where they seemed to have thrived to an alarming degree, spreading over the city in a way to make them a serious nuisance. They are much larger than any native slugs, measuring from four to six inches in length, and are likely to become very injurious to vegetation.

NOTE ON TURPENTINE, ROSIN, AND ALLIED PRODUCTS.*

Of the turpentine collected in this district very little is shipped North. Most all of it is distilled upon the water courses near the pine forests. The small quantities of crude turpentine now sent North are used in making printer's ink.

Turpentine is distilled in copper stills now. Formerly iron stills were used. Then the resulting oil was red. When the first copper still was used in Wilmington the clear uncolored oil shipped North was rejected, because it was not considered genuine "spirits."†

All crude turpentine is distilled with water. The part which water plays in the process well be seen hereafter.

The present distinction as to the grades of rosin are somewhat different from *yellow* and *transparent.*

It is not the presence of water which makes rosin *yellow.* If water gets into rosin, which it does sometimes by accident, the rosin becomes opaque. All the better grades of rosin are yellow or amber color, more correctly; but the term "yellow rosin" is not used here commercially or otherwise. The grade of the rosin depends, *first,* upon the quality of the turpentine, and *second,* upon the skill in distilling. "Virgin turpentine," the first exudation from a newly chipped tree, if skillfully distilled, will yield "window-glass rosin," of which there are two or three grades. If by any means water gets into prime rosin it becomes opaque. This accidental addition of water must take place after the rosin has been drawn off from the still.

"Yellow dip" turpentine, which is the running of the second and subsequent years, yields the medium grades of rosin; while the "scrapings," the inspissated gum from the

COLLECTING TURPENTINE.

tree facings, yields an inferior rosin, from very dark to almost black. The black rosin is not due to burning in the still, as has been stated.

Anhydrous rosin is the greater part of the stock produced; the opaque rosins, being accidental, are limited.

The following description of the process of distillation may explain further.

A fifteen-barrel copper still (barrel weighing 220 lbs. each) is charged early in the morning. Heat is applied until the mass attains a uniform temperature of from 212° to 316° F. This is continued until the accidental water, that is, the water contained in the crude turpentine as it comes from the forest, has been driven off.

The first product distilled over is pyroligneous acid, formic acid, ether and methylic alcohol, with water. This is known as *low wine.*

All the accidental water having been distilled off, a small stream of cold water is now let in, so that the heat is kept at or below 316° F., the boiling point of oil of turpentine. The oil of turpentine and water now come over, and the mixture is caught in a wooden tub. This tub is constructed as follows:—

The distillate is caught at *A* from the still and separates into water and oil. At *B* there is an overflow spout, which discharges into the tub *D.* The water is kept low enough in the lower part of the tub to prevent its overflowing through the cock *B* into the receptacle *D.* From this receptacle it is put into oak casks, well made with iron hoops, and securely glued inside.

The distiller tests the quality of the flow from time to time in a proof glass. The distillation is continued until the proportion of fluid coming over is nine of water to one of oil of turpentine. At this stage the heat is withdrawn, the still-cap is taken off, and the hot rosin, which remains in a fluid state in the still, is drawn off by a valvular cock at the side of the still near the bottom

This rosin passes through a strainer before it reaches the vat, to rid it of foreign substances, such as straw, pine cones, chips, etc. From the vat it is bailed by wooden buckets, fixed on a long handle, into the barrels.

Rosin is graded by standard samples fixed upon by the "Produce Exchange."

The yield of oil of turpentine from "virgin dip" is about six gallons to barrel.

The yield of oil of turpentine from "yellow dip" is about four gallons to barrel.

The yield of oil of turpentine from "scraping" is about two gallons to barrel.

Other-products now attract our attention, viz., the distillation of *rosin oil.*

The rosin oil of commerce is produced in the following way: Rosin is introduced into an iron still, the lower grades being used for this purpose, and heat is applied until the temperature reaches from 316° to 320° F. Water and pyroligneous acid and naphtha come over first, and for some time, until the rosin is exhausted of naphtha. The heat is then raised to near the red heat of iron, when the rosin boils, and water and *oil of rosin* distill over together. This is crude rosin oil. It is a heavy, nearly opaque, whitish viscid fluid, opalescent on the surface.

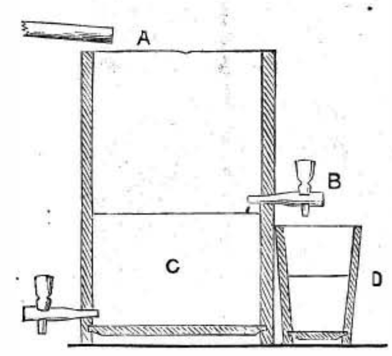
This crude *rosin oil* is rectified by redistillation, and the resulting oil is transparent, dark-red by transmitted light, with a decidedly bluish cast by reflected light. It is deeply opalescent, more so than petroleum oil.

The residuum left in the still is a black mass with a shining fracture, giving the hues of crystal aniline.

Other products still remain to be spoken of, viz., *naphtha* and *oil of tar.*

Tar when distilled yields pyroligneous acid, water, *naphtha,* or spirits of tar, and *oil of tar.* The naphtha, when purified by a second distillation, is clear and of a very pleasant terebinthinate odor. The *oil of tar* comes over in the latter part of the process, and a black residuum remains in the still resembling pitch. All but the last-named of these articles have a commercial value.

Tar is distilled in iron retorts, just as rosin is. There are many complex bodies which have come to the attention



TUB FOR SEPARATION OF TURPENTINE FROM WATER.

of the manufacturers during their operations. Some of them have been very intelligently worked out and identified by Mr. William A. Martin, the chemist of the works we have visited. Some remain to be investigated. Terebinthine products have always been exceedingly interesting chemically, and just now we are moving toward practical commercial results. I am expecting to announce, at no distant day, that we have made a sure step in the right direction.

* By Thomas F. Wood, M.D., in *New Remedies,*

† The commercial name for oil of turpentine.

The English Channel Tunnel.

The works which are going on at Abbot Cliff Tunnel, between Folkestone and Dover, on the Southeastern Railway, in connection with the sinking of a shaft for testing the geological formations of the locality, with a view to the formation of a tunnel between England and France, were inspected July 20, and pronounced satisfactory by M. Léon Say and the French engineers, including M. Duval, M. Oreton, and the Count de Montebello. A shaft 90 feet deep has been sunk from the level of the engine house at high water, and a heading has been driven to the level of high water mark for the purpose of depositing the chalk. Powerful machinery has been fixed for the purpose of driving an atmospheric drill, with which it is intended to drive a heading as far as Dover, a distance of three miles, under the line of railway, the heading at Dover to be 300 feet deep. The experiments are being carried out under the direction of Colonel Beaumont and Captain English. The Southeastern Railway Company have made a grant of $30,000 for the purpose.

Food Value of Root Crops.

Chemical analysis gives the following results with regard to the food values of different root crops:

Total Amount of Nitrogenous or Flesh-forming Material.	Pounds.
In 1,000 pounds of potatoes	20·03
In 1,000 pounds of mangolds	11·25
In 1,000 pounds of sugar beets	10·00
In 1,000 pounds of turnips	21·25
In 1,000 pounds of carrots	13·12

Total Amount of Carbonaceous or Fat-forming Material.	Pounds.
In 1,000 pounds of potatoes	237·4
In 1,000 pounds of mangolds	107·2
In 1,000 pounds of sugar-beets	174·4
In 1,000 pounds of turnips	81·7
In 1,000 pounds of carrots	139·1

THE DOWD TUNNELING SYSTEM.

FIGURES 1 and 2, see next page, illustrate the Dowd tunneling system, in perfecting which the inventor, Mr. O. B. Dowd, of 122 East Nineteenth street, New York City, has been engaged for some years past. It furnishes means of excavating for and constructing tunnels in soft and treacherous ground, and under great pressure.

The system provides a shield absolutely safe for the workmen while passing through strata of hard and soft mud, quicksand, "land-springs," poisonous gases, etc., and capable of passing bowlders and making an entrance in rock.

It provides for excavating the immense amounts of silt, clay, etc., by steam power instead of manual labor to insure rapid progress, and it provides for the construction of a tunnel with water and gastight walls, having strength even under pressure of about four tons to the square foot to allow a margin of safety of 50 to 1, and to resist constant pounding of heavy trains on its inverted arch; at the same time it has the longitudinal rigidity of a tubular bridge, so that in parts passing through "land-springs" or exceptionally soft pieces of ground there is no danger of breaking out cross sections of the tunnel. (Special attention has been called to this difficulty by able engineers, and the trouble was *practically* illustrated by the breaking out of portions of the Cleveland tunnel, under Lake Erie, the sections retaining their cylindrical form and moving several feet from line of the remaining tunnel.)

A water and gas tight joint is formed in the rear of the shield, and in the front edge of the tunnel sections afford firm and reliable support for hydraulic jacks by which the shield is propelled and guided.

Figure 1 is a longitudinal sectional elevation of a portion of a tunnel, and the shield employed in its construction. A represents a cylindrical iron shield of great weight and strength, having internal diameter slightly greater than external diameter of tunnel, B. The shield is made watertight in front by an adjustable head (C), composed of strong

A TURPENTINE STILL.

iron sections, and has a large central opening in which is fastened by bolts, etc., the collar, D, which forms the bearing for shaft, E. This shaft carries the strong rotating steel tunneling arm, F, on each side of which are blunt edge cutting tools.

The arm is about one foot in front of shield head. G is a cog-wheel upon shaft, E, for revolving it, which is effected by two oscillating compressed air or steam engines, as shown in cut on opposite sides of the cog-wheel, G. (When steam is used the smoke-pipe is connected with the ventilating exhaust tube, to carry the smoke out of the tunnel.) Shaft E is hollow and has a tube within it extending to the junction with arm, F, and the arm has two longitudinal water passages indicated in cross-sectional view, Figure 2, by dotted lines; each is connected with the water passages shown on either side of arm, F. A tube in the shaft is arranged so that by a part revolution of it the connection can be made so as always to drive the water through the side of the arm which is moving forward.

The shield being in place, the shaft and arm are moved slowly, revolving in either direction, and small quantities of water are forced through the shaft and arm to dissolve the silt and clay as they are scraped from the heading by the cutters, and form a semi-fluid, about the consistency of thick cream, according to the amount of water forced in, so that the arm is found to move easily in this sort of disk of soft material. Between this and the head of shield another disk forms, about a foot thick, of much harder consistency, and in silt or clay remains adhering to the head of the shield. It is sometimes found desirable to force compressed air through the shaft and arm, and good results are obtained. The air disintegrates and drives the earth from the front of the arm, and forms minute bubbles, and gives greater elasticity to the silt, etc., allowing the arm to move freely.

It should be observed that no part of the disk in which the arm moves is a vacuum or air-filled space, as this can occur only in exceptionally firm silt or clay; on the contrary there is a constant pressure on all sides of the arm and on the head of the shield—the pressure in difficult portions of the work being as great as four tons to the square foot.

The shield is pressed forward by hydraulic jacks, H, H. In excavating for a full size railroad tunnel eight twelve-inch bore jacks should be used, of strength capable of bearing a test of about 3,000 tons combined moving power, but arranged to work advantageously for the comparatively small power usually required of them.

Bars, I I, connect by socket joint with the pistons of the jacks, and reach back to the front edge of the iron tunnel, on which they have a reliable support. The jacks force the shield forward; at the same time the shaft and arm revolve and cut and mix the silt with the injected water, and the semi-fluid silt is pressed backward through pipes, J J, and falls into the car, K.

This car should be of sufficient strength to carry the silt removed from a section of the heading about four feet long.

When the shield is advanced until its rear end reaches the front end of the tunnel section, the gates, L L, are closed, stopping the flow of silt, etc., the car is drawn to the mouth of the tunnel by a wire rope, and the load dumped through gates in the bottom of the car. The course of the shield may be changed by shutting the cocks in the pipes leading from the pumps to the jacks on that side toward which it is to be directed, and allowing the remaining jacks to advance the opposite side.

The tunnel itself is made of solid sections of cast iron pipe, entirely free from any longitudinal seams—this form being used for economy of construction and to give greater resistance to crushing force than the previously-made iron tunnels; for instance, the second Thames, the sections of which are made up of smaller pieces bolted together.

The desired form of R. R. tunnel is a slight oval about

Several of these sections being in place, and under pressure from the jacks, four steel or iron links, or bars, O O, are placed while hot upon lugs cast on the interior of the section, as shown, drawing them together by shrinkage while cooling.

These links may be used with say five hundred tons each, or about two thousand tons combined contracting power, and in very bad ground two more bars may be used in other lugs cast on the side of the tunnel sections, to insure very great longitudinal rigidity. The packing between the sections form a water-tight joint, and it will be seen the form of joint illustrated admits of repacking at any time from the interior of the tunnel, in case a slight leak occurs.

Among minor details of the system may be mentioned the use of the well known sand ejector, but of peculiar form, consisting of a large portable tube with a smaller air tube within it extending to the end of the larger pipe.

This pipe when required is placed obliquely with its upper curved end over the dirt car, and its lower end projecting through the lower edge of the shield head, and flush with its outer face; a hose is attached to the small tube, and compressed air is driven through it, blowing the sand or earth backward and upward into the car.

This plan is found of value in certain kinds of sand for giving greater ease of motion to arm, F, but in silt or clay it is unnecessary.

The ejector is also valuable when placed from two to six feet lower down—that is, through an oblique opening at the lower front of the shield cylinder—to excavate for sinking below line of progress any bowlder or similar obstruction which might prove too great for the unaided power of the arm to force downward. While using the ejector, and, indeed, at all times, except when in hard silt or clay, the shield should be pressed forward with considerably more

need not be used, as the tunnel would be of considerable thickness.

Cost of excavating in silt or clay and putting sections in position and placing tightening bars, it is believed, need not exceed seven dollars per lineal foot. It is believed that silt can be excavated at least fifty times faster by this process than with the well-known Brunel shield, in which the earth was removed principally with the bare hand.

Before any reasonably accurate estimate of the cost of the entire tunnels can be made, it is, of course, necessary to determine the grade and the consequent length of the tunnels required. The originator of the above system, after considerable investigation, is convinced that the *inclined plane system* is far the most desirable for passing trains through most short subaqueous tunnels. In this system a long inclined plane is prepared, down which the train runs by its weight. It is then raised over a shorter incline by means of an endless wire rope, which passes over a large wheel with a grooved face, and thence to the foot of the incline, and around a small pulley, and it is moved like a belt by the large wheel at the head of the incline. This rope is supported by a number of small sheaves.

The propelling power is a stationary engine, which revolves the large wheel. For making the connection of the train with the rope, a special kind of truck with clutching device is used.

It is coupled with the ordinary cars, and is called a "pusher" or "puller," as it is used in front or at the rear of the train.

The problem being, for instance, to move a train from Jersey City to New York, it is believed best to have the mouth of the tunnel near the New Jersey bank of the river, and by one long inclined plane to run nearly three-fourths across the river, and then by a shorter and steeper

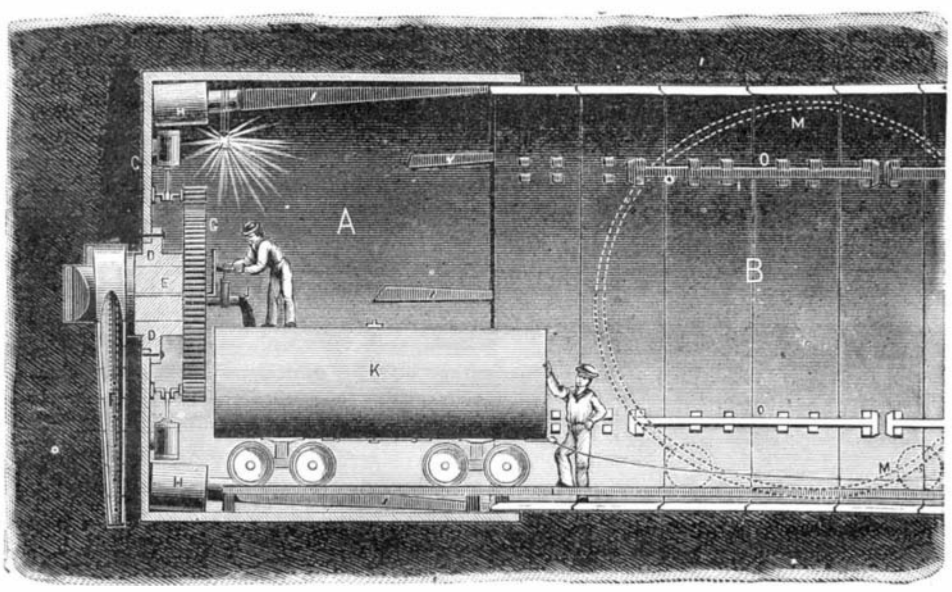


Fig. 1.

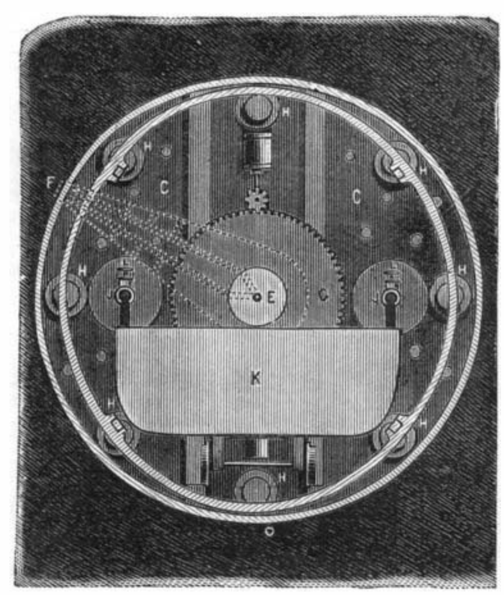


Fig. 2.

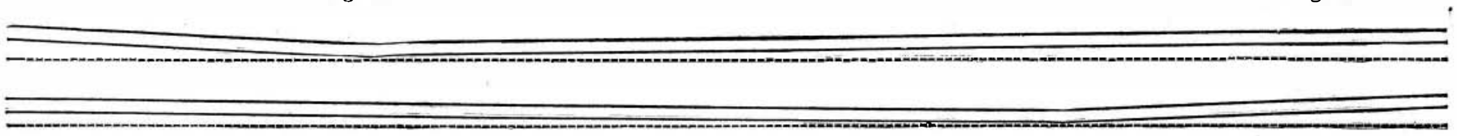


Fig. 3.

THE DOWD TUNNELING SYSTEM.

17½ feet high by 16 feet wide. This form allows the short sections of about four feet length to be carried through the completed portion by turning their greater diameter at right angles to the greater diameter of the completed tunnel, as shown by dotted lines at M. The tunnel section is fastened to two axles, thus forming a sort of car, and leaving only the axles to be thrown out of the way when the section reaches the interior of the shield, and is detached from them.

A wire rope hoisting gear is attached to the section, and it is raised by steam power and set in its permanent position. The pushing bars are then replaced against it, the pressure applied, and the car which has followed the section into the tunnel is filled, as before described.

After being cast, and before becoming quite cold, the sections are covered externally with a thick rust-proof bituminous preparation. This coating is applied by placing the section on its side with a hoop of sheet-iron of the same width as the section, but of size to leave about half or three-quarters of an inch space for the thickness of the coating. This space is filled with the composition while hot, so that it adheres to both the section and the hoop. While this is done the hoop is held by a frame coinciding with the form of the slightly elliptical opening in the rear of the shield through which it is to pass, so that, regardless of any irregularities in the rough casting of the section, the exterior of the *hoop* shall be suited to make a good joint in the shield packing, so that the rear of the shield may draw readily off from the hoop, which remains on the section, without allowing openings for irruption of water or mud.

A portion of the coating materials extends to the recess in the end of the section, to form a water tight joint.

force than the backward pressure of the earth heading incident to the weight of the superincumbent column of water and earth, to prevent excavating more material than requisite for the passage of the shield.

Collar, D, is arranged to allow of being taken into the shield with shaft and arm attached, if it is desired to renew the cutters, and means not shown are arranged to prevent silt, etc., pressing into the opening while this is done.

By the use of special cutters on arm, F, rock when not too hard may be tunneled; for instance, a rock known to exist below the Hudson river, and if this rock is as soft as believed by those claiming to know, the cutters would make very good progress through it; but if very hard, it would be desirable, after making a safe entrance within it, to remove parts of the shield head and go on by the usual methods, passing the shield through afterward and following with the iron tunnel.

When work is doing in ground filled with gas like that under the Detroit river, the car should have a tight cover, and its interior should be connected by tube with the ventilating pipe to convey the gas out of the tunnel.

As to the cost of this system, five among the best known expert authorities on a large foundry work agree in estimating the cost of casting the four-foot tunnel sections at less than thirty dollars each, or about seven dollars per lineal foot—this being in addition to the cost of the iron.

As the price of iron varies, no close estimate can be made of its cost. It is believed, however, it would be between $700,000 and $900,000 for the pig or scrap iron for two tunnels of length suited to the inclined plane system for the Hudson river. As weight is desirable, very expensive iron

grade to reach the surface not far from the river on the New York side.

A "pusher" or "puller" should be attached to the train at the last stopping place, and as the train approaches the tunnel the locomotive should be switched and the train allowed to enter the tunnel at full speed, running over the long plane to or past the lowest point. On commencing the ascent the motion will be checked, and the train may be stopped by the brakes, and the puller instantly attached to the wire rope, and the train be quickly drawn up into the passenger or freight depot.

A system is now used for lighter trains by which the ropes are attached while both the train and the ropes are running at full and nearly equal speed, and it is believed that this plan can be used for heavy trains by increasing the *power* of the machinery and the *number* of wire ropes, thus making the run through the tunnel without a stop. This would probably diminish the time of passage by more than a minute, thus allowing a much greater number of trains to pass daily. For outgoing trains the form of the tunnel should of course be simply reversed, the short incline and the stationary engines being placed at Jersey City. This system is much used, and is doubtless familiar to most readers, but slight modifications would be required.

The tunnels should be *entirely separate*, and at no point less than thirty to fifty feet apart. Fig. 3 indicates the form and approximately the grade of the tunnels for the inclined plane system under the Hudson. The south one represents the tunnel for incoming trains, and the north or upper one that for outgoing trains; the dotted lines simply indicate the horizontal.