Engineering, Civil & Mechanical.

ELECTRIC RAILWAYS.

A lecture on the utilization of electricity for working railways was recently delivered before the Birmingham and Midland Institute, by Prof. Ayrton, F. R. S., who, in conjunction with Prof. Perry, has been making a special study of the subject. Engineers, said Prof. Ayrton, had been turning their attention to the consideration whether electricity might not supplant steam or compressed air for trains and tramcars. The question was mainly one of expense, and what they had to consider was whether electric transmission of power would lead to greater economy than was possible to be obtained with an ordinary locomotive. The weight of a railway carriage filled with people was about seven tons, while the weight of a locomotive engine varied from twenty to sixty tons. Therefore the average weight of every engine might be taken as being equal to six carriages full of people. Ten carriages usually formed a train; therefore the presence of the locomotive necessitated the expenditure of at least fifty per cent. more power than would be necessary, merely to pull the train along. A still more serious objection to the use of the locomotive was that every bridge must be made many times stronger than would be necessary merely to carry railway carriages; and the repairs were many times as expensive. Compressed air had enabled the railway companies very successfully to apply brake-power to every wheel of a train; but it was to electricity that they must look to drive the train, by power applied to every pair of wheels. The electrical energy, however, must be produced either from the burning of coal, from the energy of the mountain stream, the force stored up in chemicals, or the energy of the wind. At the present time it was the first of these—namely, the potential energy of coal, which was applied to railway propulsion; and it was that form which would still be employed even when they had electric railways, as it was found that the driving of a dynamo-electric machine by a stationary steam-engine would produce electricity more economically than it could be produced by the burning of zinc in a galvanic battery. By means of a small gas-engine, driving a Gramme machine, the lecturer showed how power was produced which could be transmitted by wires, and made to work a lathe, a drill, or other apparatus at a distant point, and he explained that this method of producing electricity was the more economical by the fact that a pound of zinc only contained about one-seventh of the energy contained in a pound of coal, while the former was about twenty-five times as expensive. In employing electricity to drive a drill, flexible wires could be used to convey the current; but to drive a carriage along a railway, the simplest plan was to use the rails as the two wires, the one rail acting as the going wire, and the other as the returning wire—the electricity being taken into the electro-motor by the wheels on one side and sent back by the wheels on the other. The rails, however, must be insulated from one another, or the electricity would pass from the one to the other instead of going through the motor. It had been found hitherto impossible to insulate a long line of rails sufficiently to prevent excessive waste from leakage, and his colleague, Professor Perry, and himself had spent considerable time in devising methods to overcome this difficulty without adopting the method, which, however, had been successfully used for tramway purposes, or taking a supply of electricity with the conveyance by means of a Faure's accumulator. Instead of supplying electricity to a very long and badly insulated rail, their plan was to place by the side of the line a well-insulated cable, by means of which the electricity was supplied to a comparatively small section of the railway over which the train was at the time running. As the train left one section and passed on to the next, a brush attached to it came in contact with a mechanical contrivance which transferred the electric current to the next section, and so on throughout the number of sections of which the line might be composed. Dr. Siemens had shown practically that an electric railway would answer over short distances, and the lecturer submitted that by making up the line of short lengths, each of which was automatically rendered electrical in its turn, the difficulty arising from leakage over an extended line was overcome. He showed the working of the system by means of a model circular railway about 10 ft. in diameter, divided into four sections; and he pointed out that its arrangement afforded means by which an apparatus in a signal-box would show over what section a train was moving.—*English Mechanic.*

COMPRESSED-AIR MACHINE USED IN THE CHANNEL TUNNEL.

The length of the Submarine Continental Railway Company's Tunnel, under sea, from the English to the French shore, will be twenty-two miles; and, taking the shore approaches at four miles on each side, there will be a total length of thirty miles of tunnelling. The approach tunnel descends from the day light surface by an inclosed gallery, with an incline of 1 in 80, toward Dover, to a point on the Southern Railway-Company's line, about two miles and a half from Folkestone. The exact point is at the western end of the Abbot's Cliff tunnel, at which point the gault clay outcrops to the sea level. Half a mile of heading has been driven, by machinery, from this point; after which the works were suspended to enable them to be resumed at a point nearer to Shakespeare's Cliff, where the tunnel passes under the sea. The shaft at this point is 160 feet deep. It is sunk close to the western end of Shakespeare's Cliff. The shaft passes through about 40 feet of overlying *débris;* it then just touches the white chalk, which is pervious to water, after which it goes down to the beginning of the tunnel, which is here 100 feet below the surface of the sea. A heading, now three quarters of a mile long, has been driven in the direction of the head of the Admiralty Pier, entirely in the gray chalk, near its base, and a few feet above the impermeable strata formed by the gault clay. The idea of the projectors is so to localize the tunnel, not only in the part already made, but also when it passes out under the sea, that it shall have the body of the gray chalk above it and that of the gault clay below it, both these strata being in themselves impervious to water, and both alike having heavily watered strata on each side of them; namely, the white chalk above the gray chalk, and the lower greensand below the gault clay. This condition, together with that of providing sufficient roof between the top of the tunnel and the sea, which roof has a thickness of 150 feet, will necessitate the tunnel being turned in a curved line.

The present heading is 7 feet in diameter. Machinery is being constructed by which this 7 foot hole can be enlarged to 14 feet, by cutting an annular space, 3 feet 6 inches wide, around it. This will be done by machinery similar to that already described, but furnished with an upper bore head, suitable for dealing with chalk, to make an annular cutting, instead of acting like the first machine, which makes the 7 foot cutting. The one machine will follow the other, at a proper interval; and the *débris* from the cutting by the first will be passed out through the second machine. The compressed air, likewise, which is necessary to work the advanced machine, will be similarly passed through the machine coming behind. There will be no difficulty in speeding the machine so that they shall work along the tunnel at the same rate of progress; and the larger machine can, as well as the smaller one, do its work with a minimum of manual labor; only two men are at present needed for each machine.

The engraving shows the Beaumont & English compressed-air boring machine at work. The length of this machine from the borer to the tail end is about 33 feet. Its work is done by the cutting action of short steel cutters fixed in two revolving arms, seven cutters in each, the upper portion of the frame in which the borer is fixed moving forward five-sixteenths of an inch with every complete revolution of the cutters. In this way a thin paring from the whole face of the chalk in front is cut away with every turn of the borer. A circular tunnel is formed having a diameter of 7 feet. A man in front shovels the crumbled *débris* into small buckets, which, traveling on an endless band, shoot the dirt into a "skip" tended by another man. The skip, when filled, is run along a tramway to the mouth of the shaft. At present these trolleys, each holding about one-third of a cubic yard, are drawn by men, but before long it is hoped that small compressed air-engines will be used for traction. The rate of progress made with the machine is about one hundred yards per week, but will soon be much accelerated. As worked at present, the number of revolutions it makes is two or three per minute, which, as the advance by each revolution is five-sixteenths of an inch, amounts to boring nearly an inch a minute while the machine is at work. But Colonel Beaumont anticipates no difficulty in making the machine cut its way at the rate of three-eighths of an inch per revolution, and getting five revolutions per minute, which would give a rate of advance of two inches per minute. A very important question has been raised with regard to the supply of compressed air. Carried in four-inch iron pipes, it now reaches the machine with a pressure of about 30 lb., the pressure at the compressor at the shaft mouth being from 30 lb. to