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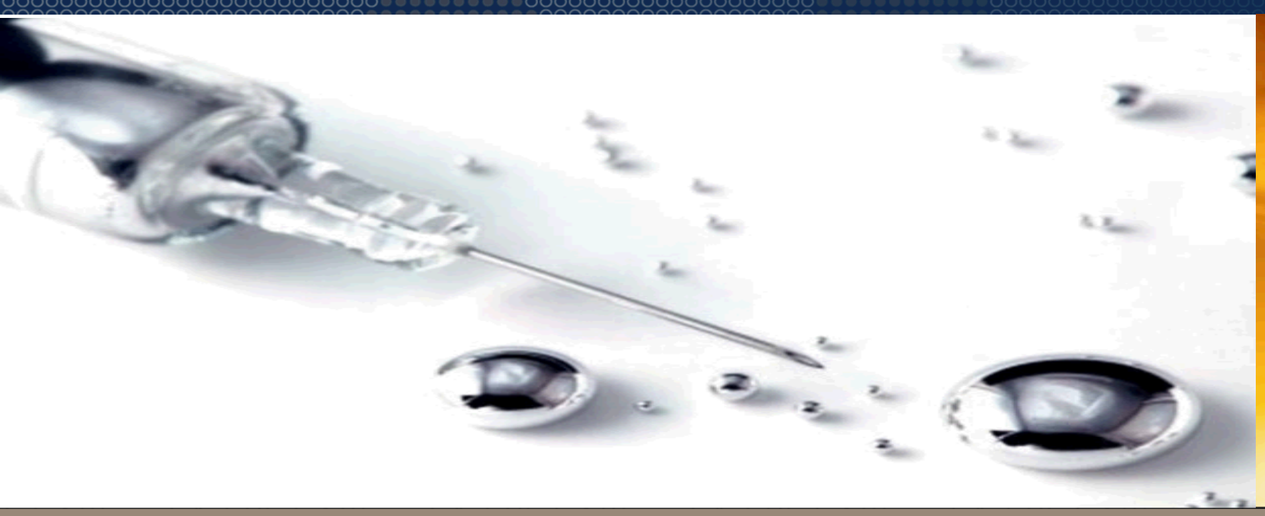

Sensory switch/accelerometer using Mercury

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Introduction to Mercury Application in sensor switch:

- Mercury acts as the piston that will be acting as the close switch between two electrodes to create an electrical contact.
- The passive nature of the switch will a circuit turn on or off when applied the correct g-level.
- This switch takes forces into consideration as the devices are tested in a centrifuge.
- The switch will be able to be applied in aerospace applications as well as any such devices that use level sensors or switches.

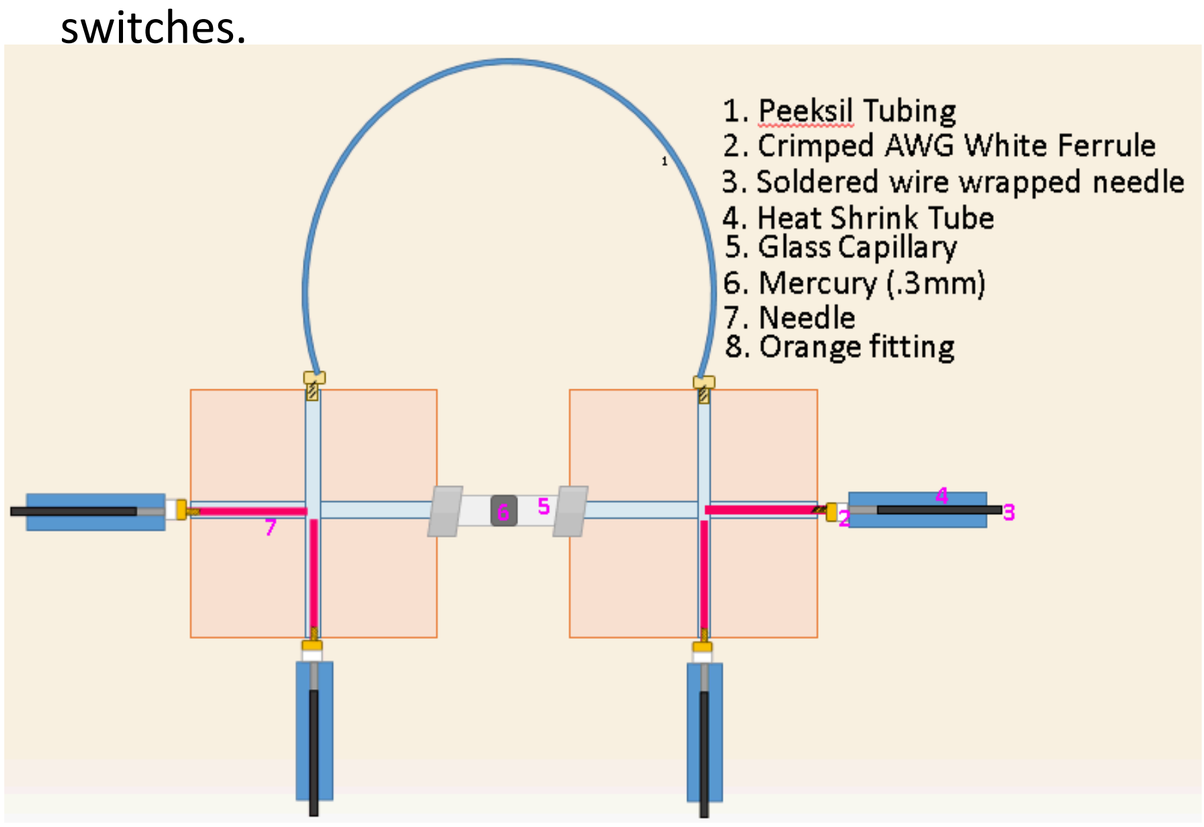


Figure 1: Switch device components with legend.

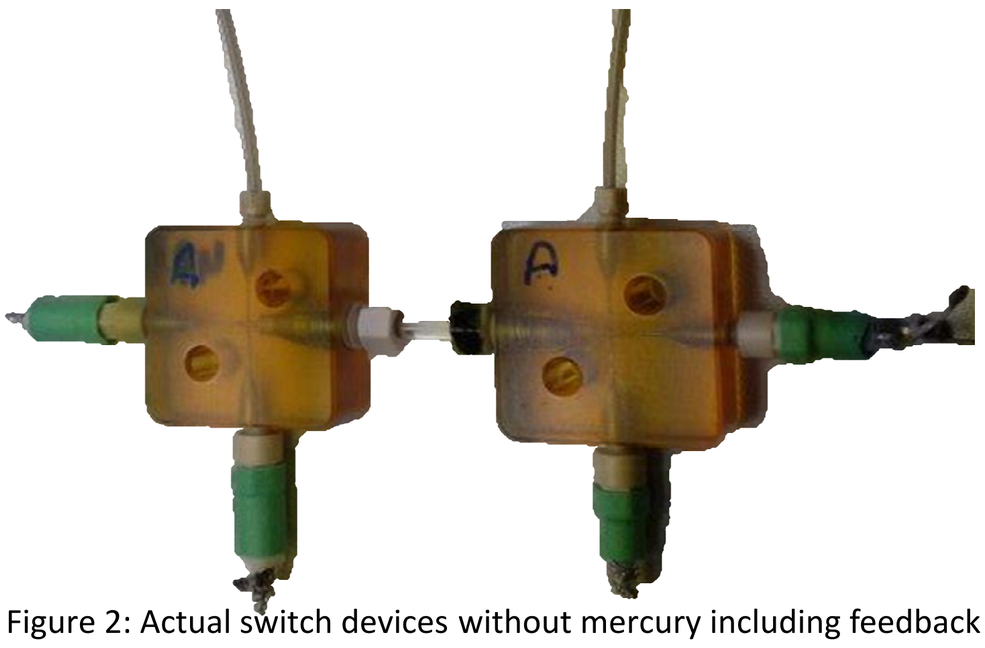


Figure 2: Actual switch devices without mercury including feedback tubing and electrode placement.

Device Components :

- Considerations for lengths and diameters need to be taken into account.
- The components of the switch include variations in diameters of the feedback tubes, glass capillaries, and the length of the mercury drops.
- Testing was done to find the best way to keep the needles in place and to keep each opening around the fittings sealed.

Assembly:

- The switch has two electrodes carefully perpendicularly placed so that a drop of mercury would create an electrical contact between the two.
- To ensure proper sealing, heat shrink tubing was used for the fitting and the electrodes so that no mercury would escape and the electrodes would stay in place.
- Soldering techniques were used on the ends of the electrodes to use the multi-meter banana clips during experimentation in the centrifuge.

Figure 3: A microscope and multi-meter were used to ensure the electrodes were in the correct position for a mercury drop size of .3mm to .6mm.

Switch Components and Safety:

- The electromechanical technologist had created a 3D printed fixture to place the switch to be placed into the centrifuge.
- The device was placed into the fixture with the banana clips placed so electrical contact can be measured during the experiment run.
- Safety measures included gloves, lab coat, goggles, and working under the fume hood due to working with mercury as well as being well read on MSDS and appropriate documentation.
- Needles were used to extract the mercury and place into the glass capillaries, thus proper measures were used to ensure safety uses of needles and mercury waste containers under the fume hood.

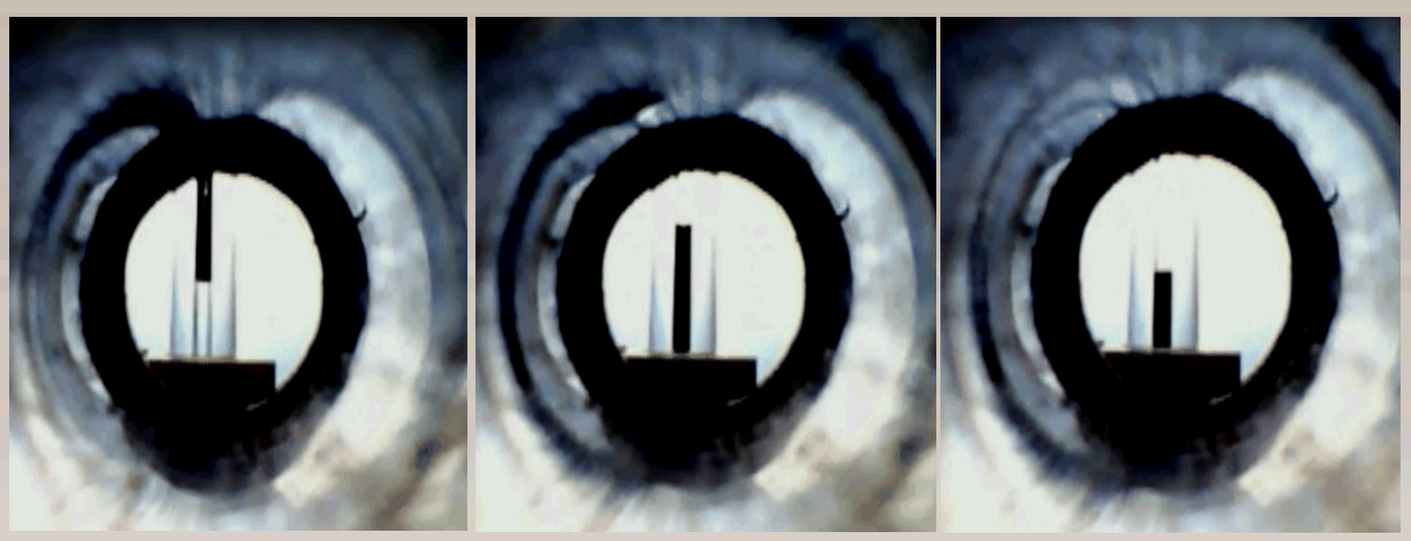


Figure 4: Figures show movement of the mercury drop in the centrifuge at a certain g-start level

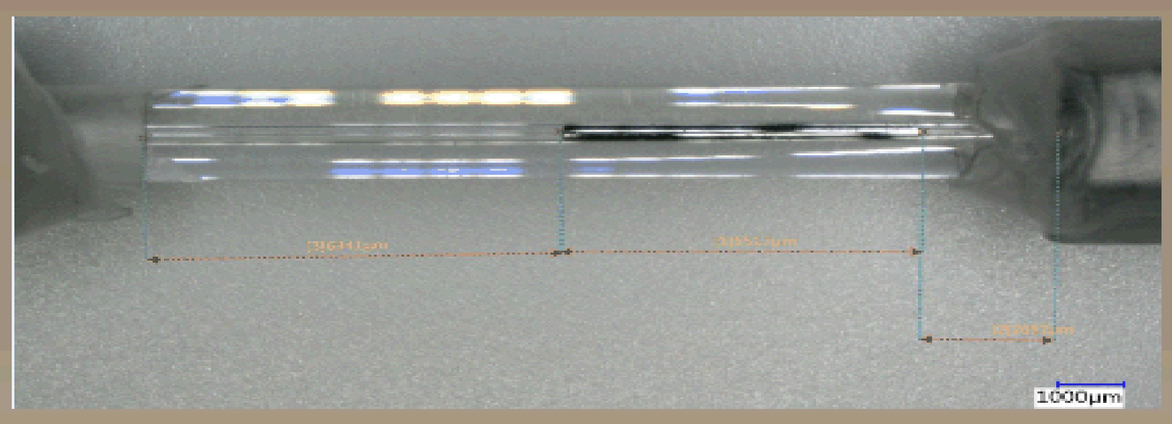


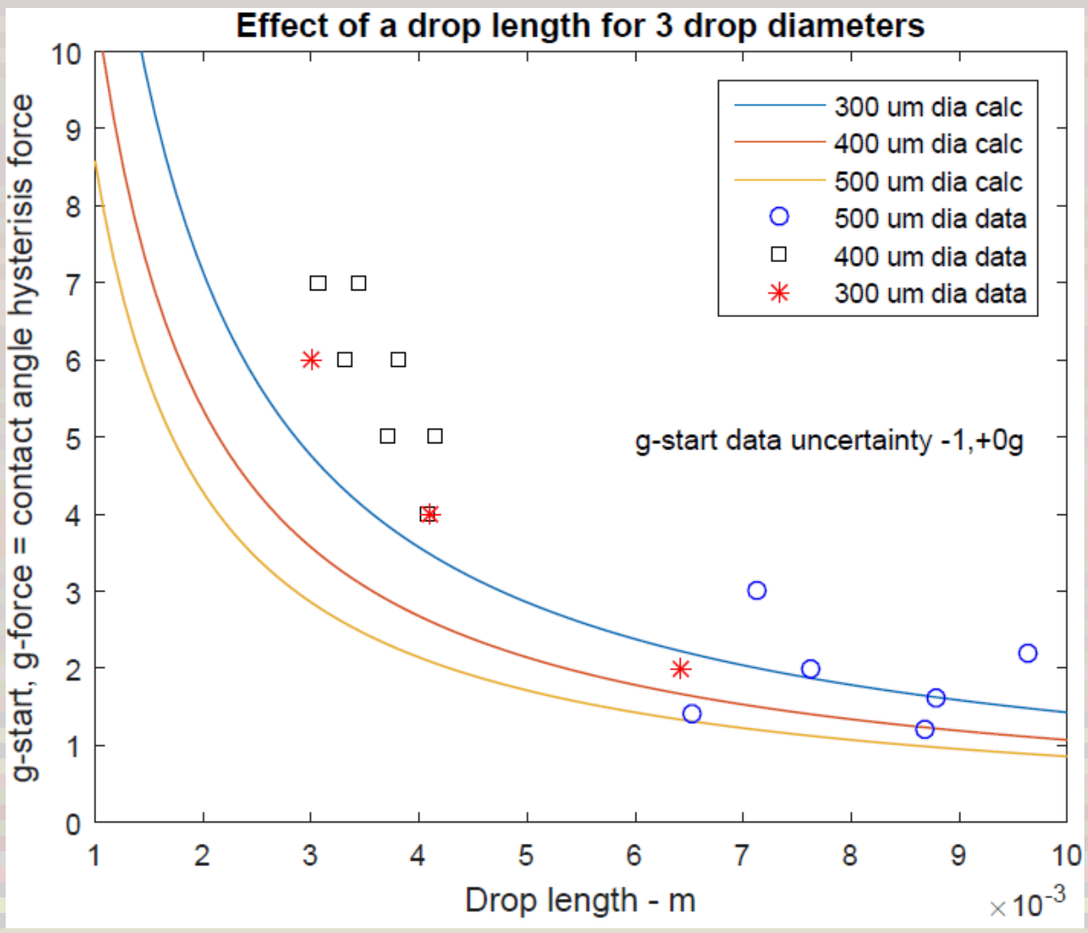
Figure 4: The capillaries were cleaned through different methods to ensure the movement of mercury to be smooth and un-disturbed. Above shows the length of the mercury that would be needed to correctly choose a g-level to start the centrifuge.

Switch Components:

- The glass capillaries used to hold the mercury were 300, 400 and 500 ID chosen from a series of calculations.
- The capillaries are between two fixtures that have the electrodes which would allow the mercury to travel to either side.
- To ensure there is no mercury spill from the capillaries, Para-film was used around the glass and fitting as seen on the left.

Experimentation and Results:

- Once the switch was placed into the fixture, it was placed into the centrifuge and a multi-meter connected to the electrodes.
- A camera is placed above the glass capillaries to capture the drop movements.
- The movement of the drops are hypothesized through various calculations that predict a g-level that the mercury would move at in the centrifuge.
- The picture to the left shows a camera view of the mercury drop at a specific g-level.



Graph 1: Shows the g-levels that are calculated depending on the ID of the capillaries versus the g-levels that were determined through experimentation.

Results:

- Solid lines are the calculated g-level which approximate when the meniscus of the mercury drops bulge.
- This indicates the beginning steps of the complete movement of the mercury, which we then tested in the centrifuge.
- The points indicate the tested g-levels when the mercury actually began to bulge.
- Although the experimental data did not match the calculated expectations perfectly, work will continue to assemble the device more precisely for better results.

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Citations: