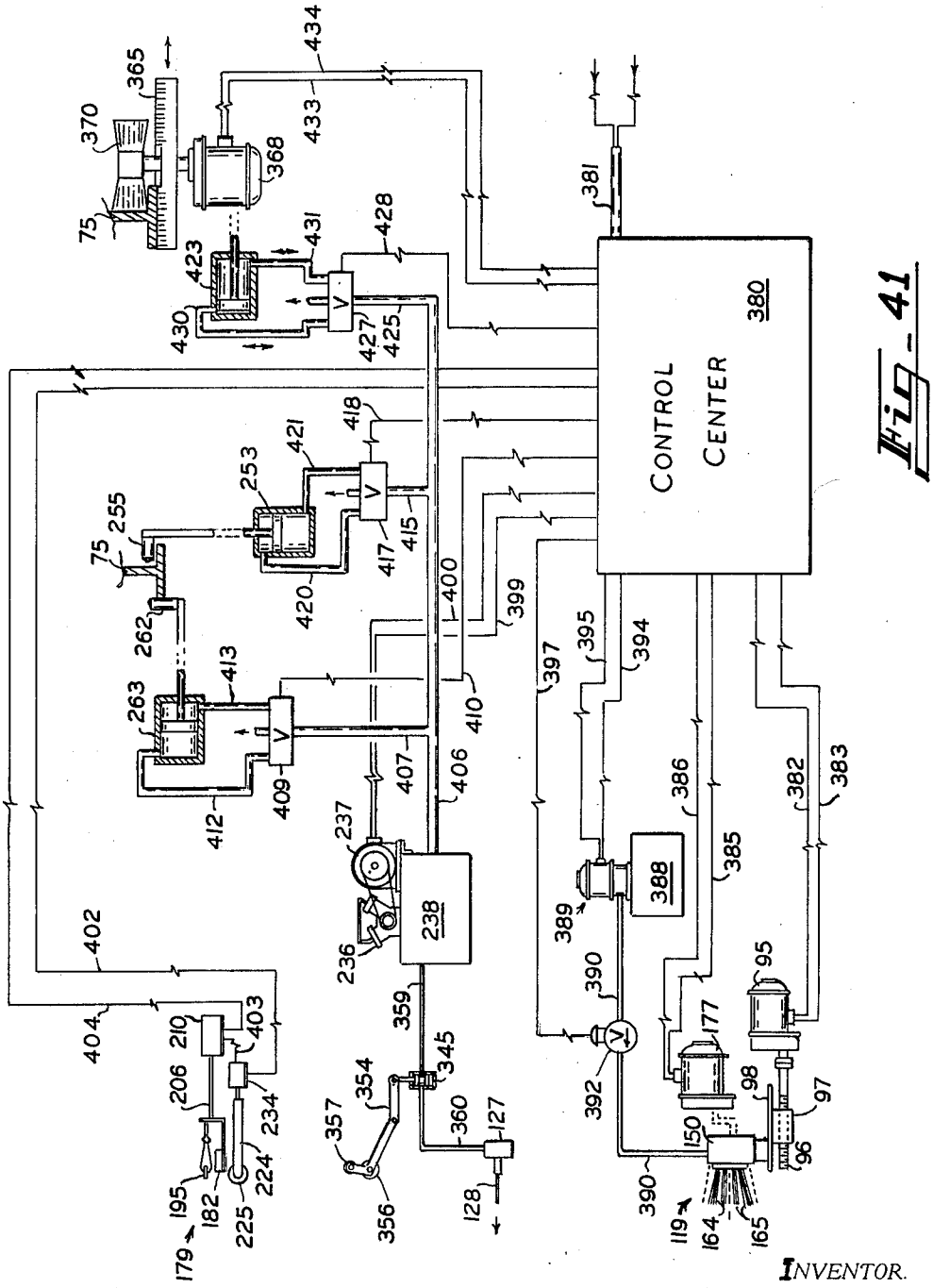

Fig - 41

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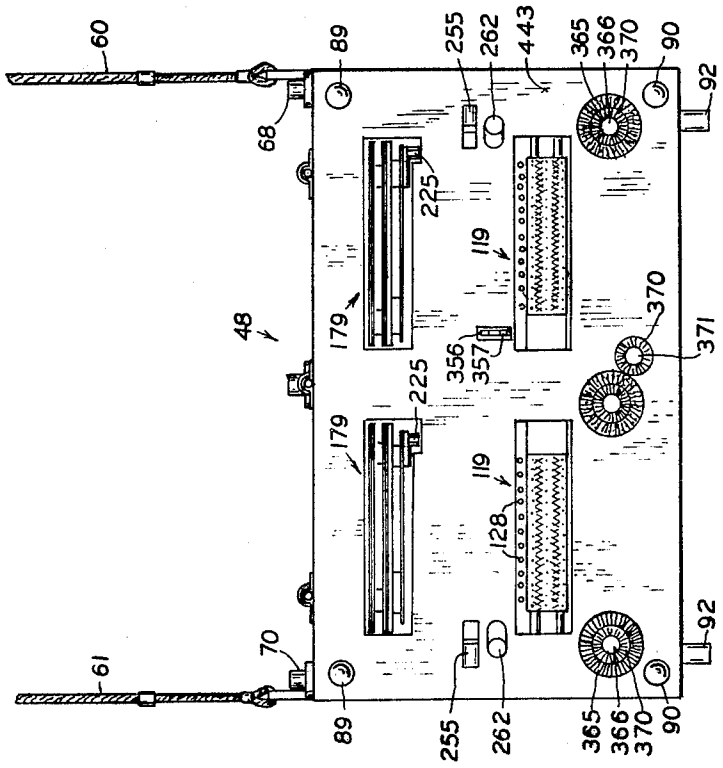

Fig-43

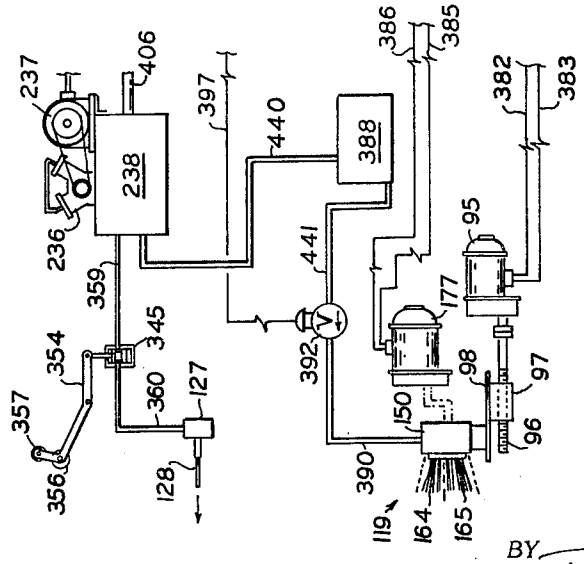

Fig-42

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United States Patent Office 3,497,902
Patented Mar. 3, 1970

3,497,902

BUILDING CLEANING APPARATUS

John Hartigan, 931 Faile St., Bronx, N.Y. 10459

Filed Oct. 4, 1968, Ser. No. 765,188
Int. Cl. A47l 1/02
U.S. Cl. 15—302 21 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus capable of being raised and lowered alongside a building and with no personnel aboard effecting all necessary operations on the building to clean either or both the opaque and the window surfaces thereof. The apparatus includes positioning and clamping means for effecting its spaced relation to a building; a washing liquid spray system; transversely reciprocable brushes to operate on normal outwardly facing building surfaces and rotary brushes to operate on external building beams; an air blast system to remove liquid and loose soil from window sills and closely adjacent glass areas, and a sponge and squeegee system operable upon window glass areas for soil and liquid removal.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to apparatus for cleaning the exterior surfaces of buildings. It relates particularly to apparatus of this kind which can perform all of its cleaning functions as it is moved, usually downwardly, alongside a building without having any personnel aboard. It relates more particularly to an apparatus of the kind described which except for reliance on external means for raising and lowering it and an external source of electrical power is fully self contained and capable of programming its own operations. It relates still more particularly to apparatus of the nature in question which is capable of performing a full scope of individual cleaning operations including spraying on of washing liquid, brushing of external building surfaces including the surfaces of protruding vertical beams, blowing dry of upper and lower window sill areas ad adjacent strips of wingramming its own operations. It relates still more pardow glass, and sponging and squeegeeing of window glass areas and adjacent opaque or sill areas of the building. It relates even still more particularly to such an apparatus which is capable of releasably maintaining its own properly spaced or aligned relation to the building being cleaned, and further is capable of great flexibility of programming according to the nature and configuration of the surface of the building to be cleaned.

Description of the prior art

The traditional method of cleaning the exterior surfaces, particularly the window surfaces, of large buildings has been manual cleaning done by men on scaffolds lowered from the roofs of these buildings. With changing architectural concepts calling for increasing use of glass and bright metal surfacing for the opaque areas of buildings between the windows the total amount of surface to be kept clean has tended to increase for modern office buildings of a given size, and further the size of office or commercial buildings generally has tended to become greater with a corresponding increase in at least the clear glass or window area needed to be kept clean on a per building basis. All of this has had a substantial effect of increasing the cost of keeping the exterior surfaces, even only the window surfaces, of large, new buildings clean by the traditional method, especially in view of rapidly rising labor costs on a man-hour basis.

For the foregoing economic considerations, taken together with the consideration of the general desirability of eliminating hazardous work, there has been for some time and now there is increasingly an incentive for developing apparatus capable of cleaning the exterior surface of a building without the requirement of any man or men riding on the apparatus. The possibility of designing such an apparatus has become more substantial as newly-constructed office buildings have tended to become smoother or more regular in surface; that is, they are seldom characterized by the very deep window sills or far-out projecting cornices or balustrades or the ornately sculpted or cast decorations such as shields, lions, gargoyles or heroic figures which were not uncommon on buildings erected in earlier times. This is, of course, true with respect to not only large office or commercial buildings but also large residential structures such as high rise apartment buildings.

Another significant and favorable development, one going along with the general smoothing of the exterior surfaces of large buildings, is that beams of various cross sectional configurations can be and now frequently are installed vertically along, or projecting through, these surfaces for both decorative effect and service as guidance members or tracks for window or building cleaning scaffolds. While not essential to the success of unmanned cleaning machines or apparatus, the actual or at least potential availability of such vertical beams is at least helpful. It is also helpful that modern office buildings are frequently being constructed with tracks on their roofs on which cars can run carrying hoisting and lowering winches and outwardly extending davits or booms for the cables on which cleaning scaffolds are hung. This makes shifting of a scaffold or a self-contained or automated building cleaning machine from location to location around a building relatively easy.

Several designs of unmanned or automated building cleaning machines, intended principally for the cleaning of windows only, have been concevied and patented. In this connection, as rather recent examples of the state of the art, reference may be had to U.S. Patent No. 3,080,592 to C. Hassage and U.S. Patent No. 3,298,-052 to M. G. Wolfe. The disclosures of the prior art, besides showing means for spraying on water or a detergent formulation as a cleaning liquid, usually show a brush mechanism of some sort, and in all such cases known to the present applicant they show rotary brushes turning about axes either parallel or normal to the windows which they are to clean. Brushes of this nature practically necessarily leave some regions of the windows untouched, either along the tops and bottoms or in the corners thereof if the windows be even somewhat inset from the opaque or masonry surfaces of a building.

Further, even though some examples of the prior art disclose wiping or squeegeeing mechanisms, none of them are deemed to show mechanisms fully effective for wiping the top and bottom window stirps or for cleaning and drying these areas and the adjacent sill areas, again where the windows have any significant extent of inset. Still further, no building cleaning machine or apparatus of the prior art known to the applicant has its appendages which actually touch the building being cleaned, i.e., its brush tufts or bristles, its wiping elements such as sponges and its squeegee blades arranged for automatic movement in and out according to variations in building contour. Thus none of them do, for example, disclose brushes which can scrub an inset transparent area or window with a given pressure or intensity of contact and then move out to scrub a masonry or metal sheathed wall surface with the same intensity, or perhaps pull back out of contact with the latter surface entirely.

Even further the applicant knows of no prior art building cleaning apparatus which is capable of cleaning the building beams along which it travels vertically, nor of releasably or yieldably clamping itself inwardly to these beams and adjusting itself laterally with respect thereto for achievement of consistently correct positioning in relation to the building which it is cleaning.

SUMMARY OF THE INVENTION

The building cleaning apparatus of the present invention is capable of operation in an unmanned, automatic fashion, and is intended to clean both the opaque and the transparent surfaces of a building, even when the latter has some significant degree of inset from the former. This apparatus is self contained except for reliance on external cables for hoisting and lowering and the furnishing to it of electric power for the operation of various motors. It carries its own supply of washing water or detergent solution and spraying or pressure discharging system for the same, and in particular it includes means to remedy the shortcomings noted above of the building cleaning apparatuses of the prior art.

The inventive apparatus includes brushes or brush assemblies which are movable and driven in a recoprocating end-to-end or side-to-side manner. Movement of this nature applied to a flatfaced brush allows the brush to be fully effective in cleaning all surfaces of a window, especially including its top and bottom strips adjacent its sills. Of course this brush movement is equally effective for cleaning the apoque or masonry surfaces of a building between its windows. Further, the present apparatus includes a compressed air system operable to emit blasts of air to drive gross amounts of water off of the top and bottom strips of inset windows and also off of the adjacent sills.

Still further the apparatus of this invention has its sponges and squeegee blades used on window surfaces all on horizontally shiftable mountings so that all of these members or elements which actually come in contact with building surfaces can be moved in toward the building or pulled back from it as appropriate upon changes in contour of the building as seen or sensed by the descending cleaning apparatus. This horizontal movement is effected automatically by signals sent out from a control center in the apparatus to power-actuated drive or shifting mechanisms. Even futrher the inventive apparatus has rotating brushes in addition to the aforementioned reciprocating brushes which serve to clean or burnish the surfaces of the building beams along which the apparatus travels. Besides this the apparatus of the present invention includes power-actuated clamping means for securing the apparatus onto the building beams and locating it with respect thereto and thus with respect to the building in both the in-and-out and side-to-side senses. Even in the engaged condition, however, these means are at least slightly yieldable to accommodate waviness or other moderate irregularities in rail shape or form without the apparatus becoming bound thereby as it descends along a building while performing its cleaning operations thereupon.

With respect to apperance, the apparatus of the present invention is capable of being fully enclosed within a unitary, box-like housing from which only the apparatus appendages actually coming into contact with a building protrude. Access to the various individual mechanisms is available through hinged cover plates. The top cover plates provide unobstructed standing and walking room for building inspectors who may occasionally ride on the apparatus, and a personnel safety or guard railing is designed to be carried by the apparatus in those cases. Landing legs are installed for proper seating of the apparatus on a street or sidewalk at the end of a descending run.

The nature and substance of the present invention as well as its objects and advantages will be more clearly perceived and fully understood upon referring to the following description and claims considered in connection with the accompanying drawings which are briefly described below.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 represents an isometric view of the building cleaning apparatus of this invention showing the apparatus disposed in cleaning position adjacent the face of a building;

FIGS. 2, 3, and 4 represent fragmentary sectional views representative of typical building constructions wherein are shown certain particular protrusions upon which the building cleaning apparatus may be disposed as it moved thereover;

FIG. 5 represents a somewhat diagrammatic transverse sectional view through the building cleaning apparatus taken along line **5—5** in FIG. 7 looking in the direction of the arrows showing the relative placement therewithin of certain of its mechanical and electrical components;

FIG. 6 represents another somewhat diagrammatic transverse sectional view through the apparatus taken along line **6—6** in FIG. 7 looking in the direction of the arrows showing the relative placement therewithin of certain other of its mechanical and electrical components;

FIG. 7 represents a sectional plan view through the apparatus along line **7—7** in FIG. 6 looking in the direction of the arrows showing the disposition therewithin of water storage tanks and the mechanism for advancing and retracting the brush assembly;

FIG. 8 represents a fragmentary transverse sectional view of the apparatus taken along line **8—8** in FIG. 7 looking in the direction of the arrows and showing said advancing and retracting mechanism;

FIG. 9 represents a fragmentary transverse sectional view of the apparatus taken along line **9—9** in FIG. 7 looking in the direction of the arrows showing supporting means for said advancing and retracting mechanism;

FIG. 10 represents a somewhat fragmentary sectional plan view of the apparatus taken along line **10—10** in FIG. 6 looking in the direction of the arrows showing the cycling drive for and with the brush and air blast components of the apparatus;

FIG. 11 represents an enlarged fragmentary end view of the support means for the brush and air blast systems, the view being taken along line **11—11** in FIG. 10 looking in the direction of the arrows;

FIG. 12 represents an enlarged fragmentary transverse view taken along line **12—12** in FIG. 10 looking in the direction of the arrows showing in section certain components of the brush and air blast systems;

FIG. 13 represents an enlarged fragmentary transverse view taken along line **13—13** in FIG. 10 looking in the direction of the arrows showing the motor drive for the brush and air blast systems;

FIG. 14 represents an exploded isometric view of the brush and air blast systems and a portion of the drive mechanism for these systems;

FIG. 15 represents a side or end view of the assembled sponge and squeegee mechanism of the building cleaning apparatus of the present invention taken along line **15—15** in FIG. 17 looking in the direction of the arrows;

FIG. 16 represents a front view of the sponge and squeeee mechanism of FIG. 15 taken along line **16—16** in FIG. 17 looking in the direction of the arrows;

FIG. 17 represents a plan view of the sponge and squeegee mechanism taken along line **17—17** in FIG. 16 looking in the direction of the arrows;

FIG. 18 represents a somewhat fragmentary exploded isometric view of the configurations and relative positions of the components of the sponge and squeegee mechanism of FIG. 15;

FIG. 19 represents an overall side or end view of the

building cleaning apparatus suspended in working position alongside a building;

FIG. 20 represents a somewhat diagrammatic plan view of a clamping mechanism for engaging, positioning and retaining the inventive apparatus in working position on and along the face of a building;

FIG. 21 represents a fragmentary front view of the clamping mechanism of FIG. 20;

FIG. 22 represents a somewhat diagrammatic plan view of another clamping mechanism;

FIG. 23 represents a plan view of the clamping mechanism of FIG. 22 with its roller elements oriented to allow the building cleaning apparatus to be withdrawn from the face of a building;

FIG. 24 represents a somewhat diagrammatic plan view of still another clamping mechanism;

FIG. 25 represents a front view of the clamping mechanism of FIG. 24;

FIG. 26 represents a somewhat diagrammatic plan view of even still another clamping mechanism;

FIG. 27 represents a somewhat diagrammatic plan view of additional members of the clamping mechanism of FIG. 26;

FIG. 28 represents a fragmentary and somewhat diagrammatic side view of an alternate arrangement of the sponge and squeegee mechanism;

FIG. 29 represents a transverse sectional view through a typical brush plate of the inventive apparatus;

FIGS. 30, 31 and 32 are somewhat diagrammatic side or end views of the brush assembly of the inventive apparatus in a sequential series of positions passing an indented window, and showing also a brush position control sensor;

FIG. 33, 34, 35 and 36 represent somewhat diagrammatic side sectional views of the air blast cycling valve of the inventive apparatus in a sequential series of operating conditions as its sensor passes an indented window;

FIG. 37 represents a somewhat diagrammatic sectional plan view of a brush arrangement for cleaning vertical T-beams extending from the face of the building;

FIG. 38 represents in a somewhat reduced scale a plan view of a plurality of brush arrangements similar to that of FIG. 37;

FIG. 39 represents a face view of the composite brush arrangement of FIG. 38;

FIG. 40 represents a side view of a safety device used with the cables for elevating and lowering the building cleaning apparatus of this invention;

FIG. 41 represents a mechanical and electrical power and control circuit diagram for the inventive apparatus;

FIG. 42 represents a fragmentary alternate power and control circuit diagram in which a connection from the air pressure tank to the cleaning water supply tank is provided for forcing water to the brush assemblies, and

FIG. 43 represents a face or front view of the building cleaning apparatus of the present invention taken along line **43—43** in FIG. 6 looking in the direction of the arrows.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings in detail, especially FIGS. 1 and 2 thereof, the building cleaning apparatus of this invention generally designated **48** has a housing **50** having a back cover **51** which is maintained on a frame **52** by means of hinges **53** and secured in place by bolt-latch members **54** and **55**. In like manner the upper surface of the housing is provided with hinged covers **56**, **57** and **58**. At each end of housing **50**, cable slings **60** and **61** are attached to ears **62**, **63**, **64** and **65** and provide a means for elevating and lowering the inventive apparatus. Disposed at each corner of the upper surface of frame **52** are upstanding pins **67**, **68**, **69** and **70**, and midway between pins **67** and **69** there is a like pin **71** attached to the frame. A retaining frame **72**, shown in phantom outline, is removably mounted on housing **50** as its vertical members have sliding fits on pins **67** through **71**. This frame serves as a guard rail so that an operator may stand safely on covers **56**, **57** and **58**, and as the cleaning apparatus is raised and lowered be transported up and down the face of a building to examine its condition of cleanliness and repair. Frame **72** may be secured to its locating pins **67** through **71** by means of small cross pin retainers not shown.

It is to be further noted in FIG. 1 that on the face of a building **74** with respect to which apparatus **48** is in working position there is a plurality of vertical T-beam members **75** which are arrayed in a regular pattern and spacing, and which may and do serve as guidance means for the cleaning apparatus. As seen particularly in FIG. 2 the wall of building **74** may include various post members **76** from which the T-beam members **75** extend. Between the several posts **76** there may be glass panels or windows **77** which are mounted at a determined distance in or indentation from the face of the wall. The cleaning of the wall including the cleaning of the glass is more fully discussed hereinbelow in connection with the operation of building cleaning apparatus **48**.

Referring next to FIG. 3 there is shown a building **80** having spaced vertical posts or pillars **81**. Attached to and extending outwardly from each of these pilars are two angles **82** and **83**. These angles have their outer legs turned toward each other so as to provide an interior channel vertically disposed to the face of the building along each pillar or column. Between adjacent columns or posts **81** there are mounted glass panels **84** in the manner of panels or panes **77** in FIG. 2 above. Referring next to FIG. 4, a building **85** is provided with vertical posts or columns **86** each of which has extending outwardly therefrom, and possibly formed integrally therewith, a square vertical facade member **87** which may be made of metal or concrete or any other suitable material. These members may be solid or they may be hollow. Located between the various posts or columns **86** are glass panels **88** as in FIGS. 2 and 3 above. Angles **82** and **83** and facade members **87**, besides T-beams **75**, may serve as guidance means for a building cleaning apparatus according to the present invention.

Referring next to FIG. 5, cleaning apparatus **48** carried by its slings is disposed in working position to be a determined distance from the face of the building **74**. This spacing or distance is maintained by means of a plurality of upper and lower ball rollers **89** and **90** running on the outer flange faces of T-beams **75**. These rollers are carried in frame **52** in such manner as to extend a determined distance from the face thereof. They are spaced in the frame so as to bear on the faces of a plurality of T-beams simultaneously. A clamping mechanism which is more fully described hereinafter serves to maintain frame **52** and hence the whole apparatus **48** in engagement and alignment with the T-beams **75** and hence with the face of the building. Extending below the frame are relatively short legs or pins **91** and **92**. These legs support the building cleaning apparatus when the apparatus has reached the ground, pavement or other landing surface.

Referring next to FIG. 6, the frame **52** carries across its bottom members a support plate **94** upon which is mounted a gearmotor **95** which carries or has attached to it a lead screw **96**. Gearmotor **95** is contemplated as reversible to turn lead screw **96** in either direction desired so as to cause an engaged nut **97** to be moved in or out along the screw. Nut **97** depends from a platform **98** upon which is mounted the brush and air blast equipment more fully shown and described in conjunction with FIGS. 10 through 14.

Referring next to FIGS. 7, 8 and 9 it may be seen that the end of lead screw **96** distant from gearmotor **95** is carried by flanged ball bearing assembly **99**. Platform **98**, illustrated in FIG. 6, also appears in FIGS. 8 and 9, and in FIG. 9 is shown as supported by shaft **101** which is one of a pair of shafts **101** and **102** slidably passing

through ball bushings 103 carried in blocks attached to the underside of the platform. One end of shaft 101 is carried by one of a pair of pedestals 104 and its other end on frame 52 in an attached support collar 105. The platform 98 and the equipment it carries are moved toward and away from the building to be cleaned in accordance with the rotation of screw 96 as the latter is turned by motor 95 and drives nut 97.

Referring next to FIGS. 10, 11, 12, 13 and 14 it is to be noted that platform 98 carries a pair of support brackets 110 and 111. These brackets are drilled to receive and retain a pair of support rods 112 and 113. These rods are carried in vertically spaced parallel array and blocks 114 and 115 containing bushings 116 and 117 are adapted to slide along them. These blocks are sized and configured to fit within and support a rectangular housing member 118 which as shown in FIG. 10 carries two brush assemblies 119. Retention of rods 112 and 113 in their supports 110 and 111 is effected by means of collars 120 and 121 which may be pinned or otherwise attached to the rods.

Referring particularly to FIG. 14 it may be seen that housing 118 is drilled to receive and retain on its front face an I-beam member 122. This member is attached to housing 118 by means of bolts and nuts mountable in aligned holes 124 and 125. The forward face of I-beam 122 is drilled for attachment to it of an angle 126. This angle carries an air blast manifold, chamber or header 127 having flexible tubular discharge tips 128 which are removably carried in short pieces of stiff tubing 129 extending from the interior of the chamber which has a compressed air feed inlet 130.

A series of bushing holes 131 are formed in I-beam 122. Around these holes and on the forward face of the beam means are provided for attaching three bushings 132, and a T-bolt 134 is slidably carried in the center bushing. The end bushings each slidably carry a support bolt 136. T-bolt 134 and support bolts 136 each have their forward end drilled to receive and carry a rod 138 which is characterized by a series of tranverse drilled holes disposed to accept cotter pins 140. Thrust shoulders on the rod are provided by washers 142. Rod 138 is pivotally retained in drilled holes 143 defined in the ends of a brush support bracket 144. This bracket 144 and rod 138 are supported in the transverse journal portions of bolts 134 and 136. Two tension springs 145 are attached at their one ends to lower wing or tab portions of the bracket 144 and at their other ends to I-beam 122 so as to urge the bracket 144 into a downward rotation around the shaft 138. A stop bolt 146 mounted in a threaded hole 147 in beam 122 is adjustable to limit the angular displacement of the bracket 144. A lock nut 148 is mounted on stop bolt 146 to retain the desired adjustment thereof.

Attached to the face or forward portion of bracket 144 is a fluid chamber 150 having extending lugs 151 whereat it is fastened to wing portions 152 of bracket 144 by means of bolts not shown. The chamber 150, which has end closure plate inserts 153, is connected through its rear panel by means of tubing 154 to a source or supply of washing or cleaning fluid such as water containing some ammonia or a dissolved or admixed detergent. The forward panel of chamber 150 has three horizontal rows of apertures 155, 156 and 157 formed therein as seen particularly in FIG. 14. The apertures in central row 156 are aligned to feed the washing or cleaning fluid into and through a row 161 of holes or apertures disposed horizontally centrally in a brush plate 158. The fluid supply when pressureized is caused to be squirted through the forward portion of this brush plate which is secured to fluid chamber 150 by the same bolts which fasten together this chamber and bracket 144. At the same time fluid is discharged above and below the brush plate through rows of apertures 155 and 157 respectively.

Referring to FIG. 29 along with FIG. 14, it is to be noted that brush plate 158 is characterized by five horizontal rows of holes 159, 160, 161, 162 and 163. The holes of row 161 align axially with those of row 156 in chamber 150 as aforesaid to serve as fluid passageways, while those of rows 159 and 160 on the one hand and those of rows 162 and 163 on the other hand serve for mounting pluralities of brush tufts of suitable, standard material such as plastic in upper group 164 and lower group 165 respectively. The holes of central row of holes 161 in the brush plate may be regarded as dispensing nozzles, as may those of top and bottom rows of holes 155 and 157 in chamber 150. The hole of row 161 discharge washing liquid essentially straight out from plate 158 between brush groups 164 and 165, while those of rows 155 and 157 are drilled or otherwise formed on axes inclined sufficiently upwardly and downwardly respectively that washing liquid emitted or dispensed from them passes at least a little above upper brush group 164 and at least a little below lower brush group 165. Thus a building surface being cleaned is wetted ahead of both descending brush groups, between the groups, and behind both groups. Liquid and loose soil left behind upper group 164 is removed by air blasting, sponging and/or squeegeeing as appropriate.

Referring again particularly to FIGS. 10 and 14, it is to be noted that housing member 118 is provided with a pair of local external stiffening plates 168 and 169 on its rearwardly facing surface and a pair of internal transverse stiffening sleeves or tubes 170. Fastened in and extending rearwardly from these plates respectively and passing through these sleeves are pins 171 and 172. As seen particularly in FIG. 10, a tie or thrust rod or link 173 extends between these two pins. The left end of link 173 is bifurcated to receive one end of a connecting arm 174 which is actuated by a crank arm 175 which in turn is cycled by means of a gearmotor 177 which is shown also in FIG. 13. As the output shaft 178 of motor 177 is rotated the outer end of crank arm 175 transcribes a circle and drives the left end of the connecting arm 174. The right end of the connecting arm oscillating about pin 172 reciprocates housing member 118 and all parts attached to it along rods 112 and 113. In actual reduction to practice, it is contemplated that the housing member 118 would travel approximately two inches on either side of a nominal dead center, which limits of travel are shown in phantom outline in FIG. 10.

Referring next to FIGS. 15 through 18, there is shown a sponge and squeegee mechanism generally designated 179 which provides means for removing the sprayed-on washing fluid and loosened soil or dirt from the window surfaces of a building. A support plate 180 is the principal base for this mechanism including a sponge 182 which may be of foamed plastic. This sponge is of a rectangular cross section and, as shown, is retained and supported between lower and upper clamp plates 184 and 185. These clamp plates are mounted on either side of the horizontal leg of an angle 186. The upper clamp plate 185 carries a spring-biased piano hinge 190 whose right hand leaf (FIG. 15) is attached to the clamp plate and angle. The outer or left hand leaf of the hinge carries and has attached to it upper and lower squeegee clamp plates 191 and 192 which have their outer ends configured to form lower and upper jaws snugly engaging and retaining a diamond-shaped back edge portion 193 of a squeegee body 194. A flexible blade member 195 of relatively soft rubber is removably carried in a longitudinal slot in the front edge or surface of the body member 194 which is of relatively stiff but still at least semi-flexible material such as extruded rubber. The thin blade 195 is thus disposed to swing or be swung upwardly in an arc having its center at the pin of piano hinge 190. The spring in this hinge, however, tends to urge the squeegee downwardly into a substantially parallel relationship to sponge 182 as shown. Angle 186 is attached through clamp plate 184 to a pair of slide members 198 which rest on plate 180

and are maintained in aligned sliding position by means of opposed retaining guides **199**. These guides permit the sponge and squeegee to be cycled within closely determined limits.

Still referring to FIGS. 15, 16 and 17, it is to be noted that each angle **186** has attached to its vertical leg two spring pins **200**. Each pin has its head end attached to the angle and its shank is fitted within a compression spring **202**, and further is slidably carried in and extends through a bushing **203** mounted on a Z-bracket **204** which is also attached to the base member **180**. Each spring **202** is confined between the Z-bracket and the head of pin **202**. The forward travel of angle **186** is controlled and limited by means of two bars **206** whose one ends are attached to angle **186** and whose other ends are attached to the plunger portions **209** of solenoids **210** mounted on plate **180**. The sponge and squeegee mechanism **179** is in operating position at its maximum outward or forward displacement and in an inactive position when drawn to its inward location as in FIG. 15. This inward location is reached by the actuation of solenoids **210** causing bars **206** to be drawn rightwardly by the movement of plungers **209**. The bars **206** draw the angle **186** and its attached slide members **198** inwardly so that the sponge and squeegee are clear of the face of the building.

Also carried by the upper forwardly extending legs of Z-brackets **204** is an upper piano hinge **212** which, in the manner of hinge **190**, is also spring biased to urge the outer leaf downwardly and toward the leg of the Z-bracket. This piano hinge **212** has attached to its outer leaf a pair of squeegee clamp plates **213** and **214** similar to the plates mounted on hinge **190**. A squeegee body **215** and flexible blade **216** are removably mounted in the clamp plates **213** and **214**. Carried on the underside of the support plate **180** and at a determined distance therefrom by means of spacers **220** is a plate **222**. This plate supports a cycling bar **224** which is adapted to retain a roller **225** on its forward end. A pair of angles **226** are attached to plate **222** to provide a spaced guide for the bar **224**. A pair of bolts **227** are mounted in the angles and extend between them. Slots **228** are formed in bar **224** and are sized to allow the bar to slide smoothly across the shank portion of the bolts **227**.

A tension spring **230** is attached at one end to one of the angles **226** and at its other end to an outwardly extending wing portion **231** of bar **224**. This spring is disposed to urge the bar forward to an outer limiting position determined by the slots **228**. A microswitch **234** is mounted on member **222**, and has its moveable member or plunger **235** disposed to engage and be actuated by the rearward or rightward movement of bar **224** and thereupon energize both solenoids **210** to draw the sponge and squeegee back from contact with the face of the building against the forward thrusting force of springs **202**. The positioning of the cycling bar from plate **180** by spacers **220** is a matter of design in any particular case depending upon the speed of descent of the cleaning apparatus along a building and the indent configurations or contourings of the building.

Referring again to FIG. 5 there is shown an air compressor **236** which is driven by a motor **237**. The compressor air thus provided is stored in tank **238** from whence it is fed to air blast manifold **127** and thence through the discharge tips **128**. The compressed air may be stored at a pressure of about eighty to ninety pounds per square inch. With air at this pressure several operations using pneumatic actuating cylinders are performed for the positioning of the apparatus on or against the building. One embodiment of an air-actuated positioning and clamping apparatus is shown in FIGS. 20 and 21 wherein building **74** has vertical T-beam members **75** extending outwardly from its external or exposed surface. Looking at the right hand one of two beams shown in FIG. 20, a clamp arm **250** is pivotally carried on a support member **252** attached to apparatus frame **52**. Also carried upon this support member is an air cylinder **253** whose piston rod **254** is pivotally attached to one end of the arm **250**. A roller **255** is carried on the other end of arm **250**, and is mounted so as to be in engagement with the underside or inside of one of the flanges of the T-beam **75** when the rod **254** is in the position shown in FIG. 20. As the rod **254** is moved outwardly, the roller **255** is moved in an arc until the roller **255** is swung free of any possible engagement with the T-beam **75**.

To clamp the frame of the cleaning apparatus to the building, the cylinder **253** is actuated to cause the roller **255** to swing in an arc and bring the roller into engagement with the flange of the T-beam until the ball rollers **90** set in frame **52** engage the face of the beam. The mechanism of cylinder or actuator **253** has at least some resilience responsive to the pressure in the cylinder and permits a certain amount of irregularity to exist in the configuration and construction of the T-beam and building without binding or seizing of the clamping mechanism as the cleaning apparatus moves along the building. Sideways positioning of the apparatus frame to the edges of the T-beams is effected by means of arms **260** each having a roller **262** carried on one end thereof. Referring particularly to FIG. 21 it may be seen that each arm **260** is pivotally carried on support member **252**. An air cylinder **263** has its piston rod **264** connected to the end of the arm distant from roller **262** and as the rod is moved the roller **262** is swung in an arc. In the condition of FIG. 21 this roller has been swung into engagement with the edge of T-beam **75** so that when opposed rollers **262** are actuated toward each other as in FIG. 20 the whole cleaning apparatus **48** is moved to and maintained in a proper side-to-side alignment with the T-beams of the building **74**.

Referring next to FIGS. 22 and 23, there is shown a positioning and clamping mechanism suitable for use with an apparatus **48** working on building **80** of FIG. 3 which has its oppositely or inwardly facing angles **82** and **83** on each pillar **81** spaced apart so as to receive the shank of a rod end member **270** and certain elements mounted on it. This rod end is formed with like right-angle extending portions in the nature of a T-head carrying rollers **271** and **272**. When the rod **270** and its rollers are oriented or positioned at ninety degrees to their position in FIG. 22 they are movable in and out of the opening between the members **82** and **83**. Such an orientation and movement are shown in solid and dashed outline in FIG. 23. To act as a clamp, the rod end **270** and its rollers are moved from outside the opening to the inner position shown in dashed outline after which the rod end is rotated ninety degrees to bring the common axis of rollers **271** and **272** into a horizontal attitude. In this orientation and attitude the rod **270** is drawn outwardly by means of an air cylinder or the like (not shown) to bring rollers **271** and **272** snugly against the interior flange surfaces of angles **82** and **83** so that the several ball rollers **90** on the frame **52** are drawn into engagement with the face of angle **82**. A roller **274** carried on an arm **275** is movable toward the angle **83** so as to engage the exterior side or web surface of this angle and bring the frame **52** into a determined transverse orientation with respect to the angle and then, acting with an oppositely paired roller **274** and arm **275** not shown, maintain the cleaning apparatus in proper side-to-side alignment with the face of the building. Arms **275** are contemplated as being moved in response to the actuation of air cylinders not shown.

Referring next to FIGS. 24 and 25, there is shown a positioning and clamping mechanism suitable for use with an apparatus working on building **85** of FIG. 4 which has a square facade member **87** on each pillar **86**. A pair of rollers **280** and **281** are each formed with a pair of spaced protruding ring portions **282**. Each of these rollers is rotatably carried on a header member **284** pivotally

mounted on an outer shaft end **285** of an arm **286**. The other end of arm **286** is rotatably located on a vertical shaft or pin portion **287** of a post member **288** carried on frame **52**. Attached to and extending outwardly from the main body of the post are a pair of stop arms **290** and **291** providing spaced opposed shoulder surfaces. Between the shoulder surfaces of these arms is disposed a lug **293** which is a part of arm **286** and is moved as the arm is moved. A resilient spring or cushion block **294** of rubber or the like is disposed between arm **290** and lug **293** and provides a means for urging the header member **284** toward the facade member **87**. Extending rearwardly from and as an integral part of the header member **284** is an actuating arm or lever member **296** to which is pivotally attached a clevis end of a link **298** which is actuated by an air cylinder or other means not shown.

In response to the reciprocal vertical movement of this link **298** the header member **284** is moved around shaft end **285** to a position adjacent the facade member **87**, that is, into its orientation or attitude shown in FIGS. 24 and 25, so as to swing the rollers **280** and **281** into engagement with the vertical facade member **87**. To disengage these rollers from this member the link **298** is moved up or down so as to rotate header **284** to an attitude such that the longitudinal axes of the rollers are substantially parallel to the face of the facade member **87**. The vertical shaft **287** and shaft end **285** are contemplated as being disposed at right angles to each other. Resilient block **294** urges the end of arm **286** and header **284** toward the vertical facade member **87** so that, as seen in FIG. 24, the inner ring portion **282** on roller **280** and the outer ring portion **282** on roller **281** tend to engage the opposing sides of facade **87**. Outward thrust or sway or swing of the cleaning apparatus away from the face of the building tends to increase this two-point engagement of the facade member by the ring portions of the rollers which tend to draw the header toward the facade member. When desired, link **298** may be moved slightly downward to incline the rotative axes of the rollers **280** and **281** to a slight angle from and above a normal or right angle disposition to the face of the vertical facade member. This slight skewing tends further to draw the frame **52** of a downwardly moving cleaning apparatus toward the building. Of course the positioning and clamping mechanism shown in FIGS. 25 and 26 would be present at least as a pair of mechanisms on any particular building cleaning apparatus **48**.

Referring next to FIGS. 26 and 27 there is shown another positioning and clamping mechanism suitable for use with an apparatus working on building **74** in FIGS. 1 and 2 which has T-beams **75** extending from its pillars **76**. In the employment of this mechanism, which like the mechanism of FIGS. 20 and 21 would be used at least in pairs with any particular building cleaning apparatus **48**, one of the inner flange surfaces of T-beam **75** is borne upon by clamping roller **302** carried on one end of arm **303**. This arm is substantially centrally pivotally mounted on a support member **304** reciprocably carried on frame **52**. On its other end arm **303** carries a cam follower **305** which is shown as a roller. A tension spring **306** has one end attached to support **304** and another to arm **303** near roller **302** so as to urge cam follower **305** toward and against a cam track member **307**. The support **304** is moved in and out as indicated by the arrows and permits and causes follower **305** to traverse the contour of the cam track member. Roller **302** is swung in an arc around pivot pin **308** as urged by spring **306** and as limited by the contour of the track member **307**. The movement of support **304** is effected by an air cylinder or electric motor not shown.

Means for the lateral adjustment of cleaning apparatus **48** with respect to T-beam **75** and the building from which it extends is shown particularly in FIG. 27. An alignment roller **309** is carried on one end of an arm **310**. This arm is pivotally carried on reciprocably movable support member **311**. On its other end the arm **310** carries a cam follower **312** which like follower **305** is preferably a roller. A tension spring **313** has one end attached to arm **310** in a manner tending to rotate the arm to maintain cam follower **312** against a cam track member **314**. Support member **311** may be moved either with support member **304** or independently of it in the direction of the arrows causing or permitting spring biased roller **309** to be swung toward or away from T-beam **75** as cam follower **312** runs along cam track member **314** with arm **310** turning about its pivot pin **315**.

Referring next to FIGS. 19 and 40, building cleaning apparatus **48** is shown as carried by cable sling **60** beyond which of course there is another sling **61**. These cables are reeled in or out to carry the cleaning apparatus up or down the face of building **74**. A motorized crane apparatus **320** of a kind known to the art is supported on rails **321** and **322** disposed on the roof **323** of the building. A retaining shoe or clip **324** is provided to clamp the crane **320** at selected locations along the rails. A cable reel **326** to wind up or pay out cable **60** thereon is carried on and is driven by a motor in the crane apparatus. A boom **327** extending from the base of the crane apparatus carries on its outer end a sheave **328** over which the cable **60** passes. Arrangements similar in the foregoing and other pertinent respects are present for the handling of cable **61**.

In the winding and unwinding of cable **60** from reel **326** it is desirable to provide a safety apparatus whereby the downward or pay out speed of the cable may be limited to a determined value with any speed in excess of this causing the cable to be automatically gripped so as to stop the further paying out of the cable. A simple safety device is shown in FIG. 40 wherein sheave **328** carries cable **60** in a groove formed in its periphery. A brake block **330** is disposed above the cable, and is just out of contact therewith. Pivotally carried by shaft **332** is nip member **334** which has a weight **335** adapted to retain it in the illustrated attitude as the cable **60** travels over sheave or pulley **328** in the direction of the arrow and at a maximum selected speed. A spring **337** carried by support **338** upholds the leftward arm portion of nip member **334** when pulley **328** is at rest or is traveling counterclockwise. A friction clutch **340** carried on shaft **332** is adjustable so that as pulley **338** is rotated by the passage thereover of cable **60** the nip member is urged clockwise around shaft **332**. When the speed of the cable **60** in the direction of the arrow is in excess of a safe speed clutch **340** urges nip member **334** to rotate with pulley **328** and to overcome the effect of weight **335** so that wedge lip **341** of member **334** is brought into engagement with cable **60** whereby this lip is moved clockwise to pinch the cable between itself and brake block **330**, and arrest or at least decelerate the descent of building cleaning apparatus **48**.

The safety stop mechanism or device shown in FIG. 40 is provided to indicate simply one of several possible means for limiting the downward rate of travel of the cleaning apparatus. A considerable number of safety devices for cables are known, and in certain states and cities only certain approved safety apparatus for this general purpose may be employed. It is contemplated that such approved designs will be used with actual reductions to practice of the present invention in conformity with the applicable codes.

Referring next to FIGS. 33 through 36 there is provided an operation sequence of views of a valve control for timing and regulating the flow of air under pressure from tank **238** to and through the flexible discharge tips **128** carried by air blast chamber **127** shown in FIG. 12. In this control an air valve generally indicated as **345** includes a cylindrical housing **347** within which a piston body **348** is reciprocably movable. A midportion **349** of the piston **348** is of a reduced diameter to provide an air

passageway around the piston as needed. At its upper end the piston is connected to a rod **350** which extends through the housing **347**. A compression spring **352** located in the lower portion of cylinder **347** acts to urge the piston **348** and rod **350** upwardly, or toward the rod end. A pivoted arm **354** is carried by the apparatus frame **52** and has one end engaged with the upper or outer end of rod **350**. The other end of the arm **354** carries in spaced array a pair of follower rollers **356** and **357** which are disposed to engage building wall **74** and move the arm or allow it to be moved in response to changes in the profile or outline configuration of the wall. Cylinder **347** is equipped with a pair of connections providing an air inlet **359** and an air outlet **360**. These connections are formed on opposite sides of the cylinder and are disposed to lie in a common plane which is at right angles to the axis thereof. As the reduced portion **349** of piston **348** is brought in way of inlet **359** the pressurized air from the inlet passes around this reduced section and flows to and through the outlet **360** to the tubular discharge tips **128**.

As thus used, the valve **345** and its associated mechanism constitute a simple air flow control device whereby as rollers **356** and **357** follow the contour of the building the arm **354** is moved to bring the reduced midportion **349** of the piston into and out of communication with the air inlet and outlet. When the upper and lower full diameter portions of the piston are in way of the inlet and outlet there is no flow of air through the valve **345**. In FIGS. 34 and 36 the reduced diameter is in communication and pressurized air flow occurs. This situation obtains as the follower rollers on arm **354** pass by the upper sill of a window **77** in the course of descent of building cleaning apparatus **48** and again as they pass by its lower sill. The spacing between follower rollers **356** and **357** along the extension of arm **354** as illustrated determines the duration of the air blast at and adjacent the upper sill of the window. This blast is contemplated to be significantly longer than the blast at and adjacent the lower sill.

Referring next to FIGS. 5, 37, 38, 39 and 43 there is shown in particular the brush arrangement for cleaning the vertical T-beam members **75** of the building **74**. This arrangement includes a face brush **365** mounted on a spindle **366** which is rotated by a motor **368** (FIG. 5). Face brush **365** has a bristle portion **369** which is movable to a position whereat it engages and polishes the face or outer flange surface portion of a given T-beam as in FIG. 37. Also carried on spindle **366** and rotated therewith is a stem brush **370** having a bristle portion **372** adapted to engage and clean one face or surface of the web or stem of any T-beam **75**. The brushes **365** and **370** are contemplated as being moved leftward from a disengaged position indicated in dashed outline in FIG. 37 to a cleaning position shown in solid outline in the course of the whole building cleaning apparatus **48** being engaged initially for a passage down and along any particular group of T-beams. As the whole apparatus **48** is moved down the face of the building, three T-beams are cleaned simultaneously by three brush arrangements in which face brushes **365** and stem brushes **370** are disposed as in FIGS. 38 and 39. As thus seen, the farthest left T-beam **75** has its face cleaned by a brush **365** and the right surface of its stem by a brush **370** both of which are mounted on spindle **366**. At the same time the farthest right T-beam **75** has its face and the left surface of its stem cleaned by similar brushes **365** and **370** both of which are mounted on a spindle **366**. The central or middle T-beam **75** has its face cleaned by brush **365** mounted on a rightwardly offset spindle **366** which also carries a stem brush **370** disposd to clean the right surface of the stem of this T-beam. Another stem brush **370** carried by a leftwardly offset spindle **371** is disposed to engage and clean the left surface of the stem of the central T-beam. As seen in FIG. 5 this last-mentioned spindle is driven by a motor **374** which is positioned at a level lower than that of the three motors **368**.

Referring next to the circuit diagram of FIG. 41 there are shown the several power and control connections to the various components of the inventive building cleaning apparatus as so far described. For the operation of this apparatus a control center **380** of a design within the ability of the prior art is provided which includes programming equipment in the nature of timers and relays of conventional construction and operation, and which is supplied with electrical power through main cable **381**. Although not shown in its full extent, this power cable is carried up from building cleaning apparatus **48** along with hoisting cables **60** and **61** to the roof of the building being cleaned, and is paid out and reeled in by mechanism of known design. The desired sequence and duration of and for the several processes of the overall cleaning operation include the movement of the brush assembly **119** which is positioned to in and out limits by gearmotor **95** in response to electrical power fed from the center to and through conductors **382** and **383**. The brush assembly **119** is reciprocated from side to side by gearmotor **177** in response to power fed along conductors **385** and **386**. Fluid for cleaning is supplied to assembly **119** from a storage tank **388** by means of a motor and pump **389** which discharge it through a conduit **390**. An electrically-operated valve **392** in this conduit serves as a discharge stop valve for the pump to effect precise turning on and shutting off of the flow of cleaning fluid. Electrical power from the control center **380** to the motor and pump **389** is provided through conductors **394** and **395** while the electrical control signals for valve **392** are provided through a conductor **397**.

The air compressor **236** driven by motor **237** supplies pressurized air to storage tank or receiver **238** from whence air flows to valve **345** through inlet conduit **359** and thence through outlet conduit **360** to air blast chamber **127** for distribution to and final emission through flexible discharge tips **128**. Electrical power from control center **380** is fed to the motor **237** through conductors **399** and **400**. The sponge and squeegee mechanism **179** shown in the upper left of the FIG. 41 has one side of microswitch **234** supplied with current through a conductor **402** and originating from the control center **380**. The other side of this microswitch is connected by conductor **403** to one side of solenoid **210** while the other side of the solenoid is connected through conductor **404** to an appropriate electrical supply and program in the control center.

The clamping mechanism such as that shown in FIGS. 21 and 22 for engaging the T-beams **75** and positioning apparatus **48** with respect to building **74** is actuated with pressurized air fed through a supply conduit **406** from tank **238**. Teed off from this conduit is a line **407** which furnishes the air under pressure to a four-way valve **409**. This valve is controlled by electrical signals sent from the control center through conductor **410**. Air cylinder **263** is connected at one end to valve **409** by means of conduit **412** and at its other end this cylinder is connected to the valve by means of conduit **413**. An air line **415** is teed off from supply conduit **406** to a four-way valve **417** which is controlled by signals fed to it from the control center through conductor **418**. Cylinder **253** has one end connected to valve **417** by means of a conduit **420**, while the other end of this cylinder is connected to the valve by means of a conduit **421**.

One of the operting assemblies of the T-beam cleaning brush system of FIG. 38, specifically the farthest left assembly, is shown in the upper right hand portion of the circuit diagram of FIG. 41. A means for moving this assembly laterally toward and away from the T-beam **75** upon which it is to operate includes an air cylinder **423** which is disposed and connected to shift motor **368** which rotates and carries brushes **365** and **370**, and which is

on a moveable mounting of any suitable kind. From supply conduit **406** a line **425** is angled off to a four-way valve **427** which receives and is controlled by electrical signals fed through conductor **428** from control center **380**. Air is supplied and exhausted between one end of cylinder **423** and valve **427** by means of a conduit **430**, and the other end of the cylinder is fed air from and exhausts air to said valve by means of a conduit **431**. The motor **368** is controlled and supplied with electric power through conductors **433** and **434**. Motor **368** which has been illustrated and described as driving the farthest left operating assembly of the T-beam cleaning brush system of FIG. 38 is only one of four motors for this general purpose, that is, for the purpose of driving various brush operating assemblies. There are two more motors **368** and a motor **374**. Associated with each of these motors to impart appropriate lateral movement to it and the brush or brushes it carries is a sutable pneumatic mechanism including an air cylinder such as cylinder **423** and a control valve such as valve **427**. These additional motors, cylinders and valves are not illustrated in FIG. 41 because it is considered that the nature of their compressed air connections from conduit **406** and electrical connections from control center **380** will be appareent from what has in fact been illustrated, they being essentially repetitive thereof.

Referring next to FIG. 42 there is shown an alternate arrangement of a fragmentary portion of the circuit diagram of FIG. 41. In this alternate circuit the washing or cleaning fluid stored in tank **388** is discharged therefrom by pressurized air rather than by the pump **389**. This air under pressure is fed by conduit **440** from receiver **238** to the top of fluid supply tank **388**. The liquid material in tank **388** now under pressure is fed through conduit **441** to valve **392**. This valve permits or prohibits flow through conduit **390** to the brush assembly **119** with conduit **390** in this case being an extension of conduit **441**. In all respects except those just described the diagram of the functions shown in FIG. 41 is continued identically in the circuit of FIG. 42.

Referring next to FIG. 43 there is shown a face or front view of the building cleaning apparatus **48** as the same is presented to a building **74** being cleaned. Pairs of upper and lower ball rollers **89** and **90** project through a front cover plate **443** and are disposed to bear and run upon the faces of the outer ones of any grouping of three vertical T-beam members **75** of the building. Two sponge and squeegee mechanisms **179** are disposed in spaced side-by-side array, and are movable forward and back through appropriately shaped openings in the front cover plate. Below each of these mechanisms is an opening in plate **443** through which one roller **225** carried by the associated cycling bar **224** protrudes. Below these rollers are face plate openings for the rollers **302** and **309** of paired clamping mechanisms disposed to engage the outer two of the three vertical T-beam members of the building providing immediate running surfaces for the apparatus **48**. Below and inwardly of these clamping rollers are openings in the face plate for a pair of brush assemblies **119** and their associated air blast assemblies of flexible tubular discharge tips **128**. Below these brush assemblies **119** which cycle side to side to clean the gross surface of the building are beam cleaning brushes **365** and **370** disposed to clean the three vertical T-beam members as in FIGS. 38 and 39.

USE AND OPERATION

It is contemplated that for each installed cleaning apparatus **48** of this invention a crane **320** will be provided on each building **74**. The cables **60** and **61** as they are wound or unwound on or from reels **326** raise and lower the cleaning apparatus at a speed of travel determined according to the particular problems of cleaning such as the materials and configuration of construction of the building. The beam and facade configurations of FIGS. 2, 3 and 4 are not intended to anticipate or represent in precise delineation all of the many configurations of vertical beams which may be used and additionally it is possible that a building to be cleaned will not itself provide any outwardly or inwardly formed vertical guides. In those buildings whereon or wherein no practical guide beams are inherently provided, it is contemplated that temporarily rigged guidance cables be provided to extend from the roof to the ground. In such arrangement these cables are movable to desired exact positions between cleaning passes and may be run through temporary or special guidance follower means on apparatus **48** such as pad eyes.

As soon as the cleaning apparatus **48** is in suitably aligned, clamped position at the uppermost portion of the building being cleaned and lowering of the apparatus by crane **320** has been started, the control center **380** continues to function and energizes the circuit of gearmotor **95**. Lead screw **96** is turned by this motor to move platform **98** outwardly until the tufts **164** and **165** of brush assemblies **119** are brought into contact with the building. Liquid material which has been compounded to have the desired washing or cleaning properties is fed from tank **388** through conduit **390** to valve **392** by either air pressure or pump action. This valve **392** is opened to permit the washing liquid to flow to chamber **150** and thence through dispensing nozzles **155**, **161** and **157** to impinge upon the contiguous surface of the building. At the same time that cleaning liquid is sprayed from and through brush assembly **119**, the motor **177** is operating. This motor turns crank arm **175** to reciprocate the housing member **118** and the two brush assemblies **119** which it carries. This action causes brush tufts **164** and **165** to scrub back and forth across the moistened surfaces of the building with which they come into contact as the cleaning apparatus descends. As stated earlier, the total side to side stroke of the brush assemblies may be about four inches, and they may have a cyclic rate of operation of about one hundred and fifty to two hundred full to and fro strokes per minute.

The brush assemblies **119** may tilt upwardly on rod **138** due to rubbing effects on a uilding, particularly when they pass by and over window sills, while at the same time tending to be held downwardly in good contact with the building surfaces by springs **145**. The splaying or flaring of the upper and lower rows of brush bristles or tufts, about fifteen degrees (15°) above and below the horizontal, taken together with the tilting of the brush assemblies, insures penetration of the bristles into essentially all surface recesses. Washing liquid or fluid sprayed out through dispensing nozzles **157** moistens and loosens soil on the building ahead of lower brush groups **165**; liquid sprayed out through nozzles **161** maintains moistness of any soil remaining to be scrubbed by upper brush groups **164**, while liquid dispensed from nozzles **155** keeps any residue of soil still present on the building after final brushing in a wet state to be subsequently removed by blowing, sponging or squeegeeing or any combination of these methods. All of these beneficial wetting and brushing or overall washing effects are enhanced by the double rows of tufts or bristles in each brush group **164** and **165**, and are achievable on buildings generally, whether a given building be essentially smooth sided, i.e., with its window glass surfaces essentially flush with its opaque surfaces, or have its windows significantly inset from its opaque surfaces on either square or slanting sills.

Referring now to FIGS. 30 and 31, it is to be noted that in certain instances the building **74** may not require cleaning of its entire outside surface but only of its window pane areas. In this circumstance the actuation of brush assemblies **119** may be triggered by a sensing device which includes a roller **450** carried on one end of a movable arm **452**. The right or other end of the arm is disposed to bear upon a microswitch **453** connected to the control center when roller **450** is running on an opaque

surface of building **74** and the tufts of brush assembly **119** are withdrawn from contact with that surface. This is the condition shown in FIG. 30. As roller **450** traverses or rolls down an opaque surface of building **74** as cleaning apparatus **48** descends it comes onto the inwardly and downwardly sloped upper sill **454** of inset window **77**. The arm **452** is now moved inwardly or leftwardly by a spring or pneumatic means (not shown) until the roller **450** just touches or at least closely approaches the surface of window **77**. This movement of arm **452** results in a signal being sent to and from the control center **380** as the arm ceases to bear on microswitch **453**. In response to this signal the brush assembly **119** is moved inwardly into contact with the window **77** and then is cycled from side to side while at the same time washing liquid is caused to be dispensed against the surface of the window. This is the condition of FIG. 31.

Referring next to FIG. 32 it may be seen that when the roller **450** descends into contact with lower slope sill **456** it commences to urge the arm **452** rightwardly or outwardly, and continues to do so until the arm again bears upon microswitch **453** to cause a new signal to be sent to the control center **380**. This signal programs the operation of motor **95** to cause the brush assembly **119** to be moved away from window **77** to a position similar to that which it has in FIG. 30 out of engagement with the opaque surface of building **74**. The side-to-side cycling of the brush assembly and the discharge of washing liquid from dispensing nozzles **155**, **161** and **157** are now stopped. Variations of this control schedule are of course possible with each programming actuation being established to satisfy the particular conditions of contour and cleaning pertinent to any individual building. The program for the movement of the brush assemblies **119** may provide for any selected portions of the building to be cleaned or if desired all portions of the building may be cleaned. For example, on certain occasions it may be desired that only selected windows in the face of the building be cleaned. On other occasions only the opaque face portions of the building may be programmed to be cleaned with the cleaning of the glass omitted.

Referring next and again to FIGS. 33 through 36 there is shown a typical operational sequence of conditions of the air blast cleaning device. In this sequence the roller **356** on pivot arm **354** traverses down the opaque surface of the building **74** until it approaches the recess for a window **77** (FIG. 33). Roller **356** then moves onto the upper sill **454** briefly until the smaller roller **357** on arm **354** comes in contact with the opaque surface of the building (FIG. 34). Arm **354** has now moved a small amount counterclockwise and the reduced diameter central portion **349** of the spring-biased piston **348** has been brought in way of the inlet **359** and the outlet **360** so that air under pressure flows to and through the flexible tubular discharge tips **128** which have now been moved in toward the building. Air emitted from the tips as a prolonged blast displaces the residual cleaning liquid and loose soil or dirt from the upper sill **454** and a small upper strip or portion of the window **77**. As cleaning apparatus **48** moves further downward to allow arm **354** to be rotated into its orientation of FIG. 35, it is to be noted that the smaller roller **357** on the arm runs or is carried off of the upper sill **454** but does not come into contact with window **77**. The piston **348** meanwhile has been moved by spring **352** to the top of the housing or cylinder **347** with its lower larger diameter portion coming in way of the inlet **359** and outlet **360** to shut off the flow of compressed air to the tips **128**.

There is no further discharge of air from tips **128** until with continuing descent of apparatus **48** the larger roller **356**, as shown in FIG. 36, is brought into contact with the lower sill **456**. Arm **354** is now moved clockwise against the force of spring **352** bringing piston **348** again into a position within cylinder **347** such as that shown in FIG. 34. This allows air to blow or blast through tips **128** against the building at or somewhat below lower sill **456** to dispose of surplus water or cleaning fluid and soil deposited or run down there during the cyclic actuation of a brush assembly **119**. Further downward movement of building cleaning apparatus **48** will bring roller **356** again onto the vertical opaque surface of building **74** with further clockwise rotation of arm **354** depressing piston **348** into its position within cylinder **347** shown in FIG. 33 and shutting off the flow of air to discharge tips **128** after only a rather short blast has been emitted from them. These tips will simultaneously be moved back out from the building along with brush assembly or assemblies **119**.

Referring next and again to FIGS. 6, 15 and 43 it should be observed that each sponge and squeegee mechanism is located above the corresponding brush assembly **119** and air discharge tips **128**. Movement of a given sponge **182** and lower squeegee blade **195** is programmed in response to actuation of their sensing roller **225** as the latter is urged inwardly or forwardly by means of spring **230** to tend to be maintained in engagement with the face of the building. In accordance with the reciprocation of cycling bar **224** which carries roller **225**, signals from microswitch **234** are fed to the control center **380** which programs the energization of solenoid **210** correspondingly. The solenoid **210** is thus actuated to cause the sponge **182** and squeegee blade **195** to be moved in and out relative particularly to window surfaces with and against the force of springs **202** in response to the linear movement of roller **225** and cycling bar **224**. The associated auxiliary or upper squeegee blade **216** which is supported from the upper leg of Z-bracket **204** may be used as shown to remove any surplus washing liquid left on the opaque surfaces of the cleaned building. In an operation where window surfaces are being cleaned, as the roller **225** moves inwardly toward the glass **77** the sponge **182** is programmed to be moved inwardly by springs **202** to come into wiping contact with the glass.

In a wiping and downwardly moving condition each sponge **182** distributes and absorbs at least a substantial portion of the washing liquid previously deposited on the glass from its correspondingly dispensing nozzles **155**, **161** and **157**. Lower squeegee blade **195** immediately above the sponge operates in a customary manner to remove essentially all of the remaining liquid or residual moisture from the glass. When the roller **225** has moved far enough down that it comes into contact with the lower sill of the window and it and cycling bar **224** are moved outwardly to trip switch **234**, a signal is fed to the control center causing solenoid **210** to be actuated to pull back the sponge and lower squeegee out of contact with at least the window surface. As sponge **182** is pulled back it is still going down, and will wipe and be effective across the surface of the lower sill. The lower squeegee blade may swing upwardly on piano hinge **190** as necessary, always tending to be restored to working or wiping orientation by the spring loading of this hinge. If sponge **182** be flexed upwardly into contact with the lower squeegee blade and assembly there will be a desirable effect of pressing absorbed liquid out of the sponge.

In certain instances it may be advantageous to have the upper squeegee blade **216** moveable toward and away from the building **74** independently of the lower squeegee in order that it may follow any contour of the outside surface of the building. Here reference is made to the arrangement of FIG. 28. Roller **225** on cycling bar **224** as it moves inwardly is brought near to but not in contact with the window glass **77**. Sponge **182** and lower squeegee blade **195** are operated in the manner just described above. The upper squeegee system includes a signaling device having a roller **460** carried on the depending portion of an angled arm **461** steadily biased inwardly toward the building. This roller is disposed to move down and along the vertical opaque surface of building **74** and then follow along an upper sill **454** until another, smaller

roller **462** at the bend of arm **461** is brought into contact with the surface of the building and runs onto upper sill **454**.

Arm **461** continues to move horizontally inwardly, and upon achieving a certain inward displacement activates a microswitch **463** to send a signal to control center **380**. Upper squeegee blade **464** which has been following down along the vertical opaque surface of building **74** is now moved or permitted to move inwardly by signals from the control center triggered by the signal from the microswitch. Thus blade **464** follows along upper sill **454**, and may make a downward pass in contact with window **77**. As the blade reaches the bottom of the window the operations just described will be essentially reversed so that the lower sill (not shown) will be squeegeed, and then blade **464** continue on down along the vertical opaque surface of building **74** below the window. Whether or not the upper squeegee blade be movable inwardly and outwardly, it may be swung upwardly as necessary on its piano hinge **212** and always tend to be returned to a horizontal attitude by the spring loading of this hinge.

The operation of the squeegee system as so far illustrated and described has been in connection with the cleaning of a building having fairly gently sloping upper sills to its windows as in FIG. 28, with the existence of lower sills of the same nature being assumed at least from the showings of FIGS. 33 through 36. In this situation the lower squeegee blade **195** of a descending building cleaning apparatus **48** may be moved inwardly fairly slowly and still come into contact with a window pane **77** essentially at the top thereof. For corresponding reasons in this same case the lower squeegee blade may travel essentially all the way down the window pane in contact therewith and then be pulled back or withdrawn therefrom without either it or sponge **182** or sensing roller **225** below it becoming bound on the lower sill.

A significant case which must be considered in addition to the foregoing is the one in which a building has inset windows with square sills, i.e., essentially horizontal sills. In this case the lower squeegee blade must be brought in very rapidly if it is to catch window pane **77** at or very close to its top, so fast in fact that there may be substantial danger of the glass being shattered by the blade. To avoid this danger, and it is important that it be avoided, the drive on the blade must be programmed or somehow restrained as by dash pots to cause or allow the blade to come in only rather slowly, just as in the case of a window with a slanting upper sill. For this reason it is not deemed that lower squeegee blade **195** or indeed any squeegee blade will be fully effective to wipe the strip of glass of a few inches vertical width or depth at the top of an inset window having square or horizontal sills. The resulting situation, i.e., the lack of squeegeeing or wiping of a horizontal strip of each window at its top is substantially alleviated according to the present invention by the air blast system described already in connection with FIGS. 33 through 36. This system, working through a plurality of air discharge tips, gives a prolonged blast of compressed air against the top horizontal strip of a window to blow the same dry, and is also effective in blowing moisture and loose soil off of the window's upper square sill.

Once lower squeegee blade **195** is in contact with the glass surface of a window having square sills, sponge **182** of course having come in contact with this glass shortly ahead of it, it may travel all of the way down the glass within the contemplation of the present invention. The only critical consideration here is that sensing roller **225** below both the lower squeegee blade and the sponge have a sufficiently large diameter or be sufficiently far back out of contact with the window glass surface that it will have no difficulty in running back off of the horizontal surface of the lower sill. Sponge **182** may come down flat on that surface as building cleaning apparatus **48** continues its descent and will simply be flexed upwardly toward the descending lower squeegee blade. Blade **195** and its mounting elements will come down on the sponge and tend to press the absorbed liquid out of it. There is no danger of the lower squeegee elements becoming bound on the lower sill of the window since the whole lower squeegee structure may swing upwardly around the axis of its hinge **190** in response to pressure from below. Of course this will be only a transient effect as the sponge and lower squeegee are pulled back by action of the control center triggered by the outward or backward movement of sensing roller **225** and cycling bar **224**.

As the sponge and lower squeegee are pulled back the sponge will make a strong wiping pass outwardly on the lower sill because of the downward pressure exerted on the sponge by the squeegee. The lower sill and to some extent the bottom horizontal strip of window glass may also be given a short blast of air to dry and clean them in keeping with the showing of FIG. 36. Primarily, however, the air blast system is relied upon to dry the upper sill and the top horizontal glass strip of a window having square sills, and not the lower sill and bottom horizontal glass strip. The latter surfaces may be adequately sponged and squeegeed as described above. Action by the lower squeegee to press liquid out of sponge **182** against the lower sill may be obtained to at least an appreciable extent in the cases of windows having sloping lower sills as well as in those of windows whose lower sills are square or horizontal. The pertinent timing arrangements especially as affecting the pulling back of the sponge and squeegee mechanism need just to be made at control center **380**. Thus it is within the contemplation of the present invention that each sponge of apparatus **48** will be essentially self-drying or self-cleaning after each usage on a window surface having even only a small amount of inset. Dirty liquid pressed out of a sponge will simply run down onto the still soiled external surfaces of a building in the path of the descending cleaning apparatus.

Referring again and finally to FIGS. 37, 38 and 39, building protrusions such as vertical T-beams **75** may tend to become discolored through oxidation or the accumulation of airborne dirt on them. Cleaning of these beams is effected through brushes **365** and **370** which are carried on motorized spindles **366**. The bristles of these brushes may be fed with an auxiliary cleaning liquid so as to perform a certain washing or scrubbing action as well as acting to burnish or polish. The particular conditions of cleaning will dictate the brush and bristle construction, the speed of operation of the brushes and also whether or not auxiliary cleaning material or fluid is required. It has been pointed out hereinbefore that the brushes and their motors are mounted so that they may be shifted out of the way of the various vertical beams on the face of the building as the cleaning apparatus is moved up or into the face of the building, and the brushes are also shiftable out of engagement with the vertical beams during the moving of cleaning apparatus **48** from one position to the next around the building. The control center **380** provides programmed operations for the various shifting or engaging and disengaging movements of rotary brushes **365** and **370**. For these and the several other programmed operations or timed movements entering into and characterizing the overall function of the building cleaning apparatus **48** each control center **380** will be individually designed within the established concepts to provide the sequence and duration of operations necssary for the individual building being cleaned.

CONCLUSION

There has thus been illustrated and described in considerable detail the structure and the mode of operation of an apparatus capable of being raised and lowered alongside a building, and with no personnel aboard effecting all necessary operations on the building to clean either or both the opaque and the window surfaces thereof, in-

cluding cleaning both outside and certain inside or recessed surfaces of at least some vertically oriented protrusions on the building which may serve as guidance means or tracks for the apparatus. Although no personnel need be present aboard the apparatus for the sake of its own operations, it is nevertheless capable of carrying them as a matter of convenience to allow direct and close inspection to be made visually of all portions of a building's exterior surface.

The apparatus includes power-operated positioning and clamping means for effecting its properly spaced or closely contiguous running relationship to a building to be cleaned, both in the in and out sense and the side to side sense. It has a washing liquid spray or dispensing system which is especially arranged to wet the surface of the building to be cleaned ahead of the apparatuses brush bristles to prepare the surface to be brushed or scrubbed, through these bristles or between groups of bristles to maintain the surface continuously moist during the brushing operation, and behind the brush bristles to leave the scrubbed surface in moist condition for a final removal of liquid-loosened and liquid-admixed soil by sponging and squeegeeing.

An especially significant feature of the invention as illustrated and described is its system of transversely reciprocable brushes which allow a vigorous scrubbing effect to be achieved on essentailly all of the outwardly-facing exterior surface of a building, particularly including the upper and lower portions of recessed windows and the associated sill surfaces at both top and bottom. Action of the brushes is enhanced in these somewhat hidden regions by having the brushes limitedly tiltable or pivotable on a horizontal axis or axes parallel to the face of the building, thus allowing the tips of the bristles to poke into most nooks and crannies around a window. Besides the transversely reciprocable brushes which might be considered to be main brushes, the rotary brushes for cleaning and burnishing vertical beams on the building surface are deemed an advance in the art, especially as they are installed on power-operated shiftable mountings to allow them to be engaged with or disengaged from a vertical beam or beams as appropriate in the course of shifting the whole apparatus from position to position around a building in the course of making successive cleaning runs or passes.

Another particularly notable feature of the present inventive apparatus is its air blast system, and more particularly the means for controlling the same to provide principally only a prolonged blast of air to blow dry the upper sill of a recessed window and the associated or adjacent narrow horizontal top strip of window glass. Of course the air blast system could be set to discharge air under pressure for liquid and loose soil removal all the way down a building, but for most of the building's exterior surface including its window glass areas this purpose may be adequately served by sponging and squeegeeing and, to be sure, evaporate drying. The glass region just at the top of a recessed window, particularly a window fairly deeply recessed on square sills, is very difficult to wipe both safely and adequately with an automatic squeezee as explained in detail hereinbefore, and of course the underside of a square upper sill is equally hard to squeegee properly. Thus air blasting or blowing away of loosened soil and free liquid is needed on those surfaces, and by having the air blast triggered or controlled to operate principally just at and on these surfaces a great economy in the generation and consumption of compressed air is achieved.

Novelty and an advance in the art are also to be found in the sponge and squeegee mechanism which is relied upon generally for the greater part of the removal of free liquid and liquid-loosened soil from the exterior surface of a building which has been scrubbed by the brush assembly of an apparatus according to this invention. The sponge effects a gross removal of loose and dirty liquid while the squeegee blade or blades perform, in effect, a polishing or finishing drying stroke of wiping, especially upon window glass areas in the path of travel of the apparatus as the squeegee mechanism moves horizontally in and out to follow the contour of the building. The sponge is carried on this movable or shiftable mechanism, and by its closely spaced positioning below a squeebee blade and/or blade holder it is caused to be pressed out substantially free of liquid on successive lower window sills. This self-clearing or self-drying feature of the sponge is of considerable practical utility.

The present invention may be embodied in more than one particular form without departing from its spirit or essential characteristics. Therefore the embodiment herein pictured and described in detail is to be considered illustrative and not restrictive, and since the scope of the invention is defined by the claims hereinafter set forth all variations, modifications and changes which fall within the metes and bounds of these claims or which form their functional as well as conjointly cooperative equivalents are thus intended to be embraced by the claims.

Accordingly, protection by Letters Patent of this ininvention in all its aspects as the same are set forth in the appended claims is sought to the broadest extent that the prior art allows.

I claim as my invention:

1. A building cleaning apparatus configured to move generally vertically parallel to the exterior surface of a building in close contiguity therewith, said apparatus comprising (1) a mechanism support framework, (2) a liquid dispensing system mounted on said framework and disposed to discharge washing liquid under pressure against said exterior surface of said building, (3) at least one brush assembly and driving means therefor mounted on said framework, said assembly being movable on said framework with its bristles in contact with said exterior surface of said building so as to provide a scrubbing action upon said surface wetted by said washing liquid, (4) an air blast system mounted on said framework and disposed to discharge air under pressure against said exterior surface of said building above said brush assembly to blow loose liquid and soil from off of said surface after the same has been wetted and scrubbed, said air blast system including means for sensing variations in contour of said exterior surface of said building and controlling the system thereby to turn on the discharge of air principally only to provide a prolonged blast to blow dry the upper sill of an indented window and a narrow top horizontal strip of window glass, and (5) a squeegee mechanism mounted on said framework above said liquid dispensing system and said brush assembly and also above the line of discharge of said air blast system, said squeegee mechanism including at least one squeegee blade disposed horizontally to wipe at least some of said exterior surface of said building after the same has been scrubbed.

2. A building cleaning apparatus according to claim 1 in which said means for sensing variations in the contour of said building controls said air blast system to additionally provide a short blast to blow dry the lower sill of an indented window.

3. A building cleaning apparatus according to claim 1 in which said squeegee blade is movable on said framework and in said squeegee mechanism toward and away from said exterior surface of said building, and further comprising means as part of said squeegee mechanism for sensing variations in contour of said surface and generating signals corresponding to the same and control means adapted to receive such signals and in turn generate power signals to move said squeegee blade automatically toward the transparent areas of an indented window at the upper sill thereof and away from it at its lower sill.

4. A building cleaning apparatus according to claim 3 which further comprises a sponge mounted on said frame-

work and disposed horizontally below said squeegee blade and above said brush assembly to wipe at least some of said exterior surface of said building after the same has been scrubbed and before it is squeegeed.

5. A building cleaning apparatus according to claim 4 in which said sponge is disposed closely below said squeegee blade to be pressed out by said blade as it, said sponge, is deflected upwardly as by a window sill.

6. A building cleaning apparatus according to claim 4 in which said sponge and said squeegee blade are together movable on said framework and in said squeegee mechanism toward and away from said exterior surface of said building to follow the contour of said surface.

7. A building cleaning apparatus according to claim 3 in which said squeegee blade is resiliently mounted on said framework and in said squeegee mechanism to allow it to to swing upwardly in response to pressure from below such as that exerted upon it by a window sill and then return to a normal wiping attitude upon the relieving of said pressure.

8. A building cleaning apparatus configured to move generally vertically parallel to the exterior surface of a building in close contiguity therewith, said apparatus comprising (1) a mechanism support framework, (2) a liquid dispensing system mounted on said framework and disposed to discharge washing liquid under pressure against said exterior surface of said building, (3) at least one brush assembly and driving means therefor mounted on said framework, said assembly being movable from side to side on said framework with its bristles in contact with said exterior surface of said building so as to provide a transverse reciprocating scrubbing action upon said surface wetted by said liquid, and (4) power-driven rotary brush means mounted on said framework and disposed to have its bristles in contact with protrusions on said exterior surface of said building extending in the direction of travel of said cleaning apparatus and serving as guidance means for said apparatus to clean and burnish at least certain surfaces of these protrusions.

9. A building cleaning apparatus configured to move generally vertically parallel to the exterior surface of a building in close contiguity therewith, said apparatus comprising (1) a mechanism support framework, (2) a liquid dispensing system mounted on said framework and disposed to discharge washing liquid under pressure against said exterior surface of said building, (3) at least one brush assembly and driving means therefor mounted on said framework, said assembly being movable from side to side on said framework with its bristles in contact with said exterior surface of said building so as to provide a transverse reciprocating scrubbing action upon said surface wetted by said washing liquid, and (4) an air blast system mounted on said framework and disposed to discharge air under pressure against said exterior surface of said building substantially on a line above said brush assembly to blow loose liquid and soil from off of said surface after the same has been wetted and scrubbed, the fluid discharge means of both said liquid dispensing system and said air blast system being mounted to perform side-to-side reciprocating movement with said brush assembly, and further said brush assembly and the fluid discharge means of both said liquid dispensing system and said air blast system being mounted on said framework to be movable toward and away from said exterior surface of said building according to changes in contour thereof.

10. A building cleaning apparatus according to claim 9 which further comprises means for sensing variations in contour of said exterior surface of said building and controlling said air blast system thereby to turn on the discharge of air principally only to provide a prolonged blast to blow dry the upper sill of an indented window and a narrow top horizontal strip of window glass.

11. A building cleaning apparatus according to claim 10 in which said means for sensing variations in the contour of said building controls said air blast system to additionally provide a short blast to blow dry the lower sill of an indented window.

12. A building cleaning apparatus configured to move generally vertically parallel to the exterior surface of a building in close contiguity therewith, said apparatus comprising (1) a mechanism support framework, (2) a liquid dispensing system mounted on said framework and disposed to discharge washing liquid under pressure against said exterior surface of said building, (3) at least one brush assembly and driving means therefor mounted on said framework, said assembly being movable from side to side on said framework with its bristles in contact with said exterior surface of said building so as to provide a transverse reciprocating scrubbing action upon said surface wetted by said washing liquid, (4) a squeegee mechanism mounted on said framework above said liquid dispensing system and said brush assembly, said squeegee mechanism including (i) at least one squeegee blade disposed horizontally to wipe at least some of said exterior surface of said building after the same has been scrubbed and (ii) retaining means for said blade, and (5) a sponge having essentially the same length as said squeegee blade mounted on said framework horizontally between said squeegee blade and said brush assembly therebelow to wipe at least some of said exterior surface of said building after the same has been scrubbed and before it is squeegeed, said sponge being disposed closely below said squeegee blade and having extensively exposed upper and lower surfaces to be pressed out by said blade and the retaining means therefor as it, said sponge, is deflected upwardly as by a window sill.

13. A building cleaning apparatus according to claim 12 in which said squeegee blade and the retaining means therefor are movable on said framework and in said squeegee mechanism toward and away from said exterior surface of said building, and further comprising means as part of said squeegee mechanism for sensing variations in contour of said surface and generating signals corresponding to the same and control means adapted to receive such signals and in turn generate power signals to move said squeegee blade retaining means and said squeegee blade toward and away from said surface according to a predetermined program of surface wiping.

14. A building cleaning apparatus according to claim 12 in which said squeegee mechanism includes (i) a first squeegee blade disposed horizontally to wipe the opaque areas of said exterior surface of said building where said building is characterized by indented windows, (ii) retaining means for said first squeegee blade, (iii) a second squeegee blade, wherebelow said sponge is closely disposed, disposed horizontally to wipe the surfaces of said windows, and (iv) retaining means for said second squeegee blade, this squeegee blade retaining means and said second squeegee blade being movable on said framework and in said squeegee mechanism toward and away from said exterior surface of said building, and further comprising means as part of said squeegee mechanism particularly associated with said second squeegee blade and the retaining means therefor for sensing variations in contour of said surface and generating signals corresponding to the same and control means adapted to receive such signals and in turn generate power signals to move said second squeegee blade retaining means and said second squeegee blade automatically toward the transparent areas of said indented windows at the supper sills thereof and away from them at their lower sills.

15. A building cleaning apparatus according to claim 14 in which said first squeegee blade and the retaining means therefor are disposed above said second squeegee blade and its retaining means.

16. A building cleaning apparatus according to claim 14 in which said first squeegee blade and the retaining means therefor are movable on said platform and in said squeegee mechanism toward and away from said exterior

surface of said building, and further comprising means as part of said squeegee mechanism particularly associated with said first squeegee blade and the retaining means therefor for sensing variations in contour of said surface and generating signals corresponding to the same and control means adapted to receive such signals and in turn generate power signals to move said first squeegee blade retaining means and said first squeegee blade automatically to follow essentially the full surface contour of said building.

17. A building cleaning apparatus according to claim **12** in which said sponge, said squeegee blade retaining means and said squeegee blade are together movable on said framework and in said squeegee mechanism toward and away from said exterior surface of said building to follow the contour of said surface.

18. A building cleaning apparatus according to claim **12** in which said squeegee blade and the retaining means therefor are resiliently mounted on said framework and in said squeegee mechanism to allow them to swing upwardly in response to pressure from below such as that exerted upon them by a window sill and then return to a normal wiping attitude upon the relieving of said pressure.

19. A building cleaning apparatus configured to move generally vertically parallel to the exterior surface of a building in close contiguity therewith, said apparatus comprising (1) a mechanism support framework, (2) a liquid dispensing system mounted on said framework and disposed to discharge washing liquid under pressure against said exterior surface of said building, (3) at least one brush assembly and driving means therefor mounted on said framework, said assembly being movable on said framework with its bristles in contact with said exterior surface of said building so as to provide a scrubbing action upon said surface wetted by said washing liquid, and (4) clamping and positioning means mounted on said framework, said means being disposed and configured to engage with protrusions on said exterior surface of said building extending in the direction of travel of said cleaning apparatus to retain the apparatus in close contiguity with said building surface while allowing it to move freely in a guided manner with respect thereto and including (i) two header elements mounted on said framework in horizontally spaced relation and in a manner allowing each at least a limited amount of rotational freedom around both vertical and horizontal axes with respect to said framework, (ii) a pair of substantially cylindrical and edged rollers mounted in parallel, spaced relation on each of said headers, the rollers of each pair of rollers being adapted to fit around a building protrusion in running engagement therewith and in skewed condition to bind on the same, (iii) resilient means biasing each of said headers to swing it around a vertical axis toward said building exterior surface, and (iv) actuating means engaged with each of said headers and adapted to rotate it around a horizontal axis.

20. A building cleaning apparatus configured to move generally vertically parallel to the exterior surface of a building in close contiguity therewith, said apparatus comprising (1) a mechanism support framework, (2) at least one flat-faced brush assembly and driving means therefor mounted on said framework, said assembly being movable from side to side on said framework with its bristles in contact with the exterior surface of said building so as to provide a transverse reciprocating scrubbing action upon said surface, and said brush assembly being additionally movable on said framework toward and away from said exterior surface of said building and further being pivotable through a limited angle around a horizontal axis, (3) a liquid dispensing system mounted on said framework and including outlet elements disposed to discharge washing liquid under pressure against said exterior surface of said building just below, through and just above said brush assembly wetting the surface scrubbed by said assembly, said outlet elements of said dispensing system being movable on said framework toward and away from said exterior surface of said building and further being pivotable through a limited angle around a horizontal axis all in keeping with similar movements of said brush assembly, (4) means for sensing variations in contour of said exterior surface of said building and generating signals corresponding to the same, and (5) control means adapted to receive such signals and in turn generate power signals to move said brush assembly and said outlet elements of said liquid dispensing system automatically toward and away from said surface according to a predetermined program of surface cleaning.

21. A building cleaning apparatus according to claim **20** in which said outlet elements of said liquid dispensing system are movable from side to side and which includes driving means for those elements to cause them to perform transverse reciprocating movement in keeping with similar movement of said brush assembly.

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