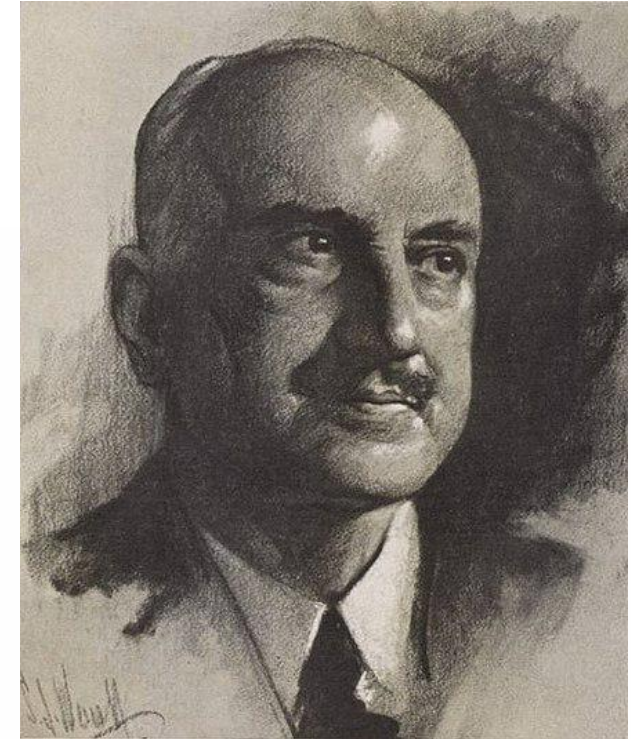


## History of Foam Fermenters

George Santayana

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Those who cannot remember the past are condemned to repeat it.

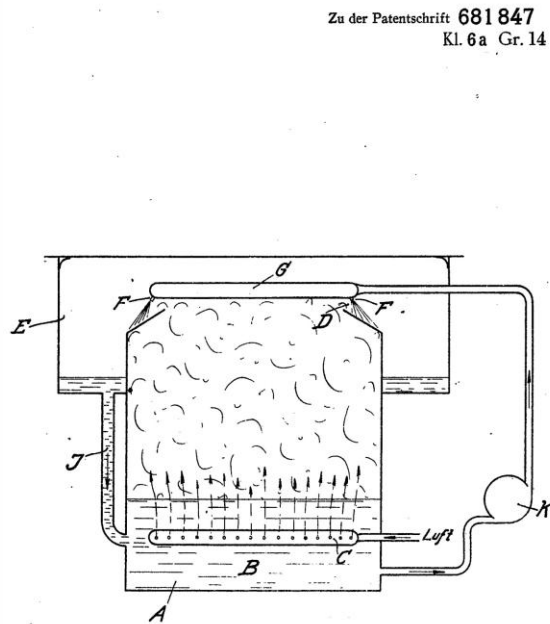


## Germany, 1937-1945

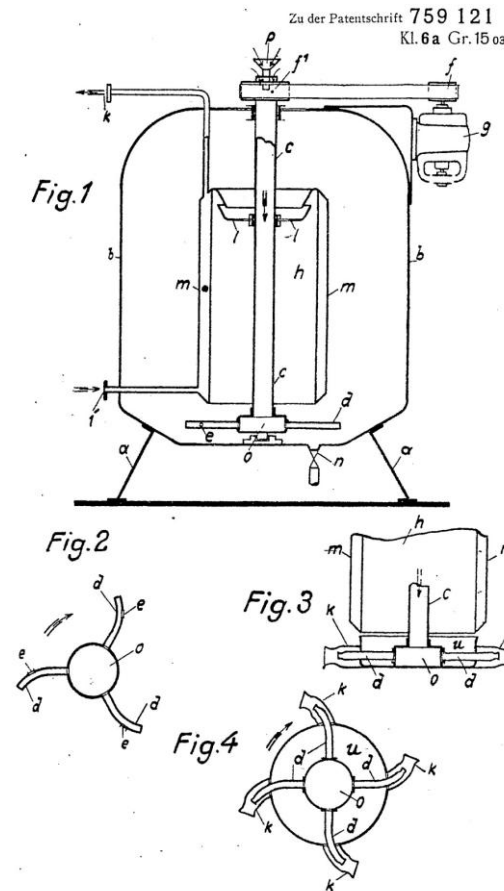
- Germany had a shortage of fuel, protein and fats during WW-II
- German paper mills had a lot of excess sugars as a byproduct of the sulfite process
- Making paper from softwood (spruce) had excess C6 sugars (glucose/mannose), and anaerobic fermentation made ethanol for fuel
- Making paper from hardwood (birch) had excess C5 sugars (xylose) which couldn't be fermented, so was used to make protein from *Candida utilis*.
- Fermenters made too much foam, and there was little fat in Germany for foam breaking, so a foam fermenter was invented at Zellstoffabrik **Waldhof** in 1939, producing tens of thousands of tons of protein, eventually in many locations in Germany
- In the 1950's, Waldhof switched to burning excess spent sulfite liquor, protein was no longer needed and was not profitable.
- Waldhof fermenters were never used again in Germany, but you can buy them today in China on Alibaba.com

# Previous Solutions – Foam Fermenters

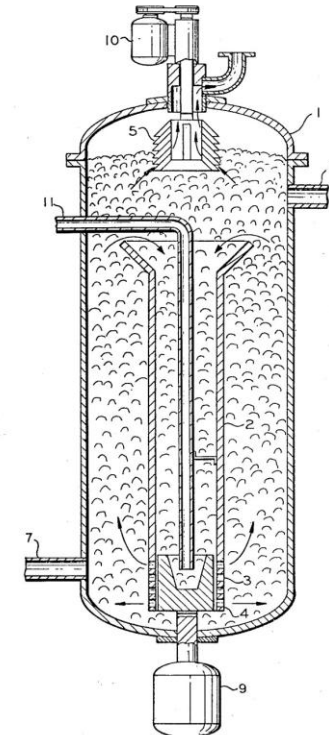
1937 – Stob Fermenter



1940 – Waldhof Fermenter



1976 – Phillips Petroleum  
U.S. Patent Sept. 28, 1976 3,982,998



## USA, 1945-1965, Foam Fermenters

- Waldhof is near Mannheim, which was in the American sector after the war, and American engineers interviewed Waldhof engineers and made copies of all the drawings for this fermenter.
- Waldhof fermenters were built at sulfite mills in Great Lakes area (Rhinelander, Wisconsin), most wood was hardwood
- Wasn't very profitable, but cleaned up water from sulfite mills
- Eventually most sulfite mills closed, Kraft pulp mills became dominant, only one Waldhof fermenter remained (Rhinelander).
- In 1947, the long-time director of Waldhof, E. Schmidt, published a complete technical description of the experiences at Waldhof, doubtful that anyone in USA ever read it.
- Schmidt, E. "Eiweiß-und Fettgewinnung über Hefe aus Sulfitablauge." *Angewandte Chemie* 59.1 (1947): 16-20.
- "the sum of fat and protein in Torula, around 50%, i.e. if you have 10% fat, there are also 40% protein, but you have 25% fat, so only 25% protein, etc."

## Market Opportunity

- Russia produces more than 100 Mt of grain, USA produces 400 Mt of corn, 40% for fuel ethanol, China is largest agricultural producer.
- Brazil, India, Russia, USA and EU produce a lot of sugar from sugarcane and sugar beet
- Main carbohydrate in Africa is cassava, which is very low in protein and lipids. Foam fermenter can make protein and lipids from Cassava.
- More than 90% of all new cars will be Electric Vehicles by 2030, so demand for bioethanol will drop significantly by 2030, so lots of excess corn, wheat and sugar
- What can all these excess carbohydrates be used for?
- Single Cell Protein for animal feed? Fish feed doesn't need carbohydrates, so *Candida utilis* with Omega-3 lipids is best to displace fish meal and fish oil.
- Beyond Meat – protein from peas, mung beans, faba beans, brown rice doesn't taste as good as salmon and chicken.
- People don't want to eat yeast but love to eat salmon and chicken. Use Omega-3 *Candida utilis* to feed fish and chickens, thus making fish and chicken with EPA and DHA.

- Lallemand is now the world leader in producing *Candida utilis* (Torula) for the food industry, in Rhinelander, Wisconsin
- Purchased Waldhof fermenter and assets of Provesta (Phillips Petroleum fermenter)
- Sulfite pulp mill is closed, Lallemand uses glucose and molasses, standard batch aseptic aerobic fermenter, doesn't use Waldhof fermenter any more.
- Lallemand Torula has no Omega-3 lipids
- There's something magic about a Waldhof fermenter that produces Torula yeast with Omega-3 lipids



## LAKE STATES®

Primary grown, dried whole cell torula inactive yeast. It is a specialty product range with the unique ability of delivering superb flavor carrier properties in different food applications, with distinctive savory notes and superior texture enhancement.



### DESCRIPTION

Lake States® production begun in 1948 in Rhinelander, Wisconsin. For over 50 years the site has been a leader in the development and commercialization of inactive dried torula yeast for the food industry, pharmaceuticals, industrial fermentations, animal feed, and pet food markets. Thanks to Lallemand investments, it is today the largest torula inactive yeast production site in the world.

The Lake States® products can be used to help to reduce the use of additives such as MSG and HVP. They are designed to impart savory notes, enhance texture and nutritional characteristics in foods. They are ideal for a broad range of processing temperatures and preparation techniques, including microwave.

If you are interested in receiving "Lake-States®" leaflet, or to learn more about our inactive yeast range, please [contact us](#) or send an e-mail to [info@bio-lallemand.com](mailto:info@bio-lallemand.com).

We will be happy to support you in the choice of the most suitable product!

### PRODUCT HIGHLIGHTS

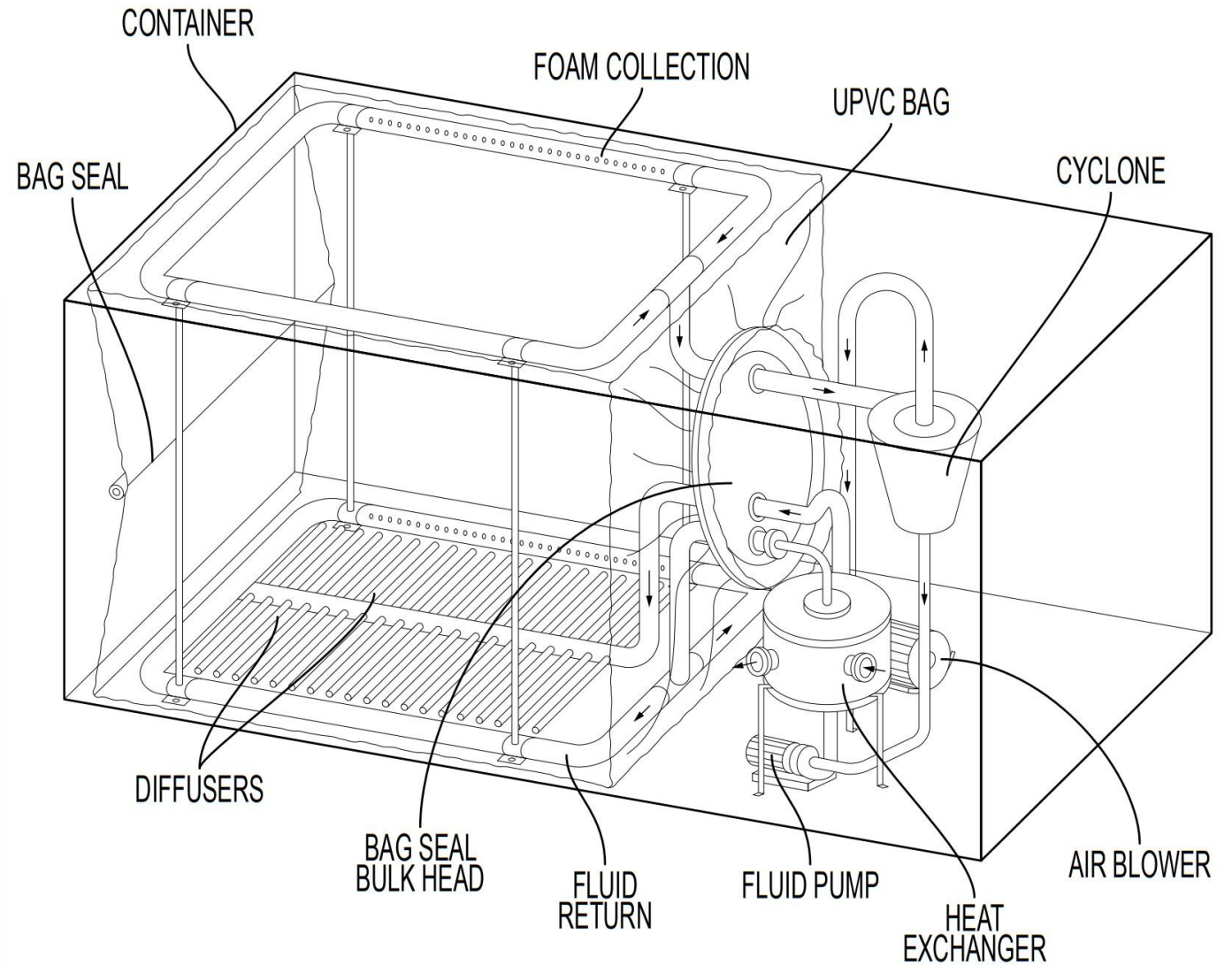
### RECIPES



## What's New in CelloFuel Fermenters?

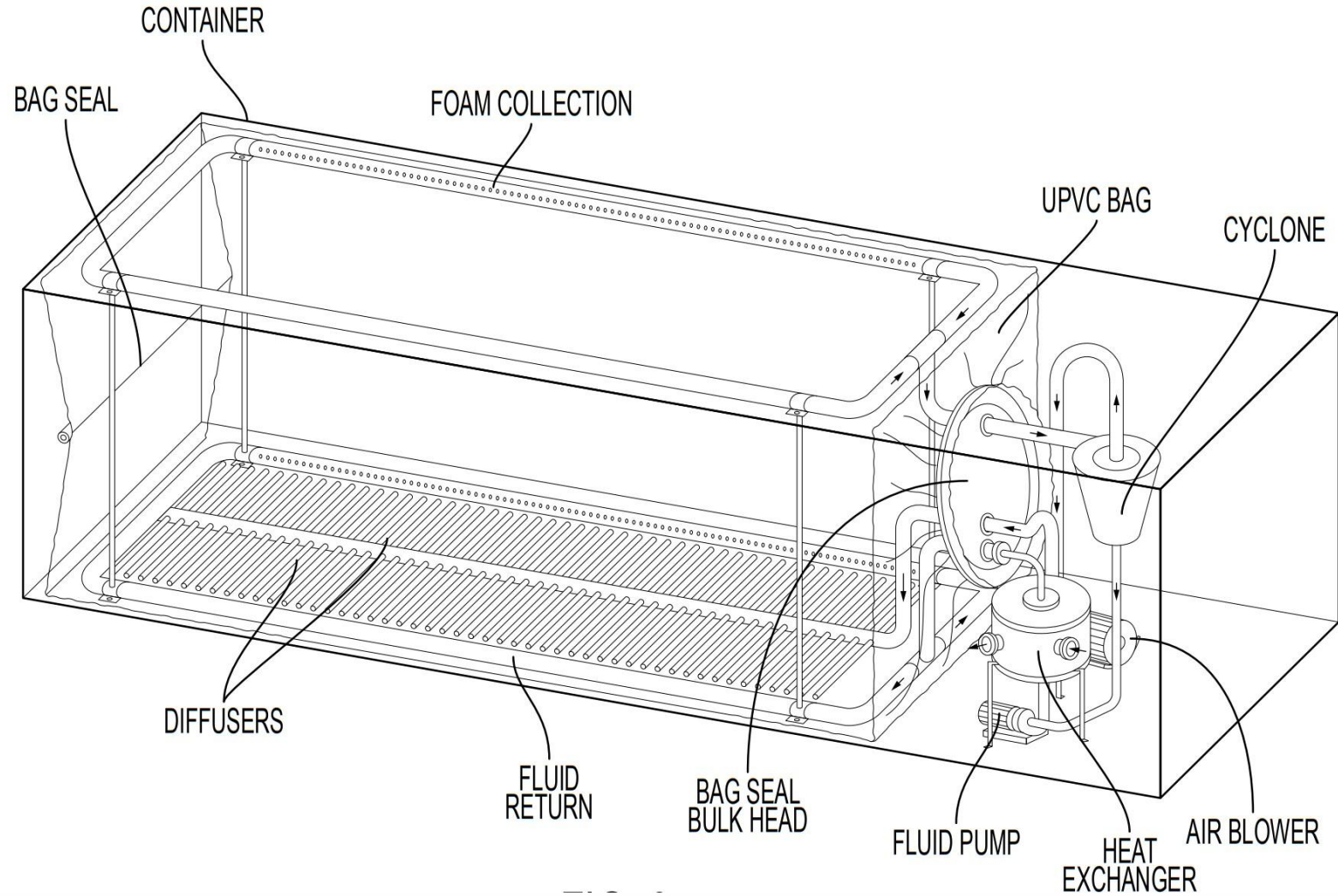
- Waldhof fermenter has a 1.5 m diameter spinning disc to make a 10% emulsion, Cellofuel fermenter uses 75mm bubbler tubes to make foam with 10% liquid, using much less energy with no moving parts.
- Waldhof fermenter removes heat by cooling emulsion with heat exchanger, but emulsion is an insulator and can't easily be cooled. Cellofuel fermenter cools fermentation liquid after breaking foam with cyclone.
- Waldhof fermenter uses spinning disk to break foam and reinject air. CelloFuel fermenter uses cyclone to break foam and reinject air, which uses much less energy with no moving parts.
- Waldhof fermenter uses a stainless steel fermenter, Cellofuel fermenter uses a UPVC fermenter in a shipping container, reducing cost.
- Waldhof fermenter uses stainless steel heat exchanger, Cellofuel fermenter uses either titanium or 316L heat exchanger to reduce nickel leaching, which works with contamination control (discussed later).

# 20 ft. CelloFuel Container





# 40 ft. CelloFuel Container



# Patent Status

Patent pending at U.S. Patent Office,

**“AEROBIC FERMENTATION USING PNEUMATIC FOAM”**  
application number **63/530,954**, priority date of **5 August 2023**

Planned PCT submission to RU, US, CN, IN, BR, EU, QA





Scale model (1/4 height/width), 600 mm x 600 mm x 4000 mm

