Dec. 22, 1942. W. E. GLIDDEN 2,305,612

MAKING NEGATIVES IN METAL OF SOLID OBJECTS OR SURFACES

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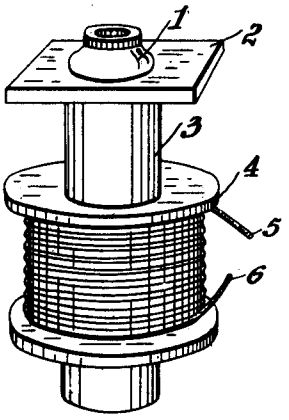


Fig. 1

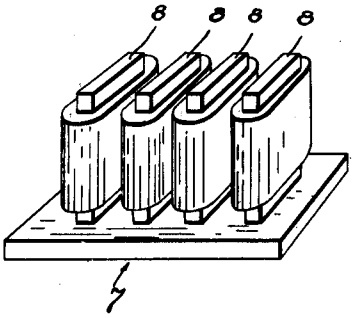


Fig. 2

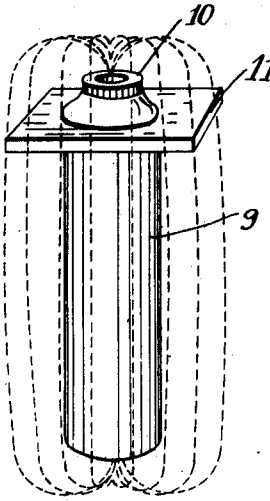


Fig. 3

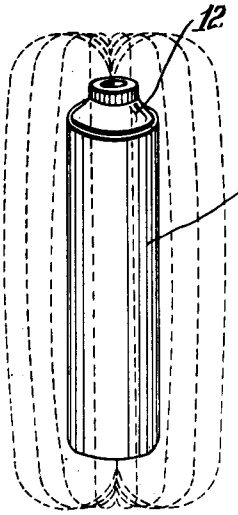


Fig. 4

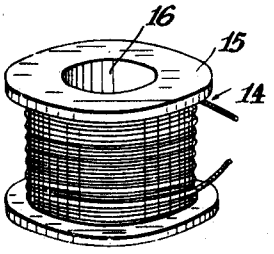


Fig. 5

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MAKING NEGATIVES IN METAL OF SOLID OBJECTS OR SURFACES

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4 Claims. (Cl. 22—190)

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, 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.

Even though a proper degree of strippable bonding is obtained, the same is as a rule by reason of its intermediate character, insufficient to counteract forces of internal stresses and strains occurring during the deposit of the detachable spray metal coating. These forces result in a peeling of the spray metal coat off the edges of the surface sprayed and thus in a warping of the spray metal coating.

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 negative 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.

I have discovered a method of making strippable spray metal negatives of molds in which the degree of bond between the sprayed metal and the matrix may be substantially disregarded and in which the warpage or peeling of the applied spray metal coat is effectively prevented. My method may be even used on smooth surfaced matrices and no surface roughening of the matrix is required.

In accordance with the invention, the object or surface herein referred to as the "matrix" of which a negative is to be formed is first provided with magnetic lines of force which pass through the matrix surface, and is thereafter sprayed with a paramagnetic metal, whereby the magnetic lines of force passing through the matrix, cause adhesion of the paramagnetic spray metal particles to the matrix, so that a spray metal shell is formed on the matrix. The magnetic attraction should be of sufficient magnitude to cause such adhesion and will then also, as a rule, suffice to prevent peeling and warpage of the applied coat.

The invention will be more fully understood from the description read in conjunction with the following drawing, in which:

Fig. 1 is an arrangement of an electromagnet and a matrix as used in one embodiment of my invention;

Fig. 2 shows a different type of electromagnet with multiple pole faces that may be used in conjunction with the invention.

Fig. 3 shows an arrangement of a permanent magnet and matrix in an arrangement in accordance with my invention.

Fig. 4 is a picture of a matrix which is itself a magnet in accordance with my invention.

Fig. 5 is a form of electromagnet which may be used in accordance with my invention.

The matrix, in accordance with my invention, may be of any desired material, either a paramagnetic or a non-paramagnetic material, but I much prefer to make the matrix of a paramagnetic material. To perform the necessary function of causing adhesion between impinging spray metal particles, and the marix, it is necessary that magnetic lines of force flow through the surface of the matrix. Therefore, if a non-paramagnetic material is used for the matrix, more magnetic force is required than in the case in which the matrix, itself, is made of a paramagnetic material. For this reason, where the matrix is very large, it is desirable to make it of paramagnetic material. In some cases, it is of advantage to make part of the matrix of a paramagnetic material and another part of the same matrix of a non-paramagnetic material. For instance the body of a matrix may be made of mild steel and the top surface faced with plaster of Paris.

Referring specifically to the drawing a matrix **1** (Fig. 1), arranged integrally with base plate 2, is mounted on the end of core **3** of electromagnet **4**. The leads **5** and **6** to the coils of the electromagnet **4** are connected to a suitable source of electric energy (not shown) and an electric switch (not shown) is preferably placed in the circuit to facilitate turning the electric current on and off.

The surface of matrix **1** should be as smooth as required for a satisfactory fidelity of the negative reproduction to be obtained on the sprayed metal shell. As no roughness is required to obtain adhesion of the metal particles to the matrix surface, this surface may be as smooth as desired and may even be polished to a mirror finish. Where the matrix surface is rough, care should be taken that the roughness is not of such degree as will cause permanent adhesion between the sprayed metal particles and the matrix, for it will then not be possible to remove the sprayed shell intact. A roughness such as is obtained by more or less heavy blasting for use in securing permanent adhesion between sprayed metal and a base material would be unsatisfactory for the purpose of this invention.

Before the spraying operation is started the electromagnet **4** is energized thus causing magnetic lines of force to flow or pass through the surface of matrix **1** and the surface of plate **2**. While these lines of force are passing through the matrix a paramagnetic material such as steel, iron, nickel, alloys of such metals, or any other paramagnetic metal is sprayed onto the surface of matrix **1** in the ordinary manner. To obtain best results it is preferred to use fine wires of the metals sprayed. With a wire type of metallizing gun, fine wires such as .057'' diameter wire and sometimes even wire as fine as .032'' wire diameter may be used. Such fine wires produce very fine particled metal spray which is particularly desirable for this purpose. The spraying of the paramagnetic material should be continued until the surface of matrix **1** is coated with at least a continuous coherent coating. Thereafter the spraying may be continued with either a paramagnetic or a non-paramagnetic metal until a metal of self supporting thickness is formed on the surface of matrix **1**. It is only necessary to use the paramagentic material for spraying until the first coherent coat is formed because the back of a sprayed metal coat is sufficiently rough to provide for a high degree of bonding with any subsequently sprayed coating. Hence, as soon as the first coherent coat is formed on the matrix **1** any metal paramagnetic or non-paramagnetic may be substituted in the gun for subsequent spraying as described above. The magnetic lines of force through the matrix surface should be maintained however throughout the formation of at least the first coherent coat.

After a shell of self supporting thickness has been formed on the matrix **1** the magnetic lines of force which pass through the surface of matrix **1** are eliminated or at least materially reduced by turning off the exciting current of electromagnet **4**. The sprayed metal shell may then be removed from the matrix and the inner surface of this shell constitutes a substantially accurate negative of the surface of the matrix.

The electrical current which is supplied to electromagnet **4** may be either alternating or direct current, however direct current is preferred. If alternating current is used, it is preferable to make the core **3** of electromagnet **4** of either a laminated or bunched wire construction such as is common practice for alternating current magnets. Also if alternating current is used the matrix **1** and its base **2** should either be made of a non-paramagnetic material or at least of a material which does not tend to become permanently magnetized such as a very mild steel, for otherwise the hysterisis losses would be too great and there would not be a sufficient number of lines of force for the successful operation of the process. Furthermore, for the same reason, if alternating current is used the metal being sprayed should also be one which does not tend too strongly to become a permanent magnet, such as very mild steel. For these reasons direct current excitation of the magnet **4** is to be recommended except in exceptional cases.

For matrices which are large and particularly for those which are thin and flat it is often desirable to use a multiple pole electromagnet such as is shown at **7** in Figure 2. The multiple pole bases **8** make it possible to pass magnetic lines of force through a matrix of large surface area.

It is not necessary for the successful operation of this method that the magnetic lines of force pass through every bit of the matrix surface but it is necessary that the lines of force pass through substantially the whole area of the surface. If for instance there are some small dead spots, i. e., spots where no magnetic lines of force exist, then the sprayed metal will not at first adhere to these dead spots. However, if the vast majority of the surface is pierced by magnetic lines of force then a few such dead spots may not necessarily prevent the successful spraying operation as such small spots will be bridged over by the sprayed metal particles which will first attach themselves to the areas which are pierced by magnetic lines of force and then by progressively attaching to each other they may thus bridge the dead spots. This condition however is not desirable and is to be avoided when possible.

As an alternate method for carrying out the invention a permanent magnet such as magnet **9** (Fig. 3) may be used in place of the electromagnet **4** or **7** of Figures 1 or 2, respectively.

Magnet 9 (Figure 3) should be made of a magnetic material which has the characteristics of retaining its magnetism, such as a high carbon steel. In carrying out my invention by the use of a permanent magnet a matrix 10 which is preferably mounted on a base 11 is placed on one pole of the permanent magnet 9. This causes magnet lines of force to flow through the surface of matrix 10 and base 11. Paramagnetic metal is then sprayed by a metal spray gun at least until a continuous coherent coating of paramagnetic metal is obtained on the matrix surface, whereupon a paramagnetic or non-paramagnetic metal is sprayed onto the back of this first coating until a sprayed metal shell of self-supporting thickness is obtained. Permanent magnet 9 may now be forcibly removed from base 11 thus eliminating or at least materially reducing the magnetic lines of force which pass through the base of matrix 10 so that the spray metal shell may be removed intact from the matrix.

As a further alternative method in accordance with the invention a matrix 12 (Fig. 4) may be constructed as an integral part of the pole face of permanent magnet 13. The formating of a self-supporting spray metal shell is carried out in this case in the same manner as described in the preceding examples except that now the surface of matrix 12 is itself a part of the pole face of magnet 13 having magnetic lines of force passing through it.

When an arrangement of this type is used it is advisable to form a sprayed metal shell of considerable thickness and strength on the face of matrix 12 so that it will permit a mechanical gripping and forcible removal from the matrix. If the shell may thus be made strong enough it may be removed from the matrix by mechanical force. However in many cases this may not be practicable and it will be necessary to eliminate or at least materially reduce the lines of force flowing through the face of the matrix 12 before the spray metal shell can be successfully removed therefrom. One way to remove these lines of force is to place the magnet 13 in the field of a de-magnetizer of the conventional type (not shown) until the magnet 13 has become at least partly de-magnetized so that the magnetic lines of force flowing through the face of matrix 12 are sufficiently reduced to permit removal of the sprayed metal shell therefrom. Another means of eliminating or at least materially reducing the magnetic lines of force which flow through the face of matrix 12 is to heat the magnet 13 to slightly above its critical temperature so that the material of magnet 13 becomes non-magnetic, thereafter the sprayed metal shell formed on the surface of matrix 12 may be removed either while the magnet 13 is still hot or after it has cooled off. If for instance the magnet 13 is made of a carbon steel it would become non-magnetic if heated to a temperature in the neighborhood of 1425° F. As an alternate to heating the magnet 13 to its critical temperature it may suffice in some cases to heat the sprayed metal shell itself which is found on the face of matrix 12 until the magnetic spray metal shell becomes non-magnetic thereby reducing magnetic attraction so that it may be removed intact.

In cases where magnetic lines of force which pass through the face of a matrix are generated by means of an electromagnet, it is not always necessary to use an electromagnet having a core 3 as shown in Figure 1. A coil of electrical wire as shown in Figure 5 at 14 will often suffice to produce the magnetic lines of force through the face of the matrix if such matrix is placed on the face of the coil 15 or if such matrix is allowed to extend at least partway into the center of the coil at 16. However, electromagnets with metal cores as shown in Figures 1 and 2 are to be preferred.

Where reference is made herein to the terms "reducing magnetic lines of force" or "reducing magnetic attraction" or "reducing paramagnetic properties" or where expressions of similar import are used the same are understood to include the limiting case in which the magnetic lines of force or magnetic attraction or magnetic properties as the case may be are reduced to the point of substantial extinction or elimination.

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

I claim:

1. Process of making negatives in metal of a matrix by metal spraying which comprises spraying metal onto the said surface of said matrix at least until a spray metal shell of at least self-supporting thickness is formed, at least that part of applied spray metal forming the first substantially coherent coat of spray metal on said matrix being paramagnetic and being sprayed onto said surface while magnetic lines of force are passing through said surface, and removing the spray metal shell substantially intact from said matrix.

2. Process of making negatives in metal of a matrix by metal spraying which comprises causing magnetic lines of force to pass through the surface of said matrix, spraying metal onto said surface at least until a spray metal shell of at least self-supporting thickness is formed, at least that part of applied spray metal forming the first substantially coherent coat of spray metal on said matrix being paramagnetic, reducing the magnetic attraction causing said shell to adhere to said surface, and removing said shell substantially intact from said matrix.

3. Process of making negatives in metal of a matrix by metal spraying which comprises causing magnetic lines of force to pass from an electromagnet through the surface of said matrix, spraying metal onto said surface at least until a spray metal shell of at least self-supporting thickness is formed, at least that part of applied spray metal forming the first substantially coherent coat of spray metal on said matrix being paramagnetic, de-energizing said electromagnet, and removing the spray metal shell substantially intact from said matrix.

4. Process of making negatives in metal of a matrix by metal spraying which comprises spraying metal onto the magnetic surface of a matrix at least until a spray metal shell of at least self-supporting thickness is formed, at least that part of applied spray metal forming the first substantially coherent coat of spray metal on said matrix being paramagnetic and removing the spray metal shell substantially intact from said matrix.

WILLIAM E. GLIDDEN.