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A COMPENDIUM

ON

RAILWAY CAR BEARINGS,

BY

R. MACKENZIE, C. E.,

CANADA,

1880.

MONTREAL, MAY 1st, 1880.

To Railway Companies and their Managers:

The very difficult and perplexed question of Locomotive and Car Bearings has now been satisfactorily overcome, and the experiments and testimonials contained in this pamphlet will set at rest any doubt as to the superiority of the STAR METAL over every other BEARING—and a perusal of it will well reward the reader for his time thus spent.

The following are a few of the advantages of the STAR METAL, viz:—

Star Metal will outwear Brass or Babbitt Composition.

Star Metal will not wear the Journal as much as Brass.

Star Metal will not heat so readily as Brass.

Star Metal will not cut the Journal when hot, as Brass often does.

R. MACKENZIE,
59 *St. Sulpice Street.*

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FACTS ABOUT FRICTION.

The resistance called friction, and the best means of reducing it in machinery, constitute one of the most important—though, by no means, the best understood—subjects of practical mechanics. What we know concerning it is due entirely to experiment, and some of the results are what might not have been expected prior to experiment. As it is impossible to render two surfaces perfectly smooth and hard if they are pressed together, the slight and insensible elevations of the one will interlock with the corresponding depressions of the other, and to produce motion between them, these slight asperities, must be abraded, or the surfaces themselves must be partly or wholly separated, resulting, in either case, in a loss of power. While on the one hand, friction is a constant and important element as a source of waste in motive power, it is, on the other hand, an indispensible condition, not only to mechanical motion, but to the stability of all structures, and to human existence itself. Its reduction to the lowest possible point in one case, and its retention to the highest possible degree in another, constitute one of the most perplexing problems in mechanics.

SLIDING AND ROLLING FRICTION.

Friction has been, usually, defined to be of two kinds, sliding and rolling; the first being that resistance, which occurs when two surfaces, either plane or curved, slide upon each other; the second, resistance when a body with a curved surface is made to revolve upon another, either curved or plane. It is difficult, however, to conceive that there is more than one kind of friction, and that what is called rolling friction is anything but sliding friction not overcome by power, and as the successive points of the surface of the rolling body come in contact with the surface over which it is rolled, constituting fulcrums, by which, on the principle of the lever, the rolling body is continually lifted against gravity and pried over the inequalities of the surface. Thus, the driving-wheel of a locomotive may be considered as an infinite number of levers, of which the fulcrums are the successive resistances of friction between the points of contact of the wheel and rail, and the weight to be overcome, the sum of the sliding frictions between the journals and their bearings. When the friction at the circumference of the wheel exceeds the friction at the axles, the power of steam being sufficiently great, the train will move forward; otherwise the driving-wheels will revolve, and the train will not advance, the so-called rolling friction being, in this instance, only sliding friction overcome by power. When, therefore, sliding friction is changed into so-called rolling friction, the advantage gained is partly in the application of the power through a lever. It will be observed that when the surface of the wheel meets with an obstruction or a grade, gravity acts against the sliding friction of the rail, and that an obstruction is more easily surmounted when the radius of the wheel is the longer. It is obvious that the longer the long arm of the lever, the more easily the centre of gravity of the wheel is lifted over the obstruction.

LEADING PRINCIPLES.

The most essential facts which experiment has shown concerning resistance, some of which, as before stated, would, hardly, have been expected prior to experiment, are, that it bears to the pressure upon the surfaces, in contact, a ratio which is constant for the same materials and condition of surfaces, and that while the character and condition of the surfaces are unchanged, friction is independent of the extent of those surfaces. The second of these facts may be illustrated in the following manner: A block of wood or iron of any given weight, having faces of different dimensions, will require the same power to move it upon a surface of the same kind, whether the block rests upon its larger or smaller face; the apparent exception in the case where one of the surfaces is being very much reduced, as a skate or an edged tool, having reference, in reality, to the effect of abrasion, or to the manner of application of the power, and not to the actual friction between the surfaces. If the ice were, everywhere, equally smooth, it would require the same power to push a man standing erect upon skates, whether the skate blades were 1-16th of an inch or six inches in thickness. But the first of these laws, that friction varies directly as the pressure upon the surfaces in contact, and is the same for the same materials and condition of surfaces, is of the greatest interest, and of the greatest practical importance in mechanics, relating as it does, to the anti-frictional value of various substances, the strength of materials between which friction may take place, and the various expedients, the use of lubricants and alloys, by which friction may be lessened.

It is found by experiment that if a block of wood or iron be moved upon a surface of the same material and degree of smoothness, by a force acting parallel with the surfaces in contact, the force, necessary to overcome the friction of the surfaces, will always be a certain fraction of the weight or other pressure which forces the surfaces together; that this power must be increased or diminished with the increase or diminution of the pressure, and that it varies in like manner with the roughness or smoothness of the surfaces, and with the nature of the materials composing them, but, otherwise, remains constant. This necessary power, which is called the co-efficient of friction, to overcome the friction between different surfaces has not been determined with great exactness, owing to the difficulty of obtaining any fixed standard of smoothness. The co-efficient of friction of iron upon iron has been estimated at about .28 of the vertical pressure; that of iron upon brass, well polished, about .116; when not so smooth about .263; iron upon copper about .17. With the friction of metals upon each other as a general rule with lubrication, the co-efficient of friction is estimated at about one-tenth of the vertical pressure. While experiment thus shows that friction is less between substances of different kinds—steel upon steel being the only exception—it is also by no means a matter of indifference which way motion is applied in those of a fibrous nature, less friction being observed to take place where motion occurs accross than when parallel to the fibres. The power that is lost in overcoming friction, it is well known, re-appears in the form of heat, which, increasing with the increase of friction, becomes not only a test of the value of lubricants, but also of the anti-frictional value of the materials in contact, and, when excessive, is exceedingly prejudicial in destroying bearings, and in firing neighboring combustibles. It is not the intention of the writer to enlarge upon the evils that have resulted from imperfect bearings, and travellers have experienced the sickening sensation caused by the smell of burning oil, arising from hot boxes, and been subjected to detention and, consequently, danger by the train being stopped between stations. Many, no doubt, have witnessed the futile attempts to remove a ruined bearing with feelings anything but agreeable. Aside from considerations of safety, which, sometimes, it might appear is not the paramount duty or object with railway companies, the destruction of journals, and, indirectly, sometimes of the train itself, are, frequently, the result of imperfect bearings.

AXLE FRICTION.

Of the various kinds of friction, I will treat on axle friction as bearing on the subject of this pamphlet, which, in railway locomotion, it is found an element of the greatest consequence to overcome. The great force with which the bearing and journal are pressed together must result in great frictional resistance and consequent waste of power; and, as in transferring the sliding friction between the rim and the rail to the sliding friction of the journal and bearing, the first named friction may be considered a power on the long arm of a lever, whose radius is the length of the wheel, and the sliding friction of the axle may be considered a weight on the short arm, whose length is the radius of the journal; it follows, that the smaller the diameter of the journal, consistent with strength, the greater mechanical advantage of the lever will be obtained. The limited surfaces, therefore, of the journal and bearing, between which friction is constantly taking place,—whilst not rendering from this cause the friction any less,—necessarily have the tendency to abrasion of the surface, and the retention and concentration of the heat, developed upon a small surface, materially, aid in the destruction of both journal and bearing.

DISCOVERY OF STAR METAL.

In the course of a series of experiments with zinc or spelter, made some years ago, it was discovered that the use of certain chemicals had a peculiar effect in changing the nature of the metal, and from this *fortunate* circumstance the celebrated Star metal bearing was constructed and given to the world. The new project, however, like all new undertakings, met with many discouraging obstacles, and the attempts, by analysis, to discover the new alloys, have retarded its universal adoption. On a prominent road in the Dominion, after repeated failures to arrive at the ingredients, another article was substituted and used for some time, till at length, owing to constant delays to trains, it was abandoned.

BRASS BEARINGS.

Prior to the invention of Star metal, the bearing most commonly in use was made of solid brass. The friction of an iron axle in a box of brass, well lubricated, was estimated at 1.40 of the total pressure with which the surfaces were brought together. With moderate pressure, low velocities and perfect lubrication, this alloy did very well for a bearing. The composition of brass, as, commonly, used for this purpose, is nine parts of copper and one of tin. Now, although copper has no marked chemical affinity for iron, combining with it chemically only in small quantities, it is, however, well known that there is a strong attraction between the two when brought together under certain conditions—an attraction which does not exist between many metals under similar circumstances. If a clean wrought iron nail be dipped into, and then withdrawn from, a dish of melted spelter or zinc, it will come out clean and without any particles of zinc adhering. If the same nail be dipped into a mass of melted copper, the copper on the other hand will, to a certain extent, adhere with great tenacity, and the nail will be to this extent coated with copper, and the same is true, to a greater extent, of tin. The same phenomenon takes place when a brass bearing becomes heated; the oil having been decomposed, the bearing becomes heated, and owing to the peculiar nature of the compound, the tendency of its elements to adhere to iron, what is known in railway parlance as "cutting," takes place between the bearing and journal, and the brass is sometimes found embedded in the latter to the depth of one-eighth—frequently of one-fourth of an inch, thus often resulting in the entire destruction of the journal.

It should be remembered that experiments have shewn, especially those of Coulomb & Renne, that not only is friction greater between surfaces of the same kind than between those of a different kind, but in the latter case friction is greater between surfaces that are fibrous than those that are crystalline and granular; brass and wrought iron are both malleable, ductile and fibrous, and for the purposes of friction may be considered as fibrous substances of the same kind, with the additional disadvantage of attraction between the particles of heated copper and tin, and the surface of the iron; take, as an illustration, a railway car brake and the iron shoes, which are far more effective than wood in bringing the train to a stop.

BABBITT METALS.

Sometime about the year 1844 a new material for bearings was given to the world, by the invention of Mr. Isaac Babbitt, of Boston. This was a soft alloy, composed of copper, tin, and regulus of antimony—not strictly speaking an invention, but the application to anti-frictional purposes of an alloy not before unknown. While it was an excellent bearing for light machinery, and possessed for railway purposes the advantages of great convenience of application and quickness of adapting itself to the journal as it was soft, and not liable to so quickly heat during the first few miles of running; on the other hand, it possessed disadvantages which rendered it unfit and too expensive for railway bearings. Its softness made it liable to receive dirt and grit, which, becoming imbedded in the material, wore out the Journals with astonishing rapidity, so that in the United States, where it had obtained considerable use, it became a common remark among Railway men: "We cannot afford to use Babbitt metal bearings—they wear our Journals so fast." Another great disadvantage was the low degree of fusibility of Babbitt metal—not much higher than that of lead—and, consequently, the frequent destruction of the bearing by melting, when, from absence of oil, higher velocity than usual or other causes, the friction was greater than ordinarily. Still another objection was the attraction existing between heated copper or tin, and iron, already mentioned in connection with brass bearings; when the Babbitt metal became melted, the tin, in its composition, would adhere to the journal and become imbedded therein, cutting it and rendering it unfit for further use.

This alloy, has, now, almost been abandoned for railway bearings.

SOFT METALS.

There are some railway companies in the United States and other countries who, a few years ago, used bearings composed of different combinations of lead, tin and antimony, which, although cheaper in cost, are very much inferior in quality to the Babbitt composition, possessing all its disadvantages in a higher degree.

With but few exceptions, wherever such alloys have been, or are being used, it is with admitted dissatisfaction.

The high fusible point of Star metal is not one of its least important qualities. In this respect it does not differ much from brass, but it is much higher than that of Babbitt or soft metals. In separating the Star metal from the brass envelope, by melting the former in the furnace, great care has to be taken or the brass will melt also. But while not differing much from brass as to the point of fusion, in case a Star metal bearing heats, it does not cut the journal, as do Babbitt metal and brass under similar circumstances. There is no attraction between the elements of the heated Star metal and the journal, and the destruction of the bearing by heating is not accompanied by the injury of the journal.

THE MOST PRACTICAL TEST,

however, of the anti-frictional value of two rubbing surfaces—the most reliable co-efficient of friction, is the quantity of heat developed between them. As in the subject under consideration, one of those surfaces, that of the journal, must, for purposes of strength, be always of the same material; the comparative amount of heat developed between the journals, and the different materials used for bearings is, in such case, an infallible measure of the waste of power. The most severe trials to which a bearing could be subjected, have clearly, established that in this respect, as, in almost, all others, Star metal is, immeasurably, superior to all other anti-frictional substances. This might, upon general principles, have been anticipated prior to such test from its known qualities, its remarkable hardness, its fine crystalline structure, and *its entire difference in nature from the material, with which it comes in contact*—qualities generally wanting in both brass and Babbitt metals.

Babbitt metals are obtainable at a nominal figure, but the users of them—after a time—find that they are, in the long run, dearer than the more costly at the outset—hence the unprecedented demand, of late, for Star metal. These cheap BABBITTS, it is evident, must be composed of something like 9-10ths of lead, or the vendors thereof could not afford to sell at 7c. per lb. and upwards—whilst, in Star metal, which lasts so much longer than either Babbitt or brass—(*vide* letter, herein, from Wm. Clendinneng, Esq.,) there is not a particle of lead.

In conclusion, I have only to repeat the conviction which a careful examination of the qualities of Star metal in connection with friction has plainly established, viz.: That the discovery of this alloy, and its application to anti-frictional purposes, are effecting an immense saving in motive power and in material; that it conduces largely to human safety and comfort, and while accomplishing these objects, it becomes, unquestionably, a benefaction to the human race.

Steps have been taken for the general use of the bearing in France, Belgium, Russia and England, where experiments, highly satisfactory, have been, and are now, being made.

The foundry for the Dominion is established in Montreal, where every bearing is made under the supervision of the writer.

They are being universally adopted in the Dominion, and are in use on the following railways:—

NORTHERN AND NORTH WESTERN RAILWAYS,
NORTH SHORE RAILWAY,
QUEBEC M. O. AND O. RAILWAY.
L. AND KENNEBEC RAILWAY,
QUEBEC AND LAKE ST. JOHN RAILWAY,
QUEBEC CENTRAL RAILWAY.
ST. LIN RAILWAY,
ST. LAWRENCE AND LAKE CHAMPLAIN R.R.
INDRUSTRIE.

whilst other companies are trying them with a view to their ultimate adoption.

R. MACKENZIE, Agent,
59 St. Sulpice Street,
MONTREAL.

CERTIFICATE

FROM

RICHARD EATON, Esq.,

LOCOMOTIVE AND CAR SUPERINTENDENT,

Grand Trunk Railway of Canada.

MONTREAL, 24th Dec., 1866.

I have much pleasure in testifying to the great advantages of the Star Metal Bearings.

From continuous experiments which I have made during the past twelve months, I find that this metal wears, considerably, longer than Brass, in the proportion of two to three—two Star Metal Bearings being equal to three of Brass.

This was the result of eleven experiments, from actual observation; one pair, especially noted, ran 39,960 miles, under a heavy sleeping car, No. 65, when the brass gave out, whilst the Star Metal was not much more than half worn.

The first cost is considerably less than brass, owing to the difference in weight.

We have now in use on the G.T.R. over 3,400 of these Bearings, and I consider them far superior to brass in efficiency and economy.

(Signed,) R. EATON.

Levis and Kennebec Railway.

CONTRACTOR'S OFFICE,
QUEBEC, January 22nd, 1875.

R. MACKENZIE, Esq.,
Railway Supplies,
Montreal.

DEAR SIR,

We have much pleasure in informing you that the Star Metal Bearings, purchased from you last spring, have given us entire satisfaction; and they bear out the recommendation you gave us of them at the time we made the purchase—and, as far as we can see (after a summer's use,) fully support the high testimonials given you by the numerous railways that have used them. We are now putting the bearings on about 40 cars (box and platform); and we doubt not that in the spring we will be in a position to give you another order for a lot.

Yours truly,

(Signed,) LAROCHELLE & SCOTT,
Contractors,
Levis and Kennebec Railway.

Northern Railway of Canada.

MECHANICAL DEPARTMENT,

TORONTO, March 30th, 1878.

R. MACKENZIE, Esq.

DEAR SIR,

In reply to your enquiry as to our experience with the Star Metal Bearings, of your manufacture, I have great pleasure in stating that they are giving us every satisfaction. We have had them in almost exclusive use, under our cars, for past three years, getting good service and mileage from them.

Yours truly,

(Signed,) P. CLARKE,

Mechanical Superintendent.

MONTREAL, April 15th, 1878.

MR R. MACKENZIE,

Montreal.

DEAR SIR,

Referring to Star metal bearings, and my testimonial thereon, dated Dec., 1868, I beg to say, whilst using them for a considerable period afterwards, they gave every satisfaction, whereas the bearings made from a pretended analysis of the veritable Star metal, and supplied to the G. T. R., were continually giving out, and caused many detentions to trains—so much so, that Mr. Brydges would not tolerate them, and stopped their use. The general adoption of these bearings would have been a great saving to the company.

Yours truly,

(Signed,) RICHARD EATON.

North Shore Railway.

CONTRACTOR'S OFFICE,
QUEBEC, March 18th, 1878.

RICHARD MACKENZIE, Esq.,
Railway Supplies,
Montreal.

DEAR SIR,

We have been using your Star Metal Bearings for about twelve months, and, so far, they have turned out well. In fact, we have had no trouble whatever. We require nothing better.

Yours truly,

(Signed), E. HARDMAN,
Mechanical Superintendent.

Quebec Central Railway.

SHERBROOKE, April 26th, 1878.

R. MACKENZIE, Esq.

Montreal.

DEAR SIR,

The Star Metal Bearings, purchased by this Company, have proved entirely satisfactory; they have run upwards of 40,000 miles, and are still in use. I find them fully 30 per cent cheaper than brass, and have much pleasure in recommending them to Superintendents who may be using that metal.

I am, dear sir,

Yours truly,

(Signed), A. HALE,

Superintendent Q. C. R.

QUEBEC, May 6th, 1878.

RICHARD MACKENZIE, ESQ.,

Montreal.

DEAR SIR,

Referring to your Star Metal Bearings, which have been in use on the Levis and Kennebec Railway for over four years, I take pleasure in endorsing the letter of our late firm, dated January 22nd, 1875, and would say, in addition, that I have no reason to change my opinion expressed in that letter. The bearings gave me entire satisfaction, and I have no hesitation in recommending their use to railway companies or contractors.

Yours truly,

(Signed), CHAS. A. SCOTT,

Railway Contractor.

North Shore Railway.

CONTRACTOR'S OFFICE,
QUEBEC, Oct. 1st, 1879.

R. MACKENZIE, Esq.

DEAR SIR,

In reply to your enquiry as to our experience with the Star Metal Bearings, I have much pleasure in informing you that they are giving us every satisfaction. We have them under all our cars, running on all classes of trains, more particularly on Construction Trains, where they get a very severe test, by heavy loads and long runs, the result of which is very satisfactory, for we experience no trouble from hot boxes where proper care and attention are given to the cars, in all cases giving a good mileage, and I consider them more economical than Brass Bearings.

Yours truly,

(Signed), J. A. SLACK,
Mechanical Superintendent.

Quebec Central Railway.

SHERBROOKE, 13th Oct., 1879.

R. MACKENZIE, ESQ.,

Montreal.

DEAR SIR,

Referring to your Star Metal Bearings which this Company has been using for some time, I am pleased to inform you that on enquiry I find that our Mechanical Superintendent can fully endorse his memorandum of April last as to their durability. I will shortly send you an order for another lot.

Yours truly,

(Signed), R. D. MORKILL.

(Copy.)

Quebec, Montreal, Ottawa & Occidental Railway

(WESTERN DIVISION.)

MASTER MECHANICS' OFFICE,
HOCHELAGA, Dec. 8th, 1879.

R. MACKENZIE, Esq.,
Montreal.

DEAR SIR,

In reply to your enquiry regarding Star Metal Car Journal Bearings, supplied to this line by your firm, I regret to say that I have not kept any mileage record of their durability, but have run them on trains against various other kinds of car journal bearings, introduced by celebrated makers, of both American and Canadian manufacture, and I am pleased to state that your Star metal bearings have, in nearly all cases, shewn by far the best results, and the fact that your Star metal bearings are used, exclusively, under all classes of cars, on this line, should be the best proof that they are giving perfect satisfaction, and

I am, Yours truly,

(Signed,) A. DAVIS.

(Copy.)

HARBOR COMMISSIONERS OF MONTREAL
Chief Engineer's Office,
MONTREAL, 18th March, 1880.

R. MACKENZIE, ESQ.,
Montreal.

DEAR SIR,—

We have two bearings 10 inches in diameter by 15 inches long under the tumbler shaft of one of our large dredges, working with a pressure of 300 lbs. per square inch at 10 revolutions per minute, lined with your Star metal, and on examining them after seven months' use, both bearings and shaft are found to be in excellent condition.

Yours truly,
(Signed,) JOHN KENNEDY,
Chief Engineer.

(Copy.)

CALEDONIA WORKS,
MONTREAL, 23rd March, 1880.

MR. R. MACKENZIE, C. E.,
Montreal.

DEAR SIR,—

Referring to your Star metal for bearings for shafting, I consider it far more economical than the ordinary Babbitt, owing to its durability, with less wear to the shafting, which is scarcely perceptible.

Yours truly,
(Signed), JOHN McDOUGALL.

(Copy.) MONTREAL, 31st March. 1880.

R. MACKENZIE,

Montreal.

DEAR SIR,—

Referring to your Star metal bearings put into use by me some seventeen months ago for my stationary engine, I have made enquiries, and my foreman says that they are doing well, and has had no occasion to touch them. Whereas, with brass, he says, every six or seven months, they have to be re-faced.

I shall use nothing else but Star metal in future.

Yours truly,

(Signed,) WM. CLENDINNENG.

(Copy.) SOREL, 9th April, 1880.

TO WHOM IT MAY CONCERN.

This is to certify that some of our largest and heaviest bearings are lined with the R. MACKENZIE STAR METAL, and after a season's operations find they are scarcely worn at all, with a great saving in oil. An outside propeller shaft bearing lined with the same metal, so far, has proved superior to any we have ever seen used working in water.

(Signed,) JAMES HOWDEN,

Mechanical Superintendent,

Harbor Trust,

Montreal.

(Copy.) MONTREAL, 10th April, 1880.

TO MR. R. MACKENZIE, C.E.,

Montreal.

DEAR SIR,

Referring to your bearings of Star metal, I beg to say, during my contract with the Government on the Montreal and Ottawa Railway, as the cars required new bearings—that I renewed them, exclusively, with your Star metal—being found more durable and economical than those taken out.

Yours truly,

(Signed), DUNCAN MACDONALD.

BABBITT.

NOTE.—In connection with the object of this pamphlet, the manufacture of Star Babbitt, for bearings for mills, sugar refineries, &c., has sprung up, and the secret alloys are now applied to this purpose also; the saving as compared with the common Babbitt, being about the same as Star metal is to brass, for railway purposes.

(Copy.)

Grand Trunk Railway.

CAR DEPARTMENT.

POINT ST. CHARLES STATION, Sept. 8th, 1865.

To R. EATON, Esq.

SIR,

No. 64, first-class car, came by No. 1 from the West, with two of the Star Metal Bearings, which answered first rate. They are now working very smoothly.

No. 22, first-class car, which has also two of these Bearings, did not return with No. 64. I cannot ascertain the cause of this.

Yours respectfully,

(Signed,) WM. CORNER.

(Copy.)

Grand Trunk Railway.

CAR DEPARTMENT.

Point St. Charles Station, Dec. 20th, 1865.

To R. EATON, Esq.

Sir,

No. 89 sleeping car had two Star metal bearings No. 13, put in to run against two brass bearings No. 13. Commenced running September 4th, between Montreal and Toronto, and has continued to do so until the present time, making 86 single trips, or 28,168 miles.

	lbs.	*oz.*
1 Star metal bearing put in....................	7	0
Taken out....................................	6	1
Lost.............	0	15
1 Brass bearing put in........................	7	0
Taken out....................................	5	11
Lost..............	1	5
1 Star metal bearing put in....................	7	0
Taken out....................................	6	0½
Lost..............	0	15½
1 Brass bearing put in........................	6	1
Taken out....................................	4	4
Lost..............	1	13

The bearings are all marked with the weight when put in and the weights when taken out. I have sent them to your office for inspection. The loss on the Star metal has averaged but 15 ounces, whilst the loss on the brass has been an average of 1 lb. 9 oz.

Yours respectfully,

(Signed,) WM. CORNER.

(Copy.)

Grand Trunk Railway.

CAR DEPARTMENT.

POINT ST. CHARLES STATION, February 17th, 1866.

To R. EATON, Esq.

SIR,

No. 53, first-class car, running (central) between Montreal and Toronto, starting October 16th, 1865, by No. 4 Train; stopped on its downward trip, Feb. 10th, 1875, and brought to Point St. Charles for repairs. This car has been running with two Star metal bearings against two brass bearings; they were weighed and the weights of each were stamped on them at the time of being put in—they have now been taken out again, weighed and stamped. This car has run 14,008 miles. I send you the bearings for your inspection.

	lbs.	*oz.*
Star metal, when put in	7	2
" " " taken out	6	9
Lost	0	9
Brass, when put in	7	15
" " taken out	6	14
Lost	1	1

Difference in wear, for the time, in favor of Star metal, 8 ounces.

	lbs.	*oz.*
Star metal, when put in	7	2
" " " taken out	6	7
Lost	0	11
Brass, when put in	6	8
" " taken out	5	4
Lost	1	4

Difference in wear, for the time, in favor of Star metal, 9 ounces.

The four bearings, in each case, were running in one truck, at cross-angles.

The loss on the Star metal has been .... 20 oz.
The loss on the brass has been .... 37 oz.

Yours respectfully,

(Signed,) WM. CORNER.

(Copy.)

Grand Trunk Railway.

CAR DEPARTMENT.

POINT ST. CHARLES STATION, Feb. 28th, 1866

To R. EATON, Esq.

SIR,

No. 56, first-class car, has been running since September 5th, 1865, between Montreal and Toronto (central); it was stopped on the 14th instant, for repairs. This car was supplied with two Star metal bearings, to run against two brass bearings; they were weighed, and the weight of each bearing was stamped on them at the time of being put in; they have now been weighed and taken out and stamped. This car has run during this time of trial, 25,362 miles; I send the bearings in for your inspection. Both Star metal and brasses were No. 1 pattern.

	lbs.	*oz.*
Star metal, when put in	7	2
" " " taken out	6	9
Loss	0	9
Brass, when put in	7	12
" " taken out	6	3
Loss	1	9
Star metal, when put in	7	2
" " taken out	6	13
Loss	0	5
Brass, when put in	7	9
" " taken out	7	0
Loss	0	9

The four bearings, in each case, were running in one truck at cross angles.

The loss on the Star metal has been 14 oz.

The loss on the brass has been 2 lbs. 2 oz.

Yours respectfully,

(Signed,) WM. CORNER.

(Copy.)

Grand Trunk Railway.

CAR DEPARTMENT.

Point St. Charles Station, April 13th, 1866.

To R. EATON, Esq.

Sir,

No. 15, first-class car, was reported to you on the 26th February as having arrived and required extensive repairs.

This car was supplied on the 16th October, 1865, with four Star metal bearings running against four brass bearings. This car, from the 16th October to the date of its being stopped for repairs, had run 24,892 miles. On lifting the car to take out the bearings we find two of the Star metal bearings and two brass bearings from one truck had been taken out and new brass bearings put in their stead; where it has been done, I have no means of ascertaining, unless you can find out this from any reports you may have. The Star metal bearings remaining together with the brass bearings, marked and stamped, were both in one truck.

They have all been again weighed and stamped, shewing as follows :—

	lbs.	*oz.*
Star metal when put in	7	0
" " " taken out	5	14
Lost	1	2
Brass, when put in	7	10
" " taken out	5	4
Lost	2	6
Star metal when put in	7	0
" " " taken out	5	10
Lost	1	6
Brass, when put in	7	10
" " taken out	5	3
Lost	2	7
Shewing that the Star metal has lost	2	8
" " " Brass " "	4	13

Yours respectfully,

(Signed,) WM. CORNER.

(Copy.)

Grand Trunk Railway.

CAR DEPARTMENT.

POINT ST. CHARLES STATION, April 20th, 1866.

To R. EATON, Esq.

SIR,

No. 63, first class car, was supplied, on the 12th September. 1865, with two Star metal bearings, running against two brass bearings, in the same truck. This car was stopped for repairs, on the 2nd instant, having run with these bearings 14,464 miles. Instead of repairing the trucks, Mr. Wilson has changed them for a pair of the same kind; but the axle boxes are No. 7, consequently could not put in the No. 1 bearings.

	lbs.	*oz.*
Star metal bearings, when put in	7	2
" " " " taken out	6	12
Lost	0	6
Brass bearings, when put in	7	14
" " " taken out	7	0
Lost	0	14
Star metal bearings, when put in	7	2
" " " " taken out	6	10
Lost	0	8
Brass bearings, when put in	7	1
" " " taken out	6	5
Lost	0	12

Loss on the Star metal, 14 oz.

Loss on brass, 26 oz.

Yours respectfully,

(Signed,) WM. CORNER.

(Copy.)

Grand Trunk Railway.

CAR DEPARTMENT.

Point St. Charles Station, Aug. 29th, 1866.

To R. EATON, Esq.

Sir,

No. 65, first-class car, started to run Oct. 16th, 1865, with four Star metal bearings and four brass bearings; this car has run eight months and three weeks, making sixty round trips since the time named; the car was two months in shop under repairs, viz.: March and April; it has run 39,960 miles. On examining the bearings on Friday last, the 24th inst., found one brass very much worn, and it had to be taken out; at the same time had to take out the Star metal bearing opposite to it; the other three Star metal bearings and the three brasses were good and fit to run for at least a month or six weeks.

	lbs.	*oz.*
Star metal, when put in	7	0
" " " taken out	5	10
Lost	1	6
Brass, when put in	7	4
" " taken out	5	1
Lost	2	3

Yours respectfully,

(Signed,) WM. CORNER.

P.S.—I send you in the Star metal and brass bearings for your inspection.

WM. CORNER.

Comparative Statement of saving by the use of Star Metal and Brass Bearings.

The saving on 100 cars, assuming the price charged to be the same for both metals, would be as follows, viz. :

	No. bearings.	lbs.	lbs.			
Cost of brass	100 X	8 X	8 =	6400	@ 30c.	$1920.00
Cost of Star metal..........	100 X	8 X	8 =	6400		
Specific gravity less by 20 p. c. =				1280		
				5120	@ 30c.	1536.00
Duration 33 p. c. greater than brass. (see G. T. R. exp.)..........						512.00
Actual cost of Star metal.........						$1024.00

In lieu, however, of the price being the same as brass, it is as 25 to 30 cents per lb., thus effecting an additional saving on 100 cars of $320, or equal in 1000 to a total saving in favor of Star metal of $22,800—for the number of bearings enumerated—which have to be replaced on an average, at least once a year. Thus showing on 1000 cars, an aggregate gain of $45,600 per annum. Equal to a saving in favor of Star metal of about 15 cents per lb., or on 1000 cars, $22,800.

The subject of lead lined bearings is a matter of secondary consideration for new work, but where it is a question of bearings to replace old ones, they are supplied with the lead lining in order to adapt the bearing to the inequality of the old journal. The discoverer of the alloys for the *Star metal* is also the originator of this idea.

Note.—Those desirous of testing the bearings, should send exact length and diameter of Journal, when new, with a wooden pattern, and a set will be supplied, on the understanding if, upon trial, they are not satisfactory, that no charge will be made.

WEIGHT OF RAILS PER MILE.

THE SECTIONAL AREA—WEIGHT PER YARD—WEIGHT PER MILE OF SINGLE TRACK

Area in Inches.	Weight per yd. in lbs.	Tons, 2,240 lbs. per mile.		
		Tons.	Cwts.	Lbs.
5	50	78	11	48
$5\frac{1}{4}$	52	81	14	33
$5\frac{1}{2}$	55	86	8	64
$5\frac{3}{4}$	56	88	—	—
6	60	94	5	80
$6\frac{1}{2}$	64	100	11	48
7	70	110	—	—
$7\frac{1}{2}$	75	117	17	16
8	80	125	14	32
9	90	141	8	64
10	100	157	3	84

To find weight in tons per mile of rail, divide weight per yard by 7, and multiply oy 11.

Number of Rails Per Mile of Track.

Length of Rail.	Number.	Length of Rail.	Number.
15 feet.	704	22 feet.	480
16 feet.	660	24 feet.	440
18 feet.	587	26 feet.	406
20 feet.	528	28 feet.	377
21 feet.	503	30 feet.	352

Number of Fish-Joints Per Mile of Track.

Length of Rail.	Number.	Length of Rail.	Number.
18 feet.	587	24 feet.	440
20 feet	528	26 feet.	406
21 feet.	503	28 feet.	377
22 feet.	480	30 feet.	352

Number of Pounds of Spikes Per Mile of Track.

Size of Spike, $5\frac{1}{2}$ by 9-16 inches.................. ....from 5,250 to 5,500 lbs.

Number of Cross-Ties Per Mile of Track.

Distance from centre to centre, 2 feet.................. .... 2,641 ties.
" " " $2\frac{1}{4}$ " .... 2,348 ties.
" " " $2\frac{1}{2}$ " .... 2,113 ties.
" " " $2\frac{3}{4}$ " .... 1,921 ties.
" " " 3 " ....1,761 ties.

Average Weight Per Bushel of Coals.

1 Bushel Anthracite = ...86 lbs. | 1 Bushel Charcoal (hard-wood) = 30 lbs.
1 " Bituminous = ...80 lbs. | 1 " Coke = ...32 lbs.