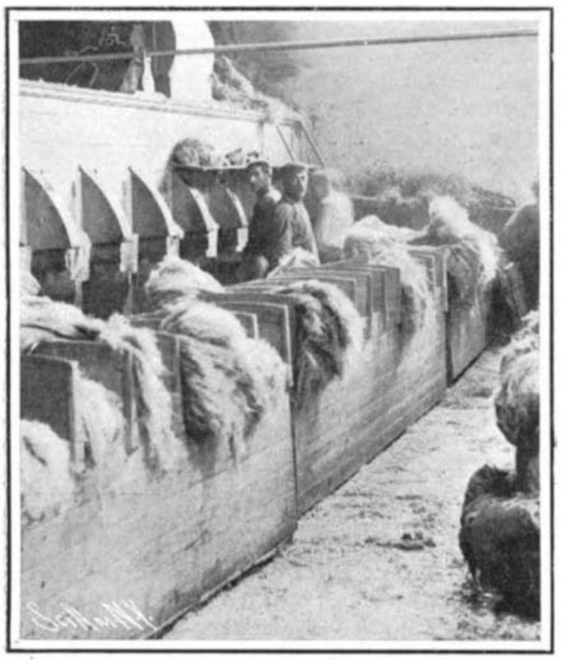
SCIENTIFIC AMERICAN

[Entered at the Post Office of New York, N. Y., as Second Class Matter. Copyright, 1905, by Munn & Co.]

Vol. XCIII.—No. 24.
ESTABLISHED 1845.

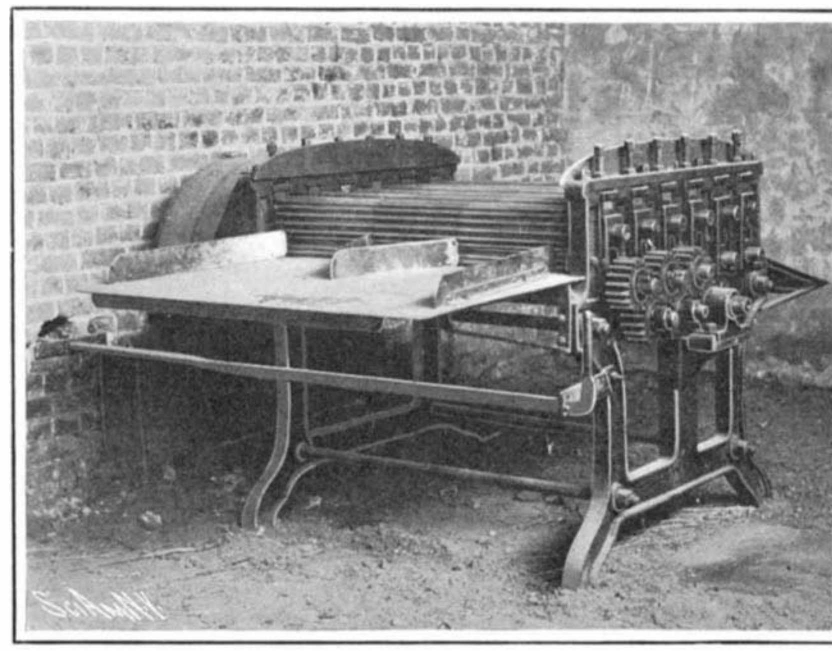
NEW YORK, DECEMBER 9, 1905.

[10 CENTS A COPY
$3.00 A YEAR.



Scutching Mill, Showing the Scutched Flax.

Cleaning the Flax Fiber. Hand Scutching.

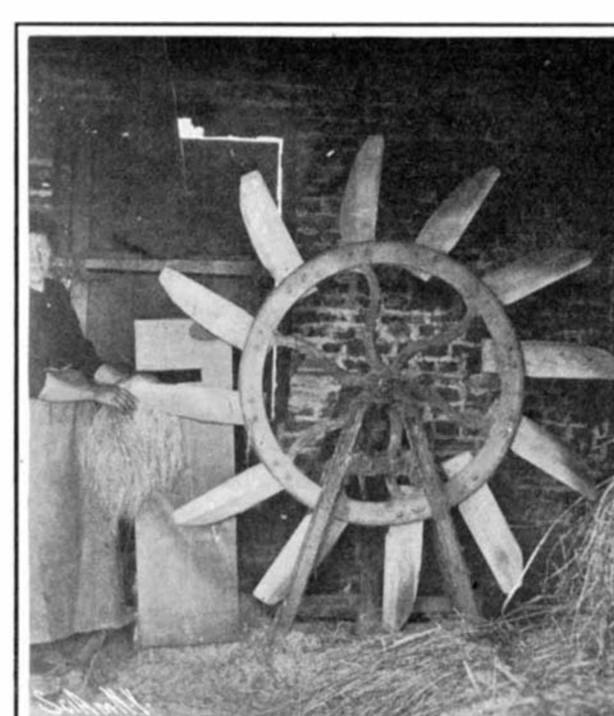


A Modern Rippling Machine.

The Flax Harvest. The Plants Made Into Bundles Prior to Stacking.

Rippling Machine in Operation.

Crates of Flax Weighted and Sunk in the River Lys.



An Old-Time Scutching Mill.

THE CULTIVATION OF THE FLAX PLANT AND THE PREPARATION OF THE FIBER FOR TEXTILE PURPOSES.—[See page 458.]

by hand levers which proved so successful on motor car No. 1 has been applied to car No. 2; but it is operated by air pressure controlled by a specially designed operating valve. The car is started at low speed and the engine disconnected or thrown into high speed, at will, simply by means of the operating valves.

The initial trip of this car was made on September 14, when a run took place from Omaha to Valley, Neb., on the main line of the Union Pacific, a distance of 34.8 miles. On the west-bound trip no effort was made for a fast run, but special mention should be made of the performance of the car in ascending Elkhorn Hill, where the grade is 42 feet per mile. This hill was climbed at the rate of 32½ miles per hour. The return trip was made at an average speed of 37 miles per hour, with a maximum speed during the run of 52 miles per hour.

On September 22 the car made a second trial run to Valley and return, and on the west-bound trip an average speed of 39.4 miles per hour was maintained. On the east-bound trip the car made 25 miles from Valley to Gilmore in thirty minutes, or at an average speed of 50 miles per hour. Several miles were covered in 57 seconds—a rate of 63.2 miles per hour—and mile after mile was run at a speed of over a mile a minute.

THE BACTERIAL PURIFICATION OF SEWAGE.

(*Continued from page 456.*)

out-of-date method except, perhaps, for finally disposing of sewage works effluents, or in isolated cases where topographical and other conditions are specially favorable to its adoption. Land treatment is used successfully at Berlin, Germany, on a tract of land of over 19,000 acres—larger than the city itself. It is kept in condition by convict labor. In one instance, a year of exceptional drought, the crops from these farms realized receipts which more than defrayed all cost of administration and maintenance. Land treatment on the whole, however, is haphazard, uncertain, and expensive.

In 1895 Donald Cameron, of Exeter, England, brought the septic tank into prominence. This consists of a large tank, in which sewage is allowed to remain, where it is acted upon by anaerobic bacteria—micro-organisms that live without the presence of air. Sewage contains a considerable portion of solid matter in suspension. By means of anaerobic action part of it becomes liquefied and goes into solution, part rises to the top as scum, while part descends to the bottom as sludge. The inlet and outlet of the tank are placed below the surface, so that the sewage may pass quietly through with as little commotion as possible. The scum which rises to the top becomes oxidized after a time, and passes off into the air as harmless gas. A certain amount of decomposition takes place in the sludge at the bottom. When the tanks are large, sludge accumulates very slowly at the bottom. At a septic tank at Mansfield, Ohio, only a few inches of deposit were drawn off after it had been in use for a year and a half.

The septic tank has proved a most useful factor in sewage purification. It is used extensively as preliminary treatment for contact beds and percolating filters. It cannot, however, be considered by itself as a system of purification; it can be used successfully only as part of one.

There are some small towns in this country, however, where septic tanks alone have been used. The results in these places have invariably been very poor. The septic tank by itself is regarded by sanitarians as little better than an apology for a sewage disposal plant. In some cases, however, when only a low degree of purification is needed, such as when sewage is put into the ocean, septic tanks have proved useful.

Perhaps the most practical method of sewage disposal is the combination of the septic tank and the contact bed. The contact bed system was devised by W. J. Dibdin, who installed the famous bed at the town of Sutton, England. In this system sewage is first passed through a screen, to prevent the floating particles from blocking the interstices of the bed. It is then passed over a coarse-grained bacteria bed. This consists of a tank three feet deep filled with broken stone, coke, burnt ballast, or other suitable material not more than three inches in diameter. It is supplied with underdrains, so that it can be easily emptied. The sewage is allowed to enter the bed until the level of the filtering material is reached. The inlet is then closed, and the sewage is allowed to remain standing "in contact" for a certain length of time. During this period the aerobic bacteria do their work. They oxidize the organic matter in solution, and in their search for food they decompose a considerable portion of the impurities. Furthermore, certain ferments knowns as enzymes aid in the work of decomposition, while the solid particles adhere to the filtering material. The sewage is then allowed to flow slowly out of the bed, leaving many impurities upon the filter material. It flows into another similar bed, where further similar action takes place. Now that the bed is empty, aerobic action goes on among the particles of sewage left in the interstices of the material. Before the next flush comes, most of the spongy matter in the bed has been converted into gases. When the bed fills again, the gas is driven out of the bed into the air above.

Such is the method in use at Sutton. It is simple and effective, and has been widely used in systems laid out more recently. After the sewage has been treated in a septic tank, it generally need only be treated in one contact bed to secure the necessary purification.

Most septic tank-contact bed systems contain several bacteria beds, so that while one bed is filling, another may be in contact, another emptying, and another resting empty. Four is a favorite number of beds for a small town plant, while six are often used.

The contact bed system involves only a small fall, so that it can be applied to almost any district. It has been in successful operation in many towns both in this country and in England. The secret of its success is the regularity of the time of contact and aeration. Experience has shown that unless such regularity is maintained the bacteria will not remain in healthy condition.

At Manchester, England, is the largest septic tank-contact bed system in the world. The beds are opened and closed at regular intervals by hand. In the more recent contact bed systems installed in this country, the invention of automatic airlock apparatus has made it possible to have the beds fill and empty at regular intervals automatically.

A more recently devised system of filtration, and one that is gaining favor in England, is known as intermittent downward filtration, percolating, or trickling filters. These filters are many feet in depth. The sewage is distributed in intermittent doses—often by means of a large revolving sprinkler. They are filled with material similar to that used in contact beds. At the bottom there is an open space for the circulation of air.

In order that percolating filters work successfully, great care must be taken in their construction. It is essential that air should always be present in all parts of the filter, scum must not be allowed to accumulate; there must be a thorough draining at the base, so that the filtrate may come from the filter easily and force air to come in by induction. During the fall of the sewage through the bed, the aerobic bacteria get a splendid opportunity to oxidize organic matter, provided they have a sufficient supply of air. The effectiveness of a percolating filter increases with its depth, so that the filters are made as deep as possible. They are generally used with septic tanks. This system is in use at Birmingham and Hanley, England, but it has practically never been applied in this country. The objections to its use are first the great fall required, and secondly the danger of stoppage through frost unless artificial heat is used. At an experimental plant at Leeds a purification of over 80 per cent was secured in three minutes by this method.

The method of intermittent downward filtration is largely used in New England. It is, however, merely an adaptation of the old system of land treatment. It consists of passing sewage over soil intermittently, so that the land after receiving one charge of sewage is allowed to rest for a certain space of time before receiving the next. Underneath are generally placed underdrains so that the effluent can easily escape. Although areas averaging as much as from ten to twenty acres per million gallons are necessary for these beds, the results obtained have been satisfactory. It is frequently necessary to pump the sewage to the filters. The best-known examples of intermittent downward filtration through sand are those at Brockton and Framingham, Mass. In both cases pumping stations are required. This system has one or two drawbacks besides its expense. Unless great care is taken, the sewage goes through the filters in channels instead of percolating through the material, while the beds frequently freeze and become useless in winter.

There is no doubt that the bacterial process of sewage treatment has come to stay. The question raised is no longer shall the bacterial system be used, but which kind of bacterial system best complies with the given conditions. All the methods I have described work successfully under the proper conditions, but the contact bed system has proved the most generally applicable because of the small fall required and its ability to operate in all weather.

THE FLAX INDUSTRY OF TO-DAY.

Of all the plants cultivated for fiber, flax, *Linum usitatissimum*, is doubtless one of the earliest, and we know of its existence from the times of the first authentic records. Even cotton, which was mentioned in the writings of Herodotus in 445 B. C., must take its place as a comparatively modern product with reference to its forerunner—linen. Because of this very antiquity, the origin of the flax plant is rather uncertain; but it is believed that it arose in the region between the Caspian Sea and the Persian Gulf. That it was cultivated and manufactured by the Swiss lake dwellers in the Stone Age in Europe is proved by the well-preserved specimens of straw, fiber, yarn, and cloth to be found in the museums. This ancient flax was, however, from another species, *Linum angustifolium*. The Egyptians produced and used flax thousands of years ago, and the Chaldæans and Babylonians carried its use to the highest state of development, employing it particularly in tapestry work. Three thousand years ago the Phœnicians extended the culture, the Greeks and Romans made it a household industry, and it subsequently became the aristocratic fiber. It is claimed that the ancient Mexicans were acquainted with both flax and hemp, and their culture in that country goes back far beyond the earliest date of our civilization. It was introduced in this country in Massachusetts as early as 1630.

While the plant can be grown in nearly every portion of the temperate world, flax is cultivated, primarily, for the production of fiber in central and northern Russia, in Holland, Belgium, Ireland, and northern Italy. In southern Russia, British India, Argentina, and the United States it is grown almost exclusively for seed production; in these regions the straw is used for fuel, stable bedding, and sometimes for forage. In a few localities in this country the straw is used for paper stock, or is made into upholstering tow. While the cultivation of flax for seed, and the manufacture of this into oil and oil-cake, have grown into industries of enormous proportions in the United States, only in a few vicinities is the plant grown for the production of spinning fiber. At Yale in Eastern Michigan, at Northfield and Heron Lake, Minn., and at Salem and Scio, Ore., the flax is cultivated for its fiber.

While flax was extensively grown and its fiber spun and woven during colonial times, it was used almost entirely as a home product for consumption in the families of the weavers, and it is probable that very little linen was manufactured for purposes other than this. While it is possible that after the successful termination of the Revolutionary war the industry would have grown to considerable importance in the hands of the American people, with the abolition of England's repressive colonial policy in regard to manufactures, the invention of the cotton gin by Eli Whitney checked its future development at once. This invention placed within reach of the manufacturer a fiber that was cheaper than flax, that required less care in preparation, more easily worked, superior for many purposes, and decidedly inferior for very few, and in consequence the manufacture of linen was practically abandoned. Until within comparatively recent times the attempts to reintroduce it have been few and far between and generally unsuccessful. Additional reasons for this are found in the expenditure of time and labor entailed by the retting process, in the difficulty in spinning and weaving a fiber with as little elasticity as this, in the consequent precariousness of the margin of profit, and finally, in the fact that the demand for the finished product is not nearly as broad or general as is that for other textiles. Nevertheless, while the linen industry in the United States is not extensive to-day, a considerable advance, measured in percentages, has been made in the last ten years. There are certain fields, such as the manufacture of linen carpet yarns, linen thread for the shoemaking industry, towels and towelings, in which the American manufacturers should be able to compete successfully. They have already occupied some and entered into others of these fields, and the growth of the industry in other directions is generally prophesied.

Nearly all the flax fiber used in the United States is imported from Russia, Holland, Belgium, and Ireland, while a small quantity comes from Italy and Canada. A great deal of the so-called "Irish flax" is grown in Belgium and sent to Ireland for preparation. The flax grown in this country is usually from Riga (Russian) or from Belgium Riga seed.

The culture of flax requires a deep, well-tilled soil in a high state of fertility. Wet soil such as some clays is disastrous to the crop. Similarly fatal are soils filled with the seeds of weeds. Moist, deep, strong loams upon upland in a fairly moist climate are especially favorable to the plant. The land must be deeply plowed and thoroughly harrowed. Because of a disease, flax-wilt, it cannot be cultivated year after year upon the same ground; but as the other ordinary crops are immune from the spores which remain in the soil, flax may be introduced in a rotation once in six or eight years.

Flax is sown early in the spring, broadcast like oats or wheat, the seeds being spread evenly at a depth of less than an inch. Though the root system is small, the growth of the plant is rapid, maturity being reached in about one hundred days. The crop must be thoroughly weeded, the operation beginning when it is about two inches above ground, as the quality of the plant when choked by weed is poor. The best flax is pulled out by the roots. This is done to avoid stain and injury, which would result from soil moisture while the cut stems were in the shock, to secure straws of the greatest possible length, to insure better curing of the straw and ripening of the seed, and to avoid the blunt cut ends of the fiber. The straw is often allowed to dry on the ground, and then to cure for two or three weeks in the shocks, though the practice varies somewhat in different countries. The seeds and leaves are removed by a process called *rippling.* This is done to-day by machinery, the heads of the unbound bundles being passed between rapidly-revolving corrugated rollers, which crush the seed pods. The seeds and leaves are then removed by means of a fanning mill. After this the straw is stacked until required for the retting.

The flax fibers, which appear to consist of pure cellulose and show no signs at all of being lignified, are held together by an intercellular substance consisting mainly of calcium pectate. The object of the retting is to decompose or make soluble these woody tissues inclosing the cellulose or bast fibers, so that they can be removed from the latter by the subsequent processes.

The water-retting of flax is a biological process induced by the action of definite organisms, the chief of which is an anaerobic *Plectridium,* which in the absence of air ferments the pectin substances of the cellular material, uniting the parenchymatous tissues, and thus causes a loosening of the bast fibers. The absolute exclusion of oxygen, which is necessary in order that the fermentation may be set up, is brought about by numerous oxygen-consuming bacteria and fungi. The products formed by the fermentation of the pectin substances are hydrogen and carbon dioxide and organic acids, especially acetic and butyric acid and small quantities of valeric and lactic acids. The injurious action of the acids produced, especially butyric, may be considerably diminished by adding alkali or lime to the retting liquid. It has been found to be advantageous to inoculate the liquid at the beginning of the retting with pure cultures of the anaerobic *Plectridium.*

On the retting process depends the quality of the linen, and it is that stage of the industry which presents the greatest difficulty. There are three methods which can be employed, and of these the simplest and least careful is dew-retting. The straw is simply spread evenly over the fields like hay to be retted by the action of the dew and the elements. The fiber resulting from this method is the most uneven and the least valuable product of the three processes. With the exception of that in use at Northfield, Minn., it is the process usually employed in this country. The second method, called pool-retting, consists in immersing the bundles of straw in stagnant pools, the softest waters, such as rain water, giving the best results. Holes are dug in the ground for this purpose, though a great part of the Irish flax is retted in "bog holes." The resulting flax fiber is better than the dew-retted product and is lighter in color, being a fairly light bluish brown. The third method consists of immersing the straw in running water. This is the form practised in Belgium, where the finest product of this kind in the world, the famous Courtrai flax, is retted in the murky waters of the sluggish river Lys. The flax straw, in bundles, is placed in crates which are weighted with stones and submerged in the water of the stream for two periods, each of from four to fifteen days according to the temperature and other conditions. After the first immersion the straw is taken out and carefully dried before the second retting. The Courtrai flax is of a light creamy color and of superior tensile strength. Its excellent qualities appear to be due not so much to the retting in sluggishly running water as to the actual qualities of that water and the peculiar ferment contained therein.

After the flax has been retted it undergoes a decorticating process, which removes the bark and the loosened, underlying, woody tissues and isolates the linen fibers in a purified condition. The first operation consists of passing the straw through a breaker, which loosens the woody portions of the stems and reduces them to fragments to facilitate the following operation, the scutching, which whips out the "chive" and all other waste matters, leaving the pure flax fiber. Within recent years machinery has been designed which successfully performs all the operations subsequent to retting, but in former times the work was done by hand or with very crude mechanical aids. One of the accompanying engravings shows an old-time scutching mill, consisting of a large wheel with flat radial wooden blades projecting from its periphery. These rapidly-revolving blades slashed the waste matter from the bundles of flax straw, which were held against a flat surface parallel to the plane of the wheel. The scutched flax is subsequenty hackled or dressed by repeated combings, which remove the short and broken or tangled fibers and thereby produce tow. Each hackling improves the quality of the fiber and, of course, adds to its cost.

Numerous chemical methods have been proposed for retting flax, to improve and shorten the natural processes, and numberless patents have been granted here and abroad, covering these artificial methods. Among them are processes consisting in heating with water under pressure, boiling with solutions of oxalic acid, soda ash, caustic soda, or the addition of various chemicals to the retting water, such as hydrochloric and sulphuric acids. Numerous patents also exist on retting pools or tanks. Few of all these processes have proven of any industrial value. However, one of the exceptions to this appears to be a process covered by patents issued to two Belgians, Dr. Georges Loppens and Honoré Deswarte. Briefly, the process consists in covering a mass of vertically-arranged flax straw in special tanks with water, constantly delivering fresh water, preferably rain water, beneath the mass and at the same time constantly withdrawing the same quantity of impure water from below the level of the fresh water. This method is now used at Northfield, Minn. During the first season it was not employed with entire success, but it appears that this deficiency may be ascribed to inexperience in the handling of the apparatus rather than to any fault of the process. There is little doubt that in the future the Loppens method, as it is called, will prove entirely successful, for it is extremely simple in operation and absolutely under the control of the operative.

Airship Competition at Milan.

During the Milan exhibition, 1906, the following aeronautic competitions will be organized: Dirigible airship competition; competition of free balloons carrying operator; competition of flying devices heavier than air; competition of kites; competition of sounding balloons; photographic competition. All competitions are international.

With the exception of the dirigible airship competition, the other competitions will not take place unless there are at least two competitors. Should the competitors only be two, the second prize will not be awarded. The competitors will be allowed, after arrangement with the committee, to trials *hors de concours.* Only the trials announced and controlled by the committee will be available as competitive trials. Among the latter the "classification trials" will be chosen for the awarding of the prizes.

Should the number of competitors make it necessary, each competition will consist of eliminating trials and final trials. The competitors for the final trials will be chosen among the better-placed in the eliminating trials, and their number will be fixed by the committee.

An international committee for the aeronautic competitions will be formed, and will be chosen by the executive committee of the exposition. To this committee all questions regarding organization, execution, and surveillance of the competitions will be deferred. In these matters it will represent and substitute the executive committee.

The request for entries must be addressed to the Comitato Internazionale per i Concorsi Aeronautici, Piazza Paolo Ferrari, Milano. A special application must be forwarded for each of the competitions the applicants are desirous of entering. All applications must reach the above-named committee in the time limits fixed by the special regulations governing the single competitions.

Illiterate Children of Immigrants Compared with Children of Native Americans.

It seems somewhat surprising at first to find a lower degree of illiteracy among the children of foreign-born parents than among the children of native parents. For the former the proportion of illiteracy is 8.8 per 1,000, for the latter 44.1 per 1,000. This difference, however, does not prove that immigrants are more anxious than natives to secure for their children the advantages of an elementary education. It is explainable by the fact that the foreign-born are concentrated in the larger cities to a much greater extent than the native population. Comparison for individual cities indicates that there is little difference in illiteracy between the two classes of children living in the same community. But such differences as can be detected are usually in favor of the children of native parents.

What Water Can Do.

Imagine a perpendicular column of water more than one-third of a mile high, twenty-six inches in diameter at the top and twenty-four inches in diameter at the bottom. Those remarkable conditions are complied with, as far as power goes, in the Mill Creek plant, which operates under a head of 1,960 feet. This little column of water, which, if liberated, would be just about enough to make a small trout stream, gives a capacity of 5,200 horse-power, or enough power to run a good-sized ocean-going vessel. As the water strikes the buckets of the water-wheel, it has a pressure of 850 pounds to the square inch. What this pressure implies is evidenced by the fact that the average locomotive carries steam at a pressure of 190 or 200 pounds to the square inch. Were this stream, as it issues from the nozzle, turned upon a hillside, the earth would fade away before it like snow before a jet of steam. Huge bowlders, big as city offices, would tumble into ravines with as little effort as a clover burr is carried before the hydrant stream on a front lawn. Brick walls would crackle like paper, and the hugest skyscrapers crumble before a stream like that of the Mill Creek plant. It takes a powerful waterwheel to withstand the tremendous pressure. At Butte Creek, Cal., a single jet of water, six inches in diameter, issues from the nozzle at the tremendous velocity of 20,000 feet a minute. It impinges on the buckets of what is said to be the most powerful single waterwheel ever built, causing the latter to travel at the rate of ninety-four miles an hour, making 400 revolutions a minute. This six-inch stream has a capacity of 12,000 horse-power. The water for operating the plant is conveyed from Butte Creek through a ditch and discharged into a regulating reservoir which is 1,500 feet above the power house. Two steel pressure pipe lines, thirty inches in diameter, conduct the water to the power-house.—The World To-day.

PROGRESS OF THE NEW JERSEY TUNNELS AND SUBWAYS.

The New York public is so greatly interested in the schemes for the further development of the original rapid transit Subways, and in the progress of the Pennsylvania tunnels and terminal station, that it probably fails to appreciate the magnitude of the scheme of tunnels connecting Jersey City traction systems with New York, and the equally important subways beneath Manhattan which form an integral part of that system. Since the amalgamation of the separate companies which originally were constructing, each of them, a pair of tunnels, one at Morton Street, and the other at Fulton and Cortlandt Streets, the work has been pushed along with all the energy and speed which abundance of capital and an energetic administration can command.

The system, as at present being built, consists of a two-track road, placed in two separate 15-foot tubes, which will extend from the Delaware, Lackawanna & Western Railroad terminal in New Jersey, along the shore line to the terminal station of the Central Railroad of New Jersey. At the intersection of the Subway with Fifteenth Street, it will be intersected by twin tunnels, which will extend from Thirteenth, Fourteenth, and Provost Streets, and connect with the two tunnels that have now been opened beneath the Hudson River to the Manhattan side. These two tunnel tracks have been carried beneath Morton and Greenwich to Christopher Street, and they will branch at the junction of Ninth Street and Sixth Avenue, into two separate pairs of tunnels, one of which will extend beneath Ninth Street to Fourth Avenue to a connection with the present Fourth Avenue Rapid Transit Subway. The other branch will extend north below Sixth Avenue to Thirty-third Street, where there will be built a large station of ample size to accommodate the great traffic which is certain to seek this route. At Thirty-third Street, also, the system will be in touch with the Pennsylvania Railroad tunnel across Manhattan Island, and consequently, New Jersey traffic, both on the trunk steam railroads and on the surface trolley lines, will be placed in direct touch with the Pennsylvania tunnels and their extensive Long Island connections, and with the rapid transit system with its many ramifications in Manhattan and Brooklyn.

The Jersey shore line Subway, south of the intersection with the Morton Street tunnels, will tap the Erie Railroad terminal, the Pennsylvania Railroad terminal, and the terminal of the Central Railroad of New Jersey. The downtown tunnels, beneath the Hudson, which will consist, like the rest of the system, of two single tubes with a single track in each, will extend from the Pennsylvania Railroad terminal in New Jersey to a large terminal station, which will be located on the two blocks on the west side of Church Street between Cortlandt and Fulton Streets. These two tracks will diverge from the New Jersey shore, one of them passing below Fulton Street, Manhattan, and the other below Cortlandt Street. The down-town terminal, in addition to the underground tracks, platforms, etc., incidental to a station of this character, will include two twenty-story buildings, one between Cortlandt and Dey Streets, and the other between Dey and Fulton Streets, and the full cost will be approximately ten million dollars. From the station an underground foot passage will be constructed through Dey Street to the Interborough Subway at Broadway, where passengers will be able to make connection with trains for Manhattan and the Bronx and for Brooklyn.

At the present writing the condition of the work is, that on the up-town tunnels the north tunnel is completed from the shaft on the Jersey side to a point where it turns out of Greenwich into Christopher Street, while the south-bound tunnel has been built from Jersey City to a point where the tunnel turns out of Morton into Greenwich Street. The first through connection on the south tunnel was made September 22 of this year, and one of the accompanying illustrations shows the first party to be taken through this tunnel from New Jersey to New York, an event which was celebrated September 29. On the down-town section of the road the work of demolishing the buildings on the site of the Fulton-Cortlandt terminal is being pushed vigorously by the wrecking companies, who are under contract to have at least half of the building removed and the ground ready for excavation within ninety days. The shafts are being sunk, and the two tunnels