

1.1.12. MODERN MAGNETIC PARTICLE FLAW DETECTORS

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Magnetic particle method of non-destructive testing is applied to detect surface and subsurface defects like discontinuities in the metal of semi-finished products, blank parts, parts, assemblies, welded joints, structures and articles at various life stages of such objects: production, operation and repair. At hazardous production facilities, magnetic particle method is used by more than 40% laboratories certified in the system of non-destructive testing. Magnetic particle method allows fatigue cracks and other defects to be detected at the early stage of their occurrence when it is difficult or impossible to detect them without special means. When correct testing technology is used, method allows detection of micro-cracks with opening width up to 0.001 mm and depth of 0.01 mm and more.

High efficiency of the magnetic particle method can be achieved only with rational selection of flaw detector, instruments, magnetic suspensions and testing modes. Such a selection is necessary, because objects tested under magnetic particle method are very diverse by overall dimensions, weight (from several dozens of grams to several hundreds of kilograms), testing conditions (parts at the stage of production or ones located in a structure with restricted access), conditions of testing performance (workshop, aerodrome field), including unfavorable weather conditions (high and low temperatures, rain, snow, etc.). In accordance with wide range of parameter values featuring tested objects, magnetic particle flaw detectors are also very diverse by weight, design (portable, movable, stationary, specialized), versatility, automation degree, schemes of magnetic field generation, level of metrological support and others.

When new flaw detectors are developed, requirements arising from such considerable diversity of test objects and conditions must be taken into account. Irrespective of application conditions and testing tasks, method efficiency and probability of flaw detection depends on many factors and, in particular, on technical characteristics of flaw detector. Magnetic particle flaw detector is the most important instrument of the magnetic particle testing. This device is intended for magnetization (and, if required, demagnetization) of test objects. Magnetizing device (electric contacts, flexible cables, electric magnets, etc.) is its main element.

Portable flaw detector of MD-M type is developed taking into account above requirements. Essential feature of flaw detector is the modular structure of its design. Flaw detector MD-M consists of three modules: module of pulse current MD-I; solenoid module MD-S; electric magnet module MD-E. These modules represent by themselves individual flaw detectors, which are not linked with each other either electrically or mechanically. Every one of flaw detector modules allows the complete cycle of magnetic particle testing to be carried out. Modular design provides mobility and convenience in testing of parts directly in an aircraft, helicopter, pipes of pipeline transport or other object.

Basing of carried out studies, pulse magnetization scheme is adopted in the pulse module MD-I, which allows current in pulse of up to 5,000 A to be obtained with small consumed power of up to 200 Wt. Pulse current ensures reliable detection of defects with elongation of less than 1 in parts of complex shape with large (by constant field) demagnetization factor. 10 memory cells are provided in unit, where part number, current rate, demagnetization duration are recorded. During testing using memory cells, testing modes,

including demagnetization current amplitude, are set automatically. This increases testing consistency and reliability.

In the solenoid module MD-S, following adjustments are provided: current, duration of magnetization and demagnetization, as well as current and pause durations in the “Current-Pause” mode. Data set for these parameters can be recorded into the memory cell of long-term storage. During testing using respective memory cell, recorded data are retrieved automatically.

In the electric magnet module MD-E, also 10 memory cells are provided, where testing technology data can be recorded. Module circuit is featured by skin-effect without current commutation in electric magnet used for demagnetization. During demagnetization, current of variable frequency from 0.5 Hz to 1,000 Hz is passed in windings of electric magnet. In this case, due to growth of inductive resistance with increase of frequency, current and depth of field penetration into metal are reduced practically to zero. Namely this factor ensures more qualitative demagnetization as compared with method of demagnetization by current commutation.

Application of MD-M flaw detectors with aviation equipment and other objects within a year has shown its high efficiency, convenience of parts testing without dismantling from structure.

On the basis of pulse magnetization scheme, flaw detector MD-10D with maximal magnetization current of 6,000 A (short-circuit current of 10,000 A) is developed. Consumed power is less than 2 kVA. Weight – 65 kg. Its application also appeared to be efficient.

Development of magnetic particle flaw detectors basing on specific tasks and conditions of testing, as well as using currently existed software opportunities will allow new generation of magnetic particle flaw detectors to be created.