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## THE ENGINEERING WORKS THROUGH, UNDER, AND OVER THE BERGEN HILLS, OPPOSITE NEW YORK.

From a point about opposite the central portion of New York city, for a distance of some fifteen miles northward, the west shore of the Hudson river presents an unbroken bluff, hundreds of feet in precipitous height, and to which the name of the Palisades has long since been given. The formation is a narrow ridge, sloping gently inland until it reaches the peninsula included between New York Bay on the east and Newark Bay on the west, where it changes into a series of irregular hills. These no longer line the river bank, but, at about a mile from the shore, rise abruptly from the otherwise level country, forming a rocky spine, which gradually tapers, and finally becomes lost in the waters which bound the southernmost end of the peninsula. The geological nature of the rock is a greenstone trap, bordered in places with, and having beneath it, an argillaceous red sandstone, besides containing, in many localities, deposits of iron pyrites.

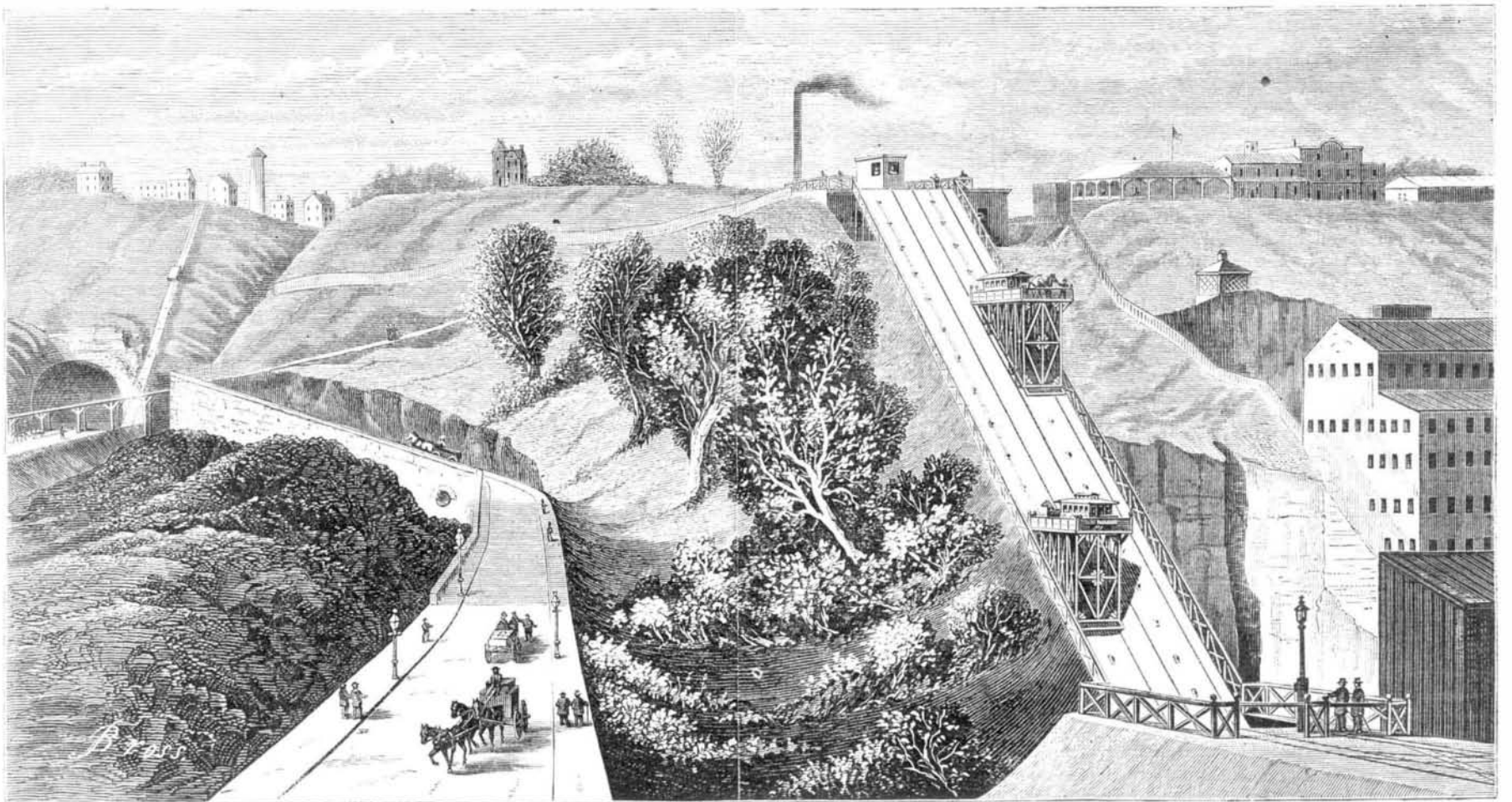
pipes, which, though not coming under any of the above heads, are nevertheless included within the narrow area over which the other operations have been carried on—a space measuring about two miles and a quarter north and south, and varying in width from half to three quarters of a mile.

The means for getting through the ridge, consisting in open cuts, have necessarily been those adopted at the southern point, where the elevation as well as width of the hill is least. Furthest south of all is the cutting of the Newark and New York road, some 3,800 feet in length and 50 feet in depth. The height of the ridge here is 80 feet. Operations were begun in 1867, and completed to a temporary grade of 100 feet to the mile, which, at the present time, is being cut down to 30 feet to the mile. The work necessitated skillful labor, since the excavations in progress are made directly beside the tracks over which the trains are constantly running.

The Pennsylvania Central cut is the oldest passage through the ridge. It is located three quarters of a mile to the north

Delaware, Lackawanna, and Western tunnel, a sketch of which our artist contributes in the annexed illustration, is located about 2,700 feet to the north of that of the Bergen bore. The western ends of the approaches intersect, and this is caused by the Delaware, Lackawanna, and Western tunnel taking nearly a direct east and west course through the ridge, the angle between the two tunnels being forty degrees. The roads, however, do not cross, as the Erie track at the western end dips under that of the other line, lying some 19 feet beneath.

The Delaware, Lackawanna, and Western tunnel is now in progress. When completed, it will be 4,200 feet long, 27 feet wide, and 19½ feet high. It was begun in September, 1873, and work has been simultaneously prosecuted at the bottom of each of the six shafts and at the two approaches. About 1,200 feet are now finished, and it is expected that by the summer of 1876 the entire work will be complete. The character of the excavation presents no extraordinary feature. Trap rock is met everywhere, and the bore will be



THE NEW RAILWAY TUNNEL AND STREET CAR ELEVATOR, JERSEY CITY, OPPOSITE NEW YORK.

On the flat plain, east of the ridge, Jersey City is built. The small adjacent towns which, quite recently, were absorbed within the corporate limits of their larger neighbor, lie to the north and south, spreading over the hills, until their westward growth meets a check in the broad expanse of salt meadows and marshes which extend from the foot of the declivity toward Newark Bay. The great railroads, however, which make Jersey City their terminus—the Delaware, Lackawanna, and Western, the Erie, the Pennsylvania Central, and a number of others which include some of the largest coal and oil transportation lines in the country—find little difficulty in crossing the wide flats which form so serious an obstacle to the enlargement of the city. True, the ground is marshy and soft; and in one instance, we learn that, in building the roads, three heavy piles were driven in one above the other before hard, holding soil was reached; but by dint of immense expanses of trestlework and heavy foundations, comparatively solid road beds have been constructed. The great barrier between New York and the inland traffic of New Jersey and Pennsylvania lies in the huge ridge to which we have above referred. Toward the surmounting of this obstacle an aggregate of engineering skill and of capital has been directed, which, considering the small area upon which such vast operations have been conducted, is perhaps without parallel elsewhere in the world. It is our object, in the following lines, to sketch briefly the results of these labors, which may be classed, first, into means for getting over; second, into means for getting under; and third, into means for getting through the hilly. To these we add short reference to another important engineering work, the Jersey City Reservoir and its conduit

of the Jersey cut, and is a sinuous line in lieu of the direct path of the former. It is, consequently, some hundreds of feet longer. Operations are now in progress for straightening it. A new cut, at an angle to the old one, and near one extremity, was made about a year ago. Save in the magnitude of these works, there is little of especial interest; and owing to their being practically incomplete, no fair estimate of their future aggregate cost can be gathered. A rough calculation, however, based on the material removed, labor, etc., up to the present, gives about a million dollars as the probable outlay for both.

Nearly a mile to the northward, the ridge is entered by the Bergen or Long Dock tunnel. This great work was begun in 1856, and completed in 1860. It crosses the hill diagonally, and is 4,311 feet long, 23 feet high, and 30 feet wide. Eight large shafts, from seventy to ninety feet deep, were sunk from the summit down to its level. The traffic through this passage includes the immense business of the Delaware, Lackawanna, and Western and the Erie railroads. This of late has far exceeded the capacity of the tunnel, since it is not permitted for one train to enter until another preceding it in the same direction has emerged. A delay of at least five minutes is thus caused, and hence but twelve trains per hour on each track can be accommodated. As the tunnel belongs to the Erie, the Delaware, Lackawanna, and Western line is necessarily at a disadvantage, and hence the occasion for the beginning of a second tunnel by the last mentioned company, to which work we shall next allude. The Bergen tunnel, it may here be remarked, is estimated to have cost in the neighborhood of one million dollars.

The eastern or Jersey City approach and opening of the

simply a clean cutting, reinforced with brick arches at the approaches and wherever signs of weakness in the rock may appear. Hand drilling is generally employed, and in the opinion of the contractors is more profitable than the employment of steam machinery for the purpose. The estimated cost of the tunnel is \$800,000.

The means for getting over the ridge are located at about a thousand feet still further north, and consist in the car elevator of the North Hudson County Car Company. This is also represented in the engraving, from which an excellent idea of its appearance may be obtained. Its object is to raise street cars, passengers, horses, and all, from the bottom to the top of the hill, a vertical height of 102 feet 6 inches. The incline is about as one to four, and the entire length of the tracks 480 feet. Of these last there are two, firmly laid upon timbers at 7 feet 10 inches gage. The cars are drawn upon two trucks made of very strong framework, the upper platforms of which are level, while the lower portions are inclined, to fit the slope of the rails. When a truck is either at the bottom or top of the road, its platform is in such a position that the car can be directly driven thereon. The closing of a bar behind the vehicle then causes chocks to rise from the track, which rest against the wheels, holding the car in place and preventing the horses moving it until the bar is once more opened. Between the two trucks extends a heavy steel wire rope, which passes over suitable pulleys at the top of the incline. This acts as a kind of safety cord and, at the same time, causes the weight of one car to counterbalance that of the other, throwing less labor upon the hoisting machinery. The engineer is stationed in a kind of pilot house on the upper platform, beneath which is a

spacious room in which engines and boilers are located. The engines, two in number and of forty horse power each, are horizontal, and are connected directly to pinions which engage in large spur wheels arranged between the two winding drums. The latter are 12 feet in diameter, and to each are brought two 1 1/4 inch steel wire ropes, which serve to hoist and lower the trucks. Inside the engineer's house above are counterpoised levers connecting with the throttle and link, and a treadle operated by the foot, which governs friction and vacuum brakes on the drums. The average time of raising one car, while lowering another, is one minute, though the same can be done with safety in half that interval. The work was begun on July 1, and finished in November 21, 1874. Mr. John P. Endries is the designing engineer, and the Dickson Manufacturing Company, of Scranton, Pa., the builders. The total cost was \$80,000. We understand that it is proposed to construct another and similar elevator further to the north, at a point where the ridge is 230 feet high.

The new distributing reservoir, now in process of construction under the supervision of Mr. J. P. Culver, Chief Engineer of the Jersey City Water Works, is located on the summit of the hill and between the positions of the elevator and the Delaware, Lackawanna, and Western tunnel. For many years past the Bergen reservoir, a small structure holding only a three or four days' supply for the city, has served the purpose of a distributor; but the increasing population has necessitated the present building, of larger accommodations. Work was commenced on the new reservoir in 1870, and will, it is expected, be completed so that a portion of the reservoir can be used during the coming fall. The area of the structure is 27 acres, or 700 feet wide by 1,700 feet long. Its capacity will be 23,000,000 gallons, this being a supply for 23 days. The depth of water will be 25 feet. The receptacle is divided into two portions, either or both of which may be drawn upon at will, and is surrounded by a heavy stone wall and puddle bank, the former 18 feet in height. The cost, up to the present time, is said to be half a million dollars. The means of supplying this reservoir consists in a huge siphon 30,075 feet long, which joins it with the reservoir at Belleville. The siphon has a fall of 29 feet, and is composed of three separate pipes resting upon a trestlework bed, which is constructed over the meadows. The oldest pipe is twenty inches, and the others, which have been placed quite recently, are thirty-six inches, in diameter. One of the latter is of cast iron; the other is worthy of special remark, as it is made of one eighth inch boiler iron, riveted together and covered inside and out with two inches of hydraulic cement.

It is interesting, by way of conclusion, to sum up the aggregate amount which has been spent in overcoming the rocky obstacle which Nature has placed at the very threshold of the metropolis, and through, over, or under which lies the most direct line from the West and South to the great market. The open cuts we placed at one million, the Bergen tunnel another million, the Delaware, Lackawanna, and Western tunnel eight hundred thousand, and the car elevator eighty thousand dollars; total, two millions eight hundred and eighty thousand dollars, or, including the second car elevator, in round numbers three millions of dollars.

SCIENTIFIC AND PRACTICAL INFORMATION.

HETEROPLASTY, A NEW MEDICAL DISCOVERY.

Skin grafting, as we have taken occasion to explain in some detail, is the removal of a piece of skin from the sound part of the body of the patient, or from another individual, and placing the same upon the raw surface of an obstinate ulcer, burn, or other wound. By thus creating centers of eccentric cicatrization on extensively injured surfaces, the rapidity of the healing process can be much accelerated.

Dr. R. J. Levis, in an extended article on this topic which we transferred to our columns some months ago, alluded to the possibility of obtaining the necessary grafts from limbs amputated for traumatic injuries. This has been repeatedly tried by Dr. Anger, of Paris, and with such remarkable success that the result is considered as certain as if grafts directly obtained from the patient were employed. Dr. Anger, however, proceeds further, and has used, not merely epidermic grafts, but those comprising much thicker layers—dermo-epidermic, he terms them—and finally he is enabled to employ the entire thickness of the skin, and even the subcutaneous cellular tissue. He has successfully transplanted grafts of the last description from 0.3 to 0.6 inch in diameter, obtained from the palmar face of an amputated finger. These were applied to an open ulcer on the leg of the patient and bound in place by diachylon bandages. Three days after the grafts were intimately united with the injured surface and manifestly vascularized. Heteroplasty is the new name given to the operation.

THE CHEMICAL CONSTITUTION OF THE BRAIN.

M. Gobley has recently completed extended investigations on the above subject, from which we adduce the following results: The human cerebral substance contains about 80 percent of water. Two albuminoid matters are present, one not differing from albumen and soluble in water; the other is insoluble, and for this the investigator proposes the name of "cephaline." The fatty substance of the brain is formed principally of cholesterin, lecithin, and cerebrin, and also olein and margaric. The organ contains certain salts, some soluble in water and in alcohol, others soluble in water and not in alcohol. During decomposition, the cerebral pulp furnishes acid products, among which are oleic, margaric, phospho-glyceric and phosphoric acids.

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THE GENERATION OF THE WICKED.

It is a fortunate circumstance that vice is ultimately self-destructive. Lust, violence, and debauchery are killing in themselves; and the children of the brutally vicious are very apt to enter upon the struggle for existence weighted with such an inheritance of weakness and disease that their early extinction is all but inevitable. It is a law of nature that the generation of the wicked shall be cut off.

To this beneficent law, however, there are serious exceptions. Certain phases of criminality—as may be seen any morning in our police courts—are not only consistent with but are usually accompanied by abundant animal vigor, capable of indefinite propagation; and the probabilities are that the criminals of future years will be chiefly descended from the sturdy sinners for whose restraint the police systems of to-day are mainly required. The criminal class, like the pauper class, is to a great extent an hereditary caste, representing the uncivilized and largely uncivilizable elements of the community. How to deal with this class, how to turn its perverted forces into useful channels, and make its perpetuation difficult if not impossible, is the great social problem of the day.

Victor Hugo has said that the quickest way to civilize a man is to civilize his grandmother. The saying is worthy of a place among the axioms of social science. Certainly when society neglects the grandmother—as it did in the case of the waif called "Maggie" (referred to in our paper of January 9), to whom Dr. Harris traces such a pestilent brood of human vipers—the succeeding generations are pretty sure to pay a heavy penalty in perpetuated savagery. Probably each one of the small army of criminals, lunatics, drunkards, imbeciles, and the rest, to which she gave being, has cost the country more than would have sufficed for the reclamation of a dozen such grandmothers to be, certainly enough to surround them with conditions which would make it impossible for any one of them to stock a country with criminals and paupers.

It will not take many such cases, it is to be hoped, to rouse the community to an appreciation of the urgent need of greater watchfulness in regard to the development of vagrant children, and all children not subject to wholesome influences. Who can say how many Maggies are skulking about city and country to-day, or cowering in homes of bru-

tality and vice, receiving the training requisite for making them criminals and breeders of criminals? For its own safety, let alone the children's present and future welfare, society is bound to adopt more liberal and thorough measures for removing such heirs of crime and criminal poverty from their corrupting environment, and for training them in ways of industry and morality.

It may be impossible to make much of such unpromising material, nevertheless it is possible to prevent much; and with social as well as with individual disease, prevention is better than cure. Every boy or girl growing up in beggary and lawlessness is the possible ancestor of a line of pariahs as numerous and burdensome as Maggie's have been; and neither prudence nor philanthropy can tolerate the neglect of them. As a matter of justice, too, society has as little right to allow the future to be afflicted with the pernicious fruit of such pernicious stems as it has to stock the fields with poisonous plants, or knowingly to establish the conditions for the development of future pestilences.

How Can Society Help Itself?

Primarily, by civilizing, so far as possible, the naturally uncivilized grandmothers, not forgetting the grandfathers also, by bringing them up in habits of honest industry in useful occupations: not in unnatural masses in prison-like asylums, but in workshops and families. This done rigorously, the criminal class will be largely cut off by conversion into something better. We shall have cause for thankfulness when so much is done. But the time is probably coming when society will see the necessity of taking still more radical measures for the prevention, not only of possible crime, but of possible criminals. In a more immediate and active sense than the words now carry, the generation of the wicked will be cut off.

Nature's processes for effecting this end are, like most other natural processes, very slow and very wasteful; still more, they are very unjust, since the innocent suffer far more than the guilty. The lusty vagabond leads a jolly life, filled to the end with all the enjoyment he is capable of; and leaves behind him a numerous progeny to pay the penalty of his misdeeds in hereditary poverty, impoverished constitutions, depraved tastes, wasting diseases, and other conditions of early defeat in life's engagements, and the morally and physically healthy are taxed for the support of almshouses, prisons, asylums, hospitals, and other places of refuge for them. For the victims, as well as for humanity at large, it were better had they never been born. We do well to make the most of them after they are born—or rather, we should do well did we do so; but would it not be infinitely better all round could their existence be made impossible from the outset?

Advantages of a Diminished Birth Rate.

The rational tendency of high civilization is toward a diminished birth rate. The waste of life that goes on in ruder societies, through wars public and private, through improvidence and unhealthful conditions of living, is immensely lessened in civilized communities, and with it the need of many births. A vastly larger proportion of the children born are able to attain maturity, and the average duration of life is much increased. A low birth rate is therefore perfectly consistent with high national power and progress, and the development of all that makes life desirable; and, as we have said, the tendency of civilization is always to attain such an economical birth rate.

But unfortunately, while the law holds good in the upper grades of civilized society, the lower and more or less uncivilized grades are under no such moral restraint. Improvident in all things, they are equally so in human life. Careless of the responsibilities of parentage, they breed like vermin; and since society throws around their offspring so far as possible all the sanitary conditions and advantages of civilization, the descendants of the lower half of any community are pretty sure to preponderate numerically. The criminal grades are especially prolific, more than enough so to make up for the destructive influences of crime. The effect upon the future well being of society can scarcely be other than disastrous, unless special effort is made to counteract the evil by preventive as well as by curative means.

The Knife Remedy.

We can only regard it as an illustration of the power of popular prejudice that people, who find nothing to condemn in the extermination of individuals whose murderous nature seems incompatible with public safety, are ready to hold up their hands in horror at the most guarded suggestion of the advisability of making it impossible for lusty savages to inflict upon the community a brood of ill balanced organisms, destined to swell the ranks of vice and crime. Yet society may be driven to adopt just such radical measures in self-defense, driven to make sterility one of the penalties for the grosser forms of criminality.

The effect on the criminal statistics of this city for the next hundred years would be something marvelous, we fancy, were the worst offenders against public peace and morality sent to the island—not as now to recuperate their wasted forces and return in a few weeks to enter more lustily than ever upon their evil courses—but to be made perfectly harmless as regards the future. In this way only, can the stream of tendency which makes for unrighteousness be dried up at its source.

It has been objected that the subjects would be spoiled as human workers, through loss of ambition and energy; but the objection scarcely holds in view of the fact that their representatives in the East have from the earliest times been prized for their serviceableness. Besides, they are of little worth as workers as they are, and the change would rather tend to diminish their rampant beastliness and make them more amenable to civilization. Many an unmanageable