Variation in the character of sludge is only to be looked for in a great manufacturing district where there are no restrictions on the discharge of trade waste into sewers; but these are sometimes very serious in their consequences, as when large discharges of tarry products from coal, water, or producer gas-plants suddenly appear.

The saving factor in the situation is the system of separate sedimentation and separate sludge-digestion tanks, so that whether it is a sudden increase of volume due to rainfall or an overpowering mixture of antiseptics, the large number of sludge tanks in all states of fermentation renders the scheme at once elastic and manageable. The capacity of the whole of the sludge-digestion apparatus is equal to 165,-

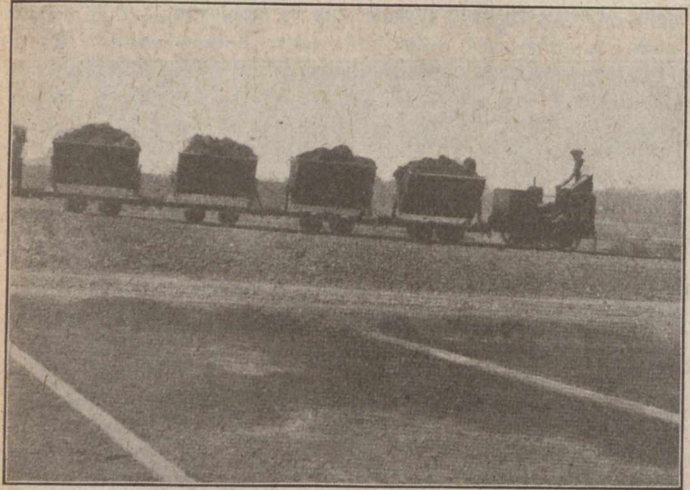

FIG. 7—FIVE TIP WAGONS DRAWN BY ELECTRIC BATTERY LOCOMOTIVE

000 cu. yds., or 28,000,000 gals., which, with the present demand, means a time retention of between four and five months.

The average analysis of the sludge for the four years 1915-18 is as follows:—

Water	92.5	%
Dry solid matter	7.5	%
Specific gravity of wet sludge (estimated)	1.0256	%
Specific gravity dry solid matter	1.50	%

The average analysis of the dry solid matter is as follows:—

Matter volatile at red heat	58.5	%
Matter non-volatile	41.5	%
Total nitrogen	2.71	%

The fatty matter in the crude sludge varies greatly, the actual limits for the figures in the analyses made being from 16.86% to 31%, with an average of 22%. These figures represent a total ether extract, but it is probable that about 2% of this ether extract is resinous matter, and the real fatty matter will be represented by an average figure of about 20%.

Those who see the Birmingham works for the first time are struck by the great distance (about five miles) which separates the sedimentation tanks from the bacteria and sludge-drying beds. In contemplating this it should be remembered that the Saltley section of the Board's works was built more than 60 years ago.

The author is responsible for selecting Minworth as the site of the main works, and the reasons were:—

1. The advisability of obtaining as isolated a site as possible where it would be practicable to have the whole of the works some day.

2. The belief which obtained 20 years ago that a 24-hr. period of septic action was beneficial, and that utilizing the capacity of the existing 8-ft. conduit (6,000,000 gals.) would obviate the need for increasing the tank capacity at Saltley.

3. The fact that the disparity between the falling gradient of the conduit, 2 ft. per mile, and the river, 7½ ft. per mile, provided an available head of 29 ft. with which to spray the sewage over the bacteria beds and eject the sludge from the silt tanks.

Minworth was also selected as the best site for completing the fermentation process of sludge treatment and laying out the drying beds. This involved pumping from Saltley, a distance of five miles—a task which looked more formidable than it turned out to be, the sludge in its fermented state having been found to be more mobile than was expected, a condition due probably to the innumerable air-bubbles between particles acting upon it as so many ball-bearings. This is illustrated to some extent by the photograph of the glass cylinder (Fig. 2), which shows fermented sludge, after a short settlement, held up by the air-globules *above* the clear water. Fig. 3 shows the crude unfermented sludge in a similar glass cylinder with the liquid above the solids.

The improvised lagoons at Minworth, which form part of the installation of 39 tanks, were formed by surplus spoil from the bacteria bed site and dry sludge from the drying bed area, and they perform at least three functions:—

(a) They give time for the completion of the fermentation process.

(b) They permit, with almost no detriment to the installation, the admission of humus from the bacteria beds, flushings from tanks and flushings from distributing pipes.

(c) They act as decanters of supernatant water.

The first is of course the primary purpose of the lagoon.

Imhoff found that he required his fermentation chambers to be large enough to contain from three to six months' storage of sludge. The author finds that the average requirement for the past four years has been equal to a storage of four months.

It has been proved abundantly that sludge dries more readily when the digestive process has been carried to exhaustion before it is pumped to the drying area; hence the economy of ample tankage.

The second is a most important function. The so-called "humus" excreted from a bacteria bed, like the sludge discharged from an activated sludge plant, is a valuable fertilizer, but so far has not been utilized because of its

FIG. 8—FILLING WAGONS WITH DRY SLUDGE

"emulsive" character and the difficulty and expense of dewatering.

When nearly 1,000 tons of it have to be got rid of each day, the importance of dewatering cannot be over-estimated. To pump it back to the beginning of the process (the detritus pit) is a practicable solution in most cases, but not when it has to be forced through five miles of pumping main. Mixing it with the sewage as it entered the silt tanks just before spraying it over the bacteria beds was tried, but was found impracticable owing to the fibrous growths which were introduced into the distributors. Allotting a lagoon to itself with the view of trying to separate solids from liquids

(*Continued on page 427*)