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F. L. CURRENT ET AL

2,880,109

METHOD OF COATING THE INTERIOR OF CYLINDERS

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FIG. 1.

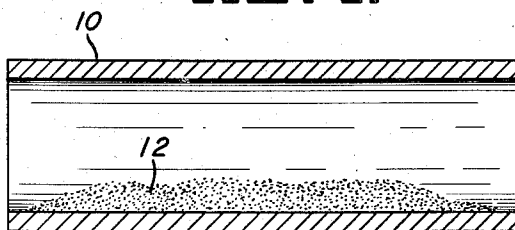


FIG. 2.

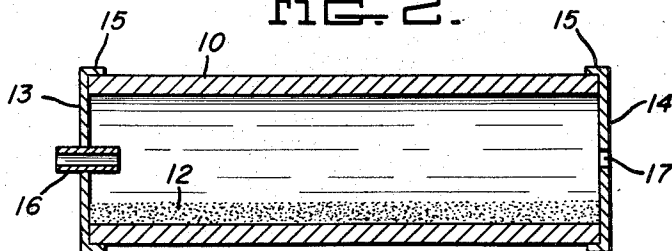


FIG. 4.

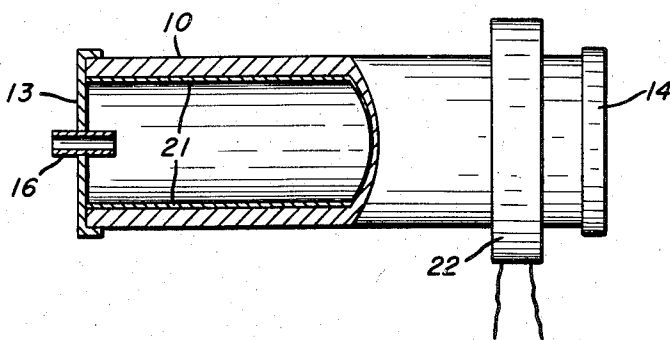
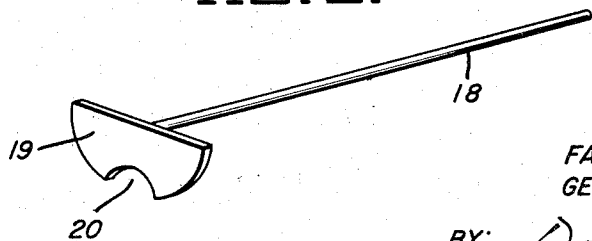


FIG. 3.



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METHOD OF COATING THE INTERIOR OF CYLINDERS

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2 Claims. (Cl. 117—22)

This invention relates to an improved method of centrifugally coating the inside of hollow metal cylinders.

Our method is especially suited for lining mild steel cylinders with hard metals which are plastic in a temperature range below their ultimate melting point, such as nickel base alloys available commercially under the trademarks "Colmonoy," "Haynes" No. 40 or "Coast Metals" No. 56. Nevertheless, the invention is not thus limited, but has general applicability wherever a cylinder can be coated by a similar procedure, for example with other metals such as copper or boron-containing cast iron available commercially under the trademark "Xaloy" or even with thermoplastics such as methyl methacrylate.

One well known method of coating the inside of a cylinder involves placing therein pieces of a metal having a lower melting point than the metal of the cylinder, heating the cylinder until this metal melts and becomes completely liquefied, and thereafter spinning the cylinder on its axis until the liquefied metal deposits centrifugally over the inner surface. One disadvantage of this method is that the base metal of the cylinder contaminates the liquefied coating metal. With some coating metals, such as boron-containing cast iron, the initial composition can be adjusted so that iron picked up during the coating operation produces the desired final composition, but with other coating metals, such as nickel base alloys, which require a limited iron content, this practice is not successful. To coat with metals of the latter type special mechanisms have been necessary to keep the coating metal out of contact with the base metal before actual deposition thereon. Another disadvantage of prior methods is that the entire cylinder must be heated at once to melt the coating metal and thus is readily distorted, and it must be maintained precisely level to prevent the charge from flowing to a low point.

An object of the present invention is to provide an improved centrifugal coating method which overcomes the foregoing disadvantages, that is, which avoids contamination of the coating metal and makes it possible to heat only a small section of the cylinder at a time.

A further object is to provide an improved coating method in which finely divided coating metal is deposited and held on the inside of a rotating cylinder by centrifugal force, and thereafter the cylinder is heated to fix the coating metal in place while still rotating.

A further object is to provide an improved coating method having the foregoing characteristics and which minimizes distortion of the cylinder by heating only short annular sections at a time, and as applied to coating materials having a plastic range by heating to a temperature below that needed fully to liquefy the material.

In accomplishing these and other objects of the invention, we have provided improved details of structure, a preferred form of which is shown in the accompanying drawing, in which:

Figure 1 is a longitudinal section of a cylinder which contains a charge of coating material;

Figure 2 is a longitudinal section of the cylinder with

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the ends capped and the coating material distributed longitudinally ready for rotating according to our method;

Figure 3 is a perspective view of one example of a tool which can be used for distributing the coating material longitudinally of the cylinder before rotating the latter; and

Figure 4 is a side elevational view of the cylinder, partly in section, showing our preferred manner of heating.

Figure 1 shows a hollow metal cylinder 10 whose inner surface has been cleaned of oxides and which contains a charge 12 of dry coating material, for example one of the aforementioned hard metals. The coating material must, of course, have a lower melting point than the base metal of the cylinder. Ideally it is charged as a minus 100 mesh powder, but the maximum size is about 50 mesh where contamination with the base metal is objectionable, and about 1/8 inch where contamination either is not objectionable or does not occur. Coarser sizes are less costly and hence are used wherever possible. The quantity of coating material is calculated to furnish a coating of the thickness desired, commonly within the range of 0.010 to 0.125 inch.

We next place caps 13 and 14 over the cylinder ends, as shown in Figure 2. Preferably both caps have friction lips 15 which engage the outside of the cylinder to hold the caps in place. The cap 13 at the left carries a gas inlet tube 16 while the cap 14 at the right has a vent 17. Next we mount the cylinder 10 in a suitable apparatus for rotating it, such as a lathe (not shown). Preferably we accelerate the cylinder slowly to facilitate distributing the charge 12. A sufficiently fine powder slowly accelerated flows in a similar fashion to a liquid and thus tends automatically to distribute itself longitudinally of the cylinder. Otherwise we can distribute the charge mechanically, for example by inserting a tool such as that illustrated in Figure 3 into the free end of the cylinder before this end is capped. This tool includes a handle 18, and a blade 19, the bottom edge of which contains a notch 20. Until the charge is fully distributed, we rotate the cylinder at a surface speed of about 50 to 80 feet per minute. Thereafter we rotate the cylinder faster so that centrifugal force holds the charge against the inner surface in a layer of substantially uniform thickness throughout the circumference. Up to this point we do not heat the cylinder, and the coating material remains in a finely divided solid form.

With the cylinder still rotating and centrifugal force holding the charge in place, we next heat the cylinder to weld or braze or otherwise fix the charge on the inside surface and form a coating 21 (Figure 4). Preferably we heat the cylinder a small annular section at a time with a heating device whose position relative to the cylinder readily can be varied, for example an induction coil 22 indicated diagrammatically in Figure 4. However, we do not wish to limit the invention to any particular mode of heating. Where the coating material is susceptible to oxidation, we maintain a non-oxidizing or preferably reducing atmosphere within the cylinder during the heating step. For this purpose a suitable gas, such as hydrogen or natural gas can be admitted via the inlet tube 16 and burned as it issues from the vent 17. Preferably we heat only to the extent necessary to produce a dense coating bonded to the cylinder surface. In many instances we need not apply sufficient heat completely to liquefy the charge. When it is necessary to liquefy the charge, the interval during which the charge is in the liquid state may be brief. Consequently the base metal does not appreciably contaminate the coating. The extent to which the charge must be heated increases with larger particle sizes; hence the lower size limit where contamination is objec-

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tionable. If necessary for metallurgical reasons, the cylinder can be cooled at any controlled rate.

Example I

As a specific example of our method, we lined a hollow mild steel cylinder with a nickel base alloy which we purchased commercially under the trade mark "Colmony #6." The composition was within the following range:

	Percent
Nickel	65-75
Chromium	13-20
Boron	2.75-4.75
Impurities such as iron, silicon and carbon	maximum-- 10

If this alloy is appreciably contaminated with iron, it does not produce a satisfactory coating. We introduced a charge of dry minus 100 mesh alloy to the cylinder, after first cleaning the inside surface of oxides, and distributed the charge longitudinally. We capped the cylinder ends and rotated the cylinder in a lathe, first at a surface speed of about 70 feet per minute and later at a surface speed of about 550 feet per minute. While the cylinder was rotating at the latter speed, we introduced hydrogen to the inlet 16 and allowed it to burn as it issued from the vent 17. We applied sufficient heat through the induction coil 22 a short annular section at a time only to weld or braze the particles of alloy together and to the inner surface of the cylinder without actually liquefying the alloy; that is, we heated to about 1850-1900 F. while the ultimate melting point is about 1925 F. The final product had a dense, firmly bonded lining of the hard alloy.

Example II

As another example we introduced a charge of dry minus 100 mesh copper to a mild steel cylinder and distributed and rotated it as before. We heated the cylinder above the melting point of copper a short annular section at a time, but only for an instant. The copper formed a dense coating without appreciable contamination. It may be pointed out that copper coatings having an excellent appearance can be obtained by prior art procedures in which the copper is fully liquefied before deposition, but iron contamination ruins their resistance to corrosion. Our method maintains the copper in the liquid state so briefly that it avoids objectionable contamination.

Example III

As another example we introduced a charge of powdered methyl methacrylate resin, which is a thermoplastic, to a cylinder. We distributed the charge and rotated the cylinder as before. By heating to 400 F., we were able to produce a dense adherent coating.

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While we have shown and described certain preferred embodiments of the invention, it is apparent that further modifications may arise. Therefore, we do not wish to be limited to the disclosure set forth but only by the scope of the appended claims.

We claim:

1. A method of lining the inside of a hollow steel cylinder with a harder nickel base alloy, which has a lower melting point and whose properties are changed adversely if the alloy is contaminated with iron, comprising charging dry finely divided alloy particles to the cylinder, capping the cylinder ends, rotating the cylinder slowly to distribute the alloy particles longitudinally, thereafter rotating the cylinder more rapidly to hold the alloy particles against the inside surface throughout the circumference by centrifugal force while these particles remain in finely divided solid form, maintaining a non-oxidizing atmosphere within the cylinder to prevent oxidation of the alloy particles, and inductively heating the cylinder a short annular section at a time below the temperature for complete liquification of the alloy while still rotating the cylinder to fix the alloy in place but maintain it free of contamination with steel of the cylinder and without distortion of the cylinder.

2. A method as defined in claim 1, in which the composition of said alloy is approximately as follows:

	Percent
Nickel	65 to 75
Chromium	13 to 20
Boron	2.75 to 4.75
Impurities including iron, silicon and carbon	maximum-- 10

and in which the cylinder is of mild steel and is heated to about 1850 to 1900° F.

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