Jan. 26, 1937. B. SANFORD 2,069,116

COMPOSITE GRINDING WHEEL AND METHOD OF MAKING THE SAME

Filed Feb. 14, 1935

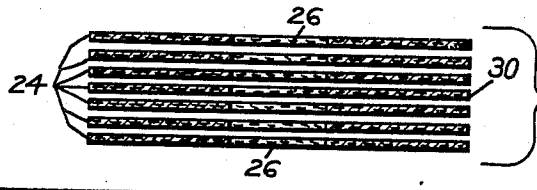


FIG. 1

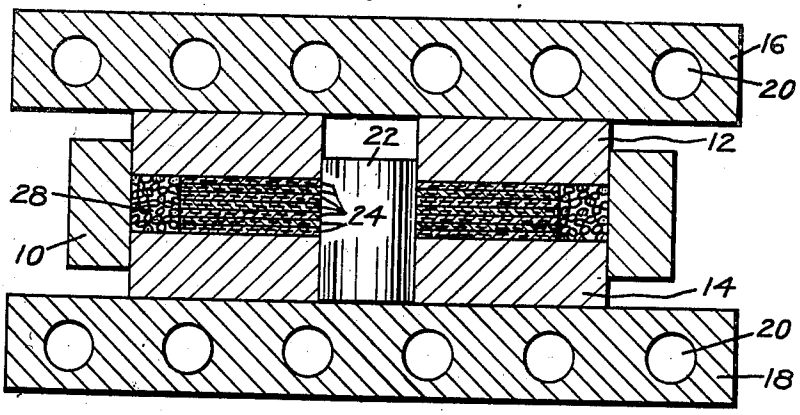
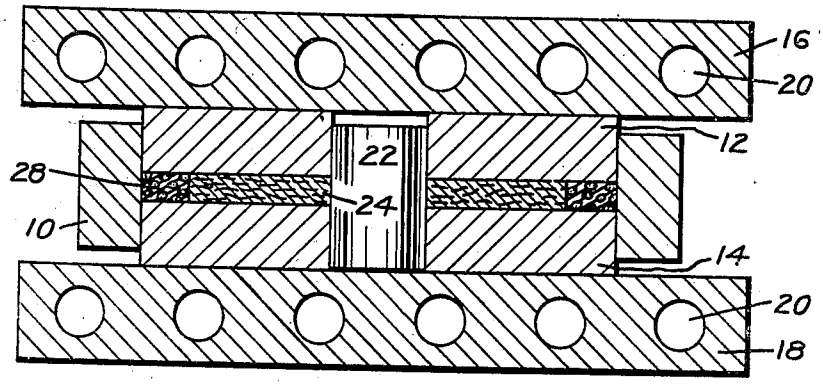


FIG. 3.

FIG. 2



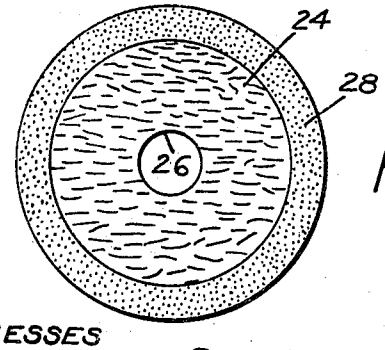
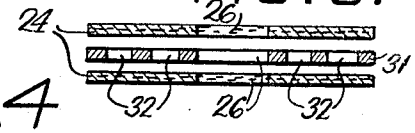


FIG. 4

FIG. 5.



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COMPOSITE GRINDING WHEEL AND METHOD OF MAKING THE SAME

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8 Claims. (Cl. 51—206)

This invention relates to abrasive wheels and more particularly to a grinding wheel having an annular abrasive rim made of resinoid bonded abrasive grains and a non-abrasive supporting center formed primarily of a resinoid composition, and to a method of making the same.

If a grinding wheel of this type is to be made of diamond grains, the expensiveness of the abrasive material requires that a construction be employed which involves the use of a non-abrasive central support so that the costly abrasive grains may be utilized to the best advantage at the outer rim portion. A similarly constructed wheel may also be required where other expensive abrasives are used. These wheels are particularly useful as cutting-off wheels or as abrasive saws required for cutting various kinds of expensive and rare metals and alloys with a minimum of waste, as well as for cutting or grinding the surfaces of extremely hard materials, such as the high speed tool steels or machine tools made of various hard metal carbides and the like. For example, it has been found necessary to make a very thin grinding wheel having a thickness of not more than $\frac{1}{32}$ of an inch for cutting or sawing thin disks from the end of a solid rod, such as quartz disks used in radio control work, tungsten and other substances which are valuable and exceedingly tough and difficult to work. Such materials are ground only with difficulty by the abrasive wheels heretofore manufactured. However, they can be worked easily by a wheel composed of bonded diamond grains.

It is found, however, that if such a grinding wheel is made of a rim of diamond or other abrasive grains united by a resinoid bond which is supported on and integral with the periphery of a central body of resinoid alone, certain manufacturing difficulties arise because of the extreme thinness of the center body portion of the wheel. The central portion of the wheel may be made by initially "hot pressing" a resinoid composition to form a premolded compact body but owing to the small amount of the granular molding material which is required to form a molded body of such thin cross-section, it is found to be extremely difficult to distribute such a small mixture of resinoid grains uniformly enough in the mold cavity to produce a final molded product of uniform thickness and strength. Moreover, this problem of distributing the material of the central body in the preforming mold has always been difficult to carry out in practice, whether for the manufacture of a thin or for a thick wheel, so that the invention herein described applies equally well to the manufacture of the central supporting body of a thicker grinding wheel having the diamond grains incorporated in a narrow peripheral layer and wherein it is important that the central supporting portion be made of uniform properties throughout.

It is accordingly an object of this invention to provide a very thin composite grinding wheel which is so constructed as to impart to it a high degree of mechanical strength and is capable of being easily and economically manufactured.

A further object of the invention is to provide a simple and economical method of making a composite grinding wheel of this type and with the properties described.

With these and other objects in view, as will be apparent from the following disclosure, my invention resides in the subject matter described in the specification and set forth in the claims appended hereto.

Referring to the drawing, which illustrates one embodiment of this invention and in which like reference numerals indicate like parts:

Fig. 1 is a cross-sectional view, on an enlarged scale, showing a set of resinoid impregnated fibre sheets ready to be placed in the wheel mold for making the central wheel body;

Fig. 2 is a diagrammatic cross-sectional view, on an enlarged scale, showing the fibre sheets assembled in a mold with the bond and abrasive mixture in position with the associated press and mold parts ready for pressing the mass;

Fig. 3 is a cross-sectional view similar to that of Fig. 2, diagrammatically illustrating the respective sections of the wheel after they have been pressed to their completed final condition; and

Fig. 4 is a plan view, in diagrammatic form, of the completed grinding wheel.

Fig. 5 is a cross-sectional view of a modification of a core member wherein a metal disk is used as a reinforcing member.

In accordance with this invention, I propose to make a grinding wheel having an outer abrasive rim of resinoid bonded abrasive grains and non-abrasive central support therefor of a laminated structure associated with a resinoid binder. The abrasive rim may be made of suitable abrasive material, such as diamond grains, silicon carbide, crystalline alumina or boron carbide grains, intermixed and united by a resinoid bond of required properties in which the mixture of abrasive and bond and the wheel center of fibrous sheet material are subsequently pressed, preferably simultaneously, although this operation may

be carried out serially on the respective portions, in a "hot press" wherein the whole mass is subjected to suitable heat and pressure conditions whereby the abrasive rim and the non-abrasive central support are compacted and united into a unitary, rigid wheel structure of required abrasive characteristics and dimensions in which the resinoid bonds are matured into the final, infusible product.

The central wheel support is made up of a plurality of laminations or layers of suitable fibrous sheet material impregnated with a suitable resinoid. These sheets may be made of many different substances, which may be made of such a structure that they are compressible during the subsequent molding of the abrasive and non-abrasive portions of the complete wheel, or these sheets may be initially preformed into a solid and reasonable dense body which is capable of flowing under the subsequent molding conditions employed during molding of the outer abrasive ring whereby the two portions of the wheel may be simultaneously formed together into a rigid unitary structure. While any suitable fibrous material and any suitable resinoid binder may be used for making the central support, I prefer to use paper or cloth sheets impregnated with synthetic resin, preferably of the phenolic type, such as a phenol-formaldehyde resin. As is well known, these resins exist in either of two stages, viz. an initial or fusible stage or a final or insoluble and infusible stage. In its initial stage, the resin constitutes a fusible, potentially reactive binder and when converted therefrom to its final infusible condition, by a process involving heat and pressure, the resin serves to hold or secure together in the form of a hard, solid unitary body the fibrous materials with which it is associated.

In the embodiment illustrated in the drawing, the resinoid-impregnated sheets are preferably made of a compressible or cellular structure of a suitable fibrous material, such as fibreboard, chipboard, paper, cloth or the like, the cells of which are partly or to a large extent impregnated with a partially hardened, fusible resinoid, and preferably a phenolic resinoid, such as a fluid "bakelite" resinoid. This resinoid impregnated body may be of any suitable dimensions but preferably formed as very thin, paper-like disks of the impregnated sheet material so that the width of the final wheel body may be accurately controlled. The resinoid which is employed to impregnate this fibrous body is ordinarily of the type of a varnish or liquid substance and is not hardened to its final infusible state until the time of or after molding the two sections of the complete wheel. That is, the resinoid material is still capable of becoming plastic and flowing under the application of heat and pressure, since it has not been completely reacted and matured to its final, hard, infusible state. This is desirable in order that the resinoid bonds in the abrasive annular rim and the central portion may both be matured and cured under heat and pressure to the final, hard, infusible product at the same time, and thus be caused to flow into one another and provide a rigid integral unitary body. It, however, is not essential that the bond and the impregnating substance be made of the same material, since various resinoids have many similar properties and will adhere to one another sufficiently for the purposes of this invention. It is also feasible to premake the central support from fibrous sheets, which may or may not be impregnated with a resinoid, in which the contiguous sheets are cemented together by a separate layer of hardened resinoid varnish which will become sufficiently plastic so as to flow slightly during the subsequent molding operation under the hot press conditions and become converted into the final infusible condition.

It will now be apparent that the central wheel support may be formed by employing these very thin sheets of resinoid substance, whereby one may place within the wheel mold, in stacked or superimposed relation, that number of these sheets which are required to produce a wheel supporting center of the desired thickness. By using this material, which has been previously formed as thin disk-like sheets, I thus obtain a wheel center in which there is a uniform distribution of the resinoid and consequently of uniform strength throughout. It is also desirable that the resinoid-impregnated fibrous body have substantially the same shrinkage under heat and pressure as does the bond and abrasive mixture in the outer grinding portion, so that the two sections may be pressed together simultaneously in a single molding operation and thus simplify the manufacture and minimize the expense of making the wheel. Also, by the use of such compressible sheet material, a lateral flow of this central, non-abrasive portion is largely minimized, and molding of the wheel is mainly provided by the uniform vertically applied pressure during relative movement of the press plates in which the force or pressure which serves to compress the body is applied to the material to be molded largely in a vertical direction and parallel with the axis of the wheel and so does not distort or shift the position of the abrasive mixture in the rim by squeezing of the laminated structure radially to any material extent.

Referring now to Fig. 2 of the drawing, which illustrates diagrammatically the assembly of the essential mold parts and apparatus required for making this wheel in a single pressing operation, the mold may comprise an annular band 10 within which are inserted the top and bottom annular press plates 12 and 14, respectively, between which is disposed the wheel material to be molded. The plates 12 and 14 are made to closely fit the interior of the mold band 10 and they are relatively slidable therein and with respect to each other whereby they may serve to compact the material to be molded to the desired extent and shape. The mold plates 12 and 14 are pressed from above and below by means of the usual press platens 16 and 18 of a conventional "hot press" (not shown), which are relatively movable by hydraulic pressure, and each of these platens contains suitable channels 20 which are suitably connected, as is well known in the art, for alternately circulating steam and cold water therethrough during the molding operation for the purpose of heating the plates to the required resinoid converting temperature and subsequently cooling them to set the bond in the molded article while it is still under the pressure of the press plates. This mold and press plate construction is, of course, mounted in any suitable manner in a hydraulic or other desired type of conventional hot press (not shown) for the purpose of forcing the parts together, as is well understood and standard practice in the art. If the wheel is to be formed with a central hole, an arbor or iron core 22 of suitable dimensions is, of course, mounted within central holes in the press plates 12 and 14 and inserted in the center holes of the

fibre disks to prevent deformation of the material when under the molding pressure.

In order to make an abrasive wheel in accordance with this invention, a suitable number of the fibrous, resinoid-impregnated sheets 24, as shown in Fig. 1 are assembled in the mold cavity around the central arbor 22. These sheets will, of course, have been cut by being died out to the required disk shape and provided with the necessary central hole 26 of a suitable size to fit over the arbor 32 and for mounting the completed wheel on a spindle.

The annular mold space between the outer edge of the resinoid sheets and the mold wall is now filled with a measured amount of suitable mixture of abrasive material and resinoid bond to form the annular abrasive rim 28. This mixture is made in accordance with standard knowledge and if diamonds are employed as the abrasive material one way, for example, employ 50 parts by volume of granular material with 50 parts by volume of a suitable resinoid bond. Suitable proportions will, of course, be employed to obtain the desired denseness or structure of this abrasive portion. The above specified proportions of diamonds and bond give a wheel of maximum density in which the pore spaces between the grains are filled and the body is substantially non-porous. Also, if desired, one may substitute other kinds of abrasive material or granular inert materials, such as silicon carbide, crystalline alumina, boron carbide or quartz, for a part of the diamond grains in the abrasive portion of the wheel. Likewise, any one of these granular materials may be used by itself, or in mixtures with fillers in this abrasive zone, it being understood that the abrasive nature of this outer rim will depend upon the type of material used, and that the invention is not limited to any particular abrasive substance. As above indicated, the abrasive material and bond in the rim portion 28 should be so constituted that this abrasive rim 28 and the non-abrasive center portion 24 will both be compressed to a proper degree when simultaneously pressed between the press plates 12 and 14, respectively. If the two materials have the same degree of compressibility, then the height of the laminated sheets and of the level of the filling of abrasive mixture in the annular zone will be the same, prior to pressing. This is preferable and is accomplished if one uses for the laminated sheets a phenolic-resinoid impregnated paper having a cellular structure in which the cells are compressible to the same extent as the final packing of the abrasive mixture in the rim. Consequently, when subjected to pressure, the two bodies will be pressed to a very dense condition and will be caused to flow sufficiently laterally so that they make an integral joint and unite completely so as to form a rigid unitary wheel structure. For the resinoid, one may use a phenolic condensation product, such as is formed by the reaction of phenol and formaldehyde or that obtained by their homologues. This applies both to the bond for the abrasive material and the impregnating resinous substance in the fibre sheets. Likewise, one may use other well-known resinoids of the nature of phthalic anhydride or "Glyptal", or the furfural resins or other resinoid substances that are becoming well known in the molding art and are applicable to the manufacture of the non-abrasive center portion of this wheel or for the bond of the abrasive portion.

If it is desired to strengthen the central portion of the wheel, then the centermost paper layer 30 of impregnated sheet material 24, as shown in Fig. 1, may be replaced by a thin perforated sheet metal disk 31 which may be suitably shaped for the purpose. Fig. 5 shows the metal disk 31 assembled with a single resin impregnated paper sheet 24 on each side thereof, but any number of the latter may be used. Upon the application of the molding pressure, the assembled sheets and metal disk 31 interposed at the central zone will be compressed so that the resinoid material will flow through the holes 32 in the metal disk to form an interlocking structure thereof, wherein the disk will aid in preventing detrimental warping of the wheel and serve to strengthen the same.

Although the invention as herein illustrated and described is particularly well adapted for use in connection with methods of molding very thin abrasive wheels, it should be understood that the novel features thereof are capable of application to the manufacture of composite abrasive wheels of thick widths wherein a non-abrasive central support is required, and the claims should be interpreted accordingly.

It is also to be understood that thick sheets of resinoid impregnated fibre or cloth may be used to make a wheel, in which case the support may be made of a single sheet or a plurality, as is desired. Also, the shapes of the wheels may be made as required, such as a tapered or straight sided cup wheel in which the backing may be considered as the central support, as herein described.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. An abrasive wheel comprising a non-abrasive supporting disk formed of layers of fibrous sheets cemented together by a resinoid, and an annulus of abrasive grains and a resinoid bond peripherally surrounding and integral with said disk and forming a wheel body of substantially uniform thickness which has its two resinoid portions united by compression while plastic and set by heat as an infusible integral mass, wherein the fibrous sheets are arranged within the planes formed by the sides of the annulus and radially strengthen the wheel.

2. A cutting off wheel of the type covered by claim 1 in which the fibrous sheets are impregnated with resinoid and the latter forms a continuous integral supporting structure which is reinforced by the fibrous sheets.

3. An abrasive wheel comprising a non-abrasive supporting disk formed of layers of paper sheets impregnated with and cemented together by a resinoid, and an annulus of abrasive grains and a resinoid bond peripherally surrounding and integral with said disk and forming a wheel body of substantially uniform thickness which has its two resinoid portions united by compression while plastic and set by heat as an infusible integral mass, wherein the fibrous sheets are arranged within the planes formed by the sides of the annulus and radially strengthen the wheel.

4. A cutting off wheel of the type covered by claim 1 in which the abrasive annulus comprises diamond grains intermixed with resinoid bond which fills the pore spaces therebetween and forms a dense substantially non-porous body.

5. A composite grinding wheel comprising a thin metal disk and side layers comprising a resinoid secured thereto and forming a central support, and an abrasive rim of resinoid bonded

abrasive grains surrounding and secured to the support by the resinoid material.

6. A composite grinding wheel comprising a non-abrasive support having a thin perforated metal disk interposed between and secured to thin resinoid impregnated fibrous sheets by the heat set resinoid, and an abrasive rim of resinoid bonded abrasive grains surrounding and integrally secured to the support by the resinoid material.

7. A cutting off abrasive wheel comprising a thin central supporting disk having a central metal plate and a layer of resinoid secured on each side thereof, and an abrasive rim comprising diamonds and a resinoid bond which is secured peripherally on the disk and united thereto by the contacting resinoid material of the two portions.

8. A cutting-off wheel of the type covered by claim 6 in which the resinoid layer on each side of the metal disk comprises a paper sheet initially impregnated with a resinoid.

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