The principal advantages of bulk handling may be summarised as follows:—

Great saving in time and cost of handling the grain.

Saves the cost of providing bags every season.

Greater reduction in the quantity of lost and damaged grain.

Greater expedition in loading and unloading railway trucks, thus increasing the effective capacity of the rolling stock.

Greater expedition in loading and unloading ships, thus reducing shipping charges.

Less Fire Insurance Rate if stored in proper fireproof structures.

Greater ease in cleaning and grade, thus saving freight and increasing selling price.

Discussion

Mr. A. J. Hart said: Mr. President and gentlemen, I am particularly pleased to be able to propose a vote of thanks to Mr. Poole for his paper, because the subject of grain storage and construction of silos, the handling of wheat, and that sort of thing, has always been of very great interest to me. I remember that I often used to watch the boats on the river, where I was brought up, discharging grain, filling silos, and, in later years, the fascination of the subject for me has ever increased.

One does not know where to begin to discuss this paper of Mr. Poole's: it is all extremely interesting. With regard to the tables, and the summary they give us of grain production in Australia, they are most enlightening, as is the striking way in which the graphs illustrate the effects of drought on the production of any crop. I was particularly surprised to notice, in looking into the table, that the yield of wheat grown in the British Isles is about 57,000,000 bushels. Very often out here one hears an expression of

amazement from an Australian going Home, who, seeing our little fields, wonders, and thinks is it worth growing wheat and that kind of thing in such small quantities. But when we consider Australia's bountiful crop is 160,000,000 bushels on this big continent, and the British Isles produce 57,000,000 bushels, the amount produced by the little home country is rather surprising. I suppose the reason is that the crops, in bushels per acre, are much heavier in those places than they are out here.

Coming to the storage and handling proposition, one thinks, at first sight, that it is most remarkable that we should have continued in Australia so long under such painfully crude methods as we have heard described to-night. The state of things shewn us was, however, hardly remarkable, because (as Mr. Poole has pointed out) it is only in the last ten years that Australia has been a serious exporter of grain at all. Ten years ago our export of wheat was practically nothing, but, taking the export to-day at its value of three-fourths of the total vast product, it is not surprising really that our methods in handling the wheat are so very much behind the expansion in the amount of wheat which has been produced.

With regard to the pictures which Mr. Poole shewed us of the stacks of bags in particular, and the waggons being drawn by bullocks, and the loss which must be consequent on building the stacks of bags, handling the wheat, re-bagging damaged parcels, and distributing the grain, we have had put before us remarkable figures—it was hardly possible to imagine that the state of affairs was anything like as bad as it is. As Mr. Poole has stated at the end of his paper, shipping is so scarce in its present state that it is no good getting the grain to Sydney, as it cannot be transferred from there. However, I do not think there has been a single instance in Australia where the railways have been up to date in getting the grain away even in normal times; so that, as Mr. Poole has stated, we shall not be

able to get this season's grain away until the next season's grain is on. One sometimes hears an objection about our shipping being unsuited for the bulk handling of wheat, but I think that would disappear directly the demand arose.

I noticed that Mr. Poole spoke of the explosions which occasionally take place in elevators. I remember reading about the subject in an engineering journal some time ago. There was an explosion in one of the big grain elevators at Buffalo, which absolutely wrecked the whole installation, and killed several men. It is really remarkable that a thing like grain dust should produce an explosion, but I have an account of a similar explosion which took place where some men were cleaning and repairing a coal-grinding mill in a cement plant. The official report stated as follows:—

> "All these explosions are caused by impalpably fine dust floating in the air in suspension. This floats in layers or strata. At a recent explosion in one of our biggest cement plants, a foreman and some of his men were repairing and cleaning a coal-grinding mill. One of the men had rammed a piece of waste on the end of a stick into a part he was cleaning, and somehow (no one knows how) it caught fire as he pulled it out. Immediately there was a swift hissing sound like a pin-wheel going off, or escaping steam, and in a flash this indescribable death travelled the length of the room, down a stairway, and back several times in layers just like a train of powder, only there was no report, no explosion, just a hissing. The men came out —they were absolutely denuded, yet seemed to retain all their faculties. The foreman said: "I'm done for, and am going to die." He still had enough life in him to tell what had happened before he became unconscious. They all died very shortly afterwards."

A terrible thing like that points out the absolute necessity of dust-collecting systems.

With regard to the photograph put on the screen—of the Grand Trunk Pacific Elevator—I do not know if you happened to notice that it was shewn as being very much out of plumb—the front part of the silos became very much out of the perpendicular owing to subsidence of the foundations; the silos were afterwards brought back to the vertical by

means of under-cutting the foundations, and by means of jacks and other appliances, but this would hardly have been possible had the silos been constructed in other material than monolithic reinforced concrete.

With regard to the failure of steel silos to withstand the weight of grain supported by friction on their sides, I know of silos constructed on the fluid theory in South Africa, and they collapsed—the sides shut down concertina-wise, just like corrugated iron, and burst the rivets, and they were repaired with angle-iron stiffenings, and eventually casing the whole with concrete.

There is much more that I should like to speak of, but, as it is late, I think it is better to make way for others.

I have, however, very great pleasure in proposing a hearty vote of thanks to Mr. Poole for his very interesting paper.

Mr. Kidd said: I have very great pleasure in seconding the vote of thanks to Mr. Poole, who has pointed out very clearly the importance of mechanically handling wheat in bulk, because, what applies to the state of things in America, applies very much more strongly here on account of the higher wages as compared to the States—we cannot get the wheat handled so cheaply. I think the Association is very much indebted to Mr. Poole for the valuable data contained in the paper, because we can glean from it the pitfalls to be avoided in the designing of such installation.

There is only one feature in the paper I should like to have heard more about, viz., the mechanical handling of wheat. I understand the pneumatic system is most in favour now, and, though most expensive, it is the least efficient. I ran out some figures while looking over the paper, and I found the figures as to efficiency are about 10 to 12 per cent. It would be very helpful to engineers designing, or thinking of designing, mechanical means of handling grain to have accurate figures of the belt conveyor and bucket elevator system, and the pneumatic system.

MR. BURTON said: Mr. Tournay-Hinde has mentioned the question of labour, and, in reference to this subject, I would like to say that the charges given for handling wheat between field and ship are very conservative in my estimation. With our present method of handling, i.e., bagging direct from the harvester, it costs 1d. per bushel for ramming and sewing, the bags cost 9/6 per dozen, which amount to 3d. per bushel on the wheat, loading and cartage is generally done by the farmer himself, and a bulk handling scheme would not show much profit in the transport, though it is not unusual to find that the bags have burst and spilled their contents on the road. Price generally paid for stacking is 5/- per hundred, and 6/- per hundred bags for trucking.

The losses in the stack are sometimes considerable owing to the primitive methods, as pointed out by the author, and it is no unusual thing to find the side of a stack showing a 4in. healthy growth before it is finally trucked. This represents a dead loss from the amount as stacked, and in some seasons is a very big item.

Mr. Poole's estimate about the saving in bulk handling is, if anything, on the modest side, as I have previously said; in fact, instead of the 4d. per bushed as quoted by the author, I should say that it would be about twice that amount. The author is to be congratulated on bringing this subject before us, for it is high time that the engineer co-operated with the producer to lighten the burden of transport and handling, which, at the present time, the latter is struggling with.

MR. A. W. TOURNAY HINDE said: There is one matter upon which I should like more information. On the last page of the paper it is stated that, by the introduction of the elevator system, a saving of 3½d. per bushel will be effected. This, it is shewn, represents a sum of £700,000, of which £400,000 is accounted for by bags alone. On the basis of £700,000 and £400,000, it means roughly that the saving due to bags is 2d. per bushel, and that, due to saving in labor, is 1½d. per bushel. Recollecting the author's remarks concerning the apparently large number of hands shewn as required to stack and handle wheat in bags, it

seems strange that the expenditure of so large a capital sum on machinery should only shew a saving of 1½d. per bushel for the labor displaced. Wheat runs from, say, 3/- to 5/- per bushel, and 1½d. would only represent a saving of 4.16 per cent. and 2.67 per cent. respectively on the cost of the article sold. It is possible that Mr. Burrell, in computing the labor costs, was not aware of Australian labor conditions and Australian methods of work. If this be so, then possibly the real saving on account of labour would shew as a greater amount. I should esteem it a favor if Mr. Poole could give a little more information on this matter when he replies to the discussion.

THE PRESIDENT: We were expecting Mr. Graham, of the Agricultural Department, here to-night, but he does not appear to be present.

It has been proposed by Mr. Hart, and seconded by Mr. Kidd, that a very hearty vote of thanks be accorded to Mr. Poole for his interesting paper. I ask you to pass this vote of thanks with enthusiasm.

(The motion was carried with acclamation.)

Before requesting you, Mr. Poole, to reply to the few questions which have been asked, I would like to add one or two to the number.

There is no question that what we have heard to-night about the bulk handling of wheat, and the descriptions of plants in America, are most interesting, and, to myself, at any rate, they come with a freshness as illustrating something of which I have previously had very little knowledge.

I find some figures in the paper which, when examined, call for additional explanation of the practical system of working plant of this description. I gather from the curves shown in the paper that there are about 60,000,000 bushels of wheat, on the average, available for export, or we expect to get that amount, as an average annual export quantity. That would amount to about 1,000,000 tons per annum. The Government, I understand, propose to put up an elevator having a capacity of 3,000,000 bushels in Sydney, another, having a capacity of half a million bushels, in Newcastle. The 3,000,000 bushel elevator will hold

approximately 70,000 tons. Now, has all the export wheat to pass through these two elevators in Sydney or Newcastle? If this is so, we have 1,000,000 tons to be handled in one year. Now, 1,000,000 tons is a big amount to be shipped. If you take an average freight boat, having a tonnage of 7,000 tons, you would require to have 140 vessels passing in front of these elevators in one year. It would appear, therefore, that the Government must have in view very much larger extensions of the elevators in order to accommodate the ships taking the wheat from the elevators. To pass 140 vessels in front of the elevators means that there would have to be a series of vessels—one every two days. Perhaps Mr. Poole will tell us how long it would take to load a vessel of 7,000 tons?

Another matter which I hoped to derive more information about from the paper was the pneumatic system of wheat handling. Although perhaps it is too big a subject to embody with the rest of the matter in the paper, it would have been interesting to have heard rather more about it. Can you tell us, Mr. Poole, to what height you can raise wheat, supposing you do away with the vertical elevator, and use the vacuum system?

With regard to box-waggons, I have seen a plan of the proposed box-waggon, and it seems rather a difficult waggon to fill; it is permanently roofed over, and unless the wheat is filled into the corners there seems likely to be a great deal of waste space in the waggon. The supply of the box-waggons is a matter for the Railway Department. If 800 box-waggons are built, a great deal of the present rolling-stock would be released from wheat carrying, and would be available for other purposes; the cost of the 800 box-waggons ought not to be put down to the initial cost of the system.

I believe the system of loading wheat into vessels is very different to the English system of unloading. If the author can give us a little information on that subject it would be interesting.

I think the remarks which have been made since the reading of the paper will shew how much it has been appreciated, and I shall be very much obliged to Mr. Poole if he will reply to the questions put to him.

Mr. Wm. Poole, in reply, said: I deeply appreciate the vote of thanks you have passed on my efforts.

In preparing the paper, it was soon apparent that many interesting engineering problems must be dealt with in a very superficial manner, as there is a practical limit to the length of papers to be read before such meetings as this. My paper to-night is already on the limit of fullness.

Mr. Kidd hit on one problem which I anticipated being able to more fully explain myself, viz., that of the pneumatic system of handling wheat. I have not done so because the object of the paper was to introduce an important subject which is new to the Engineering Association; I thought it preferable to treat the matter in a general way rather than go into engineering problems, which can be readily followed up by members in future papers. I look upon my paper as being an introduction to a very important subject.

I cannot say to what height grain is pneumatically elevated, but they certainly elevate it to the height of the bins in the old country—what the height of the bins is, I cannot say; I also do not know whether the grain is boosted in transit.

With reference to Mr. Tournay-Hinde's question as to the costs as given in the paper, those costs are not my own. Not being *au fait* with all the details of the industry, I considered it better to adopt Mr. Burrell's estimates than to put in my own. As to the cost of handling bags in general, I quite agree with a certain amount for repairs of bags and damage of wheat. One speaker (Mr. Burton) has already pointed out that the cost of the present system is probably very much larger than that given by Mr. Burrell, also that the losses were higher—in fact, he (Mr.

Burrell) indicates this in his own report; he says that the losses were considerably higher than he indicates in his report, but he understood it was rather an exceptional season; apparently it was not.

I must apologise to Mr. Tournay-Hinde for forgetting one question of his; he said something in connection with 1½d.

MR. TOURNAY-HINDE: What I referred to was this: The total saving due to mechanical handling as against labor practically only amounts to 1½d. per bushel—the principal saving was in the bags. It seemed strange that so large a capital expenditure only resulted in a saving of 2.67 to 4.16 per cent. in the value of the wheat.

MR. POOLE: Because of the losses.

MR. TOURNAY-HINDE: Yes. It seems such a very little amount to save on account of labor, after you spend such a lot of money—that is, from a purely mechanical point of view.

MR. POOLE: Of course, the mechanical handling includes the total labor, and it also includes power, depreciation, and repairs. This cost amounts to one-halfpenny per bushel, which is only one-third the cost of bulk handling, exclusive of the cost for bags.

On Burrell's basis of estimation, it costs .32 to .36 pence per bushel each time wheat is stacked and unstacked by hand. As a matter of fact, during the present season it costs .4 to .5 pence per bushel for each time it is stacked and unstacked—that is, nearly as much as the total cost for bulk handling. There will always be two sets of such handlings, viz., at the country railway station and the shipping port, quite apart from any such operations on the farm itself. In addition to these charges, there are heavy losses from spillage and damage.

Mr. Tournay-Hinde estimates that the saving for labor, viz., 1½d. per bushel, only represents 4.16 to 2.67 per cent. of the value of wheat at 3/- to 5/- per bushel. The saving in bags is an essential feature of bulk handling, and this amount deducted from Burrell's estimate is 2d. per bushel, which is 5.6 per cent. to 3.3 per cent. of the value of the wheat. The total saving is therefore 9.7 per cent. to 6 per cent., a very appreciable amount to save. Looking at the problem from a different point of view, we find that the total capital outlay of the new system would be saved in a very short time, probably five or six years.

With reference to the handling of the grain at mills, a few days ago I was discussing the matter with a prominent mill owner, and he said that his company was prepared to spend a lot of money in erecting the necessary grain silos; he also said that they, and other mill owners in the State, were not warranted in spending a halfpenny owing to Government interference in creating a wheat monopoly last year, etc. Taking one thing with another, they do not know where they stand, and do not know whether the Government is going to resume the mills or not. This particular man said that, independent of the war, they would have undertaken the erection of a large granary.

In connection with the loading of vessels, I understand that in the United States they can load about 5,000 tons in a day. I understand that in Sydney it is proposed to distribute the grain along two wharves, which will each accommodate four or five vessels; the total berthing accommodation will probably be about ten vessels.

It is quite possible that storage accommodation—whether on the farms, railway stations, or at terminals—will have to be provided for upwards of three-fourths of the total crop, because we cannot undertake to provide sufficient railway rolling-stock, or imagine sufficient vessels being at hand to take it away in a very short time. I understand

that in the United States the whole of one crop is only shifted away shortly before the next comes in, a lot of it being stored a certain length of time on the farms or collecting centres, and also terminals. Instead of handling bags, the grain is shot down a chute, and the velocity acquired by the grain enables it to be loaded into any part of box-cars, or even into holds of ships that are difficult to get at. Hand-trimming is almost avoided. The pneumatic system is used to unload it at terminal British ports, thus saving a large amount of labor in handling it.

I hope others will follow up the paper with more detailed descriptions. Mr. W. E. Adams is, I understand, writing a paper for the local branch of the Institution of Civil Engineers, in which, I understand, he will largely deal with the proposed terminal arrangements for storing, handling, and shipping grain in bulk at Sydney.

I thank you for the very patient hearing you have given to my paper. (Applause.)

THE PRESIDENT: That concludes the business of the evening.

Before we separate, I should just like to say, at the beginning of the session, that we have in front of us quite a number of interesting papers, and the Council will appreciate very heartily any discussion which may follow the papers. I would like members to prepare themselves, if they will, so that they can discuss the papers as they are read. I would especially make the suggestion to the junior members, as there is nothing, I think, which they will feel the advantage of more, later in life, than of having had the opportunity, and taken it, of getting up and speaking in public; it gives them confidence, and it will help them very materially in their future life. If they will just take this little suggestion to heart, it will, I am sure, do good to them, and be appreciated by us.

(The proceedings terminated).