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PROCESS OF TREATING ALIPHATIC HYDROCARBONS

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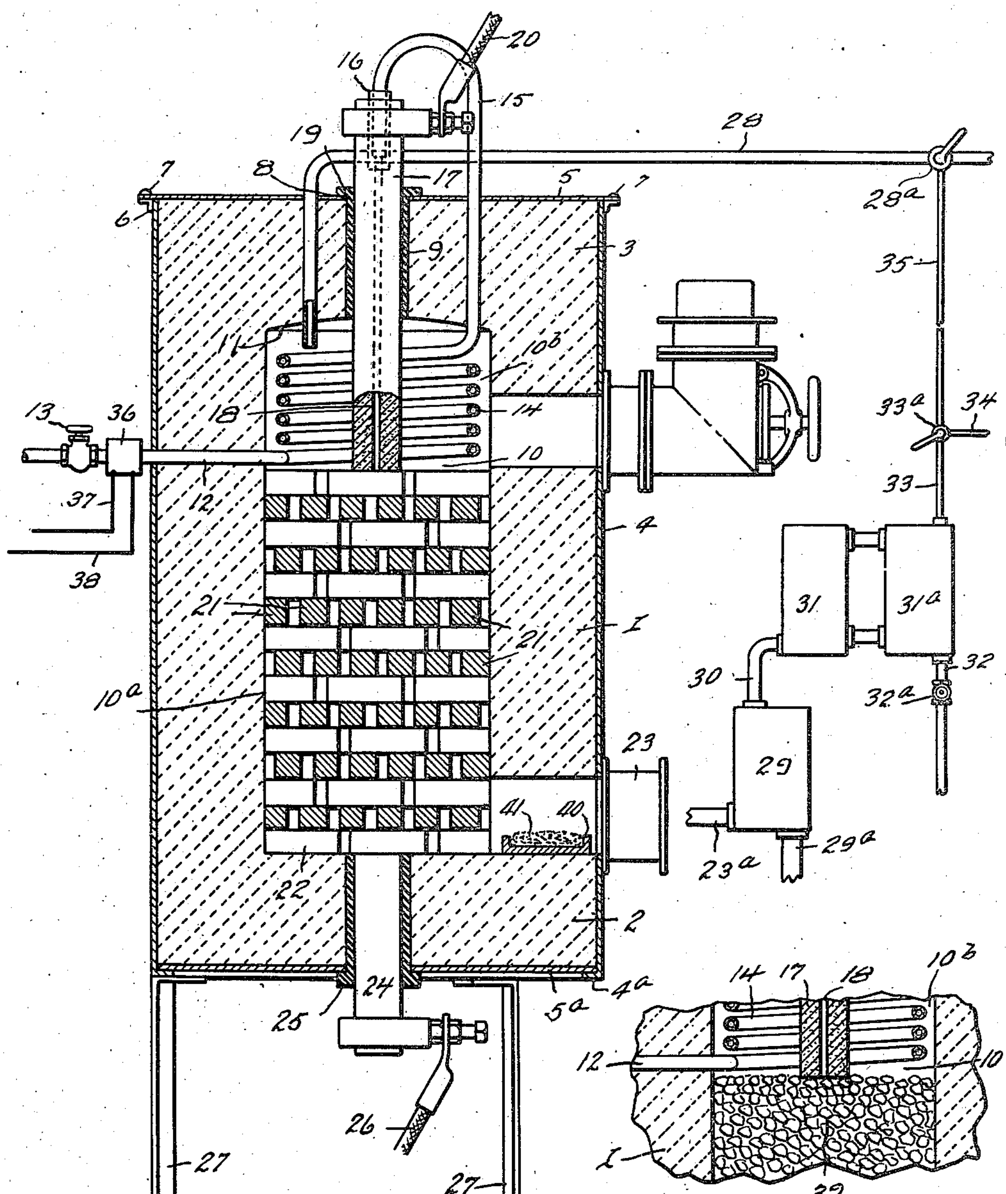

Fig. 2

Fig. 1

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PROCESS OF TREATING ALIPHATIC HYDROCARBONS

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2 Claims. (Cl. 204—31)

This invention relates to a process of treating fluids consisting principally of aliphatic hydrocarbons for the production of valuable products therefrom. A field wherein my process is of particular importance is the production of benzene from hydrocarbon fluids, especially hydrocarbon fluids including natural gas or methane. In my application Serial No. 55,387, filed December 20, 1935, I have described and claimed a process for manufacturing benzene which includes supplying a hydrocarbon fluid consisting principally of aliphatic hydrocarbons and a gas consisting principally of methane continuously through and beyond the arc produced between electrodes in a reaction chamber and into contact with a catalyst immediately adjacent the said arc. The present process contemplates such improvements over that described and claimed in the aforesaid application as will enable me to greatly increase the amount of benzene recovered in a given time.

I realize the foregoing object in and through the employment of the apparatus shown in the drawing forming a part hereof, wherein Fig. 1 represents in vertical section a furnace equipped for the dissociation of a hydrocarbon fluid, such as methane or natural gas, and, on a reduced scale, a diagrammatic illustration of an apparatus connected with said furnace for the separation of carbon and for the separation and absorption of a heavy hydrocarbon, such as benzene, whereby it may be recovered as a liquid; and Fig. 2 represents a detail in section of a modification of the furnace proper shown in Fig. 1.

Describing by reference characters the various parts illustrated in Fig. 1, 1 represents the cylindrical wall of a furnace or a generator, said wall being of refractory material capable of withstanding the temperature due to the employment of an electric arc. 2 denotes the bottom wall of the furnace and 3 the top wall of the same, the walls 2 and 3 being also made of such refractory material and all of the walls being inclosed by a shell, preferably of sheet steel. 4 denotes the side wall of said shell and 5 the top, said top being shown as secured to the wall 4 as by means of an angle iron 6 carried by the top of said wall and bolts 7 uniting the top 5 to the horizontal flange of the angle iron. The top 5 is provided with a central opening 8 (preferably circular) and registering with a similarly shaped opening 9 in and extending through the wall 3. The bottom 5^a is constructed similarly to the top 5 and is conveniently retained in place by a flange 4^a on the bottom of the wall 4.

Within the walls 1, 2 and 3 is a central chamber 10, 10^a, said chamber being preferably cylindrical and having its upper wall slightly arched as shown at 11.

12 denotes a pipe for delivering into the chamber 10 a hydrocarbon fluid, preferably methane or natural gas, said pipe being provided with a valve 13 by means of which the supply of such fluid may be varied as desirable. The pipe 12 communicates in the chamber 10 with the bottom of a coil 14 having its exterior preferably partially embedded in a lining 10^b for said chamber. From the upper end of the coil the pipe 15 extends through the top wall of the furnace and through an insulating sleeve 16 in the top of a carbon electrode 17 having a central bore 18 therethrough for the reception of the preheated gas delivered through the coil and pipe. This electrode is mounted within an insulating bushing 19, inserted in the openings 8 and 9; and the electrode is provided with a conductor 20 for electric current.

Extending downwardly from the chamber 10 and constituting an extension thereof is the chamber 10^a in which is located a discontinuous mass of material capable of conducting electricity, but, owing to the discontinuity of the mass, with the production of a myriad of short arcs between the pieces or blocks of the material. The mass of material is shown herein as made up of bricks 21, preferably of carbon and arranged in checker work formation and providing tortuous passageways for the fluid in its course therethrough and to the outlet connection 24 at the bottom of the chamber. 24 denotes a solid carbon electrode which projects through the bottom of the furnace as far as the bottom of the chamber 21, where it contacts with the bottom course of bricks 22. This electrode is mounted in an insulating bushing 25 interposed between the same and openings provided in the bottom 5^a of the shell and the bottom of the wall 2 of the furnace and is provided with a conductor 26 for electric current. The furnace is shown as supported by a plurality of legs 27.

28 denotes a pipe having a three-way valve 28^a through which another fluid (preferably hydrogen or a gas consisting essentially of hydrogen) may be introduced into the chamber 10 and may be delivered through the checker-work together with the fluid delivered through the electrode 17. The hydrocarbon fluid, which is preferably methane or natural gas, and the hydrogen (or a gas consisting essentially of hydrogen) are passed

through the checker-work to the gas outlet connection 23.

In operation, the checker-work is first heated by the current supplied therethrough to a temperature of say approximately 2000° F. The hydrocarbon fluid (preferably natural gas or methane) is then delivered to the heated checker-work and, in its passage therethrough, it is subjected to the action of the myriad of electric arcs referred to hereinbefore whereby, if the fluid employed is methane, it will be converted first into acetylene, in accordance with the reaction:—$2(CH_4)=C_2H_2+6H$. However, in passing through the checker-work and the myriad of arcs, the acetylene will be progressively polymerized into benzene in accordance with the reaction:—$3(C_2H_2)=C_6H_6$; and this polymerization will be completed by the catalyst which will be referred to hereinafter. Notwithstanding the fact that this reaction indicates the liberation of an excess of hydrogen, it has been found that additional hydrogen is necessary in order to insure the production of benzene and also to prevent the destruction of the carbon resistor. By adding hydrogen, or a gas containing a large proportion of hydrogen, to the hydrocarbon fluid, hydrogen is always available in sufficient quantity and proportion to insure the production of the benzene as well as to prevent or limit the liberation of carbon in excess of that required to produce the benzene.

From the outlet connection 23, the pipe 23ᵃ leads the aeriform products, evolved by subjecting the fluid in the furnace to the action of the electric resistor provided by the checker-work bricks, to a separator 29, which may be of any commercial form adapted to separate from the gaseous products any carbon that may be present therein, the separator having an off-take 29ᵃ through which such carbon may be removed. From the separator, the pipe 30 conducts the gaseous products into separating and absorbing apparatus 31, 31ᵃ, which may be of any standard recognized type capable of separating and condensing the benzene, or other hydrocarbon which is liquid at normal temperatures. The liquid product thus separated may be removed through the pipe 32 and the valve 32ᵃ.

Assuming that the gases treated have been methane and hydrogen, the gas remaining after the separation of the benzene will consist essentially of hydrogen and may be delivered through a pipe 33 to a three-way valve 33ᵃ, whence as much of it as may be desirable may be conducted to storage or to a point of use through pipe 34. When it is desired to use this gas as the source of hydrogen, as much of the same as is necessary for this purpose will be conducted from the valve 33ᵃ through pipe 35 to the three-way valve 28ᵃ.

36 denotes a high-frequency apparatus provided with the conductors 38, the said apparatus being applied to the pipe 12 and being capable of subjecting the gas passing through the pipe 12 to the disruptive action of the high frequency current. The high-frequency apparatus may be one of the type manufactured by the General Electric Company and the Westinghouse Electric & Mfg. Company, comprising a chamber through which the gas is conveyed, said chamber containing non-sparking high-frequency coils, whereby an initial dissociation of the gas is instituted, which dissociation is completed by subjecting the gas to the electrically heated checker-work within the furnace and to the catalyst beyond the checker-work. Frequencies of 12,000,000 cycles per second are conventional and may be employed herein.

In Fig. 2, I have shown a modification of the furnace shown in Fig. 1 only in regard to the resistor which is employed, the resistor in this case consisting of fragments 39 of resistant material, preferably carbon. A portion of the electrode 17 is shown as contacting with the top of this mass and a portion of the pipe 12 and coil 14 are shown. The electrode 24 in this case will contact with the central portion of the bottom of the mass of resistant material, being located in the same position and arranged in the same manner as shown in Fig. 1.

The separating and absorbing apparatus 31, 31ᵃ, as stated hereinbefore, may be of any standard type, one such apparatus being that known to the trade as "Lectrodryer" employing therein activated alumina.

In both forms of my apparatus, one or more trays 40 containing a catalyst 41 will be placed in the path of the gases resulting from the dissociation and immediately adjacent to the bottom of the resistor. The catalyst may be platinum black, finely divided nickel, or iron ore, and will increase the yield of benzene. The action of the catalyst has been explained hereinbefore as completing polymerization of the acetylene which is instituted at the top of the checker-work and which has been proceeding progressively from the top of the checker-work to the bottom thereof, where the catalyst is located.

By the use of the discontinuous resistance illustrated and described herein, I am enabled to obtain a greatly increased quantity production of benzene over that which is obtainable by the process shown, described and claimed in my copending application No. 55,387 referred to hereinbefore. This increase is due, not only to the ability to subject the hydrocarbon fluid to be treated to a myriad of small arcs, but also to the action of the heated body of the resistor in facilitating the decomposition of the said fluid.

This application is a continuation in part of my application Serial No. 55,391, filed December 20, 1935.

Having thus described my invention, what I claim is:

1. The process of producing benzene which comprises passing a gas consisting principally of aliphatic hydrocarbons continuously through a zone comprising a multiplicity of electric arcs and immediately thereafter into contact with a solid polymerization catalyst.

2. The process of producing benzene which comprises passing a gas consisting principally of aliphatic hydrocarbons continuously through a zone comprising a multiplicity of electric arcs and immediately thereafter into contact with a solid polymerization catalyst; removing the carbon from the gaseous mixture thus produced; separating and condensing the benzene; and passing the hydrogen obtained from such separation and condensation through the said zone in subsequent cycles of operation.

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