March 27, 1945. N. K. CHANEY 2,372,186

PYROLYZING METHOD AND APPARATUS

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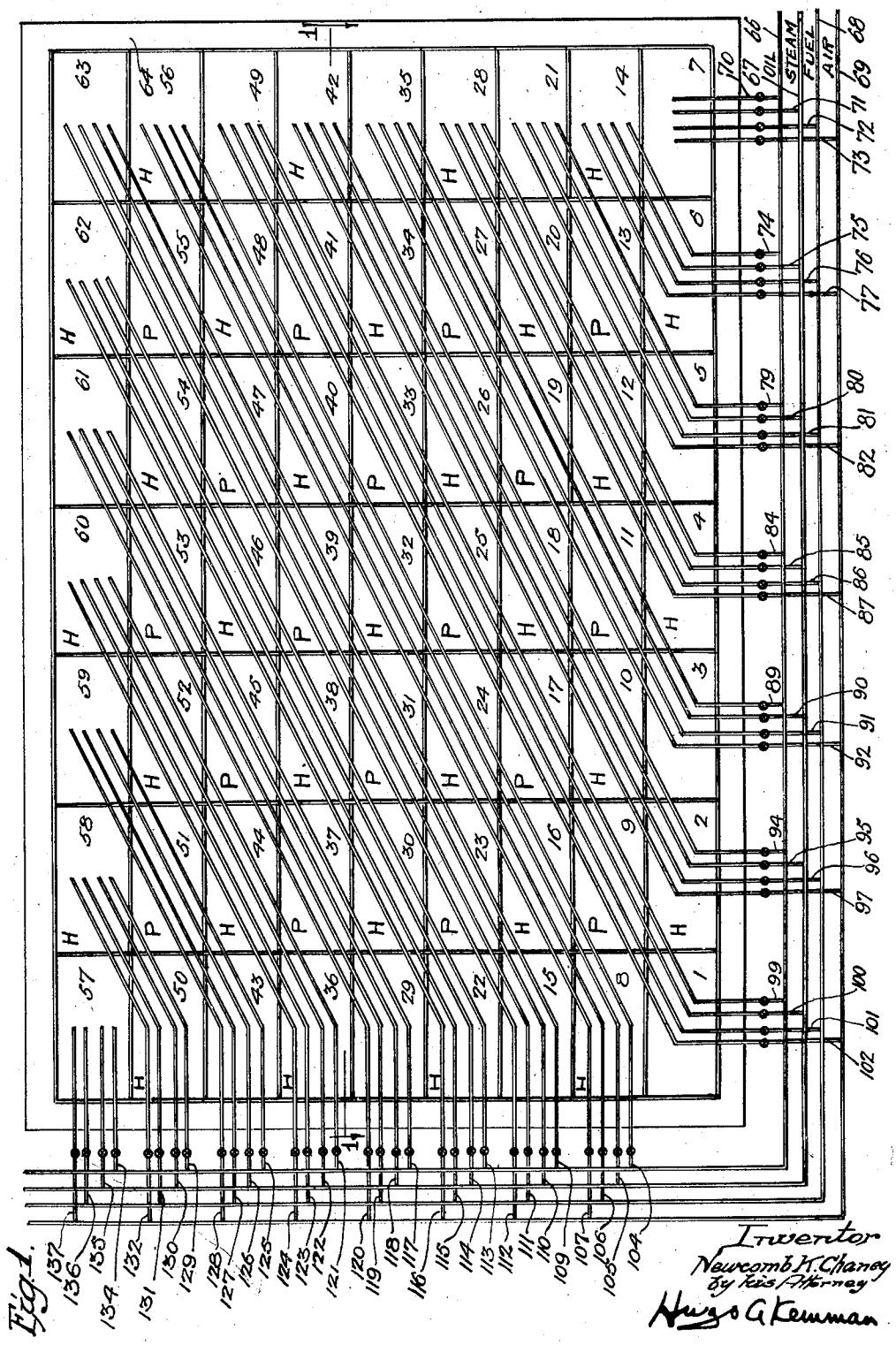


Fig. 1.

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PYROLYZING METHOD AND APPARATUS

Filed July 5, 1941 6 Sheets-Sheet 2

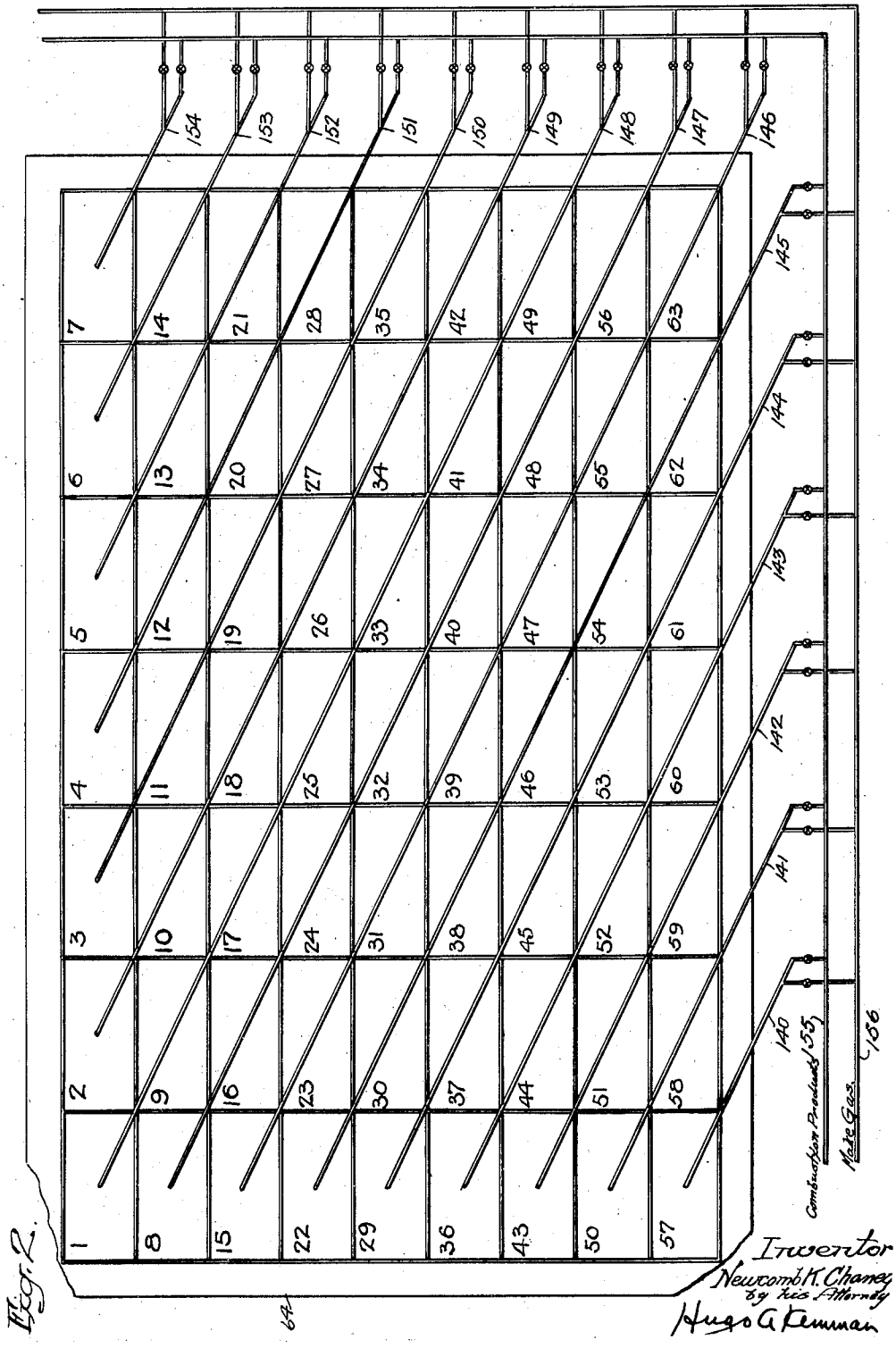


Fig. 2.

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PYROLYZING METHOD AND APPARATUS

Filed July 5, 1941 6 Sheets-Sheet 3

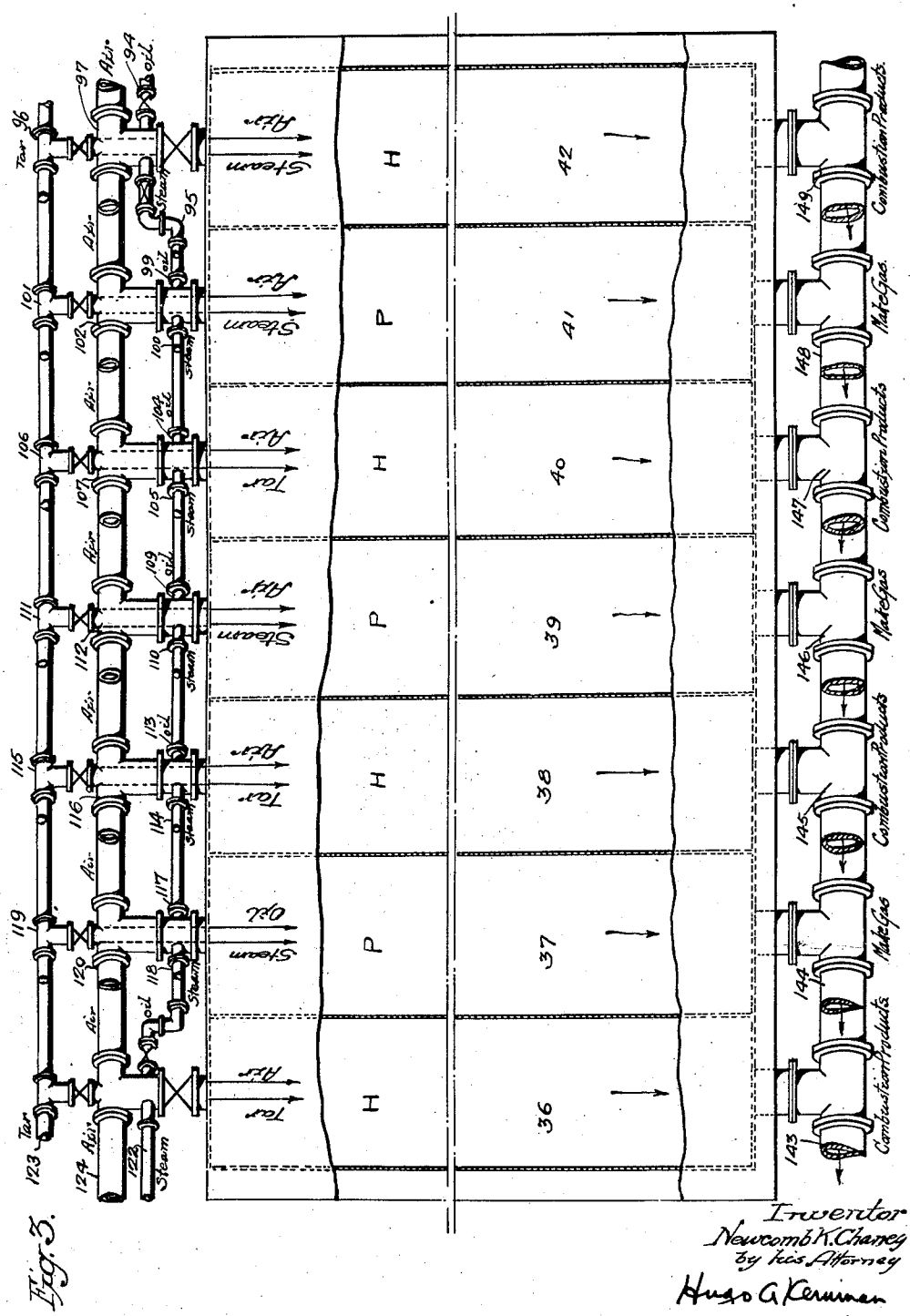


Fig. 3.

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March 27, 1945. N. K. CHANEY 2,372,186

PYROLYZING METHOD AND APPARATUS

Filed July 5, 1941 6 Sheets-Sheet 4

Fig. 4.

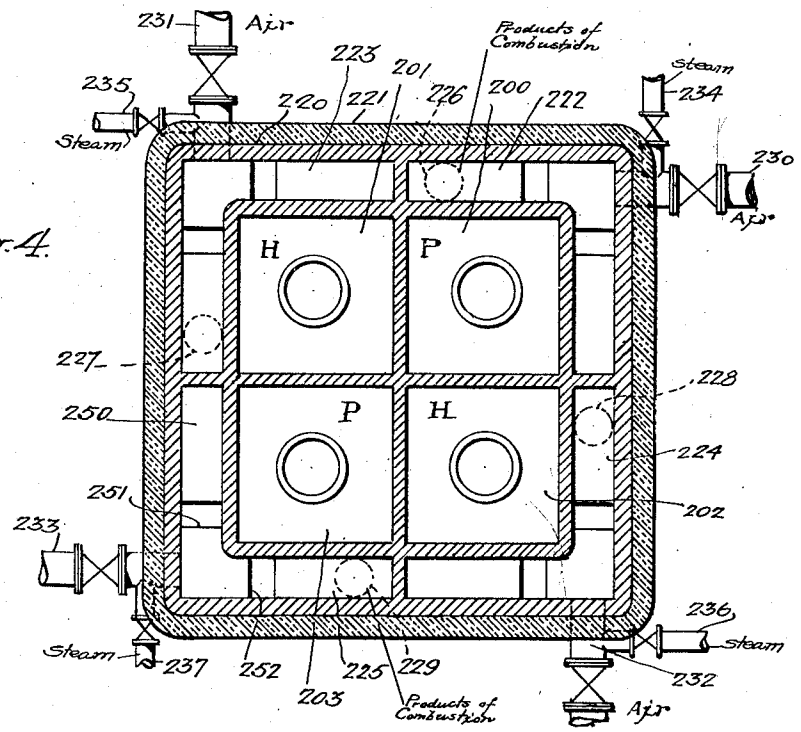
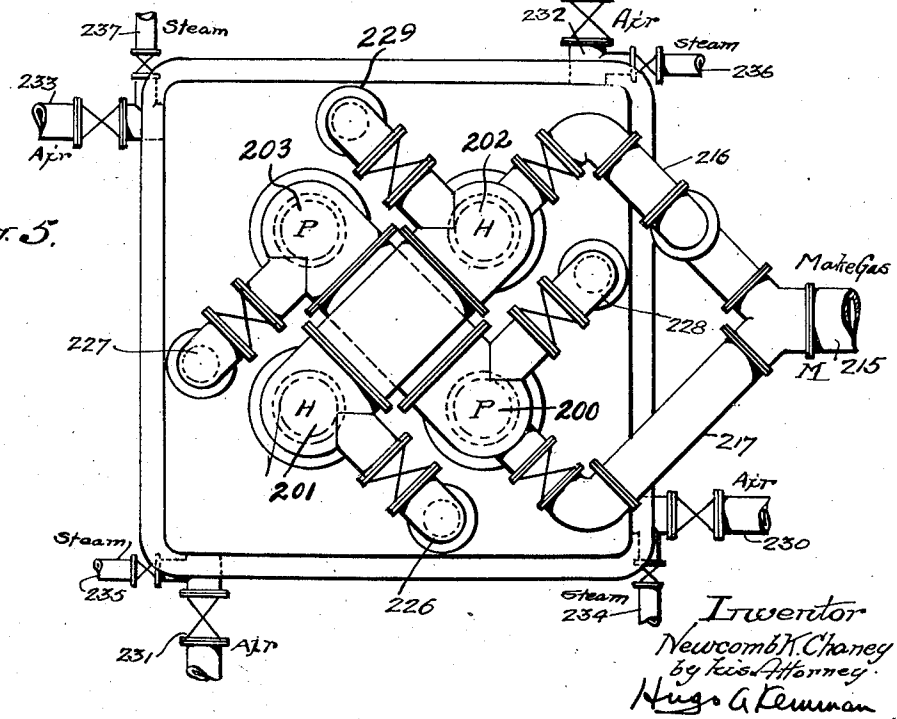


Fig. 5.



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PYROLYZING METHOD AND APPARATUS

Filed July 5, 1941 6 Sheets-Sheet 5

Fig. 6.

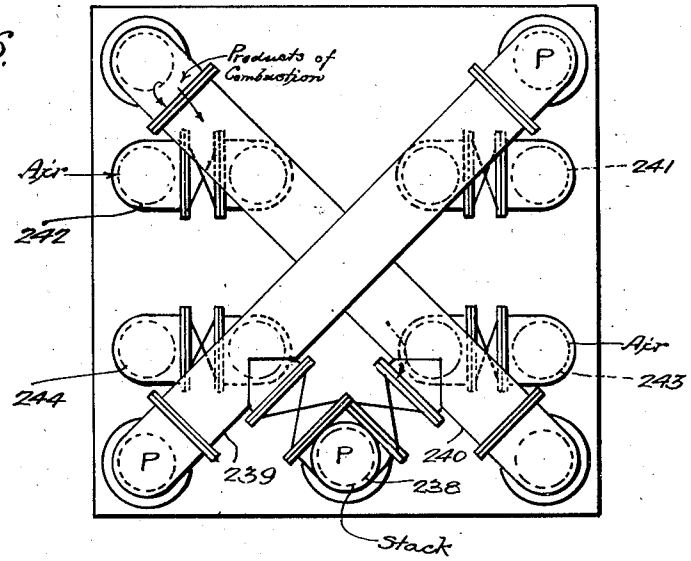
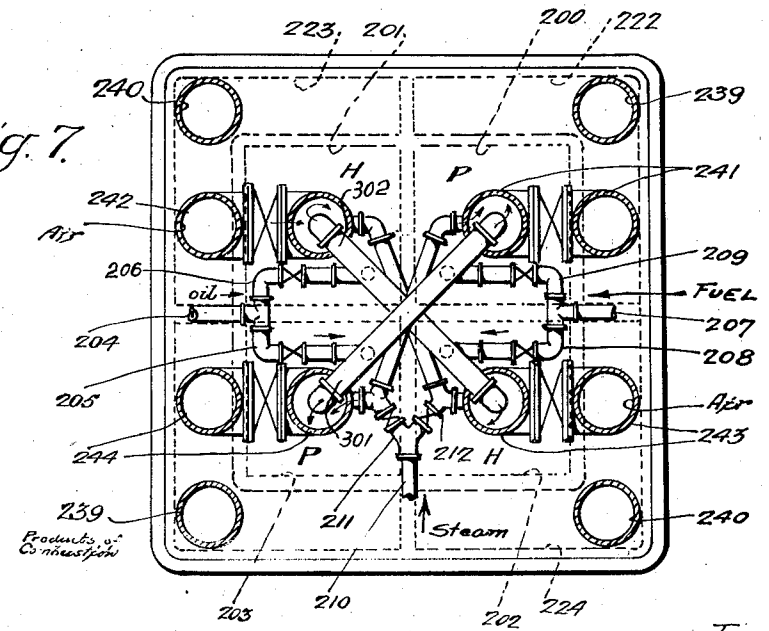


Fig. 7.



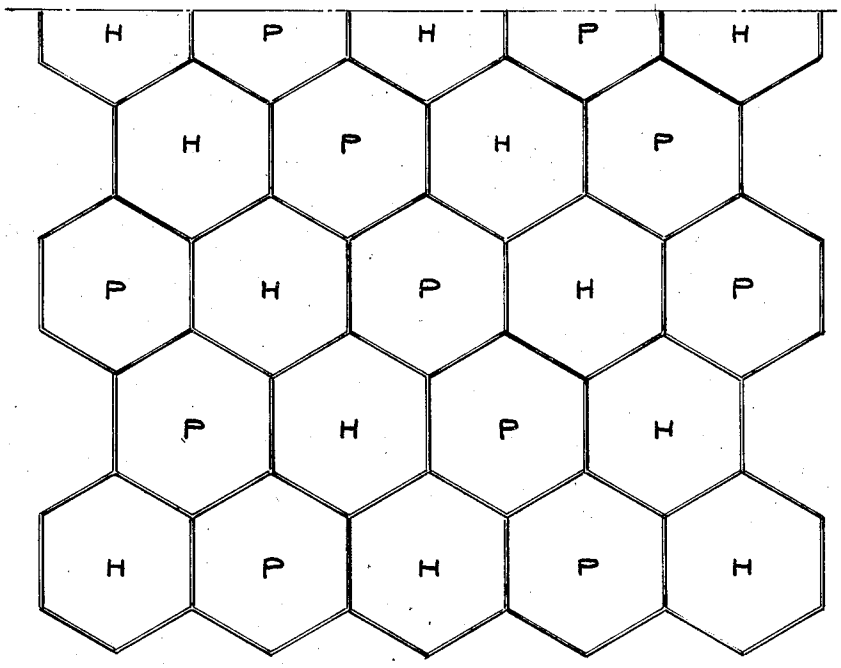
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PYROLYZING METHOD AND APPARATUS

Filed July 5, 1941 6 Sheets-Sheet 6

Fig. 8



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Patented Mar. 27, 1945 2,372,186

UNITED STATES PATENT OFFICE

2,372,186

PYROLYZING METHOD AND APPARATUS

Newcomb K. Chaney, Moylan, Pa., assignor to The United Gas Improvement Company, a corporation of Pennsylvania

Application July 5, 1941, Serial No. 401,207

4 Claims. (Cl. 196—47)

This invention relates to the pyrolysis of organic fluids which tend to form combustible deposits such as carbon or carbonaceous material during their pyrolysis. An example of such material is fluid hydrocarbon material, such as natural gas, refinery oil gas and petroleum oil.

There are three general methods of pyrolyzing fluid hydrocarbon material with respect to the application of heat required for pyrolysis. In cyclic processes such, for example, as oil gas processes and carburetted water gas processes, heat is stored in heat storage material during a heating step comprising the combustion of fuel with air, and the fluid hydrocarbon material is pyrolyzed during a step called the run, in which it is passed over the heated surfaces of the heat storage material. In continuous processes, such as are employed in the petroleum oil industry for the production of motor fuel, the heat for pyrolysis is applied through the walls of the tubes, in which the pyrolysis takes place. The third general method comprises supplying of the heat for pyrolysis by the partial combustion of the fluid hydrocarbon material being pyrolyzed.

Each of these general methods has advantages and disadvantages. In the third method, namely that of partial combustion, the heating may be very efficient, but the resulting gas is very largely contaminated with inert nitrogen, unless relatively pure oxygen is employed for the partial combustion instead of air. Also products which are desired in unoxidized form may be oxidized to undesired compounds.

In the continuous processes, comprising heating through tube walls, optimum temperatures and optimum temperature gradients may be more readily maintained than in the cyclic processes, which alternately store heat in heat storage materials such as refractories and employ the stored heat therein for pyrolysis.

However, under conditions of pyrolysis sufficiently severe to result in the cracking of any considerable portion of the fluid hydrocarbons to carbon or at least to hydrocarbons very poor in hydrogen, difficulties are incurred due to the accumulation of such products on the tube walls, resulting in eventual tube stoppage, unless there are frequent shut downs for cleaning the tubes. Moreover, such carbon accumulations on the tube walls may exert an undesired catalytic effect during the pyrolysis.

In the cyclic processes, carbon deposited on the heat storage material during each pyrolysis step may be consumed in the succeeding heating step.

One of the objects of the present invention is to provide a method of and apparatus for pyrolyzing materials of the class described which combine the advantages of the cyclic processes and apparatus of pyrolysis with the advantages of the indirect heating through the tube walls of the continuous processes and apparatus, and which also obviate their respective disadvantages.

Although as previously indicated the invention may be useful in the pyrolysis of a wide class of materials, it is perhaps more especially adapted for use in connection with the pyrolysis of fluid hydrocarbon material such as for example, individual hydrocarbons or mixtures thereof for example as found in natural gas, refinery oil gas and petroleum oil, including crude oil, cuts therefrom, and residuums.

For purposes of convenience, the invention will be more particularly described in connection with the pyrolysis of petroleum oil.

According to the present invention fluid hydrocarbon material, such as petroleum oil, is pyrolyzed by passage through a pyrolyzing chamber or chambers as for example a tube or tubes, simultaneously heated through its or their walls by combustion in an adjoining pyrolyzing chamber or chambers which may also be a tube or tubes. The functions of the chambers employed for heating and for pyrolyzing are then reversed. Pyrolysis of the oil is then carried on in a chamber previously employed for combustion, heat being supplied through a wall thereof from combustion simultaneously carried on in an adjoining chamber previously employed for pyrolysis. Sufficient air is supplied for combustion to consume whatever additional fuel may be required as well as deposits of carbon on the chamber wall resulting from the previous pyrolysis.

In other words, adjoining chambers are alternately employed as combustion flues and as pyrolyzing chambers, heat for the pyrolysis being supplied from the combustion flue to the pyrolyzing chamber through their contiguous walls or through their common wall.

Conditions of pyrolysis and the material pyrolyzed may be such that little or no fuel may be required in addition to the combustible material deposited during pyrolysis.

Other objects of the invention and other features thereof will become more apparent to those skilled in the art as the specification proceeds and in connection with the description of the accompanying figures which show forms of the invention chosen for illustration, and in which:

Figure 1 shows diagrammatically a top view of one form of the apparatus of the invention;

Figure 2 shows diagrammatically a bottom view of the apparatus of Figure 1;

Figure 3 shows, less diagrammatically and partly in elevation and partly in vertical section, a portion of the apparatus of Figure 1, said section being taken along the line 1—1 of Figure 1;

Figure 4 shows in horizontal section another form of the apparatus of the invention, said horizontal section being taken through the tubes thereof;

Figure 5 shows a bottom view of the apparatus of Figure 4;

Figure 6 shows a top view of the apparatus of Figure 4;

Figure 7 shows a second horizontal section of the apparatus of Figure 4, said section being taken above the tubes and below the cross-over connections of Figure 6.

Figure 8 shows in horizontal section a modified form of the tube arrangement of the apparatus of Figure 1.

Referring to Figures 1, 2, and 3, the nested vertical tubes 1 to 63 inclusive are arranged within the heat insulating wall 64. As illustrated, the adjoining tubes have common metal walls. It is to be understood, however, that the walls of adjoining tubes may be contiguous instead of common and may be of other materials than metal, such for instance, as refractories.

However, materials of high heat conductivity are preferred and if refractories are employed for the tube walls, it is preferred to employ such refractories as carborundum, which have relatively high heat conductivity.

Metals if employed should, of course, be sufficiently heat resisting for the temperatures to which they are exposed.

The tubes are preferably empty as shown or at least substantially devoid of packing.

Each tube is provided at its top with means for admitting petroleum oil, steam, air and fluid fuel. The fluid fuel may be any desired or available fuel, such as combustible gas, fuel oil, tar, etc.

Petroleum oil line 66, steam line 67, fuel line 68, and air line 69 are each connected with tube 7 by valved lines 70, 71, 72 and 73 respectively; with tubes 6 and 14 by valved lines 74, 75, 76 and 77 respectively; with tubes 5, 13, and 21 by valved lines 79, 80, 81 and 82, respectively; with tubes 4, 12, 20 and 28 by valved lines 84, 85, 86 and 87, respectively; with tubes 3, 11, 19, 27 and 35 by valved lines 89, 90, 91, and 92, respectively, with tubes 2, 10, 18, 26, 34 and 42 by valved lines 94, 95, 96, and 97, respectively; with tubes 1, 9, 17, 25, 33, 41 and 49 by valved lines 99, 100, 101, and 102, respectively; with tubes 8, 16, 24, 32, 40, 48 and 56 by valved lines 104, 105, 106, and 107, respectively; with tubes 15, 23, 31, 39, 47, 55 and 63 by valved lines 109, 110, 111, and 112 respectively; with tubes 22, 30, 38, 46, 54 and 62 by valved lines 113, 114, 115 and 116 respectively; with tubes 29, 37, 45, 53 and 61 by valved lines 117, 118, 119 and 120 respectively; with tubes 36, 44, 52 and 60 by valved lines 121, 122, 123 and 124, respectively; with tubes 43, 51 and 59 by valved lines 125, 126, 127 and 128, respectively; with tubes 50 and 58 by valved lines 129, 130, 131 and 132, respectively; with tube 57 by valved lines 134, 135, 136 and 137 respectively.

As shown particularly in Figure 2, at their bottoms the tubes are connected in diagonal rows by connections 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153 and 154 with both the combustion gas off-take 155 and the make-gas off-take 156, by valved branch connections.

As will be understood, the admission of oil, steam, fuel and air to the tops of any of the diagonal rows of tubes may be controlled by the valves in the lines leading from the oil, steam, fuel and air lines to the diagonal rows of tubes. Also the products from the bottom of any of the diagonal rows of tubes may be lead to either the combustion product line 155, which may lead to a stack (not shown) or to the make-gas line 156, which may lead to a holder and/or condensing apparatus or other disposal, not shown).

It will be readily understood, that the arrangement of supply of fluids to the tubes and the arrangement of withdrawal of products therefrom permits alternate diagonal rows of tubes to be employed for heating by the admission of air and fuel, to the tops thereof, with the resulting combustion of the fuel therein, and the withdrawal of the combustion products to the stack; while at the same time intervening diagonal rows of tubes are being employed for the pyrolysis of oil admitted to the tops thereof, in the presence of steam also admitted to the tops thereof; the oil being vaporized and pyrolyzed in passage downwardly through the tubes and the resultant make-gas being drawn off from the tube bottoms.

As will be seen the arrangement illustrated in these figures, is such that tubes being employed for pyrolysis of oil are surrounded on all four sides by adjoining tubes simultaneously being employed for heating, the necessary heat for pyrolysis being delivered from the heating tubes to the pyrolyzing tubes through the common tube walls. Tubes employed for heating are surrounded by adjoining tubes employed for pyrolysis and are cooled thereby.

After any desired period of pyrolysis the functions of the heating and pyrolyzing tubes are reversed. Fuel and air is supplied to the tops of the diagonal rows of tubes previously employed for pyrolysis, while oil and steam are supplied to the tops of the diagonal rows of tubes previously employed for heating. It will be understood that the necessary valve reversals are made in the lines leading off the make-gas and combustion products from the bottoms of the tubes.

It will be understood, that between reversals, the apparatus may be purged. For example, the tubes employed for pyrolysis and combustion may be purged with steam supplied to their tops after the oil has been shut off in the case of tubes employed for pyrolysis and after the fuel and air or air alone has been shut off in the case of tubes employed for combustion.

Inasmuch as the tubes at the extreme ends of the various rows if employed for pyrolysis are not entirely surrounded by tubes employed for heating, it may be preferred to omit an oil pyrolyzing operation in these tubes; and to this end it may be preferred not to furnish these tubes with oil and steam connections. If such connections are furnished, it may be preferred to provide separate valves in the oil and steam lines at these tubes to permit the oil and steam supplied therethrough to be shut-off at such tubes. If desired, individual control of supply of fluids to and of the withdrawal of products from any other individual tube may also be provided.

As an example of the division of functions of the tubes of Figure 1 at an assumed instant of

operation, the various diagonal rows of tubes have been marked H or P, depending upon whether employed at such assumed time, for heating or for pyrolysis, respectively.

In the case illustrated, the tubes at the ends of the diagonal rows are not employed for pyrolysis.

As illustrated, the row containing tubes 6 and 14 is employed for heating; the tube 13 for pyrolysis; row containing tubes 4, 12, 20 and 28 for heating; row containing tubes 11, 19 and 27 for pyrolysis; the row containing tubes 2, 10, 18, 26, 34 and 42 for heating; row containing tubes 9, 17, 25, 33, and 41 for pyrolysis; the row containing tubes 8, 16, 24, 32, 40, 48 and 56 for heating; the row containing tubes 23, 31, 39, 47, and 55 for pyrolysis; the row containing tubes 22, 30, 38, 46, 54 and 62 for heating; the row containing tubes 37, 45, and 53 for pyrolysis; the row containing tubes 36, 44, 52, and 60 for heating; the tube 51 for pyrolysis; and the row containing tubes 50 and 58 for heating.

As previously stated, the period between the reversals of tube functions may be of any desired length. It may be preferred to reverse the tubes in short cycles or it may be preferred to operate with a long period between reversals.

The length of these cycles will, of course, depend among other things upon the rapidity of carbon accumulation on the walls of the tubes when employed for pyrolysis.

The rapidity of carbon accumulation will depend upon the material pyrolyzed and upon the severity of the pyrolysis as well as upon such factors as the particular material employed for the tube walls and the character of its surface. It may also depend upon the presence or absence of a diluent supplied as a pyrolyzing environment and upon the character of the diluent supplied, if any.

Referring to Figures 4, 5, 6 and 7 these figures illustrate a modified form of the invention illustrated in the previous figures.

Numerals 200, 201, 202 and 203 indicate tubes which are alternately employed for pyrolysis and for heating. As can be seen from Figure 7, each tube is provided with a supply of petroleum oil for pyrolysis from oil line 204. Oil line 204 is connected by the valved connection 205 with tubes 200 and 203 by way of pipe 301 and by the valved connection 206 with tubes 201 and 202 by way of pipe 302.

Each tube is provided at its top with a supply of fluid fuel such as, for example, tar from the fuel line 207. The tar line 207 is connected by valved connection 208 with tubes 201 and 202 and by the valved connection 209 with tubes 200 and 203.

Each tube is provided at its top with a supply of steam from the steam line 210. Steam line 210 is connected by the valved connection 211 with tubes 200 and 203 and by the valved connection 212 with tubes 201 and 202.

Referring to Figure 5, each tube at its bottom is connected to the make-gas off-take 215. Make-gas off-take 215 is connected by the valved connection 216 with tubes 201 and 202 and by the valved connection 217 with tubes 200 and 203.

As illustrated in Figure 4 each tube has two walls in common with other tubes and each tube on the remaining two sides adjoins flues arranged within the outer shell 220, which is surrounded by the insulating material 221. The flue 222 adjoins tube 200; flue 223 adjoins tube 201; the flue 224 adjoins tube 202, and flue 225 adjoins tube 203.

The flue 222 is connected to the bottoms of tubes 201 and 202 by the valved connection 226; the flue 223 is connected to the bottom of tubes 200 and 203 by the valved connection 227. The flue 224 is connected to tubes 200 and 203 by the valved connection 228. The flue 225 is connected to tubes 201 and 202 by valved connection 229.

The flues 222, 223, 224 and 225 at their bottoms are provided with the air connections 230, 231, 232 and 233 respectively, and with the steam connections 234, 235, 236 and 237, respectively.

At their tops flues 222 and 225 are connected to the stack 238 by valved connection 239 as can be seen from Figure 6. The flues 223 and 224 are connected to the stack 238 by the valved connection 240.

Flue 222 is also connected with the top of the tube 200 by valved connection 241. Flue 223 is also connected to the top of tube 201 by valved connection 242. Flue 224 is also connected to the top of tube 202 by the valved connection 243. Flue 225 is also connected to the top of tube 203 by the valved connection 244.

The adjoining walls of the tubes and flues may be formed of metal or of refractories. If refractories are employed, refractory material of high heat conductivity is preferred, such as carborundum, though other refractories may be used.

Each of the flues 222, 223, 224 and 225 are provided near their bottoms and above the entrances of the air supplies 230, 231, 232 and 233 with horizontal partitions provided with openings and adapted to serve as means for distribution of fluids throughout the respective flues. Such a partition in the case of flues 225 is indicated at 250 provided with openings at 251 and 252.

The tubes and flues are preferably empty as shown or at least substantially devoid of packing.

As an example of the operation of the apparatus of Figures 4 to 7 inclusive, it will be assumed that tubes 200 and 203 are being employed for pyrolysis and tubes 201 and 202 are being employed for heating.

Petroleum oil is supplied to the tops of tubes 200 and 203 through oil line 204 and valved connection 205. At the same time, steam is supplied to these tubes through the steam supply line 210 and the valved connection 211.

The oil is vaporized in these tubes in the presence of the steam and the oil pyrolyzed in its passage downwardly through the tubes.

The resultant make-gas issues from the bottoms of the tubes and passes by way of the valved connection 217 to the make-gas off-take 215 and thence to storage, condensation or other treatment.

At the same time, fuel and air are supplied to the tops of tubes 201 and 202. The fuel such for example, as tar is supplied from fuel line 207 through the valved connection 208.

The air is supplied to tube 201 through air supply 231, flue 223, and the valved connection 242. Air is supplied to tube 202 through air supply line 232, flue 224, and the valved connection 243.

The fuel supplied is burned with the air in tubes 201 and 202 heating tubes 200 and 203 through the common walls shared with these tubes.

The combustion products pass downward from tube 201, and pass by way of valved connection 226 into flue 222, and upwardly through that flue heating the two outer walls of tube 200.

From flue 222 the combustion products pass by way of valved connection 239 to the stack 238.

The combustion products from tube 202 pass by way of valved connection 229 to the flue 225,

and pass upwardly through that flue heating the two outer walls of tube **203**, and thence passing by way of connection **239** to stack **238**.

The functions of the two sets of tubes, the set **200** and **203** and the set **201** and **202**, are then reversed and the set **200** and **203** becomes the heating set of tubes and the set **201** and **202** becomes the pyrolyzing set of tubes. The operation is similar to that just previously described except that fuel and air are supplied to the set **200** and **203** and oil and steam to the set **201** and **202** and the necessary valve changes are made to lead the make-gas off from the bottoms of tubes **201** and **202** to the make-gas line **215**, and combustion products from the bottoms of tubes **200** and **203**, up through flues **224** and **223**, respectively, and thence to the stack.

Between reversals the apparatus may be purged of combustion products and make-gas, the former by steam admitted through steam supplies **234** and **237** or steam supplies **235** and **236**, depending upon which tubes are being employed for heating, the latter by steam admitted through steam supply **210** and connection **211** or **212** depending upon which tubes are being employed for pyrolysis.

It will be noted that the tubes employed for pyrolysis are heated on all four sides; on two sides through the walls of the heating tubes and on the other two sides by combustion products passed from the heating tubes around these other two sides.

It will also be noted that the heating tubes are cooled on all four sides; on two sides, through the walls of the heating tubes by the oil, steam, oil vapors and gas flowing through the pyrolyzing tubes, and on the other two sides by the air for combustion.

As stated in connection with Figures 1, 2 and 3, the period between reversals of the functions of the tubes may be of any desired length and will vary with the materials pyrolyzed, the severity of the pyrolysis, and with the presence or absence of inert gases introduced during the pyrolysis as well as with the character of the tube walls.

As in the case of the apparatus of Figures 1, 2 and 3, any accumulations of carbon upon the walls of the tubes during pyrolysis of the oil may be readily consumed during the succeeding period, when that particular tube is employed for heating, sufficient air being admitted to consume the carbon accumulations as well as any additional fuel supplied for heating.

It will be seen, therefore, that the invention combines the heating through tube walls of conventional continuous pyrolysis processes which permits close control of temperatures and temperature gradients, with the periodic removal of carbon accumulations of conventional cyclic pyrolyzing processes.

The invention, although adapted for use in the pyrolysis of fluid hydrocarbon material generally, is perhaps more particularly desirable in connection with the pyrolysis of petroleum oil for the production of high yields of valuable unsaturated resin-forming hydrocarbons such as, for example, butadiene, cyclopentadiene, dicyclopentadiene, isoprene, piperylene, styrene, methyl styrene and others whose composition is not definitely determined as yet. There are also produced saturated aromatic compounds such as benzene, toluene, xylene, naphthalene and others as yet unidentified, as well as normally gaseous saturated and unsaturated hydrocarbons, such as methane, ethane, ethylene, propylene, propane, butane and butylene.

A considerable quantity of carbon or at least hydrocarbon material very poor in hydrogen is also produced especially when operating at relatively high temperatures and/or with relatively long time of contact. Such carbon tends to deposit on surfaces in contact with the material undergoing pyrolysis.

In such petroleum oil pyrolysis, oil is pyrolyzed in vapor phase in the presence of inert diluent gas such for example, as steam with close control of conditions governing the severity and character of pyrolysis. It is particularly desirable in connection with such pyrolysis to be able to maintain closely optimum temperatures and optimum temperature gradients throughout the course of the pyrolysis. This close control is more necessary in such a case than if the process is directed principally to the production of combustible gas. In the latter case, a relatively wide latitude of conditions may produce the same average result as measured by the therms in the finished gas. Deposits of carbon on the walls of the pyrolyzing chambers have an undesirable catalytic effect upon the yield of certain of the above mentioned unsaturated compounds.

It will be obvious to those skilled in the art, that many modifications of the apparatus chosen for illustration and the method as described may be made without departing from the spirit of the invention. For example, in connection with the apparatus of Figure 1 the outer tubes when employed for pyrolysis might be heated by passing around their outer walls the products of combustion from tubes employed for heating as is illustrated in the case of the apparatus of Figures 4, 5, 6 and 7.

The points of admission of the oil, steam, fuel and air may be varied widely from those illustrated as well as the points of withdrawal of make-gas and combustion products.

For example, both the pyrolysis and the combustion may be conducted upwardly through the tubes or the combustion and pyrolysis might be conducted in countercurrent relation to each other, for example, the combustion conducted downward and the pyrolysis upward.

Petroleum oil and other liquids when employed for pyrolysis may be introduced as liquids or may be vaporized prior to introduction into the pyrolyzing chambers.

As previously stated under some conditions it may not be necessary to introduce additional fuel.

The arrangements of tubes employed for pyrolysis and heating may be varied from those described. For example, in the apparatus of Figure 1, alternate rows of tubes other than diagonal rows might be divided as to function. Other arrangements might be employed.

The tubes need not be vertical, but may be horizontal or otherwise.

The pyrolyzing and the heating chambers may be of any convenient shape and constructed of any desirable material.

For example, in Figure 8 are shown in horizontal cross-section, tubes which have a hexagonal shape in that plane and which may be employed in alternate rows for heating and pyrolysis as indicated by the letters H for heating and P for pyrolysis.

Apparatus such as described if desired, may be arranged in series, the products of pyrolysis from one apparatus passing with or without in-

tervening treatment to another apparatus for further pyrolysis therein.

In the claims the term "petroleum oil" is intended to include crude oil, a cut or cuts therefrom and residuums whether introduced in liquid or vapor phase.

In the claims the term "adjoining" is intended to apply to a common wall as well as to contiguous walls and to chambers having a common wall as well as to chambers having contiguous walls.

The terms "comprises" and "comprising" in the claims are employed in their usually accepted meanings and do not exclude the employment of other steps or the presence of other means, than those described.

Therefore, changes, omissions, additions, substitutions and/or modifications may be made within the scope of the claims without departing from the spirit of the invention which is intended to be limited only as required by the prior art.

I claim:

1. A method for pyrolyzing fluid hydrocarbon material in a plurality of chambers in heat transfer relation one with another through adjoining walls having a heat conductivity at least as high as that of carborundum refractory material, which comprises pyrolyzing said fluid hydrocarbon material in certain of said chambers, simultaneously carrying on combustion in a plurality of other chambers adjoining said chambers employed for pyrolysis, a chamber when employed for pyrolysis being surrounded by a plurality of adjoining chambers employed for combustion and a chamber when employed for combustion being also surrounded by a plurality of adjoining chambers employed for pyrolysis, whereby chambers when employed for pyrolysis are heated through their walls by surrounding chambers employed for combustion and chambers when employed for combustion are cooled through their walls by surrounding chambers employed for pyrolysis.

2. A method for vaporizing and pyrolyzing liquid hydrcarbon material in a plurality of chambers in heat transfer relation one with another through adjoining walls, which comprises supplying said liquid hydrocarbon material to a chamber for vaporization and pyrolysis therein, simultaneously by admission of fluid fuel and air thereto carrying on combustion in a chamber one wall of which is in adjoining relation to a wall of said chamber employed for vaporization and pyrolysis, thereby heating said chamber employed for vaporization and pyrolysis through said adjoining walls, leading off the reslulting products of combustion in heat transfer relation to another wall of said chamber employed for vaporization and pyrolysis, thereafter supplying said liquid hydrocarbon material to said chamber previously employed for combustion for vaporization and pyrolysis therein, heating said last named chamber through said adjoining walls by combustion carried on in said chamber previously employed for vaporization and pyrolysis, and leading off the resulting products of said last named combustion in heat transfer relation with another wall of said chamber previously employed for combustion.

3. Apparatus for vaporizing and pyrolyzing liquid hydrocarbon material comprising a plurality of pyrolyzing chambers substantially devoid of packing and in heat transfer relation one with another through adjoining walls, means for alternately admitting said fluid hydrocarbon material for vaporization and pyrolysis and air for combustion of carbonaceous material deposited as a result of pyrolysis of said liquid hydrocarbon material to each of adjoining chambers, said means being arranged to admit said liquid hydrocarbon material to one chamber for vaporization and pyrolysis therein while simultaneously admitting air to an adjoining chamber to effect combustion therein, and means for leading off combustion products from a chamber employed for combustion in heat transfer relation with a wall of a chamber employed for pyrolysis.

4. Apparatus for pyrolyzing fluid hydrocarbon material comprising a plurality of chambers in heat transfer relation one with another through adjoining walls of material having a heat conductivity at least as high as that of carborundum refractory material, means for supplying fluid hydrocarbon material to certain of said chambers for pyrolysis therein together with means for simultaneously carrying on combustion in a plurality of chambers adjoining and surrounding individual chambers in which pyrolysis is being effected, and means for alternately carrying on combustion in chambers previously employed for pyrolysis together with means for simultaneously supplying fluid hydrocarbon material for pyrolysis to a plurality of chambers previously employed for combustion which adjoin and surround individual chambers at that time employed for combustion.

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