Posted by Wayne Parham on Fri, 05 Nov 2004 04:17:40 GMT
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As many of you may recall, I had sent a requisition to Eminence for an improved low-distortion "B12" subwoofer that could be used as a direct radiator in small 2ft3 vented loudspeakers or in a large folded basshorn. Eminence has decided that the device would be cost prohibitive to build at this time. They would be willing to consider continuing to work on the project if 1000 pieces were ordered and a substantial price paid to them to re-tool. Otherwise, they are not particularly interested in adding the larger flux ring required to reduce distortion at low frequencies. That leaves other options to consider, for anyone interested in an improved system.The thing that always concerned me was that portable basshorns are driven below their flare frequency, where they begin to act as direct radiators. They just aren't big enough to hit the low notes operating as a horn unless they are used in groups or near boundaries. And even in the best conditions, something this size really needs to have a lot of attention paid to motor performance in the lowest frequencies, in my opinion.Rather than ignore or evade the fact that the horn is driven under the flare frequency, this design effort seeks to address it. At the lowest frequencies, the system acts sort of like a pseudo-bandpass speaker. Increased harmonics from low frequency signals enter the throat and are acted upon by it. If this were a low-budget system, that would be one thing. But when it is to be the best it can be, as should be the case for a loudspeaker system of this cost and complexity, then I expect the performance at the lowest frequencies to be optimized. For that reason, I sought to have a flux stabilized woofer made that would perfom well and offer reduced distortion in direct radiator mode.But there is another way to do it, and I have changed my focus in this direction. With two drivers being used, they can be connected in a push-pull configuration so that they pressurize the front chamber with opposite sides of the cone. A positive pressure would be created by the front side of one cone and by the rear side of another. Any asymmetries caused by magnet non-linearity, flux modulation, or suspension non-linearity would then cancel in the front chamber. This offers great promise for reduced distortion basshorns.I am working on two models right now, a version that uses a 12" driver and another that uses a larger 15" driver. The prototype will likely be built with a LAB12 woofer, and the LABhorn can then be used for comparison, to determine the reduction of harmonic distortion provided by this horn configuration. Several people make higher power 1000 watt 15" drivers, and this makes possible a second version with higher average output. They would be crossed over to large format conical midrange horns loaded with 15" drivers at 100Hz, again to 10" conical horns at 500Hz and finally to 1" exit

likely be aproximately 18-20" in width, whereas the one with 15" drivers would need to be 26-30" wide. In this way, the 15" version would actually have a slightly higher flare rate but potentially much higher output capacity. Both horns would be the roughly the same in the other two dimensions, approximately 40" to 48", with the 12" verson slightly smaller because of its smaller

of second-order harmonics in the front chamber, so I expect they should offer much lower distortion levels than other designs. The front chamber will be larger than other designs, which will act as a low-pass filter. Improved performance in the form of reduced distortion is what motivated me to undertake this effort. But the possibility of using different drivers having increased power handling and output is a welcome improvement too.I was disappointed when the long wait for the B12 woofers ended without an improved, low-distortion woofer but am now

excited to see progress in other areas. I had made push-pull cornerhorn designs, so I'm not sure why I didn't consider it as an option for a folded horn before now. It looks like an obvious and attractive way to build a dual-driver basshorn, with the front chamber serving as a harmonics-cancellation plenum. I am quite anxious to build a working prototype for testing.

Posted by Zeno on Fri, 05 Nov 2004 15:11:35 GMT
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i am very keen with this design

Posted by Wayne Parham on Fri, 05 Nov 2004 17:51:21 GMT
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I like the concept too. Honestly, I can't find any disadvantages. If a basshorn is driven by a pair of radiators, it makes sense to connect them this way so that the front chamber serves as a harmonics cancellation plenum. It's the perfect application for this, since the front chamber partially contains the pressures from the two drivers and distortion causing asymmetries should be cancelled quite well.The front chamber volume is larger than some others, but it can be partially filled with solid material to reduce volume, if necessary. The front chamber acts as a low pass filter, so on a basshorn, it isn't a bad thing. That will serve to reduce harmonics even further, just like the horn folds do. All the other characteristics of this "push-pull plenum" horn are the same as any other horn. It's just the harmonics cancellation feature that's different, and that's done with a very simple mechanism of turning one driver around.

Posted by pgolde on Fri, 05 Nov 2004 19:23:44 GMT
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Would there be a difference in chamber pressure from a design like the Lab where the drivers both fire towards each other? How would this affect the horn loading?

Posted by Bill Fitzmaurice on Fri, 05 Nov 2004 19:44:47 GMT

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Good concept, similar to a humbucking pickup. The distortion prone components are out of phase to cancel out the HF distortion that's not in the passband anyway, leaving clean fundamentals.

Posted by Wayne Parham on Fri, 05 Nov 2004 20:25:29 GMT
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Thanks, Bill. I'm real excited about it and eager to make a prototype to test the concept. I'm not sure why I didn't think of it before, when I was having Eminence work on the B12 woofers. This is probably a better idea, because the cancellation plenum won't lose effectiveness at low frequencies like a shorting ring does. Shorting rings are great and allow 2HD reduction in a single driver. But when two drivers are used in a horn anyway, this would appear to be a good configuration to use. We'll see.

Posted by GrantMarshall on Fri, 05 Nov 2004 20:39:35 GMT
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Hi Wayne.You probably didn't think of it before because you've been trying to simplify and reduce costs in your systems. Using more drivers puts the price up and makes them harder to build. Always the engineer. Build them and they will come.Grant.

Posted by Wayne Parham on Fri, 05 Nov 2004 20:43:09 GMT
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The cancellation plenum is the horn's front chamber. It acts as a low pass filter and is one of the parameters used when modeling a horn. The magnet of the rear-facing driver protrudes, which tends to make the front chamber volume larger. But there is no reason why you can build up the internal area around the cones to displace volume if the horn design requires a small front chamber.The black area in the front chamber shows how space can be displaced to make the volume smaller, if required. These can be placed behind, above and below the driver. There is a lot of space surrounding the drivers that can be easily filled with the use of filled blocks. It is not a large extra step to add these, so if the front chamber must be made small, that's one way to do it.

Posted by GarMan on Sat, 06 Nov 2004 05:04:14 GMT
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Hi Wayne. Need some help understanding this. Are the two drivers wired in phase or out of phase from each other?Gar.

Posted by Wayne Parham on Sat, 06 Nov 2004 05:34:13 GMT
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The drivers are connected so that each will pressurize the front chamber in phase. There is also an isobaric arrangement that is sometimes called push-pull, but that's not what I'm trying to do here. What I want to do is to drive the chamber with the front side of one driver and the back side of another. If both drivers are the same, then any asymmetries caused by the motor or suspension will equalize in the throat.It is long been established that the main reason for loudspeaker distortion is asymmetry from the motor. It literally goes further in one direction than it does in the other, with the same amound of driving voltage applied. The reason is that the magnetic flux from the voice coil pushing the cone in one direction adds to the fixed magnet, and it subtracts from the fixed magnet in the other. This difference causes the motor to generate slightly less force in one direction than the other. That'swhat the shorting ring corrects. That's why it is called a flux stabilization ring, because that's literally what it does. Asymmetry is the cause of 2nd order harmonics, and reduction of second order harminics is done by restoring or improving symmetry.When mouting the radiators as shown in my drawing, the two drivers pressurize the chamber together. One driver is the "weaker" one and the other is the "stronger" one on each half cycle. So each half cycle is equalized by the fact that it always has equal amounts of drive, one strong and one weak. It is a very simple mechanism to use.

Subject: Simple!
Posted by Mike.e on Sat, 06 Nov 2004 08:56:08 GMT
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Simple concept! I heard of John doing this on a certain basshorn-but didnt see how it was implementedI think that if the Vtc,and Vrc are similar and not too different the loading will be equal. (infact perhaps the loading wont change just the individual horn parameters)-off to town to hear 1" HF horn + 15" and quiet bass!RegardsMike.e

Subject: Re: Simple!

Posted by Mike.e on Sat, 06 Nov 2004 08:58:49 GMT
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Oh also have you considered a version with 2 10" drivers such as CSX10" peerless,which have a decent displacement with shorting rings-cheap value for money drivers,and with 2 of them on one horn will result in low displacements.Cheers!

Subject: Re: Simple!
Posted by Wayne Parham on Sat, 06 Nov 2004 17:37:37 GMT
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I have been considering other vendors, and they're one of them. As for the push-pull arrangement, it's reassuring to see the concept has been applied, and that there has already been some confirmation of it. I've seen EAW use it and John S and Dennis K and I had discussed it on some other BBS systems. So that all makes me feel pretty comfortable with implementation on this horn. I'm really anxious to have a working prototype to evaluate and compare.

Posted by Wayne Parham on Sat, 06 Nov 2004 19:42:28 GMT
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I've run into two issues, one of which represents another possible improvement to existing designs. Brad Litz mentioned that having the cooling vent in the throat might make noise, and that's a good point. But this represents an opportunity too. One of the things that plagues other large high-power basshorns is that the cooling vents are restricted. They are vented into relatively small rear chambers, and sometimes very near a wall so that flow is obstructed. So doing something to plumb those vents to outside air is probably a good idea.I'm thinking of doing something like shown above. I'll have the vent hole on the speakers fitted with a pipe fitting. It can be threaded, but I think a press fit is sufficient for no more pressure than we're talking about here. I'll also mount an exit fitting on the back of the cabinet and run a large rubber hose between them. Something like a heater hose, using the same diameter as the speaker vent. I'm thinking that this approach should really help keep the voice coils cool, and prevent unwanted noise at the same time. It's not a very difficult thing to do either, just a couple of fittings and a hose between them.The other thing I'm thinking of is how to mount the drivers. They can have access panels or the entire motor assembly can be removable, and fasted with a series of studs, somthing like mounting the head of a car to the block. I'd probably make the horn complete all the way to the throat and then have a matching cutout in the plenum. The drivers can be accessed through that cutout. That would allow the entire assembly to be made solid and without access panels, which would probably make for a better seal. The two surfaces that meet would employ a rubber gasket, and they would be pulled together tightly using a series of fasteners like head bolts.

Posted by GrantMarshall on Sun, 07 Nov 2004 13:56:09 GMT
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Hi Wayne.Regarding heat removal could you offer options depending on what the persons most common use for the speaker is? One thing I realize is that you don't have a "typical" user for some of your designs and what is "best" for one person isn't for the next. Adding some noise might be a tradeoff worth making if it provides much better cooling for some people. Having test numbers to compare options would help people make their choices. I like the idea of quick access panels over removable assemblies. Removable assemblies open up opportunities for vibration, poor fit if building isn't percise, and loosening up over time.Enjoy your Sunday.Grant.

Posted by freddyi on Sun, 07 Nov 2004 16:32:50 GMT
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Hi Wayne (my apologies for not replying to note - am miserable)nice idea/simple to build & plenty of path - for home use driver requirements could be laxed - got any sims for 12" version w. couple diff TS?Best,Freddy

Posted by Wayne Parham on Sun, 07 Nov 2004 20:15:34 GMT
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I hope you're back on the mend soon. And you're right that for home use, a smaller driver set could be used. I'm thinking that the prototype will probably be configured similarly to the LABhorn in length and flare rate. That way it can be used to judge the effectiveness of the push-pull plenum and cooling vents by comparing the two horns.

Posted by Wayne Parham on Sun, 07 Nov 2004 20:50:41 GMT
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This thing is definitely intended for sound reinforcement. Like Freddy mentions above, for home use, a person could use lower-power woofers that don't even have cooling vents. Even if woofers with vents are used, they aren't going to make chuffing sounds until power is way up, probably more than most people would run in their homes. In fact, vent turbulence may be inaudible and

the ducts may not be necessary.At power levels where vent turbulence becomes audible, the horn's output may be so much louder that the cooling vent is like a whisper in a tornado. But I think external ducts will probably enhance cooling, which is a good thing at higher power levels. They wouldn't be very hard to add either. Failures in LABhorns have been mostly thermal, so this may help solve that in addition to reducing distortion.

Posted by GrantMarshall on Sun, 07 Nov 2004 22:31:33 GMT
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I understand it's intended for high power users. I think a LOT of work has been done on heat reduction by speaker producers though and if a simple vent fixed the problem there wouldn't be the effort/cost to make things more durable. Drivers would never die from heat. It will be interesting to see if there is much of a difference with this system once you test it. Best wishes.Grant.

Posted by Wayne Parham on Mon, 08 Nov 2004 00:47:53 GMT
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You're right about the work on power handling. Just twenty-five years ago, the maximum power handling of drivers was about 200WRMS. Once they added a vent, those numbers doubled and even quadrupled. Some of the newer drivers are practically the same as an older model with a vent added.But the problem is that when a driver is mounted in a very small box, it starts to contain the heat. If the box is very small, it acts like the vent weren't there at all. So horns with small rear chambers are likely to suffer from heat related problems.In a horn with a small rear chamber, there is less heat exchange because the back chamber air gets hot and can't dissipate. I imagine it gets pretty hot in there at full power, and then the vent doesn't provide much cooling. Some have used metal chamber panels in an effort to conduct heat to the surrounding air, but it seems to me that a better solution might be to just vent to outside air in the first place.I guess the real test is to plumb the system for outside venting and see what happens to power handling. Then we'll know how much benefit it brings.

Posted by jake on Mon, 08 Nov 2004 11:53:47 GMT
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Most of the restoring force applied to the diaphragm in the Labsub is because of the air spring and

not the spider / suspension of the drive unit, therefore turning one drive unit around should make a minimal difference to the linearity and therefore the distortion produced. Turning one drive unit around and running it reverse phase in a vented cabinet is a completely different matter as the greater restoring force comes from the drivers suspension which is often non linear especially at peak excursion.Turning both the drive units around and placing the heat sinks in the throat should keep the units cooler and therefore increase power handling also.Methods to reduce harmonic distortion in the horn include reducing the acoustic bandwidth of the horn by changing the throat chamber tuning and by reducing the compression ratio at the throat.

Posted by Larry Acklin on Mon, 08 Nov 2004 15:59:54 GMT
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Hi Wayne et all:Been following this one with great interest, since i've been using folded horn subs for PA for a while. Wayne, look at www.stage-accompany.com and look how they have employed forced air cooling into the performer series. ("Air system").Basic form is a fan, and a speed controller that reacts to averages of progam levels- then adjusts speed of the fan to the conditions.Also remember that most PA subs are not being used at below 40-45 hz.Nothing down there, too much potential for sstage rumble, or runaway subsonic feedback, etc. Some systems don't operate below 60 hz.Larry Acklin

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Posted by Wayne Parham on Mon, 08 Nov 2004 19:50:37 GMT
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You are right that the rear chamber in the LABhorn is very small, and the air behind it plays a significant role. Another way of looking at it is the small sealed chamber shifts the resonant frequency so that motor chamber resonance is in the passband of the horn. It is set to create a peak at lower cutoff which augments output. This is sometimes called reactance annulling.However, what is significant about this new horn is the push-pull plenum, which counteracts motor asymmetry. There is nothing in the LABhorn design that deals with this. It is well-known that the cause for harmonic distortion is primarily due to asymmetries in the motor assembly, not the mechanical suspension or pneumatic loading. That is why shorting rings are used in low-distortion drivers - They counteract the major cause of asymmetry, which is flux modulation. Another way to counteract it is the push-pull plenum arrangent.There are many things a horn does that reduce distortion, but it cannot address flux modulation. There is no mechanism to restore symmetry. Horns reduce excursion and reduce bandwidth, both of which reduce distortion components. But asymmetry is not reduced by horn loading, so the push-pull plenum has been added to address this. If a woofer with a sufficiently large shorting ring were used, that would do it too.

Posted by Wayne Parham on Mon, 08 Nov 2004 19:55:53 GMT
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I'm looking around on that site now, and having a hard time finding the link. Can you tell me where to find it on their site?

Posted by Adrian Mack on Tue, 09 Nov 2004 03:57:32 GMT
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Nice horn Wayne! I wonder if that plenum is a little large to gain complete effects of push/pull loading. How long is the pathway and mouth area? Got any Hornresp response predictions of this horn? The pathway is interesting, I've not seen a horn before that has the pathway split off into two directions. Is it the same as having one pathway with double the area/volume?

Posted by Wayne Parham on Tue, 09 Nov 2004 04:38:45 GMT
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These horns are still conceptual, and I have some issues to deal with. But I am committed to doing them because I am confident they'll provide performance improvements over existing designs. The folding pattern I've chosen for illustration is actually a pretty common "W" fold. It was easiest to show what I was talking about with this picture, but I'm not necessarily set on using it. One benefit is that if I duct cooling air to the outside, the motor chamber is at the rear of the cabinet so the ducts can be easily run to the rear. But I could also use a "Z" fold or a spiral.The main thing I'm sure of is that the push-pull plenum decreases distortion and that fresh, cool air to the voice coils will do a better job of keeping 'em cool than trapped air in a very small rear chamber. Now I have to do some exploration to find the best ways to exploit these improvements.

Posted by Adrian Mack on Tue, 09 Nov 2004 04:48:15 GMT
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Hey WayneIm sure the push/pull config will reduce distortion - John Sheerin did something similar in a dual 10" CSX basshorn, and noted very good improvements in 2nd HD. Ducting to get cool air from the outside - reminds me of the cold air intake/induction system I put on my car made from

90mm piping :P If you were to do the ducting on the vented pole piece, I think make the piping larger than the vent itself so that the airflow doesnt cause a restriction and start creating noise and air pressure buildup of its own, which would mean more distortion. Adrian

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Posted by Wayne Parham on Tue, 09 Nov 2004 05:44:21 GMT
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That's right. Dennis (DJK) and John (str8aro) and I have discussed push-pull systems in the past. John has made measurements that confirm the reduction of second harmonics using this configuration. About the cooling duct, I'm with you on that. It seems like motorheads are the first to embrace the idea. I was thinking of car stuff too when I first pictured ducting the vents. Thomas (ToFo) has proposed a dual-port anti-reversion venting system to prevent a warm air slug from travelling back and forth in the cooling duct. It has a cool air input line and a warm air exit line, each with an AR orifice to polarize flow in the proper direction. That or do something to conduct heat away within a single duct and dissipate it along the way. Perhaps introduce turbulence to get the air in contact with a large, cool surface area.

Posted by Larry Acklin on Tue, 09 Nov 2004 19:51:22 GMT
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Hi Wayne-When you go to the site, click on the SA logo. Go to the performer series, scroll down and click on the air system logo.Basic info there, and lots of good info in the PDF stuff. I saw a design (beta) where the woofer and mids also had air plenums and cooling. Dimension that box you are looking at for Delta 15's and you got a winner.Larry

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Posted by jake on Fri, 19 Nov 2004 10:22:25 GMT
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Please let me first say that I am all for trying to improve on the Lab Sub and am simply playing devils advocate.As far as I am aware the main cause of second harmonic distortion created by magnet structures is due to asymmetries in the magnetic field either side of the gap and therefore is not going to be addressed by a shorting ring which is usually used for reducing third harmonic distortion.Also the ear tends to be very insensitive to harmonic distortion at low frequencies and as the main second harmonic artefacts are going to be produced when the driver is working at the lowest frequencies of its passband then the main area of second harmonics are going to be in the

60-80Hz region and thirds higher again. By limiting the high frequency output to the horn acoustically by designing the throat chamber/throat area to have a cutoff frequency equal to your electrical cutoff frequency then you will minimize the second and third harmonics in the next driver's passband.Two of the main areas of weakness in the Labsub seem to be dust caps detaching and heat problems, the former likely caused by the pressure on the rear of the dome due to the small rear chamber and hence high pressures and the latter through trying to dissipate upwards 200watts of heat in a very small insulated space.I therefore think that if you could get both drivers magnet structures in the throat chamber this would greatly decrease the forces acting on the dome and also reduce thermal stresses leading to reduced power compression giving a useful long-term gain in acoustic output.Putting one drivers magnet assembly in a small chamber and not the other may have it's own set of linearity problems that are not encountered in the classic closed and reflex box arrangments.RegardsJakePS A quick off topic plug---The new Firefox browser is A1+++ and so is Thunderbird email clienthttp://www.mozilla.org/products/firefox/greater resistance to viruses and addware etc blah blah blah, don't forget to donate towards the cause.

Posted by Wayne Parham on Fri, 19 Nov 2004 11:51:42 GMT
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Both the shorting ring and the push-pull plenum are mechanisms that decrease second-order harmonics. Third-order will not be affected. But the same features that reduce harmonics in the LABhorn or any other basshorn apply here. Namely, the reduction of excursion from horn loading and the low-pass nature of the horn, its front chamber and the folds.Consider this: If a horn is intended to be used from 30Hz to 120Hz then the second harmonics are between 60Hz and 240Hz. This is a range that is completely in the passband of the horn. The top half-octave is just starting to be attenuated by the front chamber and the folds, but basically, all second harmonics enter the horn and are affected by it. If you think about it, sounds between 20Hz and 30Hz are not amplified by the horn, but their second harmonics are. So a reduction of second harmonics is pretty important for improving deep bass quality.Third harmionics for the same 30Hz to 120Hz range are 90Hz to 360Hz. As you can see, the range is shifted high enough that it starts to get beyond the operating range of the horn. The front chamber and folds can effectively attenuate about half of the third harmonics.Besides all this, if you can reduce harmonic distortion, it would seem to be worth doing.As for power handling, please see the post called "Loudspeaker Venting and Cooling Techniques." This shows some of the techniques we're looking at for removing heat from the motor and increasing thermal capacity. None of them will improve mechanical performance of the woofer and excursion limits will not be increased, so high-pass filters might be still be advised for extreme situations. But mechanical limits will not be decreased by any of these techniques either.About pneumatic asymmetry, the drivers will have the same volume for a rear chamber, so that's not an issue. They will share the same front chamber, so that's not an issue either. And they will each have their cooling vents plumbed to the same pressure, so that's not a source of asymmetry. There's nothing about this approach that makes it pneumatically asymmetrical.The thing left to do is to build some models for testing and we're working on that right now. As an aside, I'm very excited about the level of quality and design expertise brought to the table on the vent valves. I am confident that we will be able to provide a fitting at a reasonable

cost, and I've asked that one be made available with a right angle fitting for LABhorn owners too.After tests are done, I'll be sure and post the results at each step along the way.