Jan. 14, 1964 T. J. MARTIN 3,117,400

ABRASIVE WHEEL

Filed Aug. 6, 1962

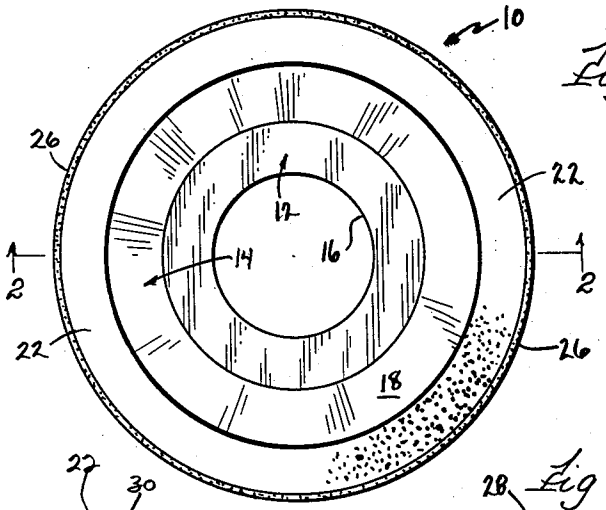


Fig. 1.

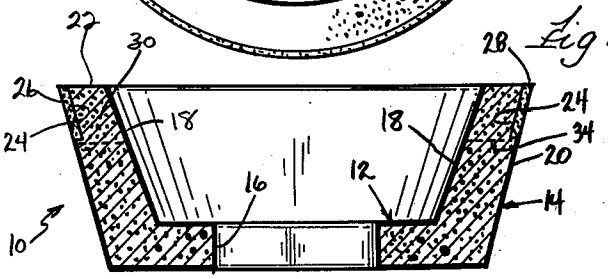


Fig 2

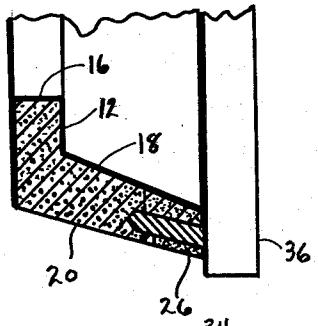


Fig. 6.

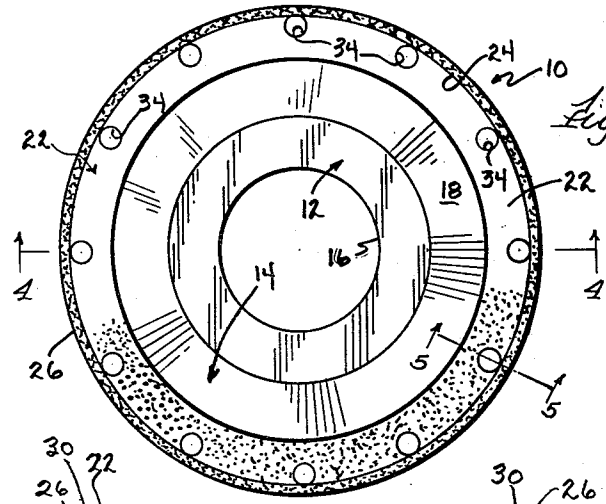


Fig 3.

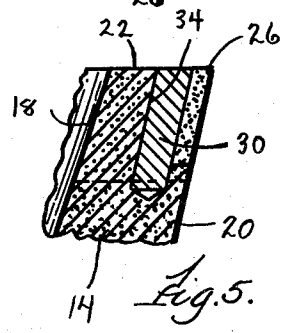


Fig. 5.

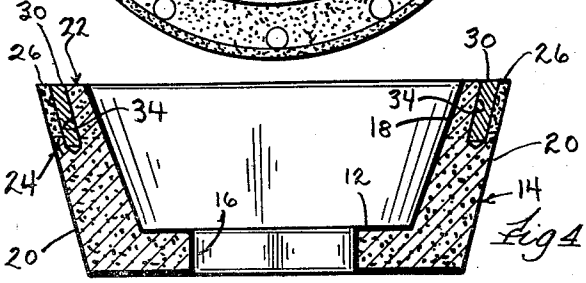


Fig 4.

INVENTOR.
Thomas J. Martin
BY George Frost
and Keith Kulie.
Attorneys.

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ABRASIVE WHEEL

Thomas J. Martin, 22 W. Elm St., La Grange, Ill.

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The present invention relates to an abrasive wheel and more particularly it relates to an improved abrasive wheel that is self lubricating and self dressing.

In conventional grinding operations lubrication is not a real problem since the lubricant, which may be water, oil or other suitable lubricating material, is directed at the interface between the grinding wheel and the work being ground. Some cooling methods for the wheel involve playing a stream of coolant upon the wheel at a point remote from the working interface to keep the wheel cool. Various other lubricating methods also are used, most of which involve directing a lubricant into the interface between the wheel and the piece being ground.

Most of the lubricating methods known result in an overspray of lubricant and general or partial blocking of the view of the piece upon which the work is being performed. This occlusion of the view of the work piece is unacceptable where it is necessary to place a precise finish upon the piece or where the work is of a detailed nature and obliteration of the view by a lubricant would result in a generally unsatisfactory working condition. In view of this, diamond grinding of the finish upon cutting tools or the like normally has been done dry without the benefit of lubrication or cooling in order to prevent any blocking of the view of the piece upon which the work is being performed. Dry grinding, of course, results in premature deterioration of the grinding wheel and can cause "burning" of the piece upon which the work is being performed due to overheating. Undue thermal stresses may also be set up in the piece due to the moderately high temperatures generated during the grinding operation due to the frictional resistance between the abrasive and the piece. An independent external coolant may not be added for the same reason that lubrication is avoided, namely, that the coolant would possibly block the view of the piece being worked upon.

Additional disadvantages are inherent in the provision of external lubricating and lubricating means in that the flow of lubricant and coolant must be adjusted in accord with predetermined practices to provide for sufficient cooling capacity without unnecessary occlusion of the view of the piece being worked upon. Further, separate reservoirs and fluid conduction means must be provided for the fluid coolant and lubricating systems and thus an additional inconvenience is introduced.

It can readily be seen that it would be convenient to provide a grinding wheel that carried its own lubricant for release onto the grinding surface during the grinding operation.

A further inconvenience in grinding operations involving diamond abrasive wheels arises from the fact that it is the common practice to provide a synthetic resin or metal base wheel for the diamond abrasive grinding section. The plastic or metal base wheel are attractive to wheel manufacturers in that they are convenient and economical to manufacture and are easily handled. However, the tenacity of these body materials and their continuous physical structure give rise to frequent interruptions in the grinding operation to cut back or "dress" these materials away from the diamond grinding surface in that they do not abrade as readily as the diamond abrasive area but rather flow and eventually impair the efficiency of the diamond abrasive section in that these materials will flow into the interstices between the abrasive particles.

In accordance with the present invention an abrasive wheel is provided that is self lubricating and that requires little or no supplementary dressing. The base wheel is provided of a granular abrasive material that is porous when formed. A suitable lubricant is disposed within the porous body or interstices between the individually bonded granules of abrasive material. The lubricant is of a character that is solid at ambient temperatures and that becomes viscous or fluid at working temperatures of the wheel so that it will, during the grinding operation, flow in a relatively thin viscous film over the grinding surfaces and thereby provide a non-occluding lubrication for the wheel and work piece. The abrasive body of the base wheel is of a material that will abrade or wear away quicker than the diamond grinding section of the wheel and thus the surfaces adjacent the working portion of the grinding wheel are always dressed to at least co-planar relation with the working portion of the abrasive wheel.

It is, therefore, a general object of the present invention to provide an improved self-lubricating self-dressing abrasive wheel.

A further object of the present invention resides in the provision of a diamond abrasive wheel that is self-lubricating.

Still another object of the present invention resides in the provision of an improved abrasive wheel having a diamond grinding surface wherein the body of the supporting wheel is of a granular abrasive material.

A further object of the present invention resides in the provision of an improved abrasive wheel having a diamond grinding surface and a base wheel of granular abrasive material wherein a lubricating wax is disposed in the interstices of the base wheel adjacent the diamond grinding surface.

Another object of the present invention resides in the provision of an improved abrasive wheel having a lubricating wax interposed in the interstices of the abrasive portion of the wheel which lubricating wax is solid at ambient temperatures and viscous at working temperatures.

A further object of the present invention resides in the provision of an improved abrasive wheel having a lubricating wax disposed in some of the interstices of the wheel body and a lubricating oil disposed in the remaining interstices of the wheel body.

Generally the abrasive wheel disclosed herein comprises a wheel having a layer of abrasive diamond particles bonded to a body section which is composed of a granular, porous abrasive material. The body section in one modification is provided with a plurality of circumferentially spaced openings about the outer periphery of the wheel adjacent the layer of diamond particles. A wax lubricant is placed in these openings. The wax is of the type that is solid at ambient temperatures and fluid or viscous at working temperatures. The heat generated by frictional resistance between the diamond particles and the piece upon which the work is being performed will serve to heat the wheel body and the wax lubricant. The lubricant will begin to flow at working temperatures forming a thin viscous film at the work interface to provide a lubricating layer of wax at the interface. The film of lubricant does not interfere with viewing of the piece and still provides for effective lubrication of the wheel and the piece upon which the work is being performed.

In another embodiment of the present invention, a wax lubricant is provided by impregnating a portion of the porous, granular body section of the base or body of the abrasive wheel. The high working temperatures cause the wax to flow and the centrifugal force acting upon the wax forces it out into the interface between the grinding

wheel and the work piece. A silicone oil lubricant may be disposed in the interstices not occupied by the wax which, for the most part, will be in the area of the wheel away from the grinding surface. The centrifugal action upon the oil will tend to force the wax completely out of the wheel body. When the wax is exhausted, the oil will be available as a lubricant body until the lubricating wax can be replenished.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, together with further objects and advantages thereof, will best be understood by reference to the following description taken in connection with the accompanying drawings in which:

FIGURE 1 is a top plan view of an abrasive wheel in accord with the teachings of the present invention;

FIGURE 2 is a cross-section view taken along lines 2—2 of FIGURE 1;

FIGURE 3 is a top plan view of a modification of the abrasive wheel manufactured in accord with the present invention;

FIGURE 4 is a side elevational view in cross-section taken along lines 4—4 of FIGURE 3 and illustrating the relation of the spaced openings about the circumference of the wheel to the diamond abrasive section of the abrasive wheel;

FIGURE 5 is an enlarged fragmentary view of the diamond layer and adjacent spaced opening for wax lubricant; and

FIGURE 6 is a fragmentary view of the abrasive wheel of the present invention in relation to the piece upon which work is being performed illustrating the flow of lubricant into the working interface.

Referring more particularly now to FIGURES 1 and 2 of the drawings, the abrasive wheel of the present invention is indicated generally at 10. The wheel 10 includes a disc-like base portion 12 and a radially extending outwardly flaring wall portion 14. The disc 12 forming the base of the wheel 10 has a centrally disposed opening 16 extending therethrough, said opening being adapted to receive the arbor (not shown) of the powered rotating means (not shown) for directing rotation of the wheel 10 during the grinding operation. The arbor and powered rotating means are well known to the art and form no part of the present invention.

The wall portion 14 defines an inner and an outer wall surface 18 and 20, respectively. The wall portion of the wheel shown for purposes of illustrating the invention tapers outwardly from the disc 12 to provide for a sharp outer edge and to allow carefully controlled grinding practices. A tubular shaped wall section rather than the frusto-conical section specifically illustrated would be equally well adapted to use of the invention disclosed herein.

The terminal portion of the outwardly flaring wall 14 defines a circumferential surface 22.

The outer wall surface 20 of the wall portion 14 includes a shallow recess 24 therein extending from the circumferential surface 22 of the wall portion for a short distance inwardly toward the disc 12 of the wheel 10. The base of the recess 24 is generally parallel with the outer wall 20 of the wall 14. The recess 24 extends circumferentially about the upper peripheral portion of the outer wall 20 of the wall 14.

A layer of diamond abrasive particles 26 is disposed within the recess 24 of the wall 14. The diamond particles 26 are bonded to each other and to the base and wall of the recess 24 to thereby define an integral unit therewith. The outer wall of the diamond particles 26 is substantially in co-planar relation with the wall surface 20 of the wall 14. The upper terminal 28 of the diamond layer 26 initially projects a slight distance beyond the circumferential surface 22 of the wheel 10. This provides for contact of only the diamond particle layer with the work piece in use and thereby prevents wear or abrasion by the base or support wheel adjacent the diamond abrasive layer. It should be observed that the diamond layer cannot extend too far above the surface 22 of the wheel since it is unsupported and if considerable grinding pressures will be developed in grinding the layer should not project beyond the surface 22 since the grinding pressures would tend to sever the layer.

A layer of lubricating wax 30 may be interposed in the interstices between the granular particles adjacent the diamond layer 26 of the wheel. The wax may be heated to fluid temperature and then forced into the interstices of the upper wall portion 14 adjacent said layer. The wax 30 will cool and harden to fill the interstitial voids. The wax preferably is disposed only in the portion adjacent the upper terminal of the wheel to a depth adjacent the lower point of the diamond layer as indicated by the dashed line 32 in FIGURE 2. Preferably a synthetic high melting point wax is disposed within the porous openings of the wheel 10. The characteristics of the wax should be such that it is solid at ambient temperatures and fluid at or about working temperatures. It should be noted that during the grinding operation with diamond wheels, as presently constructed, temperatures of approximately 500 degrees Fahrenheit will be realized at the working face and approximately 300 degrees in the adjacent wheel body. The thermal gradients are rather sharp in view of the fact that the plastic body materials normally used in the manufacture of diamond wheels are poor thermal conductors and also a certain amount of air cooling occurs due to the rapid rotation of the wheel. It has been found, during the grinding operation, that the temperatures just below the immediate surface of the abrasive wheel body of the present invention and adjacent the working interface are approximately 75 to 100 degrees F. less than the diamond grinding surface temperature. In view of this a synthetic wax such as a diotadecoyl di amino di phenyl methane may be used in the interstices of the abrasive wheel body. The above noted synthetic wax has a melting point slightly in excess of 300 degrees F. It can readily be seen that as the grinding surface approaches 400 degrees F. the lubricating wax will become viscous. The angular rotation of the wheel will develop a determinable centrifugal force tending to expel free particles from the surface of the wheel 10. The viscous wax 30 will be urged outwardly toward the surface 22 under the centrifugal action during rotation of the wheel 10 and will then be directed to the working interface between the layer of diamond particles and the work piece. The outwardly flaring wall 14 of the wheel of FIGURES 1 and 2 will tend to direct the viscous wax lubricant outwardly with respect to the central axis of the wheel 10. The still viscous wax will flow to the outer surface of the wheel 10 and thenc along the interface defined between the workface and the abrasive wheel to then flow over the diamond grinding layer to lubricate the same. Rotation of the wheel when working is not being accomplished will not effect discharge of the wax from the wheel body in that the temperature will not be high enough to precipitate sufficient viscosity of the wax to permit it to flow through the highly tortuous path defined around the granular particles of the wheel within which the wax is disposed.

A lubricating oil such as phenyl methyl siloxane may be disposed below the lubricating wax in the interstices of the body of the wheel 10 not occupied by the wax to provide an additional reservoir of lubricating means. The oil preferably is located below the wax in that the viscosity of the oil, especially at the elevated temperatures encountered in the grinding operation, will not be prohibitive so as to prevent the movement of the fluid along the tortuous path defined between the granular particles of which the body of the wheel is made. The entire outer surface of the wheel 10, except for the circumferential surface 22, may be coated with a suitable sealant, such as

lacquer or the like, to provide an impermeable coating and thereby prevent extrusion of the oil or wax from any surface other than the circumferential surface 22 of the wheel 10.

A modification of the above described construction is illustrated in conjunction with FIGURES 3 to 5 of the drawings, with the same numbers being used to identify similar portions of the wheel.

The abrasive wheel is indicated generally at 10. The wheel includes a disc-like base portion 12 and a radially extending outwardly flaring wall portion 14. The disc is provided with a central opening 16 to receive the arbor associated with the power means (not shown).

The wall portion 14 defines inner and outer surfaces 18 and 20, respectively. The terminal portion of the wall 14 defines a circumferential surface 22.

As in the form of FIGURE 1, the outer wall surface 20 of the wall 14 is provided with a shallow recess 24 therein extending from the circumferential surface 22 of the wall 14 for a short distance toward the disc 12. The radial base of the recess 24 is generally parallel with the outer wall portion 20 of the wall 14. The recess extends about the periphery of the wheel.

A layer of diamond abrasive particles 26 is disposed within the recess 24 of the wall 14. The diamond particles are bonded to each other and to the abrasive material of the base to define an integral portion of the wheel. The outer portions of the diamond abrasive layer are substantially in mating relating with the adjacent portions of the wheel 14 to provide a continuous wall conformation and circumferential surface conformation.

A plurality of circumferentially spaced openings 34 are provided about the circumferential surface 22 of the wall 14 said openings extending into the wall portion with the axes thereof in substantially parallel relation to the adjacent outer wall conformation 20 of the wheel 10. The openings extend into the body of the wall 14 to a distance slightly below the lowermost point of the layer of diamond particles. It should be observed, however, that the depth of the openings 34 is not critical in that it is necessary only to provide sufficient volume for insertion of an adequate amount of lubricant within the openings.

Lubricating wax 30 is inserted into each of the openings 34 within the wall 14 of the wheel 10. It should be observed that this form of construction possesses an advantage over the form of FIGURE 1 in that the wax may be inserted in pencil-like form into the openings 34 without first having to heat the wax to fluid temperature. Bars of the wax material 34 may be supplied for severance and insertion into the openings. The openings 34 are adjacent the rear face of the layer of diamond particles 26 of the wheel 10. Preferably a high melting point synthetic wax is disposed within the openings 34. The characteristics of the wax should be such that it will be solid at ambient temperatures and will become viscous or fluid at working temperatures of approximately 300° F. As noted hereinabove, at working temperatures realized during the grinding operation, the wax will become viscous and be able to flow. The wax, in the viscous form, will tend to flow out of the openings 34 under the urging of the centrifugal force acting upon the wax and will flow in a thin viscous layer over the diamond particle layer defining the grinding or working surface of the wheel.

As indicated in FIGURE 6, during rotation of the wheel with the work piece against the diamond abrasive layer of the wheel 10, the lubricating wax 30 will tend to be urged outwardly of the openings 34 in a thin viscous film as soon as the temperature of the area within which the wax is disposed reaches the level wherein the wax becomes viscous. As indicated hereinabove, with the wax noted, this temperature level is approximately 300° F. It should be observed that other lubricating materials may be employed that will have similar but specifically different thermal characteristics that may be employed with the concept disclosed herein without departing from the spirit and scope of the present invention. As the wax flows outwardly of the openings 34, under urging of the centrifugal force thereupon, it will tend to move over the outer periphery of the circumferential surface 22 of the wheel 10 due to the radially outwardly flaring construction of the preferred form of the wheel 10. If any wax should tend to fly-away from the wheel 10 due to the centrifugal force, it will strike the work piece 36 and be thrust into the interface between the work piece and the diamond grinding layer to serve as a lubricant therein. The wax in the viscous form however will tend to flow in a thin film over the diamond particle layer to lubricate the same while at the same time avoiding general obstruction of the view of the operation during grinding.

While I have shown and described a specific embodiment of the present invention it will, of course, be understood that other modifications and alternative constructions may be used without departing form the true spirit and scope of the invention. I therefore intend by the appended claims to cover all such modifications and alternative constructions as fall within their true spirit and scope.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A self lubricating, self dressing abrasive wheel comprising:

a porous cup shaped base wheel defining a disc portion and a wall portion integral with and extending outwardly from said disc portion, said wall portion having an outer radial surface and a circumferential surface, said circumferential surface being at the outer terminal of the wall portion, the base portion having a central opening extending therethrough, the outer radial surface having a recess therein extending along the outer surface about the entire periphery thereof from the circumferential surface a substantial distance inwardly toward the disc portion of the base wheel;

a diamond abrasive particle section disposed within the recess on the outer radial surface of the wall portion, said diamond particle section being bonded within the recess of said cup shaped base wheel;

a wax lubricant disposed in the openings of the porous wall portion of the base wheel in the area adjacent the circumferential surface and for a substantial distance inwardly thereof toward the disc portion of the base wheel, said wax lubricant having the characteristics of being solid at ambient temperatures and flowable at working temperatures and adapted at elevated working temperatures encountered during grinding to flow out over the diamond particle section under the influence of the centrifugal force encountered during rotation of the wheel to thereby lubricate the working surface of the particles;

an oil lubricant disposed in the interstices of the wall portion which are not occupied by said wax lubricant;

and a sealant applied to all the outer surfaces of the base wheel except the circumferential surface to define an outer envelope adapted to retain the wax and aid lubricant and to confine their expulsion from the wheel to the circumferential surface area.

2. A self lubricating, self dressing abrasive wheel comprising:

a porous cup shaped base wheel defining a disc portion and a wall portion integral with and extending outwardly from said disc portion, said wall portion having an outer radial surface and a circumferential surface, said circumferential surface being at the outer terminal of the wall portion, the base portion having a central opening extending therethrough, the outer radial surface having a recess therein extending along the outer surface about the entire periphery thereof from the circumferential surface a

substantial distance inwardly toward the disc portion of the base wheel;

a diamond abrasive material disposed within the recess on the outer radial surface of the wall portion, said diamond material being bonded to said cup shaped base wheel;

a dioctadecoyl di amino di phenyl methane wax lubricant disposed in the openings of the porous wall portion of the base wheel in the area adjacent the circumferential surface and for a substantial distance inwardly thereof toward the disc portion of the base wheel, said wax lubricant having the characteristics of being solid at ambient temperatures and flowable at working temperatures and adapted at elevated working temperatures encountered during grinding to flow out in a viscous film over the diamond particle section under the influence of the centrifugal force encountered during rotation of the wheel to thereby lubricate the working surface of the particles;

a phenyl methyl siloxane lubricant disposed in the interstices of the wall portion which are not occupied by said wax lubricant;

and a sodium salt of a silicone resin sealant applied to all of the outer surfaces of the base wheel except the circumferential surface to define an outer envelope adapted to retain the wax and phenyl methyl siloxane lubricant and to confine their expulsion from the wheel to the circumferential surface area.

3. In a rotatable self dressing diamond abrasive cup-shaped wheel adapted to carry and to dispense a thermally responsive lubricant:

a particle defined, porous, cup-shaped support member defining inter-particle openings and having a flaring wall terminating in a circumferential surface with a frusto-conical recess defined about the outer periphery of the wall and extending to said circumferential surface;

a diamond particle abrasive material mutually interbonded and bonded to the recess of said wall to define an integral continuous section with the support member and defining a work engaging face in juxtaposed relation to the circumferential surface;

and a thermally responsive lubricant disposed within the inter-particle openings defined in the support member, said thermally responsive lubricant having low flow characteristics at ambient temperatures thereby to remain substantially rigid with the support member in such conditions and adapted to flow relatively easy at high temperatures whereby when the abrasive wheel is in use and is heated due to frictional heat energy generated in abrasive use the thermally responsive lubricant mass will become increasingly more viscous in relation to its proximity to the work surface to flow out toward the circumferential surface of the support member under centrifugal action and over the diamond material, said particle defined support member adapted to be depleted at a significantly faster rate than the diamond abrasive whereby the circumferential surface of the support member always is coplanar with or lower than the work engaging face of the diamond abrasive material.

4. In a rotatable self-dressing diamond abrasive cup-shaped wheel adapted to carry and to dispense a thermally responsive lubricant:

a porous cup-shaped support member having a flaring wall terminating in a circumferential surface with a frusto-conical recess defined about the outer periphery of the wall and extending to said circumferential surface;

a diamond particle abrasive material mutually interbonded and bonded to the recess of said wall to define an integral continuous section with the support member and defining a work engaging face in juxtaposed relation to the circumferential surface;

and a thermally responsive lubricant disposed within the openings of said porous support member, said thermally responsive lubricant mass having low flow characteristics at ambient temperatures thereby to remain substantially rigid with the support member in such conditions and becoming fluid in the temperature range of 300° F. to 325° F. whereby when the abrasive wheel is in use and is heated due to frictional heat energy generated in abrasive use the thermally responsive lubricant mass will become increasingly more viscous in relation to its proximity to the work surface defining a flowable mass when elevated to a temperature in the range of 300° F. to 325° C. to flow out toward the circumferential surface of the support member and over the diamond particle abrasive material, said support member adapted to be depleted at a significantly faster rate than the diamond abrasive in manner not to inhibit subsequent dispensing of lubricant whereby the circumferential surface of the support member always is coplanar with or lower than the work engaging face of the diamond abrasive material.

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