INDUSTRIAL GOODS — GROUP 1

Metal-Working Machinery

NOTE:
For computer related terms, see Item 1565 or 1566.

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Technology for metal-working manufacturing processes and specially designed "software" therefor, as follows:

I. Definitions of terms used in this Item:

(*a*) "Hot die forging" is a deformation process where die temperatures are at the same nominal temperature as the workpiece and exceed 850 K (577°C, 1,070°F);

(*b*) "Superplastic forming" is a deformation process using heat for metals that are normally characterised by low values of elongation (less than 20%) at the breaking point as determined at room temperature by conventional tensile strength testing, in order to achieve elongations during processing which are at least 2 times those values;

(*c*) "Diffusion bonding" is a solid-state molecular joining of at least two separate metals into a single piece with a joint strength equivalent to that of the weakest material;

(*d*) "Metal powder compaction" is a process capable of yielding parts having a density of 98% or more of the theoretical maximum density;

(*e*) "Direct-acting hydraulic pressing" is a deformation process which uses a fluid-filled flexible bladder in direct contact with the workpiece;

(*f*) "Hot isostatic densification" is a process of pressurizing a casting at temperatures exceeding 375 K (102°C, 215.6°F) in a closed cavity through various media (gas, liquid, solid particles, etc.) to create equal force in all directions to reduce or eliminate internal voids in the casting;

(*g*) "Vacuum hot pressing" is a process which uses a press with heated dies to consolidate metal powder under reduced atmospheric pressure into a part;

(*h*) "High pressure extrusion" is a process yielding a single-pass reduction ratio of 4 to 1 or greater in a cross sectional area of the resulting part;

(*i*) "Isostatic pressing" is a process which uses a pressurising medium (gas, liquid, solid particles, etc.) in a closed cavity to create equal force in all directions upon a metal powder-filled container for consolidating the powder into a part.

II. Listed as follows:

(*a*) Technology for the design of tools, dies and fixtures specially designed for the following processes:
- (1) "Hot die forging";
- (2) "Superplastic forming";
- (3) "Diffusion bonding";
- (4) "Metal powder compaction" using:
  - (i) "Vacuum hot pressing";
  - (ii) "High-pressure extrusion"; *or*
  - (iii) "Isostatic pressing";
- (5) "Direct-acting hydraulic pressing";

(*b*) Technical data consisting of process parameters as listed below used to control:
- (1) "Hot die forging":
  - (i) Temperature;
  - (ii) Strain rate;
- (2) "Superplastic forming" of aluminium alloys, titanium alloys and superalloys:
  - (i) Surface preparation;
  - (ii) Strain rate;
  - (iii) Temperature;
  - (iv) Pressure;
- (3) "Diffusion bonding" of superalloys and titanium alloys:
  - (i) Surface preparation;
  - (ii) Temperature;
  - (iii) Pressure;
- (4) "Metal powder compaction" using:
  - (i) "Vacuum hot pressing":
    - (*a*) Temperature;
    - (*b*) Pressure;
    - (*c*) Cycle time;
  - (ii) "High-pressure extrusion":
    - (*a*) Temperature;
    - (*b*) Pressure;
    - (*c*) Cycle time;
  - (iii) "Isostatic pressing":
    - (*a*) Temperature;
    - (*b*) Pressure;
    - (*c*) Cycle time;
- (5) "Direct-acting hydraulic pressing" of aluminium alloys and titanium alloys:
  - (i) Pressure;
  - (ii) Cycle time;
- (6) "Hot isostatic densification" of titanium alloys, aluminium alloys and superalloys:
  - (i) Temperature;
  - (ii) Pressure;
  - (iii) Cycle time.

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I. Specially designed equipment, tooling and fixtures for the manufacture or measuring of gas turbine blades or vanes, as follows, and specially designed components and accessories and "specially designed software" for the equipment, components and accessories:

(*a*) Blade or vane aerofoil or root automatic measuring equipment;

(*b*) Precision vacuum investment casting equipment, including core-making equipment;

(*c*) Small-hole drilling equipment for producing holes having depths more than four times their diameter and less than 0.76 mm (0.03 inch) in diameter;

(*d*) Directional solidification casting equipment and directional recrystallization equipment;

(*e*) Segmented cast blade or vane bonding equipment;

(*f*) Integral blade-and-disc casting equipment;

(*g*) Blade or vane coating equipment, *except* furnaces, molten-metal baths and ion-plating baths;

(*h*) Ceramic blade or vane moulding and finishing machines;

(*i*) Moulds, cores and tooling for the manufacture and finishing of:
- (1) Cast hollow turbine blades or vanes;
- (2) Turbine blades or vanes produced by powder compaction;

(*j*) Composite metal turbine blade or vane moulding and finishing machines;

(*k*) Inertial blade or vane welding machines.

II. Technology (*except* installation, operation and maintenance technology) for the use of the following unembargoed equipment:

(*a*) Blade or vane belt grinding machines;

(*b*) Blade or vane edge radiusing machines;

(*c*) Blade or vane aerofoil milling or grinding machines;

(*d*) Blade or vane blank preforming machines;