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Pulse control rosette firing circuit (for the BRIDGET Deep-Tow)

R E Kirk

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Natural Environment Research Council

INSTITUTE OF OCEANOGRAPHIC SCIENCES
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ABSTRACT

This note describes the design, building and testing of a modified rosette firing circuit. It enables water bottles to be tripped under the command of logic level signals whilst requiring only a 12 volt supply. This modification allows the use of rosette samplers with a wide variety of instruments as high voltage supplies from specialised deck units are no longer required.

KEYWORDS

BRIDGET
ROSETTE
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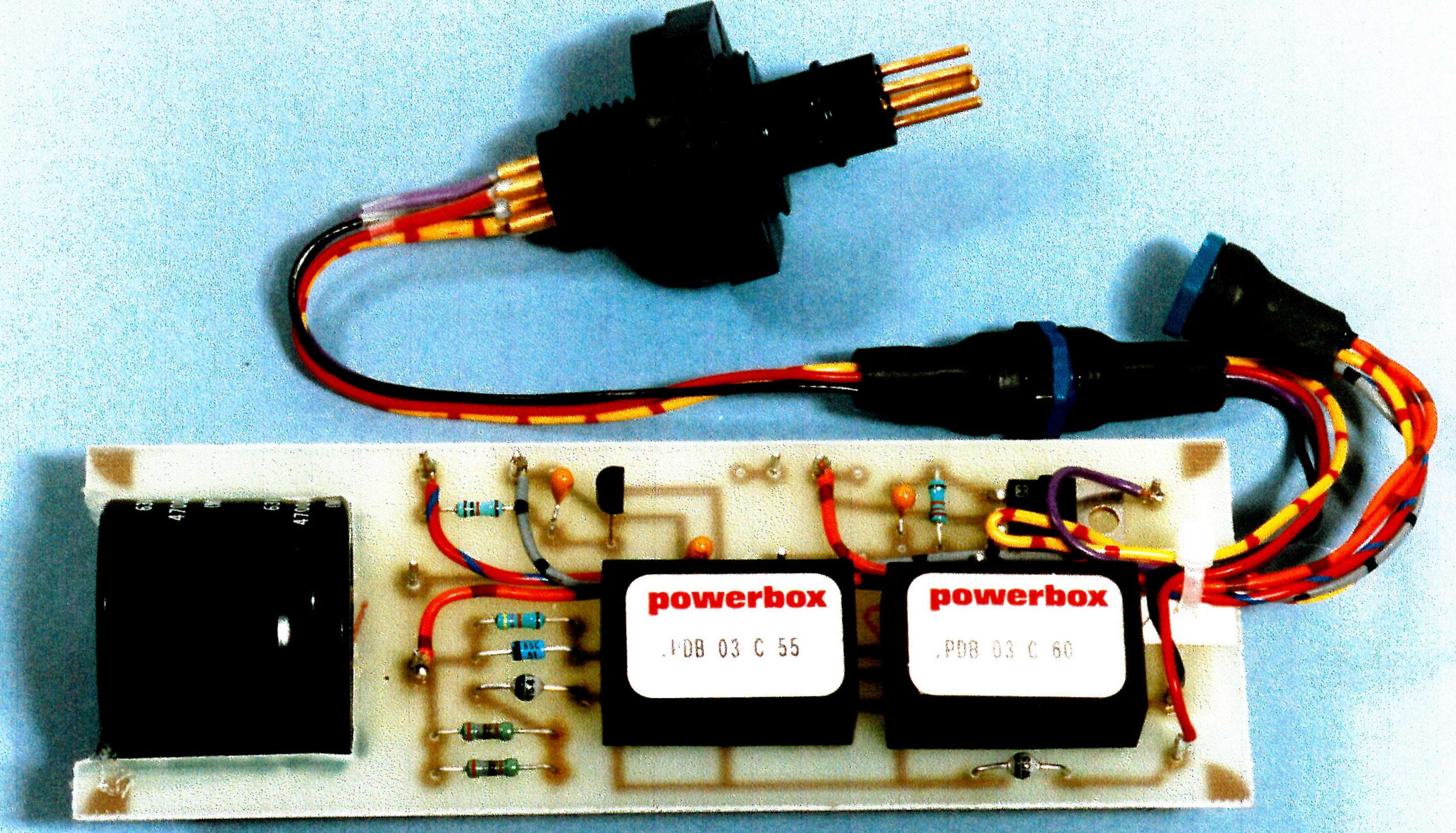
CONTENTS

FIGURES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1. INTRODUCTION.

A General Oceanics rosette unit with 2.5 litre water bottles was loaned for use on the BRIDGET deep-tow system. BRIDGET is a multisensor system designed for the investigation of hydrothermal vents and has its own data transmission and power handling systems. The original bottle firing electronics module within the rosette pylon, designed for surface command, was considered unsuitable for use on BRIDGET. In the past these sampling units have been designed for use with CTDs on long coaxial cables along which power, data and bottle firing signals were passed. Complex and expensive deck control units at the surface were used to fire bottles and report back status signals to the operator. Deck unit design was dictated by the interfacing requirements of CTD systems.

For use on the deep-tow system many of these constraints were not applicable. Rather than build a complex interface for BRIDGET that created conventional reverse voltage or tone fire signals, a new system should be devised.

The rosette was to be fired by the deep-tow electronics which could readily supply d.c. power, logic level control pulses and could monitor voltage levels. An interface to these electronics was designed as a replacement circuit card to be housed inside the rosette pylon pressure case. The original circuit card would be removed. This could be replaced whenever required for use with the original deck units.

2. DESIGN.

The basic design problem was to construct an interface circuit card that would generate a high voltage to charge a capacitor. The charge on the capacitor would then, when triggered by a logic level command pulse, be switched through a rotary solenoid. The operation of this solenoid rotates a cam to trip a water bottle closure and rotates a wafer switch to its next position which can be used to indicate solenoid operation.

Some design considerations are listed below.

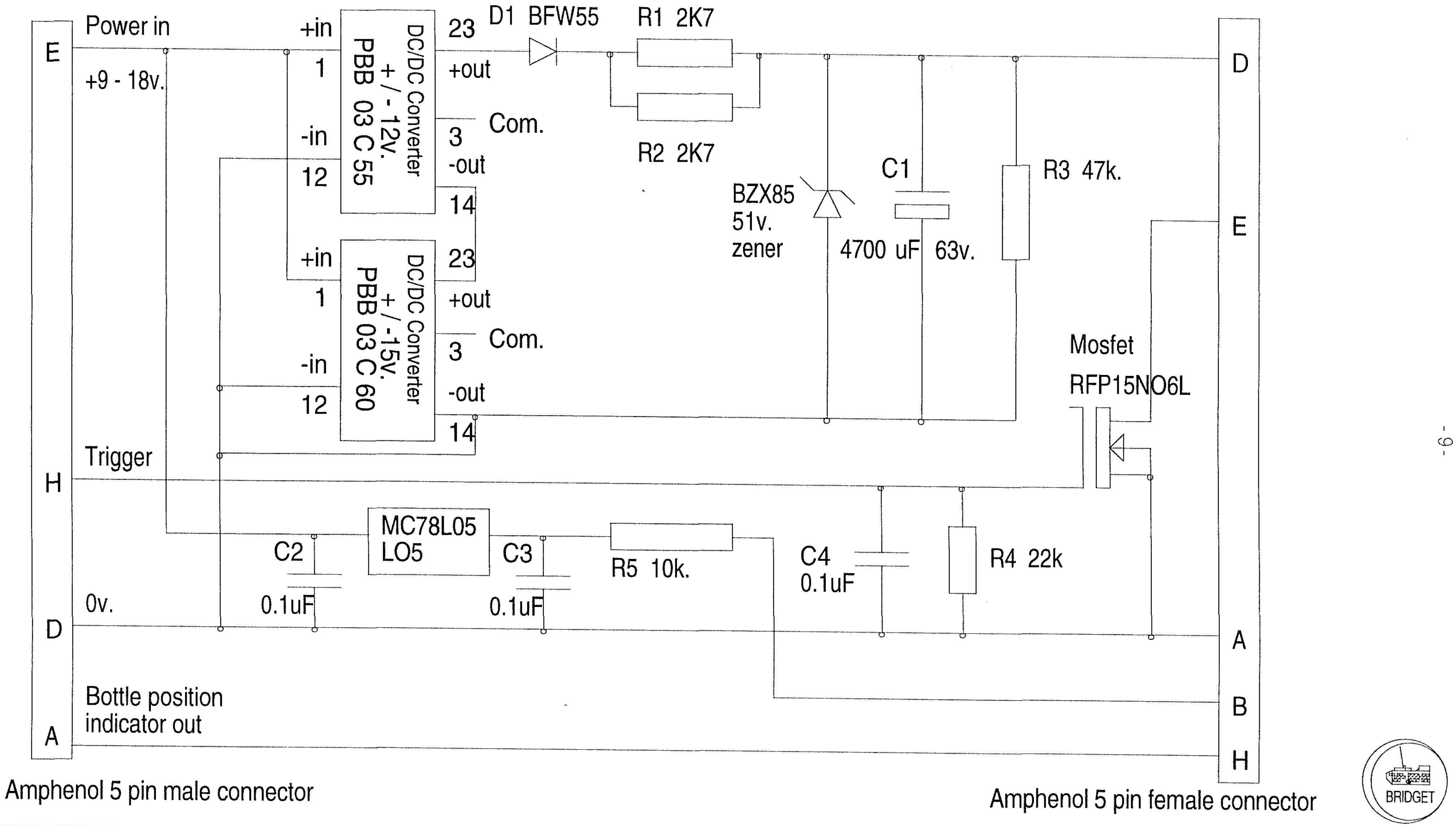
1. The unit should be capable of fitting inside the rosette pylon pressure case.
2. Energy supplied to the solenoid should be not less than that supplied by the original circuit.
3. To allow the use of either regulated or variable battery pack voltage supplies the unit should be able to accept a range of supply voltages.
4. Rosette firing should be initiated by a 5 volt logic level pulse.
5. Movement of the wafer switch wiper should be monitored by the main system electronics, which can indicate solenoid action to the operator.

The circuit devised is shown in FIGURE 1. ROSETTE PULSE FIRE CIRCUIT. Any voltage between 9 and 18 volts can be applied for reliable operation. This supplies two dc-dc converters which produce outputs of +12v.,-12v and +15v.,-15v which are connected in series to provide a main supply of 54volts. A reverse voltage protection diode D1 and current limiting resistors R1 and R2 carry the supply to the main 3,300uF. capacitor C1 used to fire the solenoid. Resistor R3 acts as a bleed resistor for the capacitor and zener diode Z1 allows large induced voltages from the solenoid coil to be conducted to circuit ground.

Trigger pulses to the circuit are shaped by the C4-R4 filter and passed to the logic level mosfet. This device has low resistance (0.2 ohms) when in the conduction mode. When triggered the mosfet completes the capacitor-solenoid-ground circuit and dumps the 51 volt charge on C1 through the solenoid stepper motor. The solenoid rotates a cam to fire a sample bottle and moves the wiper of the rotary switch one position.

The rotary switch is a 12 position single pole switch. A regulator supplied by the input voltage passes its +5 volt output through a current limit resistor R5 to alternate rotary switch terminals. The other terminals are wired directly to 0 volt ground so that as the stepper solenoid is operated then the wiper on the rotary switch is connected to 0 v. and +5v. alternately. This output is passed back to the main electronics where it is monitored and rosette operation is transmitted back to the ship. Although a report of solenoid operation does not guarantee successful bottle firing it is the best indicator available to us without placing sensors on individual sample bottles.

ROSETTE PULSE-FIRE CIRCUIT CARD see drawing ROSETTE WIRING for further details. (ROSWIRE.SKD).



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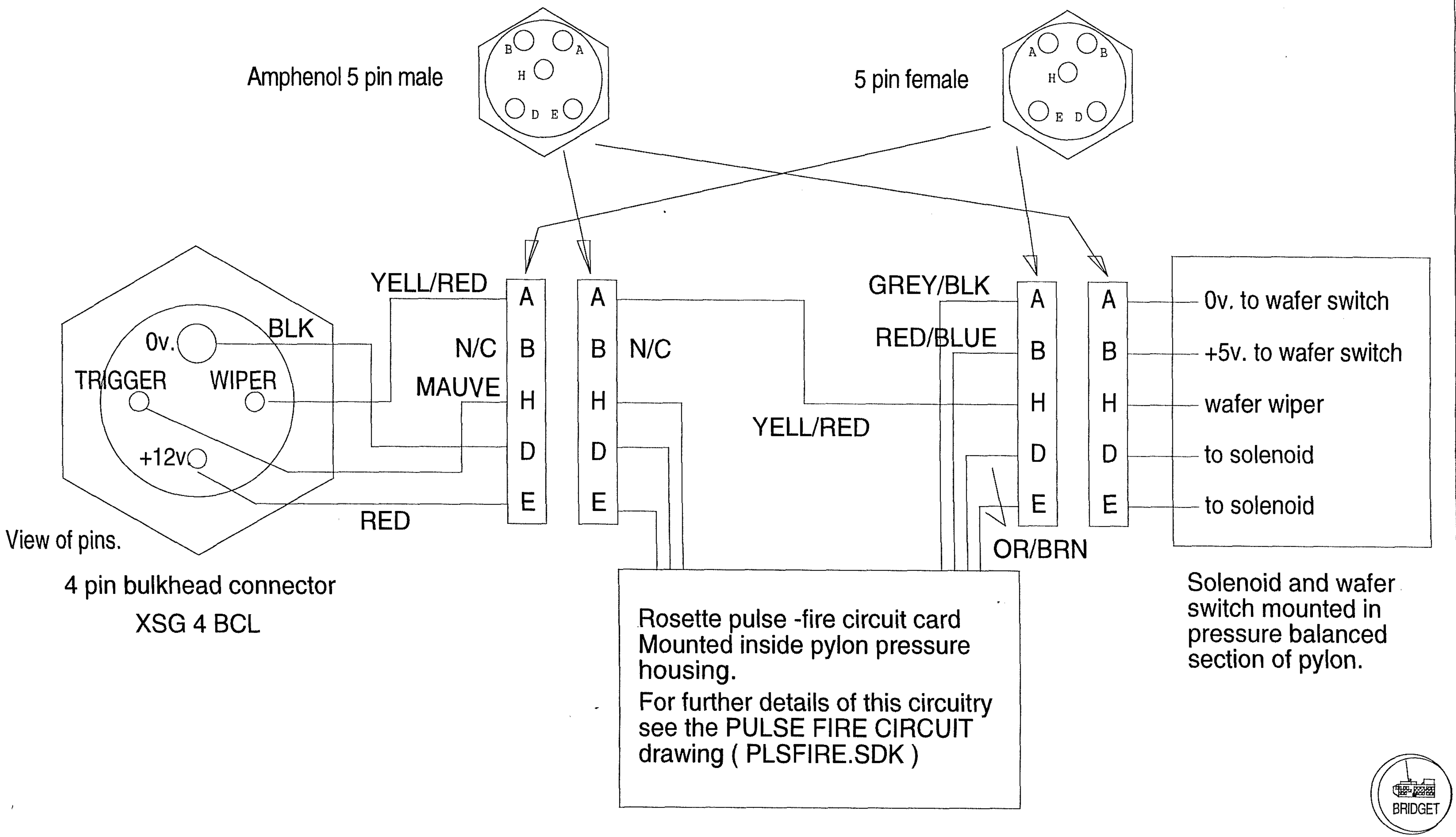
3. TESTING.

The circuit card was constructed and tested on the bench initially. When powered up from a laboratory power supply the dc-dc converters would not provide a good output voltage and go into high current consumption mode. This was found to be due to the slow rise of voltage from the supply at switch-on, failing to send the dc-dc converters into oscillation, their correct operating mode. It is important to ensure therefore that the voltage supply for the unit can provide enough initial current on power up to prevent this happening. When used on BRIDGET this did not prove to be a problem.

With a rotary solenoid connected to the circuit, operation could be initiated by connecting the trigger input wire to the output of the +5 volt regulator for short periods by hand. When connected to the BRIDGET electronics another problem arose. Operation was very irregular when the wafer switch was monitored to end the trigger pulse. It was surmised that as soon as the stepper started to move the switch wiper may have broken contact for a fraction of a second and a false voltage level sent back to the electronics. Therefore the trigger pulse seems to have started and been told to end before the rotor had completed its travel. The solution to this was to ensure that the trigger pulse supplied from the main electronics was long enough (approx. 200 msecs.) for correct stepper motor travel.

As the circuit card was the same size as the original unit it could be fitted into the pylon without problems. FIGURE 2. ROSETTE WIRING shows the electrical connections made between the bulkhead connector on the pylon end cap and the connection to the stepper solenoid and the wafer switch in the oil-filled, pressure balanced chamber. Once assembled in its pressure case and connected to the BRIDGET electronics, the system was operated over an extended period of time and at low temperatures to check reliability. The system worked very well and was ready for use at sea..



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	Filename Roswire.skd	Date 30/6/94

4. OPERATIONAL USE AT SEA.

During Charles Darwin cruise CD 90 (BRIDGET trials) in September 1994 the Rosette was deployed in the BRIDGET frame on five separate occasions during which the maximum deployed depth achieved was approximately 3,400 metres. An initial system problem which caused bottle tripping on initial power up was quickly identified and solved within the main hardware of the system. Following this the unit performed without fault. Under direct control from the ship water bottles were reliably fired and the output from the wafer switch was monitored both before and after each sample on the lab display to check operation.

This circuitry has proved to be a simple solution to a potentially complex interface problem. It has possible use in any instrumentation which, may require collection of water samples under local control of an intelligent system or simple timer arrangement that can supply power and logic control pulses.