Railway Axle Lubrication

A PAPER

READ BEFORE THE

Leeds Association of Engineers,

BY

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RAILWAY AXLE LUBRICATION.

A paper read before the Leeds Association of Engineers, February 26th, 1909.

In a paper of this kind it is impossible, and I think altogether unnecessary, for it to include much information of a technical nature in regard to the theory of lubrication itself, as this is really too big a subject, but I have endeavoured to confine myself to the subject of lubrication of railway axles and to treat it on as broad a basis as possible.

Lubrication in the past has not been considered by any means a scientific matter, in fact it has been considered of minor importance. This, however, is not the case at the present day, chiefly because scientific research has raised it to a much higher plane, and it is now carefully dealt with by the chief engineers.

The efficient lubrication of axles is now one of the most difficult problems railway engineers have to solve. It is one which has led to considerable discussion and many methods have been tried, from the simple one of filling the boxes with grease to the elaborate system of forced lubrication by means of pumps.

After railways were firmly established, demands were made for an increase in speed, which were met by the building of larger and heavier engines, then by heavier carriages. This so accentuated the difficulties caused by hot bearings that it necessitated the engineers giving special attention to " keeping the trains running."

Though at the present day the demands for increase in speed are not so great, yet the weights of locomotives and rolling-stock steadily increase, and long-distance non-stop runs at high speed are becoming essential. These latter especially make the question of the proper lubrication of axles more difficult and cause it to require more attention than ever.

It is at so recent a date as 1883 that the first serious attempts appear to have been made to lessen the difficulties under which all engineers were labouring. They had just begun to realise, or at least the more progressive had, the tremendous amount of energy which was being wasted at their bearing surfaces, and at the instance of the Institute of Mechanical Engineers, Mr. Beauchamp Tower commenced a series of experiments to which I intend making several references in the course of this paper.

Even so recently as 1905 Professor Charnock said, at a lecture given before the Bradford Engineering Society :—" It is truly remarkable that of the many details in connection with machinery, none receive less attention than the reduction of friction, and the proper lubrication of bearings."

With regard to the proper lubrication of railway axles the objects now aimed at are :—

FIRST.—An entire freedom from hot boxes, which necessitate the stopping of trains to take out the affected carriages or wagons, thereby causing delays in the train service as well as the expense of having the bearings re-fitted, and often the journals re-turned where they have been cut through seizing.

SECOND.—To reduce to the smallest possible limits the frictional resistance in starting and running and the wear and tear of brasses and journals, thus effecting a great saving in motive power ; and I may add, as a

THIRD object.—To reduce the general lubricating charges.

Mr. Beauchamp Tower, in the discussion of his second report (which he gave in 1885, on the results of his experiments), said it seemed to him the most practical inference was, that it should be actually possible to so lubricate a bearing, that not only would metallic friction be altogether done away with, and thereby the amount of power lost by friction reduced, but metallic wear and tear would also be abolished. He would not say that that result was actually possible under the circumstances then existing, but it was a reasonable

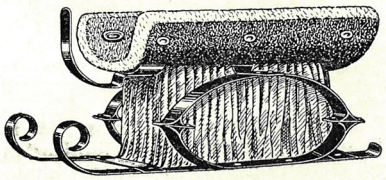
one to aim at in mechanism. By giving a profuse lubrication, and by having the brasses so arranged that there would be a uniform pressure all over the surface, it was possible to have the wear and tear between the metal and oil, instead of between metal and metal.

Although this ideal has not yet been reached in ordinary working, I know of many cases where the wear of metals is so minute as to be scarcely noticeable, but it is very patent that to add to the lives of journals and bearings, we must adopt the most perfect system of lubrication, and use specially prepared blends of oil.

Of past practice I need say but little. Grease, applied in almost the same way as at present on wagons was universal for all classes of axle-boxes, and as I purpose dealing with grease lubrication later on, I need not say anything about this system here.

Oil lubrication was first used on locomotives and was applied by means of lamp cotton, placed in holes through the bearings, which syphoned the oil down from the reservoir. This system did not give entire satisfaction and an old driver informs me that it was his custom, also the custom of other drivers, to place greasy waste in the keeps, or cellars.

This led Mr. Edward Fletcher, when Locomotive Superintendent of the North-Eastern Railway, to send out all his engines with the tender axle-boxes, and leading engine bearing keeps, packed with waste. This is the custom on many railways to-day, although the North-Eastern, with many other lines, now use pads, which have proved much more satisfactory.



Type of Lubricator (The "Armstrong Oiler") used on many railways for locomotive axle-boxes.

I do not know of any railway where grease applied from above is used on locomotives, but I understand that there are still a few carriages in which grease is used.

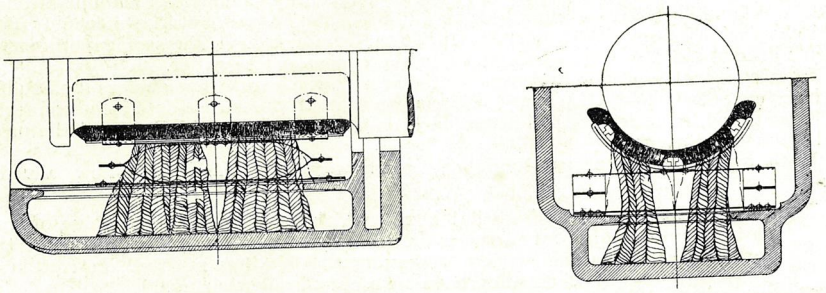
The systems of lubricating railway journals at present are :—

(1) Oil lubrication, which, with very few exceptions, is generally used for all locomotive axles; also for carriages and fast goods stock.

(2) Grease. In a very few instances for locomotives (specially applied) and fast goods stock, but generally for ordinary goods wagons and other vehicles forming slow-moving goods traffic.

OIL LUBICATION.

It is not necessary for me to describe in detail the axle-boxes and bearings, it is sufficient to say that the load is on the top of the axles, and with the exception of some locomotive bearings, the boxes are on the outside of the wheel. Many of the locomotives have boxes made of bronze, with cast-iron cellars (or keeps) and white metal filled bearings. It is the general practice to slightly champfer away the sides of the bearings so as to give the oil free access to the crown. The portion cut away varies for many reasons, the



Type of Axle-box in use on many railways for carriage stock, showing Lubricator ("Armstrong Oiler") in position.

principal one being the amount of laternal pressure. With blocks at either side of the wheel this is very slight, and the "Arc of contact" may be made short.

Where the supply of oil on bearings is obtained entirely from below, as in tenders, carriages and wagons, it is advisable, in order to secure a good feed of oil, to have the sides of the bearings well champfered away, leaving just sufficient bearing to carry the weight.

For locomotives the usual custom is for oil to be supplied to the driving and trailing journals by means of syphons fixed above the bearings. Some engineers think this is sufficient, but the majority supplement it by having a pad with feeders placed in the keeps, or have them filled with waste or other form of packing.

Messrs. Archbutt & Deeley, in their book " Lubrication and Lubricants," state that the method of cutting oil ways along the centre of the bearings and making them a good fit at the sides, is considered to be the best practice for locomotive driving wheels, but not for other bearings, the reason being that the driving axle has to carry the thrust of the piston as well as the vertical load.

They admit, however, that the cutting of oil ways or grooves prevents the pressure film from forming and causes the crown of the bearing to wear more rapidly than it otherwise would, although this is not entirely detrimental, as to some extent it tends to prevent the thrust of the connecting-rod from developing side play.

My own opinion is, that with an efficient system of lubrication from below no oil holes are absolutely necessary in the brasses, although, of course, owing to the difficulty of access to the keeps of locomotives they are to a certain extent a safeguard.

It is still the general practice for holes to be drilled and grooves cut out in locomotive bearings, but this is very rarely done in other cases.

Mr. Tower condemned the practice after making various experiments, as he found that when he applied the oil through the brass, which had grooves cut in the centre of the crown, it could not get through to the axle ; in fact it was a most effectual means of collecting and removing all oil from the journal.

With the system of oil holes and grooves, better results than Mr. Tower could arrive at are to be obtained in actual practice, owing to the vibration and side play of the axle-box, and also to the imperfect fit of brasses, which allow the oil to escape through the grooves and on to the journal.

Mr. Tower's argument was proved in practice on a locomotive running out of Leeds only last year, it being necessary to pipe back the oil to the cellar from the top of the oil holes in the bearing.

With a perfect-fitting brass, so that the oil cannot escape from the groove on to the journal, heating soon occurs and considerable trouble is caused. Dirt, dust, and ashes also enter these holes and work down between the journal and brass, and the natural result is a hot box in spite of any amount of lubrication. In addition to this when washing out the boilers, particularly when they rest on the top of the frame as is now common here as well as in America, the dirt, or scale, is washed through the holes on to the journals, which, in addition to the water getting in, causes considerable difficulty. The remedy, however, is clear, and it is to have oil cups, with lids, fixed on the top of these holes.

I have just mentioned that Mr. Tower found the system of oil holes and a groove in the crown of the journal unsatisfactory. After finding this out he experimented with an oil hole at each side of the bearing, with a groove from each running parallel to the journal. Whilst with the hole in the centre and one groove, he could not get the bearing to run cool when the load exceeded 100 lbs. per square inch, with the two holes and grooves at the sides of the bearing it did not seize until the load had reached 380 lbs. per square inch.

The axle-boxes of tenders and fast coaching stock are similar in design, having a dust-guard at the back, an oil well, and an oil-tight lid at the front, so that the interior of the box can be easily examined at any time.

The lubricant is oil, which is conveyed to the journal from the well of the axle-box by either a lubricator (consisting of a pad on a spring frame, with wicks or feeders carrying oil to the pad, which is kept pressed against the journal), or packing composed of waste (either pure cotton or a mixture of cotton and wool). In many cases horsehair, or steel wire, is mixed with the waste in order to keep it more elastic ; whilst in some instances, more especially on certain Irish lines, the lubricant is conveyed to the journal by means of packing made of cloth clippings. Crushed cotton seed is also used to some extent, and occasionally ' forced lubrication ' by means of pumps is adopted.

Bronze bearings are possibly in the majority for coaching and goods stock, but white metal filled bearings are generally fitted, as their use make it possible for mineral lubricants (deficient in oiliness) to be used in the place of the more costly vegetable oils, and perhaps more especially because of its lesser co-efficient of friction, its adaptability of conforming to the surface of the journal, together with the ease with which it can be scraped up to a good surface. For white metal to be really efficacious it must be beyond reproach, for it must not scale or flake, and it must be sufficiently hard to withstand the load and not press or squeeze out ; hence a large percentage of tin is necessary for the best work.

It was about 1884 that white metals were first used for high speed railway vehicles, on the Eastern Railway of France (Chemin d'Fer l'Est), where the number of hot boxes was considerably reduced.

Only in odd cases have bearings for fast stock oil holes through them ; the whole of the lubrication being applied from below.

The principal method is by means of a pad fixed to an iron or steel frame, with a pring to keep it pressed against the journal. The types of frame in use are innumerable,

some are good, but many are crude. Speaking generally, very little attention has been given to details ; the materials have been selected and put together in an haphazard sort of manner. In cases where wicks have been intended to convey the oil to the pad they have been sewn on with cotton, the result being that although the wicks took the oil to the bottom of the pad, it could not continue its way, as the cotton threads with which they were sewn together stopped the circulation. Consequently, it has frequently been necessary to pour oil on the top of the pad.

Again, no thought appears to have been given in the past to the selection of a suitably adjusted spring, those in ordinary use being too strong and lacking in resilience. It naturally follows that the pad being pressed hard against the journal, the pile is flattened, very quickly becoming hard and polished, making it necessary for the pad to be taken out and brushed up. In fact it has been the custom with this class of pad to take them out once a week and scrape them, pouring oil on the top, and re-inserting them for another week's running. With an efficient lubricator this is entirely unnecessary.

There have been many kinds of pads in use, the pile of some not being cut, but left in loops. This alone would prevent sufficient oil getting to the journal, even supposing that the oil had been conducted by a properly arranged system of feeders. Others have hard backs, woven so tightly that the oil cannot penetrate, whilst generally the pile is so long, and woven so loosely, that it lies down and presents its side to the journal instead of the ends, the result very soon being a hard, glazed surface.

The next popular system of lubrication for journals of fast stock is by packing the boxes with one of the various kinds of waste already mentioned. The whole system of packing boxes is really not a success ; it never has been and never can be for many reasons, even though when specially attended to it may have given fairly good results as regards keeping the journal cool, it is for a limited time only.

It may be thought a very simple matter, given an axle-box and a definite mixture of packing, to keep this up to the journal with a greasy surface to the top, and it would be considered a task which could be given to any unskilled labourer. This, however, is by no means the case. And it is very seldom that any two men who have spent years packing boxes, can be found to agree as to the best means of doing it. In the first place, to obtain anything like good results, it is often necessary that the packing should be stirred up before every run, and every hundred miles or so on long runs. This is done whilst the engines are being changed, and when necessary the boxes re-oiled. With so many men at different places working at the same box, and the many different theories as to how the packing should be done, it can be easily seen how impossible it is to get uniformity of packing—hence hot boxes. It is also easily seen how difficult it is, with waste packing, to run the long distance non-stop runs without the fear that the journals are not getting properly lubricated.

A great deal of trouble is caused by the difference in opinion as to the amount of packing which should be placed in the boxes, and undoubtedly a large amount of material is wasted. Some examiners fill the boxes as tightly as possible, with the result that the waste very soon glazes, whilst others, being aware of this evil and endeavouring to avoid it, pack it so loosely that it is forced by the movement of the journal against the lid, or front of the axle-box, leaving the inner fillet or shoulder of the journal bare. Even though packed, as it might be thought, just right for avoiding either of the two evils mentioned, as soon as a vehicle is run on a line with many curves, the same difficulty arises. After a very short run axle-boxes are found with the waste wedged up at the front of the box, leaving the inner fillet bare. **It is at the fillets** that the greater part of the thrust occurs when travelling on curves, and consequently this is where the most lubrication is required.

A further difficulty and danger with regard to waste packing was described by Mr. H. Kelway Bamber, M.V.O., when he was Carriage and Wagon Superintendent of the East Indian Railway. He wrote in *Engineering*, towards the end of 1906, under the heading " Axle-bearings for Heavy Tonnage Wagons, Indian Railways " :—

" At speeds greater than 300 ft. per minute, cotton waste packing, until recently the almost universal oil conveying material used in the axle-boxes of Indian rolling-stock, is drawn by friction from the bottom of the box and compressed so tightly between the journal and the box side as to at once retard lubrication, and frequently, on a change in the direction of journal rotation, to arrest it altogether."

" The tendency is to reduce the dead weight of goods stock by use of wheels 3 ft. 1 in. diameter " (I might just mention here that this is the standard for English railroad wagons), " and the following statement shows that for such wheels, with 5 in. diameter journals, cotton waste is liable to give trouble at train speeds as low as 25 miles per hour."

" With a diameter of 3 ft. 1 in. at a speed of

20	miles per hour	journal	speed	is	237 ft.	per minute.
30	,,	,,	,,	,,	356 ft.	,,
40	,,	,,	,,	,,	475 ft.	,,
50	,,	,,	,,	,,	594 ft.	,,
60	,,	,,	,,	,,	712 ft.	,,

From this table you will see that with the standard English wheel and a 5 in. diameter journal, at a speed of about 25 miles per hour, the danger described by Mr. Bamber begins,

whilst it also commences at a little under 30 miles per hour with a 4½ in. journal, so that it affects in actual working all fast goods stock.

In America woollen waste is generally used, which is packed up to the centre of the axle. At the end of each section where the engines are changed, and at all termini, every box is examined, and hot boxes are chalked for further inspection and attention. I may say that the amount of chalk used is considerable.

Where horse hair or steel wire has been mixed with waste, by continual attention, and the consumption of large quantities of oil, fair results have been obtained so far as cool running is concerned. The object of using horse hair or wire is to keep the packing elastic and to prevent it becoming a sodden mass. After this class of packing has been in service a certain length of time, however, especially on rough roads, the wire or horse hair has a tendency to work up through the waste and occasionally gets between the axle and brass; also the horse hair works up into lumps. In the states I had considerable experience with steel packing, and I can only recommend it to those who are seeking trouble.

Whilst I hope that I am a patriotic American, I must confess that in the matter of lubrication of axles the United States is not nearly so far advanced as England. First cost may possibly be the reason. The lubrication in the States is controlled by the Galena Oil Company, who contract on the mileage, the average cost of oil for cars of eight wheels being about ninepence per thousand miles.

There are roads in England where the lubrication is being done for less than one penny per thousand miles for the same number of wheels, and I have known it done for less than one halfpenny.

There have been further systems of packing, none of which, however, have given satisfaction. Worsted balls have been tried, five or six being placed in the boxes, which were filled with oil, and the examiner had just to stir them up so that those which had been at the bottom came up against the journal. Packing with cloth clippings, in place of waste, has been tried, and I was very much surprised last year whilst on a visit to Ireland to find this system still in use on some of the railways there, but I do not think it will be long before it is obsolete in that country as well as in England. Cotton seed I think the most unsatisfactory of all packings; I have seen tender axles burnt off where this has been depended upon—and this on an English railway.

No matter how good the quality of the packing may be, or how well the box may be packed, it is impossible to give the axle sufficient lubrication by this method. Loose waste will not hold sufficient oil up to the axle; and though, if packed tightly, some oil will reach the journal, it will be insufficient.

If the waste is so saturated on first being used that it is a semi-liquid mass, a satisfactory result is obtained for a time, but soon the oil runs out of the box back and the waste is either whirled behind the collar of the journal or jammed between the journal and the side of the box. Loose packing is not good from any point of view, except, perhaps, its adaptability to any shape of axle-box.

There are, however, a large number of engineers who still believe in waste packing. Some engineers who use it have told me that they only found it necessary to oil their axle-boxes once in about six months, and some have said once a year was sufficient. One man told me (and a very serious man, too) that he never oiled the boxes at all, and he so aroused my curiousity that I felt I must go and see the thing for myself, with this result: I found every day for a week a man pouring oil into the boxes of the same coaches. They used closed boxes on that road, and he poured it in through a hole at the front. As he could not see inside, I asked him how he knew when he had got sufficient oil in. He pointed to the wheel and said: "You can see it running out when it's full."

The engineer of that road did not use *in theory*, but his running staff certainly did *in practice*.

Of forced lubrication I need not say anything, as, with the exception of one or two very rare instances, it is not used, except on bearings which have to carry very heavy weights.

We will now turn to our last familiar method of lubricating axles, that which is in use generally on rolling-stock travelling at slow speeds, and in a few instances on locomotive driving wheels.

GREASE.—In describing oil lubrication for fast speeds I have not considered it necessary to say anything on the theory of lubrication, or to explain how the oil film gradually thickens as the journal revolves more rapidly as the train gathers speed. It has been proved that at very slow speeds, with greased journals, the frictional resistance is much less, as the thickness of the oil is not sufficient to overcome the irregularities of the bearing surfaces until the train is well under way. It is without doubt, that provided a journal has been properly greased, or running with grease as a lubricant (owing to the fact that a good grease cannot all be squeezed out between the journal and the bearing), the static, or starting friction is considerably less than with oil, though after a speed of about five miles per hour the frictional resistance is greater.

According to Messrs. Archbutt & Deeley, for very low speeds and the starting of trains, grease has an advantage over oil lubrication, but what about actual practice?

The journal of a wagon, after standing a day or two, has very little grease left on it, certainly not sufficient to lubricate it to any great extent. The grease is supplied

only through two holes in the top of the bearing, and before it will melt sufficiently to flow on to the journal must need a temperature of from 100 to 120 degrees Fahr. From this it is seen that to keep a journal cool you must first get it hot, for the whole of the bearing and the grease tray have to be heated through to a temperature of about 120 degrees before the grease melts sufficiently to flow to the journal. The heat at the journal itself must be by this time considerable, in fact nearly at seizing point, as owing to moving through the air the heat generated is soon dissipated and the top of the box is kept comparatively cool.

When the grease melts, however, very often the journal is so hot that its power as a lubricant is gone and it commences to burn ; in any case it leaks out of the box on to the ballast.

Experience teaches me that though the theory of grease lubrication, for slow-moving goods stock, is the best, in practical working this is not the case. I believe that it is not generally known to the rolling-stock superintendents that it is almost customary in the yards to make a hole through the grease to the journal and fill it with oil.

The cost for maintenance of bearings and journals where grease is used is far in excess of what it should be, owing to the lack of a satisfactory means of applying the lubricant.

I have mentioned that in rare instances grease has been used on locomotives. There is in use on some locomotives in America an expensive system, which really cannot be considered satisfactory. A cake of hard grease is pressed against the axle by springs in the bottom of the keeps, a perforated plate of lead being used between the axle and cake of grease. Though the results were satisfactory as regards hot bearings and cut journals, the frictional losses per axle were from 75 to 100 per cent. greater than with oil.

LUBRICANTS.—With regard to the lubricants themselves, it is impossible for me to say exactly what class of oil should be used, as this depends so greatly on the class of work to be done, and also on the bearings. A paper could be written on this subject alone.

There is by no means sufficient care taken on many railroads in the choice of oil, though often considerable expense is gone to in seeing that the oil supplied is to specification. I understand that it is possible to exactly match oils on the basis of chemical tests with an improperly manufactured article. The proper way of testing oil is in actual working.

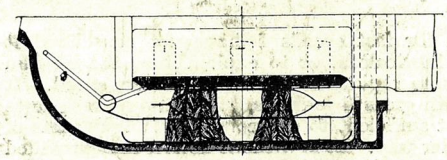
I have already mentioned that with white metal filled bearings the cheaper mineral oils can be used instead of the more expensive mixed oils which are necessary with the ordinary bronze bearings. They are, however, not used " pure," but are in reality blended or mixed oils, and although at one time the mineral oils were regarded with distrust by engineers and their chemists, when mixed with other lubricants, they are in many ways much superior to the best fixed oils. It is now the general view that the best lubricating oils are obtained by the careful blending of animal and vegetable oils, fat, or waxes, with mineral oils.

So far as grease is concerned, it should be of good quality, care being taken that it contains no china clay, as this gives considerable trouble owing to it being a very poor lubricant and also to its accumulating in the boxes. A good wagon grease should melt at from 100 to 110 degrees Fahr.

On some railways it is customary to slightly change the ingredients of both grease and oil for summer and winter use.

THE BEST SYSTEM.—In conclusion I will now describe to you what I consider to be the most effectual and practical way of lubricating railway journals at the present time. It is really impossible to have a perfect system of oil bath, and experience has taught me it is not necessary.

In the first place we will assume that we have a well-fitted axle-box and lubricating oil to suit the bearing. A good oiler is now required, the frame of which should be properly constructed and made to fit the box. The pad should be made to fit the journal and to convey oil to the whole length of it, including the fillet of the shoulder and collar, and the material used in the pad should also be such that the feeders have sufficient " capillary attraction " to fill the pad itself with oil, whilst the latter is able to hold the oil thus carried.



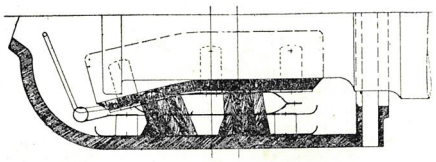
Lubricator (" Armstrong Oiler ") in position.

The feeders should be woven through the pad beneath the pile, the points of which should touch the journal and thus carry oil to the whole of it.

All the material used in the manufacture should be specially selected, and exactly of the right mixture to give the best capillary results.

To overcome the movement of the journal, the spring frame should be flexible enough to allow the pad to keep its position, and at the same time the springs should be strong enough to hold the pad up to the journal when filled with oil. It is necessary that it

should be made of light, resilient, spring steel, so that it can be easily taken in and out of almost any axle-box.



Lubricator ("Armstrong Oiler") in process of insertion in axle-box.

The strength of the springs should be adjusted so that the pressure of the pad is not too great, which would cause it to become polished and glazed, thus preventing oil from reaching the journal. To take up any undue pressure, buttons or washers are desirable; their use entirely prevent glazing.

Given an oiler such as I have described, the work of lubricating and examining axle-boxes is reduced to a minimum, and the amount of oil used becomes surprisingly small. When used in a good axle-box, which will not allow oil to be washed out through the back or front of the box, the consumption of oil is less than one pint per vehicle of eight wheels per thousand miles. The oil, in addition to being suitable for the bearing, should be free from any tarry substance and from any composition which would clog up the feeders, and care should be taken to see that the pads are kept free from moisture.

Train sets, after the trial run should, when sent into traffic, have the boxes filled with oil to a depth of half-an-inch. A further examination should be made after the vehicles have run for a fortnight, and where the oil has been absorbed by the pad, the boxes should be filled again (without removing the oiler) to a depth of one half-inch.

After this it should not be necessary to touch the boxes for periods of from ten to fourteen weeks.

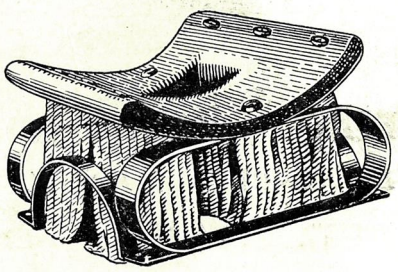
A register should be kept at each examining station showing the date train sets or vehicles are oiled and the amount of oil used. Though this is an easy matter with locomotives and with carriage stock having regular runs, regular oilings are impossible with goods stock, but this difficulty is very easily overcome by having a fixed date, say once every two months, when all goods stock at the big centres should be examined and oiled. As goods vehicles can easily run five or even six months without re-oiling, there is no danger of hot boxes through lack of oil, owing to the wagons being at outside stations at the oiling dates.

Except when absolutely necessary, the oiler should not be removed from the boxes, and when this has to be done, care should be taken that they are kept free from grit and dust.

It will be seen that a properly constructed oiler possesses many advantages over other systems of lubrication, and therefore *is the best system* for lubricating axle journals. It requires very little attention and considerably reduces the expenses in labour. The initial cost is little more than waste and very few renewals are required. A pad such as I have described will give a quarter of a million miles of service, it only being necessary to thoroughly rinse it in oil when the vehicles are in the shops for repairs. It adjusts itself on curves, and at all times ensures one-third of the journal being continuously in what is practically an "oil bath." There is no waste of oil, as when the oil is carried through the bearing it is brought back to the off side of the pad.

Finally, I might say it gives the three results which I mentioned at the commencement of my paper, were now aimed at by all railway engineers :—

(1) An entire freedom from hot boxes caused through insufficient lubrication.
(2) The smallest possible frictional resistance in starting and running, and also the minimum of wear and tear, as the journals are always kept in perfect condition, and—
(3) The lowest possible lubricating charges.



Lubricator (Armstrong Oiler") designed for use in locomotive axle-box when spring suspension link pin passes through axle-box.

THE "ARMSTRONG OILER"

(*Patented in all countries*)

Embodies all the qualifications necessary to make a PERFECT LUBRICATOR.

It is EFFICIENT AND ECONOMICAL and is pronounced by experts the BEST LUBRICATOR for railway and tramway journals on the Market.

ITS USE ENSURES :—

(1) An entire absence of hot boxes caused by insufficient lubrication.

(2) Economy in oil ; in many cases a saving of over 90 per cent. has been made by its use.

(3) A saving of over 60 per cent. in the time and labour usually devoted to examination and re-oiling.

(4) A considerable increase in the lives of journals and bearings owing to continuous perfect lubrication.

(5) The MINIMUM of FRICTION owing to the perfect condition of bearings resulting from perfect lubrication.

The life of the "Armstrong Oiler" is many times more than that of other lubricators. Oilers have run for over a quarter of a million miles, and on careful examination show practically no signs of wear.

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