

# **IRIS**



## **FLAME MONITORING SYSTEM**

**FIBER OPTIC SYSTEM**



### IRIS FIBER OPTIC SYSTEM

The following is a description of the IRIS fiber optic system which is composed of a viewing head, a fiber optic assembly and an amplifier module. Refer to drawing AS-593A which shows this assembly. Refer to drawing AS-595A which shows an assembly for a standard viewing head amplifier with adapter (instead of the amplifier module). Also refer to drawing AS-596A which shows how to couple the fiber optic assembly to an IRIS Model 300.

#### VIEWING HEAD

Two viewing heads for use outside of the boiler are provided. Both incorporate a one inch diameter lens. The longer V.H. uses a 2" focal length lens and the shorter one uses a 1" focal length lens. The longer V.H. is for larger diameter fiber optic bundles (>>.100") and the shorter V.H. is for smaller diameter bundles. Utilizing the proper V.H. will keep the angle of view close to 3°.

There is a one inch NPT female pipe thread in front of the lens for fastening the viewing head to a sight pipe. The lens is cemented permanently in place using a high temperature cement. The viewing head and fiber optic assembly is rated for 350°F. Purge air can be used down stream of the viewing head for keeping the sight pipe clear of debris by utilizing a "Y" fitting.

#### FIBER OPTIC ASSEMBLY

The new fiber optic assembly (drawing AS-586A) is composed of a .055" diameter fiber optic bundle which is enclosed with a .200" diameter flexible metal sheath. The ends of the bundle are secured in metal tips .187 inches in diameter. The fiber optic bundle is fastened to the viewing head using a "quick disconnect" retainer which is fastened to the fiber optic tip.

The end of the fiber optic bundle is "plugged-in" to an amplifier module, S513, as shown in the assembly drawing. The S513 enclosure incorporates a liquidtight connector so that the fiber optic bundle can be installed inside a liquidtight conduit for fur-

ther environmental and mechanical protection. The tip of the fiber optic bundle is held in place with a set screw inside of the S513 amplifier module. The S513 module can be installed in an outdoor environment or inside a larger enclosure. When used in an enclosure the liquidtight connector can be substituted with a strain relief connector which employs a bushing that holds the fiber optic bundle in place. The S513 module is connected to the M502 mother board using the same Amphenol-Tuchel receptacle and cable plug used for the S512 viewing head.

#### APPLICATION OF FIBER OPTIC SYSTEM

The purpose of this fiber optic system is to remove the critical components, principally the photodetector, to a less harsh environment. A second purpose is to remove the electrical power driven components to a "safe" area for applications in hazardous locations. In the latter type installation, the S513 module would have to be in a safe area or inside an explosion proof enclosure. An alternate installation would be to use one of the other type viewing heads instead of the S513 amplifier module such as S506E, S509E, S511E or S512E. The suffix "E" means that the viewing head employs a fiber optic adapter and mounting plate instead of a standard lens assembly.

#### OPERATING TEMPERATURE

The viewing head and fiber optic bundle will withstand temperatures up to 350°F (177°C). The S513 module should be operated with a case temperature below 140°F (60°C) for maximum life expectancy of the photodetector but can be operated up to 158°F (70°C) temperature without affecting operation.

#### FIBER OPTIC MATERIALS

There are basically two kinds of fiber optic materials used. One is the standard glass fiber and the other fused silica fiber. The fused silica fibers are divided into two types, Low OH and High OH. The "OH" refers to the oxygen and hydrogen content.

LIGHT TRANSMITTANCE OF STANDARD GLASS FIBER

.125" DIA BUNDLE WITH .002 DIA FIBERS

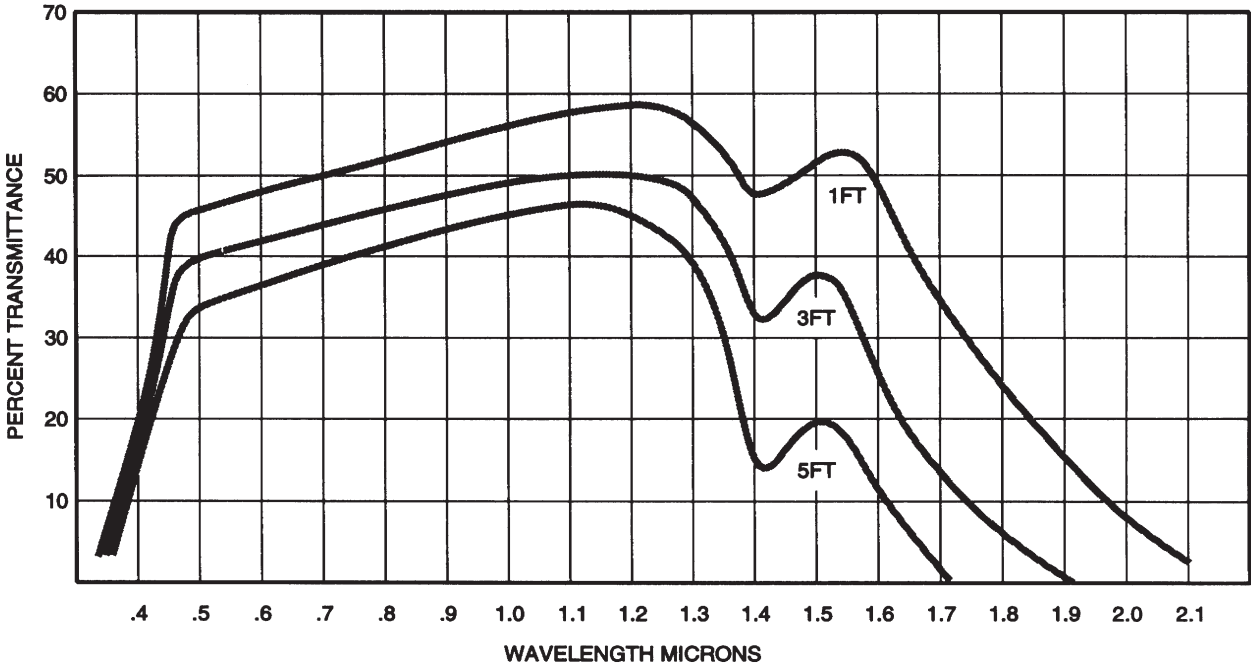


Fig. 1

RADIATION INTENSITY FOR GAS & OIL FUELS

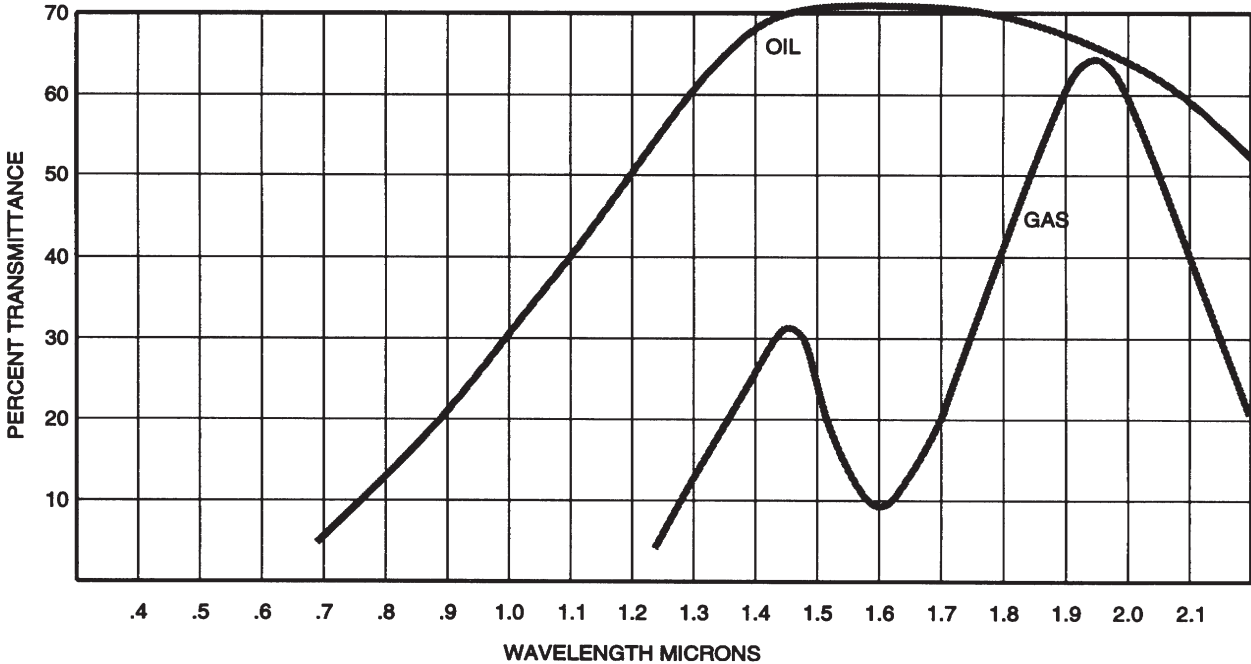


Fig. 2

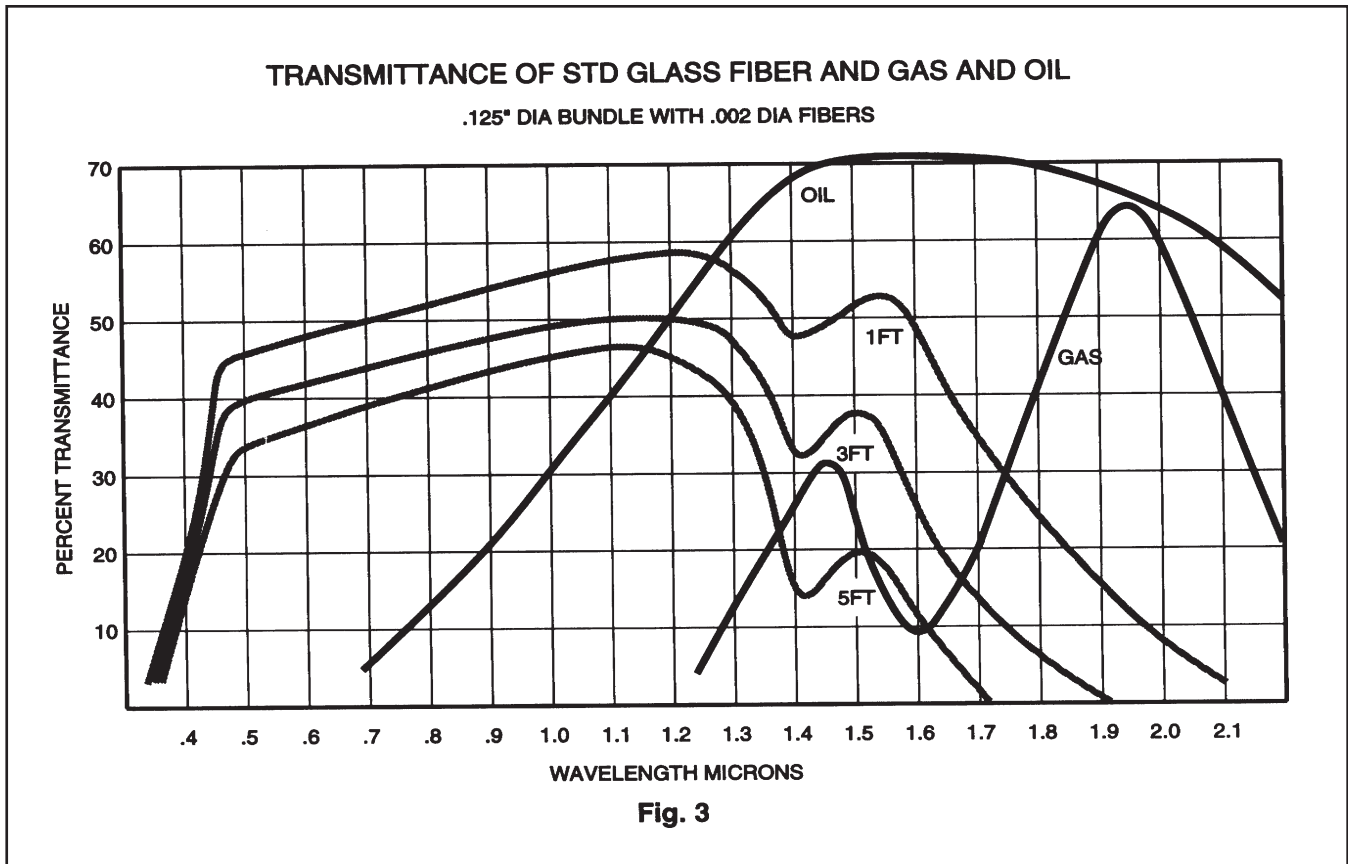


Fig. 3

Fig. 1 shows the transmittance of standard glass fibers. Note the attenuation (sharp dip) at 1400nm wavelength and the attenuation in the longer wavelengths.

Fig. 2 shows the radiation intensity of gas and oil fuels. Note the lack of intensity of gas in the range where standard glass has good transmittance and where standard glass is attenuated the gas radiation has a peak. It is obvious by comparing these graphs Fig. 3 that there is a complete mismatch when it comes to detecting propane or natural gas with standard glass fiber. This is particularly true for longer fiber optic assemblies because of the accumulative effect of the attenuation at 1400nm and the non-linearity in the longer wavelengths. For example, in a 20ft bundle there isn't much signal transmittance beyond 1400nm, which means that standard glass fiber optic materials can not be used for luminescent flames such as propane and natural gas.

Fig. 4 shows the transmittance of a Low OH fused silica material. Note that there is no attenuation at the OH 1400nm absorption point and the longer wavelengths are not attenuated as with standard glass. Low OH fibers must be used for detecting luminescent flames such as natural gas.

Fig. 5 shows the transmittance of High OH fused silica material. Note that the wavelength scale of the graph has been shifted to the right and that this glass material transmits the very short UV wavelengths. This means that this type of glass material can be used for UV flame detection. (The UV tube detector has a peak response at 200nm).

Actually three different fused silica fiber optic assemblies are offered. One, composed of Low OH fibers; another, composed of high OH fibers; and a third, made up with both Low OH and High OH fibers with a 50/50 mix.

TRANSMITTANCE OF LOW OH FUSED SILICA

TRANSMISSION MEASUREMENTS MADE WITH A .08" DIA X 5' BUNDLE

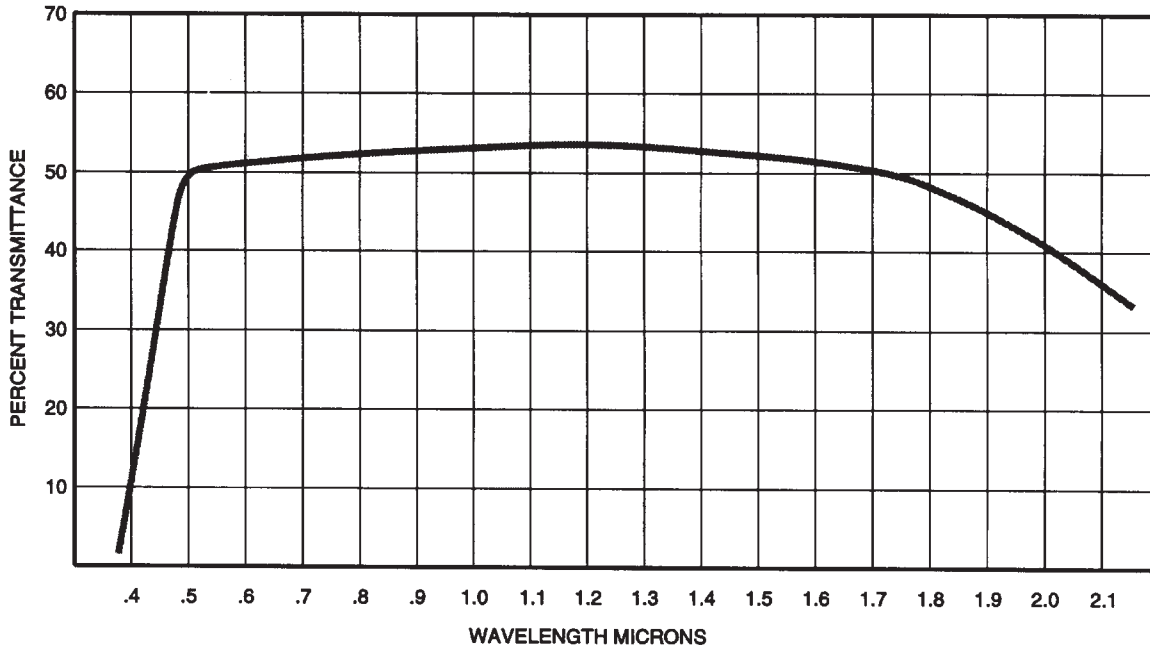


Fig. 4

TRANSMITTANCE OF HIGH OH FUSED SILICA

TRANSMISSION MEASUREMENTS MADE WITH A .08" DIA X 5' BUNDLE

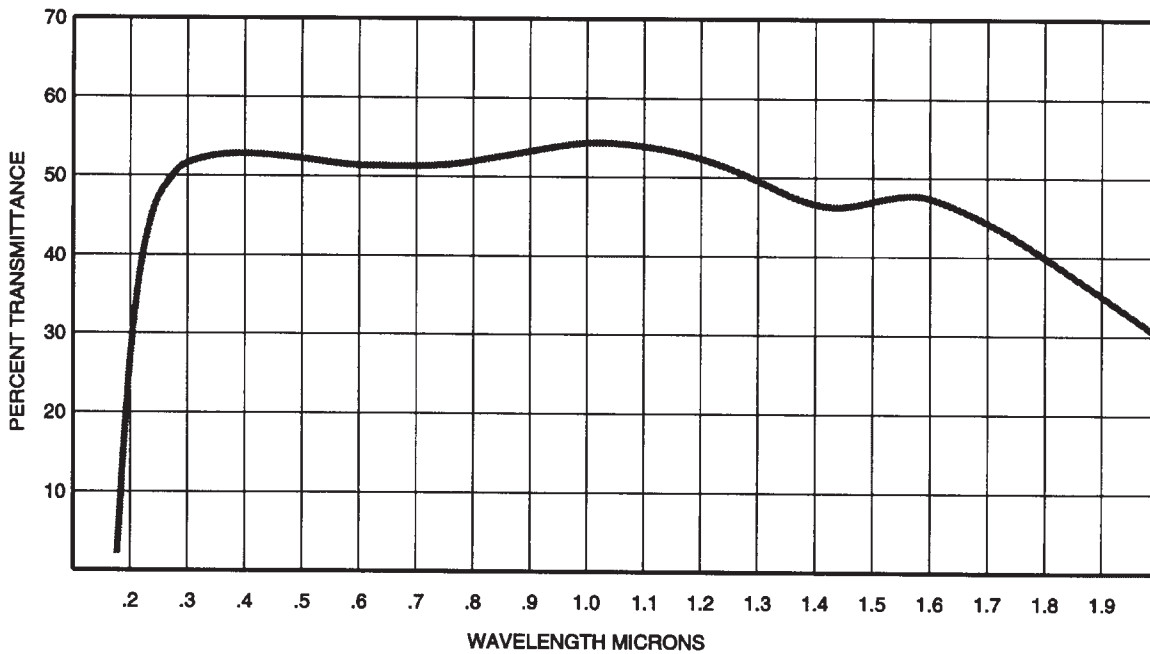


Fig. 5

## TRANSMISSION CHARACTERISTICS

The following tables show the transmission losses of the three different assemblies. The transmission ranges were measured using various signal sources which accounts for the wide spread. For example, the UV sources were a propane torch, a germicidal lamp and the IRIS portable UV source which utilizes a special UV tube. The IR sources were a propane torch and an incandescent lamp operated with very low voltage (barely incandescent). Care was taken with the S512 V. H. to make sure the measurements were well below the saturation point of the PbS photodetector.

### IR FLICKER FLAME MONITOR

CONFIG/MATERIAL	TRANSMISSION
S512 DIRECT	100%
LOW OH/HIGH OH	12-27%
LOW OH	16-35%

### UV FLAME MONITOR

CONFIG/MATERIAL	TRANSMISSION
S506 DIRECT	100%
LOW OH/HIGH OH	18-30%
HIGH OH	25-50%

Both the above assemblies were 10ft long with a fiber optic bundle diameter of .055". All measurements were made with the short focal length S580 viewing head (which has a fused silica UV lens).

It is believed that longer assemblies (>>10ft) will not exhibit attenuation characteristics much different from those shown in the tables. For example, if a 20ft assembly were used one would not experience double the attenuation shown because of the reflection of light as it travels down the bundle. As an example, using the S506 UV flame monitor, one can expect 20-40% attenuation with a 20ft High OH assembly.

## S513 AMPLIFIER MODULE

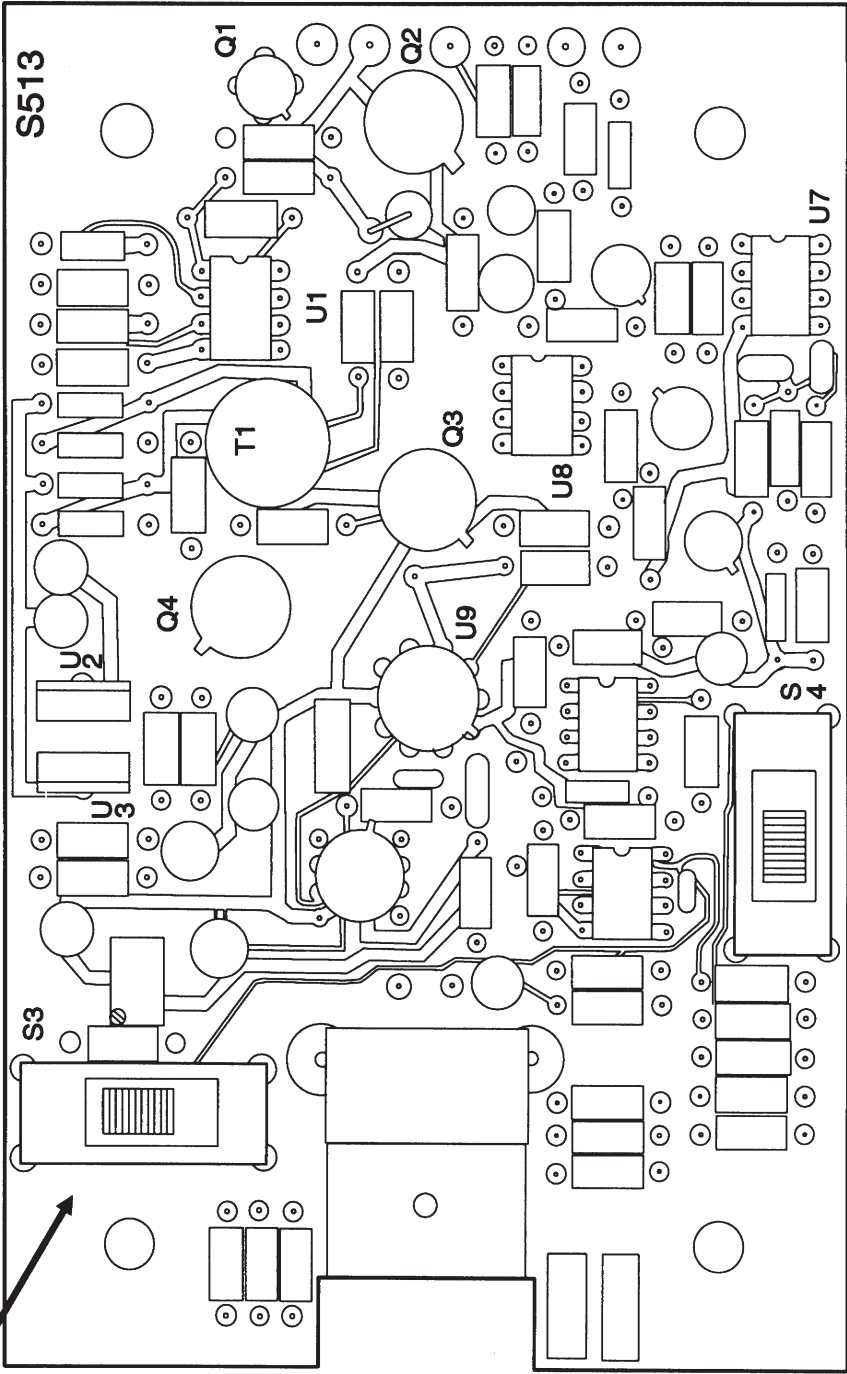
The S513 amplifier module is practically identical to the S512 amplifier. The only difference is that instead of a 25-turn potentiometer for changing the gain, a 3 position switch has been incorporated. This is shown as S3 in the assembly drawing on the next page. The position marked "H" causes a gain of 1.5 times the highest gain on the S512 (25-turn pot full clockwise), with the position marked "M" providing the same maximum gain as the S512 and the position marked "L" providing 2/3 less. The filter switch shown works the same way as the filter switch on the S512 viewing head.

### APPLICATION

The fiber optic assembly shown in drawings AS-581A/B employs a "quick disconnect" retainer (ME-582) that incorporates an internal "O" ring which prevents moisture or liquids from entering the viewing head enclosure. This retainer is mounted and sealed to the fiber optic bundle. This is done by applying silicon cement (RTV) on the tip before inserting into the retainer then tightening the 6-32 set screw to hold it in place. One should be careful not to get any adhesive on the end of the tip. This should prevent liquids from getting into the viewing head. It should be pointed out, that once this is done it is difficult to remove the retainer from the fiber optic bundle so this should be done as a final step in the installation.

The usual practice is to install the fiber optic assembly in a liquidtight conduit. It is recommended that a 1/2" liquidtight conduit be used as shown in the assembly drawing AS-594A. Shown is a T&B non-metallic liquidtight with the appropriate connector for the S513 amplifier and a boot that fits over the viewing head enclosure. This liquidtight installation will provide excellent mechanical protection as well as weatherproofing the assembly.

The T&B liquidtight shown can be used to 105°C (221°F). For higher temperatures other methods can be incorporated to give the extra mechanical integrity required. For example, an all metal conduit could



GAIN SW  
POS1 POS2 POS3  
H M L

FIL SW  
LL  
L  
M  
H

S513 AMPLIFIER PC BOARD

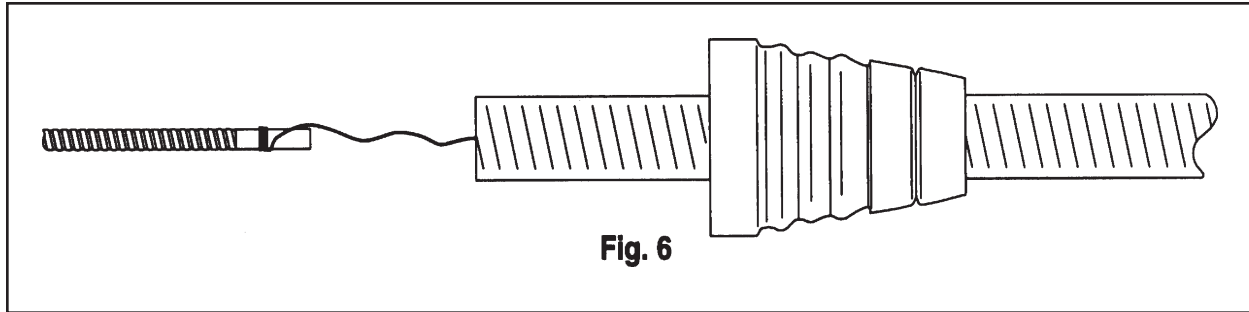


Fig. 6

be used. The fiber optic assembly by itself can be used to 177°C (350°F).

## INSTALLATION

The installation technique will depend on whether the fiber optic bundle is installed in a T&B nonmetallic liquidtight conduit or metal liquidtight conduit. In any case, the conduit will have to be fitted properly, so the description that follows should be a good guide.

When this assembly is installed or inserted into any type conduit it should be pulled by the tip through the conduit. Do not at anytime try to push or twist the assembly, for this may cause fibers to break. Pulling the assembly by the tip can be done by tying a nylon lacing cord (Alpha LC-136) to the tip. This type of lacing cord is finished with a wax which will prevent the cord from slipping off of the tip when pulling. The nylon cord should be fed through the conduit first, tying the trailing end to the tip of the fiber optic assembly as shown in Fig. 6. The fiber optic bundle can then be pulled through the conduit with the nylon cord.

The length of the conduit should be sized and cut so that there is 2 1/4" to 2 1/2" of the fiber optic bundle protruding from one end, measured to the end of the stainless steel tip. This protruding length is necessary for insertion into the S513 amplifier module. It is recommended that one install this end of the fiber optic bundle first and that this be done before clamping the liquidtight conduit. In other words, some slack at this end is needed when inserting into the S513.

Before inserting the fiber optic bundle into this mod-

ule unscrew the collar on the liquidtight connector and push it over the end of the liquidtight conduit. The tip of the bundle must be inserted into the hole in the aluminum retainer block (on printed circuit board) until it bottoms on the photodetector. Actually it bottoms or hits the window on the photodetector, so take care not to scratch or break this window or mull the polished tip end of the fiber optic bundle. Make sure the set screw is unscrewed enough to clear the hole. Use the Allen wrench supplied to secure the fiber optic assembly in place. The liquidtight conduit should be long enough to fit snug up on the connector. Once the tip is fastened securely with the set screw, pull the end of the liquidtight all the way up on the connector as far as it will go, then tighten the collar on the connector to secure the end of the liquidtight conduit.

The retainer can now be mounted and sealed to the other end of the assembly. Before doing so push the corrosion resistance boot over the end of the conduit. Refer to assembly drawing AS-594A.

The viewing head is mounted in place using the plastic 1" NPT nipple supplied. This nonconductive nipple is necessary to prevent electrical ground loops which can cause noise problems. The nipple will require a female 1" NPT fitting on the sight pipe. This can be a reducer, in case a larger sight pipe is used, or a "Y" fitting if purge air is used. Once the viewing head is screwed in place the fiber optic assembly can be attached using the "quick disconnect" retainer. Tighten the 6-32 mounting screws after attaching the fiber optic assembly and push the rubber boot over the end of the viewing head using a twisting motion.

This completes the installation except for clamping the liquidtight conduit to part of the plant structure to minimize any strain on the fiber optic assembly, particularly on the viewing head end of the assembly.

## HIGH TEMPERATURE APPLICATION

Two viewing heads have been designed for use inside of a one inch pipe. Refer to drawing AS-598A. These viewing heads have cooling fins to sink the heat away from the fiber optic assembly tip. The idea is to use forced air through the pipe to keep the fiber optic assembly cool.

The limiting temperature is dictated by the bonding cement used to secure the end of the fiber optic bundle. High temperature epoxy type adhesive is used for this purpose. The adhesive will hold the glass fibers in place up to 50°C (482°F) for what may be called a “long term period”. The adhesive will work to higher temperatures for shorter periods of time, for example, up to 350°C (662°F). Obviously, the amount of forced air and its temperature will play an important role in keeping this assembly cool enough to prevent failure in applications where the viewing head is close to the flame being monitored.

One CFM of air flowing down the 1" pipe will provide over 5ft/sec of air across the surface of the “cooling fins” on the viewing heads. If this air is at room temperature (25°C) then one can expect excellent cooling of the head and fiber optic tip.

The heat that the viewing head is going to absorb will be from conduction and radiation. One would not expect any heat to be transferred by *convection* because of the air flow. The heat *conducted* would be from the “fins” touching the bottom of the pipe and the heat by *radiation* is ever present. What heat is absorbed by the viewing head is, however, further dissipated by the air flow, so without making actual measurements, one can expect very good cooling using these “finned” viewing heads.

It is recommended that three CFM of cooling air be used so that there is a safety factor with regard to air

flow resistance in the 1" pipe and supply hoses etc. The air pressure obviously will have to be well above any positive furnace pressure in order for this amount of air to flow.

The lens material is UV fused silica which means that these heads can be used with the S506E for UV flame monitoring. (Refer to application drawing AS-597A which shows a standard viewing head housing and flange with adapter.) One of the viewing heads has a skew built in for sighting off on an angle at the viewing head end. That is, there is about a 10° skew angle that will allow one to turn the pipe and “search” for the highest flame signal reading. This will be useful for applications where the flame root may be off to one side of the viewing head pipe. Note that the viewing head has two small holes up front for tying a wire or nylon string which can be used to pull the assembly into the one inch pipe. One should not, at any time, try to push the fiber optic assembly into position for this can cause fibers to break.



For further information please contact:

Sales and Applications Support:

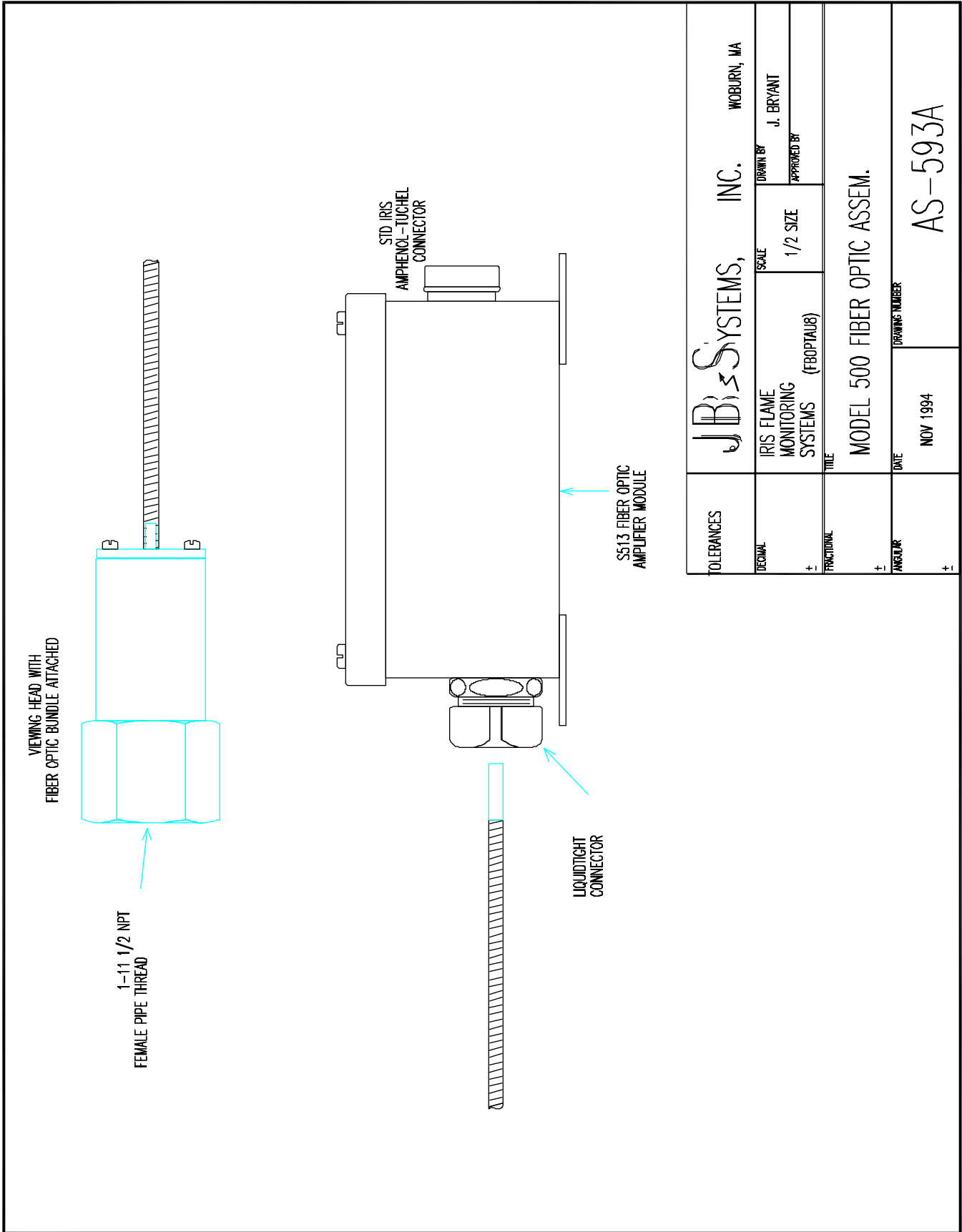
IRIS Systems Inc.  
#205, 19138 26th Avenue  
Surrey, B.C. V3S 3V7

Tel: (604) 584-IRIS<sub>74S7</sub>  
(604) 538-5972  
1-800-667-IRIS<sub>74S7</sub>  
Fax: (604) 581-9790

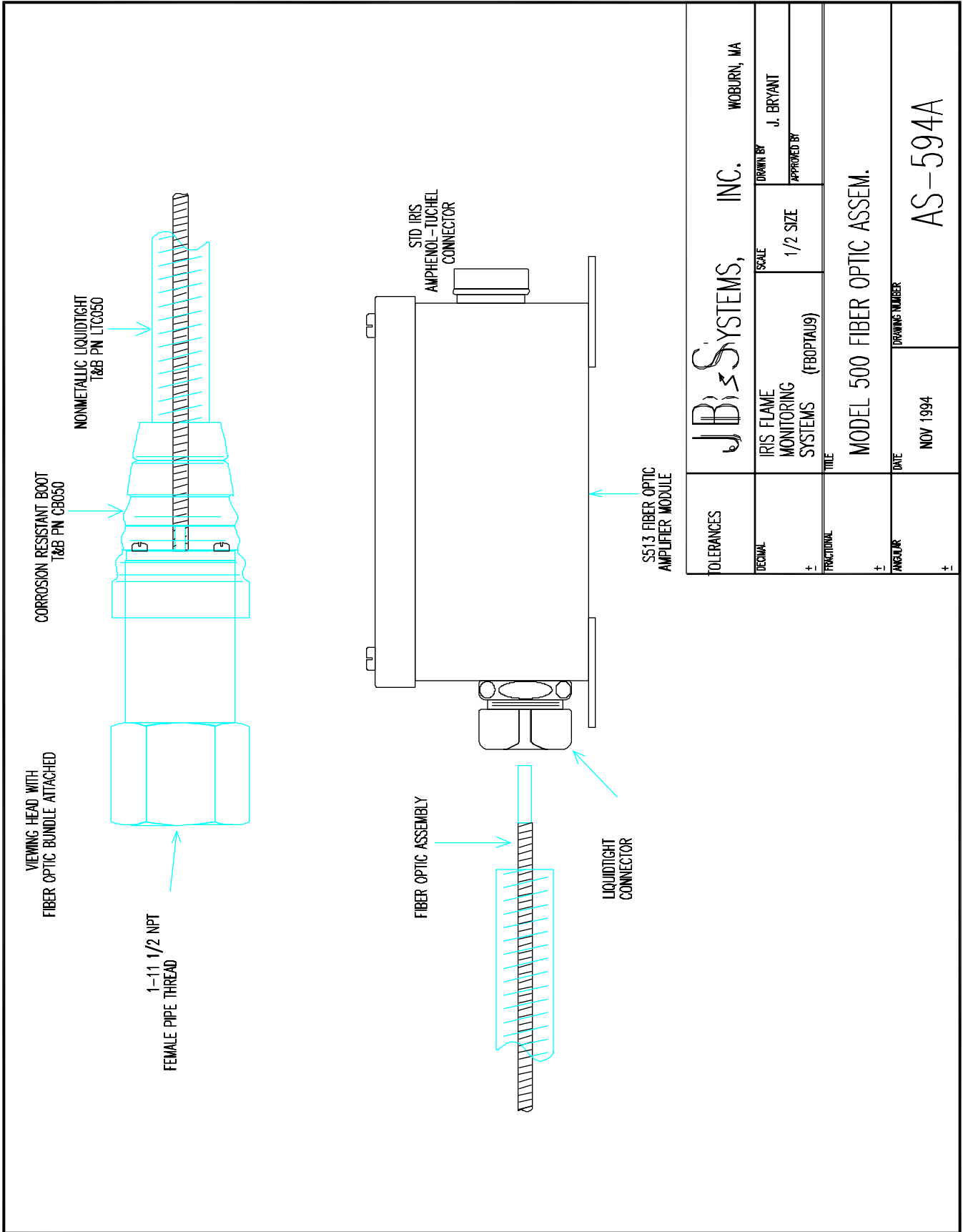
Factory and Repairs:

IRIS Systems Inc.  
(JB Systems, Inc.)  
4944 - 113th Avenue N.  
Clearwater, FL., 33760

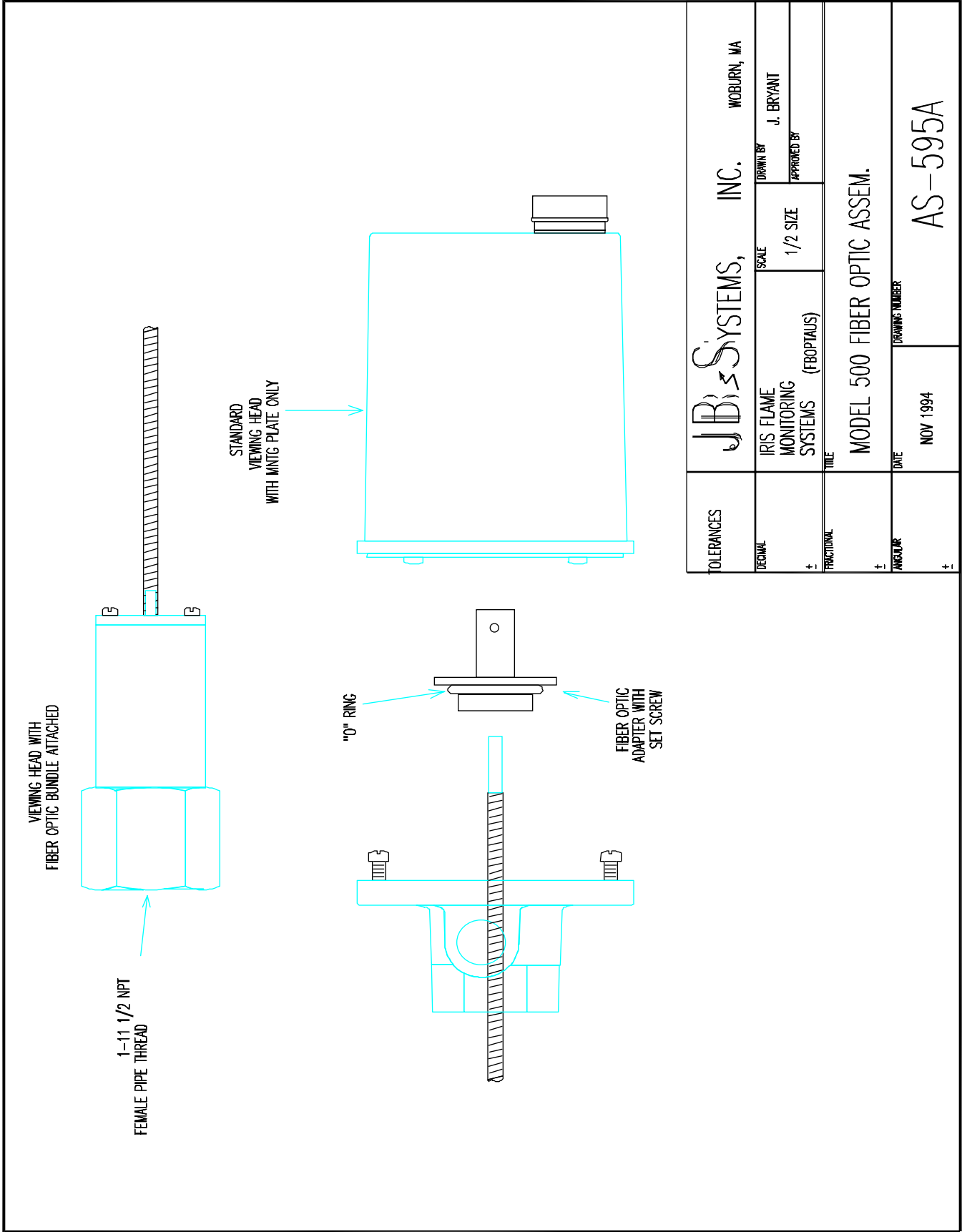
Tel: (727) 545-3900  
Fax: (727) 547-9589



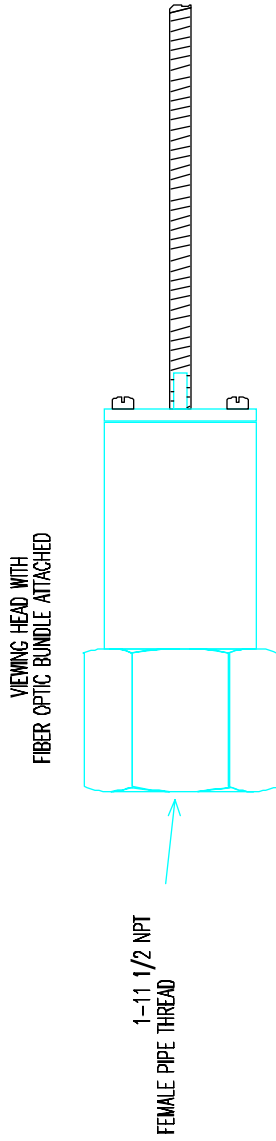
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		DATE	NOV 1994	DRAWING NUMBER	AS-593A



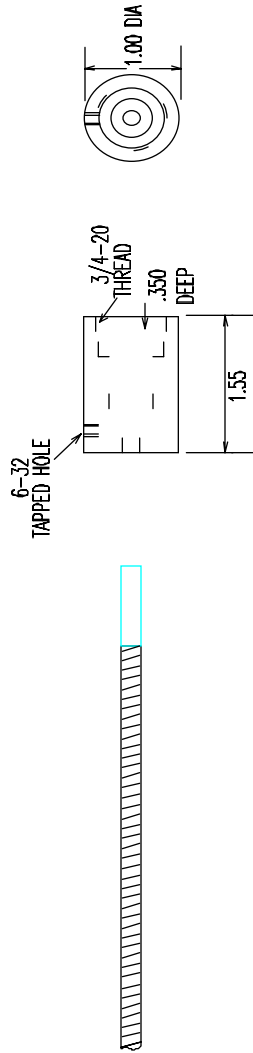
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+					APPROVED BY
FRACTIONAL		TITLE			
+		MODEL 500 FIBER OPTIC ASSEM.			
ANGULAR		DATE	DRAWING NUMBER		
+		NOV 1994	AS-594A		



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FRACTIONAL		TITLE			
+		MODEL 500 FIBER OPTIC ASSEM.			
ANGULAR		DATE		DRAWING NUMBER	
+		NOV 1994		AS-595A	



FIBER OPTIC ADAPTER FOR MODEL 300

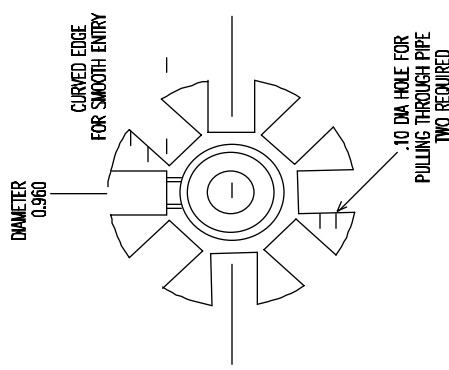
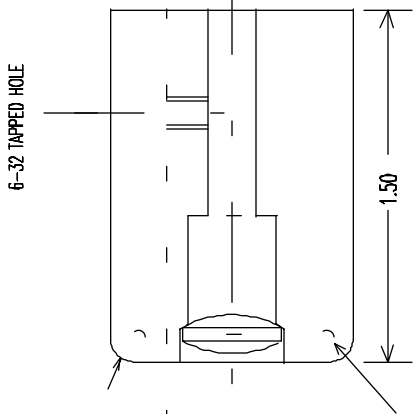


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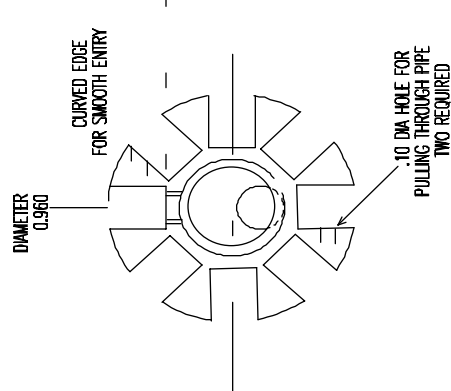
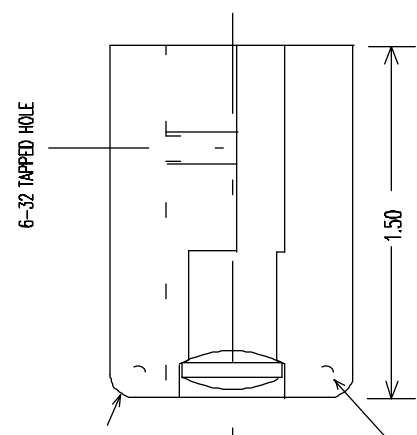
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EXTRUDED ALUMINUM

FINISH  
BLACK ANODIZE

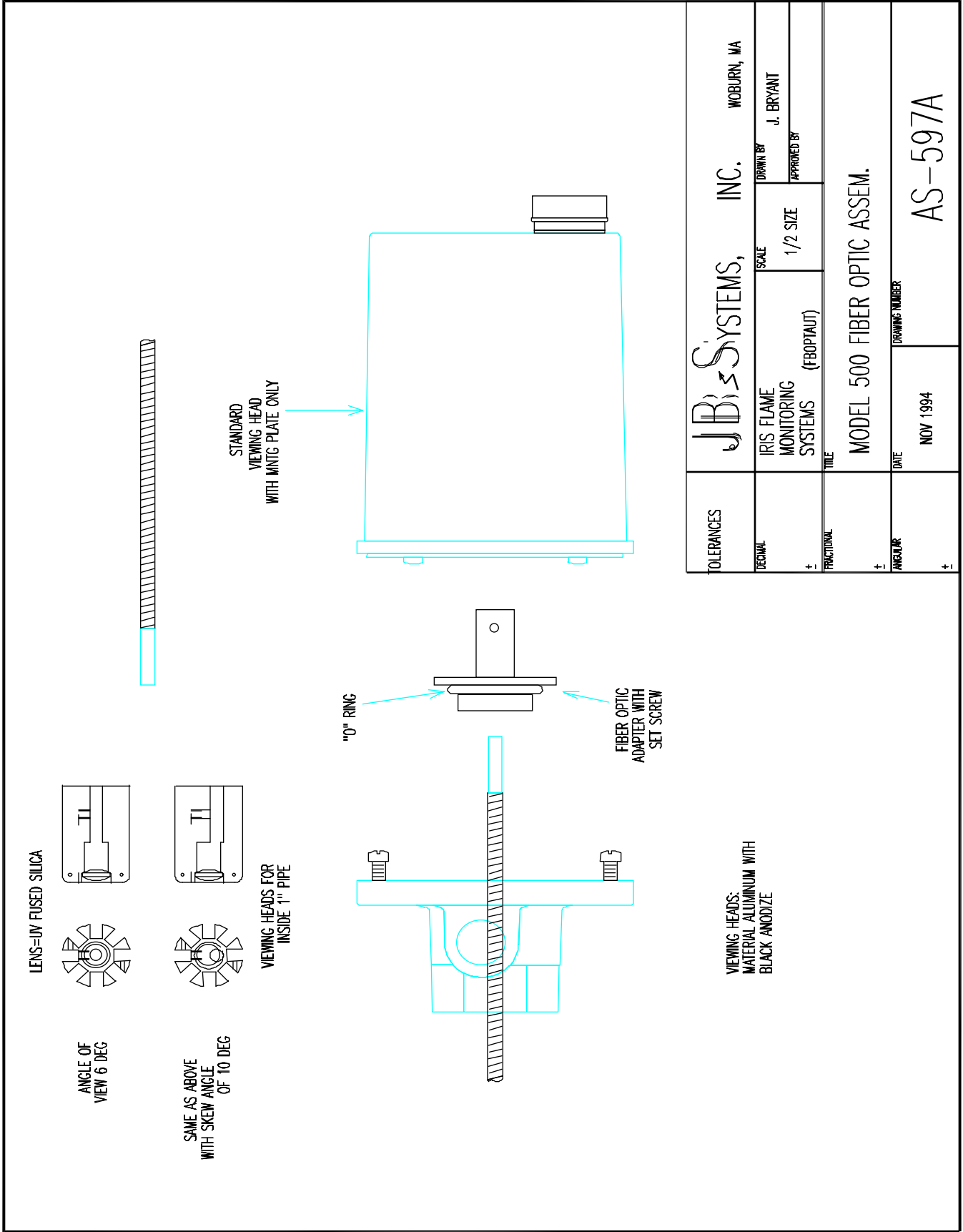
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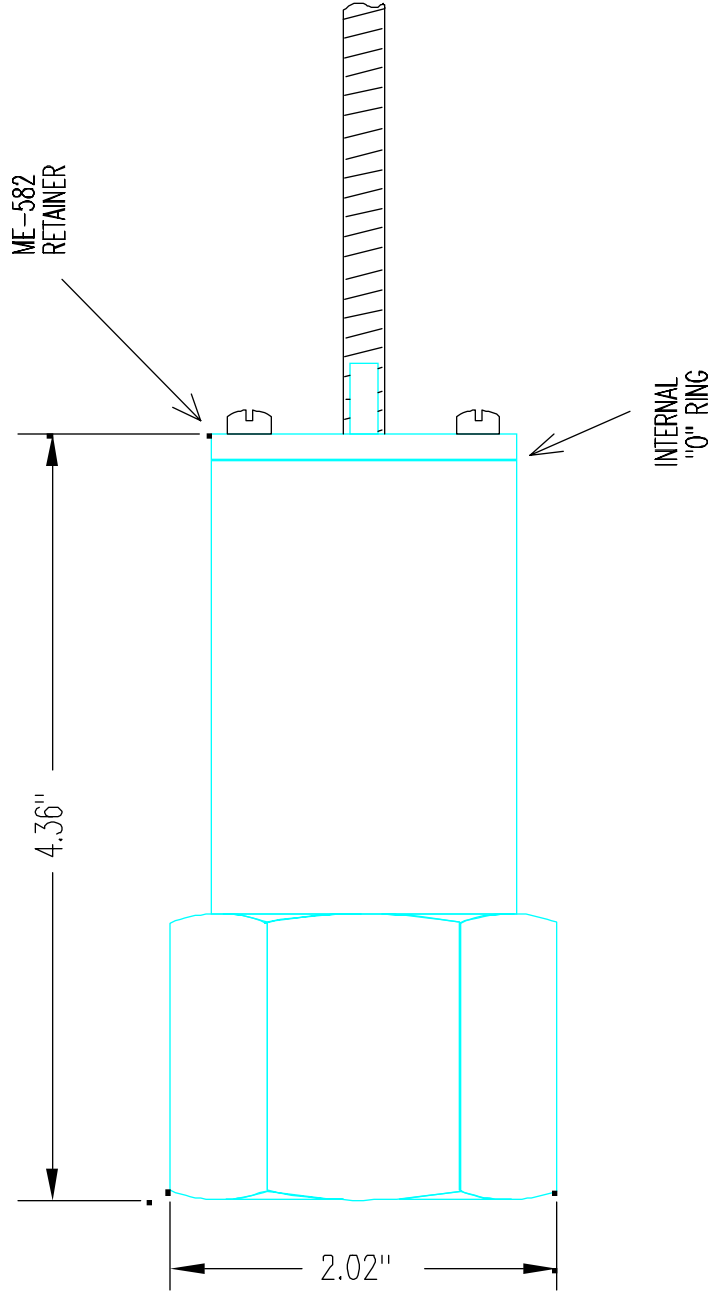
OFF SET FOR CREATING  
10 DEG ANGLE SKEW



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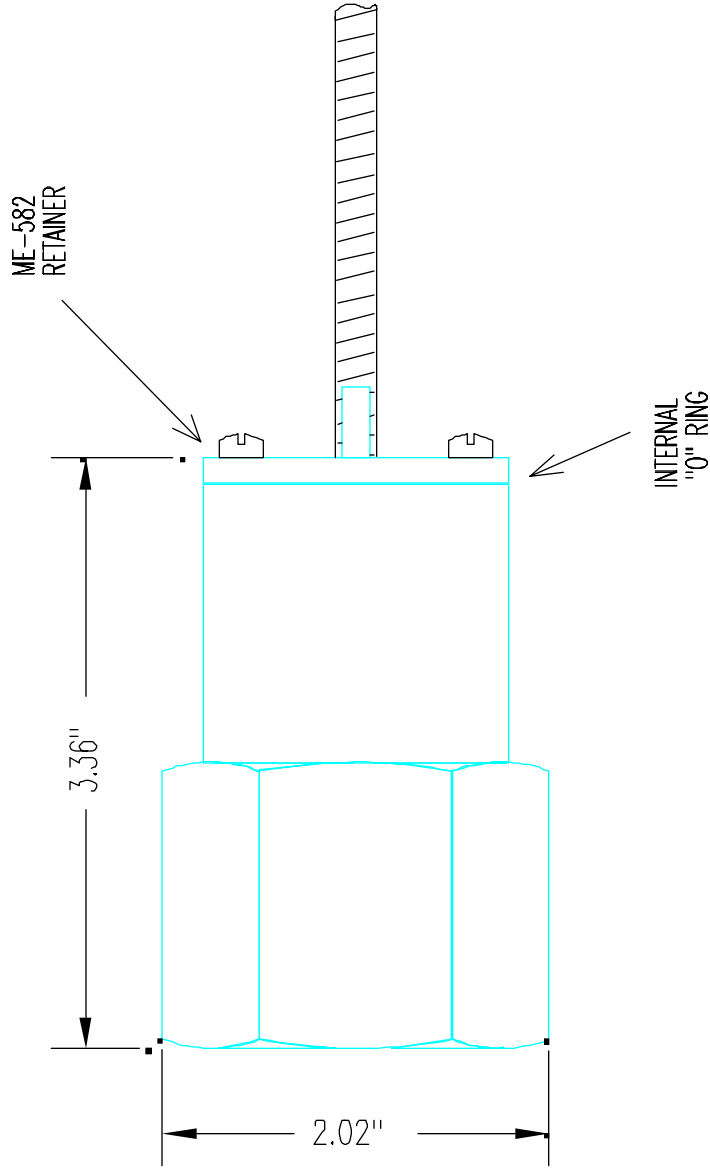


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+	-		FRACTIONAL		APPROVED BY
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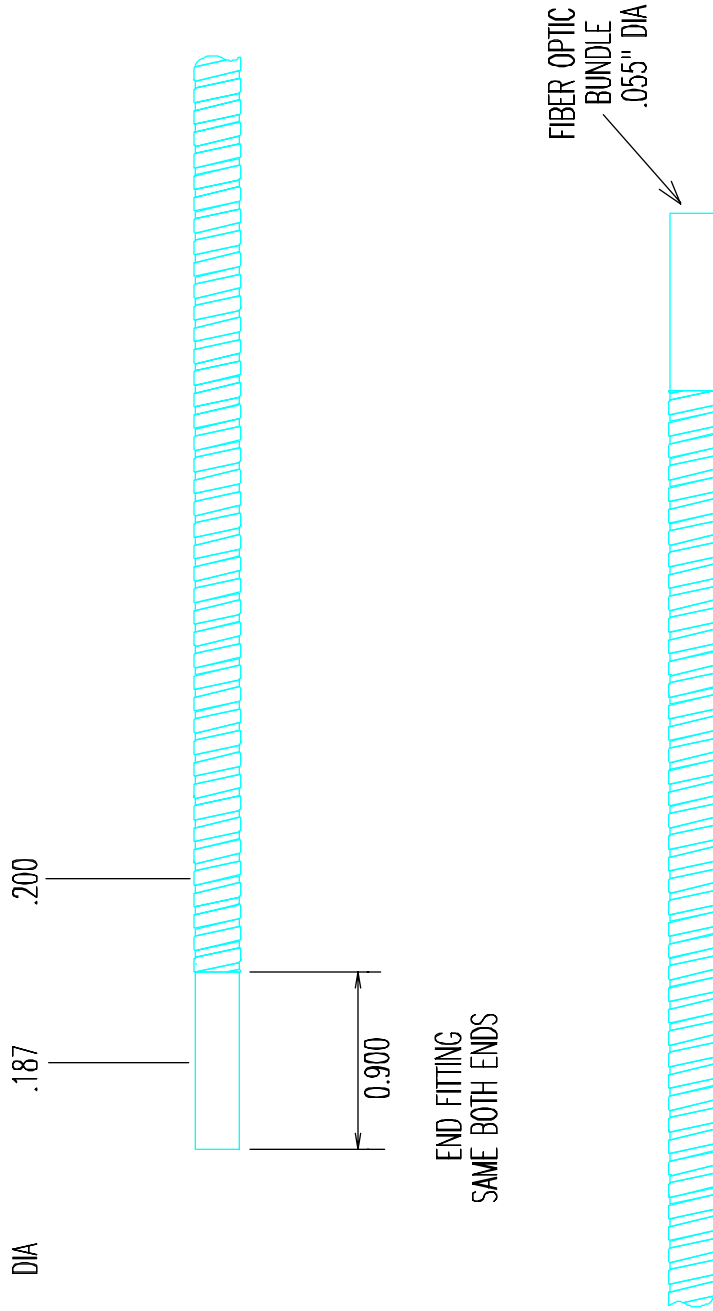
S580  
VIEWING HEAD  
WITH 2" FL

TOLERANCES	JB SYSTEMS, INC.		WOBBURN, MA
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±			APPROVED BY
FRACTIONAL	TITLE IRIS MODEL 500 FIBER OPTIC VIEWING HEAD		
±			
ANGULAR		DATE NOV 1994	DRAWING NUMBER AS-581A
±			



S580  
VIEWING HEAD  
WITH 1"FL

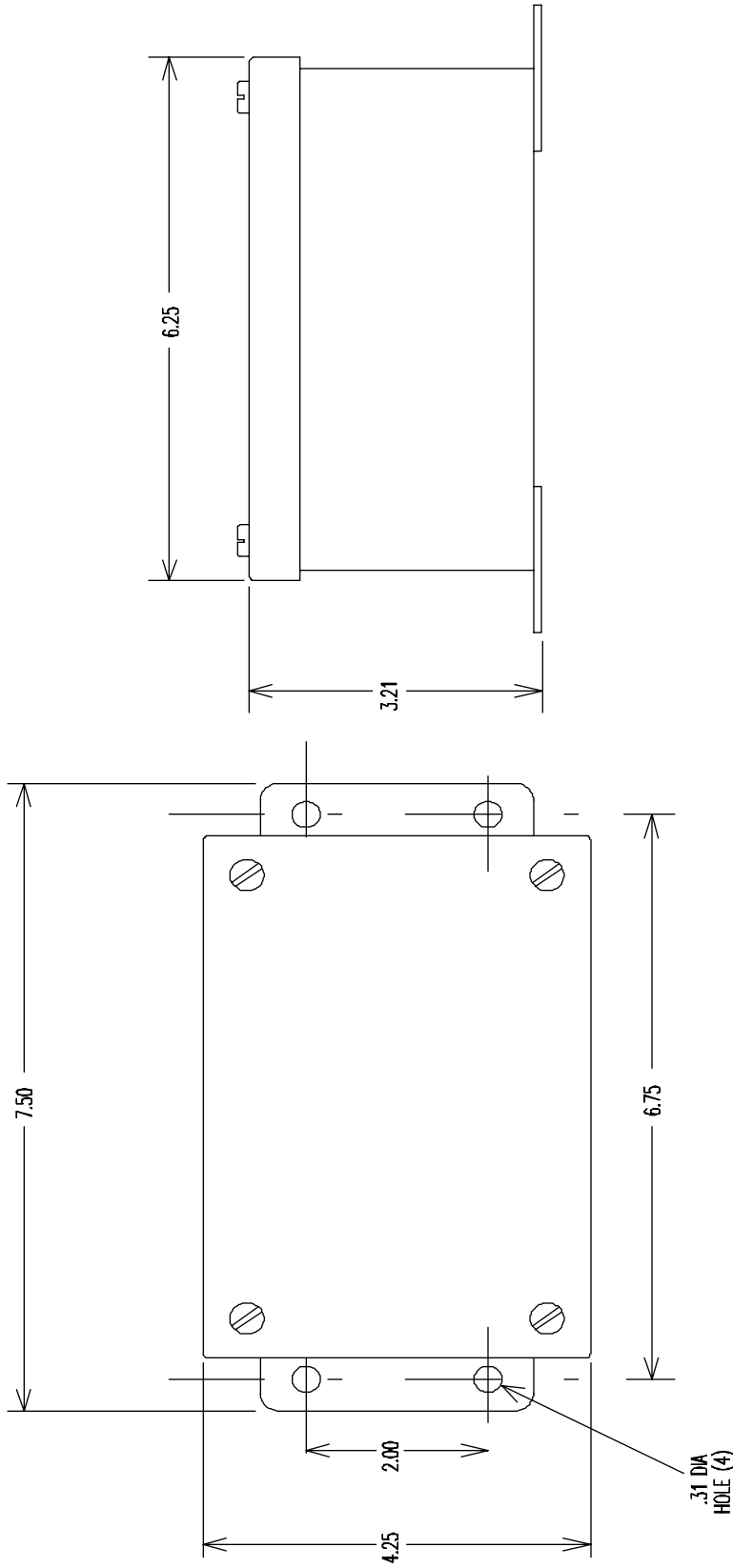
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FRACTIONAL	TITLE IRIS MODEL 500 FIBER OPTIC VIEWING HEAD		
±			
ANGULAR	DATE NOV 1994	DRAWING NUMBER AS-581B	
±			



END FITTING  
SAME BOTH ENDS

MATERIAL:  
METAL HOSE AND  
END FITTINGS  
STAINLESS STEEL

TOLERANCES	<b>JB SYSTEMS, INC.</b> BURLINGTON, MA	
DRAWING	SCALE	DRAWN BY
	1"=1"	J. BRYANT
		APPROVED BY
FRACTIONAL	TITLE	
	FUSED SILICA FIBER OPTIC ASSM	
DRAWING NUMBER	DRAWING NUMBER	
NOV 1994	AS-586A	



TOLERANCES	JB SYSTEMS, INC.		WOBURN, MA
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+			APPROVED BY
FRACTIONAL	TITLE FIBER OPTIC AMP. MODULE		
+		DATE JAN 1991	DRAWING NUMBER AS-582A
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