

THE MANAGEMENT OF A LOCOMOTIVE REPAIR SHOP.

*Paper read before the Institution by Colonel O'BRIEN,
D.S.O., Member, Horwich, on 8th October, 1920, at
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Paper No. 86b.

*Discussion in Manchester on Paper No. 86 (see JOURNAL,
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The Chairman: Gentlemen, we have met together to-night to discuss Colonel O'Brien's paper which he read at our last meeting, and as I said then, one of the main objects of our Society is to give members an opportunity of taking part in the discussions by offering their criticism and by asking questions upon the points that may not be clear to them, and we especially invite discussion from the younger members. I do not at this stage propose to say anything myself on Colonel O'Brien's paper, but shall be pleased if, before we part to-night, all the members here will take part in the discussion, and feel quite sure Colonel O'Brien will welcome criticisms and questions, and will do everything possible to give you his further opinion when he replies.

I will now call upon someone to open the discussion.

Mr. J. Parry (G.C.R., Gorton): I always find that the people in the workshop consider the locomotive as something to be made and repaired only, and it is not surprising that

such things as standardisation have taken such a hold of them. Save, perhaps, the Whitworth screw threads, there is nothing that when standardised has remained standard. The locomotive has arrived at its present stage of perfection, or imperfection, largely by a process of evolution; and those who study such things know that evolution cannot go on without there is continuous variation. Many engines have been built with parts that have been originally designed for previous classes of engine, and dubbed "standard"; these parts are invariably either too heavy, too small, or a misfit of some kind. The result is more repairs than would otherwise be necessary. Surely it is better not to have repairs to make than be able to do them cheaply. In my opinion there is not enough of what may be called "collusion" between the running department and the drawing office.

Mr. Gamble: In Appendix A to the paper, page 386, the rules governing the withdrawal of engines for repair are given. It is presumed that the importance of these rules is in the same order as that in which they are given, but in many cases the withdrawal of engines is governed more by the ability or convenience of the repair shop to deal with the repairs than by the type of engine most urgently required by the running department. This is borne out by the last sentence of this paragraph which states that light repairs are generally dealt with at once. Looking at the matter from a shop point of view, this procedure increases the weekly "paper" output of repaired engines from the erecting shop, but is frequently of very little assistance to the running department as it is usually the engines doing the heaviest work which require the heaviest repairs, and which probably necessitating heavy boiler repairs are left standing in the siding owing to the inability of the shops to deal with them at the time. The boiler shop is really the key shop to the whole situation, and unless spare boilers are kept on hand to enable the shops to deal with heavy repairs as required by the running department, and not as convenient to the shops, the efficiency of the running department cannot be maintained. To my mind the running department, as the customer, should have the last word in saying which engines are to go into the shops at a certain period.

As regards the running trial mentioned on page 395, do I understand the Author to say that all engines, including goods, with the exceptions mentioned, undergo a running trial on branch passenger trains? On many railways it is not the practice to give a running trial to goods engines; they are frequently steamed in the shed, and the only running

trial consists of being worked round for their regular job by means of lighter goods work.

As regards the repairs necessary after running trial, mentioned by the Author, are these carried out in the erecting shop, or in the sheds? And by which department? In many works the shops are responsible for dealing with all repairs necessary after trial trip, and until the engine is passed into regular traffic, and it is frequently exceedingly difficult for the running department to get these repairs quickly and efficiently carried out. The chergeman in the erecting shop, when once a particular engine has left, gets another engine in its place, and if working "contract" has no desire to put in any more time upon the engine that has left, and in consequence it is exceedingly difficult for the running department to get the necessary repairs done, and the engine, whilst normally booked to them, is for possibly a fortnight a dead loss. On paper, as far as the shops are concerned, the engine is in traffic, but it is of no use to the running department. Will the Author kindly say whether this method prevails on the L. and Y. and what is the actual average length of time after the running trial before the engines are passed into traffic? Are repaired engines run a trial trip before going to the paint shop, if such is required, or does this course only apply to new engines?

Mr. J. H. Haigh (L. and Y. Ry., Horwich): I have read the paper with very great interest for two reasons; one is that I have had some association with the works of which the description is given, and the other more important one, that in the paper little hints are given on the management of a works that cannot be obtained in the ordinary way.

There are one or two matters I wish to criticise. First of all, the relationship of the works which manufactures and repairs locomotives and the outdoor locomotive department, which makes use of the products of the works. There should be the closest possible connection between these two so that more exact ideas of the usefulness of types and alterations in designs can be formed and a more careful watch kept on repaired stock, so that if possible repaired engines should be better than ever before.

The Author appears to agree with this in paragraph *c* of Section 3 of salient points and the works should have definite information on the repairs which are necessary at sheds.

Welding and patching can be easily overdone, and I have vivid memories of the oxy-acetylene welds that were tested in the early days of the process. Such welds could not be relied upon because of oxidation and slag pockets which led to poor resistance to shock and alternating stress.

Possibly the electrical process is more satisfactory on large sections and I should like the Author to express an opinion.

The table on boiler repairs is most interesting and satisfactory, and I attribute the improved position to the greater care exercised at sheds, particularly in washing out, rather than to any alteration in design or method of manufacture, except in the case of stay renewals, which is, I think, largely due to increased water spaces.

Stay renewals show a very satisfactory reduction, but the outstanding figures for June, 1918 to June, 1919 require some explanation.

The last point that I would mention is the position of the test room, which the Author definitely stated should be entirely independent of the works. This condition, however, is not easily obtained under all circumstances, and in such cases the chief of the department is placed in a most uncomfortable position.

Such a chief should have absolute power to reject any material which failed to fulfil the requirements of the specification for the time being in force, just as though that chief were inspecting purchased materials at the works of a contractor.

Further, the close association of the test room with contractors could be of valuable assistance in placing orders by information that the department could give on methods of manufacture, etc. Many people can verify the fact that at some contractors' works the methods are not at all satisfactory, while at others all possible obstructions are put in the way of inspectors when trying to do their duty.

Mr. F. W. Attock (L. and Y. Ry., Horwich) : It would have been interesting to have heard something of the capacity in output of repaired engines from a works such as described by the Author, or to put it the other way round, the accommodation that is necessary for repairing the 1,632 engines referred to. In one of the appendices it is stated that the number of engines called in depends on the activity of the works and is governed by the weekly output of repaired engines, but presumably the output must first be determined on a time basis. The whole stock of engines requires to

pass through the works in a given time, say, two years, more or less, according to the nature of work done on the railway and the mileage run by the engines. Applying the two years' basis to the Author's figure—1,632—the output should be 816 per annum, and as the average time in the shops is 38 days, I presume 816 multiplied by 38 and divided by 300 (as represented in the working days) would give an approximate representation of the standing room required, *i.e.*, room for 103 engines. The rapidity with which engines are dealt with is of the utmost importance. The time the engine is actually under repairs in the shops does not by any means represent the whole time the engine is out of commission. The inclusive figure would probably be about three months; that figure applied throughout the annual turnover of repaired engines amounts to 204 engine years, which is a serious charge in interest on capital. Anybody who cares to work out the cost at a reasonable interest will see that a very large sum of money is involved. It is therefore apparent that the output should be equal to the demand, and consideration should be given to a system of anticipating the actual stoppage of engines by calling them in before this occurs and thus eliminating a great deal of standing time. The point I wish to make here is that the majority of engine repair shops are far too small, and that this is an expensive failing. Reference is made in one part of the paper to the locomotive works manager looking forward to a shrinkage of space rather than an increase of space; that is referred to as an ideal, and in reality I think there is a big demand for a considerable extension of locomotive shop floor space. I notice that the Author attaches much importance to the work of inspectors, and the extent to which repairs and renewals are carried out depends very largely on the discretion of inspectors. I have nothing to say against the principle of employing inspectors for this work, but it should be clearly understood that the inspector should have an efficient repair as the primary consideration and not economy of material. The economy apparently justifiable at the time may prove a source of trouble and expense if it results in the engine failing on the road or being called into the shops again before its allotted time. As it costs at least £100 to bring an engine in for repairs, that is apart from any expenditure of material in the shops, it is essential that the repair should be a thorough repair and last the predetermined time and that there should be no intermediate visit of the engine to the shops.

It is a matter for regret that the Author has been compelled to go underground for accommodation for his finished

work stores. This is a project that certainly claims the full light of day, and I suggest it might be developed on a much larger scale. That it should occupy a central position in the lay-out of the shops and form part of a large clearing depot for the receipt and dispatch of all in-going and out-going material for repairs. A substantial building and enclosed yard would be required, provided with loading ramps and cranes. Rails of 4ft. 8½ in. gauge for the accommodation of the stores vans which run daily for the transport of material between the works and outstations, and tramways for the distribution of material in the shops. This would be a most valuable asset in co-ordinating supplies and reducing the standing time of engines waiting for repair details.

In conclusion, I wish to congratulate the Author on putting into practice a policy of boiler renewal and repairs which cannot fail to keep the stock up to a high standard of maintenance and eliminate much heavy and inefficient repair work, inefficient because generally done under adverse conditions at the running sheds.

Mr. R. A. Warren (L. and Y. Rly., Liverpool): I should like to have heard something in the paper as to the system of supplying material to the outdoor department, and to have heard that there was a progressman to be appointed for that purpose. I think it is fairly obvious that while the aim in the works primarily is to get a good output, if material is wanted outside and inside at the same time, it is most likely that it will go to the inside. It does not appear to be a great gain to obtain a good output from the works if you are delaying engines at the sheds.

With reference to the improved condition of boilers, I think part of the credit should be allocated to the outside people. My experience is that the real improvement in the boilers first started with the supply of improved washing-out facilities, and later increased staff.

In the paper it is mentioned that no drawings should be altered without the co-operation of drawing office and outdoor department. If that is carried out a great saving would be made, because in some cases there is alteration in design which may make a big saving from the drawing office point of view, but which may be counterbalanced by extra work done outside. A good deal depends on the inspector who finally examines the engines, and whether he has the courage of his convictions or not. I should like to see that man independent of the works, directly under the C.M.E., and a man who has running experience so that he could be absolutely independent and uninfluenced by the inside con-

ditions, and also he should have power, if he saw work being done in the shops which was not satisfactory from an outside point of view, to draw attention to it.

With regard to the patching of cylinders, etc., I think the Author said that the outside department had no knowledge of these repairs. I think that is rather a mistake. My experience is that a good deal of trouble is given to those who have later to look after engines so repaired in the way of pegs working loose, etc.

Mr. J. R. Billington (L. and Y. Rly., Horwich): Some of the decrease in the number of broken stays can be put down to the fact that the boiler stock now includes a larger proportion of better designed boilers than in the previous period. In the past it has been the common practice to press a boiler up to a higher pressure than it was designed for, and under these conditions one cannot expect stays to live very long.

A previous speaker has referred to standardisation as being fossilisation, and I think this is a natural outcome, because as soon as one gets a thing sufficiently developed to make standard, and apparently perfect, it is generally put on one side for something new.

In regard to the subject of "customers," I quite agree with one or two of the other speakers, especially when it is taken for granted that the test room should act in a detective capacity on the works to ensure proper stuff being put into the engines; it follows that the "customer" should also be able to satisfy himself that the article is properly repaired, or constructed, and that it possesses the proper clearances, and so forth, and the organisation is wrong which does not admit of the "customer" being fully satisfied with the article he is getting.

Regarding the remarks about the drawing office, I agree that the altering of a small detail has far-reaching consequences, but not with the statement that the drawing office, acting in collusion with the outdoor department, are the worst offenders against standardisation, because the drawing office usually has enough to do without inventing work, or looking for it.

The relationship between the drawing office, the outdoor department, and the works is such as to ensure very little alteration taking place without the three departments being conversant with all facts, and being satisfied that the alterations are justifiable; this arrangement is about as perfect as one could expect to get.

It would be a good thing if the drawing office could have more information regarding failures so that design could be gradually improved; it is no good taking the failure of an isolated case; one must know the number of failures per engine per year, or per thousand miles.

The Author appears to have very great regard for "systems," but I do not care very much about them, and consider that the personnel, from the works manager downwards, is of far greater importance than any fancy system which works well on paper. The British workman does not care very much for such systems, and objects to being made into a machine, which was the tendency of "systems" carried out to an extreme. Also "systems" brought in their train a large number of non-producers. I quite agree that there must be some system, but that it should be very carefully devised and not carried out to any great elaboration.

Mr. W. Paterson (L. and Y. Rly., Horwich): The emphasis placed by the Author upon the necessity for a frank recognition of the exact relationship between the railway locomotive repair shop and its "customers"—the running department—is particularly agreeable to the latter. The general effect of the works' atmosphere in nearly every instance seems to be that the commercial instinct becomes atrophied and the "customer" suffers in consequence.

The policy outlined in the paper has, so far as the Lancashire and Yorkshire Railway is concerned, clarified the works' atmosphere and corrected the relationship referred to. The resultant benefit to the running department is quite distinct and visible; the almost complete standardisation of works products being of inestimable value because of the consequent simplification and acceleration of the repair work undertaken at the running sheds.

In regard to the phenomena mentioned in the last sentence of item 3, paragraph (g) (page 376), I must plead for the deletion of the generalisation and for the termination of the paragraph at the word "scrapped." I suggest that the real explanation of the phenomena referred to is not that we were unaware of the repair, but that in view of the special conditions prevalent during the past few years we were broad-minded enough to accept gladly and without comment even patched-up jobs in order to keep up to the daily requirements the number of engines available for traffic.

As showing the condition of the boilers, Fig. 6 should be regarded as eloquent, not only of the efficiency of the methods of boiler repairs in the works, but also of the expert

and unremitting care of those responsible for the boilers whilst in the hands of the running department. So excellent are the results of the systematic cleansing, examination and judicious repair of boilers at sheds that the incidence of boiler inspection by impartial examiners who report direct to the Chief Mechanical Engineer is welcomed, whereas twenty years ago it was more or less resented.

In regard to the assertion that the running department, in collusion with the drawing office, are the culprits most responsible for deviations from standards, we believe that the chastity of the drawing office has never been endangered by any ardency on the part of the running department. In fact, the latter welcomes and cherishes successful standardisation for precisely the same reasons as are advocated by the Author. Our only protests are against the standardisation and perpetuation of errors in design or material.

The value of this paper is enhanced by the fact that although it deals with the essentials to successful management of a very large works, the principles enunciated are such as if applied to other and less ambitious responsibilities must inevitably promote greater efficiency, and the Author has placed the members of the Institution under a great obligation to him by making available in the form the secrets of successful works' management.

The Chairman: Gentlemen,—As Chairman of this meeting, I hardly know whether I am more pleased with the paper or with the discussion which has arisen out of it. They have both been excellent. You have heard the drawing office point of view; you have heard the works point of view; and you have also heard the running department's point of view. Personally, I hardly know whether I am "flesh, fowl or good red herring," and will have to be guarded in my remarks. I had charge of a drawing office for a number of years, have worked in the running department, and now the works occupy my attention. The drawing office is an important department and should give very careful attention to the work that arises in connection with design. I found that great benefit was derived by having a casualty department, whose business it was to investigate the cause of the failure of any part of the engine in traffic. Any such failure was gone into thoroughly and carefully, and a report as to the cause was entered as briefly as possible in the drawing register in a space provided for that purpose. By this means, failures due to design were made clear, and the part was either altered or amended entirely. In regard to standardisation, this is beneficial up to a point, but any

tendency to carry it too far should be guarded against. The various details of a locomotive have to be made to suit the purpose for which they are required. One argument I have heard used against standardisation is that the Chinese carried it so far that as a nation their progressiveness ceased. I think it is clear that if one is to make progress it is essential to keep pace with the times, but I do not deprecate the use of standard parts so far as they are applicable, but a standard locomotive raises a problem that requires careful consideration.

There should be close co-ordination between the customers, the works and the drawing office, and the parts which are found to be giving consistent trouble should be immediately taken in hand and put right. The works department have to get the engines into traffic as quickly as possible, and sometimes, in order to prevent undue delay, they have to send out some part which, if they had the material, they would rather renew altogether. From the running superintendent's point of view, it would be better to renew every time, but I think Colonel O'Brien will agree with me when I say it is not always possible to systematically comply with this view. At times, engines come into the works one after the other each with the same part more or less defective, and judicious selection has to be made as to repair or renewal of the particular part.

There is one point on which I do not agree with Colonel O'Brien, and one of the speakers has commented upon it. He has said that the works should be so organised that any increase of shop space should not be necessary, and one of the reasons he gives is that the locomotive stock of the various railways has not materially increased in recent years. But my opinion is, as the engines being built to-day are considerably larger than those they displace, increased repair accommodation is required. For instance, on one railway since 1910 the renewal engines are over 7,000 tons heavier than the same number of engines displaced, and in length there is an increase of over 2,500 feet; this means increased yard, stripping and erecting shop accommodation. Again, the weight and length of the boilers have correspondingly increased, necessitating increased shop and storage accommodation for boiler repairs and renewals, and the same remarks are applicable to tenders. Surely, then, these engines and tenders cannot be repaired in the same space that was available for the engines which have been displaced. The larger engines also have heavier parts, and heavier machines and cranes are required to deal with them, all pointing to increased accommodation being necessary.

I agree with the policy of installing improved machinery with a view of turning out work more quickly and with increased economy, a policy all the more necessary to-day on account of the increased cost of labour and shorter working hours.

I quite agree with Mr. Attock that, after examination and repair of the parts, there should be a place provided to store them where they can be readily got at when required for re-erection of the repaired locomotive.

The Author speaks of having a stock of spare boilers; this again is a very excellent arrangement, because (and the Author will agree with me) the boiler not infrequently controls the time the engine is out of traffic. If, however, you are going to increase the number of your spare boilers, you must have room to store them where they can be easily got at, and with good means of transport. This, I venture to say, does not fit in very well with the argument advanced by Colonel O'Brien against increased shop accommodation. I think that one of the troubles on some of the railway shops to-day is that the room is so restricted.

The Author gives an organisation for a works classified into five groups; each ought to have the full support of all concerned.

A vote of thanks was passed to Colonel O'Brien for the reading of the paper at the last meeting, and I will now call upon him to answer the questions which have been raised by the various speakers to-night.

The Author: I do not agree that the number of repairs per annum carried out in the central repair shops of a railway should rest on a time basis. The frequency of repair is really determined mainly by the condition of the firebox and tubes; when this condition is such as to necessitate the engine coming to the works, repairs to other parts may or may not be necessary. No one can dissent from the principle of giving a thorough repair while the engine is stripped, but that is a very different matter from dealing with a part or parts obviously not requiring repairs; the principle of careful and specialised examination on stripping should therefore be adopted, and parts not requiring repair should never leave the erecting shop. The adoption of this principle, where it has not been carried out previously, will increase the output capacity of the shops; so will the introduction of high-speed tools, improvements in design and in material, and better organisation.

I should be loth to admit that it is permissible to turn

any engine out from general repairs with any part in a state unfit to run to the next general repair. If standardisation of parts has been effective, manufacture for stock should be practicable and there should be neither failure nor delay in supply. It is true that the weight and length of locomotive stock has increased, but that should hardly be a reason for additional capital expenditure on shops, unless such new shops can be proved to effect a substantial economy. The larger engines should be of improved design requiring less maintenance, not more, if the management are progressive and have learnt the lesson of experience, and improved methods and tools should enable the existing shop space to be utilised more efficiently. The number and weight of the L. and Y. locomotive stock have increased by 21.6 per cent. and 36 per cent. respectively in the last 20 years, the increase in the number of power-driven cranes and electric motors maintained is very large, and all repair work is carried out for 108-600 and 800 h.p. motor cars, two large electric generating stations and 8 substations, yet the shops are little more congested than in the year 1900.

Light repairs only constitute 8 per cent. of the repairs dealt with at Horwich; the remark that they are dealt with at once only indicated that these were not dealt with on the stripping pit. Goods engines which do pilot and shunting work do not run trial, but all main line goods and passenger engines are given a run with a light train on the regular passenger work of the branch line having its terminal at Horwich. Repairs after trial seldom necessitate the return of the engine to the erecting shop; if the very unusual case occurred of a defect necessitating a return to the shop the engine would be put on one of the light repair pits. The small adjustments usually necessary are carried out by the men of the pit which repaired the engine.

I am in agreement with Mr. Attock's remarks on the proper location and lay-out of the finished work stores, or rather, material in progress stores. I could not, however, under present conditions obtain the money for a building, so the best possible was done under present-day conditions.

Much credit for the improved condition of boilers is due to greater care in washing-out and other attention at the sheds; better design with wider water spaces has also contributed. The repaired engine inspector should be a running department man and responsible only to the head of the outdoor locomotive department; his being on the works manager's staff was incidental to the works inaugurating the system.

My reference to the offenders in making ill-advised changes in design was meant broadly and intended as a general suggestion for organisation purposes in any locomotive repair works. Careful study and statistical analysis, not only of all failures but of all cases of renewal for wear or breakage, is essential to progress. System is good and essential to smooth working, but like many other good things, must not be carried to excess.

Perfection is reached by a process of evolution, but continuous evolution is expensive and unnecessarily so, and is merely evidence of ignorance of the principles of design; in fact, continuous evolution is rule of thumb, whereas evolution by well-marked steps at well-chosen intervals is a quicker road to perfection and an inexpensive one.

I am not in favour of patching as a general rule, but in the case of the cylinders referred to, the policy was initiated very cautiously long before the war, and it was on finding that the patched cylinders were seldom referred to on the waybills that the system was extended.

I do not think welding has reached perfection; few welds are of higher value than 50 per cent. The electrical process is of most value on larger sections.