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SOLUTIONS FOR DIAGNOSING FAULTS IN AN ASYNCHRONOUS MOTOR STATOR THROUGH A FERROFLUID INSTALLATION

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ABSTRACT

Due to their reliability, robustness and multitude of variants of motors, electric machines are commonly used in industrial drives. Although they are relatively simple pieces of equipment, asynchronous motors can sometimes malfunction because of various reasons. Whether it is a problem in the supply network (lack of a phase, wrong phase sequence, different phase voltages, etc.) or an internal fault in the stator winding (interrupted winding, reversing the winding so that it begins with the end, shortened coils, etc.) motors diagnosis was a constant concern among specialists. Although a number of classic solutions are known, generally pertaining to the type of defect assumed, this paper proposes a completely new approach applicable to all types of anomalies that may occur in the functioning of these engines.

KEYWORDS: ferrofluid, rotating magnetic field, asynchronous motor

1. Introduction

The magnetic fields study and the opportunities to highlight the load line were constant concerns for the EMAD research team from "Ștefan cel Mare" University of Suceava. During the experiments, a series of images were obtained by exposing the content of a cylindrical container to a continuous magnetic field action. These images were named "CEUS figures" (Electrotechnical Department of the University of Suceava), the acronym being suggested by academician Emanuel Diaconescu in a scientific session.

Using CEUS figures, a series of devices were made in order to diagnose the defects that may appear at the machines. Because of the multitude of causes that lead to machine malfunction, we have tried to identify some types of defects. For example, the defects in the driven magnetic circuits have as immediate effect strong local heating, which leads to the premature aging of insulation. However, the most frequent defects are located in the stator winding, and they could be: strong heating, stiff starting, anomalous noise, absorbed currents unequal on phases, inappropriate rotational frequency and insufficient power.

2. Apparatus for asynchronous motors defects diagnosis

The experimental model used to obtain the CEUS figures consists, mainly, of the stator of a three-phase asynchronous motor whose rotor has been replaced by a sample container made of an insulating material, partially filled with ferrofluid. To highlight the ferrofluid movement and to capture the CEUS figures, the fluid surface was interspersed with bronze ultrafine powder that had indicator role.

The unfolded arrangement of the stator winding of the experimental apparatus is shown below in Figure 1 and Figure 2.

The CEUS figures having the form shown in Figure 2 were obtained by applying the continuous magnetic field produced by the stator of the asynchronous motor over the ferrofluid from the insulating cylindrical container.

To correlate the images with the direction of the field lines, we used a pointer located in the center of the stator, which deviated or rotated in the direction of the rotating magnetic fields when the stand was supplied.

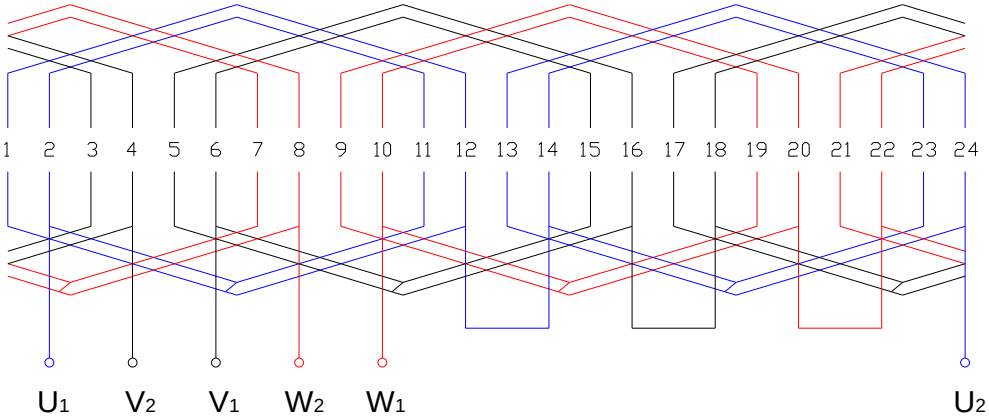

Fig. 1. *Stator winding schema used in the arrangement*

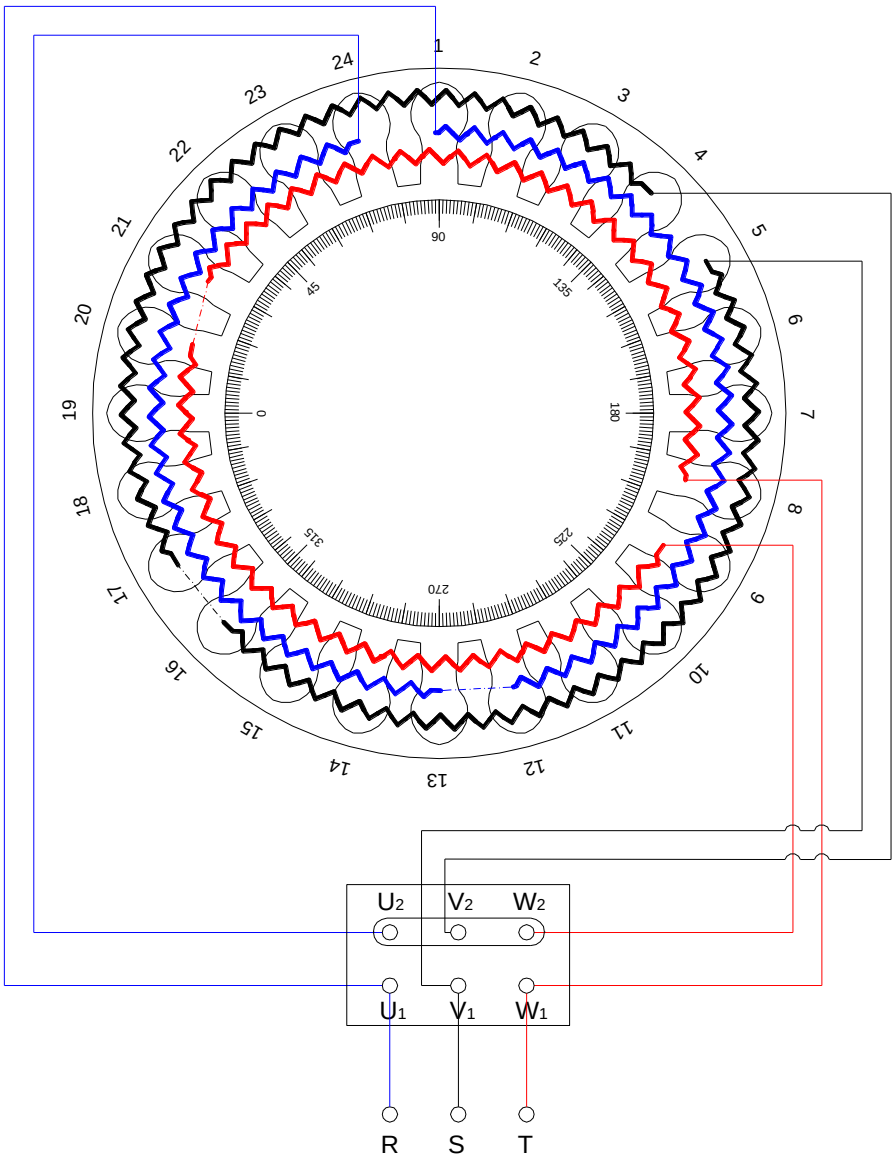

Fig. 2. *The windings disposal on the three phases into the ferrofluid container*

The entire experimental study consists of 31 distinct abnormal operating situations of the asynchronous motor for: defects in the supply network, flawed terminal connection or stator windings internal defects. Due to limited space, this paper presents only a small part of the results, respectively the typical images of the following situations:

- engine supplied in delta connection with a phase missing in the electric-power-supply-network;
- engine supplied in Y connection with a phase missing in the electric-power-supply-network;
- engine supplied in delta connection with an interrupted winding in the stator coil;
- engine supplied in Y connection whose winding whereat was reversed, beginning with the end;
- engine supplied in "V" connection.

3. The diagnosis of asynchronous motors malfunctioning

The CEUS figures for various abnormal motion types of the asynchronous motor are shown in the images presented below:

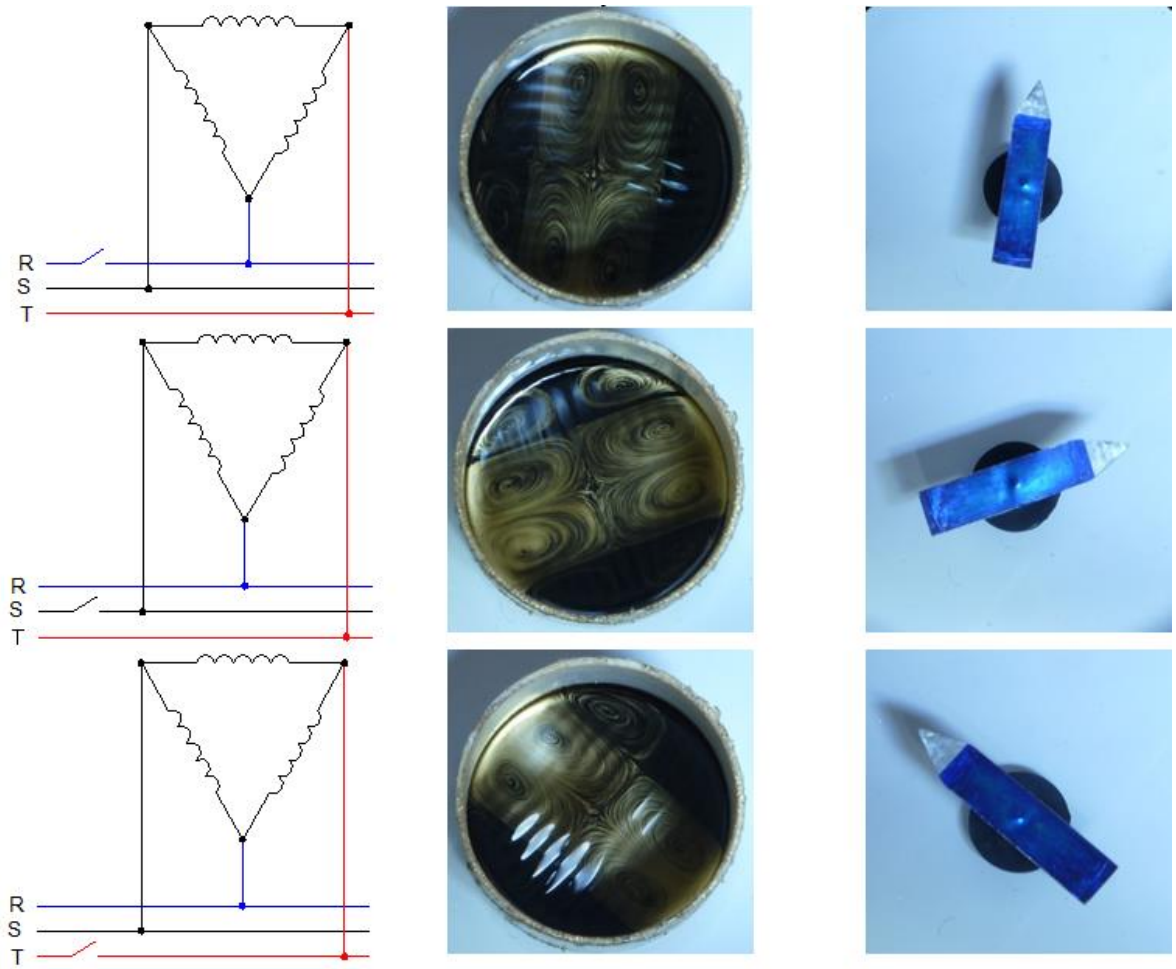

Fig. 3. *Engine supplied in delta connection with a phase missing in the electric-power-supply-network*

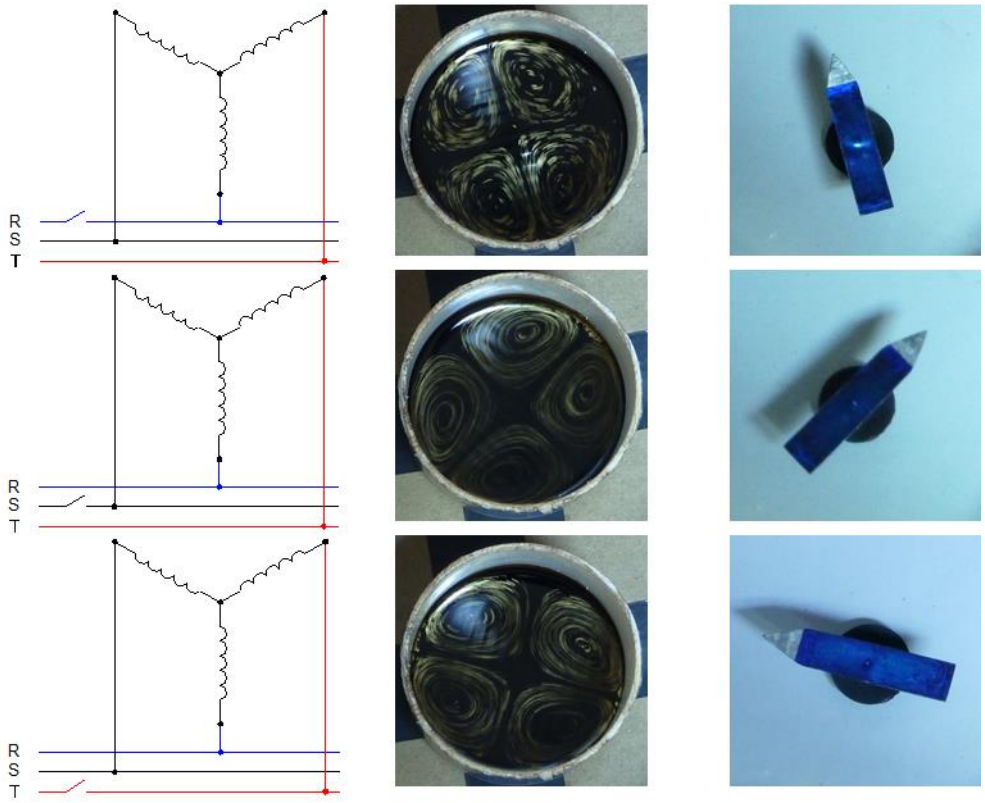

Fig. 4. *Engine supplied in Y connection with a phase missing in the electric-power-supply-network*

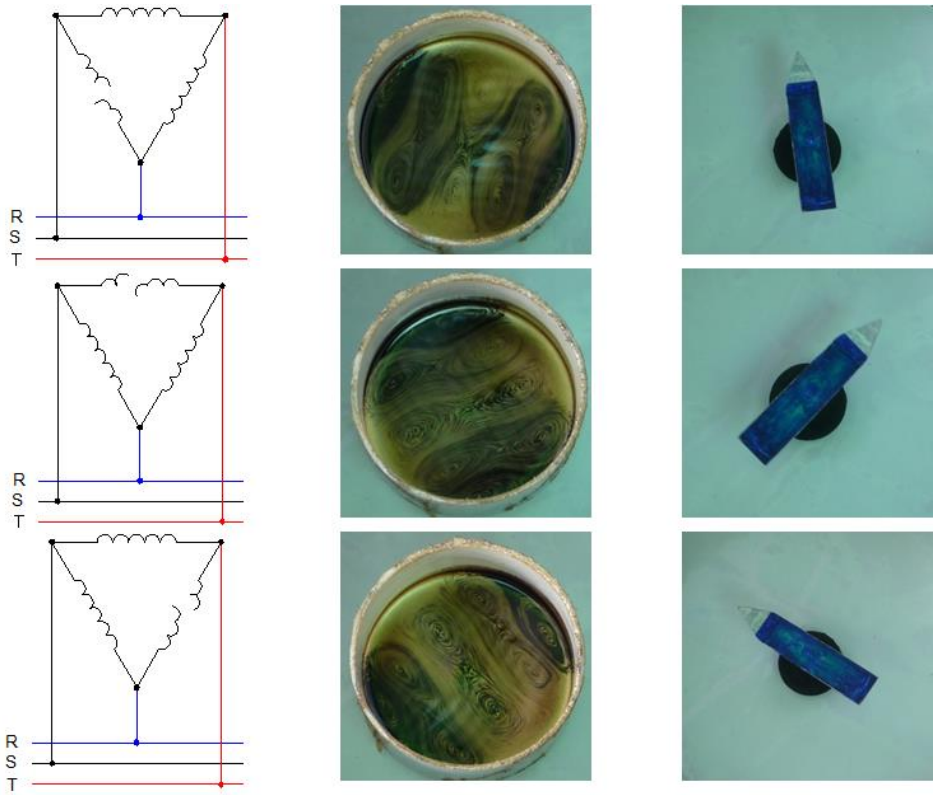

Fig. 5. *Engine supplied in delta connection with an interrupted winding in the stator coil*

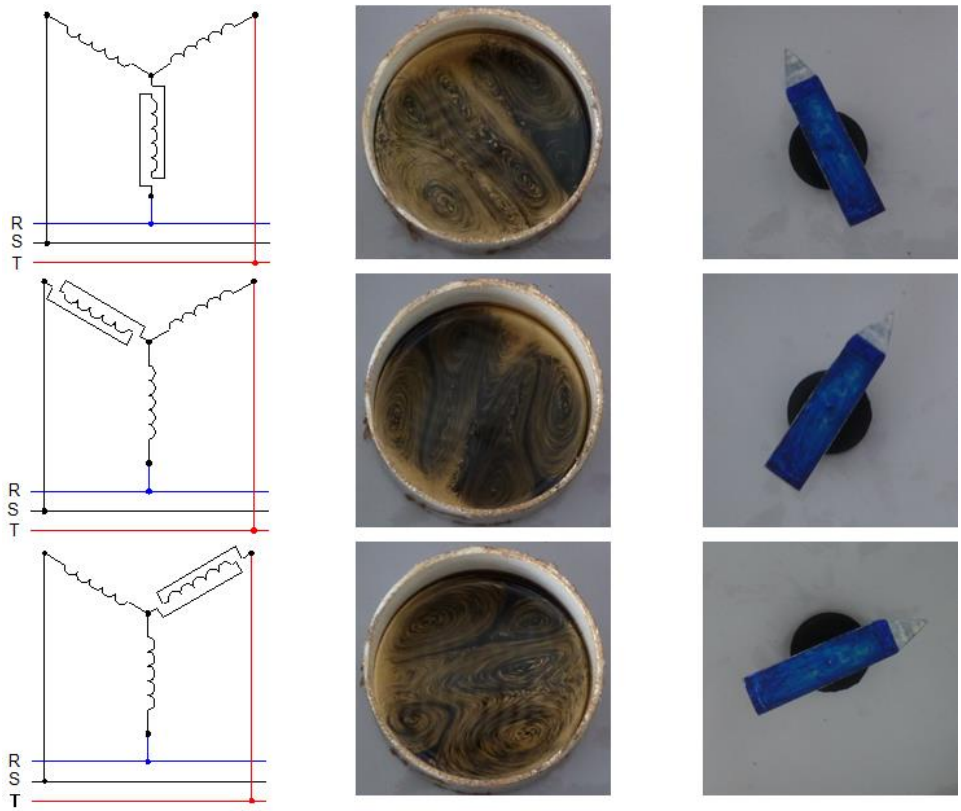

Fig. 6. *Engine supplied in Y connection whose winding was reversed, beginning with the end*

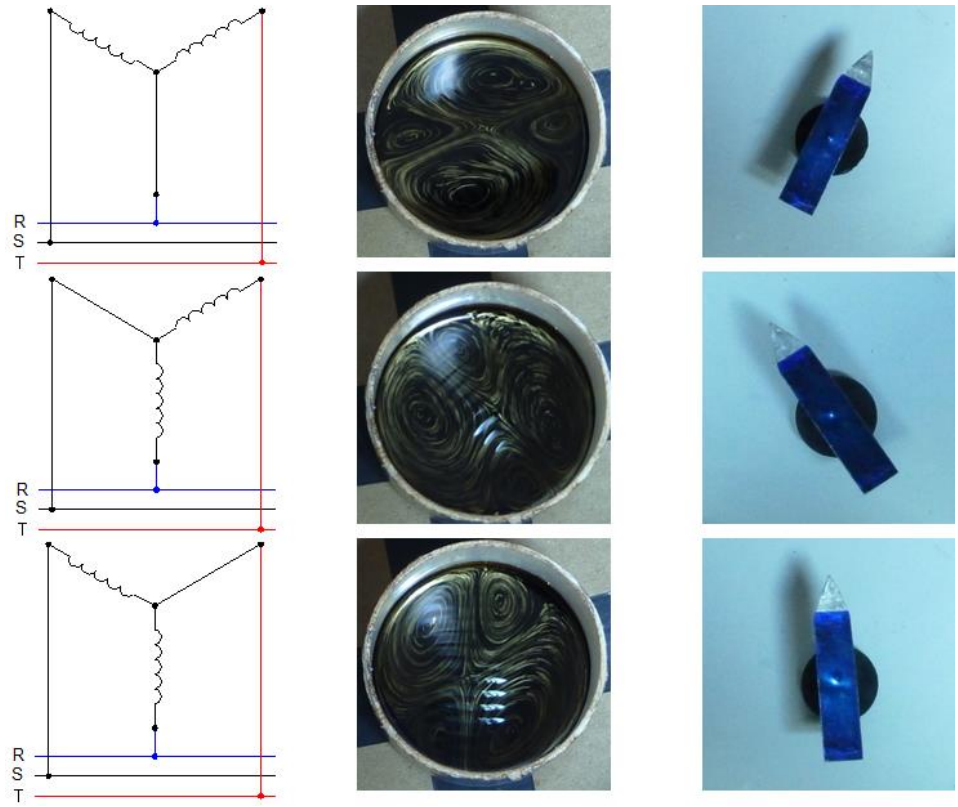

Fig. 7. *Engine supplied in "V" connection*

4. Conclusion

- The rotating magnetic field sense of rotation produced by the analyzed stator is given by the phase sequence. The ferrofluid sense of rotation is reversed compared to the rotating magnetic field.
- During the research a method has been developed to highlight the movement, by sprinkling the ferrofluid surface with a powder that has indicator role.
- To obtain the ferrofluid motion pictures at low rotational speed, a high performance camera with a high exposure time was used.
- The CEUS figures obtained are true stamps that can provide information for malfunction diagnosis of an asynchronous motor stator. Whether it is a problem in the supply network, a flawed terminal connection or stator windings internal defects, the images may point to a certain type of defect.

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