ALTERNATIVE DESIGN

OF

HYDRAULIC MANIFOLD HOUSING ASSEMBLY

JOHNSON-SEA-LINK

SUBMERSIBLE

BY

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INTRODUCTION

The existing hydraulic system on the JOHNSON-SEA-LINK II (J-S-L II) submersible consists of a pump, reservoir package and a valve-manifold assembly used to operate the manipulator. This system was acquired from Perry Ocean Products.

The manipulator has six degrees of freedom and uses six four-way solenoid valves for operation. The associated valve-manifold configuration contains these six functions, a pressure unloader valve, and an extra function for use when a piece of hydraulically operated equipment is placed on the submersible.

Since J-S-L II is a research submersible, it often carries scientific equipment that requires more than one hydraulic function for operation. This need for functions in addition to the existing auxiliary function has been satisfied by disabling one of the manipulator operations such as "wrist rotate", and rerouting that line to the equipment in need. This procedure is time consuming and prevents the manipulator from performing to its full capabilities.

Because of the need for more hydraulic functions in this system, these solutions were suggested:

1) valve - manifold configuration with twelve functions and one pressure unloader valve.
2) valve - manifold configuration with ten functions and one pressure unloader valve.

3) separate auxiliary configuration with four functions, powered by the seventh function in the existing assembly.

The above valve-manifold configurations can each solve the problem of functional inadequacies. The individual valves and manifold will not change from the existing design. They are available from Valve Research and Manufacturing Company.

With hydraulic problems solved, the new problem is to design a housing to hold the new valve-manifold configurations. This housing and its contents should be easily accessible for maintenance.

The following pages will explain the old valve-manifold assembly and how the new housing design will eliminate some maintenance problems.

EXISTING HOUSING ASSEMBLY

The present configuration contains seven function valves and one pressure unloader valve. The valve-manifold configuration is housed in a drawn aluminum box (Fig. 1). A portion of the manifold is inserted through the bottom of this box to provide access to hydraulic connections and flow adjustments.

The assembly is pressure compensated. This is accomplished by filling the housing with hydraulic oil and closing it with a urethanediaphragm. The oil is relatively non-compressible and the diaphragm adjusts to any external pressure changes placed on the system. This helps keep the assembly at ambient pressure and allows the hydraulic system to operate at its designed pressure.

Inside the housing, all electrical connections between the valves and the terminal board are permanent. The wiring between the terminal board and the housing is released by unscrewing each terminal connection. These connections tie the valves, terminal board and housing together.

The housing is mounted directly to the submersible by means of four bolts. Connected to the housing are sixteen hydraulic lines, two electrical connections and a main hydraulic supply line. Because of the number of connections holding the unit to the submersible, maintenance is usually carried out with the housing in place.

More often, maintenance on the valve-manifold assembly

consists of the following:

1) Check or repair of terminal board diodes and connections.
2) Check or repair of solenoid valves.
3) Separation of valves and manifold for cleaning.
4) General clean-up and oil change.

To ready the unit for maintenance, the four mounting bolts have to be removed; a table has to be used to hold the unit up, so that it will not hang by its electric and hydraulic lines; thirty-four bolts have to be removed to release the cover plate and urethane diaphragm; and finally, the oil has to be drained from the housing. Now the terminal board and valves in the bottom of the housing are accessible.

1) Checking the terminal board can be carried out with the panel in place.
2) To check for a faulty solenoid valve, the terminal board, which actually "straddles" the valves, has to be unbolted and pulled as far out of the way as electrical connections will allow.

To repair a valve: The terminal board must be released, the valve unbolted from the manifold, and the electrical connection must be broken.

3) Separation of valves and manifold is accomplished by removing four Allen socket-head screws from each of the eight valves.
4) General clean-up and oil change can be accomplished without further removal of parts.

This work must be done while the housing is still connected to the submersible via electric and hydraulic connections.

If it is necessary to serve the unit away from the submersible, all hydraulic and electric connections must be broken.

If the manifold itself has to be serviced; all hydraulic connections must be broken, the unit as a whole must be disassembled, and the manifold has to slide up through the housing.

Operationally, the existing design of the housing for the valve-manifold configuration is sound. From a maintenance standpoint, the unit is quite cumbersome to service.

NEW HOUSING ASSEMBLY

The new housing will be similar to the old in that it will contain valves, a manifold, electrical and hydraulic connections. The unit will also be pressure compensated. The differences in design involve the number of valves and the accessibility of the contents for service and repair.

The housing will be constructed of 5086 aluminum alloy. This alloy was chosen for its superior performance in the marine environment.

The unit will mount on a cradle assembly, much like a drawer, so it can be moved into a convenient service position (Fig. 2).

The new assembly is inverted from the current assembly (Fig. 3). This places the manifold on top of the housing and the urethane diaphragm on the bottom. The manifold is mounted directly on the cover plate. The valves are also mounted on the plate but from the inside. To connect the manifold and valves hydraulically, the cover plate has the appropriate ports. On the inside of the assembly, the valves and terminal board are linked by removable electrical connections. Electrically, the terminal board and housing are joined by a connector.

To ready the unit for maintenance, four wing nuts are loosened, the assembly is pulled forward and locked in place. For quick "troubleshooting", six latches are provided to release the manifold and adjoining cover plate, valves and terminal board. Then the configuration is removed from the

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To work on the assembly elsewhere, ten bolts are removed to release the manifold, and the assembly is unplugged from the housing. The terminal board can then be inspected easily. If a valve needs repair, the electrical connections are unscrewed and the valve can be removed from the cover plate.

The manifold is left in an easily accessible area but may be removed by disconnecting hydraulic lines. The housing remains in the cradle with oil intact or it can be pulled out of the cradle, disconnected from electrical lines, and be removed.

This design of a valve-manifold housing will reduce maintenance time. The design philosophy would also be used as an example, so that other engineers will design products that are easier to maintain.

EXISTING ASSEMBLY

Cross Section - End View

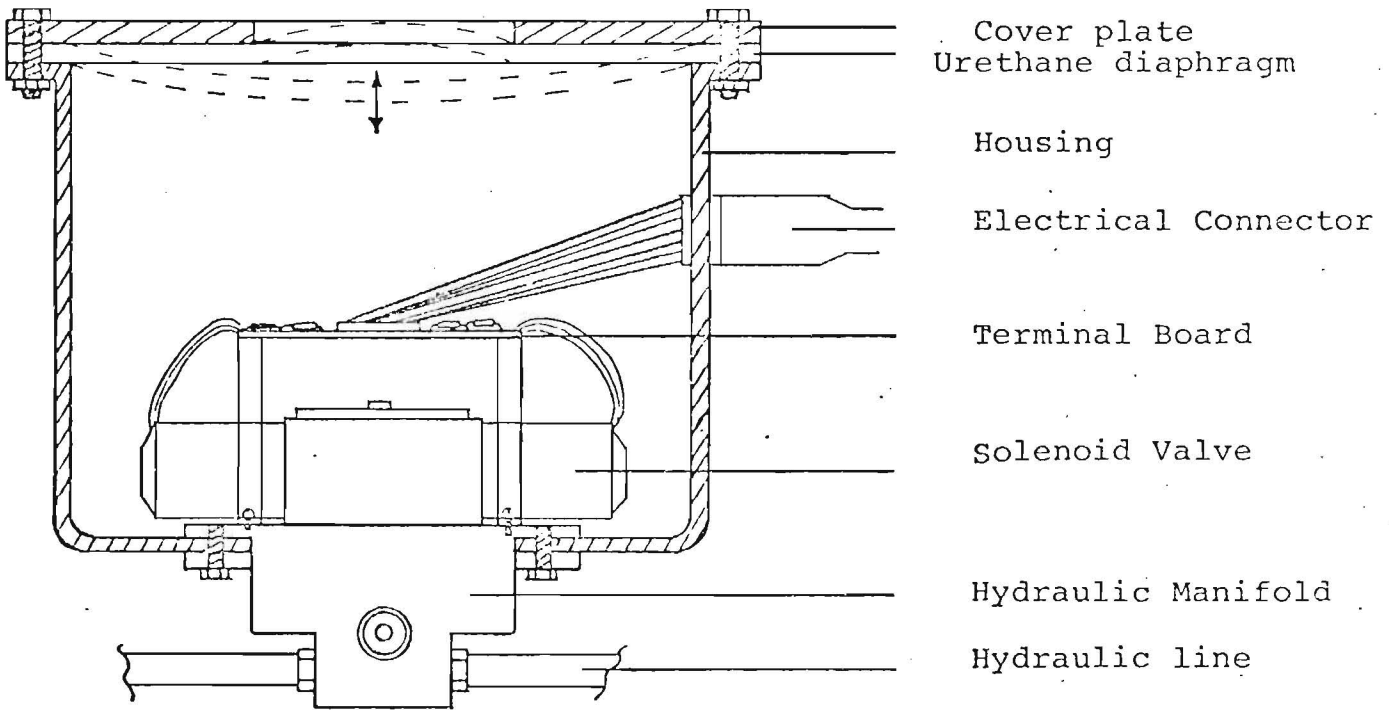
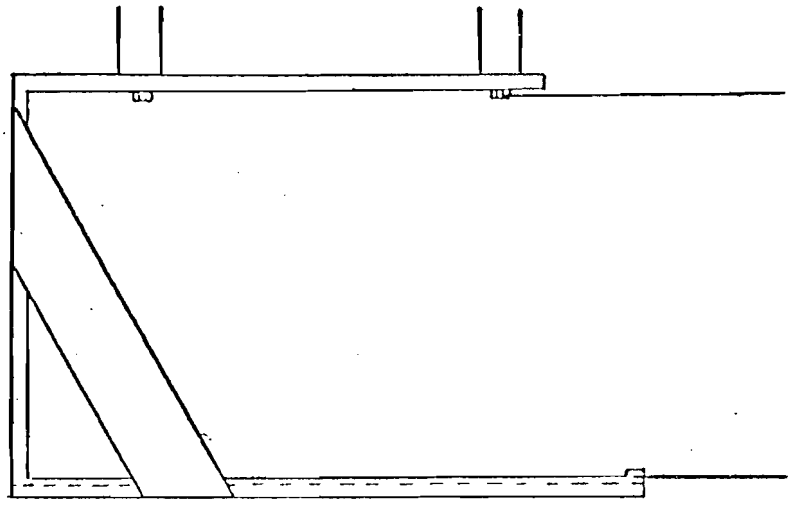
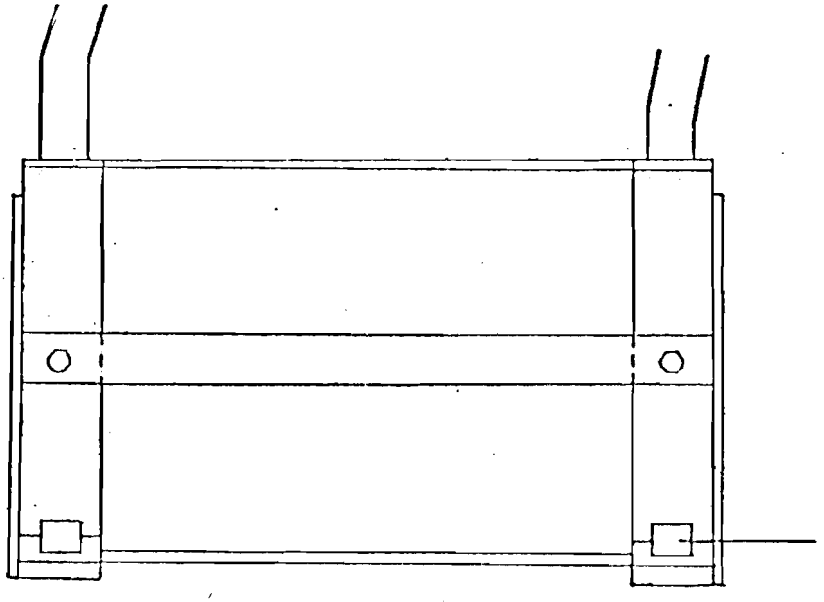


Figure 1

ASSEMBLY CRADLE



(Side View)



(Front View)

Figure 2

NEW ASSEMBLY

Cross Section - End View

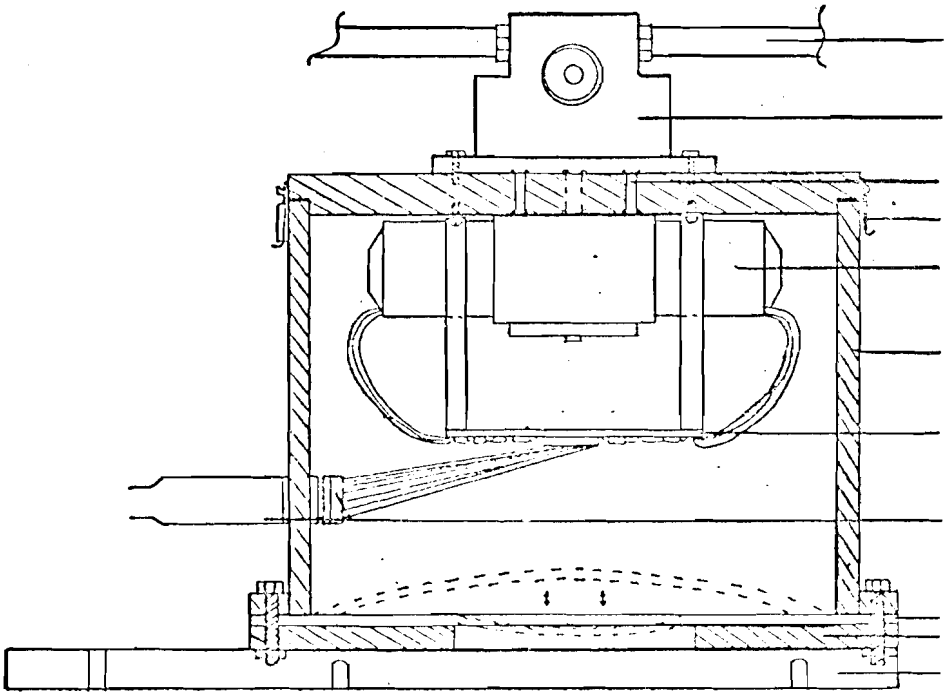


Figure 3

ABOUT THE AUTHOR

Dwayne Carlton was born in Ocala, Florida in 1959. He attended Central Florida Community College in Ocala, and received his A.A. degree in Engineering. From CFCC, he went to Florida Atlantic University on a Phi Theta Kappa Scholarship. He is presently enrolled in the Department of Ocean Engineering and is a student member of SNAME.

He plans to obtain a B.S. degree in Ocean Engineering and specialize in the field of submersible design.