This invention relates to a process and an apparatus for rapidly extinguishing the furnaces for the partial combustion of hydrocarbons, used for the preparation of less saturated hydrocarbons such as acetylene and olefines, or synthesis gas consisting mainly of carbon monoxide and hydrogen.

It is known that said furnaces for the partial combustion comprise, as essential parts, a chamber for mixing the reagents (gaseous or vaporized hydrocarbon and oxygen), a partial combustion chamber communicating with the preceding chamber, e.g., through a distributor or a grating for distributing the gaseous mixture, and a device for quenching the resulting mixture to terminate the pyrolysis reactions.

It is also known to reduce the oxygen consumption by preheating the reagents at a high temperature, which is however lower than that which would produce a spontaneous ignition of the hydrocarbon in the mixing chamber. For preventing the flame being formed in the combustion chamber from propagating in the mixing chamber, the linear velocity of the gaseous reagents is kept higher than that of the flame propagation.

Even with proper design, however, there remains some danger due to accidental causes, such as the variations of the throughput and the composition of the gaseous reagents, that backfiring may occur. In such event the hydrocarbon to be pyrolyzed takes fire in the mixing chamber. It is thus desirable to make provision for extinguishing such flame as soon as possible to avoid important loss or even a complete destruction of the distributor and the mixing chamber.

Numerous expedients have already been proposed or experimented with for this purpose. However, they have failed due to the lack of sensitivity of the combustion detector in the mixing chamber and because of the arrangement for extinguishing the furnace. Most generally blowing nitrogen into said chamber and substituting nitrogen streams for the streams of the gaseous reagents are not sufficiently rapid and efficient.

The present invention overcomes these drawbacks and makes it possible to extinguish the furnace even in a fraction of a second, when a pre-ignition occurs in the mixing chamber.

One process according to this invention utilizes an instantaneous temperature detecting means to respond to pre-ignition in the mixing chamber. Such means may with advantage be a bare thermo-couple located in the bottom of said chamber, near the distributor. Said thermo-couple may be used by the pre-ignition gives an electric signal which is used to trigger the starting up, automatically and simultaneously, of the following operations.

(1) Closing the conduits feeding the gaseous reagents by means of valves situated on the cold portion of said conduits, i.e. upstream beyond the preheaters for said reagents.

(2) Flooding with nitrogen the conduit which has been feeding the hydrocarbon to be pyrolyzed.

(3) Blocking the oxygen in the preheating section by blowing nitrogen into the oxygen conduit at a point as close as possible to the mixing chamber.

(4) Closing the product gas outlet conduit.
comprising eight "open" electromagnetic relays, the magnetic winding circuits of which are energized (after amplification) by the thermo-couple 16, and their contact circuits driving the solenoid valves 8, 11, 14, 20, 21 and 22. The valves (not shown) for closing the circuits of the fuel feeds to the preheaters 9 and 12.

At a normal run of the furnace for the partial combustion, the electromagnetic contacts and the automatic valves 20, 21 and 22 are closed and the valves 8, 11 and 14 are open. Oxygen fed through conduit 7 and heated to a temperature of about 600С. in the preheater 9, is introduced in the mixing zone 11, where it is mixed with the hydrocarbon to be pyrolyzed, fed through conduit 10 and also preheated to about 600С. in the preheater 9. The gaseous reagents are completely mixed in chamber 2 and then, passing through the parallel pipes of the distributor 4, they enter the pyrolysis chamber 5, where they are ignited. The gaseous reaction products are cooled by transversely injecting water from the sprayer 6, whereafter they pass off through conduit 13 to the acetylene purification and concentration unit.

One example of valves and valve control circuits is shown schematically in FIG. 3. Each of the inlet lines and on the outlet line is an emergency shut-off valve: 8 for the oxygen feed line 7, 11 for the hydrocarbon feed line 10, 14 for the product gas exit line 13, and 26 for the preheater fuel line 25. For quick operation these valves are illustrated as sliding gate valves of the gull wing type, having operating levers, sufficiently weighted at 29 to close the valve immediately when released, and a magnetic latch mechanism 31 adapted so long as it is energized to hold up the valve and the weight 30 during normal operation but instantly to release them when the electromagnetic coil 32 is de-energized.

A supplementary shut-off device is shown in this example, i.e., the pneumatically operated flow regulator valves 35 and 36, respectively, for the oxygen and methane supply lines. These are shown as spring-operated to close position and pneumatically operated to open position, being regulated for normal operation by pneumatic pressure lines with pressure-control devices represented by the squares 37, 38; but, for purposes of this invention, solenoid-operated valves 39, 40 are connected between the control devices, 37, 38 and the regulator valves 35, 36. Normally, these solenoid valves merely connect the pneumatically operated valves 35, 36 through the regulators 37, 38, to the pneumatic pressure lines; but, when the solenoid is operated by an emergency signal from the temperature-sensing device 16, these valves 39, 40 close the connections to the regulators, 37, 38 and vent the pressure line from the valves 35, 36, so that each valve is closed by action of its contained spring.

Similar valves 20, 21 and 22 control the emergency supply of a smothering gas such as nitrogen. Valves 20 and 22 are normally pneumatically held closed against the pressure of their springs 41, and are opened by the pressure of the springs when the pneumatic pressure on the pneumatic diaphragms 41 is vented by operation of valves 20 and 22 when the magnetic coils 45 are energized. Valve 21 is inverted, in that it is normally held closed by the spring and is opened by pneumatic pressure.

The electrical circuit for emergency closing of the valves connects all the solenoids 32 and 45 for valves 14, 19, 22, 35, 36, 8, 11 and 26 and the relay 56 in parallel with other from the power source 47 and in series with relay 48 which completes the circuit for all the valves back to the power source 47. Similarly, supervisory alarms will ordinarily be used on the compressed air and smothering gas lines, to be sure that they are always ready for emergency operation. The electrical circuit, as shown, being an emergency protective device, should ordinarily be designed for closed circuit operation with the usual supervisory alarms (not shown) to warn of any failure in the circuit.

With the circuit thus closed in normal operation, the armatures of the solenoids 32 are pulled up (as shown), the connected bell cranks being swung around their fixed pivots 50 so as to push home the latch bolts 31 to engage underlying latches 29. The valve stems are urged down against the latches by the weighted levers 30 pivotally mounted at 51.

The solenoid-operated valves 39 and 40 are held in their upper position, as shown, where the upper vent passage is closed and the lower passage connects the air pressure to the diaphragm chamber 42, so that the air pressure is equalized along the diaphragm and the valve stem connected to it.

The same is true of valves 20 and 22, but with the valves 20 and 22 pushing down the valve stem closes the valve, whereas the valves 21, 35 and 36 are opened when their stems are similarly pushed down. The valve 21 is similarly operated, but is energized through a delay relay 55, the delaying device of which is set to delay closing of the circuit sufficiently after the temperature limit is reached at 16, so that purging of the mixing chamber and furnace begins before additional oxygen in the pipe 7 is purged away by the nitrogen admitted at 18.

The opening of relay 48, by action of the temperature-responsive device 16 de-energizes all of the coils 32, 45 and 56. Valves 8, 11, 14, 20, 21, 35 and 36 are therefore immediately closed, to isolate the mixing chamber and furnace from the reagent supplies and the product treating systems; valves 32 and 40 are immediately opened to flood the isolated part of the apparatus with the smothering gas; and only later, after the predetermined delay, the valve 21 also operates to blow the smothering gas into the oxygen feed line where the relay 55 is closed so as to energize its solenoid 45a and thereby vent its diaphragm chamber 42 through valve 44a. After a sufficient delay, to assure extinguishing of the fire, the relay 48 is again closed and the system is once more restored to condition for operation. Only the amount of nitrogen (or other smothering gas) in the pipes and furnace is left in the system. It is readily separated from the product gases, by renewed normal operation. While the fire area is isolated between the closed valves 35, 36 and 14, any excess pressure is vented through the water trap 15; and, advantageously, the nitrogen or other smothering gas is supplied at a pressure sufficient to cause such venting so as to assure purging the apparatus of any burning gas before operation is resumed.

With a fire or a spontaneous ignition occurs in the mixing chamber, the temperature suddenly rises, the increase producing substantially instantaneous response by the temperature-responsive device 16, which automatically initiates the following simultaneous effects by energizing the magnetic circuits and under the action of the solenoid valves:

(1) Closing the shut-off valves 8 and 11 feeding the gaseous reagents, said valves being automatic and rapidly working, advantageously guillotine valves.

(2) Opening the automatic valve 22, thereby blowing in nitrogen and immediately purging conduit 10 downstream from the stop valve.

(3) Opening the automatic valve 20, thereby blowing in nitrogen and purging conduit 7, near the inlet of the mixing chamber, to block the oxygen contained within the conduit 7 from continuing to support combustion.

(4) Closing the automatic valve 14 on the outlet conduit of the pyrolysis gases, immediately downstream from the pyrolysis furnace, said closing forcing the venting of the gases through the safety device 15.

(5) Closing the heating devices of the preheaters 9 and 12.

After a previously determined period corresponding to that required for purging all the hydrocarbon circuit downstream the valve 11, plus a 50% margin of safety, the automatic valve 21 feeding nitrogen opens, the nitro-
gen thus introduced then purging all the oxygen circuit downstream from the valve 8.

Under such circumstances, the extinction of the flame produced in the mixing chamber 2 is substantially instantaneous in such a manner that the detecting thermocouple 16 in the mixing chamber is not damaged.

For controlling the efficiency of the process of this invention, these two points must be maintained continuously on both upstream and downstream sides of said zones and beyond the points adjacent said zones where said gases are hot.

5. In the pyrolysis of hydrocarbons by partial combustion, a process for rapid extinction of flame within a mixing chamber fed by oxygen and hydrocarbon gas preheated to near the flash point of the hydrocarbon in the oxygen which comprises shutting off the oxygen feed stream at a position upstream of that at which it is heated to said temperature and upstream of that at which the hydrocarbon, blowing nitrogen at higher pressure into the feed stream at a point adjacent to the mixing chamber, whereby oxygen is blocked, replacing the hydrocarbon feed with nitrogen upstream of the means for preheating the hydrocarbon, and venting off flame products and nitrogen downstream from said chamber, whereby nitrogen flows through the mixing chamber.

6. The process according to claim 5 which includes introducing, after a short delay, nitrogen close to and downstream of the point at which the oxygen feed stream is shut off whereby the oxygen therefrom blocked in said stream by the higher pressure nitrogen is flushed from said stream through the mixing chamber by the resulting flow of nitrogen.

7. The process according to claim 5 in which the outlet for the reacted gases from said pyrolysis is shut off immediately when flame is detected in the mixing chamber.

8. The process according to claim 5 which further comprises continually detecting a temperature in the mixing chamber, and automatically initiating said steps of shutting off feed and blowing in smothering gas in response to abnormal temperature rise resulting from ignition of the gases therein.

9. A process as defined in claim 1 in which said shutting off of the feed supply of said flame-supporting gas occurs at a substantial distance upstream from said zones, and in which said smothering gas is blown into said feed supply stream first closely adjacent said zones effecting immediate smothering of said pre-ignition flame in said pre-mixing zone by depriving said flame of further flame-supporting gas and then, after a delay sufficient to smother and extinguish said flame, additional smothering gas is blown into said flame-supporting gas feed stream at a point closer to said shut-off point for purging said feed stream.

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