Stimulating Bone Growth Using Piezoelectric Ultrasound Transducers on the Edentulous Jaw

TEAM # 12

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**Alternative Design 2: Integrated Circuitry**

The basis of the integrated circuit design is that the ultrasonic mouth guard will have an electric circuit and power supply incorporated inside of them. An ultrasonic signal will be used to induce a mechanical stress on the maxilla and mandible bones to promote bone growth. The ultrasonic signal will be generated by piezoelectric strips made of Barium titanate material that are to be inserted into mouth guard. An electric circuit will supply an ultrasonic voltage signal to vibrate the piezoelectric strips. The frequency output must be between 1 and 4 mega-hertz and the power output must be 100 mWatts per square cm. Also, the circuit must run off of a rechargeable battery. (Figure 2)

The main distinguishing feature of this alternate design is the fact that the piezoelectric strips, electric circuit and the battery are all integrated within the mouth guard. This feature sets it apart from the other designs. It offers many advantages such as eliminating the need to have an external electric circuit and battery. This provides the convenience of administering ultrasonic applications anywhere, without the need of an external handset. This will also be cosmetically pleasing since there will not be wires hanging from the patients mouth during applications. There will also be fewer parts to keep track of, and less chance that a component could be lost or broken, which is always a concern with elderly patients. Unfortunately, containing all three components of the design within the housing of the mouth guard creates several new problems to solve.

![Image of integrated circuit](image_url)

*Figure 2. Integrated Circuit. All of the components are housed inside of the mouth guard. The transducers, amplifier, oscillator, and battery must all be small enough to fit, but still powerful enough to produce the desired output.*
The most pressing problem with this design is the size constraint, with the size and shape of the mouth guard not offering a lot of space to place components. The thickness of the piezoelectric strips as well as the voltage oscillator and voltage amplifier will have to be held to a minimum. Even if those parts could be small enough it could not change the size of the battery needed. Battery technologies have advanced significantly, but there is still no battery capable of outputting 14 watts for a 10-minute application and still fit into the mouth guard.

The second most pressing problem is overheating. A high voltage amplifying circuit will produce a lot of heat. This heat generation needs ventilation. Without ventilation the circuit will become overheated. An overheated circuit will not function properly. It may not output the desired power or frequency and may stop functioning all together. Additionally, an overheated circuit is dangerous to a patient, especially when the entire circuit would be housed inside the patient. It is this concern for safety that would make this alternate design not suitable, and should not be constructed.