METAL IMPORTS FROM GREAT BRITAIN.

The following are the sterling values of the imports from Great Britain of interest to the metal trades in July, 1898-99, and the seven months ending July, 1898 and 1899:—

	Month of July.		Seven Months to July.	
	1898.	1899.	1898.	1899.
Hardware	£2,190	£1,695	£12,502	£11,145
Cutlery	11,301	3,497	30,798	29 617
Pig iron	928	2,023	7,086	7,072
Bar, etc.	383	2,373	6,042	8,089
Railroad	—	36,533	6,972	57,228
Hoops, sheets, etc.	7,772	16,620	24,047	55,455
Galvanized sheets	8,236	5,071	32,071	35,474
Tin plates	11,946	20,997	83 598	98,091
Cast, wrought, etc., iron	1,839	6,877	15,208	24,412
Old (for re-manufacture)	499	344	3,574	2,003
Steel	5,001	13,079	32,643	43,626
Lead	4,126	5,860	16,058	27,329
Tin, unwrought	1,550	2,925	11,223	12,442
Alkali	3,547	2,056	24,419	18,658
Cement	2,270	3,534	12,153	16,236

SAND FILTRATION OF PUBLIC WATER SUPPLIES.*

BY R. S. LEA, ASSOC. M. CAN. SOC. C. E.

(Continued from last issue).

The layer of gravel serves to support the sand and to conduct the water horizontally to the under-drains. The excessive thickness used in some of the old filter beds is not at all necessary, 12 or 15 inches being quite sufficient. It should consist of three or four layers of graduated sizes, the top one being fine enough to support the sand without any liability of the layers getting mixed. Around the openings into the underdrains the separate stones should be carefully placed so as to avoid any possibility of movement when the water begins to flow. If necessary the gravel must be thoroughly washed before being put in place.

In arranging the underdrainage system of a filter, which includes the gravel bed, the object to be aimed at is to cause the water to sink vertically through the sand, and as nearly as possible at a uniform rate in all parts of the bed. In order to effect this it is evident that the resistance to horizontal motion in the underdraining system must be everywhere nearly the same. Attempts have been made to calculate the proper size of the underdrains, using formulae for the flow of water through gravel and sand of various sizes. A discussion of the matter will be found in the Report of the Mass. State Board of Health for 1892, and also in Allen Hazen's book on the "Filtration of Public Water Supplies," pp. 32-41. With round tile drains, and a daily filtration rate of 2.57 million gallons per acre, Mr. Hazen suggests the following limits to the area which pipes of the different sizes should be allowed to drain:

Diam. of drain.	To drain an area not exceeding	Corresponding velocity of water in drain.
4 inches	290 square feet.	0.30 ft. per sec.
6 inches	750 square feet.	0.35 ft. per sec.
8 inches	1,530 square feet.	0.40 ft. per sec.
10 inches	2,780 square feet.	0.46 ft. per sec.
12 inches	4,400 square feet.	0.51 ft. per sec.

and a cross-sectional area for the larger and main drains of at least 1-6000 of the area drained. With the rate mentioned this would give a maximum velocity in the drain of 0.55 feet per second. These underdrains are variously constructed of open jointed channels of stone or brickwork, or of tile pipes with perforations or open joints. There is no advantage in spacing the laterals more than about 16 feet apart, as the extra quantity of coarse gravel necessary would cost more than the saving in the pipe. In some filters the underdraining has been accomplished by means of a double bottom of open brickwork supported on arches or other arrangements of the same material. The lateral drains usually rest upon the bottom of the basin, but the main drain is often placed lower. If the top of the drain is higher than the coarsest layer of gravel, that part should be closed to prevent the entrance of the fine gravel. In several of the old filters vertical ventilating pipes extend from the under-drains above the surface of the water on the bed. These are for the purpose of allowing the escape of air from below, so as not to cause disturbance by passing through the sand. They are not used in the latest filters, as it was found that they were of no advantage, but rather a source of trouble, through the formation of channels between them and the sand, which allowed water to pass without filtration.

The basin which encloses the filtering materials must of course be water-tight; and in that respect the same care must be experienced in its design and construction as would be necessary in the case of any reservoir for holding water. Its depth will depend upon the thickness of the bed and the height to which the water is to be allowed to rise, but does not usually exceed 10 or 12 feet. The bottom is usually level, or perhaps with slight depression for the lateral drains. The walls may be either vertical or sloping, depending upon the material used. Taking into account the necessity of uniformity in the filtration rate at different points of the bed, vertical sides are probably preferable to sloping. Local circumstances will as a rule, determine the best method of construction and the material to be used. The latter may include stone masonry, brick, concrete, earth embankments, puddle, etc. Concrete is a very satisfactory, and in most cases an economical material to use for any part of the structure.

If a roof is required it should consist of groined arches, supported on pillars, preferably of brick. Care is necessary to obtain a solid foundation for the latter, as the form of roof will not admit of much unequal settlement. A good plan is to form the bottom of flat inverted arches, which will give a firm and even support for all the pillars; and the lateral underdrains will then lie along the hollows midway between the rows of piers. With a roof of this kind, vertical side walls will be more economical than sloping ones. But the plane surface between the wall and the bed must be broken by projections, in order to prevent the liability of unfiltered water passing along the junction; which remark also applies to the piers. It is to prevent this same contingency that the gravel layer is only carried to within 2 or 3 feet of the walls, its place being filled by the sand which here composes the whole depth of the bed. Around the inlet and outlet chambers there should be no gravel within 5 or 6 feet of the walls.

Manholes must be constructed in the roof for the admission of light and air. Also a "run" for entering and removing the sand scrapings, etc. With piers spaced 14 or 16 feet on centres a light and strong roof can be built of concrete at a very moderate cost. When the roof is finished it is covered to a depth of two or three feet with earth surmounted by a layer of loam, which may be seeded down or laid out in flower beds, etc. For open filters the sides may be of earth embankments, made water-tight by a layer of puddle or concrete. If of the former, a paving of brick is necessary, which must be of sufficient strength to withstand the action of the ice where it is exposed.

Before proceeding with the methods of operating a filtration plant we will discuss it with reference to these important features, the inlet, outlet, underdrains, etc. With a given flow of water through the bed, the vertical distance H represents the head required to force this quantity through the surface film, the sand, gravel and underdrains. It is variously termed "loss of head," "head on the filter," "filtering head." The depth of water in the majority of European filter beds is usually from 3 to 4 feet, with the full depth of sand. In some of these filters it was allowed to rise and fall according to fluctuations in the removal of the effluent. Such variations in depth, however, are found to have an injurious effect upon the surface layer, and on the efficiency of the filtering process; in the newer plants, therefore, they are provided against by an apparatus on the mouth of the inlet pipe, by which the water when it reaches a certain height automatically closes the inlet. These consist usually of some form of balanced valve worked by a float. In connection with an open filter, such an arrangement must be protected from frost. The inlet opens into a small chamber at the side of the bed, from which it is separated by a wall. The water flows over the wall on to the bed, and is prevented from disturbing the surface of the sand by paving it for a short distance from the chamber. Sometimes the water enters by overflowing an open masonry channel extending across the surface of the bed. The loss of head, corresponding to a given rate of flow of water through the filter, will depend upon the extent to which the surface film has formed, and the friction in

*From a paper read before the Canadian Society of Civil Engineers.