Jan. 13, 1942. E. VAN DER PYL 2,270,209

ABRASIVE ARTICLE

Filed May 20, 1939

FIG. 1

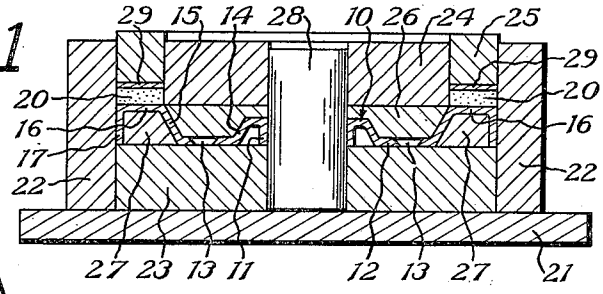
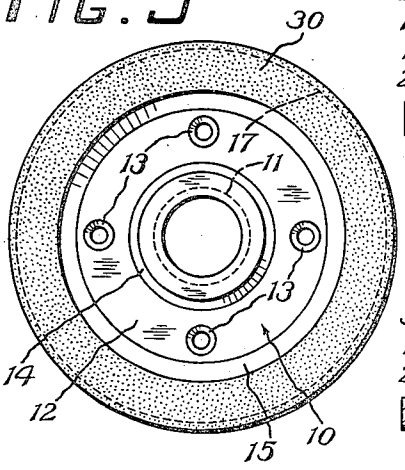


FIG. 3



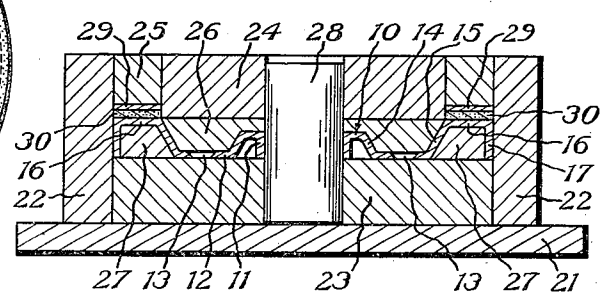
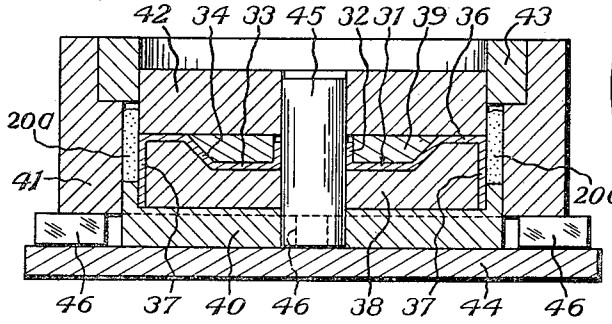


FIG. 2

FIG. 4



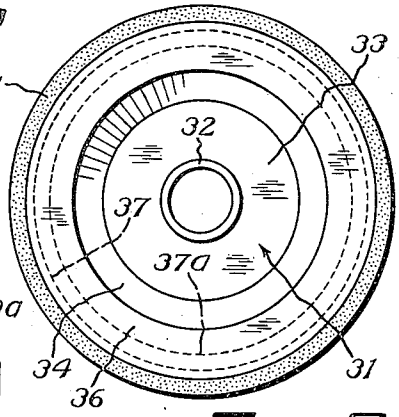
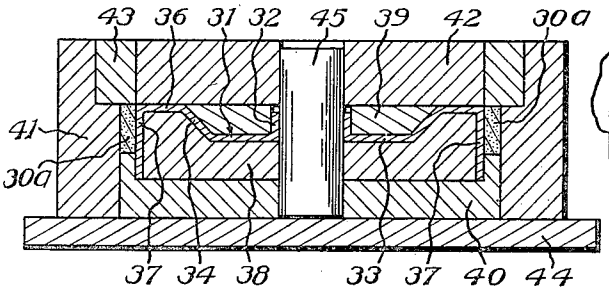


FIG. 6



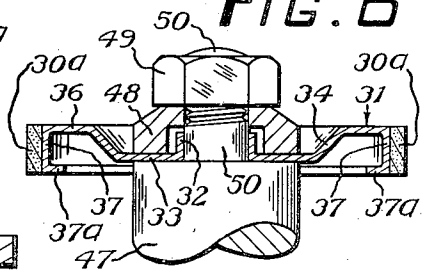


FIG. 5

FIG. 7

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2,270,209

ABRASIVE ARTICLE

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Application May 20, 1939, Serial No. 274,786

3 Claims. (Cl. 51—206)

The invention relates to abrasive articles, particularly diamond abrasive articles.

One object of the invention is to provide a satisfactory combination of bond and backing for the manufacture of abrasive articles in which the abrasive is diamond and for uses where a strong light backing is required. Another object of the invention is to provide a diamond abrasive mixture particularly suited for bonding to steel, for example cold rolled steel. Another object of the invention is to provide the optimum combination of bond and backing for the manufacture of diamond abrasive articles of the hard variety. Another object of the invention is to provide a method and apparatus for molding and a wheel structure permitting a diamond grinding wheel to be manufactured with a pressed cold rolled steel center, securing good adhesion between the abrasive portion and the center. Another object of the invention is to provide a light weight pressed metal diamond grinding wheel. Another object of the invention is to provide a diamond grinding tool of great strength and hardness capable of withstanding the most severe usage. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts, and in the several steps and relation and order of each of said steps to one or more of the others thereof, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawing illustrating two of many possible embodiments of the mechanical features of this invention,

Figure 1 is an axial sectional view of a mold which is filled but not closed;

Figure 2 is a view similar to Figure 1, showing the mold closed;

Figure 3 is a face view of the completed wheel made in the mold of Figures 1 and 2;

Figure 4 is an axial sectional view of another mold for a slightly different wheel, the mold being open;

Figure 5 is a view similar to Figure 4, showing the mold closed;

Figure 6 is a face view of the grinding wheel produced in the mold of Figures 4 and 5;

Figure 7 is an axial sectional view of the wheel of Figure 6 mounted on a spindle.

Referring first to Figure 1, I provide a pressed ferrous metal back 10, preferably made of cold rolled steel. This is a cup-shaped wheel having an internal annular flange 11 providing a good cylindrical mounting or bearing surface for the wheel, having a radial portion 12 in which may be located countersunk holes 13, having conical portions 14 and 15, the former on the inside and the latter on the outside of the radial portion 12; having a radial portion 16 upon which the abrasive is to be mounted, and having an outer cylindrical flange 17. The foregoing constitutes a very rigid but light structure which can be produced at slight cost. It is rigid because any bending stresses to bend its radial surfaces out of radial planes are resisted by the flange 11, the conical portions 14 and 15, and the flange 17. Stresses tending to collapse this wheel are resisted by reason of the fact that it is practically continuous metal from the central hole to the periphery. Nevertheless this shape can readily be made by die pressing operations so that the article is relatively inexpensive and, furthermore, great uniformity of size and shape is readily attainable. Onto the outer surface of the radial portion 16 I mold an abrasive mix 20, as will now be described in detail.

Still referring to Figure 1, I provide a mold platen 21, a mold ring 22, a mold bottom plate 23, an inside mold top plate 24, an outside mold top plate 25, a conforming plate 26, a conforming plate 27, and a mold plug 28. All of these parts excepting the platen 21 and the plug 28 are annuluses.

The mold is assembled as shown in Figure 1, ercept that the outer top plate 25 is not at first placed in position. A mixture of abrasive and bond 20 to be hereinafter described is placed in the cavity between the top plate 24 and the mold ring 22, and a soft aluminum ring 29 is then placed upon the mixture 20. The outer top mold plate 25 is then placed in position and the mold is "closed" to the position shown in Figure 2. The diamonds project from the pressed abrasive 30 since they are forced slightly into the aluminum ring 29. The mold may be closed in a suitable hydraulic press. Desirably all parts of the mold are ground to accurate dimensions and smooth surfaces and with a mold so constructed, the mold can be readily closed, reaching a pressure of four thousand pounds to the square inch without any danger of forcing the material 20 between the plates 24 and 26. As the final pressure is applied, the upper platen of the hydraulic press contacts the top plate 24, holding the various parts together firmly. During the pressing operation, the conforming plate 27 supports the thrust against the radial portion 16, so

there is no chance of the metal back 10 being collapsed. It is preferable to sandblast or otherwise roughen the outer surface of the radial portion 16 prior to the pressing operation in order to achieve a good union.

Considering now the nature of the abrasive and bond, as heretofore indicated I use diamonds but so far as certain features of the invention are concerned, other abrasives might be used. However, since the ultimate abrasive is very high in grade hardness, a hard abrasive is also desired and a composite structure as described herein has particular utility as embodied in a diamond grinding wheel. Although a wide range of ratio of abrasive to bond may be adopted, as an illustrative example of a volume percentage which represents the best proportions now known to me, I mention 25% by volume of abrasive with porosity limited to not more than 2%.

For bonding diamonds to a ferrous metal back, particularly a steel back as herein described, I use a hard metal bond obtained by pressing powdered metal and thereafter sintering.

Following the mixing of the diamonds with the bond, which is in comminuted form and consists of a mixture of powders, and following the pressing operation described, the article is first stripped from the mold and then placed in a furnace and heated. The furnace is provided with hydrogen flame curtains at its entrance and exit ends in order to exclude oxygen therefrom. Under such conditions the diamonds are not burned, the metal bond is not oxidized, and the back is uninjured.

The final article shown in Figure 3 is rigid and the abrasive portion 30 is attached so firmly to the back 10 that it cannot be dislodged therefrom under ordinary conditions of use and even abuse. The abrasive is hard and the bond is also so hard that wear is reduced to a minimum; wherefor the wheel is particularly advantageous for grinding cemented carbides and other very hard materials. In fact, it may be used for faceting diamonds themselves and also other gem stones. Of course, the type of finish obtained will depend upon the grit size of the diamonds used, and I prefer fine grit sizes of the order of from 100 to 600 grit size and even finer. The wheel is sharp cutting from the start by reason of the fact that the diamonds project slightly from the abrasive portion 30 on account of the use of the aluminum ring 29.

I am not limited to use of any particular bond provided it is a hard brittle ferrous metal bond. I may use electrolytic iron particles, as described in the patent to Gauthier No. 1,625,463, with added elements to make the bond hard and brittle. However, to obtain a hard abrasive, I sinter the bond (not described by Gauthier), heating the pressed diamond-iron mixture to around 1000° C. upwards in a furnace from which oxygen is excluded. In order to make this ferrous metal bond sufficiently hard, I add suitable amounts of comminuted carbon to produce a cementite or pearlite. The following are illustrative examples thereof:

Example 1

	Percent
Fe	94
C	3.5
Si	3.5

Example 2

	Percent
Fe	97
C	3

Example 3

	Percent
Fe	95
C	3
P	2

In each of the formulae, the ferrous metal consists of pearlite and cementite. Example 1 is the formula for gray cast iron. Example 2 is the formula for white cast iron. Example 3 is a special formula which I term phosphorous iron.

Preferably my bond, while very hard, is also somewhat brittle or friable and Examples 1, 2 and 3 are examples of such bonds. The sintering temperature employed is sufficiently high to cause the formation of true pearlite and cementite in the bond, at least so far as I am able to determine. At all events, the bond has the characteristics indicated, namely it is hard, it is also friable, and furthermore it adheres tenaciously to the cold rolled steel.

It will be noted that in Example 3 the use of phosphorus is directed. Phosphorus has the capacity of making iron very brittle and friable. Ordinarily precautions are taken to remove phosphorus from ferrous metals and alloys. Phosphorus can be used in any amount short of that point where the iron completely lacks strength, that is to say, it can be used up to about 5% of the total bond content. In the above examples, the proportions are by weight but in figuring the proportion of abrasive to bond, the volume content is referred to.

I have given a range of from 1000° C. upwards. However, it is preferable to use somewhat lower temperatures and some results can be obtained by heating to 1000° C. provided the mixture is maintained at this temperature for a longer time, say half an hour or more. When carbon additions are used, it is preferred to use an inert gas in the furnace, such as helium. But nitrogen may also be used with satisfactory results in most cases.

I can also make wheels having a peripheral diamond abrasive portion, as illustrated in Figures 4 to 7 inclusive. As shown in Figure 4, I provide a steel back or wheel 31 comprising an inner annular flange 32, a radial portion 33, a conical portion 34, a radial portion 36, and an outer cylindrical flange 37. This is placed on a conforming plate 38 and over it is placed a conforming plate 39. These parts are placed on a mold bottom plate 40 inside of a mold ring 41 and top mold plates 42 and 43 are provided in the upper part inside of the mold ring 41. The mold is completed by a mold platen 44 and a plug 45, and spacers 46 are used while filling the mold. The exact shapes of all these parts I will not describe because the same are adequately shown in the drawing. The mold is shown filled with abrasive material 30*a* in Figure 4 and it is then taken to a hydraulic press, the spacers 46 are removed, and the mold is then closed to the position shown in Figure 5. This compacts the material 30*a* against the cylindrical flange 37 and thereafter the article is heat treated, as already described. It will be noted that the flange 37 extends beyond the abrasive portion 30*a* in Figure 5; this flange may be turned over inwardly, as shown at 37*a* in Figure 7. This may be done by a spinning operation on a lathe or the like, a suitable segmental core being provided to back up the cylindrical portion of the flange 37 during the spinning or peening operation. The completed wheel is shown in Figures 6 and 7, it being shown mounted on a spindle 57 in Figure 7, being

held in place by a collar 48 and a nut 49 screwed onto a reduced portion 50 of the spindle 47. However, countersunk holes like the holes 13 might be provided for mounting.

It will thus be seen that there has been provided by this invention an article and a method in which the various objects hereinabove set forth together with many thoroughly practical advantages are successfully achieved. As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. An abrasive article comprising a preformed relatively soft ferrous metal backing and an abrasive portion comprising a sintered hard brittle ferrous metal bond and diamond abrasive particles, the whole being merely sintered together into an integral piece.

2. An abrasive article comprising a relatively soft pressed steel backing and an abrasive portion integrally sintered thereto made out of diamonds bonded with a hard brittle ferrous metal bond sintered to a unitary mass.

3. An abrasive article comprising a relatively soft pressed metal backing made out of cold rolled steel and a diamond abrasive portion comprising diamonds embedded in a hard brittle ferrous metal bond integrally attached to the cold rolled steel, the metal bond being sintered and the abrasive portion being sintered to the metal backing.

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