THE ENLARGEMENT OF THE ERIE CANAL.

BY DAY ALLEN WILLEY.

The enlargement of the Erie Canal into the New York barge canal, as it is termed, will give an unusual opportunity to test the power and capacity of American excavating machinery, owing to the varied character of the work. It is unnecessary to say that the enlargement is on such an elaborate scale that the present canal will practically be reconstructed where it can be utilized, while a considerable mileage of the new waterway will be excavated over a different route.

The portion of New York State through which the western division of the Erie passes is as different in topography from the eastern portion as the Culebra cut on the Panama Canal differs from the low, flat country at its terminals. When the original channel was constructed, one of the most difficult engineering problems to overcome was the descent from the level of the Mohawk River to the level of the Hudson—a fall of over 120 feet. This was overcome by a series of sixteen locks, which will be replaced by three, each having a lift of about 40 feet. Along the eastern division a very large amount of rock cutting will be necessitated, but on these contracts the steam shovel will also be essential, while much excavation through the swamp lands along the route will be performed by suction and probably dipper dredges.

Already some interesting machinery has been installed, especially on Contract No. 6 between Rochester and Buffalo and on Contract No. 4 on the eastern division. Enough work has been thus far performed to give some conception of the great size of the excavation required. While western New York is comparatively level when contrasted with the Mohawk Valley, the country is rolling in character, necessitating several deep cuts on the contract referred to. Up to the present the digging has been performed chiefly by steam shovels equipped with toothed bucket scoops holding from two to five cubic yards. For removing the material as it is taken from the prism, several methods have been employed. One of these on Contract No. 6 is an incline tipple. As the illustrations show, it consists of an elevated tramway, the upper end of which extends over the levee or spoil bank, the lower end reaching beneath the arc described by the shovel arm. On the incline are tram cars, which are drawn along the rails by an endless cable passing around sheaves mounted at the extremities of the incline. The cableway is operated by a stationary steam engine mounted on the lower part of the tipple. As fast as a car is filled by the shovel, it is pulled to the other end of the incline, where by means of a tripper it is automatically emptied, when it is returned to the excavation. The tipple may be provided with parallel tracks, so that an empty car can be run back and filled while a loaded car is hauled up to be dumped. The tipple is mounted on trucks, which in turn rest upon heavy rails. The engine can be utilized to move it along this track as the excavation progresses, the principle employed being the same as that utilized in the bridge tramway plants in service for unloading ore vessels on Lake Erie.

A more elaborate design for removing and depositing the excavated material is about to be placed in service on the work between Rochester and Buffalo. It is also utilized in connection with a powerful steam shovel, and includes an elevated tramway supported by towers also mounted upon movable trucks. Along the tramway passes a single or a series of buckets, which are filled by being lowered under the arm of the shovel and its scoop emptied into them. The receptacles are then hoisted to the level of the tramway, hauled by trolley and cable to the levee or spoil bank, and lowered and emptied. By this method the deposit of the material can be better controlled, and if it is utilized in the foundation of the canal bank, the piling can be done more accurately. With a conveyor of this type both banks of the canal can be built up simultaneously if it is constructed in the prism. Arms or aprons can be projected from each end completely covering the area of the bank. The steam shovel can be installed on a track laid in the ditch between the towers of the tramway, and serve it equally as well as if placed at one end, as shown in the illustration.

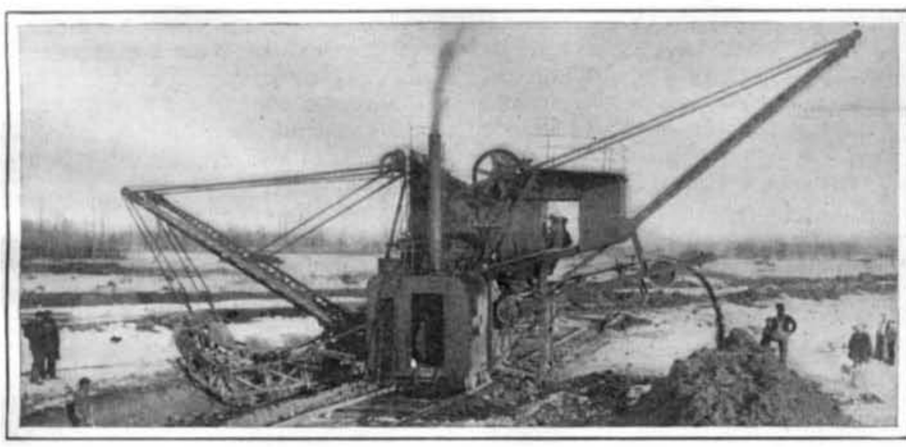
On Contract No. 4, for working on soft material the Lubecker excavator has been placed in service. It is a combination of excavator and conveyor, and travels along a track on the bank beside the canal prism. The excavator consists of a series of heavy steel scoops passing around an arm of steel framework by means of an endless chain. This arm is composed of sections, so that it can be adjusted closely to the formation of the surface, while it can be lifted clear of the ground by a second arm, which is raised or lowered by chains. As the earth is taken from the ditch by the scoops, it is carried inward and dumped upon another conveyor, which moves in the opposite direction and out upon another arm projecting from the other side of the machine. The end of the latter arm is held in position over the bank upon which the material is piled, as shown in the illustration. The capacity of the Lubecker at present in service is about 1,000 cubic yards in a day of ten hours.

An idea of the enormous amount of excavation required to complete the barge canal can be gained, when it is stated that although the distance covered by Contract No. 4 is but 4.83 miles, the material to be removed from it aggregates 2,228,000 cubic yards—enough to keep five steam shovels of 2,000 yards daily capacity employed for over six months, estimating a working day at ten hours. As already stated, however, not a little of the work has been in very hard foundation. West of Rochester cuts have been made through what appeared to be solid rock strata. Much of this is soft enough to be taken out by the steam shovels without the use of explosives.

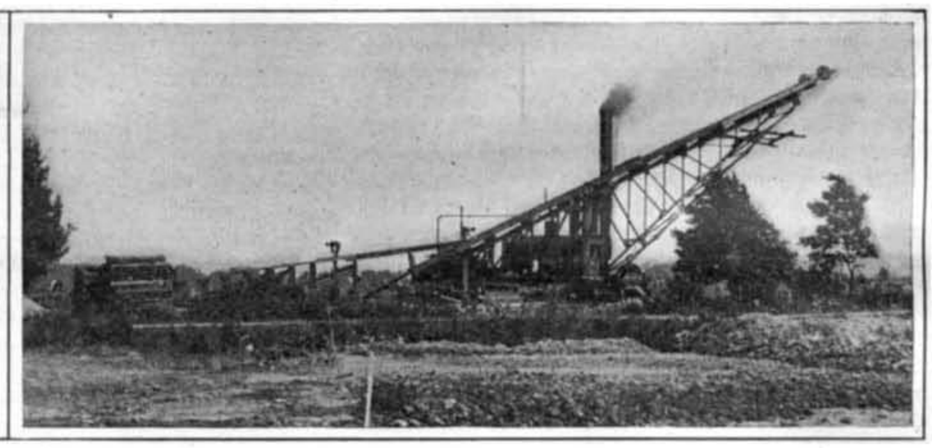
But when one thinks what the canal will become when the task is completed, it may seem worth while. The fact is that the State of New York will have the largest artificial waterway for navigation in the world with one exception, considering the length as well as breadth and depth. It is unnecessary to say that many canals are broader and deeper, but none equal the Erie, which is the main section of New York's canal system, in length. In considering the enlargement, two branches of the Erie are frequently overlooked, but the appropriation of $101,000,000 is intended to cover the cost of improving these as well. They comprise the Oswego Canal, 38 miles long, extending from Onon-

Embankment Thrown Up by Mechanical Excavator.

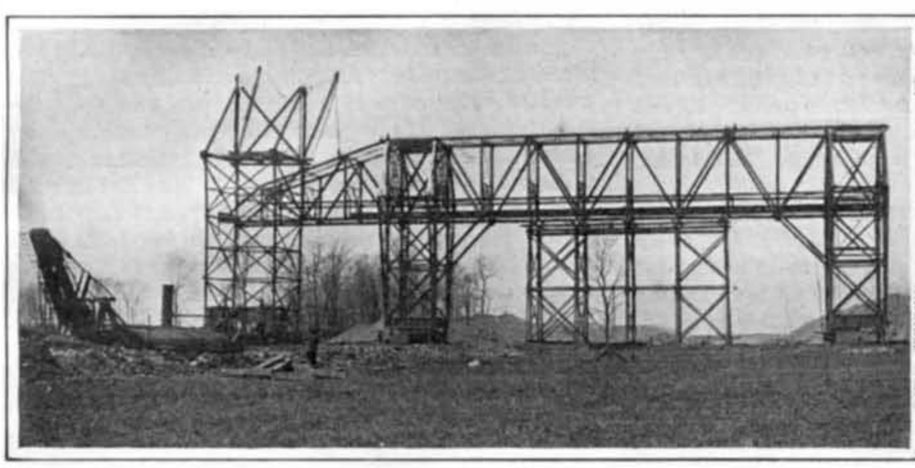
Excavation Partly Completed on Eastern Division.



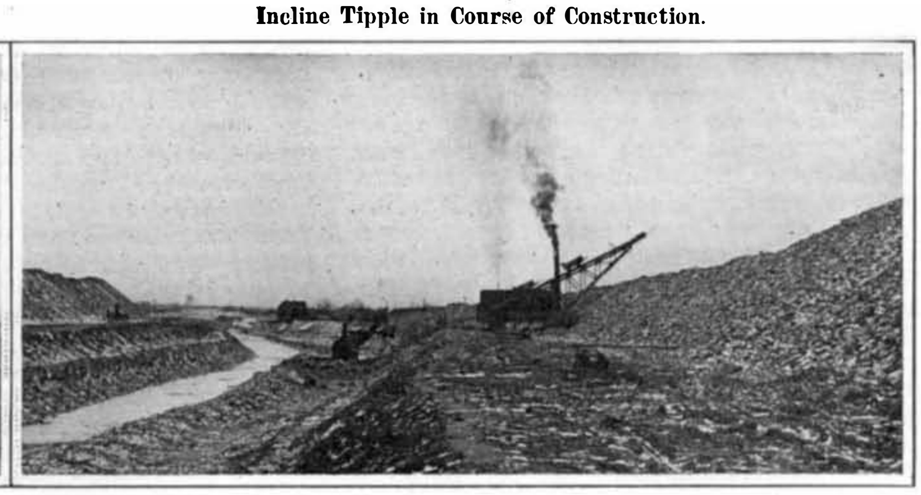
Lubecker Excavating Machine Used on the Eastern Division.



Incline Tipple in Course of Construction.



New Design of Elevated Tramway for Handling Material in Connection with Dredge.



General View of Excavation, Showing Deep Cut Near Rochester.

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daga Lake near Syracuse to Lake Ontario at Oswego; and the Champlain, 66 miles long, which furnishes a navigable waterway from the upper Hudson near Troy to Lake Champlain. Each may be called a branch of the Erie for the reason that boats passing through the Oswego Canal enter the main channel by way of Onondaga Lake, while boats from Lake Champlain bound southward and westward enter the Erie near the southern terminus of the Champlain Canal. The value of these branches is indicated by the fact that they furnish the interior of New York State its only water connection with Lake Ontario and the St. Lawrence River; and are the means of considerably swelling the traffic of the main canal, since they also give it a connection by water with Canada.

The main canal and branches will be of uniform depth and breadth on the bottom. Vessels drawing 11½ feet of water can pass from one end to the other of the system, while the width at the bottom will be at least 75 feet. Generally speaking, this means that the main canal will be enlarged to about four times its present transportation capacity. At present the depth ranges from 7 to 9 feet, about one-third of the waterway being of the latter depth, to which it was excavated by the expenditure of $9,000,000 appropriated for this purpose in 1894. When the historic "Seneca Chief," the first boat to carry freight and passengers upon it, made the trip from Buffalo to Albany, the canal was but 28 feet in width on the bottom, 70 feet on the surface, while its average depth was not over 4 feet. The demands of commerce so crowded it with traffic, that only ten years later the New York legislature authorized the enlargement which approximately represents the dimensions of the canal prior to the enlargement of 1895—a work which was not completed until 1862.

The barge of the future, however, will have a cargo capacity of 33 1-3 times the original craft, 22 2-3 times the boats of the period between 1830 and 1850, ten times those in service between 1850 and 1862, and four times as great as the average boat in present use. What is perhaps more significant, however, is the extent of the cargoes which can be shipped at one time by a fleet of tows of the new boats. The majority of the towing vessels are intended as cargo carriers, but provided with engines sufficiently powerful to pull from two to three boats in addition, moving at a rate of from 4 to 6 miles an hour. Thus from 12,000 to 15,000 bushels of wheat can now be transported from Buffalo to New York at a single shipment if desired. The present plan will probably be followed in making up tows for convenience and economy. This means that a single series of barges will carry enough grain to load an ocean steamship of 4,000 tons capacity. A very large fleet of vessels of this kind is plying across the Atlantic in the so-called "tramp" service, for it has been demonstrated that they can be constructed and equipped with engines which make them among the most economical freight carriers in the world. A single barge of the new type will carry sufficient cargo to fill the hold of many of the three-masted schooners in the American coasting trade, while a tow of four would be sufficient to load the largest square-rigged sailing vessel which plies out of New York. If one of the newer transatlantic steamships, which have been especially designed for carrying freight, were to be chartered to take wheat, for instance, exclusively, a flotilla of twenty-five of these canal boats would be sufficient to complete her cargo, or six tows, while two or three barges would carry enough grain to fill the cargo space which is devoted to this cereal on the ordinary Atlantic liner.

The cost of transportation of wheat on the present canal averages 87 cents a ton, or 1.9 mills per ton per mile—a little less than a fifth of a cent. Upon this and other statistics a calculation has been made that when the proposed improvement is completed, the maximum cost of transportation will be 26 cents a ton, or 0.52 of a mill per ton per mile. In other words, the improvement will cut down the cost of transportation to nearly 25 per cent of the average rate at present based on the ton mile. Contrasting this with the cost of railroad transportation, an idea can be gained of the competition which the enlarged waterway will offer land transportation routes. The reports of the principal railroad lines running out of Buffalo show that the average cost of carrying wheat is about 6 mills per ton per mile—three times as much as the present canal rate, and nearly twelve times as much as the rate on the enlarged canal. In other words, one of the newer canal barges would carry a cargo equal to a train of fifty cars at the same cost of hauling five with the locomotive.

The paramount object in the culture of the grape in most parts of the world has been the obtaining of wine. The extent of this will be surprising and hardly believed by those not acquainted with the statistics. Thus, for instance, there are annually produced on the globe over 4,000,000,000 gallons of wine. Of this amount, the United States produces only about 50,000,000 gallons.

INDUSTRIAL ALCOHOL: HOW IT IS MADE AND HOW IT IS USED.

(*Continued from page 43.*)

estimated from the fact that there is consumed in Germany annually for the manufacture of vinegar 16,000,000 liters (4,224,000 gallons) of alcohol. The oldest application is in cooking. In the new alcohol cooking lamps, some of which are regulatable, the alcohol is gasified before burning. In some the Bunsen principle is used; the alcohol before burning passing through a tube where it entrains with it the necessary quantity of air. For cooking purposes alcohol has great advantages; it is cleanly in application and instantly at disposal. There are also alcohol heating stoves, but they are as yet too dear to come into general use. For lighting, alcohol has only recently been used. The first incandescent alcohol lamp dates from 1895, but was not successful. The Auer lamp is better. It gives 60 to 62 candle-power and burns per hour about 13 quarts of alcohol, but has the disadvantage of requiring a permanent gasifying flame. The Helft lamps do their gasifying without a special flame, and if kept clean and in good condition give no trouble. The cost of light is 30 per cent cheaper than with petroleum. There is, however, this objection, that it takes 1 to 1½ minutes to get the flame going. Other excellent lamps adapted for the use of alcohol are in operation in Germany to-day, such as the Phoebus and the "Bogenlicht."

The use of alcohol for motors is recent. Experiments by Prof. Ernst Meyer show that the alcohol motor has a thermic efficiency of 39½ per cent, a result excelled only by the Diesel among motors using liquid fuel. The reason for this is that alcohol, containing as it does 8 to 9 per cent of water, permits a high grade of compression, without danger of premature ignition. As alcohol is not so rich in carbon as petroleum and benzine, it burns more cleanly. Prof. Meyer obtained from a motor of 20 effective horse-power a consumption as low as 8.8 pounds of 90 per cent alcohol with full load. Per horse-power per hour this cost is one cent; and the alcohol, giving only 5,600 heat units, was compared with petroleum, which gives 10,000 to 11,000. An important advantage of alcohol, which applies specially to its use in motor carriages and in engines for operating creameries and small manufacturing plants in premises adjacent to dwellings, is its absolute cleanliness and freedom from the mephitic odors which render hydrocarbon engines so offensive to many people.

The following list of the industrial uses of alcohol in England must be regarded rather as indicative than comprehensive, since the spirit is now used in a very great variety of ways in the numerous industries: Artificial lubricants, furniture polish, finish, varnish, lacquers, enamels, celluloid, zylonite, gunpowders, aniline colors, dyeing and preparation of colors, dissolving resins for hat makers, collodion, goldbeaters' skin, filling spirit levels, floating mariner's compass, extracting vegetable alkaloids, making vegetable extracts (dry), manufacture of transparent soap, quick-drying paints, preserving objects of natural history, chemical and anatomical research, sulphuric ether, chloral hydrate, chloroform, fulminating powder, liniments of soap, compound camphor, aconite and belladonna, hypersperm oil, etc.

For industrial purposes, and to render alcohol impossible of consumption as a beverage, the spirit may be either methylated or denaturized. Methylated means the addition of wood alcohol (methyl alcohol) to the spirit (ethyl alcohol). Wood alcohol is a poisonous substance, and at the same time possesses an extremely disagreeable taste, which renders it impotable. The denaturization of alcohol signifies the addition of such substances other than, or together with, wood alcohol, which render the ethyl alcohol unfit for use as a drink. The following are some German methods of rendering alcohol impotable:

I. Complete denaturization is accomplished by the addition to every 100 liters (equal to 26½ gallons) of spirits:

(*a*) Two and one-half liters of the "standard denaturizer," made of 4 parts of wood alcohol, 1 part of pyridin (a nitrogenous base obtained by distilling bone oil or coal tar), with the addition of 50 grammes to each liter of oil of lavender or rosemary.

(*b*) One and one-fourth liters of the above "standard" and 2 liters of benzole with every 100 liters of alcohol.

Of alcohol thus completely denaturized there was used in Germany, during the campaign year 1903-4, 931,406 hectoliters denaturized by process (*a*), as described above, and 52,764 hectoliters which had been denaturized by process (*b*). This made a total of 26,080,505 gallons of wholly denaturized spirits used during the year for heating, lighting, and various processes of manufacture.

II. Incomplete denaturization—i.e., sufficient to prevent alcohol from being drunk, but not to disqualify it from use for various special purposes, for which the wholly denaturized spirits would be unavailable—is accomplished by several methods as follows, the quantity and nature of each substance given being the prescribed dose for each 100 liters (26½ gallons) of spirits:

(*c*) Five liters of wood alcohol or one-half liter of pyridin.

(*d*) Twenty liters of solution of shellac, containing 1 part gum to 2 parts alcohol of 90 per cent purity. Alcohol for the manufacture of celluloid and pegamoid is denaturized.

(*e*) By the addition of 1 kilogramme of camphor or 2 liters of oil of turpentine or one-half liter benzole to each 100 liters of spirits. Alcohol to be used in the manufacture of ethers, aldehyde, agarcin, white lead, bromo-silver gelatins, photographic papers and plates, electrode plates, collodion, salicylic acid and salts, aniline chemistry, and a great number of other purposes, is denaturized by the addition of—

(*f*) Ten liters sulphuric ether, or 1 liter of benzole, or one-half liter oil of turpentine, or 0.025 liter of animal oil.

For the manufacture of varnishes and inks alcohol is denaturized by the addition of oil of turpentine or animal oil, and for the production of soda soaps by the addition of 1 kilogramme of castor oil. Alcohol for the production of lanolin is prepared by adding 5 liters of benzine to each hectoliter of spirits.

The whole amount of incompletely denaturized alcohol of the several grades above described which was consumed in Germany last year was 385,946 hectoliters, equal to 10,227,569 gallons. In addition to all the foregoing, 21,779 hectoliters of alcohol were used duty free and without denaturization of any kind for governmental or public purposes, such as hospitals, government laboratories, and for the manufacture of fulminates and smokeless powder.

Testing the Size and Heat of High-Tension and Low-Tension Ignition Sparks.

In a recently published article on ignition systems for gasoline engines, that well-known expert, Mr. Charles E. Duryea, gives the following interesting test for showing the efficiency of the contact and jump spark. It is a fact that with the contact or make-and-break spark a much smaller lead is required with any engine than must be used if the engine is equipped with the jump spark. The reason for this becomes apparent after one has made the experiment described by Mr. Duryea.

"Pass a strip of paper between the points of a jump spark plug and the paper will be perforated by the sparks, leaving a line of minute holes. To get the actual size of the spark in the cylinder the points should be separated ¼ inch or more, for it is well known that the compressed air is an insulator, and that engines which frequently miss on full charges will fire regularly when throttled, thus proving that there is a larger and better spark when there is no compression.

"To test the make-and-break spark in a similar manner, connect one wire from such a system to a piece of sheet metal on which is placed a sheet of thin paper, preferably held about 1/32 inch above the metal. Connect the other wire to a common pin and push the latter through the paper. Then pull the pin away quickly. A large spark will follow, burning a hole through the paper, frequently ⅛ inch in diameter. Compare the area of this hole with that of the minute perforation made by the jump spark, remembering that the make-and-break spark is also longer, and it will be seen that the volume and heat of the make-and-break spark is much larger, on which account it will fire a less perfect mixture."

The Current Supplement.

The current SUPPLEMENT, No. 1594, contains an unusual number of striking articles and papers. Among the more important may be mentioned the splendid address of Mr. S. S. Wheeler on Engineering Honor. Mr. John M. Thomson's paper on the Chemistry of Artists' Colors in Relation to their Composition and Permanency is concluded. The last installment of Mr. Dugald Clerk's paper on Internal-Combustion Motors is likewise published. Probably few people ever stop to think what a wonderful organ a bird's bill really is. Mr. B. S. Bowdish, in an instructive and pleasantly-written article, explains the various functions which the bills of different birds must perform. A valveless air pump is described by the Berlin Correspondent of the SCIENTIFIC AMERICAN. Atmospheric electricity in trees is the subject of an exhaustive paper.

The specific gravity of non-conducting materials is in many cases of vital importance. For marine work, especially, take, for instance, a steamer of the size of the "Teutonic," of the White Star Line, the difference in weight of the covering applied, which was of low specific gravity, effected a saving of over 100 tons in weight. If the work had been done with high specific gravity material, says Mr. Ashby W. Warner in a paper on "Non-conducting Work," read before the Cleveland Institute of Engineers, this steamer would have carried over 100 tons dead weight more than was necessary.