Dec. 22, 1959 H. FRITSCH 2,917,821

METHOD FOR ROLLING METAL POWDER

Original Filed April 1, 1954

FIG. 1

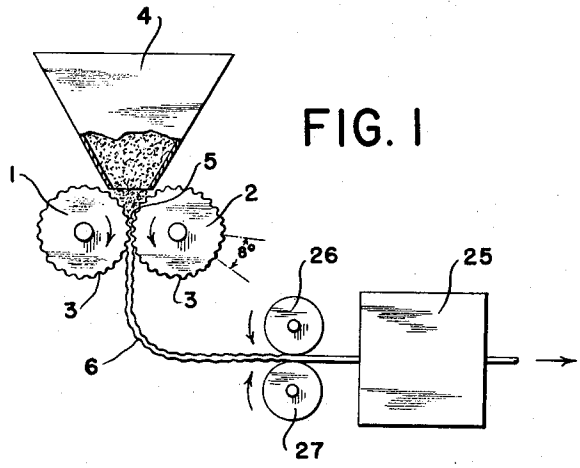


FIG. 2

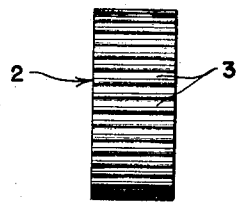


FIG. 3

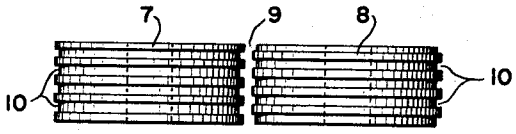


FIG. 4

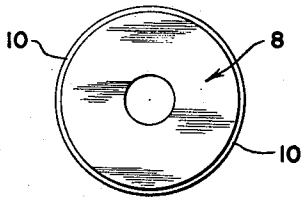


FIG. 5

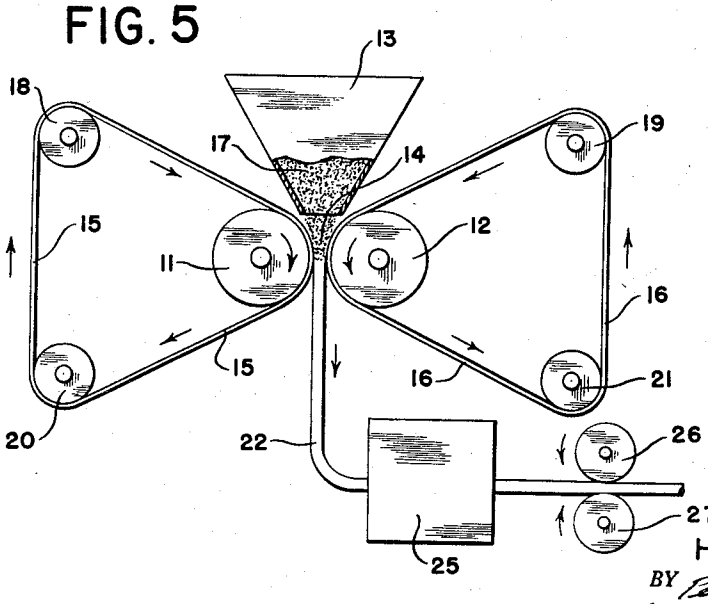
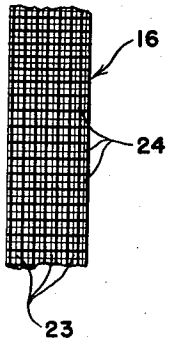


FIG. 6



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United States Patent Office 2,917,821 Patented Dec. 22, 1959

2,917,821

METHOD FOR ROLLING METAL POWDER

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Original application April 1, 1954, Serial No. 420,428. Divided and this application March 13, 1959, Serial No. 799,384

5 Claims. (Cl. 29—420.5)

This invention relates to a method for compressing metal powders into wrought metal shapes such as strips, rods, wires, sheets and the like. More particularly, the invention relates to rolling metal powders in a rolling mill in which the roll calibers are provided with shallow grooves.

According to the present invention, metal powder is compressed into wrought metal shapes by introducing the metal powder into a roll gap formed by laterally spaced oppositely disposed pressure rolls. The roll gap may be so regulated as to produce the metal shape of substantially the cross-section desired. As the metal powder passes through the roll gap, it is subjected to sufficient pressure to cause the metal powder to cohere.

In the rolling of metal powders hard steel rolls are usually employed, and during the actual compression of the powder, the powder tends to move sideways resulting in insufficiently compressed edges along the length of the strip or sheet being produced and necessitates excessive trimming along the edges of the strip. I have found that by providing the roll caliber or compression surface of the pressure rolls with shallow, flat, circumferential grooves, the resulting compacted or compressed metal powder is significantly improved. The circumferential flat grooves within the extent of the roll caliber prevents the metal powder from moving sideways and brings about, as much as possible, uniform density of the rolled compact throughout the entire width of the cross-sectional outline. These circumferential grooves have only a very small depth, generally amounting to about a fraction of a millimeter. The grooves should, however, be no deeper than approximately 10 percent of the thickness of the strip which is being made, and a depth of approximately 5 percent of the thickness of the strip being made is preferable. The grooves should be of sufficient depth to produce a roughness which will counteract any shifting of the powder in the direction of the axis of rotation of the compression rolls. The number of grooves across the width of the rolls will, of course, vary depending upon the width of the pressure rolls employed; however, with any particular width pressure rolls, the number of grooves is not critical but preferably the grooves should be only about a millimeter more or less in width and each groove separated by about a millimeter.

I have also found that by providing the compression rolls with shallow grooves extending in an axial direction within the extent of the roll caliber, that the resulting compacted metal powders are also significantly improved. In this embodiment, the height or depth of the grooves may also vary, and may also be adapted to the material to be rolled, depending upon the size of the metal particles and the thickness of the strip being rolled. The depth of the grooves as a rule will not be greater than fractions of a millimeter and, similar to the circumferential grooves, should be no deeper than approximately 10 percent of the thickness of the strip which is being produced, and a depth of approximately 5 percent of

the thickness of the strip being made is preferable. The cross-sectional outlines of the axial grooves are also advantageously sinusoidal or curved in order to preclude any sticking of the metal powder particles to the roll surface, as is apt to be the case with sharp-edged grooves.

The above reference to the depth of the axial and circumferential grooves is especially important when thin strip is being rolled, or strip on the order of about 0.5 mm. If the compact being rolled is somewhat thicker and if it is to be subjected to hot rolling, a somewhat greater latitude in the depth of the grooves with respect to the thickness of the strip being produced is permissible. The axial grooves will of course vary in number, but advantageously they should be regularly spaced about the periphery of the roll at about 8° intervals, or at least about 45 grooves about the periphery of the rolls. It is advantageous, however, to place the axial grooves so closely that there are at least two grooves in any one angle of 8°.

If both rolls are to be provided with grooves, either circumferential or axial, it is advantageous to arrange the grooves on the rolls so that they are not opposite each other, but staggered or between each other. This provides a smoother rolling operation. The width of the grooves, either circumferential or axial, is not critical, but they should be of a width which approximates the depth of the grooves. Grooves several times wider than the depth could also be used.

The axial grooves are instrumental in providing a better entrainment of the metal powder being rolled, which in turn results in an improved compacting effect and a better cohesion of the metal strip or sheet issuing from the pressure rolls. Heretofore, it has been found necessary to use a pressure roll diameter of at least fifty times the thickness of the rolled product in order to sufficiently compact the metal powder. Utilizing the axial grooves of the present invention in the pressure roll surfaces permits the use of a diameter of less than fifty times the thickness of the rolled product, and yet produces a rolled product which is sufficiently compact.

In accordance with the present invention, the grooves may also be advantageously applied to metal bands such as steel bands, which are passed through the rolls together with the powder and between the compression surface of at least one of the rolls and the metal powder, and such grooves in the metal bands will also produce improved metal compacts over the use of smooth metal bands. Providing the metal bands with cross grooves improves the compacting operation in the event traction is exerted in the direction of the roll movement.

For a more detailed description of the invention, reference may be had to the drawings in which:

Figure 1 is a schematic view showing a powder rolling apparatus having pressure rolls with axial grooves.

Figure 2 is a side view of one of the pressure rolls shown in Figure 1.

Figure 3 is a top view showing a rolling mill with pressure rolls having circumferential grooves.

Figure 4 is a front view of one of the pressure rolls in Figure 3.

Figure 5 is a schematic view showing the use of metal bands in conjunction with the pressure rolls.

Figure 6 is a view of a portion of the metal band in Figure 5 showing both longitudinal and cross grooves in the surface of the band.

Figure 1 shows pressure rolls 1 and 2 provided with axial grooves 3 within the extent of the roll caliber, and a hopper 4 for depositing the metal powder into the roll-gap 5 formed by the rolls 1 and 2. The grooves as shown have a curved cross-sectional outline. The metal strip 6 is shown having slight indentations or grooves formed therein by the grooves 3 in the rolls 1 and 2. The com-

pacted strip may then be further rolled by rolls **26** and **27** and passed through a sintering furnace **25**. Figure 2 is a side view of the pressure roll **2** showing the grooves **3**.

Figure 3 is a top view of a rolling mill in accordance with the present invention, showing pressure rolls **7** and **8** defining a roll-gap **9** provided with shallow flat circumferential grooves **10**. Figure 4 is a side view of pressure roll **8** showing the circumferential grooves **10**.

The circumferential grooves are shown in Figure 3 as having sharp corners. These grooves, however, may be provided with rounded corners or tapered sides. The grooves having rounded corners or tapered sides permit an easier withdrawal of the compact from between the rolls.

Figure 5 shows pressure rolls **11** and **12** and a hopper **13** for introducing metal powder into the roll gap **14**. Metal bands **15** and **16** are fed between the compression roll surfaces of the rolls **11** and **12** and the metal powder **17**, and are directed and driven by suitable pulleys **18**, **19**, **20** and **21**. The resulting compacted metal strip, shown at **22**, is then passed through a sintering furnace **25** and the sheet material may be rolled after sintering by the rollers **26** and **27**. Figure 6 shows a portion of the metal band provided with both longitudinal grooves **23** and cross grooves **24**.

The above drawings are of course for the purpose of illustration only, as various and obvious modifications may be made therein without departing from the scope of the present invention. For example, in Figure 5 one of the bands **15** or **16** may be eliminated in which case the pressure roll from which the metal band has been eliminated may remain smooth or may be provided with grooves in accordance with the present invention. Other manners of introducing the metal bands into the roll gap may also be utilized, if desired, aside from the use of the pulleys shown.

It is also within the scope of the present invention to provide the pressure rolls with both axial and circumferential grooves, and in this manner gain the advantage of both types of grooves. Cross and longitudinal grooves may also be used simultaneously with metal bands, as hereinbefore described, or the metal band may be provided with longitudinal grooves only, or cross grooves only.

If desired, a pair of compression rolls having a grooved surface, in accordance with the present invention, may be followed by a pair of rolls having a smooth surface in order to straighten out any slight unevenness in the surface of the compacted metal powder.

Any type of metal powder such as copper, nickel, cobalt, lead, iron, and the like may be rolled with the rolling mill of the present invention. Alloys of metals may also be produced by employing a heterogeneous powder.

The present invention, although adaptable to any type of metal powder pressure rolls, is particularly advantageous when employed on pressure rolls in which the axes are situated in a horizontal or slightly inclined plane, and their diameters a multiple of the thickness of the rolled compact, and when the roll surface is slightly roughened. The compression rolls should have a diameter of at least fifty times the diameter of the rolled metal powder compact.

The metal shapes or strips exiting from the grooved rollers according to this invention are in a partially consolidated state and can contain very small grooves which can be readily eliminated by rerolling the partially consolidated product before or after sintering or other heat treatment by rollers having smooth compression surfaces such as rolls **26'** and **27'** in Figure 5 of the drawing.

This application is a division of the copending application Serial No. 420,428, filed April 1, 1954, now abandoned.

I claim:

1. The method of compressing metal powders into wrought metal shapes which comprises feeding the metal powder into a roll gap formed by laterally spaced, oppositely disposed pressure rolls provided with compression surfaces, said compression surfaces containing grooves of a depth not greater than about 10 percent of the thickness of the wrought metal shape being produced, compressing said metal powder between said compression surfaces to form a partially consolidated metal shape containing grooves, and rerolling said partially consolidated metal shape with rolls having smooth compression surfaces to further compress the partially compressed metal shape, to eliminate the grooves therein, and to form a completely consolidated groove-free metal shape.

2. The method of claim 1 in which said grooves extend in the direction of the path of travel of said metal powder through the roll gap formed by the pressure rolls.

3. The method of claim 1 in which the grooves extend transversely to the path of travel of the metal powder through the roll gap formed by the pressure rolls.

4. The method of claim 1 in which the grooves extend both in the direction of the path of travel of the metal powder through the roll gap formed by the pressure rolls and transversely thereto.

5. The method of claim 1 in which the partially consolidated metal shape containing grooves is sintered before it is rerolled into a completely consolidated groove-free metal shape.

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