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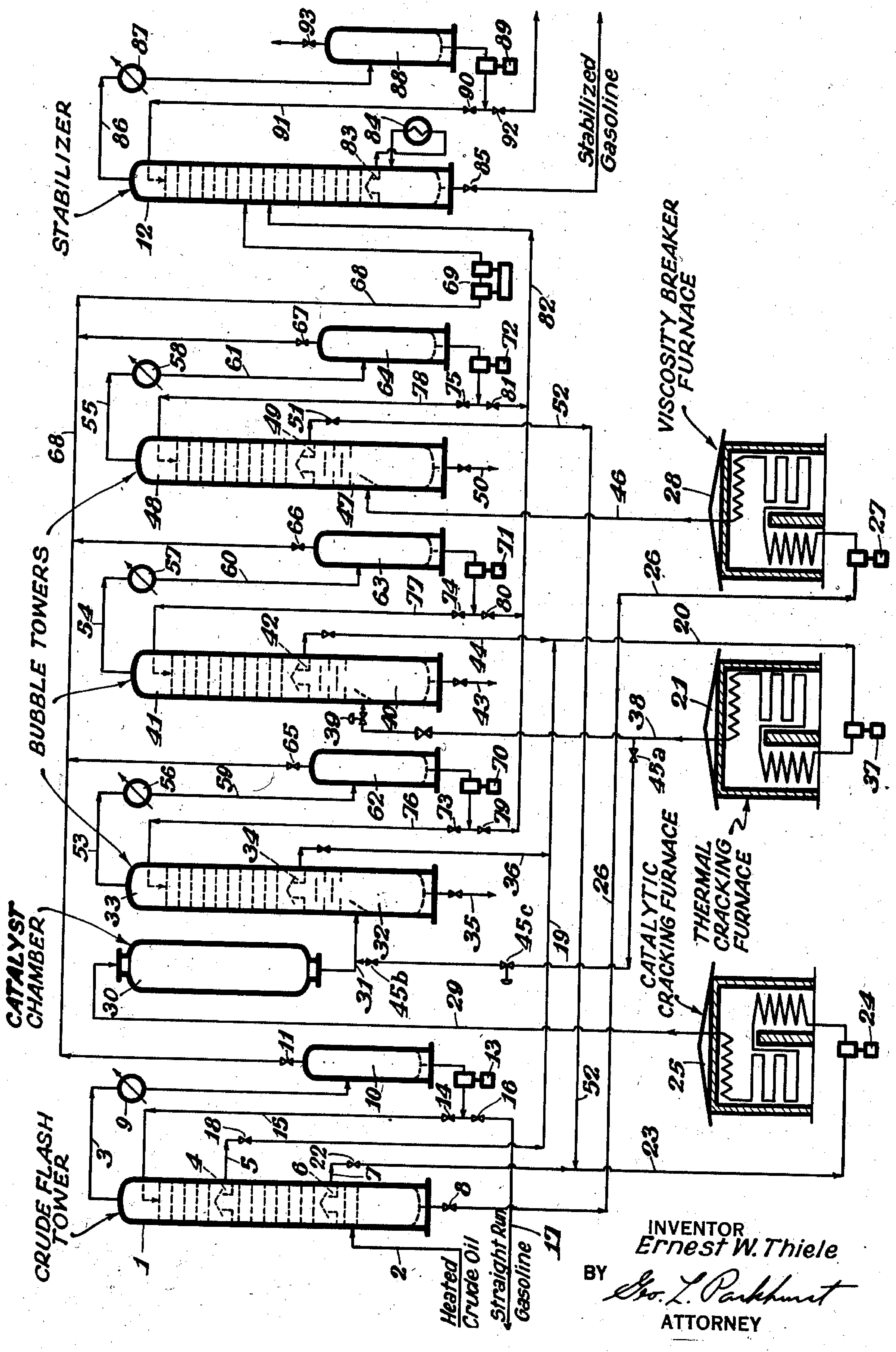

INVENTOR
Ernest W. Thiele
BY Geo. L. Parkhurst
ATTORNEY

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GASOLINE MANUFACTURE

Ernest W. Thiele, Chicago, Ill., assignor to Standard Oil Company, Chicago, Ill., a corporation of Indiana

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2 Claims. (Cl. 196—49)

This invention relates to the manufacture of gasoline and more particularly to the manufacture of gasoline by a combination cracking process.

It is an object of this invention to provide a new and improved method of gasoline manufacture. More specifically it is an object of this invention to provide a new and improved combination cracking process. Still more specifically it is an object of this invention to provide a combination cracking process involving both thermal and catalytic cracking. Another object of the present invention is to provide a combination cracking process in which cycle stock made from a viscosity breaker operation is utilized as a feed for a catalytic cracking operation. A still further object of this invention is to provide a combination cracking process involving catalytic cracking, thermal cracking and thermal viscosity breaking and in which these operations are combined in such manner as to produce larger yields of improved gasoline and to minimize operating difficulties. Other and still further objects, uses, and advantages of my invention will become apparent as the description thereof proceeds.

The invention will be described in detail in connection with a specific embodiment thereof shown in the accompanying drawing which forms a portion of this specification and is to be read in connection therewith. The drawing is in simplified flow diagram form.

Referring more specifically to the drawing, heated crude oil from a source not shown enters crude flash tower **1** through line **2**. From crude flash tower **1** light naphtha together with any excess of normally gaseous hydrocarbons passes overhead through line **3** while a heavy naphtha which serves as a reformer stock is removed by means of trap-out plate **4** through line **5**, and virgin gas oil is removed by means of trap-out plate **6** through line **7**. Materials heavier than gas oil are removed from the base of tower **1** as a residuum through valve **8**.

Returning to the light naphtha and gases which pass overhead through line **3**, these pass through condenser **9** into reflux drum **10**. Uncondensed gases from this reflux drum are taken overhead through valve **11** and ultimately enter stabilizer **12**. The condensate from reflux drum **10** is removed from the base thereof through pump **13** and a portion is returned to the top of tower **1** as reflux by means of valve **14** and line **15**. The remainder is taken through valve **16** and line **17** to storage or further treatment and constitutes the straight run gasoline portion of the product.

The heavy naphtha or reformer stock removed by means of trap-out plate **4** may suitably have an initial boiling point between about 150° F. and about 250° F. and a maximum boiling point between about 300° F. and about 450° F. This material passes through valve **18** and lines **19** and **20**, ultimately entering the coils of thermal cracking furnace **21**. As will be seen hereinafter, the feed to this thermal cracking furnace preferably includes cycle stocks from the catalytic cracking and thermal cracking operations as well as the virgin reformer stock to which reference has been made above.

Gas oil which is removed from tower **1** by means of trap-out plate **6** may suitably have an initial boiling point of from about 350° F to about 525° F. and a final boiling point of from about 575° F. to about 800° F. It passes through valve **22**, line **23**, and pump **24**, and then through the coils of catalytic cracking furnace **25**. As will be seen hereinafter, the feed to this catalytic cracking furnace preferably includes cycle stock from a thermal viscosity breaker operation in addition to the virgin gas oil to which reference has just been made.

Residuum from the base of crude flash tower **1** passes through valve **8**, line **26**, and pump **27** to the coils of thermal viscosity breaker furnace **28**.

Returning to furnace **25** the heated material passes overhead through transfer line **29** into catalyst chamber **30**. It will be understood that in actual practice a number of catalyst chambers will usually be employed either in series or in parallel and that means will be provided for the regeneration of the catalyst. Since, however, the present invention does not reside in such details, the catalyst portion of the operation has been shown in the simplest diagrammatic fashion. Various catalysts can be used in this catalyst chamber. It is preferred, however, to employ a catalyst of the argillaceous type. Clays, acid treated clay, fuller's earth, diatomaceous earth, bauxite or the like can be used. Various metal oxides and combinations of metal oxides can be employed. Synthetic clays, for instance aluminum silicate, are particularly suitable.

It is appropriate at this point to mention the conditions which may suitably prevail in the three cracking zones to which reference has been made. The conditions prevailing in catalyst chamber **30** will, of course, depend upon the stock which is being cracked, the results which are desired and particularly upon the catalyst employed. Moreover, the optimum temperature will depend to some extent on the pressure employed and both are inter-related with contact time. However, the catalytic cracking operation can suitably be conducted at about atmospheric pressure or at other pressures ranging from somewhat less than atmospheric to about 100 pounds per square inch. Temperatures ranging from about 750° F. to about 1050° F. can be used. Preferably, however, temperatures ranging from about 800° F. to about 975° F. are employed. For instance, the conditions in the catalytic chamber can be atmospheric pressure and about 900° F.

In the case of thermal cracking furnace 21 the outlet temperature can suitably range from about 875° F. to about 1100° F. but preferably from about 900° F. to about 1020° F., for instance 940° F., and the outlet pressure can suitably range from about 100 pounds per square inch to about 1500 pounds per square inch, for instance 700 pounds per square inch.

The outlet or transfer line temperature in the case of viscosity breaker furnace 28 should in general be substantially lower than the outlet or transfer line temperature in the case of thermal cracking furnace 21. The outlet temperature in the case of furnace 28 can, for instance, range from about 825° F. to about 975° F., for instance 875° F. The corresponding pressure can suitably range from about 100 pounds per square inch to about 1000 pounds per square inch, for instance 200 pounds per square inch.

Returning to catalyst chamber 30, the cracked material from this chamber passes through line 31 into evaporator 32 which is shown integral with bubble tower 33 and separated therefrom by trap-out plate 34. From the base of evaporator 32 a tar or heavy fraction may be removed through valved line 35.

All material lighter than tar passes overhead from evaporator 32 through trap-out plate 34 into bubble tower 33. From the base of bubble tower 33, i. e. from trap-out plate 34, a gas oil cycle stock is removed by means of valved line 36 and passes through line 20 and pump 37, and thence through the coils of furnace 21.

It will be noted that furnace 21 operates both on a cycle stock from the catalytic cracking operation and on a lighter reformer stock of a virgin nature. It will further become apparent as the description proceeds that a gas oil cycle stock from the thermal cracking operation itself is recycled to the coils of furnace 21. It is a general rule that, for a given degree of cracking, stocks which have already been cracked once require higher temperatures than do virgin stocks. On the other hand, it is also a rule that light charging stocks require higher temperatures than heavy charging stocks. For this reason it is particularly appropriate to cycle a light virgin reformer stock, such as that removed from trap-out plate 4 of tower 1, together with heavier cracked cycle stocks to a single cracking operation, such as that conducted in furnace 21, since the optimum conditions are approximately the same for the various stocks.

From furnace 21 these cracked materials pass through transfer line 38 and pressure reduction valve 39 into evaporator 40 which is shown integral with bubble tower 41 and separated therefrom by trap-out plate 42. Tar is removed from the base of evaporator 40 by means of valved line 43, while a cycle stock of the gas oil type is removed from the base of bubble tower 41, i. e. from trap-out plate 42, through valved line 44 and line 20, from which it passes through hot oil pump 37 and is introduced into the coils of furnace 21 as previously indicated.

In place of having separate evaporators and bubble towers for the products from catalyst chamber 30 and furnace 21, products from furnace 21 can be passed from line 38 through shut-off valves 45*a* and 45*b* and pressure reduction valve 45*c* into line 31 and thence into evaporator 32. In this case evaporator 40 and bubble tower 41 with accompanying equipment are not required. The mixed cycle stocks will leave by line 36 and enter furnace 21 together, just as when separate towers are provided.

Returning now to viscosity breaker furnace 28, it will be seen that the cracked material from this operation passes through transfer line 46 into evaporator 47 which is integral with bubble tower 48 and separated therefrom by trap-out plate 49. From the base of evaporator 47 tar is removed by means of valved line 50 while from trap-out plate 49 at the base of bubble tower 48 a gas oil cycle stock is removed by means of valve 51 and cycled via lines 52 and 23 and hot oil pump 24 to the coils of catalytic cracking furnace 25.

From bubble towers 33, 41 and 48 materials lighter than gas oil, which consist generally of gasoline range hydrocarbons and lighter materials, pass overhead through lines 53, 54 and 55, respectively, and thence through condensers 56, 57 and 58, respectively, and lines 59, 60 and 61 respectively, to reflux drums 62, 63 and 64, respectively. The gases from these various reflux drums are taken overhead through valves 65, 66 and 67 and line 68 to compressors 69 from which they pass to stabilizer 12. Any gases which are already at pressures as high as that of stabilizer 12 can, of course, be by-passed around compressors 69.

Condensate from reflux drums 62, 63 and 64 is removed through pumps 70, 71 and 72 respectively, and a portion is returned to the appropriate bubble tower by means of valves 73, 74 and 75, respectively, and lines 76, 77 and 78, respectively. The remainder of this condensate passes through valves 79, 80 and 81, respectively, and thence through line 82 into stabilizer 12.

Stabilizer 12 is operated at an elevated pressure in the conventional manner. It is equipped with a reboiler which includes the conventional trap-out plate 83 and heater 84. The stabilizer is also provided with reflux and the pressure, reboiling and reflux are controlled to take stabilized gasoline off the base of the tower through valved line 85 for storage, further treatment or use.

Gases eliminated in producing stabilized gasoline pass overhead from stabilizer 12 through line 86 and condenser 87 and thence to reflux drum 88. Condenser 87 is operated to condense such portion of the four carbon atom hydrocarbons as cannot be utilized in the finished gasoline together with a considerable amount of three carbon atom hydrocarbons. This condensate is removed from the base of reflux drum 88 by means of pump 89 and a portion of it is returned to stabilizer 12 as reflux through valve 90 and line 91. The remainder is removed from the system through valved line 92 for storage and use. Light gases are removed from the system through valved line 93.

It will thus be seen that my new combination cracking operation involves the separation of a crude oil or reduced crude oil into fractions comprising a heavy naphtha which is cracked thermally along with cycle stocks from a catalytic cracking operation and from the thermal cracking operation itself; a gas oil charging stock which is cracked catalytically on a once-through basis along with a cycle stock from a viscosity breaker operation; and a residuum which is subjected to a viscosity breaker operation which produces a gas oil type of cycle stock which is conducted to the catalytic cracking operation. Since the viscosity breaker operation is conducted in such manner as to give only a very light cracking, the gas oil produced is not far removed in characteristics from virgin gas oil and thus constitutes a particularly suitable charging stock for the catalytic cracking operation.

The flow diagram of my combination cracking process as well as the description of it is highly simplified and various details, such for instance as heat exchangers; pressure, temperature and flow control devices; safety devices; stripping towers for trap-out streams; additional valves and pumps; insulation; etc., are omitted since to detail these features would add nothing to the knowledge of those skilled in the art and would merely serve to encumber this specification unnecessarily.

While my invention has been described in connection with a specific embodiment thereof, it is to be understood that this can be modified in various ways and that I do not mean to be limited thereby but only to the scope of the appended claims which should be construed as broadly as the prior art will permit.

I claim:

1. A combination cracking process comprising separating a crude petroleum oil into fractions including a heavy naphtha fraction, a virgin gas oil fraction and a residuum fraction, subjecting said gas oil fraction to a catalytic cracking operation, separating the products of said catalytic cracking operation into fractions including a gasoline fraction and a gas oil cycle stock fraction, subjecting said gas oil cycle stock fraction together with said heavy naphtha fraction to a non-catalytic thermal cracking operation, separating the products of said thermal cracking operation into fractions which include a gasoline fraction and another gas oil cycle stock fraction, recycling said last mentioned gas oil cycle stock fraction to said thermal cracking operation, subjecting said residuum to a non-catalytic viscosity breaker operation, separating the products of said viscosity breaker operation into fractions including a clean cycle stock fraction, and recycling said clean cycle stock fraction to said catalytic cracking operation.

2. The method of increasing the efficiency of a combination thermal and catalytic cracking system for the manufacture of high quality gasoline which method comprises fractionating a hydrocarbon charging stock in the absence of cracked products to obtain a gas-oil fraction and a heavier-than-gas-oil fraction, passing the heavier-than-gas-oil fraction to a viscosity breaking system and heating it therein to a temperature of about 825 to 975° F. at a pressure of about 100 to 1000 pounds per square inch, passing gas-oil from the products of the viscosity breaking step in admixture with gas-oil from said first fractionating step through a catalytic cracking chamber at a temperature of about 800° F. to 975° F. and a pressure of about atmospheric to 100 pounds per square inch in the presence of a cracking catalyst, passing gas-oil from the products of catalytic cracking together with heavy naphtha from said first-named fractionating means to a thermal cracking zone, maintaining a pressure of about 100 to 1500 pounds per square inch and a temperature of about 875° F. to 1100° F., fractionating the products from the thermal cracking zone in the absence of products from the catalytic cracking and viscosity breaking steps, returning gas-oil from the thermal cracking fractionating step to said thermal cracking zone and blending the gasoline obtained from said first fractionating step, said catalytic cracking step, said viscosity breaking step and said thermal cracking fractionating step, respectively.

ERNEST W. THIELE.