July 13, 1965 S. STORCHHEIM 3,194,858

CONTINUOUS POWDER METALLURGICAL PROCESS

Filed Feb. 23, 1962

Fig. 1.

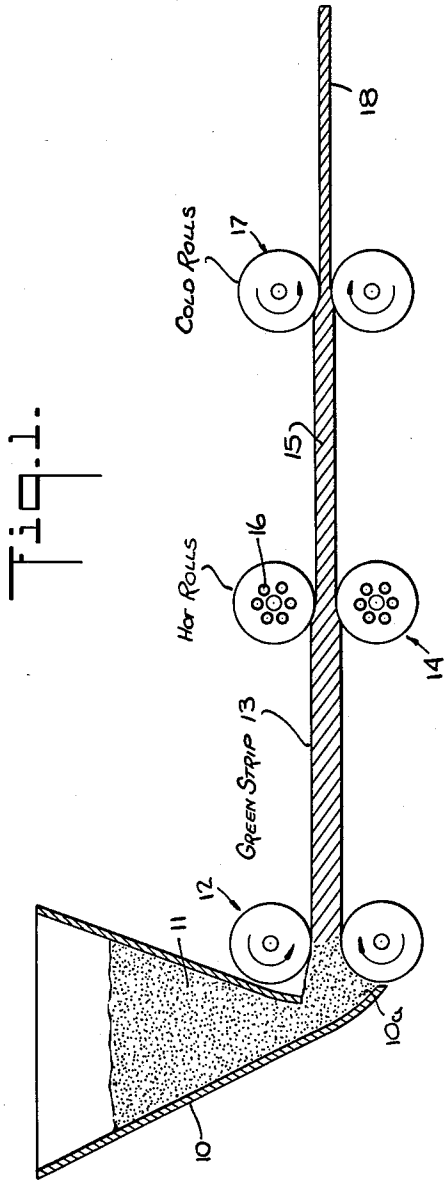
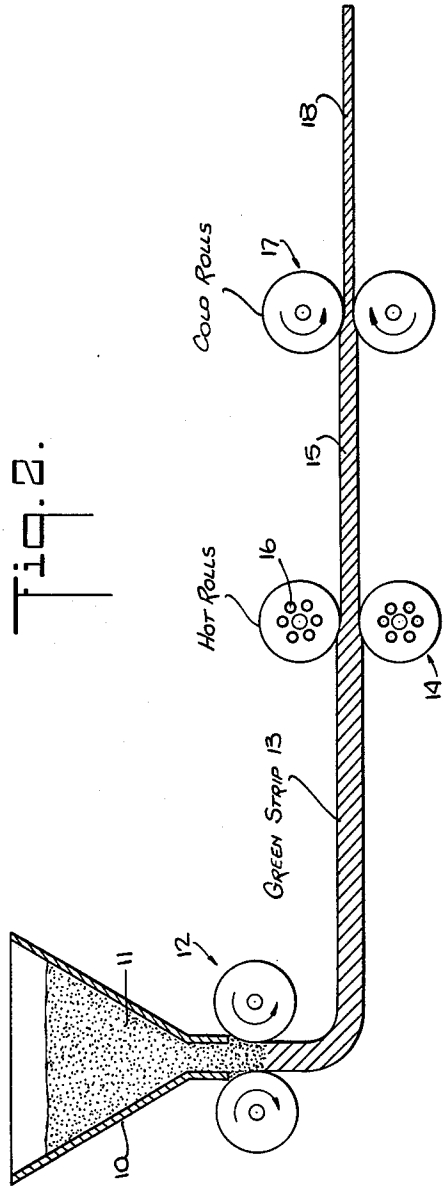


Fig. 2.



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United States Patent Office

3,194,858

Patented July 13, 1965

3,194,858

CONTINUOUS POWDER METALLURGICAL PROCESS

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Filed Feb. 23, 1962, Ser. No. 175,037
6 Claims. (Cl. 264—111)

This invention relates generally to powder metallurgical techniques and more particularly to a process for continuously consolidating metallic particles into strip or sheet form without the use of furnaces.

In general, powder metallurgy involves the formation of solid products by heating compressed metallic powders. This technique is applicable to elemental metallic particles or to complex mixture thereof, with or without the addition of non-metallic substances, and the pressing operation may be carried out at ordinary or elevated temperatures. It is possible by powder metallurgy to produce results comparable to that obtained by casting and melting and in some instances products may be fabricated having properties unattainable by conventional techniques.

In standard methods for converting powder to solid objects, pre-heating and sintering furnaces must be used in conjunction with presses or rolling mills. It is often also necessary to heat in a protective atmosphere, for powder is subject to rapid oxidation by reason of its high surface areas.

Accordingly, it is the main object of this invention to provide a metallurgical process for continuously converting metallic particles into solid strip or sheet, without using furnaces for pre-heating or sintering.

More specifically it is an object of this invention to provide a novel method of the above-noted type which is of particular value in consolidating metals having low temperature melting characteristics, such as lead, aluminum, copper and magnesium, into strip of high density.

A significant feature of the invention is that it is highly economical, there being no need for step compaction or for a protective atmosphere. Another advantage of this invention is that it lends itself to the use of particles above powder size, such as scrap or chip material or other forms of course particles.

Briefly stated these objects are accomplished by continuously feeding the metal particles to be densified into cold rolls to produce a green strip which is conveyed without interruption to one or more stages of hot or warm rolls to produce a fully densified strip of the required thickness, the heating of the rolls being effected internally without the use of furnaces.

For a better understanding of the invention as well as other objects and further features thereof, reference is made to the following detailed description to be read

in conjunction with the accompanying drawing, wherein:

FIG. 1 schematically illustrates a powder metallurgical process in accordance with the invention; and

FIG. 2 shows an alternative method of feeding the powder into the first set of rolls.

Referring now to FIG. 1, the system in accordance with the invention comprises a hopper **10** in which are fed metal particles **11**, preferably formed of the lower melting metals or alloys, such as aluminum, lead, magnesium or copper. The outlet **10***a* of the hopper is aligned with the nip of a pair of rolls **12** in a cold roll mill, the rolls acting to compress and partially consolidate the particles into a self-supporting green strip **13**. The metal particles may be in the form of relatively coarse particulates or scrap metal chips.

The green strip **13** is conveyed continuously through a second set of rolls **14** in a hot rolling mill to produce a densified strip **15**. Heating of these rolls can be accomplished in various ways, as by electrical resistance elements **16** embedded in the rolls by gas flame or even by high pressure steam. Since green strip is used for the hot roll cycle, the effect of steam on powder is eliminated from this precess. And since the metal used has a low melting point, it is possible without pre-heating furnaces to impart sufficient heat to the metal through the rolls to effect a hot rolling operation.

The densified strip **15** is conveyed through another set of rolls **17** in a hot, warm or cold rolling mill which serves to reduce the thickness of the strip to its final gauge **18**. In FIG. 1, the initial cold rolling is carried out in the horizontal direction by feeding the powders directly into the horizontal rolls. The same result can be obtained by pouring the powders onto a carrier, such as a paper web which is conveyed in the horizontal plane through the rollers and is later removed, as by burning.

In FIG. 2, the process is essentially the same, except that the first set of cold rollers **19** are in a vertical mill, and the resultant green strip is bent for feeding into the rolls **14** and **17**.

Referring now to Table I, there are shown the exact conditions under which aluminum and magnesium (ZK–10) were green strip rolled followed by warm rolling. In runs 6 and 7 where the final strip thickness for aluminum was approximately .015", the aluminum strip could be bent through approximately 180°. For aluminum alloys, higher rolling temperatures are necessary than those indicated in Table I. This may be accomplished by inserting additional cartridge heaters in the rolls and thereby increase the total kw. input.

TABLE I

Rolling of strip on 6" x 6" hot rolls

Run No.	1	2	3	4	5	6	7
Roll Temp., ° C	186	192	251	251	280	280	270–280
Material	ZK–10	Aluminum	Aluminum	ZK–10	ZK–10	Aluminum	Aluminum
Roll Opening	0	.027	.027	0	0	.027	.027
Initial Strip Thickness	.022	.089	.085	.022	.022	.089	.089
Final Strip Thickness	.011	.043	.042	.011	.010	.043	.044
2nd pass, Roll Opening						0	0
Thickness after 2nd pass						.013	.017

The process disclosed herein circumvents problems connected with rolling of hot powders, sintercake rolling or conventional powder metallurgy processes and has the following advantages.

(a) It eliminates the need for step compaction, as is

necessary in sintercake work. In addition, aluminum cannot be sintercaked continuously.

(b) The need for protective atmospheres as required in hot powder rolling, sintercake work and conventional powder metallurgical techniques is avoided.

(c) The expense of powder production is minimized or eliminated. One can use scrap material or coarse particulates.

(d) The hot rolls can be cooled with water, since strip is solid when it enters hot rolls. Contamination of powders is not possible in such cooling, as would be the case in hot powder rolling.

(e) Vertical feeding of powders optional.

(f) It can use less roll pressure than in discrete particle hot powder rolling.

(g) The rolls show longer life.

(h) Smaller roll diameters possible, resulting in less capital outlay.

(i) It eliminates use of furnaces, continuous sintering is unnecessary. This results in considerable cost reduction because of size of furnace and time of sintering which is not economical.

(j) Green strip rolling produces a more uniform strip because distribution and amount of contamination is easier to control at room temperature.

(k) The danger of explosions and fires in handling hot powders is eliminated.

While there has been shown what is considered to be a preferred process in accordance with the invention, it will be appreciated that many changes may be made therein without departing from the spirit thereof as set forth in the appended claims.

What is claimed is:

1. The method of converting metal oxidation-sensitive particles formed of a relatively low melting point metal into solid strip comprising the steps of feeding said particles into cold rolls to form a green strip and continuously feeding said green strip into at least one set of heated rolls to form a densified strip, said steps being carried out in air.

2. A system for continuously converting oxidation-sensitive metal particles into solid strip comprising a cold roll mill, a hot roll mill having means to heat said rolls, and means continuously to convey said particles of a low melting point metal in air into said cold roll mill to produce a green strip which is fed through said heated roll to densify same.

3. A system, as set forth in claim 2, wherein said hot roll mill includes electrical heating elements inserted in said rolls.

4. A system, as set forth in claim 2, wherein said hot rolls are heated by steam.

5. A method, as set forth in claim 1, wherein said particles are of magnesium.

6. A method, as set forth in claim 1, wherein said particles are of aluminum.

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