90.24 - Machines and appliances for testing the hardness, strength, compressibility, elasticity or other mechanical properties of materials (for example, metals, wood, textiles, paper, plastics).

9024.10 - Machines and appliances for testing metals

9024.80 - Other machines and appliances

9024.90 - Parts and accessories

This heading covers a wide range of machines and appliances for testing the hardness, elasticity, tensile strength, compressibility or mechanical properties of various materials (e.g., metals, wood, concrete, textile yarns and fabrics, paper or paperboard, rubber, plastics, leather). It therefore **excludes** :

(a) Instruments or appliances for examining the microscopic structure of materials (e.g., metallographic or other microscopes - **heading 90.11** or **90.12**), or for analysing materials, or measuring properties such as porosity, thermal expansion, etc. (**heading 90.27**).

(b) Instruments or apparatus designed only for ordinary measurement or checking of width, thickness, etc. (e.g., of machined parts, wire, metal goods) (**heading 90.17** or **90.31**).

(c) Instruments for detecting faults, fissures, cracks or other defects in materials (**heading 90.31**).

The machines and appliances of this heading are generally used in industrial or research laboratories for testing manufactured articles (usually carefully selected or standard specimens). They may also be used during manufacturing processes, in constructional work (in workshops, building sites, etc.) or to check goods on delivery in warehouses, etc.

They may range from large mechanically, electrically or hydraulically operated machines of considerable weight (several tons) to small portable or even pocket size instruments. Some "universal " types (e.g., for metal testing) can be used for hardness, tensile, bending, etc., tests by means of separate attachments. Although they usually operate on the " start-stop " principle, some are designed for automatic or semi-automatic operation, (e.g., for testing large output off an assembly line).

Test results may be ascertained either by direct reading (sometimes with the aid of a simple optical device such as a magnifying glass, or even a built-in microscope or profile projector), or by separate microscopic examination of the test-piece (e.g., observation of ball-test marks on metal). In addition, certain machines may have provision for recording the stresses, strains, etc., borne by the test-piece.

(I) MACHINES AND APPLIANCES FOR TESTING METALS

This group covers machines and appliances for :

(A) **Tensile testing** on test-pieces, bars, wire, cables, springs, etc. Tensile tests are used to ascertain the elasticity, breaking stress and many other important properties of a metal. Tensile testing machines are of various types (e.g., vertical or horizontal, endless screw or hydraulic load types); basically, however, they each comprise jaws or clamps for holding the sample under test.

(B) **Hardness tests** on test-pieces, bars, machined parts, etc., the hardness of a metal being measured in terms of resistance of that metal to indentation. These tests include :

(1) The **steel ball indentation test** (hardened steel or metallic carbide ball) or **Brinell test**. The indentation is produced by applying a continuous pressure (not by impact or by repeated blows) to the steel ball, by means of a lever, spring or piston; the diameter of the imprint is then measured with a microscope.

(2) The **diamond pyramid indentation test**. This test may be made by the **Rockwell method** (in which the depth of the indentation is measured with a dial comparator), or by the **Vickers method** (microscope measurement of the area of the indentation). Other forms of these tests are also used (Monotron, Shore, Knoop, etc.), and there are also instruments for testing soft metals by means of a steel indenting tool (e.g., Rockwell method). The above three tests may be carried out by the same machine.

(3) The **rebound test** carried out by the aid of **scleroscopes or sclerographs**. A small hammer (usually tipped with a diamond pyramid) is released from a pre-determined height on to the surface of the piece under test. The harder the metal, the higher will be the rebound of the hammer.

(4) The **pendulum hardness test** in which the oscillations of a pendulum resting on the specimen are observed. The pendulum consists of an inverted U-shaped cast iron body fitted in the middle with a steel ball.

(C) **Bending tests**.

(1) **Impact tests** carried out on bars (whether or not notched). The bar rests on two supports and is subjected to the repeated impacts of a ram until it breaks; its limiting resistance is thus determined.

(2) **Pressure tests** (mainly for bars), **bending tests** (springs).

(D) **Ductility tests** mainly used to test sheet metal. An indenting tool, usually tipped with a steel ball, is gradually pressed into the sheet up to the point of perforation; the first contact is recorded, and the stress and deflection are then measured.

(E) **Folding tests** (sheets, bars and wire), **compression tests** and **shearing tests** (mainly for cast iron).

(F) **Fatigue tests**. Test-pieces are not only submitted to simple stresses, as described above, but are also subjected to compound and varying stresses. These tests are carried out by means of **rotating bending machines** (the specimens rotate at high speed), or **reversal torsional machines** (in which the torsional direction is alternately reversed), **electro-magnetic fatigue-testing machines**, etc.

(II) MACHINES AND APPLIANCES FOR TESTING TEXTILES

The main tests carried out by machines of this group include :

(1) **Extensibility and resistance to rupture tests, elasticity or tensile strength under strain tests, and the like (and combinations of such tests)**. The material under test may be raw fibres or yarns, ropes or cables, ordinary fabrics, webbing, belts, etc.

These tests are made with the aid of **dynamometers** of various types, usually named after their operating principle (e.g., pendulum or balance-lever, dynamometers) or according to the material for which they are most frequently used (e.g., single yarn, twisted yarn or rope, glass fibre, hank or skein, fabric, dynamometers); these tests may also be made by the use of **extensometers**. Some dynamometers are equipped with a ball device for perforation tests on fabrics.

(2) **Tests to detect changes in the dimensions of textile samples**. The expansion or shrinkage of a sample of fabric is measured after it has been stretched in the dry and in the wet states.

(3) **Wear and tear tests**. These are carried out on textile goods liable to be exposed to friction (sheets, cloths, table linen, etc.) and sometimes also on the yarn itself.

These tests are carried out by means of **abrasion-testers, wear-testers**, etc. A strip of cloth stretched at a suitable tension is progressively worn away by a friction instrument (an abrasive disc, a rotating cylinder fitted with metal flanges, a steel milling wheel, etc.). Wear and tear resistance is measured by the number of revolutions required for the friction instrument to cause the fabric to break.

The heading **does not include** instruments used to inspect textile materials (e.g., yarn uniformity testers; strain-testers to determine the tension to which yarn is subjected on warping-frames, on spoolers, etc.; yarn torsion counters and torsiographs to measure the torsion of yarns (**heading 90.31**).

(III) MACHINES AND APPLIANCES FOR TESTING PAPER, PAPERBOARD, LINOLEUM, FLEXIBLE PLASTICS OR FLEXIBLE RUBBER

These tests are mainly concerned with tensile strength (measuring of extensibility, break-load, etc.) or resistance to perforation. They are effected by means of **dynamometers** similar in basic design to those used for textiles.

This group **includes bursting strength testers, fold testers, etc.** (e.g., for paper), **elasticity meters, reboundimeters, tensile testers, abrasion machines, plastimeters** (e.g., for rubber or plastics).

(IV) MACHINES AND APPLIANCES FOR TESTING OTHER MATERIALS

Most of these materials (e.g., wood, concrete, hard plastics) are subjected to tensile, bending, hardness, compression, shearing, abrasion, etc., tests, by means of machines and apparatus similar in principle to those used for metal testing (by ball-imprint, impact, etc.).

The heading also includes a large number of instruments, usually small in size, designed to determine the tensile strength, resistance to bending, compression, etc., of test-pieces moulded from foundry moulding sand. It also covers instruments designed for measuring the surface hardness of finished foundry moulds or mould cores.

PARTS AND ACCESSORIES

Subject to the provisions of Notes 1 and 2 to this Chapter (see the General Explanatory Note), parts and accessories of apparatus or appliances of this heading remain classified here.