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INDUSTRIAL APPLICATIONS OF INDUCTIVE THERMOGRAPHY: A NOVEL INDUCTOR FOR MULTI-DIRECTIONAL CRACK DETECTION

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Abstract

In the application of inductive thermography as a non-destructive testing technique for crack detection, the relative orientation of the induced currents with respect to the cracks is a fundamental parameter [1]. During the last year, a new multidirectional inductor has been developed [2]. In this paper, this new inductor concept is applied to the detection of defects in components that belong to different industrial sectors in order to prove its utility. Obtained results are compared to traditional inductors.

1. Induced currents description

As known, for the optimal detection of a defect, the induced currents have to be perpendicular to it, so when the induced currents can flow only in one direction, several defects will be missed (See Figure 1a). On the contrary, if different directions are covered, the total amount of defects detected is increased, leading to more robust inspection systems (see Figure 1b).

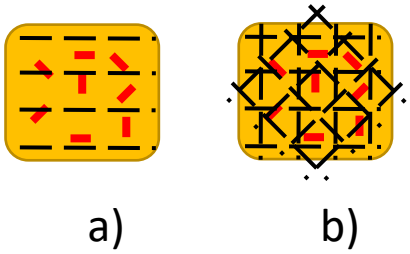

Figure 1. Induced currents in one direction (a) and multi-directional induced currents with new inductor (b)

1.1. Traditional inductors

So as to generate these multidirectional induced currents with other typical inductors, such as Helmholtz coils (Figure 2a) or U-shaped inductor (Figure 2b), a physical movement of the inductor is needed, which will lead to increasing the complexity of the inspection system and the total inspection time.

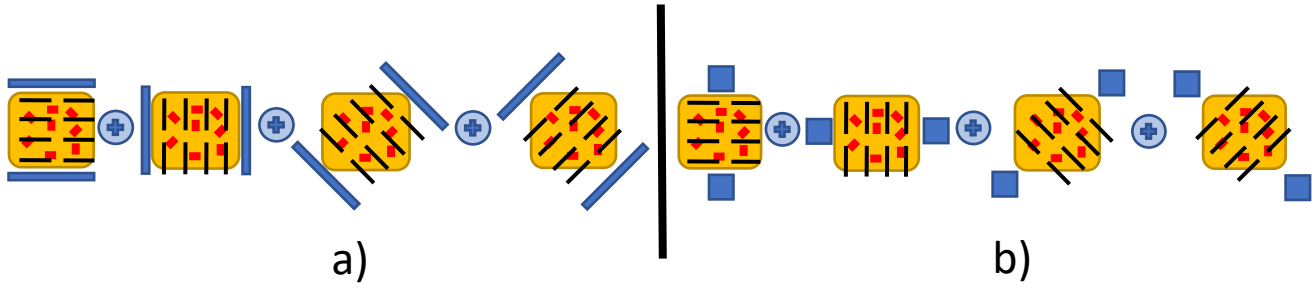

Figure 2. Scheme of two traditionally employed inductors and the rotations needed to cover different directions. Helmholtz coil (a) and U-shaped inductor, represented by its footprint (b)

1.2. Novel inductor proposed

The aforementioned multidirectional inductor [3] enables to selectively generate a discrete set of induced currents into the sample without any mechanical alteration. By this, defects in any direction can be detected, increasing the detection capability of the system.

2. Set up and experimental measurements

Experimentally, the new inductor should guarantee that the detection of cracks in different orientations is, at least, the same compared to physically rotating the inductor. Based on the same set up, two strategies will be compared:

- Current induction only in a unique direction combined with a physical rotation of the inductor in 4 different orientations (Traditional approach).
- Steady inductor in a fixed position capable of generating eddy currents in 4 different directions (New approach)

A complete study will be developed in order to compare the detection capabilities of this new inductor compared to rotating a "traditional" U-shaped (Figure 2b). This comparison between traditional and new approaches will be measured employing different criteria, such as SNR or phase contrast, based in phase images after applying the DFT.

In both cases, the set up employed will be identical both in induction and camera parameters (most representative are listed):

- Generator power: 3/5 kW
- Induction frequency: 20-60 kHz
- Number and length of the pulses: 3 to 5 pulses of 50-200 ms each
- Cooled thermal camera, optimizing frame rate and integration time.
- Spatial resolution good enough to detect the smallest crack.

3. Industrial applications and components analysed

In this work several components related to various industries are be inspected, presenting real defectology (different in each case due to the nature of the defects) in order to test the proposed inductor.

The characteristics of this new inductor offer advantages over traditional designs in various industries:

- Automotive: Reducing inspection times while maintaining the capability of detection is crucial when inspection systems are introduced into a production line without affecting other processes.

- Offshore: Chain links for offshore platforms need to be fully inspected, detecting defects in any direction. Besides this, as well as in the automotive industry, the inspection process has to be quick enough for adapting to the production cycles.

- Aeronautics: Complex geometries require more efficient solutions. Inducing currents in different directions without physically rotating the inductor is a great advantage that helps to develop inspection systems capable of accessing to complex internal areas.

4. Conclusions

- Applications of a new inductor design are presented, providing multi-directional detection without physical rotation.
- It provides several industrial advantages compared to traditional inductors: reduction of inspection times, possibility of designing a more robust and simplified inspection system, multidirectional detection, etc.
- Potential applications in different industrial fields such as automotive, offshore, aeronautics…
- Quantitative comparison, based in phase contrast, between traditional and new approach to test the performance of the inductor, shows that the new type of inductor has the same performance.

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