

CLASS 419, POWDER METALLURGY PROCESSES

SECTION I - CLASS DEFINITION

This is the generic class for producing metals, alloys or metal containing compositions in a solid or compact state from powdered or particulate material with or without heating.

SECTION II - LINES WITH OTHER CLASSES AND WITHIN THIS CLASS

The order of superiority among various metal, alloy, and metal stock areas and methods of manufacture involving them is as follows:

- (1) Class 419, Powder Metallurgy Processes.
- (2) Class 148, Metal Treatment, subclasses 22+, compositions for treatment of solid metal.
- (3) Class 75, Specialized Metallurgical Processes, Compositions for Use Therein, Consolidated Metal Powder Compositions, and Loose Metal Particulate Mixtures, subclasses 300, 301, and 303+, gaseous, liquid, or solid treating compositions for liquid metal or charges, and subclass 302, welding rod defined by composition.
- (4) Class 75, Specialized Metallurgical Processes, Compositions for Use Therein, Consolidated Metal Powder Compositions, and Loose Metal Particulate Mixtures, subclasses 228+, consolidated metal powder compositions and subclasses 255+, loose metal particulate mixtures.
- (5) Class 420, Alloys or Metallic Compositions, claimed as products.
- (6) Class 148, Metal Treatment, subclasses 95-122, 240-287, and 500-714, in the schedule order, providing for certain processes of treating solid or semi-solid metal by modifying or maintaining the internal physical structure (i.e., microstructure) or chemical property of metal, processes of reactive coating of metal or processes of chemical-heat removing (e.g., flame-cutting, etc.) or burning of metal. However, if metal casting, metal fusion bonding, machining, or working is involved, there is a requirement of significant heat treatment as described in section III, A, of the Class 148 definition.
- (7) Class 148, Metal Treatment, subclasses 33+ barrier layer stock material and subclasses 400+, stock.

(8) Class 75, Specialized Metallurgical Processes, Compositions for Use Therein, Consolidated Metal Powder Compositions, and Loose Metal Particulate Mixtures, subclasses 331+, processes of making solid particulate alloys directly from liquid metal and subclasses 343+, processes of producing or purifying alloys in powder form.

(9) Class 75, Specialized Metallurgical Processes, Compositions for Use Therein, Consolidated Metal Powder Compositions, and Loose Metal Particulate Mixtures, subclasses 10.1+ and 10.67, processes of making alloys electrothermic, electromagnetic, or electrostatic processes.

(10) Class 420, Alloys or Metallic Compositions, processes of manufacture.

(11) Class 75, Specialized Metallurgical Processes, Compositions for Use Therein, Consolidated Metal Powder Compositions, and Loose Metal Particulate Mixtures, subclasses 330+, processes of making metal and processes of treating liquid metals and liquid alloys and consolidating metalliferous material.

(12) Class 204, Chemistry: Electrical and Wave Energy, processes.

(13) Class 164, Metal Founding, subclasses 1+, processes.

(14) Class 266, Metallurgical Apparatus, subclasses 44+, processes of operating metallurgical apparatus.

This list is not complete and may be added to as the proper relationship of other areas is determined.

See References to Other Classes, below, for additional information about lines with the following types of classes:

Compound, Composition, and Material Classes;

Article or Product Classes;

Process Classes;

Apparatus Classes.

SECTION III - REFERENCES TO OTHER CLASSES

- SEE OR SEARCH CLASS:
- 29, Metal Working, appropriate subclasses for processes for manufacturing specific articles provided for in Class 29 by processes not involving powder metallurgy steps. (process class)
- 74, Machine Element or Mechanism, appropriate subclasses, for machine elements defined by structure and/or function, which may have been made by a Class 419 process. (article or product class)
- 75, Specialized Metallurgical Processes, Compositions for Use Therein, Consolidated Metal Powder Compositions, and Loose Metal Particulate Mixtures, subclasses 331+ and 343+ for processes of making metal powders and subclasses 746+ for consolidating metalliferous material that is used in metallurgical processes. (process class)
- 75, Specialized Metallurgical Processes, Compositions for Use Therein, Consolidated Metal Powder Compositions, and Loose Metal Particulate Mixtures, subclasses 303+ for consolidated furnace charges (e.g., briquettes, etc.) containing a free metal which are used as charges in Class 75 processes and for compositions which may contain metal powder which are used as fluxes in smelting and treating metalliferous ores, subclasses 228+ for consolidated metal powder compositions which may have been prepared by a Class 419 process, and subclasses 255+ for loose powder compositions containing a free metal. (compound, composition and material class.)
- 117, Single-Crystal, Oriented-Crystal, and Epitaxy Growth Processes; Non-Coating Apparatus Therefor, for processes for growing therein-defined single-crystal of all types of materials, including metal, and not including a Class 419 method step. See Class 117 for guidance in placement of single-crystal related art.(process class)
- 117, Single-Crystal, Oriented-Crystal, and Epitaxy Growth Processes; Non-Coating Apparatus Therefor, for non-coating apparatus for growing therein-defined single-crystal of all types of materials, including inorganic or organic. Coating apparatus are generally located in Class 118. (apparatus class)
- 123, Internal-Combustion Engines, appropriate subclasses for such elements of internal combustion engines as are provided for in that class, defined by structure/function, which may have been made by a Class 419 process. (article or product class)
- 128, Surgery, appropriate subclasses, for surgical devices and instruments defined by structure/functions which may have been made by a Class 419 process. (article or product class)
- 148, Metal Treatment, particularly subclass 514 for processes of pre-treatment or post-treatment of a previously sintered or compacted consolidated powder metal starting material to modify or maintain the internal physical structure (i.e., microstructure) or chemical properties of metal and wherein there is no actual step of sintering or compacting of the powdered metal recited. However, Class 419 takes as original pre-treatment or post-treatment operations as long as the sintering or compacting operation is present. See, also, Class 148, subclass 513 for treatment of loose metal powder by a Class 148 operation. (process class)
- 148, Metal Treatment, particularly subclass 513 for processes of treating loose metal particles (e.g., powder, etc.) to modify or maintain the internal physical structure (i.e., microstructure) or chemical property of metal and lacking a sintering or compacting operation. (compound, composition and material class)
- 175, Boring or Penetrating the Earth, appropriate subclasses, especially subclasses 327+, for earth boring or penetrating elements or devices defined by structure/function, which may have been made by a Class 419 process. (article or product class)
- 188, Brakes, appropriate subclasses, especially subclasses 218 through 265 , for braking apparatus or elements defined by structure/function, which may have been made by Class 419 process. (article or product class)
- 192, Clutches and Power-Stop Control, appropriate subclasses, especially subclasses 106.1 through 115 , for clutch and power-stop control apparatus or elements provided for in Class 122, defined by structure/function, which may have been made by a Class 419 process. (article or product class)
- 200, Electricity: Circuit Makers and Breakers, appropriate subclasses, for electrical circuit makers and breakers defined by structure/function, which may have been made by a Class 419 process. (apparatus class)
- 216, Etching a Substrate: Processes, for etching of all materials not otherwise provide for, including a metal. (process class)

- 245, Wire Fabrics and Structure, appropriate subclasses, for wire fabrics defined by structure which may have been made by a Class 419 process. (apparatus class)
- 251, Valves and Valve Actuation, appropriate subclasses, for valve apparatus provided for in Class 251, which may have been made by a Class 419 process. (apparatus class)
- 252, Compositions, subclass 62.55 for magnetic compositions containing a free metal or alloy which may be in a particulate state, subclass 500 for electrically conductive or emissive compositions which may include a free metal in a powder state. (compound, composition and material class)
- 264, Plastic and Nonmetallic Article Shaping or Treating: Processes, subclass .5 for processes of making nuclear fuel elements or charges not involving powder metallurgy, but powder metallurgy processes for making such products are in this class (419), appropriate subclasses; subclasses 109+ for processes of forming articles by uniting randomly associated particles not including free metal particles. (article or product class)
- 266, Metallurgical Apparatus, appropriate subclasses, for sintering apparatus, per se. (apparatus class)
- 384, Bearings, appropriate subclasses, for bearing or bearing guides defined by structure/function which may have been made by a Class 419 process. (apparatus class)
- 407, Cutters, for Shaping, appropriate subclasses, for shaping cutters tools defined by structure/function which may have been made by a Class 419 process. (apparatus class)
- 415, Rotary Kinetic Fluid Motors or Pumps, appropriate subclasses for elements of rotary kinetic fluid motors or pumps provided for in Class 415, defined by structure/functions which may have been produced by a Class 419 process. (apparatus class)
- 416, Fluid Reaction Surfaces, (i.e., Impellers), appropriate subclasses, for elements of fluid reaction impellers provided for in Class 416, defined by structure/functions, which may have been made by a Class 419 process. (apparatus class)
- 425, Plastic Article or Earthenware Shaping or Treating: Apparatus, subclasses 78+ for means for molding powdered metal. (apparatus class)
- 428, Stock Material or Miscellaneous Articles, subclass 539.5 for stock material having a metal continuous phase interengaged with a nonmetal continuous phase, subclasses 546+ for miscellaneous stock material containing particles of free metal, and subclass 570 for composite powders which may comprise a free metal. (compound, composition and material class)
- 451, Abrading, especially subclasses 540+, for abrasive tool which may have been made by a Class 419 process. (article or product class)
- 623, Prothesis (i.e., Artificial Body Members), Parts Thereof, or Aids and Accessories Therefor, appropriate subclasses for artificial body members defined by a structure which may be made by a Class 419 process. (article or product class)

SECTION IV - GLOSSARY

The meaning to be given to the various "art" terms appearing in this class, but which have not been included in the Glossary below, is the same as that generally accepted or in common usage. However, certain terms employed in this class, which are included below, have been assigned definitions tailored to meet the needs of this class and therefore those may be more restricted or less limited or even altogether different from those in common usage.

COMPACTING

Forming of particulate material into a body or shape by the application of pressure to the particulate material without heating.

CONSOLIDATION

Forming of particulate material into a unitary body without heating. This may or may not include the application of pressure to the particulate material (e.g., slip casting).

SINTERING

The term sintering includes the union of finely divided material or powder by the action of heat with or without pressure. The heat must result from a positive application of heat at some point in the process. Heat resulting from the application of pressure alone is not considered to be a positive application of heat in these subclasses. Some, but not all, of the ingredients may melt. A chemical reaction such as reduction may occur during sintering.

FUGITIVE MATERIAL

A material which is incorporated in the powder admixture which is wholly destroyed or separated from the other materials in a subsequent step prior to or during the consolidation or sintering operation.

SUBCLASSES

1 POWER METALLURGY PROCESSES WITH HEATING OR SINTERING:

This subclass is indented under the class definition. Processes for producing metals, metalloids or metal containing composition in a solid state from powdered or particulate material including a heating or sintering operation, i.e., without melting all of the ingredients.

- (1) Note. The term sintering includes the union of finely divided material or powder by the action of heat with or without pressure. The heat must result from a positive application of heat at some point in the process. Heat resulting from the application of pressure alone is not considered to be a positive application of heat in these subclasses. Some, but not all of the ingredients may melt. A chemical reaction such as reduction may occur during sintering.

SEE OR SEARCH THIS CLASS, SUBCLASS:

- 61+, for similar processes which do not apply sufficient heat to effect sintering.

2 Making porous product:

This subclass is indented under subclass 1. Processes in which a porous or cellular mass is produced during sintering.

SEE OR SEARCH THIS CLASS, SUBCLASS:

- 5, for processes of infiltration (i.e., impregnating) and producing the porous sintered product.

SEE OR SEARCH CLASS:

- 106, Compositions: Coating or Plastic, subclass 122 and see the note thereunder for other classes involving porous forming.

3 Making articles of indefinite length:

This subclass is indented under subclass 1. Processes which produce a product having one dimension, its length, considerably greater than its other dimensions, but wherein the process does not establish a finite limit for the length.

4 Filaments or fibers:

This subclass is indented under subclass 3. Processes which produce a product having a shape which is basically cylindrical with the length considerably greater than its diameter.

SEE OR SEARCH CLASS:

- 29, Metal Working, subclass 419.1, for processes of working a mass of fibered materials which (1) have been previously formed into a body or (2) which do not ultimately form a body as a result of the working step.
252, Compositions, subclasses 500+ for electrically conductive or emissive compositions.
264, Plastic and Nonmetallic Article Shaping or Treating: Processes, subclasses 171.1+ for processes of making indefinite length articles or preforms which may comprise a metallic conductor, not involving powder metallurgy.

5 Making composite or hollow article:

This subclass is indented under subclass 1. Processes involving arranging one or more distinct powder material layers or portions in contact with one or more distinct layers or portions of powder or solid material and uniting the layers or portions by sintering, or processes under subclass 1 which produces an article which includes an internal hollow space or processes under subclass 1 which involve making a porous article and infiltrating (i.e., impregnating) it.

- (1) Note. Layers or portions of powder material are considered distinct if they differ with regard to chemical composition, particle size or degree of physical compaction, if they constitute individual preformed layers.

- (2) Note. Processes herein included are those involving two or more distinct lay-

ers as in (1) Note above, in which one or more powder layers are united with one or more solid layers by a sintering step.

- (3) Note. Processes for impregnating a sintered article by immersion or diffusion are excluded herefrom and are provided for in subclass 27.

SEE OR SEARCH THIS CLASS, SUBCLASS:

- 47, for processes in which during the sintering operation one layer melts and becomes dispersed throughout the other layer.

SEE OR SEARCH CLASS:

- 216, Etching a Substrate: Processes, for the use of etching in removing one substance from another or for removing a portion of a substance (work) not otherwise provided for.

6

Powder next to powder:

This subclass is indented under subclass 5. Processes which produce a product in which two contiguous layers or portions are both formed from material which was originally in powder form.

7

One or more components not compacted:

This subclass is indented under subclass 6. Processes in which at least one of the contiguous layers or portions is not compacted during the processing.

8

Powder next to solid:

This subclass is indented under subclass 5. Process which produce a product in which one of the contiguous layers or portions is not produced from particulate material.

9

Powder not compacted:

This subclass is indented under subclass 8. Processes in which a powder layer or portion is not compacted during the processing.

10

Metal and nonmetal in final product:

This subclass is indented under subclass 1. Processes which have in the resulting product a free metal and various materials, such as elemental carbon, metal borides, carbides, nitrides, oxides or silicides, or mixtures of same.

- (1) Note. This is the generic place for the sintering of mixtures composed of (1) a free metal or a substance which changes chemically to release a free metal (e.g., a metal hydride which decomposes) and (2) nonmetallic materials such as those stated in the indented subclass definitions.

- (2) Note. For the purpose of this classification, elemental silicon is considered to be a metal.

SEE OR SEARCH CLASS:

- 51, Abrasive Tool Making Process, Material, or Composition, subclass 309 for abrasive tool making processes, materials, and compositions comprising a free metal and metal oxides.
76, Metal Tools and Implements, Making, subclasses 107.1+ for processes of making dies.
420, Alloys or Metallic Compositions, for a process of producing an alloy which contains a nonmetallic component by melting.

11

Nonmetal is elemental carbon:

This subclass is indented under subclass 10. Processes in which the nonmetal is carbon in its elemental form, i.e., not in the form of a carbon compound.

- (1) Note. The carbon may be in the form of, e.g., graphite, diamond, etc.

12

Boride containing:

This subclass is indented under subclass 10. Processes in which the nonmetal material consists of a boride.

13

Nitride containing:

This subclass is indented under subclass 10. Processes in which the nonmetal material consists of a nitride.

14

Carbide containing:

This subclass is indented under subclass 10. Processes wherein the nonmetal material includes a carbide compound.

- SEE OR SEARCH CLASS:
501, Compositions: Ceramic, subclasses 87+ for processes of making sintered ceramic compositions which include a carbide.
- 15 Complex or multiple carbides:**
This subclass is indented under subclass 14. Processes in which the nonmetal includes a mixture of different carbides or a complex phase which includes carbon combined with a metal and at least one more element which may be a metal or a nonmetal.
- 16 With another nonmetal:**
This subclass is indented under subclass 15. Processes in which in addition to the carbide there is present another nonmetal.
- 17 Single binary carbide:**
This subclass is indented under subclass 14. Processes in which a nonmetal material consists of a single binary carbide.
- 18 Tungsten carbide:**
This subclass is indented under subclass 17. Processes in which the carbide is a carbide of tungsten.
- 19 Oxide containing:**
This subclass is indented under subclass 10. Processes in which the nonmetal material includes an inorganic oxide compound.
- 20 Rare earth oxide:**
This subclass is indented under subclass 19. Processes wherein the oxide contained in the final product is a binary compound of oxygen and a rare earth element.
- (1) Note. For the purpose of this classification the term "rare earth" includes elements with atomic numbers 57-71 and 87+, i.e., lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, francium, radium, actinium, thorium, protactinium, uranium, neptunium, plutonium, americium, curium, berkelium, californium, einsteinium, fermium, mendelevium, nobelium and lawrencium.
- 21 Silver metal with metal oxide:**
This subclass is indented under subclass 19. Processes in which silver is present as a matrix material and the nonmetal is a metal oxide.
- 22 Copper oxide:**
This subclass is indented under subclass 19. Processes in which the nonmetal is a binary compound of oxygen and copper.
- 23 Powder shape or size characteristics:**
This subclass is indented under subclass 1. Processes in which one or more dimensions of or the configuration of the contour of the powder particles is recited in the claims.
- 24 Filaments or fibers:**
This subclass is indented under subclass 23. Processes in which the shape of the particles is basically cylindrical with the length considerably greater than the diameter thereof.
- 25 Controlled cooling after sintering:**
This subclass is indented under subclass 1. Processes in which the lowering of the temperature of the hot sintered product is regulated in some positive fashion.
- (1) Note. Cooling at a stated rate or in a stated atmosphere are examples of controlled cooling within the definition of this subclass.
- 26 Post sintering operation:**
This subclass is indented under subclass 1. Processes in which there is an additional positive step following the sintering operation other than controlled cooling.
- 27 Impregnation:**
This subclass is indented under subclass 26. Processes in which the interstices between the sintered particles are at least partially filled by an additional liquid or solid material which was not present during or prior to the sintering step.
- 28 Subsequent working:**
This subclass is indented under subclass 26. Processes in which the sintered compact undergoes an additional mechanical treatment.
- (1) Note. The working step may comprise, e.g., machining, assembling, forging,

peening, rolling or other shaping, cutting, etc.

- (2) Note. If the product is heated and held at such a temperature for an extended period of time, the presumption shall be that any pressing operation is a working step under this subclass definition.

29 Subsequent heat treatment, (e.g., annealing, etc.):

This subclass is indented under subclass 26. Processes wherein the sintered compact is subjected to an additional heating step.

- (1) Note. The additional heating step may be for the purpose of, e.g., annealing the sintered compact, etc.

SEE OR SEARCH CLASS:

148, Metal Treatment, subclass 126.1, for heat treating unsintered metal powder which is not eventually consolidated into a unitary body.

30 Powder pretreatment (prior consolidation or sintering):

This subclass is indented under subclass 1. Processes which include preliminary significant treatment, preparation or manufacture of the powder or particulate material, prior to any compacting or sintering.

- (1) Note. Processes here provide for which in addition include such subsequent operations as provided for below are classified here and cross-referenced to the subclasses below.

SEE OR SEARCH THIS CLASS, SUBCLASS:

44, for processes which include a preliminary treatment of a "green body" prior to sintering or consolidation.

31 Heat treatment of powder:

Processes under subclass in which the powder is subjected to a temperature above the ambient temperature.

SEE OR SEARCH CLASS:

148, Metal Treatment, particularly subclass 513 for processes of treating loose metal particles (e.g., powder,

etc.) to modify or maintain the internal physical structure (i.e., microstructure) or chemical properties of the metal and lacking a sintering or compacting operation.

32 Mechanical blending:

This subclass is indented under subclass 30. Processes in which the powders of different chemical constitution or physical characteristics are mechanically mixed together.

- (1) Note. The mixing may be performed by, e.g., tumbling, ball milling, etc.

33 Comminuting:

This subclass is indented under subclass 30. Processes in which preliminary operation includes comminution, disintegration, abrasion or other mechanical method of producing a number of smaller solid masses by the division of a larger solid mass or masses.

SEE OR SEARCH THIS CLASS, SUBCLASS:

55, for sintering processes involving plural heating (sintering) steps in which the material is comminuted between sintering steps.

SEE OR SEARCH CLASS:

241, Solid Material Comminution or Disintegration, subclass 3 for process involving mechanical comminution or disintegration preceded by solidifying, consolidating, shaping and/or sintering steps provided no chemical change is involved, and see section 2 of the main class definition of Class 241 for the lines between Class 241 and the chemical classes when a chemical change is involved.

34 Chemical blending:

This subclass is indented under subclass 30. Processes in which the mixture which is consolidated is at least in part the product of a chemical reaction between other starting materials.

35 Coating:

This subclass is indented under subclass 30. Processes in which at least some particles of powder or particulate material become covered

by a layer of some other material, other than a fugitive material.

SEE OR SEARCH CLASS:

- 148, Metal Treatment, particularly subclass 514 for processes of pre-treatment or post-treatment of a previously sintered or compacted consolidated powder metal starting material to modify or maintain the internal physical structure (i.e., microstructure) or chemical properties of metal combined with a coating operation and wherein there is no actual sintering or compacting operation present.
- 205, Electrolysis: Processes, Compositions Used Therein, and Methods of Preparing the Compositions, subclasses 80+ for electrolytic coating processes not claimed in combination with a specific sintering operation.
- 427, Coating Processes, subclasses 212+ for processes of coating, flakes, particles, or granules, per se, especially subclass 216 when the base is metal.

36 Addition of fugitive material:

This subclass is indented under subclass 30. Processes wherein a fugitive ingredient is incorporated in the powder admixture.

SEE OR SEARCH THIS CLASS, SUBCLASS:

- 40, for processes which use a fugitive liquid carrier vehicle to make a slurry. If the admixture uses a carrier vehicle and the produced preform is subjected to additional mechanical compaction, the patent is placed here (in subclass 36).

37 Additional material is solid:

This subclass is indented under subclass 36. Processes wherein the additional material is in the solid state.

- 38** This subclass is indented under subclass 1. Consolidating of powder prior to sintering: Processes which include consolidating a mass of the powder at some stage prior to sintering the particles therein.

- (1) Note. To be classified here the claimed process must recite the pressing or shap-

ing in a significant manner, e.g., a specific pressure, pressure on all faces, pressure in increments, etc.

- 39** This subclass is indented under subclass 38. Specific pressure or lack of pressure recited: Processes which recite a specific pressure during the compaction step or which recite that no nonambient pressure is imposed during the compaction step, i.e., the quantity of pressure employed during the consolidation step is recited in the claims.

- (1) Note. A compacting reciting the use of ambient atmospheric pressure, which amounts to compacting by gravitation, is classified herein.

40 Slip or slurry:

This subclass is indented under subclass 39. Processes wherein powder to be consolidated is suspended in a liquid medium.

SEE OR SEARCH THIS CLASS, SUBCLASS:

- 36, processes in which the admixture includes a carrier vehicle and the produced preform is subjected to additional mechanical compaction.

41 Extruding:

This subclass is indented under subclass 38. Processes wherein the compaction is effected by forcing the powder through a restricted orifice under pressure.

- (1) Note. Extrusion processes as here contemplated are sometimes referred as die expressing or aquirting.

42 Isostatic or hydrostatic:

This subclass is indented under subclass 38. Processes wherein the powder is compacted uniformly in all directions in a preformed flexible mold immersed in a fluid in a pressure vessel, or wherein the compaction is performed on a hydraulic or hydrostatic press.

43 Rolling:

This subclass is indented under subclass 38. Processes wherein the compaction is effected by a generally cylindrical member, the roller, moving across the surface of the powder while

- revolving about an axis or repeatedly turning over.
- 44 Pretreatment of consolidated powders:**
This subclass is indented under subclass 1. Processes which include significant treatment of consolidated powder prior to sintering.
- SEE OR SEARCH THIS CLASS, SUBCLASS:
30, for pretreatment of powder prior to compacting.
- 45** This subclass is indented under subclass 1. Sintering which includes a chemical reaction: Processes which include a chemical reaction which is effected by the conditions present during the sintering step.
- SEE OR SEARCH THIS CLASS, SUBCLASS:
46, where it is recited that an alloy is formed.
- 46 Alloying occurs during sintering:**
This subclass is indented under subclass 1. Processes wherein more than one metallic element is present in the powder being treated and the conditions present during the sintering step cause an alloy to form from those metals.
- (1) Note. For the definition of alloy see (1) Note in the definition of class (75), subclass 122.
- 47 Liquid phase sintering:**
This subclass is indented under subclass 1. Processes wherein it is recited that some portion but not all of the material melts during the sintering operation.
- 48 Heat and pressure simultaneously to effect sintering:**
This subclass is indented under subclass 1. Processes in which the particles are sintered by a combination of elevated temperature and pressure applied thereto at the same time.
- SEE OR SEARCH THIS CLASS, SUBCLASS:
38, for processes in which the material to be sintered is pressed to shape prior to heating to effect sintering, and 31 for processes in which the sintered articles is pressed after heating.
- SEE OR SEARCH CLASS:
51, Abrasive Tool Making Process, Material, or Composition, subclass 309 for similar processes involving the making of abrasive tools.
76, Metal Tools and Implements, Making, subclasses 101.1+ for similar processes involving making a tool blank.
219, Electric Heating, subclass 149, for apparatus for briquetting powder metal involving bonding of the metal particles by means of heat generated by an electric current.
425, Plastic Article or Earthenware Shaping or Treating: Apparatus, subclass 78 for apparatus for forming articles by uniting associated particles of metallic elements, alloys or amalgams.
- 49 Hot isostatic pressing (hip):**
This subclass is indented under subclass 48. Processes in which heat and pressure are simultaneously applied during the sintering step, and the pressure is applied uniformly from all directions.
- 50 Hot rolling:**
This subclass is indented under subclass 48. Processes in which the pressure is applied by a generally cylindrical member, the roller, moving across the surface of the powder while revolving about an axis or repeatedly turning over.
- 51 Multiaxial (hot hiP):**
This subclass is indented under subclass 48. Processes wherein the pressure is applied from more than one direction, but amounts to less than from all directions as is true in isostatic pressing.
- SEE OR SEARCH THIS CLASS, SUBCLASS:
42, for processes of consolidating a powder using an isostatic pressing method.

- 52 Heating by electrical means other than radiant energy:**
This subclass is indented under subclass 48. Processes in which the applied heat is produced by any method which employs electrical energy, other than radiant energy.
- 53 Plural heating steps including sintering:**
This subclass is indented under subclass 1. Processes which include a plurality of discrete heating steps, at least one of which must be a sintering step.
- 54 Different temperatures:**
This subclass is indented under subclass 53. Processes wherein at least two of the discrete heating steps are recited as occurring at specifically different temperatures.
- 55** This subclass is indented under subclass 53. Additional operation between heating steps: Processes wherein at least one operation or step other than a heating step is performed between two of the heating steps.
- 56 Special medium during sintering:**
This subclass is indented under subclass 1. Processes in which the material is sintered while in a provided environment which may be a liquid, solid, or a vacuum gas to produce a desired condition during the sintering operation.
- (1) Note. Processes in which one of the material being treated decomposes or reacts to produce a material which becomes the desired environment are included in this and indented subclasses (e.g., a metal hydride, etc.).
- (2) Note. See Class 148, Metal Treatment, appropriate subclasses, for metal heat treatment in general in special environments.
- 57 Special atmosphere:**
This subclass is indented under subclass 56. Processes wherein the special medium present during the sintering operation is a special gas or vacuum.
- SEE OR SEARCH CLASS:**
148, Metal Treatment, particularly subclass 514 for processes of pre-treatment or post-treatment of a previously sintered or compacted consolidated powder metal starting material to modify or maintain the internal physical structure (i.e., microstructure) or chemical properties of metal combined with treatment in a controlled atmosphere and wherein there is no actual sintering or compacting operation present.
373, Industrial Electrical Heating Furnances, appropriate subclasses, for electric furnances adapted to carry out such processes.
- 58** This subclass is indented under subclass 57. Hydrogen or hydrogen plus nitrogen (N₂57): Processes in which the special atmosphere comprises hydrogen with or without nitrogen being present.
- SEE OR SEARCH THIS CLASS, SUBCLASS:**
57, for the use of nitrogen as the special atmosphere without also using hydrogen.
- 59** This subclass is indented under subclass 57. Hydrocarbon or derivative (e.g., ch₄, etc.): Processes herein the special atmosphere contains hydrocarbons or substances derived from hydrocarbons other than hydrogen.
- (1) Note. The atmosphere may comprise, e.g., methane (CH₄) gas, etc.
- 60 Vacuum:**
This subclass is indented under subclass 57. Processes in which the special atmosphere is a vacuum.
- 61 FORMING ARTICLES BY UNITING RANDOMLY ASSOCIATED METAL PARTICLES:**
This subclass is indented under the class definition. Processes for making articles by uniting powders or particulate materials including a free metal without the use of heat.

SEE OR SEARCH THIS CLASS, SUB-CLASS:

1+, for similar processes which employ heat, usually at a sufficient level to induce sintering.

SEE OR SEARCH CLASS:

264, Plastic and Nonmetallic Article Shaping or Treating: Processes, subclasses 109+ for similar processes performed on materials not containing free metal particles.

62 Powder pretreatment:
This subclass is indented under subclass 61. Processes which include preliminary significant treatment, preparation or manufacture of the powder or particular material, prior to any compacting or consolidation.

63 Includes a chemical reaction:
This subclass is indented under subclass 62. Processes wherein during the pre-treatment at least one component of the powder undergoes a chemical change.

64 Includes coating of particles:
This subclass is indented under subclass 62. Processes in which at least some particles of powder or particulate material become covered by a layer of some other material.

65 Includes adding a binder material:
This subclass is indented under subclass 62. Process which include the incorporation in the powder of a material having the function of causing particles of the powder to adhere to each other.

66 Consolidation of powders:
This subclass is indented under subclass 61. Processes which include a step of compacting or forming an article by the use of positive pressure.

67 Extrusion:
This subclass is indented under subclass 66. Processes wherein the compaction is effected by forcing the powder through a restricted orifice under pressure.

(1) Note. Extrusion processes as here contemplated are sometimes referred to as die expressing or squirting.

68 Isostatic/hydrostatic pressing:
This subclass is indented under subclass 66. Processes wherein the powders is compacted or shaped by pressure exerted uniformly in all directions on a preformed flexible mold immersed in a fluid in a pressure vessel, or wherein the compaction is performed on a hydraulic or hydrostatic press.

69 Rolling:
This subclass is indented under subclass 66. Processes wherein the compaction is effected by a generally cylindrical member, the roller, moving across the surface of the powder while revolving about the axis or repeatedly turning over.

END