



# Explaining the Theremin: A Physical Approach

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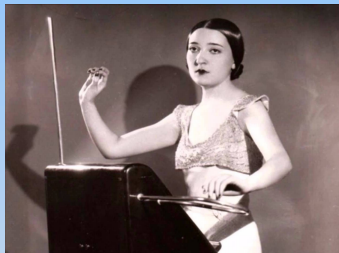


## Introduction

In 1927, Leon Theremin (born Lev Termen in St. Petersburg, Russia) invented the first ever non-contact musical instrument. It has been used by many popular musicians and in the soundtracks of several Hollywood productions.

## Origins

- Invented by Leon Theremin
- In 1920, he joined Ioffe Physical Technical Institute, where he started working on high-frequency measurement methods.
- Idea stemmed from mine detector experimentation
- This was originally called the aetherphone, and later, the thereminvox
- First contact-less musical instrument
- In 1928, he received a US patent
- Only about 500 of the original instruments were produced and sold.



Clara Rockmore: Theremin Virtuoso  
<http://www.thereminvox.com/article/articleview/21/1/22/>

## Uses

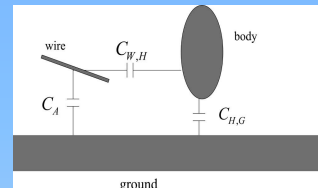
- On April 25, 1930, Carnegie Hall: ten musicians each simultaneously playing a thereminvox, (including Leon) for the first electronic orchestra performance
- It was used in songs such as the Beach Boys' "Good Vibrations," Led Zeppelin's "Whole Lotta Love," and others
- Used in movie soundtracks such as The Day the Earth Stood Still and It Came from Outer Space



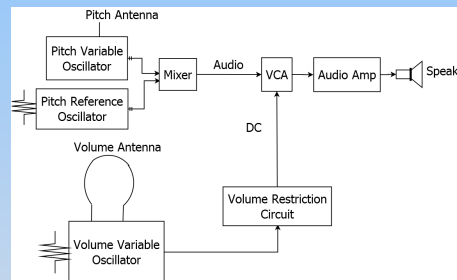
## Explanation of Theremin Circuit

### General Overview:

- Pitch antenna forms a variable capacitor system with performer's hand.
- Changes in capacitance are converted into frequencies by the beat frequency oscillator circuit.
- Volume is controlled by a second antenna.



Butler, W. & Wilson, B. (2006). Measurement and modeling mutual capacitance of electrical wiring and humans



<http://www.strangeapparatus.com/Theremin.html>

### Conversion of Signal: Beat Frequency Oscillator Unit

- Beat Frequency: Difference frequency between pitch variable oscillator and pitch reference oscillator.
- When no hand is near pitch antenna, variable and reference frequencies are identical and no sound is produced.

### Volume Control:

- Inverse set-up to pitch control circuitry
- When hand is near volume antenna, frequencies undergo destructive interference and sound is muted.

## Practice

• The Theremin is considered one of the most difficult instruments to play

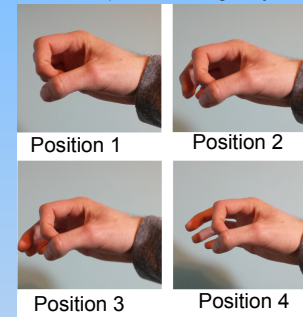
• Modern digital theremins have linear octave ranges and chromatic tuners which assist the player

### Russian Technique

- 8 hand positions
- Vibrato accomplished using the arm and wrist

### American Technique

- 4 hand positions
- Vibrato accomplished using only the arm



## Conclusion

The theremin is a very unique non-contact instrument. The pitches that are produced are the result of a capacitance change between the instrument and the player. Several playing techniques have emerged that vary in complexity and control. Digital improvements to theremins make them easier to play.

## References

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