Jan. 6, 1970 R. W. GOODRUM 3,487,841

AUTOCLAVE CLEANING DEVICE

Filed Feb. 19, 1969 7 Sheets-Sheet 1

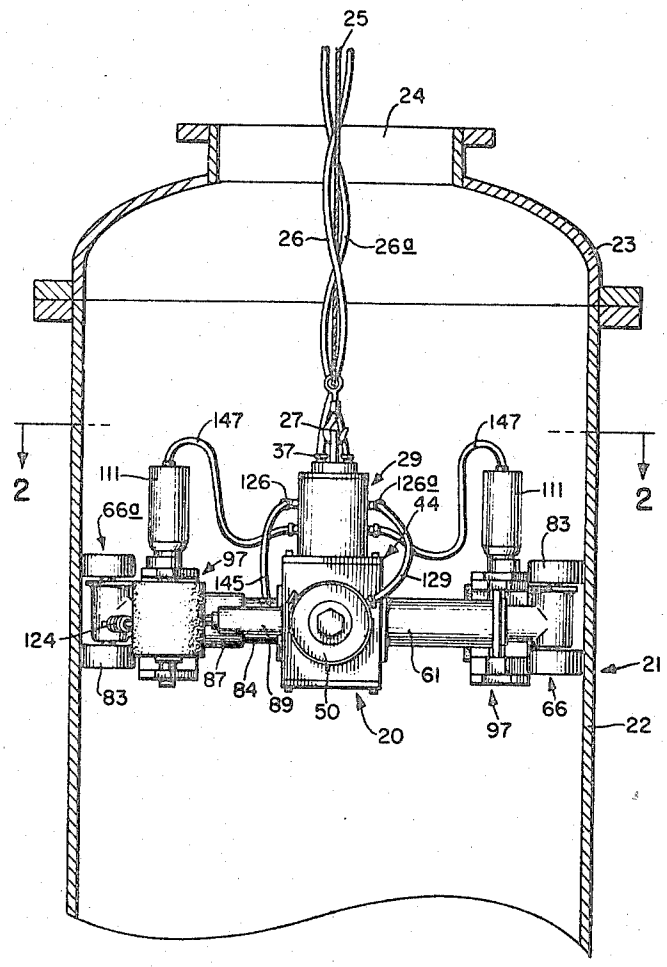


FIG. 1.

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AUTOCLAVE CLEANING DEVICE

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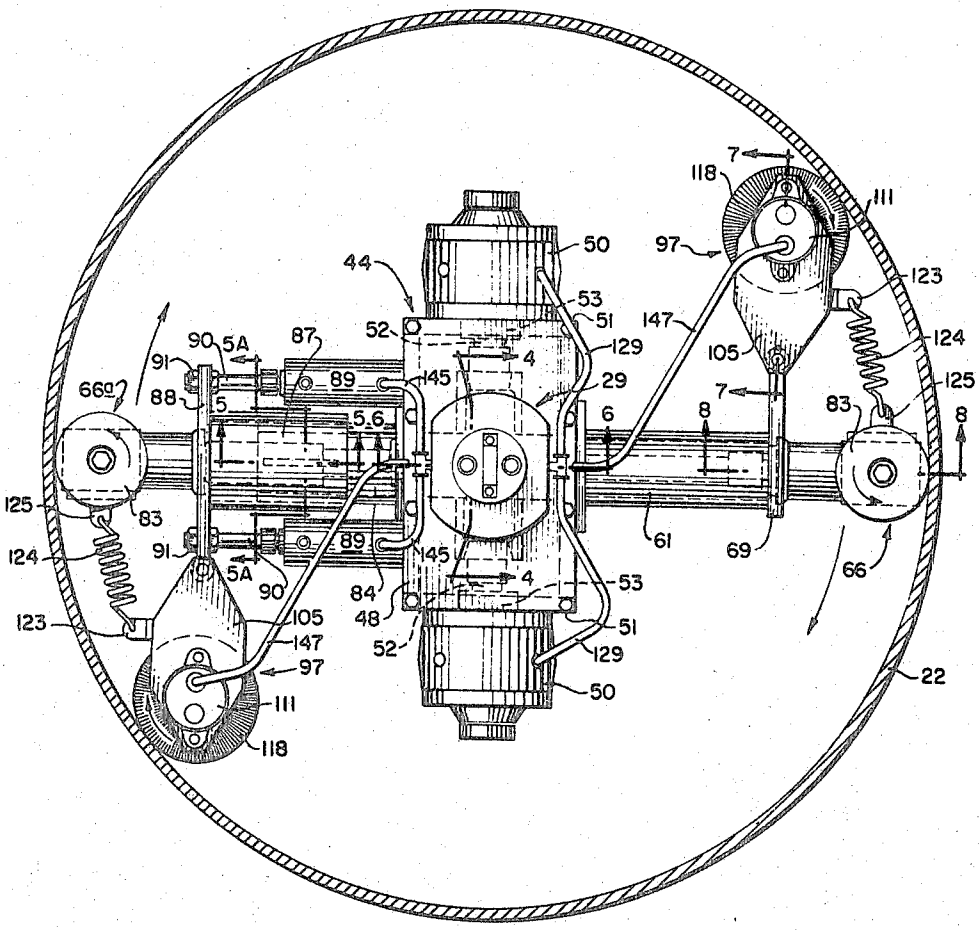


FIG. 2.

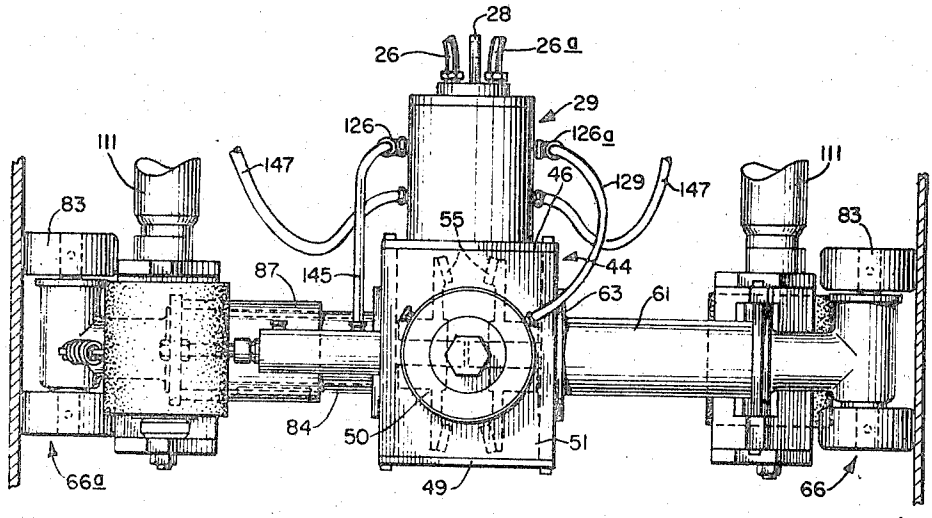

28
26
26a
29
126
126a
111
147
46
129
147
111
83
55
83
87
145
44
63
61
84
50
51
66a
49
66

FIG. 3.

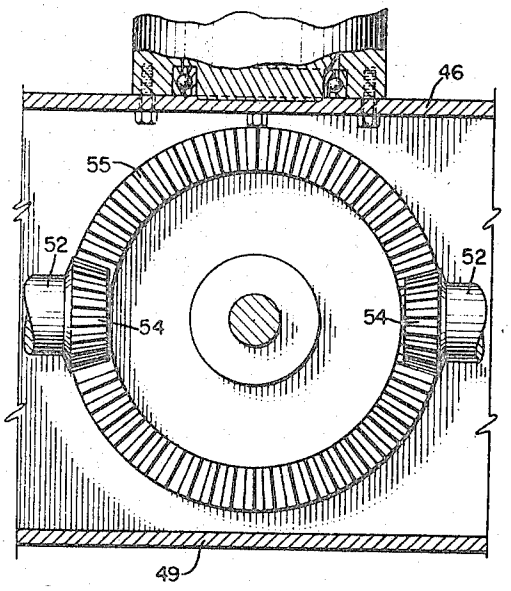

46
55
52
52
54
54
49

FIG. 4.

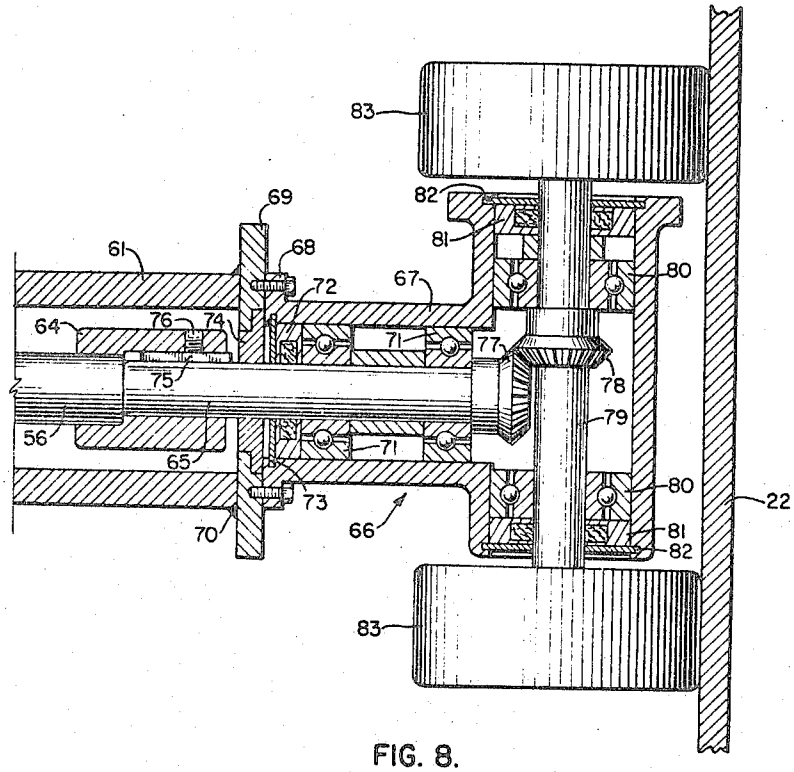


FIG. 8.

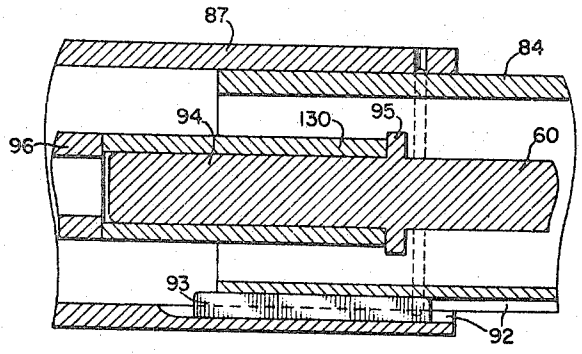


FIG. 5.

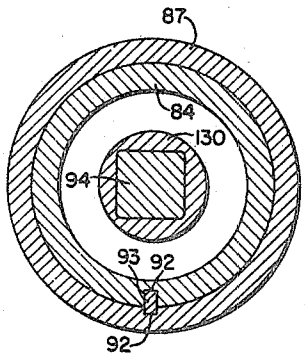


FIG. 5A.

AUTOCLAVE CLEANING DEVICE

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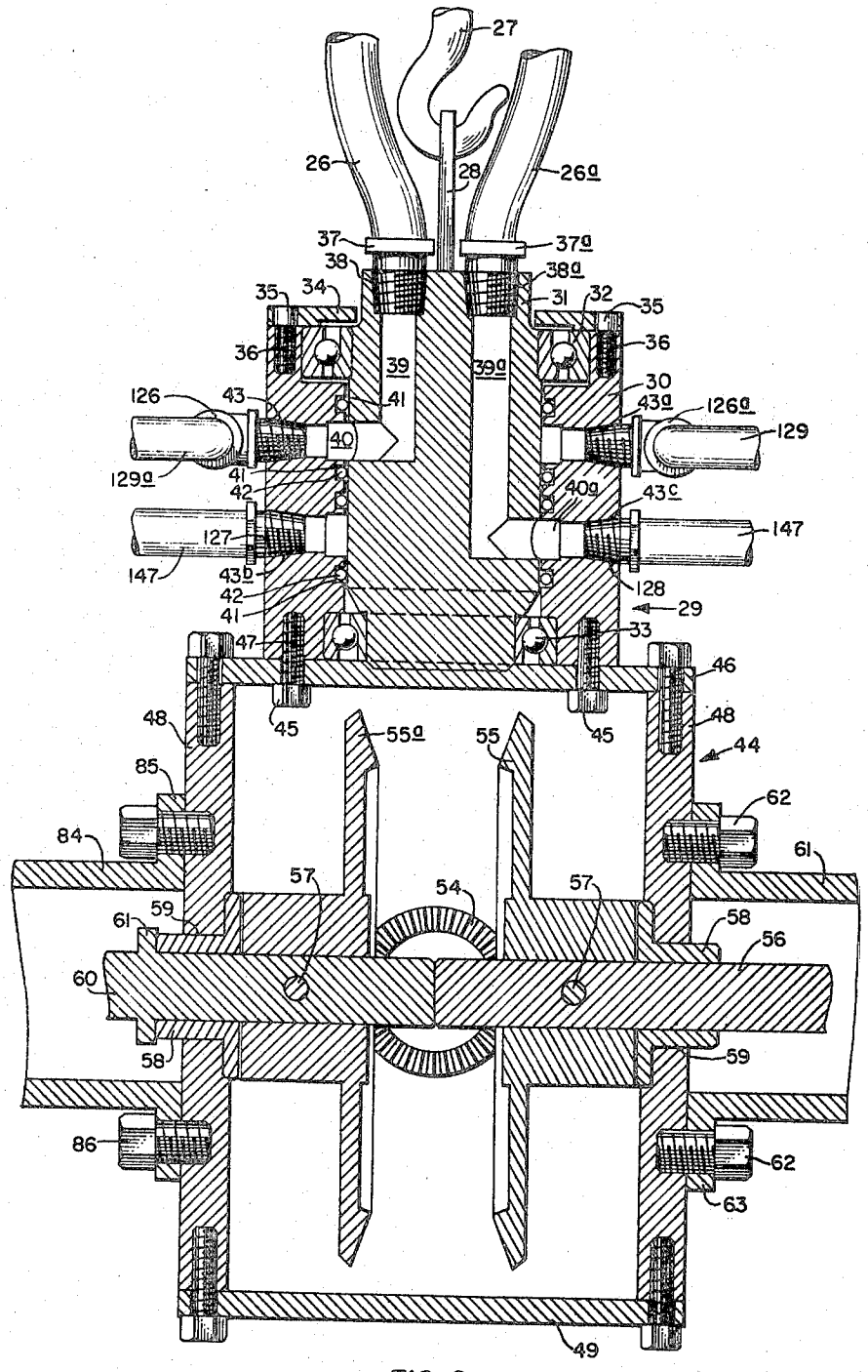


FIG. 6.

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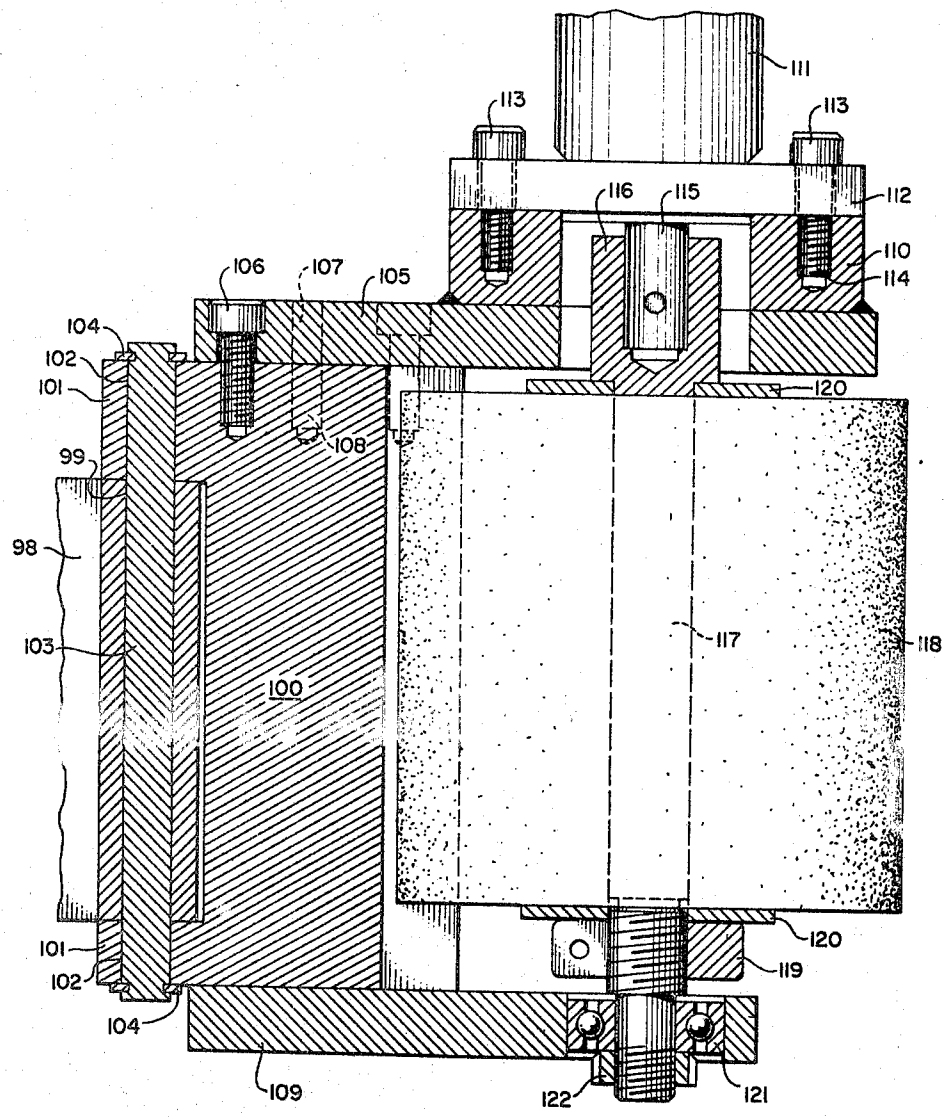


FIG. 7.

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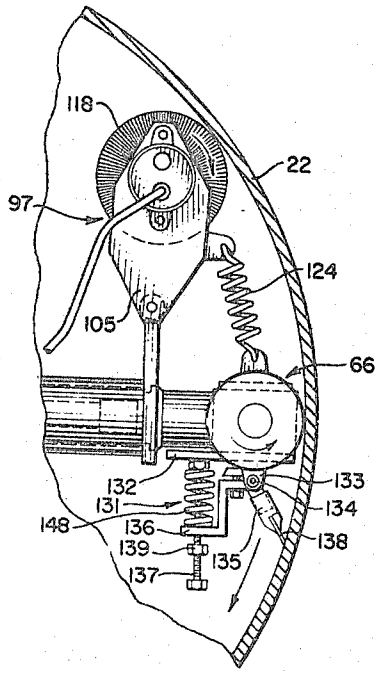


FIG. 9.

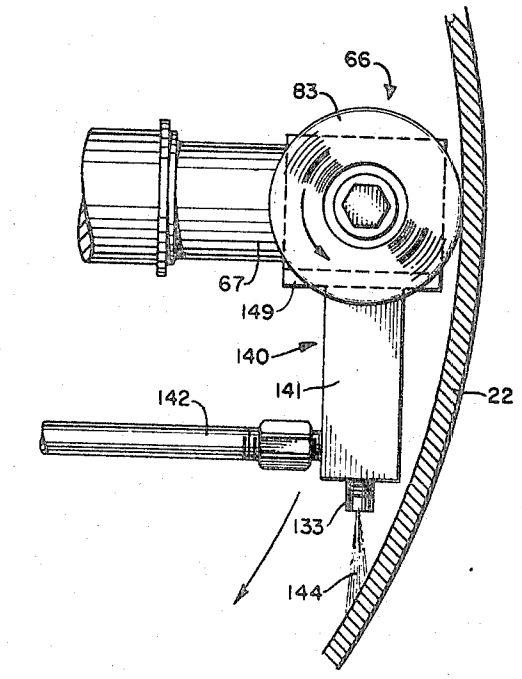


FIG. 10.

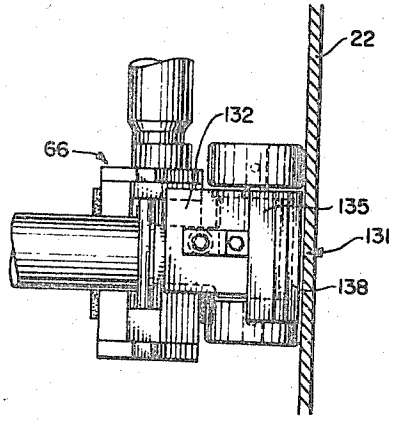


FIG. 9A.

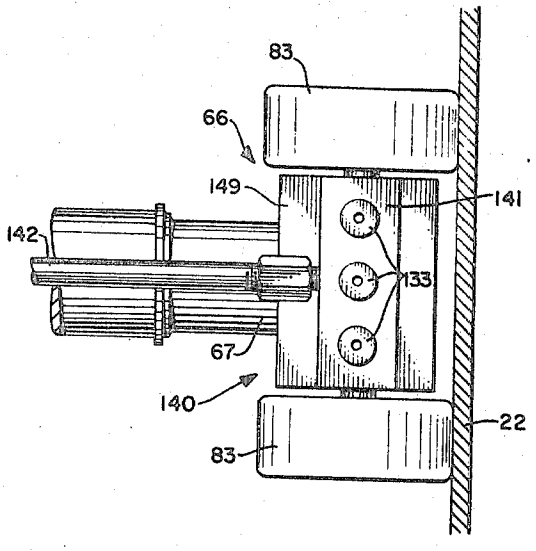


FIG. 10A.

United States Patent Office

3,487,841

Patented Jan. 6, 1970

3,487,841

AUTOCLAVE CLEANING DEVICE

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Continuation-in-part of application Ser. No. 634,758, Apr. 28, 1967. This application Feb. 19, 1969, Ser. No. 800,688

Int. Cl. B08b *3/00, 9/00;* B05b *3/18*

U.S. Cl. 134—167 4 Claims

ABSTRACT OF THE DISCLOSURE

A cleaning device for cleaning the interior walls of a cylindrical vessel. The device is adapted to be inserted through a manway or through the top of a vessel such as an autoclave. A central gear box is mounted on a swivel and has one or more motors mounted thereon. The motors are connected to the drive shafts which extend to each side thereof. The shafts are connected to a wheel assembly adapted to contact the interior sidewall of the vessel and to propel the cleaning device in a circular or spiral path around the interior wall of the vessel. In a preferred embodiment of the present invention an independently rotatable cylindrical brush is mounted at each end of the apparatus in contact with the vessel wall. Each brush is driven by a separate motor. The cleaning device includes an adjustable length arm which permits the device to be used for cleaning vessels of various widths. The independently rotating brushes thoroughly clean any deposit that may be present on the sidewall of the vessel as the device rotates around the interior of the vessel.

This application is a continuation-in-part of my copending patent application Ser. No. 634,758, filed Apr. 28, 1967, and now Patent No. 3,448,474.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to a cleaning device for cleaning the interior walls of cylindrical vessels such as an autoclave.

Description of the prior art

Present methods of cleaning large vessels, particularly autoclaves used to manufacture plastic materials such as polyvinyl chloride, require unusually long times to remove materials deposited on the walls of the vessel. One method used heretofore to clean autoclaves of polymer build-ups is to loosen the polymer by soaking with a solvent and then hand scraping to remove the loosened polymer. This is costly and time consuming in that the solvent is expensive and difficult to reclaim. Further, considerable time is occupied in swelling and loosening the polymer prior to removal by hand scraping.

Another commonly used method is for one or more men to enter the autoclave and hand clean using brushes or scrapers to clean the walls of the autoclave. This cleaning procedure is also very time consuming and expensive. Additionally, it is very difficult to completely clean all traces of polymer build-up from the walls of an autoclave by hand labor. Common time for cleaning a two hundred gallon autoclave by hand, using two men with putty knife cleaners has been found to be from thirty to ninety minutes when the autoclave has been used to manufacture suspension polyvinyl chloride resins. By utilizing the device of the present invention, the same size autoclave can be cleaned with only one man as the operator on the outside of the autoclave in about twenty minutes.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a mechanical cleaning device for a large cylindrical vessel which can be placed in the vessel through existing manways.

It is another object of the present invention to provide a cleaning device for vessels which device is capable of removing build-up deposits from the vessel wall rapidly and completely.

It is a further object of the present invention to provide a cleaning device which has independent drive means for rotating the device within the vessel and for driving the cleaning brushes.

It is still another object of the present invention to provide a cleaning device of a size and construction which can be easily handled and by one man.

It is still another object of the present invention to provide a cleaning device which can be programmed to cover the entire inner wall surface of a cylindrical vessel.

The foregoing objects are realized in a cleaning device for cleaning the interior walls of a cylindrical vessel which device includes a transverse support means having a drive means mounted thereon. The drive means include a rotatable body contacting the vessel to rotate the cleaning device within the vessel. Cleaning means are mounted on the support means and are adapted to act upon the interior wall of the vessel to clean the wall as the cleaning device rotates.

The cleaning device of the present invention utilizes separate drive means for the propulsion of the device around the walls of the vessel thereby providing a degree of freedom for the cleaning means attached thereto. In one preferred embodiment of the device separate drive means is provided for each of the cylindrical brushes to allow a different rotational speed independent of the speed of rotation of the cleaning device. The present device can be set to move the cleaning means over the entire side-wall surface of a cylindrical vessel such as an autoclave and thereby to effectively clean every square inch of the interior sidewall surface of the vessel. The device is a significant improvement over the cleaning devices used heretofore in that the present device does not require an operator to enter the autoclave to clean the sidewalls. The entire operation can be carried out with the operator observing the action of the cleaner through the manway of the vessel.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is an elevational view of the cleaning device of the present invention positioned in an autoclave;

FIGURE 2 is an enlarged plan view of FIGURE 1 along line 2—2;

FIGURE 3 is an elevational view of the cleaning device as seen in FIGURE 2;

FIGURE 4 is a cross sectional view of FIGURE 2 along line 4—4;

FIGURE 5 is a longitudinal sectional view of FIGURE 2 along line 5—5;

FIGURE 5A is a cross sectional view of FIGURE 2 along line 5A—5A;

FIGURE 6 is a cross ectional view of FIGURE 2 along line 6—6;

FIGURE 7 is an enlarged cross sectional view of FIGURE 2 along line 7—7;

FIGURE 8 is a cross sectional view of FIGURE 2 along line 8—8;

FIGURE 9 is a plan view of one arm of another embodiment of the cleaning device showing a scraper device attached thereto;

FIGURE 9A is an elevational view of FIGURE 9;

FIGURE 10 is a plan view of one arm of still another

embodiment of the cleaning device showing a hydraulic cleaner device attached thereto; and

FIGURE 10A is an elevational view of FIGURE 10.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGURE 1, the cleaning device of the present invention is designated generally by the numeral **20**. The device is shown positioned in an autoclave which is designated generally by the numeral **21**. The autoclave includes a cylindrical sidewall section **22** and a removable top section **23** having a manway **24** provided which is of sufficient width to permit entry of the cleaning device into the autoclave. While the top section of the autoclave shown in FIGURE 1 is shown as being removable, it is not essential since the cleaning device of the present invention can be used in autoclaves having only a manway. The cleaning device of the present invention can readily be made in a size such that it has a width which will readily permit it to be turned lengthwise and inserted through the manway **24**.

As seen in FIGURE 1 the cleaning device **20** is suspended in the autoclave **21** by means of a cable **25** which is attached at its upper end to a hoist (not shown). A pair of air supply hoses **26–26***a* are connected at their lower ends to the cleaning device **20** and their upper ends (not shown) are connected to throttling valves to control the flow of air through the hoses. Referring now to FIGURES 1 and 6, it will be seen that the cable **25** has a hook **27** on its lower end attached to U-bolt **28** which is threadably received in the top of a swivel assembly designated generally by the numeral **29**. The swivel assembly includes a hollow cylindrical body section **30** which has received therein a rotatable cylindrical shaped shank section **31**. The shank **31** is machined for a close sliding fit with the interior walls of the body. An upper roller bearing assembly **32** and lower roller bearing assembly **33** support the shank within the body of the air swivel assembly. Top cover plate **34** couples the shank **31** and body **30** together. The cover plate is removably mounted on the body **30** by means of cap screws **35** received in threaded openings **36** provided in the body **30**. One of the air hoses **26** has its end terminating in a threaded fitting **37** which is received in tapped opening **38** in the top of shank **31**. A passageway **39** extends from the tapped opening **38** longitudinally in the shank **31** and then transversely to communicate with an annular channel **40** provided in the inner wall of body **30**. The second air hose **26***a* is connected through threaded coupling **37***a* received in tapped opening **38***a* provided in the top of shank section **31**. A second passageway **39***a* in shank **31** is provided connecting with a second annular channel **40***a* provided in the body **30**. Shallow rectangular grooves **41** are provided above and below annular channel **40** and annular channel **40***a* in the inner wall of body **30**. Annular seal rings **42** are received in each of the annular grooves **41** and serve to seal the body to the shank section to prevent air from escaping from channels **40** and **40***a*. Upper opposed threaded openings **43–43***a* are provided in the body **30** communicating with the annular channel **40**. Similar lower openings **43***b***–43***c* are provided in the lower portion of body **30** communicating with the lower annular channel **40***a*. Threaded opening **43** receives one end of a threaded pipe T coupling **126**. The opposite threaded opening **43***a* receives one end of a similar threaded pipe T coupling **126***a*. Lower threaded opening **43***b* receives threaded hose coupling **127** and opposed opening **43***c* receives coupling **128**.

The primary drive assembly, designated generally by the numeral **44**, is connected to the swivel assembly **29** by means of cap screws **45** projecting through an opening provided in top plate **46** and received in threaded openings **47** provided in the body **30**. The primary drive assembly includes a gear box having a top plate **46**, sidewalls **48**—

48, and bottom plate **49**. The top plate and bottom plate are attached to sidewalls **48—48** by cap screws.

Referring now to FIGURES 1, 2 and 3, an air motor **50** is mounted on each end wall **51** of the gear box assembly. Each air motor is connected by an air hose **129** to the T coupling **126***a* in swivel assembly **29**. As seen in FIGURES 2, 3, 4 and 6, each air motor is provided with a shaft **52** projecting through bearing **53** provided in each end wall **51—51**. Each drive shaft **52** has attached to the projecting end thereof a tapered pinion gear **54** which is positioned between and meshes with opposed ring gears **55–55***a*.

As can be seen more clearly in FIGURE 6 right hand ring gear **55** is attached to right hand drive shaft **56** by means of locking pin **57**. This shaft extends through a bearing **58** mounted in an opening **59** provided in the wall **48** of the gear box. The left hand ring gear **55***a* is mounted on left hand drive shaft **60** by means of locking pin **57**. The shaft **60** projects through and is carried by bearing **58** provided in opening **59** provided in the wall **48** of the gear box. The left hand shaft **60** is provided with a collar **61** which bears against the outer end of bearing **58**. As seen more clearly in FIGURES 2, 3, 6 and 8, the right hand drive shaft **56** is covered by drive shaft housing **61**. The housing is attached to the sidewall **48** of the gear box by means of cap screws **62** projecting through openings in a flange **63** on the drive shaft housing. The cap screws are received in threaded openings provided in the wall of the gear box.

Referring now to FIGURE 8, the right hand drive shaft **56** is provided with a boss **64** at its outer end. The boss is provided with a cylindrical opening in its end which receives shaft **65** which is a part of the right hand drive wheel assembly, designated generally by the numeral **66**. The drive wheel assembly includes a hollow T-shaped housing **67** having a flange **68** at the base of the T which is attached to flange plate **69** which is in turn attached to the end of the right hand housing **61** by means of welding bead **70**. Cap screws extend through openings in flange **68** to attach the drive wheel assembly to the flange **69**. Drive shaft **65** is supported within the base of the T-shaped housing **67** by means of a spaced apart pair of roller bearing assemblies **71—71**. The drive shaft **65** extends through oil seal disc **72**, dust seal disc **73**, and then through bearing plate **74**. The shaft is received in the boss **64** and coupled thereto by means of a key **75** received in longitudinal slots provided in shaft **65** and matching slot provided in boss **64**. The key is held within the slots by means of screw **76**. Shaft **65** has a pinion gear **77** mounted on its outward end which meshes with and drives pinion gear **78** mounted on wheel drive shaft **79**. Drive shaft **79** is mounted in opposed sets of roller bearing assemblies **80—80** received within the T head of the housing **67**. The shaft **79** extends through oil seal disc **81** and dust seal disc **82** mounted at each end of the T head of the housing **67**. A drive wheel **83** is mounted on each end of shaft **79**. The drive wheel **83** may be made of any material but is preferably hard rubber or rubber covered in order to provide good traction against the wall of the autoclave **22**.

If desired the drive wheel assembly **66** may be commercially available off the shelf pre-assembled item. One commercially available assembly which has been found eminently suitable for use in the present invention is a one horsepower "Anglgear" unit, three way, Model R–3302, manufactured by Airborne Accessories Corporation.

Referring now to FIGURES 1, 2, 3 and 6, the left hand support assembly of the cleaning device of the present invention includes a fixed left hand drive shaft housing **84** having an integral flange **85** attached to the wall of the gear box assembly by means of cap screws **86**. The outer end of drive shaft housing **84** is received in movable drive shaft housing **87** which is welded at its outer end to bracket **88**. A pair of pneumatic or hydraulic

actuators 89—89 have their bases attached to the left wall 48 of the gear box. The actuators are mounted in an opposed position one on either side of the housings 84–87. Each actuator has a piston rod 90 extending from its outer end which, in turn, has its outer end attached by means of jam nuts 91 to the bracket 88. The actuators 89 may be powered either by air or fluid pressure, however, air actuators are preferred since an air supply is provided to the apparatus to operate the air motors. A left hand drive wheel assembly 66*a*, which is identical to assembly 66 described hereinbefore, is attached to the left arm of the cleaning device by means of bracket 88.

Referring now to FIGURES 5, 5A and 6, it will be seen that the left hand fixed housing 84 is slidably received in the movable portion of the left hand housing 87 whereby the length of the left arm of the cleaning assembly may be shortened or lengthended at will. Each of the housings 84 and 87 is provided with matching longitudinal grooves 92—92 within which is received a rectangular key 93. The key-groove combination locks the fixed and movable housings together to prevent any tendency to rotate but permits them to move longitudinally with respect to each other. The outer end of cylindrical left hand drive shaft 60 has a portion 94 which is substantially rectangularly shaped. A collar 95 separates the rectangular shaped portion 94 of the drive shaft from the cylindrical portion of the drive shaft 60. The rectangular shaped portion 94 of the drive shaft 60 slidably receives over it a mating rectangular hollow portion 130 of the left hand drive shaft 96 which powers the left hand drive wheel assembly 66*a*. Shaft 96 is connected to the drive wheel assembly 66*a* in a similar manner to that described hereinbefore for the right hand drive wheel assembly 66. The connection between rectangular shaft end 94 and the rectangular opening 130 in shaft 96 provides for lengthening and shortening of the left hand arm of the cleaning apparatus and yet furnishes a positive connection for transmitting power to the drive wheels.

As seen in FIGURES 1–3 and 7, the cleaning device of the present invention has attached to each drive wheel assembly a cleaning brush assembly designated generally by the numeral 97. The assembly is attached to the right hand arm of the cleaning device by means of an extension on flange 69. The opposite brush assembly is attached to bracket 88 on the left hand arm of the cleaning device. Flange 69 and bracket 88 each provide a vertically extending ear 98 (see FIGURE 7) which has an opening 99 provided therein. As seen in FIGURE 7 a brush spacer block 100 has projecting lugs 101 and 101*a* at the top and bottom thereof provided with openings 102 which are aligned with opening 99 in the ear 98. A pivot pin 103 is received in aligned opening 99 and 102 and held in position by means of locking rings 104. A top brush mounting plate 105 is attached to the spacer block 100 by means of cap screws 106 received in threaded openings provided in block 100. A dowel 107 is received in an unthreaded opening 108 provided in block 100 to permit accurate alignment of the top mounting plate 105. A bottom brush mounting plate 109 is attached to the bottom surface of spacer block 100 by means of cap screws and dowels and threaded openings (not shown) in a manner similar to that used for the top mounting plate 105. A support ring 110 is attached to the top of mounting plate 105 by welding or other suitable means. Air motor 111 is attached to the support ring 110 by means of mounting plate 112. The plate 112 is held by cap screws 113 received in threaded openings 114 provided in the support ring 110. The air motor has a shaft 115 extending through the opening provided by mounting ring 110 and received in an axially bored boss 116 provided on the top of brush shaft 117. A heavy duty cylindrical brush 118 is received on the mounting shaft 117. Locking ring 119 is threadably received on the lower end of shaft 117 and, in conjunction with washers 120, holds the brush on the shaft. The lower end of shaft 117 is received in bearing 121 which is mounted in an opening provided in the lower brush mounting plate 109. Lock nut 122 holds the shaft 117 in position in bearing 121.

As seen in FIGURE 2 each brush top mounting plate 105 has a lug 123 extending therefrom. A helical spring 124 has one end received in lug 123 and the other end attached to lug 125 which is fixed to the respective left and right drive wheel assemblies 66—66. The spring 124 (see FIGURE 2) pulls the cleaning brush assembly 97 into firm contact with the cylindrical wall 22 of the autoclave.

While the rotating cylindrical cleaning brush assembly 97 has been found to be extremely effective in cleaning the walls of cyindrical vessels nevertheless other cleaning attachments may be affixed to the extended arms of the cleaning device of the present invention and effectively used. Referring now to FIGURES 9 and 9A it will be seen that the brush assembly can be used in conjunction with a blade scraper device designated generally by the numeral 131. The scraper device includes a mounting plate 132 that is attached to the side of each drive wheel assembly 66 by suitable means. The plate has opposed lugs 133 extending from the top and bottom edge thereof. The lugs have openings therein which receive pivot pin 134 on which is pivotably mounted the scraper blade support 135. An L-shaped bracket 136 is bolted to support 135 and has an opening in its outer end through which projects an elongated bolt 137. The bolt is attached at its lower end to the mounting plate 132 and carries coil spring 148. Spring 148 is under compression with one end bearing against the outward end of the L-shaped bracket to force the scraper blade 138 against the wall 22 of the autoclave. Stop nut 139 on bolt 137 limits the outward movement of the end of bracket 136. The pivot mounting and spring loading of the scraper device permits it to ride over very rough projections of hard polymer on the inner wall of the autoclave without breaking the scraper blade.

Still another embodiment of a cleaning head for use in the present invention is shown in FIGURES 10 and 10A. This version of the device utilizes a hydraulic spray head, designated generally by the numeral 140, positioned in close proximity to the walls of the vessel to effect cleaning thereof. A fluid distribution block 141 is mounted on base plate 149 which is attached by suitable means to the drive wheel assembly housing 67. The block provides interior channels (not shown) which distribute the cleaning liquid supplied by hose 142 to the three spray nozzles 143 which are threadably mounted in the face of block 141. These nozzles direct a jet spray of liquid 144 against the interior wall 22 of the autoclave to effectively remove foreign materials therefrom. If desired one of the air supply hoses 26–26*a* may be used to supply cleaning liquid to the hydraulic spray head device 140, however, a separate supply line with its own channel and connecting hoses in the swivel assembly 29 is preferred.

In operation the cleaning apparatus of the present invention is suspended from the cable 25, turned on end to present its minimum width to the manway opening 24 in the autoclave, lowered down through the manway 24 into the autoclave 21, and then allowed to swing into the horizontal plane. When the cleaning device is placed in the autoclave the pneumatic actuators 89 are in the closed position so that the left arm of the device is at its minimum length. After the device is placed in the horizontal position in the autoclave the actuators 89 are powered by air supplied through hoses 145—145 to extend the left arm of the cleaning device until the drive wheels 83—83 contact the interior wall of the autoclave forcing the opposite drive wheels 83—83 into firm contact with the opposite wall of the autoclave. Compressed air is fed through line 26 from a throttling valve (not shown), through the swivel assembly, and supply hoses 129—129 to power the air motors 50—50. Air motors 50—50 rotate the apparatus around the swivel assembly 29 by means of power

transmitted through the pinion-ring gear assembly and drive shafts to the drive wheel assmblies **66—66** mounted on each end of the cleaning device. It is preferred that the drive wheel assmblies **66—66** be mounted at a very slight angle on the respective arms of the cleaning device in order that the wheels may have a slight cant which will cause the device to move in a very tight descending spiral from the top to the bottom of the autoclave thereby traversing each incremental area of the surface of the interior wall **22** of the autoclave. By utilizing a separate air supply line (not shown) the motors **50—50** may be reversed to cause the device to retrace its path back to the top of the autoclave. As the cleaning assembly rotates around the swivel each spring **124** holds each of the cleaning brush assemblies **97** firmly against the walls of the autoclave. Air supplied through the other air hose **26***a*, controlled by a throttling valve (not shown), is first conducted through the swivel then through hoses **147—147** to the air motors **111—111**. These air motors drive the cylindrical brushes **118—118** through the connecting shafts at a speed which is determined by the setting of the throttle valve. As shown by the arrows in FIGURE 2 it is preferred to have the cylindrical brushes **118** rotate in the opposite direction to the direction of rotation of the cleaning device around the swivel. It is usually more effective if the speed of air motors **111—111** is set to rotate the brushes **118—118** at a speed substantially in excess of that at which air motors **50—50** drive the cleaning device around the walls of the autoclave. When the cleaning device reaches the bottom of the autoclave, or reaches the level of the bottom entry paddle or agitator which may be in place in the vessel, the device is stopped and actuators **89—89** are deactivated so that the length of the left arm of the cleaning device may be shortened to permit the device to be withdrawn from the autoclave. If desired the cleaning action may be repeated a number of times in order to provide more effective cleaning of the interior walls of the vessel. To remove the device the actuators are maintained in their minimum length position and the device is tipped to the vertical position and withdrawn through the manway **24**. It is usually advisable to flush the walls and the bottom of the vessel with a cleaning liquid such as water or solvent to sweep away the dust and loosened particles of material which have been brushed from the walls of the vessel by the cleaning device.

The cleaning device of the present invention provides an extremely efficient apparatus for removing deposits from the walls of cylindrical vessels, particularly from the walls of autoclaves used to manufacture synthetic resins. The device has been found especially suitable for removing polyvinyl chloride deposits from autoclaves used in suspension and emulsion polymerization of vinyl chloride homo and copolymers. The device is relatively rugged and easy to maintain. It also has the advantage that it accomplishes an extremely effective cleaning job on the interior walls of the cylindrical vessel without requiring the entry of the vessel by an operator. The device has further advantages in that a number of different cleaning devices may be attached thereto which can be used for cleaning the surfaces of a cylindrical vessel.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and other modifications will be apparent to those skilled in the art. Therefore the present invention is to be limited only by the scope of the appended claims.

What is claimed is:

1. A cleaning device for cleaning the interior wall of a cylindrical vessel comprising:

(a) a swivel assembly for rotatably supporting said device,

(i) said assembly providing at least one passageway therethrough for fluid supply to said device;

(b) a primary drive assembly attached to the bottom of said swivel,

(i) said primary drive assembly having a gear box enclosing at least one ring and pinion gear arrangement drivingly connected to at least one fluid power drive motor mounted on said gear box,

(ii) an adjustable length drive shaft and a fixed length drive shaft each having one end connected to said ring gear and extending through opposite sides of said gear box,

(iii) a fixed length housing attached to said gear box and covering said fixed length drive shaft,

(iv) an adjustable length housing attached to said gear box and covering said adjustable length drive shaft;

(c) a drive wheel assembly carried on the end of each of said housings and connected to their respective drive shaft;

(d) a hydraulic spray head mounted on each of said drive wheel assemblies and adapted to direct a jet spray of liquid against the interior wall of said vessel.

2. In a cleaning device for cleaning the interior wall of a cylindrical vessel including, transverse support means, drive means mounted on said support means, said drive means including a rotatable body contacting said vessel to rotate said cleaning device within said vessel, the improvement comprising: at least one hydraulic spray head mounted adjacent each end of said support means, said spray head being adapted to direct jet spray of liquid against the interior wall of said vessel.

3. The cleaning device of claim **2** wherein each of said spray heads includes a plurality of spray nozzles.

4. The cleaning device of claim **2** wherein each of said spray heads includes a fluid distribution block having three spray nozzles mounted in the face thereof.

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