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RESEARCH ON THE EFFECTS OF ELECTRICAL DISCHARGES THROUGH ROLLER BEARINGS PART I

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Abstract:
The present study examines the effects of electrical discharges into the rolling paths and the bearing rolling bodies. The number, the size and the shape of the craters, generated by the electrical discharges, have been microscopically analysed in different lubrication conditions, while varying the power and the amperage of the discharging electrical current.

This study is essential as a very large part of the electrical rotative machines are withdrawn from usage due to the damage of their bearing components. Very frequently, the above issues are worsening by the power peaks which are a consequence of the function of electronic converters commanded through impulses. These effects are similar with the electrical discharges through bearings. The knowledge the causes and the analyze of the effects through laboratory tests lead to very useful information regarding the decrease or even eradication of these effects.

Key words: *Rolling bearings, electrical current, electrical discharges*

1. INTRODUCTION

The rotational elements of electric rotary machines are supported, in most cases, on roller bearings. The presence of electric or magnetic fields, of electrostatic discharges, or of current leakage through ball bearings generates specific defects leading to their putting out of operation prematurely.

Sometimes, the electrical discharges through ball bearings generate pits on the rolling elements, phenomenon known as "electric wear" of the bearing. Other times, these discharges create stains on the active surfaces of the rings or rolling elements and result in the modification of material composition and strength in the affected areas.

If these phenomena occur for a long time, there will appear grooves or striate on the active surfaces, which are defects that contribute to the noise and vibrations increase during operation, and finally will put the bearings out of operation. The above mentioned aspects serve to justify the importance given to studying the effects of electrical current passing through ball bearings.

2. DESCRIBING THE EXPERIMENTAL TESTS RIG

The tests rig sketch is presented in fig. 1. The motion and the torque are transmitted from the electric motor (1) towards the shaft (6) by means of the pins and disk coupling made up of non-conductive materials.

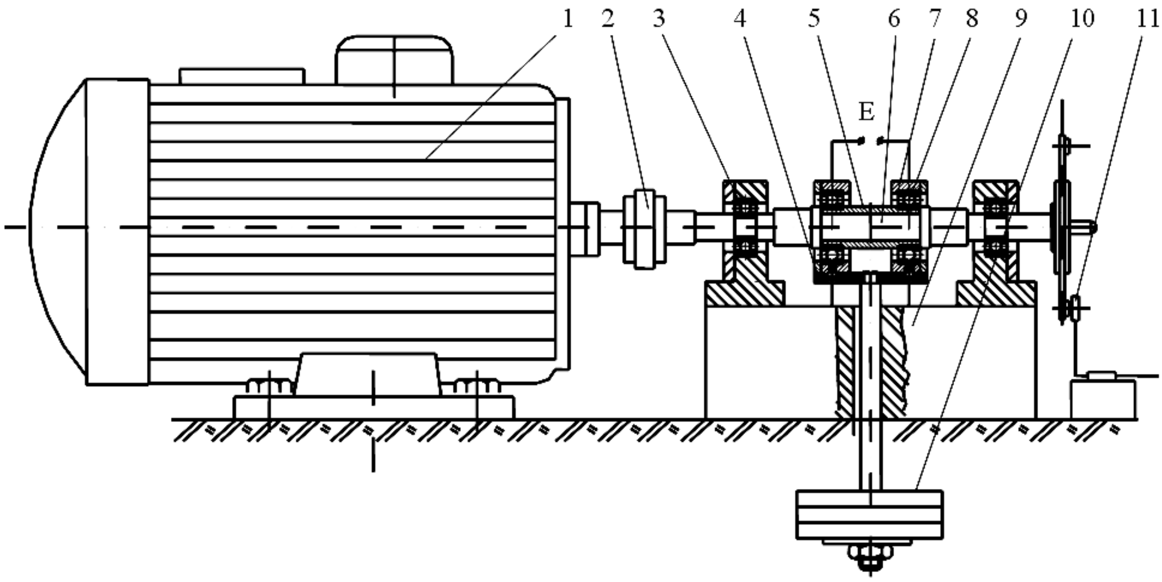

Fig. 1 Experimental tests rig

The shaft (6) is placed on two rolling bearing cases (3), fixed on the base plate (9), which is made of the same non-conductive material (high density polyethylene, type 6.6).

This way, the testing head is entirely insulated, electrically, from the rest of the rig. The two roller bearings (8) are placed on the bronze bushing (5). The radial loading of the bearings is made by means of the weights (10), fixed on the small textile laminate wafers (4).

The electric current generated by the source E enters the housing of one of the bearings under test, passes from the inner to the outer ring of the bearing, by means of the rolling balls, and, from here, it reaches the bronze bushing (5). After that, the electric current passes from the bushing (5), to the inner ring of the latter bearing under testing, goes through this bearing by means of rolling elements, and the circuit is switched on through the housing of the latter tested bearing.

Measuring the supply voltage of the current determined by the two serially connected bearings under testing, and the amperage is made by a data acquisition plate (NI 6062 E), the data being processed in a laptop (fig.2).

This way we were able to study the influences of the electric shocks obtained by the discharge of a battery of condensers. The tests were carried out at a radial load of 57,65 N, obtained by means of weights (10), at a rotational speed of 600[rev/min], given by the asynchronous electrical motor (1), supplied by a static frequency changer.

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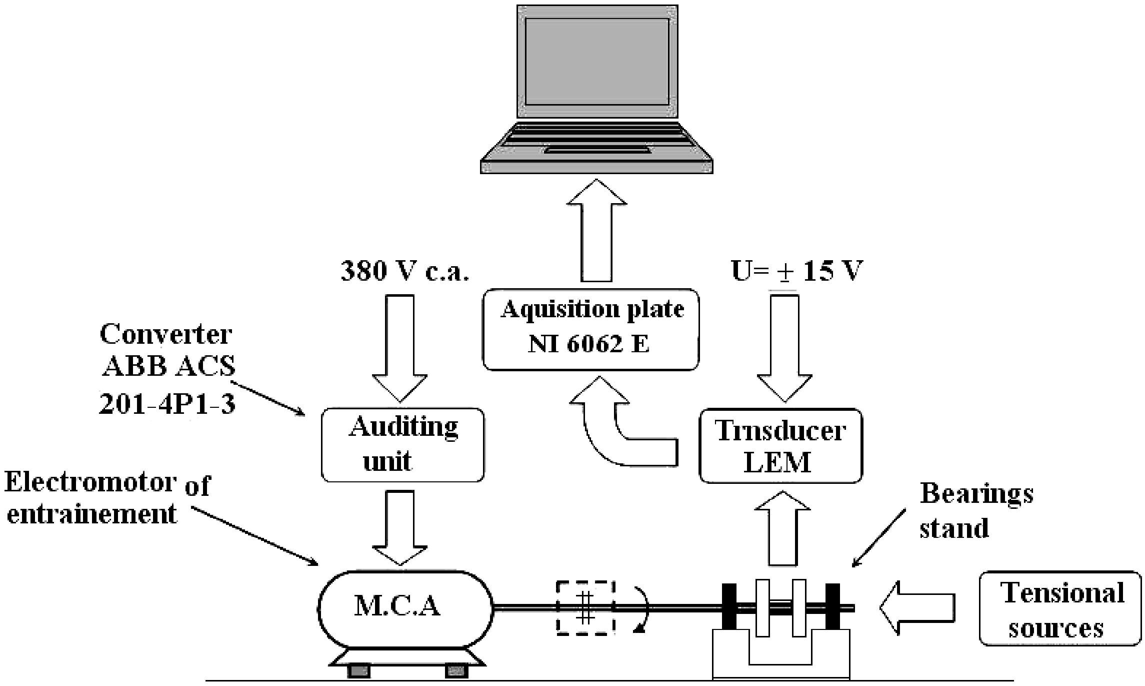

Fig.2 Control and data acquisition system of the rig.

3. CONCLUSIONS

The analysis of data and photos allowed us to draw the following conclusions:

- A first effect of discharges is a noise which exceeds the normal limits and rises directly proportional to the number of shocks (fig.4).
- In the unlubricated bearing the number of points of discharge on the surface of the ball race of the inner ring is higher than on the surface of the outer ring (tables 3, 4). This behavior is due to the dimensions the air volume between the two metallic parts; more precisely, the two volumes have different convexities. In the outer ring and balls contact, the volumes are smaller, and so are the distances, while in the inner ring and balls contact, the volumes are bigger, and so are the distances.

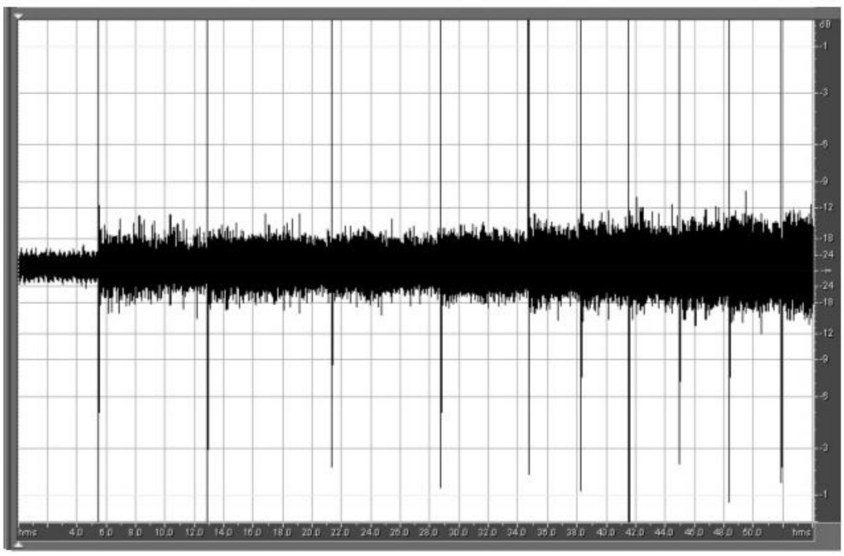

Fig.4 Evolution of noise after consecutive discharges, Beacon 325, 400 [V], 10 shocks

- In the unlubricated bearing the number of points of discharge on the surface of the ball race of the inner ring is higher than on the surface of the outer ring (tables 3, 4). This behavior is due to the different shape of the air volume between the two metallic parts; more precisely, the two volumes have different convexities. In the outer ring and balls contact, the volumes are smaller, and so are the distances, while in the inner ring and balls contact, the volumes are bigger, and so are the distances.
- The great number of discharge points (in the case of one discharge) is due to the absence of grease, case when the contact between the rolling elements and races is a purely metallic one, resulting in a good conduction on a large surface (linear discharges on the race generatrix) (photo 6, 7). This phenomenon was met when Beacon 325 grease was used (photo 2, 10) and can be explained by the different density of the two lubricants. Thus, the Chevron SR12 grease, being more fluid, creates a compact non-conductive film, whereas Beacon 325 has a granular structure, which favors multi-point discharges.
- When using the Chevron SR12 grease, the number of discharges coincides with the number of shocks applied to the bearing (table 3). This observation leads us to conclude that the discharge is made through one ball, producing one pit (photo 4,5). The situation does not repeat itself at the voltage level of 400 [V], because the current intensity reaches a double value, which presupposes the involvement of a larger surface in order to obtain a discharge. Furthermore, this grease with a highest volume resistivity will lead to a larger amount of dissipated energy.
- At the same time, it may be seen that the melted metal surfaces are larger in this case than in the other two situations (Beacon 325, unlubricated specimen).
- We have seen a different number of pits consequent to each type of tests, depending on the lubricant used, and, also, that the number of balls, by which a discharge is made, differs with each type : Chevron SR12 – one ball, Beacon 325 – three balls, unlubricated specimen – five balls (fig.5).

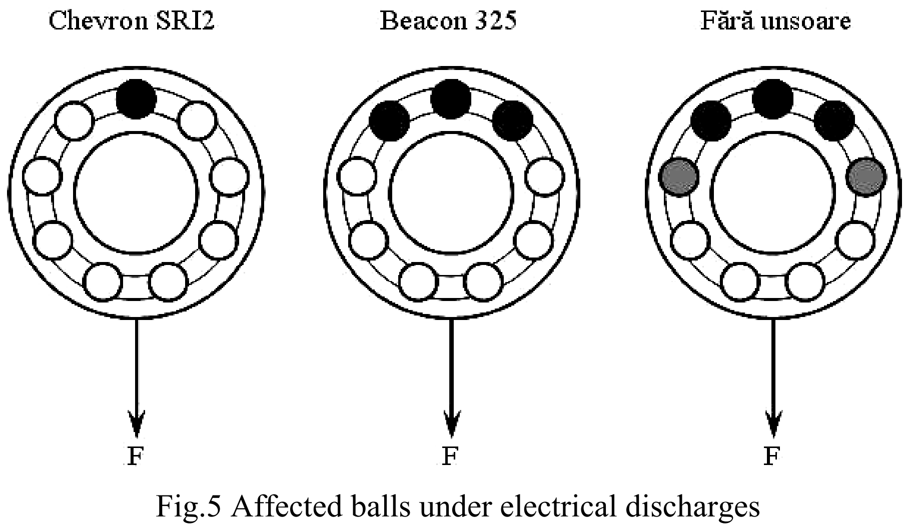

Fig.5 Affected balls under electrical discharges

- A repetition of certain discharges was seen at intervals of approx. 0.244 [mm], however, of low intensity (photo 12), which led to the conclusion that they are the effect of current passing towards the negative maximum (fig.6), as the two maxims occur at an interval of approx. 0.27 [ms].In this way we can obtain a method of determining the speed of balls revolutions, depending on charge.

**The mentioned photos are presented in the "Part II" of this paper*

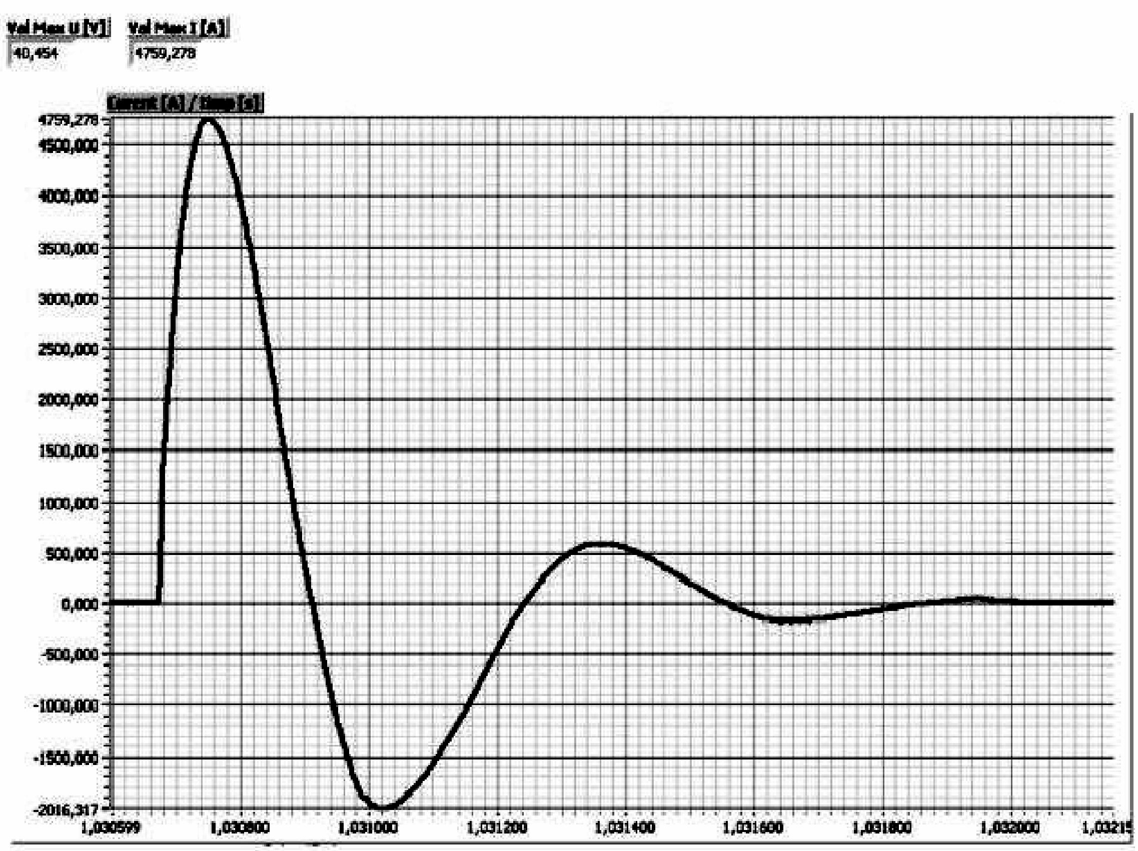

Fig. 6 Waveform of the applied shock

- In the case of unlubricated bearings, both the inner and the outer rings show a more pronounced deterioration of the race. Thus, besides the pits due to discharges, we can see a multitude of mechanical defects. One explanation of this phenomenon may be the fact that the presence of grease makes it possible for the micro-particles resulted from the melting, pinching or breaking of the welding points at discharge to be included and retained to a large extent in the outer race. If the grease is absent, they are included between the balls and race, leading to their imprinting on the race surface. (Photo 13, 14, part II).
- In the case of outer rings, there is a tendency for deteriorations to be distributed approximately on 2/3 of the race only, which is due to the influence of the load (weight) that acted radially. Mention is made that the tests were carried out at low radial load.
- A more thorough analysis of the discharge tracks has shown almost an identity between their forms on the balls and on the inner race, as can be seen in photos 15 and 16.

4. REFERENCES

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