to provide the alkalinity necessary to react with the coagulant. The turbidity runs from 1 to 1,400 parts per million, so that at times clay is added to obtain a good floc.

Cost per million gallons for coagulant and operating	$5.91
Fixed charges per million gallons	6.85
Total cost per million gallons	$12.76

We will now turn to a more recent and extensive plant, the softening and purification works at Columbus, Ohio. Messrs. Hering and Fuller were the consulting engineers, Mr. John H. Gregory the engineer in charge. The Scioto River water is a hard water from a limestone region and is polluted at times, so that both softening and filtration are carried on in the same plant. This is the largest water softening plant in the world. Lime and soda ash are used to soften the water, and sulphate of alumina is used as a coagulant. The river water flows through a screen chamber to low lift centrifugal pumps, which force the water into the head house. There the stream is diverted, part going to the saturators to be charged with lime, the major portion going into the mixers, where it meets the lime-charged water and later receives the soda ash. The velocity is kept up in the

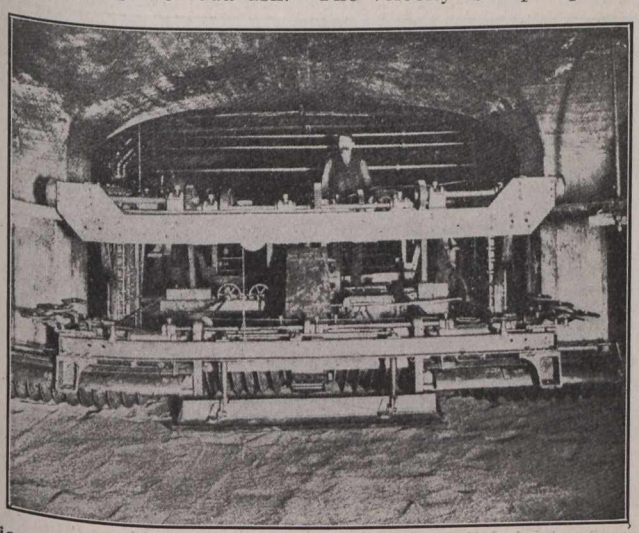

Fig. 3. Filter, Showing Strainer System in Piace, Columbus, Ohio.

mixer, so no sedimentation will occur. From the mixer the softening water flows to the settling basins, where it settles. Coagulant may be added. The settled and coagulated water then passes to the filters and the filtered water travels down into the filtered water basin. The high lift pumps which serve the city are supplied from the filtered water basin. A point of interest in the Columbus plant is the strainer system, built up in successive layers of concrete as shown, with circular brass strainer plates. The air pipes are a separate system placed in the gravel above. The controllers are novel, of a submerged type, invented by Messrs. Gregory and Jackson, working between 1 and 4½ m. g. d. with a loss of head of 12 inches.

The principal details of the plant are:

Pumping Station—

Four 300 h.-p. boilers, B & W type at 160 lbs.

Two Worthington volute low-lift centrifugals, 26" suction and discharge, direct connected to tandem compound Fleming engine, capacity 20 to 25 million gallons daily.

Two Holly high lift pumps, triple expansion, working against a head of 205 feet, capacity 7 to 25 million gallons per day.

Filter and Softening Plant—

Six saturators, capacity 6¾ m. g. d. lime water.

One mixer, 1 hour period, velocity 0.37 feet per second at 39 m. g. d.

One settling basin, 15,000,000 gallons capacity, 20 feet deep, 12 hours storage, nominal.

Ten filters at 3 m. g. d. each, at 125 m. g. d. per acre, 26′ 2″ x 46′ 8″ x 8′ 10½″ deep, net area 0.025 acre.

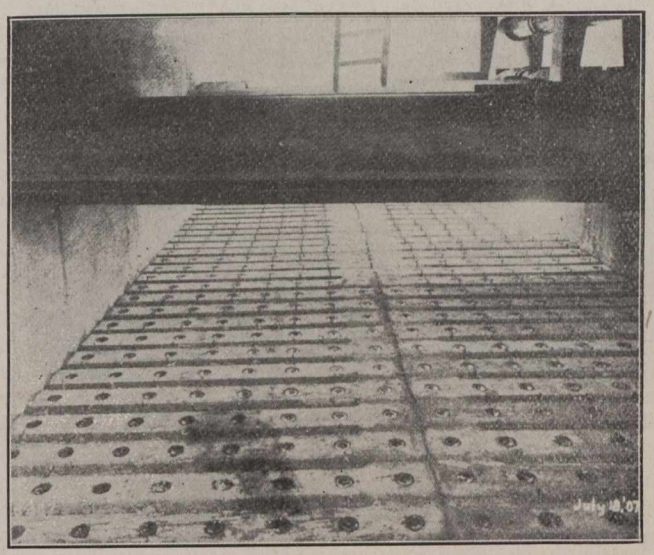

Fig. 4. Filter Showing Air Pipes and Gravel, Columbus, Ohio.

Filtered water basin built in halves, each of capacity 5 million gallons. Total storage 8 hours nominal.

One wash water tank. Capacity 104,000 gallons. Supplied by a wash water pump. This is sufficient to wash 2 filters at the rate of 8 gallons per minute per square foot for 7 minutes each, with the wash water pump running.

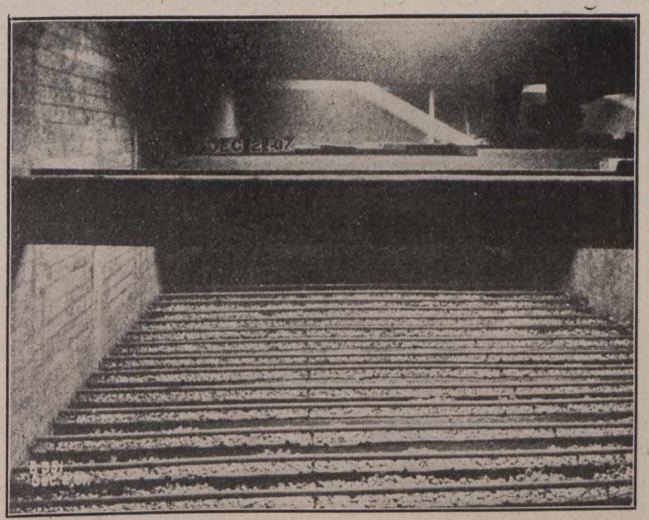

Fig. 5. Filter, Scraping Machine, Pittsburg, Pa.

In am now going to show you a machine for washing sand in place in a slow sand filter. In this scheme the slow sand filter may be run at as high a rate as 10,000,000 gallons daily per acre, in contrast to the usual rate of 3 m. g. d. per acre. The machine is the invention of Mr. Blaisdell of Los Angeles, California, and is in operation at Yuma, Wilmington, Delaware and elsewhere. The apparatus I am illustrating I saw at Yuma and is the original experimental