DISCUSSION.

Mr. W. D. CRUICKSHANK considered it very gratifying to have such a large and representative gathering, and, before opening the discussion, it might be desirable to say a word in explanation.

The Engineering Association had been in existence for over twenty-five years, its sole aim being purely educational. Its founders keenly realised the absolute necessity for the establishment of an institution which would furnish facilities and opportunities of meeting together, and of enabling them to study and discuss the prominent engineering questions of the day, and especially those relating to the successful and economical developments of Australasian resources. This was all the more necessary because Engineering was divided into so many different and distinct branches, also that civil, mechanical, locomotive, marine, mining, electrical, hydraulic, agricultural, gas, and sanitary engineers were every day becoming more or less specialists. Yet another branch had of late years been added to the list, for the refrigerating engineer had already, and must in the future, occupy a prominent and important position. As colonists they were all deeply interested in refrigeration, because of its supreme importance in connection with Australian produce. Naturally their monthly meetings were, as a rule, only attended by their own members, but occasionally a subject came before them which was of national importance, and it was because this was the case in the present instance that they had taken this opportunity of inviting their friends, who, though not engineers, would, he felt sure, be deeply interested in what they had to say.

In opening this discussion, it was desirable to state that the subject of refrigeration was by no means simple; on the

contrary, unless one was well grounded in the modern mechanical theory of heat it would be found complex and difficult. Under present circumstances, therefore, he had no intention of going into technicalities, but would, as far as possible, use plain language, speaking briefly, in a general sense and in general terms. During the last ten or fifteen years there was no branch of engineering science which had made more, if as much, progress as refrigeration, in fact its advancement, coupled with the successful application of its principles to practical work could only be described as phenomenal, while its future possibilities were almost beyond calculation.

When the history of refrigeration came to be written it would be found that the work done in Sydney occupied the place of honour, and that it was to the far-seeing perception, the energy and enterprise of the late Mr. T. S. Mort that its present success was largely due. Possibly for climatic reasons, numerous devices had been tried in New South Wales for the generation of cold, and we found patents granted in this colony dated as far back as 1858, principally for the manufacture of ice.

The great worker, the moving spirit in fact in most of the efforts made, was that clever chemist, Mr. E. D. Nicolle, who investigated this subject for years on his own account, and became associated with Mr. Mort in 1868, a patent in their joint names being granted on the 24th August of that year. Six other patents were taken out by Messrs. Mort and Nicolle, the last in January, 1876. He also noticed that Mr. Norman Selfe had taken out two patents subsequent to the above date, viz., one in April, the other in October, 1880, and which only expired in October, 1894. Referring to the work done by the late Mr. Mort, it was necessary to state that Mr. Nicolle conducted and supervised the whole of the experimental work, and it was suggestive and complimentary to that gentleman's knowledge that the refrigerating agent used was ammonia, because at the present moment this volatile liquid was allowed

to be one of the best if not the best that could be utilised both for efficiency and economy. It was not generally known what the late Mr. T. S. Mort did towards the solution of this great problem, and no more fitting opportunity could occur for making special reference to his labours.

It was his greatest ambition to succeed in sending perishable cargoes from one end of the world to the other by the aid of refrigeration, and he devoted the best years of his life and spent more than one fortune in attempting to do so. He commenced his experimental work in conjunction with Mr. Nicolle at the latter's works in Paddington, and manufactured ice by the ammonia process; then carried out a series of exhaustive and expensive experiments from about the year 1867 up to 1876, erected large freezing works at Hay-street, Darling Harbour (Fresh Food and Ice Company) and also at Lithgow, where ample stock and slaughtering yards were constructed with sufficient storage, where the meat was cooled and kept cool until placed in railway vans, when it was conveyed to the Darling Harbour works and placed in the freezing chambers, built at a cost of £50,000, while the Lithgow works cost £15,000. During this time further experiments were conducted at great expense until in 1876 when it was considered far enough advanced to send a cargo to England. Up to this date Mr. Mort had spent approximately £175,000 of his own money, and, feeling confident of success, a public meeting was called in Sydney of gentlemen representing pastoral and commercial interests. He gave a plain straightforward statement of what had been done and the amount expended, and asked their assistance in chartering a ship to take a cargo of frozen meat to England, expressing confidence that it would succeed, and pointing out in glowing language its great future and its national importance. The response came at once. £30,000 was immediately subscribed; the clipper ship Northam, 1,500 tons register, was chartered, fitted up, filled with frozen meat, and left for England. Unfortunately at that time the principles

of refrigeration were not sufficiently understood, and that, taken in conjunction with numerous chemical and mechanical difficulties, resulted in the venture turning out a signal failure, for the whole cargo was completely spoiled. When the news reached Sydney he (the speaker) remembered meeting and sympathising with Mr. Mort, venturing an opinion that he would spend no more time and money on it. Drawing himself to his full height, and in his quiet determined way, he said, "Never, Cruickshank, I have failed, it is true; but it can and it will be done, and when it is, my work will be appreciated." And then, what followed? He went home and wrote out a cheque for the £30,000 which had been subscribed, as he could not bear the idea of anyone losing anything through his representations. This man's work, not alone in this but in other branches, can only be described as gigantic. Look at the monument he has left as seen in the Fresh Food and Ice Co., the largest, if not the best of its kind in the world. He founded "Mort's Dock," an establishment that has facilities and appliances to do anything required either afloat or ashore. In agriculture he has shown what can be done by science when in harmony with practical knowledge and experience, besides developing successfully the maizina and other industries. True, he failed in refrigeration, but, like many other things that have materially ministered to the comfort and convenience of the race, success has only been attained by the information gained through repeated failures. Of all men he (the speaker) had known, he left the world better than he found it. And what a glorious record to leave; how elevating its influence; how immeasurably superior to the prevailing money-making spirit; how fresh, pure and sweet and lasting his memory must ever be; and how insignificant mere wealth or titles appear when compared with his life's labour, resulting as it had done in the profitable investment of millions of money and in the employment of many thousands of men. Few, if any, had so clear a conception of the duties and responsibilities of capital,

and his statue, which most appropriately fronts the Commercial Exchange of this great city, was a worthy tribute to one of our best and brightest colonists, and he considered it a privilege to have such an opportunity of testifying to his worth.

Although refrigeration had been prominently before us for some years, the available literature was limited, and this society was deeply indebted to Mr. Russel Sinclair and Mr. Auldjo for their valuable contributions on the subject. Referring to Mr. Auldjo's paper, it was pleasing to note that the author had successfully constructed twenty-five machines, which for economy, efficiency and satisfaction, would compare favourably with any others—and, also, that the whole of the work had been done in Sydney. But the principal statement in the paper was where he accused the Home people of gross ignorance; that the usual and accepted method of supplying the cold air by direct contact instead of by radiation was entirely wrong; that, if properly understood, it was not necessary to freeze the meat at all, and that this could be easily and cheaply rectified, &c.

Now, for two of our leading engineers—men with special training and of acknowledged ability—to practically affirm that we know all about it and the home people know very little, the probability of proving this appeared to be rather a large contract. He therefore challenged the statements, and pointed out that in the interest of all concernced they must be refuted or confirmed, and suggested the present meeting, where there would be ample opportunity of showing what was wrong and how it could be put right. Judging from the cables published in the newspapers, it would appear that something was wrong, because we found some cargoes delivered in splendid condition, bringing satisfactory prices, while others were reported as being partially or wholly damaged, were sold at a sacrifice, or altogether destroyed, and he noticed that in many instances the reasons given were because the shipper or the unfortunate producer did not know how to pack the goods, or he either did

or did not do something which he ought to have done. It was never even hinted that it was the fault of the ship or the refrigerating machinery, or a want of knowledge of how the cold should be applied. No; in almost every case the producer was the scapegoat. Whereas, in the opinion of our experts, this science had reached a stage where, by proper and intelligent manipulation, the producer should almost receive a guarantee that his goods would be delivered in the same order and condition as they were received.

In connection with this important part of the subject, he wished to draw particular attention to one or two points which, so far as he was aware, had never been publicly referred to.

Many present might have heard of the Scotchman who bought some whisky and a young dog, and who, having a neighbour who was reputed to be a good judge of both, was anxious to have his opinion. He accordingly invited him to sample the whisky, and after getting pretty mellow, asked him what he thought of it and the dog. With characteristic diplomacy his friend said, "Man, I'm surprised at you asking such questions, because the whisky is very good. Besides," he added in a confidential tone, "there is no bad whisky, although I'll allow there is some better than others; but as for the dog —well, he's a very good dog o' the kind, but he's a no a very good kind."

Now this quaint description could be applied very appropriately to refrigeration. In a mechanical sense there was, perhaps, no bad machinery, but there was some better than others, and in many cases it was very good of its kind, but like the dog, was not a very good kind. Even our most modern ships were almost all fitted with the cold-air machine, which, by comparison with the most recent ammonia process, was extravagant and wasteful to a degree. Their respective efficiencies would perhaps be better understood by the following comparison:—When James Watt invented his condensing engine, it took 5-lbs. to 6-lbs. of coal to develop a horse-power.

Now, with triple expansion engines, we could get the same power with 1½-lbs., so that the economy has increased about 400 per cent.

In an economical sense, therefore, the same thing held even in a greater ratio as regards ammonia and air, for it appeared to be an undisputed fact that the former would do the same amount of work on one-sixth of the coal. That was, as Mr. Sinclair stated in his valuable paper, "you could, with ammonia, produce 124 tons of ice in 24 hours with five tons of coal—whereas it would require 35 tons if cold air was used; besides, the ammonia machinery would occupy much less space." Then, again, all the new vessels specially built for carrying meat and other produce had—or rather were supposed to have—their refrigerating machinery in duplicate. Now, what was the true and proper definition of duplication in this instance? It simply meant that if one machine broke down, the other, being independent and distinct, could do all the work required. And, recognizing that the value of the cargo depended entirely on refrigerating machinery being able to maintain the required temperature, it was very necessary there should be no doubt about the duplication. But, so far as he knew—speaking subject to correction—there was not a single ship, even the latest and most modern, in which the refrigerating machinery could be said to be completely and independently duplicated. In almost all cold air machines there was only one condenser and one cooler, common to both machines, and if anything happened to the cooler the whole of the machinery was quite useless. That such a thing might happen was borne out by a case in Sydney a few months ago, where in a new ship, specially built for frozen meat, the bottom of the cooler gave way, the whole of the machinery had to stop, and the cargo on board had to be sacrificed. He might point out to his friend Mr. Auldjo that his machines are not truly duplicated, for both compressors and the steam cylinder were on the same crank shaft, and if it happened to break, the duplication of the compressors would be of no use.

Another and most important point was that, even allowing the mechanical duplication to be perfect, few, if any, of the specially built steamers were in duplicate so far as their "power" was concerned, and he might be permitted to point out the very marked distinction between duplication of the machinery that propelled the ship and that used for refrigeration. For example, the Orient Company's twin screw "*Ophir*." The fact of her engines being in duplicate was considered such an advantage to passengers, that it was specially advertised; for if one set of engines was completely disabled, the vessel could still travel 12 to 14 knots, and the only inconvenience would be a few days longer passage. With refrigerating machinery it was entirely different, for if one machine broke down, even for a short time, could the other do all the work? In most cases he was afraid it could not, and if not, the cargo would be partly if not altogether ruined.

Then as to spare gear. Some ships were well found, while others had scarcely the proverbial feather to fly with. Again, in almost every case the machinery space was cramped to a degree; no room to move about and do work, and also badly ventilated, resulting in a temperature unfit for a white man.

From what had been said, it would be seen that apart from the objections taken in Mr. Auldjo's paper, the present machinery could and should be improved. He knew that to carry out the necessary alterations meant more space and increased first cost—that was, while the extravagant and wasteful cold air system was retained—but whatever refrigerating agent might be used, it was not unreasonable to expect all refrigerating machines to be completely and distinctly duplicated, that in a power, as well as in a mechanical sense, one machine should be quite independent of the other.

Speaking from a commercial and insurance point of view, it would be apparent that in refrigeration, as in ships, there might be good and bad risks; because, given two vessels, one with complete duplication and ample power, the other as at

present fitted, it was evident one was much more reliable than the other, and should be duly credited in the shape of not only obtaining preference, but also higher freight.

What was required was some organised and recognised system of supervision, by means of which the present conditions of carrying our perishable cargoes would be materially improved.

According to Mr. Auldjo, if the present cold air machine was properly utilised, that was, if the generated cold was distributed by radiation and never allowed to come into contact with the air in the holds, the meat would not require to be frozen, and the chilled system could be successfully carried out, notwithstanding the cable in the press a few days ago that "America had obtained complete command of the trade, and that Australia's attempt to send home chilled meat had signally failed." The question was, Why did it fail? He hoped that Messrs. Selfe and Auldjo would give a satisfactory answer, and be able to show how the chilling of meat could be successfully manipulated, as he understood this would mean adding 40 per cent. to its present selling price, an advantage which he should not attempt to describe.

Before closing his remarks it was, perhaps, necessary to mention that another refrigerating agent had come into prominence lately, which was said to be at least equal to ammonia in efficiency. He referred to the carbonic-anhydride machine, and it was suggestive that the firm of T. and E. Hall. who had constructed cold air machines for the last ten years, had altered their system in favour of the carbonic acid. Scores of machines had been constructed, and, so far as known, with very good results. Such machines had been successfully worked in India during the last two years, also in Queensland, and there was now a large plant in course of erection in Wellington, N.Z. We, however, know very little about the actual duty or economy of this agent. If it was superior to ammonia it would soon assert itself. What we wanted was the best and most