United States Patent [19]

Kaessen

[11] **3,850,550**

[45] **Nov. 26, 1974**

[54] **CENTRIFUGAL PUMP AND MOTOR**

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[22] Filed: **Aug. 5, 1971**

[21] Appl. No.: **169,353**

[52] **U.S. Cl.** **417/372,** 415/109, 415/111, 417/424

[51] **Int. Cl.** **F04b 17/00**

[58] **Field of Search** 417/372, 424; 415/109, 415/110, 111

[56] **References Cited**

UNITED STATES PATENTS

2,506,827	5/1950	Goodner	417/424
2,885,963	5/1959	Ivanoff	417/424
2,963,980	12/1960	White	415/110
3,186,513	6/1965	Dunn et al.	415/110
3,494,291	2/1970	Carter, Jr.	417/424
3,644,067	2/1972	Yowell	417/372
3,652,186	3/1972	Carter	415/110
3,694,110	9/1972	Guinard	417/424
3,698,830	10/1972	Goyne	415/111
3,736,075	5/1973	Otto	417/424

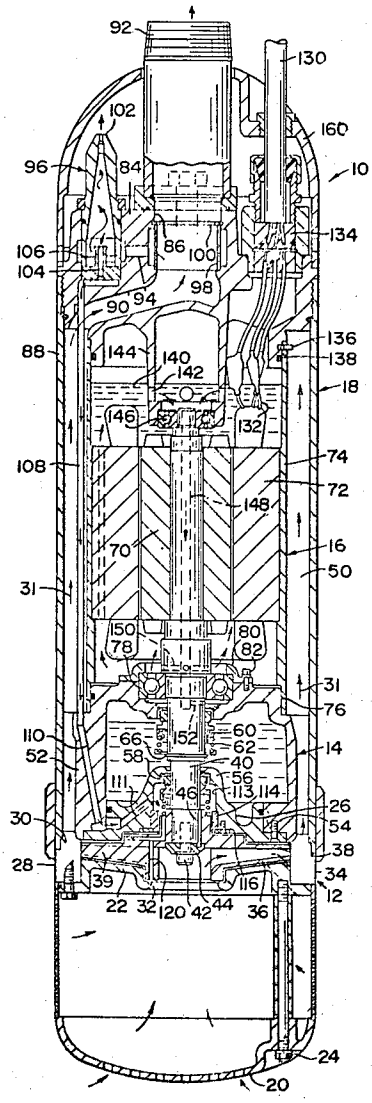
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[57] **ABSTRACT**

A centrifugal pump and motor, which may be submersible, comprising an impeller and housing means therefore including an axial diffuser, a motor in axial alignment with the impeller, and a common shaft for the motor rotor and the impeller. A tubular means encompass the motor for its length and connects to the axial diffuser for flow of pumped liquid therethrough for cooling the motor, while outlet means connect to the tubular means and an end of the shaft is journalled on a portion of the outlet means. Additionally the invention includes a vortex separator provided to receive some of the outlet liquid and means connect the cleansed outlet liquid form the vortex separator for flow of such liquid to a seal provided at the pump for seal flushing action, which seal flushing liquid can also be used to flush out the clearance spaces in the pumping chamber.

10 Claims, 3 Drawing Figures



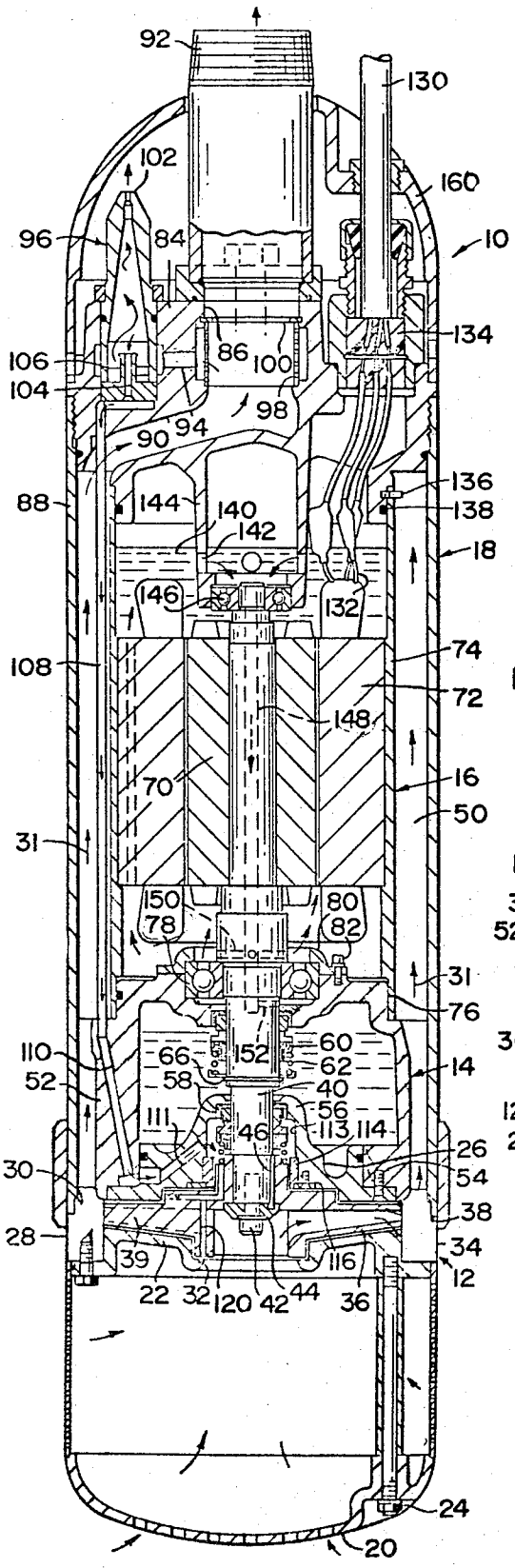


FIG. 1

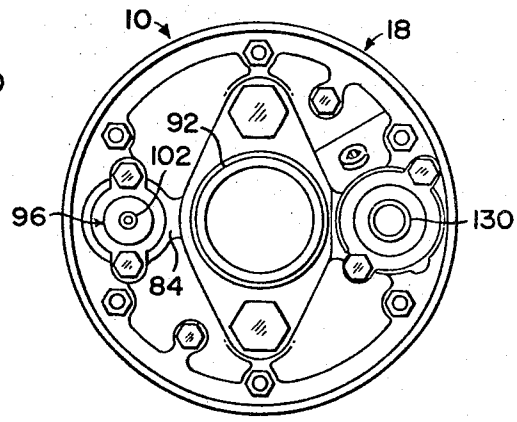


FIG. 2

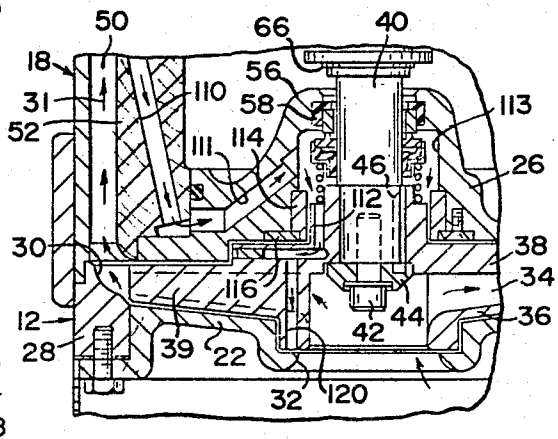


FIG. 3

CENTRIFUGAL PUMP AND MOTOR

The present invention relates to centrifugal pump and motor units, and particularly to a unit which is adapted to be operated in any desired position and which unit will handle, safely, pumped liquids having abrasive liquids therein, or hot boiling water containing sand or abrasive materials or other hot, caustic corrosive water solutions, such as atomic waste water.

BACKGROUND OF THE INVENTION

Heretofore there have been many different types of pumps provided for a wide variety of purposes. While some of these pumps have been designed for use with abrasive materials, or liquids containing abrasive materials, or have been designed for use with hot water, or caustic, still it has been difficult to obtain any satisfactory pump life in many instances. The abrasive material tends to wear out the seal or packing means in the pumps rapidly, or the pump motor may become overheated easily, the pumping assembly may be limited in the positions in which it can be used, or the caustic materials may damage the sealing means for the pump.

The general object of the present invention is to provide a novel and improved centrifugal pump and motor assembly which is adapted for pumping liquids with abrasives therein and which is characterized by the improved wear and service life of the assembly.

Another object of the invention is to provide a pump for pumping liquids with abrasives therein with a self contained vortex separator and to transfer the clean liquid output from such separator to seal means in the pump for seal flushing action.

Another object of the invention is to provide a compact, sturdy pump and motor unit wherein a portion of the outlet means provided in the pump will aid in positioning a common shaft for the motor and pump in the pump and motor unit.

Another object of the invention is to provide a pump for abrasive and caustic materials with improved service life and with improved seal and pump chamber flushing means.

Another object of the invention is to provide a tubular means connecting to the pump outlet and have such tubular means encompass the motor in the pump and motor unit for cooling the motor by flow of the pumped liquid therearound and to provide improved seal and cooling means in a pump and motor assembly.

Yet another object of the invention is to provide a pump and motor unit which can be submersed in the pumped material, if desired, and be supported in any desired manner and to provide a suitable sealed electrical connection to the motor and to provide cooling liquid forcibly pumped around in the motor for cooling the motor and varying means for the motor shaft.

The foregoing and other objects and advantages of the invention will be made more apparent as the specification proceeds.

Reference now is made to the accompanying drawings wherein:

FIG. 1 comprises a longitudinal section of the pump and motor unit of the invention;

FIG. 2 is an end elevation of the upper end of the unit of FIG. 1 with the end cap removed therefrom; and

FIG. 3 is an enlarged view of a portion of the pump and the flushing means for the pump.

When referring to corresponding members shown in the drawings and referred to in the specification, corresponding numerals are used to facilitate comparison therebetween.

INVENTIVE SUBJECT MATTER

A centrifugal pump and motor comprising, as an embodiment of the invention, an impeller and housing means therefor including an axial diffuser, a motor in axial alignment with the impeller, a common shaft for the motor rotor and the impeller, tubular means encompassing the motor for the length thereof and connecting to the axial diffuser for flow of pumped liquid therethrough for cooling the motor, an outlet means connecting to the tubular means, means on the outlet means journalling an end to the shaft thereon, a vortex separator connected to the outlet means to receive a part of the pumped material or liquid therefrom, a seal means being provided for the shaft adjacent the impeller, and means connecting the clear liquid output of the vortex separator to the seal means for flushing the same.

With reference to the details of the structures shown in the drawings, a pump and motor of the invention is indicated as a whole by the numeral **10.** This unit **10** includes a pump generally designated by the numeral **12,** a sealed chamber **14** positioned adjacent the discharge side of the pump **12,** a 3-phase electric motor **16** and a housing which is indicated as a whole by the numeral **18.**

At the inlet end of the pump and motor unit, a suitable strainer means or member **20** is provided and it is secured to an end plate or portion **22** of the housing **18** by cap screws or bolts **24,** or similar means. The end plate **22** forms a portion of the housing for the pump **12** and the other side or portion of a housing for enclosing the pump **12** includes a backing plate **26.** A diffuser ring, or axial flow diffuser member **28** provides a peripheral enclosure for the pump **12** and this axial flow diffuser **28** includes an arcuately curved section or face **30** that aids in turning the output from the pump **12** from flowing in a radial direction to flow in an axial direction as indicated by the arrows **31** on the drawings.

The pump **12** has an inlet indicated at **32** which is formed in the end plate **22** and a centrifugal flow impeller **34** is rotatably positioned in a pumping chamber defined by and formed between the end plate **22,** backing plate **26** and diffuser **28.** The impeller **34** includes a face shroud plate **36** and a rear impeller shroud or wall **38** with any suitable impeller blades **39** being provided between the shrouds **36** and **38** of the impeller and forcing pumped liquids centrifugally outwardly of the pump **12.**

The impeller **34** is secured to one end of a drive shaft **40** as by a cap screw **42** and a lock ring **44.** Also, the impeller is secured to the shaft by a key **46.**

As one feature of the invention, a tubular axial flow chamber **50** is formed within the housing **18** for receiving the discharge from the pump **12** and this extends axially of the pump and motor unit **10** to a position axially beyond the periphery of the motor **16** as hereinafter described in more detail.

SEAL CHAMBER

The seal chamber **14** is formed within a substantially cupshaped member **52** the open end of which is at-

tached to the backing plate **26** of the pump as by a cap screw means **54** or equivalent to form a chamber encompassing a length of the shaft **40.** The backing plate **26** has an axial extension or bell **56** formed thereon, and suitable sealing means **58** of a conventional nature are received within this bell **56** at the end of it adjacent to the pump **12** and are retained in position by spring means compressed between the sealing means **58** and the adjacent end of the rear shroud of the impeller **34.**

The opposite or second seal for the seal chamber **14** is provided by conventional means and include a packing means **60** engaging a shoulder on the inner surface of the base portion of the cup-shaped member **52** and which means are pressed into sealing relationship with each other around the shaft **40** as by a spring **62** confined against the packing assembly as by a retainer cup or cap located on the shaft **40** as by a locking washer **66** or the like.

The seal chamber **14** is normally filled to approximately 90 percent of its volume with a suitable seal lubricant such as a silicone oil or other conventional lubricant means whereby these seals are maintained in lubricated condition during use.

The motor **16** includes a rotor **70** that is suitably secured to a length of the shaft **40** and a stator **72** that is secured to and carried by the radially inner surface of a motor enclosure **74** received within the housing **18** and being in sealed engagement with the closed end of the cup-shaped member **52** as by a conventional O-ring **76** operativey positioned between the enclosure or sleeve **74** and an end portion of the member **52.**

One support member for the shaft **40** comprises a conventional ball bearing **78** carried by a base portion of the member **52** and engaging and rotatably supporting the shaft **40.** The bearing **78** is retained in position by an end ring **80** retained in position by cap screws **82** engaging the member **52.**

HOUSING CONSTRUCTION

The housing **18** also includes an outlet member **84** in which an outlet bore or opening **86** is provided and which connects to the axial flow chamber **50** formed by the enclosure sleeve **74** of the motor and the housing sleeve **88** by a connecting bore or chamber **90.** The outlet opening **86** in the end member provides axial discharge of the pumped liquid. Any suitable outlet pipe **92** suitably connects to the end member **84** for connection to conventional discharge means.

FURTHER FEATURES OF PUMP AND MOTOR

As an additional feature of the pump and motor unit **10,** a portion of the pumped outlet material flowing to the opening **86** will flow radially therefrom through a bore **94** that connects to a vortex separator means **96** carried by the end member **84.** The end member **84** has a second strainer **98** affixed to or against a shoulder provided in an axially inner portion of the end member **84** whereby a further straining of the pumped material is provided before any portion thereof can flow to the vortex separator **96.**

The vortex separator **96** has substantially tangential flow of liquid passing thereto as it flows into and around the closed end of this vortex separator **96** and with the material having a helical or spiral path to flow out through a discharge end **102** of the separator which end discharges into the end member **84** and flow therefrom around the outlet pipe **92** provided for the pump and flowing back into the sump or other chamber in which the unit **10** of the invention is positioned.

In flow through the vortex separator **96,** the already strained material has the solids therein carried therethrough with the primary flow of liquid material. However, a small portion of this liquid will take a reverse axial flow through the vortex outlet **104** provided by a tube **106** positioned in this separator. This outlet **104** connects to suitably axially extending holes bores or tubes **108** in the housing **18** and extending axially along the motor **16** to a connecting bore **110** formed in the cup-shaped member **52.** The bore **110** in turn connects through a bore **111** in the bell **56** to a chamber **113** in which the seal means or packing means **58** is positioned to provide a packing or seal flushing action by such water supplied under pressure to the seal or packing means **58.**

From this seal ring cavity or chamber **113,** the clean liquid under pressure will flow through a bore **112** formed in the hub portion of the rear impeller shroud **38** of the pump and the clearance provided between a bushing **114** and the adjacent portion of the rear impeller shroud to the pump chamber. A wear plate or ring **116** is carried by the backing plate **26** but extends radially outwardly immediately adjacent the rear shroud of the impeller. The pumped seal flushing liquid or water will flow radially outwardly of the pump and flush out the clearance space provided between the backing plate **26** and the rear impeller shroud to discharge into the axial diffuser **28** with the other pumped liquid.

The invention also provides for flow of some of this clear pumped pressure liquid back axially through the impeller **34** by one or more bores **120** provided in the impeller so that the flushing liquid flows through the drilled passages or bores **120** to flush the front wear ring clearance provided between the end plate **22** and the axially forward or outermost portions of the impeller at the inlet of the pump. Part of the flusing liquid then will flow radially outwardly between the end plate **22** and the adjacent surface of the front shroud of the impeller and combine with the pumped liquid in the axial diffuser and part of the flushing water will flow radially inwardly into the input liquid flowing into the pump **12.** Hence, the pumped liquid, in substantially cleaned condition with no abrasive or grit therein, can be used for seal or packing flushing action and to avoid any abrasive material being confined in the pump. The flushing action obtained will aid materially in the service life of the pump produced.

Yet another feature of the invention is that the power supply for the motor as provided by lead **130** will connect to suitable leads **132** coming from the stator of the motor and connecting to the power supply lead **130** at a connection means **134.** This connection means may comprise any suitable receptacle where the leads **132** would be soldered or otherwise bonded to the power supply leads and then the entire material can be enclosed in a potting material, such as an epoxy material, for protecting these electrical connections from any possible contamination by the pumped material or liquid in which the unit of the invention is submerged.

The end member **84,** or end bell of the motor is secured to the enclosure sleeve **74,** as by removable pins or set screws **136** and a sealed connection is provided therebetween by means such as an O-ring **138** operatively positioned between adjacent surfaces of these

members and received in a recess provided in a peripheral portion of the end member **84.**

Yet a further feature of the invention is that means are provided for circulating a lubricating and cooling material around in the motor **16.** Thus, a suitable lubricating material such as silicone oil is indicated at **140** received within the sleeve enclosure **74** for the motor. This liquid can flow axially through the stator and openings therein and it then can flow through bores **142** provided in a support section **144** provided on the axially inner end of this end member. A conventional bearing **146** is carried by the support **144** and journals the end of the shaft **40** thereon. The lubricating material will flow through this bearing **146** and it also flows into an axially extending bore **148** provided in the shaft **40.** The bore **148** extends the length of the motor **16** and usually a pair of axially spaced discharge bores **150** and **152** are formed in and extend radially of the shaft on opposite sides of the bearing **78** for flow of this insulating and lubricating fluid therethrough. Rotation of the rotor will aid in circulating the insulating liquid around these bearings provided for the shaft **40** and aid in cooling the motor **16** at the same time.

An end cap or member **160** is suitably engaged with a peripheral portion of the end member **84** while a portion of the housing **18** also engages with this end member **84** to form a continuous housing means enclosing the apparatus of the invention.

It will be seen that the pump and motor unit of the invention can be submerged in the pumped material and be supported therein in any desired way. The material discharged through or around the outlet pipe **92** will flow back out into the liquid in the sump in which the pump and motor unit is positioned. If an in line insulation is desired, the discharge from the vortex separator and passing through the outlet **102** could be piped back to the pump inlet, or the separator could be omitted and seal flushing liquid could be separately supplied.

The flushing action provided for the packing means or seal assemblies in the invention, together with the flushing action around the pump impeller, reduces the wear on seals, wear rings and impeller shrouds and allows very satisfactory operational life for the pump and motor unit of the invention even when handling a high percentage of abrasive materials. The submersible unit of the invention is suitable for use in pumping boiling water containing abrasive materials, hot caustic, atomic waste water, etc. The axial flow diffuser **28** permits a small diameter unit to be provided. The lubricant and cooling systems can be used in a vertically or horizontally positioned unit, in a submerged or non-submerged pump, as desired. The impeller **34** is secured to the shaft at one end thereof and the lubricating liquid contacts both the motor stator and rotor and is circulated around in the motor and in its bearings by the liquid circulation means provided by the bores **142, 148, 150** and **152** in the shaft **40** by the rotation thereof. Hence, the objects of the invention have been achieved.

While one complete embodiment of the invention has been disclosed herein, it will be appreciated that modification of this particular embodiment of the invention may be resorted to without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. A centrifugal pump and motor comprising
an impeller and housing means therefor forming an impeller chamber adapted to pump water containing abrasive means, said housing means including a back wear ring,
an axial diffuser,
a motor in axial alignment with said impeller,
a common shaft for the motor rotor and the impeller,
tubular means encompassing said motor for the length thereof and connecting to said axial diffuser for flow of pumped liquid therethrough for cooling the motor,
an outlet means connecting to said tubular means,
means on said outlet means journalling an end of the shaft thereon, and
a vortex separator connected to said outlet means to receive part of the pumped material, and means connecting to the vortex separator for flow of its clear liquid output to said chamber adjacent said wear ring for flushing the said wear ring.

2. A centrifugal pump and motor as in claim **1** where said impeller includes front and rear face shroud means, the flushing liquid flowing outwardly between the rear impeller shroud means and a chamber wall provided on the impeller and housing means, respectively, the impeller having at least one substantially axially directed hole extending therethrough radially offset from the impeller axis to conduct seal flushing liquid to a clearance space provided between the front impeller shroud means and the chamber wall.

3. A centrifugal pump and motor as in claim **1** and including a closed chamber forming means around said shaft between the pump and the motor, a pair of axially spaced seal means engaging said shaft at opposed ends of the chamber, and a fixed volume of liquid seal lubricant received and substantially filling the closed chamber.

4. A centrifugal pump and motor as in claim **1** where the motor has an insulating liquid enclosed therein, a pair of bearings engage the motor shaft, and liquid circulation means are formed in the shaft and extend the length of the motor for circulation of such liquid through said bearings.

5. A self contained centrifugal pump and motor unit comprising an impeller and housing means therefor forming a pump chamber and a pump including an axial diffuser, a motor in axial alignment with said impeller, a common shaft for the motor rotor and the impeller, a tubular means encompassing said motor for the length thereof and connecting to said axial diffuser for flow of pumped liquid therethrough for cooling the motor, an outlet means connecting to said tubular means, means on said outlet means journalling an end of the shaft thereon, means sealing said motor in the pump and motor unit, and characterized by
a vortex separator connected to said outlet means to receive part of the pumped material, means connected to said vortex separtor to receive clear liquid output therefrom, which means connect to a rear wall of the pump chamber for supply of clear liquid to the pump chamber to flush the clearance space provided for the impeller in the pump chamber.

6. A self contained centrifugal pump and motor unit as in claim **5** where the motor has a lubricating liquid enclosed in its rotor and in its stator, a pair of bearings

engage the motor shaft at axially opposed ends of the motor, and liquid circulation means are formed in the shaft and extend the length of the motor for circulation of said liquid through the motor and said bearings, the bearings and motor being within a common enclosure.

7. A self contained centrifugal pump and motor unit as in claim **5** where said impeller has front and rear face shroud means, and said impeller has a hub engaging said shaft and said impeller and hub have at least one substantially axially directed bore means extending through the impeller and its said shroud means to conduct part of the flushing liquid to a clearance space provided between the front impeller shroud means and the chamber wall for radial outward flow of the flushing liquid along both of said shroud means.

8. In a centrifugal pump and motor unit comprising an impeller and housing means therefor forming an impeller chamber adapted to pump water containing abrasive means and an inlet in a front wall of the impeller chamber, said housing means including a back wear ring on the back wall of the impeller chamber, a motor in axial alignment with said impeller, and characterized by

a seal means engaging said shaft spaced from said impeller chamber but operatively connecting thereto, and

means connecting to said unit to supply flushing liquid to said chamber adjacent said wear ring and seal means for flushing the same.

9. In a centrifugal pump and motor unit as in claim **8** where said impeller includes front and rear face shroud means, the flushing liquid flowing to an enclosure formed around said shaft and connecting to the impeller chamber at the back wall thereof and for flow outwardly between the rear impeller shroud means and the chamber back wall.

10. In a centrifugal pump and motor unit as in claim **9** where said impeller has a hub engaging said shaft and said impeller and hub have at least one substantially axially directed bore means extending the axial length of the impeller axis to conduct flushing liquid to a clearance space provided between the front impeller shroud means and the chamber wall and offset from the chamber inlet.

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