

Magnet-only loudspeakers

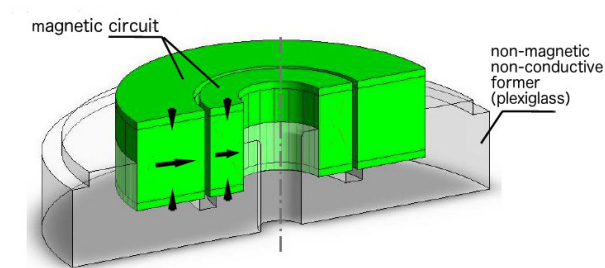
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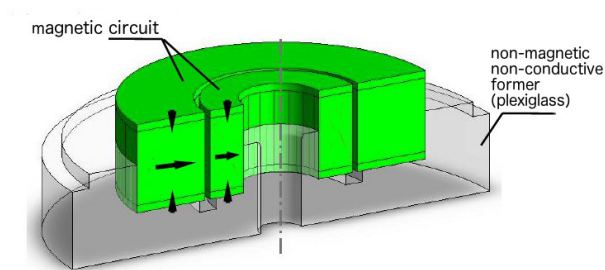
Magnet-only loudspeaker



- no iron pieces (only magnets)
- recent technology (10 yrs)
- several patents

[1] Merit, B. (2010). Contribution A L'identification Des Non-linéarités Des Moteurs De Haut-parleurs Électrodynamiques: Sur La Réalisation De Moteurs Tout Aimant. Ph.D. Thesis, Le Mans University

Magnet-only loudspeaker



Orkidia[®]



**Le Mans
Université**

Patented by Orkidia Audio and Le Mans University.

Patent No. 8,055,010 B2 (Nov. 8, 2011)

[1] Merit, B. (2010). Contribution A L'identification Des Non-linéarités Des Moteurs De Haut-parleurs Électrodynamiques: Sur La Réalisation De Moteurs Tout Aimant. Ph.D. Thesis, Le Mans University

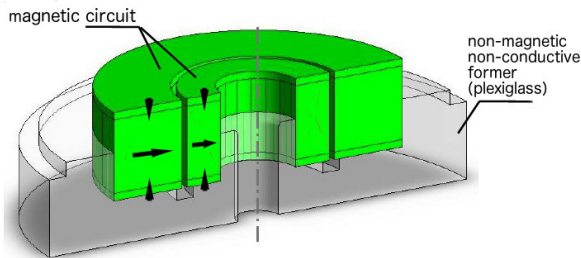
Magnet-only loudspeaker motors :

- 1) almost no eddy currents
- 2) almost no flux modulation

consequently: low distortion compared to normal loudspeaker motor

1) almost no eddy currents

Magnet-only loudspeaker



Magnets have a very low electrical conductivity. The change in magnetic flux due to the voice coil current does not cause eddy currents (there's nowhere for them to run in).

experiment n.9

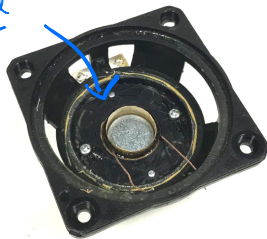
blocked impedance:

magnet-only motor vs. normal motor

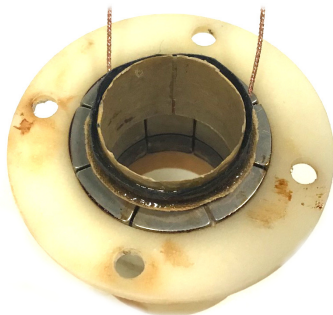
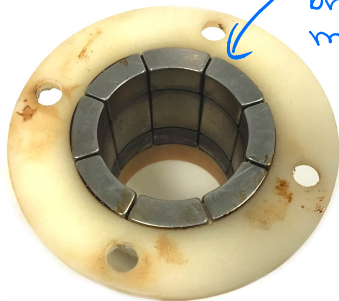
experiment n.9



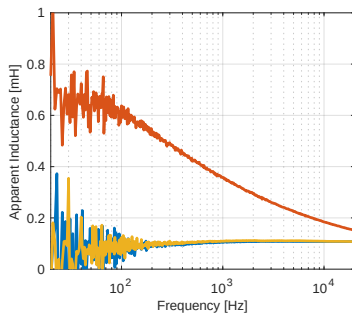
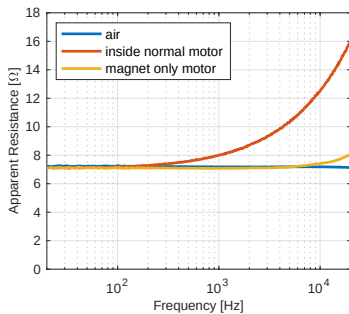
normal
motor



magnet
only
motor



experiment n.9



experiment n.9

Permeability of magnets is $\mu \cong \mu_0$ (vacuum permeability).

A **magnet-only** (or ironless) loudspeaker exhibits almost no eddy currents.

Consequently, inductance L_e and resistance R_e remain constant.

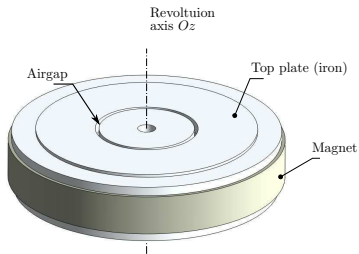
example of a research work:

blocked impedance:

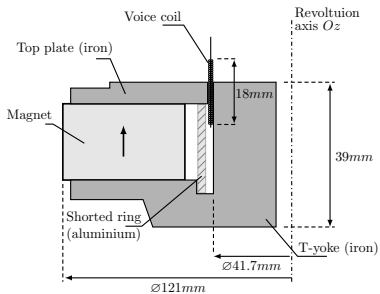
magnet-only motor vs. normal motor

magnet-only motor vs. normal motor

original (normal) motor



(a)

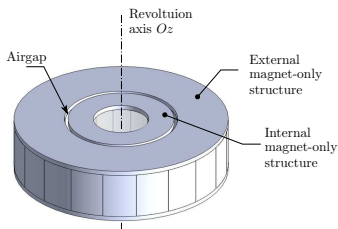


(b)

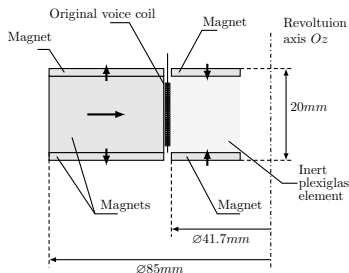
[1] Merit, B., & Novak, A. (2015). Magnet-only loudspeaker magnetic circuits: A solution for significantly lower current distortion. J. Audio Eng. Soc., 63(6).

magnet-only motor vs. normal motor

modified (magnet-only) motor



(a)

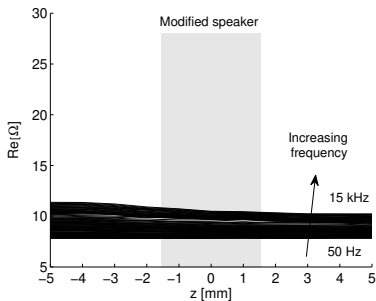
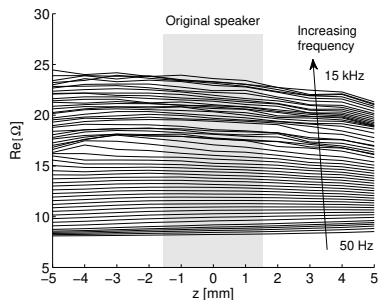


(b)

[1] Merit, B., & Novak, A. (2015). Magnet-only loudspeaker magnetic circuits: A solution for significantly lower current distortion. J. Audio Eng. Soc., 63(6).

magnet-only motor vs. normal motor

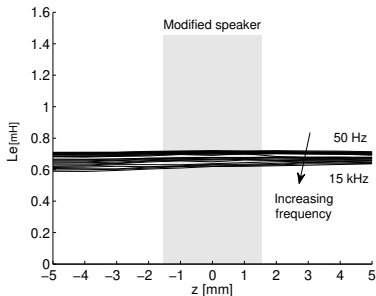
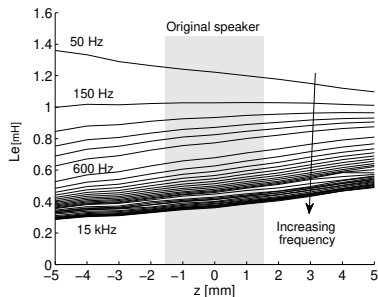
$$\text{Apparent resistance } R_e(z, \omega) = \Re\{Z_e(z, \omega)\}$$



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magnet-only motor vs. normal motor

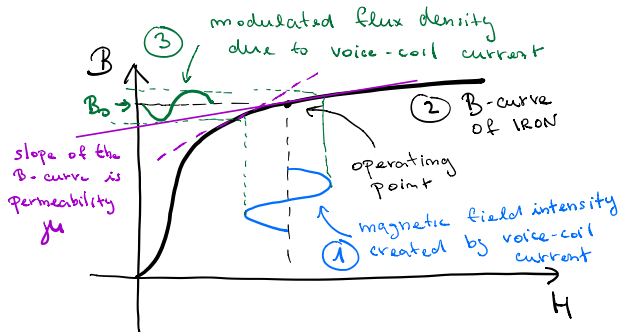
$$\text{Apparent resistance } L_e(z, \omega) = \frac{\Im\{Z_e(z, \omega)\}}{\omega}$$



[1] Merit, B., & Novak, A. (2015). Magnet-only loudspeaker magnetic circuits: A solution for significantly lower current distortion. J. Audio Eng. Soc., 63(6).

2) almost no flux modulation

flux modulation - normal motor

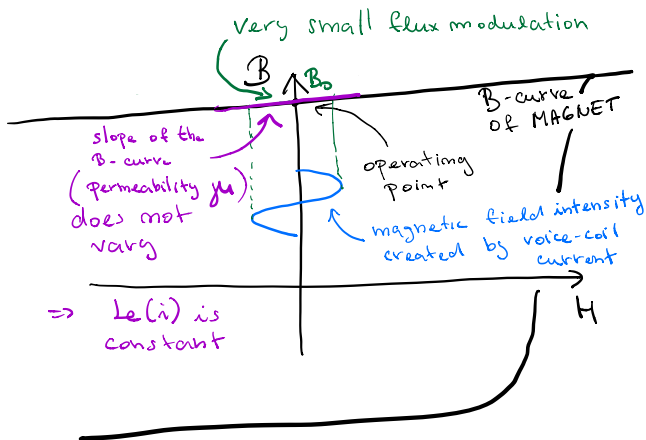


H ... magnetic field intensity (external)

B ... magnetic flux density

$\mu = \frac{dB}{dH}$... (differential) permeability

flux modulation - magnet-only motor

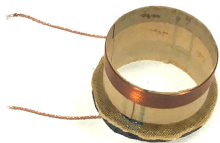


experiment n.10

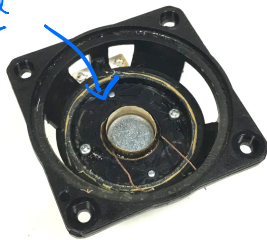
current distortion of blocked voice-coil
(no displacement)

magnet-only motor vs. normal motor

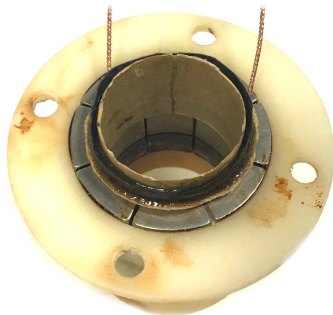
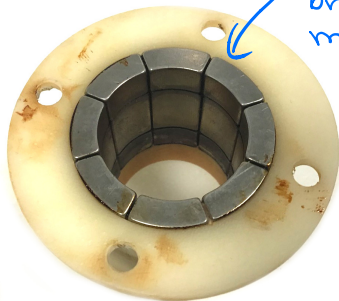
experiment n.10

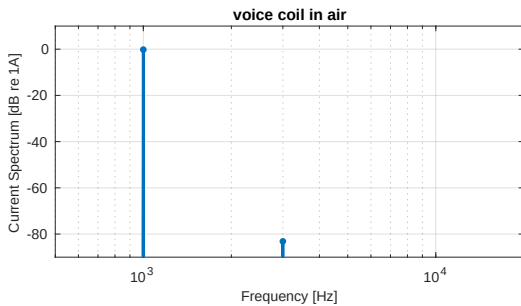


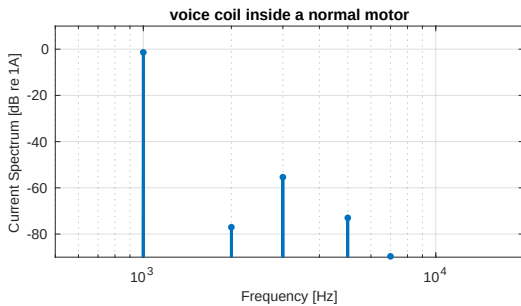
normal
motor

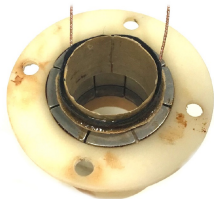
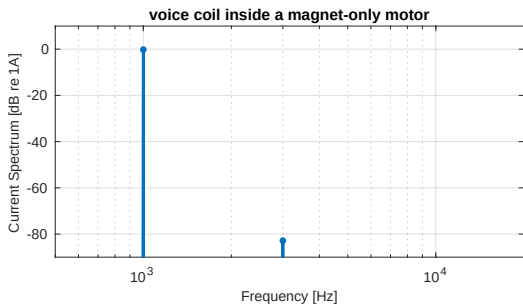


magnet
only
motor









experiment n.11

current distortion of non-blocked voice-coil
(membrane is free to move)

magnet-only motor vs. normal motor

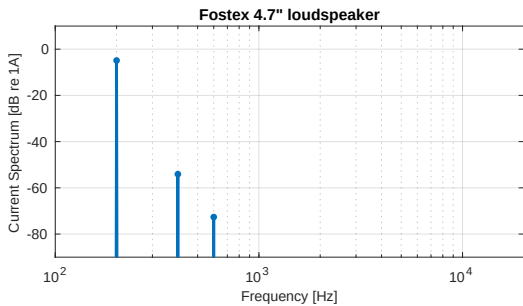
experiment n.11

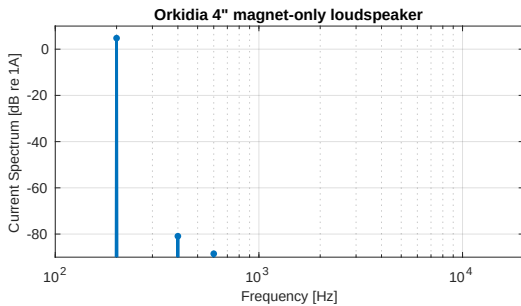


magnet-only 4" loudsepaker



traditional 5" loudsepaker





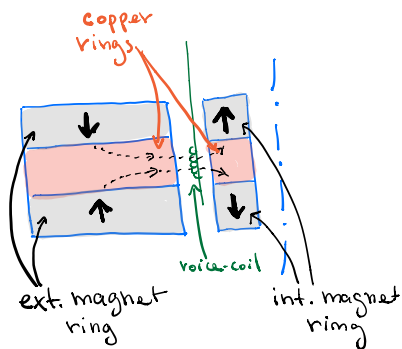
experiment n.11

compring almost same size (4-5"): magnet only motor has much less distortion

4" magnet-only loudspeaker vs. 10" normal loudspeaker:

similar distortion rather due to $Bl(x)$ and $C_{ms}(x)$.

Commercial products: Borresen acoustics



http://borresen-acoustics.com/images/Downloads/%20Boerresen-052019_web.pdf

Commercial products: Cleer audio - NEXT headphone



<https://cleeraudio.com/over-ear-headphones/next-audiophile-headphone/>

Conclusion

Magnet-only (iron-less, iron-free) motors:

- (almost) **no eddy currents** (magnets have low electric conductivity)
- very **low flux modulation** (magnet permeability $\cong \mu_0$)
- L_e is independent of displacement, current, and frequency
- much **lower distortion** compared to traditional motors

thank you for your attention ...

for more details:

- [1] Merit, B., & Novak, A. (2015). Magnet-only loudspeaker magnetic circuits:
A solution for significantly lower current distortion. J. Audio Eng. Soc., 63(6).

Patent No. 8,055,010 B2 (Nov. 8, 2011)