

# AN INDIGENOUS ARTIFICIAL LARYNX

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Usually laryngectomised patients are advised by their surgeons and speech therapists to learn Esophageal Speech. However not all laryngectomees can master esophageal speech. An alternative is to use an artificial larynx.

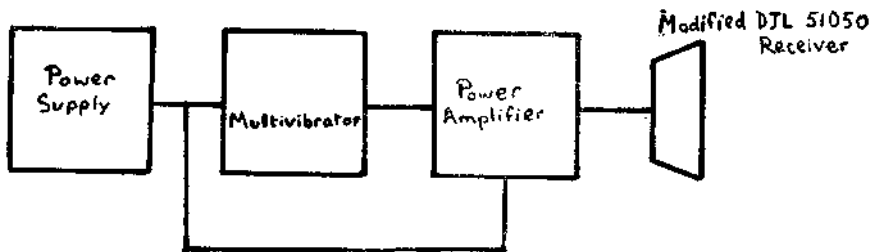
The electronic artificial larynx made by Bell Telephone Laboratories is presently being used in India by some laryngectomised patients. However, most patients cannot afford the imported larynx and also it is not readily available. It was decided that the construction of an electronic larynx based on the Bell model and made of locally available parts would solve the problem of price and availability and would be a very useful tool for restoring the speech of laryngectomised patients in India.

The primary requirement of the artificial larynx is that the artificial speech be loud and natural enough so that the speaker can be easily understood. For the speech to sound natural, it should have pitch inflection like the natural voice, should have a suitable fundamental pitch accompanied by harmonics that can be used to produce the various vowel sounds.

Secondary to the above, but still of great importance to the user, is the objective that the device be inconspicuous and hygienic.

Other important characteristics are simplicity of operation and reliability. Simplicity of operation is very desirable so that the patient will require only a minimum of training and as soon as possible, gain the psychological benefits of local communication with his family and friends. Portability is another necessary feature the unit must have.

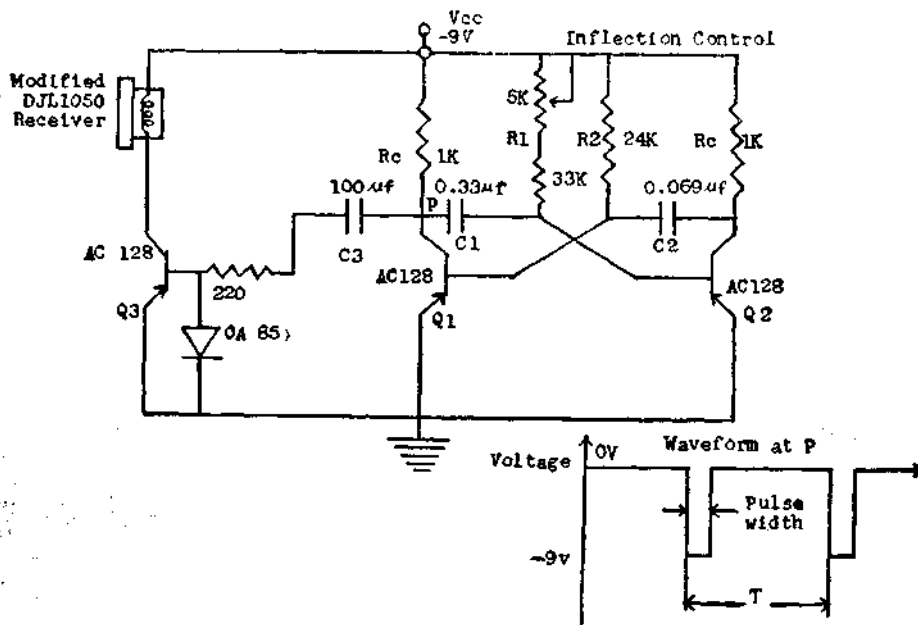
Lastly, a vital factor is low cost. In India, a Bell unit which is obtained only with great difficulty, cost above Rs 1000. This is beyond the means of most of the Indian laryngectomees. Hence the cost price of the indigenous unit should be much lower.



Block Diagram of the Electronic Artificial Larynx

The unit is seen to consist of power supply, a stable multivibrator, power amplifier and electromagnetic transducer.

The stable multivibrator produces pulses which are power amplified and fed to the electromagnetic transducer. This causes its diaphragm to vibrate. The vibrating diaphragm is held against the throat and the vibrations are transmitted through the throat wall into the pharyngeal cavity. Speech is produced by articulating the resultant tone by lip, tongue and jaw movements.



Circuit Diagram of an Indigenous Artificial Larynx

The circuit essentially consists of a power supply and a multivibrator feeding a power amplifier with negative pulses.

The DJL 51050 bipolar electromagnetic telephone ear piece (manufactured by ITI, Bangalore) used in operator's head sets was found after several modifications, to work satisfactorily.

*Performance Loudness Test.* The point of application of the artificial larynx on the throat corresponding to best out-put speech volume of the artificial larynx is measured with a sound level meter.

The test was conducted using a sustained phonation of 'ah' (as in father) i.e., normal voice with the artificial larynx.

### The results :

(Loudness with normal voice... 108phondb.)

(Loudness with artificial larynx... 105phondb)

We observed that the loudness of the –artificial larynx is satisfactory.

*Test for Frequency content.* The words 'Hello, how do you do' were said in the natural voice and then using the electronic larynx. A sound spectrogram analysis was made in either case.

*Natural voice.* (a) Overall speech amplitude vs time

(b) Spectrogram.

*Artificial larynx* (a) Overall Speech amplitude vs time

(b) Spectrogram.

In both the cases, the duration of the speech sample analysed was 2.4 seconds. On comparison of the two spectrograms we conclude that the artificial larynx does not transmit sufficient power into the pharynx to permit satisfactory development of the higher formants.

Natural voice has a bandwidth from about 80-8000 Hertz. From the spectrograms we observed that artificial larynx has a bandwidth extending to 2,5 K Hertz. This means that the artificial speech lacks fidelity..

By comparing distances between vertical striations, we see that the artificial tone has a higher fundamental frequency than the normal vocal tone. This suggests that the fundamental frequency of the artificial larynx should be decreased.

The output recorded at the extremes of the artificial larynx spectrogram corresponds to the sound radiated by the artificial larynx when the subject's mouth was closed.

If all but the diaphragm as the larynx is enclosed in sound absorbent material, less radiated sound is produced when the larynx is used. We observed that the intelligibility of the speech was better when this was done.

The amplitude vs time plots of material and artificial voices show close correspondence intelligibility as the artificial larynx is fair. It is also noted that as one listens to more and more artificial speech it becomes more intelligible, just as one would come to understand strangely accented English increasingly well by coming into contact with it often.

### Conclusion

An electronic artificial larynx modelled as the unit made by Bell Telephone Laboratories has been made out of indigenous components at considerably reduced cost and the performance of this unit has been studied,

This first model of the Electronic artificial larynx gives reasonably adequate intelligibility but the quality of speech produced has still to be improved. Apart from its use for laryngectomized patients there are other applications for it especially in the field of voice therapy.