Mechatronics Final Project

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Boiler Room Early Warning Motoring system
&
Hand Held Boiler Diagnostic Temperature Sensor

Boiler Room

Hot water Boiler

Early Warning System

- The BS2 will be used to monitor some of the common problems that plague boiler rooms across the country

- Pilot light failure

- Dirty boiler Water

- Pressure Problem /Leaking valves

- Human tampering

Making Sure the Heat Stays on

- Boilers are complicated systems that often break down
- Many problems are mechanical in nature
- While others are do to human tampering

The Pilot Assembly Problem

- The most common problem with a Gas boilers is a broken thermocouple in the pilot assembly

- If the Thermocouple does not sense a pilot light the boiler cant turn on and there will be no heat

- There is no way to know the pilot is out until the house is cold

Thermocouple

Pilot Light
Steel Thermocouple Tube
Burner
Mounting Bracket
Bracket Nut
Copper Lead
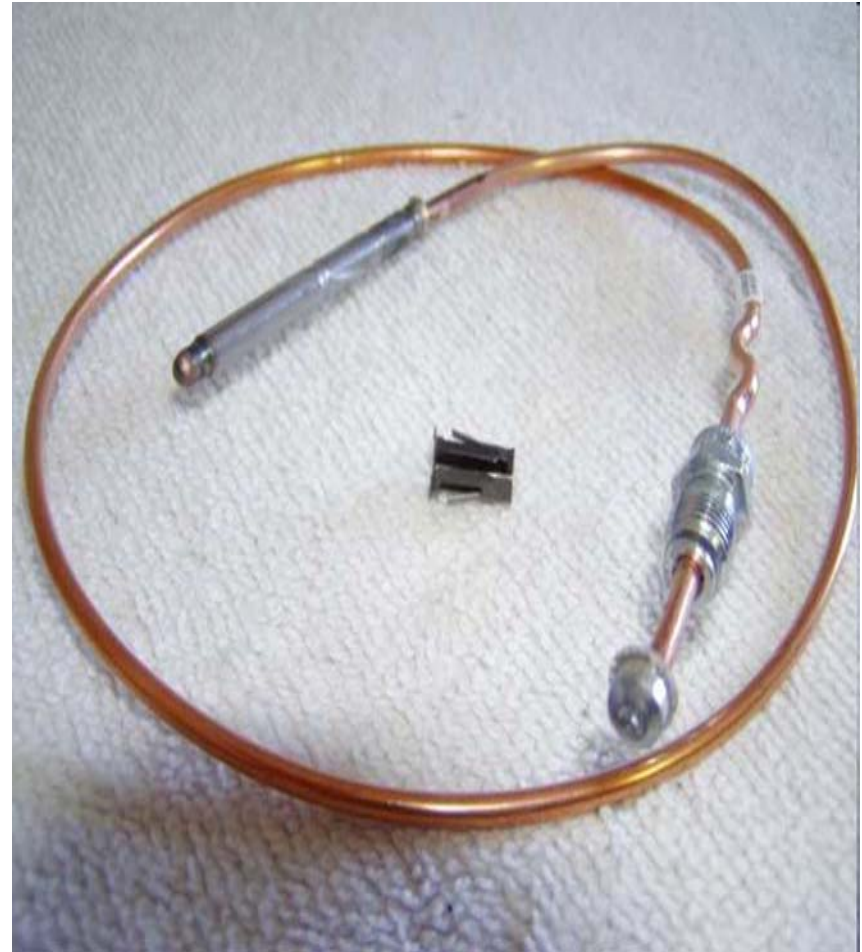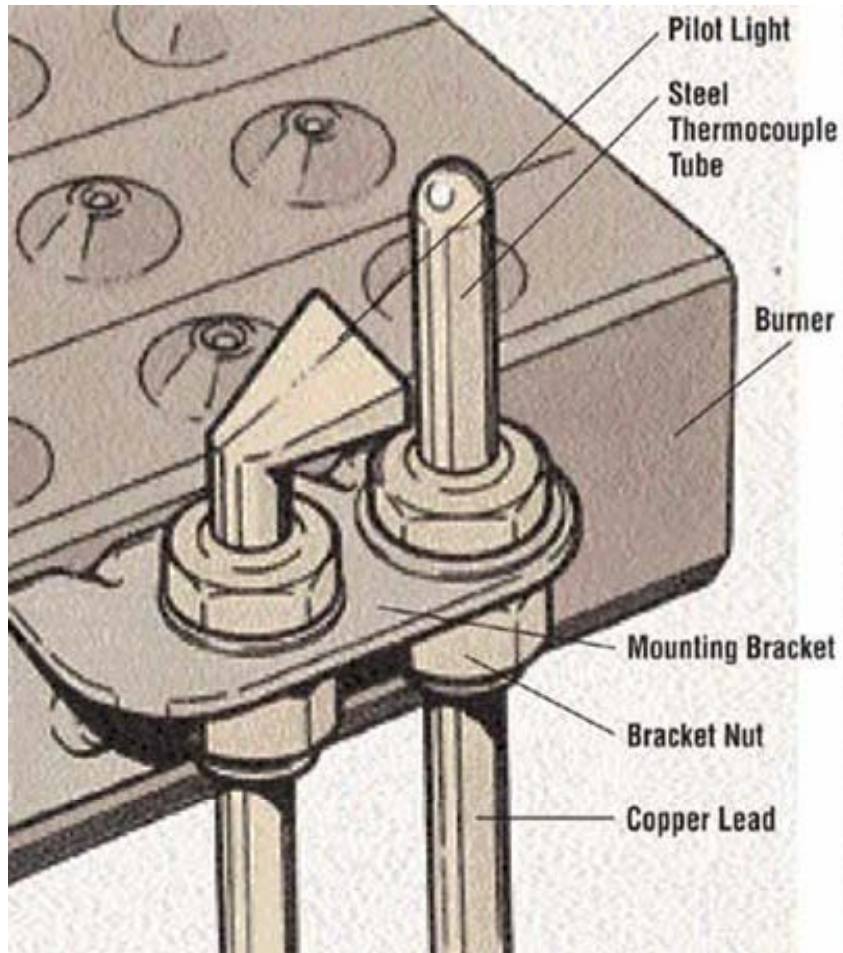
The Solution

- To insure that a faulty thermocouple can be replaced in a timely manner an early warning system must be used

- Therefore we propose using a photo resistor to monitor the pilot light

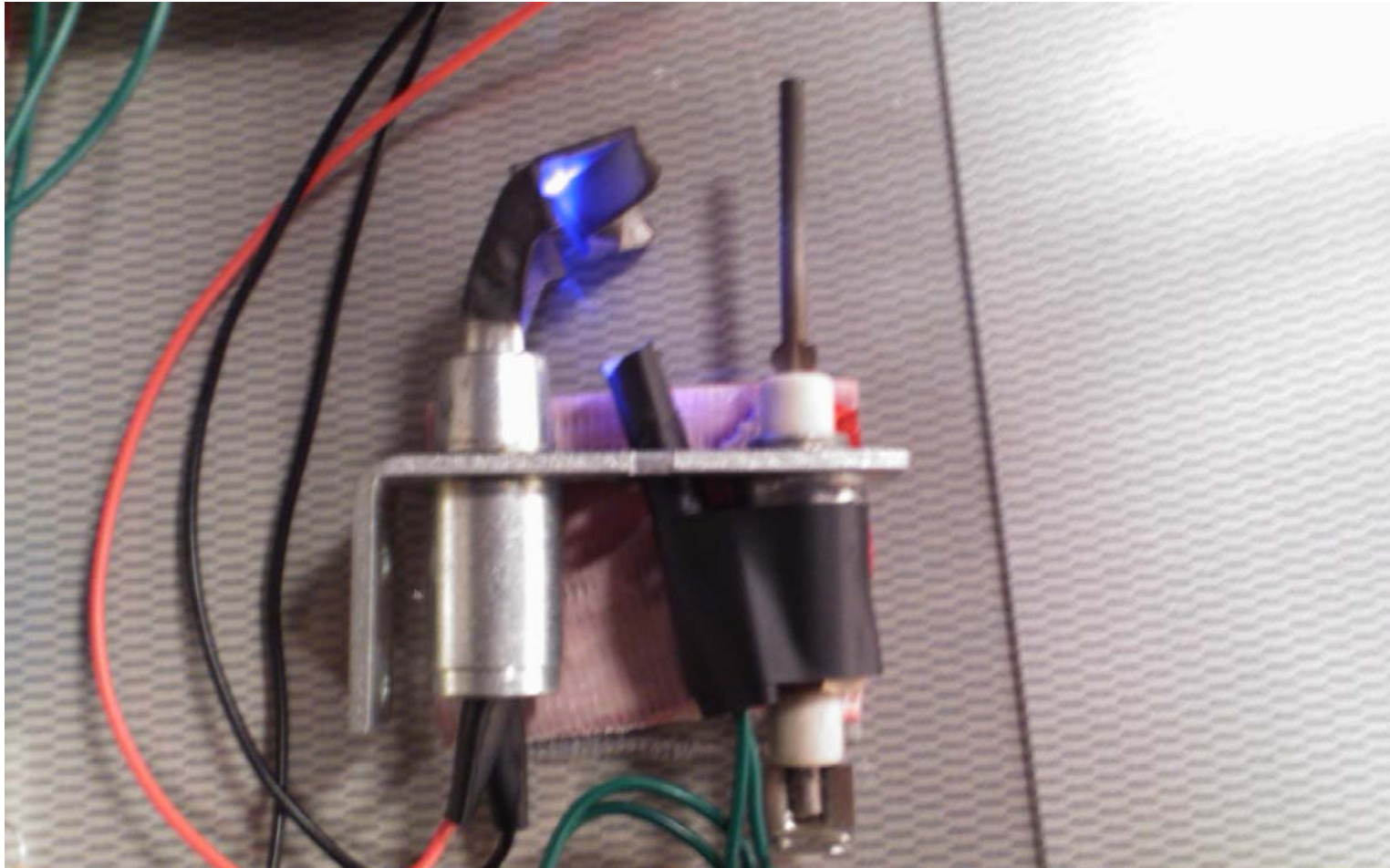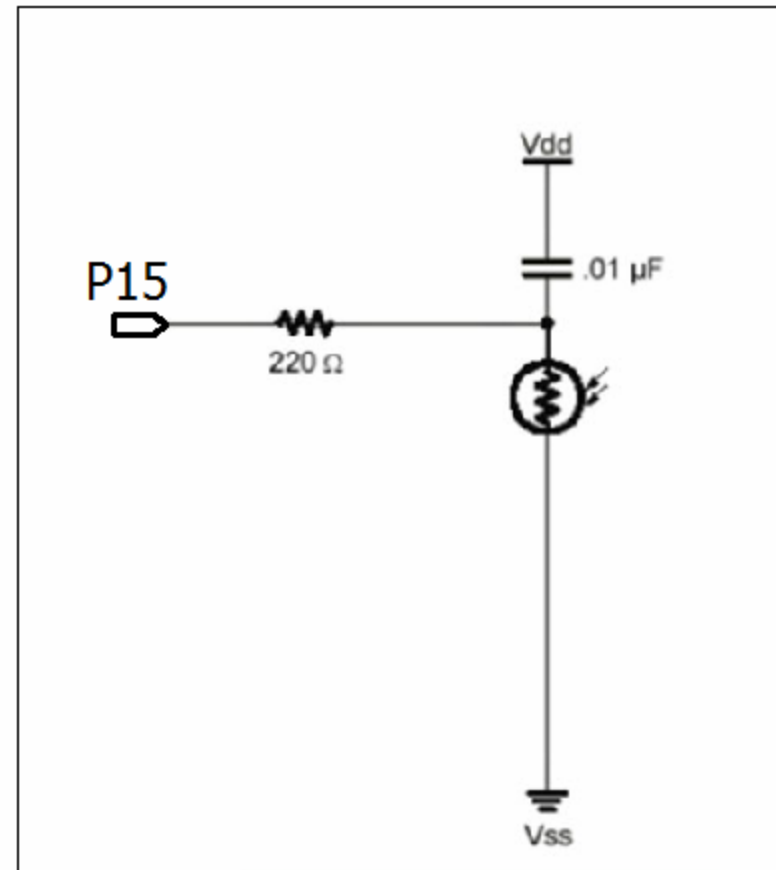- Early detection of the problem reduces the chance of greater problems

Pilot Assembly

Photo resistor

```
'Pilot assemlby chck
HIGH 15
PAUSE 100
RCTIME 15, 1, Inputtime
DEBUG HOME ,"Light = ", DEC4 Inputtime
IF (200<Inputtime )  THEN
HIGH 5
HIGH 1
   GOSUB A
ENDIF
```

The Dirty Water Problem

- Another common problem is rusty water in the boiler
- This cuts down boiler efficiency
- This means that you have to pay more to heat your house
- Therefore clean water in your boiler saves you money

Dirty Water

- Over time the water in your boiler collects rust
- This rusty water is harder to heat than clean water

The Dirty Water Solution

- We will use a Photo resistor and an LED to monitor the water color in the boiler

- When the water is dirty a motor will be used to open the drain valve and change water

- The Photo resistor LED combination will be attached to the Gauge glass of the boiler to monitor the water

Gauge glass
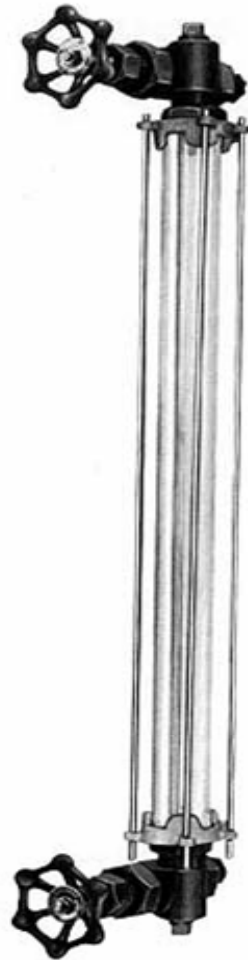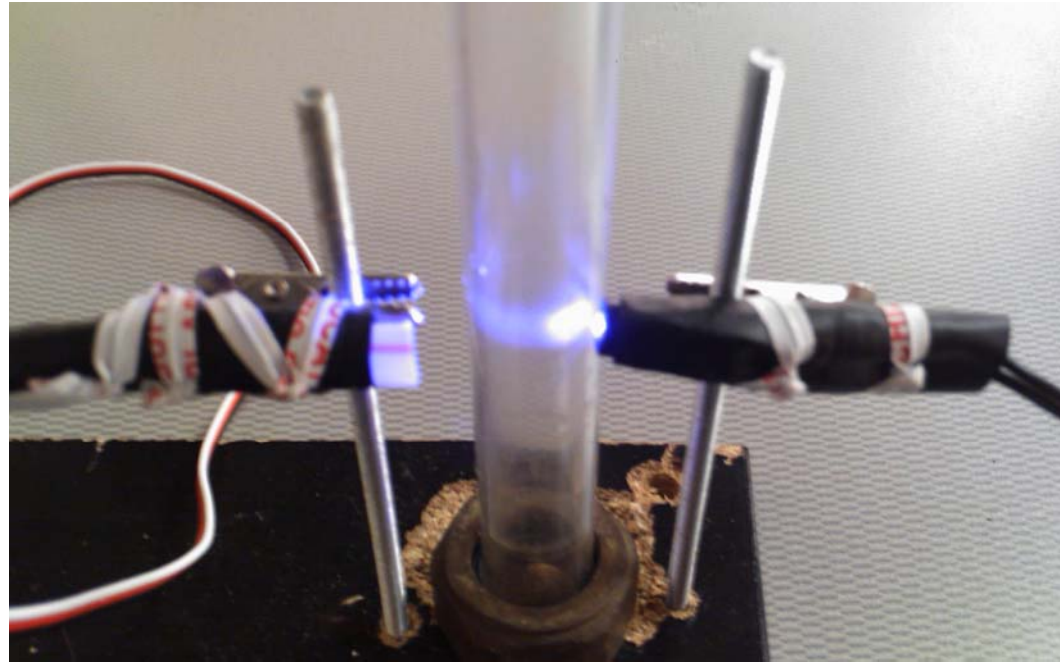
Solenoid Valve

Grainger Item

 Price **$ $125.39**

24V control

Normally closed valve

Only open when power
is supplied

Drives Closed when
power if turned off

Solenoid Valve Hook up

- Normally open Switching relay
- Therefore the BS2 could control the high load 24V Motor

Water Monitoring Code

```
'Water Check
'LED ON

HIGH  13
HIGH 2
PAUSE 100
RCTIME 2, 1, Inputtime
IF (50<Inputtime)  THEN

GOSUB A
DEBUG HOME  ,CR
DEBUG  "Light = ", DEC4 Inputtime
IF number <2 THEN
 HIGH 6
 FOR i=0 TO 90
 PULSOUT 14,500
 PAUSE 20
 NEXT
 PAUSE 1000

 FOR i=0 TO 90
 PULSOUT 14,1000
 PAUSE 20
 NEXT
 PAUSE 100

 number=number+1
ELSE
HIGH 9
ENDIF
LOW 6
ENDIF

DEBUG HOME, CR
DEBUG "light = ", DEC4 Inputtime
```
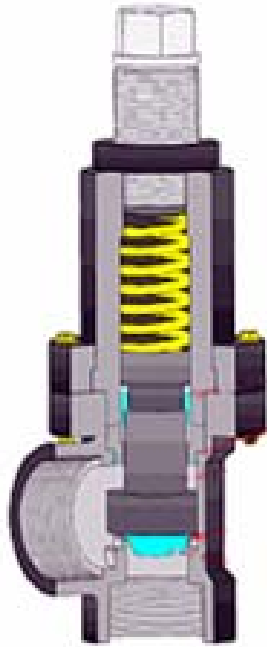
The Pressure Problem

- A Pressure problem in the boiler is usually a symptom of a larger problem

- Early Detection of a pressure problem can prevent unnecessary wear on your system

- Pressure Problems are tricky because most people don't know there is a problem until there is big problem

Expansion Tank

- Compensates for the fact that water expands as its heated
- Once the bladder in the tank breaks there will be a pressure problem
- A faulty expansion tank will eventually lead to greater problems
- Causes the pressure relief valve to open.

Pressure Relief Valve

- The Pressure Relief valve is a safety valve
- It is spring loaded
- Above a certain pressure the valve opens
- This prevents the boiler from exploding if there is too much pressure

Solution to the Pressure Problem

Compression Tank

Cold Water Supply

Series 850 or 900 Low Water Cut-Offs

Supply Main

Low Water Fuel Cut-Off Series 63

ASME Relief Valve

Test-N-Check Valves

Blow Down Valve

Hot Water Boiler
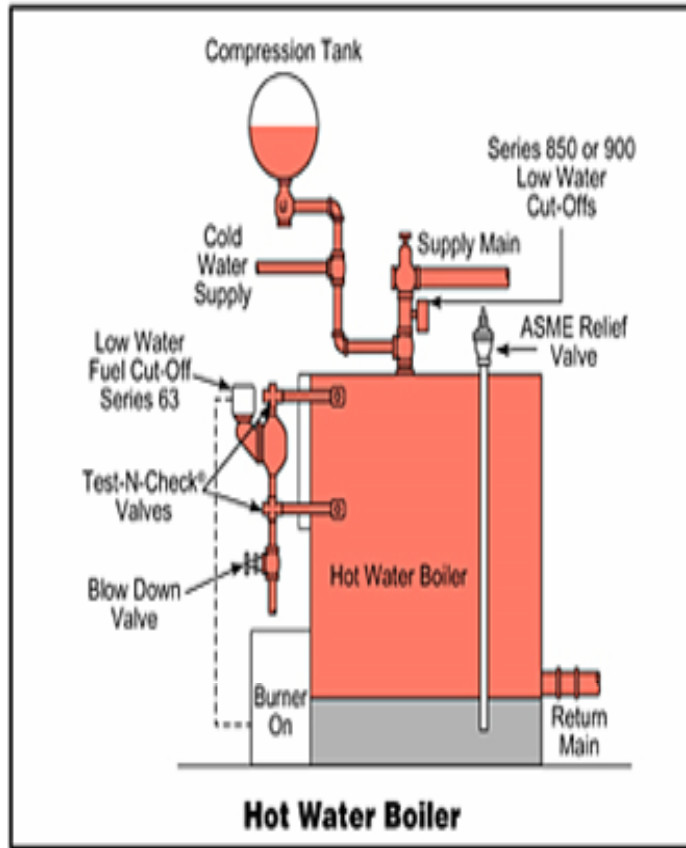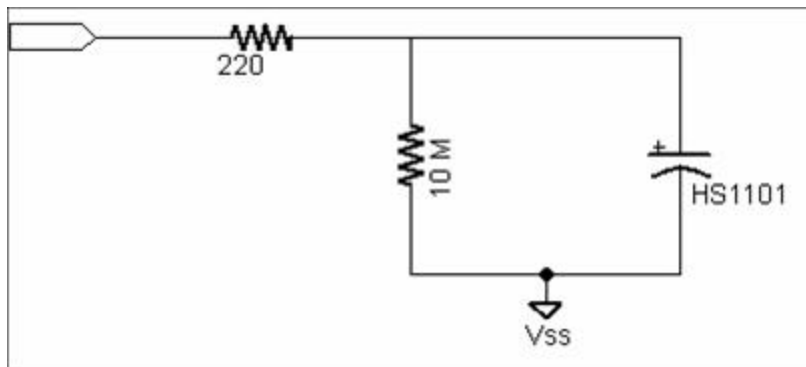
Burner On

Return Main

Hot Water Boiler

Fig. Z

- <u>U</u>se a Humidity sensor to monitor the humidity at the pressure relieve valve
- If the Pressure Relief valve is blowing water than the expansion tank may have ruptured

HS1101- Humidity Sensor


```
'Humdity
RHconstant CON 12169

HIGH 0
PAUSE 1
RCTIME 0,1, Inputtime
Inputtime=Inputtime*100
Inputtime = (Inputtime-RHconstant)/24
IF (Inputtime >60) THEN
HIGH 8
HIGH 1
GOSUB A
ENDIF

DEBUG HOME, CR ,CR
DEBUG "relative Humidity = ", DEC Inputtime, "%"
PAUSE 1000
```

The Human tempering problem

- Many tenants like to temper with the thermostat to try to get more heat
- This often ends up back firing and causing the house to become too hot
- Also raising the heat very high during the winter months costs a lot of money
- This can also cause unnecessary wear and tear on your system

Thermostat lock box

- Many landlords use lock boxes to try to secure the thermostat
- However the lock box key is universal and easily obtained

The Solution

- A simple alarm system using the BS2 to try to catch a person in the act

- Using a normally close button on the inside of a lock box as a simple alarm

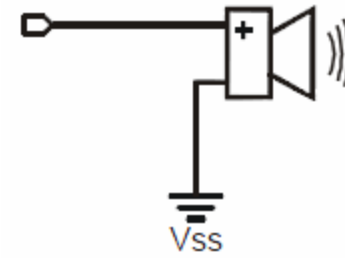- When the box is opened a signal is sent to the landlord

Lock Box with Alarm

Alarm Code and Circuit

```
'Alarm Box

IF IN12=0  THEN
HIGH 7
FREQOUT 11 ,1500, 2000
ELSEIF IN12=1 THEN
ENDIF
```
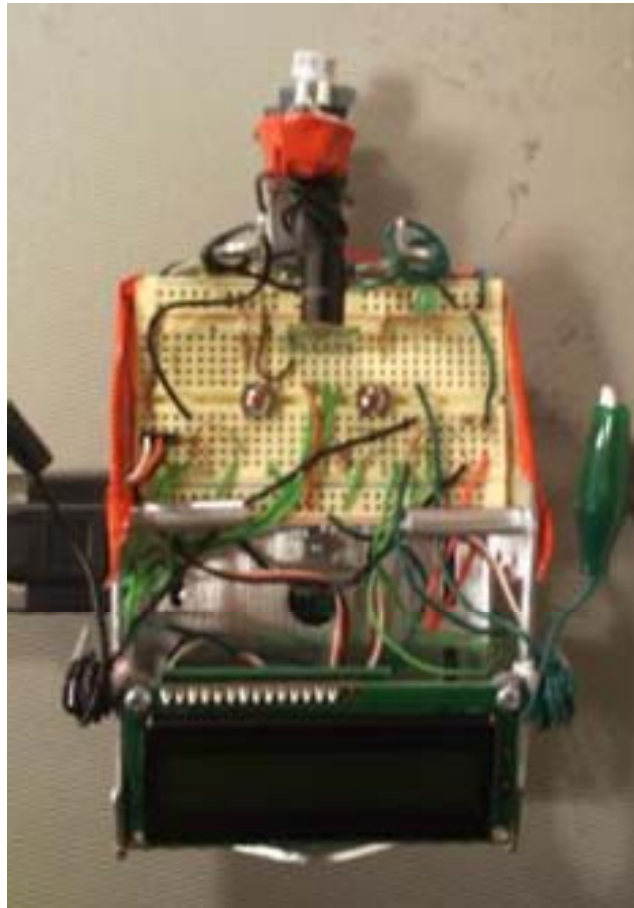
Display Panel

The display panel consists of a series of LEDs, speakers and two buttons. The LED will light according to which alarm has been tripped in the system. The LED will stay on until the reset button has been pressed by the user. Also the Speakers will sound until the mute button is pressed by the user
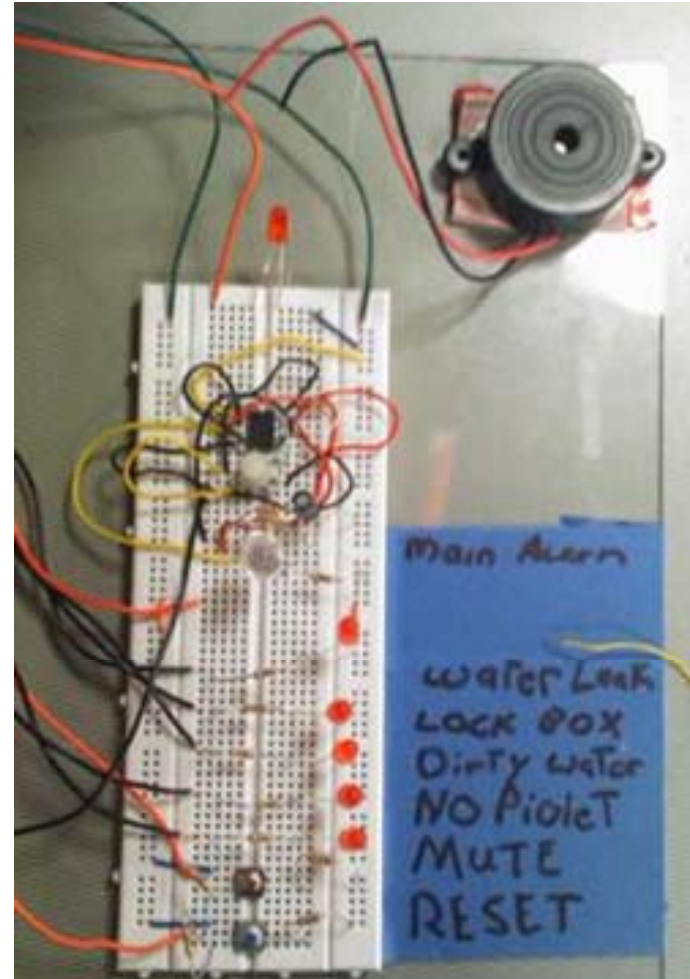
Hand Held Digital Sensor

Hand Held Boiler tester

- Temperature can tell you a lot about how your boiler is running
- Temperature drops in certain places can help you understand what is going wrong with your boiler

Diagnostic Temperature Sensor Components

- Infrared Temperature Sensor
- LCD Display
- BS2 Homework Board
- Bread board
- Sensors
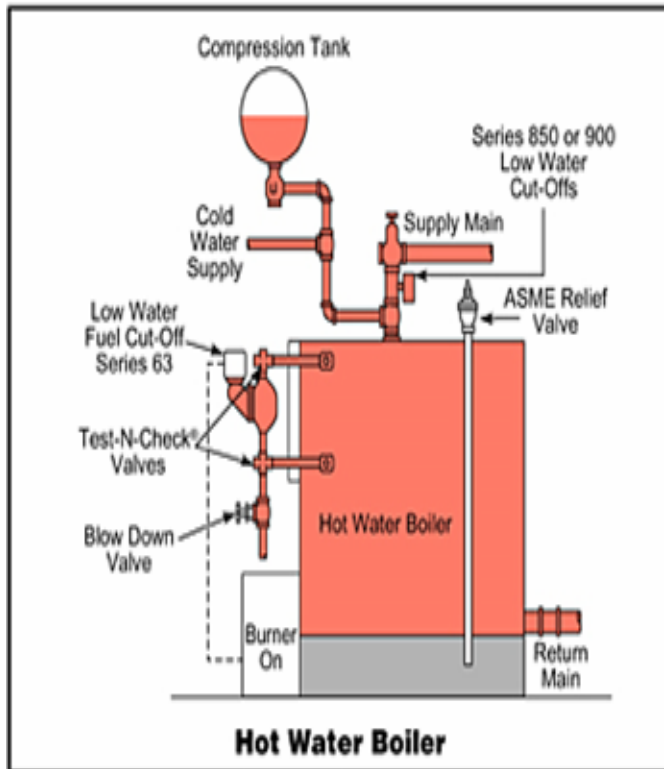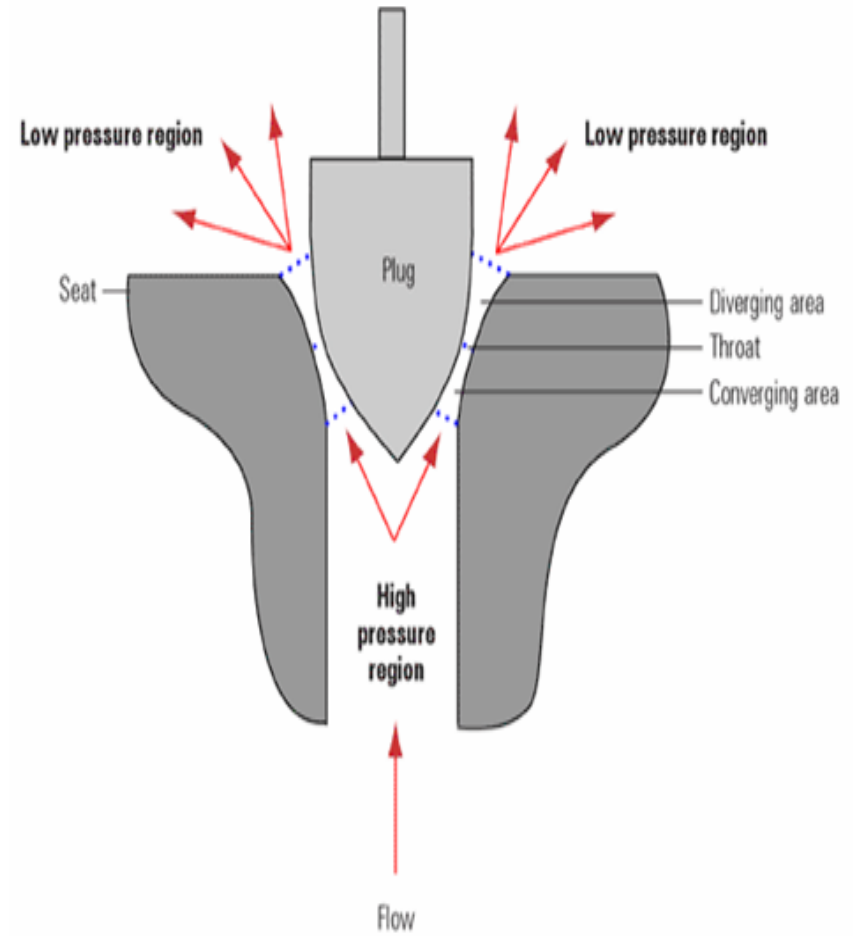
The boiler header

Fig. Z

- The boiler header is the pipe that comes out of the boiler and supplies the hot water to the system
- The header can be broken into two parts
- Before the flow control
- After the flow control

Flow Control

Flow Control

- Flow Control only opens when the circulator pump is on
- Therefore you can check if the circulator is running by checking the flow control

Low pressure region   Low pressure region

Seat — Plug

Diverging area
Throat
Converging area

High pressure region

Flow
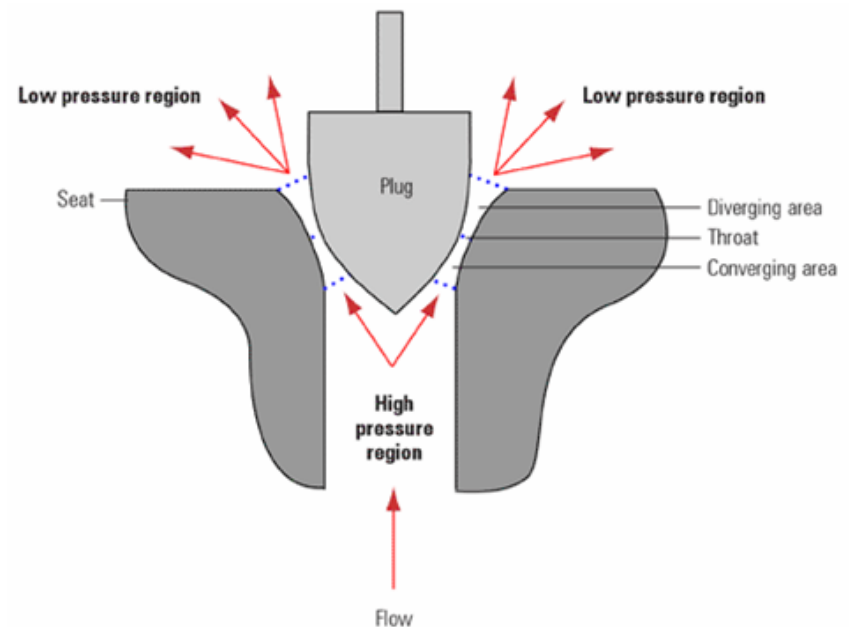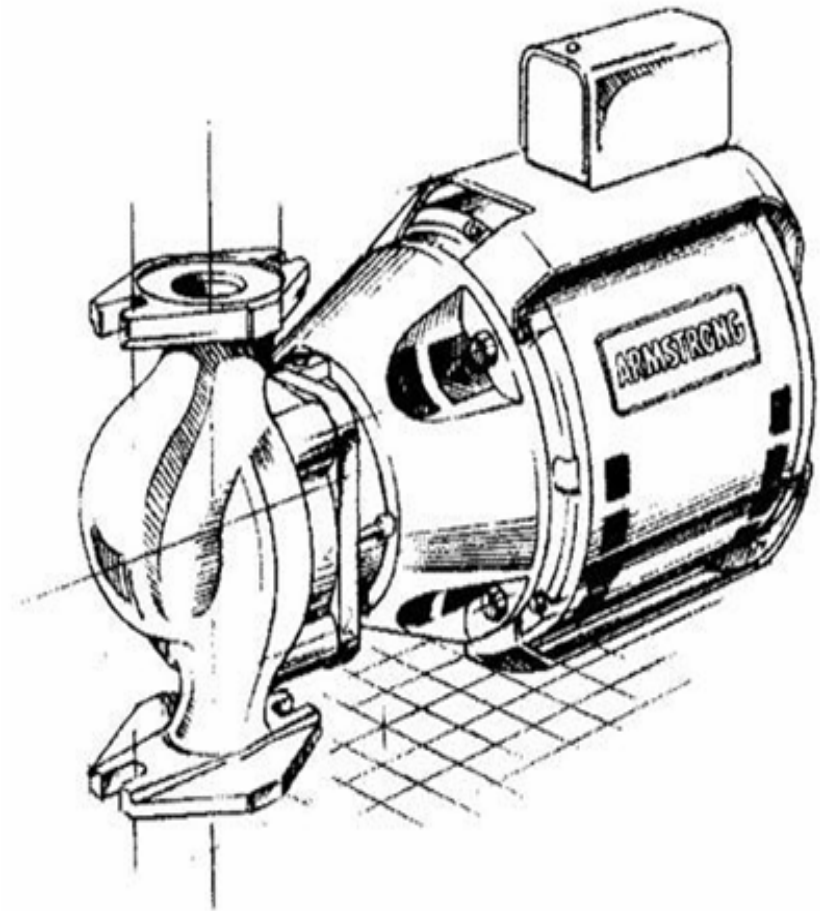
Circulator pump

Circulator pump

- On the left is a picture of the most commonly used residential circulator pump

- They run extremely quite

- They are completely sealed

- Therefore it is almost impossible to tell if they are running

Testing the Circulator

- Use the BS2 and a temperature sensor to take non contact temperature measurements

- Reading one is taken between the outlet of the boiler and the flow control

- Reading two is taken after the flow control

- By comparing the two values you can know if the circulator is working

Testing the Circulator

Fig. Z

- Reading one is taken between the outlet of the boiler and the flow control
- Reading two is taken after the flow control
- By comparing the two values you can know if the circulator is working

The three possible Outcomes
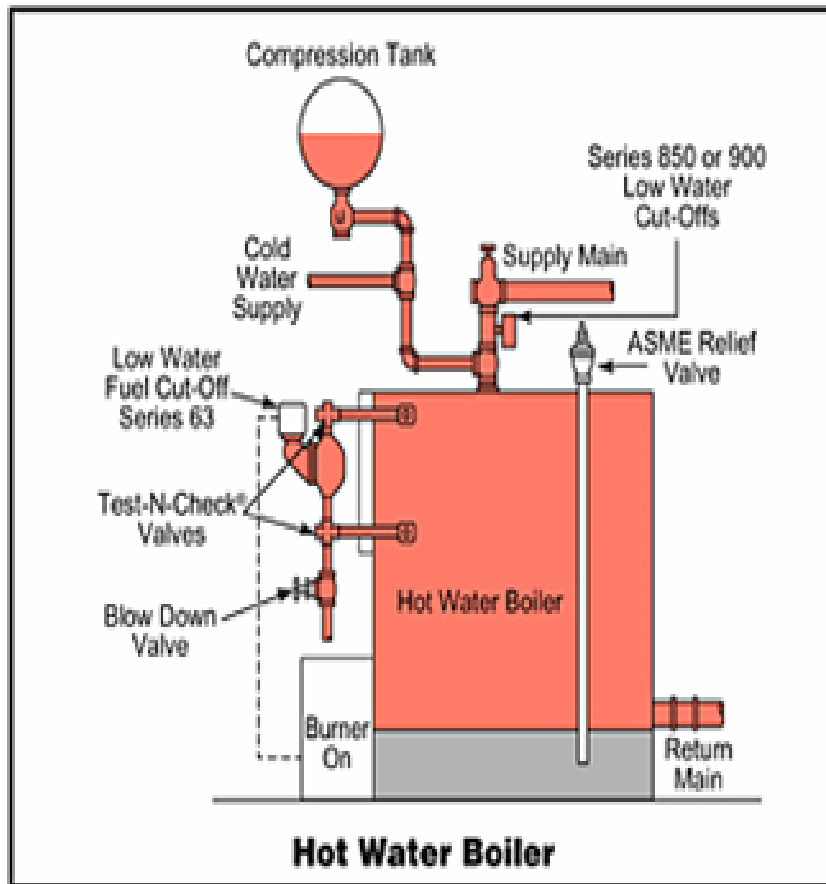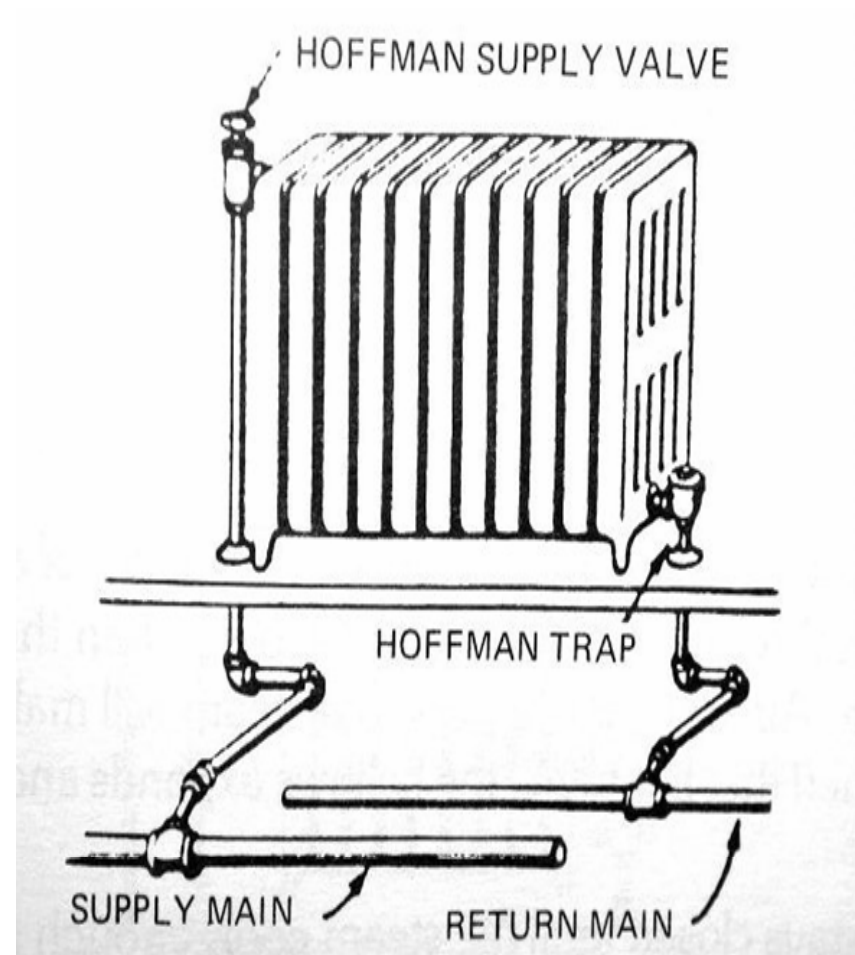
- Temp1 = Temp 2
- This means the circulator and flow control are working correctly
- Temp1 > Temp2
- This means either the circulator or flow control are not working correctly
- Temp1 < Temp2
- The readings are faulty and you must try again

Circulator Tester code

- IF (temperature < temperature2-2) THEN
- PAUSE 100 ' Pause for Serial LCD to initialize
- SEROUT 12, Baud19200, [$0C]   ' clear
- SEROUT 12, Baud19200, ["error TEST Again"]
- 'SEROUT 12, Baud19200,[$94]
- 'SEROUT 12, Baud19200, ["test again"]
- PAUSE 6000
- LOW 4
- GOTO Main
- ELSEIF   (temperature > temperature2+2) THEN
- PAUSE 100 ' Pause for Serial LCD to initialize
- SEROUT 12, Baud19200, [$0C]   ' clear
- SEROUT 12, Baud19200, [" Circulator OFF"]
- 'SEROUT 12, Baud19200,[$94]
- 'SEROUT 12, Baud19200, ["Check FC"]
- PAUSE 6000
- LOW 4
- GOTO Main
- ELSE
- PAUSE 100 ' Pause for Serial LCD to initialize
- SEROUT 12, Baud19200, [$0C]   ' clear
- SEROUT 12, Baud19200, [" CIRCULATOR   WORKING"]
- 'SEROUT 12, Baud19200,[$94]
- 'SEROUT 12, Baud19200, [" Check elsewhere"]
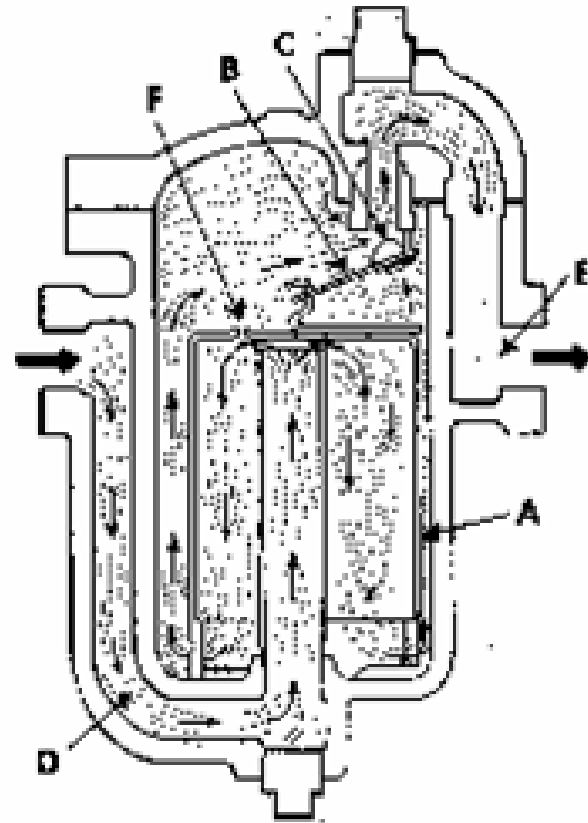
Steam Trap

- Keeps Steam in your heater and out of your return lines
- Hot steam causes the trap to close
- Cooler steam will cause the trap to open
- When the trap malfunctions the efficiently of your system drops significantly

Testing a Steam Trap

- Testing Input and output temperatures of the stream trap

- The temperatures will tell you if the steam trap is functioning

The three possible Outcomes

- Temp1 = Temp 2
- This means that the steam trap is malfunctioning
- Temp1 > Temp2
- This means the steam trap is working correctly
- Temp1 < Temp2
- The reading are faulty and you must try again

Steam Trap Code

- IF (temperature < temperature2-2) THEN
- PAUSE 100 ' Pause for Serial LCD to initialize
- SEROUT 12, Baud19200, [$0C]   ' clear
- SEROUT 12, Baud19200, ["error"]
- SEROUT 12, Baud19200,[$94]
- SEROUT 12, Baud19200, ["test again"]
- PAUSE 6000
- LOW 4
- GOTO Main
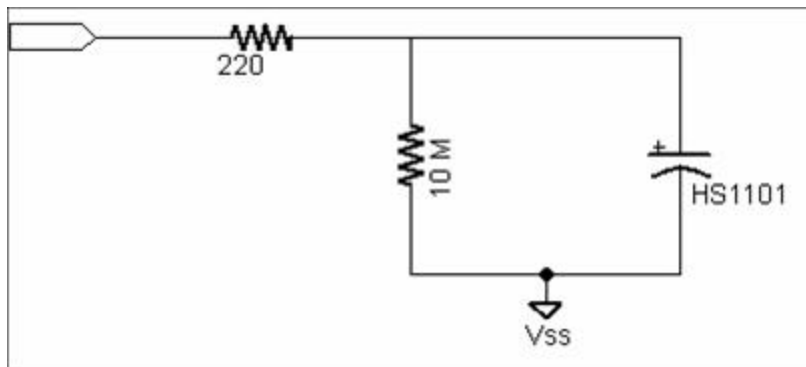
- ELSEIF   (temperature > temperature2+2) THEN
- PAUSE 100 ' Pause for Serial LCD to initialize
- SEROUT 12, Baud19200, [$0C]   ' clear
- SEROUT 12, Baud19200, ["Steam Trap good"]
- PAUSE 6000
- LOW 4
- GOTO Main
- ELSE
- PAUSE 100 ' Pause for Serial LCD to initialize
- SEROUT 12, Baud19200, [$0C]   ' clear
- SEROUT 12, Baud19200, ["Steam Trap Fail "]
- PAUSE 6000
- LOW 4
- GOTO Main
- ENDIF

Testing a Zone Value

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- This same test can be used to test zone values as well
- Zone values work on the same concept as the flow control
- However they are opened and closed by a motor

Humidity Sensor

- Take readings of humidity around the boiler room can expose potential problems

- For Example a leaking hot water heater

Taking Temperature Readings

- Taking Temperature readings inside and outside of the boiler room can be very useful

- Taking temperature reading at all the radiators can tell you how the system is working

- Also taking temperature readings at the hot water heater can prevent scalding

Continuity Tester

- Can Be used to test all the Safety switches on your boiler

- Can also be used to Check for Proper Thermostat operation

- Thermostat test

Boiler Control Loop
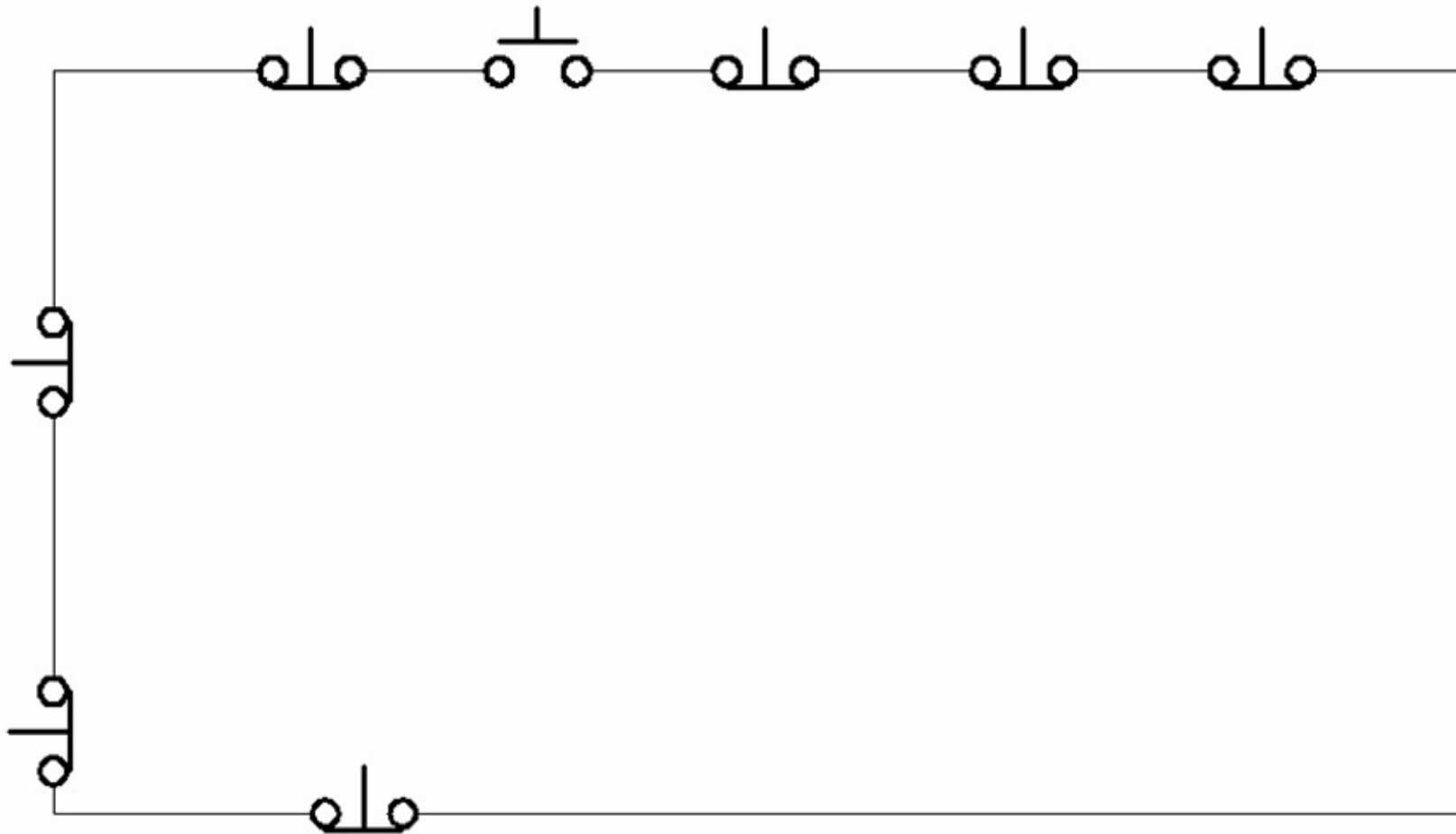
Diagnostic Temperature Sensor

```
Main:
DO
LOW 4
LOOP UNTIL IN11=0 AND IN10=0
DIRL = %11111111
TxPin CON 0
Baud19200 CON 32

DO
HIGH TxPin ' Set pin high to be a serial port
PAUSE 100 ' Pause for Serial LCD to initialize
SEROUT 12, Baud19200, [$0C]    ' clear
SEROUT 12, Baud19200, [" Check Boiler B1"]
SEROUT 12, Baud19200,[$94]
SEROUT 12, Baud19200, ["next option B2."]


PAUSE 10
IF IN11=1 THEN     'Check Boiler B1
GOTO A
ELSEIF IN10=1  THEN        'NEXT opition
GOTO B
ENDIF

LOOP 'UNTIL IN11=1 OR IN10=1      ' Waits FOR the ON BUTTON TO be pushed"

A: 'Check Boiler Ciculator

DO
LOOP UNTIL IN11=0 AND IN10=0

SEROUT 12, Baud19200, [$0C]    ' clear
SEROUT 12, Baud19200, ["T1 U FC T2 O FC."]
SEROUT 12, Baud19200,[$94]
SEROUT 12, Baud19200, ["Press Button 1 ."]
DO
LOOP UNTIL IN11 =1

'GOSUB M
```

Price List

SERIAL NO.	ITEM NAME	QTY	UNIT PRICE	AMOUNT
1	BASIC Stamp 2 Module	2	49	98
2	BS2 Board of Education	2	69.99	139.98
3	HS1101 Humidity sensor	2	4.99	9.98
4	MLX90614 Infrared Therm 10 Deg	1	59.99	59.99
5	PULSED PIEZO BUZZ	1	5.49	5.49
6	5000MCD JMBO LED	1	2.79	2.79
7	Resistors PK5 1 MEG 1/4 W	1	0.99	0.99
8	ULTRA BRIGHT UV LED PK2	1	1.69	1.69
9	TLC555 TIMER	1	1.69	1.69
10	UNIVERSAL BREADBOARD 301	2	7.99	15.98
11	PK10 MINI CLIPS	1	3.59	3.59
12	90'#22 SOLID UL	1	7.99	7.99
13	UNIVERSAL BREADBOARD 102L	1	19.99	19.99
14	SHIPPING	1	17.23	17.23
15	Standard Servo motor	1	12.99	12.99
16	LCD	1	20	20
			TOTAL USD$	418.37

Conclusion

We utilized the BS2 to achieve the purpose of our project. We made use of the available low cost sensors and circuits to monitor a Boiler system.