is in use at present for passenger trains can compare with it for cheapness and efficiency if consideration is to be given to first cost, the comfort of passengers, and security of working.

DISCUSSION.

The President, in opening the proceedings, said it was very gratifying indeed to see such a large and representative gathering there that night. It proved very conclusively that the members of the association duly appreciated and recognised the importance of the subject which was to be brought under their notice. The "brake" question had been before the public for the last few weeks. The subject had excited a large amount of professional and public interest. No doubt this had been caused by the recent lamentable accident on the New South Wales railways, but it would neither be desirable nor necessary, and he thought it would be very questionable taste, to refer to that under the present circumstances. As they all knew, this question had been fought out before, but nothing definite had been arrived at, and the large amount of correspondence which had appeared in the columns of the daily press proved the existence of a healthy rivalry as to the merits or demerits of different kinds of railway brakes. The true object of their discussion was to consider as fully as possible the various appliances at present in use, and to endeavour to make the brakes as perfect as possible. As Mr. Selfe had stated, railway brakes were only human machines, and, so far, they had found nothing in machinery that was absolutely infallible. There were, doubtless, many gentlemen present who had come with the intention of speaking. Well, their time was somewhat limited, and, without attempting to place any restriction upon any one, he hoped those who spoke would condense their remarks as much as possible. It was their desire to hear as many gentlemen speak as was possible, and if speakers would limit their addresses to a quarter of an hour, there would be nothing said, but if they

exceeded that period in any degree he would be obliged to remind them of it. He would conclude by calling upon Mr. Trevor Jones to open the discussion.

Mr. Trevor Jones said when on a previous occasion he undertood to move the adjournment of the debate on Mr. Selfe's paper, it did not quite occur to him that he was incurring the duty of opening the discussion this night, more especially as the subject of railway brakes—although he was an old railway man himself—did not fall within his profession. He would content himself by placing the debate at such a point as they left off on the last occasion. The subject was so extensive that in dealing with it it was quite possible for him to forget some of the more important points which would be alluded to, and for that reason he had placed his remarks on paper. Mr. Jones then said he did not know whether he ought to mention the two sides of the question after what the President had said in his opening remarks.

The President said they were merely assembled there for the purpose of discussing the question of the advantages or the disadvantages of the different kinds of brakes; they were not there to discuss the cause of the accident at Peat's Ferry.

Mr. Jones intimated that he would omit all reference to the railway disaster. He then proceeded to read his remarks, which were as follows:—

He thought it was unnecessary to urge the paramount importance of the subject, that was too apparent to need insistence.

The daily press having a due sense of its momentous nature involving as it did life and limbs, had opened its pages to more communications, and discussed with more pains and thought, the incidence of blame in the recent accident at Peat's Ferry, than was usually devoted to questions of so technical a character.

One of the morning journals had expressed the hope that this Association would debate the question of responsibility in the matter of the above accident. Mr. Selfe on the contrary in the paper that led to this discussion, and subsequently in a letter in the paper, had deprecated allusion to the subject, but was nevertheless unable himself altogether to ignore it.

Mr. Selfe's paper pointed to what appeared to be a serious defect in both of the most popular brakes now used in New South Wales, that was in the Westinghouse, and in the Vacuum, viz., that when either of the above brakes had been on for a short time should there occur a leak anywhere, the driver could not tell what pressure was being exerted on the brake-blocks, excepting by taking off the brakes temporarily.

Mr. Selfe had also put in italics that in neither form of brakes could the pressure on the brake-blocks be modified in the event of leakage from the reservoirs or joints.

Since the last meeting, we had been afforded an opportunity of inspecting minutely a Westinghouse brake-valve with driver's valve, and like all observers, tendered his admiration of the ingenuity displayed in its conception, and had formed the idea that it was the result of a long series of trials and corrections, rather than a direct invention.

That leakage was possible in either brake was of course irrefutable, it must therefore, he apprehended, be considered a defect if the driver could not certainly judge of the extent of leakage without the dangerous expedient of temporarily taking off his brake.

Another point to be debated was that Mr. Adams claimed superiority for the Vacuum brake over the Westinghouse, from its lesser liability to leakage arising from the smaller pressure, 15 pounds as against 60, necessary to actuate it, and moreover, that that pressure acted from outside inwards, whereby the pipe resisted bursting with more force.

While introducing these points for discussion, he held his own opinion, but refrained from giving expression to it in deference to those whose opinions and views he had come to hear.

Mr. Selfe, after enumerating the shortcomings of the two most popular power brakes now in use in New South Wales, and it should be added, expressing great admiration for both, introduced a comparatively new form of brake which claimed exemption or greater exemption than the others from the defects attributed to them, as well as greater freedom from complication, fewer parts, and greater ease of learning its application.

This was the Hanscom straight-air automatic brake which, if it realized all it claimed, promised to be a formidable rival to the Westinghouse and other pressure brakes.

This brake had been in use on the North Pacific Coast railways of North America for many months and was reported to be doing well. It was, however, too soon to form positive opinions just yet, but judging from printed illustrations, we should expect to hear of its success.

It was true that this brake required two air pipes, but by this expedient it secured that which had been deemed a great desideratum in the others, viz., that the driver could with certainty tell what pressure was being exerted on his brake blocks at any minute without taking off his brakes, by simple inspection of the gauges. He thought he had touched upon the principal features under consideration at the time the debate was adjourned, when it appeared to him that the following statements had been made and not disputed.

1. That both the Westinghouse and Vacuum brakes, though almost deemed to be the best extant, had the defect that when once applied, the driver could only judge of the amount of pressure on the brake blocks, by taking off the brakes temporarily and reapplying them, which at great speed on a down brake required great nerve; if there had been no leak, of course the pressure would be the same as indicated on his guage, but if leakage had taken place, then it would be proportionably reduced. The essence of the above seemed to be that if leakage took place in some of the rear carriages it would not be indicated on the driver's guage unless by releasing the brakes.

2. That once applied the pressure could not be modified.

3. That the Hanscom straight-air automatic brake overcame both these defects by means of a double tube. With regard to this last desideratum, he could not see why a double tube should not be fitted to both the other breaks.

The Hanscom brake claimed several other points of superiority, as less pressure, causing less leakage; simplicity of construction and handling—no storage reservoir required—accessibility of parts and many other points.

Without entering into the dispute of the Peat's Ferry accident, it might be permitted to him to give expression to one or two thoughts as to the alleged defects.

That leakage could take place, and did take place after the brakes were applied was undoubted, and that consequently it was true, more or less, to state that the pressure on the brake blocks was diminishing, more or less in all forms of air-power brake from the moment they were applied.

The leakage was not less in brakes worked with lightly compressed air or vacuum, than in those using highly pressed, because the packing of the pistons of brake-blocks was proportionately larger in the lighter, and, therefore, had a larger periphery, which was the origin of loss.

If leakage could take place and power be lost, then it was of great importance that it should be replenished during the time the brake was applied.

Also, on the same assumption, that leakage could take place, say chiefly in the brake cylinder, the theory of exhaustion was conceivable, if the leakage was sensible.

In any case, the driver's gauge should indicate the pressure on the blocks, if the gauge was to be a guide at all, and if the insertion of a return tube would secure this, as well as replenishing and modifying the pressure, then he was of opinion that it should be affixed, if practicable to all brakes.

The great importance of the subject and its complexity had caused him to trespass, he feared, too long on our patience.

Mr. Adams remarked that Mr. Campbell, the representative engineer of the Westinghouse Brake Company, urged the members of this Association at our last meeting to be careful how they formed their opinion on this subject, and not to be carried away by those who profited by the sale of brakes. This was a very eloquent termination to an able speech in favor of the Westinghouse brake, but he would say to the members to be guided by those who profit by the sale of brakes, and not to arrive at any opinion as to the merits of the Westinghouse brake until they had heard what he had to say about it, and *vice versa*. In

his remarks he should endeavour not to waste our time by saying that the Vacuum brake would lift this building, or any other such nonsense, but should confine himself religiously to the subject in hand. At our last meeting he had stated that the Hanscom brake and the Automatic Vacuum brake introduced into this colony were identical in principle, so far as the engine and tender are concerned; but this was denied by a gentleman "who profits by the sale of brakes," and who stated that they were "as wide apart as the poles." The judgment on this point he was quite willing should be pronounced by this Association, and for this purpose he had prepared a diagram sketch, which clearly showed their similarity. (Here followed explanation of diagram, illustrating Hanscom and Automatic Vacuum brakes.) As the author had claimed superiority for the Hanscom brake over the Westinghouse and Automatic Vacuum brakes mainly for controlling trains on steep gradients, he should confine his remarks principally to this particular phase of the brake question. The subject itself was almost inexhaustible, and if, during the present discussion, we succeeded in thoroughly threshing out this particular branch of it, we should have accomplished a great deed. Commencing then with the Hanscom brake, he did not hesitate to say that, in principle, it was superior, theoretically, to both the Westinghouse and Vacuum single pipe systems for the purpose of descending inclines; but there were many other things to be taken into consideration beyond this. The Westinghouse brake, however, either in its automatic or non-automatic form, was the worst possible brake for descending inclines. Before giving his reasons for this statement, it would be necessary to briefly describe the principle of that wonderful piece of mechanism which Mr. Campbell informed us worked better the longer it was in use, and, as our worthy President had happily put it, must, therefore, be like an old fiddle—the triple valve. According to this gentleman, old triple valves should be at a premium, and the instructions to inspect them every three months must only be given to enable the men to see how they are improving.

This was a most important detail, as the brake depended entirely upon its proper action. Without attempting to describe the various parts, we might say that the Westinghouse Brake Company claim that by "simply regulating the reduction of pressure in the brake pipe and causing the motion of the piston and graduating valve to be repeated, the driver can gradually introduce any desired pressure into the brake cylinder from zero up to full power;" but they make no claim to be able to gradually reduce the pressure in the cylinder, nor can they do this. In short, it only graduates the wrong way about. The pressure can be increased in the cylinder but not diminished in proportion as the speed of the train is reduced.

On the New South Wales railways, the cylinders were 10 in. diameter and 12 in. stroke; the reservoirs, 11½ in. diameter and 22 in. long, and had therefore, a cubical capacity of 2284 inches or about 2¼ times that of the cylinder. Assuming a pressure of 60 lb. per square inch stored in the auxiliary reservoirs throughout the system and each piston travelling eight inches of its stroke (in addition to one inch clearance) there would be required at each stroke of the piston 706 cubic inches of compressed air at each application He would now show what would be the effect of a few applications of the brake. Let us imagine that the train at A (see diagram) commences the descent on a gradient of 1 in 40 and that on such a gradient a pressure of 20 lb. per square inch in the cylinders is necessary to control it. Presently, at B, the gradient changes to 1 in 50 where we will assume that 16 lb. per square inch is sufficient to keep the train under control. What takes place? Air is admitted to the bottom of the triple valve piston and forces it up. This allows the air at 20 lb. per square inch which has been in the cylinder to escape into the atmosphere, and then by again manipulating the driver's valve, air at 16 lb. may be admitted to the cylinder to take its place, so that the store of air in the auxiliary reservoirs has been drawn upon to the amount of 706 inches at 20 lb. on the square inch, thereby reducing the store in the reservoirs from 2284 cubic inches, at 60 lb., to the same quantity at 54 lb. on the square inch, so that in one application

and release of the brake—merely to steady the train down our first incline—we have reduced our store of compressed air from 60 lb. to 54 lb. on the square inch. At C, we commence to descend a gradient of 1 in 30 where we shall require an increased amount of brake power viz., 27 lb. on the square inch, but having already 16 lb. in the cylinder we merely add another 11 lb. At D, we again come to a gradient of 1 in 50, where we require, as we have already seen, only 16 lb. on the square inch. To obtain this we must exhaust the 27 lb. from the cylinders and recharge them with air at 16 lb. By manipulating the driver's valve, air at this pressure may possibly be admitted, but how does our pressure stand now? At our last application we had a reserve of 54 lb. on the square inch since when we have had to call upon it for 706 cubic inches at 11 lb. on the square inch. This will have the effect of reducing our store of air from a pressure of 54 lb. to that of 48 lb. per square inch. Coming then, at D, to a grade of 1 in 50 (which only requires a pressure of 16 lb. in the cylinder), we have to release the brakes and re-apply them with this amount. We therefore, throw away 706 cubic inches of compressed air at 27 lb. on the square inch and re-apply the brakes with 16 lb., calling upon our reserve for this quantity and again reducing it from 48 lb. to 44 lb. so that with four theoretically perfect applications of the brake merely to control the train at a uniform speed we have reduced our store from 60 lb. to 44 lb. per square inch, and this may take place within one or two miles and continuing in the same ratio we find that at H, we have not sufficient pressure to apply the brakes with the required force.

We would naturally ask, "Does this actually occur in practice?" The answer was, that exhaustion always took place more or less, but drivers, after a little experience on the mountains, soon began to see that with the Westinghouse brake, it was necessary to husband their strength, and the following was what he had observed. We would notice that on our assumed gradients, we never required less than 16 pounds in the cylinder, therefore, a driver was perfectly safe in putting that in. If he came to a grade requiring another 4 pounds, did he make use of the conical seated