United States Patent

Thornton-Trump

[15] **3,680,164**

[45] **Aug. 1, 1972**

[54] **LOW LEVEL WASHING AND DUSTING APPARATUS FOR AIRCRAFT AND THE LIKE**

[72] Inventor: **Walter Edward Thornton-Trump,** 1544 Knareswood Dr., Port Credit, Ontario, Canada

[22] Filed: **June 11, 1970**

[21] Appl. No.: **45,394**

[30] **Foreign Application Priority Data**

June 12, 1969 Great Britain.....29,960/69

[52] **U.S. Cl.**.....**15/21 E,** 15/DIG. 2, 15/49 C

[51] **Int. Cl.**.....**B60s 3/06**

[58] **Field of Search**...15/21 R, 21 D, 21 E, 49, 49 C, 15/50, 50 C, 97, 98, 320

[56] **References Cited**

UNITED STATES PATENTS

3,460,177 8/1969 Rhinehart et al.....15/21 E

3,439,372 4/1969 Collier.....15/21 E

FOREIGN PATENTS OR APPLICATIONS

1,038,924 8/1966 Great Britain.....15/49 C

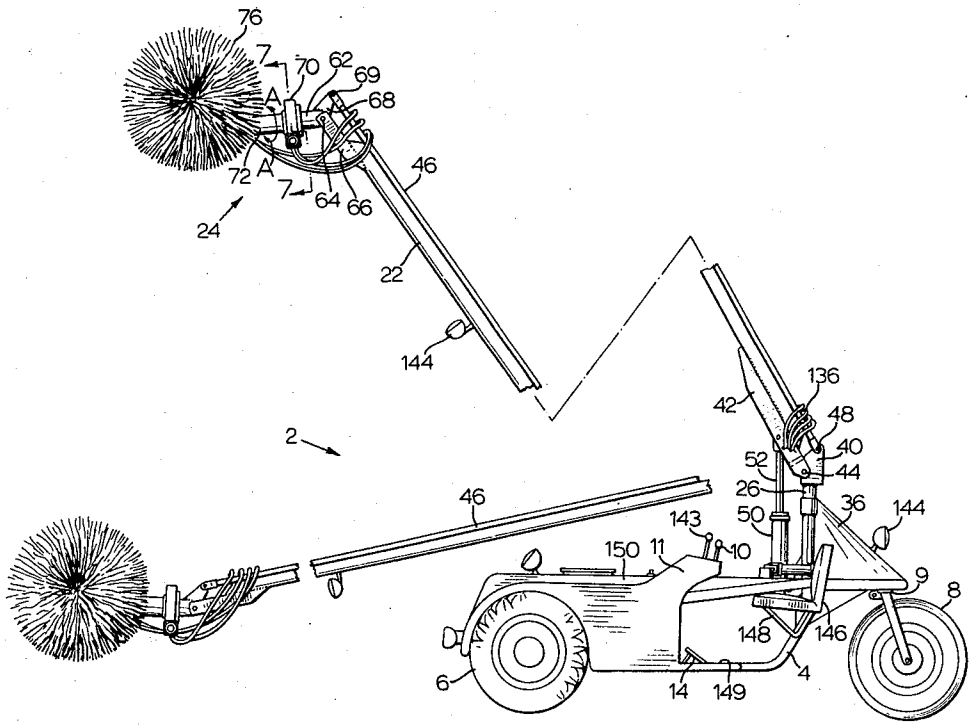
Primary Examiner—Edward L. Roberts

Attorney—Zarley, McKee & Thomte

[57] **ABSTRACT**

An aircraft washing and dusting device consisting of a small three wheeled vehicle having a boom that can be raised and lowered, with a brush on the end of the boom. The brush consists of two large diameter cylindrical halves spaced slightly apart along an axle. The axle is journelled in a housing and is rotated hydraulically, and the housing is mounted on the end of the boom for rotation by another hydraulic motor) about an axis perpendicular to the axis of the axle. The housing and brush are levelled by a levelling rod as the boom is raised and lowered. By rotation of the housing the brush can wash vertical surfaces, the underside of horizontal surfaces, and sloping surfaces.

12 Claims, 8 Drawing Figures



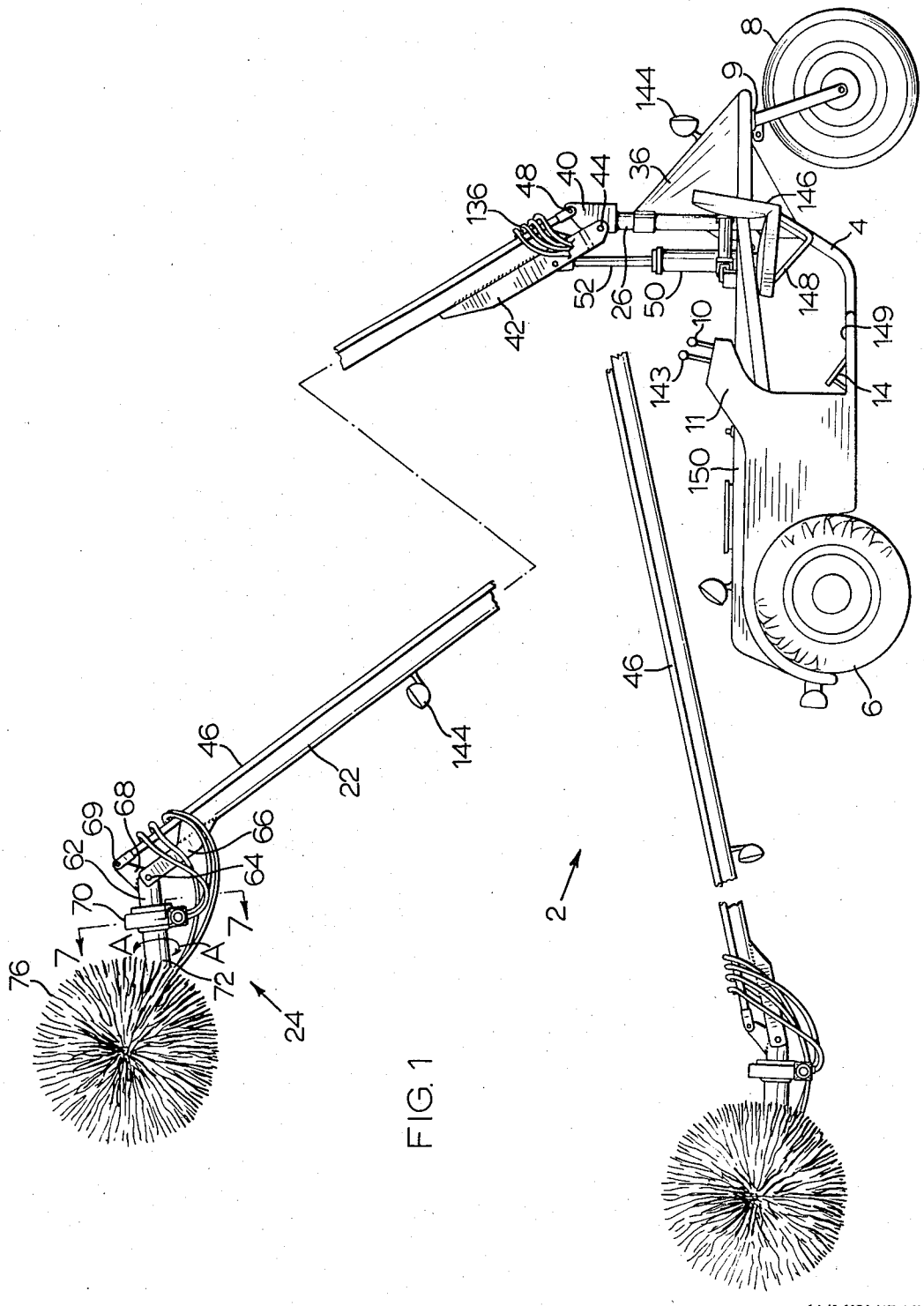


FIG. 1

INVENTOR.
WALTER E. THORNTON-TRUMP
BY Rogers, Bereskin, & Parr

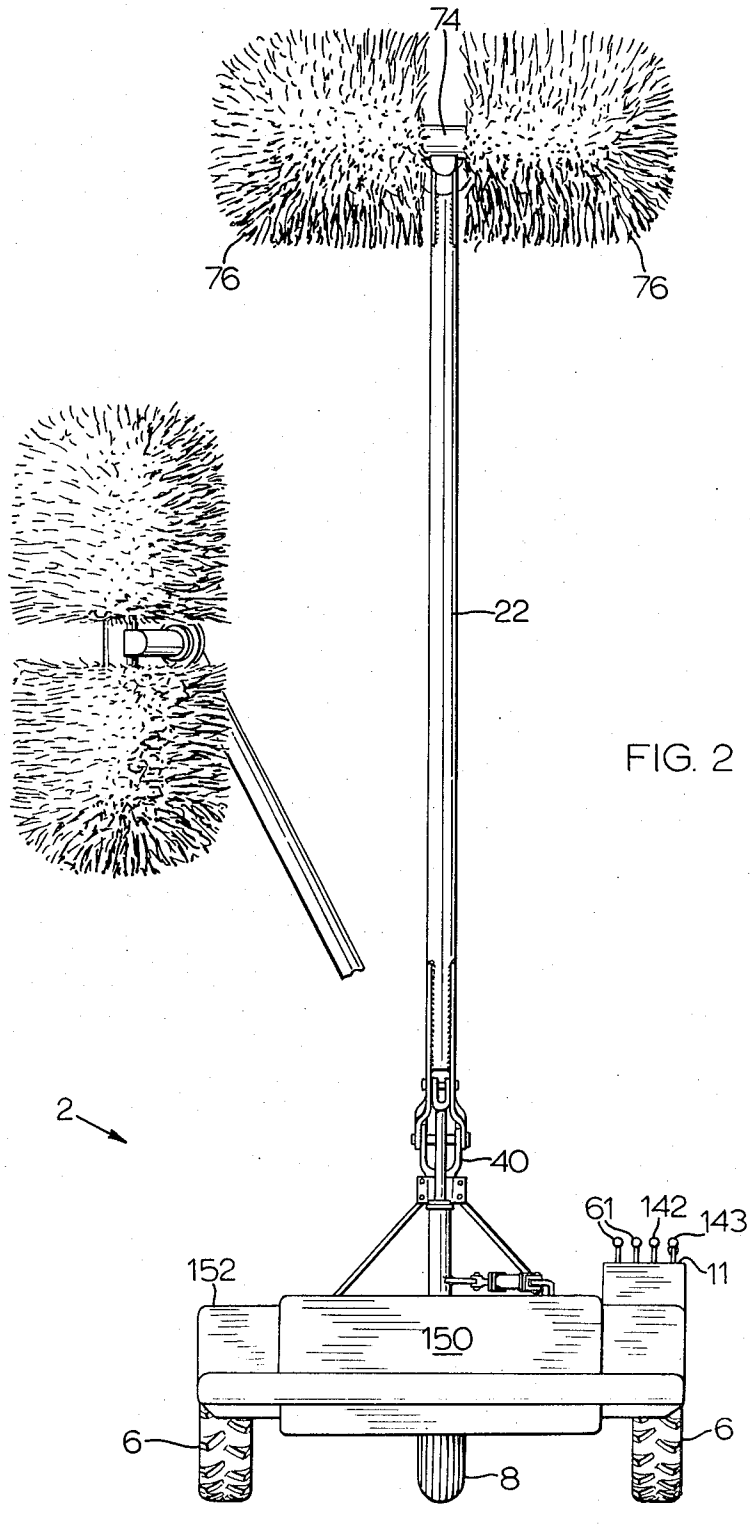


FIG. 2

INVENTOR.
WALTER E. THORNTON-TRUMP
BY Rogers, Bereskin, & Parr

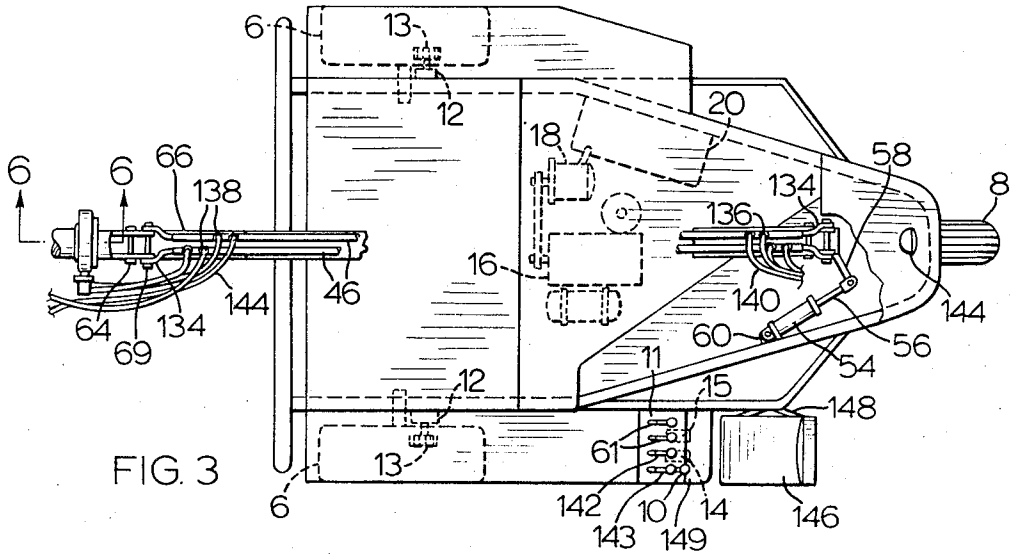


FIG. 3

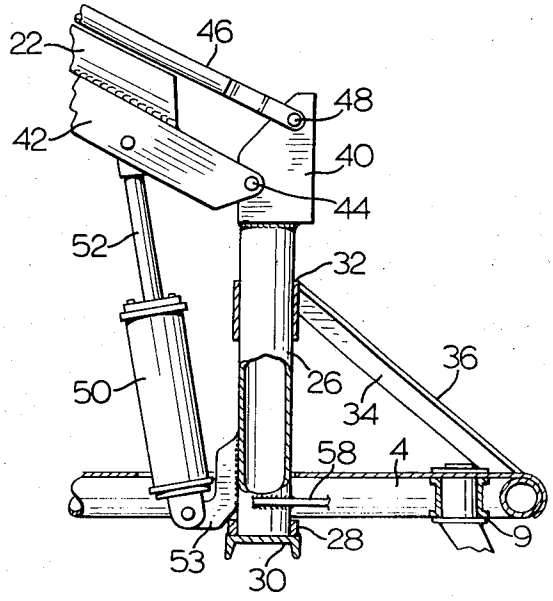


FIG. 4

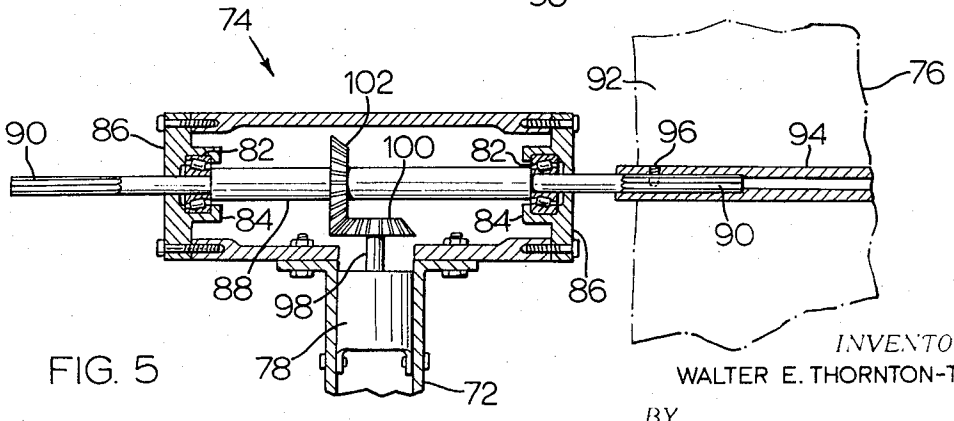


FIG. 5

INVENTOR.
WALTER E. THORNTON-TRUMP
BY Rogers, Bereskin, & Parr

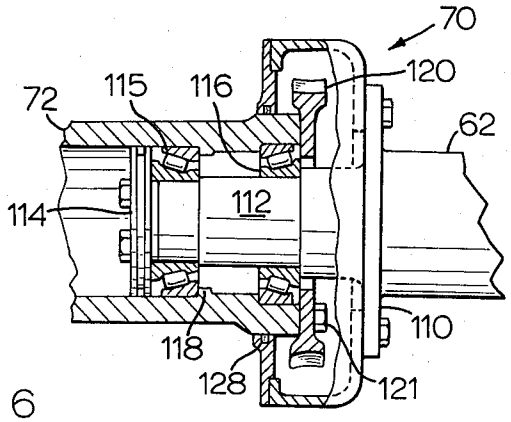


FIG. 6

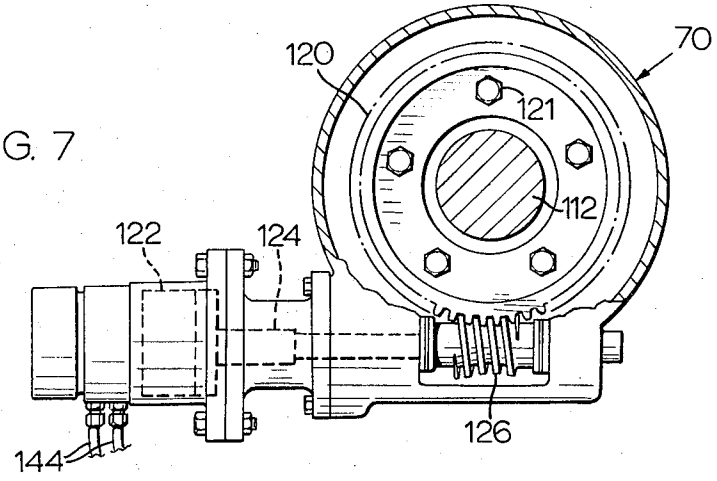


FIG. 7

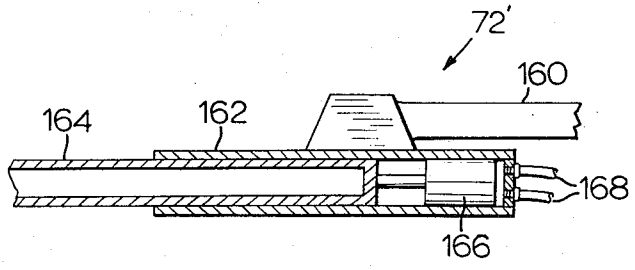


FIG. 8

INVENTOR.
WALTER E. THORNTON-TRUMP
BY Rogers, Bereskin, & Parr

LOW LEVEL WASHING AND DUSTING APPARATUS FOR AIRCRAFT AND THE LIKE

This invention relates to washing and dusting apparatus, and more particularly, it relates to washing and dusting apparatus suitable for use on the lower surfaces of aircraft.

Washing aircraft has in the past presented serious problems. It has been impossible to provide simple assembly-line apparatus equivalent to an automobile car wash, because aircraft differ much more widely than automobiles in size and shape. The practice in the past has been largely manual operation. Attempts have been made to build aerial powered brush devices, but these have generally proved unworkable because of their high cost and complex nature, and because of their bulk, which made them difficult to maneouver in cramped quarters beside and beneath an aircraft.

Accordingly, the present invention in a preferred embodiment provides a simple cylindrical brush mounted on the end of a boom for brush rotation in two mutually perpendicular directions, with levelling means provided to keep the orientation of the brush constant as the boom is raised and lowered. In a preferred embodiment of the invention, the boom is part of a small self-propelled three-wheeled vehicle of the type commonly used in orchards, thus providing an inexpensive and extremely maneouverable combination highly suitable for use in washing and dusting the lower portions of aircraft.

Further objects and advantages of the invention will appear from the following description, taken together with the accompanying drawings, in which:

FIG. 1 is a side view of apparatus according to the invention, showing the boom and brush in two different positions;

FIG. 2 is a front view of the machine of FIG. 1;

FIG. 3 is a top view of the machine of FIG. 3;

FIG. 4 is a side sectional view showing how the boom of FIG. 1 is mounted on the chassis of a vehicle;

FIG. 5 is a sectional view showing the details of the brush mounting of the machine of FIG. 1;

FIG. 6 is a sectional along lines 6—6 of FIG. 3;

FIG. 7 is a section along lines 7—7 of FIG. 1; and

FIG. 8 is a partly sectional view showing a modification of the invention.

Reference is first made to FIGS. 1 to 3, which show a brush according to the invention mounted on a self-propelled three-wheeled vehicle of the type described and illustrated in my Canadian Pat. No. 647,340 issued Aug. 28, 1962. The vehicle, indicated generally at 2, includes a frame 4 (FIGS. 1 and 3) shaped generally in the form of a V as viewed from above and made of tubular steel. Mounted on the frame 4 are a pair of spaced front drive wheels 6 and a rear wheel 8 pivotally mounted at 9. The wheel 8 is hydraulically steered by means (not shown) controlled by a steering lever 10 on a control panel 11. The front drive wheels 6 are driven by individual hydraulic motors 12 FIG. 3) mounted on the frame and carrying spur gears 13 which engage in rim gears (not shown) around the inside periphery of the hubs of wheels 6. The motors 11 are controlled in unison by an on-off foot pedal 14. The direction of the motors 11 (for forward or reverse) is controlled by a foot pedal 15 (FIG. 3) which provides forward motion when up and reverse motion when depressed.

The vehicle 2 is typically powered by an internal combustion engine 16 (FIG. 3) driving a hydraulic pump 18 which pressurizes the oil from a tank 20. The high pressure oil delivered by the pump 18 is used to operate the hydraulic motors 12 to drive the wheels 6 and is also used to power a boom 22 and brush assembly 24 now to be described.

The boom is mounted at the rear end of the machine, by means of an upstanding mast 26 (FIGS. 2, 4). The mast 26 is rotatably supported in a bottom collar 28 which in turn is mounted on a transverse cross member 30 extending between the tubular side frame members of the vehicle. The mast 26 is rotatably supported near its upper end by a collar 32. The collar 32 is supported by a downwardly and forwardly sloping beam 34 welded to the frame 4 at the apex of the frame and covered by a sloping hood 36 shaped generally in the form of a semi-cone.

The top of the mast 26 includes a forked extension 40. The boom 22 is mounted on the extension 40 by a pair of lower plates 42 secured to the bottom end of the boom. The plates 42 overlap the forked extension 40 and are secured thereto by a pin 44. A pair of levelling rods 46 are also secured to the forked extension 40 by a pin 48.

The boom 22 is raised and lowered by a cylinder 50 containing a piston having its piston rod 52 pivotally connected to the lower part of the boom between the plates 42. As shown in FIG. 4, the lower end of the cylinder 50 is pivotally secured to a plate 53 welded to the rotatable mast 26 above the collar 28, so that the cylinder 50 is free to rotate with the mast, thus enabling the boom 22 to be swung from side to side.

Side to side movement of the boom is provided by a cylinder 54 (FIG. 3) containing a piston having its piston rod 56 pivotally connected to a lever 58 secured to the mast 26. The base of the piston 54 is pivotally mounted at 60 to the frame of the vehicle. The piston and cylinder 54 enables side to side swinging of the boom 22 by about 30° on either side of the central position shown in FIG. 3. Up and down and side to side movements of the boom are controlled by control levers 61 which operate control valves controlling the flow of oil to the cylinders 50, 54 50; 54.

The brush assembly 24 at the upper end of the boom will next be described. Generally, the assembly includes a first arm 62 (FIG. 1) pivotally connected by a pin 64 to a pair of plates 66 extending from the upper end of the boom. The arm 62 includes an upwardly extending leg 68 pivotally connected by a pin 69 to the levelling rod 46, so that the orientation of the arm 62 will be kept constant as the boom is raised and lowered. The pins 44, 48, 64, 69 define a parallelogram for this purpose.

The first arm 62 includes at its free end a hydraulic motor and worm gear housing 70, to which is connected a second arm 72. The second arm 72 is rotatable about its axis as indicated by arrows A—A (FIG. 1) and is driven by a hydraulic motor in housing 70, as will be described. Mounted on the free end of the second arm 72 is a brush connecting assembly 74 (FIGS. 2, 5) which connects and rotatably supports a pair of generally cylindrical brushes 76. The brushes 76 are each about 3 feet in diameter and 3 feet long.

The details of the brush connecting assembly **74** are best shown in FIG. **5**. As shown in FIG. **5**, the connecting assembly **74** includes a hydraulic motor **78** bolted inside the free end of the second arm **72**. The assembly **74** also includes a housing **80** bolted to the free end of the arm **72**. The housing **80** contains conventional tapered roller bearings **82** secured in mounts **84** forming part of housing end plates **86**. The bearings **82** rotatably retain a stepped shaft **88** which projects about 7 inches from each end of the housing **80**. The projecting ends of the shaft **88** are splined as shown at **90**.

Each brush **76** includes a deep pile **92** secured to a central tubular shaft **94**. THe inside surface of the shaft **94** is broached at its inner end so that it fits non-rotatably on the splines **90** at the ends of the shaft **88**, and the shaft **94** is secured to the shaft **88** by set screws **96**.

Drive for the brushes **76** is provided by a shaft **98** from the hydraulic motor **78**. Shaft **98** carries a bevel gear **100** which engages a bevel gear **102** mounted on the shaft **88**. In practice, the brushes **76** will typically be driven at a speed of between 60 and 120 rpm.

Reference is next made to FIGS. **6** and **7**, which show the mechanism for rotating the second arm **72** relative to the first arm **62**. As shown, secured to the first arm **6** is a plate **110** forming part of the housing **70**. Projecting from the plate **110** is a stepped shaft **112** having another plate **114** bolted to its free end. The shaft **112** is rotatably held in fixed axial relation to the arm **72** by a pair of tapered roller bearings **115**, **116**. Roller bearing **115** is held between the plate **114** and a flange **118** in the inner surface of the arm **72**, while the roller bearing **116** is located in a recess in the end of the arm **72** and is held in position by a gear wheel **120** held to the end face of the arm **72** by bolts **121**.

The gear wheel **120** is driven by a hydraulic motor **122** (FIG. **7**) mounted in the housing **70**. A shaft **124** extends from the hydraulic motor and mounts a worm gear **126** which engages the teeth of the gear wheel **120**, so that when hydraulic motor **122** is actuated, the gear wheel **120** and the entire arm **72** will rotate about their common axis. Seals **128** between the housing **70** and the arm **72** prevents oil from leaking from the housing **70**. The rotation of the arm **72** is typically limited (by stops, not shown) to about 120° on either side of the position shown in FIG. **1**, to prevent damage to the oil lines leading to the brush rotation motor **78**.

If desired, the arrangement shown in FIGS. **6** and **7** could be reversed, i.e. the wheel gear **120** could be mounted on the end of the first arm **62**, and the housing **70** and hydraulic motor **122** could be mounted on the second arm **72**.

Oil is delivered to the hydraulic motor **122** to rotate the arm **72**, and to the hydraulic motor **78** to drive the brushes **76**, via the levelling rods **46**. To this end, each levelling rod **46** consists of two concentric pipes, one inside the other. The ends of the pipes of each levelling rod are sealed and are held by connecting fittings **134** at each end, so that they can be pivotally connected to the mast extension **40** and to the first arm **62**. Fittings **136**, **138** are welded to the pipes so that oil can be conducted into and from the pipes. Four oil lines **140** are connected to the lower fittings **136**. Two of the oil lines **140** are the pressure and return lines for the brush positioning motor **78** and extend to a control valve (not shown) operated by a control lever **142**, and then to the oil tank **20** and pump **18**. The remaining two oil lines **140** are for brush rotation, the direction of which is always the same, and one of these oil lines extends directly to the tank **20**, while the other extends to a control valve (not shown) operated by a control lever **143** and then extends to the oil pump **18**. Similar oil lines **144** (FIG. **3**) are provided at the top fittings **138** of the levelling rod and extend to the hydraulic motors **122**, **78**.

Lights **144** are provided on the vehicle and on the boom to assist the operator in event of night operation. The operator will normally sit on a seat **146** mounted by struts **148** to the frame of the machine. The seat **146** is positioned so that the operator's hands will reach the control levers **10**, **61**, **142** and **143**, and so that his feet will reach the foot pedals **14**, **15** to control the forward and rearward motion of the machine. The pedals **14**, **15** are mounted on a floor **149**.

The front portion of the vehicle will preferably contain a tank **150** which contains a detergent solution. A cabinet **152** at the side of the machine contains a detergent hose and gun.

In use, the vehicle will typically be driven to a location beneath or adjacent the lower surfaces of an aircraft to be washed. An attendant will then remove the detergent hose and gun from the cabinet (the detergent hose is connected to the tank **150**) and spray the surfaces of the aircraft to be washed. A detergent pump, not shown, will be provided in the vehicle for this purpose. The operator, sitting on the seat **146**, will then operate control handles **61** to raise and swing the boom to the required position, and he will then operate the brush positioning lever **142** to rotate the brush about the axis of the arm **72** until the longitudinal axis of the brush lies parallel to the surface to be washed. He will then operate the brush on-off lever **143** to initiate brush rotation and will then swing the boom until the brush engages the surface of the aircraft. The operator will then move the vehicle and the boom so as to move the brush over the lower surfaces of the aircraft, i.e., over the under surfaces of the wing and tail wing and over the lower part of the fuselage, typically up to the windows. The ready maneuverability of the machine, together with the deep pile adjustable position brush, facilitate fast and efficient washing or dusting of the aircraft.

If desired, the arm **72** can be made telescopic, as shown in FIG. **8**, where primed reference numerals indicate parts corresponding to those of FIGS. **1** to **7**. The only difference between the FIG. **8** embodiment and the embodiment previously described is that in FIG. **8**, the arm **72'** includes an inner portion **160** connected in the manner shown in FIGS. **6**, **7** to the arm **62**, and a tubular housing **162** extending parallel to the portion **160** and rigidly connected thereto. The tubular housing **162** slidably houses a tube **164** which can be extended from or retracted into the housing **162** by a cylinder **166** connected to the housing **162**. The cylinder **166** contains a piston having its rod connected to the tube **164** to provide the desired stroke which will typically be 3 or 4 feet. Power is provided through hoses **168**. The top of tube **164** is connected to the brushes in the same manner as shown for the tip of arm **72** in the FIGS. **1** to **7** embodiment.

If desired, the hydraulic system for the machine may include relief valves for the lift and swing cylinders **50**, **54** (and also for the brush positioning hydraulic motor **78**), to limit excessive pressure on the aircraft surfaces being washed. In addition, if desired a sensing servo system may be installed to control the operation of the lift and swing cylinders **50**, **54**, and of the brush positioning motor **78**, and of the movement of the vehicle, so that the brush will automatically track along the aircraft surfaces, thus reducing the amount of control needed by the operator.

What I Claim As My Invention Is:

1. Aircraft washing and dusting apparatus comprising:

a. a boom,

b. means supporting said boom for up and down movement of said boom, and power means for raising and lowering said boom,

c. an arm mounted at the end of said boom,

d. generally cylindrical brush means having a longitudinal axis,

e. mounting means mounting said brush means on said arm for rotation of said brush means about its longitudinal axis and for rotary movement of said brush means about a second axis substantially perpendicular to said longitudinal axis,

f. said mounting means including first motor means for rotating said brush about its longitudinal axis, a second motor means for rotating said brush about said second axis,

g. and levelling means for **5** the orientation of said arm constant as said boom is raised and lowered.

2. Apparatus according to claim **1** wherein said brush means comprises two cylindrical brush portions, connecting means located between and connecting said brush portions with said brush portions being in coaxial and axially spaced relation, said mounting means including a second arm connected to said connecting means and extending at right angles to the axis of said brush portions, the extent of said connecting means in a direction radially of said brush portions being substantially less than the diameter of said brush portions.

3. Apparatus according to claim **2** wherein said connecting means comprises a shaft coaxial with said brush portions and connecting the same, a housing having means journalling said shaft for rotation in said housing, said housing being connected to said second arm, said first motor means being located adjacent the connection of said housing with said second arm, and gear means connecting said shaft with said first motor means.

4. Apparatus according to claim **3** wherein said first motor means is a hydraulic motor.

5. Apparatus according to claim **2** wherein said mounting means includes means mounting said second arm on said first arm for rotation of said second arm relative to said first arm about said second axis.

6. Apparatus according to claim **4** wherein said means mounting said second arm on said first arm includes a wheel gear mounted on and coaxial with one of said arms, and a worm gear engaging said wheel gear, said second motor means being mounted on the other of said arms and being drivingly connected to said worm gear.

7. Apparatus according to claim **2** wherein said means for levelling said first arm comprises a levelling rod connected to said first arm and to said means supporting said boom.

8. Apparatus according to claim **2** wherein said means for levelling said first arm comprises a levelling rod connected to said first arm and to said means supporting said boom, said first and second motor means being hydraulic motors, said levelling rod comprising at least three fluid conduits for conducting hydraulic fluid to and from said motors.

9. Apparatus according to claim **2** wherein said means supporting said boom comprises a three wheeled vehicle, said vehicle having a forward end having two independently driven wheels mounted thereon, and a rear end having a central caster mounted wheel thereon, said boom being mounted near said rear end for side to side swinging movement.

10. Apparatus according to claim **2** wherein said means supporting said boom comprises a three wheeled vehicle, said vehicle having a forward end having two independently driven wheels mounted thereon, and a rear end having a central caster mounted wheel thereon, said boom being mounted near said rear end for side to side swinging movement, said apparatus further including first control means for controlling operation of said boom and vehicle and second control means for controlling operation of said brush, said first control means including a set of hand control levers and said second control means including a pair of foot pedals, and an operator seat positioned on said vehicle for an operator sitting on said seat to reach both said levers and said pedals.

11. Apparatus according to claim **2** wherein said brush portions are each approximately 3 feet in length and 3 feet in diameter, and the spacing between said brush portions is between 6 and 12 inches.

12. Aircraft washing and dusting apparatus comprising:

a. a housing having first and second ends,

b. a rotatable shaft means in said housing having first and second ends extending outwardly through said first and second ends of said housing respectively,

c. first and second cylindrical brushes secured to said first and second ends of said shaft means respectively, said brushes having a diameter substantially greater than the diameter of said housing,

d. a tubular arm means rigidly secured at one end to said housing and extending in a direction at right angles to the axis of said brushes,

e. a motor means enclosed in said tubular arm means at said one end operatively connected to said shaft means in said housing for rotating said brushes about the axis thereof,

f. a second housing secured to the other end of said tubular arm means,

g. a second arm means secured to said second housing and being disposed in a parallel relationship to said tubular arm means and being rotatable with respect thereto,

h. and a second motor means in said second housing for rotating said tubular arm means about a second axis perpendicular to the axis of said brushes.

* * * * *