July 14, 1970 R. S. MEYER 3,520,666

BISMUTH ALLOY IMPREGNATED GRINDING WHEEL

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Fig. 1.

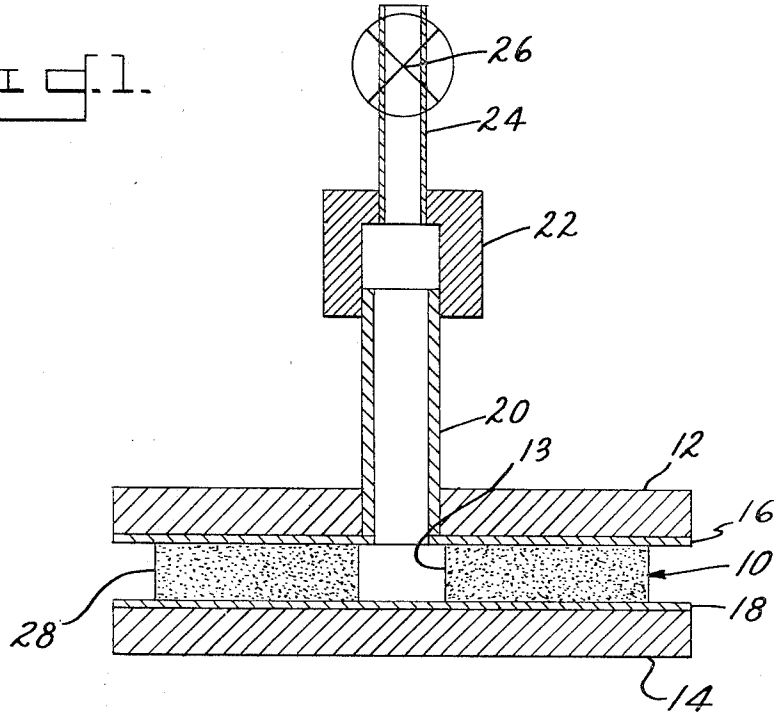
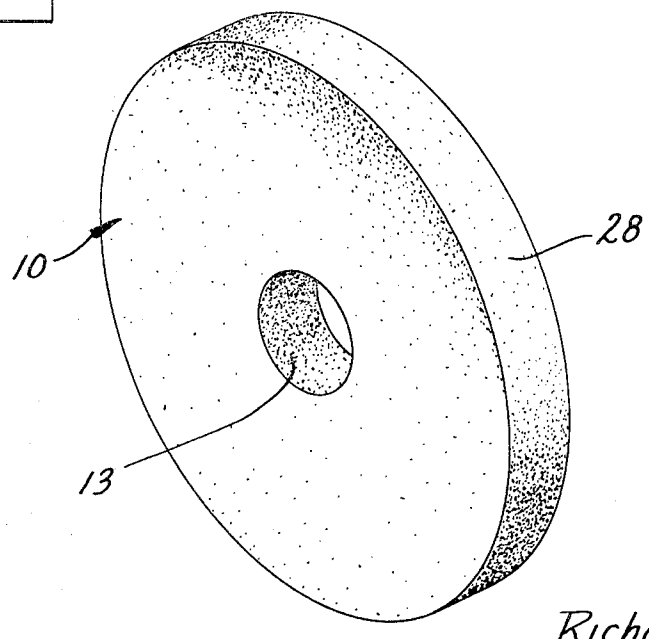


Fig. 2.



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BISMUTH ALLOY IMPREGNATED GRINDING WHEEL

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ABSTRACT OF THE DISCLOSURE

A porous abrasive grinding wheel impregnated with a low melting point bismuth-base alloy which acts as an electrical conductor for use in electrolytic grinding.

In recent years, the so-called super metals, and alloys made with these methods, have become more and more important in space age and related applications. This increased importance has given rise to many problems however, in that unlike standard metals and alloys, they are not readily workable by conventional machining techniques.

One of the problem machining areas is that of grinding parts fabricated from the super metals and alloys. Particularly, it was found that the use of the standard grinding wheels, such as aluminum oxide, silicon carbide, and the like, was very time consuming. In attempting to overcome the time factor involved with these wheels, diamond grinding wheels were employed. While diamond grinding did reduce the time factor, cost factors and wheel reconditioning have negated its wide acceptance.

At this point, the industries involved decided that the most economical and practical method of grinding the super metals and alloys was by means of electrolytic erosion or deplating.

Today, there are many electrolytic grinding wheels commercially available. A common example of these wheels may be described as vitrified aluminum oxide type which are impregnated with electrically conductive "inks." Such wheels are typified by U.S. Pat. 3,216,854.

While most all of the electrolytic grinding wheels heretofore produced have been sufficient to accomplish their primary purpose of grinding the super metals and alloys, most have given rise to problems of one kind or another. For example, in many wheels the impregnation procedure requires complex high pressure equipment, or the impregnating materials are expensive.

It is an object of the invention to provide an inexpensive yet effective electrolytic grinding wheel.

It is a further object of this invention to provide an electrolytic grinding wheel which is easily produced.

The above and other objects and advantages of the invention will become more clear when considered with the remaining disclosure and the drawings, in which:

FIG. 1 is a schematic of apparatus used to produce the grinding wheels of the present invention; and

FIG. 2 is a perspective view of a grinding wheel of the present invention.

Basically, this invention involves a standard grinding wheel impregnated with a low melting point, bismuth-base alloy that is electrically conductive.

As is known, electrolytic grinding proceeds somewhat differently than form grinding in the conventional manner. While an electrolytic grinding wheel is used in the conventional manner, the wheel, which has a conductive filler therein, acts as a cathode, the grinding table as an anode, and the liquid coolant as an electrolyte. Under this set-up, when current is passed through the system, a deplating operation results.

The rate of stock removed in such a system is governed by Faraday's law, rather than wheel performance, and can be expressed as follows:

$$W=MIt/Fj$$

where

W=weight of material removed, grams,
M=atomic weight of material, grams,
I=current, amperes,
t=time, second
F=95,500 coulombs/gram equivalent, and
j=valence of material.

From the above, it can be seen that the weight of material removed is directly proportional to the current supplied. Therefore, it has been found desirable to use a material having a low resistivity as a conductive filler in electrolytic grinding wheels. Such materials have in the main been silver, copper and aluminum. While these materials and mixtures of same have low resistance, the cost of preparing them for impregnation in a grinding wheel is quite expensive and calls for the use of complex heat and pressure equipment.

In accordance with this invention, an electrolytic grinding wheel which is produced from a standard porous abrasive wheel is impregnated with a low melting point bismuth-base alloy.

While it is realized that alloys employed in the present invention must sacrifice some resistivity to the materials mentioned above, the advantages gained by the use of the low melting point alloys outweigh the loss in resistivity.

In general, it has been found that bismuth-base alloys having melting points of from 130° F. to 220° F. are the most desirable from two standpoints. First, porous grinding wheels may be easily and readily impregnated with such alloys by the use of simple equipment; and second, the melting points of such alloys permit safe handling without danger of serious burns and/or fire in the event of accident or spillage.

As depicted in FIG. 1, the wheel **10** to be impregnated is placed between two steel plates **12** and **14** having gaskets **16** and **18** thereon. The upper plate **12** has a riser pipe **20** connected thereto. Detachably mounted at the other end of the riser pipe **20**, is a pipe cap **22** and an air hose **24** with a pressure regulator **26** therein.

To use the apparatus, the wheel **10** is clamped between the plates **12** and **14** with its hub **13** registered with the lower end of the riser pipe **20**. The complete unit is then placed in an oven at 200° F. to 210° F. to bring its temperature to a point in excess of the melting point of the alloy employed so as to prevent solidification of the alloy during impregnation. After the apparatus has been uniformly heated, it is removed from the oven and melted alloy of the type described above is added to the riser pipe **20** and forced under pressure into the pores of the wheel **10**, impregnating the wheel radially outwardly from the hub **13**. The application of from 5 to 20 pounds of air pressure from the air hose **26** has been found suitable to effect complete permeation of the wheel. When the alloy is observed to be uniformly exuding from the face of the wheel **28**, the air pressure is released and the wheel is removed from the clamping apparatus and allowed to cool at room temperature. Prior to solidification of the alloy, any excess is scraped from the sides of the wheel **10**.

By the use of the above described apparatus, it was found that the preparation of the wheels as described provides uniform distribution of the alloy throughout the wheel. This, of course, is highly desirable in that the balance of the wheel is not materially affected by the impregnation.

As mentioned above, a low melting point bismuth-base alloy is preferred in the production of the grinding wheels

of this invention. While eutectic and non-eutectic alloys may be used, it has been found that due to the sharp melting point characteristic of eutectic alloys, their use is preferable.

As an example of an electrolytic grinding wheel of the present invention, a batch of standard vitrified aluminum oxide, type 1 shape wheel, 7 inches in diameter and ½ inch thick, was impregnated with a bismuth-base alloy of the following composition: 50% bismuth, 26.7% lead, 13.3% tin and 10.0 cadmium. This particular alloy is marketed by the Cerro de Pasco Copper Corporation under the trade name "Cerrobend." Being an eutectic alloy with a melting point of 158° F., it has been a traditional choice for such applications as fusible elements in sprinkler heads, fire door releases, and the like.

After the above wheels had been impregnated and allowed to cool, they were tested for rotational stress strength in accordance with the requirements of the "American Standard Safety Code for the Use, Care and Protection of Abrasive Wheels." The wheels, which were designed to operate at 7,700 s.f.p.m., were tested at 12,200 s.f.p.m. and no adverse effect was noted. In addition, one of the wheels so produced was spin tested to destruction at 20,700 s.f.p.m.

After the wheels were tested for rotational stress strength, one was placed on a Brown & Sharpe surface grinder adapted for electrolytic grinding by the addition of a 150 amp Anocut Power Pack Unit. At a wheel speed of 7,700 s.f.p.m., tool steel containing 15% tungsten was plunge ground at a depth of .035 inch and 1 inch/minute traverse. During the test, it was noted that there was no

problem in drawing the full capacity of 150 amperes of current and that sparking was minimal.

While the above disclosure has been primarily directed to an aluminum oxide wheel impregnated with a low melting point, bismuth-base alloy, it is to be understood that other types of grinding wheels, such as vitrified silicon carbide wheels, also may be utilized.

What is claimed is:

1. In a vitrified abrasive porous grinding wheel composed of materials selected from the group consisting of aluminum oxide and silicon carbide, an electrically conductive impregnant, substantially filling the pores of said grinding wheel, comprising an alloy having a melting point in the range of 130–222° F. in which the predominant material is bismuth, said alloy also containing lead, tin and cadmium.

2. In a vitrified abrasive porous grinding wheel as set forth in claim **1** in which said alloy is a eutectic alloy.

3. In a vitrified abrasive porous grinding wheel as set forth in claim **1** wherein the electrically conductive impregnant comprises a eutectic alloy composed of 50% bismuth, 26.7% lead, 13.3% tin and 10.0% cadmium.

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