the value of the above addition to the triple valve is apparent. It supplies the all-important advantage of being able to graduate off.

In conclusion, the author acknowledges his thanks to Mr. Humphrey for the assistance received in the preparation of this paper.

DISCUSSION.

Mr. W. D. Cruickshank, in opening the discussion, said that he had listened to the reading of the paper with a considerable amount of pleasure. The method proposed by the author of comparing the Westinghouse and Vacuum Coy's. brakes was misleading, as any person who understood the practical working of brakes must be aware of the fact that they were not fully applied once in five hundred times, and therefore the figures given were of little value. He did not consider it just or reasonable to base calculations on any figures but those obtained under ordinary average working conditions. When a full application of the brake was made it would be in the case of an emergency stop, and under such circumstances economy was a secondary consideration, the primary one being one of life or death.

One advantage the Vacuum Coy.'s brake had over the Westinghouse, was that with a train having two locomotives both of them could apply the brakes, but with the Westinghouse this could not be done. In connection with this point the railway authorities had acted very wisely in introducing more powerful locomotives on the mountain trains, one being able to do the work that had previously required two of the smaller class.

In conclusion, he wished to state, without prejudice, that there was a certain kind of knowledge that could not be gained from books, and although the printed descriptions and drawings supplied by the Westinghouse Coy. were got up in splendid style, no man could fully understand or appreciate the ingenious mechanical application of even a few of the points in these brakes unless he had carefully studied the apparatus in operation. The statement made by the author that the Westinghouse brake was not safe was much too bold, and such a statement showed a want of practical knowledge of the working of both the Vacuum and Westinghouse brakes.

Mr Morse, in reply, said that habitual and observant travellers on our suburban railways would not agree with the statement of Mr. Cruickshank, that the brakes were not fully applied once in five hundred times; the suburban service was so pushed in keeping time that at almost every station a practical denial was given to it.

Referring to emergency stops, Mr. Cruickshank said it would be better to brake couplings than to kill passengers. This was so, and there was nothing in the paper which would lead to a contrary opinion, but the question was, whether an improvement might not be effected. It was certain that if some means were devised, say electricity for instance, which would cause all the brakes to become simultaneously engaged, there would be no such result from emergency stops as broken couplings, drawbars, buffers, &c. At the same time it should be remembered that the brake could be fully applied without bringing the quick action valve into operation, although perhaps more slowly.

In concluding, Mr. Cruickshank remarked that the Westinghouse brake was perfectly safe with one train pipe, and that a qualified statement in the paper to the contrary evinced a want of practical knowledge in the working of the Vacuum and Westinghouse brakes. This remark would be best answered

by reproducing his own remarks made shortly after experiments on the Westinghouse brake, respecting the exhaustion theory. Mr. Cruickshank on that occasion said:—"Looking at the Westinghouse brake as a whole, it appears to me that its weak point lies in the fact that by careless handling, and injudicious management, the stored power in the small reservoir may be exhausted, which means that the driver may have a large quantity of power in his main reservoir and yet the small reservoir be practically empty, and on heavy down grades a little carelessness, inattention, and want of judgment, may result in his losing control of his train." This was exactly what the paper stated when treating of this brake. He further stated:—"Where the Westinghouse people made the mistake, was in claiming too much for it. Like any other human machine it has its good qualities and its faults, which may, no doubt, and will be, improved. Let us, therefore, hope that, as in this age of progression we cannot stand still, the present discussion may be the means of making railway brakes more economical and reliable than at the present time." This hope of Mr. Cruickshank has, in a large measure, been fulfilled in several inventions which have been described in the paper.