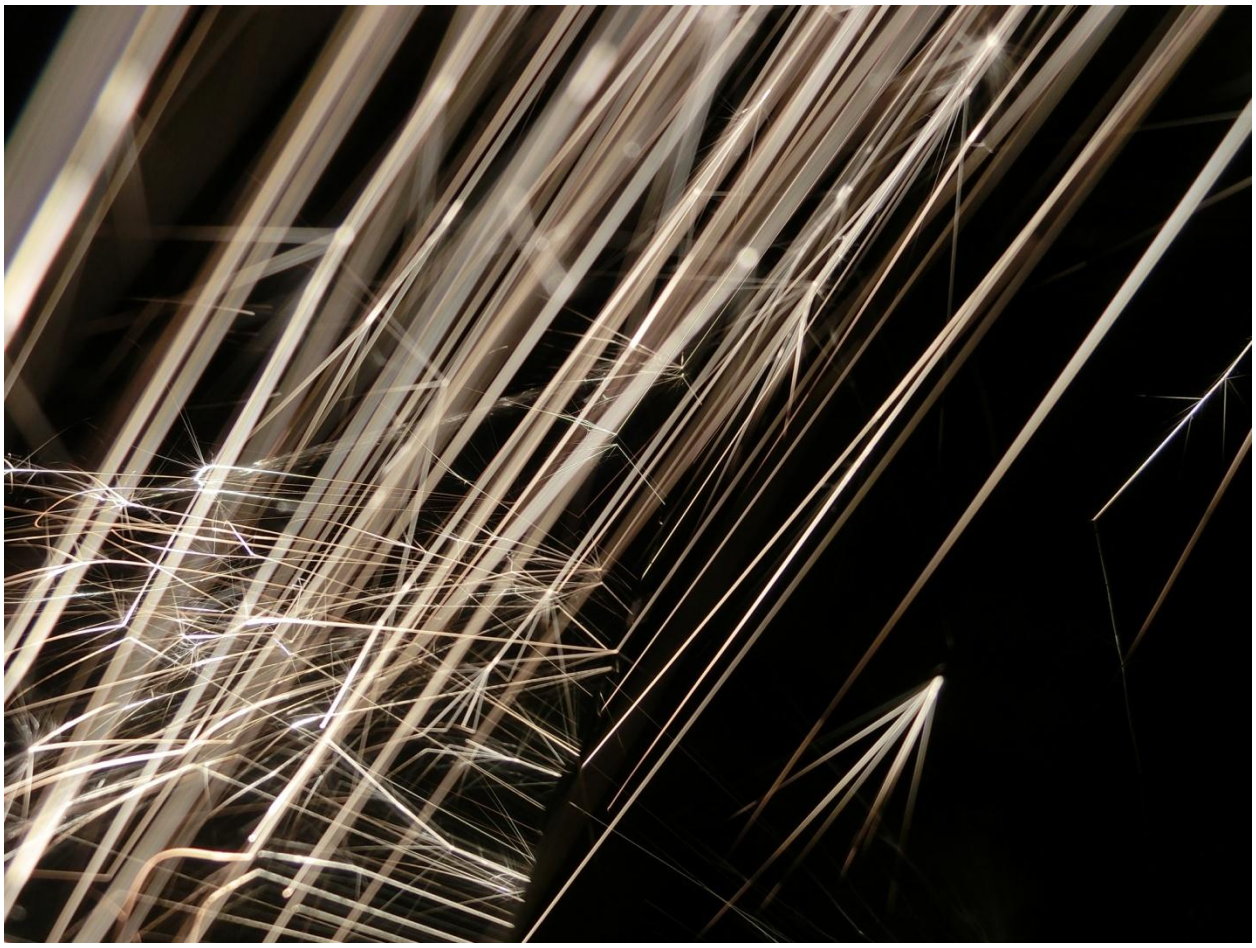
Falling Sparks
Group Assignment Report #2



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Purpose

This image was created for the CU Boulder Mechanical Engineering course MCEN 4151 Flow Visualization "Group 2" assignment. The intent of this assignment was to work within a random group composed of students from different backgrounds and experience levels, relying on each other to help visualize a desired flow phenomenon. Our team (Group 9) composed of Lotem Sella, Paul Sweazey, Wayne Russell, and Aaron Porras decided to focus on the flow of sparks impacting both water and glass.

Flow Apparatus

The apparatus (below) used to visualize the sparks hitting the water and mirror was a 10 gallon fish tank filled almost to the top with a broken mirror laid flat across the top. To create the sparks we took a scrap piece of angle iron and ground it with an angle grinder. The spark direction was manipulated to fall on the glass and water. The amount of sparks was controlled by the amount of pressure applied to the angle grinder.

One of the more interesting aspects of observing a spark flow as compared to say a liquid or gas is that you can see the individual particles and how they interact on the particle level. This was fascinating to me because it let me break the flow down in to a single point where the forces and interactions with this particle could easily be broken down. Some of the interactions I came up with for the particle were: drag/viscous, impulse acceleration, convection, conduction, radiation, and gravity. As I analyzed the flow further I realized that it was a fairly unique non-homogeneous flow where the particles were losing mass throughout the flow. This mass reduction of the particles was due to the energy they were putting off in the form of heat and light.

Visualization Technique

As the team and I began the shoot we found that the background of the room we were in was a bit distracting to the phenomenon. To remove this distraction we decided to eliminate all of the light in the room and let the sparks be the primary light source. As a result of shooting in the dark we were able to achieve a very black background which contrasted the bright sparks perfectly. To visualize the flow even better we used a mirror to provide a 2nd dimension to this single dimension image and also provide a solid medium for the spark flow to interact with. To provide another medium for the sparks to interact with we also used water, which when impacted by the sparks almost immediately extinguished their glow.

Photographic Technique

The camera used to take this image was a high speed Casio EX-ZR100 set in manual mode to allow for control of ISO, Aperture, and Exposure time. Since we were shooting in a low light situation and I wanted the clearest image possible, the ISO was set to a low value of 100. As for the F-stop, it was set to f/3 to blur the sparks nearest to the camera and give the image depth. The focus was fairly close at 4mm which helped with the detail and stability of the image. Also after some playing around I set the exposure to a half second, which seemed to highlight the flow of the sparks well. The camera's maximum resolution of 3000 x 4000 was selected to provide as much detail possible.

As post processing goes I spent a good amount of time in Photoshop attempting to highlight different aspects of the spark flow and add some artistic effect, but found myself drawn to the original in the end. Below you can see some of the modifications in which I attempted to tweak the image curves all of which I felt weren't as good as the original.

Reflection

An interesting aspect this image reveals is that one can analyze the type of sparks emitted to identify the type of material being ground. This “method of determining the general classification of ferrous materials”[2] is known as “Spark Testing. Comparing the sparks from this experiment to a few common material spark types (below [1]), we can see that the piece of angle iron is most likely a mild steel.

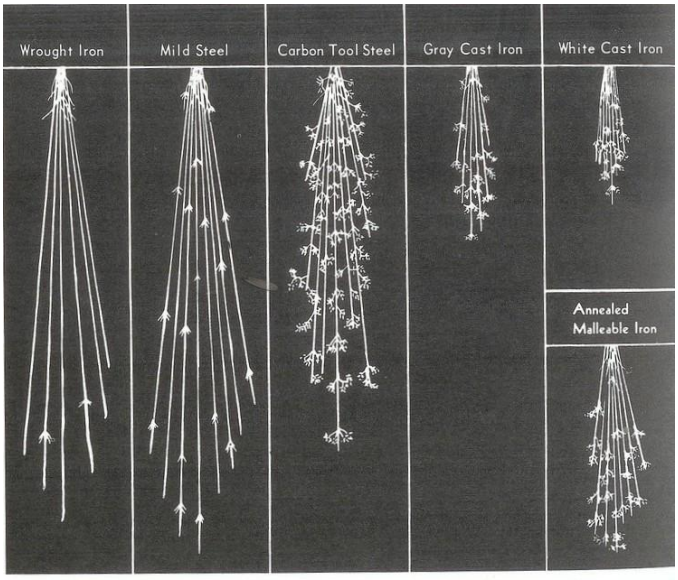

Fig. 24-4. Spark test for common cast irons and steels. (Norton Co.)

In the end, I really enjoyed how my image turned out and feel it completely fulfilled my intent. I believe the image outlines the fluid physics well. I also attempted to research why the sparks split/explode apart occasionally. Unfortunately I couldn’t find too much on that matter and may have to look in to that deeper in the future. If I were to develop the idea further I would like to experiment with different materials to see how they might flow differently.

[1] "Google Images." Google Images. N.p., n.d. Web. 16 Apr. 2013.
[2] "Spark Testing." *Wikipedia*. Wikimedia Foundation, 13 Apr. 2013. Web. 16 Apr. 2013.