

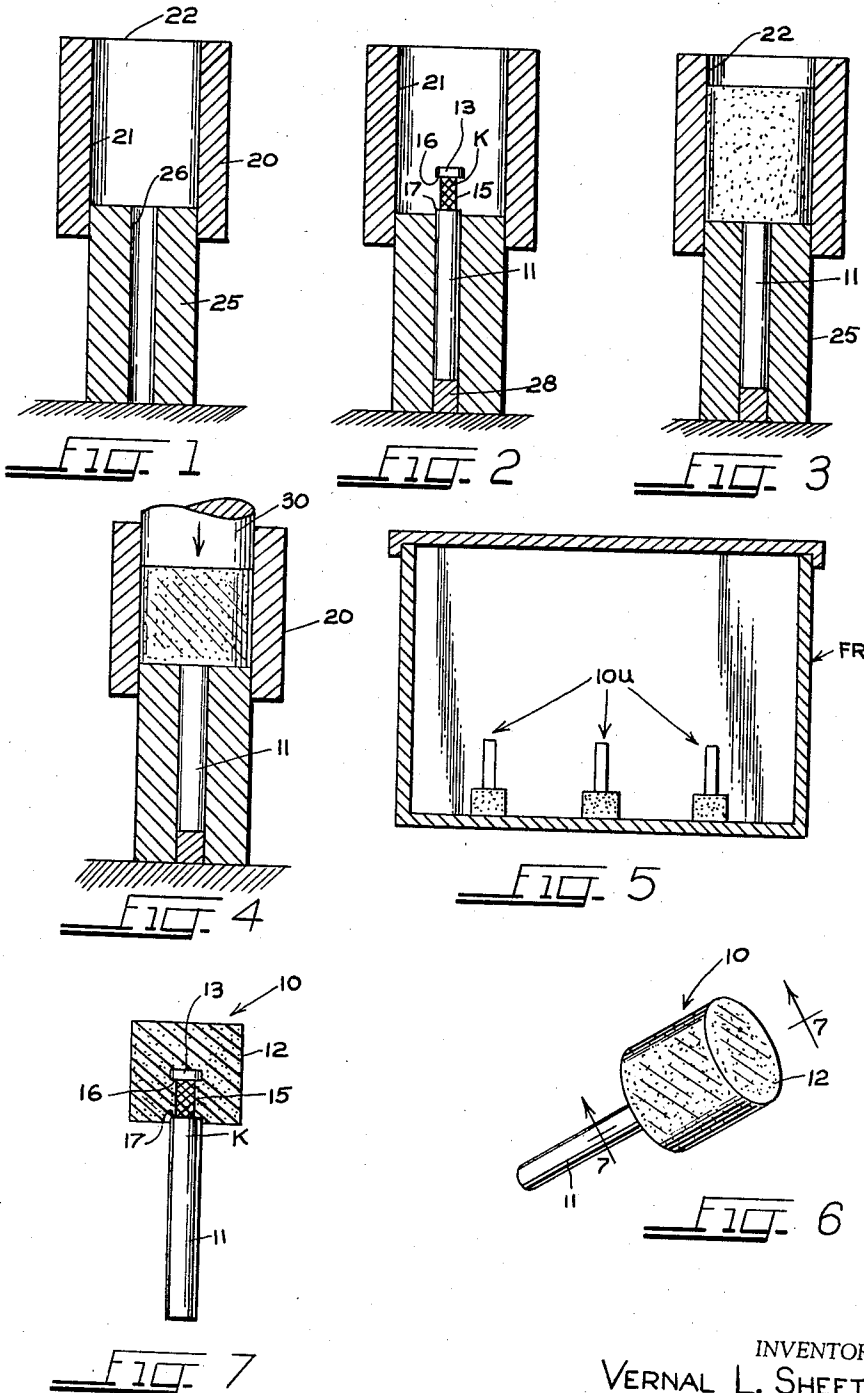
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V. L. SHEETS

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ABRADING WHEELS

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INVENTOR.
VERNAL L. SHEETS
BY
Wallace and Cannon
Att'ys

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ABRADING WHEELS

Vernal L. Sheets, Valparaiso, Ind., assignor to Chicago Wheel & Manufacturing Company, Chicago, Ill., a corporation of Illinois

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This invention relates to mounted abrading wheels, and in particular to abrading wheels comprising a vitreous binder affixed to a steel mandrel.

Abrading wheels of the kind to which the present invention relates are composed of finely divided abrasive material such as alumina, silicon carbide or the like bonded by a fused vitreous binder material. Such an abrading wheel is to be affixed to a metallic mandrel to afford a so-called mounted abrading wheel, and the mandrel at the free end thereof is adapted to be secured in a power tool incidental to using the abrading wheel for the desired polishing or grinding operation.

The commonly adopted method of manufacturing mounted abrading wheels has entailed pressing in a die cavity under relatively high pressure the composition that is to afford the wheel, such composition including an abrasive material and a binder for the abrasive. The die cavity is complementary to the wheel to be formed, and usually the composition for the wheel has been pressed about a fixed core or insert in the die cavity affording a bore in the compacted wheel composition. The wheel composition thus provided with a bore is removed from the die cavity and fired, that is, subjected to heat to produce fusing of the binder to permanently bond together the abrasive particles. Next, the bore in the wheel is swabbed with cement, or the end of the mandrel to be joined to the wheel is provided with cement, and the mandrel is then inserted in the bore of the finished wheel. Usually, the cement is of a nature requiring a heat cure to effect the desired bond between the wheel and the mandrel.

Alternatively, the wheel may be formed and fired, and then drilled to afford a bore for the mandrel.

It will be seen from the foregoing that the commonly adopted methods of manufacturing mounted abrading wheels have entailed individual mounting of a mandrel in the bore of the related abrading wheel having a preformed bore. It is known that such individual mounting of the mandrel involves numerous rejects, and therefore a substantial overhead, due to inaccurate alignment of the mandrel, and this is particularly so in those instances where the cement used to affix the mandrel to the wheel requires a heat cure, since during the heat cure cycle the cement commonly used undergoes an intermediate softening stage which encourages tilting of the mandrel out of true. Therefore, in the absence of special precautions, an unusually large number of rejects are encountered in manufacturing mounted abrading wheels according to either of the foregoing methods, and it will be appreciated that clearance is required between the diameter of the mandrel and the diameter of the bore of the wheel because otherwise there would be an unacceptably low clearance volume for the cement used to join the mandrel to the wheel. It is this need for clearance volume which introduces the uncertain aspect of mandrel alignment mentioned above.

It of course would be desirable to integrate the wheel

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and the mandrel in one operation as by pressing the loose composition for the wheel directly about the affixing end of the mandrel, and this method of production is in fact feasible in those instances where the binder included in the abrasive composition for the wheel is in the form of a thermosetting resin or the like, but this method of manufacture has not been feasible in those instances where it is desired to use a vitreous binder requiring high temperatures in the neighborhood of 2000° F. to effect the required softening of the binder material incidental to developing its binder properties. This is so for the reason that if the mandrel is to be directly united to the wheel at the time the abrasive composition is compacted subsequent heating of the assembly including the wheel and the mandrel is required in order to set the binder, whether the binder be resinous or vitreous, and the temperature used to thus set the binder could not be so high as to adversely affect the mandrel. In other words, a thermosetting resin setting or curing let us say at 500–600° F. enables firing of the assembly to be accomplished at temperatures having no adverse effect on the mandrel, but such method of production of mounted abrading wheels involving union of the mandrel and the compacted but unfired abrasive composition in the first instance is not feasible where temperatures required to set the binder are in the neighborhood of 2000° F., a temperature which at least discolors a stainless steel mandrel and which adversely affects the grain structure of plain, that is unalloyed carbon steel, and which often causes warping of the mandrel due to thermal softening of the mandrel.

The primary object of the present invention is to enable mounted abrading wheels to be manufactured having a steel mandrel united to the abrading wheel at the time the abrasive composition is compacted to form the wheel and wherein the abrasive composition includes a vitreous binder. Specifically, it is the object of the present invention to manufacture abrading wheels having an abrasive composition including lead borosilicate glass as a binder by compacting the composition in a die cavity about the affixing end of a steel mandrel disposed in the die cavity, and to fire, that is, heat the thus-united parts including the wheel and the mandrel at a temperature around 1200° F. which is sufficient to fuse the binder to produce the desired binding of the abrasive particles and permanent union of the abrading wheel to the mandrel. In other words, the present invention makes possible production on a commercial scale of mounted abrading wheels including a steel mandrel and a wheel having a vitreous binder, which has long been an aim of the art.

One important aspect of the present invention is that the method of manufacture herein involved enables a mandrel to be used having an enlarged head at the wheel affixing end thereof, so that the accomplishment of this is a further object of the present invention. Thus, the use of a mandrel having an enlarged head at the end to be affixed to the abrading wheel has heretofore not been capable of satisfactory accomplishment in connection with an abrading wheel including a vitreous binder where separate manufacture of the wheel and then individual mounting of the related mandrel in the bore of the wheel is entailed, since the open end of the wheel bore would have to be as large in diameter as the mandrel head, and hence there would be no useful complementary mating of the wheel and the mandrel; and moreover, the association of the mandrel and wheel would be a loose fit entailing the likelihood of misalignment mentioned above.

Another object of the present invention is to afford a vitreous-bonded mounted abrading wheel having a mandrel with an enlarged head at one end thereof fitting

into the abrading wheel in such a manner that there is a full and complete complementary or interfacial mating of the parts.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show a preferred embodiment of the present invention and the principle thereof and what I now consider to be the best mode in which I have contemplated applying that principle. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

In the drawings:

Figs. 1 to 4 inclusive are schematic sectional views of a press illustrating progressive stages of manufacture of a mounted abrading wheel in accordance with the present invention preliminary to firing the abrading wheel and the mandrel that is affixed thereto;

Fig. 5 is a schematic sectional view showing firing of assemblies taken from the press;

Fig. 6 is a perspective view of a completed mounted abrading wheel of the kind contemplated by the present invention; and

Fig. 7 is a sectional view taken substantially on the line 7—7 of Fig. 6.

The present invention is illustrated in the drawing as pertaining to the production of mounted abrading wheels as 10 shown in Figs. 6 and 7 of the drawing, such mounted abrading wheels comprising a mandrel 11 having an abrading wheel 12 affixed to one end thereof. As shown in Figs. 2 and 7 of the drawing, the mandrel 11 in accordance with the present invention is formed at the affixing end thereof with an enlarged annular head 13. Inwardly of the head 13, the affixing end portion of the mandrel is reduced in diameter at 15 to afford an upper or outer annular shoulder 16, and preferably this reduced portion of the mandrel is knurled at K or otherwise provided with ribs and grooves to in effect increase the area of the mandrel that is affixed to the abrading wheel. The end of the knurled or reduced portion of the mandrel opposite the shoulder 16 is further defined by a lower or inner annular shoulder 17 which also represents the inner end of the shank portion of the mandrel which is adapted to be fitted in a chuck or the like of a power tool. It will be recognized from Fig. 7 that the abrading wheel 12 is fully complementary to the portion of the mandrel 11 surrounded by the abrading wheel, that is, the abrading wheel and mandrel meet at an interface which is fully complementary to the enlarged head 13 of the mandrel, the reduced or the knurled portion 15 and the lower shoulder 17. Under the present invention, the abrading wheel comprises the usual finely divided abrasive, and the abrasive particles are bonded together by a vitreous binder which also serves to bind the abrading wheel permanently to the affixing end of the mandrel.

The affixing end of the mandrel defined in the foregoing manner can be conveniently afforded by machining the stock for the mandrel. As an example, the stock may be one-quarter inch in diameter, which will be the diameter of the head 13 and the shank portion of the mandrel to be fitted in a power tool, and the knurled portion 15 will be reduced by one to three thirty seconds of an inch.

The method of production under the present invention is illustrated in progressive stages in Figs. 1 to 5 of the drawing, and to this end there is used a press embodying a cylindrical outer sleeve 20 defining a cylindrical mold cavity 21 open at one end 22. The opposite end of the mold cavity 21 is adapted to be closed off by a cylindrical block 25 having an elongated bore 26, the block 25 being partially inserted in the mold cavity 21 from the lower end thereof. It will be observed in Fig. 1 that the bore 26 of the block 25 opens at both ends of the block 25.

The first step incidental to production of a mounting abrading wheel 10 in accordance with the present invention is to dispose the mandrel 11 in the bore 26 of the block 25 so that the affixing end of the mandrel projects into the die cavity as shown in Fig. 2. It is preferred that the mandrel be so positioned that the shoulder 17 be disposed within the die cavity sufficiently to expose a portion of the shank of the mandrel 11 below the shoulder 17 to the die cavity. This is conveniently accomplished by use of a plug 28, Fig. 2, disposed in the bottom of the bore 26 of the block 25 so to afford a fixed support for the lower end of the mandrel 11 with the affixing or upper end of the mandrel projected the desired amount into the die cavity 21.

The loose, granulated abrasive composition that is to afford the wheel 12 of the mounted abrading wheel is next used to fill the die cavity 21 to the required depth as shown in Fig. 3, and under the present invention this composition comprises 70 to 95 percent by weight abrasive particles such as alumina, silicon carbide or the like of desired particle size, and accordingly 5 to 30 percent by weight of powdered lead borosilicate glass of approximately 325 mesh. The following is an example in accordance with the foregoing:

EXAMPLE 1

Material:	Parts by weight
Abrasive particles	70-95
Binder (Example 2)	30- 5

EXAMPLE 2.—BINDER

Lead borosilicate glass

Silica	37.6
Boric acid	5.9
Red lead oxide	46.5

To afford a temporary binder for the abrasive composition, the permanent binder ingredients of Example 2 above are mixed with silicate on the basis of approximately one part by weight of sodium silicate to 3½ parts by weight of the lead borosilicate glass. It may here be mentioned that the proportion of abrasive particles to binder of Example 2 will determine the desired hardness of the wheel, that is, the hardness of the wheel will vary in a direct ratio with the amount of binder material used.

After the die cavity has been filled to the desired extent as shown in Fig. 3, predetermined of course according to the desired axial dimension of the finished product, the abrasive composition is subjected to pressure by a ram 30, Fig. 4, entering the die cavity 21 from the open end 22 thereof, and this ram has a predetermined pressure and stroke sufficient to compact the loose abrasive composition in the die cavity 21 to the desired density and thickness. Following this operation, the ram 30 is withdrawn and the abrasive composition has been sufficiently compacted to enable the wheel and mandrel to be handled as an assembly.

Each assembly removed from the die cavity is in a "green," that is unfired state inasmuch as the abrasive composition is only compacted and the binder has not as yet been vitrified, but nevertheless the pressures entailed during compaction of the abrasive composition in the die cavity 21 were sufficient, together with the sodium silicate temporary binder, to cause temporary adhesion of the abrasive composition and cohesion of the unfired wheel to the mandrel.

As shown in Fig. 5, a heat treating furnace is illustrated at FR, and the unfired assemblies 10U that are to be fired are arranged therein. Any desired source of heat can of course be used, and the expression "fired" is used generically herein broadly to designate the heat treating operation as entailing heating of the assemblies 10U to cause fusion or vitrification of the lead borosilicate glass binder particles producing permanent bonding of

the abrasive particles composing the abrading wheel and a permanent union of the abrading wheel to the affixing end of the mandrel. Based on the foregoing examples, each assembly as it is removed from the die cavity 21 is first allowed to dry in air to at least partially dry the sodium silicate temporary binder, and then each assembly is fired as in a furnace FR for a minimum of four hours with a maximum temperature of 1200° F. Thus, in accordance with the present invention, relatively short heating cycles are entailed at relatively low temperatures in comparison to cycles of nearly forty hours at temperatures well in excess of 1200° F. as formerly used in producing mounted abrading wheels having a vitreous bond. Of particular importance in the present instance is the fact that the low firing temperatures involved do not adversely affect a mandrel of stainless steel or a mandrel of plain carbon steel.

Hence, while I have illustrated and described the preferred embodiment of my invention, it is to be understood that this is capable of variation and modification and I therefore do not wish to be limited to the precise details set forth, but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

I claim:

1. A mounted abrading wheel comprising a mandrel, said mandrel being composed of steel and having an

attaching end portion, and an abrading wheel bonded complementally and interfacially directly to and in contact with said attaching end portion of the mandrel, said abrading wheel being composed primarily of abrasive particles in an amount of about seventy to ninety-five parts by weight of the abrading wheel, the remainder of the material in the abrading wheel consisting of a relatively low melting point lead borosilicate glass binder consisting of silica, boric acid and red lead oxide fused to form a matured glass binder which binds together the abrasive particles and binds the wheel to the mandrel.

2. A mounted abrading wheel according to claim 1 wherein the steel mandrel is selected from the group consisting of stainless steel and plain carbon steel.

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