

## 1. The Kinematics of Inversion

Paul Schatz discovered the motion phenomena of inversion and adapted it for technical applications.

In the early 30's Paul Schatz was studying the inversion of platonic polyhedra. His central theme was: By what manipulation is it possible to turn the inside of a body to the outside?

If you take a cube and remove parts at two diagonal corners, you get a 6-section band around the cube. This „cube belt“ can be turned inside out (Fig. 1).

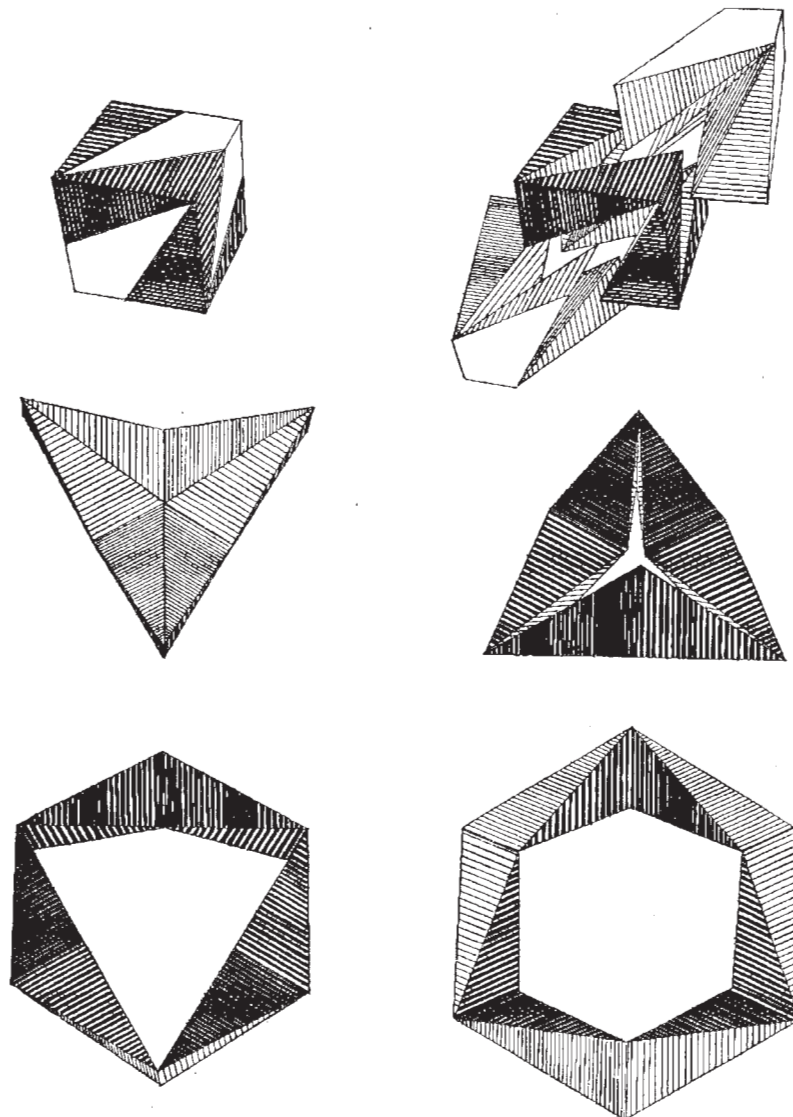


Fig. 1: Construction of the Cube Belt

In his search for technical usage Paul Schatz developed the very special inversion mixer. He took 3 segments of the cube belt and fixed the ends at a defined distance. If you turn this belt around itself, the movement of the middle section performs the same inversion movement as the Bioengineering Inversina (Fig. 2).

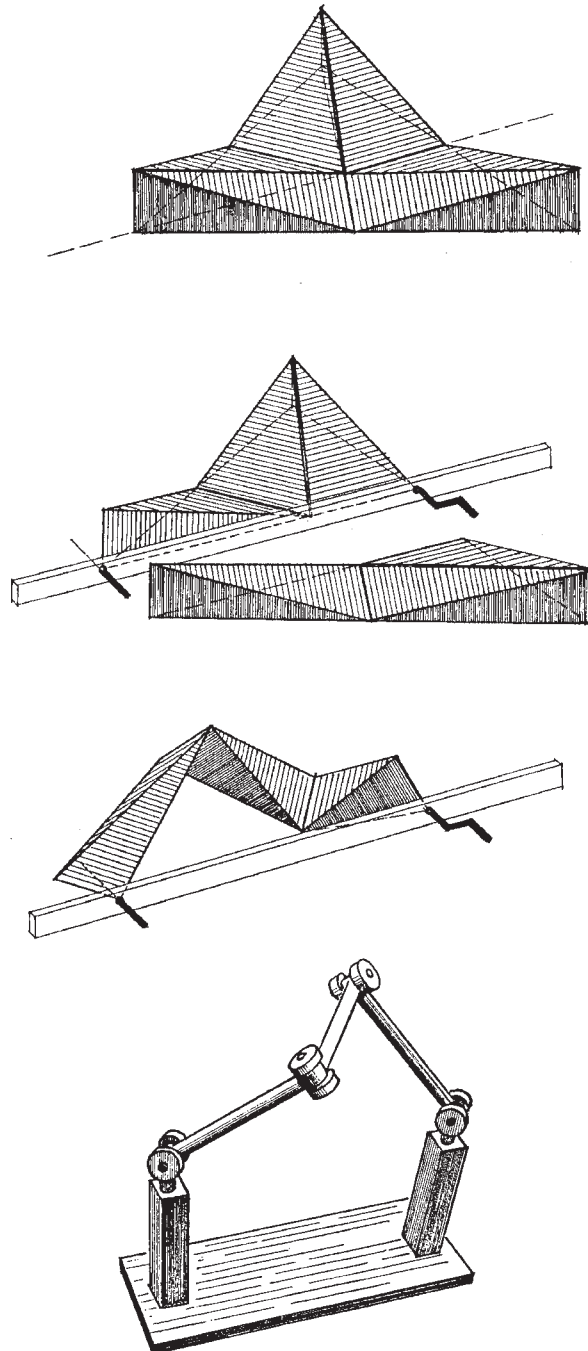


Fig. 2: Technical Application of the Cube Belt

The motion of the inversion is similar to the manual mixing of small vials in the lemniscate (figure 8). But in addition to the manual movement in the figure 8, the mixing vessel in the Bioengineering Inversina also rotates and tumbles.

An identical motion is generated when rolling an oloid on a surface. The oloid was also identified by Pauls Schatz. It is generated as hollow form when the 6-section cube belt is twisted around one corner fixed on a table.

When rolling on a surface, the oloid does not move smoothly but pulses in a rhythmical motion. It seems to run quicker when rolling over an edge compared to the rounded surface (Fig. 3).

It is this harmonic pulsating movement which generates the outstanding mixing quality and efficiency of the Bioengineering Inversina.

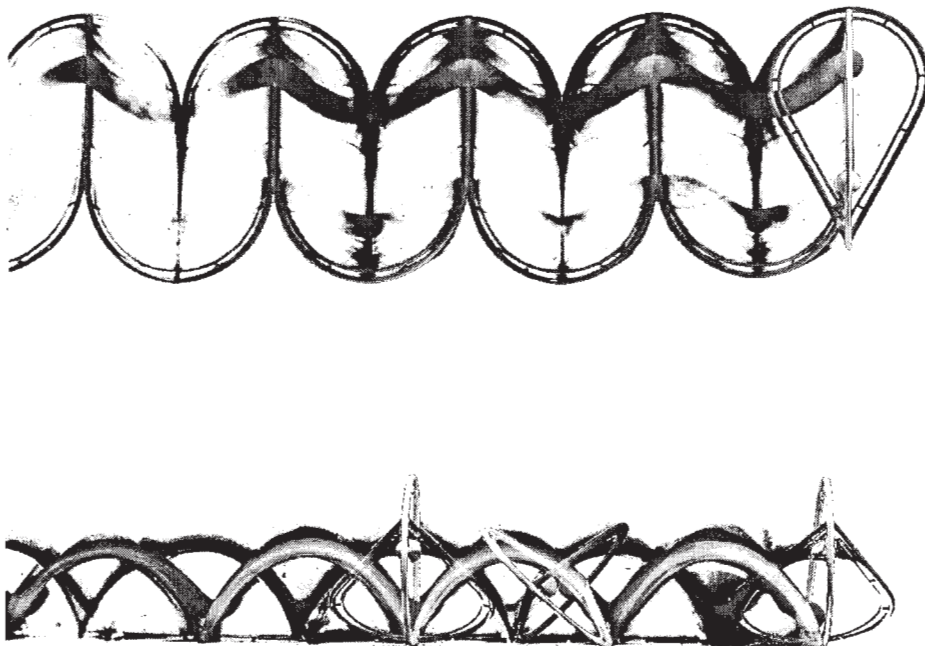


Abb. 3: Bewegungsablauf eines Oloids - von oben und seitlich

## 2. The Bioengineering Inversina for Solid State Fermentation

The pulsating inversion movement of the Bioengineering Inversina fluidizes your solid fermentation substrate and gently forces it into constant motion. Due to friction the material attaches to the vessel walls and is lifted with the wall, when it rotates. At the highest point gravity pulls the material down, where it is displaced by the rhythmically pulsating vessel wall.

Without any sharp reversal of movement the solids undergo alternating compression and decompression. Due to this very special motion even compounds with highly varying physical properties do not segregate. So the maximal mixing quality is constantly maintained and does not decrease.

Due to this unconventional motion the Bioengineering Inversina is a highly efficient but gentle high-performance unit for solid state fermentation.

In combination with the peripheral systems of the Bioengineering bioreactor and fermentation equipment such as measurement and controls or dosing systems the Bioengineering Inversina represents a high-quality solid state fermentation system also suitable for most fragile organisms, such as e.g. hairy root cells.

The following requirements for solid state fermentation are met by the Bioengineering Inversina:

- continuous process

Our retrofit kit with central in- and outlets enables the continuous use of the Bioengineering Inversina for fermentation. The ports are used for e.g. aeration, addition of buffering media or substrate, sampling, harvesting, temperature and humidity control.

- high mixing efficiency

Fermentation requires the immediate transfer of gases and substrate to your organisms with least possible concentration gradients and highest concentration homogeneity.

The spectacular inversion movement gives best interaction between the gaseous and solid phases of your fermentation. Due to the rhythmical motion the substrate does not form agglomerates.

- gentle mixing

Some organisms and certain compounds are damaged by shear force or are sensitive to heat. The gentle mixing motion of the Inversina enables its use for the fermentation of solid substrates even using very fragile organisms.

Due to the construction of the Bioengineering Inversina without internal rotating parts no local temperature peaks are generated in the vessel which might harm your organisms or denature your substrate.

- sterile and contained fermentation

If required, the container with its periphery is autoclavable or in-situ sterilizable. The container is then inoculated and inserted into the Bioengineering Inversina system.

Our know-how in sterile technology enables the longterm cultivation over months without contamination.

If you require a sterile or contained continuous solid state fermentation system that is mixed most efficient and gently, the Bioengineering Inversina is the best choice.