secure this separation of the products, four distinct lines of development have been followed:—

(1) By the insertion of a permeable diaphram between the anode and the cathode.

(2) By employing a mercury cathode which is alternately the cathode in the electrolyzing compartment of the cell and the anode in an adjoining compartment where the amalgam of metallic sodium and mercury is decomposed by water.

(3) By placing the cathode under the anode and depending upon the stratification of the electrolyte which occurs due to the different densities of the brine solution and the caustic solution surrounding the immersed cathode.

(4) By the use of a fused salt electrolyte and a molten lead cathode.

Only the diaphram and the mercury types survived commercial exploitation in this country on account of the inefficiency and cost of maintenance for the other types indicated above under items three and four.

The several forms of diaphram cells which have been commercially operated, consist of two groups:—

(a) Cells with submerged diaphrams and cathodes.

(b) Cells in which the electrolyte comes in contact with one face only of an unsubmerged diaphram.

Very early in the history of electrolysis, Le Sueur, Gibbs, Crocker, Nelson and others conceived and operated cells of the submerged diaphram, or first group. Le Sueur employed a horizontal diaphram and Gibbs employed a circular cell with a vertical diaphram.

The unsubmerged diaphram group is in turn subdivided into two classes,—with permeable and impermeable diaphrams.

All of the permeable diaphrams for both the unsubmerged and the submerged group of cells are composed of asbestos paper or cloth, disposed in the cell in such a manner that they separate it into two distinct compartments, designated (1) as the anode compartment, into which the saturated brine is introduced and where the chlorine is formed; and (2) the cathode compartment, where the caustic soda is formed.

With cells of the submerged diaphram group it is possible to a large extent to keep the chlorine gas and the caustic soda separated by maintaining a liquor level in the anode compartment higher than the level in the cathode compartment, thus inducing a continuous flow from the anode to the cathode chambers. Nevertheless, by osmotic action and mechanical interchange through the diaphram, the salt caustic liquor from the cathode compartments invades the anode compartment and there combines with the chlorine to form sodium hypochlorite, which results in the loss of these two products and causes a rapid disintegration of the anode, as previously noted in the description of the laundry cell.

Cells of the submerged diaphram type operate in practical service at not more than eighty-five per cent. current efficiency (excepting only the Billiter-Siemens cell), with a maintenance which is in direct ratio to their lack of efficiency; because, the less efficient the cell, the more hypochlorite is formed in the anode compartment, with the consequent shortening of the life of the anodes.

Cells of the submerged diaphram type operate with reasonable efficiency during the first few weeks of service after a new diaphram has been inserted, but as the age of the diaphram increases, it becomes less permeable and accordingly more effective as an osmotic vehicle for the contamination of the anode by the products of the cathode compartments.

With cells of the second group, having the diaphram immersed on one side only, the above-described contaminating influences are entirely eliminated, because there is no large body of caustic liquor present in the cathode compartments, since the cathode liquor is withdrawn as fast as it is formed. It follows that in actual service cells of this type closely approximate theoretical current efficiency, with a resulting increased output and a longer life than can possibly be attained by cells of the submerged diaphram type.

The Allen-Moore cell, as installed by the Montreal Water & Power Co., is of the unsubmerged diaphram type and is guaranteed to have a current efficiency of not less than ninety-two per cent.

Description of the Installation.—The chlorine cell installation consists of a salt storage bin (having a capacity of 40 tons of salt), the brine saturating and purifying equipment, two 15-h.p. motor generator sets, four chlorine cells and the silver ejectors and distributing lines for applying the chlorine water to the water to be treated.

The brine saturating and purifying equipment consists of three vertical galvanized iron saturators (twenty-seven inches in diameter by six and a half feet in height, provided with a spray system at the bottom and an outlet six inches from the top), and two concrete reaction tanks having a capacity of 82 cubic feet each. These tanks are built with sloping bottoms and are provided with a pipe grid for air agitation. Two sand filters are provided for filtering the purified brine which passes from the filters to the two concrete storage tanks, having a capacity of 276 cubic feet each.

The distributing lines for applying the chlorine water to the water to be treated are one-inch chemical hose lines, and the chlorine gas is ejected into the water by means of a silver ejector, which maintains a four-inch vacuum on the chlorine cells and takes the gas from the chlorine main through the ejector to the distributing lines.

Description of Chlorine Cell.—The four electrolytic cells are of the Allen-Moore type. Each cell is a standard 600-ampere unit and is 7 feet long by 20⅜ inches wide. Each cell is provided with Acheson graphite anode plates, and pure wrought iron perforated cathode plates. As stated previously, the Allen-Moore cell is of the unsubmerged diaphram type and uses asbestos paper for the diaphram material. Unlike several other types of electrolytic chlorine cells, the cell box of the Allen-Moore cell is made of concrete, properly protected at the surface to withstand the action of the chemicals.

The cells are connected in series and are provided with short-circuit switches or cut-outs. The voltage carried on each cell is approximately 3.3 volts, and each cell is capable of producing 32 pounds of chlorine per 24 hours.

Preparation of Brine Solution.—A small quantity of water under pressure is allowed to flow in the bottom of the saturators. The saturators being charged with salt, a saturated solution of salt is delivered to the two concrete reaction tanks. A sufficient quantity of soda ash is added to the brine in the reaction tanks to combine with the calcium and magnesium salts present in the brine, and the contents of the tanks are agitated for one-half hour to insure complete mixing of the soda ash solution with the brine, and also to hasten the reaction. The solution is then allowed to remain in a quiescent state for one hour to allow the precipitate formed to settle, when the solution is filtered through the sand filters into the purified brine storage tanks. A sample of the purified brine is