Sample Kit

FLEXINOL®

Instructions

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Introduction

This sample kit is designed to help the 'first-timers' understand how Flexinol® actuator wires work. You can also find more information about Flexinol®, why it works and what may limit the material by obtaining either an Information Packet (Free) and/or a Deluxe Kit ($199) from Dynalloy, Inc. (Address located on the cover of this document).

This is an exciting material which contracts a muscle fiber when electrically charged. Electricity flows through the wire much like a light bulb! This in effect causes heat in the Flexinol® wire and begins to restructure its' molecular and crystalline forms into shorter lengths. When the wire is contracting it exerts a nominal and usable force.

Flexinol® actuator wires have a great amount of uses for a vast amount of fields including Automotive, Computer and Entertainment. When used properly it can be smaller, lighter, and easier to apply physics' principles to enhance motion.

One of the important lessons from this kit is how to use geometry to enhance the motion. The motion available from the Flexinol® wire is limited, and sometimes we want more movement than the wire can provide directly. To solve this challenge we often use leverage or a linkage to increase the motion. Doing the experiments will show you how you can use the same piece of wire in different configurations to get substantially different magnitudes of movement. With a little creativity and innovation you may find new, better, and more fitting arrangements that suit your needs. This is great start to show you the nature of the shape memory material. Flexinol®!

List of Materials:

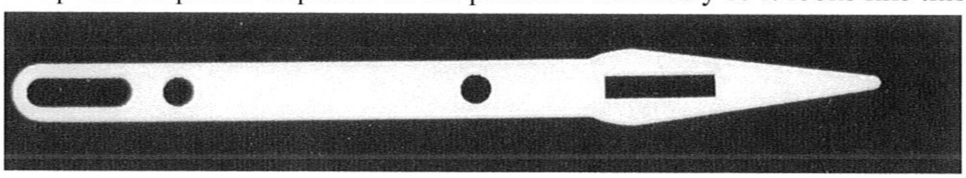
Hardware

1. (1) Lower Attachment
2. (1) Spring Slider
3. (1) Spring Tension Attachment
4. (1) 11.5" U-channel
5. (2) Support Braces- Left & Right
6. (1) Mounting Base
7. (1) Measurement Arm
8. (1) Slider
9. (1) Pointer
10. (1) Bushing
11. (1) Spring
12. (1) #2 Washer
13. (2) 2-56 1.5" bolts
14. (10) 2-56 hex-nuts
15. (4) 2-56 1/2" bolts
16. (1) 2-56 3/8" bolt
17. (2) 2-56 5/16" bolts
18. (1) 2-56 3/16" bolts
19. (1) Scale
20. (1) Steel wire 6.25"
21. (3) Flexinol® 0.006"Ø 4.75"
22. (1) Phillips head screwdriver
23. (1) Battery Pack

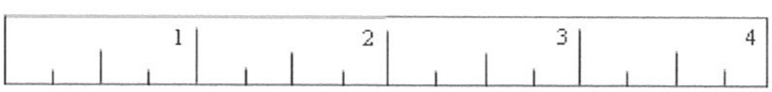
Tools
(not provided with kit)

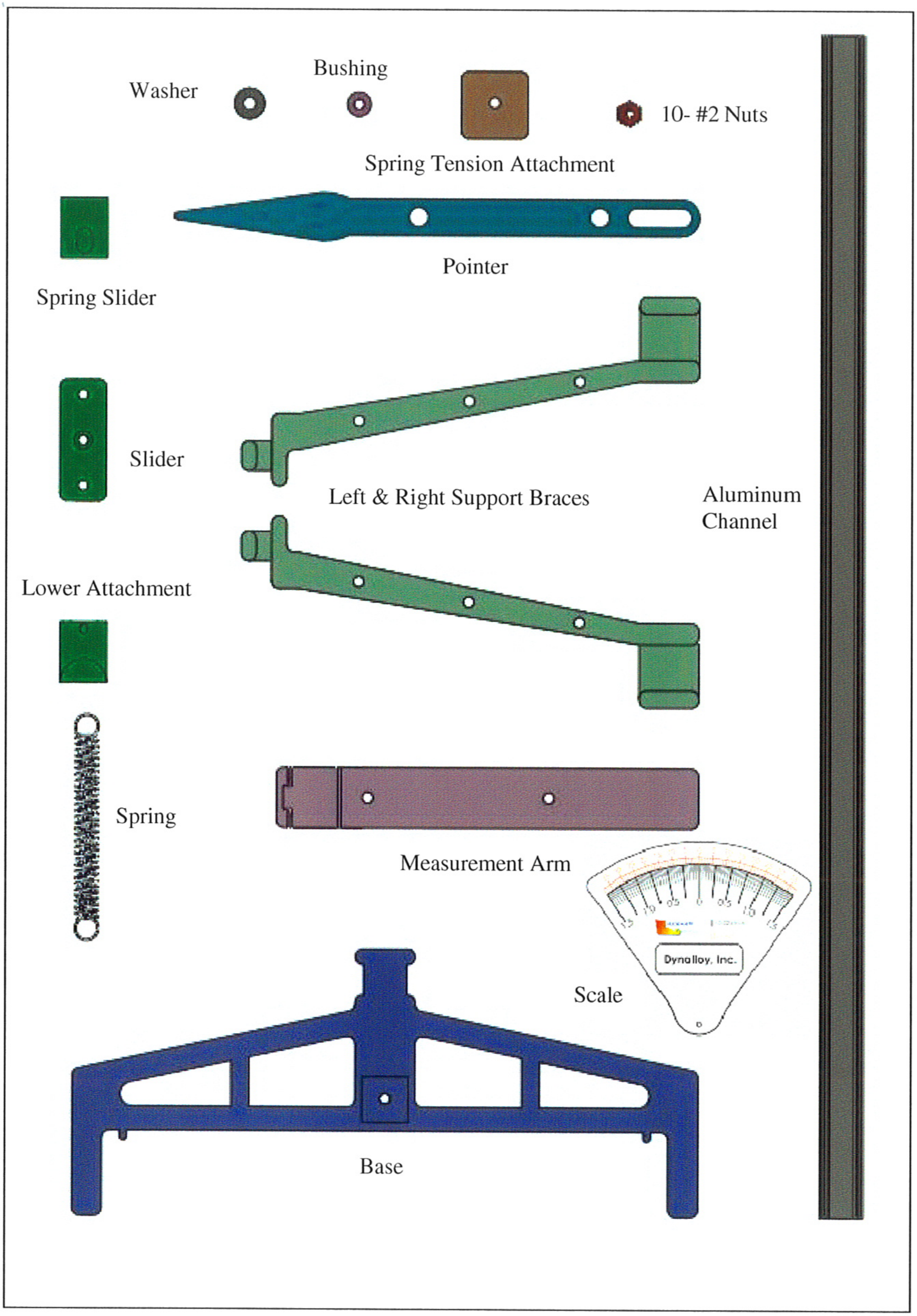
(1) Scissors (not shown)
(1) Double-Side Tape 2" (not shown)
(2) AA batteries (not shown)

Pop out the pieces of plastic in the pointer if necessary so it looks like this:



Ruler- you can cut this out and
use to measure experiment 2



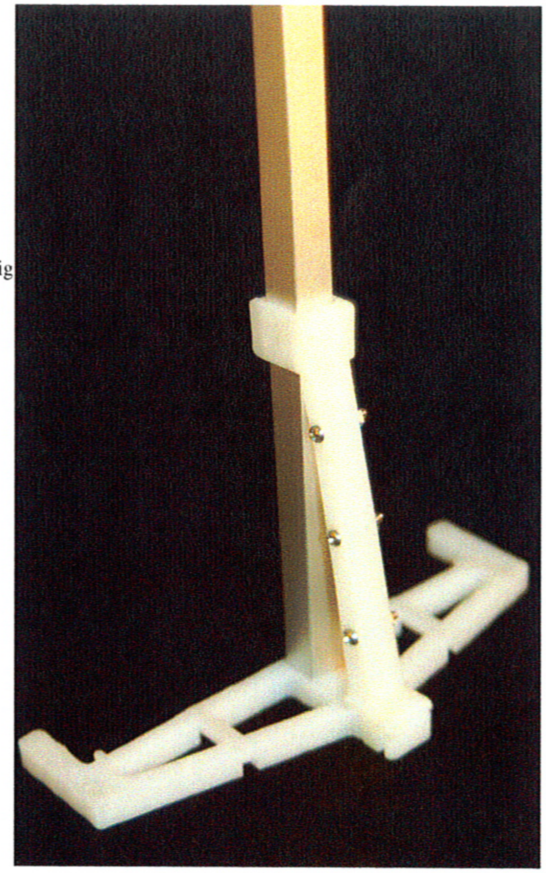

Washer
Bushing
10- #2 Nuts
Spring Tension Attachment
Spring Slider
Pointer
Slider
Left & Right Support Braces
Aluminum Channel
Lower Attachment
Spring
Measurement Arm
Dynalloy, Inc.
Scale
Base

Setup and Installation

To get setup for these 3 projects make sure you take a good look at the parts list and familiarize yourself with what you'll be working with.

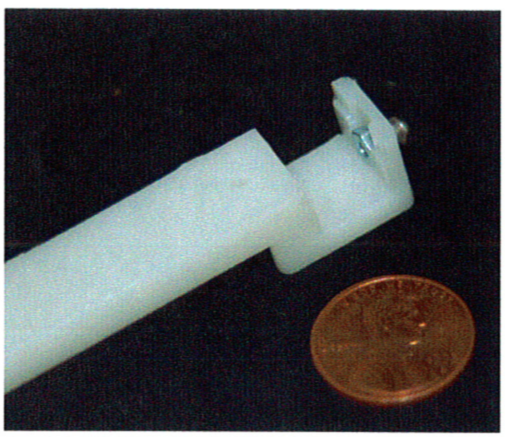
The first step is to make the '**Mounting Base Assembly**'. Use the 11.5 inch U-channel, the left & right Support braces and the Mounting Base, (item# 4,5,6), three of the ½ inch long bolts, and three of the nuts to connect them as below. The two support braces clamp around the base and the channel, locking all these laces together.

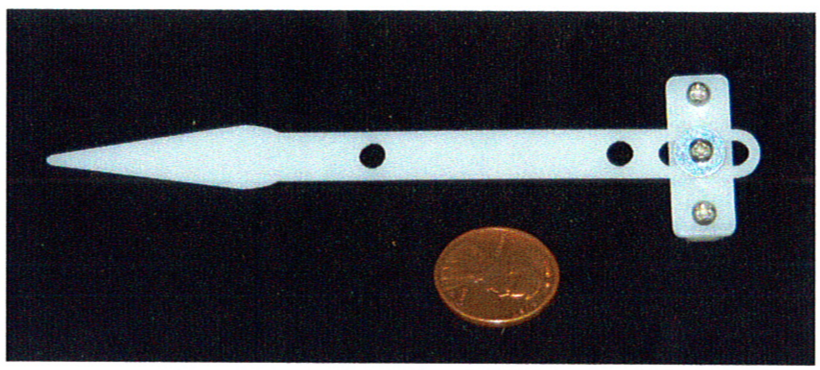
Fig



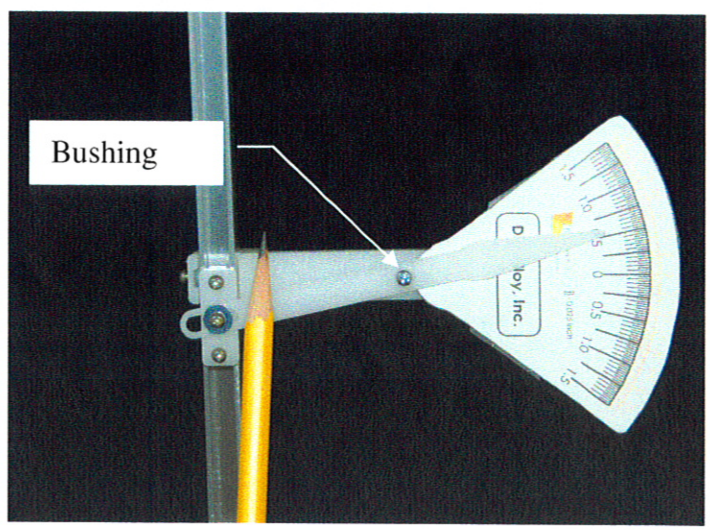
Wherever there is a bolt, there is a location on the back side for a nut. Except for the support braces, these nuts have recesses that prevent them from turning. You should tighten the bolts firmly but gently. If you over tighten you can easily damage the parts.

The Measurement Arm (item# 7) is made so you can adjust the vertical position. Put a nut on the inside of the side, and start the bolt into the nut as shown below.

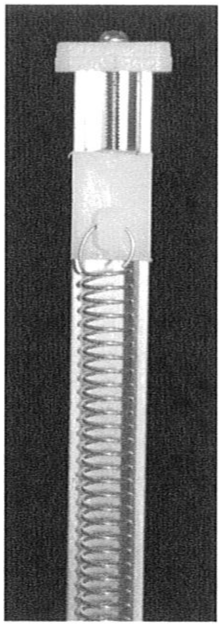




Place a 5/16" bolt into each of the top and bottom holes in the Slider with a nut on the backside. Leave these somewhat loose. Place a 3/8"bolt with a washer in the center slide hole, with a nut on the backside. It should look as shown above.

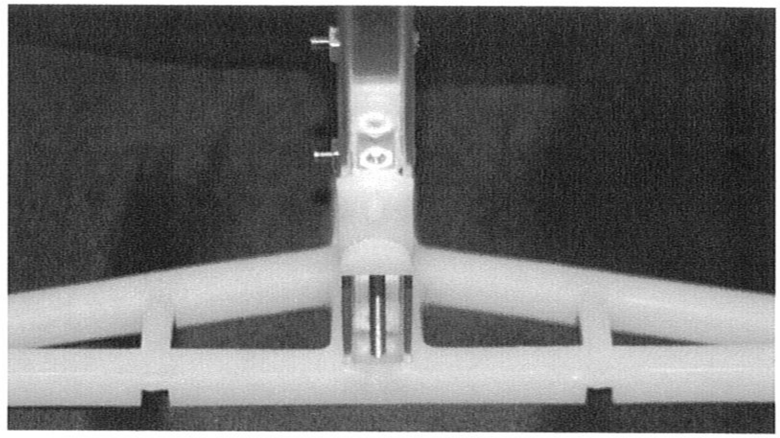


Cut out the scale along the black outline, and punch or cut out the hole on the left side. Tape it onto the measurement arm so the hole at the left of the scale is over the outer hole in the measurement arm. Slide the measurement arm onto the channel a bit above the center of the channel. Tighten the bolt in the side slightly to hold it in place. Place the slider into the channel. Secure the slider to the measurement arm by inserting a ½" bolt through the the bushing, through the pointer and into the outer pivot hole in the measurement arm, and into a nut on the backside of the arm. See photograph

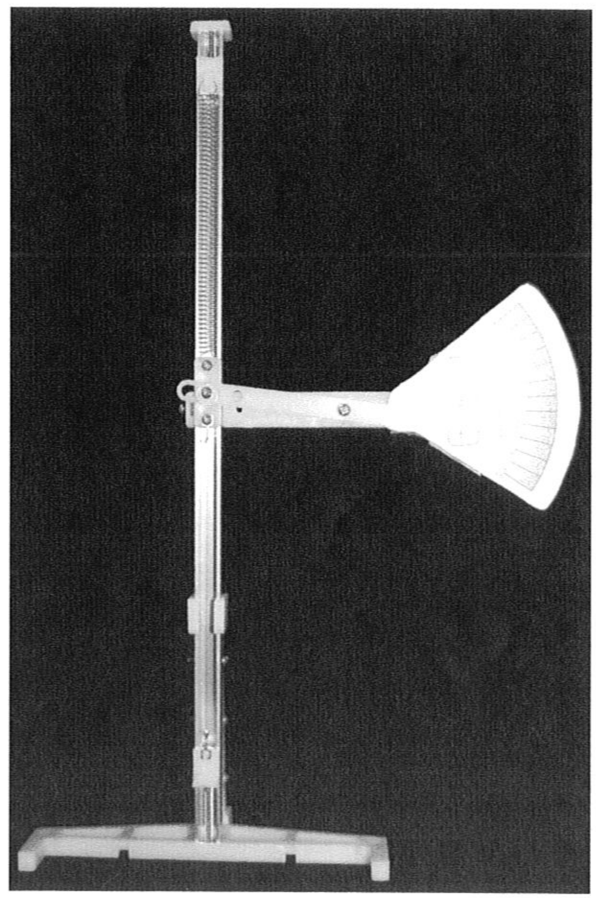


Now you need to make the upper and lower spring tension assemblies. Place one of the 1.5 inch bolts through the hole in the Spring Tension Attachment, through the Spring Slider and into a nut on the underside. Insert this into the top of the channel. Hook the spring over the top screw in the slider and onto the hook in the spring slider. See at left.

Place a nut into the recess on the top of the Lower Attachment. Insert another bolt through the hole in the base, through the lower attachment, and into another nut. It should now look like this.



Your last step is to attach the Flexinol®. Remove one of the .006 inch diameter wires with crimped ends. First hold the Flexinol® wire next to the channel and move the measurement arm to put the slider in the correct position so the Flexinol® will be just tight. Slide the upper crimp over the head of the lower bolt on the slider. Slide the lower crimp over the hook on the lower attachment. You are now ready to begin the experiments.



Project One - Linear Contraction

ASSEMBLY:

If you have completed the setup and installation from above the fixture is ready for testing. Loosen the screw on the side of the measurement arm, and adjust it so the pointer is on zero. You can then measure the difference when power is applied to the wire.

OPERATION:

Activate the Flexinol® by clipping the red wire of the Battery Pack(item# 13) with an alligator clip to the screw at the bottom of the Slider. Touch the black battery wire to the bottom of the Flexinol® (see Fig 4.a). Current will pass through the Flexinol® actuator wire causing it to heat by electrical resistance and contract like a muscle fiber. It will take a second or two for the lever to move and stop in the new position (take note of the position). Removing the black wire will stop the current and the Flexinol® will relax. The spring will pull the Flexinol® back to its original length.

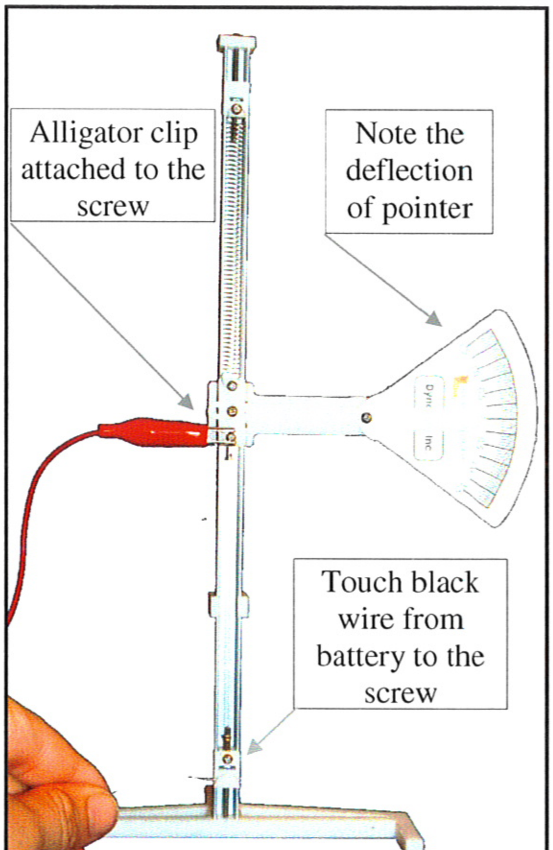
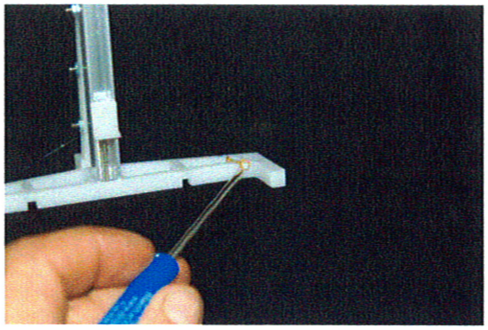


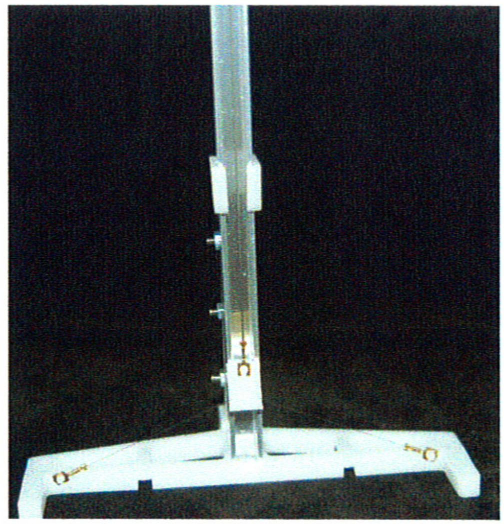
Fig. 4a

Project Two - Bow String Movements

ASSEMBLY:

This project demonstrates one way to reduce the force on the Flexinol® and get more travel out of the pointer. Due to the geometry of the Bow String, this will require less spring force than Project One. Change the configuration by removing the spring and the Flexinol®. Remove the 1.5" bolt that holds the Lower Attachment in place and set it aside. It won't be used for the project 2 or 3. Remove the bolt holding the pointer to the measurement arm. This will allow you to unhook the slider from the spring and from the Flexinol wire. Connect the Steel Wire to the lower bolt on the Slider, and slide it over the hook on the Lower Attachment. Attach the Flexinol® to the Mounting Base by sliding it over the two hooks on the base. These are a tight fit, and you will need to press them with a pen or a screwdriver. If you have trouble you can trim the pins slightly using a hobby knife or sandpaper. See photograph.

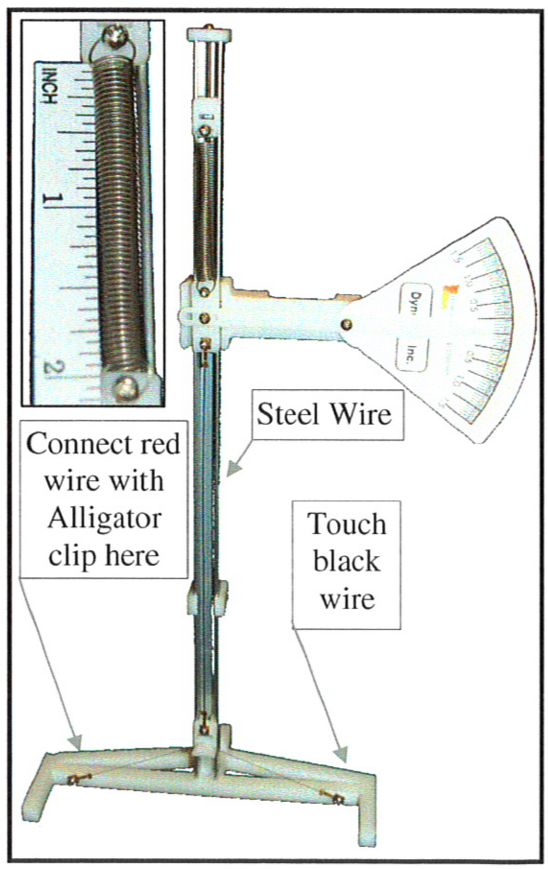




Adjust the **Spring Tension Assemblies** so the spring measures ~1 $^3/_4$". Adjust the measurement arm so that the pointer is at zero. Loosen the screws enough for the pointer to move*

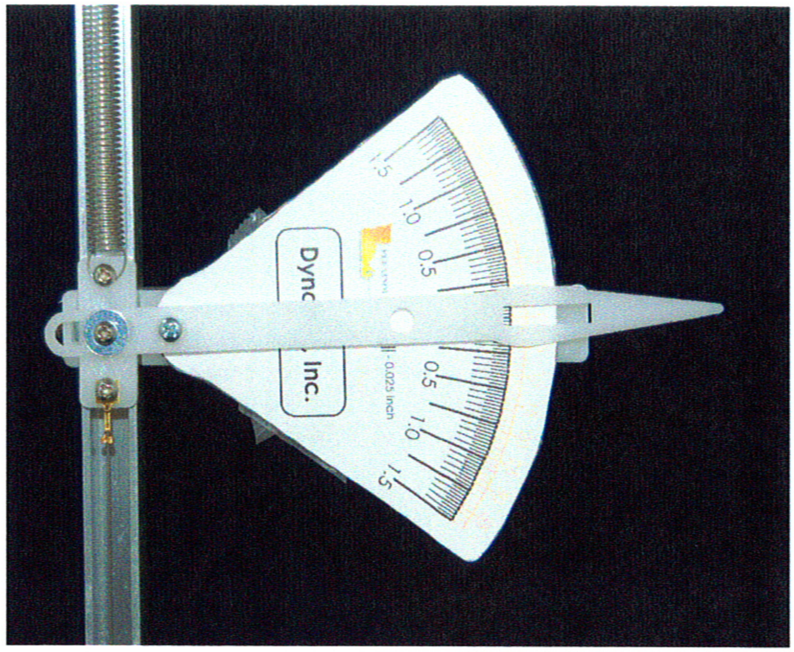
OPERATION:

Activate the Flexinol® by touching the Alligator clip and black wire from the battery pack to the Flexinol® screws as shown in Fig 5a. In this configuration there is approximately double the amount of travel on the Scale than in Project 1. This configuration has many uses in latches or in locking mechanisms.



Project Three – Changed Pivot Lever

ASSEMBLY:



This project will show the largest displacement on the Scale due to the double lever design. Note that the actual amount of movement in the Flexinol® is the same as in project 2, but the scale will show about four times more stroke than Project 2 because of the leverage. Simply remove the screw and bushing that hold the pointer to the measurement arm. Remove the scale and the nut on the reverse side of the measurement arm. Attach them through the inner or left hole in the measurement arm but otherwise the same way.

OPERATION:

Activate this the same way as in Project Two. Notice the same Bow String with a different lever configuration can show much more travel than Project Two, with the same wire, mechanism, and electricity.

Congratulations!! This concludes the demonstration of our Flexinol® actuator wire. Now you may interested in doing some experiments of your own! We wish you the best.

Appendix

NICKEL – TITANIUM ALLOY PHYSICAL PROPERTIES

1	Density	0.235 lb/in³ 6.45 g/cm³
2	Specific heat	0.20 BTU/lb.-°F 6-8 cal(mol.°C)
3	Melting Point	2282 °F 1250 °C
4	Heat of Transformation	10.4 BTU/lb
5	Thermal Conductivity	10.4 BTU/hr-ft-°F 0.05 cal(cm-°C-sec)
6	Thermal Expansion Coefficient	
	Martensite	3.67x10 -6/°F 6.6x10 -6/°C
	Austenite	6.11x10 -6/°F 11.0x10 -6/°C
7	Electrical Resistivity	
	Martensite	421 ohms/cir mil ft (approx.)
	Austenite	511 ohms/cir mil ft (approx.)
8	Linear Resistance (approx.)	
	.003 inch diameter wire	4.3 ohms/inch
	.005 inch diameter wire	1.7 ohms/inch
	.006 inch diameter wire	1.25 ohms/inch
	.010 inch diameter wire	0.44 ohms/inch

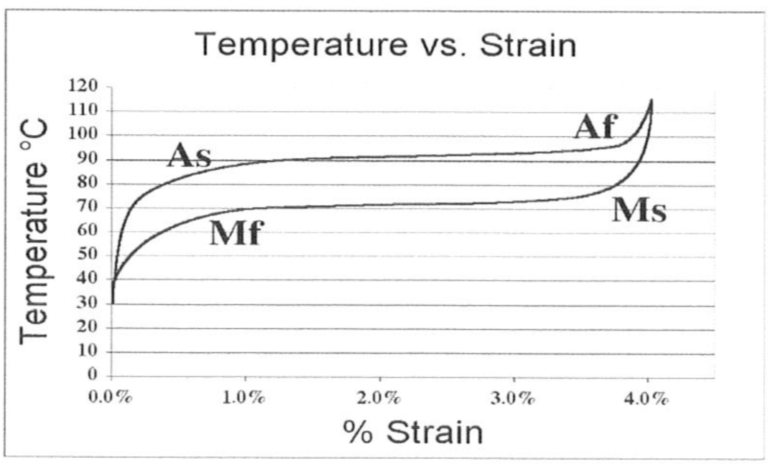


Fig 7

Temperature vs. Strain tests will show the percent of change in Flexinol® length against changes in temperature with a constant 20 ksi stress applied to the wire (90°C transition temperature). See Fig. 7.