2022

THEORY OF C2S™

THE CONCENTRIC COPLANAR STABILIZER FOR COHESIVE SOUND REPRODUCTION

"Sound is a physical phenomenon. Its creation, design and development must submit to the physical laws of nature."

-Mikhail Dinaburg

DINABURG TECHNOLOGY
USPTO Patent: US10812912B2

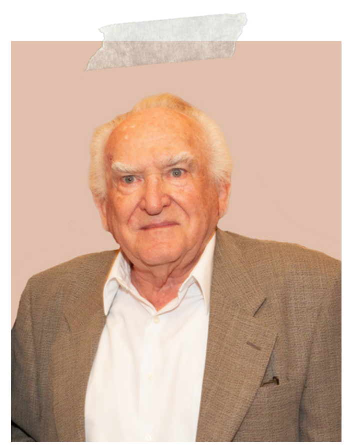
INVENTOR BIO

Mikhail Rafailovich Dinaburg was born on August 8, 1934, in the city of Melitopol, Zaporozhye region, Ukraine.

In 1957, he received a degree in physics. After a short career of teaching physics at a Polytechnic Institute, Mikhail enjoyed a career in industrial manufacturing where he was the head of various engineering teams where he engaged in both design, research and development, as well as the full cycle of production preparation. He was responsible not only for the development of products, but also making sure everything worked properly in production, so that the workers in the workshops could produce high-quality parts and provide high-quality products.

In February 1998 Mikhail and his family immigrated to the United States of America.

Mikhail Dinaburg is an audiophile, a physicist and engineer. For over two decades, he has dedicated himself to developing the Dinaburg patented Technology. With help from some of the world's top specialists using leading-edge technologies, Mikhail was able to prove his theory and technology works in real-world applications and delivers results that your eyes might not believe, but your ears won't be able to deny.



Mikhail Dinaburg
Inventor

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In striving to achieve quality audio today most sound reproduction systems utilize a multi-driver approach, typically a woofer, midrange, and tweeter. In many systems, a subwoofer is part of the configuration. These systems inherently have a multitude of complications and difficulties associated with sound reproduction. The full amplitude and frequency range of natural sound (meaning sound created by any instrument including voice) emanates from a single point, or acoustic center. For example, when a note is played from a trumpet, all of the sound comes from the bell. The low frequencies of the note do not come from one part of the trumpet and the higher frequencies (overtones) come from a totally different part. However, when this note is reproduced from multiple distinct drivers, the amplitude and frequency range of the natural sound is split between multiple acoustic centers. In Electro-Acoustics, DSP is used primarily in place of classic electronics that has been in common use since the 1970's. THe Linkwitz Transform (bass energy) and Lnkwitz Riley (move acoustic centers vertically) are two of many examples that certainly improve fidelity. DSP CANNOT improve distortion but C2S™ can.

A great deal of effort is put into time alignment of drivers in multi-way speaker systems from DSP time delays to Linkwitz-Riley Crossovers. These are not needed in the C2S™ alignment which is inherently time aligned and phase linear throughout the audio spectrum.

In addition, enormous time and resources are spent trying to achieve pristine audio fidelity. To deal with unwanted sound from a loudspeaker cabinet (enclosure), intricate and complex enclosures fabricated from esoteric composite materials.These enclosures can weigh over 100 lbs.

Amplifier power requirements continue to grow, systems of speakers and amplifiers with over 1000 watts are no longer rare. Speaker and audio-component interconnect cables using ultra-expensive esoteric conductors have become common.

Yet the most difficult problem to resolve remains - the elimination of unwanted sound energies emanated by the flexing of the loudspeaker cone (diffuser) and other surfaces of the loudspeaker cabinet.

"The source of the distortions, the masking and tainting of sound must be eliminated at any cost" (Opinion of the engineers at Wilson Audio).
The issue with the unforgivingly low efficiency of the speaker, and sound system in whole remains.

THERE ARE TWO POSSIBLE DIRECTIONS:

1.Continue to fight with the unwanted sound energies generated in the frontal plane of the diffuser and the energies reflected from the back side of the speaker by modifying cabinets, filters, and all other components of a sound system. (What is being done today).
2.Utilize these energies to reproduce live, undistorted sound which creates a whole new concept of sound reproduction and takes sound reproduction to the next level.

Systems created for sound reproduction have always strived for the best possible sound quality given the constraints imposed on a specific design (e.g., materials cost, when product has to be introduced, etc.) Regardless of design constraints, the music only is heard when it has been reproduced by the end component, the speaker. Regardless of the combination and quality of preceding components, at the end of the audio signal chain, it is the speaker that produces the end result (sound). To take this one step further, the main component which creates the sound is a diffuser (the radiating diaphragm). Therefore, this is where I have focused my research and development efforts for these past twenty-two years.

Sound reproduced by a loudspeaker, no matter how advanced the design, will always add distortion. The question is, where is the distortion coming from and what causes it?

Years of experimenting eventually brought me to the conclusion that there is more in this distortion issue that meets the "Ear", no pun intended. I understood that I needed to find the cause of sound distortion during playback, and then come up with a solution.

I proposed a new theory, the theory of “Diffuser Active Volume Stabilization”
This new theory was based on BOYLE's physical law - PV= CONSTANT.

The absolute pressure exerted by a given mass of an ideal gas is inversely proportional to the volume it occupies if the temperature and amount of gas remain unchanged within a closed system.

The theory of "Diffuser Active Volume Stabilization” focuses on the small volume of air around the diffuser (diaphragm – usually cone shaped) - this volume is equal to the active area of the diffuser - S, multiplied by the amplitude of diffuser oscillations - H.
$V=S\times H$

According to this theory, sound (actually the particle velocity of the air molecules which create the sound waves) is created in a narrow strip of air in front of, and just behind, the diffuser in a height equal to the amplitude of the diffuser oscillations. The state of this air volume will affect whether the diffuser oscillates in ideal piston motion so that it moves in strict accordance to the electrical signal from the amplifier. Any diffuser movement that does not follow the amplifier signal will create distortion.

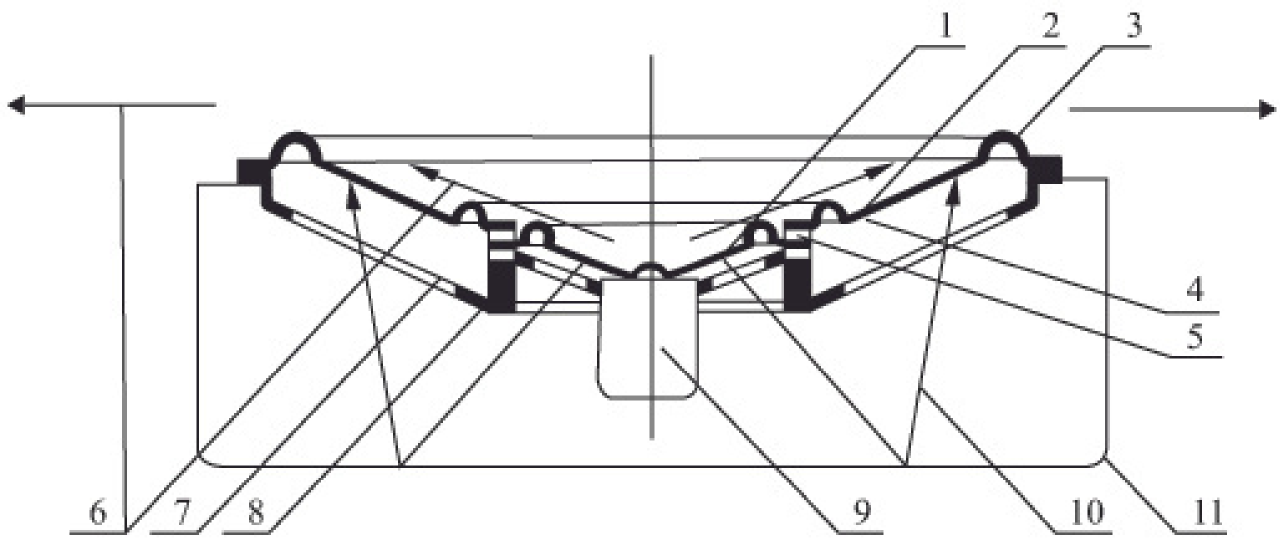
It is established that various forces act on the moving (oscillating) diffuser including forces associated with voice coil and air pressure. The moving diffuser is affected by the braking force of the air pressure inside the enclosure when moving away from the listener (moving backward) and also holds it when moving towards the listener (moving forward). These forces change the volume of air (Volume = Diffuser surface area × Height of diffuser displacement) on either side of the diffuser. These two unequal volumes introduce distortion. Any speaker that has a diffuser, by its nature produces sound with distortion.

Therefore, maintaining a constant volume of air around the diffuser is critical to minimizing distortion. In order to prevent these unequal air volumes on either side of the diffuser, it is necessary to install a stabilizer. Such a stabilizer is located around the active part of the speaker (that portion which has the motor structure attached to it). For this stabilizer to function in accordance to Boyle's Law, it must be concentric with, and coplanar to, the active part of the loudspeaker. Dinaburg Technology refers to this Concentric and Coplanar Stabilizer as C2S™. In previous publications and patent documents, the C2S™ has also been referred to as the Integral Coaxial Speaker Cone and a Passive Ring Radiator. Although the C2S™ does exhibit the behavior of a passive radiator, it does much more as will be explained in this paper.

KEY CONCEPT OF A C2S™ LOUDSPEAKER DRIVER:

THE DIFFUSER CONSISTS OF TWO INDEPENDENT PARTS, ACTIVE AND STABILIZING, WORKING IN THE SAME VOLUME OF AIR, CREATING SOUND TOGETHER. COMBINATION OF PROPERTIES OF THE TWO PARTS OF THE DIFFUSER ALLOWS TO REPRODUCE SOUND WITH REQUIRED CHARACTERISTICS (e.g., accurately following the amplifier signal) and MINIMAL DISTORTION.

C2S™ Loudspeaker driver components



1. Active part
2. Stabilizing part
3. Outer Surround
4. Stabilizing part
5. Passive ring
6. Direction of propagation of sound energy in the frontal plane
7. Basket
8. Basket structural member
9. Magnet
10. Direction of propagation of sound energy, inside enclosure from reverse side of the active part of the diffuser
11. Cabinet

After the first samples of speakers were made, it was found that such a speaker, when held by hand outside the enclosure creates low distortion with a linear transfer function. You can see how, under the action of the active part of the diffuser, the stabilizing part oscillates and both parts works together.
·It was found that the active part radiates energy, not only forward and backward, but also in the plane of the diffuser, around the circumference to the sides.
·This is the energy that existing designs do not use; they try to get rid of it. It introduces distortions and forces designers to make heavier/more dense cabinets. This energy can be used to create sound without distortion and increase the efficiency of the speaker.

THE STABILIZING PART OF THE DIFFUSER PERFORMS THE FOLLOWING FUNCTIONS:

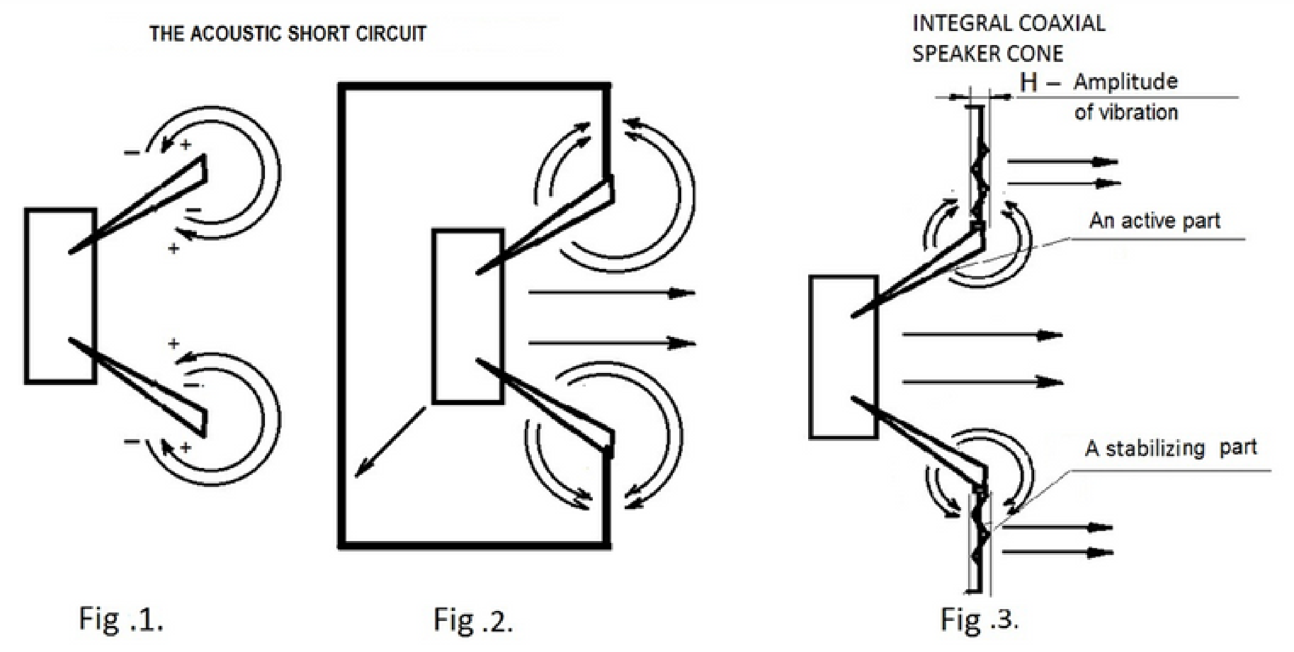
1. Maintains a constant volume of air around the diffuser and prevents sound distortion from occurring.

2. Creates a balance between the active and stabilizing parts.

3. Collects unused energy in the plane of the active diffuser and energy reflected from the back wall of the cabinet and turns it into useful sound energy, in addition to the sound that the active part creates. This is the energy existing diffusers do not use; they try to get rid of it.

4. Solves the problem of obtaining the full range of frequencies from one source. Extends the bass range of the sound zones of the active part of the diffuser with minimal distortion.

5. Solves the problem of acoustic short circuit. This is explained below



(Figure 1). shows the active driver suspended in air with no enclosure. Sound will radiate from the front of its diffuser into the room but it will be minimal.Most of this sound energy recirculates.This is known as an acoustic short circuit.

To make the active driver work properly, it is then mounted in an enclosure (Figure 2). Much more sound energy radiates into the room but there is still recirculating energy which hits the enclosure baffle. This can cause cabinet resonances and is also wasted sound energy.

By attaching C2S™, this wasted energy is now utilized (Figure 3).This balances the air volume in front of, and behind, the active and stabilizing parts which in turn makes the speaker more efficient and reduces distortion.

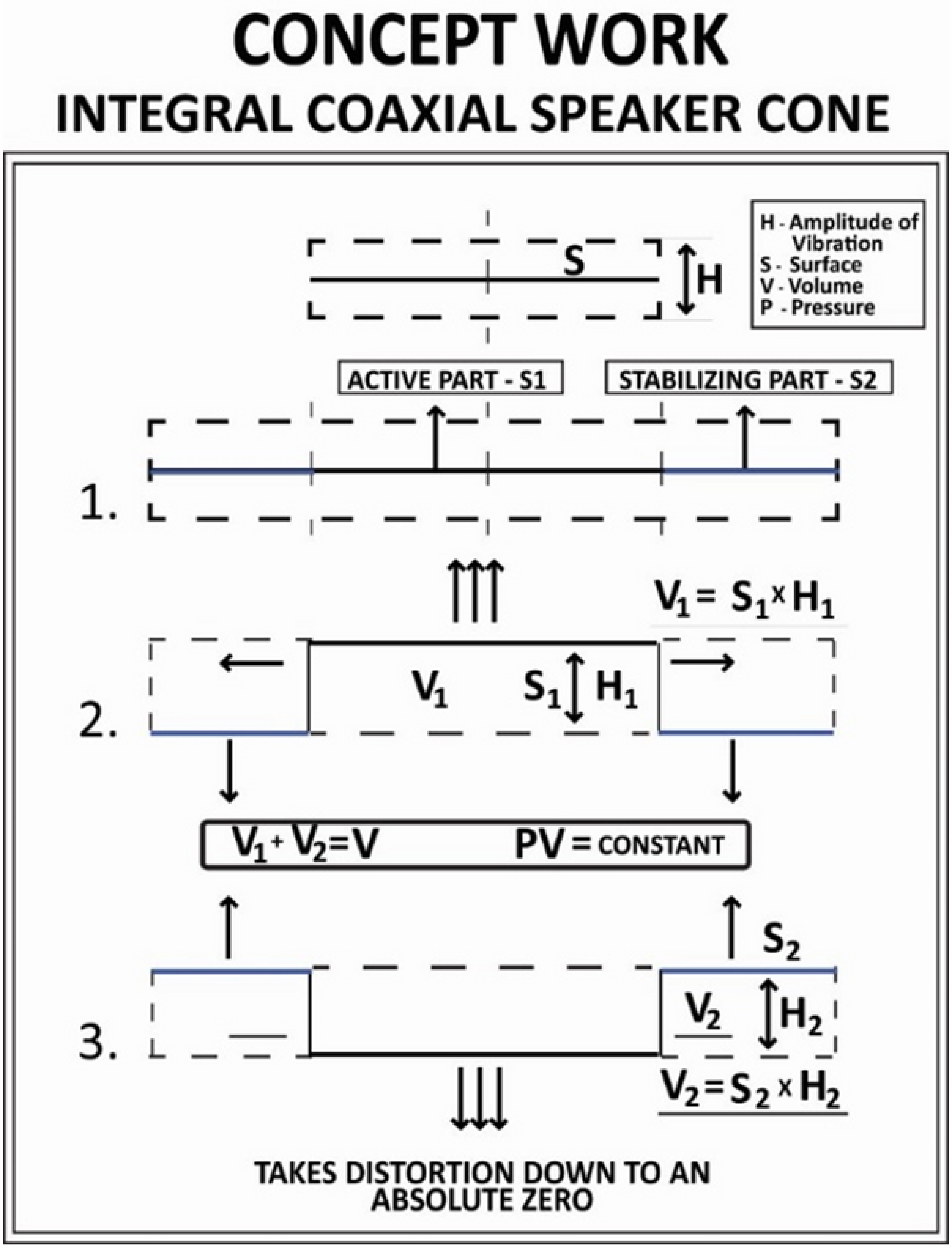


Figure 4: Concept Work Integral Coaxial Speaker CONE

At the top of the diagram (Figure 4) is shown the generally accepted diffuser area - S, which fluctuates with the amplitude - H. It fluctuates in a certain volume of air (S*H).

Position 1
The active part and the stabilizing part of the diffuser, creating sound together (both portions are in phase and sound is generated towards the listener).

Position 2
When around the active part of the diffuser, the stabilizing part of the diffuser is independently suspended. Under the action of the signal, the active part begins to move forward on H1. The sound will be created when the air in front of the active part is completely compressed. But around the diffuser, there are no obstacles in diameter, and part of the compressed air will go to the side and carry with it energy, which will cause the stabilizing part to move backward, thereby relieving the load from the active part, which causes the speed of the diffuser to slow down forward motion. If the speed of the diffuser changes, there is distortion.

Position 3.
This is the return of the active part of the diffuser to its original position. The total volume of air around the two parts of the diffuser is V1+V2=V PV=CONSTANT (Boyle's Law)
If the volume of air around the diffuser does not change in the height of the amplitude of the oscillations, then there are no additional forces that distort the sound.

THE TESTS SHOWED THE FOLLOWING RESULTS:

BETTER EFFICIENCY

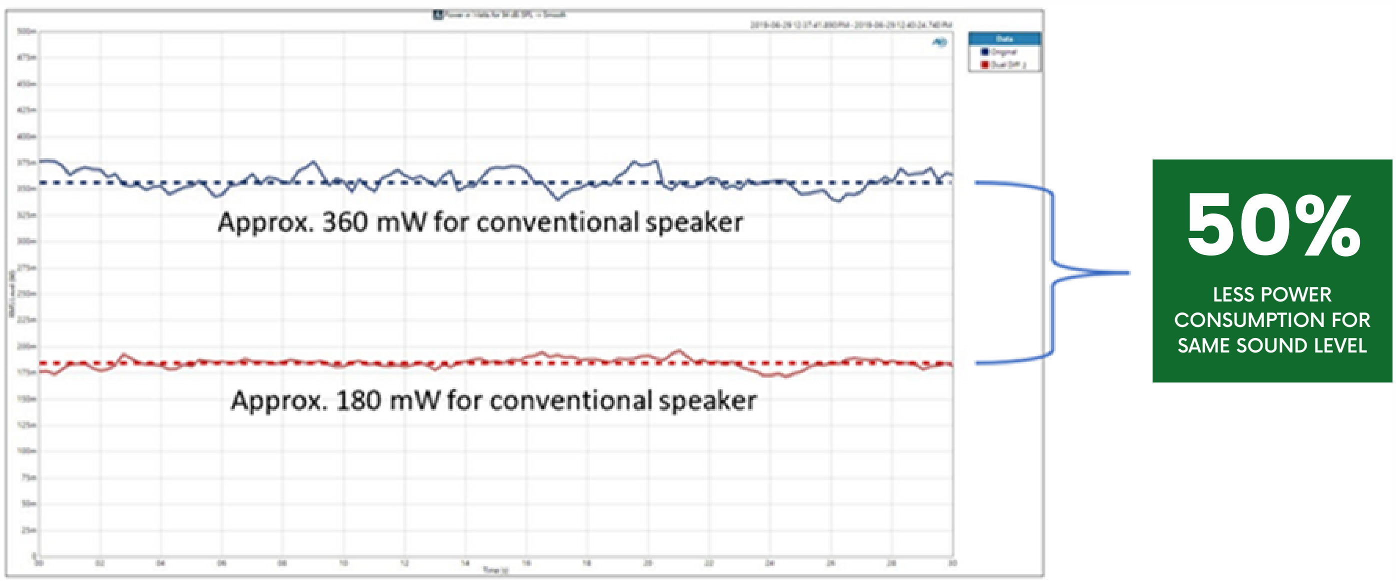


Figure 5: Power Consumption

In (Figure 5), this measurement was made using the Audio Precision APx 517 audio analyzer and a GRAS 46AE ½” free-field measurement microphone. The power level was set to produce 94 dB SPL with band-limited pink noise (20 Hz to 2 kHz) as the excitation signal. The conventional speaker was a 5.5” midrange driver mounted in a sealed enclosure. This same driver was then used as the active part of a 12” Dinaburg driver where the 5.5” midrange was

LOWER DISTORTION

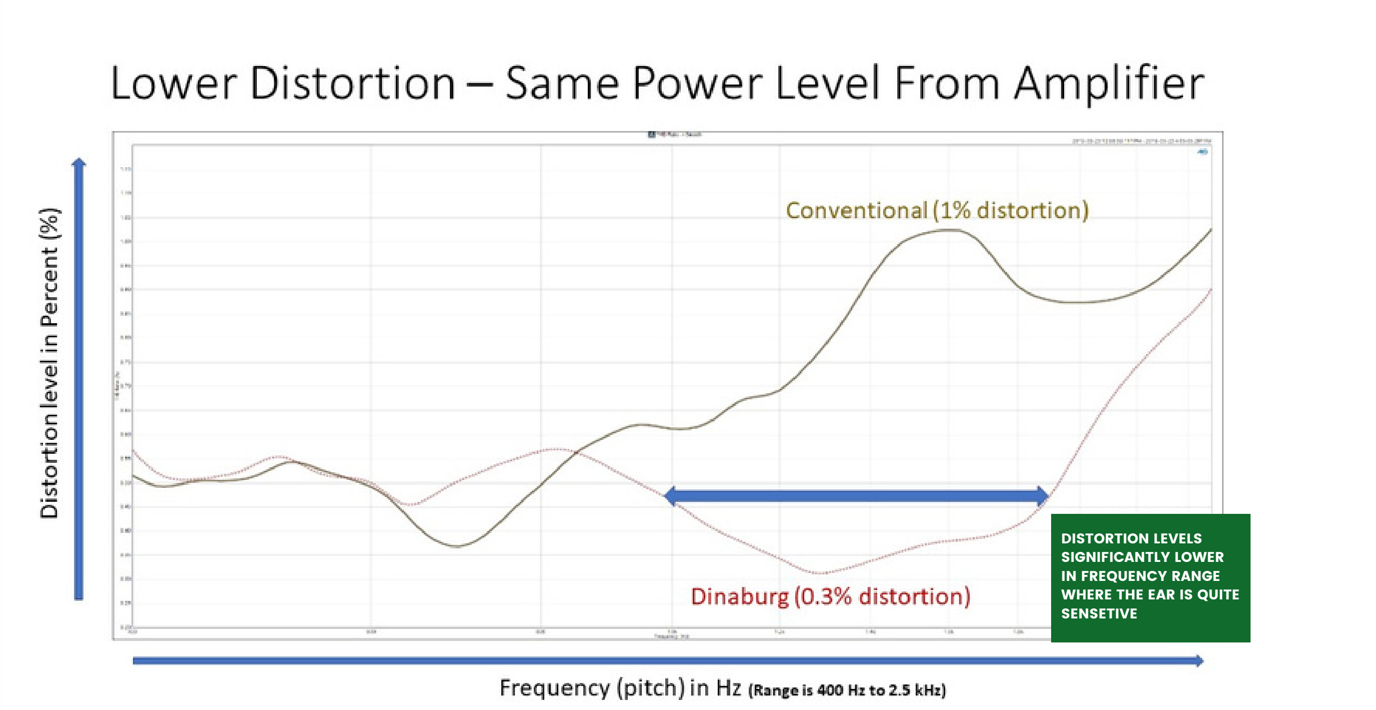


Figure 6: Total Harmonic Distortion

(Figure 6) shows the measured distortion of the midrange in its sealed enclosure and that same midrange after it was modified with the concentric and coplanar stabilizer. The frequency range (X-axis) is 400 Hz to 2.5 kHz which is in the flat frequency portion of the midrange. The Total Harmonic Distortion (THD) of the midrange was as high as 1% at a 1-watt power level. When the concentric and coplanar stabilizer was added, this distortion was reduced by as much as one-third (10 dB). In particular, this dramatic reduction in THD is in the frequency range where the ear is most sensitive. Subjective listening tests of various Dinaburg drivers, ranging in overall diameter of 6" to 12" have shown that vocals, in particular songs with female vocals, sound more natural. Songs with harmonies are more detailed when compared to being reproduced strictly from the active midrange driver.

COMSOL MODELS

Dinaburg Technology contracted the services of JJR Acoustics (JJR Acoustics, LLC - Excellence in Audio) to create COMSOL models of a finished loudspeaker system utilizing the patented Dinaburg technology and another finished system based on a typical loudspeaker driver and separate passive radiator (vent substitute). The Dinaburg driver was a total of 6" in diameter with a 3" active diffuser. The other speaker product comprised of 3" driver and a passive radiator. The passive radiator was located on the rear wall of the enclosure opposite the 3" driver. The surface area of separate passive radiator was equal to that of the concentric and coplanar stabilizer (80 cm2) and their respective resonances were the same (20Hz). Each system enclosure was in a sealed, 2.6 liter box.

The COMSOL model shows that at frequencies below 500 Hz, these two systems are equivalent see (Figure 7). Above 500 Hz to about 5 kHz, the Dinaburg Technology driver is actually more sensitive. As this frequency range is where the ear is most sensitive, perceptually the Dinaburg Technology driver will sound a bit louder. The frequency response is based on a distance of four (4) meters in a free field.

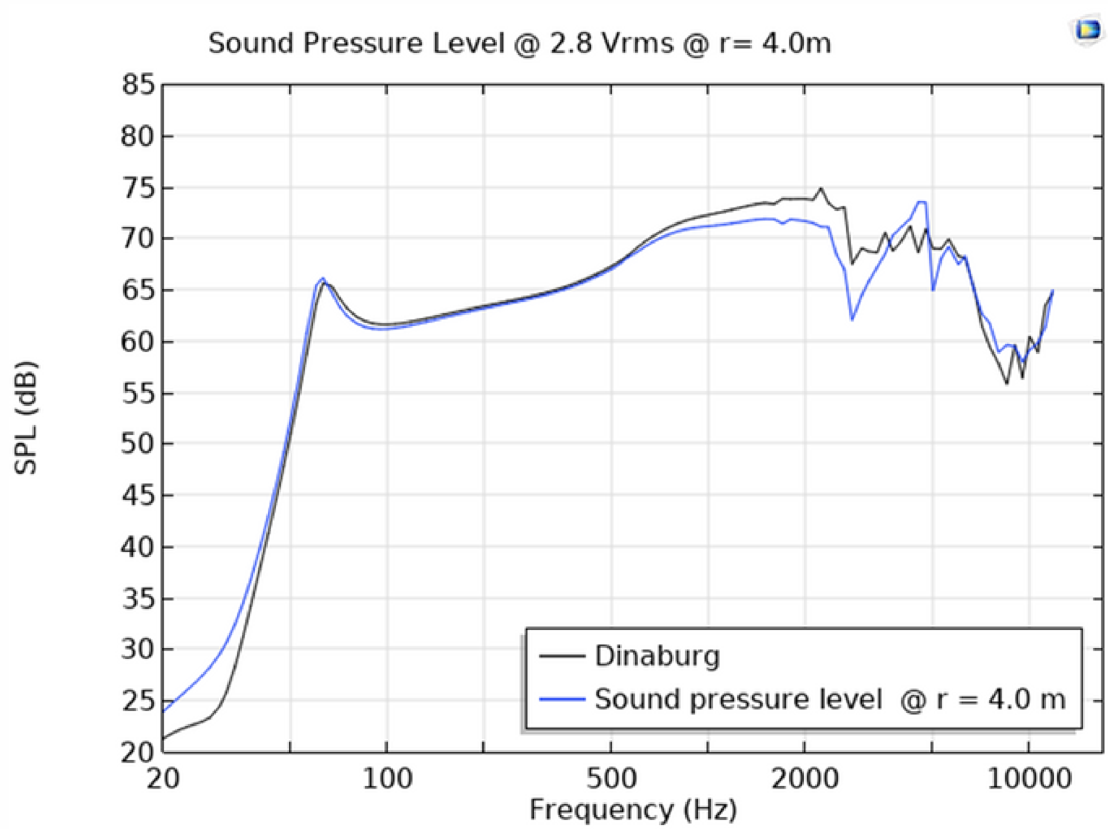


Figure 7: Modeled frequency response at 4 meters in free field with 1 watt input

COMSOL CONFIRMS THEORY OF CONCENTRIC AND COPLANAR STABILIZER BALANCING PRESSURE:

What is most interesting from the COMSOL model is that it confirms the hypothesis that the C2S™ maintains a balance of forces on the active and stabilizer diffusers. As stated earlier, my fundamental premise is that with diffusers of conventional drivers, there is an imbalance of force on the diffuser surface due to Boyle's Law not being obeyed when the diffuser moves towards the listener or back into the enclosure. This imbalance will cause the diffuser to not move as a rigid piston which, in turn, creates distortion. This imbalance can only be corrected when a C2S™ is added.

To better understand what to look at in the following figures, Figure 8 shows the cross section of a Dinaburg Technology driver. The shaded rectangular areas represent the volume of air described in Figure 4. This volume is S*H where S is the diffuser surface area and H is the diffuser excursion. For the Dinaburg Technology driver, there are two volumes, V1 and V2. For a conventional driver used in the rear passive radiator design modeled in COMSOL, this air volume will only be V1.

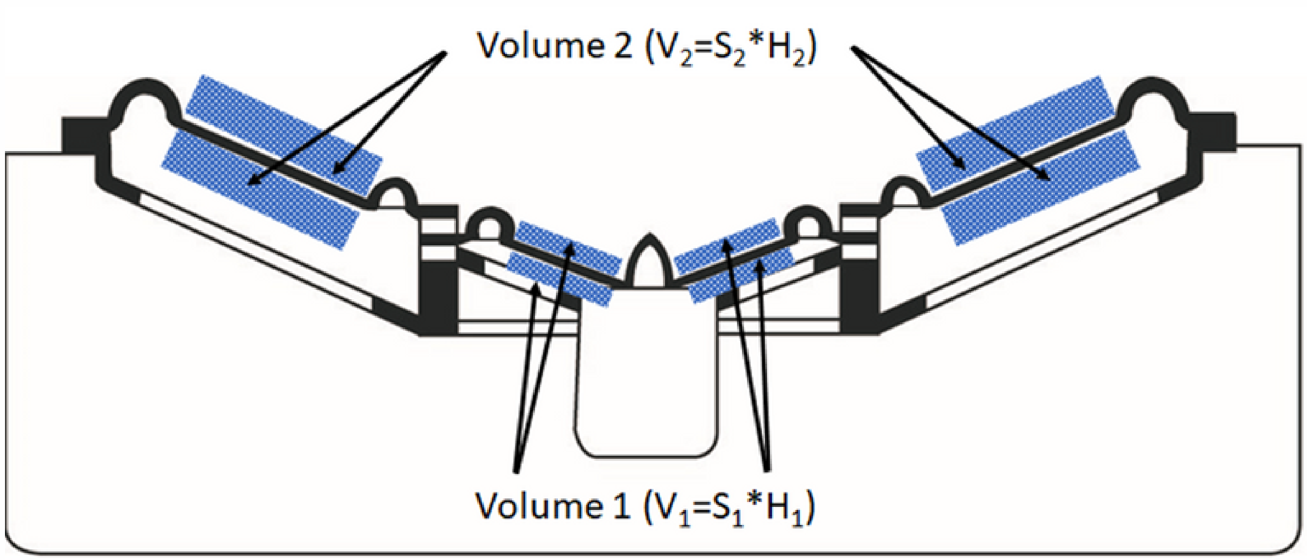


Figure 8: C2S™ Loudspeaker Driver

At low frequencies, the sound pressure just in front of the diffusers for a Dinaburg Technology or conventional driver and just behind it are the same see (Figure 9). The dark brown color represents a SPL of around 110 dB. This pressure (and hence force) is balanced on either side of each driver. The rear passive radiator design modeled in COMSOL, this air volume will only be V1.

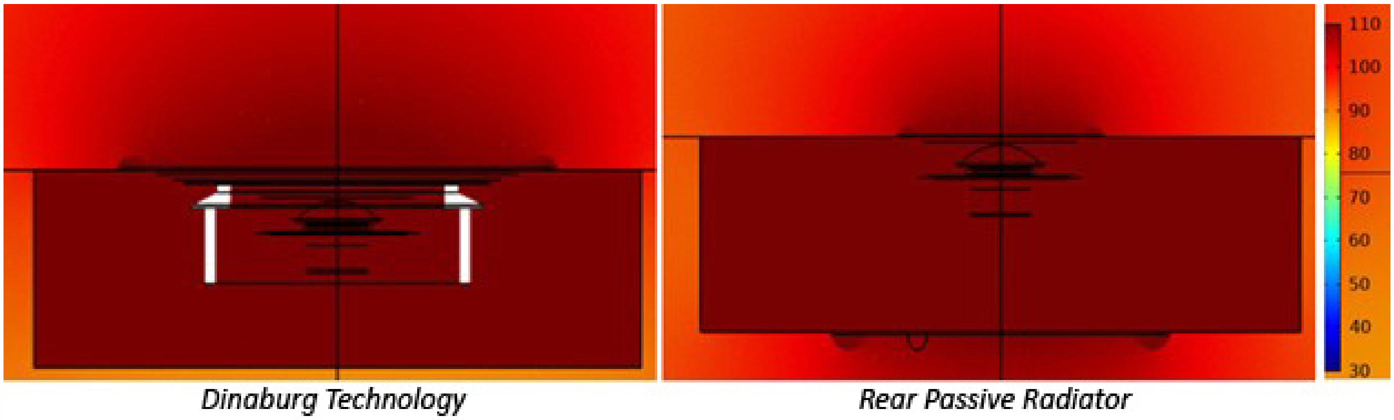


Figure 9: COMSOL model showing SPL at 75 Hz

When the frequencies are much higher, only the Dinaburg Technology driver can maintain the balance of SPL on the front and back surface of its diffuser. In Figure 10, the SPL just in front of and behind the Dinaburg Technology and conventional drivers is around 110 dB (6.32 Pascals or 6.32 N/m2). With the conventional driver, the back surface of its diffuser has an SPL around 90 dB (0.63 Pascal or 0.63 N/m2) or less. At 500 Hz, the conventional diffuser can have sound pressure (forces) that are 10 times less (20 dB) on its back surface than front surface. This behavior is seen with additional COMSOL models where frequencies are extended to 2 kHz and beyond. The balanced forces placed on the diffuser parts of a Dinaburg Technology driver is the main reason why distortion is so low compared to conventional technology.

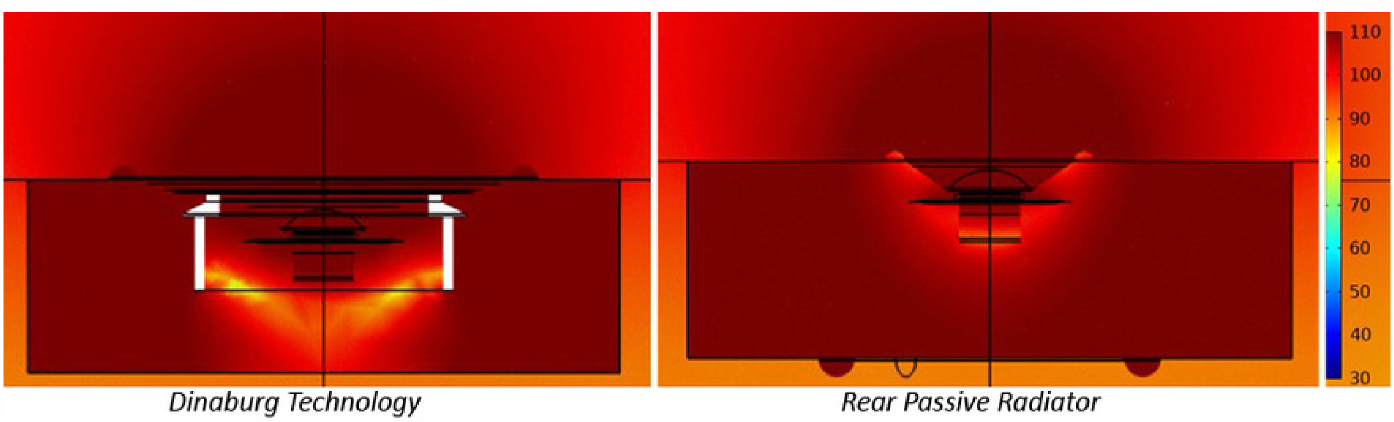


Figure 10: COMSOL model showing SPL at 500 Hz

CONCLUSION

A loudspeaker driver that utilizes the patented Dinaburg Technology offers the following benefits when compared to conventional loudspeaker technology:

01 Significantly lower distortion in the vocal frequency range where the ear is most sensitive.

02 Greater efficiency in the midrange frequency band (sounds louder which can be a competitive advantage).

03 Better performance of passive radiator (vent substitute) product except that only one hole is needed and not two (one for the driver and one for the separate passive radiator (less energy consumed during manufacturing).

04 In a conventional Passive Radiator or Bass Reflex Box, the Radiator or port needs to be on a different side of the box than the active radiator (especially in physically small designs). In the C2S™ alignment, the stabilizer is ALWAYS concentric and coplanar no matter how small the cabinet. This translates to a far greater level of creative freedom in the final product design.

ACKNOWLEDGEMENTS

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- Mike Klasco | MENLO SCIENTIFIC / Consulting
- Barry Vogel | ALTI / Consulting

We thank you for your continued support in our efforts to enhance the sonic experience through science and advanced technology.

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