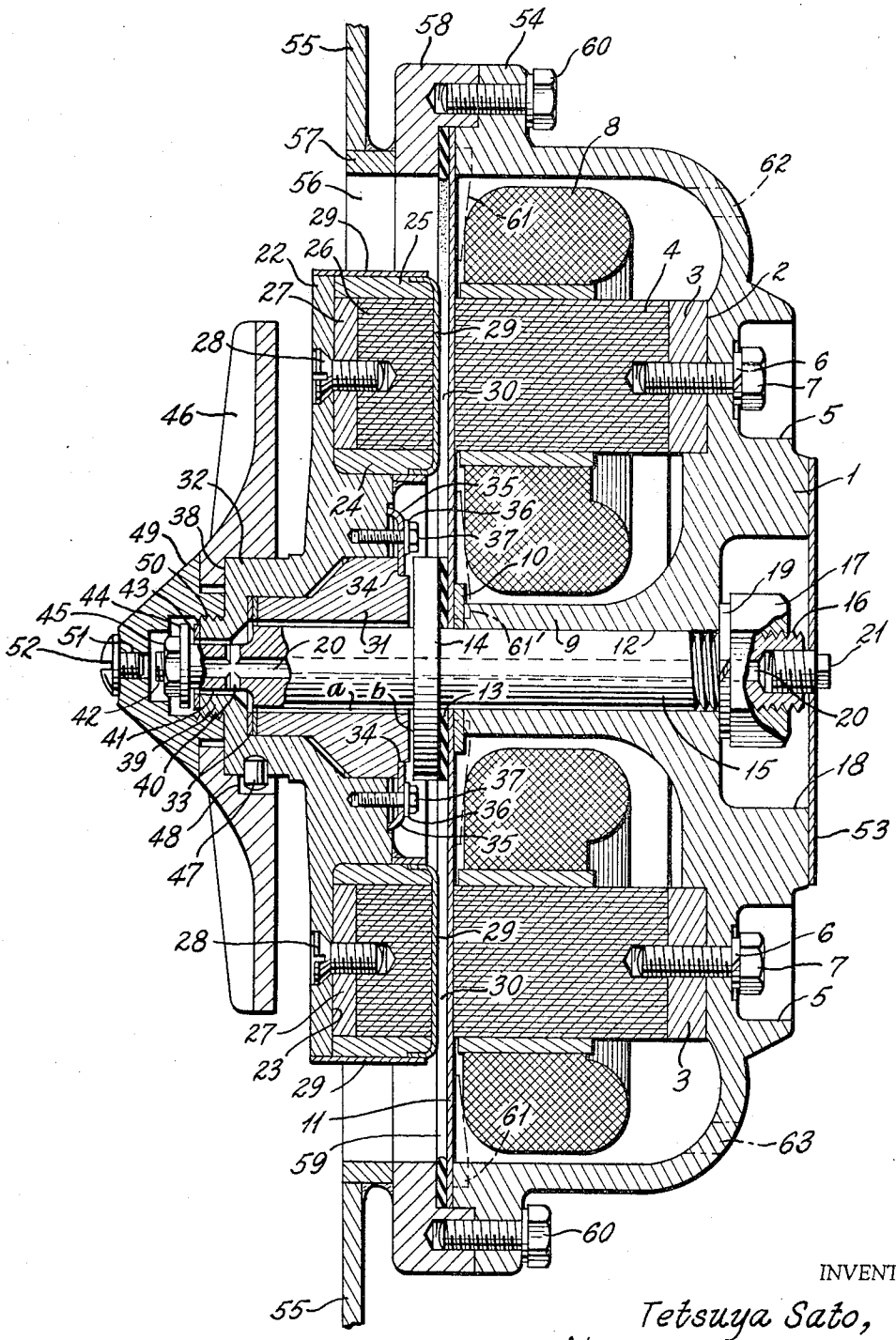
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LIQUID AGITATING DEVICE

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LIQUID AGITATING DEVICE

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The present invention relates to a liquid agitating device adapted for use in chemical industry for the purpose of agitating liquids or in an electrical washing machine.

In a conventional liquid agitating device comprising a rotating shaft for driving an agitating vane and extended through an agitating tank, it is necessary to use a liquid sealing means such as an oil seal, a mechanical seal, etc., in order to prevent the liquid in the agitating tank from leaking out of the tank along that portion of the shaft which extends through the tank.

Such liquid sealing means, however, becomes rapidly degraded due to a slight vibration of the shaft or to pulverized solid particles contained in the liquid to be agitated, which results in a leakage of the liquid, thereby adversely affecting the function of the liquid sealing means.

In order to obviate such disadvantages, it has been proposed to suspend vertically a long shaft from the upper part of the agitating tank and secure an agitating vane to the lower end of the shaft so as to immerse the agitating vane in the liquid to be agitated, thereby omitting that portion of the rotating shaft which extends through the agitating tank. Such device, however, has disadvantages that the long driving shaft journaled in the bearing causes wearing of the shaft very soon, and that presence of a transmission mechanism for driving the long shaft including an intermediate bearing, gears, pulleys, belts, etc., reduces the life of a driving motor, increases the installation cost and lowers the transmission efficiency.

Any similar conventional device has disadvantages that the agitating tank has to be provided at its outside with extra equipment, and that an agitating power loss becomes large.

The object of the present invention is to obviate the above mentioned disadvantages and provide a liquid agitating device adapted to prevent the liquid being agitated from leaking out of the agitating tank. Another object of the present invention is to prevent the outside air from penetrating into a hermetically sealed vacuum agitating tank and having the additional advantage that reduction of a space occupied by the device and running costs thereof is possible.

For a better understanding of the invention, reference is taken to the accompanying drawing, in which a single figure is a longitudinal sectional view showing an embodiment of the present invention.

Referring to the drawing, **1** represents a motor casing which is open at its inner end and provided at its inner peripheral edge with an annular step **2**. To this annular step **2**, several supporting plates **3** are welded. An annular stator core **4** of an axial air gap type induction motor is secured to the supporting plates through the aid of several bolts **7** which extend through several cavities **5** formed at given intervals along the outer periphery of the outside wall of the motor casing **1** and also through washers **6**. A stator coil **8** of the axial air gap type induction motor is wound around the stator core **4**. Thus, the motor casing **1** encloses therein the stator core **4** and the stator coil **8** of the axial air gap type induction motor.

The motor casing **1** is provided at its center part with a center projection **9** which is integral with the casing **1**.

An end plate **10** bears upon the inner end of the center projection **9**, whilst a sealing partition wall plate **11** of non-magnetic anti-corrosion material bears closely upon the opposite side of the end plate **10** and upon the inner periphery of the casing **1** and the inner end of the stator core **4**.

A bore **12** is drilled through the center projection **9** of the motor casing **1**. The outer part of a fixed shaft **15**, having an intermediate fitting flange **14** which is integral with the shaft **15**, extends through a packing **13**, the partition wall plate **11**, the end plate **10** and through the bore **12**. The outer end of the fixed shaft **15** has formed at its outer periphery threads **16** for threaded engagement with a washer **19** and a nut **17**. The nut and washer rest in a cavity **18** formed at the center of the outside wall of the motor casing **1**. An internal axial hole **20** is formed along the axis of the fixed shaft **15**. The axial hole **20** is hermetically closed by a sealing plug **21** detachably threaded into the outer end of the axial hole **20**.

Provision is made for a rotating body **22** which has formed on its outside surface an annular step **23**. An annular rotor core **26**, having squirrel cage type inner and outer copper rings **24** and **25** of the axial air gap type induction motor, is secured to said annular step through several supporting plates **27**, welded at given intervals along the inside surface of the annular rotor core **26**, by means of several bolts **28**. The outside exposed surfaces of the rotor core **26** and of the inner and outer copper rings **24** and **25** and also the inner and outer circumferences of the latter rings are painted with an anti-corrosive paint or covered with an anti-corrosive sheet metal **29**. The rotor core **26** is arranged in opposition to the stator core **4** to form an air gap **30** therebetween.

The rotating body **22** is provided at its center part with a boss portion in which a bearing **31** is fitted to form the air gap **30**, the axial length of which is adjusted with the aid of a few washers **33**. The bearing **31** is provided at its outer peripheral edge bearing upon the intermediate fitting flange **14** with several notches **34**. Clamping pieces **35** in engagement with several notches **34** serve to clamp the bearing **31**, the clamping pieces **35** being fastened to the outside surface of the center boss **32** with the aid of washers **36** and bolts **37**. As a result of this, the bearing **31** can be made integral with the rotating body **22** and be rotatably mounted around that portion of the fixed shaft **15** which lies inside the intermediate fitting flange **14**.

The center boss **32** of the rotating body **22** is formed at its inside with a stepped part **38** having a cylindrical portion **39** projected from the stepped part **38**. The fixed shaft **15** is formed at its inner end with a reduced portion **41** extending through the cylindrical portion **39**. The reduced portion **41** is formed with several holes **40** communicated with the axial hole **20** of the fixed shaft **15**. The reduced portion **41** is formed around its end portion with threads **42** which are brought into threaded engagement with a nut **45**. The nut **45** bears upon the inner end of the cylindrical portion **39** through a washer **44** and several adjusting washers **43** in order to prevent removal of the rotating body **22**. The adjusting washers **43** serve to set the rate of axial displacement of the rotating body **22**.

Around the circumference of the stepped part **38** is fastened an agitating vane **46** by means of a lock pin-groove connection **47** and **48**. The groove **48** is formed at the center step of the agitating vane **46**. Provision is made for a cap nut **49**, having a threaded portion **50** which is in mesh with the outside threads of the cylindrical portion **39** such that the cap nut **49** may be made integral with the rotating body **22**.

The cap nut **49** is provided at its center with a tapped hole **51** into which a locking bolt **52** is detachably

threaded. The center cavity **18**, formed in the outside wall of the motor casing **1**, is closed by an end plate **53** fastened to the outside wall of the motor casing **1**.

The motor casing **1** is formed at its inner peripheral edge with a flange **54**. An agitating tank wall **55** includes an annular fitting frame **57** welded to the inner circumferential edge of the tank wall **55** to form an opening **56**. To the annular fitting frame **57** is welded an annular flange **58** which is L-shaped in section and arranged in opposition to the flange **54**. The flanges **54** and **58** are clamped together with a gasket **59** and the partition wall plate **11** by means of several bolts **60** so that the agitating vane **46** may be located in the agitating tank **55**.

In operation of the device constructed as above mentioned, the rotor core **26** is caused to rotate by the magnetic induction effect of the stator core **4**, which results in a rotation of the rotating body **22** which is integral with the rotor core **26** and journalled about the bearing **31**. At the same time, the agitating vane **46** which is integral with the rotating body **22** is caused to rotate about the fixed shaft **15**, thereby agitating the liquid in the agitating tank **55**.

The stator core **4** and the stator coil **8** in the motor casing **1** are separated and protected from the liquid to be agitated in the agitating tank **55** by means of the partition wall plate **11**. This also permits a safety operation to be continued and the motor casing **1** to be hermetically sealed from the wall of the agitating tank **55**, without leaking the liquid to be agitated in the agitating tank **55** out of the motor casing **1**. Thus, the invention provides a reliable way of preventing leakage of the liquid in the agitating tank **55** without it being necessary for any sealing means such as an oil seal, mechanical seal, etc. to be used in order to prevent the leakage of liquid as is ordinarily found in the conventional device.

Moreover, since the agitating vane **46** is made integral with the rotating body **22**, having the rotor core **26**, by means of the cap nut **49**, it is possible to replace the agitating vane **46** with any vane suitable for the kind of the liquid to be agitated. As explained with reference to the above embodiment, a hollow shaft having an integral axial hole formed therein is used as the fixed shaft **15**. The fixed shaft **15** is detachably provided at its outer and inner ends with the sealing plug **21** and the sealing bolt **52**, respectively. Thus, if a clean liquid is used as the liquid to be agitated and the outer sealing plug **21** is threaded into the outer end of the axial shaft **15** and the inner sealing bolt **52** is removed from the cap nut **49**, the pressure difference produced during the agitation of the liquid renders it possible to effect a forced circulation of the liquid from the tapped hole **51** through the inner axial hole **20** formed in the fixed shaft **15**, the transverse hole **40**, a radial air gap *a* formed between the fixed shaft **15** and the bearing **31**, a slight air gap *b* formed between the intermediate fitting flange **14** and the bearing **31** and the air gap **30** formed between the partition wall plate **11** and the outer end surface of the rotor core **26** to the agitating tank **55**. If a slurry containing foreign solids, crystals, etc. is used as the liquid to be agitated and the outer sealing plug **21** is removed from the end of the fixed shaft **15** and the sealing bolt **52** is threaded into the cap nut **49**, the clean liquid may be fed into the inner axial hole **20** in the fixed shaft **15** to effect a forced circulation of the clean liquid. This considerably facilitates the lubrication for the bearing **31**. Thus, it is possible to lubricate the rotating surface which lies between the fixed shaft **15** and the bearing **31** for the agitating vane **46** with the aid of the liquid to be agitated or any other clean liquid, thereby maintaining a smooth rotation of the agitating vane **46**. This lubrication serves to prevent wear of the rotating members resulting from overheating at the rotating surface which lies between the fixed shaft **15** and the bearing **31**. Even as the bearing **31** becomes worn and the rotor core **26** comes into contact with the partition wall plate **11** and there is tendency to stop the rotation of the agitating vane **46**, the stator core **4** and the fixed shaft **15** together with the partition wall plate **11** assure a hermetical seal against leakage of the liquid from the agitating tank **55**.

The above mentioned rotating means according to the invention in which use is made of an axial air gap type induction motor to drive an agitating vane without causing any leakage of the liquid is far superior to any conventional rotating means in which a rotating shaft extends through an agitating tank. The advantage of the device according to the invention can easily be understood if compared with the conventional device wherein use is made of a radial air gap type induction motor as a rotating means. If the radial air gap type induction motor is used as the rotating means, that portion of the motor which projects out of the agitating tank becomes long, so that it is necessary to reinforce the fitting part of the agitating tank. Moreover, a number of means are required to lubricate and cool the bearing. In the conventional device, both the stator and the rotor rotating in the stator are immersed in the liquid, so that the power required to revolve the rotor in the stator in the liquid is not utilized to agitate the liquid, thereby increasing the power loss. Contrary to this, the present invention has advantages that the dimension of the portions outside the agitating tank **55** can be made smaller by several times, i.e., one tenth, than required for the radial air gap type induction motor. Moreover, the present invention makes it possible to prevent the outside air from penetrating into a hermetically sealed vacuum tank used as the agitating tank, which could not be attained by any conventional shaft sealing device. The overall efficiency of the device according to the invention in which all of the rotating members are immersed in the liquid is several times that of the conventional agitating device wherein use is made of the radial air gap type induction motor for the purpose of driving the agitating vane through a long shaft and a transmission means arranged outside the agitating tank. The partition wall plate **11** inserted in the air gap **30** formed between the stator core **4** and the rotor core **26** is made of a material which is non-magnetic and has a high resistivity in order to limit the flux density and therefore decrease the eddy current loss to an extremely small value. The rotor core **26** is of a squirrel cage type construction in which laminated silicon sheet steel is combined with a copper bar and a copper ring, which results in a high output agitation in an extremely efficient manner and a continuous agitation in a large type agitating tank of the order of 100 tons.

In carrying out the invention into effect, if a vacuum tank or a high pressure tank is used as the agitating tank **55**, provision is made at the inside of the opening and at the outer periphery of the inner end of the projection **9** of the motor casing **1** of annular lining plates **61** and **61'** made of non-magnetic material such as SUS material, etc., and welded to the partition wall plate **11** for the purpose of reinforcing the latter.

If use is made of a hot liquid heated to a high temperature of the order of 120° C.–250° C. as the liquid to be agitated, the partition wall plate **11** is painted at its inner surface with a heat insulating material such as silicon rubber and the motor casing **1** is divided into two chambers in which cooling water is caused to circulate through an inlet **62** and an outlet **63**, thereby protecting the stator coil **8** from overheating.

As above mentioned, the invention makes use of a rotating shaft which does not extend through an agitating tank and may be applied to a vacuum tank and a high pressure tank without allowing leaking liquid out of the tank and without allowing the outside air into the tank. The invention also makes use of a rotating means and also an axial air gap type induction motor so as to provide an agitating device which is compact in construction and highly efficient in agitating operation, which could never be attained by any conventional rotating means.

Though the invention is described by means of an em-

bodiment as shown in the drawing, yet various modifications can of course be made without departing from the scope of the invention.

What we claim is:

1. A liquid agitating device comprising a casing, a stator core and stator coil of an axial air gap type induction motor enclosed in the casing, a partition wall plate made of a non-magnetic and non-corrosive material and closely fastened to the inside surface of the casing, a fixed shaft secured at its outer portion to the center part of the casing, an agitating vane journalled about a bearing on the inner portion of the fixed shaft and including a rotor core arranged in opposition to the stator core to form an air gap therebetween, means passing through the center of said fixed shaft for introduction of a lubricating and cleansing fluid to said bearing, and an agitating tank, the peripheral edge of the casing and the circumferential edge of an opening formed in the agitating tank being secured together such that the agitating vane is positioned in the agitating tank.

2. A liquid agitating device comprising a casing, a stator core and stator coil of an axial air gap type induction motor enclosed in the casing, a partition wall plate made of a non-magnetic and non-corrosive material and closely fastened to the inside surface of the casing, a fixed shaft secured at its outer portion to the center part of the casing, a rotating body including a rotor core and journalled through a bearing about an inner portion of the fixed shaft, an internal axial hole formed through the axis of said fixed shaft for the introduction of lubricant to lubricate and cleanse said bearing, said lubricant being moved about the bearing by a pressure differential produced during agitation of the liquid to effect a forced circulation of the liquid, said rotor core being arranged in opposition to the stator core to form an air gap therebetween, and an agitating vane secured to the rotating body, and an agitating tank, the peripheral edge of the casing and the circumferential edge of an opening formed in the agitating tank being secured together such that the agitating vane is positioned in the agitating tank.

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