$$\text{N.O.C.} = \frac{11430 + 299 + 89808}{240000000} = \$0.000423 \text{ per bushel.}$$
$= 42.3$ cents per thousand bushels.
Equivalent to about \$0.01692 per ton.

II. Conditions :—
The same as Example I, except that service is 12000 hours per year.

$$\text{N.O.C.} = \frac{11430 + 299 + 44904}{120000000} = \$0.000472 \text{ per bushel.}$$
$= 47.2$ cents per thousand bushels.
Equivalent to about \$0.01888 per ton.

III. Conditions :—
The same as Example I, except that the material handled is fine (small size) coal.

$$\text{N.O.C.} = \frac{641 + 12.017 + 3736704}{240000000} = \$0.01557 + \text{ per ton}$$

IV. Conditions :—
The same as Example III, except that service is 1200 hours per year.

$$\text{N.O.C.} = \frac{641 + 12.017 + 1868352}{120000000} = 0.01558\text{—per ton}$$

Assuming conditions that are commonly encountered in practice, the accompanying examples well illustrate the real economic value of the screw conveyer and they also bring out apparently surprising facts. Under the conditions considered, it will be noted that the screw conveyer is not relatively as economical a method of handling grain as it is for handling heavier materials such as coal, ore or cement—that is, when measured by weight of material conveyed. This is true even though the depreciation, renewals, repairs and similar expenses are only about one-third as great in a grain conveyer as in a conveyer subjected to the more severe operations of handling the heavier materials. The reason for this is that proportionally to the weights of the materials the capacity of a screw conveyer is very much less when handling the relative light grain and, as less power is also required for the operation of any given size of conveyer of specified length carrying grain, the burden represented by interest on investment, insurance and taxes, which amounts to a more or less constant sum per year, irrespective of the nature of the material handled or the number of hours the equipment is in operation, is, in the case of the relatively light grain, considerably greater per weight of material handled. The average weight of grain, etc., is from 25 to 50 per cent. lighter than the weight of a similar quantity of ore, cement, etc., and though the economic value of a screw conveyer as a carrier for the two classes of materials does not vary to quite such an extent, still, an appreciable difference does exist. Another interesting point brought out by the examples is that the economic value of the equipment is not affected as much by the hours of operation when handling the heavier materials as when carrying the lighter grains. This is also due to the fact that for the more severe work the item of power is very much greater proportionally than when the working conditions of the conveyer present less difficulty. Nevertheless, screw conveyers are frequently employed in the handling of grain and of materials of similar nature and are decidedly economical at such service; particularly when they are long, as then the overhead burden is somewhat lessened.

A modification of the standard type of screw conveyer that has been considered is extensively used in the mixing of several materials while they are, at the same time, being conveyed from one location to another. For instance, in the mixing and delivery of concrete. Such conveyers usually have the spiral flight in the form of succeeding paddles in place of a continuous ribbon, or else have double flights, one a ribbon flight for conveying and the other a system of paddles for agitating and mixing the ingredients. These adaptations, however, although they are examples of apparatus for mechanically handling materials, should not be classed with standard types of conveying machinery, the principal subject of the present discussion.

[NOTE.—This is the second of a series of articles bearing upon the Mechanical Handling of Materials written for *The Canadian Engineer*. A third article will follow in an early issue.—Ed.]

WATERPROOFING OF CONCRETE.

Although it did not arrive at sufficiently definite conclusions to enable it to formulate specifications for the making of concrete structures waterproof, or for materials to be used in such work, the Committee on Waterproofing Materials, of the American Society of Testing Materials, reached certain conclusions which will be of assistance in securing impermeable concrete. These formed the basis of the committee's report at the convention in Atlantic City in June.

The work was found to subdivide naturally into three branches:

1. The determination of causes of the permeability of concrete, and the best methods of avoiding these causes.

2. The rendering of concrete more waterproof by adding other substances.

3. The treatment of exposed surfaces after the concrete or mortar has been put in place, either by penetrative, void-filling or repellent liquids, making the concrete itself less permeable; or by extraneous protective coatings, preventing water having access to the concrete.

These several subdivisions were considered separately:

Causes of Permeability of Concrete.—In the laboratory and under test conditions using properly graded and sized coarse and fine aggregates, in mixtures ranging from 1 cement, 2 sand and 4 stone to 1 cement, 3 sand and 6 stone, impermeable concrete can invariably be produced. Even with sand of poor granulometric composition, with mixtures as rich as 1 cement, 2 sand and 4 stone, permeable concrete is seldom, if ever, found and is a rare occurrence with mixtures of 1 cement, 3 sand and 6 stone. But the fact remains, nevertheless, that the reverse often obtains in actual construction, permeable concretes being encountered even with 1 cement, 2 sand and 4 stone mixtures, and are of frequent occurrence where the quantity of the aggregate is increased. This the committee attributed to:

(a) Defective workmanship, resulting from improper proportioning, lack of thorough mixing, separation of the coarse aggregate from the fine aggregate and cement in transporting and placing the mixed concrete, lack of density through insufficient tamping or spading, and improper bonding of the work joints, etc.

(b) The use of imperfectly sized and graded aggregates.

(c) The use of excessive water, causing shrinkage cracks and formation of laitance seams.

(d) The lack of proper provision to take care of expansion and contraction, causing subsequent cracking.

Properly graded sands and coarse aggregates are rarely, if ever, found in nature in sufficient quantities to be available for large construction, and the effect of poorly graded aggregates in producing permeable con-