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THE ABT SYSTEM OF RAILWAYS FOR STEEP GRADE LINES.

(Extract from the *Engineer*, 12th November, 1886.)*Laid on the Table by the Hon. E. Mitchelson, with the Leave of the House.*

WE called attention last week to some of the disadvantages which are inseparably connected with the use of any "ladder-like" form of rack for steep-grade railways, and we mentioned that a system of rack has been invented by which these difficulties are satisfactorily overcome. We now proceed to describe this system, as most successfully carried out on the Blankenburg-Tanne Railway, in the mountains of the Harz, and which has there afforded a most satisfactory proof of the practicability of working steep gradients in the most economical manner by combining the ordinary system of adhesion with the use of a peculiar form of central rack.

Mr. Roman Abt, the inventor, is a well-known Swiss engineer, who has been previously for some years associated with Mr. Riggenbach in the construction of central-rack railways.

The Blankenburg-Tanne Railway opens up a large district of the Harz, and brings the mines of Huettenrode, the coal-fields and ironworks of Ruebeland, the stone quarries of Elbingerode, and the State ironworks of Rothehuetten and Tanne into connection with the network of Prussian State railways, which had, till the construction of the line under notice, terminated at the foot of the mountains owing to the want existing at that time of means for surmounting the steep gradient in an economical and satisfactory manner.

The length of the line, which is of a normal gauge, is $16\frac{3}{4}$ miles, of which $4\frac{1}{2}$ miles, or, including terminal ends $4\frac{3}{4}$ miles, are provided with a central rack in lengths varying from 14 chains to 77 chains, a practical solution being afforded, by the mode of working to be now described, of the very interesting problem of utilising the ordinary adhesion in combination with a central rack.

There are two watersheds to be surmounted, the second and highest of which is 1,000ft. above Blankenburg. The prevailing gradient on the central rack portion is 1 in 16.6 for a total length of 3 miles 8 chains; the steepest gradient on the other portion, worked by adhesion, is 1 in 40. No less than 50 per cent. of the line is in curve, the minimum radius on the rack being $12\frac{1}{2}$ chains, whilst that on the ordinary rail portion is 9 chains. The permanent way consists of steel rails weighing 60lb. per yard, resting on Schneider's improved Vautherin iron sleepers, which each weigh 90lb. The characteristic feature of Abt's system is its departure from the primitive and "ladder-rack" employed by Riggenbach on the Rigi and other railways. Mr. Abt's rack consists of three soft steel bars of rectangular section, $\frac{3}{4}$ in. thick, 4 $\frac{1}{2}$ in. deep, and 8 $\frac{3}{4}$ ft. long, provided with involute teeth, and placed side by side, each being one-third of a tooth in front of its neighbour, as in the well-known Hooke's gearing. In the pitch line of the teeth of the rack the space of the teeth themselves measures 2 $\frac{3}{4}$ in., the teeth of the pinions on the pitch line 2 $\frac{1}{2}$ in., and the spaces 2 $\frac{5}{8}$ in. The pinion consists of three separate toothed discs mounted on the same shaft, the teeth being stepped in the same manner as those of the rack, and the discs themselves, being connected to the shaft by means of springs, are thus allowed a slight play relative to each other, to take up any trifling irregularities in the spacing of the teeth. Owing to the plan of placing the bars as described above, a fresh cog is engaged in every $\frac{3}{4}$ in., and at the moment of engagement five other cogs are in complete contact. The advantage of this arrangement is self-evident; a smoothness of motion, quite noiseless even at high speeds, is attained, which was quite impossible with the ladder rack, whilst the fracture of a tooth—an event which would have been disastrous with the latter system—is here, owing to the fact that several teeth are simultaneously in contact, not followed by any serious consequence. The bars are laid so as to break joint with each other, thus giving a practically continuous structure to the rack, and equalising throughout the effect of expansion or contraction from changes of temperature. With the length chosen for the bars, and a distance between the sleepers of 2ft. 10 $\frac{1}{2}$ in., one bar—allowing $\frac{1}{4}$ in. full for expansion—just covers three spans; consequently one butt joint falls on each chair. On the ladder-rack system the rack had, in the case of curves, to be specially designed and constructed for each radius; with the system under notice the same form of rack can be used for curves as for the straight road, and the strains are considerably reduced. No difficulty whatever has arisen from snow or mud even during very severe winters. A very important feature of the system is the means provided for insuring that the pinion enters the rack, without necessitating a