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The Göbel Bending Wave Patent

1. The bending wave principle

1. 1. Wave propagation in solid media

Inducting vibration energy in a solid medium leads to the propagation of different kinds of wave forms: In thicker media, mostly dilatational and longitudinal waves emerge. Surface waves appear on the interfaces between two different surfaces. In thinner media, also transversal waves or bending waves propagate. The velocity of propagation always depends on the inducted frequency. In addition to this, the different wave forms are being influenced by the following parameters:

- the propagation of dilatational and longitudinal waves are dependent on the material constants, which are determined by the molecular structure, thus the density and the molecular chain.
- the spread of surface waves are subject to the molecular structure of both interfaces.
- transversal waves, where no change of volume or density is connected with the change of wave propagation, are dependent on elasticity, the specific weight, and the ability to contract transversally.
- in addition to the inducted frequency, bending waves are subject to the bending stiffness (E-Modul) and the mass density.

It is only transversal and bending waves that are suited for sound propagation, as they raise a sufficiently high amplitude on a surface.

1. 2. The basic principle of a bending wave loudspeaker

In order to illustrate the basic principle of a bending wave loudspeaker, the following image is very helpful:

> Just imagine you are throwing a stone into a lake! The water surface is being destabilised by this impulse. This shows, as we can witness a wave that propagates equally to each side.

A bending wave loudspeaker is based on the same principle:

A wave front is being raised on a membrane (in our case the water surface) by an electrodynamic exciter (in our case the stone). This wave front propagates on the membrane, exactly like the wave front on the water surface. A bending wave has emerged. Due to the changes of air pressure resulting from this wavefront we hear an acoustic noise.

1. 3. The stiff bending wave loudspeaker

Only a stiff bending wave loudspeaker is qualified for a sound reproduction that features a very broadband frequency / phase linearity, and an impulse fidelity without any sound-focusing effects. As mentioned above, the propagation of bending waves on the membrane is dependent on the frequency that has been inducted. This effect is called the „dispersion of the bending wave“ and it causes a rise of the phase velocity on the membrane while the frequency increases.

The frequency, where the phase velocity on the membrane and the phase velocity in the air are the same, is called „coincidence frequency“. It can be controlled by the bending stiffness (E-Modul) and the mass density.

2. The GÖBEL bending wave loudspeaker

An ordinary stiff bending wave loudspeaker bypasses the changes of air pressure, which are being produced by bending waves below this coincidence frequency. This means that the bending wave loudspeaker works only as a normal piston loudspeaker in this range. Above the coincidence frequency the efficiency factor increases by leaps and bounds and the bending wave starts to detach at an angle of > 0 degree.

In contrast to an ordinary stiff bending wave loudspeaker, the GÖBEL bending wave loudspeaker also emits sound by bending waves below the coincidence frequency. The secret of this feature is the special mass density and the damping characteristics of the sophisticated GÖBEL 9-layer membrane. Through our patented membrane, we achieve a very slow transition from a bending wave emitted sound to a piston emitted sound, which results in a perfect around dispersion. This makes it also possible to perfectly integrate an ordinary loudspeaker (e.g. subwoofer). Apart from this, the slow transition cuts off the excursive increase of the efficiency factor.

A GÖBEL bending wave loudspeaker doesn’t only induce a bending wave in a controlled way onto the membrane through the entire frequency range. It also damps the bending wave through the entire frequency range. Because, in a similar way to a wave front reflected on the shore of a lake, a bending wave is being reflected on the membrane. The result: a resounding, diffused and washed-out sound.

The GÖBEL bending wave loudspeaker does not have this problem. Our patended membrane contains three measures to prevent any reflections on edges:

2.1 The special bending wave membrane

The basic material of the 9-layered bending wave membrane is produced according to our specifications and consists of a special kind of wood, which contributes through its specific properties (volumetric weight, lignin content, compression strength,...) to the outstanding characteristics of the GÖBEL membrane.

In addition to this, the anisotropy (inhomogeneity) of the wood prevents a distinctive resonance. Our sophisticated procedure of resinating, webbing and compressing the basic material adds to the peerless GÖBEL sound. We only use resin and webbing of best kind and quality, which ensure, in addition to the sound-relevant properties, the best available resistance to ageing and durability.

Through the exact compilation of the webbing layers, the specific measurements of the membrane, the precise adjustments of the heartwood and the physical characteristics of our core material, the amplitude of an emitted bending wave is being constantly damped through its entire runtime on the membrane.

2. 2. The clamping around the bending wave panel

The clampings around the edges of the membrane consist of various materials (aluminium, rubber, silicon, foam rubber, MDF) to ensure an even limitation of the wave through the entire bandwidth. Through this measure, any reflections on the interface to other media are eliminated through the entire bandwidth, which is more than 7 octaves.

2. 3. The incisions on the bending wave panel

The laser cut incisions are designed to eliminate any reflections on the edges. Apart from that, the cuttings adjust the stiffness of the panel. The required geometric angles have to be exactly calculated and precisely executed. In order to reduce production tolerances, the incisions are made with a computer-operated laser. Through this labour-intensive procedure the heartwood is being hermetically sealed and any chipping is being anticipated.

Due to all of these measures, we created a worldwide unique and dynamic loudspeaker, which reproduces all kinds of sound very truely and unveils every „Detaille“ of your favorite music. Not only the outstanding loudspeakers of GÖBEL Audio use the bending wave principle, many instruments like violins, guitars and pianos use it too!

To make a long story short: our bending wave loudspeaker is the most natural loudspeaker in the world!