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ATOMIZING NOZZLE AND POURING CUP ASSEMBLY
FOR THE MANUFACTURE OF METAL POWDERS
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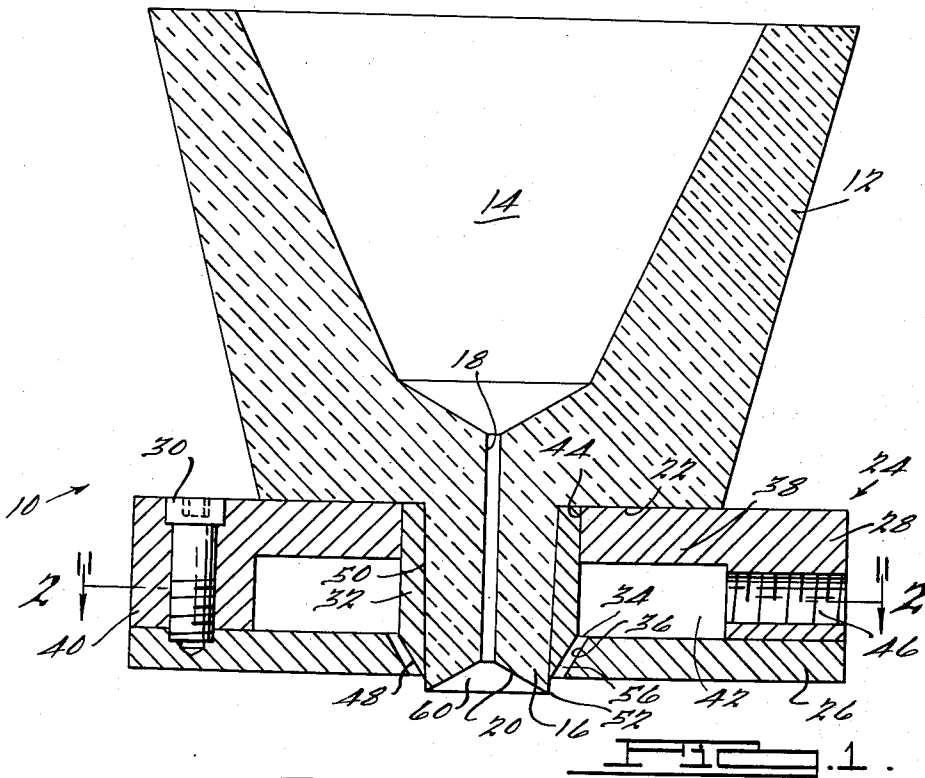


FIG. 1.

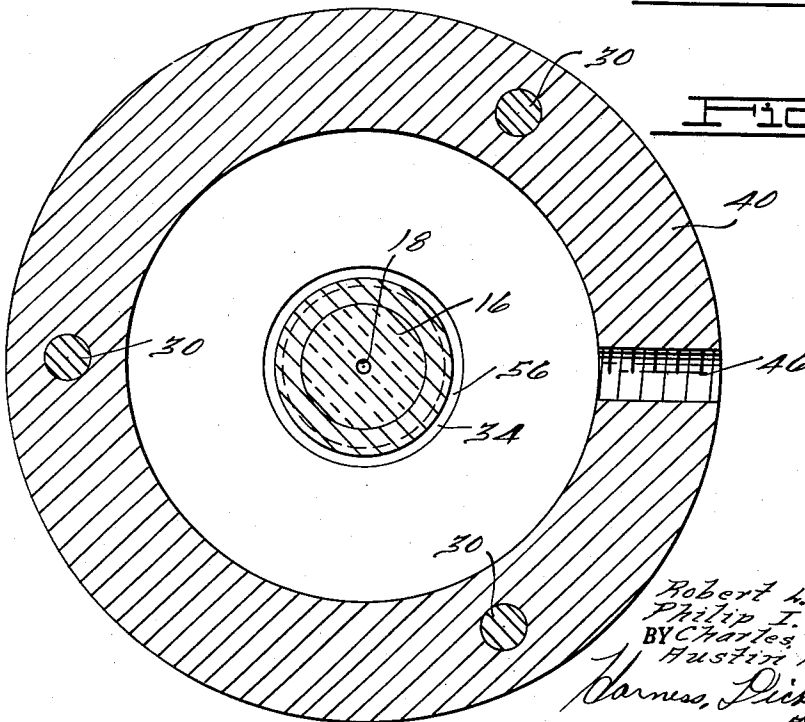


FIG. 2.

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ATOMIZING NOZZLE AND POURING CUP ASSEMBLY FOR THE MANUFACTURE OF METAL POWDERS

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3 Claims. (Cl. 18—2.5)

This invention relates generally to apparatus for making metal powders and more particularly to a pouring cup and nozzle assembly which is capable of producing dense metal particles of very fine size.

The production of metal powders which are made up of particles in a desired range of sizes and which are also clean and of low oxide content and which can be produced from a wide range of metal alloy compositions has been a desirable objective for some time. However, previously available equipment has not been capable of producing satisfactory powders of this type.

It is an object of this invention, therefore, to provide a pouring cup and atomizing nozzle assembly which is capable of manufacturing metal powders from any elemental metal or any known alloy composition and having particles in the various size ranges desired which have a low oxide content and meet the necessary density objectives.

A further object of this invention is to provide an atomizing nozzle and pouring cup assembly which is simple in construction, economical to manufacture, and efficient in operation in producing clean high density metals powders.

Further objects, features and advantages of this invention will become apparent from a consideration of the following description, the appended claims and the accompanying drawing in which:

Figure 1 is a vertical sectional view of the pouring cup and nozzle assembly of this invention; and

Figure 2 is a horizontal sectional view of the assembly of this invention, looking substantially along the line 2—2 in Fig. 1.

The pouring cup and nozzle assembly of this invention, indicated generally at 10, is illustrated in Fig. 1 as consisting of a cup member 12 formed of a ceramic or refractory material which is capable of being heated to the temperature of the molten metal which is to be atomized and formed into a powder. The cup 12 is formed with an upwardly facing cavity 14 into which the metal to be atomized is poured and a depending cylindrical stem portion 16 which has an axial passage 18 that communicates at its upper end with the cavity 14 and terminates at its lower end in the center of the lower end surface 20 of the stem portion 16. The cup 12 has an annular bottom surface 22 which surrounds the stem portion 16 and is flat for seating the cup 12 on the top side of a nozzle unit 24 which is of an annular shape and extends about the stem portion 16.

The nozzle unit 24 consists of a bottom plate section 26, an upper section 28 which is secured by bolts 30 to the lower section 26, and a nozzle insert 32 arranged in a coaxial relation with the stem portion 16. The lower plate section 26 is circular and has a central opening 34 defined by an edge surface 36 which is of a downward and axially inward inclination. As a result, the opening 34 is of a progressively smaller diameter in a downward direction.

The upper nozzle section 28 has an upper plate portion

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38 provided with a depending annular outer wall or flange 40 which cooperates with the plate portion 38 to form a downwardly facing cavity 42. The plate portion 38 also has a central opening 44 which is positioned in vertical alignment with the opening 34. A threaded inlet opening 46 in the wall 40 of the upper section 28 is adapted to be connected to a suitable supply pipe for the atomizing medium such as a fluid and/or gas with which the cavity 42 is to be supplied.

The nozzle insert 32 is generally tubular in shape and has its bottom end surface 48 arranged in a concentric parallel relation with the surface 36 on the lower plate section 26. In other words, the angular inclination of the surface 48 relative to a horizontal plane corresponds to the angular inclination of the surface 36. In the illustrated embodiment of the invention, this inclination is about sixty degrees. The outer diameter of the nozzle insert 32 provides for a pressed fit of the nozzle insert 32 in the opening 44 in the top section 38. The inner surface of the nozzle insert 32 is tapered so that the diameter thereof decreases in a downward direction to facilitate the nesting therein of the stem portion 16 which is similarly tapered to provide for a tight fit of the stem portion 16 in the insert 32. As shown in Fig. 1, the cup stem portion 16 has its inclined lower end surface 20 extended outwardly so that it intersects the outer generally cylindrical surface 50 of the stem 16 so as to form a relatively sharp edge 52 at the lower end of the stem portion 16. This edge 52 is located below the lower end of the nozzle insert 32 at least one-sixteenth of an inch so that it is positioned directly in the path of the atomizing medium issuing from the nozzle unit.

In the use of the assembly 10, a suitable atomizing medium under pressure is supplied to the cavity 42. In one embodiment of the invention, this medium is nitrogen gas and the pressure of this gas builds up in cavity 42 so that it issues from the downwardly and inwardly inclined outlet passage 56 formed between the inclined surfaces 36 and 48 as a stream traveling at a high rate of speed. The size of the passage 52 is maintained between 0.01 inch and 0.04 inch depending upon the atomizing medium which is supplied to the cavity 42. The passage size is readily adjusted by moving the nozzle insert 32 toward or away from the bottom plate section 26.

This stream of gas travels inwardly across the lower edge 52 of the cup stem portion 16 and creates a vacuum within the frusto-conical space 60 enclosed within the annular surface 20. This vacuum draws the molten metal in the cup 12 downwardly through the discharge passage 18 which is between one-sixteenths and three-eighths inch in diameter so as to provide for a downwardly moving film of metal on the surface 20. In addition, this vacuum seats the tapered stem portion 16 tightly in the tapered nozzle insert 32.

The molten metal travels outwardly on the inclined surface 20 to the edge 52 where the atomizing medium issuing from the discharge passage 56 intersects the stream of metal at substantially right angles. The force of this moving stream atomizes the molten metal into small particles.

The size of these particles is dependent primarily upon the pressure in the cavity 42; the higher the pressure, the smaller the particle size. For example, using a "316" stainless steel as the material to be atomized, when a pressure of four hundred pounds per square inch (400 p.s.i.) in the chamber 42 is used, seventy-seven percent of the yield was of minus one hundred mesh size. When, in a subsequent test, the pressure was dropped to one hundred pounds per square inch (100 p.s.i.), only forty-two percent of the yield was minus one hundred mesh size.

In practice, atomizing pressures have ranged between seventy pounds per square inch (70 p.s.i.) and seven hundred pounds per square inch (700 p.s.i.) in the successful production of powder. The edge 52 is maintained in a sharp condition to prevent the metal from cooling and solidifying thereon and the diameter of the opening 18 is maintained between one-sixteenth and three-eighths of an inch. The thinner the film of metal that is supplied to the edge 52, of course, the smaller the particle size. For example, using "316" stainless steel as the material to be atomized and using a pressure of one hundred pounds per square inch (100 p.s.i.) in the chamber 42, a forty-two percent minus one hundred mesh yield is obtained with a three-sixteenths of an inch diameter opening 18. This percentage drops to twenty-one percent when the diameter is increased to three-eighths of an inch.

Although the invention has been described with respect to a preferred embodiment thereof, it is to be understood that it is not to be so limited, since changes can be made therein which are within the scope of the invention as defined by the appended claims.

What is claimed is:

1. Apparatus for manufacturing metal powder comprising means forming a downwardly extending discharge passage for molten metal, said means having an outer surface and an annular downwardly and outwardly inclined lower end surface communicating at substantially the center of the upper end thereof with the discharge end of said passage and intersecting said outer surface at the lower end thereof to thereby form an outer edge, and nozzle means arranged in a substantially concentric relation with said annular surface, said nozzle means having discharge passage means arranged so that an annular downwardly inclined stream of gas from said nozzle means is directed across said outer edge of said inclined surface for drawing molten metal out the lower end of said discharge passage so that it flows downwardly on said end surface and said gas stream atomizes the molten metal flowing off said edge to thereby form metal particles.

2. Apparatus for manufacturing metal powder comprising means having a generally cylindrical downwardly extending portion provided with an axial discharge passage for molten metal, said cylindrical portion terminating at its lower end in an annular surface which is inclined downwardly and outwardly from the lower discharge end of said passage and intersects the cylindrical outer sur-

face of said portion so as to form therewith a relatively sharp edge, and nozzle means extending about said cylindrical portion for directing a downwardly inclined stream of gas across said sharp edge for drawing molten metal out the lower end of said discharge passage so that it flows downwardly on said end surface and said gas stream atomizes the molten metal flowing off said edge to thereby form metal particles, said surface and said stream being substantially at right angles relative to each other.

3. Apparatus for manufacturing metal powder comprising means having a generally cylindrical downwardly extending portion provided with an axial discharge passage for molten metal, said cylindrical portion terminating at its lower end in an annular surface which is inclined downwardly and outwardly from the lower discharge end of said passage and intersects the cylindrical outer surface of said portion so as to form therewith a relatively sharp edge, and nozzle means extending about said cylindrical portion for directing a downwardly inclined stream of gas across said sharp edge for drawing molten metal out the lower end of said discharge passage so that it flows downwardly on said end surface and said gas stream atomizes the molten metal flowing off said edge to thereby form metal particles, said surface and said stream being substantially at right angles relative to each other, said nozzle means including a member positioned about said passage means and having an opening bounded by an annular surface which is inclined downwardly toward the axis thereof, a tubular nozzle insert member positioned about and arranged in a tight fit relation with said cylindrical portion and having the lower end surface thereof positioned within said opening and inclined downwardly in a parallel spaced relation with said annular surface, said spaced surfaces forming an outlet passage for said nozzle means arranged so that said sharp edge is in the path of gas discharged therefrom.

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