Mr. Tripp. tortuous line was shown by the plan. In a distance of less than a mile, by judicious treatment of the ground by the Chief Engineer, some 100° of curvature were saved, with no increase of work so far as the profiles could show. No doubt every man of any experience in location can recall similar cases. This is a very interesting subject, and one capable of almost endless discussion from the very fact that what is right in one section is impracticable in another. The writer regrets that others, of those having long experience in the matter, have not found time or inclination to write on the subject.

Mr. Lavis. F. LAVIS, ASSOC. M. AM. SOC. C. E. (by letter).—While insisting on the superiority of so-called paper location, the writer wishes to emphasize the point that such a projected location should only be made by a man familiar with every detail of the ground, just as familiar as the Geniuses referred to by Mr. Whinery. The writer believes, as in fact was stated in the paper, that the undeniable ability of many of the older locating engineers is just as necessary to-day, but that it should be supplemented by scientific methods and proper surveys. This contention he thinks is fully supported by most of those who have discussed the paper. Where the Genius would go along the hillside fitting the curves to the topography, the plodder would probably be in his tent at night, after he had gone over the ground two or three times, fitting in a tangent where the Genius was fitting the curves, and, ten chances to one, he would accomplish it with the same or less cost for construction.

The methods necessary to attain the desired results must vary with the conditions under which each particular survey is made. In regard to keeping transit notes, the writer believes that the method shown in the paper is generally used, and that it answers all purposes, whether the curve is run forward or backward. At whatever station the instrument is set, or to whatever station it is sighted, the method is always the same: Set the vernier to read the angle belonging to the station sighted at (as a fore-sight) and turn off the angle belonging to the station to be set. For instance, on the curve noted (page 121): Instrument at 735, fore-sight on 738, it being required to set 736; set the vernier at 4° 51′ 14″, sight on 738, turn to 3° 51′ 14″, and set station 736, as required.

The writer prefers to double all angles, instead of reading both verniers, as this is a check on sighting, reading and recording.

In regard to the plane table and stadia, from quite extensive experience of both, and from the opinions of many engineers who have tried these methods on railroad location, and actual data of cost, the writer is convinced that these methods are not applicable to work of this class. He would like to go further into details in this matter, but feels that it would unduly prolong the discussion, and the matter has been already commented upon.

Mr. Lavis. The writer would like to emphasize, particularly, Mr. Whinery's estimate of the topographer. It is difficult to get such men for the salaries generally paid. They, above all things, need an "eye for country;" and that seems to be a gift which is inborn, and not the result of education.

The procedure of the transit party on preliminary lines, as described by Mr. Oakley, is the same as that followed by the writer, and was incorporated with other similar details in the first draft of the paper, but was cut out, as the paper seemed to be quite too long.

The writer would like to correct an apparently mistaken impression of Mr. Howard, that the final location was fixed on the ground wholly by vertical distances. The writer states, page 120: "The points on the located line were fixed by horizontal distances from the hubs on the preliminary, and, also, etc." In ordinary country the horizontal method is preferable, but, where steep slopes are encountered, vertical distances, also, should be used as a check. The writer's experience has been that, with a skilful locating engineer, it is very seldom necessary to back up on the final location, and that in any, except very rough, country, absolutely correct topography is an unnecessary refinement. Good alignment is necessary, and a long tangent is not going to be broken up because a few contours go astray.

Mr. McHenry's definition of engineering, as "The art of making a dollar earn the most interest," is particularly applicable to location. The object of a railroad location survey is, not to get a beautiful topographical map, but to get the best line on the ground for the least cost. Most maps on which the location is projected are made on a scale of 400 ft. to the inch, occasionally, 200 ft. to the inch. At 400 ft. to the inch, it is difficult to plot or see less than 10 ft., hence the absurdity of measuring for contours or using a 5-ft. stick. The height of the eye varies less than a tenth or two, and an engineer who cannot pace 300 ft., within 10 ft., over any kind of ground, ought to go out of the business.

Mr. Howard's methods would increase the cost of getting the topography four or five times, over the methods described in the paper, with no compensating result, if the locating engineer knows his business and is not the machine feared by Mr. Whinery. The real point, which has apparently been missed by those who have discussed the paper, is that too much attention to small details of topography results usually in a line with too much curvature. The engineer's mind is cramped with too much attention to details. Use a small scale, and lay the line down boldly to the general topography, and do not fuss around if some particular little contour goes around the wrong side of a house, or some boulder is not shown. Again, after all the fussing to get the line 5 or 6 in. this way