heating, the periphery of the tube being hotter than the interior. The average amount of heat supplied may be thus brought to the desired quantity, but some of the oil is cracked at high temperatures and some at low. As a result the desired products may never be obtained, for their properties are in no way supplied by mixing the compounds produced by cracking at higher with those produced at lower temperatures. As is shown subsequently, all disadvantages of this sort may be eliminated by simple mechanical improvements.

A more serious objection to cracking in tubes, particularly in those of small internal diameter, such as the $\frac{3}{16}$-inch or $\frac{1}{2}$-inch tubes employed in some of the processes previously mentioned, is the deposition of carbon. This can not be avoided when hydrocarbon mixtures are cracked, as the temperature necessary to bring about partial decomposition of the lighter molecules will inevitably bring about some total decomposition.

Obviously the difficulty of removing from a long continuous coil a deposit of accumulating carbon is considerable. Attempts have been made to minimize carbon deposition by maintaining a high rate of flow through the tubes. In Hall's process, for example, a speed equivalent to 6,000 feet per minute is attained, on the theory that carbon formation and accumulation is much more pronounced at a slow rate of flow than at one of great rapidity.

It is obvious that a coating of carbon on the walls reduces the thermal efficiency of the tube, thereby necessitating a greater fuel consumption to maintain the desired temperature. The carbon deposition necessarily incident to high temperature, with consequent plugging of small tubes, has always justly been considered an objection to any tubular system.

Difficulties on account of the adherence of carbon to the heated contact surface are not confined to tubes. Humphreys,[a] in his letters patent for an improved form of still, states that in the original Burton process only about one-third of the initial charge of oil could be distilled before difficulties resulted through carbon accumulating on the still bottom. Humphreys has endeavored to obviate the danger resulting from excessive carbon deposition by having a still equipped with one or more false bottoms.

ADVANTAGES OF USING LARGE TUBES.

The use of tubes of considerable diameter in place of small tubes obviates the objections advanced against the use of tubes and gives a high degree of efficiency. With vertical tubes 8 inches or more in diameter it has been possible to remove carbon continuously by a mechanical device to be described.

The carbon deposition incident to the gasoline process is almost negligible.

[a] Humphreys, R. E., U. S. Patent 1122003, Dec. 22, 1914.

In the benzene-toluene process, carbon formation is unavoidable. Fortunately, however, it has been possible so to regulate furnace conditions that the carbon appears either as a light powder or a tarry sludge, rather than as a dense and adherent coke.

The use of tubes gives a number of advantages lacking with the conventional still. First, the vertical arrangement of the tubes permits carbon to pass down and out of the cracking or reaction zone, so that it does not interfere with the control of furnace conditions. Second, the cheapness of tubes as compared with stills is an important recommendation. Third, the danger incident to the treatment of large quantities of liquid at a given time is minimized, this feature alone being sufficient to justify the use of the tubes. Fourth, continuous 24-hour-a-day operation is possible with tubes, whereas with the conventional types of still, operation is intermittent because of the necessity of stopping frequently in order to remove unconverted liquid and carbon deposits from the still.

As regards efficiency and low initial cost the tube is believed to have decided advantages over the large receptacle or retort. The fact remains, however, that in the most extensively employed cracking process for producing gasoline (the Burton-Humphreys) stills are used, and millions of gallons of oil are handled yearly. This is, perhaps, evidence of the skill and ability of the inventors and of the operating company rather than proof of the intrinsic superiority of the still.

LABORATORY EXPERIMENTS LEADING TO DISCOVERY OF BUREAU OF MINES PROCESSES.

DESCRIPTION OF EXPERIMENTAL APPARATUS.

The apparatus used for the laboratory experiments here described is shown in figures 9 and 10. It consisted essentially of an electrically heated furnace body made of wrought-iron pipe $1\frac{1}{2}$ inches in diameter and 32 inches long. For a distance of 18 inches the pipe was wrapped with nichrome resistance wire, an insulation of asbestos being placed between the iron pipe and the resistance wire. A $\frac{3}{4}$-inch wrought-iron pipe was welded at right angles into the furnace body to serve as a container for the pyrometer point. Both the furnace body and the side tube were incased in a 5-inch asbestos pipe covering to minimize radiation.

In the upper part of the furnace tube a perforated plate was placed, upheld by a thin rod running vertically through the furnace. The space above the plate was filled with steel balls to facilitate the vaporization of the oil entering the tube, the steel balls being purposely kept above the cracking zone of the furnace in order to preserve their intended function as a vaporizer.