DEVELOPMENT OF A FIBER OPTIC SWITCH

Final Report

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Prepared for

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by

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Contents

Summary and Conclusions

The final assembly of switches made from two inch diameter discs of .125 inch thickness has resulted in observed switching speeds of 2 millisecs. The motion required is about 3 microns from on to fully off.

Development of a smaller disc and general miniaturisation will reduce inertia and allow faster rise times.

Mechanical assemblies are composed of closed frame mounts which are relatively free of thermal and mechanical stress induced distortion.

Testing for age has been carried out over a two month period, with excellent results. All four deliverable units have remained in good adjustment. The drive is by fast rise time high voltage applied to the piezo drivers and this gives a fast switch but also a considerable impact at the fiber to fiber interface. If this snap action is found to be a cause of future failure then a shaped high voltage transition may be needed to reduce the impact at closure, or an alternative piezo drive such as a bending element where the response is damped by the more complex assembly.

The high voltage drive is obtained from a simple ladder network of voltage doublers from the line.

Switch Construction

The switch is shown in Fig 1. The frame F supports the switch assembly made up of the discs D and piezo driver P. An adjustment screw S is used to set the switch gap, or space between the discs. The resulting tension is dependent on the initial spherical shape of the discs the material and dimensions. The gap is closed by expansion of a piezo stack and opened by relaxation of the stack and the spring back of the discs.

The discs support the fiber which is ground and polished by a fairly complex process developed by CIR to make optical contact couplers, resulting in a generally spherical surface supporting a fiber which is a few micro inches above that surface. This allows assembly such that optical contact can be made between two fiber components giving an evanescent coupler. There is no interleaving material in the space between the fibers such as index matching oil as in the well documented "Stanford" coupler.

The air contained in the gap flows into wells, which are small core drilled depressions in the surfaces of the discs. The volume ratio of well to gap is large and this prevents a large pressure increase on closure. The alternative would be to evacuate the gap and seal under vacuum, which may give even faster switching speeds as the viscosity of the air in a thin layer is considerable.

The optical contact coupler and a method of volume production are the subject of patent applications.

Fig 2 is a schematic of the the high voltage supply for the piezo drivers.

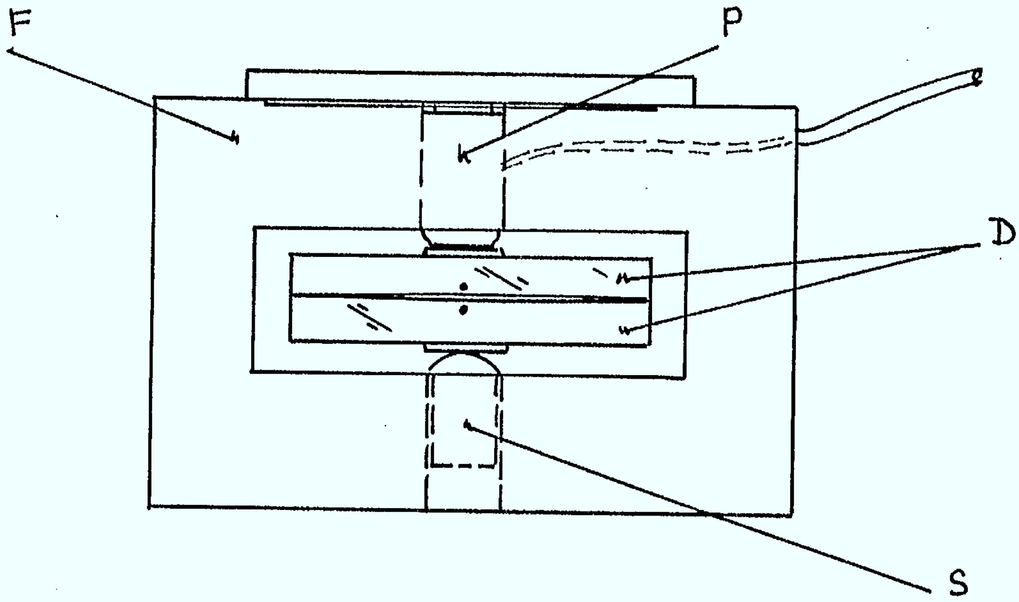
Construction Methods

There are two major activities, the manufacture of the discs and the assembly methods.

Thin substrates are difficult to make in general due to flexibility but are made more difficult when slots and grooves are made to support a fiber. The tools and methods of mounting are generally well known to opticians but there are a large number of variations. The lens making industry especially for large volumes has been reduced to an exact science but there still remains an element of the black art in custom optical work. The techniques used at CIR to make the individual discs are based on the methods of half coupler manufacture with the addition of many trial and error efforts to accomodate thinner substrates. If multiple discs or some other shape is needed for assemblies of switches in a spliceless system, then block methods will be required similar to the current production of miniature couplers at CIR.

The switches were assembled in a variation of a VR Coupler Mount, a standard CIR product, in which there are degrees of freedom for translation and rotation of coupler halves. A vertical compression arrangement was added along with modified support structures to allow the switching action. An epoxy of low viscosity was applied to the edge of a pair of discs and enough resin enters the gap by capilliary action to seal the unit.

FIG 1



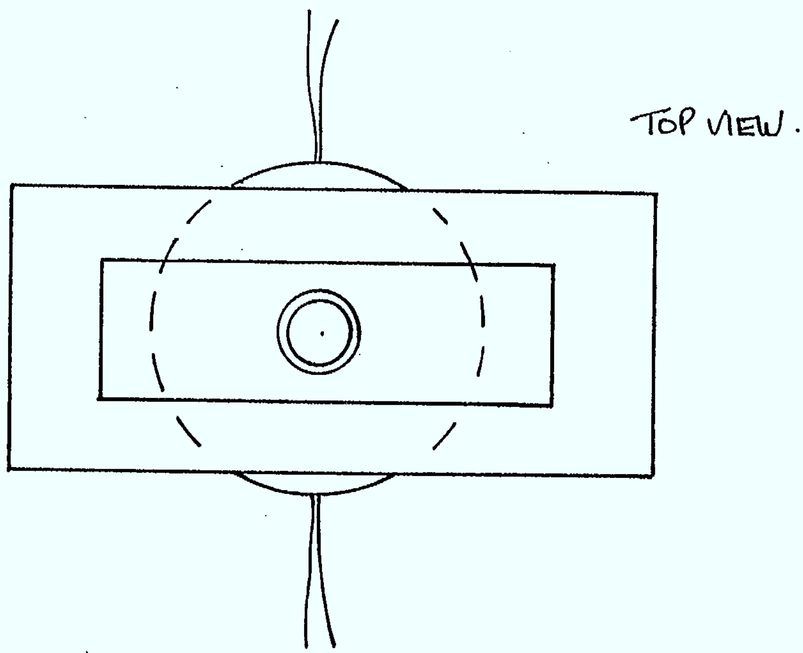
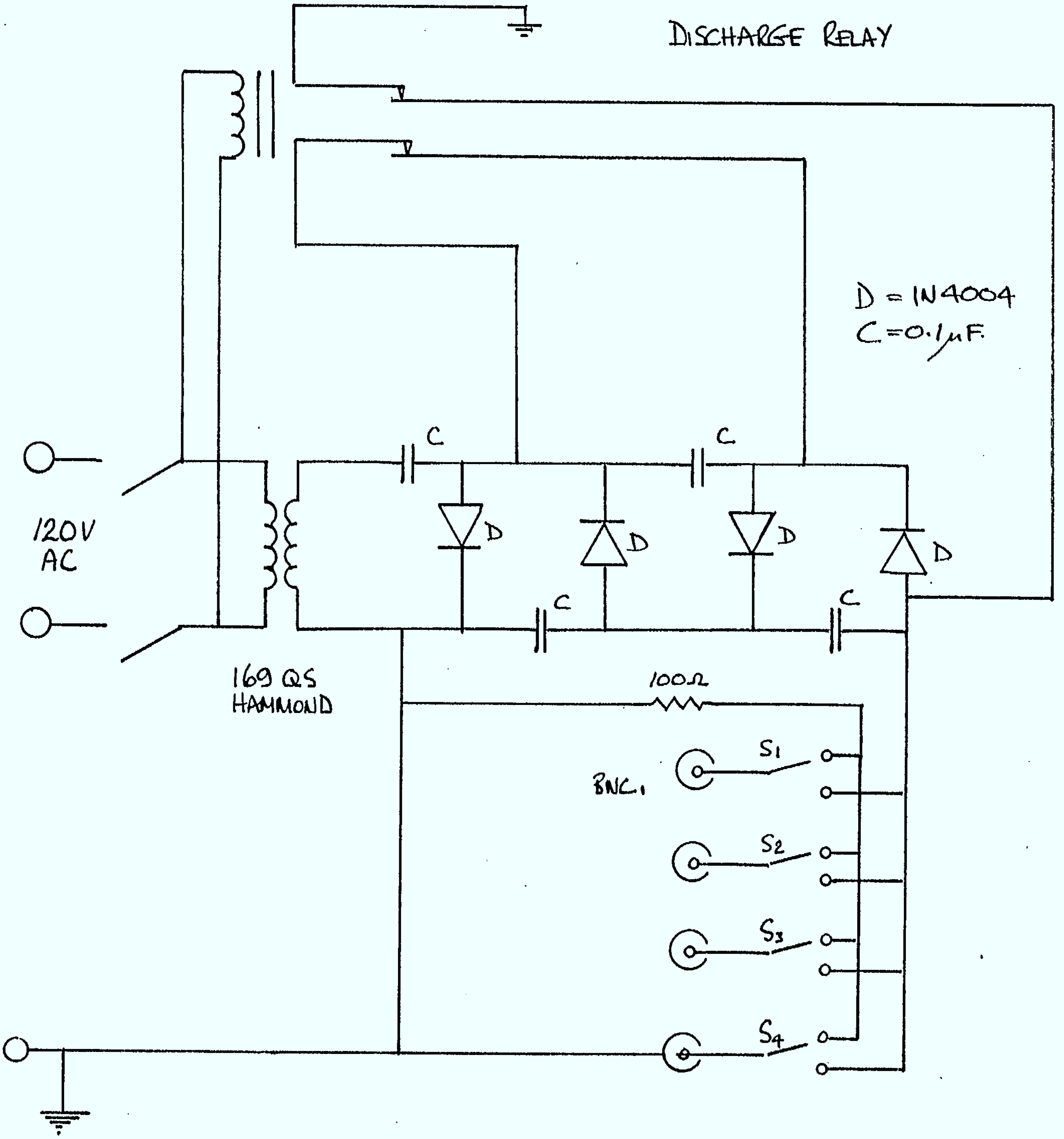
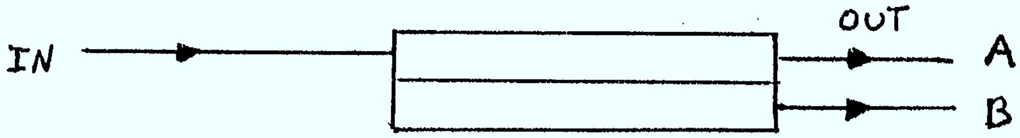


FIG 2


DISCHARGE RELAY
D = 1N4004
C = 0.1μF.
C
C
C
C
D
D
D
D
120V
AC
169 QS
HAMMOND
100Ω
BNC1
S1
S2
S3
S4



SWITCH #

1

	A	B
OFF	100%	0
ON	50%	50%

2

	A	B
OFF	100%	0
ON	50%	50%

3

	A	B
OFF	100%	0
ON	1%	99%

4

	A	B
OFF	100%	0
ON	3%	97%

OPTICAL SWITCH TEST DATA