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(54) METHOD OF PROCESING SOLID HYDROCARBONACEOUS MATERIAL.

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Description

Technical Field

This invention relates to a method of processing solid hydrocarbonaceous material and has been devised particularly though not solely for the processing of different grades of oil shale or the like wherein a simple set of apparatus may be readily adapted for use in processing different types or grades of solid hydrocarbonaceous material.

Background Art

In the past many different ways have been proposed to recover oil from solid hydrocarbonaceous material such as oil shale, coal, tar sands, peat and lignite. For convenience throughout this specification the processing of oil shale will be referred to although it is to be understood that the processes described can be applied to other forms of solid hydrocarbonaceous material. In many of the methods previously proposed hot gases are passed over or through the oil shale particles in a retort causing effluent vapour containing oil to be given off from the oil shale. It has been a problem with such methods that the nature of the oil shale in different locations varies widely and therefore requires widely varying retorting residence times, pressure levels, temperature levels, and heat input or heat recovery schemes to process the oil shale economically. In most instances it is possible to recover heat for the heating of the oil shale by oxidising the residual carbon remaining after retorting the oil shale, but once again the amount of residual carbon remaining varies widely depending on the nature of the feed shale and different areas therefore have very different requirements.

In addition existing retorting technologies vary from moving fixed beds of oil shale resulting in degeneration of the particle size or lack of control of the hot and cold effluent streams to fluidized beds of oil shale where large power consumption may be required to move the oil shale from one phase to another.

Attempts have been made in the past to provide efficient methods of processing solid hydrocarbonaceous materials of different grades and qualities, but none of these have been particularly satisfactory. In EP-A-41460 there is described a very simple method wherein two retorts are used to process oil shale and wherein the process is then reversed to utilise the heating value of the residual carbon in the partially processed shale. This process only utilises two retorts and is a distinctively batch-type process requiring a long cycle time due to cooling and loading and unloading problems associated with the use of only two retorts.

US-A-4285547 refers to the in situ processing of oil shale by forming retorts from underground chambers. In this method of processing the underground chambers are not interconnected by flow control valves. Although each underground chamber in US-A-4285547 is used in turn for each of the processing phases, the chambers are not capable of being operated in a continuously cyclic manner by changing interconnections between the various chambers.

It is an object of the present invention to provide an improved and economic method for processing solid hydrocarbonaceous material using simple and comparatively cheap apparatus.

Accordingly the invention provides a method of processing solid hydrocarbonaceous material through three or more phases using three or more retorts interconnected by conduits incorporating control valves arranged such that opening and closing selected valves changes the interconnections between the various retorts, and wherein the valves are opened and closed in a predetermined sequence causing each retort to be used in turn for some or all of the desired phases and then reused as the sequence is repeated such that the phases are cylically performed by all or selected ones of the retorts in turn, and wherein the three phases include,

a first phase comprising the treatment of fresh solid hydrocarbonaceous material with a hot gas causing effluent vapours to be given off,

a second phase comprising the passing of combustion supporting gas through at least partially spent solid hydrocarbonaceous material which has already been processed in the first phase, oxidising residual carbon on or in the material and giving off gas heated thereby which is then passed to the retort in the first phase as the said hot gas, and

a third phase comprising the cooling and unloading of spent material and the recharging of the retort with fresh material while the other two retorts are in use in the first and second phases.

In one form of the invention the third phase referred to above may be divided into two separate phases whereby the cooling of the spent material is performed in a separate phase from the discharging and recharging of the retort with fresh material.

Preferably the heat given off in the cooling phase is used either for preheating the raw feed material or for enhancing the oxidisation of the residual carbon on the material in the second phase.

The method is suitable for use with either fixed bed retorts wherein the gas flow through the retort is from the top to the bottom or for use with fluidized bed retorts with the gas flow from the bottom to the top of each retort. The method selected will depend on the nature of the solid hydrocarbonaceous material, the fixed bed processing being more efficient and therefore suitable for use with lower yield material, e.g. less than 90 litres per tonne, and the fluidized bed processing being easier to control and more able to cope with fines in the raw feed material.

Brief Description of Drawings

Notwithstanding any other forms that may fall within its scope, one preferred form of the invention and variations thereof will now be described by way of example only with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic view of a typical retort used in the method according to the invention.

Figure 2 is a schematic view of a plurality of retorts at the various phases used in one embodiment of the method according to the invention and incorporating fixed bed retorting.

Figure 3 is a schematic view of four retorts used in a form of the invention particularly suitable for the processing of coal.

Figure 4 is a schematic view of four retorts suitable for use with fluidized bed processing in a self-sufficient heat source situation, and

Figure 5 is a schematic view of three retorts used in an embodiment of the invention for use with fluidized bed processing where there is a high carbon residual on the partially processed feed material.

Modes for Carrying out the Invention

In the preferred form of the invention oil shale is processed in a controlled cyclic approach using a plurality of retorts each provided with inlet and outlet valves as shown in Figure 1. The retort may be used in a number of different configurations having different numbers of phases of processing but the retort shown in Figure 1 is provided with three inlet valves X, Y and Z and three outlet valves R, S and T for use in a process incorporating three active phases. In this manner gases from various sources are fed into the retort 1 through an inlet 2 from various sources controlled by the servoed valves X, Y and Z. Similarly the outlet of gas from the retort is made through outlet 3 to a predetermined destination controlled by the servoed valves R, S and T. Although the retort has been shown with an upper inlet 2 and a lower outlet 3 for use in fixed bed processing, it will be appreciated that the inlet may be located at 3 and the outlet at 2 as desired for fluidized bed processing.

Normally when the retort is involved in processing the valves X and R are opened for the first cycle, the valves Y and S are opened for the second cycle and the valves Z and T are opened for the third cycle to cycle the retort through phases I, II and III respectively. These valves are typically remotely controlled by a pre-programmed controller to cycle the retort through the phases as required by the operating sequence.

In use of the invention a plurality of retorts as shown in Figure 1 may be utilised in a number of different configurations.

In a typical fixed bed operating system as shown in Figure 2, five such retorts are provided as it is believed that this number of retorts gives the most likely operating cycle for fixed bed processing. It will be appreciated, however, that a larger or smaller number of retorts may be used, operated on the same method according to the invention. Each retort is provided with inlet and outlet valves as described with reference to Figure 1 so that each retort may be cycled through the three phases shown in Figure 2 as I, II and III, and also through the cooling down phase V and the loading and unloading phase IV as will be described further below.

The characteristics of oil shales from various deposits around the world or within the same deposit can vary as to:

(1) their kerogen content and charateristics,

(2) their crushing characteristics and friability,

(3) moisture content,

(4) chemical water,

(5) residual carbon remaining in or on the spent shale, and/or

(6) chemical composition of the host material.

Once the basic characteristics of the oil shale or other solid hydrocarbonaceous material are established through testing or comparative analysis, the process steps specified herein can be ascertained together with the time required for each cycle, suitable particle sizes, up or down flow of gases through the beds, suitable pressure levels and temperature requirements. When these conditions for various oil shales are determined, a processing scheme can be developed on cyclic time retorting.

Assuming the basic characteristics of the oil shale have been generally established and the process has been designed to incorporate these, the cyclic process steps or operation and mechanical features are as follows:

Raw oil shale is firstly crushed by conventional means to provide a feed material consisting of particles not greater than 100 mm. Screening to produce the desired feed material is carried out in a conventional fashion and the resulting shale feed for a fixed bed processing system would consist of a combination of anywhere from - 100 mm to + 7 mm in particle size or at a narrow size range such as a variation of 7 mm between particle sizes. For an ebullating or fluidized bed processing system a configuration of - 7 mm can be adapted. The sized shale is fed to a retort feed bin (not shown) used in conjunction with each of the retorts at atmospheric pressure. During the cyclic operation of the method each retort is placed in a loading and unloading phase wherein the feed material is fed from the feed bin into the retort after the spent shale has been unloaded from the retort.

In the configuration shown in Figure 2, loading and unloading of the retort 4 is achieved in phase IV wherein the retort is loaded outside the active processing cycles but within one cycle time. The loading can take place at the same time as the retort is unloaded. Once the retort is loaded it can be blocked off ready to be cycled into phase I operation. The valves shown as A through F in Figure 2 are simply one set of the valves shown in the typical retort configuration in Figure 1 and are operated by a conventional automatic cyclic timer, opening and closing valve numbers A through F as programmed to distribute gases through the various phases of operation of the process. Phase I for example is initiated by the cyclic timer opening valves A and B permitting hot gas to flow into retort 5 from retort 6 which is in phase III of the operation through the open valves F and A. The hot gas flowing into retort 5 through stream 7 heats up the shale in the retort and initiates the removal of moisture, if any, and the retorting of the shale. The gas will flow for a specific period of time which is the same time for the processing of retort 8 in phase II and retort 6 in retort III. The pressure level of the hot gas stream 7 and the process scheme will depend upon the characteristics of the shale and possibly the other process related steps outside the process scheme described herein. The hot gas passing into retort 5 is cooled in that retort during phase I while at the same time combining with water, if any, and hydrocarbons released by the shale.

The combined gas, with possibly some liquids due to the condensation resulting from the combined gas stream being cooled by flowing across the colder shale bed, becomes stream 9 leaving the phase I retort. Stream 9 can either be cooled by conventional indirect or direct heat exchange methods to a temperature depending on the characteristics of the shale. The indirect cooling is achieved through a heat exchanger 10 to a receiver 11 which acts as receiver, separator, surge or knockout vessel, or oil quench tower in those cases where the direct heat exchange method is employed, for the purposes of:

(1) separating oil, water and gas,

(2) reducing liquids being transmitted to blower fan 12,

(3) providing surge capacity for control purposes and

(4) a direct heat exchanger to condense oil and water.

Both oil and any water are transmitted out of the process scheme in separate streams by way of water pump 13 and oil pump 14. Gas from the receiver 11 is passed through stream 15 to blower fan 12 and pressurised to compensate for pressure loss in the process scheme. The gas streams 9, 15, 16, 17, and 7 flow as a continous flow distributed to the different retorts when the cyclic timer opens and closes the multiple remote controlled valves connected to each retort.

With the shale bed in retort 8 partially retorted and residual carbon deposited on the retorted spent shale, air or an oxygen rich stream 18 is combined with steam 15 and fed to retort 8. The oxygen acts as an oxidising agent by converting some of the residual carbon to carbon dioxide and carbon monoxide. The proper amount of oxygen and the oxidation step produces sufficient heat to retort the shale in retort 8.

The gas leaving retort 8 via stream 16 will include hydrocarbons and perhaps water and is cooled by conventional direct or indirect heat exchange methods to a temperature depending on the characteristics of the shale. Stream 16 flows through the indirect heat exchanger 19 to receiver 20 (similar in configuration to receiver 11) and water is pumped out through pump 21 and oil through pump 22 in a similar manner to the operation of pumps 13 and 14 respectively. Gas given off from receiver 20 is passed through line 17 to retort 6 which is presently in phase III of the operation. The process scheme is such that additional pressure compensating blowers could be added as the economics of the process dictate or the receiver vessels 11 and 20 could be combined into one vessel and serviced with the addition of a single blower.

Some of the spent shale from phases I and II has residual carbon not fully oxidised in phase II. Air or an oxygen rich stream 23 is combined with stream 17 and fed to retort 6. The oxygen performs the same task in retort 6 as it did in retort 8 by providing a temperature rise to streams 17 and 23 sufficient to heat up and retort the phase I retort 5 by stream 7.

The retorting process is expected to produce not only liquid hydrocarbons but a gaseous stream in excess of what is required by the process. Excess gas streams 24 and 25 are extracted from the process as required, combined and used as convenient for the process support facilities or transmitted to outside the appropriate area or combusted to produce heat for the retorting process.

Phases I, II and III are operating in a continous flow pattern and at the same time the cyclic timer is programmed to switch the valving at the retorts so as to take each retort through a complete cycle of phases I, II and III. The number of retorts can include a loading and unloading phase or a further processing phase to cool the spent shale bed. Such phases are typically shown by the retorts 4 and 26. In addition it is possible to retort in two or more retorts by using indirect heating from outside or within the process scheme.

In alternative configurations of the invention as shown in Figures 3, 4 and 5, the solid hydrocarbonaceous materials will be processed in a fluidized or ebullating bed. Once again each retort is provided with a plurality of controlled valves adapted to cycle the retort through various phases. The number of phases and hence the number of retorts varies depending on the scheme used.

In the scheme shown in Figure 3, four retorts are used in a four phase configuration generally designated R1, R2, R3 and R4. The raw feed shale is firsty fed into the retort R1 and preheated by hot gas passed through line 30 from combustor 31. The combustor is fed with air at 32 (and fuel as an option) which may be controlled to achieve the desired preheat temperature. Water, carbon dioxide, nitrogen, carbon monoxide and other gases given off from the retort R1 may be cycled through line 33 by way of a blower 34 back into the combustor 31 with excess gases going to waste at 35.

The retort so loaded and preheated is then cycled into a first phase for retorting in R2 wherein the feed material is heated by a hot gas through line 36. The gas is heated in a second phase in retort R3 by the burning of residual carbon on or in the material which has previously been processed in the first phase in retort R2. A combustion supporting gas such as air is blown into retort R3 at 37, fluidizing the bed in the retort and oxidizing the residual carbon on or in the oil shale material.

In the preferred form of the scheme shown in Figure 3, a fourth retort R4 is provided used in a cool down or third phase. A proportion of the effluent vapours passing from the process as off-gas at 38 is directed via line 39 into the retort R4 and used to cool the material within the retort. The gas so heated in the retort R4 is passed via line 40 into retort R3.

The effluent vapour product given off by the processing retort R2 goes through a receiver 41 which cools the gases by direct heat exchange method as previously described with the withdrawal of cooled off-gas through line 38 and the separation of oil and water from the system via pumps 42 and 43. Excess heat is subtracted in the heat exchanger 44 or by an indirect heat exchanger located before receiver 41.

The scheme shown in Figure 3 is particularly suitable for use in extracting oil vapours from coal and may be used with either a fluidized bed process as shown in Figure 3 or in a fixed bed scheme where higher efficiency is required or coal characteristics permit. Coal may be burnt to provide the heat source necessary in the combustor 31.

In a further fluidized bed scheme as shown in Figure 4, four retorts R1, R2, R3 and R4 are provided used in two discrete interconnected cycles as shown. Each retort passes in sequence through the positions R1 to R3 to R4 to R2. The raw feed shale is passed into retort R1 where it is preheated by gas through line 45 from retort R2 in which gas is being heated by the cooling of shale after the oxidising of residual carbon in retort R4. A receiver 46, water pump 47, heat exchanger 48, and blower fan 49 are provided as previously described. An indirect heat exchanger could be used to cool the effluent from R1 as an alternative to heat exchanger 48.

Once the feed material has been preheated in retort R1 the system is cycled so that retort R1 becomes retort R3 wherein the feed material is retorted by hot gas passed through line 50 from the oxidization of residual carbon on or in the material in retort R4. This material is oxidized by air blown into retort R4 at 51 which is heated by the oxidation of the residual carbon and passes as hot gas through line 50 to retort R3. A portion of the effluent vapour as off-gas at 52 is directed via line 53 into the retort R4.

In a further embodiment of the invention as shown in Figure 5, a fluidized bed processing scheme may be simply adapted using three retorts in three separate phases. The basic retorting is performed in retort R1 under the influence of hot gas fed through line 54 from retort R2 wherein the gas is heated by the oxidisation of residual carbon on the material which has been previously retorted in retort R1. The phase II retort R2 is then cycled to a phase III shown by retort R3 for the cooling of the solid hydrocarbonaceous material which is achieved by a proportion of the effluent vapour through line 55.

The effluent vapours given off through line 56 are treated in a receiver 57 in a similar manner to that shown for the previous configuration.

In this manner a method of processing oil shale or other solid hydrocarbonaceous material is provided which enables a simple set of apparatus to be manufactured which may then be used in a flexible manner to suit the requirements of the oil shale in any one particular location. These requirements may be met by arranging the apparatus in different configurations, examples of which are described above, and by providing different times for the phases of each cycle. Provided that a minimum of three retorts is used one or more retorts may be added or omitted from each scheme as desired to raise or lower the efficiency as required.. Similarly the process scheme or plant may be adapted for two or more sets of retorts which may be operated in parallel or further retorts may be added to reduce cycle time or improve the efficiency of the process.

Claims

1. A method of processing solid hydrocarbonaceous material through three or more phases using three or more retorts interconnected by conduits incorporating control valves arranged such that opening and closing selected valves changes the interconnections betweeen the various retorts, and wherein the valves are opened and closed in a predetermined sequence causing each retort to be used in turn for some or all of the desired phases and then reused as the sequence is repeated such that the phases are cyclically performed by all or selected ones of the retorts in turn, and wherein the three phases include:

a first phase comprising the treatment of fresh solid hydrocarbonaceous material with a hot gas causing effluent vapours to be given off,

a second phase comprising the passing of combustion supporting gas through at least partially spent solid hydrocarbonaceous material which has already been processed in the first phase, oxidising residual carbon on or in the material and giving off gas heated thereby which is then passed to the retort in the first phase as the said hot gas, and

a third phase comprising the cooling and unloading of spent material and the recharging of the retort with fresh material while the other two retorts are in use in the first and second phases.

2. A method of processing solid hydrocarbonaceous material as claimed in claim 1, wherein three said retorts are cycled through the three said phases.

3. A method of processing solid hydrocarbonaceous material as claimed in claim 1, wherein four said retorts are cycled through four phases;

the first phase comprising the treatment of fresh solid hydrocarbonaceous material with a hot gas causing effluent vapours to be given off;

the second phase comprising the passing of combustion supporting gas through at least partially spent solid hydrocarbonaceous material which has already been processed in the first phase, oxidising residual carbon on or in the material and giving off gas heated thereby which is then passed to the retort in the first phase as the said hot gas,

the third phase comprising the cooling of spent material or the further processing of that material,

and the fourth phase comprising the unloading of spent material and the recharging of the retort with fresh material.

4. A method of processing solid hydrocarbonaceous material as claimed in claim 3, wherein the cooling of the material in the third phase is achieved by passing a proportion of the effluent vapours given off in the first phase through the retort in the third phase and thence into the retort in the second phase.

5. A method of processing solid hydrocarbonaceous material as claimed in either claim 3 or claim 4, wherein the fourth phase incorporates the pre-heating of the fresh material after loading into the retort by the passing of hot gases through the retort.

6. A method of processing solid hydrocarbonaceous material as claimed in claim 3, wherein the fresh feed material in the fourth phase is preheated by passing a cooling gas through the retort in the third phase, cooling the material therein and thereby heating the gas which is passed to the retort in the fourth phase.

7. A method of processing solid hydrocarbonaceous material as claimed in claim 6, wherein effluent vapours are given off by the pre-heating of the material in the fourth phase, a proportion of the effluent vapours being recycled through the third phase retort as the said cooling gas.

8. A method of processing solid hydrocarbonaceous material as claimed in any one of the preceding claims, incorporating an additional retort and wherein an additional intermediate phase is incorporated into the cycle between the first and second phases wherein the hot gas given off in the second phase is passed to both the first and intermediate phase retorts for treatment of the solid hydrocarbonaceous material therein causing effluent vapours to be given off from the retorts in both the first and intermediate phases and allowing treatment conditions of the material in the first and intermediate phases to be varied as between those phases to suit the nature of the raw material.

Patentansprüche

1. Ein Verfahren zur Verarbeitung von festem kohlenwasserstoffhaltigem Material durch drei oder mehr Phasen unter Verwendung von drei oder mehr Retorten, die untereinander durch Rohrleitungen mit Regelventilen verbunden sind, wobei die besagten Regelventile so angeordnet sind, daß das Öffnen und Schließen ausgewählter Ventile die Verbindungen zwischen den verschiedenen Retorten ändert, und wobei die Ventile in einer vorbestimmten Folge geöffnet und geschlossen werden, die bewirkt, daß jede Retorte der Reihe nach für einige oder alle der gewünschten Phasen verwendet und dann bei Wiederholung der Folge wieder verwendet wird, so daß die Phasen von allen oder ausgewählten Retorten der Reihe nach zyklisch ausgeführt werden, und wobei die drei Phasen in

einer ersten Phase bestehen, die die Behandlung von frischem, festem kohlenwasserstoffhaltigem Material mit einem heißen Gas umfaßt, was Abgabe von Abdämpfen bewirkt,

in einer zweiten phase, die das Hindurchleiten von Verbrennung erhaltendem Gas durch mindestens teilweise erschöpftes, festes kohlenwasserstoffhaltiges Material umfaßt, das bereits in der ersten phase verarbeitet wurde, wobei der Restkohlenstoff an oder in dem Material oxidiert und dadurch erhitztes Gas abgegeben wird, das dann der Retorte in der ersten phase als das besagte heiße Gas zuströmt, und

in einer dritten Phase, die das Kühlen und Entladen von erschöpftem Material und das Wiederbeladen der Retorte mit frischem Material umfaßt, während die beiden anderen Retorten in der ersten und in der zweiten Phase im Betrieb stehen.

2. Ein Verfahren zur Verarbeitung von festem kohlenwasserstoffhaltigem Material nach Anspruch 1, bei dem drei besagte Retorten zyklisch durch die drei besagten Phasen hindurch betrieben werden.

3. Ein Verfahren zur Verarbeitung von festem kohlenwasserstoffhaltigem Material nach Anspruch 1, bei dem vier besagte Retorten zyklisch durch vier Phasen hindurch betrieben werden;

wobei die erste Phase die Behandlung von frischem, feste kohlenwasserstoffhaltigem Material mit einem heißen Gas umfaßt, was Abgabe von Abdämpfen bewirkt,

die zweite Phase das Hindurchleiten von Verbrennung erhaltendem Gas durch mindestens teilweise erschöpftes, festes kohlenwasserstoffhaltiges Material hindurch umfaßt, das bereits in der ersten Phase verarbeitet wurde, wobei Restkohlenstoff an oder in dem Material oxidiert und dadurch erhitztes Gas abgegeben wird, das dann als das besagte heiße Gas der Retorte in der ersten phase zuströmt,

die dritte phase das Kühlen von erschöpftem Material oder die weitere Verarbeitung des besagten Materials umfaßt,

und die vierte phase das Entladen von erschöpftem Material und das Wiederbeladen der Retorte mit frischem Material umfaßt.

4. Ein Verfahren zur Verarbeitung von festem kohlenwasserstoffhaltigem Material nach Anspruch 3, bei dem das Kühlen des Materials in der dritten Phase durch Hindurchleiten eines Teiles der in der ersten Phase abgegebenen Abdämpfe durch die Retorte in der dritten Phase

und somit in die Retorte in der zweiten Phase bewirkt wird.

5. Ein Verfahren zur Verarbeitung von festem kohlenwasserstoffhaltigem Material nach Anspruch 3 oder Anspruch 4, bei dem die vierte Phase das Vorwärmen des frischen Materials nach Einführung in die Retorte durch das Hindurchleiten von heißen Gasen durch die Retorte umfaßt.

6. Ein Verfahren zur Verarbeitung von festem kohlenwasserstoffhaltigem Material nach Anspruch 3, bei dem das frische Aufgabematerial in der vierten phase vorgewärmt wird, indem man ein Kühlgas durch die Retorte in der dritten Phase hindurchleitet, das darin befindliche Material kühlt und dadurch das Gas erhitzt, das der Retorte in der vierten Phase zugeführt wird.

7. Ein Verfahren zur Verarbeitung von festem kohlenwasserstoffhaltigem Material nach Anspruch 6, bei dem Abdämpfe durch das Vorwärmen des Materials in der vierten phase abgegeben werden, wobei ein Teil der Abdämpfe durch die Retorte in der dritten Phase als das besagte Kühlgas umgeleitet wird.

8. Ein Verfahren zur Verarbeitung von festem kohlenwasserstoffhaltigem Material nach einem der vorstehenden Ansprüche, das eine zusätzliche Retorte umfaßt und bei dem eine zusätzliche Zwischenphase in den Zyklus zwischen der ersten und der zweiten phase eingeschaltet wird, wobei das in der zweiten Phase abgegebene heiße Gas den Retorten sowohl der ersten als auch der Zwischenphase zur Behandlung des festen kohlenstoffhaltigen Materials darin zugeleitet wird so daß die Abgabe von Abdämpfen aus den Retorten der ersten und der Zwischenphase bewirkt und die Möglichkeit geschaffen wird, die Behandlungsbedingungen des Materials in der ersten und in der Zwischenstufe zwischen den besagten Phasen der Beschaffenheit des Rohmaterials entsprechend zu variieren.

Revendications

1. Procédé de traitement de matériaux hydrocarbures solides en trois phases ou plus utilisant trois cornues ou plus interconnectées par des conduits comportant des soupapes de commande disposées de telle manière que l'ouverture ou la fermeture de certaines soupapes sélectionnées modifie les raccordements entre les diverses cornues, et où les soupapes sont ouvertes et fermées selon un séquence prédéterminée provoquant l'utilisation de chaque cornue tour à tour pour une partie ou la totalité des phases souhaitées et en provoquant sa réutilisation lors de la répétition de la même séquence de telle sorte à ce qu'il y ait application cyclique des phases par toutes les cornues ou par certaines sélectionnées tour à tour et où les trois phases englobent:

une première phase représentant le traitement des matériaux hydrocarburés solides frais au moyen d'un gaz chaud provoquant l'émission de vapeurs résiduaires,

une deuxième phase représentant le passage de gaz de combustion à travers des matériaux hydrocarburés solides tout au moins partiellement épuisés et déjà traités en première phase, provoquant l'oxydation du carbone résiduel dans le matériau ou sur celui-ci ainsi que l'émission de gaz chauffé par ce procédé et qui est ensuite utilisé en première phase comme ledit gaz chaud passant à travers la cornue, et

une troisième phase représentant le refroidissement et la décharge du matériau épuisé ainsi que le rechargement de la cornue avec des matériaux frais tandis que les deux autres cornues sont utilisées pour les première et deuxième phases.

2. Procédé de traitement des matériaux hydrocarburés solides selon la revendication 1, où lesdites trois cornues passent selon un cycle par lesdites trois phases.

3. Procédé de traitement des matériaux hydrocarburés solides selon la revendication 1, où lesdites quatre cornues passent selon un cycle par lesdites quatre phases;

la première phase englobant le traitement des matériaux hydrocarburés solides frais au moyen d'un gaz chaud provoquant l'émission de vapeurs résiduaires,

la deuxième phase englobant le passage de gaz de combustion à travers des matériaux hydrocarburés solides tout au moins partiellement épuisés qui ont déjà été traités en première phase, provoquant l'oxydation du carbone résiduel dans le matériau ou sur celui-ci ainsi que l'émission de gaz chauffé par le procédé qui est ensuite utilisé en première phase comme ledit gaz chaud passant à travers la cornue,

la troisième phase englobant le refroidissement des matériaux épuisés ou le traitement supplémentaire desdits matériaux,

et la quatrième phase englobant la décharge des matériaux épuisés et le rechargement de la cornue avec des matériaux frais.

4. Procédé de traitement de matériaux hydrocarburés solides selon la revendication 3, où le refroidissement du matériau en troisième phase est obtenu par le passage d'une proportion des vapeurs résiduaires émises en première phase à travers la cornue en troisième phase puis ensuite à travers la cornue en second phase.

5. Procédé de traitement de matériaux hydrocarburés solides selon la revendication 3 ou la revendication 4, où la quatrième phase comporte le préchauffage des matériaux frais après leur chargement dans la cornue et au moyen du passage de gaz chaud à travers cette cornue.

6. Procédé de traitement de matériaux hydrocarburés solides selon la revendication 3, où le matériau de charge frais en quatrième phase est préchauffé par le passage des gaz de refroidissement à travers la cornue en troisième phase, provoquant ainsi le refroidissement des matériaux dans celle-ci et le chauffage du gaz traversant la cornue en quatrième phase.

7. Procédé de traitement de matériaux hydrocarburés solides selon la revendication 6, où le préchauffage des matériaux en quatrième phase provoque l'émission de vapeurs résiduaires, dont

une proportion est recyclée à travers la cornue de troisième phase comme ledit gaz de refroidissement.

8. Procédé de traitement de matériaux hydrocarburés solides selon l'une quelconque des revendications précédentes, comportant une cornue supplémentaire et où une phase intermédiaire supplémentaire est ajoutée au cycle entre les première et deuxième phases où les gaz chauds émis en seconde phase traversent tant la première phase que la phase intermédiaire pour le traitement des matériaux hydrocarburés solides, provoquant ainsi l'émission de vapeurs résiduaires dans les cornues tant dans la première phase que dans la phase intermédiaire, et permettant une variation du traitement des matériaux entre la première phase et la phase intermédiaire pour correspondre à la nature du matériau brut.

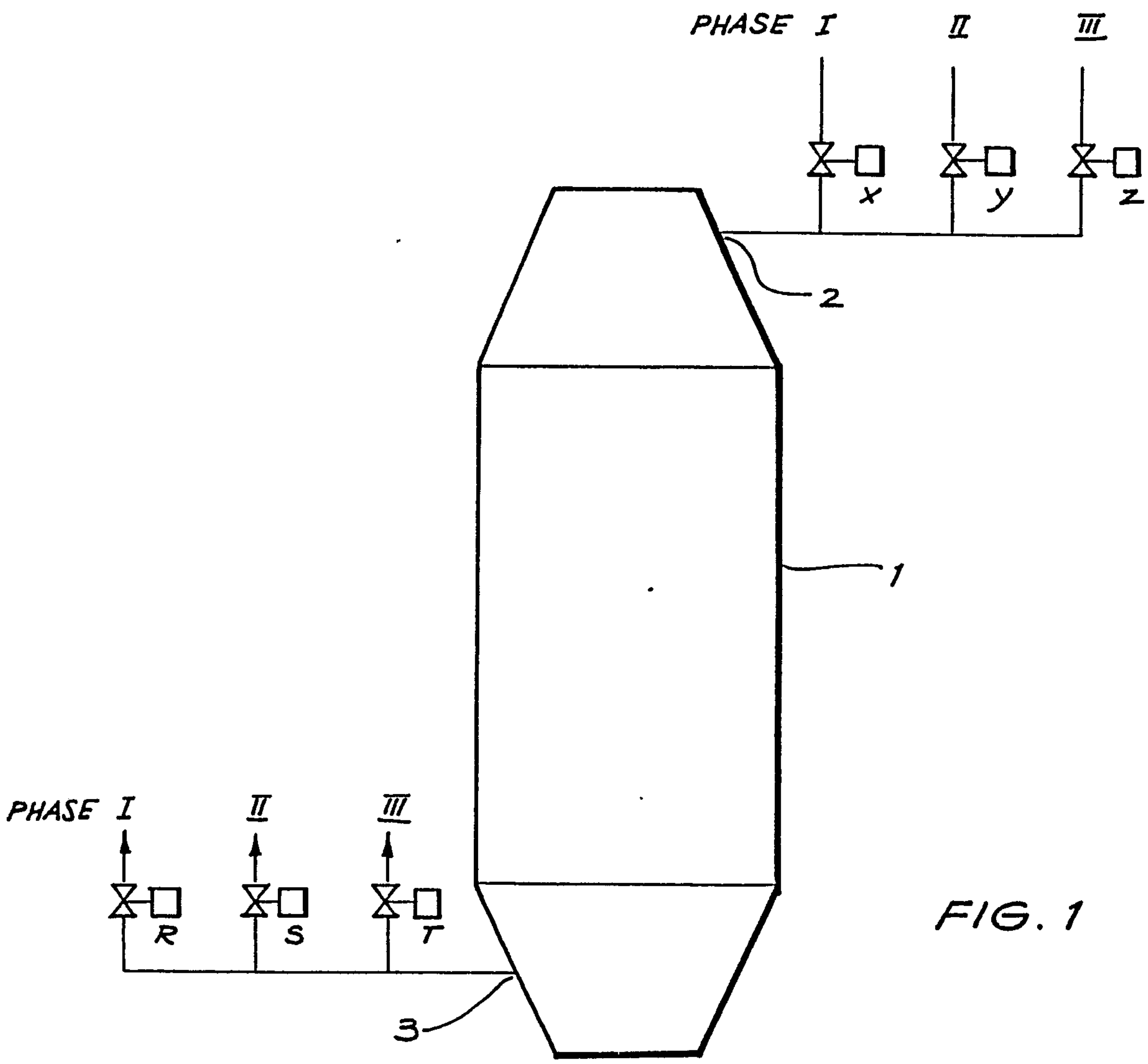

FIG. 1

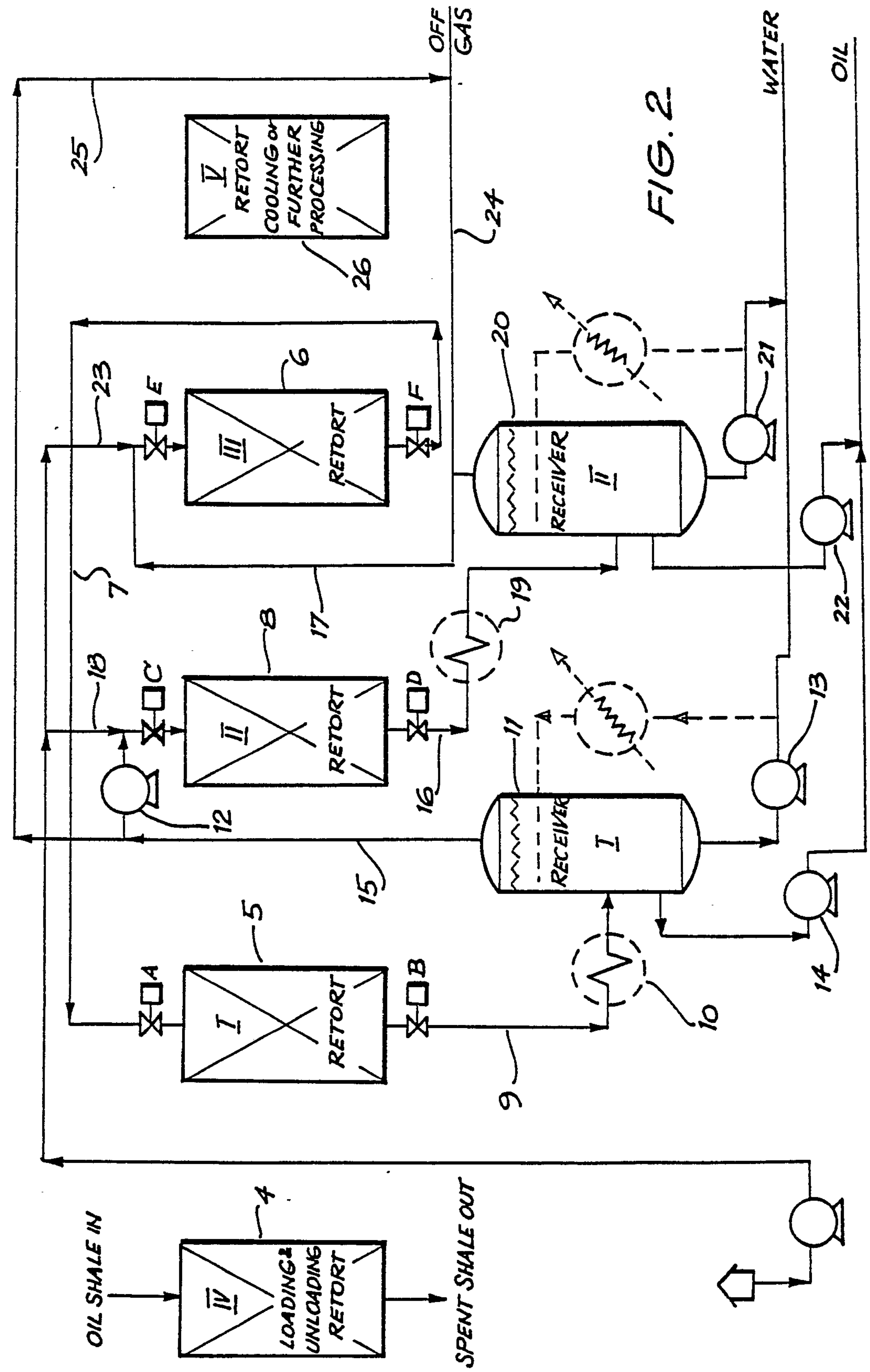
OFF GAS
WATER
OIL
25
24
V RETORT COOLING or FURTHER PROCESSING
26
23
E
F
6
III RETORT
20
21
RECEIVER II
7
17
8
18
C
D
II RETORT
19
22
12
16
11
13
RECEIVER I
15
5
A
B
I RETORT
10
14
9
4
OIL SHALE IN
IV LOADING & UNLOADING RETORT
SPENT SHALE OUT

FIG. 2

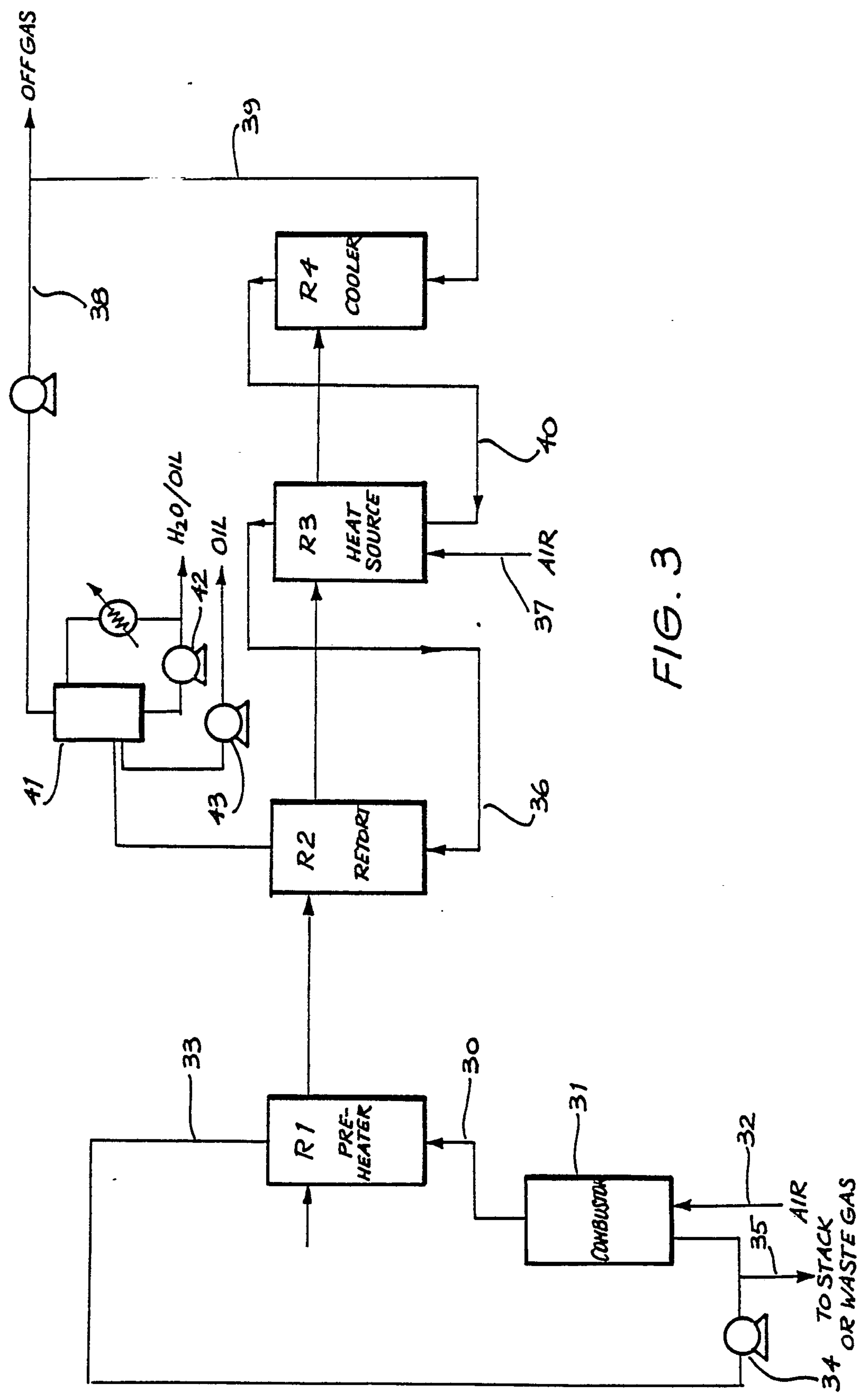
OFF GAS
39
38
R4
COOLER
40
R3
HEAT SOURCE
AIR
37
H_2O/OIL
OIL
42
41
43
R2
RETORT
36
33
30
31
R1
PRE-HEATER
COMBUSTOR
32
AIR
35
TO STACK OR WASTE GAS
34

FIG. 3

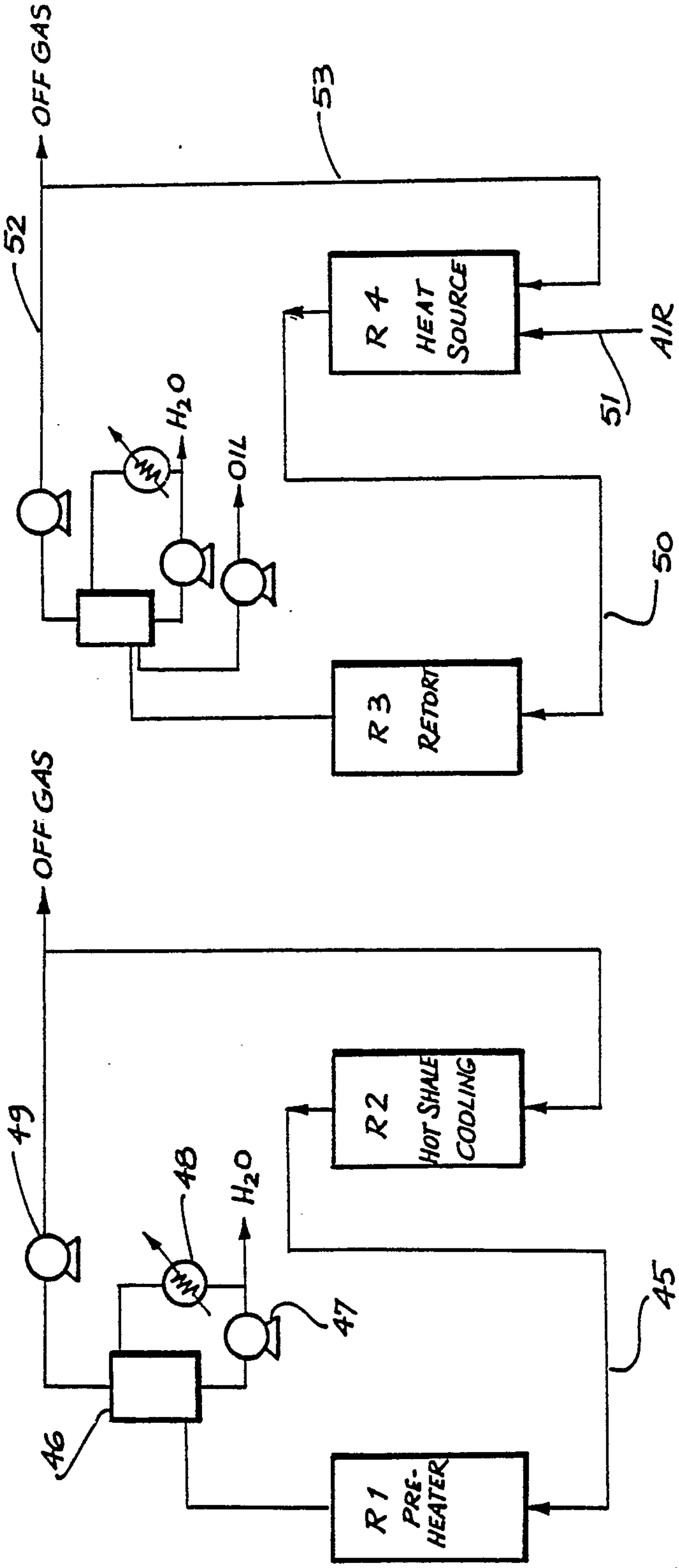
OFF GAS
53
52
R 4
HEAT
SOURCE
AIR
51
H2O
OIL
50
R 3
RETORT
OFF GAS
49
48
H2O
R 2
HOT SHALE
COOLING
47
45
46
R 1
PRE-
HEATER

FIG. 4

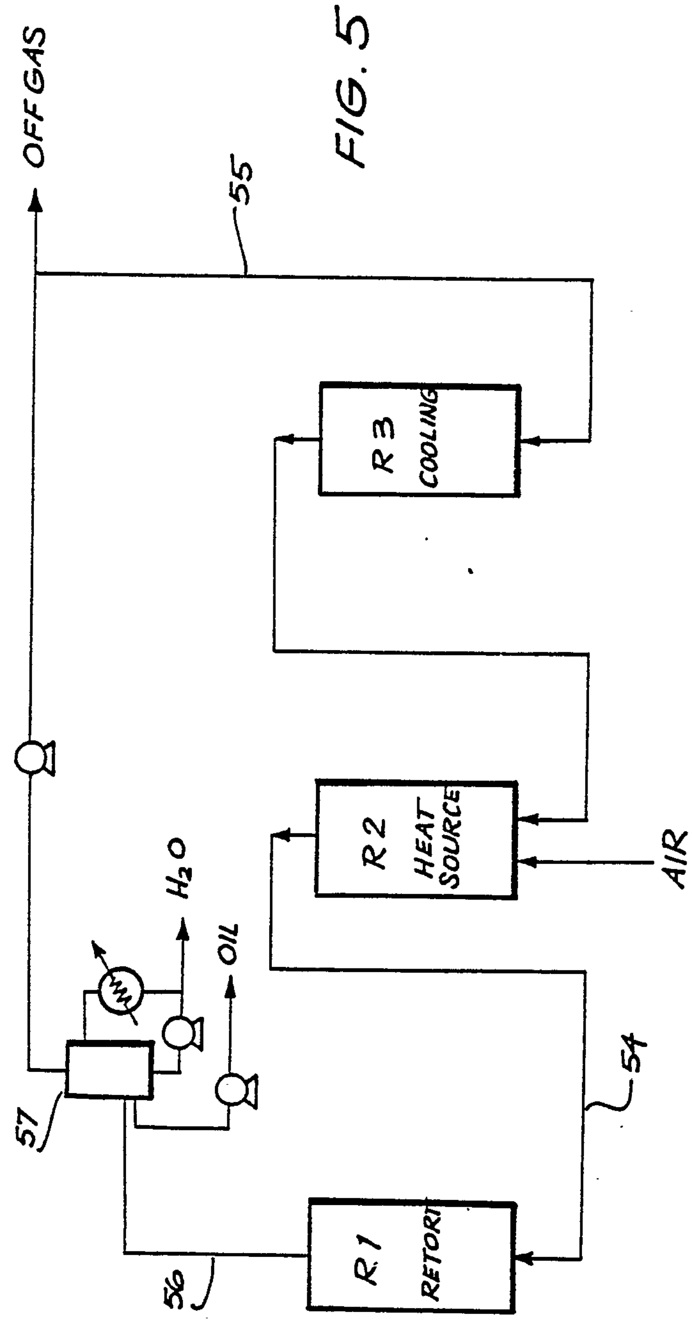
OFF GAS
55
R3
COOLING
R2
HEAT SOURCE
AIR
R1
RETORT
54
56
57
H_2O
OIL

FIG. 5