reduction of the speed of the train. The automatic entering rail, about 10ft. long, is hinged at one end to the rack, and towards its other end is in the form of an inclined plane, the teeth gradually increasing in height from 0 to the height of the teeth on the rack. Under this end of the entering rail are placed strong spiral springs to admit of vertical play of the rail. Should the teeth of the pinion not gear immediately on entering they gradually adapt themselves within a few feet of distance travelled over. This arrangement has been found to answer perfectly.

The locomotives are constructed as tank-engines. The three axles of the adhesion wheels, which are in front of the fire-box, are coupled. A Bissel truck is placed under the foot-plate. In working order each of the driving axles has a load of 14·5 tons, and the Bissel axle of 12·4 tons. The fuel and water are carried principally by the latter, so that the variation in quantity has very little influence on the adhesive power of the engine. There are two pairs of cylinders —one for the adhesive and one for the cogged-wheels—with separate steam pipes and independent action, the former outside, the latter inside of the smoke-box. Steam is only admitted to the latter pair of cylinders when the engine has entered the rack-sections of the line.

The toothed gearing is supported by an entirely separate frame resting on the two outside axles of the adhesion wheels, so that the grip of the toothed wheels is in no way affected by the play of the springs. The frame can be lifted to allow for wear and tear of the tires, and instead of the whole being a dead load when not in action, it adds to the adhesive power of the engine when working as an ordinary locomotive.

The two rack wheels are coupled, the rear one being the driver. With the ladder rack it was found to be impossible to couple thus two toothed wheels, owing to the inequalities in the pitch of the teeth. Each of the pinions is fitted with two disc brakes worked from the same spindle; a second spindle brakes the leading and trailing wheels of the adhesion axles. In addition to this there are two separate air brakes, one for the adhesion cylinders and the other for the rack cylinders. The other fittings are much the same as in an ordinary locomotive, except that, owing to there being two complete engines under one boiler, many of them are duplicated. The weight of the engines in working order is 55·9 tons.

The engine can haul a train of 120 tons up the gradient of 1 in 16·6 at a speed of 7½ miles per hour, or the same train up the gradients of 1 in 40 at a speed of 15½ miles per hour, it being thus possible in every case to develope the full power of the locomotive, and so to gain time, and diminish the cost of working. In descending the gradients it is not found necessary to brake the coaches, as the air brakes on the cylinders are sufficient to control the speed of, and stop the train, when required. By this arrangement the usual wear and tear of the tires is considerably diminished, but provision has also been made for emergencies by fitting the whole of the rolling stock with Heberlein friction brakes, which are under the immediate control of the engine-driver by means of a friction reel and continuous cord, and which also apply themselves automatically on any coupling breaking.

The cost of the Blankenburg-Tanne Railway (including four locomotives, six passenger coaches, two post wagons, thirty open trucks, six covered trucks, one saloon carriage, and six ordinary trollies, amounting to £28,500; purchase of land £7,000; stations, £11,000; permanent-way, £49,000), was only £175,000, or about £10,458 per mile. A very careful estimate has been made to show what would have been the cost of constructing, in this case, a simple adhesion railway instead of a combined rack and adhesion line, considering the smaller area of land required for the latter and the economies of construction. The result showed a saving of about £1,600 per mile in favour of the Abt system, the economy being especially noticeable in the items of excavation and masonry, the former being about three and a-half times and the latter about six times larger for the simple adhesion line than for the Abt system. Railways upon the Abt system are being constructed at Lehesten, and at the extensive slate quarries of Mr. Oertel in Bavaria. We understand that Mr. Abt has also submitted to the Swiss Federal Council a proposal to built a line of railway on his system up the Rhone Valley from Brieg, the present terminus of the Western Railway of Switzerland, to join the St. Gothard line at Airolo, in Italy, thus opening up the Upper Valais, and bringing the Western Railway into direct communication with the railways of Northern Italy. The estimated cost of this line of 38 miles is £920,000—about £24,210 per mile.

Those of our readers who desire further particulars as to the Abt system, all the details of which appear to have been most carefully and ingeniously worked out, we would refer to the very valuable paper on the subject read in March, 1886, before the American Society of Civil Engineers, by Mr. Walton W. Evans, M. Am. Soc. C.E., and published in the fifteenth volume of the "Transactions" of that Society. To this paper we have to acknowledge our indebtedness for some of the data given above. Mr. Evans sums up the advantages of the Abt system by stating that, in his opinion, "the rack, which thus far had been regarded more as a sort of makeshift to be applied in extraordinary cases which required extraordinary means, has been advanced by Mr. Abt into a most important element in the planning of new roads, or in the economical operation of old ones. New and vast fields are thus opened up to railway enterprise, and roads which never could have been thought of on account of enormous expense, can now be built and operated at so much lower cost, that they will prove safe and paying investments for capital."

NOTE.—A reference to the minutes of proceedings of the Institution of Civil Engineers shows that the speeds obtained on the above railway are, in one case, on the rack portion 4·65 miles per hour, and on the other portion 9 miles per hour; and in another case 5 to 6 miles per hour on the rack. Also that the cost of the Abt engines is about £3,500 each; and the gauge of the railway is 4ft. 8½in. None of the books which I have seen so far contain any information as to cost of working. It is scarcely necessary to say, however, that the cost of haulage on the steep inclines must be very much greater than on an ordinary railway. In cases where incline is carried over steep hill sides, in order to avoid a tunnel, the question of relative cost of maintenance, including possible difficulty with snow drifts and shingle slides, &c., is also a matter for consideration.—JOHN BLACKETT, Engineer-in-Chief.