UNITED STATES PATENT OFFICE.

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METHOD OF PRODUCING FORMED METALLIC ARTICLES.

1,359,353. Specification of Letters Patent. Patented Nov. 16, 1920.

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To all whom it may concern:

Be it known that I, CHARLES L. GEBAUER, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvement in Methods of Producing Formed Metallic Articles, of which the following is a full, clear, and exact description.

This invention relates to a method of forming metallic articles and has for its objects the provision of a new method whereby the production of certain classes of articles out of known, common, and fusible metals can be facilitated, and whereby articles of use can be made out of metallic substances which hitherto could be worked by no known method.

The essence of my invention consists in this that the metal in finely divided condition is compacted by great pressure into the substantial or exact size and shape of the article desired, after which it is brought to an elevated temperature less than its melting point and maintained at that temperature for a considerable time. As a result of this treatment the particles cohere together in a solid, rigid, integral, homogeneous whole, which whole bears the finished shape and size without necessity of machining or forming operations. Furthermore articles made in this way are generally more dense than if made by casting processes, while several metals can be treated thus which from their infusibility can not be cast or from their hardness can not be machined after casting.

In my former Patent No. 1,223,322 granted April 17, 1917 and in my former applications Nos. 113,313 and 169,176, filed Aug. 5 1916, and May 17, 1917, respectively I have described articles made by compacting together two or more distinct metals of different fusing points and heating the same to a temperature intermediate their several fusing points, which I formerly supposed was essential to success, but I have discovered that a solid rigid homogeneous article can be produced by compacting to the desired shape either a finely divided single metal or finely divided mixture of metals and by suitably heat treating the same at a temperature less than that of fusion of the single metal in the first case or less than that of any of the metals in the second case.

This invention is of use for a great many purposes in the arts and sciences: for example in the construction of electrodes for vacuum tubes; in the production of all manner of tungsten or molybdenum articles for electrical, chemical, mechanical or metallurgical uses; for the manufacture of dies, bearings, small parts, intricate patterns, etc., in iron, nickel, chromium, vanadium, titanium, or the alloys of same or like metals; or in mixtures of titanium, vanadium, chromium, molybdenum, tungsten, manganese, iron, cobalt, nickel and the like as in making compound substances for special purposes to take the place of the expensive casting, forging, and machining.

As one example of my improved process and of an article made therefrom I may make a valve part out of iron reduced by hydrogen, compressed hydraulically to the shape desired under a pressure of, *e. g.*, 2,000 pounds per square inch, and raised to a dull red heat (*e. g.*, 800° C.) and maintained at that temperature for about one hour.

As another example I make puppet valves for internal combustion engines by compacting iron, nickel, tungsten and chromium into a mold under a pressure of 4,000 pounds per square inch and afterward maintaining the same at a temperature of about 1200° C. for about half an hour.

As another example of my improved method I make tools and dies by compacting into a suitable mold a mixture of iron, molybdenum and chromium under a pressure of 1,000 pounds per square inch and thereafter heating the same for about one hour to a temperature of about 1200° C. In each of the above cases I preferably employ a preponderance of iron with about 10% of chromium, the balance consisting of the remaining ingredients named.

If the mixture be first compacted under sufficient pressure I find that little or no change in shape or size will take place during the succeeding heat treatment. My invention is characterized by compacting together the pure metals in finely divided form to the ultimate shape required and subsequently treating them to a temperature greater than their critical temperature but less than the melting point of any of them. By critical temperature I mean the lowest temperature at which molecular rearrangement of the material becomes possible.

This temperature varies very greatly for different substances, as is well known, where-

fore no fixed minimum temperature can be given. Thus in gold and lead molecular rearrangement will take place at ordinary temperatures, in hardened steel this action will occur at the temperature of boiling water though slowly, and in the case of tungsten the minimum critical temperature appears to be at least 1000° C. The time required becomes less as the temperature approaches the melting point of the substance, and increases with the mass of substance treated. The process herein set forth is applicable either to homogeneous masses of a single metal or to mixtures of metals whose melting points all lie above the critical temperatures of all, but is not applicable to such mixtures as those of lead and tungsten wherein the melting point of one lies below the critical temperature of the other.

Having thus described my invention, what I claim is:—

1. The process of producing a formed metallic article which consists in compacting the finely divided metallic substance to the desired shape and size under great pressure and then heat treating the same at a temperature above the critical temperature of all its components but less than the fusing temperature of any component until the particles shall have cohered rigidly together.

2. The process of producing a formed metal article which consists in mixing together a plurality of finely divided metals all of whose melting points lie above the critical points of all, compacting the same under great pressure to the desired form of the finished article, heating the same to a temperature intermediate the lowest fusing point and the highest critical point of any of the components, and maintaining such temperature until the particles shall have cohered rigidly together.

3. The process of producing formed articles containing alloys of iron-metal group and chromium-group metals, which consists in mixing intimately together one or more iron group metals and one or more chromium group metals, compacting the same under great pressure to the finished form desired, heating the same to a temperature between about 1000° C. and 1400° C., and maintaining the article at this temperature until thoroughly coherent.

In testimony whereof, I hereunto affix my signature.

CHARLES L. GLÄSAUER.