

UNITED STATES PATENT OFFICE.

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PROCESS OF PRODUCING ALLOYS.

SPECIFICATION forming part of Letters Patent No. 724,524, dated April 7, 1903.

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To all whom it may concern:

Be it known that I, WILLIAM CALVIN TILDEN, a citizen of the United States, residing at Washington, in the District of Columbia, have invented a new and useful Process of Producing Metallic Alloys, of which the following is a specification.

My present invention relates to a novel metallurgical process for producing metallic alloys.

The invention has for its object the origination of a process so general in its application to the production of metallic alloys as to constitute a distinct principle or metallurgical law.

It is well understood by those skilled in the art that the physical properties of an alloy vary materially in accordance with the order in which its component metals are fused and the proportions thereof. For this reason the production of a perfectly homogeneous structure in an alloy has depended solely upon laborious experimentation for the purposes of determining the percentage quantities, conditions of temperature, pressure, and rapidity of cooling, &c., necessary to a perfect combination of the component metals to produce an alloy capable of being remelted without disturbing the balance of its component metals. Therefore, except in specific instances, metallic alloys produced by known processes are wanting in that intermolecular uniformity or homogeneity which is absolutely essential in order to permit the remelting of the alloy without disturbing its balance, and in view of this fact I have conducted experiments extending over a protracted period for the purpose of determining under what circumstances or conditions most, if not all, metals may be perfectly combined or alloyed. As the result of such experimentation I have discovered that a perfect alloy of most metals useful in the arts may be obtained by selecting from a given group of metals to be alloyed one whose melting-point is below the melting-point of the most refractory metal of the group and by fusing the selected metal to form a bath. In this bath, the temperature of which is below the fusing-point of the most refractory metal, the several metals are successively fused in the inverse order of

their fusibility, the temperature of the bath being constantly reduced in order to approximate the fusing-point of the next metal to be fused, and thereby preventing the loss of metal by volatilization. In order, however, that the process which I have originated may be more clearly comprehended, it may be well to select a group of metals and recite specifically, by way of an example, the manner in which these metals may be combined to produce an alloy or magma the physical structure of which is of such absolute uniformity as will permit the remelting of the alloy without disturbing the balance of its component metals. The group selected for the purposes of this example may be—

No.	Metals.	Percentage.	Approximate melting-point.
1.....	Ni	16.5	2,800° Fahrenheit.
2.....	Cu	63	2,000° Fahrenheit.
3.....	Al	11	1,300° Fahrenheit.
4.....	Zn	9.5	780° Fahrenheit.

Of this group of metals it may be noted that nickel is the most refractory and that zinc is the most fusible. The nickel, copper, aluminium, and zinc therefore stand in the inverse order of their fusibility and numbered, respectively, 1, 2, 3, and 5. Considered with respect to the temperatures of their melting-points the metals are also recited in their inverse order, and it is in this aspect that one of the most important features of the process is discernible. The nickel—that is to say, the metal having the highest fusing-point or the least fusible metal of the group—will if placed in a molten metallic bath become fused at a temperature considerably below its normal fusing-point—to wit, that temperature at which it would fuse if subjected alone to the action of heat. The difference between the normal fusing or melting point of a metal and the temperature at which said metal will fuse in a molten bath will therefore determine which of the component metals of a proposed alloy may be used most advantageously for the initial bath. For instance, in the example given nickel, the most refractory of the component metals, will fuse alone or normally at about 2,800° Fahrenheit and will fuse in a

molten bath of copper at something less than 2,000° Fahrenheit. Therefore I may select as a bath metal any one of the component metals which may be subjected to 2,000° Fahrenheit without volatilizing or burning, and of course any metal whose fusing-point is between 2,000° Fahrenheit and 2,800° Fahrenheit may be utilized as the bath. Thus in the example copper is selected as the bath metal because it is that metal which will fuse the nickel or most refractory metal at the lowest possible temperature and which will not be injuriously affected by the temperature necessary to this result. If, however, the proposed alloy were to include any other metals within the range of availability thus defined, any one of them might be utilized as the initial bath metal. As a general rule I select for the bath that metal standing second in the inverse order of the fusibility of the several metals of the group, because I have found that almost universally the metal bearing such relation to the several components will be productive of the best results when employed as a bath. In the example the bath is formed by fusing the copper at about 2,000° Fahrenheit. In this bath is next placed the several other component metals, separately and successively in the inverse order of their fusibility—first the nickel, then the aluminium, and finally the zinc. The nickel, although its fusing-point is about 2,800° Fahrenheit when subjected alone to the action of heat, will fuse at something less than 2,000° Fahrenheit when fused in the copper-bath, as stated, and as this temperature is not sufficient to volatilize the copper it will be seen that there will be no loss incident to the volatilization of the most fusible of the two metals thus combined. The temperature of the bath, which is now composed of copper and nickel, is permitted to fall below the boiling-point of the metal next in order—to wit, the aluminium—and although the temperature of the bath may not fall either to or below the fusing-point of the aluminium it may be brought well within the temperature at which the aluminium will volatilize, and as a consequence there will be no loss incident to volatilization when the aluminium is added to the copper and nickel. In like manner the temperature of the bath, which latter is now composed of copper, nickel, and aluminium, is reduced below the boiling or volatilizing point of the zinc, and said metal is added to complete the molten metallic mass or alloy. The fused compound is then removed from the furnace and rapidly cooled. The rapid cooling of the mass is an important feature of my discovery, since I find that it is productive of an alloy or compound ingot having desirable properties which are largely attributable to the sudden cooling of the metal. These properties not only facilitate the remelting of the alloy without disturbing the balance thereof, but also render the compound more ductile and more readily exten-

sible or drawable, and thus vastly increase the range of utility of the product. In practice the sudden cooling of the metal is effected by casting the ingot around a hollow core and within a shell or mold, both the core and shell being artificially cooled, so that the heat of the cast is absorbed by both interior and exterior cooling means. This step of the process may, however, be practiced in a variety of ways.

It will now be noted that I have produced an alloy by producing a metallic bath from a metal whose melting-point is below that of one or more metals of the component group and by thereafter fusing in said bath the several other metals of the group in the inverse order of their fusibility, and while I prefer to form the bath of that metal standing second in the inverse order of the fusibility of the several metals it may be desirable in some instances to employ another metal of the group for this purpose, provided the interval between the melting-points of the selected bath metal and the most refractory metal is not sufficient to cause the burning of the bath metal in order to produce the temperature necessary to the fusing of the least fusible metal of the group.

By carrying out the process described I am enabled to produce alloys of metals whose melting-points are widely separated and in which the original quantities of the component metals appear in the proportions desired and with practically no loss by volatilization and combined in a manner to produce that intermolecular uniformity of structure or homogeneity which is a property of first importance in all alloys. It will furthermore appear that by reason of the comparatively low temperature at which the fusing of the most refractory or least fusible metal is effected the practice of my process will be distinguished by great economy in fuel and will make possible the employment of more simple and less expensive types of furnaces.

It should be understood that while I have directed the foregoing description to a description of my process as practiced in the formation of alloys from virgin or simple metals its range of utility is not to be understood as being limited to the formation of such alloys. On the contrary, the term "metal" as employed in the claims must be construed as comprehending either a single natural element or virgin metal or as a compound metal, for the reason that any number or all of the component parts of my alloy combined in the manner described may themselves be alloys. Thus I may combine a number of virgin metals with an alloy or a number of alloys or a number of virgin metals, either of these components being considered as a metal and treated as such in the practice of the process—that is to say, the component parts or materials which are to be combined in accordance with my process, whether said parts be simple or compound metals, are to be subjected

to treatment in accordance with the relation of their fusing or melting points to the fusing or melting points of the various other component parts, and, as before stated, the term "metal" as employed in the claims is therefore to be understood as being of sufficient scope to comprehend both simple and compound metals, the latter being usually termed "alloys." I desire it to be distinctly understood, however, that I do not desire to limit the application of my process to any particular class or character of alloys or to confine myself to any special order of procedure except such as may be necessary in the practice of the process as defined in the appended claims.

What I claim is—

1. That process for producing a metallic alloy from a group of metals which consists in first producing a metallic bath by fusing one of said metals and in subsequently fusing the remaining metals in said bath in the inverse order of their fusibility, the temperature of the bath being reduced below the boiling-point of each successive metal before the introduction thereof in said bath.

2. That process for producing a metallic alloy from a group of metals which consists

in first producing a metallic bath by fusing one of the component metals other than the most refractory of said metals, and in subsequently fusing the remaining metals in said bath in the inverse order of their fusibility, the temperature of said bath being reduced below the boiling-point of each successive metal before the introduction thereof in said bath.

3. That process for producing a metallic alloy from a group of metals which consists in first producing a metallic bath by fusing one of the component metals other than the most refractory of said metals, and subsequently fusing the remaining metals in said bath in the inverse order of their fusibility, the temperature of said bath being reduced below the boiling-point of each successive metal before the introduction thereof in said bath, and finally in rapidly cooling the resulting compound.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

WILLIAM CALVIN TILDEN.

Witnesses:

LOUIS G. JULIHN,
A. V. BRITT.