United States Patent [19]

Hatley

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[54] **TANK CLEANING MACHINE WITH SELECTIVE WASH PROGRAMMING**

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[73] Assignee: **Butterworth System Inc.**

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[30] **Foreign Application Priority Data**

Apr. 28, 1972 United Kingdom 19907/72

[52] **U.S. Cl.** .... **239/227,** 134/167 R, 239/240

[51] **Int. Cl.** **B05b 3/04**

[58] **Field of Search** .... 239/225, 227, 237, 240; 134/24, 167 R; 416/167

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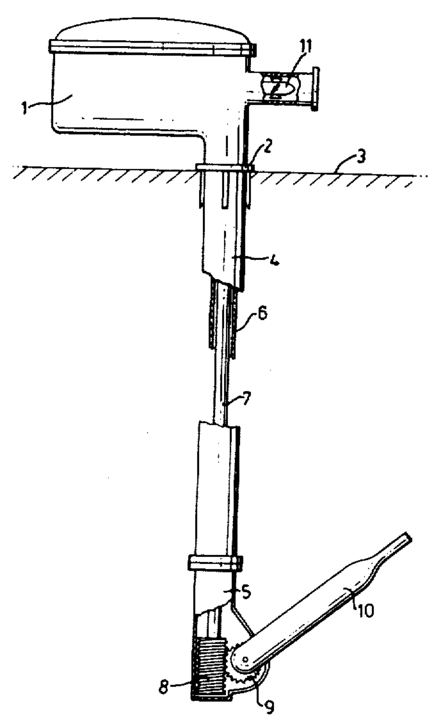
[57] **ABSTRACT**

A tank washing machine, suitable for cleaning the tanks of marine oil tankers, in which washing liquid is discharged from a nozzle mounted on a housing which is rotatable about a first axis (e.g., vertical) in relation to other normally fixed parts of the machine. The nozzle is pivotable or rotatable about a second axis (e.g., horizontal) which at an angle to the first axis. A single driving means (preferably a single turbine powered by wash liquid) is connected via gears and a clutch mechanism to rotate the housing about the first axis and via other gears to pivot or rotate the nozzle about the second axis, the ratio of the angular speeds of the nozzle and housing about their respective axes being constant, but the absolute angular speeds being varied in accordance with a selected program (e.g., as determined by the profile of a cam) so that distant tank walls are sprayed as effectively as proximate walls, during use.

17 Claims, 9 Drawing Figures



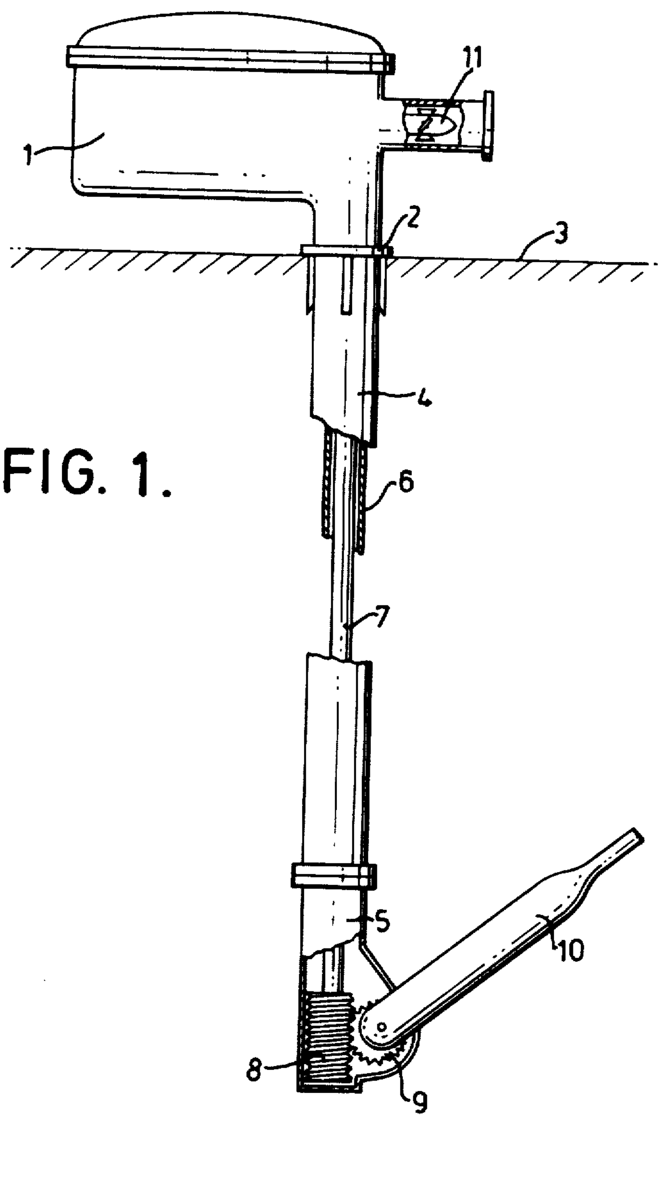


FIG. 1.

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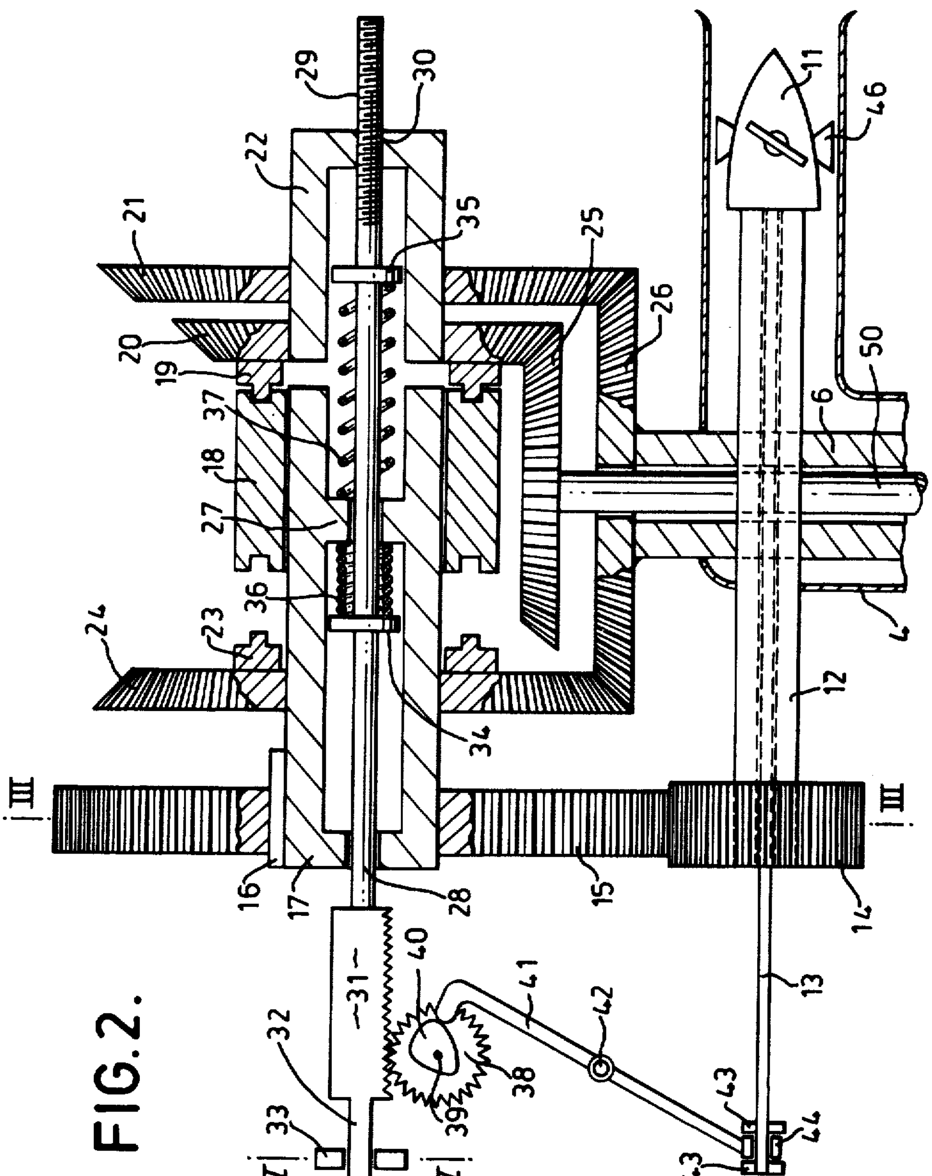
FIG. 2.



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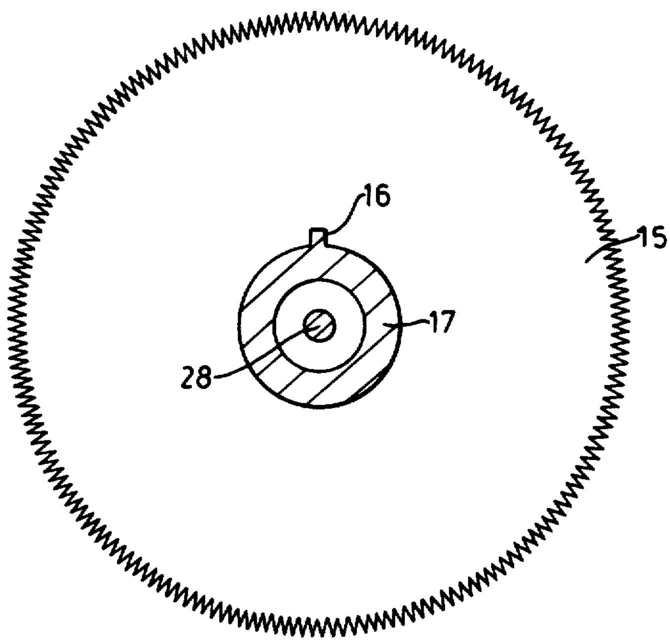

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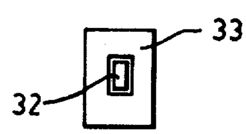

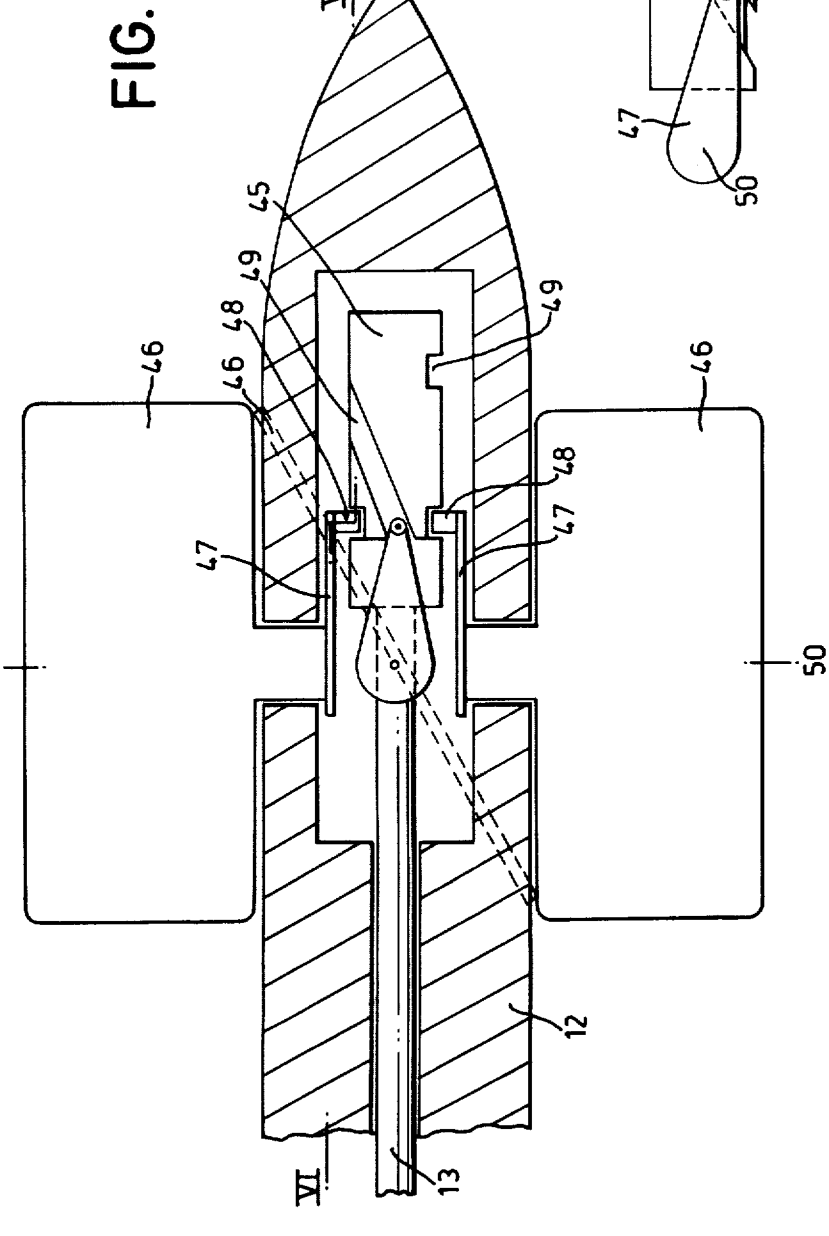

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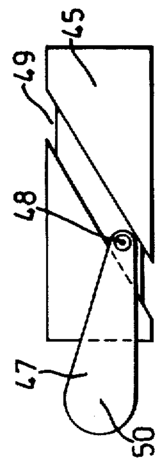

FIG. 6.

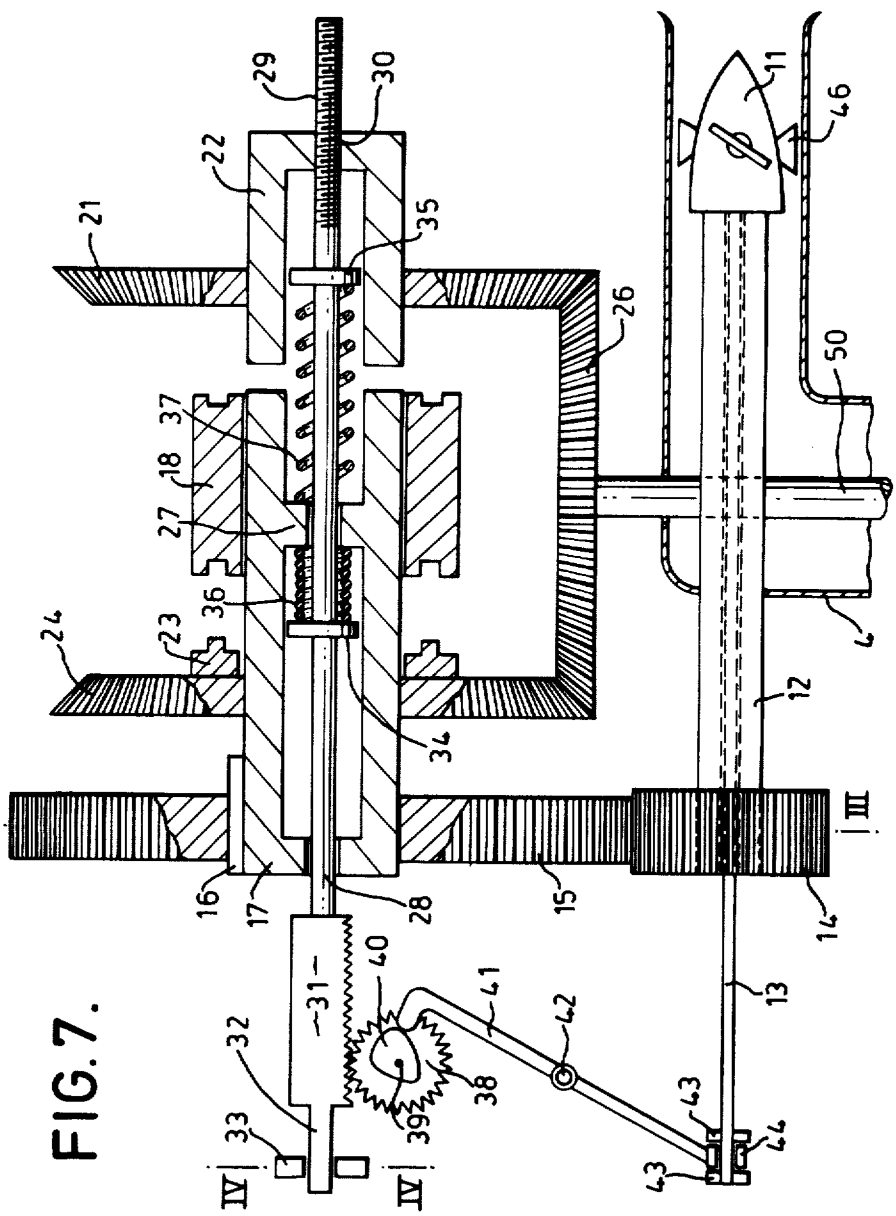
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FIG. 7.

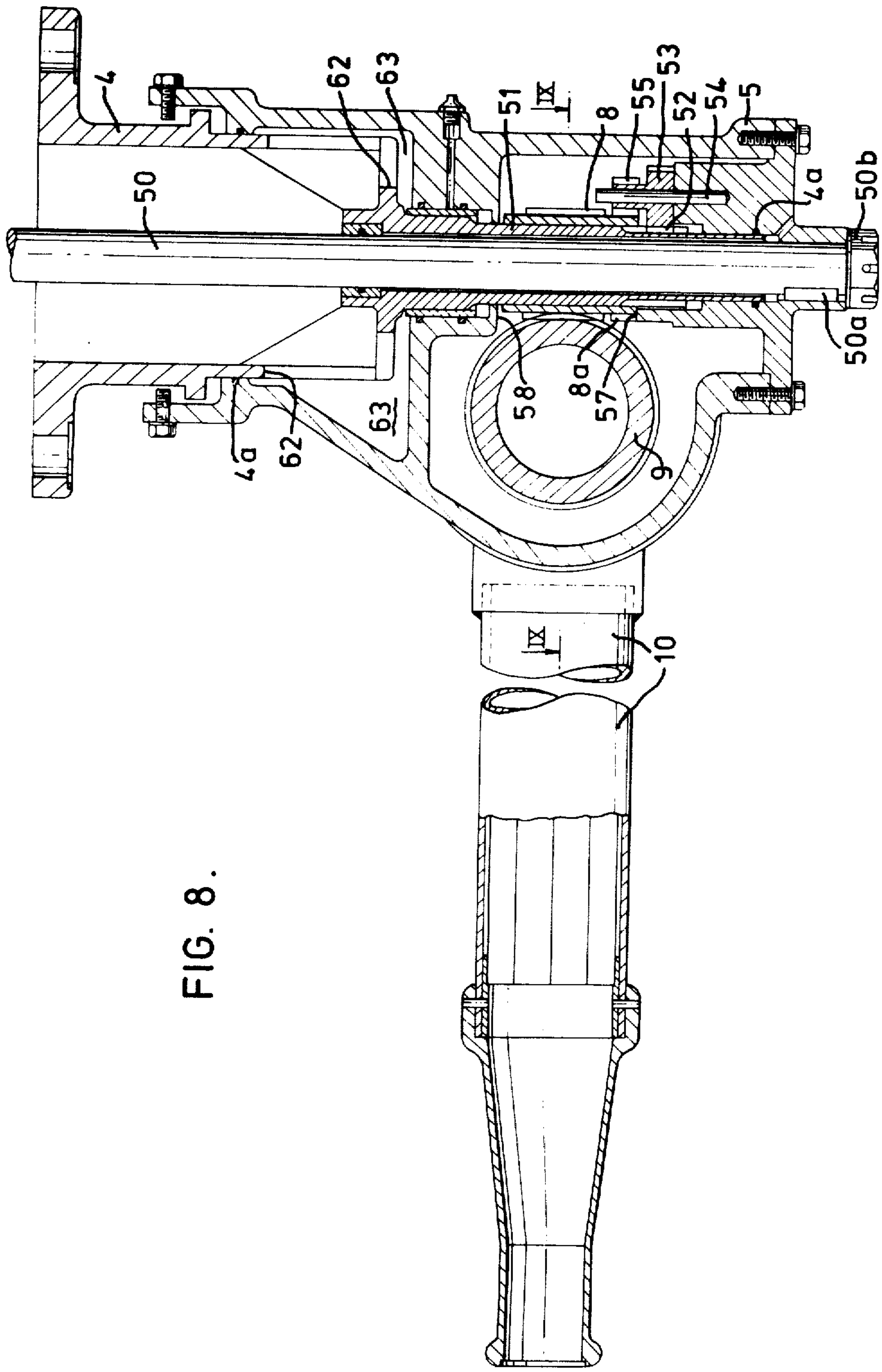

FIG. 8.

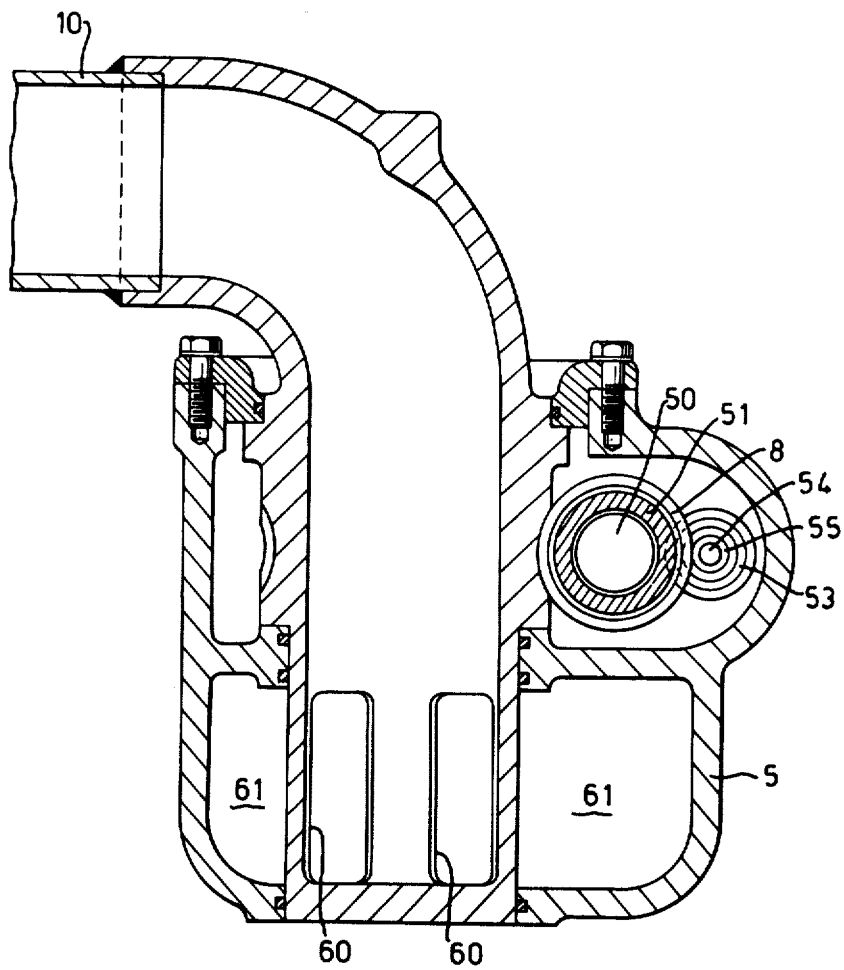

FIG. 9.

TANK CLEANING MACHINE WITH SELECTIVE WASH PROGRAMMING

This invention relates to machines for cleaning tanks.

Many machines have been described for cleaning tanks, e.g., tanks of oil tankers. Usually the tank washing is carried out by the use of jets of water ejected through a nozzle. On some machines the nozzle is mounted on a housing which rotates slowly about a vertical axis and at the same time the nozzle oscillates more slowly about the horizontal axis. In this manner substantially the whole of the tank wall area receives jets of water from the nozzle.

Such machines however, have one serious defect and that is their inability to equalize the wash water over the whole tank surface. This occurs because the nozzle is suspended relatively close to the underside of the tank top, and it is normal for the nozzle to elevate a fixed amount about the horizontal axis for every turn about the vertical axis. If the nozzle housing is rotated at a constant rate the nozzle will take as long to travel from the vertically downward position to the horizontal position as it will do to travel from the horizontal position to the vertically upward position, thereby supplying as much wash water to the top metre or so of the tank as the whole of the rest of the tank.

We have now reduced this problem with the machine of this invention which employs a variable speed turbine, and this results in variations in the rotational speed of the nozzle housing and the speed of oscillation of the nozzle about the horizontal axis.

The present invention provides a method of cleaning a tank employing a tank cleaning machine of the type having a nozzle which is rotatable or pivotable about a first axis substantially perpendicular to the longitudinal axis of the nozzle, the nozzle being mounted in a housing which is rotatable about a second axis at an angle to the said first axis, the method comprising driving the nozzle and the housing about their respective axes from the same drive means with their angular velocities in a constant ratio, and varying their absolute angular velocities in a predetermined manner in accordance with a selected program.

In another aspect, the invention comprises a tank washing machine comprising a nozzle which is rotatable or pivotable about a first axis substantially perpendicular to the longitudinal axis of the nozzle and which is mounted on a housing which is rotatable about a second axis at an angle to the said first axis, a conduit for supplying a tank wash liquid to the nozzle, a common drive means connected for rotating the housing and rotating or pivoting the nozzle in such a manner that the angular velocity of the housing will be in a fixed ratio in relation to the angular velocity of the nozzle, and means for varying the absolute rate of rotation of the housing and of the nozzle, about their respective axes, in accordance with a selected program. Preferably, the selected program is provided by the interaction of a cam and a cam follower which are driven from the said drive means, and the relative movements of the cam and cam follower are employed to influence the power output from the drive means, e.g. by varying the relative angle between the blades of a drive turbine powdered by the wash liquid and the angle of impingement of the wash liquid on the blades.

According to this invention a tank washing machine suitable for cleaning tanks of oil tankers comprises a wash liquid supply pipe in communication with a nozzle housing rotatable about its longitudinal axis, a nozzle fixed to the nozzle housing, said nozzle being rotatable about an axis at an angle to its own longitudinal axis and at an angle to the axis of rotation of the housing, a turbine actuated by the flow of wash liquid, means whereby, whilst the turbine is rotating, the relative angle between the turbine blades and the flow of wash liquid impinging on the turbine blades may be varied (e.g., by changing the altitudes of the blades, and/or by changing the direction of liquid flow onto the blades employing flow nozzles) and means whereby the speed of rotation of the turbine controls the speed of rotation of the nozzle housing and the speed of the rotation of the nozzle.

The wash liquid supply pipe is usually designed so that when the machine is installed in position for use, at least a large part of the pipe projects substantially vertically into the tank from the roof of the tank. Preferably it carries an annular plate for fixing to the hole in the roof of the tank. Part of the supply pipe may if desired be bent, e.g., through 90°, so that when the machine is fitted in position part of the supply pipe outside the tank is for example horizontal so that it can be connected easily to the source of wash liquid.

The nozzle housing communicates with the wash liquid supply pipe and usually it is co-axial with this pipe, and therefore usually rotates about a substantially vertical axis when the machine is in position in the tank.

The nozzle is rotatable about an axis at an angle to the axis of rotation of the housing, and usually this angle is a substantial angle, e.g., 90°. Thus, in the preferred embodiment when the axis of rotation of the nozzle housing is substantially vertical when the machine is in position in the tank, the axis of rotation of the nozzle is substantially horizontal. Usually the axis about which the nozzle is rotatable is substantially 90° to its own longitudinal axis. Generally the nozzle does not rotate completely about its axis of rotation, but oscillates about this axis.

The turbine is actuated by the flow of wash liquid, and the turbine should preferably be located at the entrance to, or in the wash liquid supply pipe.

The angle which the turbine blades make with the flow of wash liquid affects the speed of rotation of the turbine, and preferably it is the angle which the blades make with the longitudinal axis of the turbine which is altered. Means can be provided which are capable of continuously varying the angle of the turbine blades. In the preferred embodiment this means of varying the angle of the blades of the turbine comprises a slidable rod, co-axial with the axis of the turbine, the sliding of which rod along the axis of the turbine causes by means of linked levers, the variation of the angle the blades of the turbine make with the plane at right angles to the axis of the turbine.

The angle which the turbine blades make with the flow of wash liquid can however be varied by having fixed turbine blades and altering the angle at which the wash liquid impinges on the blades. This arrangement would involve a number of substantially radial vanes placed in the wash liquid supply pipe immediately before the turbine, and a device for altering the angle which these blades make with the longitudinal axis of the wash liquid supply pipe, thereby altering the angle at which the wash liquid impinges upon the fixed blades of the turbine.

The speed of rotation of the turbine controls the speed of rotation of the nozzle housing and the speed of rotation of the nozzle. In the preferred embodiment of the invention, the turbine is connected to a rotatable shaft which rotates with the turbine blades.

Rotation of this rotatable shaft through gears and other rotatable shafts causes rotation of the nozzle housing and the nozzle. By this means variation in the speed of the turbine blades results in variations in the speeds of rotation of the nozzle housing and of the nozzle.

In the preferred embodiment of the invention the slidable rod which varies the angle of the blades of the turbine is linked to a pivoted lever, the other end of which is moved by a rotatable cam. Rotation of the cam causes longitudinal shifting of the slidable rod and hence variation of the angle of the turbine blades. By using cams of different profile one can alter the variation in the speed of the turbine blades.

So that the nozzle can oscillate rather than completely rotate the machine is preferably provided with means for reversing the direction of rotation of the nozzle periodically. This may be achieved by means of a slidable and rotatable clutch with two faces, each face of which can engage separately with two other rotatable clutches. This slidable clutch is caused to slide periodically so that it engages first one and then the other of the other two clutches. By means of gears, rotation of one of these clutches causes the nozzle housing and nozzle to rotate in one direction, whereas rotation of the other clutch in the same direction causes the nozzle housing and nozzle to rotate in the opposite direction. Alternatively, the direction of rotation of the nozzle about the horizontal axis may be reversed while maintaining the direction of rotation of the nozzle housing in the same direction.

The direction of rotation of the nozzle can of course be reversed by other means, e.g., by means of a rotating partially toothed wheel engaging first one gear train, and then another gear train.

It is a preferred feature of this invention that the speed of rotation or oscillation of the nozzle is very much less than the speed or rotation of the nozzle housing. This is obviously achieved by gear reduction and in practice the speed or rotation of the nozzle housing is usually from 10 to 200 times, e.g. 20 to 60 times, that of the speed of rotation or oscillation of the nozzle.

The tank cleaning machines of this invention will now be described with reference to the accompanying drawings in which:

FIG. 1 shows a general elevation of a machine according to the invention, with certain parts cut away to show the interior thereof,

FIG. 2 is a vertical section through the top part of the machine of FIG. 1.

FIG. 3 is a section through III—III of FIG. 2.

FIG. 4 is a section through IV—IV of FIG. 2.

FIG. 5 is a sectional elevation of the turbine and turbine shaft of the machine of FIGS. 1 and 2.

FIG. 6 is a section through VI—VI of FIG. 5.

FIG. 7 is a vertical cross-section through the top part of another machine in accordance with the invention.

FIG. 8 is a vertical cross-section through the bottom part of the machine whose top part is depicted in FIG. 7, and

FIG. 9 is a horizontal cross-sectional plan on lines IX-IX of FIG 8.

Referring to FIG. 1 of the drawings, the machine **1** is mounted by means of annular plate **2** on the top of a tank **3** with the wash liquid supply pipe **4** passing into the interior of the tank **3**. At the lower end of the machine there is a rotatable housing **5** which is connected to a drive tube **6** which is co-axial with and can rotate inside the supply pipe **4**. Co-axial with and inside the drive tube **6** is a shaft **7**, the lower end of which terminates in a worm **8**. This worm meshes with a worm wheel **9** which is connected to the nozzle **10**.

Referring to FIG. 2 of the drawings the turbine **11** is housed in the horizontal portion of the wash liquid supply pipe **4** and is connected to the hollow shaft **12** which rotates with the turbine. Inside shaft **12** and co-axial therewith is another shaft **13**, the function of which is to be described later. Fixed to shaft **12** is gear **14** which meshes with gear **15**. Gear **15** is keyed at **16** (see also FIG. 3) to shaft **17**, but the shaft **17** is free to slide axially through the gear **15**. Attached to shaft **17** is a clutch member **18** which is capable of engaging with another clutch member **19** which is fixed to bevel gear **20**. Bevel gear **20** and another bevel gear **21** are fixed to and mounted on a hollow shaft **22**. Clutch member **18** is also capable of engaging with a clutch member **23** which is fixed to a bevel gear **24**. The bevel gear **24** and clutch member **23** are mounted on the hollow shaft **17**, but the shaft is free to shift longitudinally with respect to the gear **24** and clutch member **23**. Bevel gear **20** meshes with a bevel gear **25** mounted on shaft **7**, and bevel gear **21** meshes with a bevel gear **26** mounted on the drive tube **6**.

Hollow shaft **17** has an internal annular shoulder **27** which serves as journal bearing for a rod **28** which is co-axial with shaft **22**. One end of rod **28** is provided with a screw thread **29** which meshes with an internal thread **30** of shaft **22**. The other end of rod **28** is connected to a rack **31** which has an extension **32** which can slide longitudinally in a guide **33** (see also FIG. 4).

Mounted on rod **28** are two annular axially adjustable stops **34** and **35**, in between which are compression springs **36** and **37** located either side of the annular internal shoulder **27** of shaft **17**.

Rack **31** meshes with a gear **38**, which rotates when the rack moves longitudinally. Gear **38** is coupled via shaft **39** to a cam **40**. The cam **40** moves a lever **41** pivoted at **42** which is provided at one end with a bearing **44**. This bearing **44** engages with two stops **43** on the shaft **13**. Alternatively lever **41** may be moved manually by displacement of fulcrum pin **42**.

Referring now to FIGS. **5** and **6** of the drawings the shaft **13** terminates in a square end **45**. Three of the four turbine blades **46** are shown and attached to each at the inward end of each is a pivoted lever **47** to which is fixed a pin **48**. Each pin **48** engages in a slot **49** (oblique to the longitudinal axis) in the square end **45** of the shaft. Longitudinal movement of rod **13** results in shifting of the levers **47** thereby altering the inclination of the blades **46** about their axes, two of which are shown at **50**.

The operation of the tank cleaning machine is as follows:

Wash liquid, usually water, enters the wash liquid supply pipe **4** and impinges on the blades **46** of the turbine causing the turbine **11** to rotate. The wash liquid passes down the vertical section of the wash liquid supply pipe **4** and eventually passes out through the nozzle **10**.

Rotation of the turbine blades **46** causes shaft **12** to rotate and with it gears **14** and **15**, and shaft **17**. Since clutch member **18** is fixed to shaft **17** this clutch member also rotates, and as shown in FIG. **2** it engages clutch member **19** which also rotates with clutch member **18**. Rotation of the clutch member **19** means that bevel gears **20** and **21** and shaft **22** on which the gears **20** and **21** are mounted also rotate. Rotation of gears **20** and **21** also causes rotation of bevel gears **25** and **26**, and shaft **7** and tube **6** respectively. Due to the difference in the gear ratio between gears 20/25 and 21/25 shaft **7** and tube **6** will rotate at different speeds. This in turn means that worm **8** and housing **5** respectively will rotate at different speeds. In practice it is usual for the gear ratios to be chosen so that shaft **7** and hence worm **8** rotates slightly slower than housing **5**. This in turn means that worm gear wheel **9** rotates even slower.

Whilst shaft **22** rotates its internal screw thread **30** meshes with the screwed end **29** of rod **28**. As shown in FIG. **2** this causes rod **28** to shift slowly towards the left. Rotation of this rod **28** is prevented by means of the guide **33** preventing rotation of extension **32** of rack **31**. As rod **28** moves towards the left the stop **35** gradually compresses spring **37** and at the same time spring **36** which is initially compressed between should **27** and stop **34**, becomes less compressed. This continuous compression of spring **37** and relaxation of spring **36** will result eventually in the clutch member **18** suddenly shifting from right to left so that it engages clutch member **23**. Since clutch member **18** is fixed to shaft **17**, rotation of the clutch members **18** and **23** occurs and with it rotation of bevel gear **24** which is usually of the same size as and having the same number of teeth as bevel gear **21**. This means that bevel gear **26** now rotates in the opposite direction as also does bevel gear **25** (through bevel gear **20** fixed to shaft **22** which carries bevel gear **21**). It can be seen therefore that when bevel gear **25** reverses direction so will shaft **7**, and worm **8**. This reversal of direction also means a reversal of direction of rotation of worm wheel **9**, and this means that if nozzle **10** has been slowly rising it will now slowly descend, and vice-versa.

As rod **28** moves longitudinally so will rack **31**. This engages gear **38**, rotation of which causes cam **40** to rotate. Rotation of the cam causes pivoted lever **41** to pivot about the fulcrum pin **42**. By means of the bearing **44** and stops **43** movement of lever **41** causes shaft **13** to move longitudinally. As explained previously movement of shaft **13** causes inclination of blades **46** to alter, thereby altering the angle which the blades **46** make with the flow of wash liquid. This causes the speed of the turbine **11** to alter, and hence the speed of rotation of housing **5** and speed of oscillation of nozzle **10**.

By adjusting the position of stops **34** and **35** and by changing cams so that different profiles are used representing different selected washing programmes, one can readily alter the speed of rotation of housing **5** and also the speed of oscillation of nozzle **10** to meet the requirements of the particular tank being cleaned.

Reference is now made to FIGS. **7, 8** and **9** which illustrate the principal constructional features of a different design of machine in accordance with the invention. In FIGS. **7, 8** and **9**, features which are common also to the embodiment of FIGS. **1** to **6** are given the same reference numeral.

In the embodiment of FIGS. **7, 8** and **9**, the relative rotation or angular speeds of the housing **5** and the worm **8** (and consequently the worm gear **9**) are derived by a reduction gear arrangement, described below, in the housing **5** rather than from a reduction gear arrangement in the top of the machine as is the case with the previous embodiment, and the reduction gear arrangement in the housing **5** is driven by means of a single drive shaft **50** rather than the combination of the shaft **7** and drive tube **6** of the previous embodiment.

Referring particularly to FIG. **7**, it will be seen that the meshed bevel gears **20, 25** of FIG. **2** are absent, and that the clutch member **19** is attached to the inwardly-directed face of bevel gear **21**. Bevel gear **21** and bevel gear **24** are both meshed with a bevel gear **26** (which may alternatively be in the form of a crown gear wheel, not shown, as will be apparent to those skilled in this art), and bevel gear **26** drives the single shaft **50** which extends downwards into the rotatably-mounted housing **5**.

From the description of the first embodiment, it will be apparent that when the clutch member **18** is engaged with clutch member **19**, the rotation of the shaft **50** will be in the opposite direction to that when the clutch member **18** is engaged with the clutch member **23** on the bevel gear **24**. Accordingly, the shaft **50** will rotate a predetermined number or revolutions in one direction and then a predetermined number of revolutions in the opposite sense as the clutch member **18** engages alternately with the clutch members **19** and **23**. All the other functions of the parts shown in FIG. **7** are substantially the same as the parts shown in FIG. **2**, including the arrangement previously described, by which the speed of rotation of the turbine **11** controls the speed of rotation of the shaft **17** and of whichever of the bevel gears **21, 24** is engaged by the clutch, and of the bevel gear **26**.

Reference is now made to FIGS. **8** and **9** from which it will be seen that the shaft **50** is attached to the rotatably-mounted housing **5** by means of a key and keyway **50*a*** and locked nut **50*b***. The housing **5** is mounted for rotation about the stationary vertical liquid supply pipe **4** on bearings **4*a***, of which only some are shown in FIG. **8**.

The liquid supply pipe **4** supports a stationary tube **51** which terminates at its lower end in an annular recess between the shaft **50** and the housing **5**. The tube **51** is provided with an external gear ring **52**. A spur wheel **53** is mounted for rotation on a stub shaft **54** which extends upwardly from the base of the housing **5** parallel with, and offset from the axis of shaft **50**, and the spur wheel **53** meshes with the gear ring **52**, so that rotation of the shaft **50** and the attached rotatable housing **5** causes planetary rotation of the spur wheel **53** about the axis of the shaft **50**. Attached to the spur wheel **53** and mounted for rotation on the stub shaft **54** is a second, smaller pinion wheel **55** which meshes with a spur gear **8*a*** on the worm **8** which is mounted, in any known suitable way, for rotation about the stationary tube **51**. The rotation of the worm **8** causes rotation of the worm wheel **9** and hence causes changes in the elevation or attitude of the nozzle **10** in the same way as in the embodiment of FIGS. **2** to **6**.

The gear ratios between the stationary gear ring **52** and the meshing spur wheel **53**, between the spur wheel **53** and the smaller pinion wheel **55**, and between the pinion wheel **55** and the spur gear **8*a*** can easily be selected to provide a desired ratio between the rotational or angular speed of the shaft 50 and the speed of the worm 8. Although the reduction gear arrangement within the housing 5 of the embodiment of FIGS. 7 and 8 is more expensive to make than the simple worm-and-gear wheel assembly in the housing 5 of the embodiment of FIGS. 1 to 6, in many cases, the overall cost of the machine of FIGS. 7 and 8 may be cheaper than that of the machine of FIGS. 1 to 6 since only one drive shaft (50) is required compared with the two shafts 6 and 7, and for some duties, these shafts may be about 12 feet long. Nevertheless, the type of tank cleaning machine of this invention which may be preferred by the ultimate user may be determined by operational factors which outweigh advantages of the FIG. 7 embodiment.

The top section of the machine of FIGS. 7 and 8 can be made smaller since the size limitations on the bevel wheels 21, 24 and 26 are less stringent in the absence of the other two bevel wheels 20, 25 of FIGS. 1 to 6. It will be seen in FIG. 8 that the thrust of the water jet is shared equally between bearings or sets of bearings (which are illustrated, but not all indicated by reference numerals) on each side of the jet reaction line. It will be clear to those skilled in the art that bearings or sets of bearings may be provided and so arranged in the housing 5 of FIG. 1 that the water jet thrust is shared between a plurality of bearings.

In order to enhance further the washing operation which can be performed by machines in accordance with the invention, the worm 8, as shown in FIG. 8, is free to slide axially a short distance along the support tube 51 between a lower shoulder 57 in the housing 5 and an upper shoulder 58 in the housing 5. A suitably short distance is one-half of the product of the speed reduction ratio of the gear-train 52, 53, 55, 8*a* and the pitch of the worm, or approximately this product.

When the direction of rotation of the shaft 50 is reversed due to the previously-described change of engagement of the clutch member 18 with the clutch members 19 and 23, the change in direction of the reaction of the worm 9 on the worm 8 will cause the worm 8 to move axially along the shaft 50 in the space between the lower shoulder 57 and the upper shoulder 58. The final position of the worm 8 will be at an abutting location with one or other of the shoulders 57 or 58, thereby imparting to the worm gear 9 and the attached nozzle 10 a starting position on reversing the direction of angular movement which is non-coincident with their positions prior to reversal of direction of angular motion, due to lost motion in the gear train 52, 53, 55, 8a, 8, 9 as outlined above, and equal to about one-half of the effective pitch of the gear train. The non-coincident position of the nozzle 10 at each reversal is advantageous in mitigating any tendency of the wash water jet leaving the nozzle 10 to make substantially repetitive wash patterns in the tank thereby further improving the thoroughness of washing that can be effected by the machine of the invention. It will be apparent to those skilled in the art that the worm 8 of the embodiment of FIGS. 1 to 6 can also be arranged for limited axial movement relative to the housing 5 for the same purpose.

In FIG. 9, there are shown the flow apertures 60 at the end of the nozzle 10 within the housing 5 through which wash water passes from regions 61 of the housing 5 to the nozzle 10. Wash water is supplied to the regions 61 from the wash water supply pipe 4, as shown in FIG. 8, via apertures 62 at the lower end of the pipe 4 within the rotatable housing 5 from which it passes into the spaces 63 of the housing 5 which communicate via apertures, not shown, with the regions 61. Although the manner in which wash water or other wash liquid is passed to the nozzle 10 has been particularly described with reference to FIGS. 8 and 9, it will be appreciated by those skilled in the art that the same or a similar arrangement can be used in other embodiments of the invention.

In the foregoing description, reference has been made only to the principal parts of the machines of the invention, but it will be understood by those skilled in the art that there will be other parts such as bearings between relatively rotatable parts, and glands and seals to prevent undesirable leakage of liquids.

It will be appreciated by those skilled in the art that features which have been described or mentioned with particular reference to one of the two illustrated embodiments may be incorporated in the other of the two embodiments, without departing from the invention as defined in the appended claims.

I claim:

1. A tank washing machine suitable for cleaning tanks of oil tankers, comprising a wash liquid supply pipe in communication with a nozzle housing rotatable about its longitudinal axis, a nozzle fixed to said nozzle housing, said nozzle being rotatable about an axis at an angle to its own longitudinal axis and at an angle to the axis of rotation of said housing, a turbine having turbine blades actuated by the flow of wash liquid from said wash liquid supply pipe, means operably driven in response to the impingement of said wash liquid on said turbine blades and including program means for causing said tanks to be cleaned in accordance with a predetermined programmed wash cycle, said program means operably connected for changing the speed of said turbine, and means connecting said turbine to drive said nozzle and nozzle housing for automatically varying the speed of each of said nozzle housing and said nozzle during operation as a function of said predetermined programmed wash cycle of said program means.

2. A machine according to claim 1 wherein the nozzle housing is co-axial with the wash liquid supply pipe.

3. A machine according to claim 2 wherein said turbine is located at the opposite end of said wash liquid supply pipe from said nozzle housing and is connected thereto by means of a rotatable shaft.

4. A machine according to claim 2 wherein the nozzle is rotatable about an axis disposed at an angle of 90° to the axis of rotation of the nozzle housing.

5. A machine according to claim 4 wherein the axis about which the nozzle is rotatable is disposed at substantially 90° to its longitudinal axis.

6. A machine according to claim 1 wherein said turbine blades have a variable pitch and said program means are operably connected therewith through means comprising a slidable rod co-axial with the axis of the turbine, and means for connecting said rod with said program means and said turbine blades so that sliding of said rod is in accordance with said program means for varying the pitch of said turbine blades in response thereto.

7. A machine according to claim 6 wherein said program means comprises a rotatable cam having profile

corresponding to said predetermined programmed wash cycle, and liner means connected at one end for sensing said profile and at the opposite end for causing said rod to slide as a function of the sensed profile.

8. A machine according to claim **6** wherein the nozzle oscillates about its axis of rotation.

9. A machine according to claim **8** comprising a slidable and rotatable clutch member having faces at opposite ends thereto, each of said faces adapted to engage with two other rotatable clutch members respectively, and gear means connected to said other rotatable clutch members and to the nozzle and nozzle housing so that when an adjacent face of said slidable clutch member disengages from engagement with one of said other clutch members the opposite face thereof engages with the other of said clutch members which causes a reversal in the direction of rotation of the nozzle and nozzle housing.

10. A tank washing machine for cleaning storage tanks, comprising a nozzle having a longitudinal axis and mounted for pivotal movement about a first axis substantially perpendicular to said longitudinal axis, a housing for pivotally mounting said nozzle and being rotatable about a second axis disposed at an angle relative to said first axis, conduit means for supplying tank wash liquid to said nozzle, common drive means connected for rotating said housing and for causing said nozzle to pivot in a predetermined fixed angular velocity relationship, predetermined tank wash profile means for defining a desired automatic wash program for cleaning said tank, said tank wash profile means connected with said common drive means for regulating the speed thereof as a function of said tank wash profile means and for automatically varying the absolute rate of angular velocity of said housing and said nozzle in accordance with said tank wash profile means, said tank wash profile means comprising cam means having a cam surface defining said wash program, and cam follower means for tracking said cam surface and connected with said common drive means for regulating the speed thereof in response to the tracked cam surface.

11. A machine according to claim **10** wherein said common drive means includes a turbine actuated by the flow of wash liquid.

12. A machine according to claim **11** wherein said turbine includes turbine blades, and comprising lever means for varying the angle between said turbine blades and the direction of flow of wash liquid impinging thereon in accordance with the cam surface as sensed by said cam follower.

13. A machine according to claim **12** wherein said turbine blades have a variable pitch.

14. A machine according to claim **13** wherein said means for varying the relative angle between said turbine blades and the wash liquid impinging thereon comprises a slidable rod co-axial with the axis of said turbine, and lever means connecting said rod to said turbine blades for causing the pitch of said turbine blades to vary in relation to the pitch of said turbine blades a vary in relation to the sliding movement of said rod.

15. A machine according to claim **14** wherein said slidable rod is operably connected to a first end of pivotably mounted lever means, said lever means carrying at the opposite end thereof said cam follower means disposed in operable tracking contact with said cam surface.

16. A machine according to claim **15** wherein said cam means is rotatably mounted.

17. A tank washing machine adapted for cleaning the interior of a cargo storage tank, comprising variable speed drive actuated by wash liquid, said speed varying automatically in accordance with a predetermined wash program for said tank, predetermined wash program means operably connected with said drive means for causing the speed of said drive means to automatically vary in accordance with said wash program for said tank, nozzle means for use in cleaning said tank and means connecting said drive means to said nozzle for automatically varying the speed thereof in accordance with said wash program, whereby said tank is cleaned in a predetermined optimum manner.

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