

furnace (combustion chamber). The decision was influenced in considerable measure by the desire of the cooperating company to obtain products in large quantities as soon as possible. Accordingly, a furnace containing a battery or nest of 10 tubes,  $4\frac{1}{2}$  inches in diameter by 10 feet in length, was constructed.

The oil was fed into the tubes by gravity. The amount of oil passing into the top of each tube to be vaporized was regulated by a needle valve placed between the oil-supply compartment and the flange connection on the top of the tube. A great deal of experimentation was necessary in order to keep the rate of flow constant during the continuance of a run. It was necessary frequently to change the piping that led from the oil-supply tanks to the head of the tubes in order to get the proper rate of flow. The general conclusion was reached that gravity feed of heavy oil is undesirable.

The wide variations in the results obtained from the individual tubes, owing to improper control of heating, made it necessary to reconstruct the furnace and alter the methods of heating. The use of a fan blower was found to give improved results in obtaining a proper admixture of air and natural gas, which was used for heating purposes. In each tube a stirring rod, operated by a motor drive, was used for a period of some seven weeks in this furnace. This rod consisted of a pipe to which short lengths of chains were attached, the chains being so staggered as to cover the inner periphery of the tube, as a result of centrifugal action, when the rod was revolved. The use of these stirring rods for the removal of carbon from the inner walls of the tubes was not found satisfactory in tubes of this diameter. After an average of approximately four hours' operation the tubes would be choked with carbon and it was then necessary to remove the rods and clean them of deposited carbon, and also clean the interior of the tubes. Experiments proved that when stirrers were not used the small  $4\frac{1}{2}$ -inch tubes would operate two to three hours longer before becoming choked with carbon than when the stirring rods were used. The use of the rods, therefore, was abandoned so far as this furnace was concerned, and the runs increased in length as a result.

The shaft of the stirring rod, which naturally became highly heated, afforded an excellent place for the deposition of the free carbon caused by the decomposition of the gases. The carbon deposit would gradually build up until it choked the tube and no longer permitted the free passage of the gases. More than a month was consumed in trying to adjust the heating conditions so as to duplicate the successful results obtained with the single  $4\frac{1}{2}$ -inch by 10-foot tube. Although individual tubes would give a fair amount of conversion, other tubes gave relatively slight efficiency. The choking of the tubes after a few hours operation necessitated a shutdown of the