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APPARATUS AND PROCESS FOR DISTILLING OR CRACKING HYDROCARBONS OR THE LIKE

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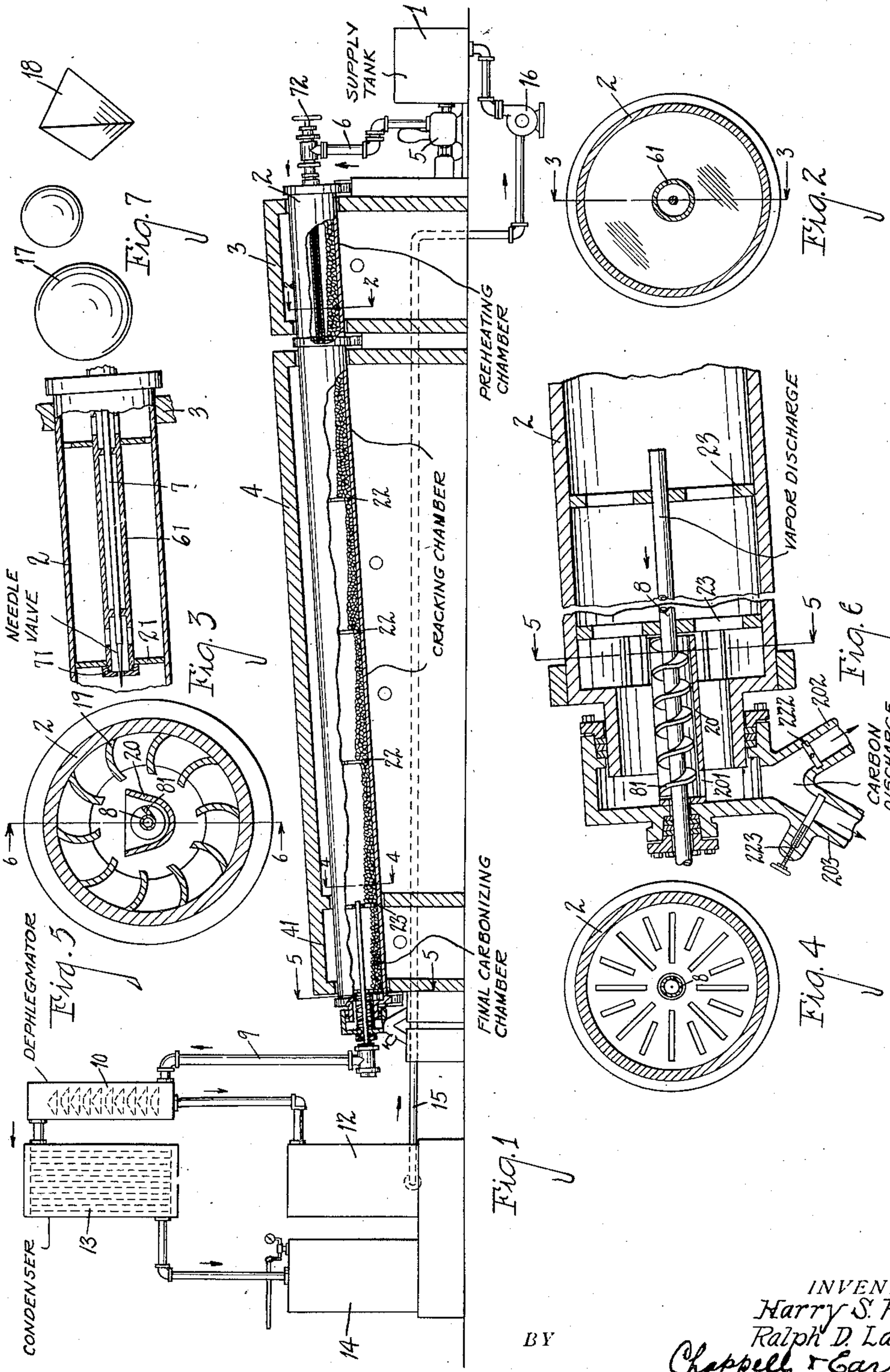

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

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APPARATUS AND PROCESS FOR DISTILLING OR CRACKING HYDROCARBONS OR THE LIKE

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This invention relates to improved apparatus and process for distilling and cracking liquids such as hydro-carbons.

The objects of the invention are:

First, to provide an improved means for thoroughly heating and at the same time avoiding accumulation of solid matter, such as carbon, as residue in the apparatus and insuring the separation and discharge thereof.

Second, to provide an improved method and process whereby the volatile and solid elements are effectively separated in a continuous process.

Objects pertaining to details of the apparatus and the process will definitely appear from the detailed description to follow.

We accomplish the objects of our invention by the apparatus illustrated in the accompanying drawing, in which:

Fig. 1 is a diagrammatic partially longitudinal sectional elevation of our apparatus, the furnaces being shown conventionally and in section and part of the retort in full lines.

Figure 2 is an enlarged detail transverse sectional view through the preliminary heating part of the retort on line 2—2 of Fig. 1 showing the continuous partition.

Fig. 3 is a vertical enlarged detail sectional view on line 3—3 of Fig. 2 showing details of the needle expansion valve between the auxiliary heating chamber and the main distilling and cracking chamber.

Fig. 4 is an enlarged transverse detail sectional view on line 4—4 of Fig. 1 showing the form of the end screen partition.

Fig. 5 is an enlarged detail transverse sectional view on line 5—5 of Fig. 1 through the discharge means for the accumulated carbon.

Fig. 6 is an enlarged detail vertical sectional view on line 6—6 of Fig. 5 showing details of such discharge apparatus and the support and connections at the discharge end of the retort.

Fig. 7 is a detail view of the impact and abrading and heat conducting bodies used in the different segments of the heating retort, comprising a quantity of balls and angular bodies, preferably tetrahedral in form, for action, insuring the cleaning, separation and delivery of the carbon or other solid material which may be deposited, and at the same time act as heating bodies to effectively distribute the heat for distillation.

The parts of the apparatus will be identified by numerals of reference which are the same in all the views.

1 is the storage tank for the liquid or hydro-carbon that is to be distilled and cracked. 2 is the revolving cylindrical externally-heated retort. 3 is the preliminary furnace and 4 is the main furnace with a finishing section 41 for heating the retort. 5 is the compression pump delivering from the storage through connection 6 into the first compartment of the retort. 7 is the needle valve acting on the valve seat in the cap 71, controlling the flow of liquid from the preheating to the expanding chambers of the retort. 8 is the central vapor discharge pipe from the retort. 9 is the discharge connection to the dephlegmator 10. 11 is the pipe connecting the dephlegmator 10 to the receiving tank 12 for heavy ends. 13 is the condenser for the volatile distillate and 14 is the storage tank therefor. 15 is the return pipe from the tank 12 for the heavy ends.

16 is a centrifugal pump for drawing and returning heavy ends to the storage tank 1 where they are admixed with the supply and recirculated. The retort 2 is divided by continuous partition 21 into a closed compartment which is heated by the auxiliary furnace 3 which is run at a considerably lower temperature than the main distilling furnace. This is supplied through supply pipe 61 to which the delivery pipe 6 from the compression pump 5 is connected by suitable means.

A needle valve 7 seated in a valve seat in cap 71 on the supply pipe 61 and controlled by hand-wheel 72 regulates the discharge of liquid from the first retort compartment. Screen partitions 22 made up of suitable disks with slotted perforations divide the main part of the retort into a series of compartments and a similar partition 23, supporting centrally the discharge pipe 8, is at the end and forms a final compartment in the furnace section 41 which is maintained at a much higher temperature than the main body of the furnace to finish driving the volatile material out of the carbon preliminary to discharging the carbon through the discharge means.

Within each of the compartments of the revolving retort are impact bodies made up of a series of balls 17 and irregular angular bodies 18, (see Fig. 7) the irregular angular bodies being preferably tetrahedral in form which presents a maximum of scraping blade to the weight of the bodies. These bodies are preferably made of white iron, which is heat resistant and very durable in action. The cylindrical bodies cause the entire mass to flow and the angular bodies, preferably tetrahedral, although other forms can be made use of, scrape the sides of the retort clean.

The balls cause the mass to flow freely so that

the impact bodies respond in the rolling action to cause a ready and steady flowage of the said impact bodies. These bodies, being made of white iron, become thoroughly heated and serve to distribute the heat through the liquid and vapor and insure the full benefit of the heating action. Any carbon separated is deposited among these tumbling bodies and eventually is passed on through the screens to the discharge end.

The discharge end is provided with a series of flights 19. These are adapted to carry the carbon up and deposit it into an open trough 20. Secured to the discharge pipe 8 is a spiral 81 for advancing the carbon to the discharge opening 201 where the same drops down to the discharge chutes 202, 203 controlled by suitable valves 222, 223. Pipe 8 revolves because it is secured to the partitions 22 and, of course, carries with it the spiral 81.

It will thus be seen that with a supply of liquid to be treated, the same is forced by the compression pump 5 through connection 6 and pipe 61 into the first retort compartment. It is there heated in a preliminary way to thoroughly heat the liquid which is kept agitated and the heat distributed therethrough by the tumbling bodies therein which stir up and maintain within the liquid any carbon that may be deposited.

As soon as this is heated sufficiently, it passes out through the expansion valve 7 into the main distilling chambers of the retort where a much higher temperature is maintained and a lower pressure. This cracks the oil or readily distills whatever is being distilled and any solid deposit is, of course, collected by the tumbling bodies and gathered into their mass because of their constant scraping action on the revolving side of the retort.

As the angular bodies keep the balls scraped, the material is in a floating condition in the mass of tumbling bodies and is advanced gradually from one compartment to another until it passes to the final compartment of the retort, where the final furnace 41 raises the temperature to a very high point, driving off all of the volatiles and permitting the carbon to pass on to the discharge end where it is picked up by flights and dropped into the discharge trough where the screw carries the same to the discharge chute out of the system.

The distilled products pass at once through the pipe 8 and connection 9 to the dephlegmator 10, thence to the condenser 13 and to the receiver 14 where the same are stored. The heavy ends drop out at the bottom of the dephlegmator through pipe 11 to the tank 12 from which they are pumped back through the pipe 15 by the pump 16 and return to the storage tank 1 for recirculation.

In the distilling of ordinary high boiling point oil, the temperature maintained in the first compartment is about 450° Fahr., the temperature in the main compartment is about 900° Fahr., there being at the same time a great reduction in pressure in the main compartment. The final compartment of the retort is heated to about 1150° Fahr. by the final furnace section, which rapidly drives off and discharges into the main body of the retort the remaining volatiles.

The pressure in the first compartment is that due to the confining of the oil under the pressure indicated at 450° Fahr. The reducing valve is then opened and discharges into the remainder of the retort which is connected through the pipe 8 to the discharge 9 and only needs to be sufficient to properly deliver the volatiles distilled. Thus only a moderate pressure is required.

The carbon or other solid is then picked up by the rotating flights as indicated, the cracked oil is passed through the dephlegmator and the heavy ends returned for recirculation.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. In an apparatus for distilling or cracking hydrocarbons, the combination of an externally heated tumbling barrel ball mill retort, a partition dividing the same into an auxiliary low temperature compression chamber and a main low pressure high temperature distilling and cracking chamber, transverse screen partitions dividing the distilling chamber into compartments, a supply reservoir, a compression pump adapted to deliver from the supply reservoir into the auxiliary compression chamber, an expansion valve between the compression chamber and the distilling chamber to permit the expansion from the compression chamber to a lower pressure in the distilling chamber, a centrally axially disposed discharge pipe from the said distilling chamber to discharge the gaseous and vapor material therefrom, a dephlegmator connected to the exit of said discharge pipe, a condenser connected to the vapor outlet of the dephlegmator, a receiver connected to the liquid outlet of the dephlegmator, connections from the said receiver with a pump for returning the said heavy ends to the supply reservoir for recirculation, an axially disposed spiral trough discharge conveyor at the discharge end of said distilling chamber, flights in the end of said retort for elevating and delivering solid residue material to the trough of said conveyor, and heat controlling impacting bodies in the said retort comprising balls and angular bodies reacting therewith for removing solid accumulations from the inside of the retort and from the said impact bodies and advancing the said solid residue matter to the discharge conveyor.

2. In an apparatus for distilling or cracking hydrocarbons, the combination of an externally heated tumbling barrel ball mill retort, a partition dividing the same into an auxiliary low temperature compression chamber and a main low pressure high temperature distilling and cracking chamber, transverse screen partitions dividing the distilling chamber into compartments, a supply reservoir, a compression pump adapted to deliver from the supply reservoir into the auxiliary compression chamber, an expansion valve between the compression chamber and the distilling chamber to permit the expansion from the compression chamber to a lower pressure in the distilling chamber, a centrally axially disposed discharge pipe from the said distilling chamber to discharge the gaseous and vapor material therefrom, means connected to the discharge pipe to separate and receive the heavy ends, connections from the said means with a pump for returning the said heavy ends to the supply reservoir for recirculation, an axially disposed spiral trough discharge conveyor at the discharge end of said distilling chamber, flights in the end of said retort for elevating and delivering solid residue material to the trough of said conveyor, and heat controlling impacting bodies in the said retort comprising balls and angular bodies reacting therewith for removing solid accumulations from the inside of the retort and from the

said impact bodies and advancing the said solid residue matter to the discharge conveyor.

3. In an apparatus for distilling or cracking hydrocarbons, the combination of an externally heated tumbling barrel ball mill retort, a partition dividing the same into an auxiliary low temperature compression chamber and a main low pressure high temperature distilling and cracking chamber, transverse screen partitions dividing the distilling chamber into compartments, a supply reservoir, a compression pump adapted to deliver from the supply reservoir into the auxiliary compression chamber, an expansion valve between the compression chamber and the distilling chamber to permit the expansion from the compression chamber to a lower pressure in the distilling chamber, a centrally axially disposed discharge pipe from the said distilling chamber to discharge the gaseous and vapor material therefrom, means connected to the discharge pipe to separate and receive the heavy ends, an axially disposed spiral trough discharge conveyor at the discharge end of said distilling chamber, flights in the end of said retort for elevating and delivering solid residue material to the trough of said conveyor, and heat controlling impacting bodies in the said retort comprising balls and angular bodies reacting therewith for removing solid accumulations from the inside of the retort and from the said impact bodies and advancing the said solid residue matter to the discharge conveyor.

4. In an apparatus for distilling or cracking hydrocarbons, the combination of an externally heated tumbling barrel ball mill retort, a partition dividing the same into an auxiliary low temperature compression chamber and a main low pressure high temperature distilling and cracking chamber, transverse screen partitions dividing the distilling chamber into compartments, a supply reservoir, a compression pump adapted to deliver from the supply reservoir into the auxiliary compression chamber, an expansion valve between the compression chamber and the distilling chamber to permit the expansion from the compression chamber to a lower pressure in the distilling chamber, a centrally axially disposed discharge pipe from the said distilling chamber to discharge the gaseous and vapor material therefrom, a dephlegmator connected to the exit of said discharge pipe, a condenser connected to the vapor outlet of the dephlegmator, a receiver connected to the liquid outlet of the dephlegmator, connections from the said receiver with a pump for returning the said heavy ends to the supply reservoir for recirculation, means to discharge the solid residue material, and heat controlling impacting bodies in the said retort comprising balls and angular bodies reacting therewith for removing solid accumulations from the inside of the retort and from the said impact bodies and advancing the said solid residue matter to the discharge conveyor.

5. In an apparatus for distilling or cracking hydrocarbons, the combination of an externally heated tumbling barrel ball mill retort, a partition dividing the same into an auxiliary low temperature compression chamber and a main low pressure high temperature distilling and cracking chamber, transverse screen partitions dividing the distilling chamber into compartments, a supply reservoir, a compression pump adapted to deliver from the supply reservoir into the auxiliary compression chamber, an expansion valve between the compression chamber and the distilling chamber to permit the expansion from the compression chamber to a lower pressure in the distilling chamber, a centrally axially disposed discharge pipe from the said distilling chamber to discharge the gaseous and vapor material therefrom, means connected to the discharge pipe to separate and receive the heavy ends, means to discharge the solid residue material, and heat controlling impacting bodies in the said retort comprising balls and angular bodies reacting therewith for removing solid accumulations from the inside of the retort and from the said impact bodies and advancing the said solid residue matter to the discharge conveyor.

6. In an apparatus for distilling or cracking hydrocarbons, the combination of an externally heated tumbling barrel ball mill retort, a partition dividing the same into an auxiliary low temperature compression chamber and a main low pressure high temperature distilling and cracking chamber, transverse screen partitions dividing the distilling chamber into compartments, a supply reservoir, a compression pump adapted to deliver from the supply reservoir into the auxiliary compression chamber, an expansion valve between the compression chamber and the distilling chamber to permit the expansion from the compression chamber to a lower pressure in the distilling chamber, a centrally axially disposed discharge pipe from the said distilling chamber to discharge the gaseous and vapor material therefrom, a dephlegmator connected to the exit of said discharge pipe, a condenser connected to the vapor outlet of the dephlegmator, a receiver connected to the liquid outlet of the dephlegmator, connections from the said receiver with a pump for returning the said heavy ends to the supply reservoir for recirculation, an axially disposed spiral trough discharge conveyor at the discharge end of said distilling chamber, flights in the end of said retort for elevating and delivering solid residue material to the trough of said conveyor, and heat controlling impacting bodies in the said retort.

7. In an apparatus for distilling or cracking hydrocarbons, the combination of an externally heated tumbling barrel ball mill retort, a partition dividing the same into an auxiliary low temperature compression chamber and a main low pressure high temperature distilling and cracking chamber, transverse screen partitions dividing the distilling chamber into compartments, a supply reservoir, a compression pump adapted to deliver from the supply reservoir into the auxiliary compression chamber, an expansion valve between the compression chamber and the distilling chamber to permit the expansion from the compression chamber to a lower pressure in the distilling chamber, a centrally axially disposed discharge pipe from the said distilling chamber to discharge the gaseous and vapor material therefrom, means connected to the discharge pipe to separate and receive the heavy ends, an axially disposed spiral trough discharge conveyor at the discharge end of said distilling chamber, flights in the end of said retort for elevating and delivering solid residue material to the trough of said conveyor, and heat controlling impacting bodies in the said retort.

8. In an apparatus for distilling or cracking hydrocarbons, the combination of an externally heated tumbling barrel ball mill retort, a partition dividing the same into an auxiliary low temperature compression chamber and a main low pressure high temperature distilling and crack-

ing chamber, transverse screen partitions dividing the distilling chamber into compartments, a supply reservoir, a compression pump adapted to deliver from the supply reservoir into the auxiliary compression chamber, an expansion valve between the compression chamber and the distilling chamber to permit the expansion from the compression chamber to a lower pressure in the distilling chamber, a centrally axially disposed discharge pipe from the said distilling chamber to discharge the gaseous and vapor material therefrom, means connected to the discharge pipe to separate and receive the heavy ends, means to discharge the solid residue material, and heat controlling impacting bodies in the said retort.

9. The continuous process of cracking liquid hydrocarbon material in an externally heated tumbling barrel ball mill retort having an auxiliary compression chamber and a cracking chamber and containing heat conducting angular grinding elements and ball grinding elements, consisting in subjecting the said hydrocarbon liquid to a preliminary heating in the said compression chamber under pressure and temperature below the cracking temperature of the material being treated, passing the said liquid through a small expansion valved aperture into the succeeding low pressure cracking compartment, heating the same to a higher degree and maintaining a lower pressure than in the said auxiliary chamber and subjecting the entire contents of the retort to the action of the said angular and ball heating and grinding elements to distribute heat and insure the deposition of the separated carbon and solid material and prevent its adhering to the inner surface of said retort, and reducing the said solid material to a powder and separating and discharging the powder from the retort.

10. In an apparatus for distilling or cracking hydrocarbons, the combination of an externally heated tumbling barrel ball mill retort, a partition dividing the same into an auxiliary low temperature compression chamber and a main low pressure high temperature distilling and cracking chamber, transverse screen partitions dividing the distilling chamber into compartments, a supply reservoir, a compression pump adapted to deliver from the supply reservoir into the auxiliary compression chamber, an expansion valve between the compression chamber and the distilling chamber to permit the expansion from the compression chamber to a lower pressure in the distilling chamber, a centrally axially disposed discharge pipe from the said distilling chamber to discharge the gaseous and vapor material therefrom, a dephlegmator connected to the exit of said discharge pipe, a condenser connected to the vapor outlet of the dephlegmator, a receiver connected to the liquid outlet of the dephlegmator, connections from the said receiver with a pump for returning the said heavy ends to the supply reservoir for recirculation, an axially disposed spiral trough discharge conveyor at the discharge end of said distilling chamber, flights in the end of said retort for elevating and delivering solid residue material to the trough of said conveyor, and heat controlling impacting bodies in the said retort comprising balls and angular bodies reacting therewith.

11. In an apparatus for distilling or cracking hydrocarbons, the combination of an externally heated tumbling barrel ball mill retort, a partition dividing the same into an auxiliary low temperature compression chamber and a main low pressure high temperature distilling and cracking chamber, transverse screen partitions dividing the distilling chamber into compartments, a supply reservoir, a compression pump adapted to deliver from the supply reservoir into the auxiliary compression chamber, an expansion valve between the compression chamber and the distilling chamber to permit the expansion from the compression chamber to a lower pressure in the distilling chamber, a centrally axially disposed discharge pipe from the said distilling chamber to discharge the gaseous and vapor material therefrom, means connected to the discharge pipe to separate and receive the heavy ends, connections from the said means with a pump for returning the said heavy ends to the supply reservoir for recirculation, an axially disposed spiral trough discharge conveyor at the discharge end of said distilling chamber, flights in the end of said retort for elevating and delivering solid residue material to the trough of said conveyor, and heat controlling impacting bodies in the said retort comprising balls and angular bodies reacting therewith.

12. In an apparatus for distilling or cracking hydrocarbons, the combination of an externally heated tumbling barrel ball mill retort, a partition dividing the same into an auxiliary low temperature compression chamber and a main low pressure temperature distilling and cracking chamber, transverse screen partitions dividing the distilling chamber into compartments, a supply reservoir, a compression pump adapted to deliver from the supply reservoir into the auxiliary compression chamber, an expansion valve between the compression chamber and the distilling chamber to permit the expansion from the compression chamber to a lower pressure in the distilling chamber, a centrally axially disposed discharge pipe from the said distilling chamber to discharge the gaseous and vapor material therefrom, means connected to the discharge pipe to separate and receive the heavy ends, an axially disposed spiral trough discharge conveyor at the discharge end of said distilling chamber, flights in the end of said retort for elevating and delivering solid residue material to the trough of said conveyor, and heat controlling impacting bodies in the said retort comprising balls and angular bodies reacting therewith.

13. In an apparatus for distilling or cracking hydrocarbons, the combination of an externally heated tumbling barrel ball mill retort, a partition dividing the same into an auxiliary low temperature compression chamber and a main low pressure high temperature distilling and cracking chamber, transverse screen partitions dividing the distilling chamber into compartments, a supply reservoir, a compression pump adapted to deliver from the supply reservoir into the auxiliary compression chamber, an expansion valve between the compression chamber and the distilling chamber to permit the expansion from the compression chamber to a lower pressure in the distilling chamber, a centrally axially disposed discharge pipe from the said distilling chamber to discharge the gaseous and vapor material therefrom, a dephlegmator connected to the exit of said discharge pipe, a condenser connected to the vapor outlet of the dephlegmator, a receiver connected to the liquid outlet of the dephlegmator, connections from the said receiver with a pump for returning the said heavy ends to the supply reservoir for recirculation, means

to discharge the solid residue material, and heat contolling impacting bodies in the said retort comprising balls and angular bodies reacting therewith.

14. In an apparatus for distilling or cracking hydrocarbons, the combination of an externally heated tumbling barrel ball mill retort, a partition dividing the same into an auxiliary low temperature compression chamber and a main low pressure high temperature distilling and cracking chamber, transverse screen partitions dividing the distilling chamber into compartments, a supply reservoir, a compression pump adapted to deliver from the supply reservoir into the auxiliary compression chamber, an expansion valve between the compression chamber and the distilling chamber to permit the expansion from the compression chamber to a lower pressure in the distilling chamber, a centrally axially disposed discharge pipe from the said distilling chamber to discharge the gaseous and vapor material therefrom, means connected to the discharge pipe to separate and receive the heavy ends, means to discharge the solid residue material, and heat controlling impacting bodies in the said retort comprising balls and angular bodies reacting therewith.

15. The continuous process of cracking hydrocarbon materials comprising subjecting said hydrocarbon materials to a preliminary heating under pressure and at a temperature below cracking temperature of the material being treated, passing the material through a small expansion valved aperture into a tumbling barrel ball mill retort and there cracking said material by heating it to a higher degree under a lower pressure than in said preliminary heating, and subjecting the entire contents of said retort to the action of combined angular grinding elements and ball grinding elements, all of which grinding elements are heat conducting to distribute heat and insure deposition of the separated carbon and solid material and prevent its adhering to the inner surface of the retort, and reducing said solid material to a powder and separating and discharging said powdered material from the retort, whereby the process may be carried on continuously without interruption for cleaning the retort.

16. In an apparatus for distilling or cracking hydrocarbons, the combination of an externally heated tumbling barrel ball mill retort, a partition dividing the same into an auxiliary low temperature compression chamber and a main low pressure high temperature distilling and cracking chamber, a supply reservoir, a compression pump adapted to deliver from the supply reservoir into the auxiliary compression chamber, an expansion valve between the compression chamber and the distilling chamber to permit the expansion from the compression chamber to a lower pressure in the distilling chamber, a centrally axially disposed discharge pipe from the said distilling chamber to discharge the gaseous and vapor material therefrom, means connected to the discharge pipe to separate and receive the heavy ends, means to discharge the solid residue material, and heat controlling impacting bodies in the said retort.

17. In an apparatus for distilling or cracking hydrocarbons, the combination of an externally heated tumbling barrel ball mill retort, a partition dividing the same into an auxiliary low temperature compression chamber and a main low pressure high temperature distilling and cracking chamber, a supply reservoir, a compression pump adapted to deliver from the supply reservoir into the auxiliary compression chamber, an expansion valve between the compression chamber and the distilling chamber to permit the expansion from the compression chamber to a lower pressure in the distilling chamber, a centrally axially disposed discharge pipe from the said distilling chamber to discharge the gaseous and vapor material therefrom, means connected to the discharge pipe to separate and receive the heavy ends, means to discharge the solid residue material, and heat controlling impacting bodies in the said retort comprising balls and angular bodies reacting therewith.

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