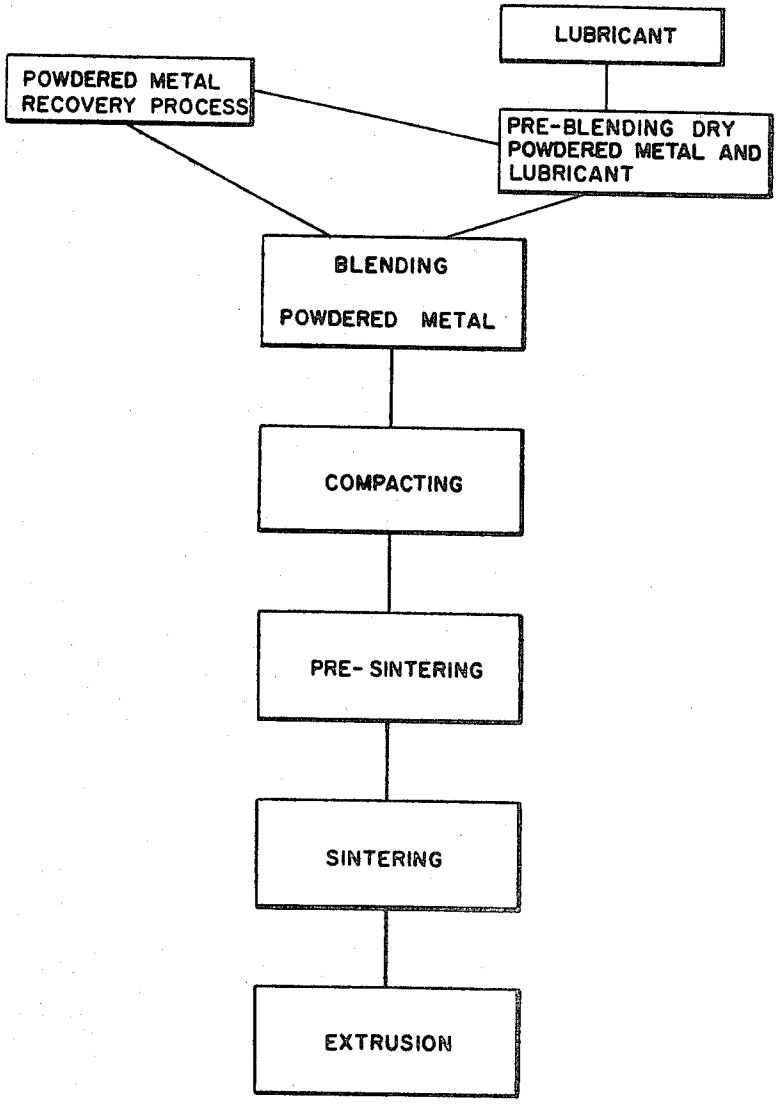
Sept. 10, 1968 T. J. BARTZ 3,401,033

METHOD OF BLENDING POWDERED METAL AND LUBRICANT PRIOR TO SINTERING

Original Filed March 9, 1961



INVENTOR.

THEODORE J. BARTZ

United States Patent Office 3,401,033
Patented Sept. 10, 1968

3,401,033

METHOD OF BLENDING POWDERED METAL AND LUBRICANT PRIOR TO SINTERING

Theodore J. Bartz, Marcellus, N.Y., assignor, by mesne assignments, to E. W. Bliss Company, Canton, Ohio, a corporation of Delaware

Original application Mar. 9, 1961, Ser. No. 94,487, now Patent No. 3,293,006, dated Dec. 20, 1966. Divided and this application June 7, 1966, Ser. No. 571,351
3 Claims. (Cl. 75—.5)

ABSTRACT OF THE DISCLOSURE

The disclosure pertains to the art of mixing powdered metal and lubricant in powdered form to achieve a blended mixture for use in forming green compacts. A quantity of powdered metal is separated from the original batch and is preblended with lubricant by feeding both through a series of sieves in a prescribed manner. Thereafter, the preblended batch is added to the original batch of powdered metal and the entire batch intermixed until blended with the lubricant.

This application is a division of application Ser. No. 94,487, filed Mar. 9, 1961, now Patent No. 3,293,006.

This invention relates broadly to the manufacture of structural parts. More particularly, this invention relates to the manufacture of structural parts such as tubing fabricated from metal in small particle or powder form.

It is well known that metal such as copper may be recovered from raw material including copper values through a chemical recovery process that produces as an end product discrete metallic particles generally known as powdered copper.

It is also known that the powdered copper may be compacted in order to form structural parts such as bearings, gears or bushings, etc. It is also known that powdered copper of the kind under consideration may be compacted and rolled into copper strip.

In order that the metallic particles forming a batch or quantity of powdered copper may be compacted, it is desirable to introduce into the batch of metallic particles an agent serving as a lubricant for the purpose of promoting union between the individual particles to cause coalesence and particle adherence when the batch is subject to forces developed in the compacting operation.

Under normal circumstances the lubricant or bonding agent is purged from the compact or resulting unitary metallic structure or shape during a sintering operation conducted prior to a metal forming operation. In the past it has been difficult to mix the lubricant or bonding agent with the particles forming the powdered copper so that adequate adherence of the particles may be achieved. Accordingly, it is an object of this invention to provide an improved method of mixing a bonding agent with a charge of metallic powder to provide a more efficient compaction of the metallic particles when it is desired to form the particles into a compact suitable for extrusion into tubing.

In the formation of tubing from compacted metallic particles by extrusion, I have discovered that unlike the fabrication of other structural shapes such as sleeve bearings, that an undesirable amount of "fines" will be detrimental to the formation of a tubular member. It is another object of this invention to provide a formulation of metallic particles in terms of their physical size that is suitable for the formation of tubing by the extrusion of a compact composed of discrete metallic particles formed into a predetermined structural shape by the application of suitable densification forces.

A further object of the invention is the provision of a novel method of making a compact or cylindrical briquette from powdered copper of the kind under consideration suitable for extrusion into tubing.

Another object of the invention is the provision of a structural member such as tubing wherein the wall of the tubing is formed by extruding a unitary compact formed of discrete metallic particles having particular physical characteristics such as size that lends itself to the efficient formation of tubing by the extrusion method.

These and other objects of the invention will be apparent upon a consideration of the ensuing specification and the drawing comprising a line diagram of the operation involved.

As pointed out above, it is generally know that discrete particles of copper may be formed by chemical recovery processes or by electrolysis. Copper formed in the manner described consists of a multitude of individual particles of copper which may be subjected to grinding or similar operations in order to provide a quantity of powdered copper having particular physical characteristics. In order that the powdered copper be suitable for formation into structural shapes such as sleeve bearings, it is well known that the metallic particles have certain physical sizes determined by the American Society of Testing Materials, known as A.S.T.M. standards and more commonly referred to as sieve sizes. Another organization that has established standards for the measurement of metal particles is the Metal Powder Industries Federation. It is also generally known that the A.S.T.M. sieve sizes bear a direct relationship to the size of the individual particles. For example, a sieve or screen classified as an an A.S.T.M. #325 consists of openings through which metallic particles having a dimension of 44 microns or less, will pass. In the art, metallic particles that pass through a #325 sieve are classified as fines. Other conventional sieve sizes used to classify particle sizes bear the following numerical designations, 100, 150, 200, etc. For the purpose of subsequently compressing a predetermined quantity of powdered copper into a structural shape, the physical characteristics of the quantity are defined in terms of percentages of particles that are retained or passed through a given sieve size. I have discovered that while copper particles in the classification generally referred to as fines may be suitable for formation into a structural shape such as a sleeve bearing, the fines that may be included in any given quantity of powdered copper for formation into a compact to be sintered and subsequently extruded into tubing, is limited. In this regard, I have discovered that fines of powdered copper of an average particle size less than ten microns are unsuitable for formation into a compact to be subsequently extruded into a tube. The term compact as employed herein refers to a substantially cylindrical slug of powdered copper densified through compression, by suitable equipment, of powdered copper particles so as to present a rigidly self-sustaining unitary part. The cylindrical slug is provided in addition with an axially extending opening co-extensive with the axis of the cylinder. For illustration, under circumstances where lengths of tubing of 58" having an outer diameter of ⅜" and a wall thickness of .016" are required a compact having a height of 1.800", an outer diameter of 1.041" and an inner diameter of .381", prior to sintering as described below, has been found suitable for subsequent extrusion into the tube.

The separation of fines of an undesirable dimension may be accomplished by a manufacturer or supplier of powdered copper of the kind under consideration. The specification for powdered copper of the kind used in the formation of copper tubing normally includes as an upper

limit, particles that will pass a #100 (A.S.T.M.) mesh screen or sieve. However, it has been found the presence of one half of one percent in any given quantity of powdered copper that will not pass the #100 mesh screen, does not have any appreciable effect on the compacting and extrusion operations. The majority of the particles of powdered copper fall in the size category determined by a #325 mesh screen. This value usually runs between fifty-five to seventy percent.

I have found that the following specification of particle size for powdered copper can be satisfactorily compacted and subsequently extruded to form copper tube.

Percentage of particles retained on a #100 sieve	0.5
Percentage of particles passing through a #100 sieve but retained on a #140 sieve	5.6
Percentage of particles passing through a #140 sieve but retained on a #200 sieve	6.6
Percentage of particles passing through a #200 sieve but retained on a #230 sieve	12.4
Percentage of particles passing through a #230 sieve but retained on a #325 sieve	15.5
Percentage of particles passing through a #325 sieve	59.9

An important feature of the invention is the discovery that the average particle size of the metal passing through the #325 screen should not be less than ten microns. The manner in which the average particle size of the fines referred to above is controlled is known in the art and described in a bulletin entitled, "Method for Determination of Average Particle Size of Metal Powders by the Fisher Subsieve Sizer," M.P.I.F. Standard 32–60, issued July 1960 by the Metal Powder Industries Federation, Metal Powder Producers Association.

By limiting the average size of the fines in the manner proposed, more efficient compacts are formed and more complete dioxidation is accomplished in the sintering operations. For example, the more minute particles present more surfaces per batch to be lubricated as well as furnishing more surfaces for the formation of oxide.

Once the powdered copper specification has been selected and the particles that pass through the #325 screen have an average particle size of at least ten microns, the powder is mixed with a lubricant in the manner broadly described above.

Another feature of this invention pertains to the method of mixing the lubricant with the powdered copper so that an efficient bond is subsequently obtained during the compression operation employed to form the compact. It has been determined that lithium stearate in powder form may be employed as a lubricant and successfully mixed with powdered copper in the manner to be described:

The novel method of mixing the lubricant with the powdered copper involves separating from a given quantity of powdered copper an amount that, for convenience, may be ten to twenty percent of the entire charge or quantity of powdered copper to be subject to compression in a compacting machine. The separated portion of powdered copper is then fed through a series of sieves preferably larger than the #100 mesh size. I have found that if two sieves of the #50 mesh size and two sieves of the #75 mesh size are employed in the manner to be described successful blending of the powdered copper and lubricant may be achieved. As the powdered copper and lubricant are fed through the sieves the sieve assembly is subject to a mild vibrating action for the purpose of feeding by gravity the mixture through the sieves. Beneath the lowest sieve in the sieve assembly is positioned a container for the purpose of receiving the charge after it passes through the sieves. The mix of powdered copper and lubricant deposited in the container is agitated by shaking the container to determine the extent of separation of the two constituents in the container. If, at the conclusion of the agitating action the lubricant tends to separate from the powdered copper the two materials are fed once again through the sieves and the agitation action of the container repeated. It will be observed that after each pass through the sieves the tendency for the two constituents to separate becomes less. I have successfully blended two materials forming a charge of ten pounds after four passes through the sieve assembly.

Once it has been determined that adequate mixing of the two constituents has been accomplished, the mixture is then added to the initial or original batch and blended with conventional blending equipment for a period of time sufficient to assure complete mixture of the powdered copper and lubricant. By pre-blending in the manner described the subsequent step of adding the pre-blended mixture to the original batch of powdered copper causes a thorough intermixing and assimilation sufficient to assure efficient densification of the individual particles in the batch.

After the powder has been mixed with lubricant in the manner described, the batch is fed to a compacting machine for the purpose of forming individual compacts of the dimensions described above.

After the compacts have been formed they are subjected to a sintering action consisting of two steps. The first passage is accomplished through a furnace having an atmosphere of disassociated ammonia at a temperature of 1200° F. The second step consists of passing the compacts through the furnace at an elevated temperature. During the pre-sintering or first step, the lubricant is burned off in the form of a volatile gas. The second step at the elevated temperature is for the purpose of purging the individual particles of oxide which forms on the surface.

The compacts after passing through the sintering furnaces are coated with a lubricant, for the purpose of facilitating extrusion of the compacts, and fed to an extrusion press.

In the extrusion press the compact is received in a container arranged in a die block and is subjected to pressures sufficient to extrude it by a punch member having an axially extending mandrel for insertion in the axial opening of the compact. The metal is then extruded in a path about the mandrel in the die member to form the tube.

The tubing formed in the manner described possesses a relatively fine grain structure which after annealing appears relatively undistrubed.

While I have described one illustration of my invention, it will be obvious to those skilled in the art that modifications will suggest themselves, which modifications fall within the claims appended hereto. Accordingly, it is not my intenstion to limit the invention by the description above, but rather offer same for elucidation only.

I claim:

1. The method of mixing a substance composed of discrete metallic particles with a material serving as a lubricant for the purpose of promoting coalesence and adherence of the particles upon compression thereof, which consists in the steps of separating from the batch a portion of a batch of the substance to be mixed, introducing the separated portion together with a predetermined amount of the lubricating material through a plurality of sieves, agitating the mixture issuing from the sieves to determine the extent of interspersion of the metallic particles and lubricating material, repeating the steps of introducing the mixture through the sieves and agitating the resulting mixture until satisfactory union between the metallic particles and the lubricating material is achieved and admixing the separated portion and interspersed lubricating material with the remainder of the batch.

2. The invention set forth in claim 1 wherein the step of introducing the separated portion of metallic particles and lubricating material through the sieves is accomplished through sieves having openings greater than the largest size of the individual particles of lubricating material.

3. The method of mixing a substance composed of discrete particles of a metal with a lubricating material, employed for the purpose of promoting coalesence and adherence of the metallic particles upon compaction thereof, which consists in the steps of separating a portion of the metallic substance from the batch to be mixed, introducing the separated portion together with a predetermined amount of the lubricating material through a plurality of sieves subject to mild vibratory action, agitating the mixture of metallic particles and lubricating material passing through the sieves to determine the degree of mixture achieved by passage through the sieves, reintroducing the mixture through the sieves and agitating the deposition from the sieves until separation is insignificant, introducing the separated portion into the batch and admixing the separated portion with the batch until assimilation of the portion into the batch is achieved.

References Cited

UNITED STATES PATENTS

2,386,544	10/1945	Crowley	75—222
2,776,887	9/1957	Kelly	75—222 X
3,001,871	9/1961	Thien-Chi	75—211
3,131,239	4/1964	Calis	75—222 X
3,282,675	11/1966	Parker	75—.5
3,320,057	5/1967	Palmateer	75—212 X

CARL D. QUARFORTH, *Primary Examiner.*

A. J. STEINER, *Assistant Examiner.*