July 12, 1966 H. E. THORNTON 3,260,773

PRODUCTION OF BRONZE POWDERS

Filed April 9, 1964 2 Sheets-Sheet 1

Fig. 1.

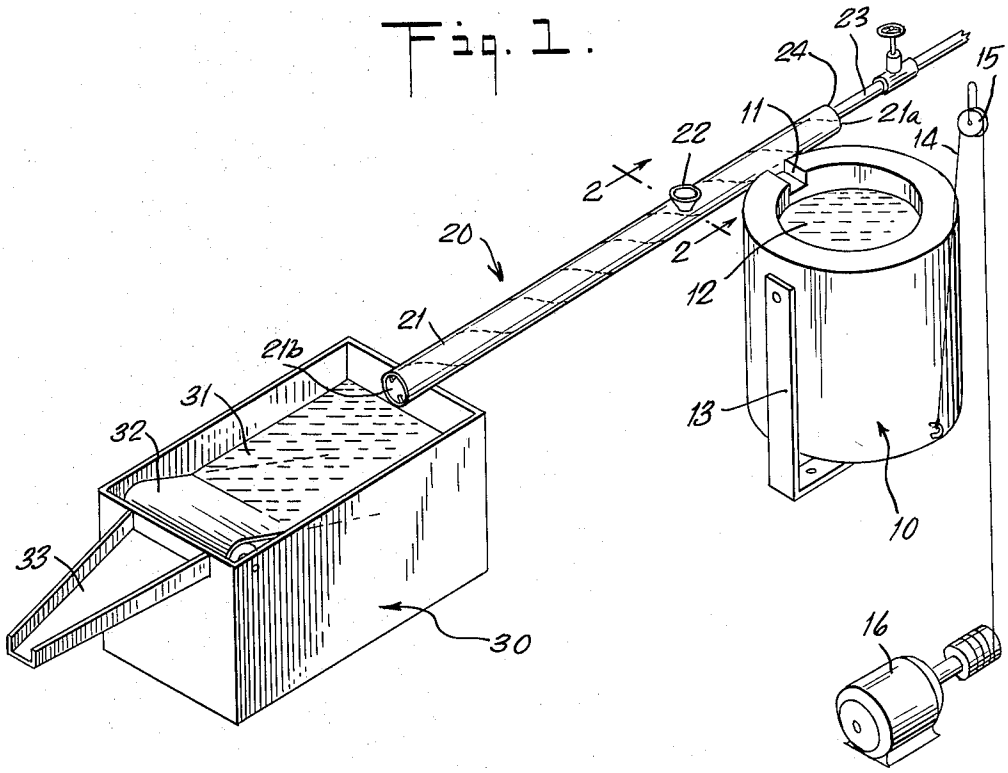
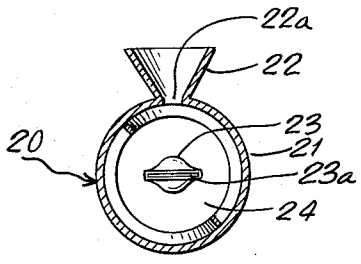


Fig. 2.



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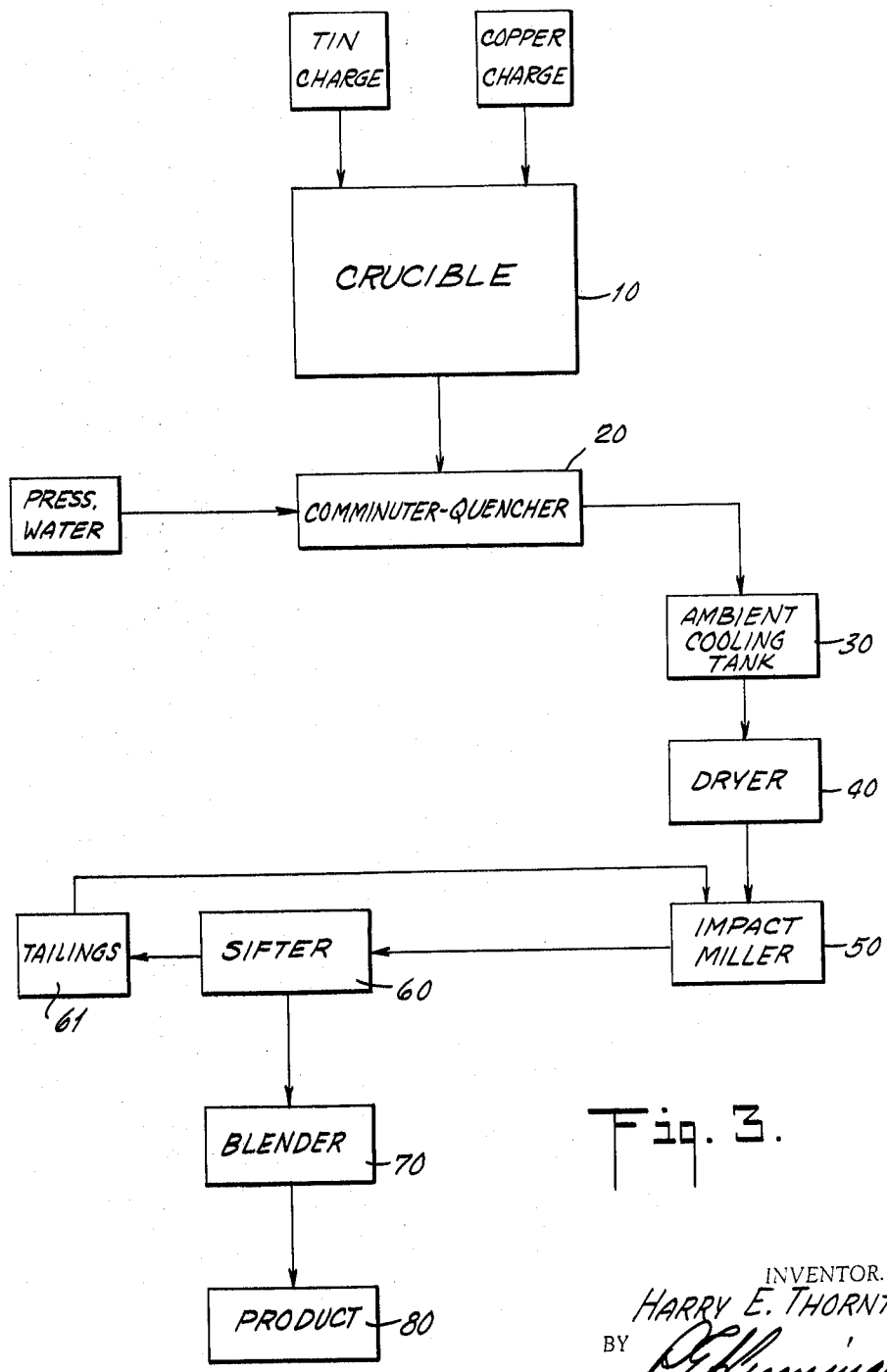


Fig. 3.

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PRODUCTION OF BRONZE POWDERS

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4 Claims. (Cl. 264—12)

This invention relates to the comminuting of molten metal to produce metal powders of desired properties, and more particularly relates to the production of comminuted bronze alloy powder from a copper-tin melt.

One important difficulty in producing fine bronze powder has been that most bronzes have not been efficiently adaptable to use with well-known and advantageous techniques for the final reduction of the intermediate bronze powder to a fine powder by pulverizers whose action is based upon impact. It is thus clearly seen, that production of fine gauge bronze powder by, for example, impact mills would produce better and more economical product, if a way could be found to produce a feed to such mills that was more readily and uniformly adaptable to impact pulverization.

In general, a complete process for the production of bronze powder involves production of the melt, comminution and quenching of the melt into particles, and finally a series of steps adapted to mill and sift the particles to the desired size and uniformity. It has now been found that the problem of producing fine bronze powders by economical impact milling techniques is not to be solved by refinement of the milling steps themselves, but by proper comminution and quenching in accordance with the present discovery.

It is accordingly an object of the present invention to provide apparatus and process for the economical production of fine gauge bronze powders from an initial melt.

Another object of the invention is to provide means for economically optimizing the brittleness of comminuted bronze particles produced from a melt.

Another object of the invention is to provide means for the improved utilization of powdering techniques that are based upon particle brittleness in the production of fine powdered bronze.

These and further objects and advantages of the invention will be more fully understood upon reading of the following detailed description of one presently preferred but merely illustrative embodiment of the inventive principles, when taken in conjunction with the drawings, wherein like reference characters denote like parts in all views thereof, and wherein:

FIGURE 1 is a somewhat schematic perspective view of comminuting and quenching apparatus according to the invention,

FIGURE 2 is an end section view of one portion of the apparatus of FIGURE 1 taken on line 2—2 therein and showing internal details thereof, and

FIGURE 3 is a flow diagram of the various steps employed in the practice of the present invention.

Briefly, it has now been discovered that insofar as bronze powder or similar non-brittle powders are concerned, the comminution step and the quenching step, which heretofore had been separate in timing, are advantageously combined. When comminution of the melt and quenching of the particles is practiced during the same relatively prolonged time, a more brittle bronze powder is formed, which powder may therefore then be economically dealt with by impact milling techniques or the like, so as to provide fine bronze powder without departing from advantageous milling techniques because of lack of good results therewith.

Referring now to the drawings, there is shown in FIGURE 1 a crucible **10** having a pour-spout **11** and filled with molten bronze alloy **12**. The crucible **10** is adapted to be tipped forward on pivot assembly **13** by means of cable **14**, block **15**, and winch **16**. Disposed in generally horizontal fashion near the pour-spout **11** of crucible **10** is comminuter-quencher **20** which comprises an elongated generally tubular channel **21** having a funnel **22** communicating therewith near one end thereof, said funnel **22** being positioned so as to lie directly under pour-spout **11** of crucible **10** when the latter is tipped for pouring of its melt **12**. At one end **21***a* of channel **21** is pressurized water pipe **23** adapted to introduce water under pressure into channel **21**. The opposite end **21***b* of channel **21** overhangs ambient cooling tank **30** which is partially filled with water **31** and contains conveyor means **32** for removing comminuted particles from tank **30** to trough **33**, whence said particles are delivered to a drying stage, not shown in apparatus form in FIGURES 1 and 2.

Before discussing the particular advantages of the comminution and quenching apparatus just generally described in connection with FIGURE 1, the nature of comminution itself shall be pointed out so that a fuller appreciation of the benefits of the present invention may be had.

Broadly, comminution has in this art consisted of forming a uniform spray from the melt, and then quenching that molten spray in a water bath. The most obvious technique is to spray the molten metal into a tank of water, so that the globules, separated in space, are separately quenched. Various methods of producing such a spray are known, such as nozzles and other mechanical contrivances.

One well known means of producing a spray from a stream of metal descending toward the quenching bath, is to buffet that stream with a high pressure fluid, such as compressed air or pressurized water. For example, in U.S. Patent 2,956,304 to Batten et al., issued October 18, 1960, a plurality of pressurized water streams impinging from all sides tears the descending molten metal stream into spray drops which continue their fall to a quenching tank therebelow.

It will be apparent that the purpose of the waterjets in the prior art, of which the aforesaid U.S. 2,956,304 is an example, is merely to break-up or comminute the metal stream. Waterjets are superior to air jets for this purpose only because of their higher mass and greater availability. When operating in the manner of the prior art, as shown by U.S. 2,956,304, it can be shown that the momentary contact of the waterjets with the descending molten metal stream produces virtually no quenching thereof, there being no sufficient time nor mass of water, but rather that at least 95% of the quenching action occurs when the then comminuted spray droplets hit and descend into the water quench tank below.

For the usual kinds of metals so treated, the aforesaid technique produces satisfactory results. Heretofore, it was thought that bronze was no different in that respect, that is to say, forming a metal spray by any means followed by quenching in a water bath was accepted as the appropriate manner in which to form powdered

bronze as well as other metals. The fact that bronze powder was more than ordinarily difficult to reduce to a fine powder, and did not adapt well to impact milling in general, was seen to be merely characteristic of bronze powder itself.

It has now been discovered that the manner of comminuting and quenching a bronze melt has a decided effect upon the ease with which the particles can later be reduced to a fine powder, and particularly on the degree of difficulty encountered in using impact milling techniques. Returning now to the apparatus shown in FIGURES 1 and 2, it will be seen that when crucible **10** is tipped by winch **16** so as to pour contents **12** into funnel **22**, the molten metal is guided through orifice **22***a*, best shown in FIGURE 2, into the interior of channel **21**. The end **24** of channel **21** is preferably closed off, and pressure water pipe **23** enters therethrough, and terminates in spray nozzle end **23***a*. The channel **21** itself is of generally cylindrical outline, but preferably has a somewhat spiral or other undulating configuration to its walls, as best shown in FIGURE 1.

The charge **12** in crucible **10** is, of course, molten alloy of tin and copper. For example, an alloy of 65% tin and 35% copper by weight may exist at approximately 2200° F. as melt **12**. It will be appreciated that the heat of fusion of the melt, as well as the heat represented by the elevation of the melt above the melting point, must both be given up to solidify the metal poured into funnel **22**. Consequently, a great deal of steam is produced in channel **21** when the molten metal descending through orifice **22***a* is sprayed under pressure with a waterjet from jet **23***a*.

It has been found that not only does such a waterjet comminute in the metal stream as in the prior art, but that the steam produced causes a violent turbulence that prevents agglomeration of particles before they are fully solidified. To that end of course, it is desirable to have channel **21** closed off, except at end **21***b*, not because any appreciable pressure is built up therein, but because violent turbulence and boiling occur. In the prior art involving spraying downward into a tank, agglomeration was avoided by the geometry of the fall. In horizontal extended flow through a channel agglomeration might well occur before the particles were fully solidified, because of the considerable heat to be absorbed by the water before the particles solidify, except that the violent turbulence apparently prevents that. It should be noted that the optional undulating or spiral outline of channel **21** is intended to enhance the aforesaid turbulence.

In addition to solidifying within channel **21**, that is, in addition to losing their heat of fusion therein, the now comminuted particles are rapidly reduced in temperature, that is, are also quenched therein. In practice the volume of metal introduced at funnel **22**, the volume of water introduced at **23**, and the length of channel **21**, are coordinated so that the particles expelled, along with water and steam, from end **21***b* are not appreciably higher than 212° F. This may be accomplished by regulation of the tilting angle of crucible **10** by means of winch **16**, and by regulation of the valve on pressurized water means **23**.

It is not fully understood why the bronze particles solidified and quenched in the foregoing manner are more adaptable to impact milling than are particles produced by spraying directly into a tank. While no theory is advanced, it is possible that the globules directly sprayed into a tank are too elevated in temperature to be properly quenched. It is known that droplets of such highly elevated temperature form a pocket of steam around themselves when they enter a liquid bath. The steam interface thus formed acts, relatively speaking, as an insulator between the hot particle and the relatively cold water. In any event, the violently and intimately admixed particle and water mixture created by the present apparatus coexists for a relatively extended time, and apparently better chilling of the particles is effected, so that the mixture

of particles spewn into tank **30** from end **21***b* of channel **21** is more brittle than heretofore was the case.

The function of tank **30**, of course, is merely to receive and store the particles spewn from end **21***b* of channel **21**, and incidentally to cool them from their perhaps 212° F. or so temperature down to ambient. It may be estimated that the particles emerging from end **21***b* are more than 95% quenched before entering water **31** of tank **30**. The conveyor **32** disposed in tank **30** delivers the particles therein up to trough **33**, from where they are fed to the remaining steps in the operation, not shown in apparatus form.

Continuing with reference to FIGURE 3, therein is shown in diagrammatic form, the steps of charging tin and copper to the crucible **10**, and from there introducing the melt to comminuter-quencher **20**, from whence, upon introduction of pressurized water, particles are spewn in quenched form into ambient cooling tank **30**, all as already described.

From trough **33** of tank **30**, as aforesaid, the particles are delivered to dryer **40**, which may be a typical rotary direct flame fired unit similar to the type used for drying gravel in asphalt plants. Particular attention must be paid to the drying step, so that the brittleness introduced is not lost by inadvertent annealing. It has been found that all the benefit is not easily lost in any event, but that care in drying preserves the maximum benefits of the invention in the subsequent milling stage.

The dried particulate material is metered from the dryer into an impact miller **50**. A second mill (not shown) can be operated in series with the illustrated mill. An advantageous machine is the model ISH manufactured by the Pulverizing Machinery Company. The output of the mill is fed to a standard sifter **60**, which produces tailings **61** which are recycled to mill **50**, and which delivers its product to a standard blender **70** which produces the final product **80**, in the amount of about 1500 pounds per 24 hour day, with the equipment designated.

Unlike prior art bronze powdering operations, wherein the comminuted bronze was formed by spraying into a water bath, the present process produces a first stage product that is adaptable to subsequent impact milling because of its increased brittleness. As will be appreciated by those skilled in the art, bronze has been a notorious problem to pulverize to fine powder, and heretofore where impact milling was possible at all, it was inefficient in that the soft bronze often tended to "smear" rather than to pulverize, thus necessitating frequent shutdowns and other expensive difficulties.

While particular means have been described, it will be apparent that substitutions may be made without departing from the scope of the inventive principles. The appended claims are not limited to the precise embodiment described, but to the scope of the invention itself.

What is claimed is:

1. Process for the production of particulate embrittled bronze from a melt comprising forming an essentially horizontal stream of pressurized water spray; metering liquid molten bronze essentially perpendicularly into said stream; producing particulate bronze and water mixture by impact at the intersection of said spray with said molten bronze; guiding said mixture in an essentially horizontal concurrent flow while boiling and turbulence are occurring therein; and collecting said mixture.

2. Process for the production of particulate embrittled bronze from a melt comprising forming an essentially horizontal stream of pressurized water spray; metering liquid molten bronze essentially perpendicularly into said stream; producing particulate bronze and water mixture by impact at the intersection of said spray with said molten bronze; guiding said mixture in an essentially horizontal concurrent enclosed flow while boiling and turbulence are occurring therein; varying the flow of said water and said molten bronze so as to adjust said turbulence; continuing said concurrent turbulent flow until es-

sentially complete quenching has occurred; and collecting said mixture.

3. Process according to claim 1 wherein are continued the additional steps of separating said embrittled particulate bronze from said mixture; and impact milling said bronze to a desired degree of fineness.

4. Process according to claim 2 wherein are continued the additional steps of separating said embrittled particulate bronze from said mixture; and impact milling said bronze to a desired degree of fineness.

References Cited by the Examiner

UNITED STATES PATENTS

2,265,801	12/1941	Cooke	264—11
2,652,594	9/1953	Campbell.	
2,859,183	11/1958	Ashley et al.	
3,023,454	3/1962	Kuzell et al.	264—11

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