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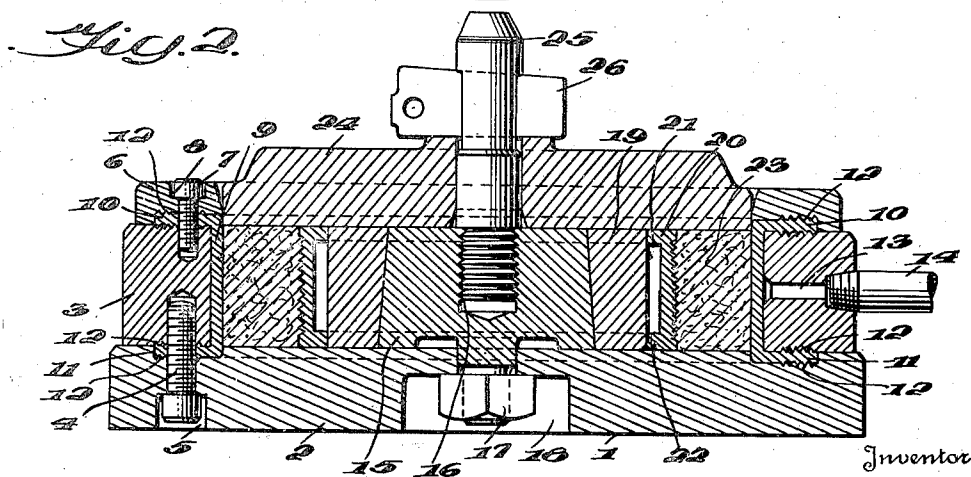
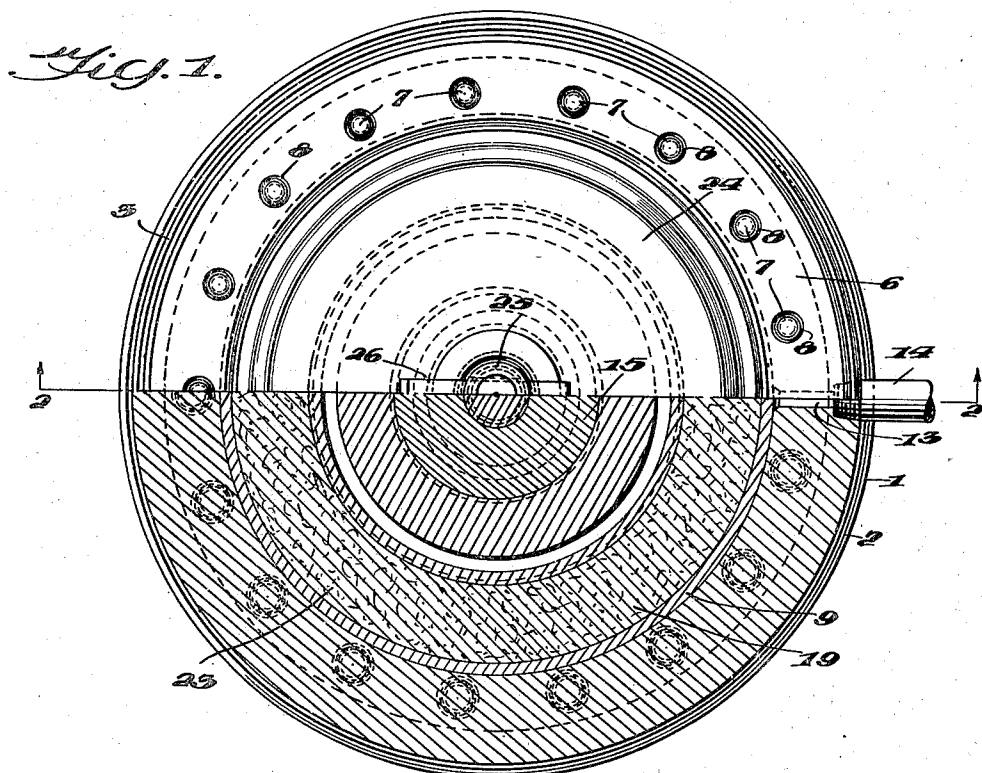
D. E. MULHOLLAND

2,449,407

APPARATUS FOR FORMING GRINDING WHEELS

Filed May 24, 1943

3 Sheets-Sheet 1



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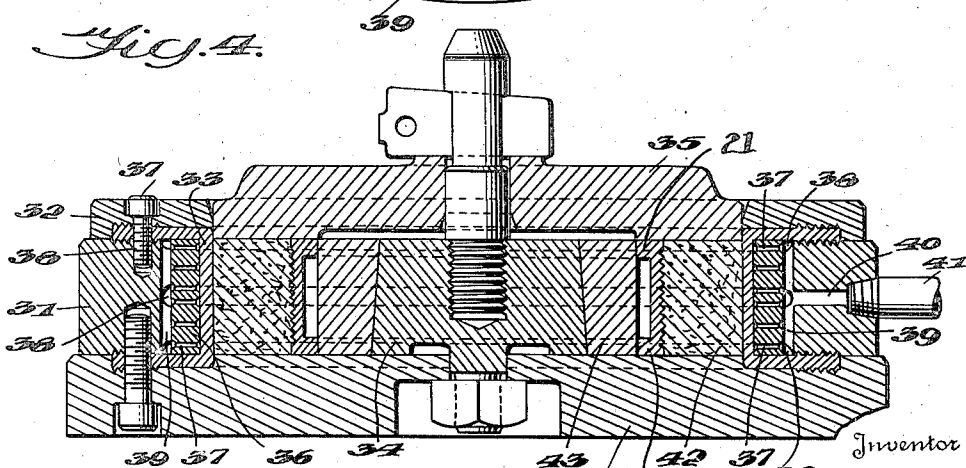
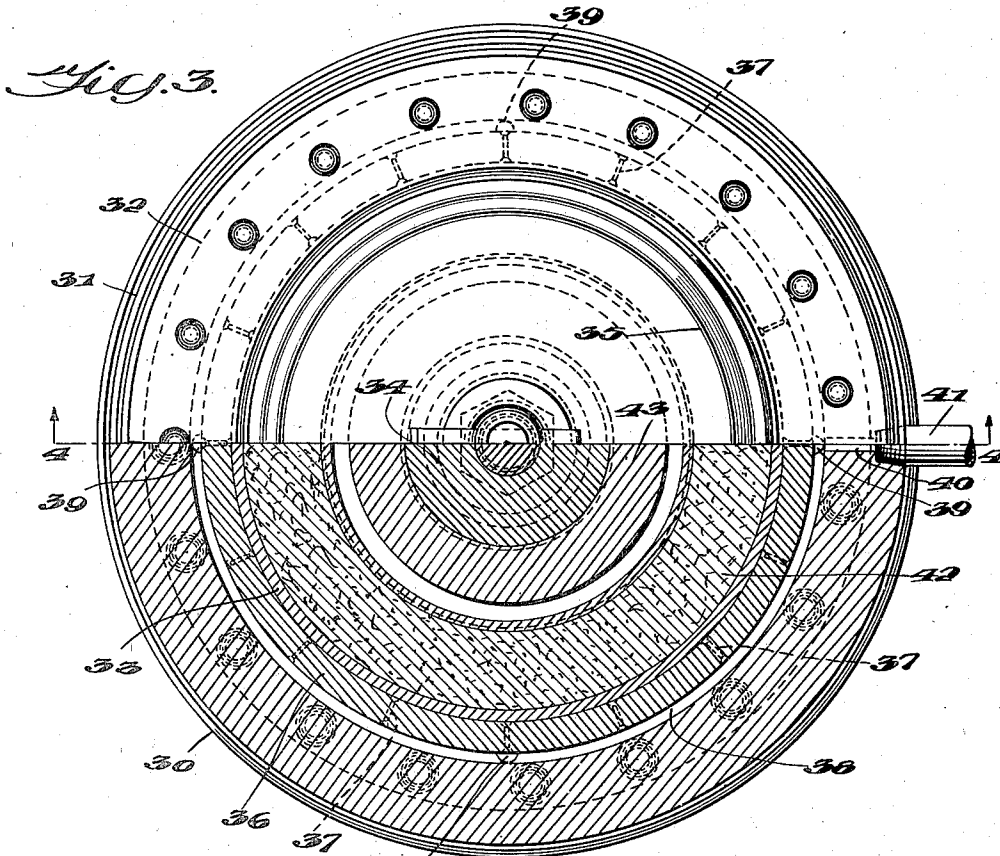
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APPARATUS FOR FORMING GRINDING WHEELS

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3 Sheets-Sheet 2



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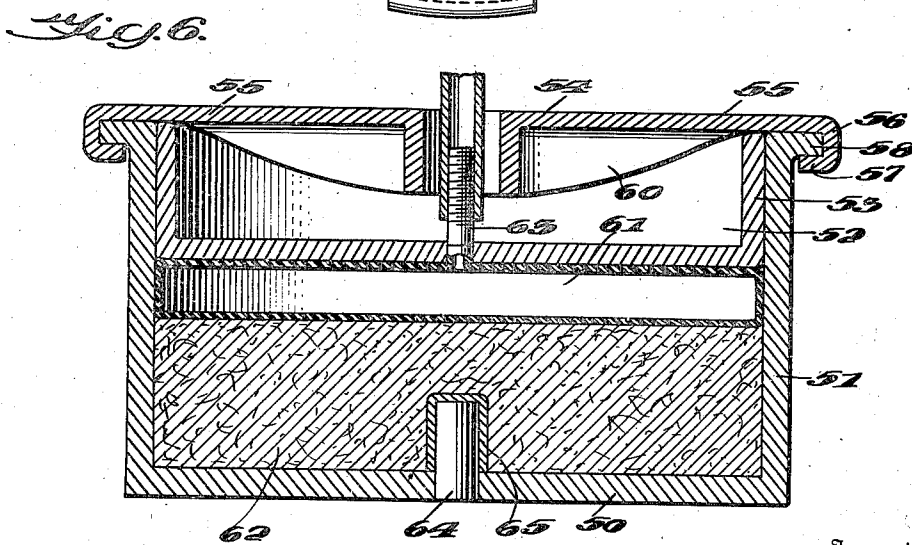
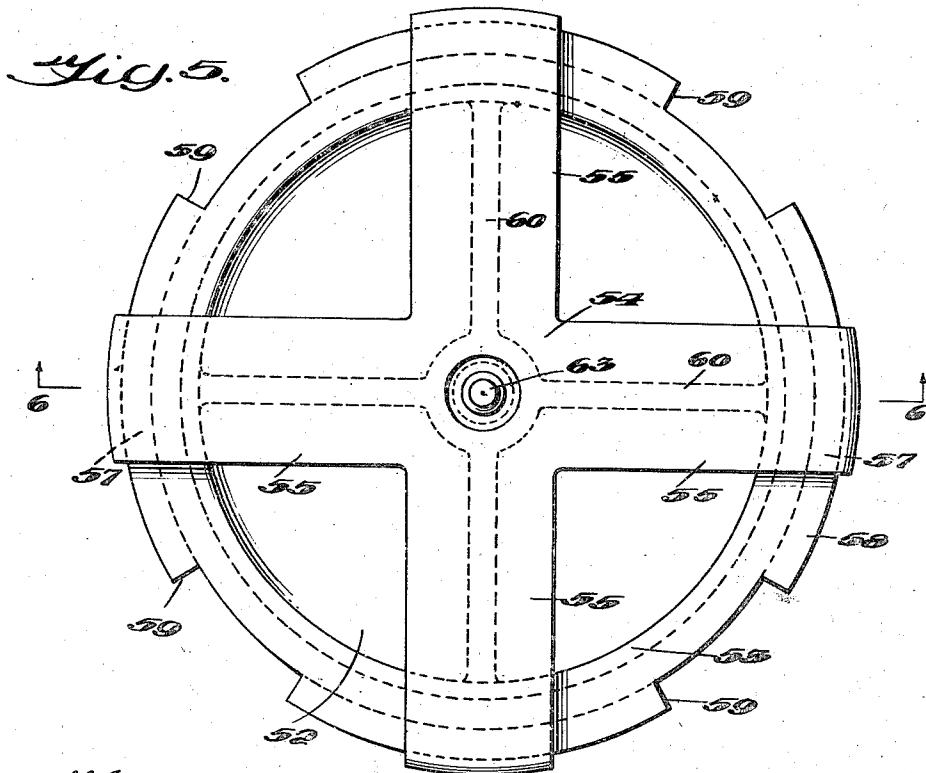
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APPARATUS FOR FORMING GRINDING WHEELS

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3 Sheets-Sheet 3



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APPARATUS FOR FORMING GRINDING
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5 Claims. (Cl. 18—5)

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My invention relates to an apparatus for forming wheels for grinding or polishing lenses, quartz, prisms and other articles made of glass, metal or the like.

The principal object of the invention is to provide a grinding or polishing wheel with a portion containing abrasive or polishing material which is of substantially uniform density, the voids being substantially uniformly distributed throughout the mass so that all portions of the grinding or polishing area thereof will wear at the same rate.

A primary feature of the invention consists in placing an uncompacted mixture of abrasive grains or polishing material and a bonding medium into a mold, applying fluid pressure to the mixture and subsequently applying heat to the mold while the pressure is maintained to either chemically change the bond or to solidify the same.

Another feature of the invention consists in providing a mold for receiving the mixture containing abrasive or polishing material, the mold having a substantially cylindrical side wall and a removable top wall and a fluid pressure actuated deformable means within the mold for cooperating with the mixture placed therein whereby the latter is subjected to uniform fluid pressure for compressing it to substantially uniform density.

A further feature of the invention consists in providing the mold for receiving a mixture containing abrasive or polishing material with resilient and flexible means subject to fluid pressure adapted to encircle the mixture within the mold, said means being adapted to transmit pressure radially to the mixture for compressing it to substantially uniform density.

A still further feature of the invention consists in providing a mold having a base and a cylindrical side wall and in having a wheel hub disposed within the mold which defines with the side wall thereof an annular space for receiving a mixture of abrasive or polishing material, fluid pressure operated means being provided for compressing the mixture in the mold to substantially uniform density.

Other and more specific features of the invention, residing in advantageous forms, combinations and relations of parts, will hereinafter appear and be pointed out in the claims.

In the drawings,

Figure 1 is a view partially in plan and partially in section of one embodiment of the apparatus used in constructing the abrasive or polishing wheel.

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Figure 2 is a sectional view taken on line 2—2 of Figure 1.

Figure 3 is a view similar to Figure 1 illustrating a modified form of the invention.

Figure 4 is a sectional view taken on line 4—4 of Figure 3.

Figure 5 is a plan view of still another modified form of the invention.

Figure 6 is a sectional view taken on line 6—6 of Figure 5.

Referring more particularly to the drawings, and especially to the form of the invention shown in Figures 1 and 2 thereof, 1 indicates the mold or die having a base 2 and a cylindrical side wall 3 which is preferably formed as a separate ring-shaped member and is removably secured to the base by a plurality of bolts 4 whose heads are countersunk in recesses 5 in the under side of the base 2.

The side wall 3 is advantageously provided with an upper removable ring section or member 6 and these two parts are rigidly secured together by a plurality of bolts 7 whose heads may be conveniently countersunk in recesses 8 in the upper surface of the ring 6.

Overlapping the inner face of the cylindrical side wall 3 is a flexible and resilient diaphragm 9 which is made of any suitable material which will readily yield in response to fluid pressure.

This ring-shaped diaphragm has outwardly extending portions 10 and 11 respectively adjacent its upper and lower edges. The upper portion or flange 10 of the diaphragm is firmly clamped between ring 6 and the side wall 3 of the mold while the bottom portion or flange 11 is firmly clamped between the side wall and the base of the mold. The diaphragm and its flanges are, of course, continuous and the faces of the base 2, side wall 3 and ring 6 which coact to clamp the diaphragm are suitably roughened or serrated, as indicated at 12, so that, when the bolts 4 and 7 are tightened, the diaphragm is sealed with respect to the side wall 3.

Extending completely through the side wall 3 from the outer side thereof to the inner face of the diaphragm is a passageway 13 which is adapted to have communication with a pipe 14 leading to a source of fluid pressure (not shown).

Centrally disposed within the mold is a centering member 15 which is preferably provided with a stud 16 which extends downwardly through an opening in the base 2 and is screw threaded to receive a nut 17 disposed within a recess 18 on the under side of the base for rigidly securing the centering member in place.

Member 15 serves to center within the mold a

hub 19 to which is adapted to be applied a mixture of abrasive grains or polishing material and a bonding medium. The opening within the hub into which the centering member extends is preferably tapered so that the completed wheel may be easily mounted on a mandrel or shaft having a corresponding taper without danger of the wheel slipping with respect to the shaft and with an entire absence of lateral play in the wheel so long as the coating inclined surfaces of the sub and shaft are maintained in engagement. The outer surface of the centering member 15 is conically tapered to exactly the same degree as the inner surface of the hub so that the hub will always be accurately centered within the mold.

The hub employed preferably has swedged on its outer surface a band or ring 20 whose inner surface is conveniently formed with marginal flanges 21 and 22, the inner surfaces of which engage the outer face of the hub 19. This band 20 permits the grinding or polishing portion of the wheel to be readily replaced after the same has worn to its permissive limit. The hub member and the side wall of the mold on which the diaphragm 9 is mounted define an annular space for receiving a mixture, designated 23, of an abrasive or polishing material and a suitable bonding medium such as shellac, crude rubber or synthetic resin. While the mixture may be of any desired consistency when introduced in the mold, I have found that with either shellac or a resin bond the best results are obtained when it is in a granular state. In the initial forming of a rubber bonded abrasive or polishing material the crude rubber or latex is intimately mixed with the abrasive grains or the polishing powder and with the vulcanizing material by rubber mills or the like and the resultant product stripped from these rolls may be used if desired to fill the space 23 of the mold.

When the space between the hub and the side wall of the mold has been filled with the mixture of abrasive or polishing material and bonding medium to approximately the top of the hub, the mold is closed by a top wall or cover 24, which is adapted to seat on top of the centering member 15 and the hub and also to neatly fit within the inner face of the upper portion of the diaphragm 9. The top wall may be conveniently secured in place by means of a stud 25 which extends through an opening in the center thereof and is screw threaded with the centering member 15. The upper end of the stud 25 is provided with a transverse slot for receiving a wedge-shaped key 26 which is adapted to engage the outer face of the top wall 24 and thereby easily and effectively secure it in place.

With the top wall 24 thus secured in place, fluid under predetermined pressure is admitted to the passageway 13 and is thus applied to the inner face of the diaphragm, not only at the point adjacent the inner end of the passageway but to the entire inner face of the diaphragm because the latter flexes easily and permits the fluid under pressure to readily pass between the contiguous faces of the diaphragm and side wall 3 of the mold. Due to the flexibility and resiliency of the diaphragm, the mixture of abrasive or polishing material and bonding medium within the mold will be compressed to substantially uniform density. The pressure on the mixture being radially inward and being uniform throughout the entire diaphragm since the fluid is static or substantially so at the time the optimum pressure is maintained, hence any large voids if present in the

mass will be greatly reduced in area and the density of the mass will be substantially uniform over its entire cross sectional area.

While still under pressure, the mixture is heated to a temperature sufficient to cure the bonding medium of the mixture. The heating may be conveniently accomplished by placing the entire mold in a suitable heating chamber. The pressure on the abrasive mixture should be maintained substantially constant and suitable means (not shown) is provided to compensate for the expansion and contraction of the mass during the heating and cooling cycles to which the mass is subjected as will be later pointed out. After the bonding medium has hardened, set or cured, the heating chamber is opened and after the mold has cooled the pressure is released, the mold withdrawn from the chamber and the cover 24 is then removed and the grinding or polishing wheel taken from the mold. It will, of course, be appreciated that the outer surface of the abrasive portion of the wheel will not be entirely smooth or it might not even be concentric with the axis of the wheel. Consequently it may be necessary to mill or grind the outer surface of the wheel until it is concentric with its axis and to the desired degree of smoothness.

A grinding or polishing wheel when formed by use of the apparatus or by the method outlined has been found to have a substantially uniform density throughout its entire cross sectional area. Not only are the voids of small size but they seem to be uniformly distributed throughout the mass. Since the entire operation is performed with both the mold and the grinding or polishing material in a static condition the uniform distribution of the abrasive grain or the polishing material which was obtained prior to the entry of the mass within the mold is not disturbed and the abrasive grains or polishing material will therefore also be found to be uniformly distributed throughout the entire mass of the grinding or polishing portion of the wheel. The uniform density of the abrasive or polishing portion of the wheel gives a wheel of the desired character which after being trued will be found to be substantially in balance not only initially but throughout the life of the grinding or polishing portion thereof.

In the form of the invention illustrated in Figures 3 and 4, the mold is provided with the same principal parts as the one shown in Figures 1 and 2; namely, a base 30, cylindrical side wall 31, top ring 32, flexible diaphragm 33, a centering member 34 and cover 35. The only change in the embodiment of the invention shown in Figures 3 and 4 is that a ring 36 is loosely mounted between the cylindrical side wall 31 of the mold and the flexible diaphragm 33. The ring 36 is provided with a plurality of radial openings 37 which communicate with circumferential grooves 38 formed in the inner surface of the side wall 31 of the mold. One of these circumferential grooves may be located substantially midway between the ends of the side wall and may be semi-cylindrical in shape, while others of the grooves may be located adjacent the ends of the side wall. Connecting the circumferential grooves at a plurality of points at approximately 90° intervals, for example, are a plurality of axially extending semi-circular grooves 39, one of which communicates with a radial passageway 40 extending through the side wall 31 and communicating with a pipe 41 leading to the source of fluid pressure. It will, of course, be appreciated that, when fluid under pressure is admitted into passageway 40, it rapid-

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ly flows through the circumferential and axial grooves 38 and 39 respectively and thence into the radial openings 37 in the ring 36 where it co-acts with the flexible diaphragm 33 to radially compress the mixture 42 of abrasive material and bonding medium on the hub 43. The method to be followed in forming the abrasive or polishing wheel in the apparatus shown in Figures 3 and 4 is the same as with the apparatus illustrated in Figures 1 and 2.

In Figures 5 and 6 an embodiment of the invention is illustrated for forming an abrasive disk or polishing wheel which is adapted to be used either for rough edge grinding or for lap grinding; that is to say, the wheel may be mounted so that its outer curved face or periphery constitutes the working surface or so that one of its opposed flat faces constitutes the working surface.

The mold or die illustrated in Figures 3 and 6 is of substantially cylindrical shape having a base 50 and a side wall 51. The mold is closed by a cup-shaped follower or cover 52 having an up-turned peripheral flange 53 contiguous with the side wall of the mold. The follower may be advantageously held in place by a keeper member 54 which may be of substantially cruciform shape to provide a plurality of arms 55. Each of these arms has a downwardly extending portion 56 which terminates in an inturned flange 57 for projecting beneath the outwardly projecting annular flange 58 formed at the top of the side wall of the mold. Flange 58 has a plurality of cut-out portions 59 of slightly greater width than the arms 56 so that, by initially positioning the keeper 54 with the arms 55 adjacent the cut-out portions 59, the keeper may be rotated one way or the other to bring the inturned flanges 57 of the arms into cooperative engagement with the under side of the outturned flange 58 of the mold. The keeper may be advantageously reinforced by flanges 60 extending longitudinally of the arms 55.

A flexible and deformable diaphragm member 61 is adapted to fit within the mold between the follower 52 and the mixture 62 of abrasive or polishing material and bonding medium which is placed within the mold. Connected with the diaphragm and extending upwardly therefrom through central openings in the follower 52 and in the keeper 54 is a pipe or stem 63 communicating with the interior of the diaphragm through which fluid under pressure may be admitted thereto. As in the previously described modifications suitable means (not shown) is connected to the pipe 63 so as to maintain the fluid under substantially uniform pressure within the flexible diaphragm during the curing and subsequent cooling of the abrasive or polishing wheel.

Fitting within a centrally located aperture in the base 50 of the mold is a cylindrical plug 64 which projects inwardly into the mold and is adapted to receive a cylindrical cup-shaped sleeve 65. This plug and sleeve is positioned within the mold before the mixture of abrasive or polishing material and bonding medium is introduced therein so that the disk will be formed with the cylindrical plug 64 molded therein. The method of forming the wheel is substantially the same as that followed with the molds illustrated in the other figures of the drawings; that is to say, the desired quantity of the mixture of abrasive or polishing material and bonding medium is placed within the mold after the sleeve 65 has been mounted therein on the plug 64. Thereafter the flexible diaphragm which may conveniently be in the form of a rubber bag is placed on top of the

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mixture and the follower 52 secured in place on top of the bag by the keeper 54. Fluid under pressure is then admitted to the bag so as to compress the mixture to substantially uniform density. While the pressure is maintained within the bag, the mold is subjected to heat to set and harden the bonding medium, after which the mold is allowed to cool and the pressure is released from the diaphragm. The mold is then opened and the wheel removed.

If the wheel is to be used for lap grinding, the sleeve 65 may be interiorly threaded so that the wheel may be removably attached to a rotatable spindle and a hole may be drilled through the center of the wheel to permit a suitable coolant to be projected through the wheel on to the work. If the wheel is to be used for edge grinding, a large opening may be bored through the center so that it may be easily clamped on to the end of a rotating spindle or a hub such as shown in Figures 1 to 4 may be substituted for the sleeve 64. The opening for the stud 16 as shown in Figures 2 and 4 being either filled or omitted entirely.

Since the method of making and the form of the wheel is identical whether polishing material, such as rouge or oxides of lead or tin, are mixed with a bonding medium to form a polishing wheel, or whether abrasive material, such as aluminum oxides, silica oxides or silica carbide, are mixed with the bond, to form an abrasive wheel, the terms "abrasive material" and "polishing material," and "grinding wheel," and "polishing wheel" are to be considered as synonymous in the specification and appended claims.

For a number of years, there has been a controversy in the glass grinding and polishing art as to whether the polishing step is, in fact, an abrasive action or the result of a quasi-chemical reaction between the polishing medium, the coolant and the body to be polished. This controversy has not yet been definitely settled and, for this reason, if for no other, the terms "abrasive" and "polishing" used in the specification and claims should be considered as synonymous.

What I claim is:

1. An apparatus for forming a grinding wheel involving a mold having a disc-like cavity for receiving a mixture containing abrasive material; said mold comprising a base having an up-standing frusto-conical member rigid therewith and adapted to center a hub of said wheel within said cavity, a circular side wall of uniform diameter coaxial with and spaced from said frusto-conical member, means firmly securing said side wall to said base, a ring firmly secured to said side wall, an elastic lining embracing the inner area of said side wall and being clamped between said base, and ring at opposite ends of said wall, and a cover bearing upon and being removably secured to said frusto-conical member; said cover fitting neatly within said ring.

2. An apparatus for forming a grinding wheel involving a mold having a disc-like cavity for receiving a mixture containing abrasive material; said mold comprising a base having an up-standing frusto-conical member rigid therewith and adapted to center the hub of said wheel within said cavity, a circular shallow side wall of uniform diameter coaxial with and spaced from said frusto-conical member, means firmly securing said side wall to said base, a ring mounted upon and firmly secured to said side wall, said ring being coaxial with said frusto-conical member, an elastic lining embracing the inner area,

of said side wall and being clamped between adjacent portions of said side wall, said base and ring, said elastic lining being selectively subjected to fluid pressure and adapted to transmit said pressure to said abrasive material for compressing the latter against said hub to substantially uniform density, and a cover co-axial with said ring and adapted to fit within the same one face of said cover bearing upon and being removably secured to said frusto-conical member.

3. In an apparatus for forming a grinding wheel involving a mold having a disc-like cavity for receiving a mixture containing abrasive material, said mold comprising a base having a centering member rigid therewith and adapted to center the hub of said wheel within said cavity, said base defining one side of said cavity, a circular side wall coaxial with and spaced from said centering member, means firmly securing said side wall to said base, a ring firmly secured to said side wall and being concentric with said centering member, an elastic liner embracing the inner area of said side wall and being clamped by said base, side wall and ring, said elastic liner defining the periphery of said cavity, and a cover bearing upon and being removably secured to said centering member within said ring; said cover defining another side of said cavity.

4. An apparatus for forming a grinding wheel involving a mold having a disc-like cavity for receiving a mixture containing abrasive material; said mold comprising a base having an upstanding frusto-conical member rigid therewith and adapted to center a hub of said wheel within said cavity, a circular side wall coaxial with and spaced from said frusto-conical member, means firmly securing said side wall to said base, a ring mounted upon and firmly secured to said side wall, an elastic liner embracing the inner area of said side wall and having one edge clamped between said ring and side wall and another edge clamped between said base and side wall, means upstanding from said frusto-conical member, a

cover bearing upon said frusto-conical member within said ring, and means removably securing said cover to said upstanding means.

5. An apparatus for forming a grinding wheel involving a mold having a disc-like cavity for receiving a mixture containing abrasive material; said mold comprising a base having an upstanding frusto-conical member rigid therewith and adapted to center the hub of said wheel within said cavity, a circular side wall coaxial with and spaced from said frusto-conical member, means firmly securing said side wall to said base, a ring mounted upon and firmly secured to said side wall, an elastic liner embracing an inner area of said side wall and having one edge clamped between said ring and side wall and another edge clamped between said base and side wall, means upstanding from said frusto-conical member, a cover bearing upon said frusto-conical member within said ring, means removably securing said cover to said upstanding means, and means in said side wall for transmitting fluid pressure to said elastic liner whereby the latter is caused to transmit pressure to said mixture to compress the same.

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