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METHOD OF MAKING A SOLID LENGTH OF ALUMINOUS METAL

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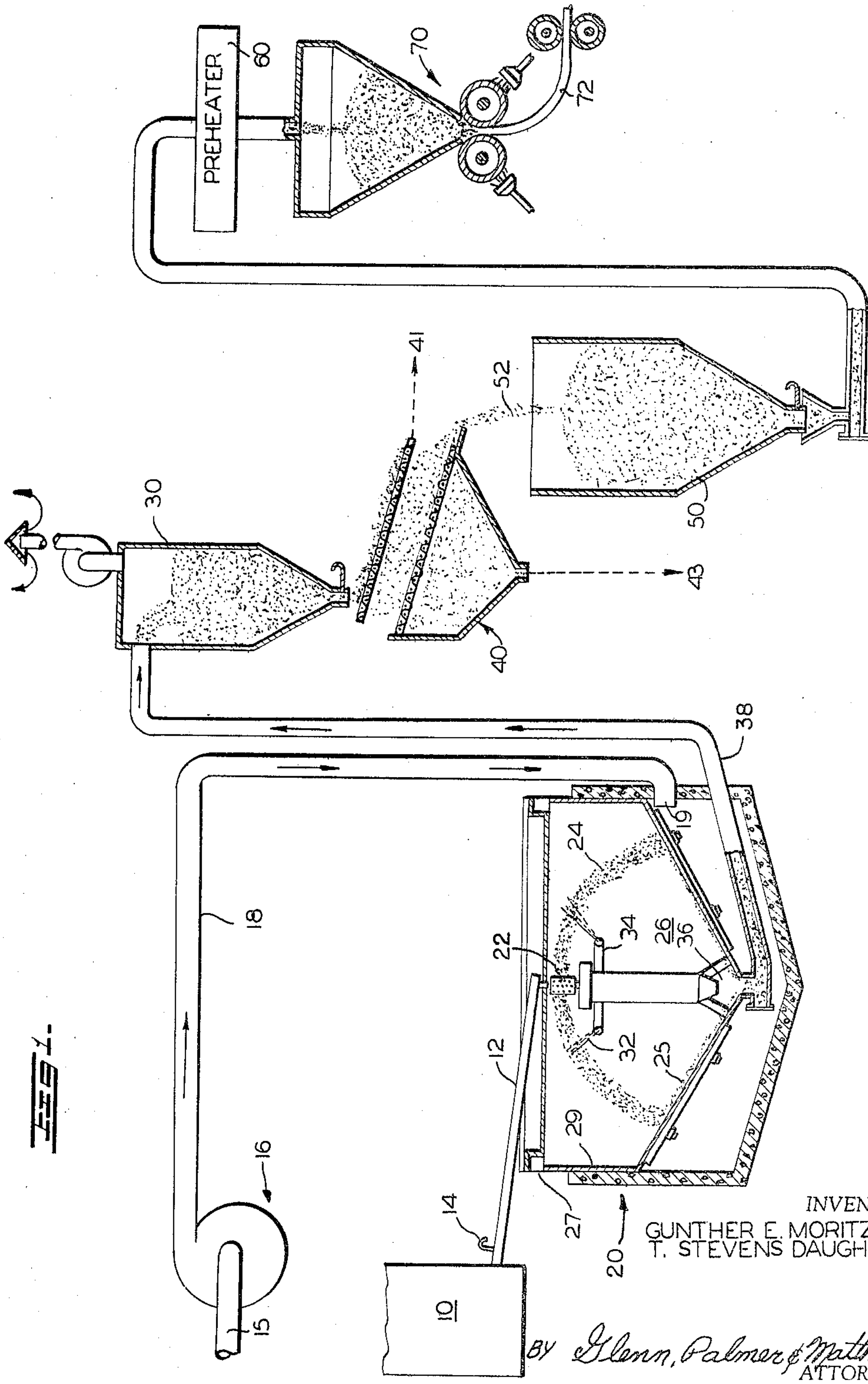

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FIG. 2

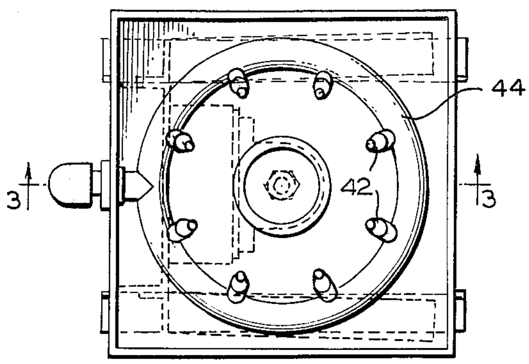
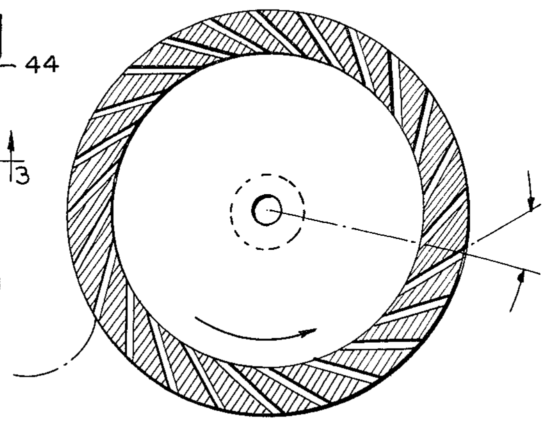


FIG. 4



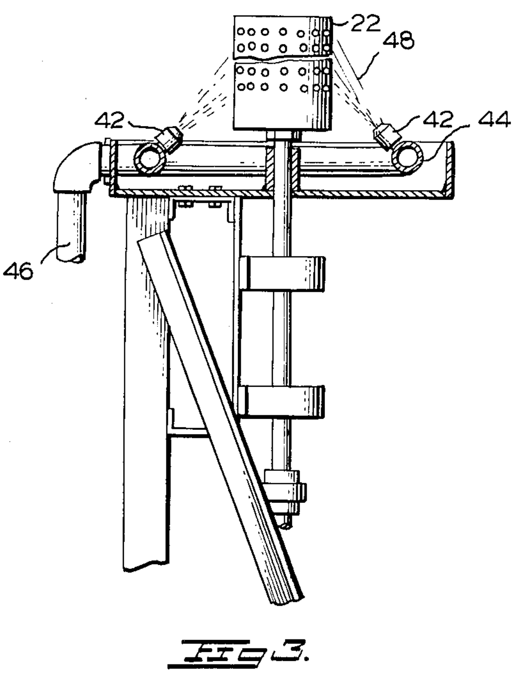
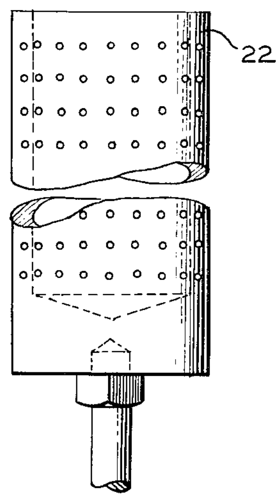


FIG. 3.

FIG. 5.



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METHOD OF MAKING A SOLID LENGTH OF ALUMINOUS METAL

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5 Claims. (Cl. 75—213)

This invention relates to the manufacture of solid lengths of aluminous metal by rolling cast particles of such metal.

The copending application Serial No. 768,686 of T. Stevens Daugherty, filed October 21, 1958 (now U.S. patent 3,076,706, issued February 5, 1963), concerns a method of consolidating aluminous metal particles by rolling the particles under pressure, without the necessity of subsequent sintering. That method includes the steps of preheating aluminous metal particles, feeding the preheated particles in free-flowing condition to a set of work rolls, and rolling the particles under pressure between the rolls. Various types of particles are disclosed as having utility for this purpose, although centrifugally cast particles are generally preferred for various reasons.

One of the essential characteristics of the particles which can be successfully consolidated with the method of application Serial No. 768,686 is that the particles be free-flowing in the preheated condition as they are fed to the rolls. In accordance with the present invention, certain refinements in the particle casting technique are utilized which not only provide that characteristic, but the resulting particles have also been found to be superior in other respects for rolling purposes. Thus, various ways have been found to produce centrifugally cast particles having superior properties for rolling into fully consolidated products, and an improved method is provided for producing such products.

There are two approaches which can be used to advantage in this regard: (1) the rotatable, perforated pot for casting particles may be provided with outlet passageways which are not radially directed, but are inclined forwardly in the direction of rotating the pot; and (2) the particles of molten metal emerging from the pot may be subjected to the influence of a burner flame in order to allow more time for the effects of surface tension to influence the particle configuration. The use of angled passageways for discharging the molten metal from the pot can have the additional benefit of reducing the distance of throw for a given set of operating conditions, thereby reducing the size required for the collection system. Either approach causes the particles produced to be slightly thicker and more blunt, other conditions being the same.

Quite unexpectedly, furthermore, the particles which are flame treated, whether the passageways in the pot are angled or radial, have been found to exhibit improved characteristics for rolling purposes. More specifically, the flame treated particles can be rolled with lower power requirements and they produce less separating force on the rollers during the consolidation procedure. This is extremely significant in the rolling process, since a particular advantage lies in the economic gains compared to conventional mill practices for producing sheet.

Additional objects, advantages, and details of the invention will be discussed or are otherwise apparent with reference to the accompanying drawings in which:

FIGURE 1 is a semi-schematic diagram of the operations employed in accordance with the invention;

FIGURES 2–5 are enlarged apparatus details of the portion of FIG. 1 relating to the particle-casting operation.

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The sequence of operations from molten metal to a fully consolidated strip is shown in FIG. 1. The molten metal is fed from a melting or holding furnace **10** to the centrifugal casting unit **20**, which includes a rotating perforated pot **22**. The resulting centrifugal action produces a stream of molten metal particles which are subsequently solidified during the course of their trajectory **24** through a cooling atmosphere of air or other gas in the casting space **26**. It is preferable that the particles be substantially solidified prior to contacting a collection surface, in order not to cause distortion of the particles upon impact.

The particles are transported to separator **30** and thence may be screened, if desired, through limiting screens shown at **40** to remove unsuitable or undesired particles. Arrow **41** indicates the overflow of excessively large particles, whereas arrow **43** indicates the underflow of excessively fine particles. A storage bin **50** is provided to collect the useful particle stream **52**.

Subsequently, the particles are transported to a preheating station **60** and from there to a rolling mill **70**, as shown, to form a fully consolidated strip **72**. This rolling operation is elaborated in the aforesaid copending application, the disclosure of which is incorporated herein by reference.

Discussing the present invention now in greater detail, the molten metal is fed from furnace **10** through an insulated trough **12**, under control of a gate or regulator **14**, and into the rotatable container **22**. The speed of rotation of the container is suitably adjusted with regard to the size of outlet passageways in the container and other parameters, to cause the desired centrifugal effects upon the molten metal. The distance of throw has been found to be an effective indication of the proper combination of operating conditions: the preferred acicular particles being produced by projecting the particles at least 6 feet, and preferably 8 to 12 feet, by the time they have fallen about one and a half feet (using a pot having radial passageways). The corresponding distance of throw will be less when the passageways are angled from the radial direction.

Ambient air from the machine environment is introduced into the intake **15** of a blower or fan **16**, to be forced through conduit **18**, entering the casting unit at **19**. Casting unit **20** includes a conical bottom **25** which provides the particle collecting surface. Entering air is circulated to the casting chamber and is discharged through outlets **27**, which are located circumferentially around the upper part of the cylindrical wall **29**. The air or other gaseous medium may be exhausted into the surrounding atmosphere, or else collected either for reuse or for discharge outside the building.

Water mist **32** issuing from nozzles spaced along circular pipe **34** may be sprayed into the path of particles **24** in order to effect control of the air temperature and to vary the particle cooling rate as required.

The particles are caused to gravitate downwardly for collection on the slanting surface **25**, whence they are directed to outlet **36** and the transporting conduit **38**. Alternatively, the particles may be collected from a pool of water.

Structure of particular significance (see FIGS. 2 and 3) is the ring of burners **42** surrounding container **22**. The burners are supported by gas conveying ring **44**, which is supplied through pipe **46** with gas pre-mixed with combustion air. The burners are directed toward container **22** and are disposed peripherally to maintain a burning flame zone **48** which blankets the path of particles emerging from the container.

The principal function of the flame zone is to alter the cooling rate of the particles of molten metal being cast. As previously indicated, this flame zone provides a sufficient time interval for the effects of surface tension to influence particle configuration. Premature solidification of the metal is thereby avoided and formation of undesirable sharp tips on the particles is minimized. Most significantly, the flame treated particles are more readily rolled into fully consolidated products. It is believed, furthermore, that the flame zone relays formation of an oxide layer on the particles, which could adversely influence particle geometry. Another benefit is that the flame, which is subject to precise adjustment by conventional control means, tends to stabilize the thermal condition of the container 22, thereby compensating for variations in the temperature of the molten metal coming into the container from the furnace.

FIG. 5 shows a typical distribution of outlet holes in container 22, and FIG. 4 shows a cross-section of such a container having outlet passageways angled forwardly in the direction of rotation. It has been found that an angle of about 45° produces substantially the same effect on particle size as the use of a flame zone with radial passageways.

The following examples are presented as illustrative of the invention:

Example I

(a) Particles of aluminous metal (1100 alloy) were centrifugally cast from a rotating pot having radial outlet passageways of 0.076" diameter. The pot size was 2¼" O.D., and the speed of rotation was 1500 r.p.m.; input metal temperature was about 1400° F.

The ring of burners shown in FIG. 2, for example, was supplied continuously with gas, and a flame zone was maintained around the pot for a distance of about 4–6 inches from the pot.

The following screen analysis of the particles produced was obtained in accordance with M.P.A. Standard 5–46, using the indicated U.S. Standard Sieves:

Mesh:	Wt. percent retained
+10	1.5
−10+20	64.5
−20+30	33.9
−30+40	0.1

(b) This compares with the following analysis of particles produced without the use of a flame zone, but under otherwise comparable conditions:

Mesh:	Wt. percent retained
+10	1.4
−10+20	49.1
−20+30	49.0
−30+40	0.5

Particles produced under each of the above conditions were subsequently preheated to about 600° F., fed in free-flowing condition to the nip of a pair of work rolls, and rolled under pressure to form a fully consolidated strip. Table I compares certain data obtained from the rolling operation.

TABLE I

Description of Particles	Roll Separating Force×1,000 lb. (per inch of strip width)	Mill Power (k.w. per inch of strip width)
(a) Flame treated	27.5	1.72
(b) Not flame treated	30.3	2.10

From this data, it is apparent that the flame treated particles caused a reduced separating force on the rolls and required significantly reduced power during the rolling operation.

Example II

In the manner of Example I, two groups of particles were cast under otherwise the same conditions but with the outlet passageways of the pot angled at about 45°

(see FIG. 4). Table II compares the rolling characteristics of these particles, (a) with and (b) without the flame zone around the pot. Both types of particles had substantially the same screen analysis as the flame treated particles of Example I.

TABLE II

Particle Description	Roll Separating Force×1,000 lb. (per inch of strip width)	Mill Power (k.w. per inch of strip width)
(a) Flame treated and angled holes	27.8	1.85
(b) Angled holes, not flame treated	29.9	2.13

Again, it is apparent that superior rolling characteristics were exhibited by the flame-treated particles.

As indicated in the copending application previously referred to, the preheat temperature for the particles to be rolled is in the range from about 450° F. to about 1200° F., ordinarily from about 750° F. to about 1000° F. In addition, substantially all of the particles should be retainable on a 200 mesh sieve to avoid the hazards associated with finer particles, and for other reasons stated in that application. It is desirable, furthermore, to employ such artificial cooling of the mill rolls as is necessary to maintain the particle-engaging roll surfaces adjacent the inlet roll nip at a temperature not exceeding the temperature of the particles entering the rolls.

The invention is applicable to pure aluminum and also to alloys containing more than 50% aluminum, and the expression "aluminous metal" is employed herein as inclusive thereof.

While present preferred embodiments of the invention have been illustrated and described, it will be recognized that the invention may be otherwise variously embodied and practiced within the scope of the following claims.

What is claimed is:

1. The method of making a solid length of aluminous metal, comprising the steps of: forming cast particles of aluminous metal, substantially all of which are retainable on a 200 mesh sieve and individually covered with a surface layer of aluminum oxide, by projecting particles of molten aluminous metal through a burning flame zone and thereafter cooling the particles to cause solidification of the molten metal in flight; feeding the solidified particles at a temperature in the range from about 450° F. to about 1200° F. and in free-flowing condition to a set of work rolls; and rolling said particles under pressure between the rolls to form a fully consolidated length of aluminous metal in which the particles are bonded metal-to-metal.

2. The method of claim 1 in which the particles are fed to the work rolls at a temperature in the range from about 750° F. to about 1000° F.

3. In the method of making a solid length of aluminous metal comprising the steps of centrifugally projecting elongated particles of molten aluminous metal through a space, said particles being substantially molten in a first zone in said space and being substantially solidified in a cooling atmosphere in a second zone in said space, collecting the solidified particles and feeding them in free-flowing condition at a temperature in the range of about 450° F. to about 1200° F., to a set of work rolls, and rolling the particles between said rolls to form a fully consolidated length of aluminous metal in which the particles are bonded metal-to-metal, the improvement comprising reducing the power required to roll said particles by flame treating the substantially molten elongated particles in said first zone sufficiently to cause them to solidify in a modified elongated shape in said second zone.

4. In the method of making a solid length of aluminous metal comprising the steps of centrifugally projecting elongated particles of molten aluminous metal through a space containing enough air to oxidize the surface of the particles, said particles being substantially molten in a first

zone in said space and being substantially solidified in elongated form in a cooling atmosphere in a second zone in said space, collecting the solidified particles and feeding them in free-flowing condition at a temperature in the range of about 450° F., to about 1200° F., to a set of work rolls, and rolling the particles between said rolls to form a fully consolidated length of aluminous metal in which the particles are bonded metal-to-metal, the improvement comprising reducing the power required to roll said particles by flame treating the substantially molten elongated particles in said first zone sufficiently to blunt their ends when they solidify in elongated shape in said second zone.

5. Method according to claim **3** wherein substantially

all of the solidified particles are retainable on a 200 mesh sieve.

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