BIOENGINEERING
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## 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).

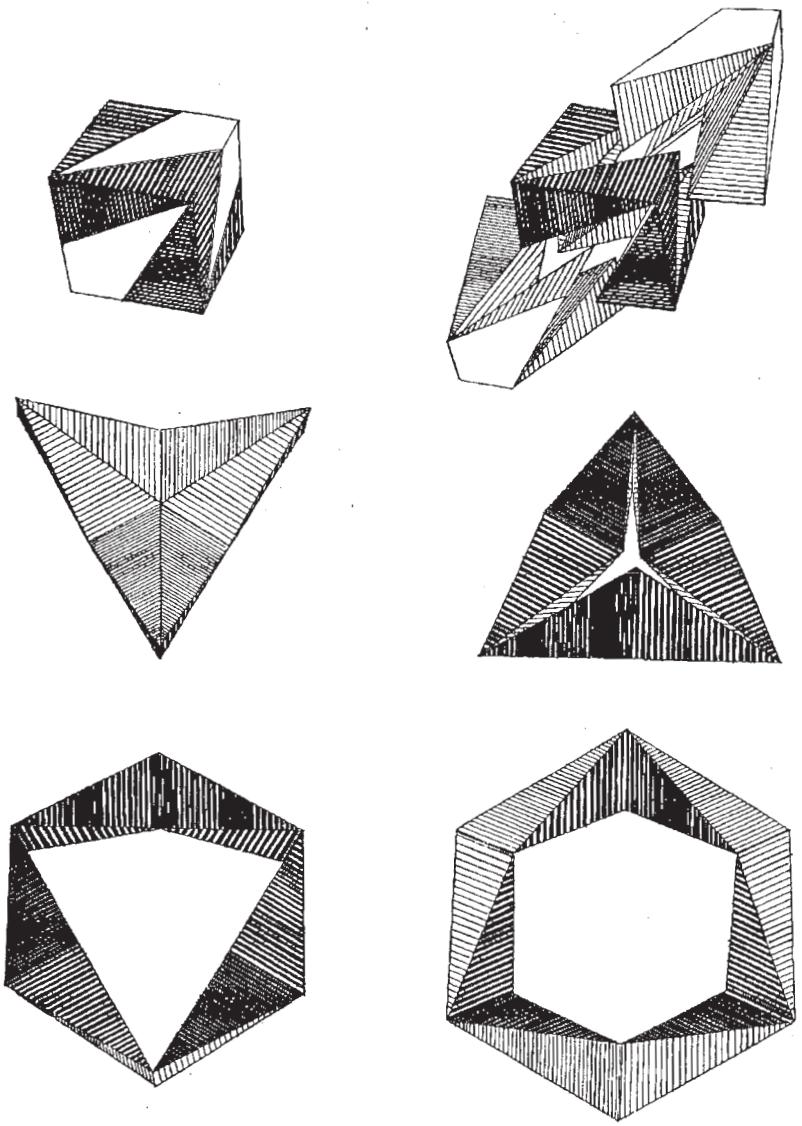

Fig. 1: Construction of the Cube Belt

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).

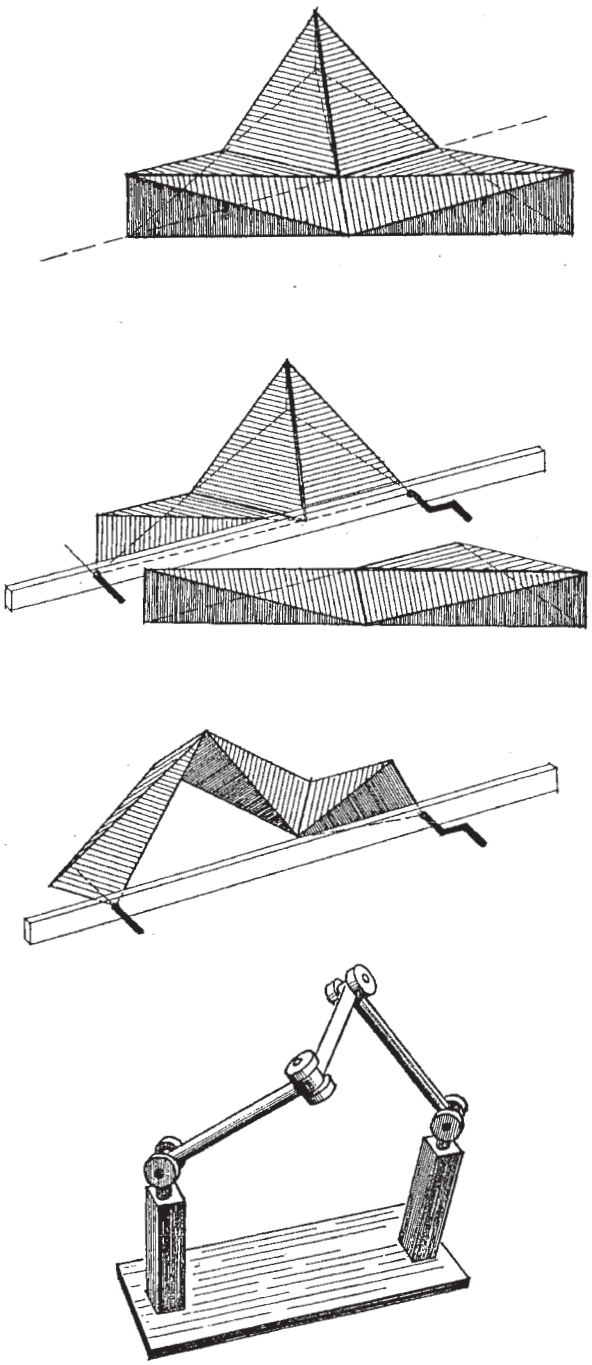

Fig. 2: Technical Application of the Cube Belt

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 genereated 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.

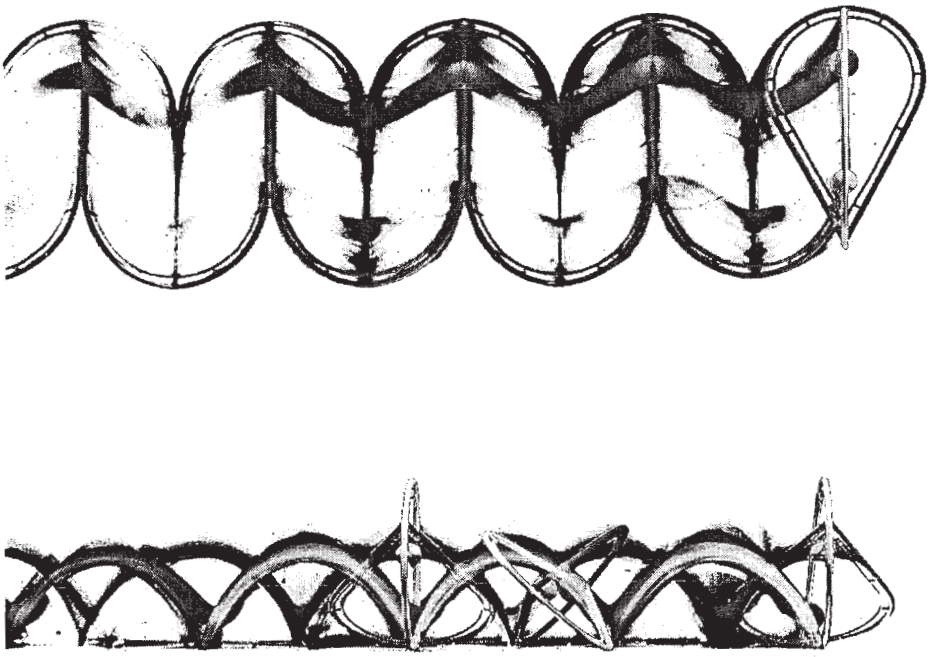

Abb. 3: Motion pattern of an Oloid - top and side view

## 2. Mixers in comparison

Compounds with different physical properties are often very difficult to mix.

Properties such as density, size, surface roughness, moisture pick-up and adhesion define the behaviour of solid particels. Also properties of fluids such as density, viscosity and hydrophicity influence the mixing proces..

The limits of generally used mixing systems such as barrel mixers or shakers are quickly reached when mixing compounds with different densities or sizes are used.

**Barrel mixers** (e.g. drum or double cone mixers) rotate the mixing vessel around a horizontal shaft. The mixer content is lifted with the vessel wall and flows, trickles or flies down by gravity.
**Disadvantages:** Smaller or heavier particles sink deeper and segregation zones are generated.

In **Mixers with mechanical stirring devices** (e.g. ribbon or plough mixers) the mixer blades are rotated on horizontal, vertical or inclined shafts.
**Disadvantages:** Here also heavier or smaller particles sink deeper due to gravity or centrifucal force. The high rotating speed and the forced motion generate shear forces harming the compounds. Depending on the mixer construction local temperature peaks are generated which heat up the mixer content.

**Shaker mixers** move the compounds either in a circle or back and forth on a line. The counpounds are displaced and accelerated by the moving vessel wall.
**Disadvantages:** Mixing almost only occurs in fluids.

After reaching a maximal mixing quality all this mixer systems show **segregation** generated by centrifugal force or gravity. The optimal time for harvesting of your mixture has to be experimentally defined. If this timing is missed, additional mixing cycles and tests are required.

If you are not in the position to accept above disadvantages and require quick and high quality mixing, the Bioengineering Inversina is your mixer of choice.

## 3. The Bioengineering Inversina

The pulsating inversion movement of the Bioengineering Inversina fluidizes your mixing material 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 mixing material undergoes alternating compression and decompression. Due to this very special motion even compounds with highly varying physical properties do not segregate. The quality of the mixture or of the emulsion does not decrease.

Due to this unconvential motion the Bioengineering Inversina is a highly efficient but gentle high-performance mixer.

The following requirements are met by the Bioengineering Inversina:

- high mixing efficiency

  Do you need best possible homogeneity? Do you have to analyze representative samples or have to guarantee distribution coefficients? Are your compounds of different density or size and in highly unequal concentrations? Do you fear the lump formation when adding liquid to your powders?

  The spectacular inversion movement gives best mixing results even when dealing with problematic material compositions.

- short mixing time

  In a fraction of time compared to standard mixing equipment (e.g. 4fold shorter mixing of pharmaceutical compounds) the Bioengineering Inversina produces optimal mixing results.

  Your products are manipulated during a shorter period of time. In addition you reduce working and handling time and increase the throughput of the unit.

- no segregation of the different compounds

  In the Bioengineering Inversina segregation of the different compounds does not occur. The optimal mixing result is reached and maintained over the complete mixing period. So there is no need to experimentally define and meet the optimal mixing time. You are less dependent on the mixer parameters for the subsequent processing of your products.

- gentle mixing

  Certain compounds are sensitive to heat or react with contact of local temperature peaks. Other compounds are changed or damaged by shear force.

  If you require gentle mixing that at the same time has to be highly efficient, we recommend the Bioengineering Inversina.

  The gentle mixing motion of the Inversina enables its use for the fermentation of solid substrates by fragile organisms as well as for the mixing of explosives.

- sterile, contained and dust-free mixing

  Different flasks or vessels including your compounds are installed in the Bioengineering Inversina. As we adapt the Inversina to your specific containers, there is no need for material transfer or decanting for the the further processing or transport of your goods.

  Using your standard containers no dead time due to cleaning or adaptation to other vessels is required.

- continuous process

  Our special retrofit kit with central in- and outlets enables the continuous use of the Bioengineering Inversina.

  Due to this adaptation in combination with the very gentle and efficient mixing , the Inversina has also been used for the aerobic fermentation of solids.

  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 fermentation system.

- products for homeopathy

  The inversion motion meets the mixing requirements for the production of homeopathic pharmaceuticals.

**Summary: In shortest periods of time the kinematics of inversion enables highly efficient mixing with minimal damage and without local temperature peaks.**

## 4. Technical Advantages of the Bioengineering Inversina

Compared to our competitors we have following advantages:

- Two driven axles guarantee the exact and controlled movement of the mixing vessel at every position
- Continous rpm control instead of fixed rotational speeds (on request an rpm indicator and timer can be installed)
- Installation of different flasks is also possible with the 20 Litres Invesina. In general the Bieongineering Inversina is adapted to your standard containers.
- The hygienic stainless steel drip pan enables easy cleaning of the unit
- Continous feeding and harvesting for mixing or solid state fermentation is possible by the installation of a special adaptor.
- todays design

## 5. Application fields of the Bioengineering Inversina

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| Analytics | Sample preparation for quality control in all industrial fields |
| Batteries | Blending of dry cell components |
| Cement industry | Quality control and R&D |
| Cosmetics | Mixing of face powder and nail polish |
| Dental industry | Mixing of materials for artificial teeth |
| Diamond tools | Mixing of diamond powder and binding material in the production of grinding wheels |
| Dyes and Pigments | Manufacture of colour compositions |
| Elektrotechnics | Mixture preparation for magnets and carbon brushes |
| Explosives and Pyrotechnics | Production of fuses, rockets, fireworks |
| Food | Preparation of dry food |
| Homeopathy | Preparation of dilutions |
| Metal finishing | Deburring on small precision parts |
| Nuclear industry | Mixing of uranium dioxide granules |
| Pharmaceutics | Prepration of tablet-filling material |
| Plastics | Mixing of resins and pigments |
| Printing Inks | Production of toner mixtures |
| Tungsten carbide tools | Mixing of metall powders |

Further applications are:

Dissolving of solids
Washing of solids with solvents
Dispersion and emulsion preparation
Extractions
Polymerisations
Grinding as ball mill