

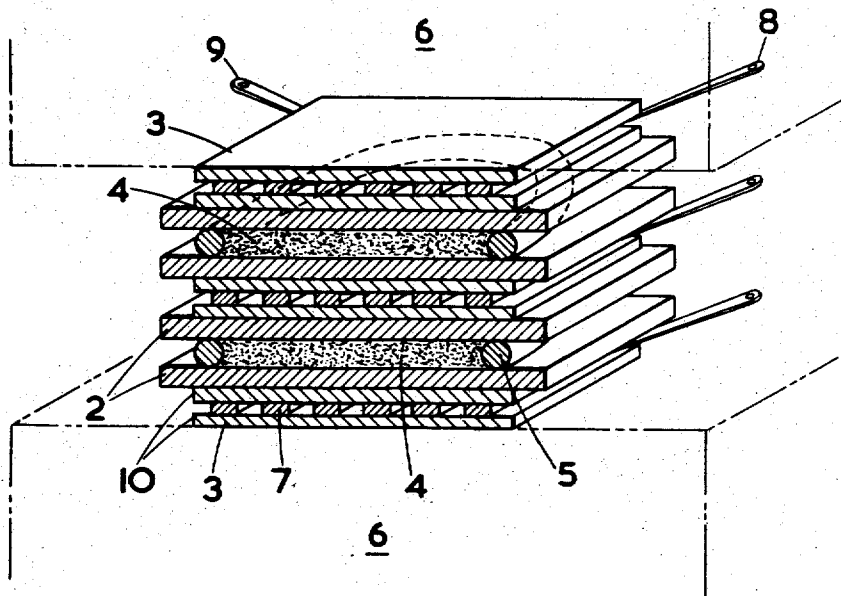
May 12, 1959

A. BLAINEY

2,886,433

PRODUCTION OF SHEET FROM PARTICULATE MATERIAL

Filed Jan. 4, 1951



Robert B. Hanson
By *ALAN BLAINEY*
Attorney

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PRODUCTION OF SHEET FROM PARTICULATE MATERIAL

Alan Blainey, Strand, London, England, assignor, by mesne assignments, to the United States of America as represented by the United States Atomic Energy Commission

Application January 4, 1951, Serial No. 204,425

9 Claims. (Cl. 75-214)

This invention refers to the production of sheets, including shaped plates and blanks, by the hot or cold pressing of non-coherent material such as granular or powdered metal, granular or powdered oxides, slurries, pastes and plastic mixes.

Its primary object is to avoid the use of expensive and/or short lived pressing tools, that is, dies and specially profiled rolls, and so to reduce the cost of the product and to provide in a simple manner for the making of the product in a variety of shapes or sizes.

The invention resides in a process for forming coherent sheet material from granular or powdered material that coheres under pressure comprising the step of compressing a layer of the granular or powdered material when laterally confined by deformable strip material such as wire. The powdered material may be compressed between flat plates or plain rolls together with strip metal conforming to the desired contour of the product and deformable under the operating pressure to permit of the necessary compression of the material.

Discs may be formed with the aid of wire or strip metal rings introduced into the press singly or side-by-side or stacked one on another, metal plates being employed as necessary to protect the faces of the press and to separate the rings of a stack, and the material to be pressed being smoothed into the spaces bounded by the rings.

For hot-pressing operations, flat heater elements may be placed against or between the rings. Alternatively, induction heating or oven heating may be employed.

Lengths of pressed sheet may be formed by rolling the granular or powdered material together with two wires spaced apart according to the desired width of the pressed sheet and drawn by the rolls from spools or reels.

The invention is particularly applicable in the production of discs, blanks and extended sheets of pressed and sintered metal powder and metal-oxide powder. A representative example of the application of the invention will now be given with reference to the single figure of the accompanying drawing which is a sectional view of a demountable stack for use in the construction of beryllium windows for X-ray tubes.

The demountable stack consists of a series of 4" square plates 2 made from No. 18 gauge Nimonic, that is a nickel-chromium alloy having high creep strength which renders it suitable as a material for the construction of dies, and coated with colloidal graphite, flat heater elements 3 and layers 4 of beryllium powder formed as a paste with paraffin and contained by 2½" diameter rings 5 of soft iron wire sixty-thousandths of an inch thick. The stack is assembled in a hydraulic press 6. The elements 3 consist of Nichrome strips 7 having connecting leads 8, 9. Insulation is provided by mica sheets 10. The press is initially operated to apply to the stack a small axial load (up to 25% of the final pressure) to press the parts together and so to prevent or reduce oxidation of the beryllium in the subsequent heating stage.

The stack is then heated, by current flow in the heater elements 3, to bring the layers of beryllium powder to

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sintering temperature (800° C.) and the press is operated to apply a pressure of about 12½ tons per square inch for a period of five minutes. In this pressing operation, each flat circular mass of beryllium is flattened and compressed, the ring bounding each mass yielding under the applied pressure. As a result of the combined heating and pressing, dense discs of beryllium metal are produced.

This process is applicable to other metals for which pressing and sintering in dies is customary.

In another example of the process according to the invention boron discs are formed by the cold pressing of boron powder, the resulting compacts being subsequently heated to sinter the powder. The pressing process is similar to that described in the previous example but the stack in this case consists simply of alternate rings, such as ring 5, and plates, such as plate 2, bounding the boron powder.

A pressure of up to 50 tons per square inch is applied, after which the stack is dismantled and the boron compacts brought to sintering temperature in an oven.

This process is generally applicable to elements and compounds normally cold-pressed in hardened dies prior to a heat treatment.

In a further example of the invention sintered discs of refractory oxides such as alumina, beryllia, magnesia are made by hot pressing. The powdered oxide is contained in a stack of alternate plates and rings, the plates being graphite discs and the rings being of tungsten. A high-frequency furnace is employed for heating the stack, the heat being developed in the graphite discs.

Many variants within the scope of the invention are possible.

Shapes other than circular discs may be made by using appropriately shaped loops of wire or metal tape, or appropriately shaped deformable strip-metal blanks, instead of rings.

The invention may be applied to the production of sheet material by hot or cold pressing between rolls. The granular or other material to be compressed into sheet form is fed, for example, on a backing sheet of thin "Nimonic" between the rolls together with two wires preventing lateral spread of the material and yielding under the pressure between the rolls to permit compression of the material. Heating may be provided by passing an electric current between the rolls so as to pass through the material whilst under pressure.

For example, the alloy of iron, nickel and cobalt, known as Kovar, and used for metal-to-glass seals is normally produced by casting and rolling, this process giving rise to considerable wastage of the alloy. The alloy may be made by compacting and sintering a mixture of the powdered metals, the compacting into a coherent strip being performed by rolls and confining wires as above described.

I claim:

1. A process for forming coherent sheet material from particulate material which coheres under pressure, comprising the steps of laterally confining a layer of the particulate material in a boundary material deformable in all lateral directions under axial pressure, and axially compressing the layer of particulate material together with the boundary material.

2. A process according to claim 1, and heating the compressed material.

3. A process for forming coherent sheet material from particulate material that coheres under pressure, comprising the steps of supporting the particulate material in a layer, laterally confining the layer in its supported position by a boundary material deformable in all lateral directions under pressure, rolling the layer and boundary material at high pressure to compress the material into a

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coherent sheet while simultaneously compressing the boundary material.

4. A process according to claim 3, and applying heat to the material during the rolling step at the location of the applied rolling pressure.

5. A process for forming coherent sheet material from particulate material which coheres under pressure, comprising the steps of wetting the particulate material with a hydrocarbon vaporizable by heat, laterally confining a layer of the particulate material, axially compressing the layer while axially compressing and deforming the lateral boundaries of the material, and heating the material during said compressing step.

6. A process according to claim 1 wherein the boundary material is a wire.

7. A process according to claim 1 wherein the particulate material is a metal powder.

8. A process for forming coherent sheet material from particulate material which coheres under pressure, comprising the steps of supporting a layer of the particulate material between spaced, parallel hardened plates, later-

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ally confining said layer in a strip of boundary material deformable in all lateral directions under axial pressure, said boundary material having greater resistance to deformation than said layer of material and axially compressing the layer of particulate material together with the boundary material, to compact said layer while deforming said boundary material.

9. A process according to claim 8 in which a plurality of layers are stacked together compressed simultaneously.

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