Description of the Invention

(1) **Background of the Invention:** Describe the general area of technology to which your invention relates. Briefly state and explain the current situation in that area in view of (1) relevant patents, publications and other public literature or disclosures, (2) the problem(s) the invention is intended to solve, (3) what others have done to address the same or similar problem(s).

Measurement of the Coefficient of Friction (COF) of optical fiber has historically been a hits and misses process. Techniques that are used include the drawing of a fiber over a metallic cylinder (a known mass attached to a distal end and a force measuring means to the proximal end), measuring said force while pulling the fiber over said cylinder and then calculating the COF. Another method is to wind a layer of fiber about the cylinder then passing the fiber-under-test (FUT) over this fiber and measuring the resultant force.

There are two forces of concern: a) the Static COF, f_s, and b) the Dynamic COF, f_d. f_s is the friction that must be overcome to make a resting body move; f_d is the friction that must be overcome to keep a body in motion while on a flat plane that is normal to the center of the Earth. Roughness does not contribute to COF in that it is lifting the body upwards normal to the surface and is counteracting the force of Gravity.

In a system where a given body of a known mass under the force of Gravity is made to move on a surface that is Normal to the Earth's center, the COF can be calculated from the following equation (where μ = COF):

$$\mu = \text{Force Measured} / (\text{Mass of Object})(\text{Acceleration Due to Gravity})$$

In the case of a strand or fiber, this definition needs to be altered because of the fiber's fleeting mass. Instead the *body's* mass is replaced

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by a hanging mass, the sliding surface, a cylinder and the fiber is wrapped *n* times, measured in ***radians***. In other words:

$$\mu = \frac{2e(f_1 / (f_{mass} * A)}{\pi}$$

Where μ = COF

Π = № of wraps; each 180° constitutes π, so 2π = 360°

f_1 = Measured force in g

f_2 = Force of the hanging mass in g

A = Acceleration due to Gravity ($9.8 m/s^2$)

This technique might be acceptable if the physical characteristics of the cylinder could be exactly duplicated for each instance of the test thereby returning the same values each time a test is performed. In reality the surface wears, surface roughness changes, the diameter may change with temperature or wear, and its composition may differ each time a new cylinder is fabricated, just to mention a few. Another issue is, except in the production of metallic fibers, once wound on a spool; seldom do fibers come into contact with metal. Most of the time, it is a fiber-to-fiber contact that causes concern.

A similar technique is to wrap one or more layers of fiber on a mandrel and then to slide the FUT over these stationery fibers. The primary drawback is the effort in winding a new test mandrel and the required accuracy to insure each is laid down in identical fashion.

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An object of this invention is to provide a means to evaluate the COF of a fiber or strand with respect to itself.

Another object of the present invention is the ability to acquire measurements of high repeatability.

A further object of this invention is the simplicity of the test fixture.

A yet further object of the present invention is the ability to scaled-up to an on-line system for production.

A still further object of the present invention is the ability to apply a variety of tensions to the fiber or strand simulating ***in situ*** conditions.

These and other objects of the invention will be apparent from the following description of the invention.

(2) **Abstract/Summary of the Invention:** State the general nature of the invention and define the invention in its broadest terms.

This invention relates to a means for determining the Coefficient of Friction (COF) of a filament or strand, and including but not limited to, an optical fiber by intertwining or twisting with itself and measuring the forces therein applied.

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(3) **Advantages:** Outline and explain the advantages or benefits (either technical or commercial) of your invention over the prior technology and how it solves the problems identified in the Background section.

The major impediment to all present embodiments for the measuring of Coefficient of Friction (COF) is that the measurement is referenced to a material that is different from the fiber or strands itself. In the case of optical fiber, a concentric polymeric coating is usually placed on the fiber both for protection and aiding of some optical properties. This generally means that a polymer is tested against a metal or different fiber and as the composition, cure, finish and temperature changes, so do the results.

The present invention measures the COF of a fiber with respect to itself by twisting a fiber and measuring the drag or frictional forces created at the twists. The distal end of the fiber is pulled at a constant rate while the force is measured with a suitable transducer means. The proximal end has a mass which is chosen by the user to represent real-world conditions; this mass is usually between (but not limited to) 20g and 90g.

(4) **Brief Description of Drawings/Figure:** If applicable, use drawings, charts, photos, tables or other figures to describe the details of the invention. For each figure, write a sentence or two describing what the figure represents and what it signifies

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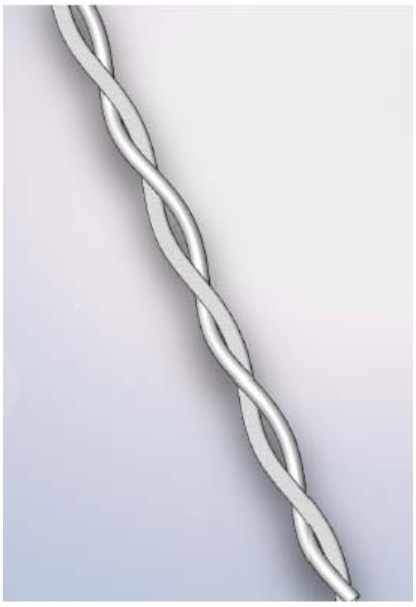

Figure 1 Twisted fibers.

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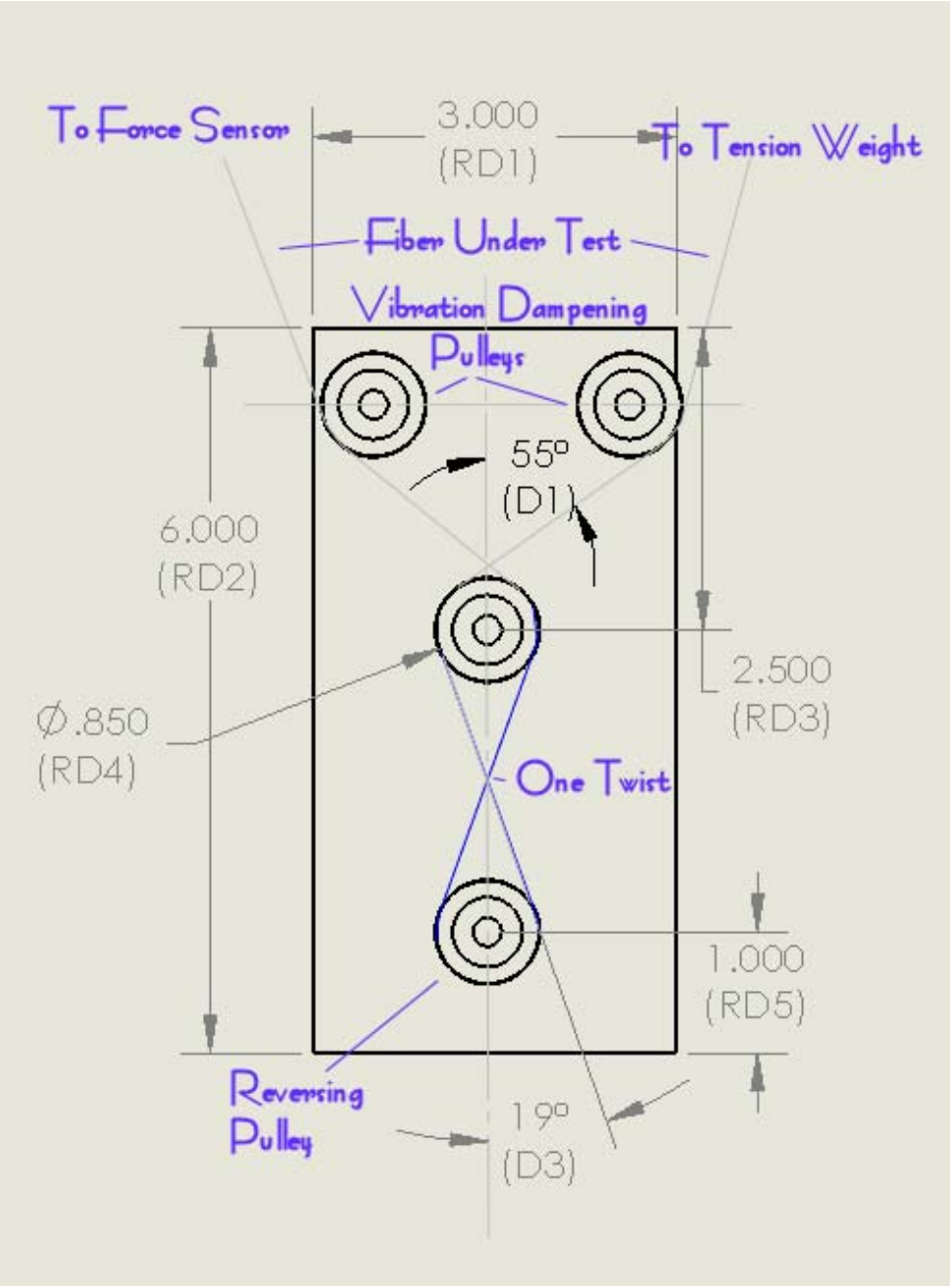

Figure 2 COF device.

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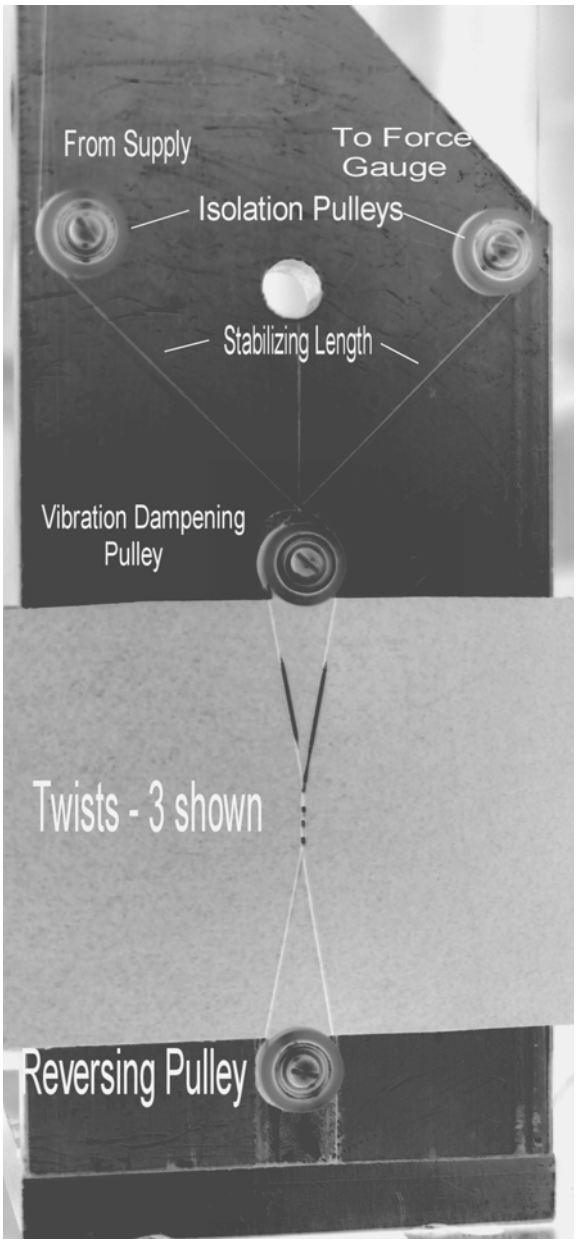

Figure 3 Image of COF device with Fiber installed.

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Figure 1 is a drawing-representation of a fiber twisted 5 times.

Figure 2 is a schematic representation of the means to generate friction between two different points of the same fiber.

Figure 3 is a photograph with annotations describing various aspects of the friction means of figure 2.

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(5) **Detailed Technical Description of the Invention:** Describe the technical specifics of the invention. The description should be sufficient to permit a person not familiar with the invention to understand what it is and how it works. The description should enable a person working in the technology to make, use or practice the invention without much more experimentation.

Where:

$$\mu = \frac{\ln\left(\frac{T_2 - \Delta T/2}{T_1 + \Delta T/2}\right)}{2\pi n}$$

μ = COF

e = natural log

T_1 = Weight (mass under influence of Gravity)

T_2 = Force measured by transducer

ΔT = zero-twist tension

n = № of wraps

α = angle between in and out; 38° for one twist

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(6) **References**: If available, list any patents, articles, reports, product information sheets or any other prior art literature relating to and possibly helpful in understanding or evaluating the invention. Electronically available documents may be submitted along with the electronic ID in the email to your Dept. Manager, otherwise, paper copies can be attached to the mailed-in original ID.

1. ASTM D 3412—07 *Standard Test Method for Coefficient of Friction, Yarn to Yarn*
2. Corning Incorporated R- **104257**

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