1893.

VICTORIA.

LOCOMOTIVE BRANCH INQUIRY BOARD.

REPORT OF THE BOARD OF INQUIRY INTO CERTAIN MATTERS CONNECTED WITH THE LOCOMOTIVE BRANCH OF THE VICTORIAN RAILWAY DEPARTMENT.

PRESENTED TO BOTH HOUSES OF PARLIAMENT BY HIS EXCELLENCY'S COMMAND.

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TO HIS EXCELLENCY THE GOVERNOR IN COUNCIL.

WE, the members of the Board appointed by Your Excellency in Council, on the seventeenth day of October, 1892, to inquire into certain matters connected with the Locomotive Branch of the Railway Department, as set out in an annexed paper marked A, present our duty to Your Excellency, and have the honour to submit this our Report :—

We first met on Monday, the twentieth day of October, and continued our sittings at the Railway Offices on the twenty-fourth idem. The Superintendent of the Locomotive Branch was then in attendance. We subsequently met as frequently as our other engagements permitted up to the tenth day of November to hear the witnesses, but found it impossible to proceed further in that direction without suitable assistance to collect and bring forward available evidence. Large files of correspondence and returns were placed before us, but our time was too much occupied to permit of an exhaustive examination of them. We therefore decided on the tenth day of November to adjourn and ask for suitable professional assistance. The Crown Solicitor having been desired to take the matter in hand, we resumed our sittings on the seventeenth day of February, when Mr. C. A. Smyth, instructed by the Crown Solicitor, appeared to assist the Board in the examination of witnesses.

In the early stages of our inquiry Mr. Box appeared as counsel for the Locomotive Superintendent, but only on two days. The Locomotive Superintendent after the twentieth day of February absented himself, and did not again attend until he was himself examined as a witness, when Mr. Box also appeared. It is not within our experience of previous inquiries that the head of an important branch of the Public Service, having applied for an investigation into the management and working of his branch, without sufficient reason absented himself from such investigation, and we are bound to add that the course taken by the officer in question has increased our trouble, and has added to our responsibility.

During the earlier weeks of our proceedings we several times visited the railway workshops and the railway stores at Newport, and also visited the North Melbourne and Port Melbourne engine-houses and workshops, making at each place a careful examination, and questioning many of the officers and men.

We now proceed to answer *seriatim* the nine questions set out in the annexure to the Order in Council, and will then submit some general observations and suggestions.

A full transcript of the shorthand writers' notes of the evidence, and an abridgment thereof, are appended :—

1. Whether stores, material, and machinery have been procured of an unsuitable description and size, and have been ordered far in excess and in advance of requirements ; and whether such stores and material have accumulated, causing loss.

We find that some unsuitable stores and material have been procured at different times, and that stores and material have been ordered in advance of requirements, and that to some extent loss has resulted.

Timber.—The stock of timber at Newport on 1st July last was worth at its original cost £104,628, and the average consumption since the year 1886–7 has been £21,640 worth per year.

We are of opinion that it is advisable to maintain a stock of timber equal to the estimated requirements of the Department for three to five years, having regard to the difference in time required for seasoning the various kinds and the various sizes of the timber, to the facility which exists for obtaining each description, and to the purpose for which it is intended. The total stock at Newport does not exceed five years' supply if the estimate be based upon the amount used in past years; but inasmuch as the Chairman of the Commissioners has informed us that, speaking generally, the existing rolling-stock is sufficient for the largest business anticipated—irrespective of new lines not yet authorized—for the next three years, the stock of certain kinds will probably be found greater than necessary.

Rimu Timber.—A large stock of rimu timber, amounting in value to £6,303, was obtained during the past three years. This is a low-priced timber, but doubts were entertained in the Department as to its durability and suitability for railway purposes. In view of these doubts we are of opinion that orders for so large a quantity should not have been issued, and that only sufficient for a thorough trial should have been obtained.

As regards its merits the evidence is very conflicting. The Chairman of the Board has himself inspected the stock, selected samples for testing, and made personal inquiries, the results of which will be found in Appendix No. 1.

Material, &c.—In some instances material has been obtained for the construction of rolling-stock intended for new lines which had not and have not now received the sanction of Parliament. The material could easily have been obtained in a few months after a decision of Parliament had been arrived at, and long before the rolling-stock could be wanted. This is notably the case in regard to a contract entered into in 1888 for 10,000 buffers, of which 8,394, valued at £16,386, remained in stock on the 1st July last.

Buffers.—These buffers were for the construction of 2,500 waggons, the order for which was afterward countermanded by the Commissioners. It would in this instance have been sufficient to have entered into a contract for buffers to be delivered as required. We are satisfied, from evidence and inquiries we have ourselves made, that buffers could be delivered in three or four months from the time of giving the order. We therefore consider that the course taken was utterly unwarranted.

Westinghouse Brake.—There was on the 1st July last a stock of 950 sets of the Westinghouse brake, of the value of £18,338. This is not excessive if the policy of fitting this brake to the whole of the goods stock be carried out, but in the event of the present policy of the Commissioners being continued it is excessive. The policy of attaching the brake to goods stock is dealt with under question No. 4.

"*C. H. C.*" *Iron.*—In the year 1888 a quantity of 330 tons of Cammell's Homogenous Charcoal iron was obtained from England, of which 240 tons, of the value of £5,586 remained in stock on 1st July last. This iron appears to have been unknown in the Railway Department, and to have been purchased upon the strength of advertising sheets that had been received. Although very expensive it proved to be unsuitable for the purpose for which it was ordered, principally because it did not weld well. The result shows that only a limited quantity for experiment should have been ordered in the first instance.

Channel Bars.—The stock of channel bars on the 15th December last was 930 tons, of the value of £11,433. Some of the bars are not of length suitable for the standard stock now being constructed, but even if it were otherwise this large quantity is not likely to be used in any reasonable time. This class of goods is readily obtainable from England at short notice, and therefore the accumulation is greater than should have been permitted, and a heavy loss seems inevitable.

Old Materials.—We have inspected a quantity of old materials which have been lying in stock for a considerable time. Much is obsolete and practically useless. The total value is about £4,300. This accumulation we do not consider excessive as the result of the last 30 years' working of the department, but we recommend its being used up or disposed of as opportunities arise.

2. Whether stores have been improperly ordered without calling for tenders, and whether contractors have been improperly allowed to vary the character of goods contracted for.

Stores ordered without Tender.—Stores have been ordered in large quantities without calling for tenders, and, in our opinion, improperly. This has been the constant practice of the Department, and from the 1st July, 1884, to the 30th June, 1892, £664,966 worth, principally iron and steel, was so ordered in England and Germany. More than half of this amount was ordered from two English firms.

It was stated in evidence that four or five firms of admitted standing known to supply articles of unimpeachable quality are always ready to send such material to Victoria, and no reason exists why competition should not be the rule. No tender need be accepted, and therefore it would not be compulsory on the Agent-General to receive supplies from any firm of inferior repute. The present practice does not, in our opinion, tend to economy.

When sending orders to England and the continent, officers of the Locomotive Branch appear generally to have indicated the particular firm to which the order should be given. This is highly unsatisfactory. No such responsibility should rest with individual officers.

An instance was brought under our notice in which the rule that goods to the value of over £100 should be obtained either by tender or under the previous authority of an Order in Council was evaded. Several orders were given to Messrs. Davies and Baird and to Messrs. Smith, Phillips, and Dawson for steel axle-boxes, each order being for less than £100, but under these orders about 900 boxes were delivered as required, at about 30s. each.

We have also had our attention drawn to an instance in which the Locomotive Branch made a requisition direct on the contractors, Messrs. Briscoe and Co., for goods of which there was at the time a supply in the storekeeper's hands. It is, however, stated that the branch store into which the goods would have gone has been handed over to the departmental storekeeper, so that this irregularity is unlikely to recur.

A return, which we have caused to be prepared, shows that from the 1st July, 1885, to the 31st December, 1892, £49,803 worth of material was obtained in Victoria without tender. A considerable portion of this consisted of excess deliveries on timber contracts, notably £17,051 for teak. This matter is further dealt with under question No. 3.

In one instance an Order in Council was not obtained until attention was drawn to the omission by the Commissioners of Audit.

Variations of Contract.—Evidence has been produced before us showing that a contract for canvas and twine was entered into on the 4th July, 1890, with Mr. G. H. Adams. Afterward the Locomotive Branch desired a different quality and pattern which was clearly not covered by Mr. Adams' contract. This different quality was obtained from him at a higher rate, the total cost of the supply being £6,250, without competition. We see no reason why tenders should not have been called. The course actually followed was, we think, improper.

Other alterations made in contracts do not appear to us to require comment, except in the case of Mr. Ellis's contract, where rimu timber was supplied in an unseasoned condition; this amounts to an unbusinesslike proceeding on the part of the Department, which should have known that there was no rimu in a fit condition to use.

3. Whether a large quantity of teak timber was ordered from a non-contracting firm at about the same time that notice was given to the then contractors to discontinue supplying similar timber.

A contract for the supply of teak by Messrs. Johnson and Sons was terminated in 1887, and after such determination teak was received from Messrs. Phipps Turnbull and Company and from Messrs. Ross and Company.

In explanation of the acceptance of supplies from these firms it has been stated that tenders were invited in 1880 for a quantity of teak, and that Messrs. Phipps Turnbull and Company obtained a contract for a portion only of the specified quantity; but an understanding existed that they should subsequently have the privilege of supplying the full quantity, that they made their arrangements accordingly, and that the Department consequently considered it only fair to receive the shipments which came to hand in pursuance of such arrangement.

Messrs. Johnson and Sons' contract was terminated on the ground that Australian timber would do equally well and be much cheaper. They protested against the course taken by the Department.

We are not satisfied with the explanation. If any such understanding really existed with Messrs. Phipps Turnbull and Company, it is not easy to see the need for calling for fresh tenders. If the reason for cancelling Johnson and Sons' contract was sound, that should have been a sufficient answer to the subsequent requests of Messrs. Phipps Turnbull and Company and Messrs. Ross and Company. We do not think any sufficient excuse has been given for this serious irregularity.

4. Whether rolling-stock which should have been repaired has been broken up, and improper and unnecessary alterations and additions made in and to rolling-stock, causing needless expense, loss, and waste.

Rolling-stock.—As the old rolling-stock referred to is no longer in existence it is impossible for the Board to state from personal inspection whether or not it could have been advantageously repaired. Moreover, the evidence taken on this point is very conflicting. Our opinion is, after very careful consideration, that while a considerable proportion of the vehicles were properly destroyed, a desire to introduce a new and more massive type led, in many instances, to the premature condemnation of stock that could and should have been repaired. The term "obsolete" was very freely used by the advocates of the policy of breaking up, and "obsolete" often meant that the particular vehicle was merely of slightly different proportions to the standard which had been fixed in a somewhat arbitrary manner, and without sufficient deliberation and consultation with the Traffic Branch. When a vehicle was broken up, not only was the timber work, which doubtless was more or less rotten, destroyed, but the ironwork also was broken or cut up and sent to the smithy to be forged anew, with the exception of the wheels and axles, which were laid aside. These have accumulated in very large numbers, for which there appears little prospect of any further use, as they are too light to carry the new and heavier type of waggon. The ironwork, according to the great weight of evidence, was sound and good, and with the addition of new woodwork fit to run for many years. The introduction of the new and heavier type of waggon, carrying a load of 10 tons, and the condemnation of the old I waggon, carrying 8 tons, are thus responsible for the loss of many thousands of pounds worth of useful ironwork. We have failed to elicit any evidence tending to show that the increase in strength unaccompanied by any increase in size of these waggons was necessary or asked for by the Traffic Branch, and consequently we consider that in this case great loss has been caused by a hasty and injudicious determination to alter the type of the most numerous class of vehicle on our railways. Consequent upon the adoption of the new standard underframe for trucks, the increase in the size of the M or cattle truck followed, in order that the same underframe and wheels might be employed. This increase in size is complained of by the Traffic Branch as unnecessary, inconvenient, and tending to loss of revenue.

Precautions, we consider, have been sadly wanting with regard to the breaking up of rolling-stock. In other departments of the Public Service nothing, however trifling, can be destroyed or thrown on one side, without a previous survey by three officers, and nothing can be sold without the authority of a Minister; but in the Railways no sufficient precautions seem to have been taken with regard to rolling-stock. We think that, in future, no such stock should be broken up without a written report of its condition, age, and value, and as to the possibility of its effective repair, signed by the workshop managers, and countersigned by the Locomotive Superintendent, being approved by the Commissioners. The reports should be carefully written in a book to be kept for that purpose.

In regard to the second portion of question No. 4 we have given attention to a large number of alterations and additions to rolling-stock, the principal of which are as follow:—

Axle-boxes and pans.—Of these there have been three principal types.

The first was an ordinary oil-box with a shallow pan and a gun-metal plug for withdrawing the pad.

In the second the box was the same as in the first, but the pan was deeper.

The third was a new design of box with a deep pan, a new form of pad, and no plug.

The first type appears to have been wasteful of oil which splashed out when the vehicle oscillated or ran round a curve. The adoption of the second type appears to have resulted in economy as regards the consumption of oil, and to have been generally approved by the men engaged in attending to the boxes. This change from the first to the second type we regard as desirable.

The adoption of the third type has not been generally approved. This form has been much objected to on account of the great labour and loss of time required to examine and change the pad. The evidence goes to show that though the box and pan were somewhat cheaper to construct, the alteration was undesirable.

A more recent change has been the substitution of steel for cast-iron in the axle-boxes. This adds considerably to the first cost, but the extra strength will no doubt greatly reduce the percentage of fractures, and the expense and inconvenience arising therefrom. Whether this advantage will outweigh the disadvantage of the extra cost cannot be stated with certainty until further experience has been obtained. The number of steel boxes fitted to the trucks has up to the present been too small and their introduction too recent to enable a judgment to be formed on this point.

Axles.—As already indicated a large number of rejected axles with wheels attached have accumulated at Newport, and the quantity is increasing. This result is due to the adoption of a standard axle with 4-inch journals for all new and rebuilt stock; and this, in turn, was consequent upon an increase made in the carrying capacity of the I goods waggon from 8 tons to 10 tons.

We have no evidence that the increase of carrying capacity, with the corresponding augmentation of the size of the journals was necessary, or that it was called for by the Traffic Branch.

Buffer Cases and Guides.—A large number of trucks have been fitted with buffers of a standard pattern, and the discarded buffer-cases and guides have been sold as old iron. The perishable india-rubber springs with which the old buffer-cases were fitted were costly, and rendered a change desirable; but we think that the majority of the old buffer-cases could have been retained and fitted with steel springs instead of india-rubber. In any event sufficient experiments should have been made to demonstrate the advisability or otherwise of the course pursued before condemning the old cases. The action taken appears to have resulted in considerable loss.

Cow-catchers.—In consequence of an intention on the part of the Railway Commissioners to place cattle-pits at level crossings in place of gates, an order was issued some time ago that all engines except those on the suburban lines should be fitted with cow-catchers. We are of opinion that cow-catchers are essential on lines with cattle-pits, but there is a conflict of evidence as to whether they are worth their cost on lines provided with gates and gatekeepers. We are ourselves somewhat in doubt, and suggest that this matter be further considered by the Commissioners.

There are about 190 main line engines fitted with cow-catchers, but it is asserted that no difference can be made between main lines and branches because engines are liable to run on either. This assertion ignores the fact that certain classes of engines are too heavy to be permitted to run upon any but heavy lines.

On engines used exclusively for shunting, cow-catchers are both unnecessary and inconvenient, and as there is little difficulty in attaching and detaching them they should be removed from engines so engaged.

We find that cowcatchers were inadvertently affixed to a few suburban engines, but were taken off when the mistake was discovered.

Engine Lamps.—About 70 engines have been fitted with a new description of American lamp, the contract price of which is £18 10s. against a cost of 32s. for the old lamp. It is claimed for this new class of lamp that with them an obstacle can be seen at night by a driver at a much greater distance than was the case with the old lamp.

We are of opinion that at the present contract price the lamps are extravagant and an improper addition to the engines. It was, however, stated in evidence, and inquiries we have ourselves instituted lead to the same conclusion, that they could now be supplied and fitted for £5 or £6 each, and at this price we think their use would be justifiable. The cost of maintenance is about the same for either lamp.

It was given in evidence that many of the lamps which were fitted were not used. This reveals a serious laxity of discipline which should receive immediate attention.

The fact that lamps were obtained at £18 10s., which it is now stated can be procured for £5 or £6, also calls for investigation.

Upholstery and Decoration of Passenger Carriages.—The internal fitting of the AA standard passenger carriage is of a very different and much more costly character than that previously adopted. The broader seats and the larger windows undoubtedly add much to the comfort of passengers, and the green leather of the upholstery is cleaner and more sanitary than the cloth formerly used. These changes we regard with approval.

Other alterations we consider unduly costly. The lincrusta walton used for lining the upper parts of the carriages, together with the mirrors and pictorial illustrations, appear to us to be superfluous. A simple treatment in varnished or polished wood, somewhat similar to that adopted by the Melbourne Tramway and Omnibus Company, would, we think, suffice.

A sample of green leather submitted to us was of very inferior quality; a fact which indicates that greater care should be taken in inspecting and testing material purchased.

Westinghouse Brake.—On passenger and cattle trains the Westinghouse brake is undoubtedly a most valuable appliance, expediting the traffic, giving increased safety, conducing to the comfort of passengers, and diminishing the wear and tear of the rolling-stock. This conclusion was admitted by all the witnesses, and corresponds with almost universal experience. The extension of the brake to the goods stock, however, is a question on which experts differ largely, and as to which practice on railways elsewhere varies greatly. Very strong arguments have been urged in its favour, and special stress has very reasonably been laid on the fact that so large a proportion of the Victorian train mileage is mixed, and that consequently the goods stock should be fitted with the brake in the interest of the safety and comfort of the passengers. On the other hand, the large first cost, the additional weight, and the inspection, lubrication, and maintenance of the brake on thousands of ordinary goods waggons, exposed to the roughest usage, and frequently left unused for a considerable time, during which there is at least a possibility of the lubricant hardening and stopping the action, raise grave doubts as to the economy, while the safe and successful working of our railways for many years before the brake was introduced clearly negatives the necessity for its application to goods waggons.

In weighing the arguments for and against the brake, the nature of the lines traversed, the speed desired, the amount of traffic, and other considerations must be taken into account. Large portions of the Victorian railways are situated in extremely level country, the stations are at considerable distances apart, the trains few in number, and the speed is but moderate. On these we consider the objections to the brake outweigh its advantages. Such lines can be worked with safety and convenience by the aid of the engine and tender brakes and the handbrake in the guard's van. On other lines the conditions are different; gradients of 1 in 50, 1 in 40, and even in one instance 1 in 30 of considerable length occur; and important and busy stations are not infrequently found at the foot of such gradients; the speed desired is higher, and the amount of traffic and consequent risk of collision greater. In such cases the arguments for the brake carry much more weight. Nevertheless the fact remains that steep lines such as Melbourne to Bendigo, Melbourne to Seymour, and Geelong to Ballarat have carried for many years, with but few and slight accidents, a dense traffic without the aid of the brake.

Taking in consideration all the facts disclosed by the evidence, and availing ourselves of other sources of information, we are of opinion that the extension of the brake to the goods stock was premature, and should have been postponed until the demand for it became more urgent, and the general trend of railway practice elsewhere was more emphatically in its favour.

As matters stand, we would suggest that the brake should not be fitted at present to any more goods vehicles, and that those to which it has been applied should be used on the more hilly lines, leaving the remainder to be employed as far as possible in level parts of the country.

5. Whether too many types of rolling-stock have been manufactured, and whether the designs for and construction of rolling-stock and stationary and other engines have been defective, unsuitable, and costly, and carried out at an unnecessarily great expense, and without consultation with the branches interested, whereby the cost of maintenance and the expenditure on patterns has been unduly increased.

6. Whether serviceable engines have been improperly disposed of and a large number of unnecessary and unsuitable engines have been ordered.

As these two questions to a certain extent cover the same ground, we have found it convenient to consider them together under the following heads :—

Locomotive Engines.—Before the new standard, or, as they are often called, Jeffreys' types were introduced, about six years ago, the locomotive stock of the Victorian Railways was of the most miscellaneous character, there being more than 25 distinct classes, while in many cases engines belonging nominally to the same class presented differences of detail sufficient to prevent the various parts being interchangeable, and so necessitated separate stocks of duplicate parts for engines apparently identical. Some of these engines had been obtained direct from English, Belgian, and American makers by whom they were designed, others had been designed and constructed in the colony, while others still had been acquired by the purchase and absorption of the Geelong and Melbourne Railway, and Melbourne and Hobson's Bay Railway Company's stock. This unfortunate state of things necessitated the keeping of enormous stocks of duplicate parts, caused great inconvenience and risk of mistake in effecting ordinary repairs, and in numberless other ways tended to increase the cost and diminish the efficiency of our locomotive service.

Things being in this undesirable condition the late Commissioners employed Mr. Jeffreys, a British expert of good repute, to advise them in the establishment of a limited number of standard types suitable for all the requirements of the Victorian Railways. Mr. Jeffreys introduced five new classes of engines differing more or less from any of the old types, but having the advantage of the most perfect interchangeability among themselves. In the five classes there are only two types of boiler, only two sizes of cylinder, and only three sizes of driving wheels. A single crank shaft fits every engine, while the same pistons, cross-heads, connecting rods, and other moving parts, could be used indiscriminately for passenger and goods engines. As an example of standardization and interchangeability carried to the utmost limit, Mr. Jeffreys' engines were singularly perfect. It was decided to adopt these locomotives to the exclusion of all others, so that as the old engines wore out, were disposed of by sale or destroyed by accident, they would be replaced by standard engines.

The economy and convenience of such an arrangement is obvious, and was strongly and properly insisted upon by various witnesses. But while the scheme of standardizing the locomotive stock is in the main a proper and desirable one, we have evidence to show that the actual types adopted were not in all cases those most suitable for the present requirements of the Victorian Railways. There is no doubt that had the late Commissioners instead of introducing entirely new types, simply adopted as standards such existing types as had given most general satisfaction under the actual conditions, the scheme though perhaps not quite so consistent and perfect in its details, would have met with far less opposition both within and without the Locomotive Branch.

The new standard types of engine are as follow :—

Class A.—Heavy express or fast passenger engine. This engine is similar in general design, but differs in detail and proportion of its parts from the old Class A, which had proved a most satisfactory and popular engine. Comparing the Standard

with the old A, we find that the former has a considerably larger grate area, and consequently is likely to be better supplied with steam, and better able to keep time with inferior fuel than the latter. On the other hand, there is a general consensus of opinion that it does not run so smoothly, while the actual results of the weighing show it to be more severe on the road. There would appear to be grounds for anticipating that an alteration in the arrangement of balance weights would beneficially affect the running of this engine. See Appendix No. 2.

Class D.—This is an entirely new type. Evidence shows it to be a satisfactory engine for passenger traffic on a sufficiently heavy line. As, however, no lighter type of passenger engine is provided under the scheme of standardization, we presume that this class was intended for a light line passenger engine. For this purpose it is not suitable, being too heavy for the rails. It will be necessary, therefore, either to provide engines of a lighter type, or to strengthen considerable portions of the permanent way of the existing lines, a work involving very heavy outlay.

Class E.—Heavy suburban tank engine. The evidence shows this type to be satisfactory as to power and steady running. As a suburban engine on strongly constructed lines, such as those in the vicinity of Melbourne, it leaves little to be desired. As to proportions of boiler, cylinders, mechanism, and driving wheels, it is a duplicate of type D above-mentioned. The necessity for a reasonable number of engines of this type is unquestionable, in view of the fact that many of the suburban engines were previously overloaded by the increasing weight of trains, and were further of several different and, more or less, imperfect types.

Class R.—This is a goods engine, having six wheels coupled, each 4 feet 6 inches diameter; the boiler, cylinders, and mechanism generally being duplicates of Classes D and E. Great complaints have been made of the injurious effect of this engine upon lines of not specially heavy construction, and its use has been prohibited by the Commissioners upon light lines. The principal charges brought are excessive weight and want of flexibility on curves, the latter defect being due to the length of wheel base and the want of lateral freedom at the leading axle-box. The general consensus of evidence is strongly against these engines on all except heavy lines with curves of large radius. It is possible that some relief on curves might be obtained by allowing a small amount of lateral movement at the leading axle, while the vertical effect on the rails might be somewhat mitigated by the insertion of properly proportioned balance weights, with which the engines are at present not provided. The difference in size, weight, and tractive force between these engines and Class Y, next to be described, is so small as to raise the question whether one Class would not have been sufficient. If two different sizes of goods engines were necessary, a greater difference should, we think, have existed between them.

It may be here mentioned that a type of engine known as the old R has been in use on the Victorian Railways for a number of years with very satisfactory results. Had this been made a standard, it would have supplied what is at present greatly needed, viz., a light-line goods engine capable of travelling at a fair rate of speed over light rails and round sharp curves. In weight and power the old R bears approximately the same relation to the Y as the strength of the so-called light lines does to that of the heavy lines. We conclude, therefore, that the new R type is neither necessary nor suitable.

Class Y.—This is a goods engine for use on the heavily constructed lines. In its proportions and capabilities it exceeds the new R, which it otherwise resembles, by about 10 per cent., and as the heavy lines are able to carry it, there appears to be no reason for the use of the new R upon them. The performance of the Y engines is shown by the evidence to have been satisfactory with heavy trains at comparatively low rates of speed. There have been some complaints of unsteady running, which are not surprising when it is noted that the usual balance weights in the wheels have been wholly omitted. The insertion of suitable balance weights would have a beneficial tendency.

The strongest argument that has been used in our hearing in favour of the new R is, that by its use on the light lines the necessity of running special trains is obviated, and traffic charges thereby reduced. This is undoubtedly true, and were the advantage obtainable without damaging the lines, would be a cogent reason for the multiplication of this class of engine. As it is, however, the traffic facilities are dearly bought at the cost of increased charges for the maintenance of the permanent way.

The only effective method of obtaining a powerful engine capable of running without injury on a light line of railway is by multiplying wheels, and so reducing the proportion of weight applied at any one point on the rail. This is done extensively in American practice, where locomotives having 8, 10, or even 12 wheels are used, and a very high tractive force is thus combined with a comparatively light axle load. These engines somewhat resemble in their arrangement and detail what is known as the W class on the Victorian railways, a class that has a good record for being light on the road and pulling fairly heavy loads. The only objection that we have heard made to these locomotives is that, owing to the small size of the wheels and comparatively complicated mechanism, they necessitate a considerably increased outlay in attendance and repairs. It is worthy of note that Mr. Woodroffe, the Engineer of Existing Lines, who commenced his career in the Locomotive Branch, strongly urges that one of these American types known as the "Consolidation" should be introduced here for heavy goods traffic. We further understand that the New South Wales Railway Commissioners have adopted such engines, with, we believe, satisfactory results, for heavy traffic on steep gradients.

The latter part of question 6 speaks of "a large number of unnecessary and unsuitable engines." We have already stated our reasons for considering the new R to be rightly classed under this heading. We would further add that in our opinion the E class has been unduly multiplied, and that of the 50 engines of this type ordered in April, 1891, from D. Munro and Company and the Phœnix Foundry Company, at least 25 could have been dispensed with. These 50 engines are said to have been ordered in view of the probable early construction of new suburban lines. As these lines are not likely to be constructed for several years these engines, suitable for heavy suburban work only, will be in excess of requirements.

We consider it was unwise to place such large orders before the construction of the lines was authorized by Parliament. In our opinion not more than 25 should have been ordered, leaving the rest to be put in hand when the construction of the lines was finally decided upon.

In constructing the standard engines in this colony certain departures from Mr. Jeffreys' original designs took place. The most important of these was the introduction of compensating levers between both the leading and driving, and trailing and driving wheels of the Y engines, and between all the wheels of their tenders. This, as might have been anticipated, robbed the engines and tenders of all longitudinal stability, and caused them to pitch violently. The removal of half of the number of these levers remedied the defect, but considerable loss to the department ensued. The contract price of the engines was necessarily higher than it would have been had these levers been omitted in the original drawings, and the work of removing them and re-arranging the attachments of the springs involved some expense. All this would have been saved had a little careful consideration been given beforehand. Further alterations were made in connexion with the fire-box door, the coupling between the engine and tender, and the lubricators to which Mr. Jeffreys objected. These do not appear to be matters of much importance.

Stationary Engines.—No evidence upon this subject having been placed before us, and our inquiries not having elicited any special complaints about such engines, we have nothing to report under this head.

It may be remarked that the stationary engines used by the Locomotive Branch are few in number, and usually of small size, the largest that have come under our notice being duplicates of those in use in several of the Melbourne Tramway engine-houses.

Passenger Carriages.—The question of ornamentation of passenger carriages was dealt with under query No. 4. Beyond this we have no remark or complaint to make.

Brake Vans.—There have been complaints of undue rigidity in the springs of more than 40 of these vans, and a petition signed by 67 guards was received, complaining of the injurious effect upon persons compelled to ride in them. These vans were altered and greatly improved at a cost of £13 each.

We are of opinion that such a defect should not have existed in so large a number of vehicles. Had the first one or two vans been thoroughly tested, as all new types of rolling-stock should be, this defect would have been discovered, and the necessity of altering about 40 vans at a cost of £13 each would have been obviated.

Cattle and Sheep Waggons.—The new types of cattle and sheep waggons were introduced without consulting the Traffic Branch, and when the vehicles were on the road they were found unsatisfactory, and gave rise to serious complaint, on account of extra weight and unsuitability to the established routine of the branch. Further, there were certain small defects in detail that should have been avoided, which increased the repairs needed. We are of opinion that such new types should not be introduced without the written approval of the Traffic Branch after thoroughly testing a pattern vehicle.

Q. R. Bogie Trucks.—In the case of these, complaints have arisen as to undue weight of doors and weakness of certain details. As these trucks are not numerous we do not regard the matter as serious. It is to be noticed that these vehicles carry very heavy loads with an unusually moderate tare.

Coal Trucks.—A few complaints have arisen of bulging of frames and insecurity of the door fasteners. These are small defects, but should be guarded against in future construction.

Medium or I Waggons.—These form the most numerous class of vehicles on our railways, and upon their design the greatest care should have been bestowed. The earlier type, carrying 8 tons, appears to have given satisfaction. The new type, introduced without consultation with the Traffic Branch, is no larger, but is stronger, carrying 10 tons, and is somewhat heavier. Whether this is an advantage will depend upon the nature of the loading. With light and bulky material, weighing not more than 8 tons per truck full, there is no advantage in the extra strength and considerable disadvantage in the extra weight of the new type. There is also a small but still perceptible increase in the frictional resistance, due to the greater diameter of journal in the new waggon. We have already, in reply to question 4, dealt with this matter, and our opinion is there expressed.

Consultation.—In opposition to the evidence of the Locomotive Superintendent and the late Chairman of Commissioners, we hold most strongly the importance, and desire to insist most emphatically upon the necessity of constant communication and hearty co-operation between the various branches of so large a business as the Victorian Railways. In no other way can the convenience of the public and the economical administration of the Department be conserved. The evidence we have taken shows a serious lack of such communication in times past. Large and important modifications, both of engines and other rolling-stock, have taken place without the desire or concurrence of the Existing Lines and Traffic Branches. We recommend that before any new type of engine is introduced that plans showing its wheel-base, wheel-load, balancing, and all other particulars affecting its action upon the permanent way and bridges be submitted to the Existing Lines Branch, and a written approval obtained. Had this been done in connexion with the Jeffreys engines much expense and friction would have been obviated. This recommendation is specially important in view of the evidence of the Engineer of Existing Lines, which discloses the fact that some of our older bridges are considerably below the standard of strength insisted upon by the best British and American authorities, and that in at least one instance an alarming fracture has already taken place. To subject such bridges to the action of heavy engines—possibly imperfectly balanced—without the fullest consideration is altogether improper, and in the event of disaster would leave the Locomotive Branch under the most serious responsibility.

Further, we hold that the designs of all rolling-stock, including engines, should be submitted to and formally approved by the Traffic Branch, in writing, before the construction of more than a pattern engine or vehicle be allowed. That branch alone is competent to judge as to the best carrying capacity as regards both bulk and weight of all vehicles, and the most convenient arrangement of doors, fastenings, and other details affecting their daily use; and it is equally the sole authority as to the best size of trains and speed of travel, upon which data the capabilities of the engines should depend.

Had such approval been sought and obtained in connexion with many types of vehicles brought under our notice, much dissatisfaction and loss would have been avoided, and the Locomotive Branch would have been clear of the charge, which we consider proved against it, of having supplied both engines and other rolling-stock of a defective, unsuitable, and costly nature without consultation with the branches interested.

Engines disposed of.—Altogether, nine engines have been sold since the year 1885. Of these, three (Nos. 12, 34, and 36) were engines imported by the Geelong and Melbourne Railway Company about the year 1857, and altered by reducing the size of the wheels and by coupling. Nos. 34 and 36 were of small size.

Four were of the N class (Nos. 6, 7, 9, and 19). They probably date back from 1856 to 1863, and were handed over to the Victorian Railways by the Melbourne and Hobson's Bay Railway Company. They are small tank engines suitable for light work and short runs only.

No. 122 was of the K class of Mr. Meikle's design. This design was objected to and condemned by a Board of Experts.

No. 11, V, was an engine used in shunting at Newport ; the work is now done by a crane locomotive.

The evidence tends to show that most of the above engines might have been used on some light lines, and therefore it appears to us that they were improperly disposed of.

7. Whether expensive experiments have been conducted, some of which have caused loss by damage to permanent way and rolling-stock.

The only occurrences known to the Board that can be reasonably included under this head are those connected with the balancing of certain engines during the latter part of 1887 and the commencement of 1888. With reference to these occurrences we would point out—firstly, that the proper balancing of a locomotive is a matter of the highest importance and utility, tending to smooth running, economy of fuel, reduction of maintenance expenses, and minimization of injury to the road. A locomotive having balance weights either too large or too small injures itself as well as the road over which it travels. Secondly, that an inspection of the locomotives belonging to the Victorian railways reveals glaring errors and inconsistencies in connexion with this question. Engines of similar character, used for similar work, are in some cases heavily balanced and in others not balanced at all, while in those that are balanced there are inexplicable variations in the position of the balance weights. This anomalous state of things, which must tend seriously to increase the expense of maintaining and working the railways, was at the outset noticed by the present Locomotive Superintendent, who proceeded to make calculations and experiments with a view to the proper balancing of all engines. Unfortunately, in his calculations he overlooked a very important factor, upon which depended the maximum pressure of the engine wheels upon the rails. The engines so balanced ran smoothly and freely, but at high speeds had a most injurious effect which would have been foreseen had the calculation been properly made. One of these engines, No. 365X being driven at an excessive speed down a long gradient, destroyed about three miles of rails, and led to the abandonment of what, if properly carried out, would have been a most useful reform.

In reply to a series of questions, a return was presented to Parliament, with a report annexed, in which it was stated that a notice, dated 28th January, 1888, restricting the speed of this and similar engines to 30 miles per hour, was exhibited in the North Melbourne engine sheds before the date of the accident, namely, 4th February; but the evidence before us was clear that no notice to that effect was posted in the sheds till afterwards. Further, we may say that it seems to us exceedingly doubtful whether the very excessive speed supposed to have been attained by this engine was really reached, particularly as the memorandum hereinafter mentioned will show that a very much less speed was amply sufficient to produce the observed effect.

After the accident referred to the engine was suspended by chains and worked with a view of studying the effect of the balancing. There is nothing improper in such an experiment, provided due precautions are taken for the safety of those making it, and interesting and valuable results have been so obtained and are recorded in standard works on the subject. In the present instance, however, the experiment was so tried as to cause considerable alarm on the part of those engaged upon it, while no useful result appears to have been arrived at, consequently the money that it cost was wasted, although it was not a serious amount.

After the abandonment of the balancing scheme a number of sector-shaped plates of iron that had been prepared for the purpose of balancing other engines were cut up into washers and used in connexion with the holding down bolts of the machine tools at Newport. This was the best use that could be made of the material, and is the foundation of certain reports that have passed current as to the burying of these plates for the purpose of concealment. A quantity of lead obtained for the same purpose was not returned as it should have been to the departmental store.

The question of balancing being of a very technical nature, our Chairman, as a scientific expert, has prepared a memorandum upon it, which will form Appendix No. 2.

8. Whether there was proper authority for the construction of engines, the establishment of moulding shops, and other works.

We find that proper authority was obtained for the construction of engines in every case, no contract for this purpose having been let without the knowledge and written approval of the Railway Commissioners.

With regard to the moulding shop at Newport, the construction of which was stopped after a portion of the foundations had been laid, we find no proper and sufficient authority was obtained. In the original design for the Newport buildings, a moulding shop is shown occupying a portion of the space now included within the smithy. As the work of erection proceeded it was found necessary to enlarge the smithy, and this was done by dispensing with the division wall, and so adding the moulding shop to it. This change deprived the establishment of one of its most important divisions, and this deficiency the Locomotive Superintendent proceeded to remedy on his own responsibility, and without the concurrence of the Commissioners.

There is no evidence that any other works within the apparent meaning of this question were undertaken without proper authority.

Our answer is based on the assumption that the written approval of the Commissioners was, within the meaning of this question, in every instance a sufficient authority for the expenditure.

9. Whether the working expenses of the Locomotive Branch have been unreasonably increased, and whether its administration has been wanting in economy and efficiency.

Tabulated statistics of the Locomotive Branch, and a number of diagrams constructed from them, were submitted in evidence. A careful study of these, and comparison with the results obtained in adjoining colonies, while making due allowance for varying local conditions, lead to the conclusion that the ordinary working expenses had not, on the whole, been unreasonably increased. Some items of expenditure, notably the cost of repairs per train mile to engines and passenger carriages, show, though with occasional fluctuations, a steady diminution which is highly satisfactory in view of the increase in size of the locomotive, and the size and speed of trains. Yet it is not clear how far this might be due either to improved design, material and workmanship, or to the greater facilities afforded by the establishment of the Newport workshops, or, on the other hand, to the construction of a large number of locomotives and carriages which have not yet required any heavy repairs. In the case of repairs to and lubrication of goods waggons, the examination of the statistics does not give so favorable a result. The cost varies from year to year, sometimes increasing, sometimes diminishing, but no pronounced downward tendency is apparent. The amount of fuel consumed per engine mile has augmented during the last few years in a rather higher ratio than the increase in the size of the locomotives warrants. Although the effect of this increase on the total expenses has been largely counteracted by recent reductions in the price per ton, the point is one that should be inquired into. In the absence of explanation, it appears anomalous that large locomotives, professedly embodying the results of the latest experience, should consume about ten per cent. more fuel in doing a given amount of work than

smaller engines of types now stigmatised as obsolete. The consumption of oil and tallow in the engines has also increased to a larger degree than it apparently should have done. Although this item forms an almost imperceptible fraction in the total cost of running the trains, it should not therefore be less jealously watched and kept down to the lowest attainable limit.

These conclusions are drawn from statistics compiled by the officers of the Locomotive Branch, but it is not possible for us to verify the facts or to trace the data to their source. Our replies to earlier questions show that excessive stocks of material have been procured, vehicles have been broken up which might have been made serviceable, large numbers of locomotives have been constructed though objected to by the Existing Lines Branch, and new types of rolling-stock have been introduced unasked for by the Traffic Branch. The system of rebuilding vehicles in such a manner as to produce stock totally new in all but their respective numbers shows an apparent determination to obtain new stock at the sacrifice of old, and without burdening working expenses for repairs. A number of other similar instances also show that economy has not been regarded. It has been admitted that in the aggregate large sums have been improperly charged to construction or loan account which should have been charged to maintenance. It is manifestly to the interest of the Locomotive Branch to reduce its apparent working expenses to a minimum, and the charging of items to construction that ought to be classed as maintenance is an extremely facile and not easily detected mode of attaining that end. No doubt there are numerous instances where a plausible case may be made out for transferring a given item from the one account to the other. A bias on the part of those allocating the charge may lead them, without dishonesty, to relieve the one and unduly load the other.

It must, however, be stated for the Locomotive Branch that there is ample proof of energy and a desire for improvement in methods and of the stock with which the work of the railways must be carried on. This is apparent even in such an instance of conspicuous failure as the attempt to balance engines.

We are compelled to say that we feel doubtful of the accuracy of the favorable figures given in the statistics, and in the management of the Locomotive Branch there has been, in some directions, a conspicuous disregard of that economy which is so absolutely necessary in the conduct of so large a branch of a State department and in dealing with such immense sums of public money.

Concluding Remarks.

In bringing this Report to a close we venture to submit a few general observations.

Our inspection leads us to believe that the workshop at Port Melbourne should be closed, and the alterations and repairs hitherto effected there be, in future, made and done at Newport, excepting trifling repairs, such as now done at North Melbourne running shed. The surplus artisans now employed at Port Melbourne could, if transferred, be supervised at Newport by the existing staff of foremen, and the senior foremen found to be redundant and not required should be pensioned off. We ascertained that a number of cow catchers had been made at Port Melbourne, although no sufficient appliances existed there for the work. It should have been done at Newport at a less cost.

We think the necessity for maintaining at its present strength the professional and office staff at Newport should receive the early attention of the Commissioners. We found during the progress of our investigation that much unnecessary trouble was taken and much valuable time wasted in the preparation of orders for materials not authorized by the Commissioners. We are at a loss to understand why particulars and details should be prepared of materials necessary for the construction of rolling-stock before the Commissioners have decided to build any stock of the kind, and, apparently, sometimes before Parliament had decided on the construction of lines on which such stock was proposed to be used. And, in this connexion, we think the attention of the Commissioners should be invited as to the responsibility for faulty designs for certain vehicles—which failure was disclosed in the course of our inquiry—with a view to ascertain with whom the blame rests.

Further, we suggest an exhaustive examination into the necessity—if it exists—for the employment of all the men now in the workshops. We do not say they are not fully employed, but we have grave doubts whether they are all necessarily employed, and while we fully admit that work is done there in a most complete manner and finished style, we think it may be found that some of it, at least, might be done outside, by contract, more cheaply and sufficiently well.

While inspecting the tarpaulin shed we observed numerous appearances denoting great want of care of tarpaulins in use. It appears to us that much more vigilance on the part of those charged with the supervision of shunting and similar work to prevent needless injury should be insisted upon. While on this subject we may mention with satisfaction that the employment by the Locomotive Superintendent of lads to work sewing machines in making up and repairing tarpaulins has been productive of a marked decrease in the outlay on these articles.

With regard to timber, we learned that it was—and probably still is—the practice to receive timber considerably in excess of orders. We see no necessity for this, and think the practice should be checked. The custom of accepting timber of inferior quality and short lengths at a reduction, at the discretion of the yard foreman, is another matter that calls for attention. In one instance that came under our notice, the price allowed for the portion of the supply not according to specification, was clearly in excess of its value as compared with contract rates.

A payment to certain contractors of a sum of £3,000 without any necessity, and without the Government receiving any consideration therefor, seems to us to call for further explanation. The contractors in question may or may not have been unfortunate, but we cannot see that it is any part of the duty of a Government department to afford aid to a firm in pecuniary difficulties.

We think the matter of returns presented to Parliament calls for attention. The return laid on the table of the Legislative Assembly relating to the so-called Lancefield accident, while not actually in opposition to facts, was calculated to induce an erroneous impression as to the cost of the material employed.

The absence of protection from the weather to carriages of great value is a matter which seems to us to call for immediate attention. One carriage, said to have cost £4,200, we saw standing exposed to sun and rain, and the failure to give such vehicles proper cover appears a very false economy. It is also worthy of consideration whether valuable timber should not also be sheltered. Stacks which we especially noticed in this connexion were at one time covered by old tarpaulins, but after those tarpaulins wore out nothing further was done, although special attention was called to the want by the Locomotive Superintendent. Apparently the blame rested with the Departmental Storekeeper.

We could not avoid being struck by the neglected and dirty appearance of some second class carriages which came under our notice. Of course these cannot be as comfortable and commodious as those of the first class, but no reason exists why they should be sent out in the state alluded to, nor, indeed, why there should be so marked a contrast in the degree of comfort afforded.

The want of system and supervision in connexion with the departmental store struck us forcibly. Iron, for instance, was assumed to be received by the Storekeeper and entered in his books, but supplies were taken from time to time, just as they thought fit, by the foremen of the workshops, and by the master blacksmith. When stock was taken—more or less irregularly—and a certain quantity was found to be absent, covering orders were given by the Locomotive Branch to the Storekeeper. There seems to be no reason why material intended for use in the locomotive workshops, and apparently for no other purpose, should not be delivered direct to the locomotive store, and why the foremen of the shops should not be held responsible. An absence of business methods was very conspicuous in connexion with the whole store arrangements, and the evidence of the Storekeeper was of little assistance to us.

Papers connected with a tender accepted on the 12th day of May, 1890, from Messrs. Gray Brothers, have been laid before us, and some evidence in connexion with the matter was afterwards given. The firm appears to have come to Victoria by invitation of the Department, and erected workshops and plant at Williamstown. Their tender for manufacture and supply of solid wrought-iron engine, tender, carriage, and waggon wheels for three years was much lower than that of the other firm tendering, but, for some reason which we utterly fail to appreciate, the then Commissioners divided the contract between the two firms at Gray Brothers' prices. Up to

May, 1892, the other firm had obtained orders £3,000 in excess of those given to Gray Brothers. The total value of the contract, according to a return placed before us, was £17,219. We regard this mode of dealing with a successful tenderer as unfair, and calculated to cause loss to the Department in the future. No evidence whatever has been furnished that Gray Brothers' work was unsatisfactory, or that the wheels were not sent in as required.

The evident want of harmony between different branches of the Railway Department is much to be deprecated, and is doubtless partly responsible for unnecessary outlay in various directions to which we have already more especially referred in our answer to question 9. The sooner this unfortunate state of affairs comes to an end the better it will be for the department. Officers, especially those occupying positions of great trust and responsibility, should all work harmoniously for the common advantage, and with the recollection that all are but parts of one large whole. It is neither necessary nor would it be advantageous to go into details, but it is impossible to avoid alluding to this state of things, which we do with the earnest hope that a better feeling will in future prevail.

We have to say, with regret, that the mode of giving evidence adopted by certain of the witnesses—officers of the department—did not impress us favorably. In one instance some statements of the witness were certainly of a self contradictory character, and in another, somewhat evasive. Possibly, however, this may have been partly due to their peculiar position, and their fear of consequences to themselves.

In conclusion, we have to place on record our sense of the valuable and loyal assistance afforded to us by Mr. F. H. Bruford, who has acted as our secretary. We have great reason to be satisfied with his care and accuracy, and his strictly impartial manner of dealing with the various parties and the immense mass of papers—documentary evidence and returns—placed before us.

All which is respectfully submitted.

Dated at Melbourne this thirty-first day of May, in the year of Our Lord One thousand eight hundred and ninety-three.

W. C. KERNOT,
Chairman.

A. P. AKEHURST.

A. W. HOWITT.

ANNEXURE "A" TO ORDER IN COUNCIL OF 17TH OCTOBER, 1892.

1. Whether stores, material, and machinery have been procured of an unsuitable description and size, and have been ordered far in excess and in advance of requirements; and whether such stores and material have accumulated, causing loss.

2. Whether stores have been improperly ordered without calling for tenders, and whether contractors have been improperly allowed to vary the character of goods contracted for.

3. Whether a large quantity of teak timber was ordered from a non-contracting firm at about the same time that notice was given to the then contractors to discontinue supplying similar timber.

4. Whether rolling-stock which should have been repaired has been broken up, and improper and unnecessary alterations and additions made in and to rolling-stock, causing needless expense, loss, and waste.

5. Whether too many types of rolling-stock have been manufactured, and whether the designs for and construction of rolling-stock and stationary and other engines have been defective, unsuitable, and costly, and carried out at an unnecessarily great expense, and without consultation with the branches interested, whereby the cost of maintenance and the expenditure on patterns has been unduly increased.

6. Whether serviceable engines have been improperly disposed of, and a large number of unnecessary and unsuitable engines have been ordered.

7. Whether expensive experiments have been conducted, some of which have caused loss by damage to permanent way and rolling-stock.

8. Whether there was proper authority for the construction of engines, the establishment of moulding shops, and other works.

9. Whether the working expenses of the Locomotive Branch have been unreasonably increased, and whether its administration has been wanting in economy and efficiency.

APPENDIX No. 1.

RIMU OR RED PINE OF NEW ZEALAND.

A considerable stock of this timber has been obtained and is now stored at Newport. It was procured at the suggestion of the present Locomotive Superintendent, and in opposition to the opinion of his predecessor, Mr. Mirls. The reason for obtaining it was economy, its price being 14s. 7d. per hundred square feet, or less than a fourth of what was paid for teak which was previously used.

The evidence with regard to this timber is conflicting. Several of the witnesses object to it as short in the grain, liable to warp, and showing symptoms of decay. One alleges that some of the timber is not rimu at all, but an inferior timber known as *matai*. On the other hand its advocates point to its very low cost, state that it is most extensively used in the South Island of New Zealand for railway rolling-stock and building purposes, and refer to the North Melbourne Town Hall as a conspicuous example of its strength and durability. Finding it impossible to come to a satisfactory conclusion from the evidence submitted, I made an inspection of the timber at Newport, and found it to be of two qualities, the inferior of which I understood to have been accepted at 1s. per hundred feet reduction. My own impression from examining the stacks is that this reduction was not sufficient to cover the difference in quality. If the first quality timber was worth 14s. 7d. the second does not appear to me worth more than 10s. or 11s. at most. The timber of both qualities had in some instances warped to a degree sufficient to render it almost valueless. Fortunately the number of pieces that had so warped was a very small proportion of the whole, and the remainder was fairly straight and uniform, so that the percentage of loss from this cause would probably be trifling. The colour of the timber was not pleasing, and a number of planks that I had taken down from the stacks appeared to me at first to show signs of decay, but closer examination did not confirm this conclusion, and it is quite possible that the discolouration I noticed was harmless.

Proceeding next to the North Melbourne Town Hall, I found that the professional officers were but recently appointed to their positions, and consequently unacquainted with the history of the building. The Town Clerk, however, who has been in his present position for many years, and is familiar with the history of the hall from the very first, assured me that there never had been any complaint, trouble, or fracture, and that certain ceilings that had been renewed were renewed for reasons quite apart from the employment of rimu timber. He further very courteously took me into the basement below the great public hall, and allowed me to examine the rimu joists supporting the floor. These I found to be in good order, showing no signs of either warping or decay, while their strength was evidenced by the fact that they had endured for many years the stress due to the occupation of the hall by crowded public meetings and frequent balls. The evidence from the North Melbourne Town Hall was therefore entirely satisfactory as regards the strength and durability of the timber when not exposed to the weather. Making further inquiries, I found that a leading firm of architects in Melbourne had largely employed this timber in a mansion they had recently built, and were about to employ it in a church of considerable architectural merits. They, however, had not used it for joists or heavy framing, but for dadoes, seats, and other fittings.

While at Newport, I placed a private mark on several planks, which I personally selected, and had them forwarded to the Engineering Laboratory at the University. There the timber was sawn up, and the pieces tested in the large testing machine. The result of the experiments then made was that the timber improved on acquaintance, working well with the saw, chisel, and plane, and revealing a close texture. It compared favourably with a piece of well-seasoned kauri subjected to the same tests. The experiments upon the compressive and cross-breaking strength showed it to be a tougher and more fibrous timber than kauri, bending rather more before breaking, and not breaking with so short a fracture.

A number of comparative results obtained in the laboratory from this and other standard timbers are given in the following tabular statement:—

Resistance to compression along the grain in pounds per square inch, obtained from experiments on pieces averaging 1 foot long and 3 inches square. Two specimens of each timber were tested—

Rimu.	Kauri.	Oregon.	Blackwood.
6014	4346	5666	6319
6526	4212	6166	5925

Resistance to compression across the grain in pounds per square inch, obtained by crushing cubes of $2\frac{1}{2}$ to 3 inches side—

Rimu.	Kauri.	Oregon.	Blackwood.
1440	1725	556	1883
1376	1945	573	1910

Resistance to detrusion or shearing along the grain in pounds per square inch—

Rimu.	Kauri.	Oregon.	Blackwood.
1273	1646	1000	2765

Cross breaking—Modulus of rupture in pounds per square inch—

Rimu.	Oregon.	Blackwood.
10760	6728	8424
11303	7095	9495

The last-mentioned results were obtained from comparatively large specimens, averaging about 20 square inches sectional area, supported at points four feet apart and loaded at the centre. Two experiments were tried on specimens of rimu and kauri $2\frac{1}{2}$ inches wide and $1\frac{5}{8}$ thick, 2 feet span. These small specimens, as

is usually the case, give higher results than the larger ones, the modulus of rupture being 14,267 for rimu and 12,758 for kauri, and the rimu was tougher and broke with a more fibrous fracture. Its deflection before yielding was also greater.

The above experiments were made on the better of the two qualities of rimu, and on well-seasoned and sound specimens of the other timbers. The inferior rimu was also tested, but with variable results. Sometimes it equalled the good samples, but in other cases fell short by as much as 20 per cent. As far as possible the experiments were made in duplicate, and both results are recorded.

My conclusion, therefore, is distinctly favourable to this timber. At the same time it must be remembered that neither these experiments nor the satisfactory experience at the North Melbourne Town Hall give any absolute guarantee of its durability when exposed out of doors to extreme changes of temperature and rapid alternations of moisture and dryness. That can be determined by actual experience only.

W. C. KERNOT.

APPENDIX No. 2.

MEMORANDUM RESPECTING THE PROPER MODE OF BALANCING LOCOMOTIVE ENGINES.

When an ordinary locomotive engine is in motion, certain disturbing forces are brought into existence by the centrifugal effect of revolving masses not concentric with the axis of rotation, and by the inertia of the reciprocating masses. These disturbing forces increase with the square of the speed, and consequently may be comparatively unimportant at ordinary speeds, and yet become most destructive at speeds not very largely exceeding the ordinary. These forces may be resolved in a horizontal direction parallel to the line of railway, and in a vertical direction. That component of the disturbing forces acting horizontally causes a fore and aft jerking of the engine, very unpleasant to the drivers, and injurious to the draw gear. The vertical component causes the pressure of the wheels on the rails to vary, but if the rails are solidly supported, and the force when acting upward is less than what is required to lift the wheel off the rail, no perceptible vertical motion of the engine will ensue, although the rails may be subjected to a vertical pressure varying during each revolution from zero to double the static wheel load. The speed at which this state of things exists for any wheel may be called the *critical speed* of that wheel. At any speed greater than the critical speed the wheel will jump, rising completely off the rail at a certain part of the revolution, and falling again with a blow or impact. The centrifugal effect of all revolving masses may be exactly counteracted by placing other masses having the same moment (*i.e.*, weight multiplied by radius) diametrically opposite. If the counteracting mass, or balance weight, as it is generally called, cannot be placed in the same vertical longitudinal plane as the mass to be balanced, as for example, when it is required to balance an inside crank by weights in the wheels, the balance weight must be divided into two parts having the same ratio to each other as the distances from the crank to the two wheels respectively, and the larger of the two portions placed in the adjacent, and the smaller in the distant wheel. An axle or wheel so treated is free from all centrifugal disturbance, and may be said to be in a state of *normal balance*. A normally balanced axle or wheel gives rise to no disturbing action whatever, and its critical speed is infinite. Its pressure on the rail is invariable, and is simply equal to the static load. A normally balanced engine is, therefore, the one that does a minimum of injury to the rails. It is, however, subject to the horizontal disturbing forces caused by the inertia of the reciprocating parts, and which evidence themselves by the previously mentioned fore and aft jerking.

It is possible to remove this fore and aft jerking by placing extra balance weights in the wheels calculated for the reciprocating parts, just as the normal balance weights are for the revolving parts, but this is accomplished at cost of introducing a vertical disturbance, and so reducing the critical speed from infinity to an amount that may lie within the range of ordinary working. This is almost certain to be the case if the extra balance is concentrated in the driving wheel, but will probably not be the case if it is divided equally between all the coupled wheels. The first of these arrangements is that which existed in locomotive 365X at the time that it caused the so-called Lancefield accident; and an engine so balanced will run, as this particular engine did, very smoothly up to the critical speed, provided the rails are strong enough to endure the large and constantly varying pressure upon them; but directly that speed is exceeded, the driving wheels will jump and hammer the rails. As the critical speed of 365X was only 48 miles per hour, while the actual speed according to the finding of the Board of Inquiry was 75, the hammering or pounding must have been tremendous, and there is not the slightest cause for astonishment in the fact that rails were bent, broken, and marked by the blows of the wheels. Had the extra balance, instead of being concentrated in the driving wheels, been divided equally between all the coupled wheels, there would have been a minute and probably imperceptible increase in axle friction, but the critical speed would have been raised in the ratio of $\sqrt{3}$ to 1, or to 83 miles per hour, a speed that such an engine is never likely to attain. 365X may be described as having been balanced entirely in the interest of smooth running, and utterly regardless of the interests of either tires, rails, or bridges. Such an engine should not be permitted to run on any railway. It is further to be remarked that an arithmetical error appears to have been made, whereby the balance weight became about 100 lbs. greater even than this extreme mode of treating the question would require.

As an absolutely perfect balance, both in a horizontal and vertical direction, of both revolving and reciprocating parts is physically impossible, the best practical arrangement must be of the nature of a compromise, in which a greater or less portion of the reciprocating masses are left unbalanced, and this

proportion will vary with the relative importance attached to smooth running and easy pressure on the rails. If the rails are weak, and the engine heavy, normal balancing is recommended, longitudinal unsteadiness in running being submitted to rather than subjecting the road to a pound of pressure more than is absolutely necessary. On a strong road, on the contrary, and with passenger trains in which longitudinal vibration is undesirable, extra weights, equally divided between the coupled wheels, and calculated to balance not more than three-fourths of the reciprocating parts may be permitted in addition to the normal balances.

It may here be remarked that as it is of the utmost importance that the weight of the reciprocating parts be reduced to the minimum, this is to be done by careful design, and the employment of the material that combines strength and lightness in the greatest degree. At the present time this material is probably steel, but it is not unlikely that in the near future aluminium or some of its alloys will be available, and give still better results.

From what has preceded it will be seen that each driving wheel of an inside cylinder engine will contain two balance weights of different sizes at right angles to each other. These two may be, without altering the running of the engine or its action on the rail, replaced by a single weight whose size and position are such that its centrifugal effect is the resultant of the centrifugal effects of the two weights it replaces.

An inspection of a large number of our locomotives leads irresistibly to the conclusion that this vitally important question of balancing is not always understood by locomotive designers. The most singular variations and inconsistencies reveal themselves at the first glance. Engines of almost identical form and size are treated in totally different ways. For example, the new A, the old A, the B and the L are engines of a precisely similar character, the difference being a small variation in size, and in the arrangement of minor parts, and yet they are balanced in four totally different and irreconcileable ways. The Y, the X, the new R and the O are also engines of a similar character, and yet the Y and new R are absolutely devoid of balance weights, while the X and the O have weights of very respectable size in their driving wheels. Now all these conflicting systems cannot be right, while it is perfectly conceivable that they all may be wrong.

The experiments that led up to the re-balancing of engine 365X, and the destruction of the rails between Lancefield Junction and Sunbury, evidence a desire on the part of the Locomotive Branch to remedy this unsatisfactory state of things which was creditable, but the concentration of the whole of the extra balance belonging to the reciprocating parts in the driving wheels show that the question was looked at from one point of view only, and that all other considerations were completely subordinated to the one object of extinguishing the fore and aft jerking of the engine. This unfortunate, one-sided mode of looking at the question was the cause of all the mischief, including the destruction of a great length of permanent way, the risk of wrecking a following train, and the checking at its inception of a most desirable reform. Had the officers of the Locomotive Branch been content with balancing *three-fourths* of the reciprocating parts, and had they distributed the weights required for that purpose in equal proportions in the leading, driving, and trailing wheels, they would have gained nearly the whole of the advantage they actually did gain, while the undesirable vertical force would have been only one-fourth of what it actually was, and the critical speed, or speed at which jumping and pounding commenced, would have been raised to over 96 miles per hour, a speed the engine could never even remotely approach. Had this course been taken the engine would unquestionably have been regarded as a perfect success, and by this time, most probably, every other engine on our railways would have been balanced on similar lines, with most valuable results in the way of increased speed, smoother running, and reduced coal consumption.

From numerical data supplied by the officers of the Locomotive Branch I have worked out a number of results as to the balancing of various engines, which I here subjoin—

ENGINE 365X.

1. Present balancing, 116 lbs. at 22 inches radius in driving wheels; no balance weights in leading and trailing wheels—

Maximum pressure of driving wheel on rail at 50 miles per hour ...	18051
Ditto, leading and trailing, ditto	21129

Critical speed, 82 miles per hour.

2. Balancing at date of accident, 551 lbs. at 19·75 inches in driving wheel; 110 lbs. at 22 inches in leading and trailing wheels—

Maximum pressure of driving wheel on rail at 50 miles per hour ...	33128
Ditto, leading and trailing, ditto	15600

Critical speed, 48 miles per hour.

as 50 miles per hour is above the critical speed, the driving wheels will at a certain part of the revolution rise up from the rails and fall upon them again with a blow.

3. Normal balancing, 167 lbs. at 20 inches, and 45° from crank in driving wheel; 131 lbs. at 20 inches, and opposite cranks in leading and trailing wheels—

Maximum pressure of driving wheel on rail at all speeds	15848
Ditto, leading and trailing, ditto	15470

Critical speed, infinite.

4. Compromise balancing in which the whole of the revolving and three-fourths of the reciprocating parts are balanced, the weights being distributed between the different wheels so as to load the rails as lightly as possible. 240 lbs. at 20 inches, 38° from the crank in driving wheel; 68 lbs. at 20 inches, 152° from the crank in leading and trailing wheels—

Maximum pressure of driving wheel on rail at 50 miles per hour ...	19088
Ditto, leading or trailing, ditto	18710

Critical speed, 109 miles per hour.

It will be seen from the preceding that this last or compromise balancing renders the engine decidedly lighter on the rails than it is at present, while it secures nearly the whole of that freedom from fore and aft motion which was obtained by the second system which proved so disastrous to the road; and these advantages will exist, though not quite in the same proportion, at all other speeds, as well as at that for which the numerical results have been computed. This balancing should be adopted for all engines of this class.

New A Class, sometimes called Kitson's A.

1. Present balancing equivalent to 110 lbs. at 30 inches in driving wheels, and 74 lbs. at 30 inches in trailing wheels—

Maximum pressure of driving wheel on rail at 60 miles per hour ...	18340
Ditto, trailing, ditto	15576

Critical speed, 181 miles per hour.

2. Normal balancing, 138 lbs. at 30 inches, and 31° from crank in driving wheel; and 72 lbs. at 30 inches, opposite cranks in trailing wheels—

Maximum pressure of driving wheel on rail at all speeds	16520
Ditto, trailing, ditto	15456

Critical speed, infinite.

3. Compromise balancing in which the whole of the revolving, and about half of the reciprocating, parts are balanced, and the weights distributed so as to load the rails as lightly as possible. 162 lbs. at 30 inches, and 29° from crank in driving wheel; 35 lbs. at 30 inches, and 155° from crank in trailing wheel—

Maximum pressure of driving wheel on rail at 60 miles per hour ...	18340
Ditto, trailing, ditto	18340

Critical speed, 181 miles per hour.

This latter or compromise balancing is recommended as being no heavier on the rails than the present system, while it reduces the longitudinal disturbing force by about 4 tons at 50 miles per hour, as compared with the present state of the engine, and by 3 tons as compared with normal balance. An examination of the old A class of engines which have always had a reputation for smooth and easy running, shows, that taking into account the difference in the weight of the moving parts, the system of balance adopted is almost identical with that here proposed for the new A class. There is but a very trifling difference, the effect of which is that the old A balancing is by an insignificant amount less favourable to the rail, and more favourable to the engine than that here proposed. The old A is by far the best balanced engine of those I have critically examined. It is further to be noted that the F, which appears from a somewhat cursory examination to generally resemble the old A in its balance, is also generally commended for easy and fast running. It may, therefore, be claimed that the arrangement of balance weights now proposed for the new A engines is not a novel experiment, but is practically identical with what has for years proved highly satisfactory in the case of the old A and F classes.

The D and E engines being similar in their arrangements to the A class, may be balanced in a similar manner. As the wheels are not large enough to permit the weights to be placed 30 inches from the centre, they must be situated at a shorter radius and be proportionately larger. Taking 20 inches as the probable radius of the centre of gravity, the driving wheel weight should be 243 lbs. at 29° from the crank, and the trailing wheel weight 51 lbs. at 155°. Strange to say, the weights are actually larger, being about 250 lbs. and 112 lbs. respectively. This extra driving weight is conducive to smooth running, and is not objectionable on good rails, but if the rails are weak and it is desirable to distress them as little as possible, some relief may be gained by reducing it to 210 lbs. The trailing weight is not consistent with that in the driving wheels, and in any case the running of the engine would be improved by reducing it by at least 30 lbs., and shifting it round to the position recommended for the A class.

New (or Kitson's) R and Y Classes.

These engines are similar in character to the X class, but with smaller wheels and rather lighter moving parts, and might with propriety be similarly balanced. They are actually, however, *absolutely devoid* of balance weights, and are consequently much more severe on the rails, and much less steady in running than they ought to be, and this fault is specially to be deprecated in the R class, for the existence of which there is no reason, unless it be capable of running on light lines. The same investigation will apply with approximate accuracy to both classes, the difference in the weights of the moving parts being unimportant.

1. Present state without balance weights—

Maximum pressure of driving wheel on rail at 45 miles per hour ...				R 22032
Ditto	ditto	ditto	...	Y 23600
Ditto	leading or trailing	ditto	...	R 18830
Ditto	ditto	ditto	...	Y 19378

Critical speed, R 63 miles per hour, Y 67 miles per hour.

2. Normal balance, 172 lbs. at 20 inches radius, and 38° from crank in driving wheel; 104 lbs. at 20 inches radius opposite crank in leading and trailing wheel—

Maximum pressure of driving wheel on rail at 45 miles per hour ...				R 14532
Ditto	ditto	ditto	...	Y 16100
Ditto	leading or trailing	ditto	...	R 14112
Ditto	ditto	ditto	...	Y 14658

Critical speed, infinite.

3. Compromise balance, 200 lbs. in driving wheel at 20 inches radius, and 37° from the crank; 80 lbs. in leading and trailing wheels at 170° from crank—

Maximum pressure of driving wheel on rail at 45 miles per hour			...	R 15662
Ditto	ditto	ditto	...	Y 17230
Ditto	leading and trailing	ditto	...	R 15142
Ditto	ditto	ditto	...	Y 15688

Critical speed, 160 miles per hour.

The above results of computation show that in the case of both these engines the critical speed is at present dangerously low, and might be attained when descending a long gradient, in which case the so-called Lancefield accident would be almost certainly repeated. They also show that at the comparatively moderate speed of 45 miles per hour, a speed doubtless often attained on the road, that the maximum pressure of the driving-wheel on the rail is almost 50 per cent. more than the static load, which is ample in the case of the R engine to account for all the damage done to the line. With normal balance weights this engine ought to be capable of running on rails at least 10 lbs. lighter per yard than it requires at present. As, however, normal balancing does not mitigate the fore and aft jerking, the compromise balancing is recommended as being better for the engine and nearly as good for the road.

In the case of the Y engine that is used on strong roads only, the compromise might, with advantage, be modified in the direction of balancing more of the reciprocating masses, to the extent of 250 lbs. at 34° from crank in driving, and 50 lbs. at 144° from the crank in leading and trailing wheels. This would render it a little harder on the road, giving a maximum pressure of 19,350 lbs. as against 23,600 at present at 45 miles per hour, but would almost entirely abolish the longitudinal jerking now complained of. In this case the critical speed would be nearly 100 miles per hour and, consequently, far above any actual running.

The calculations leading up to the foregoing results have been carefully made and thoroughly checked so that their substantial accuracy may be relied upon. The pressures upon the rails have been computed as at the highest probable working speeds of the engines, these being taken as 60, 50, and 45 miles per hour for 6 ft. 5 ft. and 4½ ft. wheels respectively. The results show clearly the cause of the so-called Lancefield accident, of the destructive action of the R engines on the light lines, and of the generally acknowledged fact that the new A engines, while exceeding the old ones in boiler power and maintaining a better speed up steep grades, are inferior in speed when on a level or running down a grade. This being so, I would urge the Railway Commissioners to have all the locomotives of all classes whatever, and not only those above discussed, carefully examined with a view to bringing them all to that satisfactory state of balance that is now found in a few specially favoured classes only; and I shall be most happy to render any assistance toward the accomplishment of so desirable an object.

W. C. KERNOT.

By Authority: Robt. S. Brain, Government Printer, Melbourne.