United States Patent [19]

Strickland

[11] **3,764,233**

[45] **Oct. 9, 1973**

[54] **SUBMERSIBLE MOTOR-PUMP ASSEMBLY**

[75] Inventor: **Alvah T. Strickland,** Kailua, Hawaii

[73] Assignee: **The United States of America as represented by the Secretary of the Navy,** Washington, D.C.

[22] Filed: **Nov. 15, 1971**

[21] Appl. No.: **198,679**

[52] **U.S. Cl.** **417/414,** 417/371

[51] **Int. Cl.** **F04b 35/04**

[58] **Field of Search** 417/360, 371, 410, 417/414, 422, 902

[56] **References Cited**

UNITED STATES PATENTS

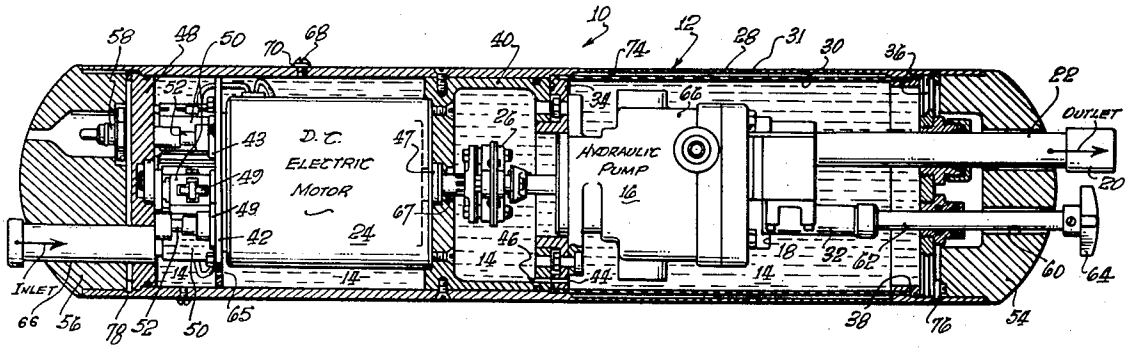
2,551,623	5/1951	More	417/902 X
3,237,852	3/1966	Shaw	417/902 X
3,041,977	7/1962	Boyd	417/414
3,434,656	3/1969	Bellmer	417/371 X
2,759,665	8/1956	Wilber	417/311 X
1,905,599	4/1933	Nowitsky	417/371
2,897,763	8/1959	Wright	417/360
1,891,771	12/1932	Mendenhall et al.	417/414
2,060,649	11/1936	Warner	417/414 X
2,455,022	11/1948	Schmidt	417/414 X
2,725,824	12/1955	Arutunoff	417/414

Primary Examiner—C. J. Husar
Assistant Examiner—Leonard Smith
Attorney—Richard S. Sciascia et al.

[57] **ABSTRACT**

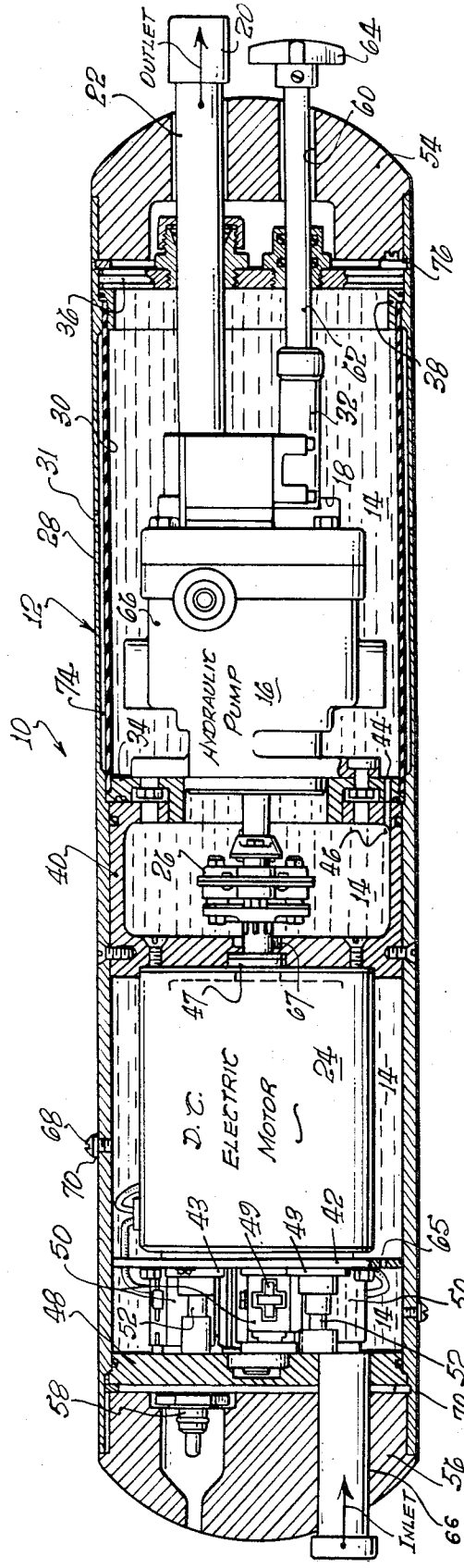
A submersible motor-pump assembly including: a reservoir casing which is adapted to contain a hydraulic fluid; a hydraulic pump mounted within the casing, the pump having an inlet which is located within the casing and an outlet which is extended through the casing; an electric motor for purposes of driving the aforementioned hydraulic pump; and the casing having means for equalizing the pressure within the casing with respect to ambient pressure.

8 Claims, 1 Drawing Figure



PATENTED OCT 9 1973

3,764,233



INVENTOR.
ALVAH T. STRICKLAND,

By ERVIN A. JOHNSTON,
ATTORNEY

SUBMERSIBLE MOTOR-PUMP ASSEMBLY

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

The old method of providing power to submersible systems involved only the conversion of d-c electric energy to mechanical energy with no hydraulic intermediary step. With such an arrangement propellers on the submersible were driven directly by electric motors. A disadvantage of this prior art approach is the high cost of d-c submersible electric motors and electronic motor controllers. Also, electronic motor controllers have not demonstrated a high reliability when exposed to ocean pressures.

In reviewing prior art systems which convert d-c electric energy into mechanical energy in the form of high pressure hydraulic oil, one is faced with bulky designs which would not be satisfactory for many deep submersible vehicles. In U. S. Pat. No. 3,434,443 there is disclosed a buoyancy transport vehicle which is operated by a diver and must be compact in order to carry out its intended purposes. This vehicle required a power unit which would utilize battery power to provide hydraulic fluid under pressure for driving various thrusters on the vehicle.

SUMMARY OF THE INVENTION

The present invention provides a very compact and streamlined power unit which will operate at deep ocean depths to convert d-c battery power to mechanical energy in the form of high pressure hydraulic fluid. This has been accomplished by providing a submersible motor-pump assembly which includes: a reservoir casing which is adapted to contain a hydraulic fluid; a pump mounted within the casing, the pump having an inlet which is located within the casing and an outlet which is extended through the casing; an electric motor for driving the pump; and the casing having means for equalizing the pressure within the casing with respect to ambient pressure. With such an arrangement the casing may be cylindrical and of thin wall light weight construction.

STATEMENT OF THE OBJECTS OF INVENTION

An object of the present invention is to provide a compact and reliable power unit which will convert d-c electric energy into mechanical energy in the form of high pressure liquid media.

Another object is to provide a low cost, low weight, compact, deep submersible power unit which is easy to disassemble and maintain, not effected by depth of pressure, and low in noise level.

Other objects and many of the attendant advantages of this invention will be readily appreciated as it becomes better understood by reference to the description and accompanying drawings which follow.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a longitudinal cross sectional view of the submersible motor-pump assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing there is shown in FIG. 1 a submersible motor-pump assembly **10** which includes a reservoir casing **12** which is adapted to contain a hydraulic fluid **14**, such as MIL–H–5606 hydraulic oil. A pump **16** with its own housing is mounted within the casing and has an intake **18** which is located within the casing and an outlet **20** which is extended through the casing by any suitable means such as pipe **22.**

An electric motor **24,** preferably a d-c electric motor is mounted within the casing **12** for driving the pump **16.** The motor **24** is drivingly connected to the pump **16** by a flexible coupling **26** and has its own housing.

The casing **12** has means for equalizing the pressure within the casing with respect to the ambient ocean pressure. This equalizing means may include the casing **12** having a port **31** which opens to the ambient ocean environment, and the bladder being mounted in the casing **12** so that ambient pressure is applied to the exterior of the bladder. In the preferred embodiment, the bladder **30** is coextensive with the pump **16** and its appurtenances, to be described hereinafter, since the pump intakes hydraulic oil within this area. In order to establish pump pressure at a selected level above ambient the pump may be provided with a compensator **32** which is also located within the bladder area.

The pump **16** may be supported within the casing **12** by a plate **34** which is transversely mounted within the casing **12.** The plate **34** in combination with a plate **36** and an annular ring **38** adjacent the plate **36** may comprise a means for sealing the ends of the bladder **30** about the pump **16** and compensator **32.** The plate **34** is in turn mounted to a combination mount **40** to which the electric motor **24** may also be mounted. A plate **42** may act as an axial alignment guide for the motor field as well as a mounting bracket for electric sockets **43.** A space may be provided within the combination mount **40** for the mounting of the flexible coupling **26.** Further, the plate **34** and combination mount **40** are provided with ports **44** and **46** respectively for communicating hydraulic fluid between the pump and flexible coupling spaces. Hydraulic fluid may pass between the flexible coupling and electric motor spaces through the ball bearing **47.**

A removable end plate **48** is transversely mounted within the casing **12** and is spaced from the plate **42.** The electric motor **24** has brushes **49** which are held within brush holders **50** that are mounted on the removable end plate **48** so as to be located within the space provided between this plate and the plate **42.** Pins **52** combined with sockets **43** may be utilized for connecting the brushes **49** to the electric motor **24** so that the brushes can be easily removed with the plate **48** for inspection and then easily reconnected to the electric motor after maintenance. The motor armature is splined where it mates with the flexible coupling so that it may be removed for commutator maintenance after removal of plate **48.**

The casing **12** may include caps **54** and **56** which are mounted at each end thereof. Male connectors **58** (one shown) may be provided for carrying d-c electric power to the motor **24.** The cap **54** may have a passageway **60** for receiving a control arm **62** from the compensator **32.** The control arm **62** may terminate in a control knob **64** outside the housing **28** for selectively

adjusting the output pressure of the pump **16** at a desired level above ambient pressure. The outlet tube **22** also extends through this cap **54.**

Hydraulic fluid passes through the ball bearing **47** and flows through the annular space between the motor armature and field. The plate **42** is shaped like a large washer so that fluid can pass into the brush area. A hole **65** allows oil to flow from the brush space into the annular space between the motor and the casing **12.**

In the preferred embodiment hydraulic fluid may be returned to the unit by a pipe **66** through the plate **48.** In this way hydraulic fluid is circulated through the entire unit carrying away foreign particles which may erode from the brushes and aiding in heat transfer from the motor. However, it may be desirable in some cases to use a hydraulic fluid in which d-c electric motor brushes cannot operate satisfactorily. In this case the hydraulic fluid must be returned by a pipe (not shown) through the plate **36** and a space **67** may be provided for a shaft seal to prevent the passage of hydraulic oil into the motor spaces. The motor spaces may be filled with a fluid which is compatible with the brushes such as hydraulic fluid MIL–H–5606. This fluid may be compensated to ambient pressure by means of an external compensator (not shown) which is connected to the motor spaces by means of a passageway (not shown) through plate **48.** The motor spaces may be filled with fluid through this passageway. A screw **68** and sealing washer **70** may be provided for bleeding off air trapped within the case during the filling process and also for bleeding off gasses generated during operation due to arcing of the brushes.

In the preferred embodiment filling of the unit with hydraulic fluid is accomplished through the hydraulic fluid return inlet pipe **66.** The screw **68** is used to bleed trapped air from the unit.

In the preferred embodiment a torpedo propulsion motor is utilized since these motors are generally designed for minimum size and weight for a given horsepower and also for maximum efficiency. Two examples of such motors are the propulsion motors for the MK–32 torpedo (5 HP) and the MK–34 torpedo (11.5 HP).

In order to dampen the sound of the operation of the pump **16** the casing **12** may be provided with an annular recess **74** adjacent the exterior of the bladder **30** so as to provide a space for containing seawater therebetween. By such an arrangement noise vibrations of the pump **16** must travel through the hydraulic oil **14,** bladder **30,** seawater within the space **74,** and the housing **28** before transmission to the outside ocean environment. These many interfaces considerably reduce the noise generated by the pump **16.**

The end plates **36** and **48** may be retained within the housing **28** by snap rings **76** and **78** respectively. The spaces where the hydraulic pump oil is located may be sealed from the ambient ocean environment by the various "**0**" rings shown in FIG. **1.**

It is now readily apparent that the present invention provides a very compact and reliable power unit which will convert d-c battery power to mechanical energy in the form of pressurized hydraulic oil. The pressurized hydraulic oil may be utilized for driving hydraulic thrusters on a deep submersible or for other undersea purposes.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

1. A submersible motor pump comprising:

a reservoir casing which is adapted to contain a hydraulic fluid;

a pump of the type having a housing with a fluid intake and a fluid outlet;

means mounting the pump in the casing with the fluid intake of the pump positioned for intaking said hydraulic fluid from within the casing;

conduit means connected to the outlet of the pump and extending through said casing for discharging the hydraulic fluid exterior the casing;

said casing having means for equalizing the pressure within the casing with respect to ambient pressure, the equalizing means including:

said casing having a port opening to ambient; and

a bladder for containing the liquid media, said bladder being mounted in the casing so that ambient pressure is applied to the exterior of the bladder;

said casing having an annular interior recess adjacent the exterior of the bladder for providing a space for containing sea water therebetween;

said casing having a cap mounted at each end thereof;

said conduit means extending the pump outlet through one of the caps;

said casing being generally cylindrical;

said bladder being generally tubular;

means for sealing the ends of the bladder within the casing;

an electric motor of the type having a housing;

said electric motor being mounted in one end portion of the cylindrical casing and the pump being mounted in the other end of the portion;

means drivingly connecting the pump to the electric motor;

the electric motor end portion of the casing having a hydraulic fluid inlet for receiving fluid to the assembly;

the assembly spaces for the motor, driving means, and pump being in liquid communication with one another so that received fluid will first cool the motor and then supply the pump;

a plate transversely mounted within the casing for supporting the pump;

a combination mount disposed within the casing for supporting the pump plate and the electric motor;

the connecting means between the electric motor and the pump being located within the combination mount;

a removable end plate transversely mounted within the casing and spaced from one of the electric motor plates;

said electric motor having brushes which are mounted on the end plate and located within the space between the end plate and said one of the electric motor plates; and

pin and socket means connecting the brushes to the electric motor.

2. A submersible motor-pump assembly comprising:

a reservoir casing which is adapted to contain a hydraulic fluid;

said reservoir casing having a pump chamber and a motor chamber;

a pump of the type having a housing with a fluid intake and a fluid outlet;

means mounting the pump in the pump chamber with the fluid intake of the pump positioned for intaking said hydraulic fluid from within the pump chamber;

conduit means connected to the outlet of the pump and extending through said casing for discharging the hydraulic fluid exterior the casing;

a bladder mounted in the pump chamber around the pump; and

said casing having a port which communicates ambient pressure with the exterior of the bladder.

3. A submersible motor-pump assembly as claimed in claim **2** including:

said reservoir casing being elongated;

an electric motor of the type having a housing;

said electric motor being mounted in the motor chamber;

the motor chamber having a hydraulic fluid inlet for receiving hydraulic fluid to the reservoir casing so as to supply the pump and cool the electric motor.

4. A motor-pump assembly as claimed in claim **3** including;

said casing having a cap mounted at each end thereof; and

said conduit means extending the pump outlet through one of the caps.

5. A motor-pump assembly as claimed in claim **3** including:

said casing being generally cylindrical;

said bladder being generally tubular; and

means for sealing the ends of the bladder within the pump chamber.

6. A motor-pump assembly as claimed in claim **5** including:

said pump chamber having an annular interior recess adjacent the exterior of the bladder for providing a space for containing sea water therebetween.

7. A motor-pump assembly as claimed in claim **6** including:

a plate transversely mounted within the pump casing for supporting the pump;

a combination mount disposed within the casing between the pump and motor chambers for supporting the pump plate and the electric motor; and

the connecting means betwen the electric motor and pump being a flexible coupling which is located within the combination mount.

8. A motor-pump assembly as claimed in claim **7** including:

a removable end plate transversely mounted within the motor chamber and spaced from one of the electric motor plates;

the electric motor having brushes which are mounted on the end plate and located within the space between the end plate and said one of the electric motor plates; and

pin and socket means connecting the brushes to the electric motor,

whereby the brushes can be removed with the end plate for inspection and then easily reconnected to the electric motor.

* * * * *