The same witness's demonstration that in this particular instance the derailing speed would be higher than the overturning speed of the engine depends for its validity on the figure assumed for the coefficient of friction between the steel flange of the tire and the steel rail against which it is sliding under pressure. The higher the coefficient of friction the greater is the tendency for the flange to mount the rail on striking a curve. At very slow speeds the value of this coefficient approaches that of static friction, which (as between rail and tire under dry conditions) is generally taken as 0·25, a fact which no doubt has some bearing on the derailments that sometimes occur at low speeds on very sharp curves or turnouts. As the speed rises, however, the coefficient of friction first drops very rapidly, and then more slowly. Mr Gard has used the value 0·2, against which the only criticism that can be levelled is that it is, if anything, somewhat higher than is compatible with the known behaviour of steel tires sliding on steel rails except at the lowest speeds. It is probably much in excess of the true figure, which is unlikely to have been higher than about 0·14 or 0·15, and may have been even less if there were mist or dew on the rails. But, even assuming the value 0·2, it is shown that with a speed in the proximity of the overturning speed and at a time previous to the actual overturning the concentration of weight that was being thrown, as a result of the operation of centrifugal force, on to the outer wheels was more than sufficient to counteract the forces tending to make the flange of the tire mount the rail.

It may be observed that simple derailment, even on a curve, does not involve overturning. Overturning, however, inevitably involves derailment; and we concur in Mr. Gard's conclusion that, in the circumstances of the present case, derailment was a consequence and not the cause of—or even a contributory factor in—the overturning.

The introduction of Spiller's formula in this connection may perhaps have tended to obscure rather than to clarify the issue. Spiller's formula, however, does not purport to give, for any specific locomotive, the precise speed at which that locomotive will necessarily derail on a given curve. This is clear enough from Mr. Wansbrough's evidence, and was in effect admitted by the author of the formula himself in the discussion that followed the reading of his paper before the Institution of Civil Engineers in 1908. But, as was also indicated in sufficient detail in Mr. Wansbrough's evidence, Spiller's formula can be, and is legitimately, applied in the form of a general rule to indicate what may be regarded in practice as an approximation to the limit of safety (which is the approach to danger) for ordinary traffic purposes. Further, though (also in practice) a lower and safer restriction is commonly imposed, that is not to say that Spiller's formula is to be accepted as defining the actual speed at which a particular engine will derail on a particular curve, because, quite definitely, it does not. It does, however, sufficiently justify the Department's practice in respect of speed-restrictions on curves; and that, as we understand Mr. Wansbrough's evidence, was all that he claimed for it.

In his calculation made to establish the probable train-speed by a consideration of the position of the cars that were disconnected from the engine and the leading car, and disregarding the position of the engine, Mr. Wansbrough assumed that the engine and the leading car had reached, or almost reached, their final position before the division of the train and the consequent automatic emergency application of the brakes took place. We are of the opinion that this assumption, though erring on the conservative side, cannot be accepted: for, if it were correct, the remainder of the train when disconnected could not have possessed the momentum necessary to carry it on to its final position and also to create the destruction that resulted. It seems quite likely that when the engine overturned the leading car, the rear end of which had then just reached the circular curve, was approaching its overturning speed, and that the pull of the tender coupling completed the overturn. The evidence of passengers in the leading car is consistent with a state of overturning; and if this happened the breaking of the Westinghouse hose must have practically synchronized with the time of derailment. If the parting of the train did not occur simultaneously with the first derailment, then it must have happened not later than the time at which the engine struck the left-hand batter, when and after which there would be a violent deceleration which, had the following portion of the train shared in it, would have brought it to a standstill much sooner than was the case.

Again, as a secondary process for estimating the approximate speed of the train at the instant of leaving the rails, Mr. Wansbrough's quotation of values assumed by the late Professor Robert Julian Scott for retarding factors acting on a derailed train may perhaps be of more academic interest than practical value so far as the present case is concerned, for it is beyond all reason and experience to imagine that a locomotive and carriages after derailing at or about 25 miles per hour would proceed in such a fashion, for such a distance, and with such disastrous effects on the stock concerned, as did the train now under consideration.

The retarding forces acting on the cars were of a threefold character:—

(1) The ordinary retardation due to heavy braking, which in the case of the last car and van and almost all the fifth car was all they contributed to the total stopping force. In this connection it is appropriate to mention here that at a speed of 25 miles per hour the brakes alone would have brought the vehicles to a standstill on the rails in less then 250 ft.

(2) The second, third, and fourth cars travelled on the rails from approximately their positions at the time of derailment of the engine to a point in the vicinity of the point of derailment, and then travelled over the sleepers and ballast to the positions at which they finally came to rest. They travelled with brakes on until they had their bogies torn off by the impact with the leading car, and thereafter they slid on their undergear, a surface as unfitted for sledging as could well be imagined. Furthermore, for part of the distance they were subjected to the additional retardation due to friction against the batter of the cutting; and they were being pushed, not pulled.