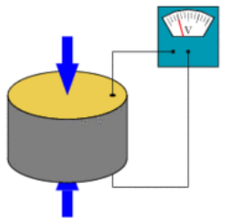
SYNTHESIS

The inability of renewable energy sources when competing with non-renewables is a fact. Moreover, it has become a challenge because of the lack of alternatives that await us in the future. Seeing this problem and following our desire to create a more efficient world, we decided to focus our project on this area. In other words, improved performance of piezoelectric materials and their application to railway transports in order to obtain energy with the passage of trains.

Piezoelectricity is a property that certain materials have due to their asymmetrical structure. Thanks to this feature, when squashed they generate a voltage difference. While the foregoing applications are limited to tiles or even shoe soles, we thought that we could take on a force of a larger scale, seeing as the energy exerted by a person is very small compared with the force that a train can generate.



Thus, we began investigating each and every one of the materials available on the market, and created them chemically as well. Then we developed an integrated circuit that would convert the alternating current generated by these into a direct current, which could be useful for a subsequent energy storage.

Finally, we created a removable module to be placed between the sleeper and the rail, with a mechanism composed of shock absorbers and actuators in order to obtain the greatest performance from the piezoelectric material. The results were so successful that we presented the project to Metro Bilbao and RENFE, who are currently studying its feasibility.

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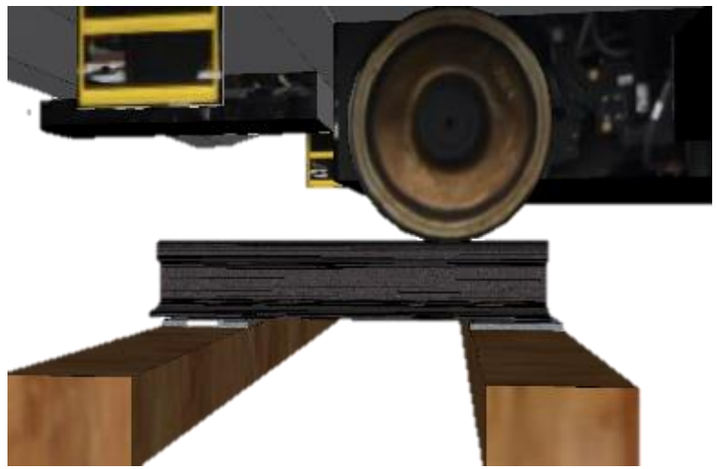
Analysis of piezoelectricity and its application as an energy source in railway transport



Instinctive

A project made by:

Fernando Arana Ruiz

Ander Fernandez de Larrea

GOAL

To transform the mechanical energy, obtained by the pressure made by the passage of trains, into electrical energy thanks to some piezoelectric modules located under the railway.

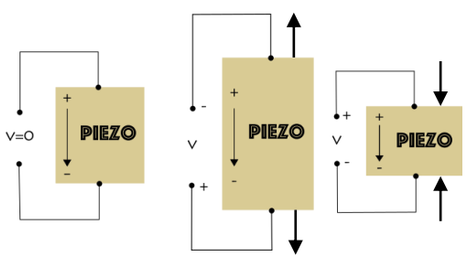
Due to the strategic placement of the modules, we could be constantly generating energy, being able to supply *Metro Bilbao's* needs for its lighting and signaling.

INVESTIGATION

The origin of the piezoelectric effect dates back to 1881 thanks to the Curie brothers, Pierre and Jacques, who discovered it while they were studying quartz. Followed by an extensive period of research that looked into ways to improve its application, the most used material is now PZT.

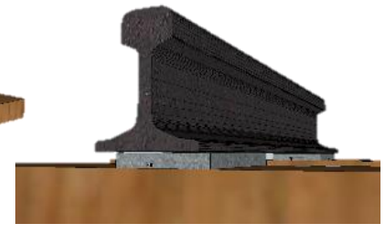
Piezoelectricity happens due to the internal structure of some materials, which can be anything from quartz to PZT. When they are squashed, they bulge a little bit, and this bulge leads to a bulge in charge. In this way, one face of the crystal can end up having a different charge to another face, and this difference in charge leads to a potential difference, which is commonly known as voltage.

Up until now, piezoelectricity has been used as an energy harvesting device in shoe soles, tiles or even in dance club floors.

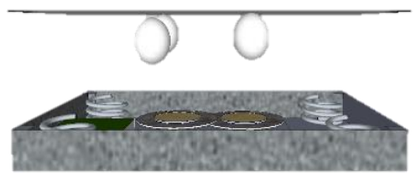


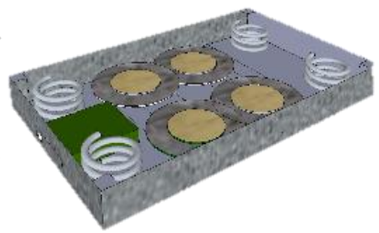
PROPOSAL

To transform the mechanical energy made by trains into electric energy by an independent piezoelectric module placed between the railway and the railroad tie.

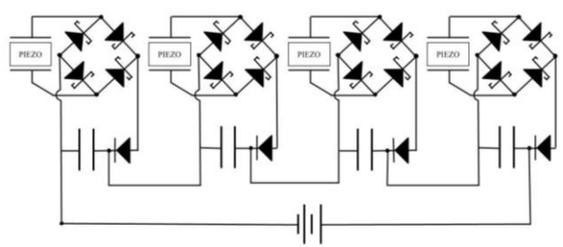


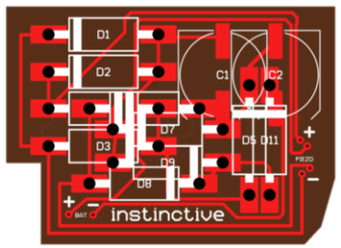
Due to the high pressure applied by the train, the piezoelectric material cannot be directly placed as it could break. So that they have to suffer less, we have designed a module composed by four piezoelectric ceramics and by four other shock absorbers.

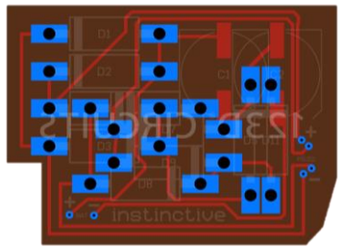




To stock up the generated energy we designed a integrated circuit. This circuit has a full wave rectifier so the alternating current is transformed into a direct current. Moreover, it also has a capacitor which flattens current peaks, so the current can be used. Finally, the serially placed capacitors are linked to a battery which collects the energy.







RESULTS

We used Bilbao's *San Inazio* station as a hypothetical station as it receives the majority of the city's train traffic. By putting 800 modules, we would obtain 2185.6972 kWh of energy, which is the amount needed to supply 627 houses with power.

CONCLUSIONS

The generated energy, even if it looks small, is enough for lighting and signaling purposes. Furthermore, it would have a great impact on the environment, reducing 830kg of CO_2 per hour. With this amount of energy, 2.335.898€ would be saved per year, recovering the investment in 3.06 years.

DIVULGATION

We presented our project to *Metro Bilbao*, *RENFE* and *Adif* who are currently studying its feasibility. We also presented it to the President of the Basque Government and in the radio. We won first prize in the *Elhuyar Zientzia Azoka* and in the VI edition of the *Don Bosco Prizes*. We also got a special mention from *Tumaker*.

Want to collaborate? Contact us!