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Wentzell

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[54] **METHOD OF MANUFACTURING STRIP FROM METAL POWDER**

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[52] **U.S. Cl.** ..... **29/423,** 29/149.5 S, 29/527.2, 29/527.7, 29/DIG. 39, 117/105.3, 164/46

[51] **Int. Cl.** **B23p 17/00**

[58] **Field of Search** ..... 29/527.2, 527.7, 29/DIG. 39, 149.5 S, 423; 164/46; 117/105, 105.3

[56] **References Cited**

UNITED STATES PATENTS

3,221,392	12/1965	Gould	29/149.5 S
2,129,702	9/1938	Merle	164/46
2,864,137	12/1958	Brennan	164/46
2,490,543	12/1949	Robertson et al.	29/527.2 X
3,310,870	3/1967	Parikh et al.	29/527.2 X
2,639,490	5/1953	Brennan	117/105.3 X
3,025,182	3/1962	Schrewelius	117/105
3,378,392	4/1968	Longo	117/105 X
2,289,311	7/1942	Wellman	29/423 X
3,652,317	3/1972	Porta et al.	29/423 X

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[57] **ABSTRACT**

A method is provided for forming metal strip from metal powders by spraying the powder as molten metal onto a cooled moving metal foil and thereafter consolidating the foil and sprayed metal by applying pressure.

8 Claims, 2 Drawing Figures

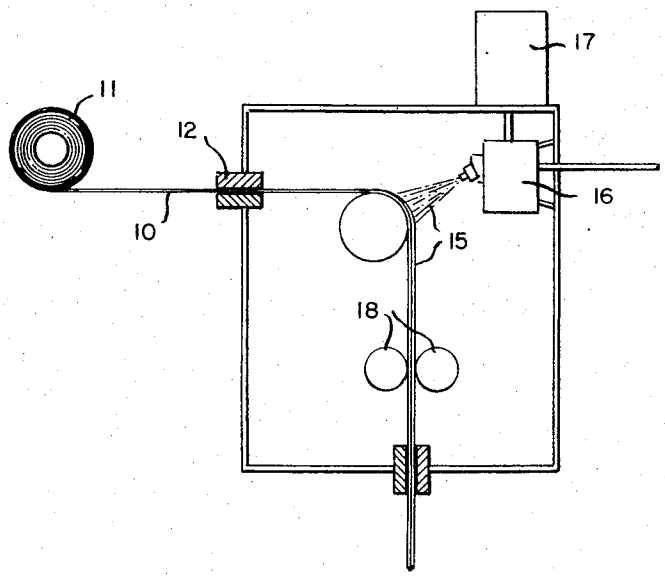


Fig. 1.

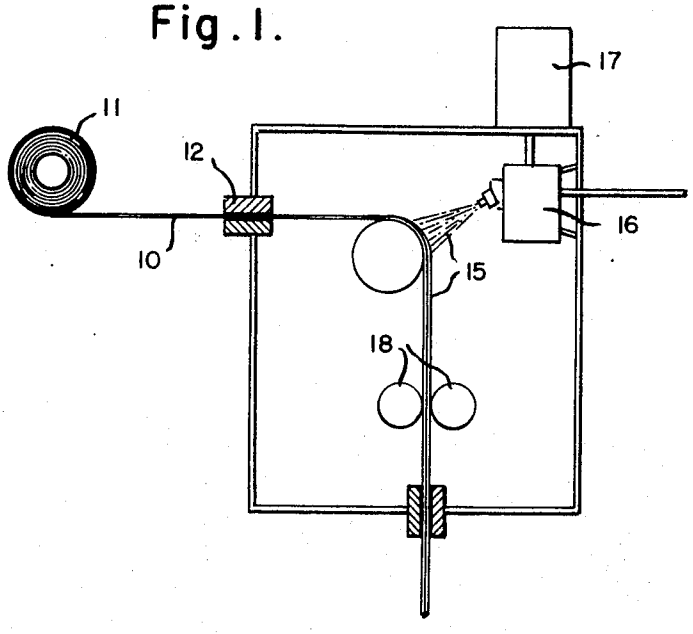
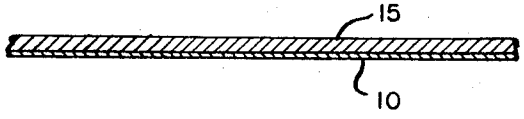


Fig. 2.



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METHOD OF MANUFACTURING STRIP FROM METAL POWDER

This invention relates to methods of manufacturing strip from metal powder and particularly to a method of making superalloy strip from powder, although the method will apply to other alloys as well.

Normally the metals known as superalloys, i.e., alloys of iron, nickel or cobalt which will maintain usable mechanical properties at elevated temperatures, are cast into ingots which are then either forged or bloomed into slabs, cut and conditioned, rolled into either bands or plates, conditioned and then finally rolled into strip and cut. There are several heat treatments necessary throughout the process and a final heat treatment dependent on the customers requirements. All of this costs time and money. Perhaps more important is the fact that this large amount of hot working tends to deplete boron from superalloys through oxidation. Boron is essential to stress rupture life at elevated temperature.

Sheet and strip of nickel, aluminum and iron have been rolled directly from metal powder by feeding the powder through a mill with its rolls in a horizontal plane. When rolling strip in this fashion it is necessary that the green strength of the strip be sufficient to allow subsequent processing. This means that the powder must have a special configuration conducive to providing high green strength. Superalloy powder having high purity is generally made by a dry process which results in spherical powder having poor cold compactability lacking the special configuration necessary to provide green strength.

I have invented a method of making metal strip from metal powder which makes it possible to form strip from powder without regard to its shape. In my method I feed the metal powder through a plasma gun or similar metallizing gun onto a substrate of aluminum, copper or iron strip or foil, the foil being in intimate contact with a cooling element at the time the hot metal particles are sprayed onto the substrate. The metal spraying operation is carried out in an inert atmosphere such as in an inert gas purged chamber. Preferably the sprayed foil is cold rolled to a predetermined reduction and then resprayed if greater thickness is desired. The amount of spray applied and the amount of cold rolling are dependent upon the particular alloy and the desired thickness. Each subsequent spraying or metallizing after rolling will stress relieve the strip. Since all heat treatment is carried out in an inert atmosphere oxidation is eliminated. The substrate may be removed from the finished strip by preferential etching using for example hydroxide for aluminum foil and nitric acid for copper or iron.

In the foregoing general description of my invention I have set out certain objects, purposes and advantages of my invention. Other objects, purposes and advantages will be apparent from a consideration of the following description and the accompanying drawings in which:

FIG. 1 is a schematic section through an apparatus for carrying out the practice of this invention, and

FIG. 2 is a section through a strip made from metal powder according to my invention.

Referring to the drawings I have illustrated a sheet of foil **10** being delivered from coil **11** through a chevron seal **12** into the interior of chamber **13** where it passes over a water cooled roll **14.** The foil **10** is sprayed with molten superalloy **15** from a plasma gun **16** supplied with powdered superalloy from a hopper **17.** The molten superalloy **15** solidifies on the foil **10** to form a layer of superalloy which is passed between pressure rolls **18** to cold roll the newly formed superalloy strip **15.**

If a greater thickness of strip **15** is desired than can be applied with one pass in front of plasma gun **16,** then the coating operation is simply repeated as many times as is necessary. The spraying of molten superalloy onto the strip **15** will stress relieve the previously formed layer **15** without danger of oxidation.

If the substrate **10** is to be removed the composite strip is passed through an appropriate etch solution to dissolve it away from the superalloy strip **15** after cold rolling.

In the foregoing specification I have set out certain preferred practices and embodiments of my invention, however, it will be understood that this invention may be otherwise embodied.

I claim:

1. A method of forming strip from metal powders comprising the steps of

a. converting a metal powder to a molten metal spray,

b. applying the molten metal spray in an inert atmosphere to a moving metal foil in a substantially uniform layer to form a major component of the combined thickness,

c. cooling the metal foil and molten spray applied thereto to solidify said molten spray while in said inert atmosphere, and

d. consolidating said foil and sprayed metal by applying pressure thereto.

2. A method as claimed in claim **1** wherein the foil is cooled simultaneously with the application of the molten spray thereto.

3. A method as claimed in claim **1** wherein the foil is coated with metal spray while changing direction of the foil.

4. A method as claimed in claim **1** wherein the metal foil is a member selected from the group aluminum, nickel, copper and iron.

5. A method as claimed in claim **1** wherein the metal is consolidated by pressure rolling.

6. A method claimed in claim **1** wherein the metal powder is passed through a plasma gun to form a molten spray of metal.

7. A method as claimed in claim **1** wherein the foil is removed by etching after consolidation of the metal.

8. A method as claimed in claim **1** wherein the foil is passed over a water cooled roll in an inert atmosphere and the molten metal sprayed onto the foil while the foil is on the water cooled roll.

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