APPLYING FIBER OPTIC TECHNOLOGY TO PUMP OFF CONTROLS

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INTRODUCTION

For many, their first introduction to fiber optics was the decorative lamps of the late sixties. **A** group of optical fibers was tied together at one end and splayed out in a fan at the other. **A** bright bulb at the tied end illuminated the fibers, and light emerging form the loose end made them sparkle. It created a lovely effect, but had little practical use.

Fiber optic technology has come a long way from the glittering lamps of the sixties. During the seventies, the telecommunications industry began to experiment with fiber optics in telephone circuits. From there, the growth of fiber optic applications has been explosive. Fiber Optic application is now becoming commonplace in our homes and businesses-carrying not only telephone communications but also data, cable television, internet and security functions to name a few.

THE ADVANTAGES OF FIBER OPTICS

The attraction of optical fiber transmission systems is that they can carry information at high speeds over long distances. Because they carry signals as light, optical fibers are not subject to electromagnetic interference, which can disrupt and block signals that are carried on wires. Also, fiber optics is non-conductive and is an excellent choice for communication applications where the atmosphere contains explosive gasses and avoiding sparks is critical.

The non-conductive nature of fiber optics makes it an ideal choice for oil field use. While pump off controls is a somewhat narrow application, the benefits to be realized are significant.

The main benefit of applying fiber optic technology to pump off controls is that of mitigating damage caused by strong electrical surges. The main source (although not the only source) of strong electrical surges encountered in the oil field is lightning strikes.

LIGHTNING DAMAGE

Lightning usually terminates on some vertical projection of a structure. In open country where there are no structures, it can strike anywhere, but has a preference for high ground or hills if they are in the vicinity of the thundercloud. On an oilfield location, the tank battery, the heater-treater and the pumping unit are usually the tallest structures and offer the most convenient targets for lightning.

When lightning strikes, the "return stroke" produces the destructive effects. The return stroke can be considered as an intense positive current *from* ground or as the extreme lowering of negative charge *to* ground. In short, the return stroke neutralizes the opposite charges between the cloud and the earth. After the first return stroke it is usual for another region of the cloud to provide sufficient charge for a second stroke, or several more strokes, separated by intervals of 10 to 20 milliseconds. This return discharge of one stroke or several strokes is called a flash.

In a return stroke the current produced averages 20,000 amps and can be as much as 100,000 amps in exceptionally intense storms. The return stroke current heats the path instantly to temperatures of 15,000 degrees to 20,000 degrees *C,* making the air luminous and creating the explosive air expansion heard as thunder. With the occurrence of these events it is not difficult to understand that peripheral equipment can be damaged as a result of lightning strikes to other equipment on location.

The objectives in lightning protection are to save property from damage as much as possible and to minimize the disruption of services. There are several very effective methods of protecting locations from lightning damage. Location lightning protection is another subject that is too broad for this paper; however, it bears further investigation for operators of oilfield locations.

APPLYING FIBER OPTICS TO PUMP OFF CONTROLS

In the case of pump off controls, D-Jax Corporation had developed very effective internal lightning protection for their pump off controls. A system of thermistors, resistors and MOV's proved very effective in mitigating damage from powerful electrical surges such as nearby lightening strikes. However, this system could not prevent catastrophic failures in cases of direct strikes. While these events were rare, they were troublesome and costly for the operator. D-Jax Corporation set about finding a way to eliminate or at least significantly reduce the occurrence of catastrophic lightning damage in Penny Pincher pump off controls.

The solution to the problem of mitigating lightning damage was found in isolating the logic board of the Penny Pincher from the power supply board using fiber optic couplings. D-Jax Corporation holds a patent for fiber optic couplings in pump off controls. (See Figure 1)

The fiber optic circuit D-Jax uses between the power supply and the logic board is very simple. It consists of an emitter (transmitter), which converts normal electrical signals to light and sends them through the optical fiber. Optical fibers are glass, plastic or plastic-clad glass. The fiber system terminus **is** a receiver that converts the light signal back to an electrical signal. (See Figure 2).

The isolation begins with the 110 V power supply which feeds the logic board 12 VAC reducing the potential for flashover and collateral damage. Another potential source of surges **is** the sensor circuit coming from the gearbox pedestal. The sensor circuit is conventional copper wire to the power supply and fiber optic from the power supply to the logic board. Any surges brought in by the sensor circuit will stop at the power supply.

The control relay circuit carries signals from the logic board to the power supply board via fiber optic. From the power supply board to the control relay, mounted in the power panel, the signal is carried by conventional copper wire. Again, any strikes or surges originating at the power panel will be stopped at the power supply board.

While this configuration cannot hope to completely eliminate all damage from lightning strikes or other powerful electrical surges it does minimize the economic impact of damage when it does occur. By isolating the logic board from the power supply board, catastrophic damage will occur only to the power supply, which is about one-fourth as costly to replace as the logic board.

THE RESULTS

In actual field applications, the system has proven very effective thus far. D-Jax has installed approximately 450 fiber optic based controls. Many of these controls were installed in areas where lightning has been extremely problematical in the past. Also, these controls have been in service, in these areas, through an entire lightning season. D-Jax has yet to see a failure of either the power supplies or the logic boards that is attributable to lightning or other electrical events.

D-Jax is continuing research and development for ways of improving pump off controls with even broader applications of fiber optics.

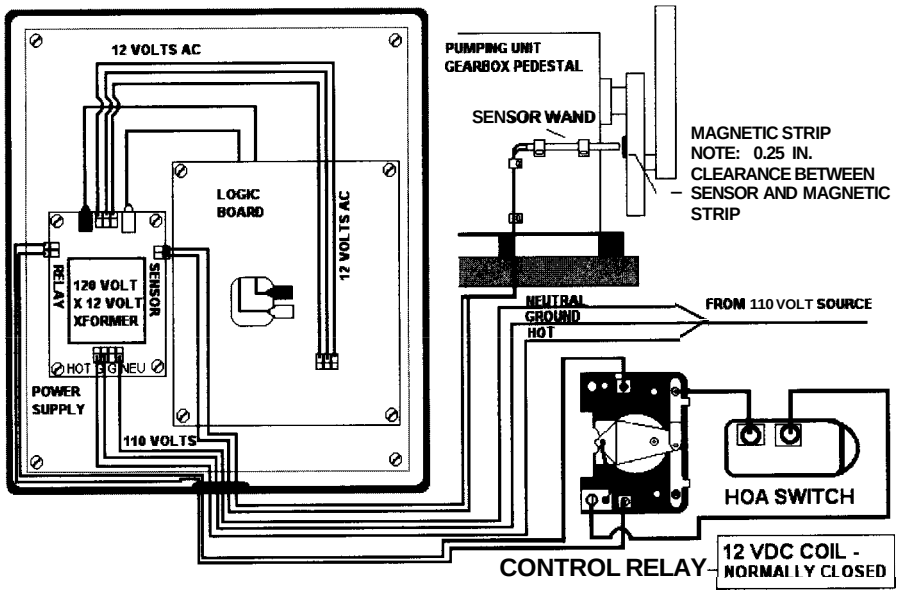

Figure 1 - Penny Pincher Pump Off Control Installation Schematic

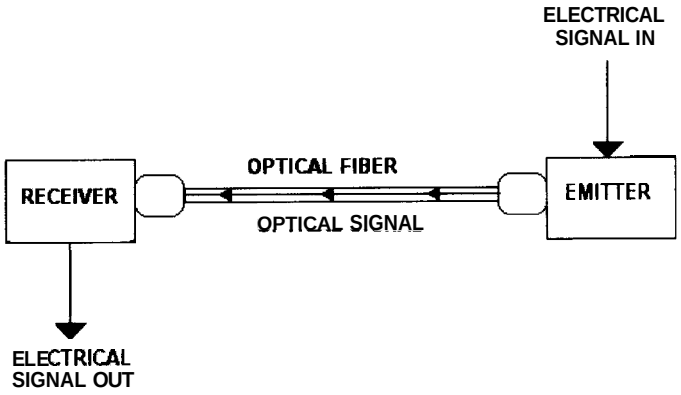

Figure 2 - Simple Fiber Optic System