THE HALFORD GRADIENT RAILWAY.

A few months ago, we published in the SCIENTIFIC AMERICAN a detailed description of the Langen Suspension Railway, which is at present nearing completion between Barmen and Elberfeld in the Wupper Valley, Germany. Another principle of the suspension railway has been devised by a Mr. Halford, of London, which is certainly not wanting in the element of novelty. In this system no machinery of any description whatever is applied to the cars. The inventor utilizes the laws of gravity. His permanent way is normally perfectly horizontal; but each of the sections into which it is divided may be inclined at will, so as to produce an inclined plane or gradient. By this means, once the car is started it continues in motion, since the track from one terminus to the other is resolved into one continuous incline. An actual railway has not yet been constructed upon Mr. Halford's idea, but he has erected a small working model, built to scale, of which we present an illustration.

The model is 150 feet in length over all, and is divided into six sections, each measuring 25 feet in length. Each of the sections weighs 100 pounds, and when inclined produces a gradient of 1 in 72. The sections are raised by means of hydraulic rams, which are placed beneath the abutting ends of the sections and at as many intermediate points (in a full-sized track) as may be judged necessary. The sections are joined at the terminals by means of a long pin, which passes through an elongated hole at the end of the girders. An allowance is made at the junctures for the sliding movements of the sections in rising and falling, yet when resting in their normal position the joints are perfectly flush. Fig. 1 shows the general construction of the model. The raising rams are placed at each end, and the column in the center is the supporting ram. The supporting rams can be introduced at frequent intervals, since they simply carry the weight of the girders.

The track consists of a double row of rails, set to a narrow gage, on the upper face of the girders. Upon this track runs a trolley which carries the two passenger cars, one suspended on each side, as shown in our illustration. The center of gravity by this means is placed below the level of the rails, so that comparative safety is assured, notwithstanding the high rate of speed. The trolley itself carries the driver of the train, who occupies a cab in which is placed all the controlling gear of the train.

The raising of the track by the hydraulic rams is automatically accomplished. The accompanying figure represents two sections of the track, *A* to *C*. To start the cars at *A*, the driver, by means of a lever within his cabin, connected with wires controlling the hydraulic rams laid along the track, causes the ram behind him to rise. As the track is resting upon this ram, it is lifted, and a gradient is thus formed from *A* to the lower terminal of the section at *B*. By this action the car is placed upon an incline, and as its movements are completely free, it travels to the lower end of the gradient by the mere force of gravity. When within about 5 feet of the hydraulic ram at *B*, a lever in the driver's cabin automatically depresses a lever, called an actuator, fixed upon the track. The depression of this latter lever opens the valves supplying the hydraulic ram; the water enters the cylinders and gradually forces the piston in an upward direction, lifting the track and trolley, so that now another incline is produced from *B* to *C*. The upward movement of the ram is very slow, and the piston does not reach the limit of its stroke until the car has passed the juncture, *B*. As the cars pass from one section to another, the rams automatically lower themselves, so that the track resumes its former horizontal position. The piston works so smoothly and the track is raised so gradually that the lifting motion is not perceptible. In fact, it appears as if the train were running along a perfectly level track. In the event of the powerful brakes, with which the train is supplied, breaking down or temporarily failing, the driver, by the movement of a lever, can raise the ram in front of him and lower the one behind him, so that the track is converted into an upward incline, which must necessarily retard the progress of the train and eventually bring it to a standstill. By the same means the driver can also regulate his speed. When sufficient momentum has been attained, the driver can decrease the stroke of the ram, thus lessening the steepness of the gradient, or he can throw the hydraulic rams completely out of action, and thus run along a level track. In the model of the railway, the gradient is steeper than it would be upon a practicable railway. Although the model is of interest, the device would be too costly for application to full sized railways because of the enormous expenditure of power involved in raising the deadweight of the track and supporting girders.

Number of Section.	Time Occupied by Cars in Passing.
Starting section	8 seconds.
Second "	6 "
Third "	4½ "
Fourth "	3½ "
Fifth "	2½ "
Sixth "	(barely) 2 "

A GRADIENT RAILWAY—END VIEW OF TROLLEY AND CARRIAGES.

It will be seen from the above that there are possibilities of high speed in this method of locomotion, though it does not possess sufficient advantages to enable it to replace the present system of railroads. The initial outlay for the construction of the track would be great, although at the same time it is true that there are no locomotives to keep in repair, and the wear and tear upon the track would be reduced. Costly machinery would be necessary in the way of central station plants, for the purpose of pumping the water for the hydraulic rams. In a full-sized railway, of course, the weight of the superstructure, which would consist of a series of massive bridge girders, would be enormous, but this should offer no insuperable difficulty in view of the fact that a pressure of 1,000 pounds to the square inch is frequently employed in hydraulics.

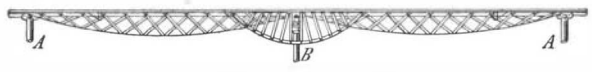


Fig. 1.—SIDE ELEVATION OF SECTION OF RAILWAY.
A A, hydraulic raising rams; *B*, supporting ram.

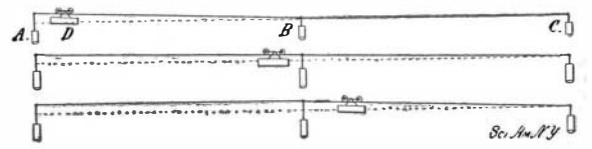
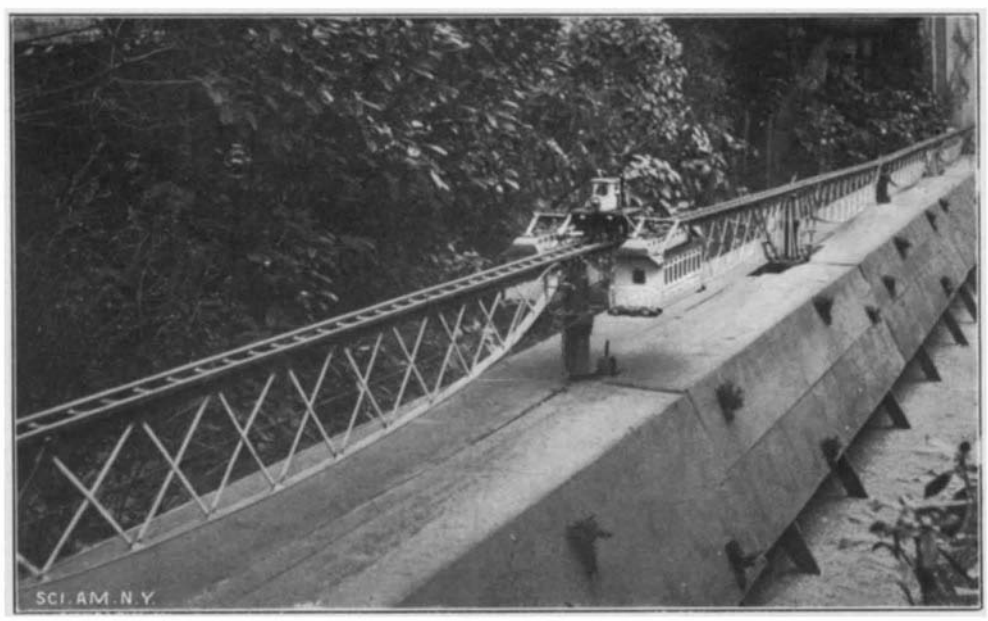


Fig. 2.—DIAGRAM SHOWING RAISING OF TRACK BY HYDRAULIC RAMS DURING PROGRESS OF TRAIN, *D*.

There is one great advantage it possesses over the ordinary railway that cannot fail to impress one. On the present railroad systems, when the weight of the train is increased the speed is diminished, but on the Halford Gradient Railway the increment of the load has just the reverse effect, the heavier the load the greater the speed. Recently, by special request, Mr. Halford demonstrated his system to the members of the British Institution, and considerable interest was evinced in the invention by the scientists of that association.



A SECTION OF THE TRACK, SHOWING THE TRACK GIRDERS AND HYDRAULIC LIFTING-JACKS.

Toning of Bromide Prints.

It is often found desirable to change the tone of bromide prints, and a number of processes have been devised for accomplishing this; one of the best of these methods is that which has been recently described by Mr. Ferguson in a communication made to the Royal Photographic Society. Mr. Ferguson has been experimenting in this direction ever since 1895, and has at last perfected a process which is claimed to give fine results with bromide paper or glass transparencies. In this process the toning action is brought about by the use of ferricyanide of copper; this is formed by adding 75 parts by weight of sulphate of copper to 66 parts of ferricyanide of potassium, both having been dissolved separately. On adding the two solutions a greenish-gray precipitate is formed, which, however, is not very stable and is difficult to separate by filtering; it is best separated by decanting the liquid and washing with water. After several changes of water most of the remaining sulphate of potassium solution is removed.

The ferricyanide of copper is now to be dissolved in order to form the toning bath. Mr. Ferguson, after a number of experiments, found that the citrate of potassium was by far the best solvent, although the oxalate may also be used. To make the toning bath, 10 per cent solutions of neutral citrate of potassium, sulphate of copper, and ferricyanide of potassium are made; it is best to use distilled water. The solutions are mixed in the following proportions:

Citrate of potassium, 10 per cent solution	250 parts.
Sulphate of copper, 10 per cent solution	35 "
Ferricyanide of potassium, 10 per cent solution	30 "

Add the sulphate to the citrate, mix, and add the ferricyanide, when the ferricyanide of copper formed remains in solution. The solution may be used in various strengths, but it is preferable to dilute it to one-twentieth. The prints, which have been developed somewhat stronger than usual, are washed carefully after fixing, and placed in the bath, being kept in movement. In a short time a warm black is obtained, which soon passes to brown, then purple, and finally to red tones, with a diminution in intensity of the image. Positives on glass may be also toned by this bath. Mr. Ferguson states that remarkably fine colors are obtained by this toning process, and recommends it to all persons who wish to vary the ordinary tone of bromide prints.

Trans-Siberian Train Lighting.

The trains which are now running over the section of the Trans-Siberian from Moscow to Irkutsk are provided with a complete electric system which serves for the lighting and heating of the cars, as well as for the water and milk heaters in the dining car. In the baggage car has been placed an installation consisting of a boiler, a steam turbine and a dynamo of 5 horse power, which gives the current at a tension of 65 volts; the plant is under the supervision of an engineer appointed for the purpose. Under one of the cars is disposed a battery of accumulators, which assures the lighting for four hours in case an accident should happen to the dynamo plant, and the latter may be stopped during the night when only a few lamps are in use. Electric cigar-lighters are placed in each compartment.

The lighting is carried out by globes placed in the ceiling, by brackets and portable lamps. The globes of the sleeping compartments, corridors, etc., contain two lamps provided with a switch; the others have one lamp. The portable lamps, which are usually suspended from the partitions by brackets, may, if necessary, be placed upon the tables. The lamps are from 5 to 16 candle power, according to their position; the whole number of lamps in a train represents 1,000 candle power. The circuits are so arranged that most of the lamps are turned off after midnight. In the sleeping compartments the lamps which illumine each has an automatic switch by which it is extinguished or turned on as the curtains are drawn or opened.

THE London County Council Fire Brigades Committee are considering the question of motors for fire apparatus.