

Feb. 6, 1940.

E. VAN DER PYL

2,189,259

GRINDING WHEEL

Filed May 19, 1938

Fig.1

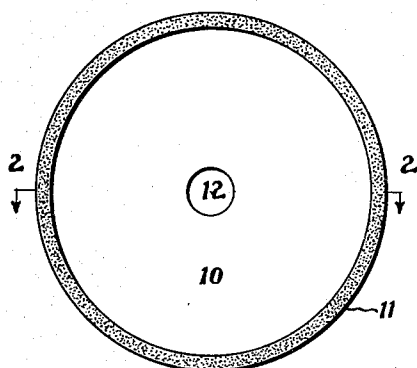


Fig.2

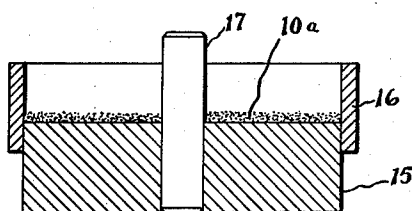


Fig.3

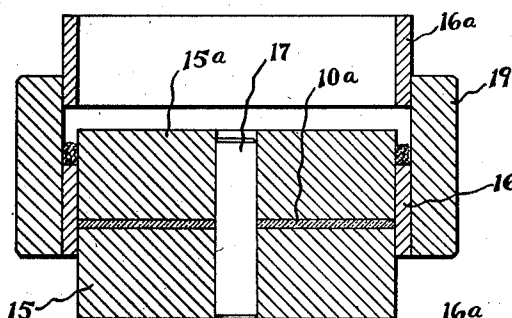


Fig.4

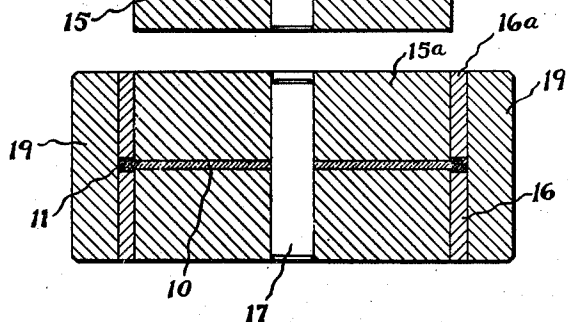


Fig.5

Inventor

EDWARD VAN DER PYL

By *George Compton*
Attorney

UNITED STATES PATENT OFFICE

2,189,259

GRINDING WHEEL

Edward Van der Pyl, Holden, Mass., assignor to
Norton Company, Worcester, Mass., a corpora-
tion of Massachusetts

Application May 19, 1938, Serial No. 208,859

1 Claim. (Cl. 51—278)

The invention relates to grinding wheels, and with regard to its more specific features to diamond grinding wheels.

One object of the invention is to provide a superior cutting-off wheel. Another object of the invention is to make an extremely durable diamond grinding wheel. Another object of the invention is to make a hard bonded diamond grinding wheel. Another object of the invention is to produce an abrasive wheel of long life and tough characteristics. Another object of the invention is to provide an integral wheel the center portion of which is metal and the outer portion of which is metal containing abrasive. 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 claim.

In the accompanying drawing showing one of many possible embodiments of the mechanical features of this invention,

Figure 1 is a side view of a diamond wheel manufactured according to the invention;

Figure 2 is a cross sectional view taken on the line 2—2 of Figure 1;

Figure 3 is a cross sectional view of mold parts into which has been placed the material forming the center of the wheel;

Figure 4 is a cross sectional view of the mold subsequent to the incorporation of the abrasive material; and

Figure 5 is a cross sectional view of the mold after it has been closed.

I provide a quantity of copper in powdered form. This may be electrolytic copper, if desired, or it may be produced in any other suitable manner but preferably it should be relatively pure and finely divided. That is to say, I prefer to use powder finer than 200 mesh size and the impalpable flours give excellent results in actual practice.

I provide a quantity of tin also in powdered form and the foregoing specification as to purity and fineness equally apply. I then make a mixture of the tin and copper powders and as an example of a mixture which I now prefer, I use 18.6% (by weight) of tin, the remainder copper. It should be understood, however, that I may use any of the alloy mixtures specified in my prior

Patent No. 2,072,051. So far as broad features of the invention are concerned, I may use any other metal powders.

The mixing of the powders is usually accomplished by placing the measured amounts in a cylindrical glass jar and placing the jar on a pair of parallel rollers rotating in the same direction to revolve the jar. The jar may be left on the rollers for two or three hours and requires no attention and at the end of that time the powders are found to be very thoroughly mixed.

Referring now to Figures 1 and 2, the completed cutting-off wheel comprises a central portion 10 of pressed and sintered metal powder and an outer portion 11 of pressed and sintered metal powder containing diamonds, there being a central hole 12 in the wheel for mounting on a spindle. The central non-abrasive portion 10 may be somewhat thinner than the outer abrasive portion 11 to provide good clearance in a cutting-off operation.

Referring now to Figure 3, I provide a mold bottom 15 which is a cylinder with a central hole. I further provide a mold ring 16 and a central plug 17. Putting the parts together as shown in Figure 3 (the ring 16 may be held up by shims, not shown), I fill the space inside of the mold ring 16 with a measured amount of the mixture of copper and tin powders 10a. I level this off carefully by means of hand scrapers or the like.

Referring now to Figure 4, I provide a mold top plate 15a which is identical with the bottom plate 15. I also provide an outer mold ring 19. I place the top plate 15a on top of the mixture 10a and place the outer mold ring 19 around the inner mold ring 16. I then fill the space between the top plate 15a and the mold ring 19 with a mixture of the two metal powders and diamonds or other abrasive. I then insert an upper inner mold ring 16a inside the outer mold ring 19, as shown in Figure 4. I then take the entire mold to a press and close the mold to the position shown in Figure 5. After the mold is closed, the plug 17 may readily be pressed out and the outer mold ring 19 may be readily stripped, after which the rest of the mold readily separates.

The result is a wheel as shown in Figures 1 and 2 and when considerable pressures are used, this wheel has considerable strength. However, I prefer to heat treat the wheel which causes the metal particles to sinter together and makes the entire wheel stronger and the bond for the diamonds somewhat more brittle. I may sinter at a temperature which will not burn the diamonds and indeed even below the red heat temperature

of the metal powders employed. The effect of the heating operation, however, is to cause a metallurgical change in the structure of the wheel so that the final product is an integral piece of considerable strength and the diamonds are held in place for a long time so that substantially their entire abrasive life is utilized.

Considering now more specifically the exact proportions of the ingredients, the abrasive annulus 11 consists of 25% by volume of diamonds, the remainder metal bond of which 18.6% is tin and 81.4% is copper. The central portion 10 consists of 18.6% tin and 81.4% copper. However, the amount of mixture 10a is calculated such that the central portion 10 will be from 5 to 15% denser than the abrasive portion 11. This involves existence of a certain amount of porosity in the outer portion 11 prior to the sintering. The sintering causes the various portions of the wheel to shrink very slightly, approximately to the actual specific gravity of the alloy and to a body with substantially no porosity. I have found that for the thicker wheels a lesser amount of difference in density will suffice for good results. That is to say, the thinner the wheel proportionate to its diameter, the greater the difference in density. A wheel of the proportions shown in Figures 1 and 2 may be satisfactorily manufactured with a difference in density of 10%. Very thick wheels may require a difference in density of no more than 5%.

From actual experience in manufacture I have found that, especially for the thin wheels, a difference in density of the two sections of the wheel prevents the separation of the two portions into separate pieces and also warping of the center portion. In fact, my experience has been that wheels of the proportions indicated in the drawing could not be successfully made with the center portion of equal density with the outer portion. First attempts to make the wheel described herein, according to which the density was uniform throughout, resulted in failures.

Industry at present uses a large quantity of cemented carbide cutting tools in turret lathes, boring mills and many other machine tools. Owing to the great hardness of this material, it has been difficult to work it. Heretofore resinoid bonded diamond wheels have been used for cutting up rods into small tool portions, but this practice has been abandoned by some owing to the high cost of the wheels. In the use of resinoid bonded diamond grinding wheels of a shape somewhat like the wheel of Figures 1 and 2, only slight pressures could be used since otherwise the wheel would buckle. It is believed that these resinoid bonded wheels wore out long before the entire cutting life of the diamonds had been used. In other words, the bond released the diamonds before they had become dulled. The diamond abrasive bond structure according to my Patent No. 2,072,051, one example of which is the abrasive structure according to the present invention, is harder than resinoid, is tough and to some extent brittle, and the diamonds are held much longer. I believe that I hold the diamonds in place under most conditions of operation for a large portion of their useful life, that is to say until they have become somewhat dulled. Using a cutting-off wheel as shown in Figures 1 and 2, considerable pressure may be applied as the wheel is comparatively strong and the bond is comparatively hard. Accordingly, a cutting-off operation takes very much less time using the wheel of the present invention than it did using prior resinoid

bonded diamond cut off wheels. Furthermore, the wheel wear in such a cutting-off operation is very much less.

While the cutting-off wheel is an outstanding example of a successful embodiment of my invention, it should be understood that the invention is in no wise limited thereto since other types of peripheral abrading grinding wheels can be made according to the invention and so far as certain features are concerned, the invention may be embodied in a cup-shaped wheel or other type of wheel the side face of which is the abrasive portion. Furthermore, so far as certain features of the invention are concerned, it may be embodied in wheels the abrasive of which is other than diamond, for example alumina, silicon carbide or boron carbide.

The pressing of the wheel of the invention may be done in a hydraulic press using a pressure of the order of 2500 pounds to the square inch. The sintering may be done at a temperature of 550° C. I may in some cases use in the sintering furnace a non-oxidizing atmosphere, for example a reducing atmosphere (hydrogen) or nitrogen or an inert atmosphere, for example argon. This, however is a further precaution and in the case of the specific bond specified above and a temperature of 550° C. an excellent wheel can be made without this precaution. For further disclosure of bonds which can be used with good effect and for further directions in pressing and sintering, reference may be made to my prior Patent 2,072,051 previously referred to.

As an example of comparative results for wheels made according to the present invention and resinoid bonded diamond wheels, I caused wheels to be prepared according to the following specifications:

Resinoid bonded wheel

A standard resinoid bonded diamond wheel was manufactured according to the best practice known whose dimensions were diameter 4", thickness .040", and 1/2" hole; this consisted of 25% by volume of 100 grit size diamond grain, 1/8" deep at the periphery, united to a resinoid center. The resinoid throughout was phenol formaldehyde produced according to standard methods by a well known manufacturer. After the wheel was pressed, it was baked for twelve hours at 160° C. to polymerize the resin.

Metal bonded wheels

Three metal bonded wheels were made up of dimensions the same as the resinoid bonded wheel, that is to say 4" in diameter, .040" thick, with 1/2" hole. These wheels were likewise made from 100 grit diamond grain with standard concentration, namely 25% diamonds by volume. Likewise diamonds occupied 1/8" in the periphery.

Wheel A

Wheel A consisted of 81.4% copper, 18.6% tin, sintered in a reducing atmosphere at 550° C.

Wheel B

Wheel B consisted of 76.8% copper, 19.2% tin, and 4.0% nickel sintered in a reducing atmosphere at 550° C.

Wheel C

Wheel C consisted of 72.4% copper, 13.2% tin and 14.4% nickel sintered in a reducing atmosphere at 550° C.

In the foregoing as well as the previous description, the percentages of the ingredients of the

alloy are by weight while the percentage of diamonds to bond is by volume, since it is easier to make calculations this way. In the case of wheels A, B and C the central portion was pressed to a ten percent greater density than the outer portion in accordance with previous description. Probably in these cases the porosity of the inner portion after pressing is only two or three per cent by volume and after sintering, the entire article virtually lacks porosity. The following table shows the results of tests under uniform conditions of the above wheels:

Wear	Resinoid wheel	Wheel A	Wheel B	Wheel C
Cutting glass.....	.0062"	.0005"	.0008"	-----
Cutting cemented tungsten carbide.....	.0223"	.0024"	-----	.0043"

The formation of a center portion of integral structure with the peripheral abrasive portion and of strong metal permits the utilization to the best advantage of the abrasive qualities of metal bonded diamond grinding composition, especially in a thin cutting-off wheel where strength to resist the grinding pressure which results in radial and lateral stresses is of the utmost importance.

Wheels manufactured according to the present invention are unitary wheels and are metallurgically unitary in the sense that the individual metal particles out of which the wheel was made cannot be identified, have lost their separate existence, and the entire wheel including the

abrasive portion as well as the center portion is jointless and seamless and the crystalline structure of the metal is not broken by the original boundaries of the particles which were used to make it. In other words, the particles have grown together into a solid piece.

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 various possible embodiments might be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, 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:

The method of making a diamond grinding wheel which comprises making a mixture of diamond grain with powdered metal, making another mixture of all metal powder, filling the inner part of a mold with the all metal powder, filling the outer part of the mold with the metal powder and diamond grain mixture, and selecting an amount of material for each part with relation to the mold such that in a pressing operation the inner part is between 5 and 15% denser than the outer part, closing the mold, then sintering at a temperature below the melting point of the metal.

EDWARD VAN DER PYL.