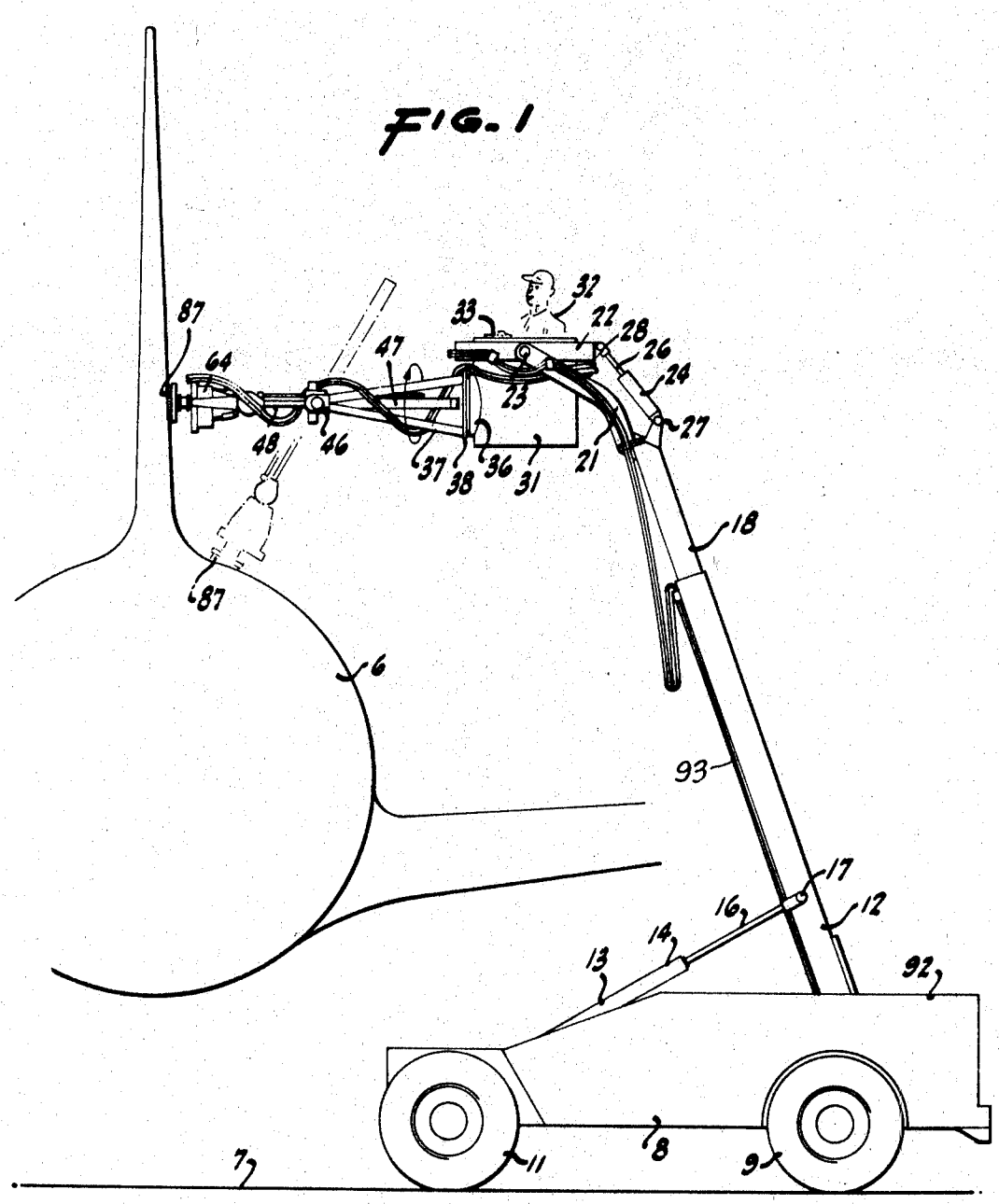
April 22, 1969 D. C. COLLIER 3,439,372

AIRPLANE WASHING DEVICE

Filed July 10, 1967 Sheet 1 of 4

FIG. 1



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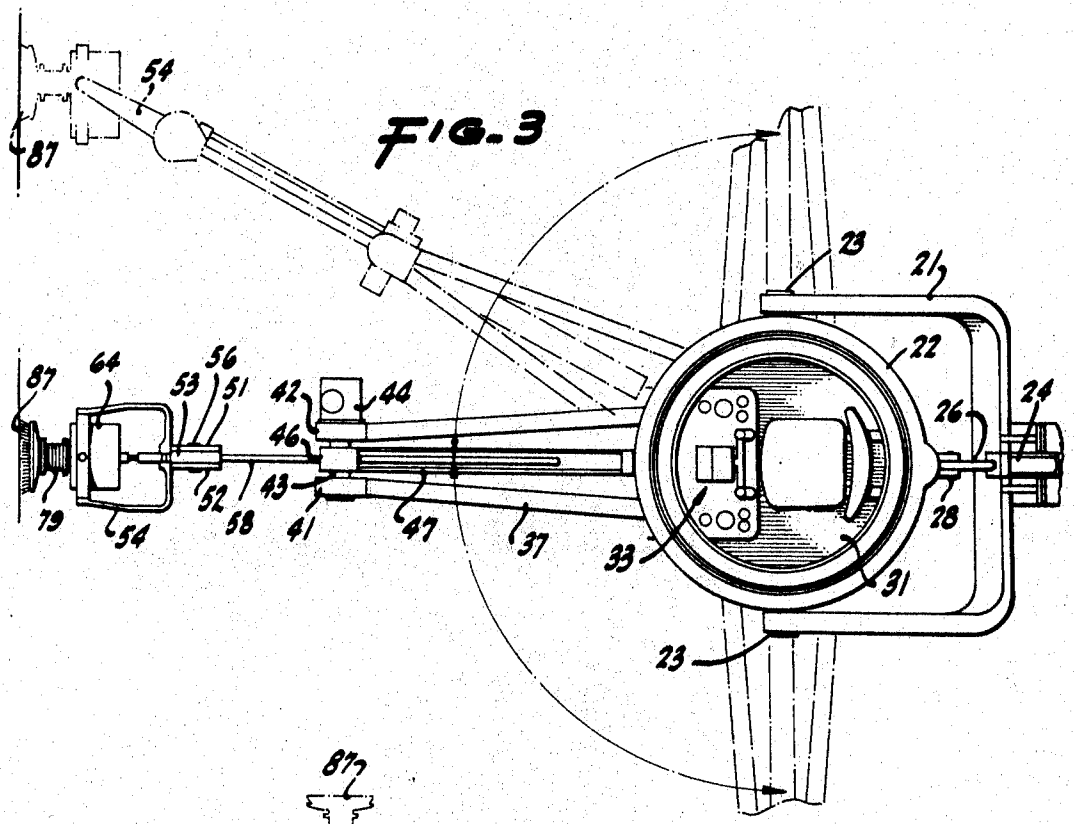
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Lothrop & West
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April 22, 1969 D. C. COLLIER 3,439,372

AIRPLANE WASHING DEVICE

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FIG. 3



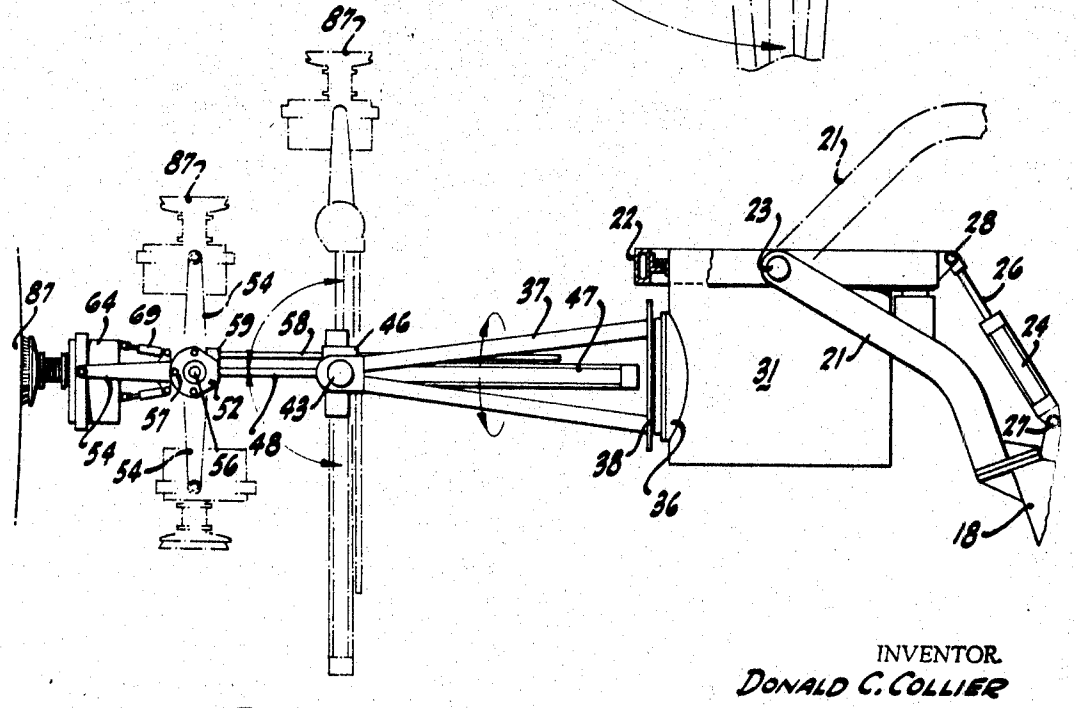


FIG. 2

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AIRPLANE WASHING DEVICE

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FIG. 5

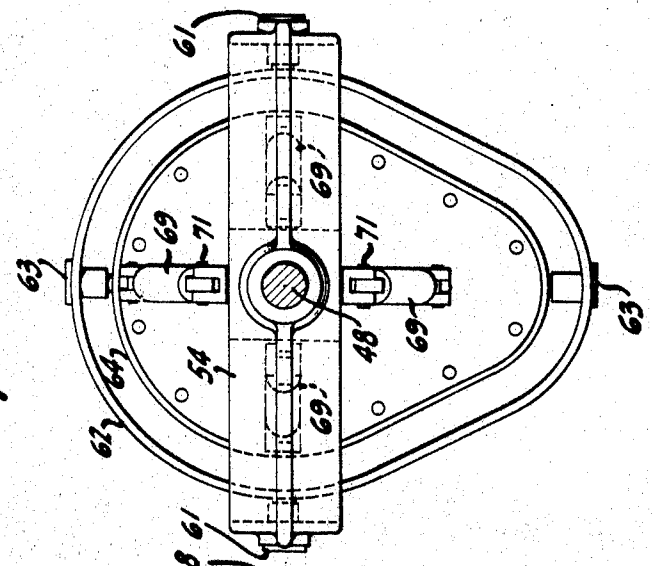
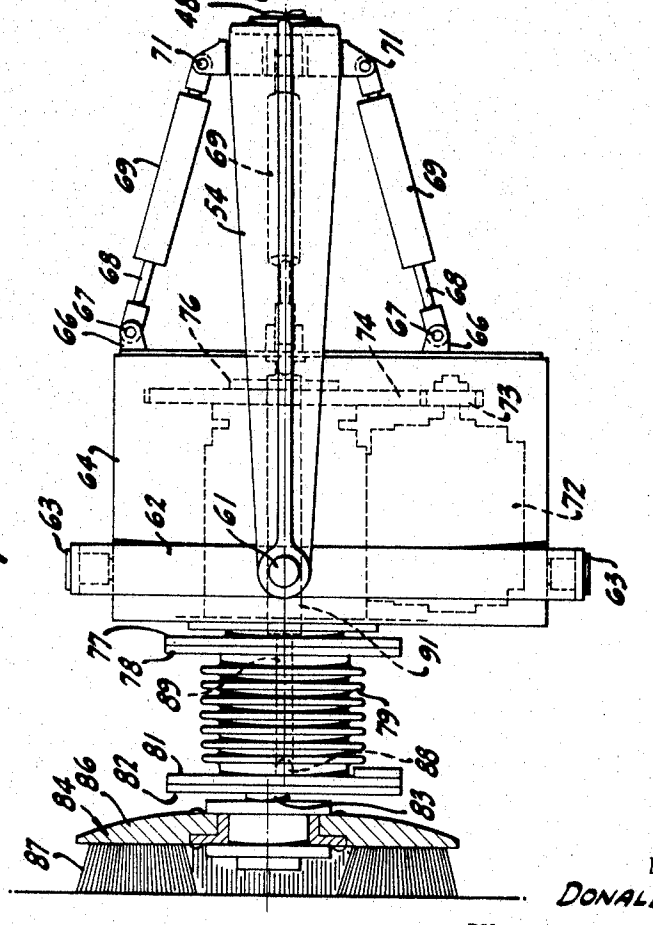


FIG. 4



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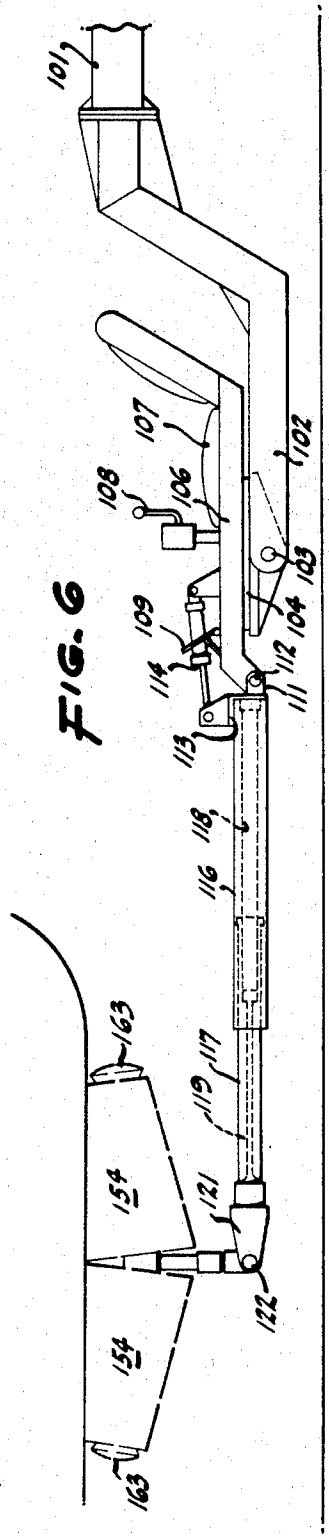


FIG. 6

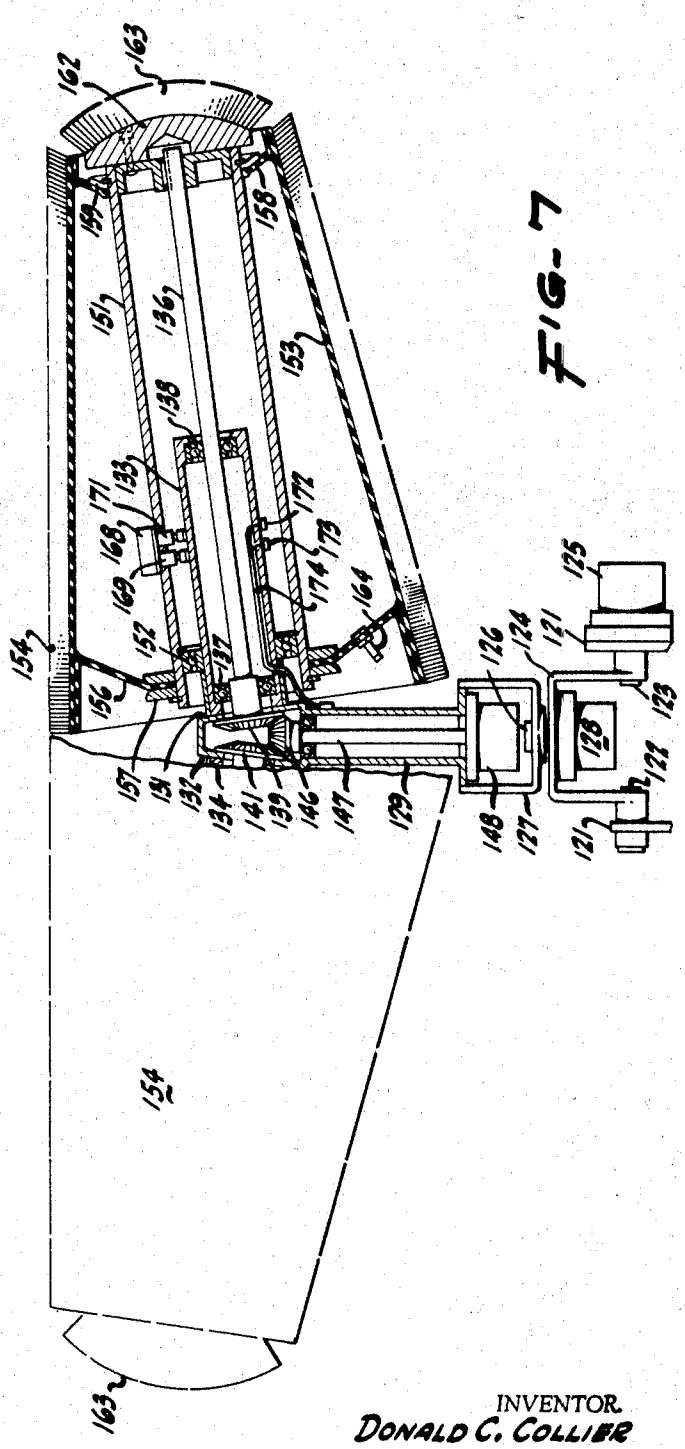


FIG. 7

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3,439,372

AIRPLANE WASHING DEVICE

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Int. Cl. B60s 3/06; A47l 11/283; B24b 23/00
U.S. Cl. 15—21 7 Claims

ABSTRACT OF THE DISCLOSURE

A device for washing airplanes has a vehicle carrying washing supplies and a rotatable turntable orientable to various positions and carrying an operator's station and controls for an extensible boom on which a rotary power driven scrubbing brush is mounted. The brush mounting permits the brush to be variously oriented and includes means for maintaining a selected brush pressure against the surface being washed.

My invention relates to devices useful in washing surfaces of objects such as airplanes, large vehicles and the like particularly when the configuration or contour of the article being washed is composed of simple and compound curves and flat surfaces and is ordinarily rather difficult to engage with washing materials and scrubbers unless extensive hand work is employed.

It is therefore an object of my invention to provide an airplane washing device which dispenses with hand work yet which can cover with a scrubbing motion all of the various configurations, whether simple or compound, of an airplane exterior or the exterior of a comparable body to be washed.

Another object of my invention is to provide an airplane washing device which is readily portable from place to place so that planes in different locations can be washed from time to time.

Another object of the invention is to provide an airplane washing device which can readily be controlled by a single operator not only as to the motion of the carrying vehicle, but also as to the operation of the washing structure.

Another object of the invention is to provide an airplane washing device which is completely self-contained and can be utilized in a remote location to accomplish the desired purposes.

Another object of the invention is to provide an airplane washing device which is relatively simple in its construction yet which effectively accomplishes airplane washing.

Another object of the invention is to provide an airplane washing device in which the degree of contact between the washing device and the object being washed can be established and maintained at a desired value.

Another object of the invention is in general to provide an improved airplane washer.

Other objects together with the foregoing are attained in the embodiments of the invention described in the accompanying description and illustrated in the accompanying drawings, in which:

FIGURE 1 is a side elevation of one form of airplane washer in washing engagement with an airplane;

FIGURE 2 is a side elevation to an enlarged scale of a portion of the structure shown in FIGURE 1;

FIGURE 3 is a plan, with portions broken away, showing the mechanism of FIGURE 2;

FIGURE 4 is a side elevation to a greatly enlarged scale of the scrubbing brush portion of the airplane washing device;

FIGURE 5 is an end elevation of the structure illustrated in FIGURE 4;

FIGURE 6 is a side elevation of a modified form of airplane washer, a portion of the structure common to the original modification being omitted to reduce the size of the figure, and the brushes being shown in operation on an airplane; and

FIGURE 7 is on the left half a side elevation of the brush structure shown in FIGURE 6 and in the center and on the right is a cross section through the axis of rotation of a brush and attendant mechanism.

In a presently suitable form of the device useful in connection with an airplane **6**, of generally recognized configuration, standing on the ground **7**, I provide a washing machine which includes a vehicle **8**. This has a pair of drive wheels **9** at one end and a pair of steering wheels **11** at the other end, the vehicle also being provided with the customary power source, speed changing and drive mechanism (not shown). The vehicle is particularly provided with a jack cylinder **12** mounted on the vehicle **8** so as to be pivoted for swinging movement in a vertical longitudinal plane, the actual motion of the jack cylinder **12** being caused by a fluid expansible chamber mechanism **13** having a lower cylinder **14** appropriately mounted on the vehicle **8** and having a piston rod **16** connected by a pivot pin **17** to the jack cylinder **12**. When the cylinder **14** is appropriately filled and emptied in accordance with standard practice, the jack cylinder **12** is swung in a vertical arc.

Although the jack cylinder itself affords a fair height of operation, it is preferred to extend the height of operation even more. For that reason, there is telescoped within the jack cylinder **12** a jack plunger **18** which can readily be actuated by hydraulic means so as to telescope almost completely within the cylinder **12** or extend a substantial distance therefrom. Means are provided (not shown) of a standard sort to prevent rotation of the jack plunger **18** within the jack cylinder **12**.

Adjacent its upper end, the jack plunger **18** carries a fork **21** extending to a ring **22** in the nature of a gimbal ring. Pivot connections **23** secure the ends of the fork to the gimbal ring so that the gimbal and fork can pivot about a transverse horizontal axis with respect to each other. The particular relative location about that axis of the ring **22** is controlled by a hydraulic cylinder **24** and its accompanying plunger **26** connected by pivots **27** and **28** to their respective mountings. When the cylinder **24** is operated in the customary way by the usual controls, the relative angularity between the gimbal ring **22** and the jack plunger **18** is fixed and held at any desired value.

Since the supervision of the mechanism and its operation is under the control of one man, and in order to afford him a convenient, comfortable and versatile station for his activities, there is provided within the gimbal ring **22** a basket **31** of generally circular cylindrical configuration mounted on bearings to rotate within the gimbal ring **22** about an axis normal to the general plane of the gimbal ring. The basket **31** is of adequate size to contain an operator **32** and has indicators and controls **33** available to the operator within the basket. These controls not only govern the operation of the vehicle **8**, but likewise govern the operation of all of the other instrumentalities involved in the airplane washer.

The basket **31** in one portion is provided with a base **36** affording a support for a boom **37** joined to the base **36** by an intervening bearing **38** so that the boom **37** can turn about a generally longitudinal, horizontal axis with respect to the basket **31**. The boom **37** is preferably of skeleton construction and extends outboard of the basket **31** to provide a pair of journals **41** and **42** (FIGURE 3). Mounted to rotate within the journals **41** and **42** about a horizontal, transverse axis is a shaft **43** at one end extending into a hydraulic motor **44** effective when energized to rotate the shaft **43** through at least one hundred eighty degrees, or preferably somewhat more than that. Secured to the shaft **43** and rotatable therewith is a housing **46** on which one end of a hydraulic cylinder **47** is mounted,

the other end of the cylinder being freely cantilevered. When actuated by the usual control instrumentality, fluid is introduced into the cylinder **47**, the piston rod **48** is projected therefrom and forms an extension of the boom **37**. When the actuating fluid is reversed with respect to the cylinder **47**, the boom extension is retracted. With this arrangement and with appropriate controls on the actuator **44**, the boom extension **48** can be extended a substantial distance from the basket **31** and can likewise be tilted at any desired angle so as to move along an axis intersecting the longitudinal axis of the boom **37**.

The outboard end of the boom extension **48** carries clevis plates **51** and **52** (FIGURE 3) lying on opposite sides of a tongue **53** forming part of a fork **54**. Since the tongue is rotatable with respect to the plates **51** and **52** through approximately one hundred eighty degrees, means are provided for selecting a position for the tongue **53** with respect to the boom extension **48** and for holding the parts in the selected locations. The tongue **53** is joined to both of the plates **51** and **52** by a pivot pin **56**, and a locking pin **57** (FIGURE 2) engages both of the plates **51** and **52** and engages the tongue **53** in either one of three principal, eccentric locations so that, as shown particularly in FIGURE 2, the fork **54** can be pointed and held directly upwardly or can be pointed and held directly downwardly as departures from the usual central position as shown in FIGURE 2 in full lines.

To make sure that the plates **51** and **52** always retain their proper orientation despite the torque load thereon, a reinforcing and positioning rod **58** is secured at its outboard end to a lug **59** forming part of the plates **51** and **52** and at its other end slidably engages the housing **46** secured to the shaft **43**.

The twin arms of the fork **54** at their outboard ends engage pivot pins **61** in turn engaging a gimbal ring **62** so that the gimbal ring can oscillate freely about a generally horizontal transverse axis with respect to the fork **54**. The gimbal ring also carries pins **63** engaged in appropriate lugs extending from a casing **64**. With this gimbal mounting the casing **64** can occupy any one of a number of different inclined or adjusted positions relative to the boom extension. In order to hold the casing **64** in any selected position with respect to the fork **54**, the casing has a number of lugs **66** to which pivot pins **67** connect the piston rods **68** of a plurality of hydraulic cylinders **69**. The cylinders are connected by pivot pins **71** to the base of the fork **54**. Upon appropriate actuation of the various cylinders **69**, the casing **64** can be given any desired orientation with respect to the fork **54** since there is relative rocking motion between the casing **64** and the fork **54** by virtue of the interposed gimbal ring **62**.

The casing within its confines carries a hydraulic motor **72** under appropriate control and having a pinion **73** meshing with a gear **74** designed to turn a quill or sleeve **76** appropriately mounted in suitable bearings and at its forward end enlarged to afford a flange **77** to which is connected the flange **78** of a flexible and collapsible bellows **79**. A similar flange **81** at the forward end of the bellows engages and is secured to a flange **82** on which the hub **83** of a brush **84** is disposed. Preferably the brush hub is offset or has its axis displaced from the general rotational axis of the bellows **79**. The brush **84** includes a back **86** and likewise has a number of bristles **87** extending from the back and terminating approximately in a plane.

With this mechanism and since the motor **72** is supplied with appropriate actuating fluid under standard control at the operator's station, when the motor revolves, the quill is likewise revolved and this also rotates the flexible bellows **79** so that the bellows serves as a torque transmitting member and causes the brush **84** to rotate substantially in accordance with the rotation of the bellows but also in an orbital path since their axes are somewhat displaced in a radial direction.

Particularly in accordance with this invention, I provide means for maintaining a selected relationship between the brush **84** and the casing **64** so that the pressure exerted by the brush against the airplane, for example, is kept very closely within decided limits. For that reason, there is provided on the flange **82** a connection **88** to one end of a plunger **89** axially movable within a sleeve **91** coaxially arranged and mounted at its inboard end on the end of the housing **64**. The plunger and sleeve represent a transducer.

Thus as the brush **84** is rotated in its orbital path and is forced against a surface to be washed, as shown in FIGURE 1, the bellows **79** collapses more and more as more and more pressure is exerted, and by the same token the plunger **89** is likewise forced farther into the sleeve **91**. This displacement inwardly is effective upon an appropriate controller (not shown) to vary the fluid supply to the cylinder **47** so that the brush **84** operates at an appropriate pressure despite the change in position. The brush as well as the intervening bellows **79** move toward and away from the casing **64** as irregularities in the surface are encountered, but by operation of the sensing mechanism, the plunger **89**, the sleeve **91** and their appurtenant parts, the pressure exerted by the brush against any contacting surface is maintained within narrow limits substantially at an optimum or desired value.

Preferably the vehicle **8** carries one or more tanks **92** containing appropriate supplies for the washing brushes, the supplies being in the nature of water and detergent. While the device is principally used for washing, it is also suitable for use as a polisher. In that case, a supply of polish on the vehicle is also made available. The tank **92** is connected to the vicinity of the brush by appropriate flexible hoses **93** (FIG. 1), only some portions of which are shown to avoid cluttering and obscuring the drawings. The flexible hoses are arranged to accommodate all of the various positions the brush can occupy with respect to the carriage **8**.

In the use of this structure, the operator at his station initially operates suitable controls to bring the vehicle **8** to a desired station alongside the airplane **6**. The operator in his basket **31** by operating appropriate controls therein stops the vehicle and extends the piston rod **16** to position the jack cylinder and the jack plunger at the desired angle and extension. The operator then starts the brush revolving and through the flexible hose supplies it with water and cleaning material such as detergent. The operator traverses the brushes in various different ways, depending upon the shape of the surface being washed, either by moving the vehicle **8** forward or backward or by traversing the boom extension or by operating the jack plunger **18** within the jack cylinder **12**.

The operator can also rotate the boom **37** and can not only project and retract the boom extension but can also make it rotate into a suitable position about the axis of the shaft **43**. The operator can from time to time make a manual setting on the interconnection between the clevis plates **51** and **52** and the tongue **53**. Further, the casing **64** can move resiliently within the gimbal ring **62** and the brush can flex the bellows in various directions. Thus, the operator can move the brush **84** with its bristles **87** into tight engagement with any adjacent surface of the plane, whether flat or of single curvature or of compound curvature. The pressure of the brush on the surface being washed is automatically maintained by the in-built corrective action. The flexible bellows **79** not only acts as a driving mechanism, but also accommodates the brush to any desired angle or pressure value. By appropriate manipulation of the various controls at his central station, the operator **32** can, as shown by various dotted line disclosures in the drawings, move the brush in various different ways to accommodate the undulatory surfaces of the plane. Since the pressure against the plane is substantially constant, the scrubbing effect is as drastic as desired and can be made effective to remove grime and dirt under widely different

conditions so that a satisfactory washing job is readily accomplished on all of the airplane's exposed surfaces.

In some instances it is desired to arrange the airplane washing mechanism to take care of surfaces which are very close to the ground, the actual clearance available being less than three feet. Under those circumstances, an arrangement such as shown in FIGURES 6 and 7 is preferred. All of the vehicle or carriage construction is the same as previously described except that the jack plunger, formerly **18** and now **101**, is provided with a forked end **102** carrying opposite pins **103** supporting the base member **104** of a turntable. Appropriate hydraulic mechanism (not shown) sets and holds the desired angularity between the turntable base **104** and the fork arms **102**.

Rotatably mounted on the turntable base **104** is a turntable platform **106** carrying a partially reclined seat **107** at the operator's station and having various controls **108** and **109** to govern the various instrumentalities. With this arrangement the base **104** can be tilted up and down and the platform **106** can be rotated about a generally vertical axis at the control of the operator.

To the forward end of the platform **106** there is connected a clevis **111** held by a pivot pin **112**, the clevis being part of a frame **113** which can be moved about the axis of the pins **112** by a hydraulic jack mechanism **114** having standard connections. Included in the frame **113** is the non-circular telescopic base portion of a boom **116** within which is slidably mounted a boom extension **117** likewise of non-circular cross section. The parts **117** and **116** can telescope with respect to each other in a longitudinal direction but do not have relative rotation about the longitudinal axis. Longitudinal displacement is controlled by an interior hydraulic cylinder **118** at its base secured to the frame **113** and carrying a piston rod **119** at its forward end secured to a clevis body **121** at the leading end of the boom extension **117**. When the cylinder **118** is appropriately actuated, the boom extension is moved into and out of the boom. The clevis **121** has pins **122** and **123** (FIGURE 7) in transverse alignment, the pins **122** and **123** both being secured to a yoke **124** designed to rotate about the transverse axis of the pins **122** and **123** under the urgency of a hydraulic motor **125** installed on one of the arms of the clevis **121**.

Mounted on the yoke **124** for rotation about the axis of a pin **126** is a fork frame **127**, the fork frame and pin being fastened together and being connected to the drive shaft of a hydraulic motor **128**, so that the fork frame **127** can be rotated about the pin axis with respect to the yoke **124**. The fork frame extends outboard and includes a housing portion **129**. The housing portion is symmetrical and on opposite sides of the center has inclined faces **131** and **132** on which interior housings **133** and **134** are disposed. Since both sides are similar, the description of the right side applies also to the left side. Within the housings **133** and **134** are mounted dihedrally arranged drive shafts **136** carried by bearings **137** and **138**. Each shaft is connected to a respective one of a pair of bevel gears **139** and **141** both meshing with a bevel pinion **146** at the end of a shaft **147** passing through the housing portion and being appropriately rotated at relatively high speed by a hydraulic motor **148** on the adjacent portion of the yoke housing.

The shaft **136** is rotated as a driver. Also, the shaft **136** carries a part of the weight of a brush shell **151** concentric with the shaft **136**. The shell **151** rests on a bearing **152** at one end and is carried by the shaft at the other end so that the shell rotates with the shaft **136**. Means are provided for affording a special brush mounting and brush construction. The brush itself is preferably a highly pliable or flexible rubber-like outer conical bag **153** having bristles **154** mounted in it and extending radially from it. At one end the flexible conical envelope **153** is merged with a conical end wall **156** secured by a rim mechanism **157** to the shell **151**. At the other end the sleeve **153** has a conical wall **158** secured by a locking ring **159** on the tube or shell **151**. Additionally, the shaft **136** at its end carries a block **162** from which bristles **163** project so as to afford a substantially uninterrupted brush surface. The conicity of the brush shells and the dihedral angle of the shafts are such that the brushes present substantially a continuous surface for scrubbing.

The interior of the mounted brush envelope **153** or bag is substantially airtight and the wall **156** is provided with an air-inflation stem **164** of the usual sort to admit air of the desired pressure. With this mechanism the brush can be advanced against the surface to be cleaned and will flex considerably to accommodate minor irregularities and curvatures in the surface. With a given pressure against the surface to be cleaned, the bag will deform or deflect. The deflection will be a known or predetermined amount depending upon the air pressure within the brush bag **153**. In the event grossly excessive pressure is imposed upon the brush envelope **153**, the two end walls **156** and **158**, being conical or dished, tend to collapse toward the rotational axis and permit the brush to deform very materially. When the pressure again relaxes, the resiliency of the parts is sufficient to restore them to the locations shown in FIGURE 7.

The mechanism as so far described is often entirely sufficient to accommodate the brushes to most irregular surfaces. However, under some circumstances it is preferred to provide a pressure and deflection sensitive servo mechanism for operating the hydraulic controls of the boom so as to maintain the desired contact between the brush and the surface being cleaned. To that end, there is disposed on the rotating shell **151** a piezoelectric mechanism **168** having the property of varying an electrical output in accordance with the imposed pressure. The piezoelectric cell **168** has leads **169** and **171** extending to collector rings **172** and **173** in turn joined by wires **174** on the stationary part of the structure. The conductors **174** connect to a control for the cylinder **118** or the cylinder pack **114** or both of them.

In the attitude of the brush shown in FIGURE 6, extra pressure of the brush against the surface increases the air pressure within the envelope **153**. This increase is detected by the piezoelectric device **168**, which sends a signal through the conductors **174** to the control for the cylinder jack **114**. Thus by changing the action of the cylinder jack **114**, the precise amount of pressure of the brush against the surface can be regulated. If, however, the member **124** and its appurtenances happens to be rotated approximately ninety degrees from the position shown in FIGURE 6 to work against a vertical surface, then the extra pressure is in a generally axial or longitudinal direction and the response is by the cylinder **118**.

In this form of the device, the brush can be supplied with cleaning material such as water and detergent or with polishing materials and operates in about the same way as the previous embodiment. In this instance, the brush itself has a great deal more flexibility.

What is claimed is:

1. An airplane washer comprising a mobile main frame, a turntable, means for mounting said turntable on said main frame for rotation about a vertical axis, a boom on and extending from said turntable, a boom extension, means for mounting said boom extension for projection and retraction on said boom, a brush carrier, means for mounting said brush carrier on said boom extension for movement relative to said boom extension, means for moving said brush carrier relative to said boom extension, a rotary brush, means for resiliently mounting said brush for rotation on said brush carrier, means for rotating said brush, and means responsive to said resilient mounting means for positioning said brush relative to said brush carrier.

2. An airplane washer as in claim 1 in which said boom and said boom extension project and retract along a boom axis and said brush carrier is rotatable relative to said turntable about said boom axis.

3. An airplane washer as in claim 1 in which means are provided for mounting said brush carrier on said boom extension for relative pivotal movement about a transverse horizontal axis.

4. An airplane washer as in claim 1 in which means are provided for mounting said boom extension for pivotal movement about a transverse horizontal axis relative to said turntable.

5. An airplane washer as in claim 1 in which an operator and control station is provided on said turntable.

6. An airplane washer as in claim 5 in which said main frame is a self-propelled vehicle and controls for said vehicle are located at said operator and control station.

7. An airplane washer as in claim 1 in which said frame is part of a vehicle, a wash material tank on said vehicle, and flexible means for conducting wash material from said tank to said relatively movable brush.

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U.S. Cl. X.R.

15—50; 51—180