

# **Deodorisation and Physical Refining of Fats**

**Ray Cook**

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**[www.ebortec.co.uk](http://www.ebortec.co.uk)**



**1890's Population explosion in USA and Europe fuels demand for butter substitutes**

**Simple boiling methods adopted to improve flavour of seed oils**



# 1927 Scientist invents steam deodorising of hot oil under vacuum.

March 22, 1927.

E. WECKER

1,622,126

PROCESS FOR SEPARATING VOLATILE SUBSTANCES

Filed March 13, 1924

2 Sheets-Sheet 1

Fig. 1.

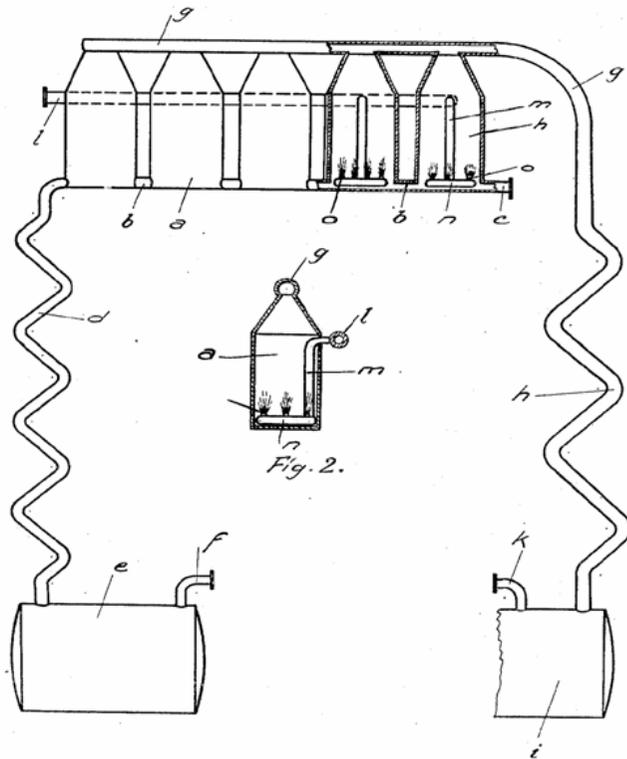
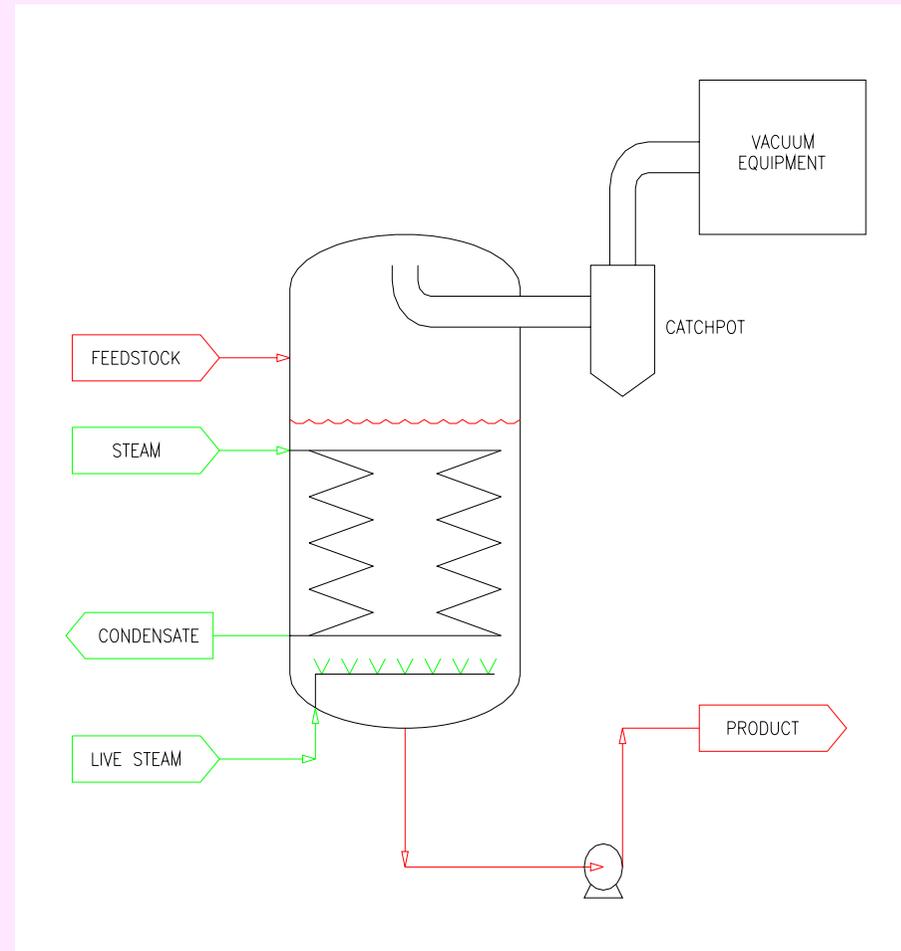


Fig. 2.

Inventor:  
Ernst Wecker.

Att'y: Thacker & Clerk





# **Alton E Bailey**

(1907 – 1953 )

- In 1945 Alton E. Bailey published Bailey's Industrial Oils and Fat Products. ( Now in 6<sup>th</sup> Edition )
- Introduces scientific basis for the process of deodorisation and fatty acid distillation.
- Introduces concept of flavour evaluation and identification.
- Develops the Bailey semi continuous column deodoriser, providing workhorse for the refining industry for next four decades.

Oct. 12, 1954

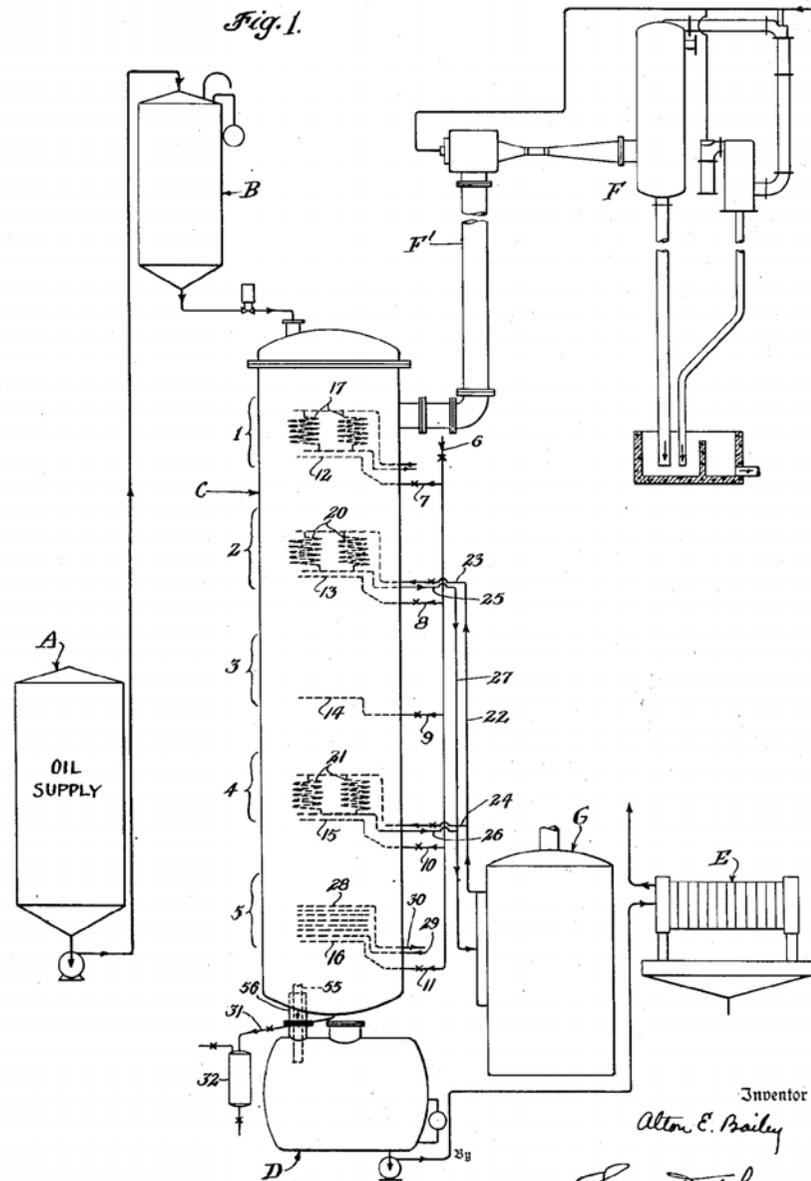
A. E. BAILEY

2,691,665

METHOD AND APPARATUS FOR DEODORIZING OILS

Filed Oct. 16, 1948

4 Sheets-Sheet 1



# Bailey Semi Continuous Deodoriser 1954 ( Girdler - Votator )

Aug. 21, 1956

B. H. THURMAN

2,759,883

PROCESS FOR DEODORIZATION OF GLYCERIDE OILS

Filed Aug. 15, 1950

2 Sheets-Sheet 1

# Thurman Horizontal Deodoriser 1956

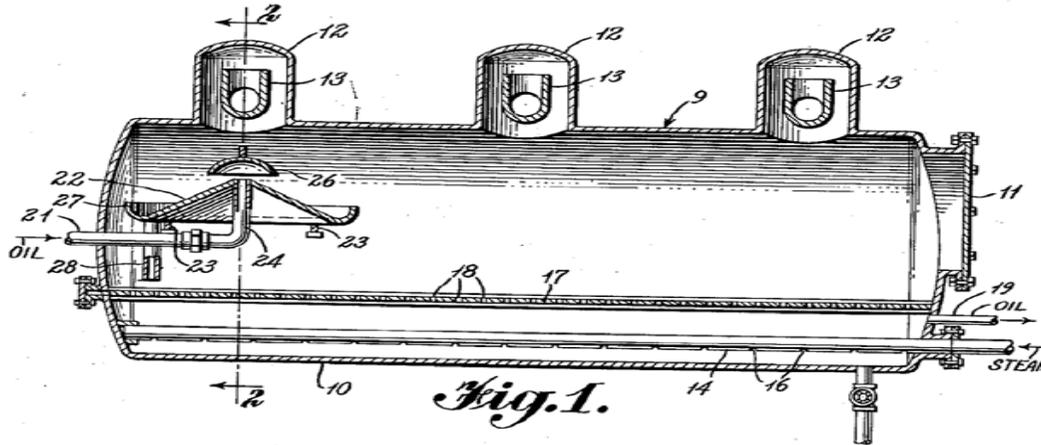


Fig. 1.

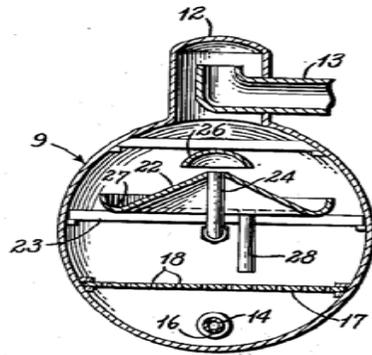


Fig. 2.

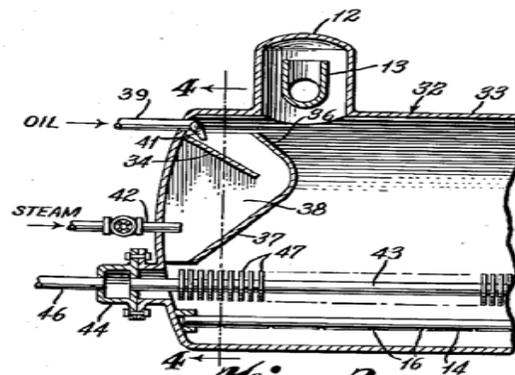


Fig. 3.

INVENTOR

*Benjamin H. Thurman*

BY *Bacon + Thomas*

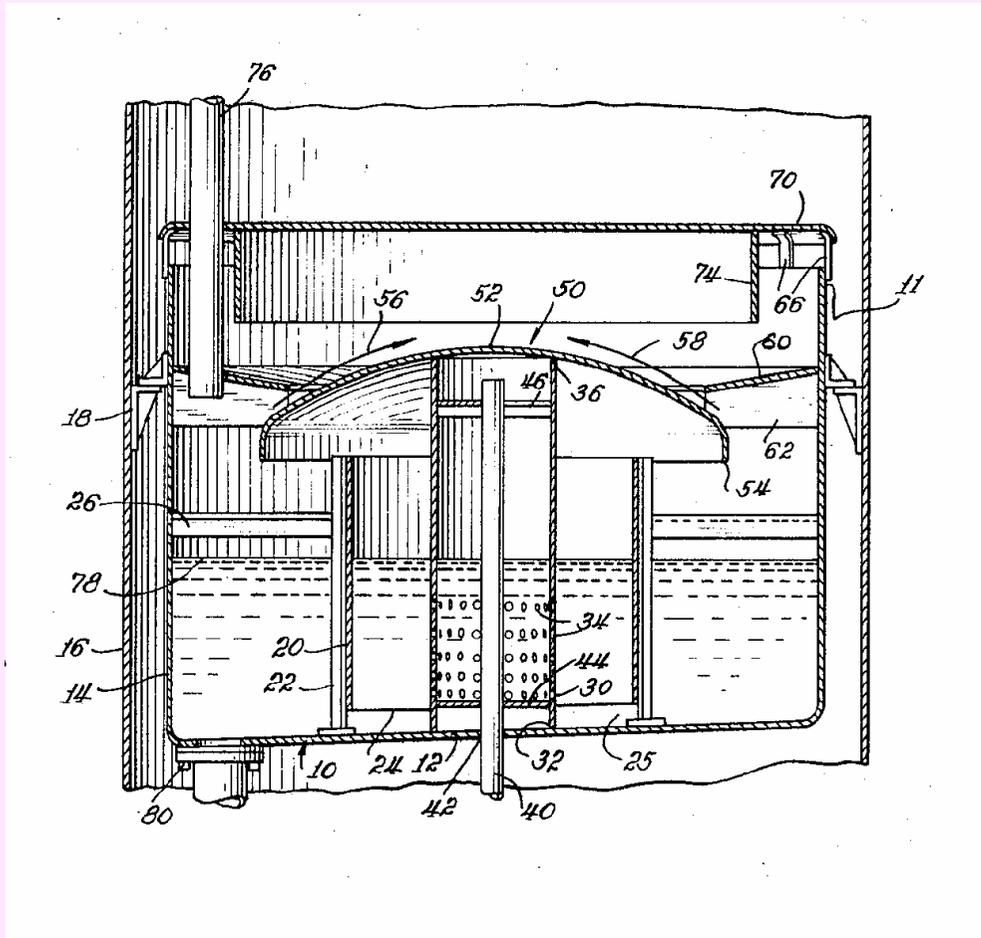
ATTORNEYS



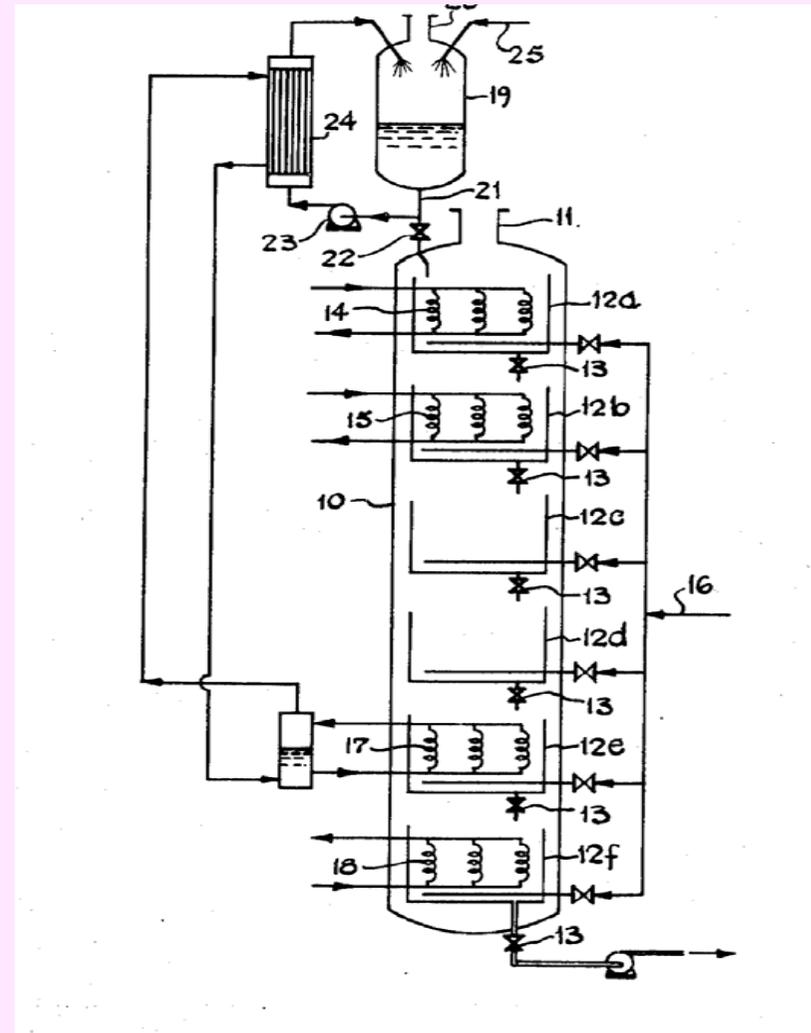
## **Steady progress in the 60's and 70's**

- Major improvements in sparge tray design
- General introduction of high temperature deodorisation by thermal heating fluids or electric heaters.
- Introduction of single shell deodorisers.
- Development of horizontal deodorisers.
- Better heat recovery systems.

# Important inventions in the 1970's



Votator High Efficiency Stripping Tray  
Patent No US 3,693,322



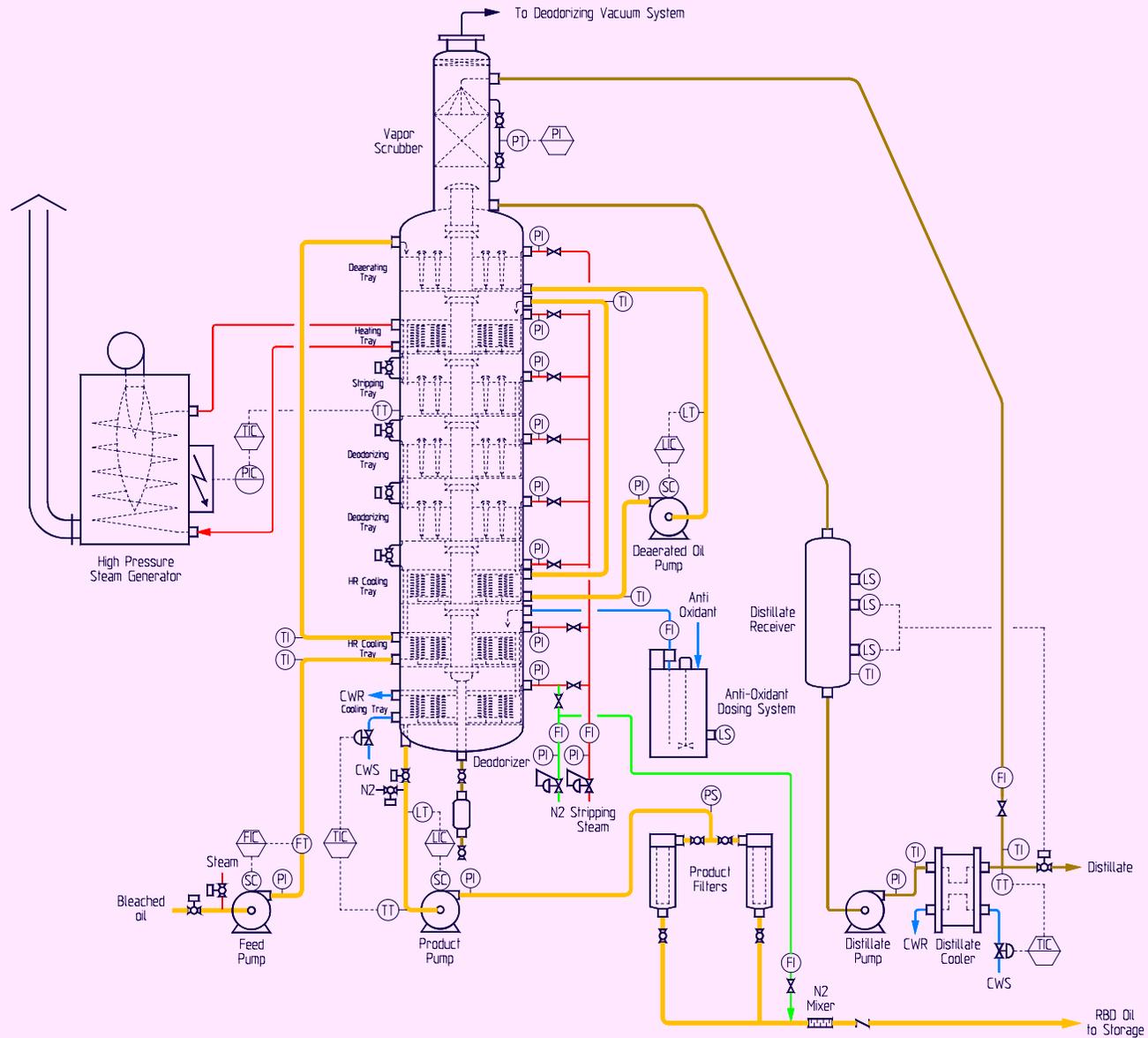
Simon Rosedown Thermosyphon  
Patent No US 3,999,966



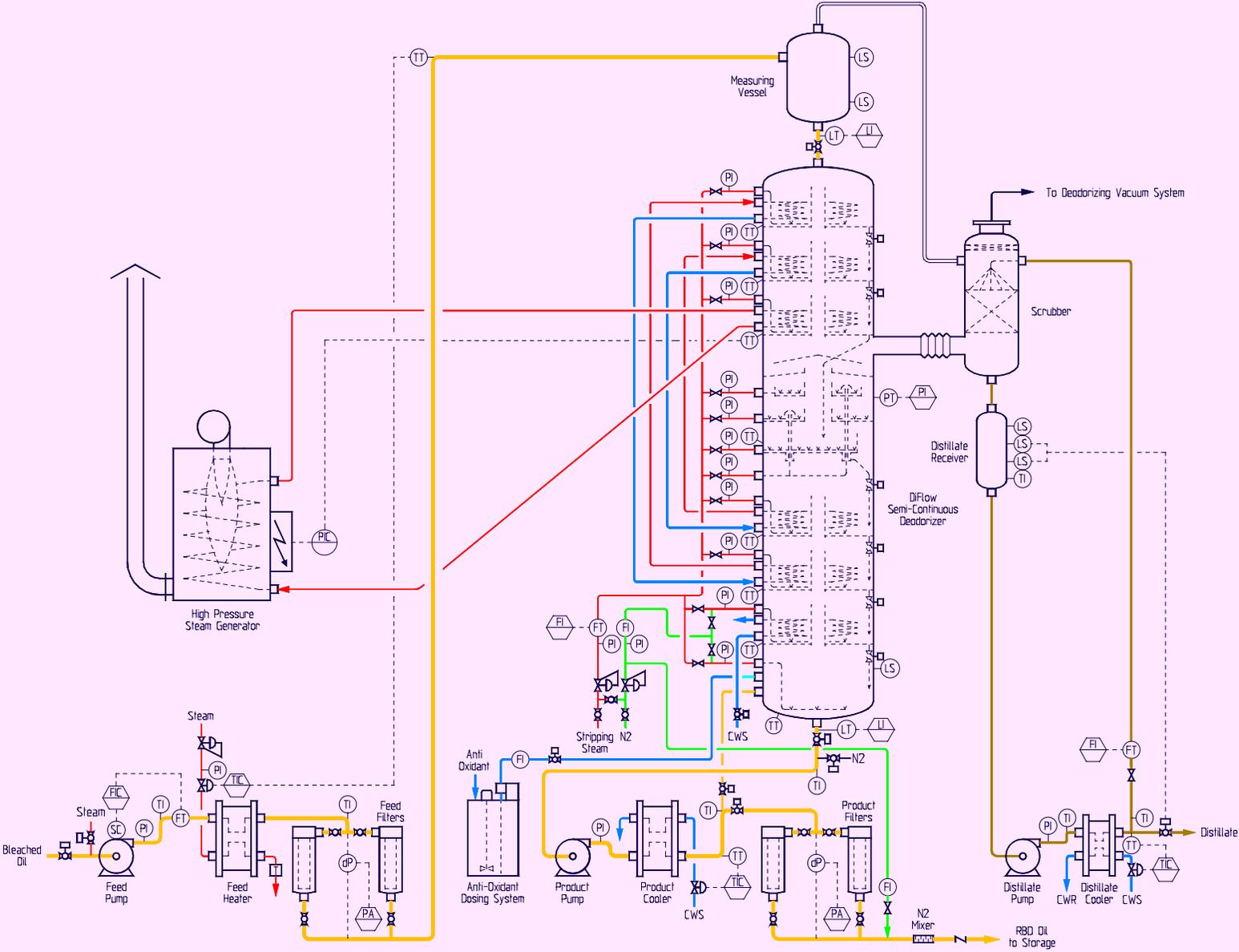
## What can go wrong – Will go wrong

- Heating fluid incident in Japan in 1968 causes many deaths resulting, ultimately, in worldwide ban on mineral oil heaters and the development of HP closed loop steam boilers.
- Deodorisers over simplified by multi stage heat recovery resulting in poor flavour profiles.
- Early single shell designs failed to prevent extreme damage by air leaks in hot oil.
- Problems associated with thermally induced isomerism not recognised until the late 1990.s

# Modern Continuous Deodorizing (With acknowledgement to Crown Ironworks Inc)



# Modern Semi-Continuous “Diflow” Deodorizer (With acknowledgments to Crown Ironworks Inc)





US005437714A

**United States Patent** [19]  
**Cook et al.**

[11] **Patent Number:** 5,437,714  
[45] **Date of Patent:** Aug. 1, 1995

[54] **SEMI-CONTINUOUS DEODORISER**  
[75] **Inventors:** Raymond Cook; Donald G. Sewell,  
both of York, England  
[73] **Assignee:** Eborotec Limited, York, England  
[21] **Appl. No.:** 331,731  
[22] **Filed:** Oct. 31, 1994

[30] **Foreign Application Priority Data**  
Nov. 4, 1993 [GB] United Kingdom ..... 9322788  
Jul. 8, 1994 [GB] United Kingdom ..... 9413794

[51] **Int. Cl.<sup>6</sup>** ..... B01D 19/00; C11B 11/00  
[52] **U.S. Cl.** ..... 96/201; 96/199;  
96/203; 99/470; 99/472; 210/180; 261/148;  
261/152; 554/175; 554/205  
[58] **Field of Search** ..... 99/470, 472, 483;  
55/222, 195, 208; 96/199, 201, 203, 204;  
210/180; 261/113, 123, 124, 148, 152; 426/417,  
484, 486-488, 492; 554/175, 184, 205

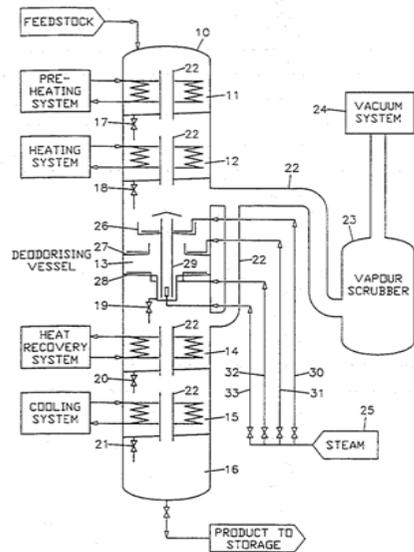
[56] **References Cited**  
**U.S. PATENT DOCUMENTS**  
3,693,322 9/1972 Lineberry et al. .... 96/203 X  
3,933,953 1/1976 Leva ..... 261/148  
3,999,966 12/1976 Naylor ..... 210/180 X  
4,072,482 2/1978 Aoki et al. .  
4,089,880 5/1978 Sullivan ..... 554/205  
5,241,092 8/1993 Cheng et al. .... 554/205  
5,315,020 5/1994 Cheng et al. .... 554/175

5,374,751 12/1994 Cheng et al. .... 554/205  
**FOREIGN PATENT DOCUMENTS**  
520097A1 12/1992 European Pat. Off. .  
963151 7/1964 United Kingdom .  
2176713 1/1987 United Kingdom .

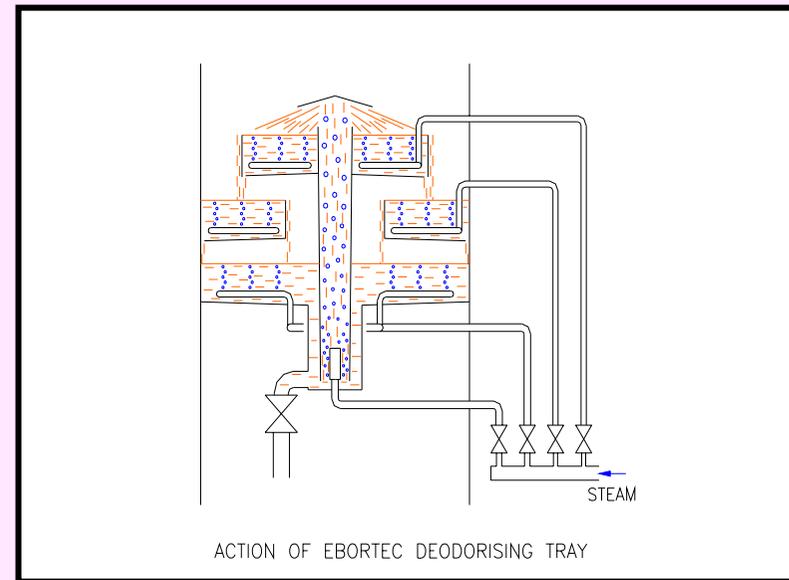
*Primary Examiner*—Timothy F. Simone  
*Attorney, Agent, or Firm*—Nies, Kurz, Bergert &  
Tamburro

[57] **ABSTRACT**  
A combined vertical column and shallow tray semicon-  
tinuous deodoriser for edible oils and fats and compris-  
ing a column (10) of discrete vessels and a deodorising  
vessel (13) disposed within or valve-connective thereto.  
In the operation of the device, heated oil from a vessel  
(12) is supplied to deodorising vessel (13) wherein it is  
circulated by steam injection at (33) through a lift tube  
(29), between a plurality of vertically separated self  
draining shallow trays (26, 27, 28). The entire oil con-  
tent of deodorising vessel (13) is circulated there-  
through approximately once a minute for a period in the  
region of eighteen minutes to strip free fatty acids and  
other volatile components from the oil by falling curtain  
and steam sparge techniques, and then the oil batch is  
discharged to a heat recovery vessel (14) and a cooling  
vessel (15) before product discharge.

10 Claims, 7 Drawing Sheets



# Eborotec Cascade Deodoriser 1997 (Patent No US 5,437,714)



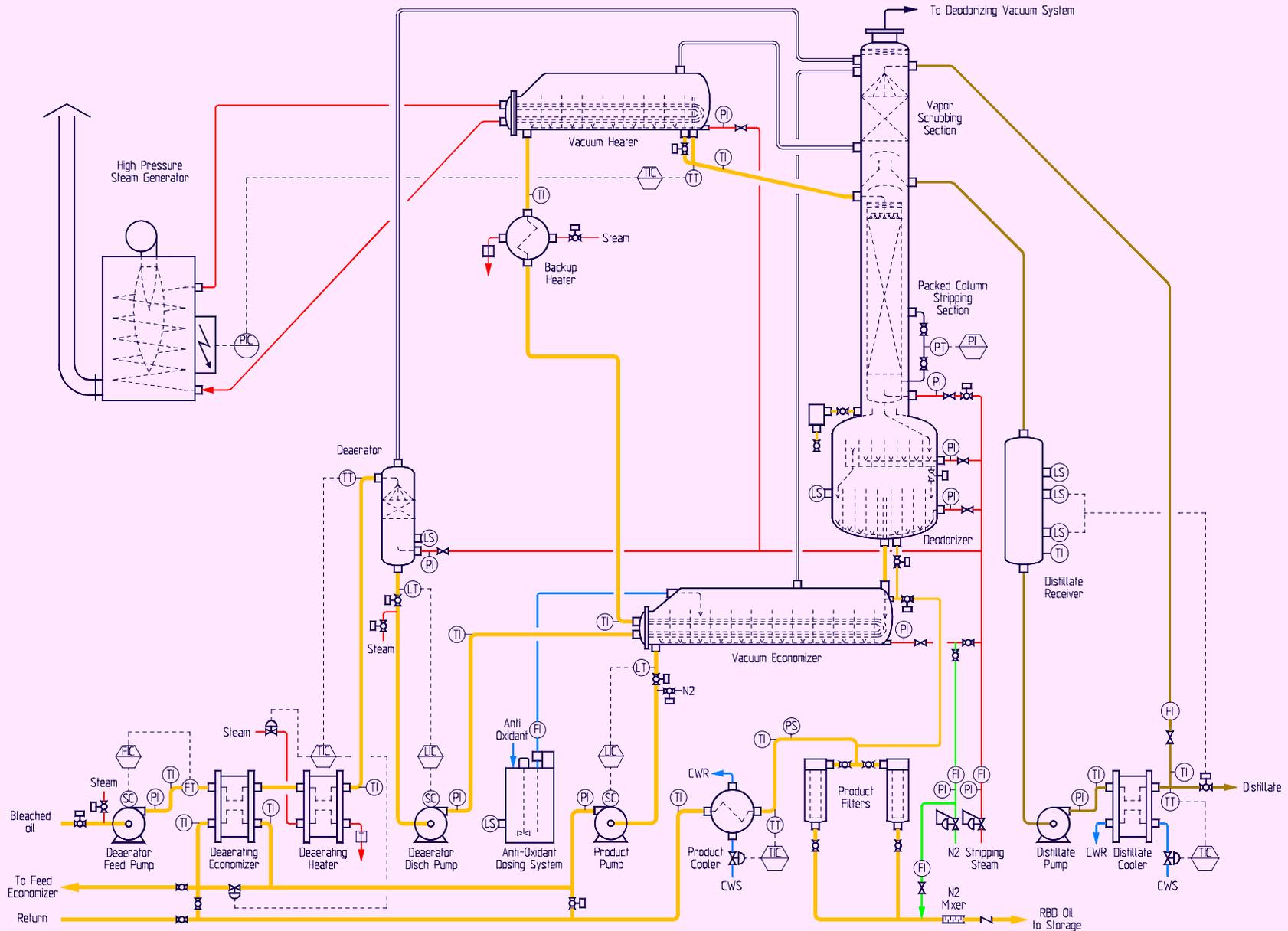


## **Development of physical refining in 1980's and 90's**

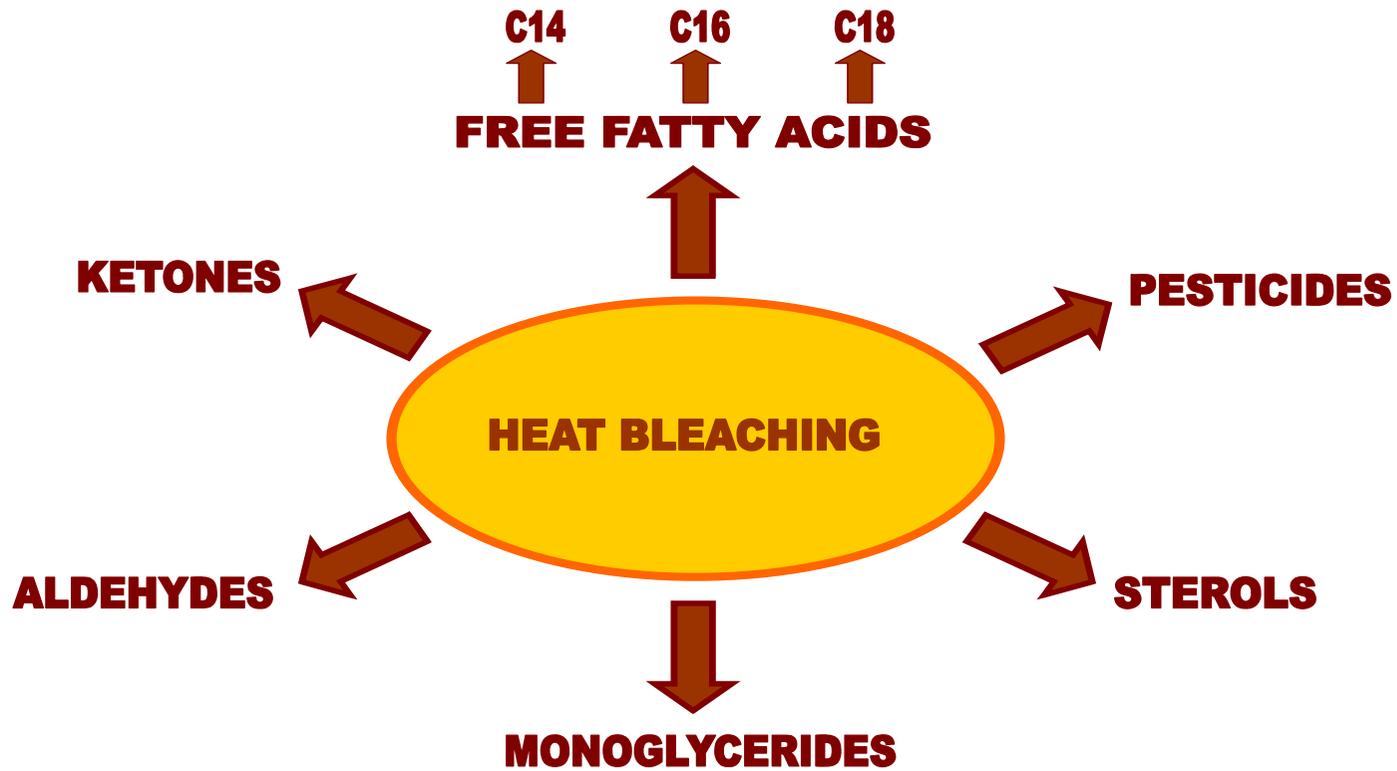
- Initially motivated by palm oil industry's demands for improved refining yield.
- Major environmental advantages by avoiding soap stock splitting.
- Improvements in degumming technology allow physical refining of liquid oils by 2000.
- Introduction of packed column technology reduces energy costs.
- Separation and recovery of distillates using multiple condensers

# Continuous Deodorizing with Packed Column

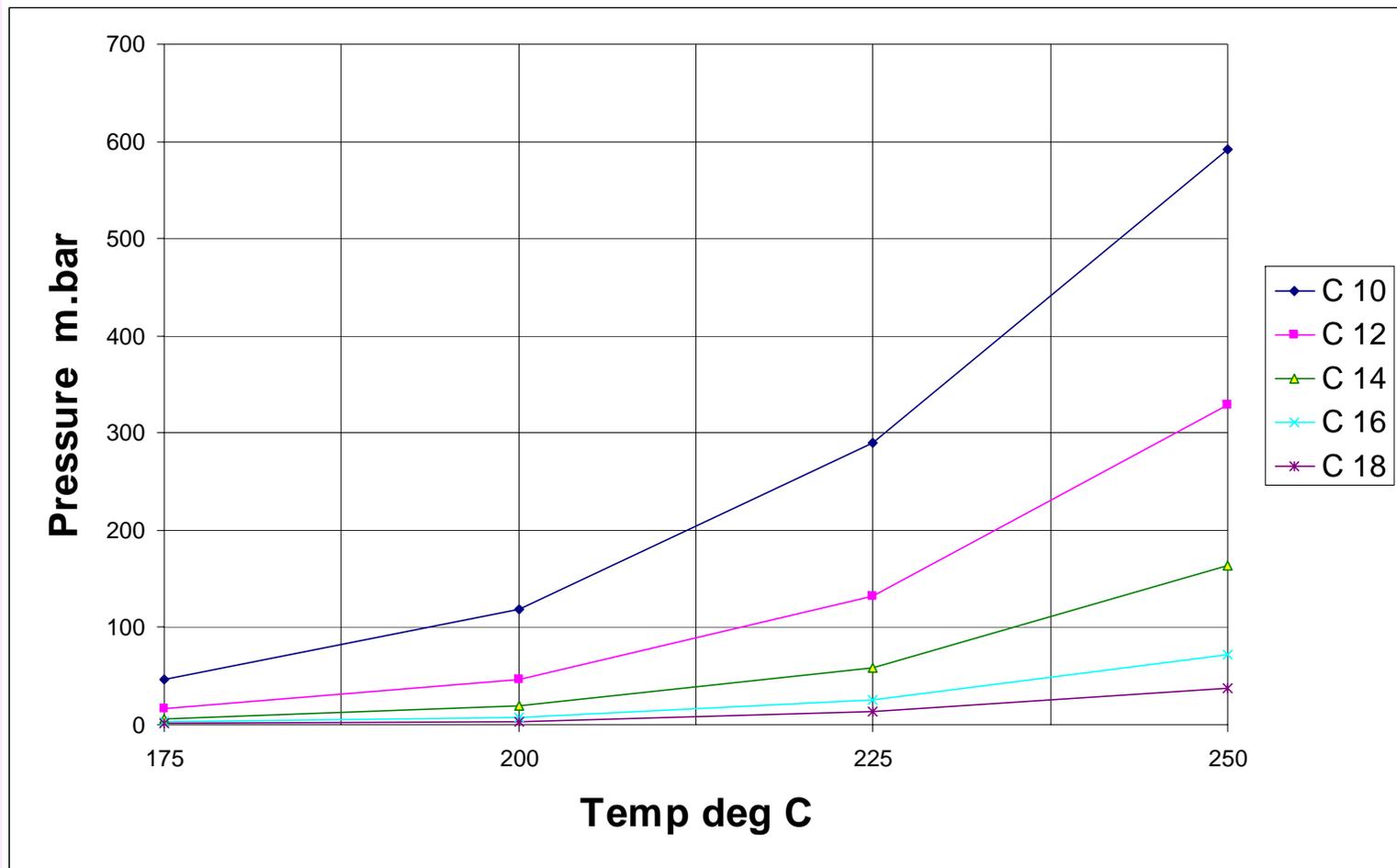
(With acknowledgements to Crown Ironworks Inc)



# What is Deodorisation?



# Vapour pressures of pure free fatty acids



# Physical laws affecting distillation rate

## ➤ Raoult's Law

For a given temperature the partial pressure of a constituent in a solution, is a function of it's molar concentration and it's vapour pressure in pure form.

This is particularly significant when ffa is high, e.g. in crude Palm oil, 5% ffa equates to a molar concentration of ~14%

## ➤ Dalton's Law

The molar ratio of the vapours issuing from the oil being deodorised equals the ratio of their partial pressures.

In this respect the introduction of a carrier gas, such as steam or nitrogen can assist the mass transfer of the volatile compounds.



## **Factors which affect the rate of mass transfer of volatile compounds**

- Vapour pressure of volatile compound
- Molar concentration of volatile compound
- System temperature
- System pressure
- Amount of steam used to carry volatiles
- Efficiency of transfer to steam bubble
- Bubble size and number
- Design of deodorisation equipment

# Bailey's simplified steam stripping equation

Where  $V_a$  &  $V_o$  are the initial and final molar concentrations of ffa.  
 $P_t$  is the system pressure &  $P_a$  is the vapour pressure of the ffa.  
 $S$  represents the moles of steam required.

$$S = \frac{P_t}{E \times P_a} \times \ln \frac{V_a}{V_o}$$

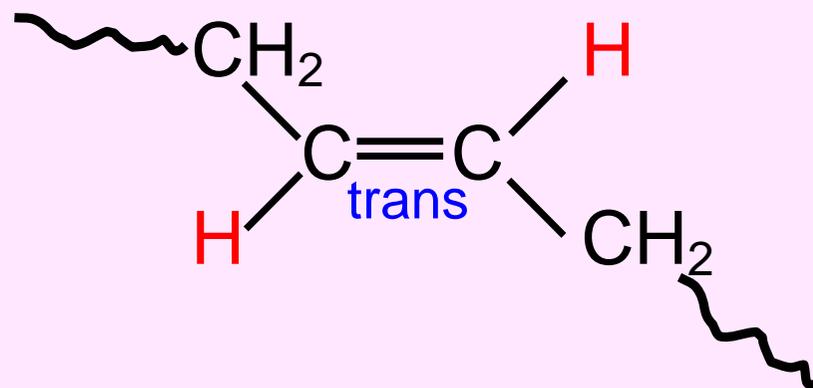
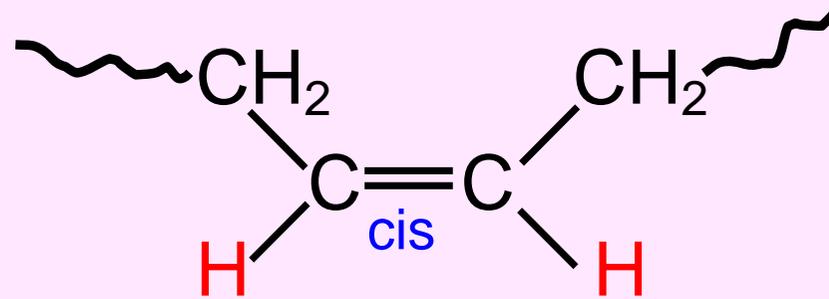


# Negative Considerations During Deodorisation

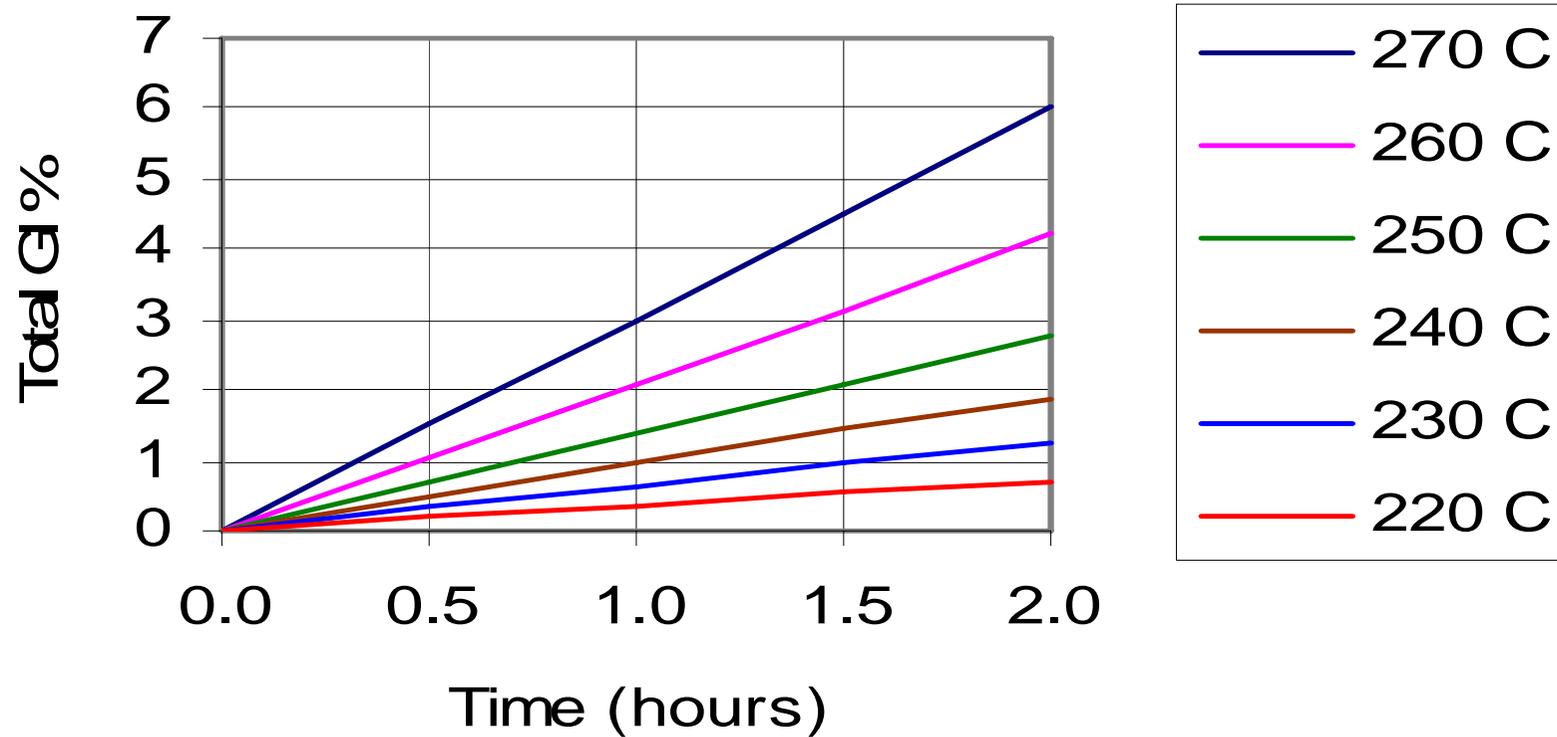
- Thermal degradation > off flavours
- Hydrolysis
- Rearrangement isomerism
- Thermally induced trans isomerism
- Polymerisation through air leaks
- Colour fixation of phosphatides
- Loss of tocopherols

# Geometric isomerism

(Mainly affecting Linolenic acid)

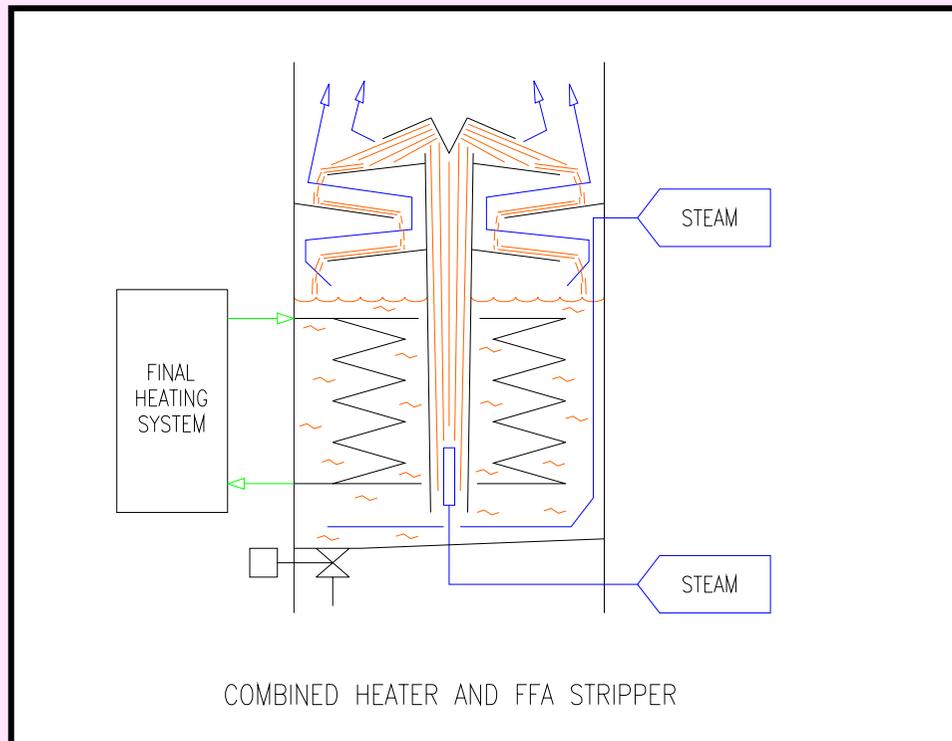


## Illustration of effect of Time and Temperature on formation of Geometric Isomers in Rapeseed Oil



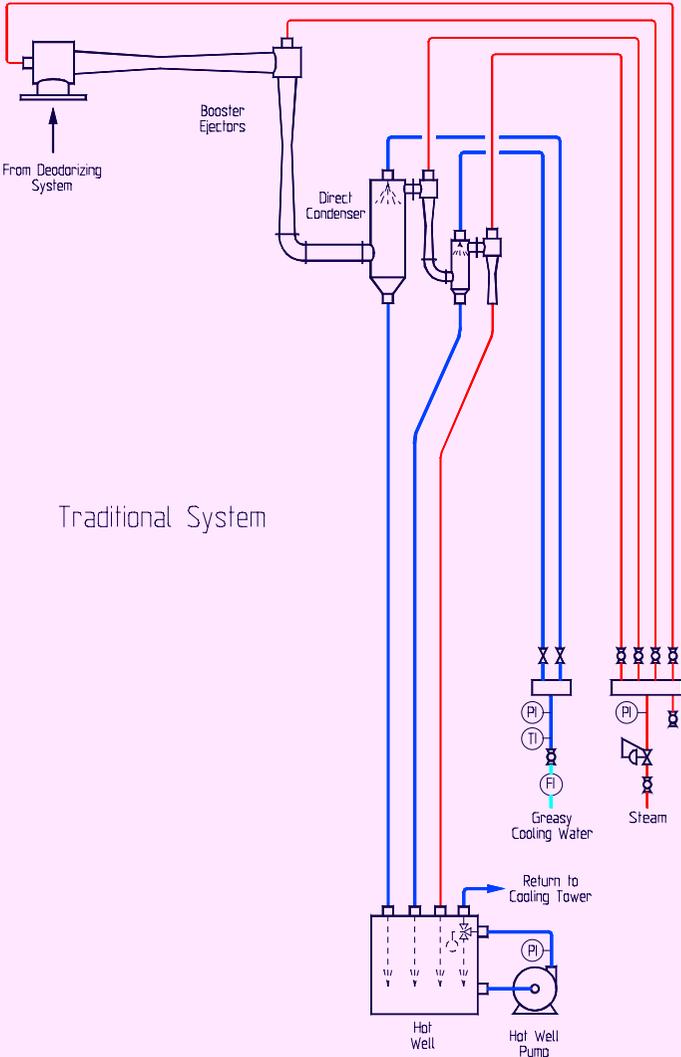
# Combined heating & stripping tray

(Minimum time and temperature > minimum trans)

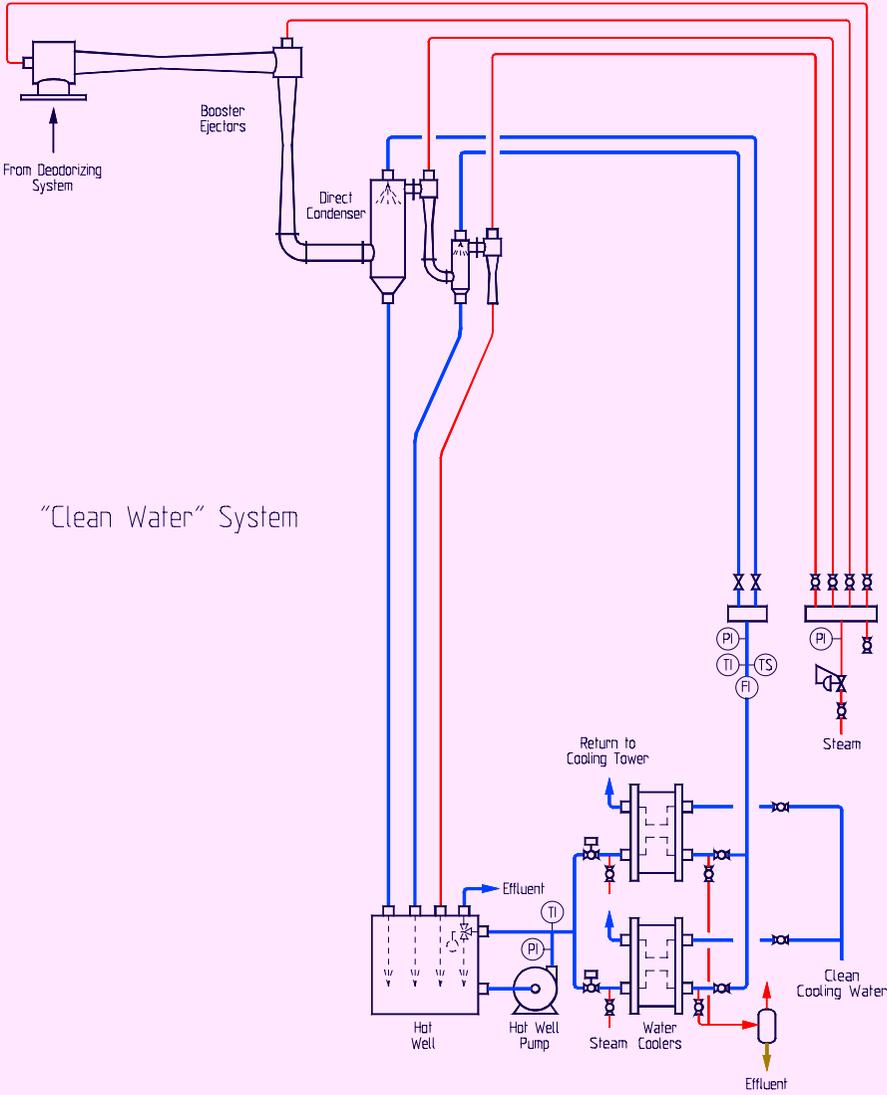


Ebortec patent No GB 2,354,770

# Traditional Vacuum Systems



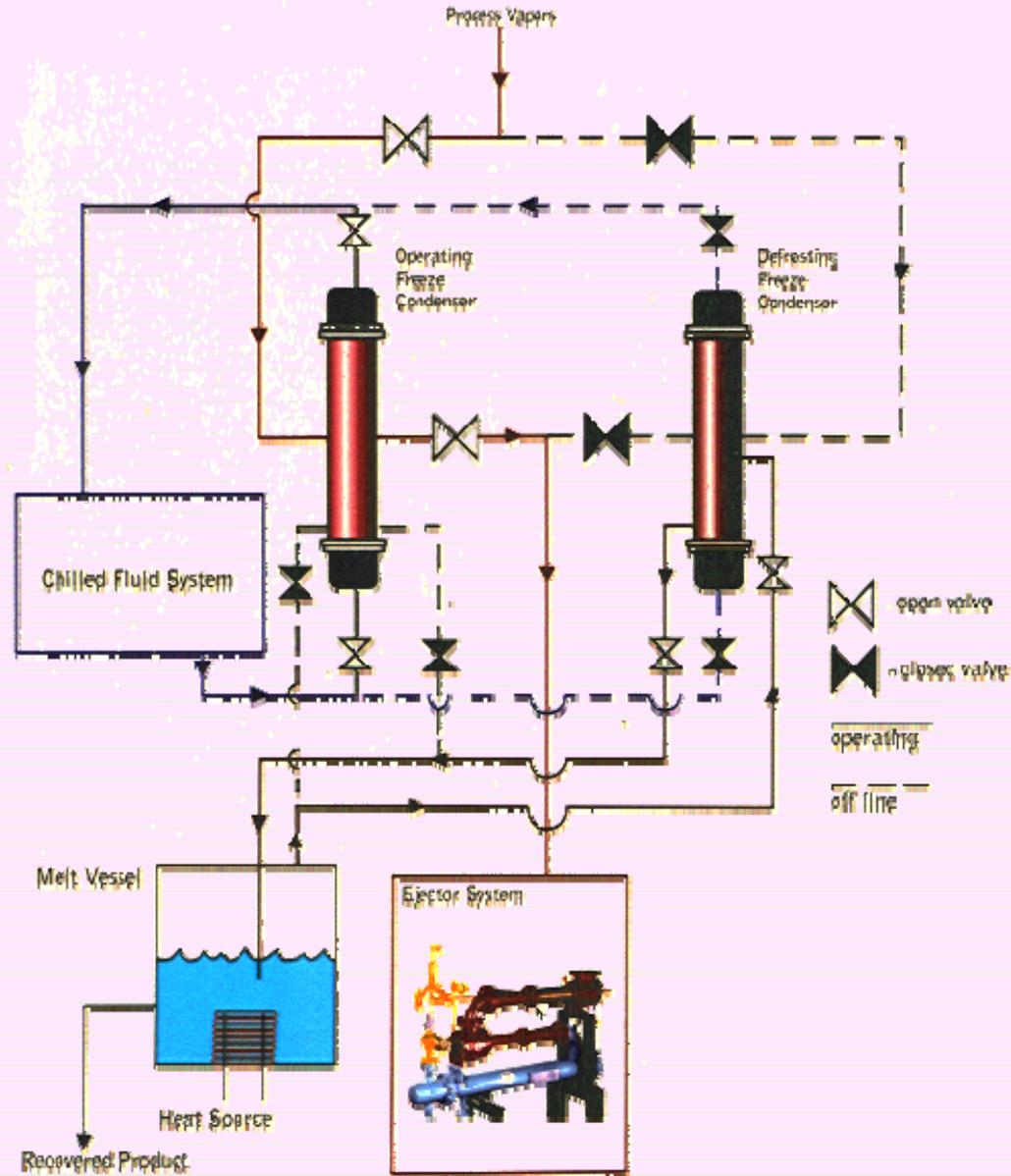
Traditional System



"Clean Water" System

# Freeze Condensation

( with acknowledgement to the Graham Corporation)



# Deodorizing Using Ice Condensing Vacuum Systems



Alternating Ice Condensers



Ice build-up in Condenser

**Thank you for listening**

