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PROCESS OF MAKING NEGATIVES IN METAL
OF SOLID OBJECTS OR SURFACESRea A. Axline, Forest Hills, Herbert S. Ingham,
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6 Claims. (Cl. 22-196)

This invention relates to a new and useful process of making negatives in metal of solid objects or surfaces.

One object of the invention comprises, inter alia, the making by metal spraying of substantially accurate negatives or molds and reproductions or replicas in metal of solid objects or surfaces and this and other objects will be seen from the following description.

The application of metal coatings to solid objects or surfaces by metal spraying is achieved by the use of a metal spray gun, i. e., a device by which metal is fed to a heating zone from which zone metal particles, at least some of which are molten or in a heat plastic condition, are propelled against the object or surface by a blast of air or other gas. Various types of spray guns are commonly used for this purpose. In order to obtain a substantially coherent coating on the object or surface sprayed, it is essential that the metal particles, as they impinge upon the surface sprayed, enter into a bond with such surface to a sufficient extent to permit the formation of a satisfactory coating thereon. If the bond between the impinging metal particles and the surface sprayed is not sufficient for the formation of a substantially coherent metal coating, the spray metal will not adhere to such surface and is either blown off by the force of the blast from the spray gun or, if it forms flakes upon the surface sprayed, these flakes curl, thus preventing the formation of the desired coating. In such cases it is necessary to provide for the requisite degree of bonding between the impinging metal particles and the surface sprayed by the use of suitable methods. The surface to be sprayed may thus be pre-treated, for instance, by sand blasting, grit blasting, machining, acid etching or the like to render the same rough or porous.

For the procurement of detachable spray metal coatings it is requisite that the bonding between the spray metal coating and the surface to which it is applied be of such intermediate degree that not only a satisfactory coating is obtained, but that the same may be removed from the surface sprayed substantially intact, i. e., without injury to the coating. Such intermediate degree of bonding, however, is in some cases difficult to achieve.

In the making of negatives or molds and replicas or duplicates in metal of solid objects or surfaces by metal spraying, the object or surface sprayed upon is usually called a "matrix," i. e., a substantially accurate negative of the object or

surface to be obtained therefrom. If the matrix is itself a negative of a model, a model being an object or surface desired to be reproduced, it constitutes a mold from which replicas or duplicates of such model can be made, whereas if the matrix is itself a positive of a model, it constitutes a so-called "master" (i. e., either the original of the object or surface desired to be reproduced, or, a substantially accurate replica or duplicate of such object or surface) from which a negative or mold may be made. Such negatives or molds are, for instance, produced for use in the multiple reproduction of articles in various industries and particularly in the plastics, rubber and similar industries.

We have discovered that it is possible to obtain substantially accurate spray metal negatives of solid objects or surfaces without the necessity of procuring any intermediate degree of bonding of the spray metal coating to the matrix sprayed and to obtain a spray metal coating that may be separated and removed from the matrix sprayed substantially without injury to the coating.

In accordance with the present invention, a special matrix is used. This matrix consists of a suitable alloy which, when converted from the solid into the fused state, is substantially free from expansion in volume and preferably which additionally, when converted from the fused to the solid state is substantially free from shrinkage in volume. The melting and softening point of such alloy must be lower than the melting and softening point of the spray metal to be applied thereto. Such matrix material of the desired characteristics is, for instance, a lead-tin-bismuth-antimony alloy consisting essentially of 27.5% to 28.5% lead, 13.5% to 16% tin, and 48% to 50% bismuth and 7 to 9% antimony; we prefer, however, a lead-tin-bismuth-antimony alloy consisting essentially of 28.5% lead, 14.5% tin, 48% bismuth and 9% antimony. Good results have been obtained with a bismuth-lead alloy consisting essentially of 55% to 60% bismuth and 40% to 45% lead. The preferred alloy of the bismuth-lead type is one consisting essentially of 55.5% bismuth and 44.5% lead. This latter alloy is distinguished by the fact that it will neither substantially shrink nor expand when converted from the solid into the fused or the fused into the solid state. The characteristic of substantial freedom from expansion when melting is essential in accordance with our invention, for, if the bulk of the matrix would be subject to change in volume when melted, injury to the mold surface may result as the con-

sequence of such expansion. On the other hand, if the material of the matrix would appreciably shrink, upon conversion from the fused into the solid state, such matrix material could not be used, within the practical application of our invention, for the preferred preparation, i. e., by casting, of a matrix constituting a negative of an object or surface to be reproduced, as its shrunk surface would not represent a substantially accurate negative of such object or surface.

The matrix may be prepared in any desired manner as, for instance, by hand, or by machining, or in any other way. In the practical application of the invention the matrix is preferably made by a casting operation, i. e., by casting the matrix material on or around the object or surface desired to be reproduced in spray metal.

The next step incident to our invention is the spraying of a suitable spray metal onto the matrix. This spray metal has a melting and softening point higher than the melting and softening point of the alloy of the matrix and is such as can be applied to the matrix to produce thereon a substantially coherent coating. When using a gas blast type spray gun in which heated metal is sprayed, care should be exercised that the spraying conditions are so adjusted that the relatively high temperatures, as a rule attending the spraying of metals in this manner, are not imparted to the matrix, at least not to an extent to cause the melting or softening thereof during the formation of the first self-supporting coherent spray metal coating on the same. A variety of expedients may be used to accomplish this purpose, such as spraying the matrix with relative slowness and/or at a greater distance from the spray gun, cooling the matrix, etc. After a spray metal coating of suitable thickness, usually referred to as a shell, is formed, the same may be further backed up, if desired, by either spraying with metal or in any other manner, such as by casting a backing thereon. The matrix is finally subjected to a temperature above the softening and melting point of the matrix alloy and below the softening and melting point of the spray metal coating to thereby fuse at least the surface of the matrix, thus recovering the spray metal coating substantially intact and carrying on its surface the negative design of the matrix. In some cases it may not be necessary to subject the entire matrix to the fusion temperature of the matrix material or to effect a fusion of the matrix in toto; the desired removal of the matrix material may be often successfully accomplished by the fusion of but the surface of the matrix.

Depending upon the particular procedure used, our process in its practical application is capable of a variety of uses. If it is, for instance, desired to produce a spray metal mold for the multiple reproduction of plastic materials by a molding operation, a matrix of the alloy in accordance with the invention is first produced, constituting a suitable substantially accurate duplicate of the article desired to be molded. This matrix may be prepared for instance by casting a bismuth-lead alloy into or onto a previously prepared negative of the object or surface desired to be reproduced. Such negative may be, for instance, made in the form of a suitable plaster cast of the original article or a model thereof, such as a plaster-of-Paris cast, or the like. The matrix is then sprayed with a suitable metal and after the spray metal shell of satisfactory thickness is obtained, the matrix is

fused and thus the spray metal shell is recovered constituting a substantially accurate negative of the matrix in the form of a mold.

The process in accordance with our invention also lends itself to the reproduction of articles such as, for instance, the reproduction of molds. In this instance the alloy matrix is preferably prepared by casting, i. e., applying the matrix material in molten or heat plastic condition around or onto the original object or surface desired to be reproduced or a master thereof. After separating the matrix from its base, the former constitutes a substantially accurate negative of the article desired to be reproduced and may now be sprayed with a suitable spray metal to the desired thickness. The thusly prepared spray metal shell, after the removal of the matrix by fusing the same, constitutes a substantially accurate duplicate of the original article or master intended to be reproduced. If the original article was a mold the spray metal shell thusly obtained is a substantially accurate duplicate mold.

When separating the matrix from its spray metal shell by effecting a fusion of the matrix, traces of the matrix material will remain adhering to the spray metal shell surface. Though it is possible, if desired, to remove the same, we have found it of advantage and prefer to retain these matrix material traces on the spray metal shell surface and to rub the same into the latter by a burnishing operation. We have discovered that in this manner the surface of the spray metal coatings thusly obtained possesses a much greater density than the normal spray metal surface which as a rule is relatively porous. This result is particularly desirable where the spray metal shell surface is to be used as a mold surface.

The foregoing description is for purposes of illustration and not of limitation and it is therefore our intention that the invention be limited only by the appended claims or their equivalents in which we have endeavored to claim broadly all inherent novelty.

We claim:

1. Process of making negatives in metal of a matrix which comprises spraying metal onto a matrix, consisting of an alloy which, when converted from the solid into the fused state is free from expansion in volume, and which possesses a softening point and a melting point lower than the softening point and the melting point of said spray metal, while the surface of said matrix is in a substantially rigid condition, at least until a substantially self-supporting coherent spray metal coating is obtained on said matrix, thereafter fusing at least the surface of said matrix and recovering said spray metal coating substantially intact.

2. Process according to claim 1 in which said matrix consists of an alloy having 55 to 60% bismuth and 40 to 45% lead.

3. Process according to claim 1 in which said matrix consists of an alloy having 27.5 to 28.5% lead, 13.5 to 16% tin, 48 to 50% bismuth and 7 to 9% antimony.

4. Process of making negatives in metal of a matrix which comprises spraying metal onto a matrix, consisting of an alloy which, when converted from the fused into the solid state is free from shrinkage in volume and which, when converted from the solid into the fused state is free from expansion in volume, and which possesses a softening point and a melting point lower than

the softening point and the melting point of said spray metal, while the surface of said matrix is in a substantially rigid condition, at least until a substantially self-supporting coherent spray metal coating is obtained on said matrix, there-
after fusing at least the surface of said matrix and recovering said spray metal coating substantially intact.

5. Process according to claim 4 in which said

matrix consists of an alloy having substantially 48% bismuth, 28.5% lead, 14.5% tin and 9% antimony.

6. Process according to claim 4 in which said matrix consists of an alloy having substantially 44.5% lead and 55.5% bismuth.

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