

## Making the Onken Enclosure, Jean Hiraga Audiophile No. 2, December 1977

Many Audiophiles are looking for "real" bass sound. To try to access it, all means have been implemented: enclosures of large size, multiple drivers, separate bass-amplification, active filters, EQ, Motional Feedback servoS. Others have preferred to modify and improve the characteristics of the listening room, which is of course very important: arrangement of the speakers, absorbers, selective reflectors in frequency, resonators to absorb multiple peaks and resonances. But "true" bass sound not only means objective quality being the result of well calculated enclosures.

This article will describe an ONKEN brand loudspeaker, reserved in Japan for a very demanding clientele. Studied around 1965, however, it was marketed, in very small quantities, in 1973. Large size (some 360 litres) it was a considerable success and was used (and still is) as a reference system by a known Japanese magazine. In the October 1973 issue of Radio Experimenter's Magazine, Mr Koizumi described it in all its details. Since then, many enthusiasts build it as well as several loudspeaker manufacturers. In spite of the simplicity of this enclosure its realization requires good knowledge of carpentry! There are about 4,500 to 5,000 speakers made by Japanese amateurs, certified copies of the Onken speaker. Given the zero publicity of the firm Onken, it was really necessary that the results are exemplary so that many amateurs undertake its realization. Because we should not forget that in Japan, the choice of Japanese speakers as imported is extremely broad and allows for severe comparisons. If Onken's midrange speakers and tweeters are made "drop-in" Audiophiles de France will be able to experience the remarkable qualities of this enclosure, thanks to its easy realization and its affordability.

It is however understood that the bass speaker recommended here is not the Onken, but a model that brings, when mounted in this chamber (an important point) very close results. This model, the ALTEC, model 416-8A was indeed the only speaker giving close results, among many models tried.

Before proceeding to other details, it is recommended that Audiophiles eager to build this enclosure, respect all the details of the realization and the dimensions of the enclosure. Even "recalculated", "enlarged" or "miniaturized" models have resulted in failures in Japan.

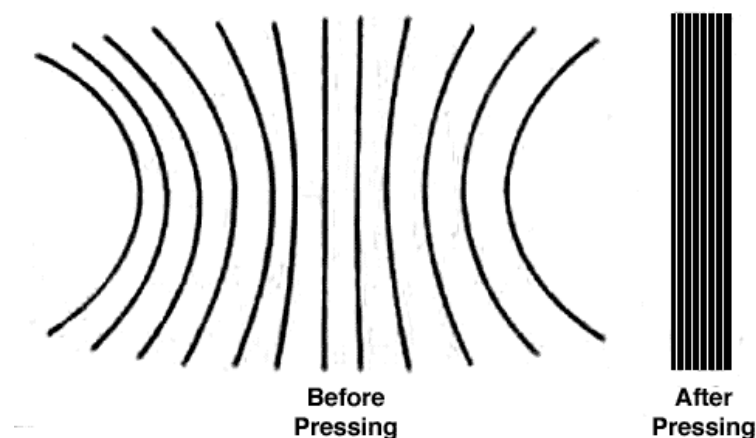
### Preliminary recommendations

This speaker is recommended for discerning Audiophiles dissatisfied with the quality of the bass sounds of their system. Although many factors will affect the final quality of the bass, the important points to respect are: 1/ listening room of acceptable dimensions, more than 4 x 6 m 2/ very rigid floor and well cushioned (double carpet). With these two conditions respected, other points will play on the quality of the bass: tonearm, headshell, turntable-mat, to list the most sensitive.

### ONKEN Enclosure: wood presses under ten tons

The original speaker ONKEN is very superior to imitations, even perfectly realized. This sensitive difference in listening seems to come from wood. This 25mm thick plywood is specially made for Onken near Nagoya where the majority of furniture and piano manufacturers are located. This wood, called either shinaban plywood or Canadian plywood has the particularity of being not only very heavy, but to be composed of thin slats strongly hot folded, by ultrasonic process and then pressed by a press of 10 tons. It should be noted here that before pressing each ply is strongly convex or concave and after pressing (hot) it remains a constant thickness that gives high rigidity.

By hitting this type of plywood with a fingertip one notices a pure and clear sound. In general, it is rather either a dull or "cracked" sound caused either by a press too light, or by a non-homogeneous bonding, or by a lack of glue. The quality of the wood used is important for the 400-600 Hz sector, a difficult band to reproduce and located near the connection with the midrange speaker.



Plywood used for ONKEN speakers. Strongly folded and curved and pressed with hot glue by a 10 ton press.

Readers therefore need to find a very heavy and hard wood in this thickness. Let's add that using a lower quality wood of double thickness does not really help. Wood of quality close to the one used on the Onken speakers can be found either in Switzerland or at the manufacturers of small boats ( "marine" quality wood).

## Felt

The 15mm felt used in the ONKEN enclosure is made of 100% pure wool and moderately pressed (medium density). In no case should we use glass wool or a different amount of felt, chosen after long tests and objective and subjective measurements.

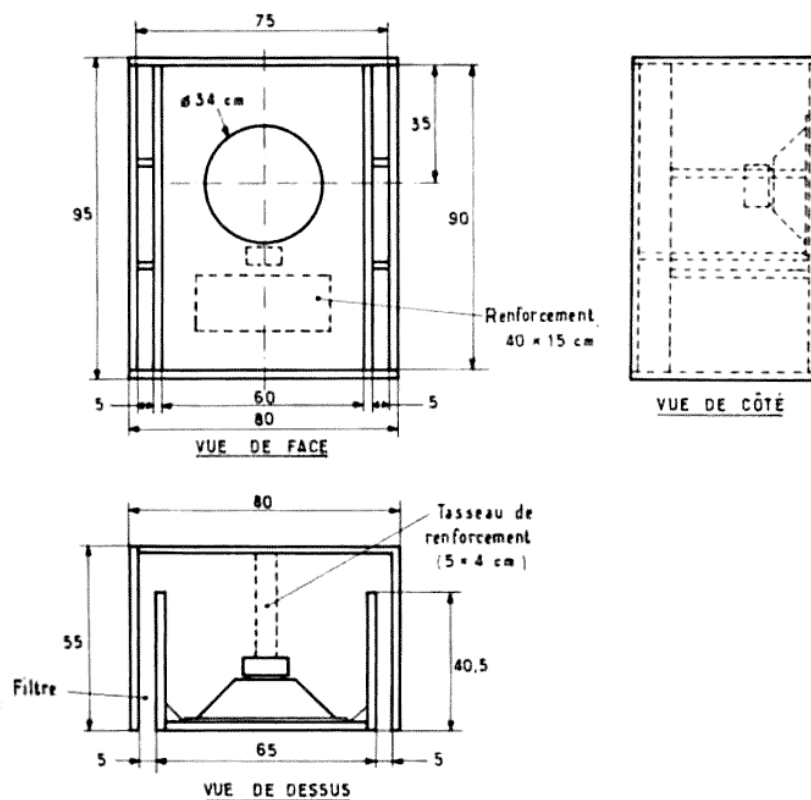
## Manufacturing

The wood selected and found, it is always recommended to have it cut and glued by a well-equipped carpenter. The final bonding of the six walls must be done precisely, and heavily clamped.

All cleats and anti-vibration reinforcements are screwed and glued, another point to respect. Note that the front panel is removable and fixed by 16 screws (+ head) of length about 42 mm. In most cases, the tightening of these screws can not be done by hand (use a t-bar driver or a speeder-handle).

The first part to make are the two side walls with vent ducts. The completed side parts are glued at once with the top, bottom and back. Before this assembly note that cleats are screwed and glued which allows the screwing and gluing of the back. The glue used is hot glue, used by carpenters. Synthetic rubber-based glue is not recommended here.

Note the presence of many reinforcements on most walls, which are all screwed and glued. The six walls are also screwed and glued, taking care to hide the marks left by the screws on the outer walls. It can be used for this either special glue (very thick) or a mixture of plaster and glue, which will be equalized after complete drying.



The finish of Onken speakers is made by a special paint applied in two parts. The first rendering after drying the "cracked" surface, thickness about 1 mm; the second is a spray paint, very dark gray, semi-mat. The front panel should not have a grill.

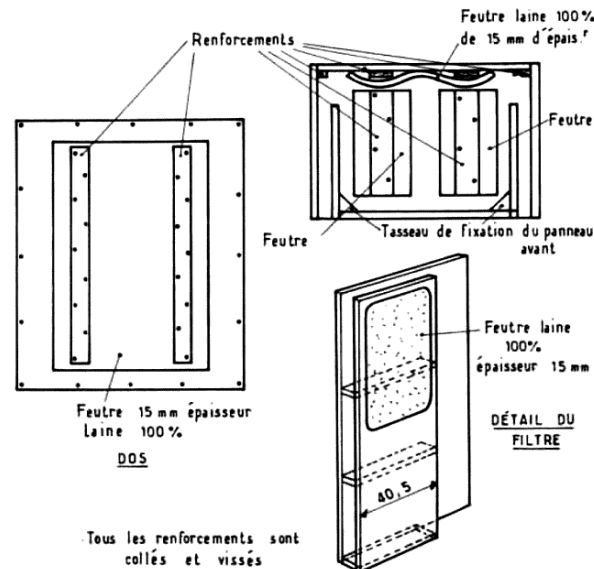
Another important point is to mount the speaker through the back of the cabinet and not fixed in front. Despite the many theoretical disadvantages, the rear mounting is the one giving the best subjective results. Note that the baffle perforation, 34 cm in diameter, has been calculated for the best phase response and thus a disturbing part of the speaker's external suspension is hidden.

## Fixing the speaker

The 416-8A loudspeaker basket, although imposing, must be attached carefully. This speaker is high efficiency and has a very narrow air gap. The slightest deformation is enough to shift the frame / membrane assembly.

It is therefore necessary to screw very slowly and little by little each screw. One can also screw with baffle separated from the ground by two cleats while injecting a sinusoidal signal of very low frequency, 5 to 10 Hz, at the limit of bottleneck.

If the generator can allow it, go lower in frequency (1 to 2 Hz) so that at these frequencies, inaudible, any decentering will be felt. This setting must be done in total silence.



Layout of the reinforcements

The back side has a waterproof window, dimensions 6 x 10 cm on which will be fixed on the inside, a bakelite plate, thickness 1 cm. including the speaker terminals. Choose terminals of quality and generous dimensions. Those used on the Onken enclosure have an outside diameter of 15 mm, length 3 cm.

Connect the terminals and the loudspeaker with quality wire, like "LUCAS", the one giving the best results here.

## Speaker Break-in

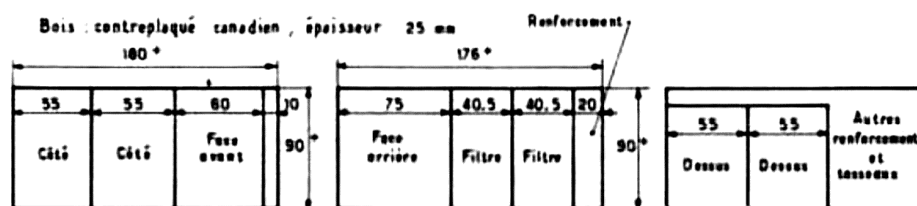
If it poses environmental problems it is essential to get an early operation. Break-in mainly concerns the external suspension and the centering spider, which must not be so loosened by hand.

Proceed as follows:

Inject at 0.6 watts the following signals:

25 Hz for 5 hours 110 Hz for 2 hours 1000 Hz for 2 hours 3,000 Hz for 1 hour

in the order above, repeat 4 times. This break-in is important and avoids the many adjustments and re-adjustments during the following months.



Detail of panel cutting

## Speaker Layout

Out from the back wall by at least 1 meter. Away from side walls by at least 1 meter. Placed directly on the ground or on a stone base. Very demanding audiophiles can make polished granite slabs on 5 sides (edges + top) of dimensions 65 x 90 x 8 cm. Place hard felt (minimum thickness 5 mm) between the slab and the enclosure.

The minimum distance between the inner walls of the speakers is 1.80 m.

## Crossover Frequency

Most common is 600 Hz cutoff with 12 dB per octave. A quality active filter is advantageous, but it is possible use a passive filter consisting of a 3m inductor, made of large diameter wire (3 to 3.5 mm in diameter as on the Onken filters) and a capacitor with impregnated paper, quality, unpolarized, value 24  $\mu$ F (or 2 capacitors of 12  $\mu$ F mounted in parallel). Do not use wound coils of sheet metal or ferrite core. Connect the filter elements with large wire diameter 3 mm.

## Advantages of the ONKEN enclosure

It is always possible, by cone treatment for example, to make a loudspeaker mounted in an enclosure have a very linear frequency. Unfortunately this is always at the expense of performance and definition.

The average efficiency of the Onken speaker is 96 dB per watt, about 10 dB more than conventional speakers. In the majority of cases a power amplifier between 5 and 50 watts is largely sufficient. This speaker can accept 60 watts, its exceptional performance translates acoustically to an intense level, difficult to live with, but not distorted. In comparison a low performance speaker would require 3,000 watts to achieve the same level, which is technically impossible without destroying the voice coil. This is more commonly reflected by saturation and limitations on musical peaks.

This speaker, mounted with the Altec 416-8A Speaker gives results very close to the original speaker Onken. For a level of 100 dB at 1 m, the distortion remains less than 0.8% at 35 Hz, 0.2% between 60 and 600 Hz . This performance is it difficult to obtain at so low a cost.

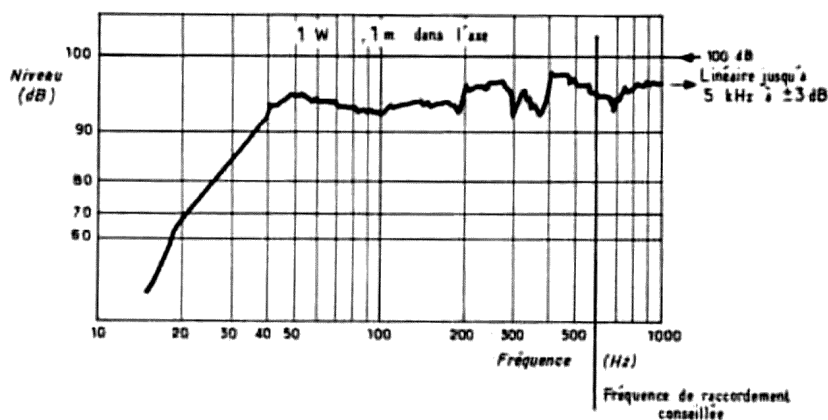
## Musical qualities

This speaker has been detailed in the Review of Sound (No. 275). The bass quality also depends on the quality of the midrange and the treble, the bass sound of Onken speakers is characterized by great lightness, firmness and exceptional dynamics.

Audiophiles who do not like large-diameter bass speakers must first of all consider that the most important thing in a loudspeaker is not the mass of the diaphragm (very light in the case of 416-8A), but rather the ratio transmitted energy / mass of the cone, which in this case is very high and plays a major role in the results.

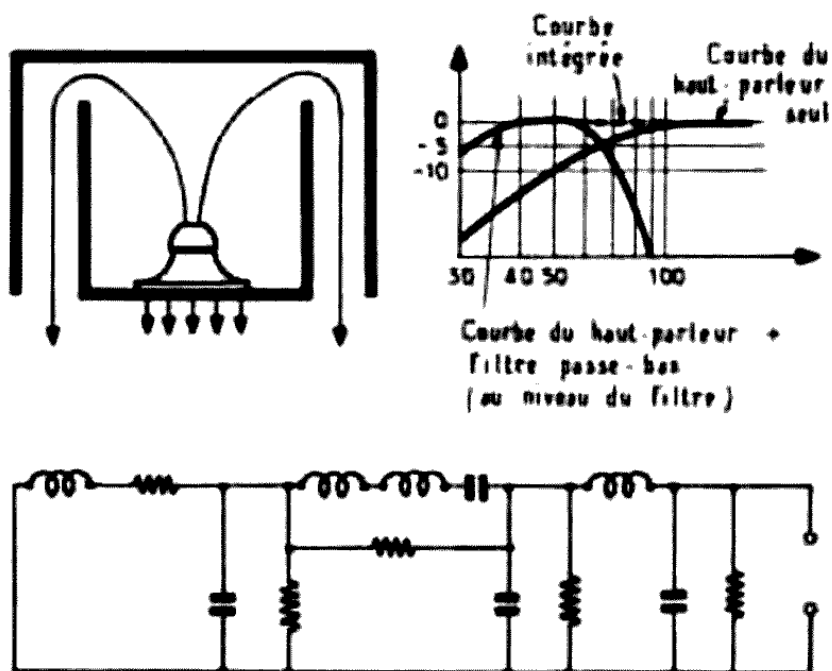
The magnet used on the 416-8A is a central magnet, not a crown, which minimizes magnetic leakage (a piece of ferrous metal does not "stick" to the magnetic circuit, despite the large total magnetic intensity and very generous air gap flow: 15,000 Gauss (1.5 Tesla) In most cases, not only is the membrane heavier, the magnet less powerful and the gap wider, but the crown magnet introduces an inevitable magnetic leak, easy to demonstrate, this leak can reach 30% which further aggravates the energy / mass ratio.

ONKEN SPEAKER FR CURVE, with Altec 416-8A



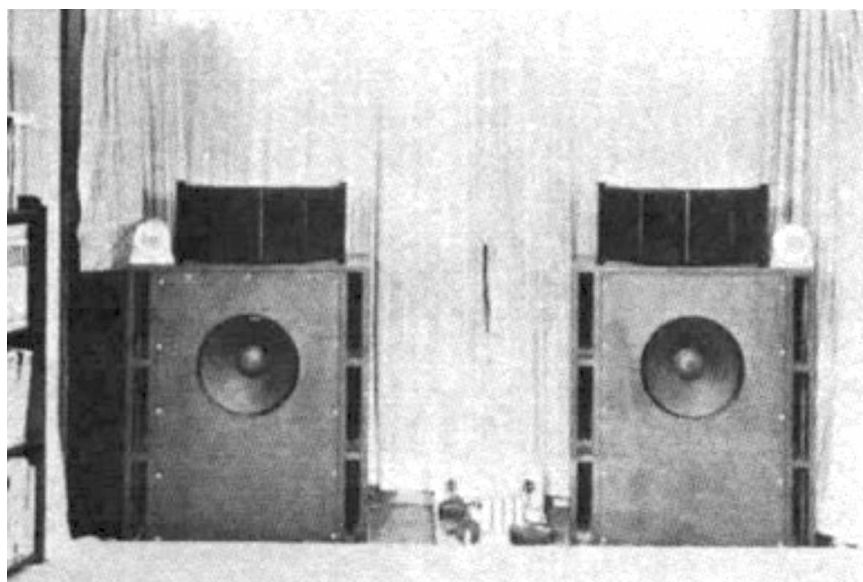
Note the exceptional performance (96 dB per watt on average) and the good linearity (35-1000 Hz  $\pm$  3.5 dB)

Even without causing too much coloration, a large mass driven by low energy makes the perfect control of the cone impossible. By touching the stylus tip of the cartridge one can hear the bass speaker "beat" and "drag". If the acceleration is easy, the reverse is less, because it is impossible to instantly stop a cone of 100 to 130 gr am with such a weak force. This comes down to the relationship between the power of an engine and the mass of a car . On this point the 416-8A, which is nothing new, combines the advantages of an ultra-powerful motor to a light and rigid cone.



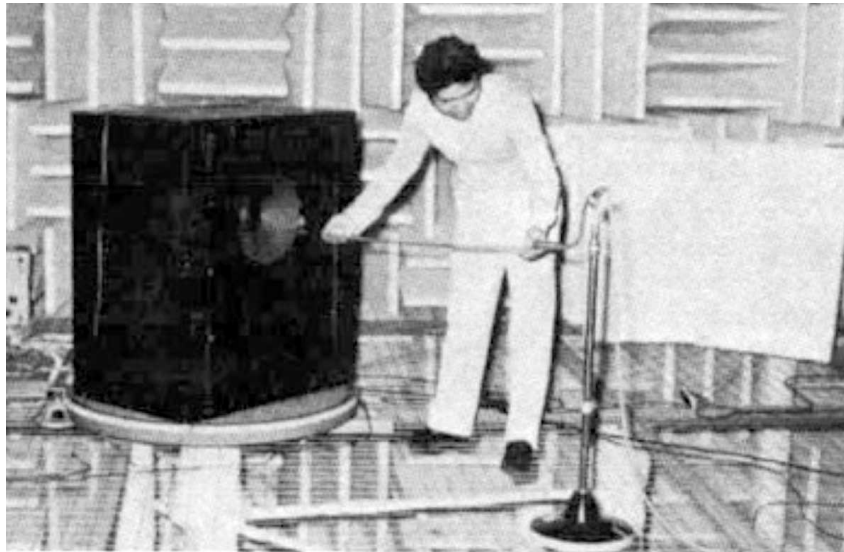
Equivalent Circuit of the Onken speaker. This system had been proposed before 1950 by Jensen. Very close to the "acoustic line" or sees however, that despite its appearance, this speaker is not the type "Bass Reflex". This equivalent circuit is indeed a damped low-pass filter and not a resonant circuit.

In the Onken, it does wonders: very frank attacks, perfect clarity at low or high level. Thus this speaker can simultaneously reproduce several very different bass sounds: a very soft and fuzzy bass (room, reverb, distance effect) on which can be detached at the same time other bass sounds to the strings "torn", cello with all the richness of the resonances of the body, the serious dry and percussive percussion, the jerky and intense breath of the exhaust of a tractor ...



In general, even without noticing colouration defects in a large majority of speakers, it should be noted that there is still a "similarity" more or less marked between several serious sounds reproduced, signs of another form of colouration which one could call "colouration of musical expression".

Properly tuned this speaker, is, as it had been described in the article, able to remain completely absent on some programs not containing serious bass, which may seem obvious but is hardly respected. When setting, it is recommended to start with sound sources containing virtually no bass and adjust the level of the bass to the limit of perceptible. Without touching the levels, we then pass the sounds of more and more serious cello, bass, bass drum, organ. This setting is tricky and needs to be repeated several times, at medium level, leaving all tone controls in a linear position.



Let's say that the system proposed here, for the bass, is not "a good speaker", but that it is certainly a faithful device, capable of reproducing a great variety of serious sounds, with an astonishing freedom of expression .

Recently, the 416-8A loudspeaker has been replaced by the 416-8B, differing in its chassis and magnet. However, it is recommended to buy the old version, the differences playing mostly on the extreme low (band 30-50 Hz). Thus proposed its cost price is interesting given its performance, reduced cost price only to:

- Two Altec 416-8A speakers
- Six boards of 180 x 90 cm x 25 mm
- Pure wool felt
- Two 600 Hz 12 dB low pass filters
- and good ears for final tuning!

Hope that this enclosures will know deserved success in France.