PATENT SPECIFICATION

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(Under Section 91, subsections (2) and (4) (a) of the Patents and Designs Acts, 1907 to 1932, a single Complete Specification was left in respect of this Application and of Application No. 15156/37 and was laid open to inspection on Dec. 11, 1937).

COMPLETE SPECIFICATION

Improvements relating to the Catalytic Production of Hydrocarbons

We, RUHRCHEMIE AKTIENGESELLSCHAFT, of Oberhausen-Holten, Germany, a Body Corporate organized and existing under the Laws of the German State, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

It is known that the synthesis of hydrocarbons by the reduction of oxides of carbon with hydrogen is a reaction which is extremely sensitive to heat, so that to effect such synthesis special heat exchanging apparatus is needed. Thus heat-exchanging apparatus may be employed which consist of a reaction chamber containing a system of metal plates disposed parallel to one another at short intervals, and juxtaposed parallel tubes placed one below another and extending through the metal sheets at right angles. To carry off the reaction heat developed during the conversion of the mixture of carbon monoxide and hydrogen, a cooling medium such as water under pressure is passed through the tubes. By this means a good cooling effect is secured, but it is not altogether impossible for small fluctuations of temperature to occur within the apparatus, because heat is carried off by the circulated cooling liquid not only at the hotter but also at the cooler portions of the reaction chamber, smaller quantities of heat being released at these cooler portions, for example, in consequence of the lower efficiency of the catalyst.

According to the invention circulation of the cooling water or other liquid, is effected by thermo syphonic action, for which purpose the ends of the cooling tubes extend into water chests common to all the tubes, and the cooling water from a steam boiler enters one of the water chests and after passing through the cooling tubes leaves the water chest that is mounted at the other end of the cooling tubes and returns to the steam boiler which is mounted in a position higher than the apparatus.

The common chests may be replaced by systems or groups of water chests.

According to the most important feature of the invention, the cooling water enters the cooling tubes only to the extent that the water heated in the tubes by absorption of reaction heat can ascend to the steam boiler. The water cannot, however, return to the steam boiler until it has reached a temperature which is higher than the temperature in the steam boiler. The great advantage of this becomes apparent on the apparatus being put into operation. As the contact mass may not be equally effective at all temperatures, it would not, while the heat is being withdrawn continuously by means of a circulated cooling liquid, be heated to the necessary reaction temperature at positions where the generation of heat is smaller, so that a catalytic effect is not produced to the necessary extent. Since according to the invention the flow of cooling water through each tube is automatically regulated by the amount of reaction heat evolved locally, the heat produced is stored at the colder positions until these too have reached the reaction temperature. Harmful overcooling such as could arise under certain conditions on the passage of a determined constant quantity of water through each tube is thus quite impossible. The more desirable temperature constant within the whole reaction furnace, obtained by the automatic regulation of the quantity of water flowing through, has, it will be understood, a favourable effect on the yield, so that there is an appreciable rise in output from the reaction chamber. Important simplification of the heat exchanging apparatus employed for carrying out the process of the invention forms a further advantage in so far as a special mechanical device for pumping the cooling medium can be entirely dispensed with.

The invention is hereinafter described with reference to the accompanying drawing.

Referring to the drawing, A (Figure 1)

is a reaction chamber, through which extend a large number of tubes B, only a few being shown in the drawing for the sake of clearness. The tubes B are at their ends welded into common end plates C_1 and C_2. Connected to the end plates C_1 and C_2 are collecting chests D_1 and D_2 respectively for receiving and discharging the cooling medium, which flows from the steam boiler E through the pipe F to the collecting chest D_1 and returns from the collecting chest D_2 to the steam boiler E by way of the pipe G.

Instead of a single collecting chest for the cooling medium, into which extend all the tubes B, it is possible, as shown in Figure 2, to employ a system of cooling medium receiving boxes H formed for example of tubes of square cross-section, only certain of the tubes B extending to each receiving box H, while the receiving boxes H are connected to the collecting chests K_1 and K_2 by means of short distributor pipes J, the collecting chests K_1 and K_2 being in turn connected to the pipes F and G which lead to the steam boiler E.

The heat exchanging apparatus according to the invention as illustrated in Figure 1 of the accompanying drawing operates as follows: The cooling medium employed, water by way of example, enters the water chest D_1 from below, flows through the cooling water tubes B and enters the second common water chest D_2 provided at the ends of the tubes: it leaves the water chest D_2 at the upper end and enters a pipe G leading to a steam boiler E. The contact mass is provided between the tubes B. The water under pressure is heated in the tubes B to a degree corresponding to the amount of heat produced locally in the contact mass; it rises in the water chest D_2 and in the pipe G leading to the steam boiler E owing to the smaller specific gravity of the hotter water; it evaporates in the steam boiler E to an extent corresponding to the amount of heat absorbed and the constant steam pressure. Fresh water is injected into the steam boiler E at L, the quantity corresponding to the quantity of water converted into steam. By automatically adjusting the pressure in the steam boiler E, the water which is not evaporated is always maintained at a constant temperature corresponding to the required conversion temperature in the reaction-chamber. The water in the steam boiler, which is cooler than the water which rises to the steam boiler, flows back to the reaction chamber A by way of a second pipe F and again enters the first water chest D_1 from below. By this means the water is maintained automatically in circulation by simple thermo-syphonic action.

It is surprising that it should be possible to cause water to circulate without the use of pumps notwithstanding the small difference of temperature that must exist between the water in the steam boiler and the cooling water in the tubes, in view of the uniform temperature regulation in the reaction chamber. The simplification of apparatus hereinbefore referred to consists principally in that the tubes extend directly into the water chests and are not connected outside the chamber by bends to produce a system of coiled tubing in order to conduct the water to and fro through the reaction chamber in the tubes that are disposed at the same vertical height. The present method has the further advantage that for each apparatus only one supply pipe and one discharge pipe for the cooling water is necessary, whereas in the known construction, distributor pipes to the various coils are necessary. Further, when the pipes in the apparatus according to the invention become leaky, every single tube is accessible by opening the water chests and can be made watertight again by the introduction of a tubular lining, whereas in the known construction all the bends of one coil have to be cut off to enable the individual tubes to be tested for leakiness. This simplification of apparatus provides simpler and more effective working of the apparatus.

It has been found particularly advantageous to dispose the reaction chamber in an inclined position so that the cooling medium which is being heated in the tubes can ascend to the collecting box which is mounted at the outlet end of the tubes. This assists the thermo-syphonic action and at the same time prevents the formation in the tubes of steam pockets which would cause a reduction in the reaction heat given up to the cooling medium, for the reason that the resulting steam bubbles ascend, by reason of the sloping position of the tubes, directly to the collecting box mounted at the outlet end of the tubes.

It is further of advantage to connect a number of reaction chambers to a common steam boiler, as shown in Figure 3. Moreover, where a number of steam boilers are employed, they may be connected together for the purpose of equalising the pressure. The great advantage of this method of cooling, over that hitherto employed, is that all the reaction chambers are maintained at the same reaction temperature irrespective of the heat developed in any one reaction chamber. The greater uniformity in reaction temperature thus obtained has a very favourable effect on

the yield of liquid hydrocarbons which is adversely affected by small changes of temperature during the reaction, which is known to be extremely sensitive to temperature change.

The system of connections according to the invention employed for the cooling systems of the reaction chambers has the added advantage that during synthesis a reaction chamber whose catalyst is reduced in efficiency or is to be regenerated before a harmful reduction in yield has set in can be regenerated at synthesis temperature without any necessity for additional heat being supplied, since the reaction heat developed in the other reaction chambers suffices fully to bring to synthesis temperature the chamber whose catalyst is to be regenerated. As the cooling systems of the reaction chambers are connected up to one and the same steam boiler and the respective steam boilers belonging to separate reaction chamber batteries may be linked together and the steam pressure can be regulated at a central position, it is not necessary specially to regulate the supply of water under pressure in the case of the chamber the catalyst in which is to be regenerated. The great advantage of this is that the operation of the plant is very much simplified.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

1. A method of effecting benzine synthesis from carbon monoxide and hydrogen by the use of a solid catalyst and suitable heat exchanging apparatus which comprises a gas-tight reaction chamber and traversed by a system of tubes in which is contained a cooling medium, such as water, consisting in producing a thermo-syphonic circulation of the cooling medium through the tubes by providing at one end of the tubes a water chest or system of water chests having a supply conduit and at the other end of the tubes a water chest or system of water chests having a discharge conduit and connecting a steam boiler to the supply and discharge conduits in such manner that the cooling medium coming from the steam boiler is supplied to one of the water chests or system of water chests and the cooling medium is returned to the steam boiler from the other water chest or system of water chests, the boiler being at a greater elevation than the reaction chamber.

2. A method according to claim 1, characterised in that the tubes in the reaction chambers are disposed in an inclined position.

3. A method according to claim 1 or claim 2, characterised in that the cooling systems of two or more reaction chambers are connected to a common steam boiler.

4. A method according to claim 1, 2 or 3, characterised in that two or more boilers are connected together for the purpose of the equalization of pressure.

Dated this 29th day of May, 1937.

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Agents for the Applicants.

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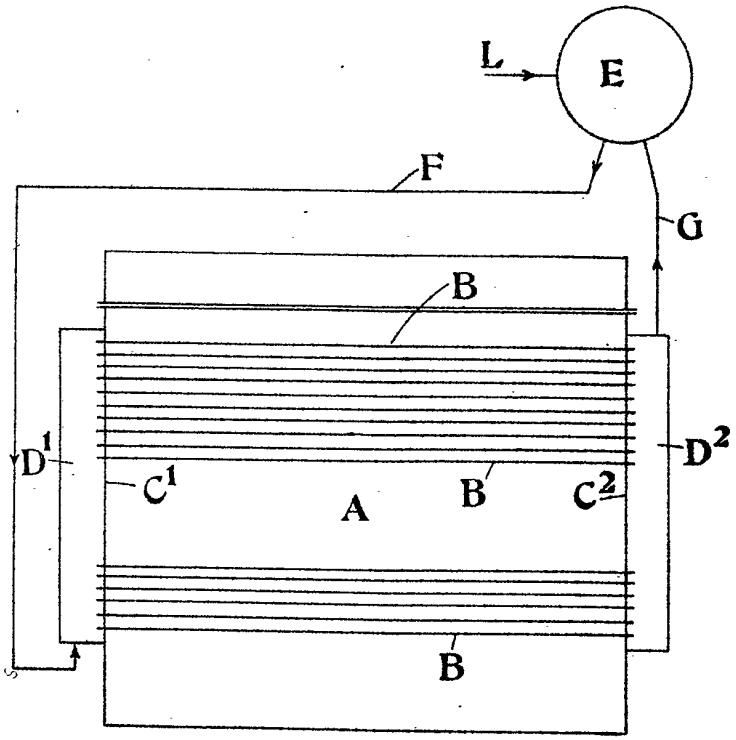

Fig.1.

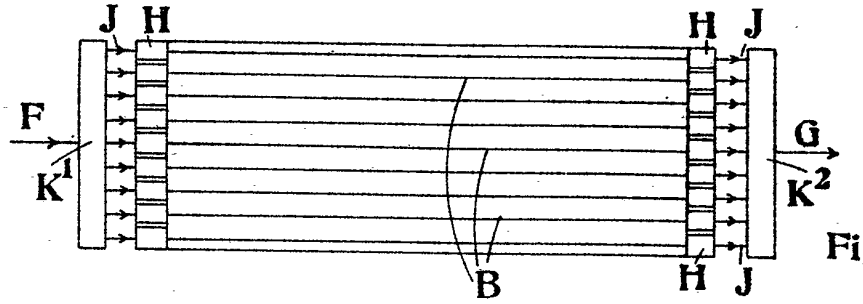

Fig.2.

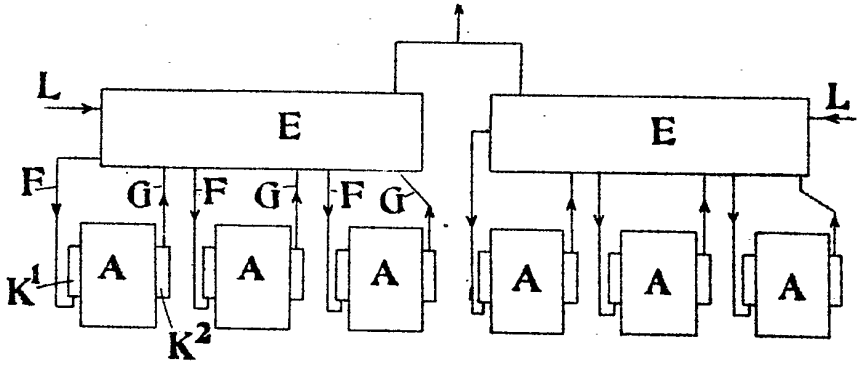

Fig.3.

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