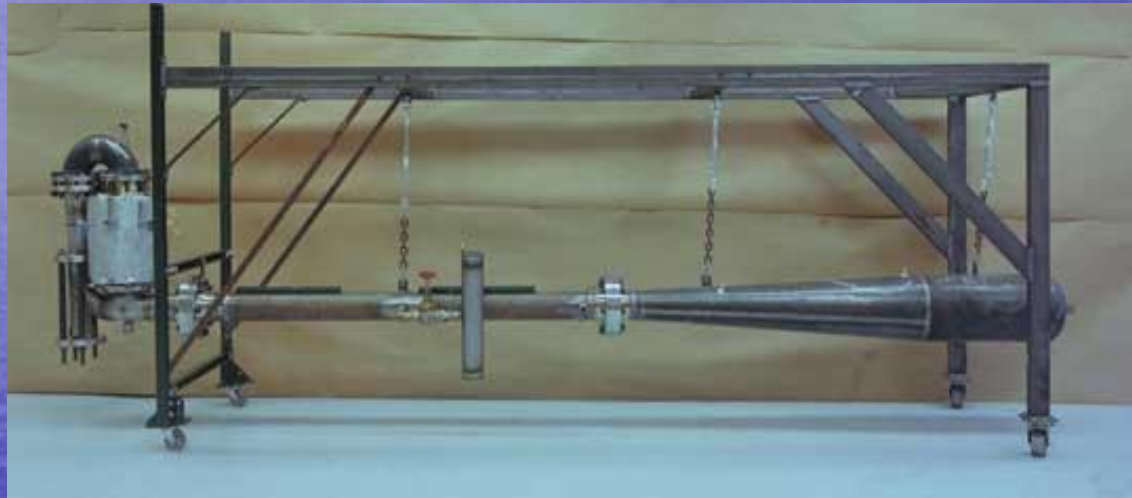


# THERMOACOUSTIC REFRIGERATION



*Presented by:*

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# OUTLINE

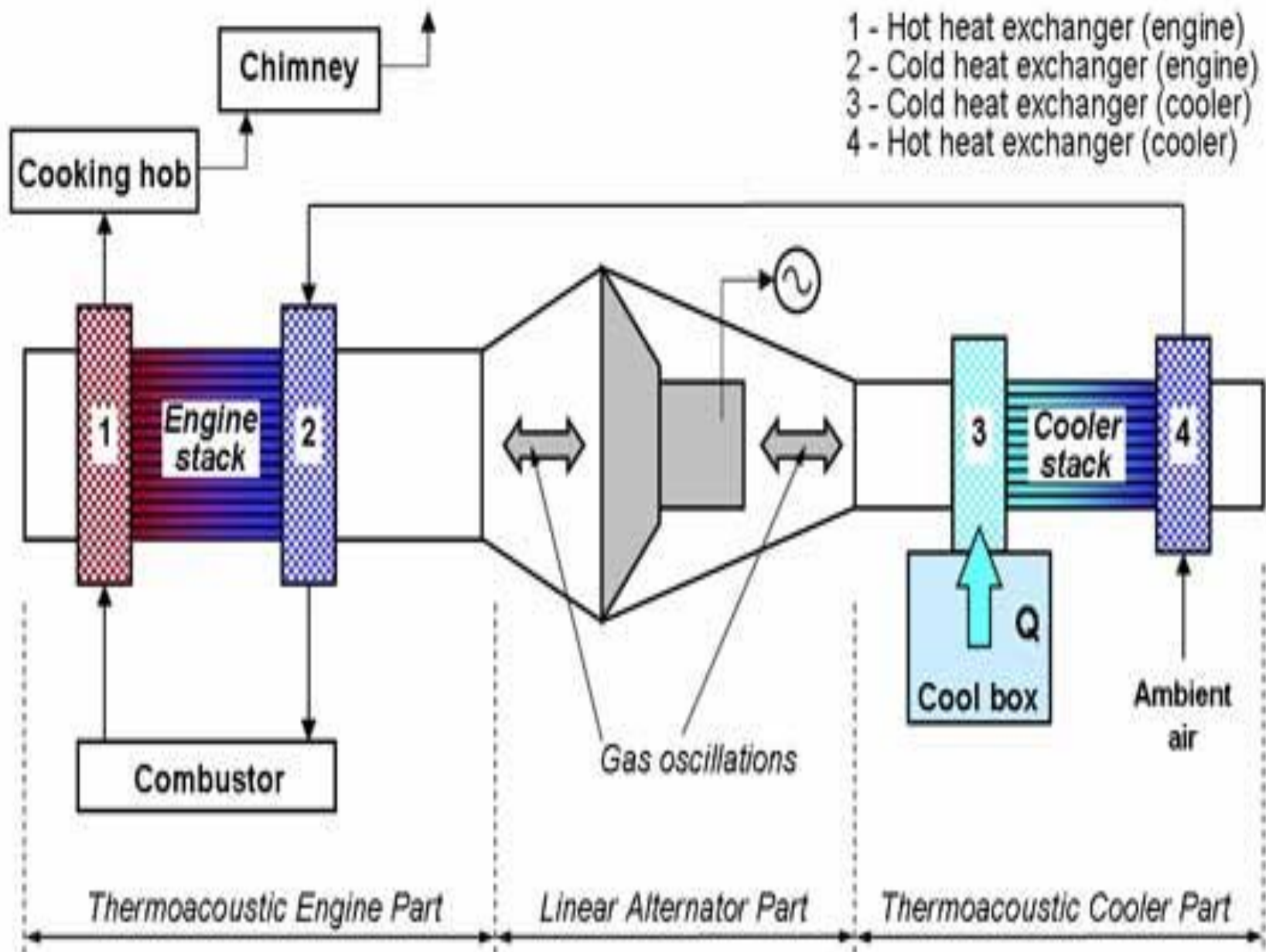
- **INTRODUCTION**
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# INTRODUCTION

- **Thermoacoustic refrigerator is a mechanical device which converts mechanical work to temperature difference that can be used in cooling.**
- **This is done through acoustic waves.**
- **Thermoacoustics is based on the principle that sound waves are pressure waves. These sound waves propagate through the air via molecular collisions. The molecular collisions cause a disturbance in the air, which in turn creates constructive and destructive interference. The constructive interference makes the molecules compress, and the destructive interference makes the molecules expand. This principle is the basis behind the thermoacoustic refrigerator.**



- **Thermoacoustic refrigerators use acoustic power to pump heat from a low temperature to ambient temperature. The heat-pumping mechanism takes place in the pores of a structure called a stack. As a typical parcel of the gas oscillates along a pore, it experiences changes in temperature. Most of the temperature change comes from adiabatic compression and expansion of the gas by the sound pressure, and the rest is a consequence of the local temperature of the solid wall of the pore.**



# DEFINITION

- **Thermoacoustic refrigerator** : It is a device which converts acoustic power to refrigeration.
- **Linear motor** : It is a device that produces linear oscillatory motion in a gas or acoustic power.
- **Thermoacoustic engine** : It is a device that produces linear oscillatory motion or acoustic power utilizing heat.

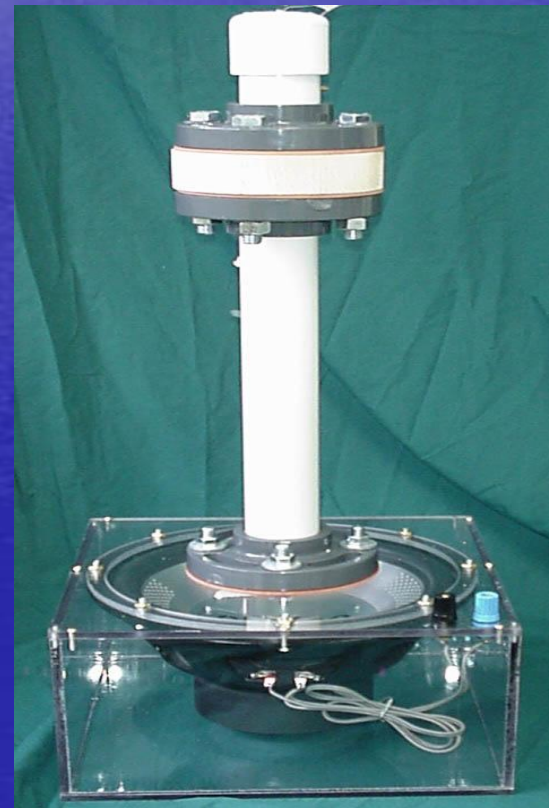


# DESIGN DESCRIPTION

- Thermoacoustic Refrigerator :
  - Unpressurized System
  - Air as Gas Medium
  - Loudspeaker as Acoustic Driver
  - Variable design (stacks)
  
- Advantages of Thermoacoustic Refrigeration :
  - No Environmentally-Harmful Refrigerants
  - Mechanically Simple

# Main Prototype Components :

- Speaker
- Gas
- Tube
- Stack
- Heat Exchangers

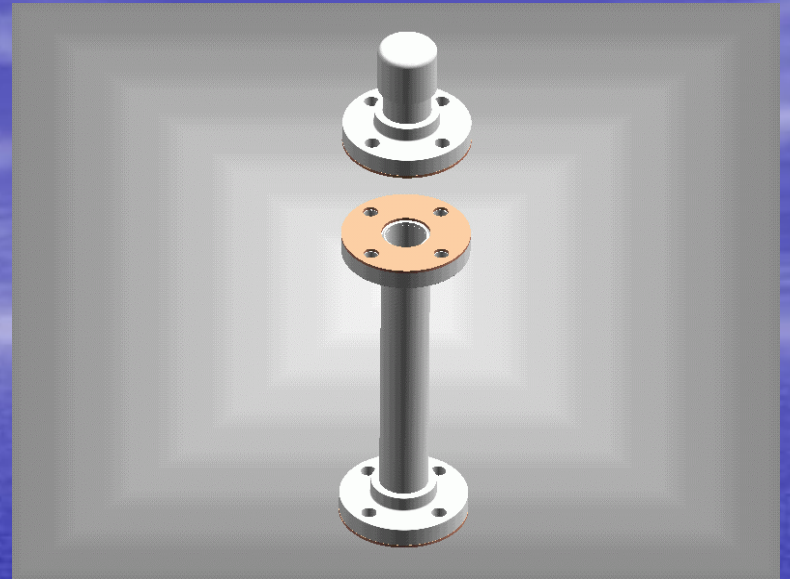




- **STACK:** The most important piece of a thermoacoustic device is the stack. The stack consists of a large number of closely spaced surfaces that are aligned parallel to the resonator tube. The purpose of the stack is to provide a medium for heat transfer as the sound wave oscillates through the resonator tube.
- **RESONATING TUBE:** The standing sound wave is produced in a resonating tube.
- **HEAT EXCHANGER:** Both ends of the stack is connected to heat exchangers, thus coupling the stack to a heat source or heat sink, the transfer of heat would be more efficient.



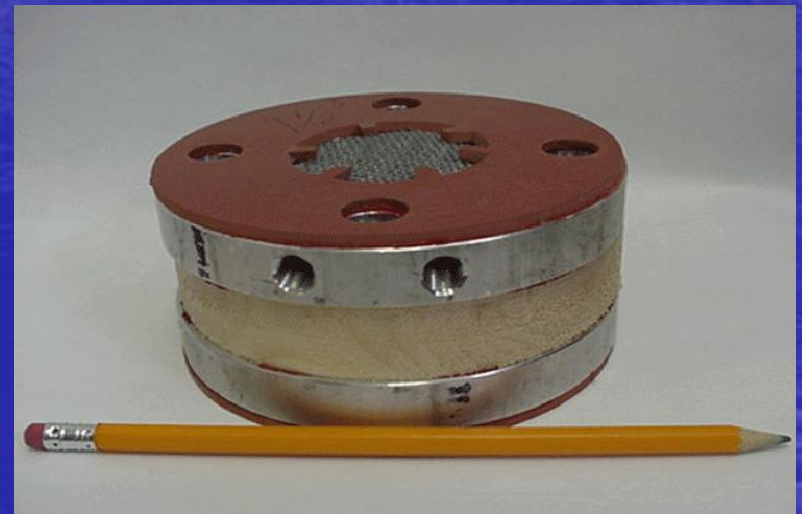
Speaker



Tube



Stack



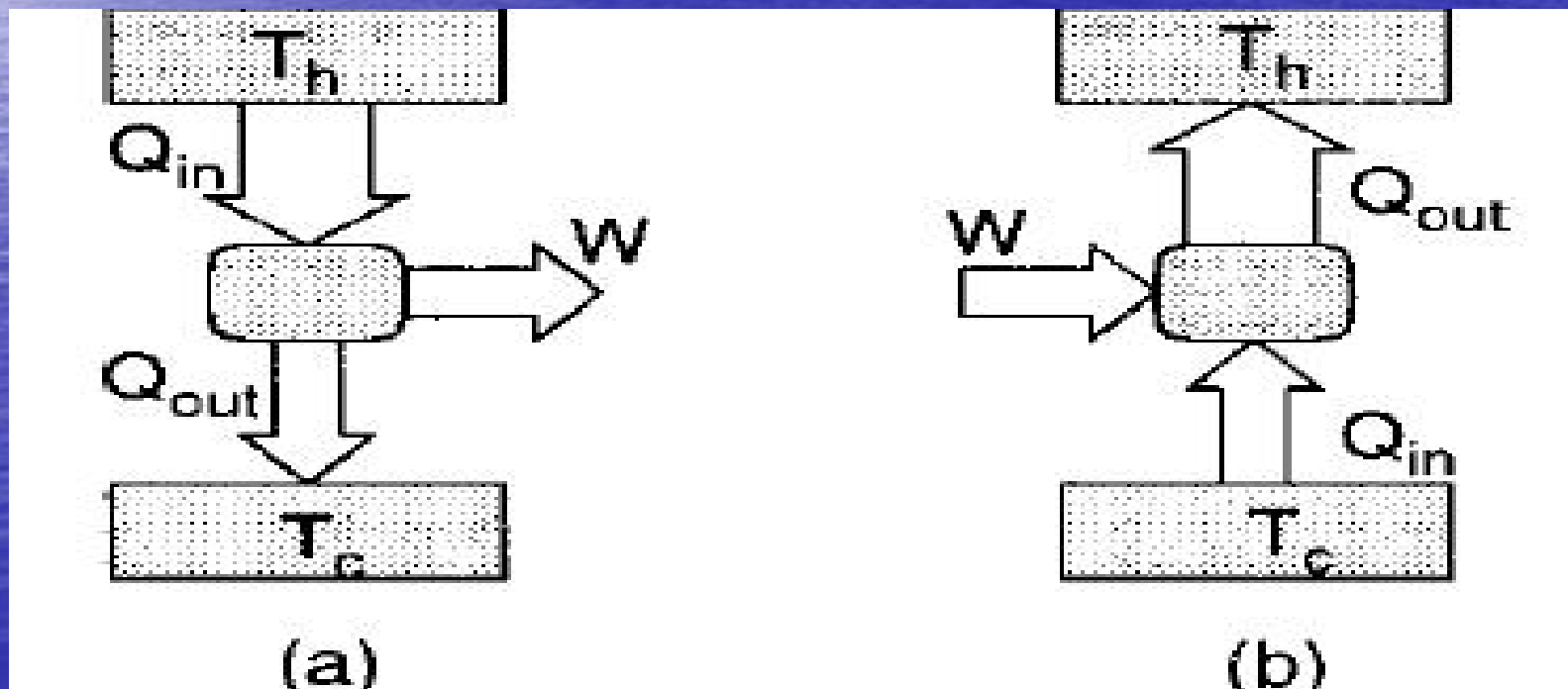
Heat Exchangers



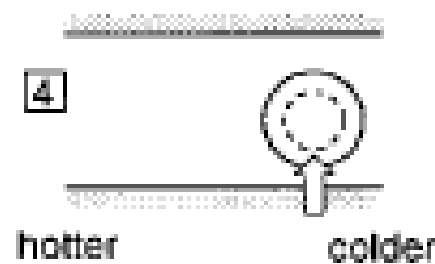
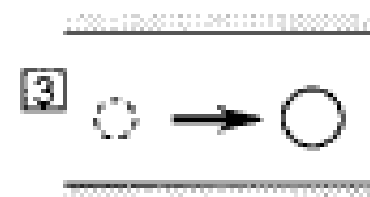
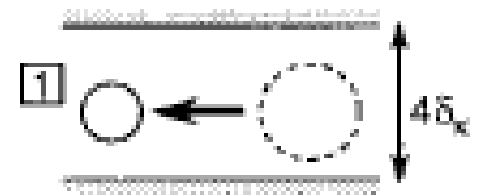
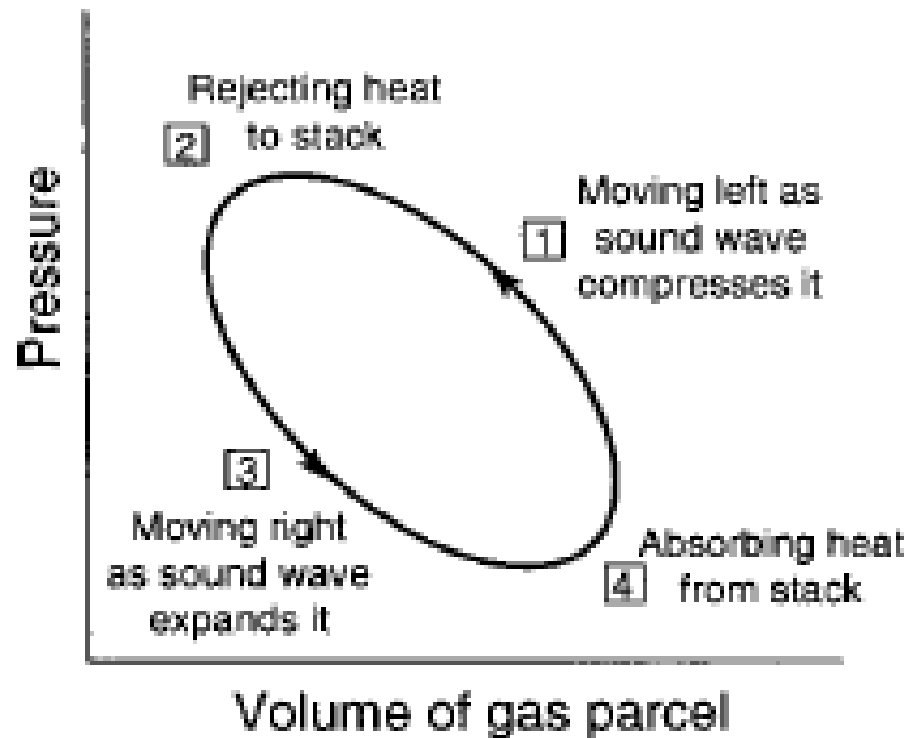
# Thermoacoustic Refrigerator

(a) Prime mover: heat power is converted into acoustic power.

(b) Refrigerator: acoustic power is used to generate refrigeration.



# Thermoacoustic Cycle for refrigeration

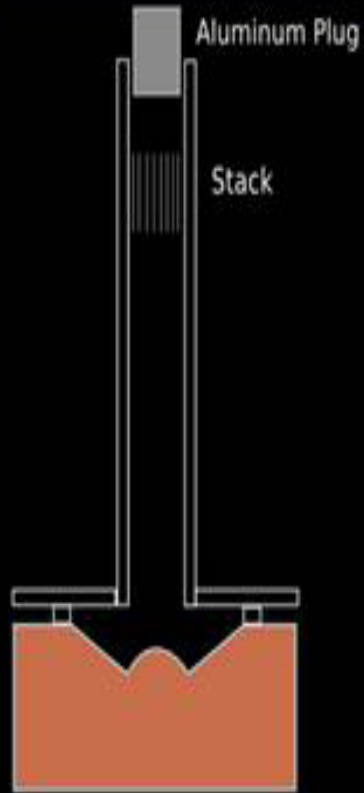




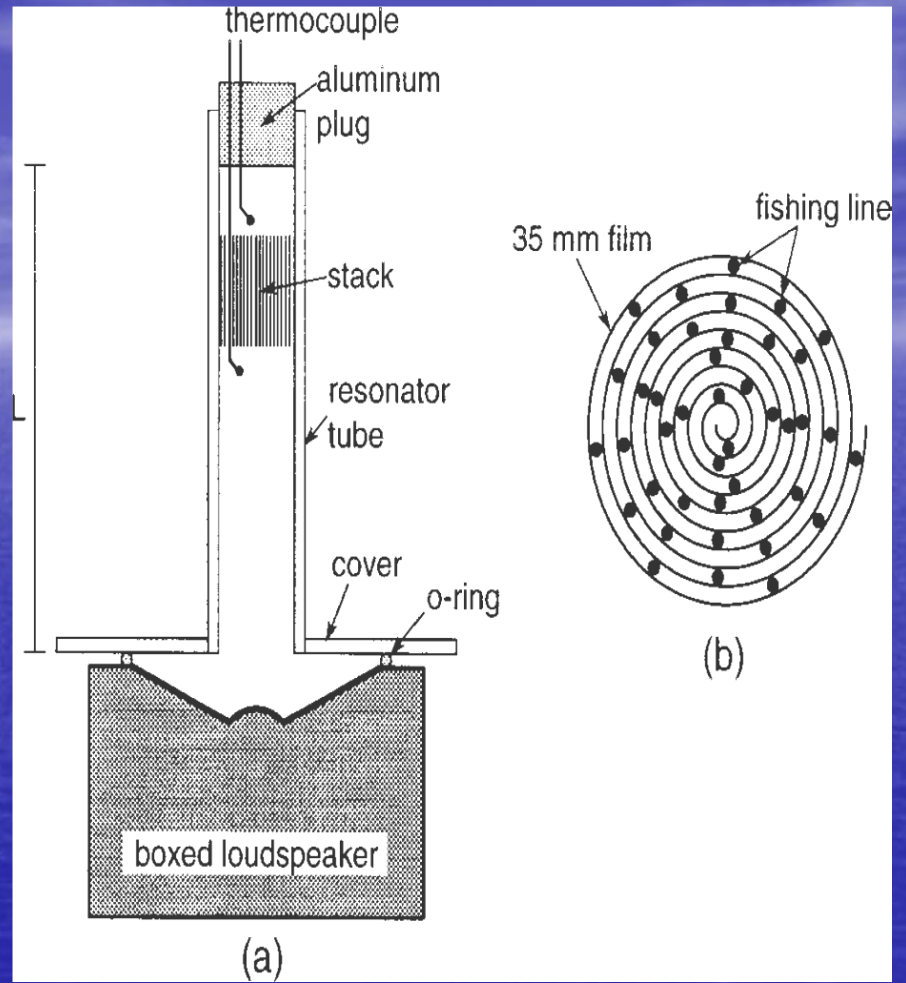
- Starting from point 1, the packet of gas is compressed and moves to the left. As the packet is compressed, the sound wave does work on the packet of gas, providing the power for the refrigerator. When the gas packet is at maximum compression, the gas ejects the heat back into the stack since the temperature of the gas is now higher than the temperature of the stack. This phase is the refrigeration part of the cycle.
- In the second phase of the cycle, the gas is returned to the initial state. As the gas packet moves back towards the right, the sound wave expands the gas. Although some work is expended to return the gas to the initial state, the heat released on the top of the stack is greater than the work expended to return the gas to the initial state. This process results in a net transfer of heat to the left side of the stack. Finally, in step 4, the packets of gas reabsorb heat from the cold reservoir to repeat the heat transfer process.



Cross Section of Stack



Boxed Loudspeaker  
Cross Section of Refrigerator



(a)

(b)



## **APPLICATIONS:**

- Cooling or heating
- Upgrading industrial waste heat
- Cheap energy source

## **BENEFITS:**

- No moving parts
- Environmentally friendly
- Use of simple materials

# CONCLUSION:

- Thermoacoustic refrigerators use sound waves to generate cooling. Furthermore, they use inert gases that are friendly to the environment. Their unique working mechanism and promising future have attracted many researchers.
- the effectiveness of thermoacoustic refrigeration for electronic devices, low cost, high efficiency cooling devices have broad applications in commercial industries and households.
- Thermoacoustic refrigerators use acoustic waves to transfer heat. Although their benefits compared with their vapour-compression counterparts are environmental friendliness, robustness and simplicity, they are currently still less efficient than traditional vapour-compression refrigerators.



THANK YOU