O T T A W A July 2nd, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1255.

Examination of Defective Ball Bearings.

(Copy No. 4.)

DISTRIBUTORS OF M-R-C BALL BEARINGS IN CANADA

DOMINION BEARINGS LIMITED

Aircraft. Industrial & Automotive Bearings

272 Van Horne Street

TORONTO, CANADA

Cable Address
CANMOTOR

4

September
seventeenth
1942

Mr. L. W. Fleck,
Alexander Fleck Ltd.,
416 Wellington St.,
Ottawa, Ont.

Dear Mr. Fleck:

Further to our letter of September 14th, the writer had occasion to visit the Marlin-Rockwell Corporation factory at Jamestown, New York, and checked up on pending complaint you have with respect to hollow balls, in connection with our #5215-R21 bearings.

We enclose an eight-page leaflet issued by M-R-C entitled "Ball Bearing Troubles" by Mr. Thomas Barish, their assistant chief engineer. On the last page of this leaflet, you will find reference to the fact that damage caused by heat will result in balls becoming hollow and appearing to have been made that way.

During our discussion on your subject, the engineer who explained matters to me gave me a wealth of technical information which I cannot hope to relay to you successfully. We went into the subject of the Department of Metallurgy Report which you submitted, the application for which the bearings were used, the reason why the first bearing installed at the factory was O.K. whereas the same type of bearing supplied by us appeared to be unsatisfactory, and everything else in relation to the subject.

It became clear to me:

(1) M-R-C thoroughly understand the nature of bearing failures, and would make no effort to conceal the actual cause in any particular case.

(2) In your case the failure was directly due to a combination of faulty installation, and awkward engineering application. This would explain why the skilled and experienced installation of the bearing at the factory had resulted in proper functioning, whereas subsequent installation of the new bearing by someone less familiar with exacting requirements of that particular piece of equipment would result in imperfect functioning that finally ended in damaging generation of heat and resultant destruction of balls.

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(3) The technical report by the Department of Metallurgy Laboratory, while done by experts, reveals a possible lack of that extensive familiarity with bearings and balls and their operation that only an organization like M-R-C with their many years of bearings experience would develop. The writer became convinced during his visit that such bearings problems can be understood thoroughly only by the people who are steeped in bearings work every day of the year and do nothing else.

The above does not reflect in any way on the sincerity of your customer in claiming the defect, nor on the knowledge of the laboratory experts who prepared your report. It merely points to something that can be found in any technical field, namely, the existence of special conditions which come to the attention of a person only when he has been concentrating on that particular field over a period of years. To explain more would necessitate the sort of elaborate technical explanation that was given to me verbally on Tuesday, and which could not possibly be incorporated in writing. This explains, perhaps, why M-R-C's engineering department had not got around to communicating with you as we requested. They found it difficult to render the above in a satisfactory written form, but they nevertheless knew that they were right in insisting that the bearings supplied to you were actually perfect, but that their subsequent defective condition developed as a result of faulty installation plus original difficult engineering application which required special experience in the factory making the original equipment in which the bearing was used. such as is available

Does the above cover the ground satisfactory? I hope you won't think it is an effort to evade responsibility. The latter point was covered by our letter of July 14th and our issuing of complete credit to you for the bearing. While we agree with M-R-C that there was no fault of theirs or ours involved, we issued full credit to you because we felt that you were acting in perfectly good faith and we didn't want to see you penalized in any way. On the other hand, we appreciate your desire to have a satisfactory technical explanation, and we hope the above will be accepted in place of same.

Assuring you of every effort to be of service, we are

Yours very truly,

DOMINION BEARINGS LIMITED

I. M. Gringorten

IMG/EL

4

552 Booth Street,
Ottawa, Ontario,
17th July, 1942.

Alexander Fleck Limited,
416 Wellington Street,
Dttawa, Ontario.

Attention of Mr. L. W. Fleck.

Dear Sir:-

In acknowledgement of your letter of July 13th, 1942, regarding receipt of three copies of investigation No. 1255 - "Examination of Defective Ball Bearings", and the forwarding of one copy to your supplier, we shall be very pleased to receive whatever comments the bearing company may wish to make.

Yours very truly,

for C. S. Parsons.
Chief of Division.

MCP:RM

ALEXANDER FLECK LIMITED
416 WELLINGTON STREET, OTTAWA, ONTARIO
ESTABLISHED 1842 TELEPHONE 3-1127
MANUFACTURERS AND DISTRIBUTORS OF PULP AND PAPER MILL MACHINERY AND SUPPLIES

July 13, 1942.

Mac Fleck

Dr. Gordon Farnham,
Ore Dressing and Metallurgical Laboratories,
Department of Mines and Resources,
552 Booth Street,
Ottawa, Ontario.

Dear Sir:

We acknowledge with thanks receipt of three copies of your Investigation No. 1255 entitled "Examination of Defective Ball Bearings", and have forwarded one copy of this report to our supplier. If the bearing company has any remarks to make in connection with your report, we will advise you.

Yours very truly,

ALEXANDER FLECK LIMITED,

L. W. Fleck
com

President.

L. W. Fleck:COM

COPY COPY ALEXANDER FLECK LIMITED COPY COPY

Ottawa, Canada

DOMINION BEARINGS LIMITED

272 Van Horne Street

TORONTO, CANADA

Investigation No. 1255

June
fourth
1942

Alexander Fleck Limited,
416 Wellington St.,
Ottawa, Ontario.

Attention Mr. L. W. Fleck

Gentlemen:

The following is a report received from Marlin-Rockwell Corporation, Jamestown, N.Y., on the steel balls taken from a defective #5215-R21 ball bearing:

" We gave these balls a very careful physical and metallurgical examination, and found that three were soft and two were hard. One of these two balls was fractured and found to be hollow. The grain in the fracture of the shell was fine and uniform. The other was fractured and was found hard in the centre.

We are quite positive that the condition of these balls is the result of operation of the bearing, and that these balls were subjected to intense heat, possibly through lack of lubrication in the bearing, which could very easily have happened when the bearing was replaced by your customer. It is quite possible that the customer forgot to add the proper amount of lubricant, or since the #5215-R2-1 bearing is a tapered bore bearing, there is a very definite possibility of incorrect mounting. If the inner ring has pulled up too tightly on the tapered seat the bearing is subjected to a heavy internal squeeze with resultant rapidly increasing rate of generation of heat due to squeezing of the balls between the inner and outer rings with rapid break down of ball and race bearing surfaces.

There is a very definite possibility that these balls were subjected to such operating conditions and there is a possibility that if the ball were heated sufficiently and worked severely enough between the inner and outer races it would have a tendency to draw the metal away from the centre of the ball and the ball would have the appearance of being hollow.

However, we wish to emphasize that in all the hundreds

DOMINION BEARINGS LIMITED

272 Van Horne Street

TORONTO, CANADA

of thousands of ball fractures we have examined, to check our manufacturing processes, we have never found a hollow ball. We do not make nor use hollow balls in our bearings. This is quite definitely the result of operation of the bearing, and the application should be checked carefully to insure against this recurring.

May we suggest that in cases of this kind, where part of a failed bearing is returned to you and it has a very unusual appearance, that you insist on your customer returning the entire bearing to you for examination by us.

It is quite likely that the bakelite compound retainers were completely destroyed, but there certainly must have been enough evidence of the inner and outer rings left to return them to us.

In view of our examination, and our knowledge of the manufacturing control of these balls, we do not believe that you should make any adjustment to your customer for this bearing.

As further evidence against the possibility of this bearing having hollow balls, we wish to point out that if the manufacture of hollow balls were a possibility there might be one hollow ball in a bearing which would fail and give definite conclusion as to the cause of failure. However, there would be no case that we can imagine where all of the balls or a proportion of the balls would be hollow in a bearing."

In view of the above we feel that you would not call on us for replacement.

Assuring you of our co-operation and desire to be of service, we are

Yours very truly,

DOMINION BEARINGS LIMITED,

(Signed) A. Sheppard.

COPY

ALEXANDER FLECK LIMITED
Ottawa, Canada

March 17, 1942

Dominion Bearings Limited,
272 Van Horne Street,
Toronto, Ontario.

Gentlemen: Re: Bearings - M.R.C. 5215-R2-1.

We have had returned from one of our customers some balls from an M.R.C. 5215-R2 Bearings, which we installed in a Hydrafiner and shipped to this customer. This machine had been in operation two weeks only when this bearing proved defective.

When replacing this bearing with another one which we sent to our customer, they dismantled the original one and found the balls to be hollow, and the failure seems to be attributed to this cause.

This is the first time that we have been aware that ball bearings were made with hollow balls and we would ask you to have this checked up.

We wrote you today about sending us full information with regard to Priorities for these bearings which we have on order with you, but if this sort of thing is going to happen, we will have many machines down unless you can impress upon your principals the urgency of filling our orders promptly. We have endeavoured not to have any more in stock than we actually need, and have been ordering on you in this way. However, as eight more machines have gone out to the trade, we are increasing our Order point to take care of these, and are therefore enclosing a further order, No. 8767, for twelve of each type of bearing.

Yours very truly,

ALEXANDER FLECK LIMITED,

L.W. Fleck:COM President

P.S. We are enclosing under separate cover a sample of the balls from the defective bearing.

BUREAU OF MINES
DIVISION OF METALLIC MINERALS
—
ORE DRESSING AND
METALLURGICAL LABORATORIES

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

O T T A W A July 2nd, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1255.

Examination of Defective Ball Bearings.

Origin of Material and Object of Examination:

On June 6th, 1941, Mr. L. Fleck, of Alexander Fleck Limited, Ottawa, Ontario, brought in pieces of a broken ball bearing and one unbroken ball. The broken ball, which had failed in service, appeared to be hollow and to have contained in the hollow a piece of ball bearing steel. It was requested that the balls be examined in order to determine the reason for the failure. For purposes of comparison, a ball bearing

(Origin of Material and Object of Examination, cont'd) -

taken from our stores, which will be referred to herein as the "standard" ball, was also examined.

Hardness Tests:

Results obtained in hardness tests made using the Vickers method with a 30-kilogram load are as follows:

Material	Vickers	Brinell (converted)	Rockwell "C" (converted)
Outer surface, "Marlin" ball	296	296	30
Inner surface, "Marlin ball (and loose piece of ball bearing)	366	355	38
Unbroken "Marlin" ball	360	352	37
"Standard" ball	720	594	60

Microscopic Examination:

Sections were cut which included the material which was hardness tested. These sections were given a metallographic polish and etched in a 4 per cent picral solution. Figure 1 (X1000 magnification) shows the structure of the "standard" ball. It consists of fine spheroids of cementite (the white iron chromium carbide constituent) in a background of dark etching drawn martensite. Figures 2 and 3 (X2000 magnification) were obtained from the outer area of the broken ball. In both figures the white particles are iron chromium carbide, the black background fine pearlite. In Figure 3 it may be seen that the carbide has segregated into a large cluster which is rounded off at the end by the forging operation. Figure 4 (X2000 magnification) shows the structure of the surface of the broken

(Microscopic Examination, cont'd) -

ball that faced the hollow inside. The white material, which again is cementite, is present in stringers at grain boundaries rather than in spheroids. The dark background material is pearlite, the lamellar iron--iron carbide constituent produced when steel that has been heated over the critical temperature is cooled fairly slowly through that critical. The loose piece in the centre of the broken ball has practically the same structure.

Discussion of Results:

The "standard" ball has the structure and hardness expected in good ball bearings, as such bearings should be quite hard and have the chromium carbide present in the form of spheroids. The pieces of Marlin ball examined were all in poor condition. All pieces are too low in hardness, while only the extreme outer surface of the broken ball contains carbides in the proper spheroidal form. This outer surface, however, contains an area which shows a large amount of carbide segregation.

It is certain, then, that the metal in the used ball is in an unsatisfactory condition. The problem is to determine whether manufacturing procedures or service conditions are responsible for this condition.

Certainly the segregation of carbides shown in Figure 3 cannot have occurred as a result of improper treatment in service. This segregation must definitely be considered as a defect in the steel as supplied to the ball manufacturer.

Leaving the outer surface of the ball out of consideration, from the lamellar pearlite structure of the steel it can definitely be concluded that the final heat treatment

(Discussion of Results, cont'd) -

the steel has received is a heating over the lower critical followed by a relatively slow cooling. A properly made ball bearing, however, is quenched from its upper critical, so if it be assumed that structure faults were produced in service this would mean that the heat of friction was sufficiently high to heat the ball to at least 1400° F. This is manifestly absurd, as the bakelite retainers would be completely destroyed at a very much lower temperature and balls working at such a temperature would be in the plastic condition and consequently would work out of shape. It is our definite opinion, then, that the ball was supplied in an unsatisfactory condition and we cannot visualize any service conditions which would allow a ball to "work" hollow while still keeping its external dimensions.

Difference in the carbon content of the outer skin and the inner portion of the metal might account for the difference in the structure of the outer and inner portions of the broken ball. This may have occurred as a result of heat treating in a non-neutral atmosphere.

It would seem that the balls have been given a normalizing treatment and then not re-heat-treated, probably because they were found to be defective. By some mischance this defective material was mixed with regular production.

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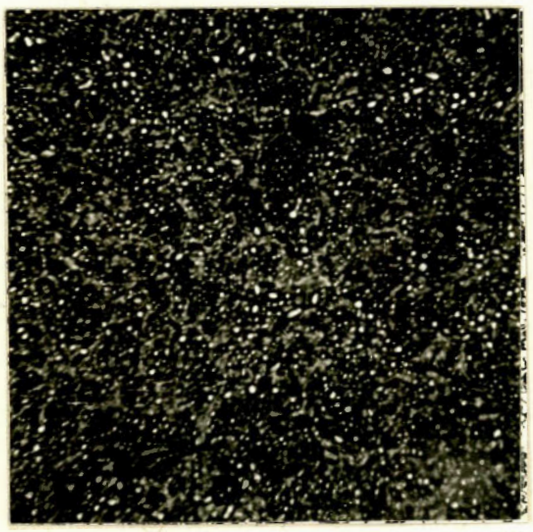
GSF:PES.

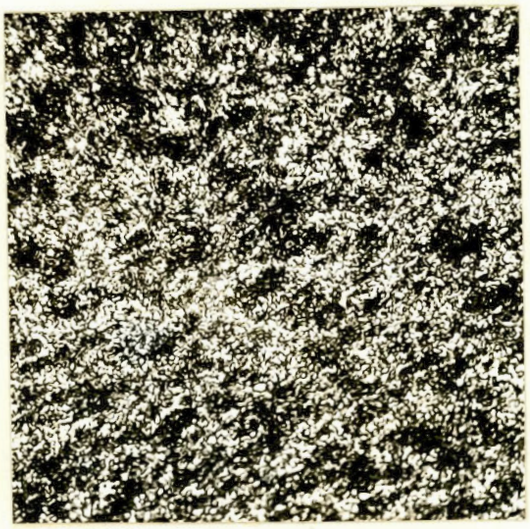
Figure 1.



X1000, picral etch.

"STANDARD" BALL.

Figure 2.



X2000, picral etch.

OUTER EDGE OF BROKEN BALL.

Figure 3.

X2000, picral etch.

OUTER EDGE OF BROKEN BALL, SHOWING SEGREGATION.

Figure 4.

X2000, picral etch.

AVERAGE STRUCTURE OF BROKEN BALL.

GSF:PES.