

# CITY REFUSE AND ITS DISPOSAL.\*

## A DIFFICULT METROPOLITAN PROBLEM.

BY H. DE B. PARSONS.

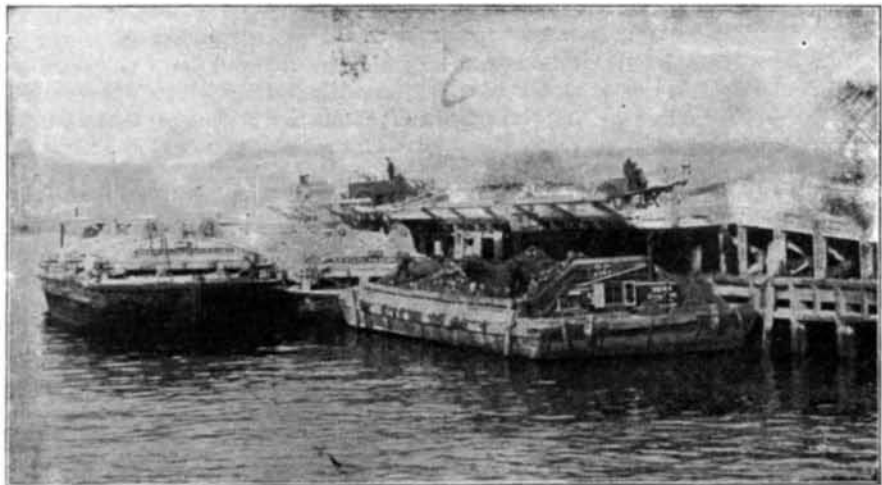
CITY-WASTE materials may be divided into three parts: sewage; city refuse; and trade refuse. These may be further subdivided as in Table I.

The total refuse, excluding snow and dead animals, collected in the year 1906 by city and permit carts

fuse, as collected in the Boroughs of Manhattan and the Bronx, city of New York, are: Garbage, 1,110 pounds per cubic yard; ashes, 1,086 pounds per cubic yard; rubbish, 143 pounds per cubic yard; street-sweepings, 1,016 pounds per cubic yard. The weights

be used to reclaim land where a combined collection would be decidedly objectionable. In such case, the garbage, rubbish, and sweepings have to be dealt with separately.

2. *Dumping into water.*—All classes of refuse could



A TYPICAL NEW YORK DUMPING BOARD.

Barney dumper under outer board is receiving ashes; scow under nearer board is receiving garbage.



ONE OF THE NEW STEEL COLLECTING WAGONS.

A vehicle for the sanitary carrying of refuse.

from the five boroughs of Greater New York amounted to 3,159,182 tons. The average quantities of refuse

per cubic yard of these materials as collected in other boroughs vary to some extent. The greatest differ-

TABLE I.  
Classification of City Wastes.

Sewage	Liquid and Semi-liquid Refuse	House sewage. Street, roof and area drainage. Night soil.
City Refuse	Household Refuse	Garbage
		Animal matter. Vegetable matter. Meat and bones. Fruit.
	Ashes	Steam ashes. Household ashes.
		Paper. Wood. Rags and bedding. Leather and rubber. Metals. Bottles, glass and crockery. Sweepings from buildings.
	Rubbish	Animal manure. Pavement dirt. Droppings from carts. Materials from building construction. Rubbish and leaves.
Street Refuse	Street sweepings	
	Dead animals	
Trade Refuse	Snow	Cellar excavations. Materials from building construction. Stable manure. Market offal. Slaughter-house offal. Dead animals.

collected yearly per capita in Greater New York are given in Table II.

The average weights of the different classes of re-

TABLE II.  
Average Yearly Collection of Refuse Per Capita.

	Pounds.	Yards.	Percentages.	
			By Weight.	By Volume.
Garbage.....	181	0.163	12.31	8.45
Ashes.....	936	0.862	63.68	44.64
Rubbish.....	93	0.650	6.33	33.65
Street sweepings.....	260	0.256	17.68	13.26
Total refuse.....	1470	1.931	100.00	100.00

ence is noted in the unit weight of street-sweepings, which from macadam roads are heavier than those from asphalt or stone block pavements.

*Methods of disposal.*—There are six generally recognized ways for disposal of refuse, some of which are limited to one or more of the subdivisions of Table I. These are:

Methods.	Application to
1. Dumping on land.	All subdivisions.
2. Dumping into water.	All subdivisions.
3. Plowing into soil.	Garbage and street-sweepings.
4. Feeding to swine.	Garbage.
5. Reduction process.	Garbage.
6. Incineration.	All subdivisions (except steam ashes).

1. *Dumping on land.*—Where primary separation is in force, ashes, with or without street-sweepings, can

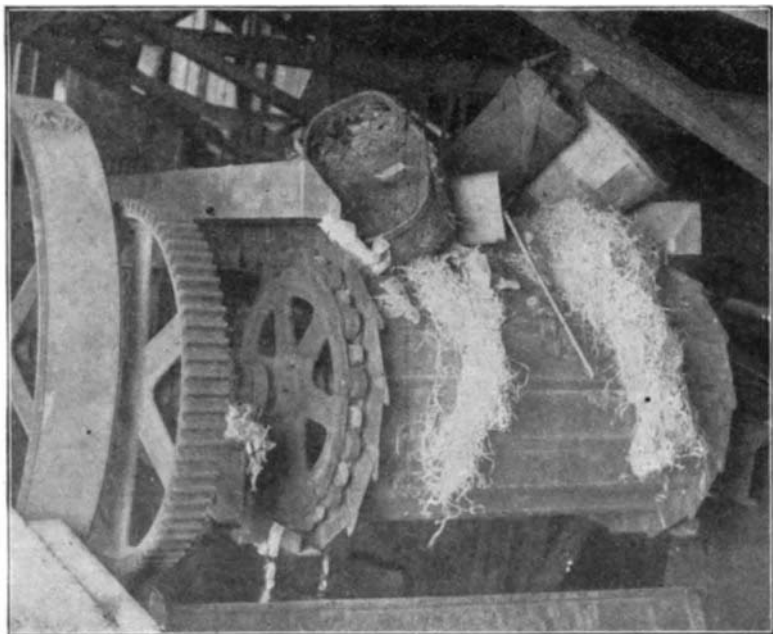
be dumped into water provided that the water is large enough in volume to dilute and scatter those portions which float, and deep enough to permit the heavier portions to sink without interfering with channels or navigation. Unless there be an almost uniform current away from the neighboring shores, this method cannot be recommended, and, where in use, efforts are made to abandon it in favor of some other.

3. *Plowing into soil.*—This method is only applicable to garbage, and possibly to street-sweepings. The soil should be sandy and the farm area large. The hauls will be necessarily long, and it requires the primary separation system for collection. It is inapplicable to cold climates where the ground freezes.

4. *Feeding to swine.*—This is a method applicable only to fresh garbage, unmixed with other refuse. It is seldom considered for large cities.

5. *Reduction.*—These processes consist of some method of "rendering" the garbage, by which the oil and grease are extracted, leaving a residue called "tankage." It is only applicable to garbage practically freed from rubbish, and can only be adopted by large cities, for, unless there be sufficient garbage, the first cost is prohibitive. Furthermore, it is only profitable when the garbage is rich in grease, which is one reason why it has not been more generally adopted by the southern cities of the United States. The best known systems are the Arnold, using live steam for melting and cooking; the Merz and the Simonin, using a solvent like naphtha and benzene.

The oil and grease are sold at a price varying from 2 to 4½ cents per pound. The crude oil is refined by the purchasers and used for commercial purposes. Its chief constituents are glycerine, stearine, and red oil.



RUBBISH DISCHARGED BY CONVEYER BELT INTO FURNACE HOPPER.



RUBBISH ON THE TRAVELING CONVEYER BELT.  
The pickers sort out over half the material and sell it; the rest is conveyed to the furnaces.

### THE DISPOSAL OF CITY REFUSE.

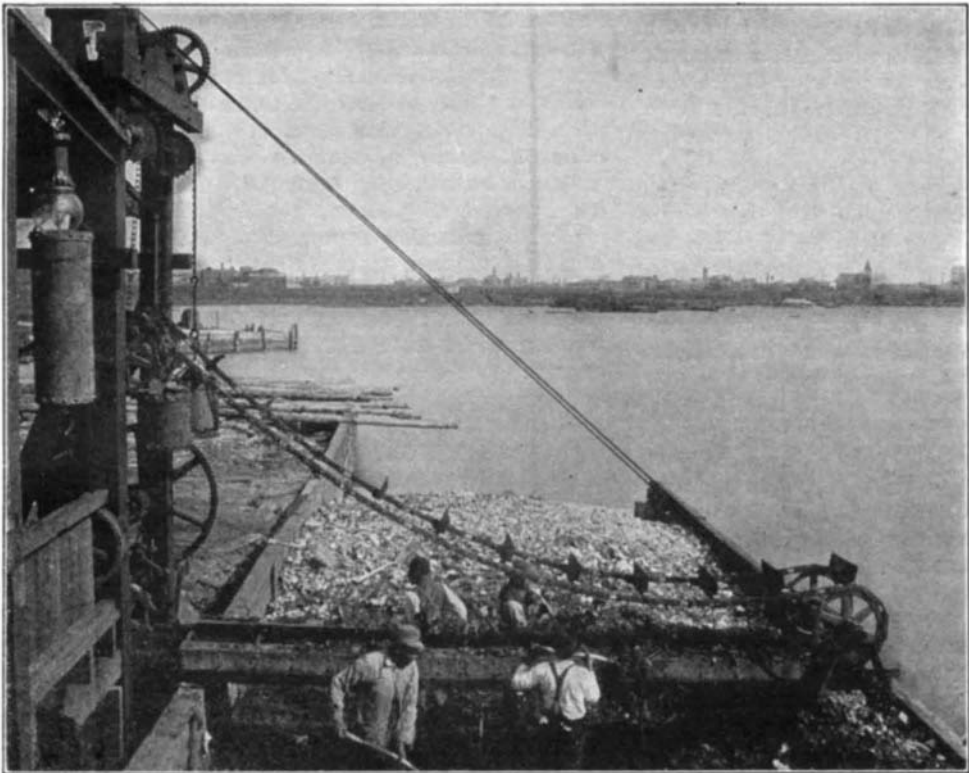
The tankage, when dried and ground, is odorless and dark brown in color. It is sold as a base for the manufacture of commercial fertilizers, and the principal market is in the Southern States. The price is based on the "units" of ammonia which it contains

are successfully worked by contract, a bonus is paid for the reduction.

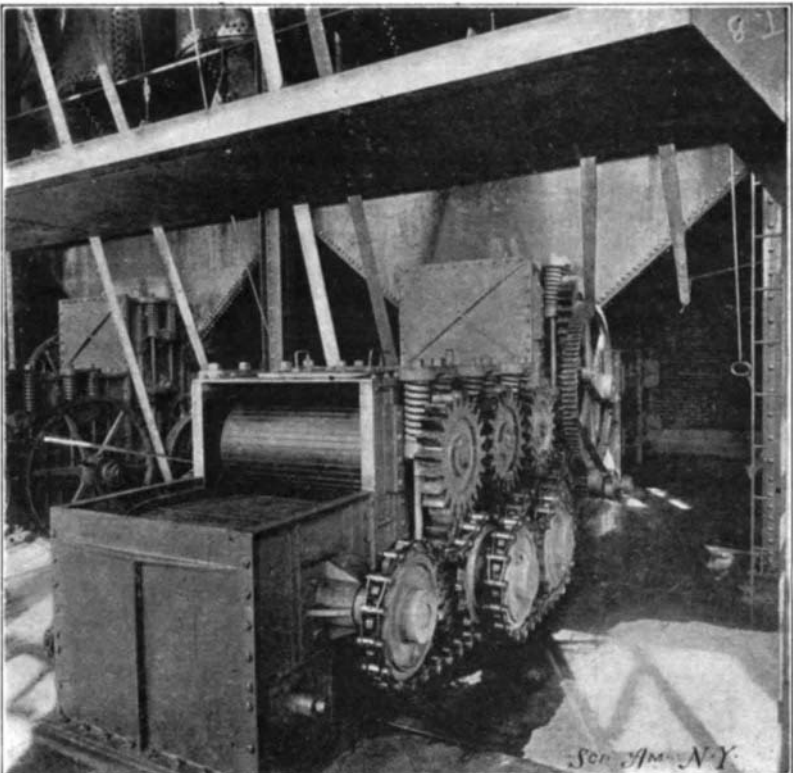
The advantages of reduction are:

1. The organic or putrescible matter of the garbage is converted into grease and tankage, which are harm-

garbage. There is no advantage in incinerating ash collections alone, as the expense would probably exceed the gain. It may be practicable at some future time to separate the coal and cinders, and such a process has been proposed, but not tried on a sufficiently large



AUTOMATIC CONVEYER FOR UNLOADING GARBAGE. (BALTIMORE PLANT.)



DETAILS OF THE PRESS OF THE BALTIMORE PLANT.

and its freedom from grease, and is variable. The tailings, or discarded tankage, are generally burned in the plant for fuel.

An approximate average working analysis of a reduction works is:

	Per Cent by Weight.
Water and factory losses.....	55
Grease (and oil).....	3
Tankage.....	9
Tailings.....	3
Total.....	100

The first cost of a reduction plant is large, on account of the expensive machinery required; and the cost of operation and maintenance is high, because of the labor, fuel, wear and tear on the machinery and the corrosive action of the acetic and other acids produced during certain stages of the process. In general, reduction plants are not self-supporting, even if the garbage is delivered free at the works. In Cleveland, Ohio, a reduction plant is used by the municipality, and it is the only plant for which the financial details are available. The works are about self-supporting when the garbage is delivered to the plant without charge and when grease can be sold for at least 4 cents per pound. In cities where such works

less. Therefore, the garbage can be cared for in a sanitary manner.

2. It saves components which have a commercial value.

3. With a properly designed and carefully worked plant, the process need not be a nuisance, and its adoption adds a manufacturing industry to the city.

The disadvantages are:

1. Expensive machinery and apparatus with large costs for renewals and repairs.

2. The offensive odors that are apt to be given off require expense to prevent an annoyance.

3. As the works have to be situated at some distance from the city, haulage is an important factor.

4. Requiring skilled labor, there is some danger of strikes.

5. The garbage must be separately collected. There will always be some foreign material, tin cans and the like, which requires sorting out at the works.

6. There is usually but one plant, as a number of small plants would not pay. The whole system, therefore, would be crippled by fire or by any other cause that would stop the plant.

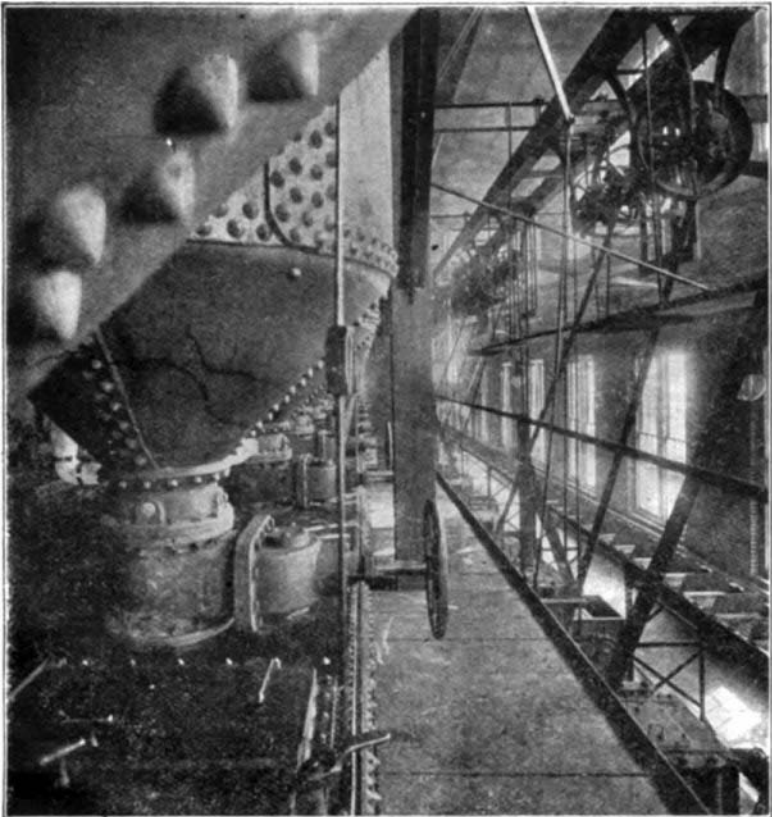
7. The process provides for the garbage only, leaving the remaining refuse to be treated otherwise.

*Incineration.*—Garbage cannot be incinerated alone unless previously dried or unless a fuel is used. It requires about one pound of average coal (10,000 B.T.U.) to incinerate eight pounds of raw New York

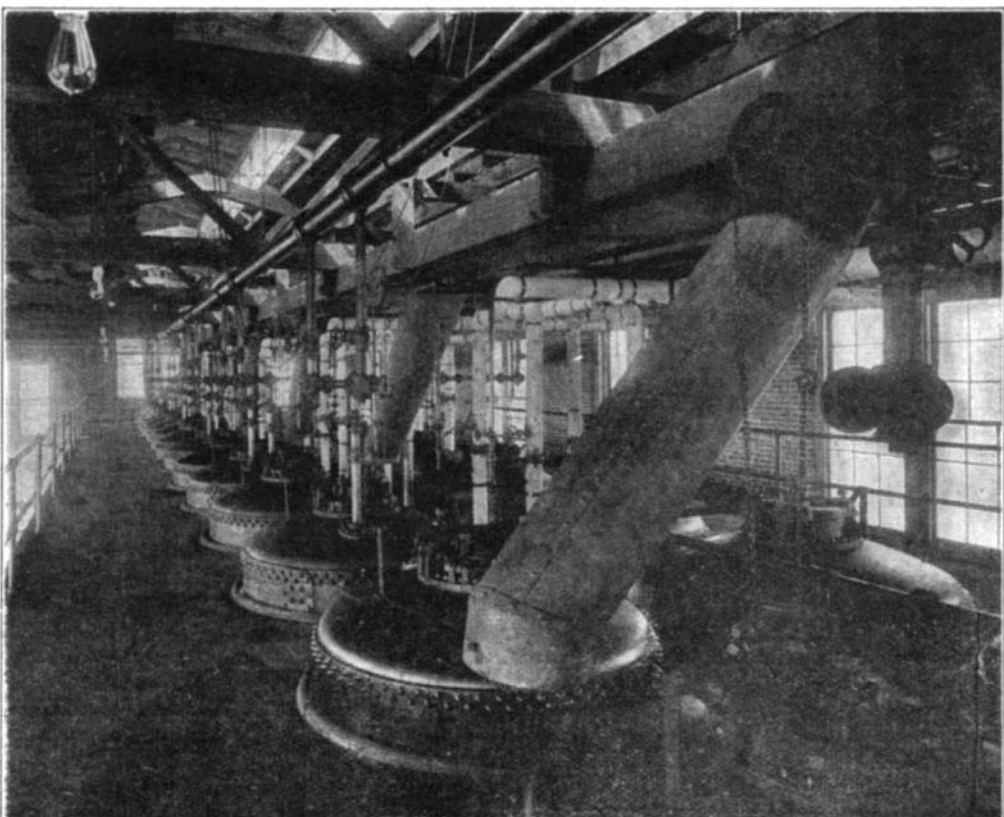
scale to warrant any predictions as to success. Rubbish burns readily and produces great heat. Some difficulties have been experienced by the production of slag. Street-sweepings from the better paved and centrally located streets will burn, as ordinarily collected, without the addition of other fuel, particularly as they contain a large amount of rubbish. When different classes of refuse are mixed, the aggregate is self-combustible, the coal and cinder in the ashes and the rubbish supplying the fuel required to dry the garbage and street-sweepings.

Sanitary incineration requires a high temperature not only to destroy offensive matter, but to make the escaping gases innocuous. The average temperature in the combustion chamber should be at least 1,500 deg. F.

The residue from incineration of mixed refuse amounts on an average to about 33 per cent by weight, or 60 per cent by volume. The volume at the destructor is large on account of the spaces between the clinkers, but when placed in a dump the volume is less, as the fine ash and dust work into the spaces. The heat may be utilized for power, and the clinker and ashes for brick-making, concrete-mixing, and for filling. It would be possible to press crude garbage and drain off some 15 per cent of the water beforehand, but this would add complications and might not pay in some places. On the other hand, it might render incineration possible in places where the other classes



THE VALVE GALLERY IN THE DIGESTER DEPARTMENT OF THE BALTIMORE PLANT,



UPPER PORTION OF THE DIGESTER DEPARTMENT, SHOWING THE TOPS OF THE DIGESTERS AND FEED PIPES. (BALTIMORE PLANT.)

THE DISPOSAL OF CITY REFUSE.



of refuse are not fully collected or not found in quantity. In order to obtain high temperatures in the furnace, artificial draft should be used. One of the advantages of the plenum system for artificial draft over any form of induced or vacuum draft is the preventing of an inrush of cold air to chill the furnace when the doors are opened for firing, and the use of loose-fitting fire doors, which are more easy to operate than tight-fitting doors required for the induced systems. The draft pressure varies from 1/4 inch to 3 inches of water pressure, but should not be too great, as holes are apt to be burned in the fuel-bed and the stoking requires too constant attention. Probably a 1 to 1 1/2 inch pressure is sufficient, but the best pressure should be determined by experience for each locality. The air supply in the blast should be about 46 cubic feet, or 3 1/2 pounds per pound of average mixed refuse. Many furnace designers prefer a steam jet to an air blast, and both systems have their advantages.

In America the failures have been chiefly due to incorrect designs of furnaces, large grates, slow combustion, low temperatures, too much reliance on stoking, and inexperienced firemen. Unless high temperatures are generated in the furnace cell, the garbage mass will be subjected to frying rather than to cremation, and odors are sure to be discharged from the stack. The furnace should be designed only after careful study of successful plants. Owing to the high temperatures maintained, the fire-brick work should be laid up with freedom for expansion. The fire-bricks, according to the experience of George Watson,\* should be laid with very close joints, and consist of from 60 to 70 per cent of silica, with 30 to 40 per cent of alumina. While a little iron is harmless, potash and soda tend to act as a flux, and should be present only in small quantities.

- The advantages of incineration are:
1. When properly worked, it destroys all organic matter and offensive gases and reduces to ash all garbage, ashes, rubbish and street-sweepings.
  2. The collections of ashes, rubbish and street-sweepings furnish the fuel. Garbage will also burn after drying.
  3. Some revenue can be obtained from the heat generated through its conversion into power.
  4. The system is sanitary, as fire is a sure destroyer of all germ life.
  5. The hauls can be short, as a number of incinerators can be built and worked to advantage.
  6. Civic authorities can work these plants better than reduction works, as they are more simple and less commercial.
  7. No necessity for separate collections.
  8. As a number of plants can be built, the risk of interference by fire or other causes of stoppage is reduced.

- The disadvantages are:
1. The necessity of having expert firemen, and of exercising great care to make the incineration satisfactory.
  2. When not properly designed or worked, incineration plants emit objectionable odors and dust.
- Fuel values.**—Table III gives approximate calorific values for the different classes of refuse, as collected in New York, and may be taken as representative of a large American city in the Northern States.

TABLE III.  
Approximate Calorific Values of Refuse in B.T.U. per Pound.

	Dry Material.	Material as Collected, Including Water.
Garbage	8,700	1,800
Ashes	3,000	1,800
Rubbish	7,500	6,500
Street Sweepings	7,000	3,600

In a mixed collection, these classes are found in about the following proportion, so that the combined calorific value would be approximately determined by the following calculation:

	Percentage Collected by Weight.	Calorific Value, B. T. U.
Garbage	12.3	221
Ashes	63.7	1646
Rubbish	6.3	409
Street Sweepings	17.7	637
Total	100.0	2913

This calorific value is about one-quarter of that of coal. If a ton of coal is worth, say, \$3, then the mixed refuse would be worth about \$0.75 per ton, less the additional cost of the handling of the refuse. One cubic yard of mixed refuse weighs about 960 pounds and of coal about 1,300 pounds, that is, the bulk of the refuse is about one-third more than that of coal for equal weights. In the same way the effi-

\* George Watson, Trans. Amer. Soc. M.E., 25, 1904.

ciency of the furnace for burning refuse is less than that for coal, when considered as a heat generator. Rubbish collections in New York have been burned on a large scale and accurate data obtained. (See Transactions American Society of Civil Engineers, 57, 1906.) Trials were made in December, 1905, to determine the rate of evaporation of water per pound of rubbish burned, and the results were an equivalent from and at 212 deg. F. of 1.64 pounds and 2.16 pounds. Subsequently, other trials were made by different observers, which gave equivalent water evaporations of 2.28 pounds, 2.29 pounds, and 2.17 pounds, respectively, per pound of rubbish.

The Borough of Westmount, Canada, has a mixed refuse destructor plant, which is worked in connection with the municipal electric lighting station. The average result, extending over a period of eight months, was that 2,000 pounds of refuse were equivalent to 283 pounds of coal. An evaporation trial, made in May, 1906, gave an average equivalent evaporation of 1.36 pounds of water per pound of refuse. The equivalent evaporation reported by J. T. Fetherston for eighteen European destructor plants, were, maximum 2.66 pounds, minimum 0.88 pound, and average 1.62 pounds of water per pound of refuse. These are gross evaporations, and in order to obtain the net useful steam produced for power purposes it is necessary to deduct that used for the forced draft apparatus.

**Disposal.**—The costs of incineration are not easily obtainable, because the figures are not always reported, and when reported are not on the same basis and are, therefore, not comparable. Furthermore, there are very few high temperature incinerating plants in America. The heat generated is unquestionably a valuable asset, but it should always be treated as a by-product. The object of an incinerating plant should be primarily to destroy the combustible portion of the refuse, and to reduce the several kinds to ash, thus leaving but one grade of material to be handled for final disposition, which is suitable for land filling and other purposes.

Closely associated with economy is the question of haulage. If the collection carts have long hauls to the central receiving stations, it means the maintenance of a large staff of men, horses and carts. The hauls, therefore, should be as short as possible, which can be secured by dividing the municipality into districts and placing in each district a receiving station. The ideal system would treat the material in these receiving stations, simply leaving the removal of the residue to the place for final disposition.

Garbage could not be treated by the reduction process in this way, as the reduction plants are not economical in small units, and are liable to be offensive. Where the reduction process is adopted, a system of primary separation allows the garbage alone to have the long haul to the reduction works, while other refuse could be delivered to the central stations and have the benefit of the short haul.

In comparing methods on a basis of costs of maintenance and working, it is proper to include in the costs the disposal of all the city refuse. Some methods can treat one, two, or more of the subdivisions, while others can handle but one.

The following items of cost will be found of interest:  
**COST OF COLLECTION, CITY OF NEW YORK, 1906.**  
Garbage, Ashes, Rubbish and Street-sweepings.

	Manhattan and the Bronx.	Brooklyn.
Total cost	\$1,744,300	\$772,900
City cart loads	1,747,871	630,000
Cost per cart load	0.999	1.225

**COST OF FINAL DISPOSITION, CITY OF NEW YORK, 1906.**  
Garbage, Ashes, Rubbish and Street-sweepings.

	Manhattan and the Bronx.	Brooklyn.
Total cost	\$215,300	\$468,800
Cart loads	2,313,286	738,056
Cost per cart load	0.352	0.635

MANHATTAN AND THE BRONX.		
	Garbage.	Ashes, Rubbish and Street Sweepings.
Total cost	\$218,300	\$582,200
Cart loads	250,260	2,043,724
Cost per cart load	0.873	0.285

**COST OF INCINERATION, MIXED REFUSE, WESTMOUNT, CANADA. INCLUDING OPERATION, REPAIRS, RENTS, AND TAXES, 1907.**

	Sinking Fund and Depreciation.	
	Without.	With.
Incineration, one ton	\$1.05	\$1.34
Revenue from steam	.55	.55
Net cost of incineration	.50	.76

STUDYING THE CONDOR IN ITS NATIVE HAUNTS.\*

By WILLIAM L. FINLEY.

IN October of 1895, a pair of California condors (*Gymnogyps californianus*) were seen about one of the canyons of a certain range of mountains in Southern California. A search was made for the home of these birds at the time, but it could not be found. Every year since then, the pair of big birds have been seen, and many times efforts made to find the nest, but each time the hunters returned unsuccessful. One year additional evidence was found in the bleached bones and scattered feathers lying in the bed of the canyon. This bird was in all probability the young of that year and was ruthlessly destroyed by the rifle of some wanton wanderer. In 1905 the pair of old condors and a young bird, hardly able to fly, were seen perched on the limbs of an old dead tree, and the place was marked as this seemed to be definite proof that the home was nearby. But even this apparently definite proof was far from revealing the condor's nest in the rocky crevices and cliffs of the mountain side.

On March 10, 1906, I set out with two companions to make further search for the nest, and after a long and arduous search discovered it, the mother bird having been frightened into revealing it by pistol shots.

We climbed to the rock above the nest and found it was a huge boulder set well into the mountain. Against this was leaning a big stone slab about ten feet high. This left a space about two by six feet and open at each end. This cave was lined with leaves and fine rock and in the middle was one big egg. We thought it was not far from hatching by its glossy surface and the tenacity with which the mother stayed on her nest.

It seemed to be the sound of the pistol that the condor feared, for that alone had made her leave her home. Twice one of the boys had crossed above the nest, and we had been yelling back and forth, but she had paid no attention to that.

A few days later we returned to the spot with camera, to obtain if possible a photographic life history of a bird which will soon be extinct. A heavy sea-fog hung low over the country, but we had hopes that there was blue sky beyond. As we went on the fog did not clear, and the prospects were indeed gloomy. We finally stowed away part of our equipment in the brush and with one camera started off.

When we climbed over where we could look between the rocks and see into the cave, the old bird was on. I went closer and could see her bald head of orange color, and the great black bird still sat on the nest. I climbed up within four feet of her and whistled and yelled till she rose on her feet. She looked so big that I shrank back at the thought of her pitching in to defend her young, for when she rose, I glanced in and saw a youngster not larger than the egg. His head was bald like his mother's, but baldness did not signify age in this case, although his head was fleshy-pink in color. He was weak, for he could hardly kick, and he seemed to raise his head with difficulty as he cried out in a wheezing, hissing note. Beside him lay the end of the egg from which he had emerged not many hours before. He was not yet dry. He was not even well clothed, for behind his little wings, the flesh was bare and his belly was bare, while the rest of his coat was down of pure white.

At first the mother arose and her neck feathers ruffled up in anger. Then as her baby began to squirm, she put her head down and covered him partly with her bare neck. Then it was evident we could not scare her from her den. But we had to have a picture of this baby bird, the nestling of the largest bird that flies, and one that is so rare in the ornithological world. Crawling over closer where I could look through the crevice in the rock, I got down within three feet of the mother as she sat hovering her chick. I could almost touch the white on her shoulder and plainly see the blood-red eyes that watched me, and the edging of white on her wing feathers. But she sat still till I reached in with a short stick, when she drew back as if to strike, but I had the advantage of her, for I knew that in that narrow place the big bird was almost helpless. When she arose and stepped back, I gently rolled the chick over nearer to me and reached in and took him in my hand. The mother sat in sullen silence.

We immediately set up the camera in the pelting rain and focused it on a sheltered spot just outside the den of the old bird, then placing the chick on the ground, took a snap of him. Covering him quickly so as to keep him warm, we tried four more exposures in about the same position. But the darkness of the weather made a slow exposure necessary and the youngster wiggled most of the time. But by that time it suddenly dawned on us that he was getting chilled and I hastily put him back in the nest.

But to my chagrin, the old bird just sat with her head down and paid no attention to the chick under her nose, who had now grown too weak to even squirm.

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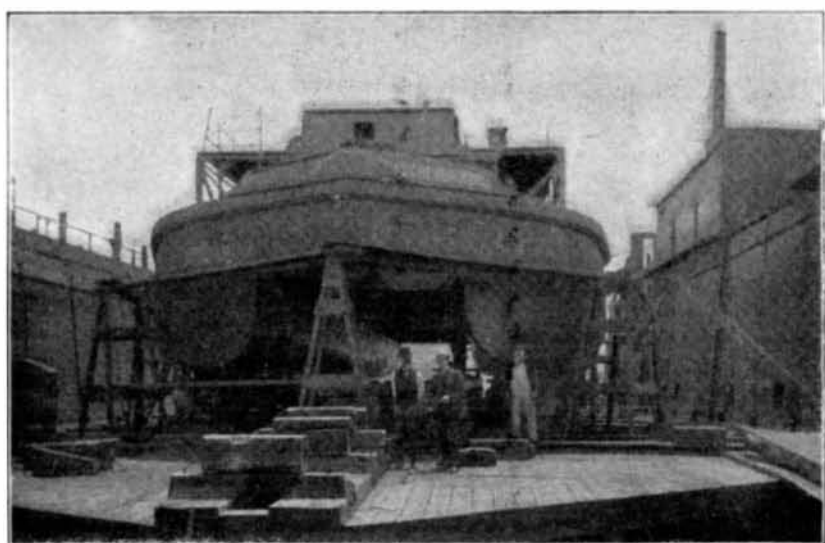
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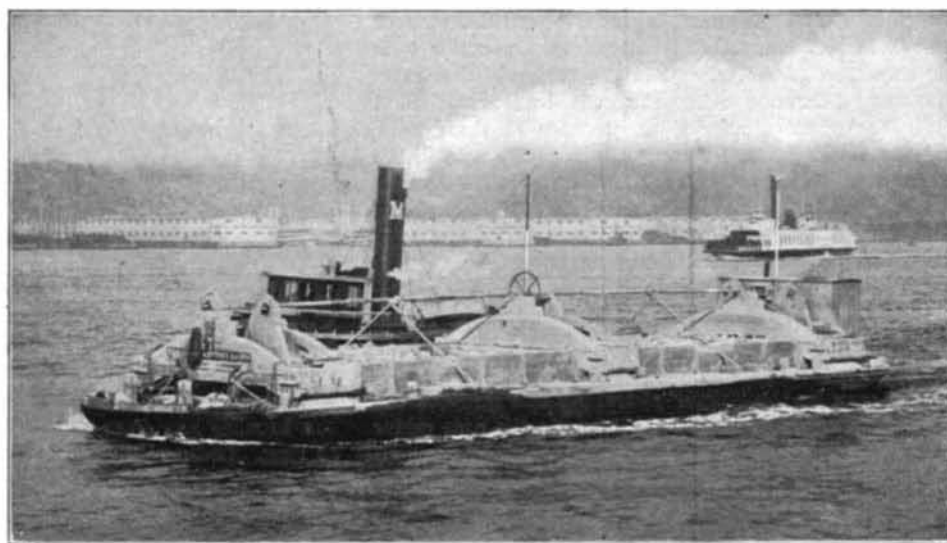
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A DELEHANTY STEAM SCOW, SHOWING THE DOUBLE PONTON.

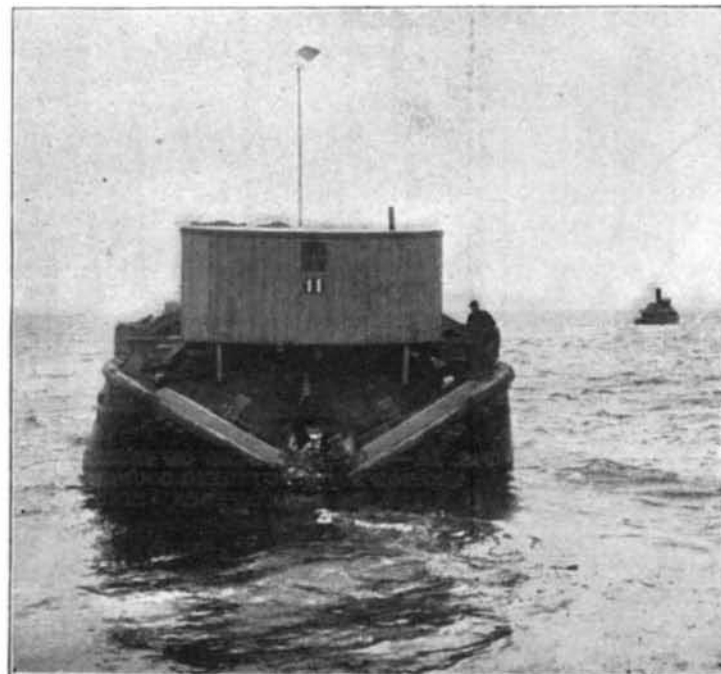


TOWING A BARNEY DUMPER OUT TO SEA.



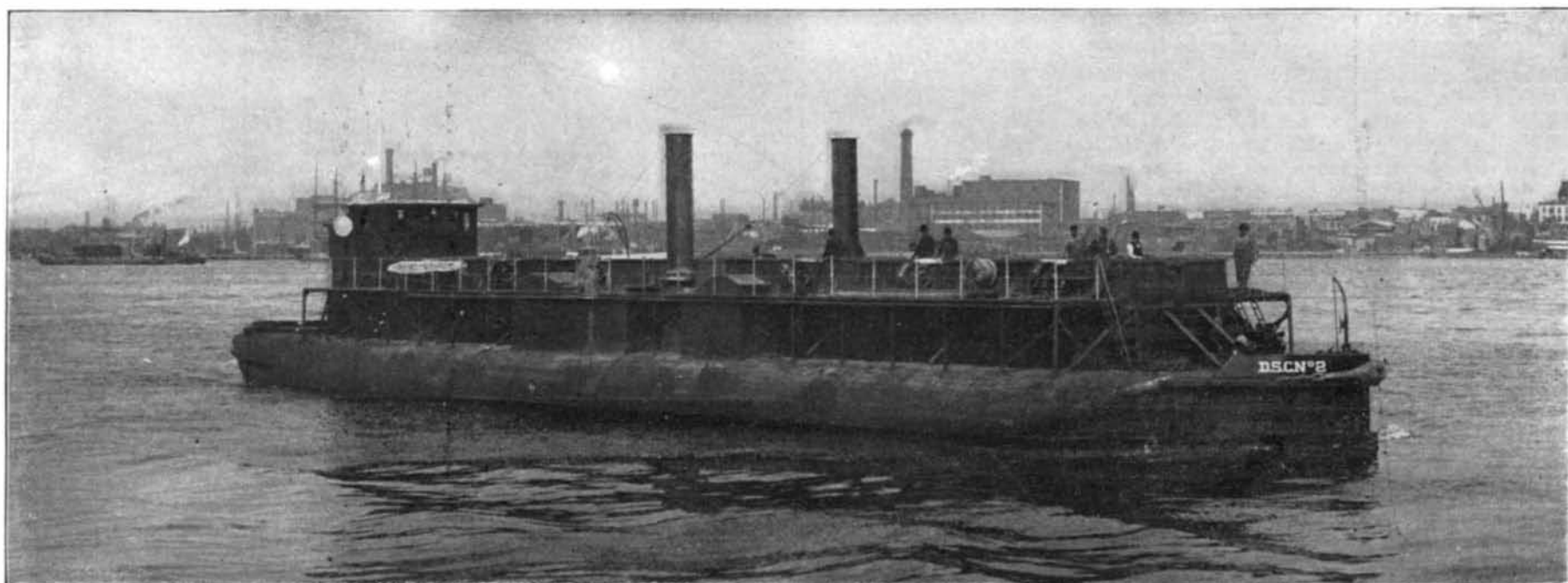
THE OLD WAY OF DUMPING GARBAGE AT SEA.

A former cause of the defilement of beaches in the vicinity of New York.



A BARNEY SCOW IN THE ACT OF DUMPING AT SEA.

The two hulls have separated to discharge the material.



THE DELEHANTY AUTOMATIC STEAM DUMPING-SCOW "ASCHENBROEDEL"

THE DISPOSAL OF CITY REFUSE.—SEE PAGE 8.