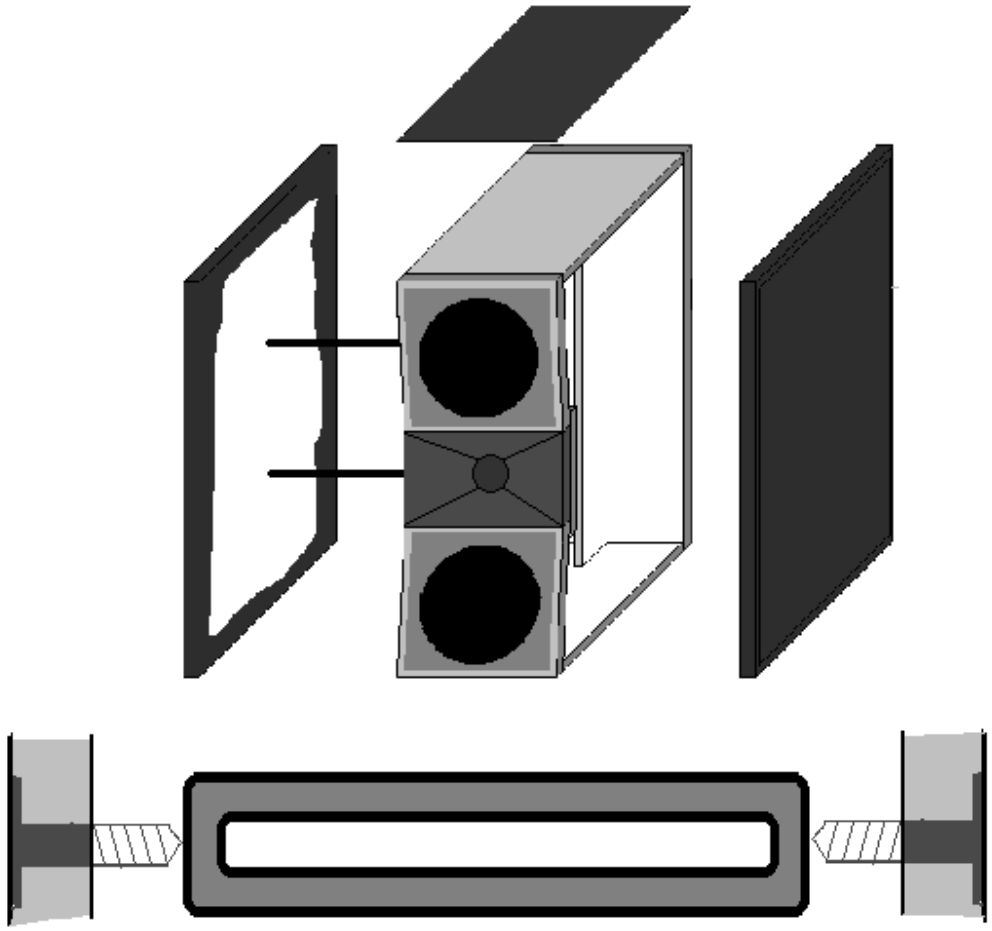
Loudspeakers in practise: D'Apolitto.

In this chapter different loudspeakers will be presented and discussed.

At first we will look at some 2 way D'Apolitto.

The higher efficiency for the bass/mid in parallel is very welcomed.
Their level thereby can be adjusted to fit the tweeter's level.
Dampening of that unit can then be avoided, and you will get a loudspeaker of higher sensibility, not to mention the higher transparency from a tweeter without damping.
At the same time the bass/mid can be partly corrected for lose of level, where the front baffle gets too small to behave as support for the bass.
The correction last mentioned is dependent on the room and the placement of the loudspeakers in it.
These constructions are not following the filter theory connected to D'Apolitto, as all units will work in phase with one another.
The main guideline is of course the sound, but some thoughts have been thrown into the appearance.
Good loudspeakers are boxes, nothing can be done about that, and that often collide with the wife's accept - the well-known WAF.
Women very often have a very ambivalent attitude to loudspeakers. They like the sound but not the size. I believe it would help, if the design was more organic and they could be allowed to decide the final appearance of the box. That could really be a great advantage in more ways.
It is so normal to have a finish of veneer or paint. These are regrettably reflecting surfaces even away from the front, and that is colouring the sound in an unpleasant way.
The only way around that is to cover the enclosure with dampening material.
This again can be covered with cloth found in an enormous number of variations.
Thereby room for the women's creative mind is created, and the appearance of the loudspeaker can be made to fit with the rest of the living room.
In order to have freedom to change that cloth, the box must be built possible to take apart, and that lead to a main improvement of the unit's working conditions.
Further it is important that all units are pointing directly towards you and have their ***acoustic centres placed on an arc of a circle with you at the centre***.
Therefore also a possibility to vary the radius of that arc must be incorporated.
Last and not least the quality of sound must serve the women's ears. They simply listen in quite another way than men. This is probably connected to their factual higher ability to learn languages, which again might be caused by their fate by nature to be objects for rape and plundering. ***It is a mechanism of survival still present in their genes.***
. .
Figure on the next page:

The loudspeaker is open with a front shaped as an arc. All parts can easily be covered with any ductile material. The sides are tightened and kept in place using two or more cheap double nuts with opposite treads (in use for antenna wires).
With units at place you further can attach the back of the magnets to the backside support to strengthen the tiny baskets of the bass/mid and the whole construction



The dimension is chosen to be:
Back: 50*18 and support 46.8*10 cm
Sides: 33.8*50.6. These must be cut to follow the front's approximation to an arc and have a 3-mm overhang.
Top/bottom: 30*18 cm
Front: 2 parts 18*18 and 1 part 18*12 cm
You are of course free to choose differently, but then following data can only be guiding.
The front consists of 3 separate boards: 2 for bass/mid and 1 for treble.
These pieces must be cut at an angel of 45 degree to help airflow on front as behind it.
The board for the treble unit is spaced with bitumen to the correct depth and the corners rounded of by silicone rubber. (See fig.)

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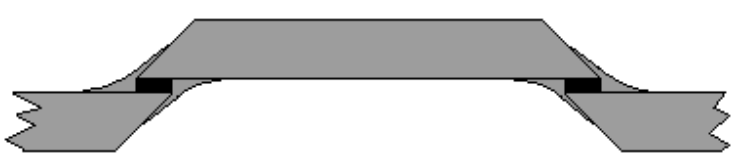
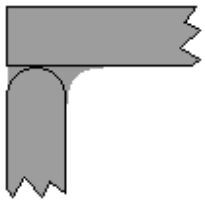




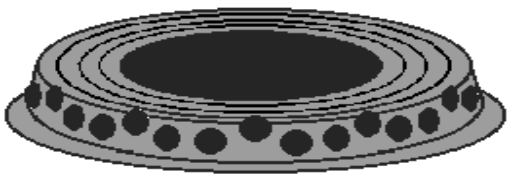
So are also the two boards for the bass/mid glued to top and bottom plate and corners rounded of using only silicone rubber. This gives you the opportunity to vary the distance to your position within limits of course, as the silicone rubber will serve as a hinge. As a side effect this method also dampens the mechanical transfer through the boards.

As a rule of thump the acoustic centre on dynamic units is very near the assembling between the voice coil and the diaphragm, when the filter is done correct.

Holes for the speakers in the three boards at front are cut. For the bass/mid the edge behind are rounded or cut in 45 degree with a moulding machine to create free airflow. The top, bottom, back and support inside on the back are glued together with normal glue. (See figure at top)

Fig. Rounding of back edge of the hole for bass/mid unit.

The treble in use is the Scan-speak 9300 and the bass/mid are the well-known SPH 130 from Monacor. .
Modifications: The back suspension of bass/mid can be softened by great amplitude.



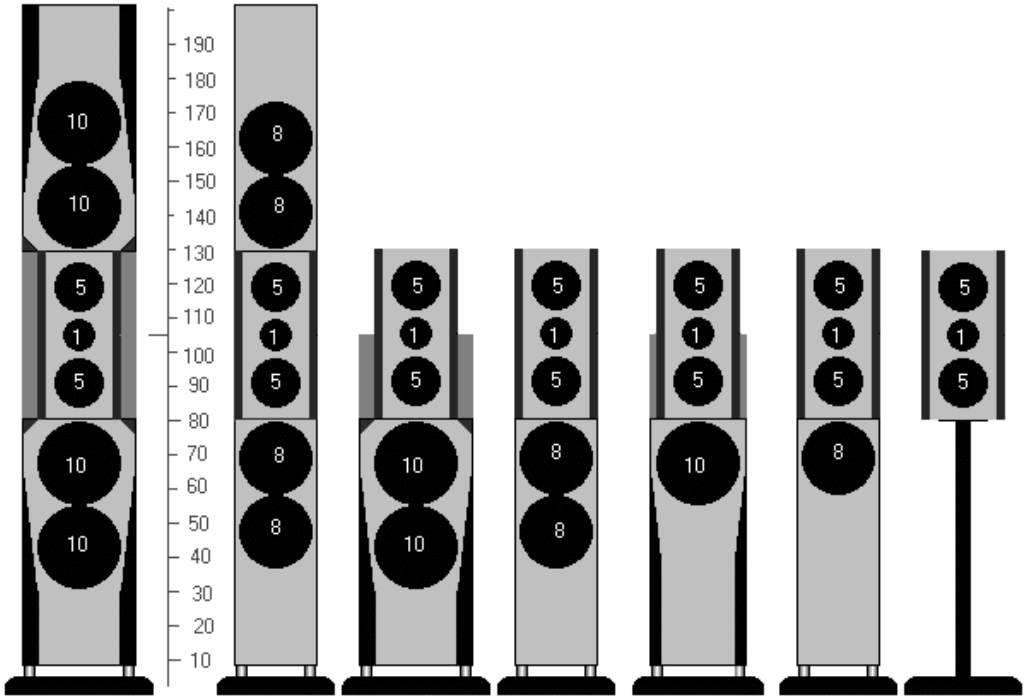
Further this suspension is burnt open with 8*3 holes with the tip of a solder.
If you soften this part too much you can stabilise it again with treads glued onto the upper outer folding and the edge of the basket. (it hasn't been necessary until now)
NB! Small parts from this burning of holes can disturb at start, but will be broken down be large excitation of the diaphragm.

The suspension at front is softened with silicone oil mixed with 20% silicone fat.

The valley formed by the basket and the rubber-suspension is filled out with butyl-foam (red) and silicone fat (black).

The diaphragm is covered with a thin layer of "Isopunkt" in order to dampen the grumpy sound at certain frequencies so typical for paper diaphragms.
At last a magnet of the same size as the one present is added. If you like you can add one more.
All this done you'll end up to have a bass response with a resonance frequency at 59 Hz and a Qt at 0.46 with a sensibility at 93-94 dB. A perfect fit to the treble unit when they are dampened 3-4 dB, which also is enough to correct for the 6 dB lose, caused by the tiny baffle, but a surprise awaits you.

When the cabinet is covered with felt and cloth as shown page 2, the cabinet is closed no more. It now forms an air resistor of high value, and this lowers the total Q of the units to 0.41. (0.39 if 2 magnets are added)
This will normally be seen as a minus, but taking the room and the use of the Linqwitz-Grainer amplification in account it in fact is an advantage.
This construction is intended to **stand-alone or to be a part of larger systems**, where it will be extended with a single bass or two basses in D'Apolitto and even two double basses also D'Apolitto.
Your work invested in this is therefore not wasted.



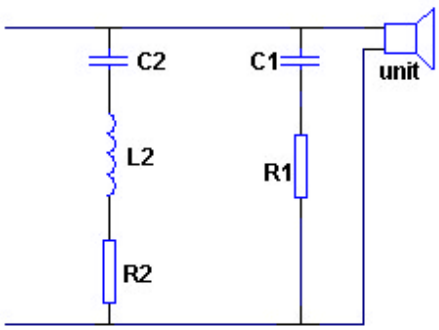
Drawings of some ideas are presented here. Other ideas will be shown in detail later in this article.

If you would prefer this small box as your only loudspeaker, it is normal in order to gain more bass from such a small system to make it as bass reflex cabinet, but I will suggest another way far better to control – The Linqwitz-Grainer solution.
This was presented in Wireless World in 1978 and consists of a little circuit between pre- and main amplifier.
Its way of working is ingenious. First it ***corrects the turn of phase*** created around the resonance frequency by the units and the cabinet. Then it amplifies according to your decision. You must decide either a frequency for the –3dB point or better the properties of a wanted loudspeaker concerning resonance frequency and Qt.
You shouldn't go too far from the loudspeakers own, but a resonance frequency at 35 Hz and a Qt at 0.35 more or less should be sufficient. This doesn't need to be a wild shot, as it is possible to determine rather precisely.
The DC-amplification can be calculated from 40*log (Fr(high)*Fr(low)) in this situation 40*log (59/35)= 9 dB.

You are really free to choose, but it is advisable to take your room in account. The best way is to measure the loudspeaker's capacity to generate bass of its own from your position of listening. You should concentrate at very low frequencies below the basic resonance of your room where it builds up the level with 12 dB pr. octave opposite the role of from the closed cabinet, why the level is linear. This should therefor give you a pretty good idea of the DC-amplification.
You must in order to achieve natural sound add 4 dB to your readings as your final soundpressure at 20 Hz should be –4 dB. ***You shall not have linear bass-response from your listen position***. The mild rounding of this decay from 200 Hz to 20 Hz is solely dictated by the value of the electrically created Qt.

*The damping generated by the Qt at resonance frequency is calculated from the expression 20*log (Qt) but it must be seen together with the room amplification, why the determination of the final Qt in your specific room must be found by experiments. It is most problematic to measure. Start with low value ex. 0.35 and take direction f rom that.*

As a stand-alone loudspeaker this construction is not a party-loudspeaker. It is for the lover of classical music, jazz, opera and other categories where the level of sound is mostly moderate but desire of full range is a must. You can't expect to recreate these kinds of music without the two deepest octaves present in correct level and phase. For this the bass reflex solution is of absolutely no use.



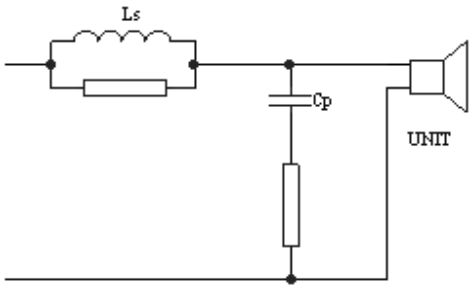
Correctional networks.
At first the units must be corrected for variation of impedance.

Bass/mid: C1 and R should be 15 and 15 in parallel=30 uF and 3.3+0.33=3.63 Ohm.
C2, L2 and R2 should be 3300 +3300=1750 uF, 4.8 mH and 3.6 Ohm
These values are given for bass/mid looked upon as one unit, you can gain greater stability if the single unit is corrected, which reduces the units ability to crosstalk. The values of R and L should be doubled and C halved.

Treble: C1 and R should be 2.8 uF and 5.6 Ohm

C2, L2 and R2 should be 82 uF, 0.85 mH and 6.3 Ohm, this last is the total resistance for L2 and R2.

The correction of lost level due to the baffle.
This can be done in two ways:



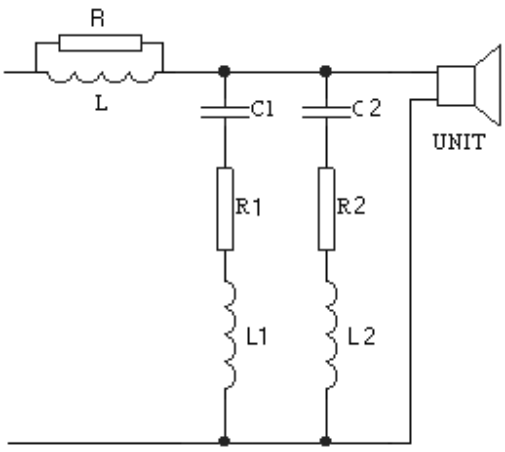
1. You can tilt that specific part of frequency, where the loss occur
2. You can dampen the middle of the frequency band.

For these units the first option is chosen, as there is sufficient level upwards from this unit. See fig.

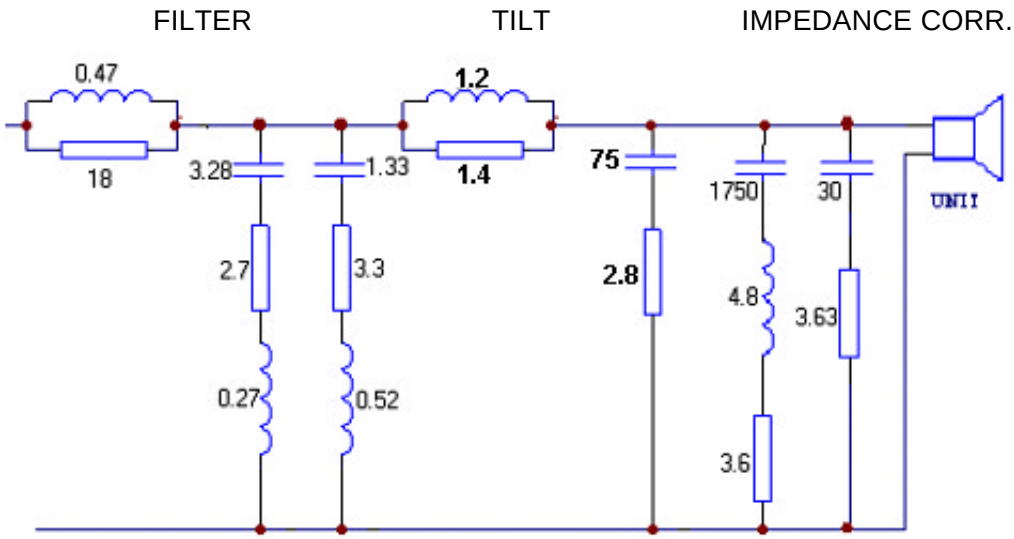
Very good parts must be used here, especially the coil and the serial resistor, where I of course use the graphite resistor in serial with the inductor coil.

Ls and R in parallel with it should be 1.2 mH and 1.4 ohm
Cp and R in serial with that should be 75 uF and 2.8 ohm.

The capacitor can be reduced some in value in order to flatten the level and the turn of phase for this circuit. It will result in a slight rise of impedance in its working area, bu t that again is welcomed, seen together with the unavoidable loss of energy due to the resistance in the coil from the dividing network. Remember that the low resistance formed by the two loudspeakers in parallel will seriously increase the quality of thes e coils.
Regrettably you can't use normal toroid coils here, but the band coil from Jensen supported by caps manufactured from iron powder works fine. Be sure they fill the area inside the coil not necessarily the whole volume, so I recommend use of the e nd-caps, which fit precisely.

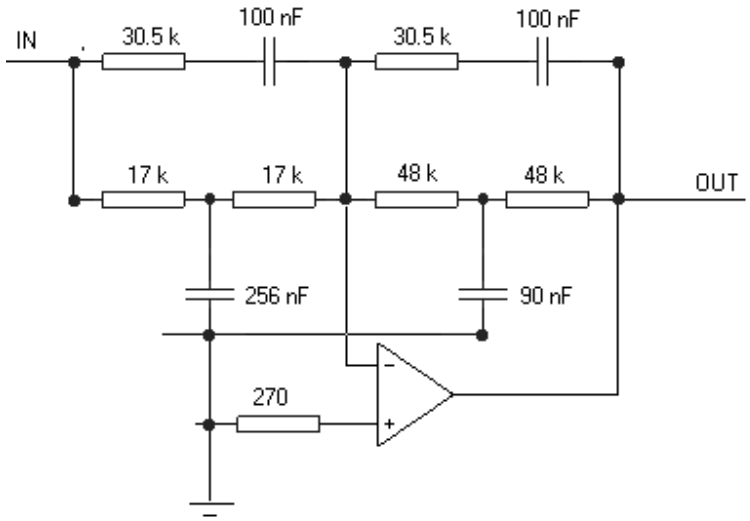


The dividing network for this construction is chosen to be 2nd order Linqwitz Riley.
The goal is to create the right shape of the level from the units. Bring all useable sound forward and not waste it as normally done.
Therefore the inductance of the filter-coil is chosen as low as possible but high enough to create an impedance sufficient enough to keep the total load together with the treble as constant as possible. In order to shape the output level, I manipulate with the impedance seen from this coil and even bypass it if needed. See fig.
By this technique it is possible to use the output from the bass/mid up to 10 kHz.
With a dividing frequency at 2 kHz you should expect correct summation from these units up to this frequency from the correct position of listening.
L and R should be 0.47 uF and 18 (20 or 22) Ohm
C1, R1 and L1 should be 3.28 uF, 2.7 Ohm and 0.27 mH
C1, R1 and L1 should be 1.33 uF, 3.3 Ohm and 0.52 mH
L1 and L2 can be made from thin wire, so the resistor can be avoided.
This end the passive part for bass/mid, and the circuit should now look:



The active part (If you need bass amplification)

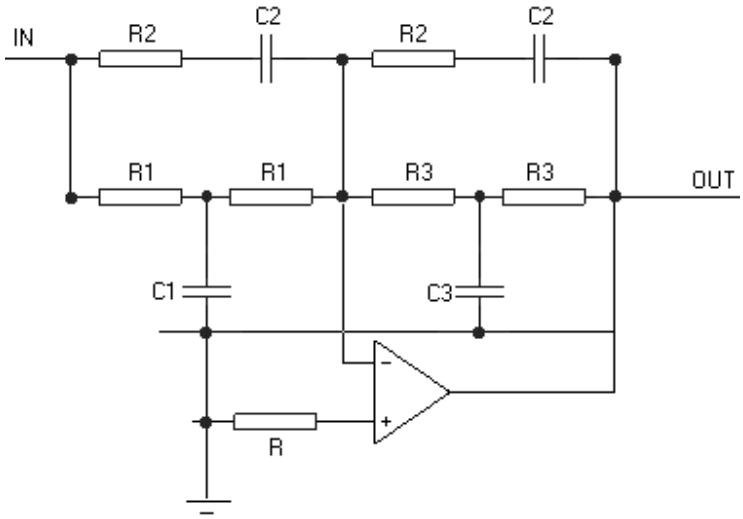
For this the “Linqwitz/Grainer” solution is used. The shown solution transforms the loudspeaker with its data of resonance frequency 59 Hz and Qt 0.41 to a new loudspeaker with resonance frequency 35 and a Qt 0.35. This should be sufficient to fill a room of 20 to 25 square metres,



The power supply is simple. Two 9-volt batteries or two 12 volt sealed accumulators and 2 Jensen four pole 47000 uF 16-volt electrolytic capacitors.
This amplification of bass **must not be compared to the old day’s loudness regulation.** But can in a way be used as such. The very big difference is this solutions ability to correct the turn of phase on the actual loudspeaker, and must be seen as a part of that.
As mentioned earlier The DC-amplification is dependent on the proportion between the actual resonance frequency and the wanted one. To give you possibility to choose differently the formulas are given below
NB! The price of these parts are so low, that I see no problem in making more of these solutions to switch between, dependent on your listening level and your room.
The quality and precision for the values of the components are critical. Don’t try to use the normal circuit board, but stick to hardwiring with silver. As support for the

components you can use a small board made from pertinax equipped with holes in the normal way.
A normal power-supply has been tried with disappointing results, why the mentioned batteries/accumulators must be used. Together with the Jensen four pole electrolytic capacitor.
Also lower values for the resistors and higher for the capacitors has b een tried with a negative result.

The Linqwitz – Grainer bass equaliser.

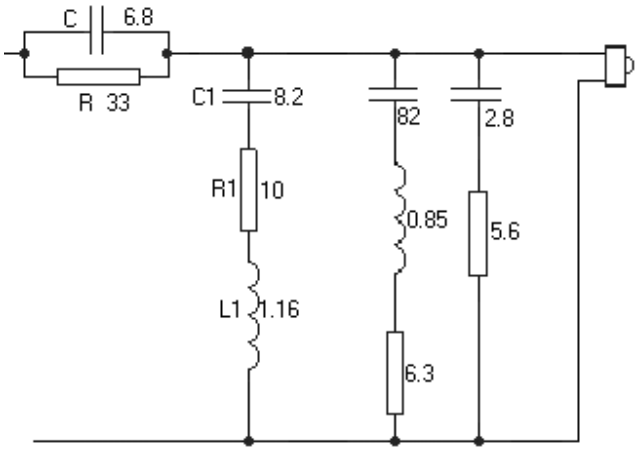


To calculate you must determine 4 parameters.
The resonance frequency of your loudspeaker F0.
The resonance frequency you want your loudspeaker to have Fe.
The Qt of your loudspeaker Q0.
The Qt you want your loudspeaker to have Qe.

Control of realisation:
For the circuit to work k=(F0/Fe-Q0/Qe)/(Q0/Qe-Fe/F0) must be positive.
If that is the case with the chosen parameters, then you choose a value for C2 in Farad (1E-7F for example).
R1=1/(2*pi*F0*C2*2*Q0*(1+k))
R2=2*k*R1
R3=R1*(F0/Fe)^2
C1=C2*(2*Q0*(1+k))^2
C3=C1*(Fe/F0)^2
Amplification at DC is 40*log (F0/Fe)
This will create problems for sure, if you play LP's. The solution is simple – play without the Linqwitz-Grainer. This solution is also valid for many CD's, as bass-reflex loudspeakers often are used as control monitors, why the very deep bass is out of control – the producer simply can't hear it.

The tweeter.
This most complicated part **must** be countersinked into the front. This will form reflecting edges and walls destroying the sound from this unit totally. In order to repair this you must take apart the front plate of the dome or make a copy. You shall use this part in order to smoothen out the surroundings felt by the dome. Place the front plate precisely in its place, and prepare it, the front board and walls against water. Now you make a plaster cast around and on the front plate of the dome, in which you form a conical horn beginning in the hole in the front plate and ending at the edges around the dome by scraping with a ruler. You must later enlarge the hole to free the screws, that assemble the front plate, and remove the plaster, where it is thin.
When dry and grinded in, this plaster part is put into place, and the removed part of plaster just around the dome is substituted by plasticine – yes the whole front surface of the plaster should be covered with a thin layer of this material. The surface of this "horn" can be covered with cloth, felt, wash leather or left as it is. All material leaves a print on the sound – that - is for you to decide.
This done right, you will be surprised, how straight a level of sound can be achieved from so rough start conditions.

The dividing network
C and R should be 6.8 uF and 33 Ohm
C1, R1 and L1 should be 8.2 uF, 10 Ohm and 1.16 mH
The rest of the circuit is the correctional network mentioned earlier. (See figure next page))



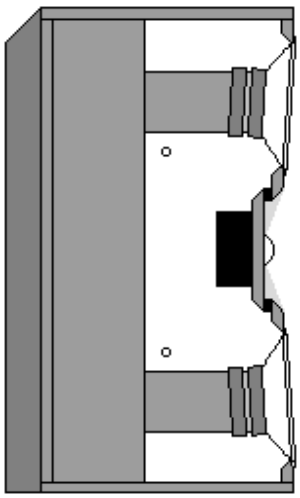


Figure.

From this you see the construction with the sides removed. Before the sides are pl aced and taut, the units must be taken away. On the front part of the support for the magnets bitumen is placed. This material becomes adhesive and is soft for slow movements. So when the units are replaced you should tighten the screws slowly by hand, els e the tiny basket will be deformed.

The box behind the loudspeaker is for the dividing network.

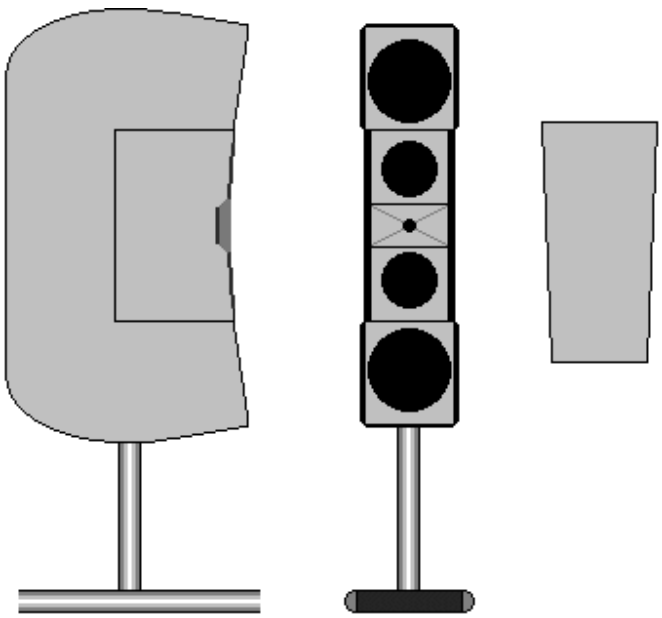
Wires for the single units are lead to the box through drilled holes in the back of the enclosure. In order to simplify the hardwired -dividing network it is advisable to keep positive and negative termination to each side and place termination on which to solder the wires from the amplifier at the bottom.

The stand.

To get most out from this construction, the tweeter should be placed in the same height as your ears when you listen. The two bass/mid units must point directly towards you.

This doesn't spoil the possibility for more listeners, but there will be created a sort of a hot spot in which you will get the maximum listening experience.
If you can place the loudspeakers so, that the front baffle continues to the floor you will get the best result.
An idea could be to build a simple shelf for CD's, LP's or books. This would have the same size as an eventually coming bass cabinet.
An interesting idea for a bass enclosure has popped up during the work with this construction, as the reproduction inside the hot spot is so exceptional good. Therefore this new design for the bass is developed with all sides pointing at the listening point. See fig.
This loudspeaker will be a three-way d'Apolitto, which for now just is an idea of design.
A name for this construction - inspired from the sound of it middle-section and the telephone-like bass-enclosure – would be "***The communicator d'Apolitto***"
Another idea of softening the appearance and with a more normal placement of the bass units I would call "***The communicator".***

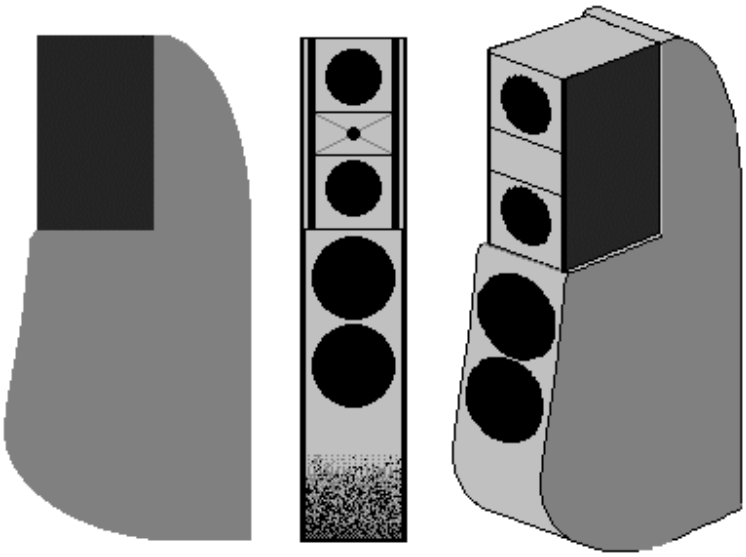
The communicator d'Apolitto



Side-view ***Front-*** ***Top-***

All sides are directed towards the "Hot spot!"

The communicator



Results from listening.
This simple 2-way construction has open new doors for what can be achieved from loudspeakers of this size.
They are really full-range, disappear completely, and leave you only the recorded soundstage for you to experience. They are very different from normal but all in a positive way.
Their tone and timbre can be adjusted to your taste in several ways for you to explore:
1. The Linqwitz-Grainer.
2. The tilt and
3. The level of treble.

Adjustments on these will reach over several octaves, why you should correct in small steps.
This construction is so precise, that it only leaves you the possibility to enjoy the music in full, if the absolute phase is correct. Wrong it is heard very clearly as a diffuse centre- and an unsettled soundstage. ***You will learn to hear that****.*
You will regrettably also learn, that the recording, storage and later treatments of the material introduce many faults.
Further it will conjure every mismatch from your gear – but shouldn't a good loudspeaker do exactly that?
At last you can build a loudspeaker, that not only is a monitor but a very musically one.

Warning! You will only get these results if you use very precise parts. The so normal 10% accuracy simply doesn't work.

A very useful trick concerning treble in general is to hang a single very thin and loose piece of paper from a paper serviette in front of the speaker. This paper must hang free

only fastened at the top. Its way of changing the sound in a more natural direction is astonishing, and it can't be done electrically.

Målinger og lytteindtryk

A greater 2-way d'Apolitto

This construction uses 2 pieces of 6-inch units and a 1-inch treble.
The enclosure is floor standing on a U-formed plate wherein the dividing network is placed. This gives you possibilities to adjust the height of the treble to your position.
For this construction units from the French manufacturer "Focal" are used. They are said to be very good. I use them on recommendation and their higher impedance so suited coupling in parallel.
As the enclosure is bigger than the former one, a special matrix is used seen through transparent sides. See figure.
The grey box with smaller holes (they should be smaller and of greater number) is inspired from the construction of exhaust pipes. I have always been very impressed of that physically small device's ability to silence the explosions from the motor. To others and my ears it works beautifully also here. The slots on the back form an airflow resistance to soften the spring ability of the air closed in.