IonicSound

A new approach to Ion Wind Loudspeakers

Desaraju “Sai” Subrahmanyam

Presentation overview: (12 slides, 20 min.)

What is it?

Why do it?

Done before?

What's new?

What more?

Drawbacks?

What is it?

IonicSound

IonicSound is

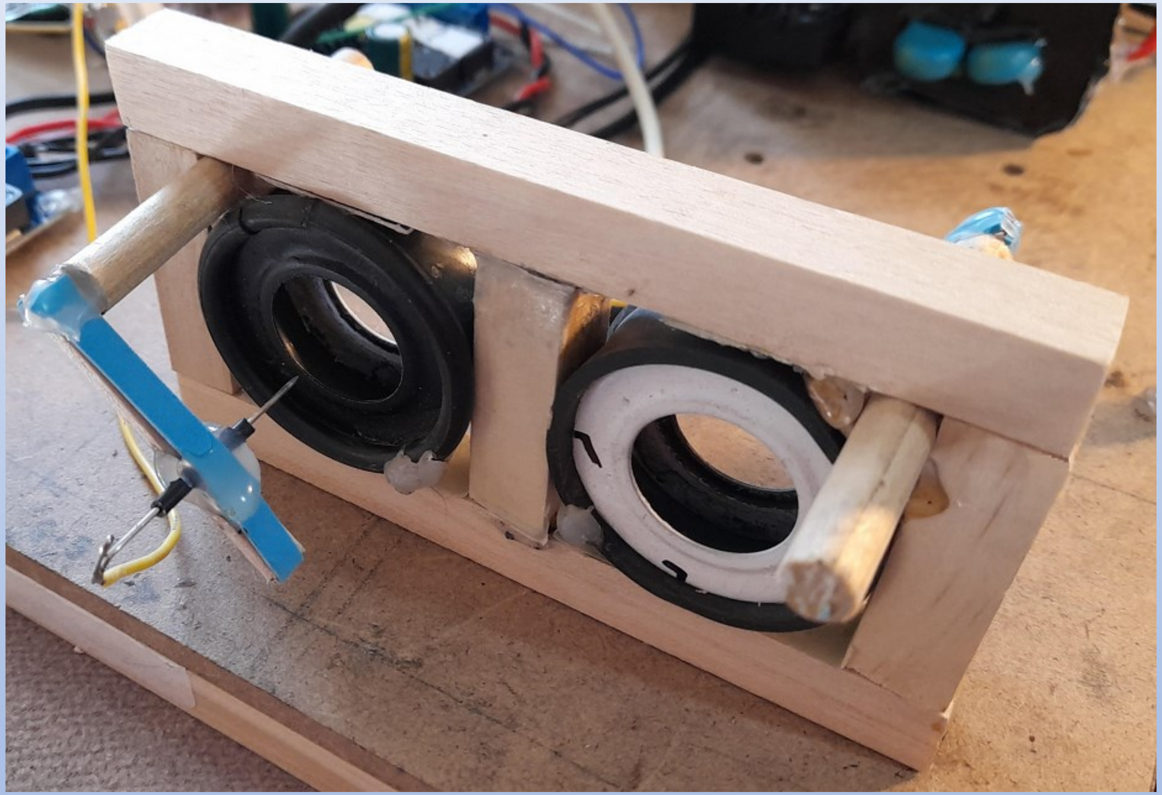
an innovative new technique
of producing sound waves
by using ions to vibrate air molecules

Sound is produced directly from the audio signal

without using a diaphragm to move the air and
without using large audio currents and
without using large audio voltages (in kV range)

US patent and ePCT applications filed 2020/2021

IonicSound



Prototype – having two radiators

What is it?

A radiator having two electrodes
- one a needle
- one a ring

Ion flow
- between needle and ring
- pushes the air

Ion flow modulation
- according to audio signal
- using new technique
- produces sound

Why do it?

Conventional loudspeakers use diaphragms to move the air,
electrical coil and magnet to move the diaphragm,
surround and spider to support and restore the diaphragm
and a walled enclosure to house the assembly

Each of these elements has properties that go against the perfect reproduction
of sound according to the applied electrical signal

Resulting in sound distortion, uneven frequency response, poor impulse response

They need large amounts of audio current to drive the physical assembly
requiring powerful solid state amplifiers that introduce their own imperfections
a high quality amplifier can cost a few thousand USD
yet about 80% of its output power is wasted

They need cross-over networks to distribute the sound to different radiators
which introduce their own imperfections

Done before?

The concept of using ions to vibrate air molecules for producing sound is not new

Prior art survey reveals that designs based on the concept were commercially available at least as far back as the 1950s

Hobby kits that produce sound thru arc discharge available today at a few hundred USD

In one way or another, the prior art relies on converting the audio signal to high voltage levels (more than 1 kv, at least 3 kV for useful output)

Their disadvantages are

- too large,
- too heavy,
- too weak (limited range between ionization and sparking, reverse acceleration),
- too expensive,
- too dangerous (arc discharge flame, ozone, loose ions),
- too skewed in frequency response (HV transformers for 20 Hz?)

What’s new?

IonicSound

Small size, prototype radiator has 28 mm dia. (1.125”)

Patent-pending technique enables wide range of ion current

- at least two octaves of swing in ion current has been achieved as of now
- the high voltage (kV) used for ionization is not modulated
- the audio signal is not boosted to high voltage (kV) range

Electrode design minimizes reverse acceleration

Relatively strong sound for ion wind approach

- prototype radiator produces 82 dB SPL measured at 30 cm distance
- measured without an enclosure

Protype SPL is not limited by any fundamental restriction of the new technique

- Rather, it is limited by electrical circuit design, component ratings, radiator dia used in the prototype
- SPL can be improved and has been improved over design iterations

What’s new?

IonicSound

Scalable

boost SPL to commercial grade by:

scaling up to larger dia radiator (need higher operating voltage, say order of 50 kV, a matter of careful design, low power order-of-100 W power supplies at 400 kV are commercially available and inexpensive)

scaling out, to multiple radiators (overall physical size may come to the same ballpark as conventional tower speakers, ESL, Magnepan)

improving electrical circuit design and component ratings

Radiator does not load the upstream audio source (amplifier)

the same amplifier can be used regardless of 1, 10, or 100 radiators

class A amplifiers can be used to provide the audio signal
allows higher quality audio signal

What's new?

IonicSound

Flexible geometry

- Commercial grade embodiments may have multiple radiators
- The multiple radiators can be arranged in different geometric configurations,
  - the speaker as a whole need not have a rectangular face
- Attractive for vehicle applications

Configurable for flat frequency response (no crossover network needed)

- of course, superior transient response (impulse, square wave)

Efficient

- no order-of-80% loss to ohmic heating
- in theory, all the electrical energy is dissipated to the air
- may be attractive for EVs, other battery-powered applications

Lightweight

- no bulky magnets, no bulky baskets, no bulky walled enclosures
- enclosure can be made of perforated sheet that does not color the sound

What's new?

IonicSound

Inexpensive

demo model component cost is around USD 200 for stereo channels

TCO offsetting amp cost can be very attractive

very few component parts, no moving parts, no precision parts

=> can be hand-assembled, start-up costs can be extremely low

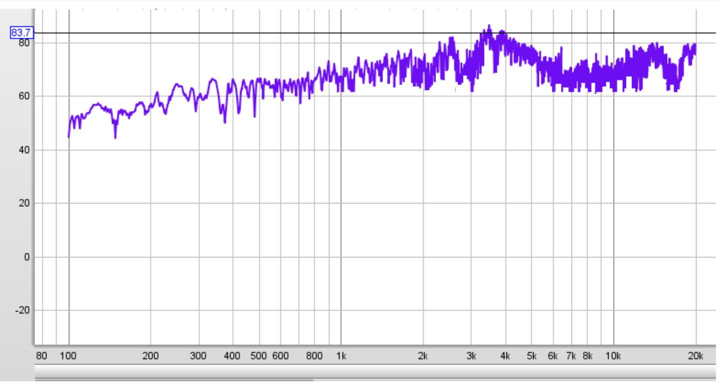
=> is easy and inexpensive to repair; warranty and repair terms can be attractive

Safe

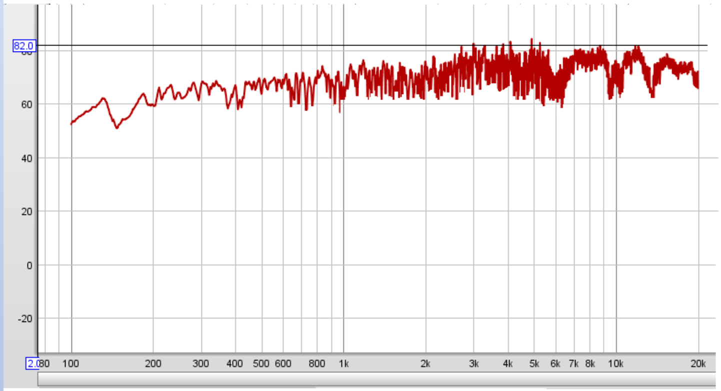
no arc, no glow discharge, no flame
very low ozone, loose ions

IonicSound

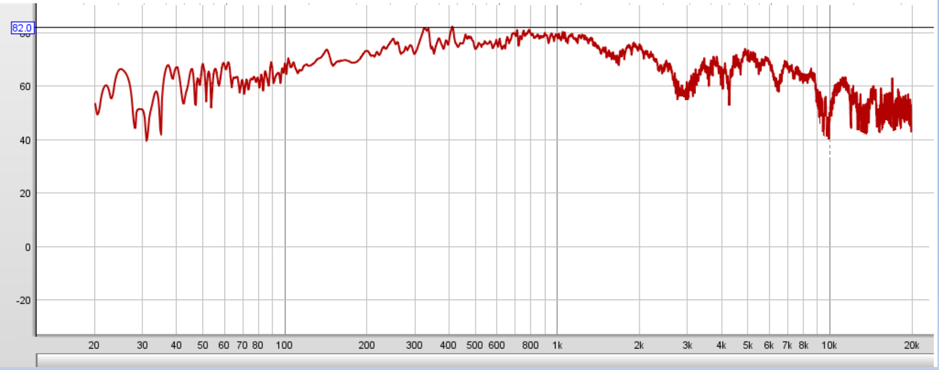
Frequency response of prototype



Configuration 1



Configuration 2



Configuration 3

What more?

IonicSound

Digital Loudspeaker

IonicSound technique enables a quality digital loudspeaker that can reconstruct the sound in the air directly from digital signals

eliminating the need for an expensive DAC (USD 3000)

superior sound with fewer processing stages at comparable cost

Drawbacks?

trace amounts of loose ions

closed circuit needle-to-ring design allows maximum absorption of working ions emitted into the fluid

loose ions can be absorbed in the enclosure by earthing it

trace amounts of ozone

can be reduced by local UV-C irradiation, local heating