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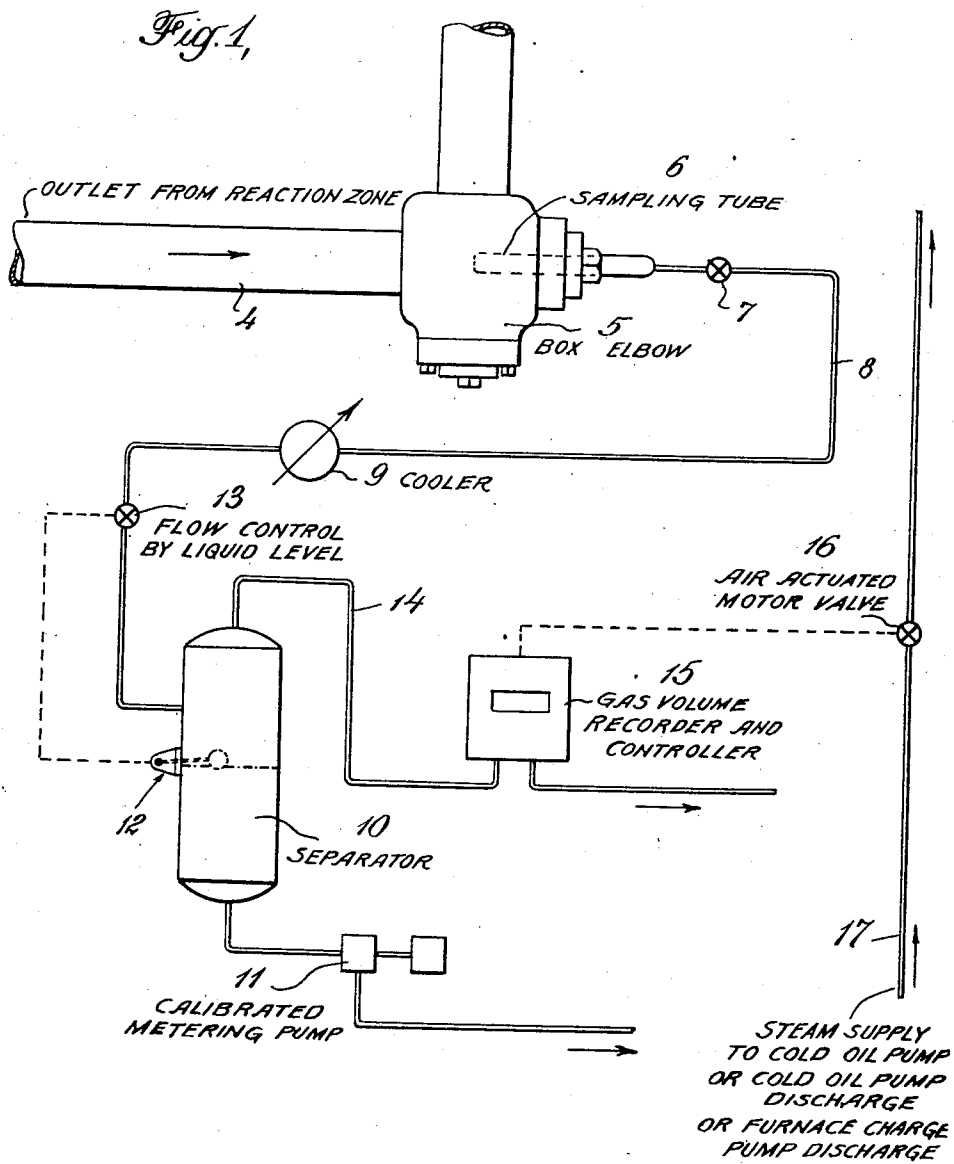
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HYDROCARBON CRACKING PROCESS

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2 Sheets-Sheet 1



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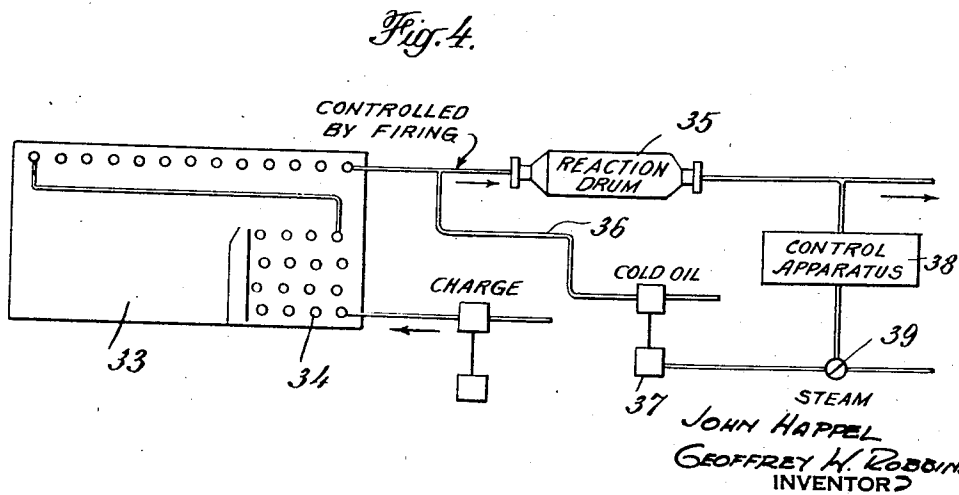
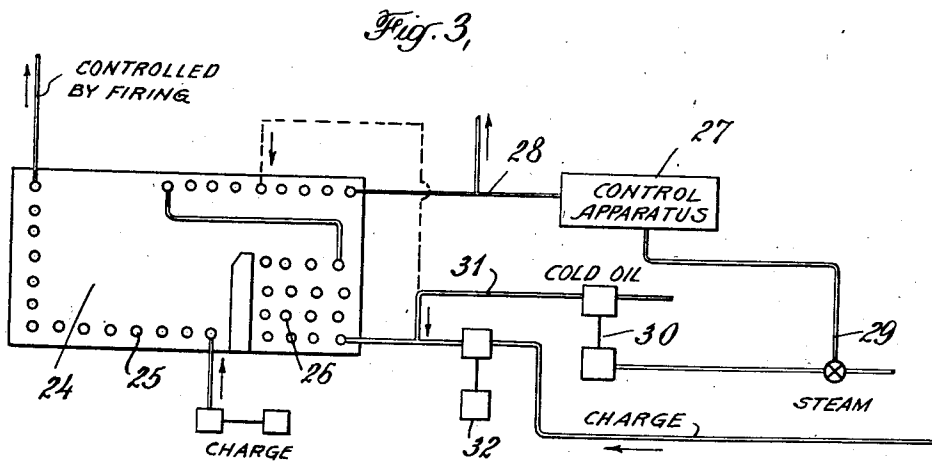
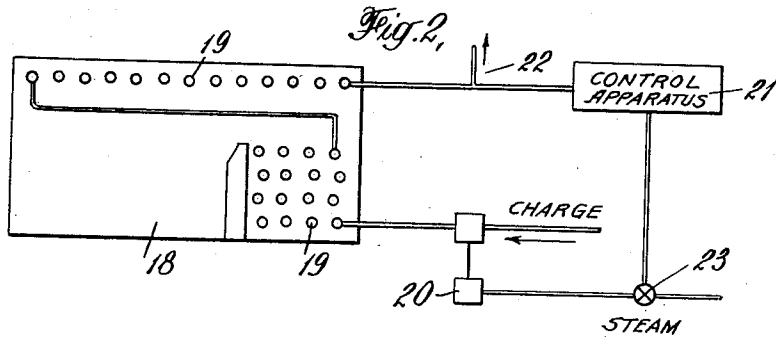
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HYDROCARBON CRACKING PROCESS

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HYDROCARBON CRACKING PROCESS

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4 Claims. (Cl. 196—47)

This invention has to do with methods for the control of the operation of cracking of hydrocarbons and similar operations of thermal treatment of hydrocarbons wherein flowing streams of hydrocarbon material are subject to heating. It is particularly applicable to control of the operation of multicoil cracking processes, wherein two or more treating coils, used for the same or for different purposes, are mounted in the same furnace.

Since the thermal conversion of hydrocarbons is capable of control by control of the factors of time and temperature, many systems have been developed for accomplishing such control. A rough control upon time of exposure, temperature being constant, and rate of flow being constant, can be had by variation of pressure. But in the general case, the factors which are held constant are rate of flow and pressure upon outlet, and control of temperature is attained by varying the rate of firing of the furnace in accordance with observed temperature of outlet oil. This has some defects, the most obvious one being the time-lag due to the heat storage capacity of the furnace, but nevertheless is widely used and in general satisfactory when applied to proper operations. It is not capable, however, of being utilized to control the operations where two or more coils are heated in the same furnace for the accomplishment of similar or different treatment of two separate streams of oil.

These and other defects in the present systems available for the control of such processes have led the applicants to the provisions of the system disclosed herein.

The system of control disclosed herein is based upon the commonly known fact that the percentage of gas formed, in any hydrocarbon heat treatment process in which gas is one of the products, is a quite sensitive measure of the extent of the reaction taking place, and upon the concept that the evolution, separation, and measurement of such gas could be availed of to provide a rapid, accurate and simple means of control for reaction, and particularly for each of several reactions conducted simultaneously. To avoid time-lag effects inherent in furnace control, and to make the control more precise and more widely adaptable, the system disclosed is one wherein the evolution of gas from a reaction is utilized for the control of flow quantities charged thereto.

It is an object of this invention to provide a convenient and accurate means of control of any process wherein a gas is produced as one of the products of such process, actuated by observing

the amount of gas so produced and altering operating conditions of the process in accordance with variations in the amount of gas produced therein.

Another object is the provision of a control means applicable individually to one of several operations carried on in an inter-related fashion, as of one of several cracking coils located in the same furnace. A further object is the provision of a method of control which is to a great extent free of time-lag. A principal object is the provision of a method of control whereby with other factors held relatively constant, temperature and/or time of treatment may be controlled by varying flow quantities in response to variations in the gas content of the product of the process.

Other objects are in part obvious and will in part appear hereinafter.

In order to understand this process of control reference is now made to the drawings attached to and forming a part of this specification.

In these drawings Figure 1 sets forth in diagram form the essential elements of our control system, while Figures 2, 3, and 4 show in diagram form, its application to several problems of control in oil conversion processes.

Referring now to Figure 1, wherein the essential elements of the control system are shown, we find pipe 4 representing an outlet pipe from a hydrocarbon-containing reaction zone. At some convenient point, where a representative sample of the material flowing in pipe 4 may be obtained, as, for example, at box elbow 5, there is inserted a sampling tube 6, controlled (merely as to open or shut) by valve 7 and leading through pipe 8 and cooler 9 to separator 10. In passing through cooler 9 the sample is cooled to a temperature which may vary widely from process to process, but which, for any one process, should be constant and should be so selected as to provide separation between the products of the process which are normally liquid and those which are normally gaseous under the temperature and pressure obtaining in the separator 10. Since it entails the least difficulty in operation of subsequent apparatus, the separator temperature should be at or near atmospheric. The separator pressure may be above, at, or below atmospheric pressure, and for most hydrocarbon conversion processes it will be above atmospheric pressure. Liquid collected in separator 10 will be withdrawn therefrom at a constant predetermined rate by a calibrated pump 11, and the liquid level in separator 10 will be held constant by a liquid level control 12 operating a

valve 13 installed in pipe 8. Gas will leave the separator by pipe 14.

Such a setup of apparatus will bring about the withdrawal through sample tube 6 and finally through pump 11 of a constant quantity of liquid per unit of time and will cause the flow through pipe 14 of a quantity of gas whose relationship to the constant quantity of liquid is determined by what has happened in the reaction zone from which pipe 4 leads. If the reaction therein is one in which gas is produced, as in the cracking of gas oil, the flow of gas will increase, in proportion to liquid, for more intense cracking. If the reaction is one for the conversion of gases to liquids, as in thermal polymerization of gases, a proportional decrease of gas indicates more intense reaction. In any event, in practically any hydrocarbon process, the variation of proportion of gas to liquid is a quite reliable indication of what is happening in the reaction zone. The production of gas is utilized by us for control of reaction by passing it through pipe 14 and through any one of a number of commercially available types of instruments wherein the flow of gas may be observed and its variation from a preselected normal quantity may be utilized to actuate a control valve. Such an instrument is shown diagrammatically at 15 and variations from the preselected normal gas flow are utilized thereby for the control, in known manner, of valve 16 in pipe 17. Valve 16 being utilized to control flow quantities to the reaction zone, it may be that pipe 17 is either the pipe through which oil is flowing to the reaction, or the steam pipe supplying the pump which introduces such oil to the reaction. In either event a control is established over a flow quantity to the reaction, as will be more readily understood in connection with Figures 2, 3, and 4.

In Figure 2 a setup for the control of a simple system composed of a single cracking coil as shown, consisting of a furnace 18, containing a coil 19 fed by charge pump 20. The control apparatus of Figure 1, indicated diagrammatically at 21 samples the outlet pipe at 22, and in response thereto, controls the steam supply to pump 20 through the agency of valve 23. Furnace firing conditions and coil outlet pressure being held constant by other controls, not shown, the system described acts to counteract an increase in oil outlet temperature, which results in an increase of cracking, as shown by a proportional increase of gas produced, by increasing the amount of oil introduced to the coil per unit of time.

In Figure 3 a more complicated setup is shown, exemplary of the field to which this form of control is most highly applicable. In this figure, a furnace 24 houses a principal cracking coil 25 and is fired by independent controls actuated for the proper control of this main coil. An auxiliary cracking coil 26 is also installed in the same furnace. Obviously, in the absence of accurate individual control the proper operation of coil 26 would be fortuitous. In this instance the control system, indicated by 27, operating upon a sample continuously withdrawn from the outlet of coil 26 at 28, is utilized, through valve 29 and pump 30, to control flow quantities in coil 26 by governing the amount of oil injected through pipe 31. Obviously, the control could also be effected through governing of pump 32. Thus an accurate and convenient individual control of reaction in coil 26 is effected.

Similarly in Figure 4 there is shown a setup wherein a fired coil and a reaction zone, are utilized, and "cold" oil introduced into the flowing stream between the furnace and the reaction zone, consisting of furnace 33, containing coil 34, which passes through reaction zone 35, "cold" oil being introduced through pipe 36 by pump 37. The "cold" oil, which is so-called because it is at a lesser temperature than that oil flowing from the furnace, and which may be at any temperature up to and including cracking temperatures, may be introduced either for the sole purpose of controlling cracking conditions within 35 or may be introduced for the additional purpose of obtaining cracking of the "cold" oil. In any event, the gas evolution in 35, with furnace conditions in 33 held constant by individual control, is dependent upon the amount of cold oil introduced and competent control of the system is readily had by use of the control system of Figure 1, as indicated at 38 to control the amount of "cold" oil through valve 39 which governs pump 37.

Other possible and profitable applications of this system of control will be evident to those skilled in the art and all such applications we deem to be within the scope of our invention as defined by the claims appended hereto.

We claim:

1. That method of operating a plurality of hydrocarbon conversion coils installed in the same furnace which comprises continuously withdrawing a representative sample of the stream flowing through one of said coils from a point near the end of said coil, cooling said sample to a predetermined temperature, separating the liquid so produced from the gas so produced, controlling the amount of sample withdrawn so that the amount of liquid produced is substantially constant, measuring the volume of gas produced from the sample in relation to the liquid produced, and varying the amount of oil introduced to said coil proportionally to the gas/liquid ratio found to exist in said sample, while maintaining the operating conditions of other coils substantially constant.

2. That method of controlling a hydrocarbon conversion process which comprises the following steps: flowing a stream of hydrocarbon material continuously through a conversion zone wherein it is exposed to conversion conditions of heat and pressure predetermined for the desired conversion, continuously removing a representative sample from the flowing stream at a point near the end of the conversion zone, cooling the sample stream to condense the liquid portion thereof, separating the liquid so produced from the remaining gaseous portion, controlling the amount of sample withdrawn so that the amount of liquid produced is substantially constant, measuring the volume of gas produced from the sample in relation to the liquid produced, and varying the rate of flow of hydrocarbon material in the said stream flowing through the reaction zone in response to variations in the gas/oil ratio of the sample from a predetermined normal ratio.

3. Apparatus for the control of a hydrocarbon conversion process wherein hydrocarbons pass in a flowing stream through a reaction zone comprising means for continuously obtaining a representative sample from said flowing stream from a point near the end of said reaction zone, means to cool said sample, means to separate the liquid

- portion of said sample from the gaseous portion, means to so control the amount of sample withdrawn so that the amount of liquid produced therefrom is substantially constant, means to
5 observe the ratio of amounts of gas and liquid produced from said sample, and means to vary the amount of hydrocarbons flowing through the reaction zone in response to variations in the gas/liquid ratio of the cooled sample.
- 10 4. That method of controlling a multifunctional hydrocarbon conversion operation wherein a first stream of oil is exposed to conversion conditions within a furnace and at the completion of desired conversion passes therefrom into
15 an unfired reaction zone, and a second stream of oil is introduced to said first stream between said furnace and said reaction zone, said second stream being converted in said reaction zone largely through the agency of heat stored in said first stream, in which regulation is accomplished by continuously removing a representative sample from the combined flowing streams at a point near the end of the reaction zone, cooling
5 the sample stream to condense the liquid portion thereof, separating the liquid so produced from the remaining gaseous portion, controlling the amount of sample withdrawn so that the amount of liquid produced is substantially constant, and varying the amount of oil introduced
10 as said second stream proportionally to the gas/liquid ratio found to exist in said sample, while maintaining the conversion conditions for said first stream substantially constant.
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