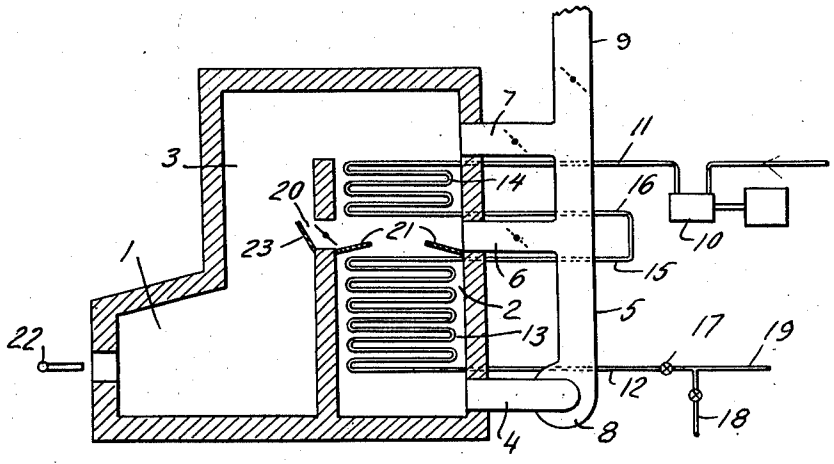
July 11, 1939. H. L. PELZER 2,165,725

ART OF CRACKING HYDROCARBONS

Filed April 4, 1930



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Patented July 11, 1939 2,165,725

UNITED STATES PATENT OFFICE

2,165,725

ART OF CRACKING HYDROCARBONS

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Application April 4, 1930, Serial No. 441,649

4 Claims. (Cl. 196—110)

This invention relates to improvements in the manufacture of lower boiling hydrocarbon oils, such as gasoline, from higher boiling hydrocarbon oils, such as gas oil and reduced crude oil, by cracking operations. This invention provides improvements, in both methods and apparatus for heating oil to cracking temperatures, which are advantageous in several respects but particularly in that they afford methods and apparatus by which the temperature gradient of the oil passing thru the heating operation may be given almost any desired characteristics at the choice of the operator, both effectively and efficiently.

The development of cracking operations in which oil is subjected to severe cracking conditions to produce motor fuel gasoline of improved anti-knock properties has developed, as an element of increasing importance, a requirement for more precise control of the temperature gradient of the oil passing thru the heating operation and for the maintenance of temperature gradients having characteristics not to be obtained by the more simple heater arrangements and heating operations previously used. This invention is of general application in meeting these requirements in conjunction with various types of cracking operations.

This invention, however, is of special value and application in carrying out operations in which high boiling oil is heated to a cracking temperature under high pressure and in which the hot oil products of this heating operation are separated into a vaporized fraction and an unvaporized fraction under lower pressure, or so-called "pressure coil" cracking operations. This invention is also of value and application in carrying out operations in which high boiling oil is heated to a high cracking temperature substantially in the vapor phase.

In one aspect, this invention is a modification of the invention described in my application filed April 4, 1930, Serial No. 441,648, upon which Patent No. 1,845,554 was granted February 16, 1932.

In carrying out the method of this invention, heating gases from a fire-box in which fuel is burned are passed successively over a first battery and a second battery of heating tubes, a part of the heating gases which have passed over both batteries of heating tubes is recirculated over the second battery of heating tubes together with the heating gases which have passed over the first battery of heating tubes and a part of the heating gases fresh from the fire-box, the heating gases fresh from the fire-box reheating, by direct heat exchange, the recirculated heating gases before the mixture of heating gases is passed over the second battery of heating tubes, and oil is passed thru one and then the other of the batteries of heating tubes and heated to a cracking temperature during passage therethru. To provide for tempering of the heating gases fresh from the fire-box before they first contact with the heating tubes of the first battery, another part of the heating gases which have passed over both batteries of heating tubes may be recirculated over both batteries of heating tubes together with the heating gases fresh from the fire-box.

Thus, according to the invention, almost any desired temperature gradient may be maintained with respect to the oil passing thru the heating tubes. The heating gases recirculated over the second battery of heating tubes may be heated, by admixture with heating gases fresh from the fire-box, to a temperature the same as or higher than that at which the heating gases from the fire-box first contact with the heating tubes of the first battery. The extremely flexible control of the temperature gradient of the heating gases during their passage over the heating tubes thus afforded makes possible, in conjunction with control of the rate of oil circulation and the direction of oil circulation thru the heater, the maintenance of almost any desired temperature gradient of the oil passing thru the heater.

The oil may be passed thru the batteries of heating tubes generally countercurrent to the flow of heating gases thereover or generally concurrent with the flow of heating gases thereover, or the oil may be passed thru part of the heating tubes countercurrent to and thru part of the heating tubes concurrent with the flow of heating gases over the heating tubes. One of the advantages of the invention, however, is that it makes possible elimination of inversions and reinversions of the direction of oil flow in passage thru the heater without sacrifice with respect to flexibility of control. Thus, according to the invention, almost any desired temperature gradient of the oil passing thru the heater may be maintained with simple continuous flow of the oil thru the heater, either generally countercurrent to or generally concurrent with the flow of heating gases.

According to the invention, oil flowing thru the heater may be brought rapidly to a high cracking temperature and then maintained at

substantially the same temperature for a further period in the heater, or it may be brought rapidly to a high cracking temperature and then maintained at a temperature increasing at a slower rate and approximately uniformly with respect to time for a further period in the heater, or it may be heated to a temperature, ultimately a cracking temperature, progressively increasing but increasing at a diminishing rate while flowing thru the heater, for example.

The apparatus of the invention comprises a heating flue and heating tubes arranged in the heating flue, a fire-box communicating thru a primary passage with one end of the heating flue and thru a secondary passage with an intermediate part, or with several intermediate parts, of the heating flue, means for forcing heating gases withdrawn from the other end of the heating flue into the intermediate part, or parts, of the heating flue, and means for forcing oil thru the heating tubes.

The invention will be further described in connection with the accompanying drawing which illustrates, diagrammatically and conventionally, in elevation and partly in section and with parts broken away, one form of apparatus embodying the invention and adapted for carrying out the invention.

Referring to the drawing, the apparatus illustrated comprises a furnace including a fire-box 1 and a heating flue 2, a flue 3 connecting the fire-box 1 with the upper end of the heating flue 2 and a stack flue 4 communicating with the lower end of the heating flue 2, ducts 5, 6 and 7 including a fan 8 for recirculating heating gases withdrawn from the lower end of the heating flue 2 thru the lower part of the heating flue 2 by way of the duct 6 and thruout the heating flue 2 by way of the duct 7. Dampers are provided, as illustrated, in the ducts 6 and 7 and in the stack 9 for controlling the recirculation and discharge of heating gases therethru. Two or more batteries of heating tubes, connected in series to form a continuous heating conduit, are arranged in the heating flue 2 and a pump 10 is provided for forcing oil thru the heating tubes. The oil is supplied to the heating tubes thru the connection 11 and the hot oil products are discharged therefrom thru the connection 12 in the apparatus illustrated. The oil may likewise be supplied to the heating tubes thru the connection 12 and discharged therefrom thru the connection 11, or it may be supplied to the second battery of heating tubes 13 thru the connection 12, passed from the second battery to the first battery of heating tubes 14 thru the connections 15 and 11 and discharged from the second battery of heating tubes thru the connection 16. In carrying out so-called "pressure coil" cracking operations in the apparatus illustrated, the pressure in the heater may be maintained and regulated by means of the valve 17, and an oil cooler than the hot oil products discharged thru the connection 12 may be introduced thru the connection 18 to arrest the cracking reaction initiated in the heater. The hot oil products may be discharged thru the connection 19, in the case of so-called "pressure coil" cracking operations, for example, to any suitable evaporator for the separation of vaporized and unvaporized fractions, or, in the case of vapor phase cracking operations, to a tar separator.

The heating gases recirculated over the second battery of heating tubes 13 are introduced into the heating flue 2 thru the duct 6 intermediate the first battery of heating tubes 14 and the second battery 13. A part of the heating gases fresh from the fire-box 1 is also introduced into the heating flue 2 intermediate the first battery of heating tubes 14 and the second battery 13 thru the duct 20. The duct 20 is also provided with a damper for controlling the circulation of heating gases therethru. A pair of baffles 21 are provided in the intermediate part of heating flue 2 above the second battery of heating tubes 13 to promote intermixture of the recirculated heating gases introduced thru the duct 6, the heating gases fresh from the fire-box introduced thru the duct 20, and the heating gases which have passed over the first battery of heating tubes 14. This intermixture of these gases results in reheating the recirculated heating gases introduced thru the duct 6 before the resulting mixture passes over the second battery of heating tubes 13. By regulating the rates of introduction of the recirculated heating gases and the heating gases fresh from the fire-box into the intermediate part of the heating flue 2 thru the ducts 6 and 20, the recirculated heating gases may be reheated to a temperature higher than that of the heating gases fresh from the fire-box as they first contact with the heating tubes of the first battery 14. It will be understood that one or more ducts corresponding to the duct 6 may be provided connecting the duct 5 with several intermediate parts of the heating flue 2 and, similarly, that one or more ducts corresponding to the duct 20 may be provided connecting the flue 3 with several intermediate parts of the heating flue 2.

That part of the heating gases withdrawn from the lower end of the heating flue 2 and not recirculated thru the heating flue 2 is discharged thru the stack flue 9. Fuel for combustion is supplied to the fire-box, in the apparatus illustrated, by means of the burner 22. Preheated air, preheated by heat exchange with the waste heating gases escaping thru the stack 9, may be supplied to the fire-box 1 for combustion.

In the apparatus illustrated, the rate of heat transfer in the lower part of the heating flue 2 is improved because of the increased velocity of flow of heating gases therethru resulting from the increase in volume of the heating gases flowing therethru because of the recirculation of the heating gases introduced into the intermediate part of the heating flue. The heating tubes in the upper part of the heating flue 2, which are the first to contact with the heating gases fresh from the fire-box, may be protected by tempering these heating gases fresh from the fire-box with heating gases withdrawn from the lower end of the heating flue 2 and recirculated therethru thru the ducts 5 and 7. The heating tubes may, with advantage, as in the apparatus illustrated, be protected from direct radiation from the fire-box by the provision of an appropriate bridge wall and appropriate baffles, such as baffle 23 beneath the duct 20, as illustrated.

I claim:

1. In heating oil to cracking temperatures in cracking operations, the improvement which comprises passing heating gases from a firebox in which fuel is burned successively over a first battery and a second battery of heating tubes, recirculating part of the heating gases which have passed over both batteries of heating tubes over the second battery of heating tubes together with the heating gases which have passed over the first battery of heating tubes and heating gases

fresh from the fire-box, thereby reheating the recirculated heating gases by direct heat exchange with the heating gases fresh from the fire-box before the mixture of heating gases is passed over the second battery of heating tubes, and passing oil thru one of the batteries of heating tubes and then thru the other and heating it to a cracking temperature therein.

2. In heating oil to cracking temperatures in cracking operations, the improvement which comprises passing heating gases from a fire-box in which fuel is burned successively over a first battery and a second battery of heating tubes, recirculating part of the heating gases which have passed over both batteries of heating tubes over the second battery of heating tubes together with the heating gases which have passed over the first battery of heating tubes and heating gases fresh from the fire-box, thereby reheating the recirculated heating gases by direct heat exchange with the heating gases fresh from the fire-box to a temperature higher than that of the heating gases from the fire-box as they first contact with the heating tubes of the first battery before the mixture of heating gases is passed over the second battery of heating tubes, and passing oil thru one of the batteries of heating tubes and then thru the other and heating it to a cracking temperature therein.

3. In apparatus for heating oil to cracking temperatures, in combination, a heating flue and heating tubes arranged therein, a fire-box communicating thru a primary passage with one end of said heating flue and thru a secondary passage with an intermediate part of said heating flue, means for forcing heating gases withdrawn from the other end of said heating flue into said intermediate part, and means for forcing oil thru said heating tubes.

4. An oil heating furnace comprising a combustion space, a heating space, a flue, connections for passing gases from said flue to said heating space and to said combustion space, comprising conduits connecting said flue and said combustion space and heating space, and dampers in said conduits.

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