The following Provisional Specification describes the invention.

**Field of the invention** - An interdisciplinary engineering application of control, electronics, mechanics and biological sciences to develop an assistive and therapeutic device for human voice rehabilitation

**Background and Problems in the Prior Art**

**Background** - The ability to communicate verbally is seen as an essentiality by the majority of people in everyday life. It forms the core of self-expression, as it enhances the level of interaction that takes place among people. Through speech, a person is not only able to communicate what one thinks but also what one feels. The pitch is normally created when air pressure from the lungs vibrates vocal folds of the larynx. The vibrations of vocal folds along with the movement of the lips and tongue is used to generate human voice. When one undergoes laryngectomy (larynx removal), the affected individual cannot speak naturally anymore.

Every year 3,000 Americans (1 in 100,000 globally) undergo total laryngectomy due to surgical removal of the larynx as treatment of laryngeal cancer, or due to automobile accidents, burns or trauma. Total laryngectomy profoundly alters the physiology of respiration and deglutition, and the production of voice as well. Loss of glottal sound production is the greatest disability for most of the patients, following surgery. Therefore, rapid effective voice restoration is crucial for the prevention of psychological, social, and economic consequences of post-laryngectomy aphonia. Loss of the larynx results in the inability to produce normal speech and the need to breathe through a hole (stoma) in the neck. However, since the main articulators still remain intact, a prosthetic device can be used to acoustically excite the vocal tract for the production of alaryngeal speech.

There are only a handful of techniques available for the patients to regain their voice. Speech rehabilitation after total laryngectomy can be broadly subdivided into three major categories: (1) Esophageal speech, (2) Tracheoesophageal puncture (TEP) and (3) Electronic Oscillating devices. An artificial Electrolarynx is one of the most popular electronic oscillating devices.

**Problems of a Typical Electrolarynx**

There are many ways in which the electrolarynx strays from ideal voice production; however, to improve the device we must first understand what these deficiencies are. In a review wherein groups of electrolarynx users and speech pathologists were asked to rank different problems with the electrolarynx, the top five deficits ranked as follows were:

1) Reduced intelligibility ("EL speech is hard to understand")
2) Lack of fine control over pitch and loudness variation, and voice onset/offset ("EL speech is monotonous")
3) Unnatural, non-human sound quality ("EL speech sounds robotic/mechanical")
4) Reduced Loudness ("EL speech is too quiet")
5) Inconveniences related to EL use ("EL is inconvenient to use")

The primary concern of EL users and speech pathologists is the impaired intelligibility of EL speech. This has many contributing factors which include voiced-unvoiced consonant distinction, the background noise of the device, and intonation control.

**Objects of the invention:**

The main object of the invention is to design and manufacture electrolarynx remarkably minimizing its price to

make it more economical and affordable, thereby being lightweight yet rigid, less power consuming and reliable. The other important object of this invention is to add control over the quality of voice output, by controlling the sound characteristics, i.e. frequency and amplitude. Another object of the invention is to include the feature of voice recording to serve multiple purposes of self-evaluation or recovery tracking by the patient, and also for voice amplification of the user to be audible. Furthermore, the advancement object of the invention is to bring in a simple user interface in smartphones for the digital control through an Android application, thus, making the device wirelessly controllable. Yet another object of the invention is to design the device to be available for hands-free usage for more convenience to the user.

**Brief description of the preferred embodiment/s and its working:**

The entire working of the device can be branched into four submodules/parts. This instrument is a unique combination of electronic, mechanical and metallurgical sciences. It is a 9 volt battery powered device. When the push button is pressed sound vibrations are produced from the vibrating disc, aka diaphragm. The instrument is to be held against the throat with the vibrating disc touching the throat. When the push button is pressed vibrations are transmitted into the lower portion of vocal tract. These vibrations are articulated into speech by the normal movement of the tongue, lips and teeth.

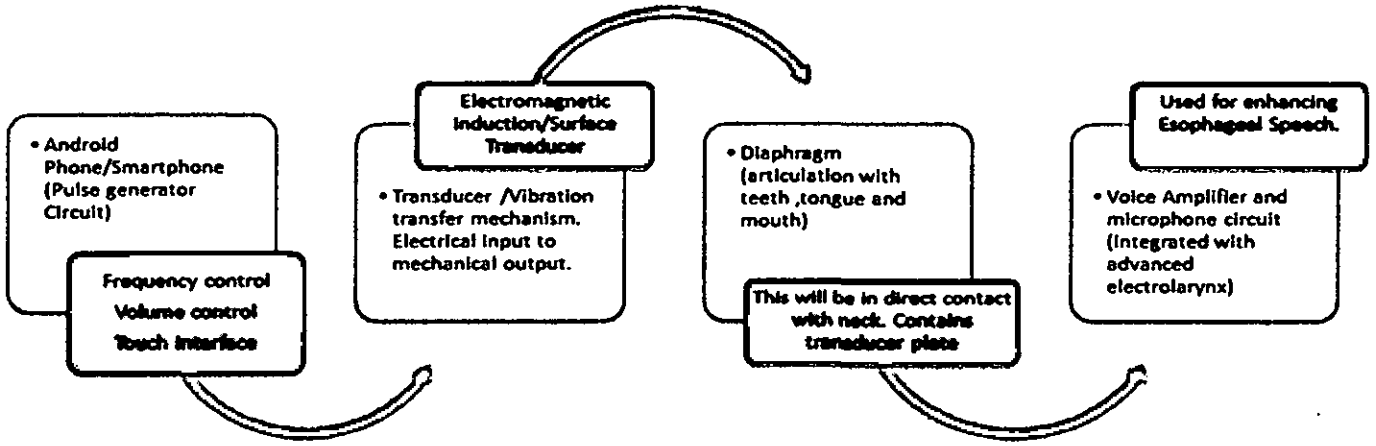
The first module is generation of essential wave/pulse from an Android smartphone. The second module is conversion of the pulse into vibration using a transducer. The third module is transmission of vibration through diaphragm. The fourth and final module is the voice amplification.

Android smartphone takes vital role as pulse generator and also a multi-controller as it provides control over change in frequency, change in amplitude and also a versatile touch interface making the device more user-friendly. It generates a square wave of required characteristics (mainly, frequency and amplitude) that can be set by user/therapist through the android application, which is then given as input to the transducer circuit. Transducer circuit comprises an IC that converts the electrical input from the Android source to the mechanical vibratory motion of electromagnet. The entire transducer vibrates through this square wave and this, in turn, phonates the throat of the patient via diaphragm. This external vibrating all the throat of the patient enables the patient to activate his/her voice and enables him/her to communicate vocally again. Voice Amplifier amplifies the voice of the patient which is feeble due to mechanical restraints of the throat after laryngectomy. The voice amplifier part has an IC LM386 that amplifies the input from a microphone that is attached to the electrolarynx and it is placed in such a way that it has a direct input from the mouth of the patient to this microphone. This microphone takes the input as the voice of the patient and its output works as the input to the voice amplifier circuit where the patient's voice is amplified and sent out to an 8-watt speaker, also connected to the device itself. Thus, an audible and intelligible voice can be produced simultaneously.

**Brief description of Figures herein:**

The figures added herein give a glimpse of the working of the device and the flow of energy from one form of signal to the final form of vibration to produce sound.

IDF:1521




**Flowchart representing the functioning of the device**

There are two prototypes of the hand-held electrolarynx made in this project: one wired and one wireless, which are shown in Fig.2. Also showing the scale beside for estimates. They can be seen to be carrying a microphone on the *vibrator side at the top of the device and a speaker is arranged at the bottom which faces the listeners. The circuitry* is packed inside the device holding the vibrator at the top enclosed by a diaphragm. In Fig. 3. The hands-free electrolarynx is shown that holds the vibrator to the neck continuously, which can be fastened with a Velcro as per the required comfort of the user. Fig. 1. Gives snapshots of the Android application developed for touchscreen/digital user interface for the users to control the sound characteristics to required values.

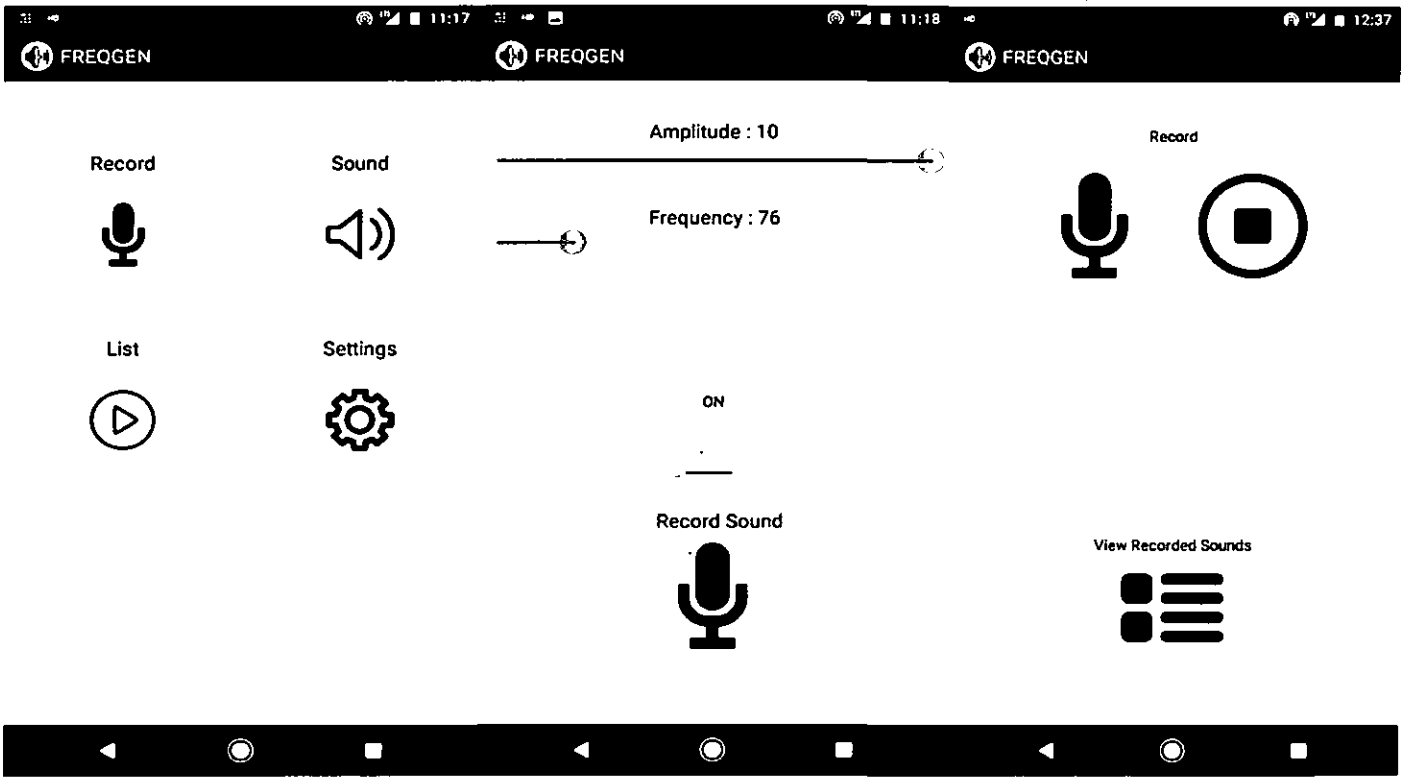



**Fig. 1. Screenshots of the Android App Developed**

IDF:1521


Fig.2. The two prototypes of the Advanced Electrolarynx made

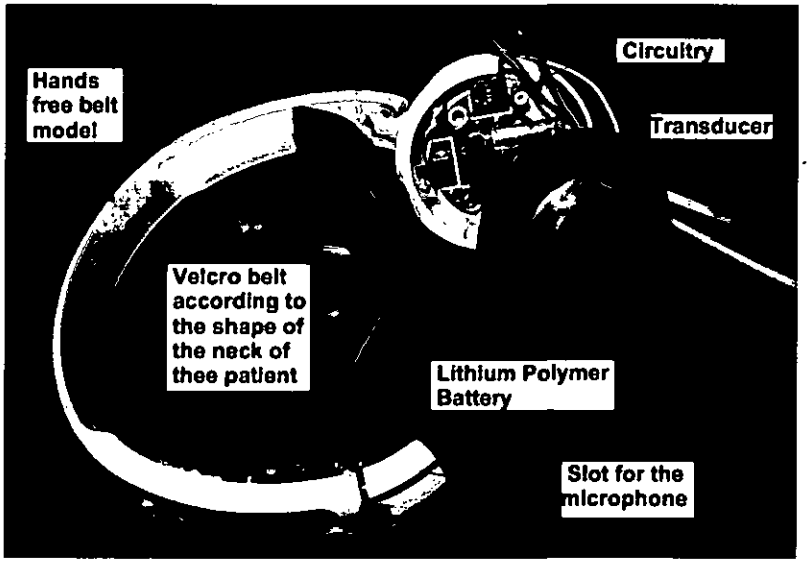



Fig.3. Hands-free model of the Advanced Electrolarynx