The Heat Seeking Flame Probe (HSFP)

SMART project

Polytechnic university

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Teachers

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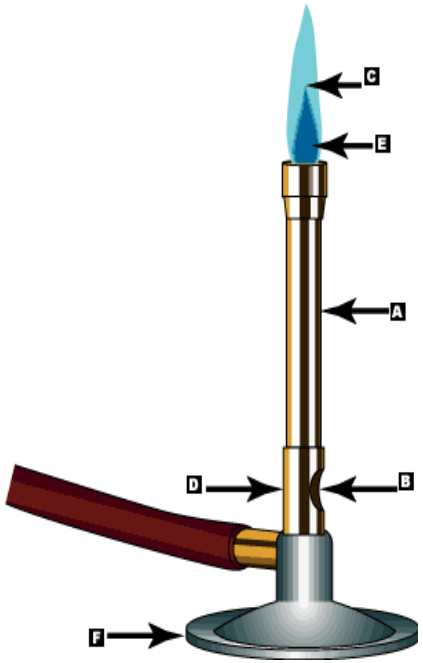
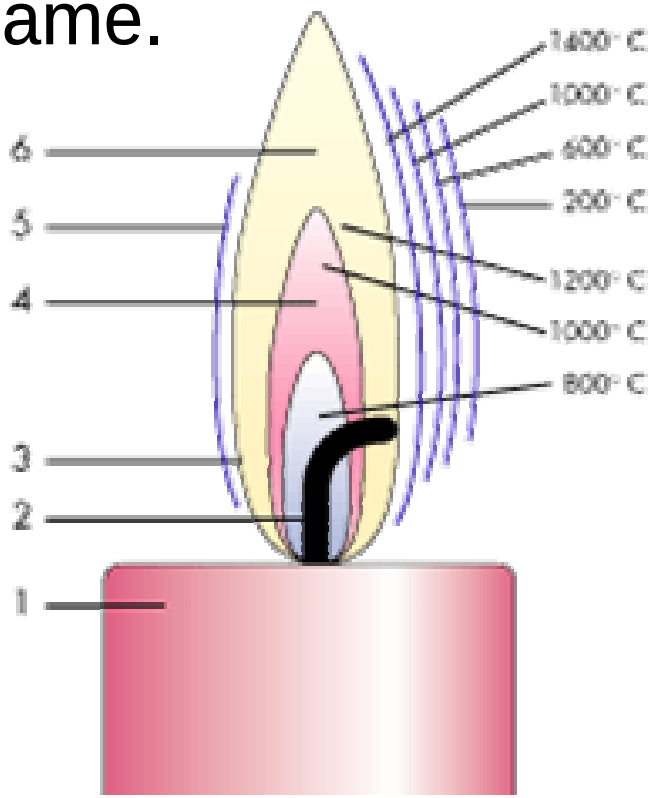
Objective

- Design the Heat Seeking Flame Probe (HSFP) which will vertically traverse a flame, sampling different temperatures, until it locates the hottest section of the flame.
- This should be at the top of the center cone in a Bunsen burner methane flame.
- The apparatus will display the different temperatures detected on an LED display.



- Students in high school Chemistry are commonly taught that the hottest part of a flame at the top of the inner cone.

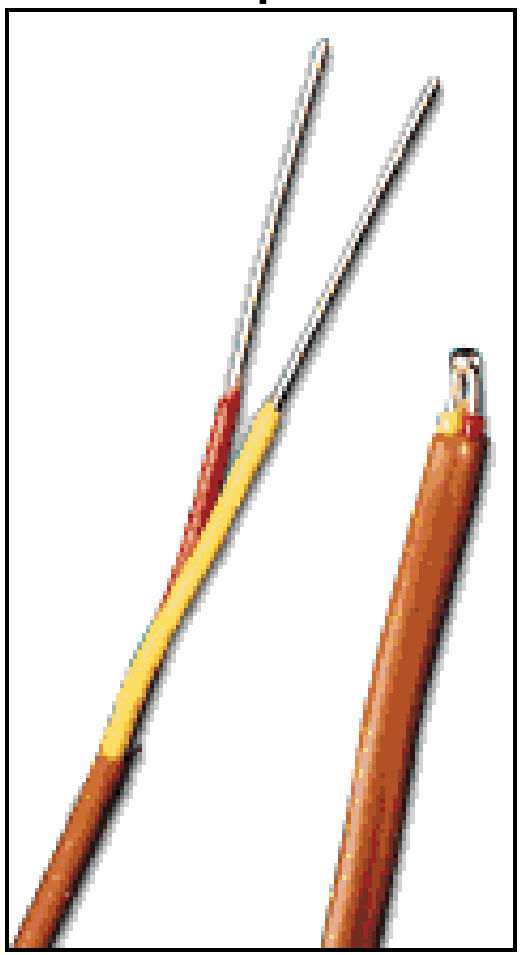
- The HSFP will enable the students to visualize the change of temperature at different heights within the candle flame.



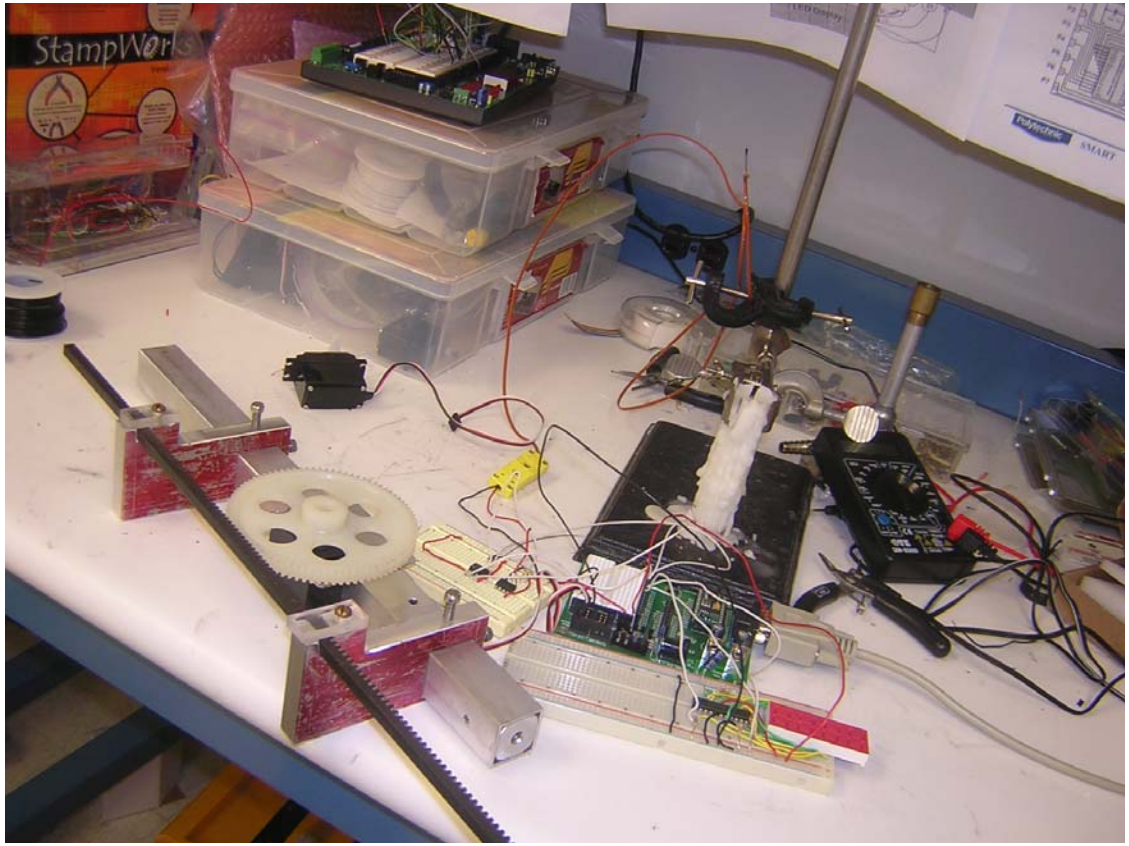
The Seebeck Effect :

* discovered by Thomas Seebeck in 1821

* established that a voltage (the “Seebeck voltage”) will be generated when two wires of differing metallic composition and at different temperatures are placed in contact at a junction.

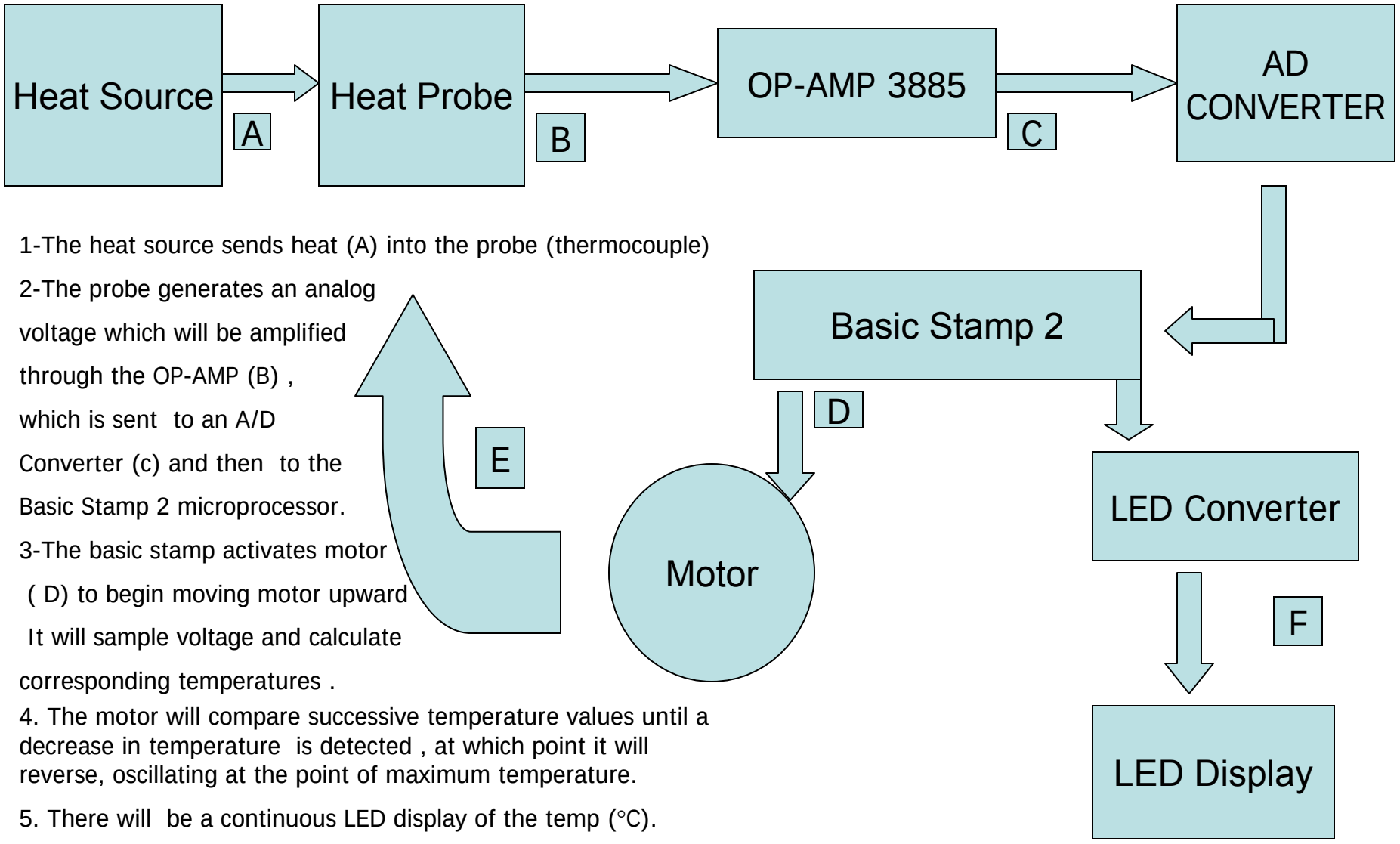


List of Materials



- Basic Stamp 2
- Type K thermocouple
- Servo motor
- ADC 0831
- OpAmp 358N,
- LED 4 digit display and driver chip MAX219
- Aluminum assembly
- 3” spur gear and gear track
- Ring stand with clamp
- Plexiglass platform and wind-shielding box
- 8 inch candle

Flowchart of Signals and Actions



1-The heat source sends heat (A) into the probe (thermocouple)

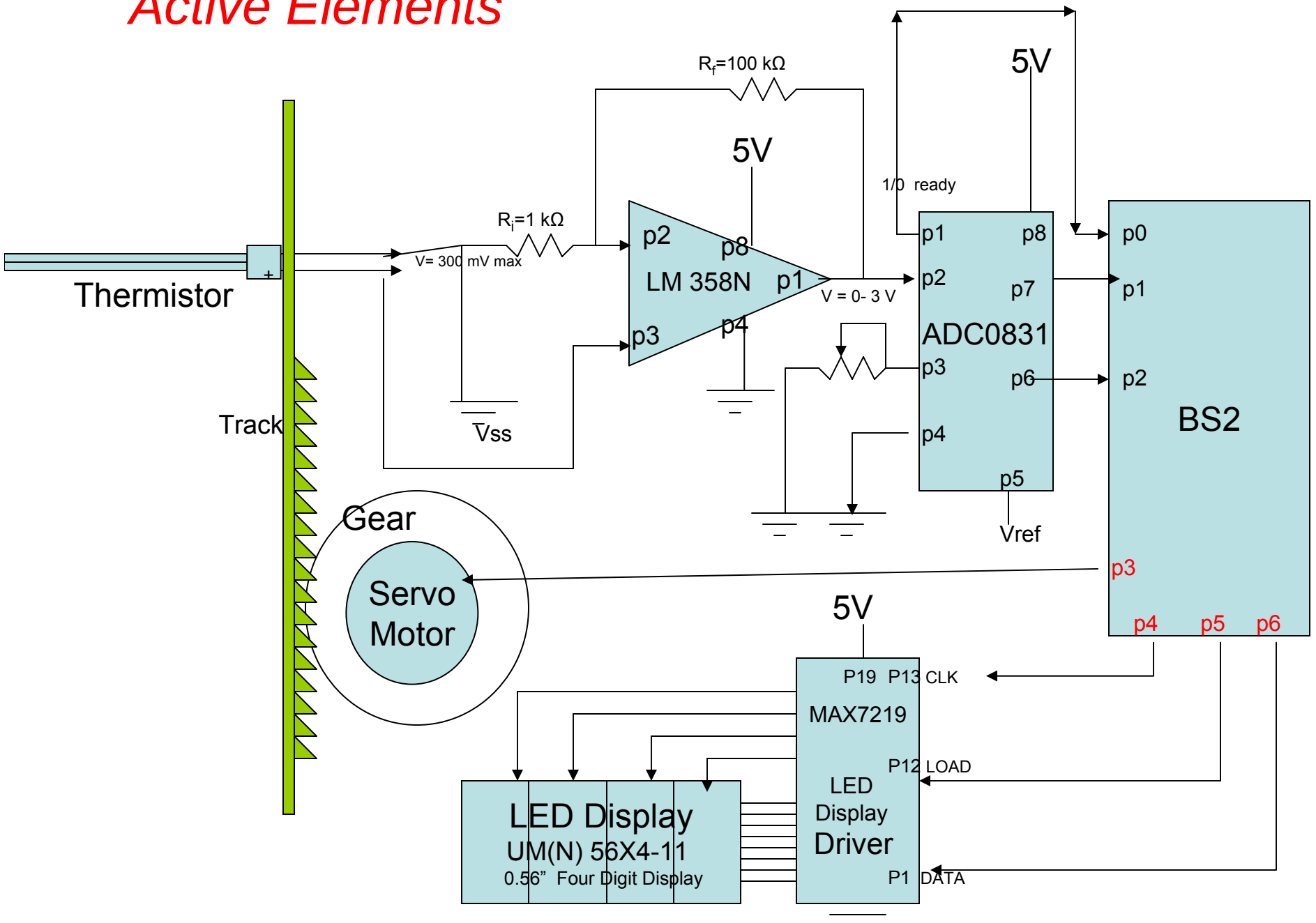
2-The probe generates an analog voltage which will be amplified through the OP-AMP (B) , which is sent to an A/D Converter (c) and then to the Basic Stamp 2 microprocessor.

3-The basic stamp activates motor (D) to begin moving motor upward It will sample voltage and calculate corresponding temperatures .

4. The motor will compare successive temperature values until a decrease in temperature is detected , at which point it will reverse, oscillating at the point of maximum temperature.

5. There will be a continuous LED display of the temp (°C).

Active Elements

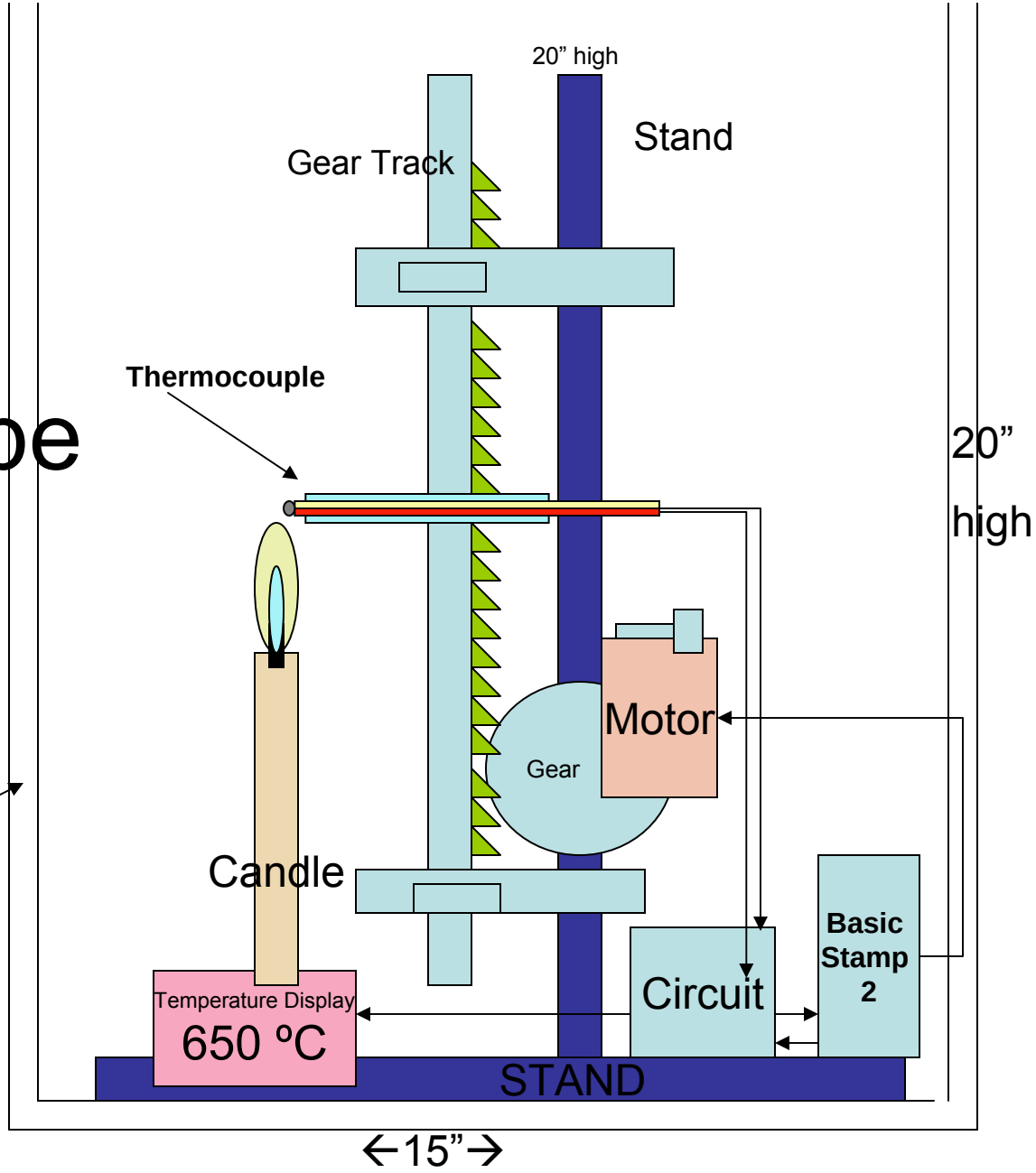


Sequence of Actions

1-The heat source sends heat (A) into the probe (thermocouple)
2-The probe generates an analog voltage which will be amplified through the OP-AMP (B) which is sent to an A/D Converter (c) in the Basic Stamp 2
3-The basic stamp activates motor (D) to begin moving motor upward

4. The motor will compare successive temperature values until a decrease in temp is detected at which point it will reverse, oscillating at point of max temp.
5. There will be a continuous LED display of the temperature (F).

Heat Seeking Flame Probe



Plexiglass box

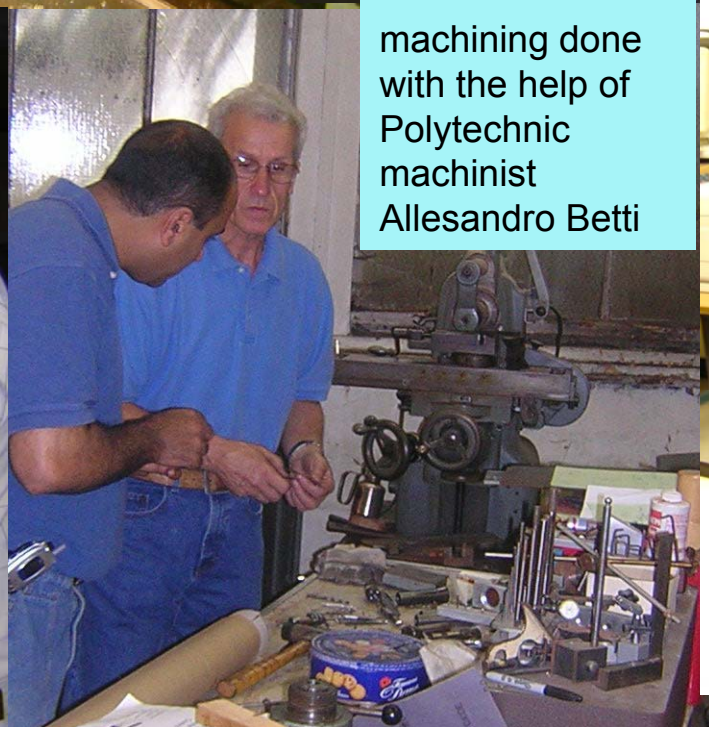
20 “ height

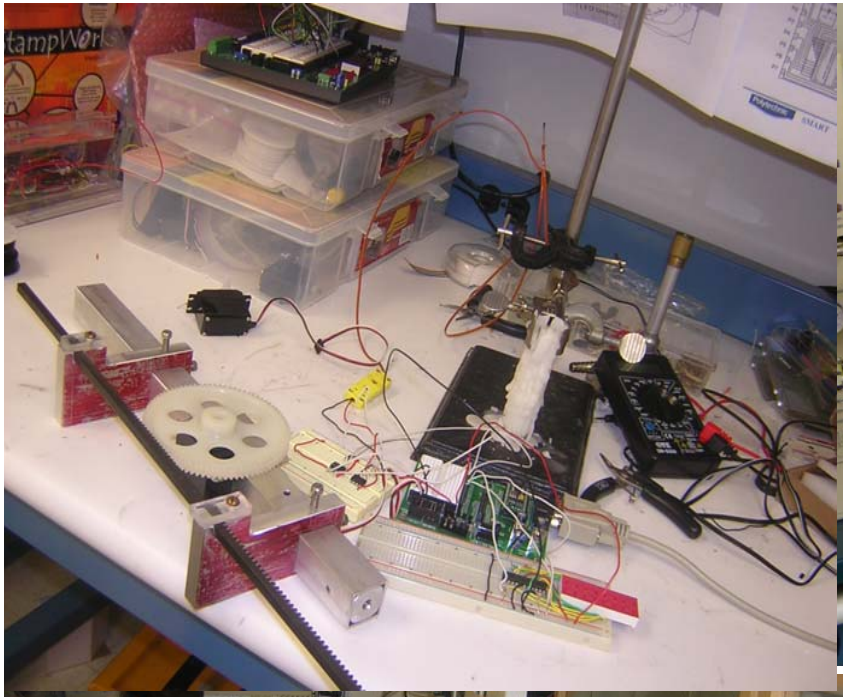
15” width base

10 “ length base

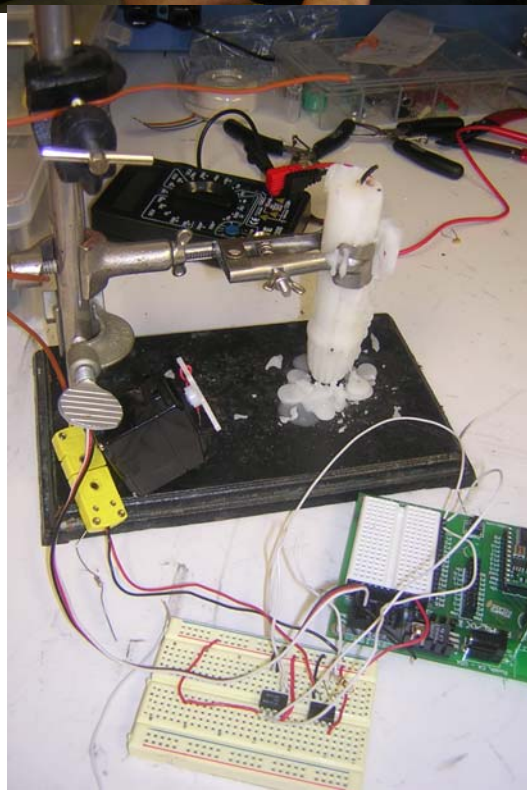
Plexiglas and aluminum

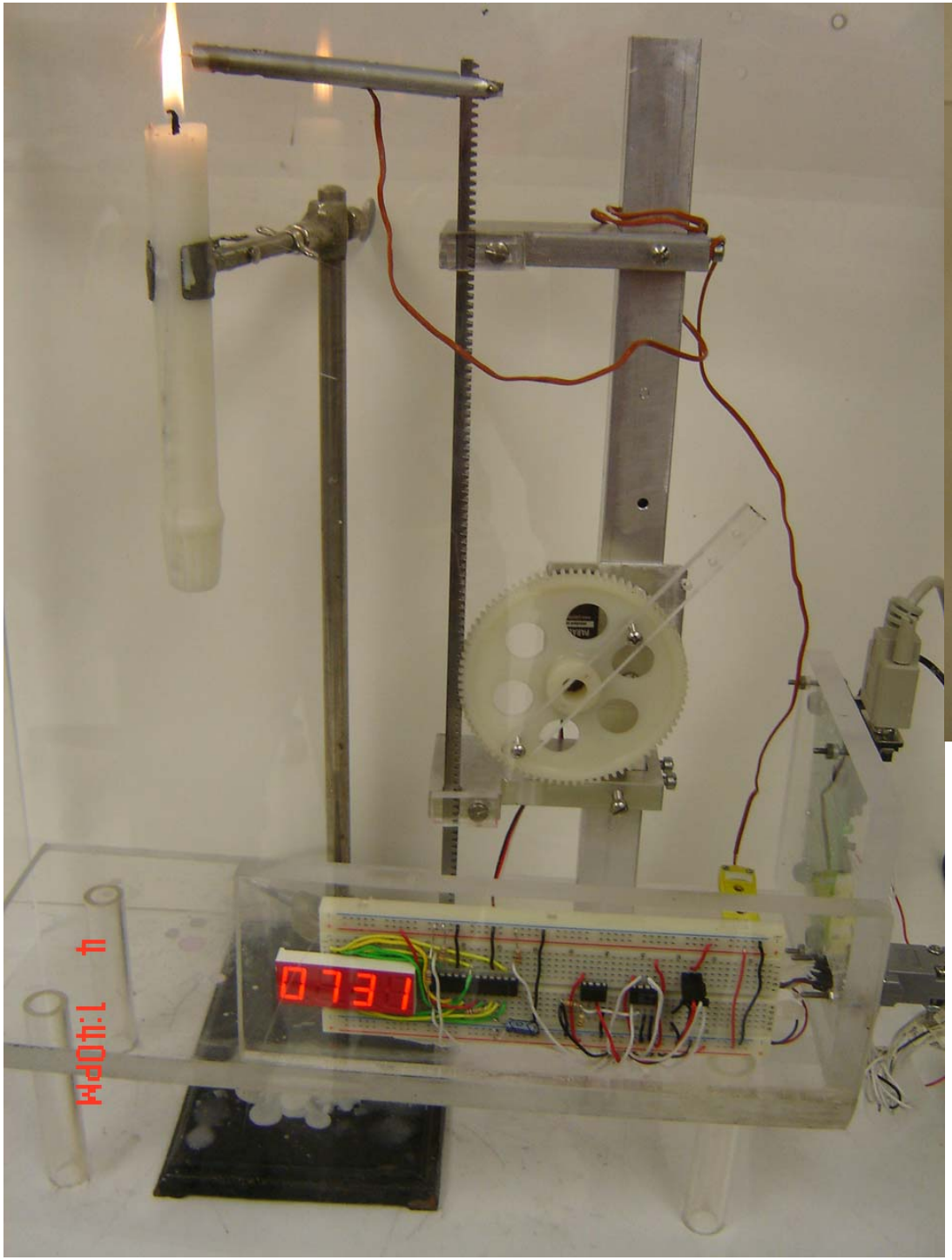
machining done with the help of Polytechnic machinist Allesandro Betti

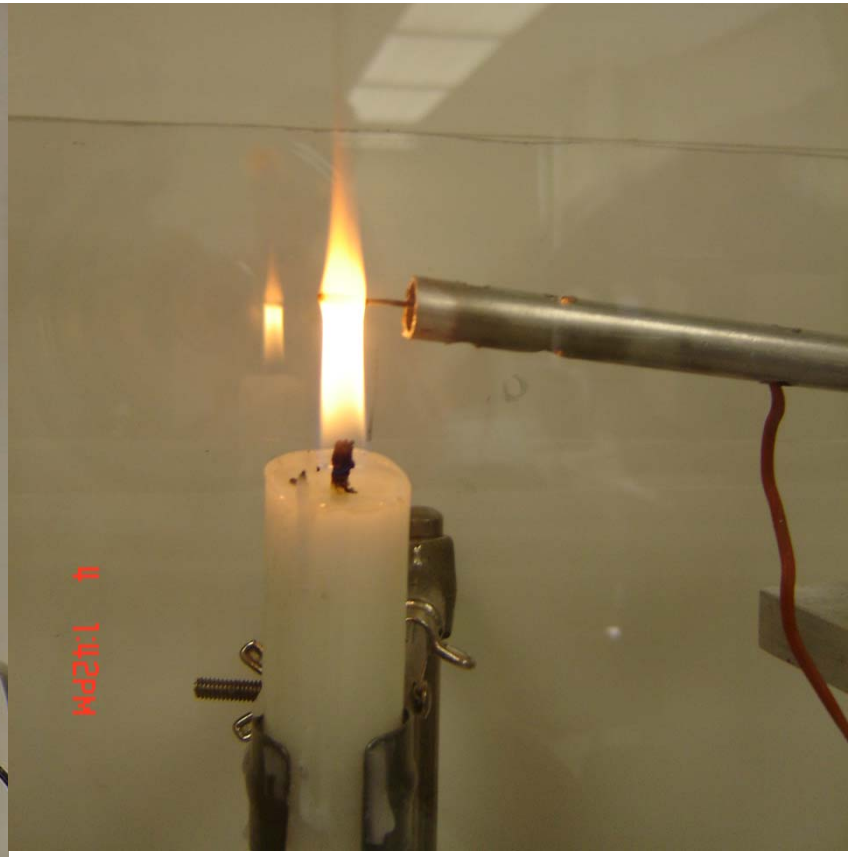




Electronics assembly, programming, trouble-shooting and calibration was done in components over the course of several days

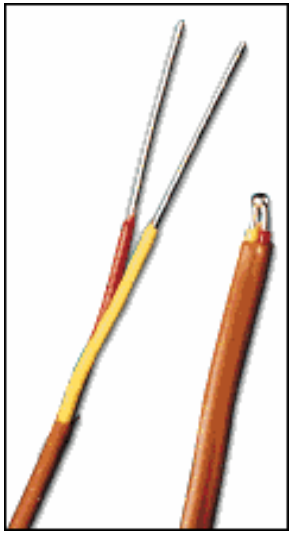






The working HSFB

Experimental Data



The thermocouple alone (apart from the circuit) produced voltages in the 0.5 – 3.0 millivolt range when placed in water below the boiling point:

Unamplified voltages

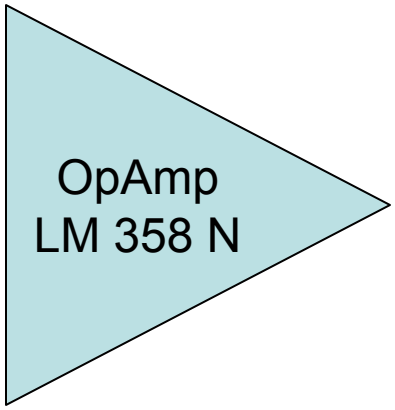
Temperature	Voltage
3°C	- 0.5 mV
21°C	+0.1 mV
36 °C	+0.5 mV
65 °C	+1.5 mV
82 °C	+2.1 mV

The above observations indicate a temperature change of approximately 40 C°/mV.

These signals had to be amplified by an OpAmp before read by the ADC.

Amplified voltages

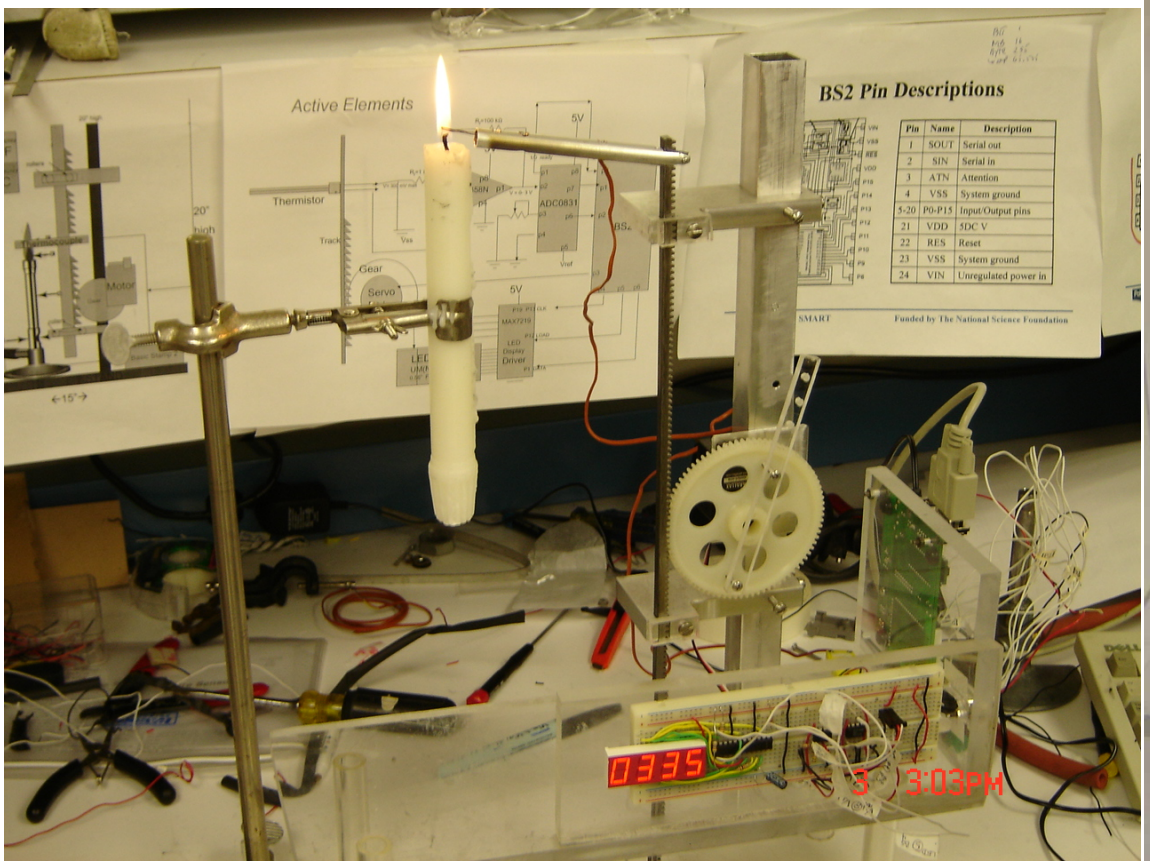
Temperature	Voltage
0°C	0.00 V
8.5°C	0.03 V
16 °C	0.07 V
20 °C	0.09 V
24 °C	0.10V
34 °C	0.14 V
37 °C	0.16 V
57 °C	0.24 V

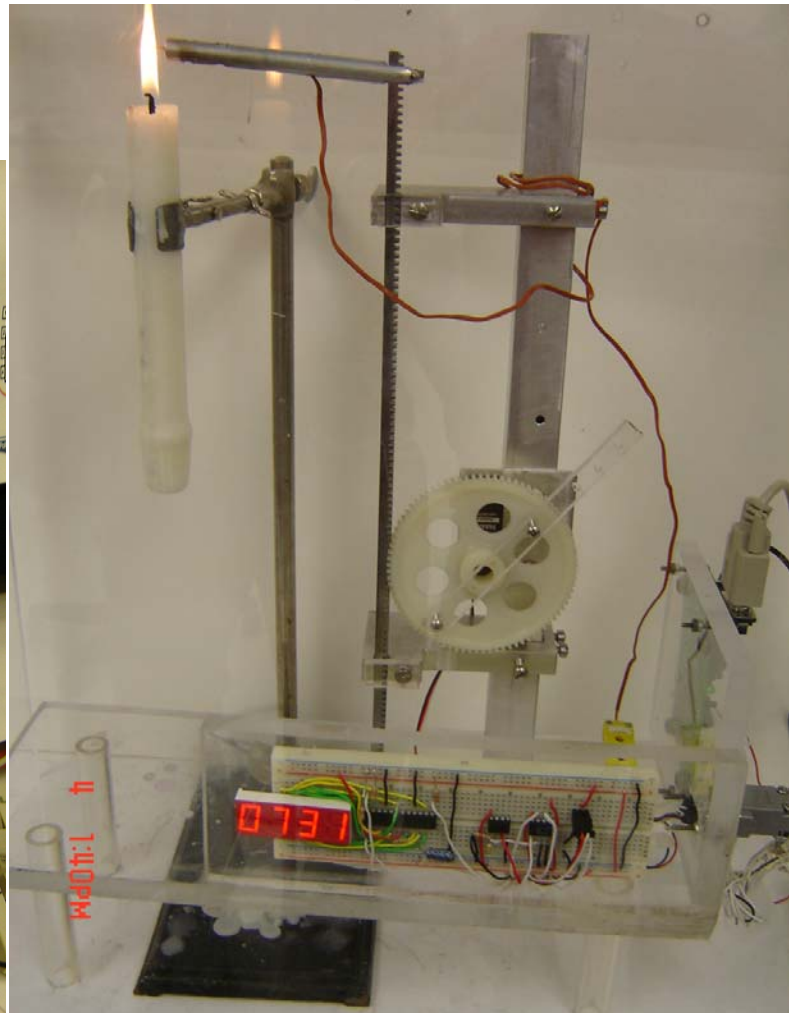


*These amplified voltages were used to calibrate the HSFB to **240 Celsius degrees per Volt** produced by the circuit.*

Results:

The HSFB does in fact automatically locate the flame's hottest spots. Because the flame is dynamic, the hot spot constantly changes, varying in the 600 -750 °C range, and the HSFP follows those changes. At the lowest point of the wick flame temperatures as low as 200-350 °C are found.





Implementation in the Classroom

The HSFB is an available working demonstration for the different temperature zones in a candle flame (part of the NYS Regents **Chemistry** curriculum).

Other Curriculum Applications:

Physics & Technology : thermocouples, voltage, thermodynamics, robotics, mechatronic control, temperature conversions.

Acknowledgments

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