Sept. 27, 1966 M. A. SAAD 3,275,241

APPARATUS FOR CLEANING TANKS

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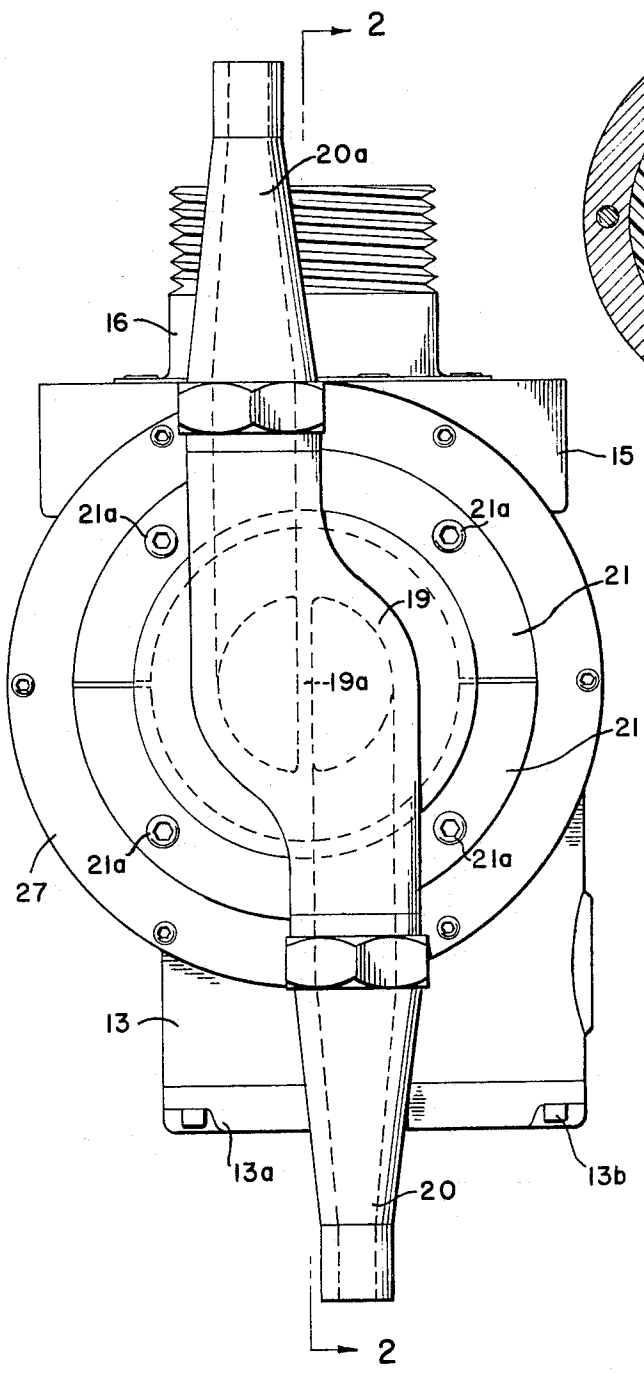


FIG_1

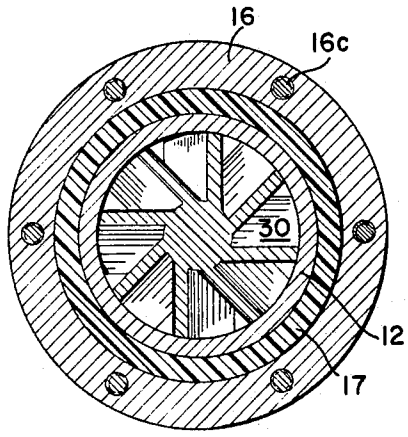


FIG_3

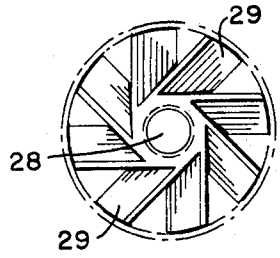


FIG_4

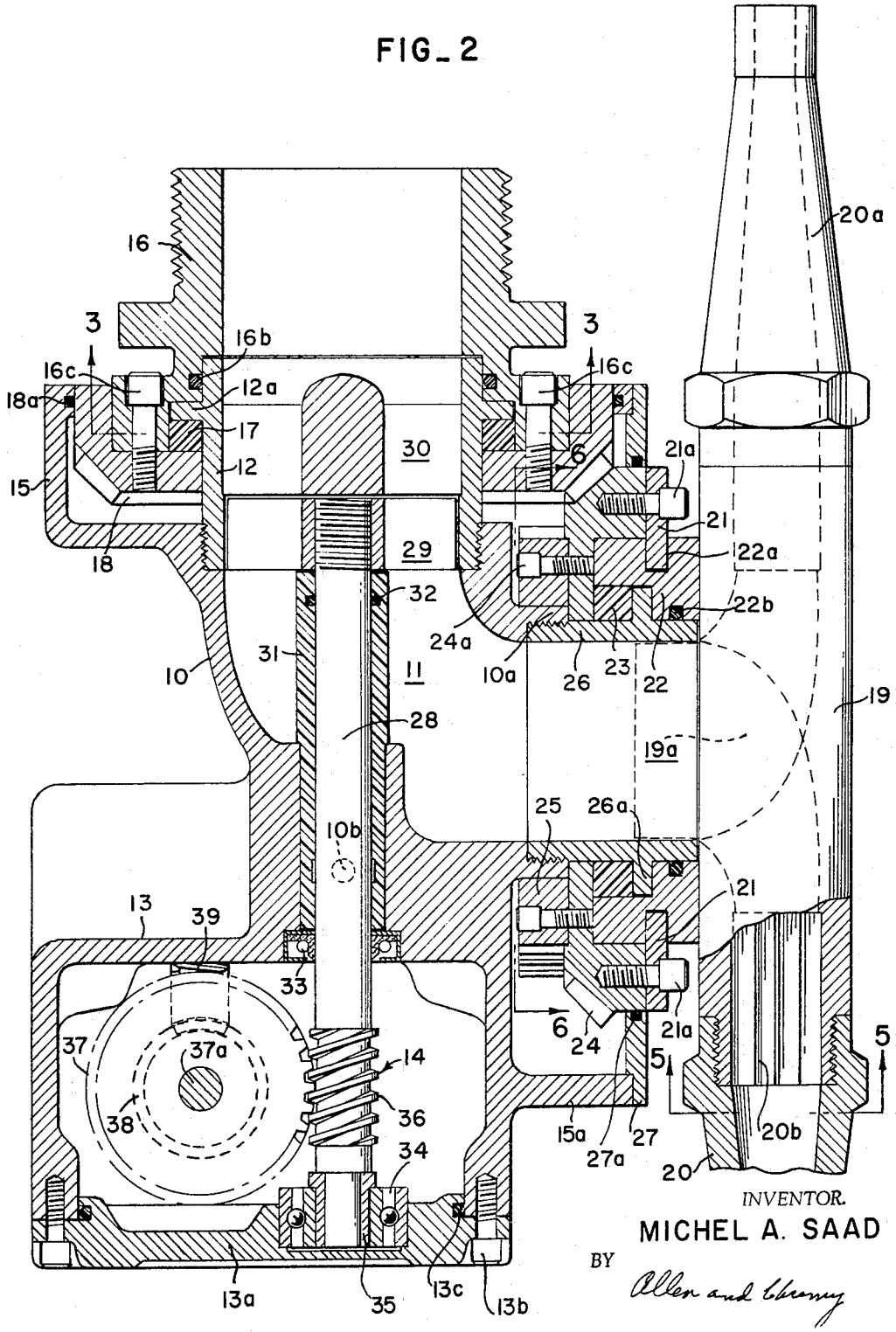
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APPARATUS FOR CLEANING TANKS

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FIG_2



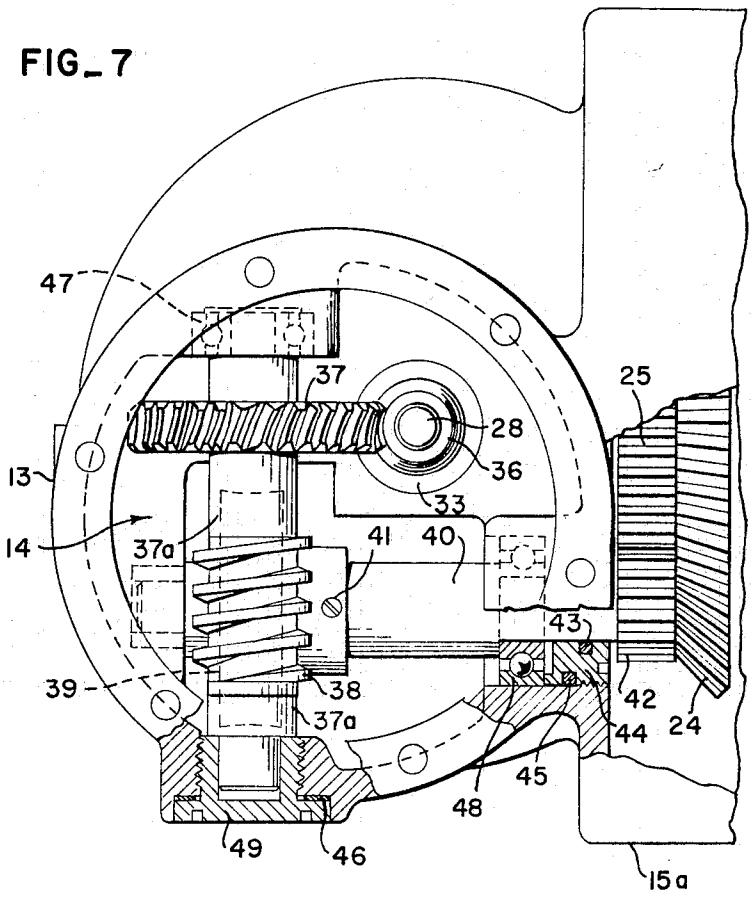
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Sept. 27, 1966 M. A. SAAD 3,275,241

APPARATUS FOR CLEANING TANKS

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FIG_7



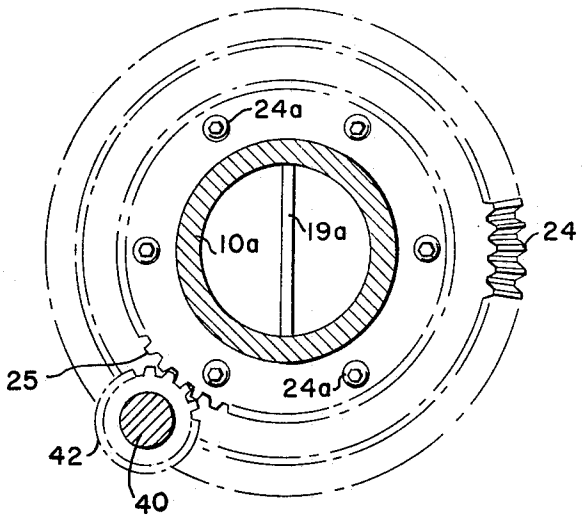


FIG_6

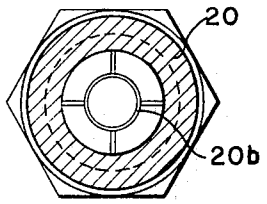


FIG_5

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3,275,241

APPARATUS FOR CLEANING TANKS

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Filed Oct. 18, 1965, Ser. No. 497,423
8 Claims. (Cl. 239—227)

This invention relates to a water jet cleaning device for washing out shipping and storage tanks.

This application is a continuation-in-part of my copending application Serial No. 364,153 filed May 1, 1964.

An object of this invention is to provide an improved device which is water rotated and which is constructed to direct two or more jets of cleaning solution over the inside surfaces of shipping or storage tanks to wash and clean the insides thereof.

Another object of this invention is to provide an improved hydraulic tank cleaning device having improved bearings and seals whereby improved operation is obtained and the life of the device is increased.

Another object of this invention is to provide an improved hydraulic tank cleaning device utilizing a bearing assembly which is a combination of a thrust bearing and face seal in which the face sealing material and bearing material is made of a plastic including tetrafluoroethylene polymer, and the sealing action is accomplished by hydraulic pressure.

Still another object of this invention is to provide an improved hydraulic tank cleaning device which is provided with a threaded coupling member for connecting it to the fluid supply, said coupling member being connected to a thrust bearing and bevel gear arrangement which is stationary and about which this device rotates during the operation thereof, said device also being provided with a similar thrust bearing and bevel gear combination on the nozzle side of the device, both of the thrust bearings being provided with O-ring seals whose main function is to prevent dirt, cleaning solution and other foreign material from entering the thrust bearings.

Still another object of this invention is to provide an improved hydraulic tank cleaning device with clutch means engaging the nozzle head which allows free rotation of the nozzle head, the clutching of the nozzle head being responsive to hydraulic pressure.

Still another object of this invention is to provide an improved hydraulic tank cleaning device utilizing a turbine and reduction gearing in which the drive shaft of the turbine is provided with a seal and bearing made of a material including plastic, such as tetrafluoroethylene polymer, to prevent the cleaning solution from entering the reduction gear box. The bearing is also provided with an O-ring seal inside thereof engaging the drive shaft.

Another object of this invention is to provide an improved hydraulic tank cleaning device provided with a casting which is made in one piece so as to reduce the weight thereof, said casting also being provided with a passageway therethrough of comparably large diameter which may be lined with corrosion-resisting material, said passageway having few obstructions and no sharp bends.

Still another object of this invention is to provide an improved hydraulic tank cleaning device that is provided with a reduction gearing in the drive arrangement thereof, said reduction gearing being housed in a sealed gear box provided with oil lubrication and inside bearings except on the input and output shafts thereof.

Still another object of this invention is to provide an improved hydraulic tank cleaning device in which the cleaning solution, shortly after leaving the turbine drive of the device, is guided by flow-straightening devices so

that the lengths of the nozzles of the device may be made as short as possible.

Still another object of this invention is to provide an improved hydraulic tank cleaning device that is provided with a one-piece casting used for the housing thereof, said casting also being provided with circular guards extending around the bevel gears, one of said gears engaging an O-ring in the guard therefor to seal this gear within this guard, the other gear also being sealed with a circular cover and O-ring.

Still another object of this invention is to provide an improved hydraulic tank cleaning device in which the turbine drive thereof is provided with a shaft that is supported only by two bearings so as to allow better aligning of the shaft.

Still another object of this invention is to provide an improved hydraulic tank cleaning device in which one of the gears in the gear box is provided with a shear pin which is used as a safety feature if the device strikes an object while the clutch is engaged, resulting in a high torque on the nozzles.

A further object of this invention is to provide an improved hydraulic tank cleaning device in which the water after leaving the turbine drive of the device is guided by flow-straightening devices which straighten the flow of the cleaning solution, said devices starting with a web upstream of the nozzle housing of this device which extends into the nozzle support.

Other and further objects of this invention will be apparent to those skilled in the art to which it relates from the following specification, claims and drawings in which, briefly:

FIG. 1 is an elevation view showing the nozzles of this device;

FIG. 2 is a vertical section taken along the line 2—2 of FIG. 1;

FIG. 3 is a sectional view taken along the line 3—3 of FIG. 2;

FIG. 4 is a detail view of the turbine;

FIG. 5 is a sectional view taken along the line 5—5 of FIG. 2 showing the water flow straighteners;

FIG. 6 is a sectional view taken on line 6—6 of FIG. 2; and

FIG. 7 is a view eliminating the gear box cover to show the speed reduction gear train.

Referring to the drawing in detail, reference numeral **10** designates the housing of this device which may be made in one piece by casting suitable metals or alloys such as various types of bronze, stainless steel or the like, or plastics with suitable fillers. This housing is provided with an elbow-shaped cavity **11** therein, one end of this cavity is threaded to receive the tubular bushing **12** which is treaded thereinto. The housing **10** is provided with a gear box **13** in which the reduction gearing **14**, which will be described hereinafter, is positioned. The gear box **13** is provided with a cover **13***a* attached to the gear box by screw **13***b*. An O-ring **13***c*, made of neoprene or the like, is placed in a circular groove in the cover **13***a* to prevent oil leakage from the gear box. The housing **10** is also provided with projecting guards **15** and **15***a* in which the bevel gears **18** and **24**, respectively, are positioned so that they are enclosed thereby.

This device is provided with a threaded member **16** for connecting it to a conventional supply pipe which supports the device in the tank being cleaned and through which the cleaning solution is provided to the device. The member **16** is provided with a flange through which a plurality of holes are formed for receiving the bolts or machine screws **16***c* which are used for attaching the member **16** to the bevel gear **18**. Thus, the coupling member **16** is rigidly attached to the bevel gear **18** with

respect to which bushing **12** is rotatable. Bushing **12** is threaded into the housing **10** so that the passage through this sleeve is aligned with the cavity **11** in the housing. The seating of bushing **12** in the housing is machined to ensure aligning of the passageway therethrough without any clearance in the seat. The bevel gear **18** is enclosed by the flange member **15** provided to the housing. An O-ring **18***a* is positioned in a circular groove in the guard **15** and forms a seal with the bevel gear **18**.

The bushing **12** is provided with a flange **12***a* extending radially therefrom near the outer end thereof, and an annular cavity is provided between this flange and the bevel gear **18** for receiving the ring-shaped seal and bearing **17**. The bearing **17** is made of a material including plastic, such as tetrafluoroethylene polymer, designated in commerce as "Teflon" or the like impregnated with powdered metal, glass, graphite or the like. The ring member **17** functions as a bearing between the coupling member **16** and the bushing **12**. O-ring **16***b*, made of neoprene or the like, is provided as a seal between member **16** and bushing **12** to prevent dirt, cleaning solution and foreign matter from entering the bearing. O-ring **16***b* is positioned in a circular groove formed in the coupling member **16**, and this O-ring forms a seal with the bushing **12** near its outer end.

This device is provided with a nozzle supporting member or head **19** to which the nozzles **20** and **20***a* are attached by suitable threads. Member **19** is provided with an annular flange **22** which has a groove **22***a* formed in the outer surface thereof for receiving the clutch segments **21**. These segments are semicircular, as shown in FIG. 1, to permit positioning them in groove **22***a*, and they are attached by bolts **21***a* to bevel gear **24**. The bevel gear **24** and the ring gear **25** are attached to each other by machine screws **24***a*. Bevel gear **24** and ring gear **25** are rotatable with respect to the housing **10** around the neck **10***a* of the housing which fits into the ring gear **25**. The inside of this neck **10***a* is threaded to receive the threads of the bushing **26** whereby this bushing is attached to the housing. The seating of bushing **26** in the housing is machined to ensure aligning of the passageway therethrough without any clearance in the seat.

The bushing **26** is also provided with a radially extending flange **26***a* near the outer end thereof, and the ring-shaped bearing **23** is positioned between this flange **26***a* and the bevel gear **24**. The ring-shaped member **23** is also made of plastic material such as "Teflon" or the like, impregnated with powdered metal, glass, graphite or the like, which forms an efficient long-wearing bearing surface. An additional seal in the form of an O-ring **22***b*, made of neoprene or the like, is provided to prevent dirt, cleaning solution and foreign matter from entering the bearing. O-ring **22***b* is positioned in a circular groove formed in the flange member **22** of the nozzle-supporting head. Cover **27** is attached to guard **15***a* by suitable screws, as shown in FIG. 1. O-ring **27***a*, positioned in a groove formed in the cover **27**, forms a seal with bevel gear **24**. While impregnated plastic bearings are definitely better, ball bearings of suitable alloys such as Monel or stainless steel may be substituted for the plastic impregnated rings **17** and **23**. However, ball bearings will not function as seals, and if they are used, then the O-rings must be used for sealing purposes.

The drive shaft **28** is supported in the housing by a bearing **31** which is made of impregnated "Teflon" or the like, as previously described in connection with bearings **17** and **23**, and the ball bearing **34** which is positioned in a recess in the cover plate **13***a* attached to the gear box which encloses the reduction gearing train **14**. The turbine **29**, which is positioned in the bushing **12**, is threaded to shaft **28** by threads which correspond to the direction of rotation so that the turbine will not become loose during rotation. The turbine **29** is positioned downstream of the vanes **30** which guide the cleaning solution to the turbine blades. The vanes **30** may also function as a strainer.

The bearing **31** is in the form of a long sleeve, as illustrated in FIG. 2, and an O-ring **32** is provided in this bearing **31** to reduce the tendency of liquid passing along the shaft **28** through the bearing and into the gear box enclosing the gear train **14** in which the pressure is relatively low. The hole **10***b* provided in the casting and connected to the outside is to ensure that any leakage past the O-ring **32** does not enter the gear box. Opposite hole **10***b* a groove is provided in bearing **31** to ensure all liquid leaking past O-ring **32** to be drained to the outside. Thus, this groove also acts as a seal. The oil seal **33** on the gear box side is provided to prevent any oil leakage to the outside of the gear box.

The shaft **28** is provided with a worm **36** which meshes with the gear **37** that is pinned to the shaft **37***a*, which is journaled in the walls of the gear box, and one end of which is provided with ball bearing **47**. The worm **38** is pinned or keyed to the shaft **37***a*, and this worm meshes with gear **39**, which is positioned behind the worm **38** on shaft **37***a* and is shown in broken outline in FIG. 7. The gear **39** is pinned by the shear pin **41** to the shaft **40**, which is also journaled in the walls of the gear box, and which extend out of the gear box. Ball bearing **48** is provided to shaft **40** adjacent to seal arrangement including O-rings **43** and **45**. The pinion gear **42** is an integral part of the shaft **40**. O-ring **43** is provided around the shaft **40** and is positioned in an inner groove in threaded ring **44**, and another O-ring **45** is positioned in a groove formed in the outer surface of ring **44**. The O-rings **43** and **45** function to prevent oil from leaking out of the gear box **13** and water from entering said gear box from the outside. An alternative structure taking the place of these O-rings is an oil seal such as the oil seal **33**, positioned around the shaft **28**. Bearing **49** for shaft **37***a* is threaded into the gear box as shown in FIG. 7, and a gasket **46** provides a seal between bearing **49** and the gear box **13**. The pinion gear **42** meshes with ring gear **25** that is attached to the bevel gear **24** and to the clutch **21**.

The operation of this apparatus is as follows:

The water or cleaning fluid is given a tangential component of velocity or acquires an angular momentum by the guide vanes **30** positioned upstream of the turbine **29**. The blades of the turbine **29** are inclined such that most of the angular momentum is absorbed by the turbine. The water then flows through the main cavity **11**, and its flow is straightened by means of the flow straighteners **19***a*, which is a part of the casting of the nozzle housing **19**, and additional flow-straightening members **20***b* positioned just ahead of the tapered nozzles; thus, the jets leave the nozzles **20** and **20***a* in a substantially straight direction, and the degree of divergence is minimized.

The turbine drives the shaft **28** at a relatively high speed, and this is reduced by means of two sets of worms and gears which are positioned in the gear box **13**. The output of the gear box drives the pinion gear **42**, which meshes with the spur gear **25**. This drives the bevel gear **24**, which meshes with the stationary bevel gear **18** and thus provides for roation of this device about its vertical axis.

Hydraulic pressure inside of the nozzle head **19** tends to force the head away from housing **10** and thus cause the clutch **21** to grip surfaces of groove **22***a*, thus causing the clutch **21**, which is attached to the gear **24**, to rotate the nozzle head **19** as an integral part with gear **24**. Nozzles **20** and **20***a* are thus rotated about the horizontal axis.

Bevel gear **25** is provided either with a lesser or a greater number of teeth than bevel gear **18** so that the water jets from the nozzles **20** and **20***a* are directed to different surfaces of the tank for each revolution thereof. It is preferred that the number of teeth in these bevel gears differ by one.

Plastic impregnated bearing **31** of the shaft **28** has the O-ring **32** imbedded in the bearing to prevent leakage, also a hole **10***b* is provided in the casting connected to the

outside and located after the O-ring **32** to insure that no fluid enters the gear box from the main cavity **11**. The oil seal **33** on the gear box side is provided to prevent any oil leakage to the outside of the gear box.

While I have shown a preferred embodiment of the invention, it will be understood that the invention is capable of variation and modification from the form shown so that its scope should be limited only by the scope of the claims appended hereto.

What I claim is:

1. Apparatus for washing the interior of a ship tank and the like, said apparatus being adapted to be suspended in the tank by a fluid supply conduit, comprising the combination of a housing having a curved main cavity, said main cavity having an inlet and an outlet, stationary coupling means having one end connected to a fluid supply conduit, means including a first thrust bearing means rotatably supporting said housing on said coupling member so that said coupling member is connected to said inlet of said rotatable housing, said coupling means having a bevel gear attached thereto, said bevel gear engaging said first thrust bearing means, cleaning fluid nozzle means including a nozzle head, means including a second thrust bearing means for rotatably supporting said nozzle means on said outlet of said housing, a second bevel gear associated with said nozzle head and meshing with said first mentioned bevel gear, said housing having means engaging the peripheral portions of said bevel gears providing bearing surfaces for said bevel gears, clutch means responsive to hydraulic pressure in said cavity, said clutch means coupling said nozzle head to said second bevel gear, said clutch means comprising a member attached to said second bevel gear engaging said nozzle head on the outside thereof, and means responsive to fluid flowing through said cavity rotating said nozzle head with respect to said housing and said housing with respect to said coupling means, said means responsive to fluid flow including said bevel gears and said clutch means, said bevel gears having different predetermined numbers of teeth so that the jets of cleaning fluid directed from said nozzles against the interior surfaces of said tank progressively impinge on different areas of said tank surfaces as said nozzle means is rotated with respect to said housing and said housing is rotated with respect to said coupling means so that the entire surface of said tank is covered with cleaning fluid during a cycle of operation.

2. Apparatus as set forth in claim **1** further characterized in that said member of said clutch means comprises a pair of substantially semicircular members engaging said nozzle head in a groove formed therein, said substantially semicircular members being removably attached to said second bevel gear.

3. Apparatus as set forth in claim **2** further characterized in that the outlet of said housing is provided with a bushing having a flange thereon and said last mentioned thrust bearing is positioned between this bushing flange and the second bevel gear.

4. Apparatus as set forth in claim **1** further characterized in that said nozzle head is provided with a passageway connected with the outlet of said main cavity and liquid flow straightening baffle means is provided in said passageway.

5. Apparatus as set forth in claim **1** further characterized in that said peripheral portions of said bevel gears are sealed by O-rings positioned between said peripheral portions and the means of said housing which engage said peripheral portions.

6. Apparatus as set forth in claim **1** further characterized in that said means responsive to fluid flow includes a speed reduction gear train provided with an output shaft driven by a gear of said train mounted thereon and connected thereto by a shear pin which is adapted to shear off in case an excessive torque is applied to said nozzle means tending to rotate said nozzle means.

7. Apparatus as set forth in claim **1**, further characterized in that said means responsive to fluid flow through said cavity comprises a turbine, a shaft extending between said turbine and a gear box, said shaft supporting said turbine adjacent to said inlet, a speed reduction gear train in said gear box having the input thereof connected to said shaft, a bearing comprising a wear-resistant plastic positioned on said shaft, said bearing of wear-resistant plastic extending substantially from said turbine to said gear box and an oil seal positioned on said shaft in said gear box adjacent to said wear-resistant plastic bearing.

8. Apparatus as set forth in claim **7** further characterized in that the shaft bearing includes a polymer of tetrafluoroethylene, said shaft bearing having an internal groove against said shaft, said housing wall having an opening therein leading from said shaft to the outside of said housing to provide an exit for any fluid leaking along said shaft past said O-ring from said main cavity.

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